



# SAFEX NEWSLETTER

## No. 48, 1st Qtr. 2014



### CONTENTS

<b>Your Captain Speaking</b>	<b>1</b>
- Ulf Sjöblom (Forcit)	
<b>Incident Reporting</b>	<b>3</b>
- Monitoring our performance	
<b>Know the Expert Panel</b>	<b>4</b>
- David Vlncé	
<b>QRA Corner</b>	<b>5</b>
- Is distance all I need?	
<b>Science at Work</b>	<b>7</b>
- No contribution	
<b>Our Regulatory World</b>	<b>8</b>
- The Safety Triangle	
<b>Explosives Competence</b>	<b>11</b>
- ESA role profiles	
<b>Pondering the Profession</b>	<b>14</b>
- Occupational Hygiene	
- Dynamite Factory at Ardeer	
<b>Congress Chat</b>	<b>19</b>
- Workgroup Sessions	
<b>Explosives Eco-talk</b>	<b>20</b>
- Remediation of LS magazine	
<b>NEW Under Lock &amp; Key</b>	<b>25</b>
- Is industry the missing link?	
<b>Safety Snippets</b>	<b>27</b>
- Flatulent cows	
<b>Inbox</b>	<b>28</b>
<b>Tony's Tale-piece</b>	<b>30</b>
- Basis of Safety Part2	

### *This is your Captain Speaking*

#### **Ulf Sjöblom (Forcit)**



With a Master of Business Administration degree, Ulf Sjöblom has 30 years experience in the process industry mostly in executive positions with companies such as AGA, Wärtsilä, Visko and Forcit

He joined Forcit as a Member of the Board in 1999 and was given executive responsibilities in 2002 as Director of Business Development. In 2006 he was appointed CEO of the Forcit Group. He is also a Board Member of the Chemical Industry Federation of Finland and member of the Executive Committee of FEEM.

Ulf Sjöblom is 55, married and the proud father of 4 children. In his spare time he enjoys hunting, fishing, boating and outdoor life in general.

Forcit was founded 1893 in Hanko, Finland. The company employs 270 people in Finland, Sweden and Norway with the following business units:

- Forcit Explosives specialising in civil explosives such as bulk emulsion explosives, cartridged emulsion and NG explosives, NG pipe charges, ANFO and detonating cord. The products and services are supplied to the mining industry, quarries and the construction industry.
- Forcit Defence is in the military explosives and systems sector producing plastic bonded explosives and insensitive munition and systems. The products are supplied to defence forces mainly within EU/NATO.
- Finnrock which is a consulting services company.

Safety is a subject about which people have written books. May I be permitted to try and express our thoughts about the way we approach safety within the Forcit Group as briefly as possible. At the same time, I'll state some general questions that are bothering me.

One of the challenges within our industry is the vast number of rules and regulations, documentation, policies and written working principles. It is a challenge to get everybody in the organization to grasp the core content of all the material which is produced to guide our industry towards a safe operation. To enable everybody in the organization to remember our main thoughts regarding safety, we have narrowed down our messages into a few key words that are easy to remember in all situations and thereby enable us to further develop our safety culture within the company.

**Safe, reliable, competitive** are the key words we use when we approach strategic issues. Each strategic decision should make our operations safer, make us more reliable as a business partner and increase our competitiveness in the market place. We have also made a strategic decision to broaden our safety

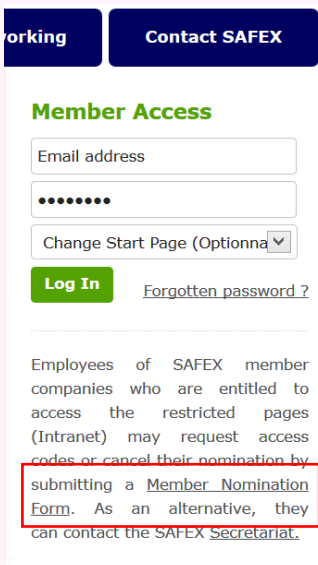
## First Congress deadline is upon us!

If you want to be assured of the special rate SAFEX was able to negotiate with the Warsaw Marriott, you must make your Hotel Reservation through SAFEX before 30 March, which is only in a couple of days' time. You can do so by either:

- e-mailing your completed Hotel Reservation Form to the Secretariat in MS Word format; or
- making your hotel reservation online at the SAFEX Home Page provided you have your own individual access codes to the SAFEX Intranet

If you require a Hotel Reservation Form, please contact the Secretariat ([secretariat@safex-international.org](mailto:secretariat@safex-international.org)) right away. If your company is a member of SAFEX, you can ask for individual access codes by:

- Going to the SAFEX Home Page <https://www.safex-international.org/>
- Clicking on the **Member Nomination Form** link in the *Member Access* section at the top of the right hand column (see figure below)
- Completing the Form and submitting it



orking      Contact SAFEX

### Member Access

Email address

.....

Change Start Page (Optional) ▾

**Log In**      [Forgotten password ?](#)

Employees of SAFEX member companies who are entitled to access the restricted pages (Intranet) may request access codes or cancel their nomination by submitting a **Member Nomination Form**. As an alternative, they can contact the SAFEX Secretariat.

knowledge by actively taking part in the international safety work, through SAFEX, FEEM, KCEM (Competence Centre for Energetic Materials) and Nordiska Säkerhets Möte (Nordic Safety Meeting). This is very demanding for a small organization like ours, but very rewarding thanks to the knowledge shared by knowledgeable colleagues throughout the industry.

The words **safety, quality, productivity** sit comfortably alongside our strategic key words and guide us in our day to day operations. They also dominate when we make investment decisions. It is important to remember that these key words do not contradict each other. On the contrary they most often support each other.

Our human resource activities are guided by the words **competence, awareness, trust**. In the Nordics there is no formal education directly applicable to the explosives industry. Formal knowledge is therefore complemented with working experience and in-house education throughout a person's working career. We also have the ambition to give time for transfer of knowledge from a former employee to an incoming employee. Due to a low personnel turnover, this has been possible most of the time.

The awareness that our safety work is never finished is extremely important. We should always be aware, that there are risks involved in our business and there is, therefore, always room for ongoing improvement. Continuous monitoring of the operations by everybody in the company is an important means of improving the safety. All potentially dangerous situations, near-events and accidents are reported, analysed, corrected and communicated. Every person who reports a potential hazard or near-event is given a small reward. Every small potential risk that is eliminated, eliminates a potential serious accident.

In our internal inspections we approach safety issues from five different perspectives: safety, processes, environment, chemicals and security. It means a lot of work and written documents. But all the written instructions in the world will not ensure you run the business safely. In order to operate an explosives business safely you need to be able to trust all the members of the organization. Having people with the right competence and the right awareness, combined with the right attitude will give you the best opportunities of operating safely. I have often asked myself the question: "Is the extensive written safety material that is produced designed to limit liabilities in case of an accident instead of aiming to increase the safety of our business?"

To guide our safety efforts we use targets, follow up and feedback. Targets for improved safety are set and continuously followed up by a cross-organizational group focusing on safety and environmental issues. The group also follows up the corrective actions from the reports of potential hazards, near-events and accidents. The safety targets are tied to a bonus scheme for every white collar company member and will also be implemented into the salary system of every blue collar employee.

Our target is simply to be a leader in the field of safety

May I conclude by leaving you with the question that bothers me: "Will the fierce competition in most of the European markets affect the financial position of some explosives companies to the extent that the safety culture of parts of the European explosives business degenerates?" I sincerely hope not.

May I wish all your readers' success in their businesses and safe operation in the coming years.

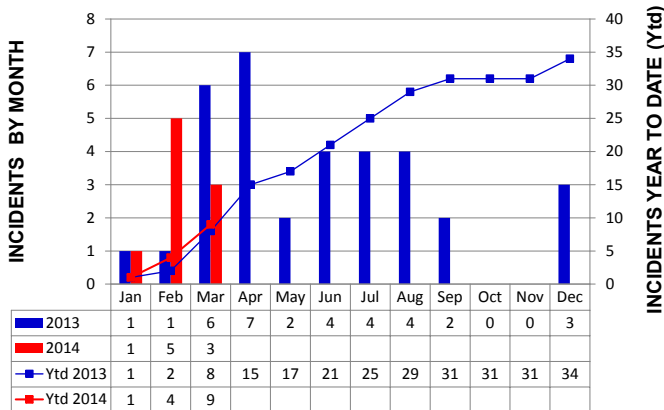
## Incident Reporting

### 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 learns from its members’ experiences through the incident reports we receive. By applying these lessons we can prevent similar incidents recurring. That is why we track our incident reporting performance as follows:

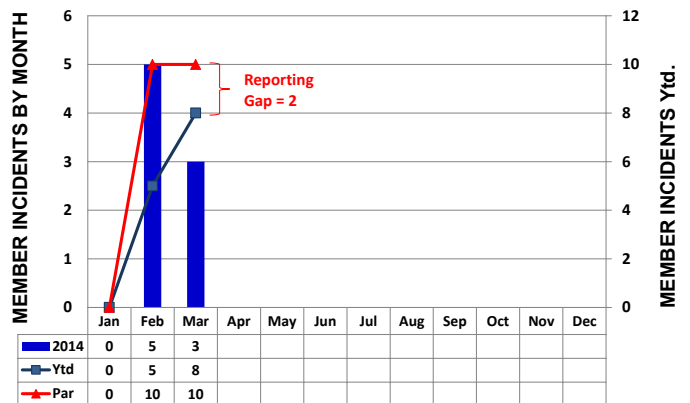
ALL INCIDENTS REPORTED: Ytd 2014 vs 2013



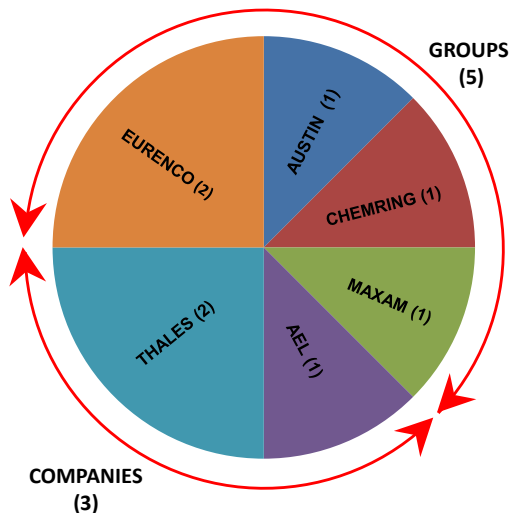
**All the incidents reported.** This chart compares the sum of non-member and member incidents reported to SAFEX every month this year to the previous year. We have reported about the same number of incidents this year as in the same period last year. Last year’s performance was low compared to previous years. We are therefore still concerned whether the incidents we have are being reported. 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 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 that have been reported this year. The gap between the number of MI’s reported and PAR is our Reporting Gap. The Reporting Gap is much smaller than it has been in previous reports. It will be great if we can maintain that position by avoiding incidents with serious consequences.

MEMBER INCIDENTS REPORTED Ytd. 2014



MEMBERS INCIDENT CONTRIBUTORS: 2014 Ytd.



**Contributors of member incidents.** This chart identifies those members who reported incidents. It shows the number of incidents each of these members reported relative to the total number of MI’s received. The chart distinguishes between Groups and Companies merely to indicate the performance of the two membership categories. There are about twice as many operating units in the Groups than single Companies. As expected the Groups have reported about twice as many incidents as the Companies so far this year which is a welcome reversal of previous trends. .

## 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 possess expertise in specific fields. He must also be willing to make his expertise available to SAFEX members on a commercial basis which is agreed between the expert and the member. SAFEX does not get involved in the detailed arrangements but merely “connects” the Expert and the Member with the need.

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 specialize in the fields of expertise designated by the client Member. It is then up to the Member to select an Expert and enter into an agreement directly with him.

### David G Vince

#### PERSONAL

**Position:** Retired  
**Company:** Independent Consultant  
**Location:** Melbourne, Australia  
**Education:** 1968—BSc (Hons)  
 1973—PhD (Chemistry)  
**Language:** English



#### CAREER OUTLINE

##### ICI Explosives, Australia

**1975:** Explosives Research Chemist, Ascot Vale  
**1978:** Development Officer, Deer Park  
**1985:** Technical Superintendent, Deer Park

##### IES Limited, Australia

**1993:** Technical Manager, Deer Park

##### Orica Australia

**1997:** Various Technical Management roles

##### Independent Consultant

**2011- current**

#### EXPERTISE

- **Product and process technology** for the manufacture of lead styphnate; dextrinated lead azide; PETN; boosters; detonating cord; electric detonators; non-electric detonators (pyrotechnic delay)
- **Operational support** including technical management of IE plants (above categories); hazard and risk identification and management; bases of safety; incident investigations; and training

#### TYPICAL ASSIGNMENTS

**1975-1977:** Investigated synthetic thickeners for water-gel explosives

**1978-1984:** Developed a commercial range of packaged water-gel explosives, including permitteds and high strength TNT-energised watergels, and specified corresponding manufacturing processes. ANFO-type explosives projects such as low cost fuels, stability in hot-ground sulphide ore bodies.

**1985-1996:** Technical support for the design and commissioning of the first Australian non-electric loading line. Developed boosters sensitive to initiation by low-energy detonating cord. Specified and installed a static-electric control system for detonator manufacturing. Contributed to drafting a formalised BOS system for manufacture of initiating explosives (IE).

**1997-2006:** IE technologist for the design and commissioning of an Orica JV explosives factory in Weihai, China. Installed dextrinated lead azide manufacturing facility at an external Chinese explosives factory. Presented the safety case for first road transport of commercial lead azide in China. Plc controlled plant for remote manufacturing of dextrinated lead azide at the Orica Weihai factory.

**2007-2010:** Provided general IE technical support for the Australia/Asia region. Member of the Orica initiating systems Expert Panel.

**2007-Now:** Technical consultant for Hunan-Orica-Nanling Civil Explosives Co Ltd with key responsibilities for lead azide plant, cap loading and treatment of site-wide process effluent.

## QRA Corner

Welcome to another instalment of the SAFEX Newsletter series called the QRA Corner. Each column will examine a particular aspect of state-of-the-art applications, large-scale testing, and algorithms associated with Quantitative Risk Analysis (QRA) models. Your authors will rotate between Lon Santis who runs his own consulting business, Explosives Risk Managers LLC; John Tatom, Manager, Explosives Safety Group at APT Research, Inc; and Mike Swisdak, creator of the US Department of Defense' ESKIMORE large scale test program and currently a senior scientist at APT Research. Our previous instalments comprised a series of questions and answers that often come up when the issue of QRA is first raised and the issue of large scale testing to enhance the algorithms used. This instalment focuses on how various roof and wall constructions can help us with the directional effects of secondary debris discussed in the last instalment.

### All I need is more distance, right?

by

Lon Santis (Explosives Risk Managers LLC)

The last couple of articles in this column discussed the directional effects that are demonstrated by secondary debris and described testing to determine how various roof and wall constructions stop such debris. In this round, we will discuss how we can use this information and what it gains us.

Just as the roof protects against debris falling from the sky, an exposed structure's (ES) wall construction has a significant influence on horizontal, high velocity debris. It stands to reason that a reinforced concrete ES with a thick concrete roof will protect occupants from all debris much better than a modular trailer. So in a scenario where debris is the primary hazard, we want any exposed people to be in concrete structures. This kind of scenario may involve an event with a moderate amount of explosive that generates lots of primary

fragments, in a building that creates lots of secondary debris. The occupants of a robust ES are protected against the debris as much as possible, even if the ES is in a high debris density region.

On the other hand, in a scenario when the primary hazard is building collapse from overpressure, we would rather have people in an ES like a flimsy and flexible trailer. This kind of scenario may involve a large amount of explosive in the open that does not generate a lot of debris and an ES subjected to significant overpressure and impulse.

Now add directionality of the debris field to the equation, and we have some very powerful yet basic tools for risk management. Figure 1 shows a hypothetical scenario modeled in IMESAFR v2.0 with two types of ES at the same distance from a potential explosion site (PES). As in all the examples below, the

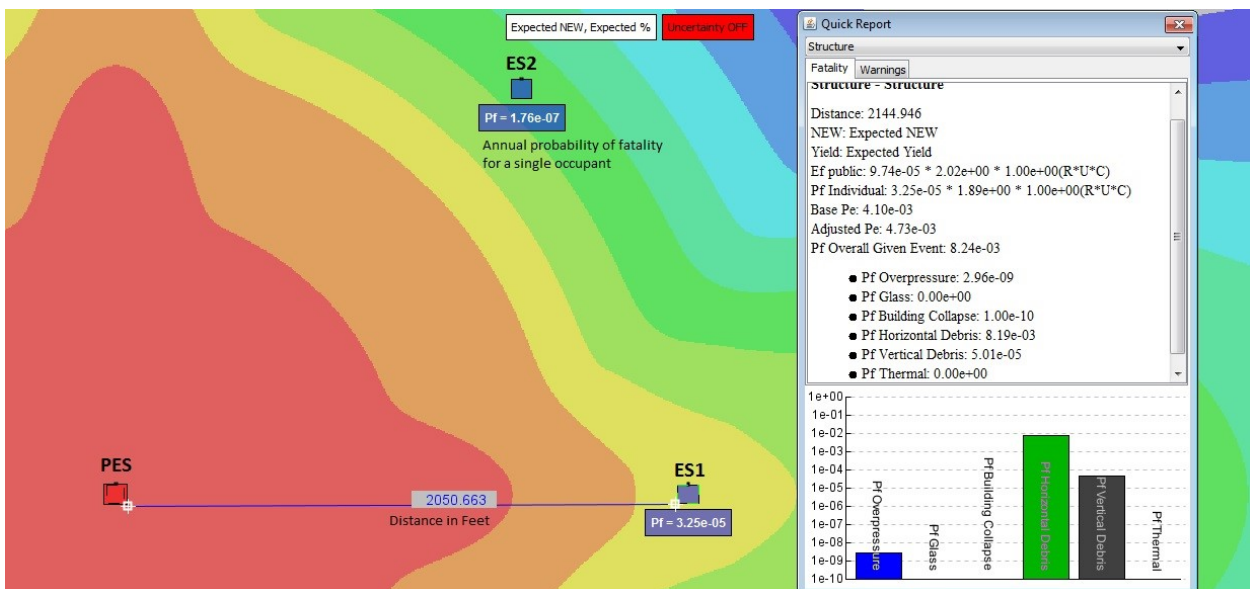
ES meet the quantity-distance standards used in the U.S.

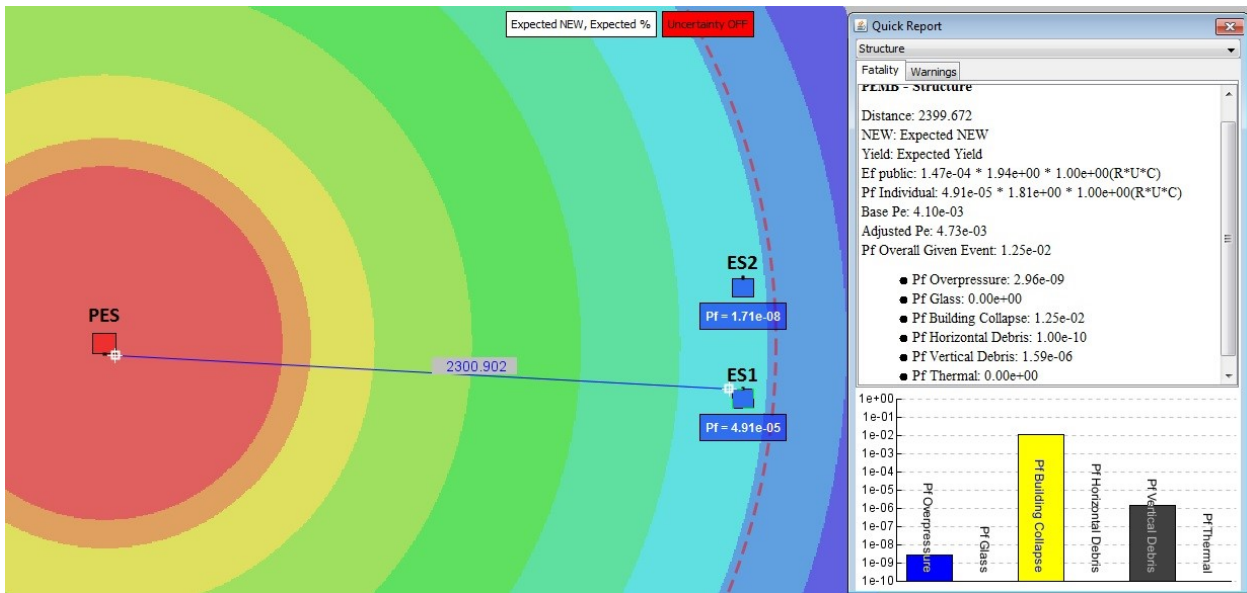
The PES is a medium sized concrete structure with 30,000 pounds (13,600 kilograms, kg) of metal cased explosives. The two ES are large pre-engineered metal buildings (PEMB), similar to those called "high-bays." As in all the following examples, the ES have one occupant each and distances are shown in feet.

Figure 1 is a screenshot with annotations from the software and shows many of the critical inputs and outputs to the scenario. The various shaded areas are debris density contours.

A "Quick Report" for ES1 is shown in Figure 1 and displays certain key information about the relationship between ES1 and the PES. In this article, we will primarily discuss the bar charts at the

**Figure 1:** Debris sensitive ES around a debris generating PES.





**Figure 2:** Overpressure and impulse sensitive ES around a PES with high NEW.

bottom of the Quick Report. These show the probability of fatality given an event occurs ( $P_{f|e}$ ) for each hazard mechanism. In this scenario, horizontal debris (the green bar) is the dominant hazard mechanism to occupants of the ES, followed by vertical debris (the dark gray bar).

Because ES1 is in a higher debris density area, over two orders of magnitude difference in risk exists between the two ES. The  $P_{f|e}$  to a person in ES1 located off the normal to a side wall is  $8.24 \times 10^{-3}$  (1 in 121). In ES2, located on the corner, the  $P_{f|e}$  is  $4.47 \times 10^{-5}$  (1 in 22,400). The only difference between the two ES is their orientation to the PES.

Figure 2 illustrates a hypothetical situation with two structures at the same distance from a PES that does not generate a lot of debris or show secondary debris directionality.

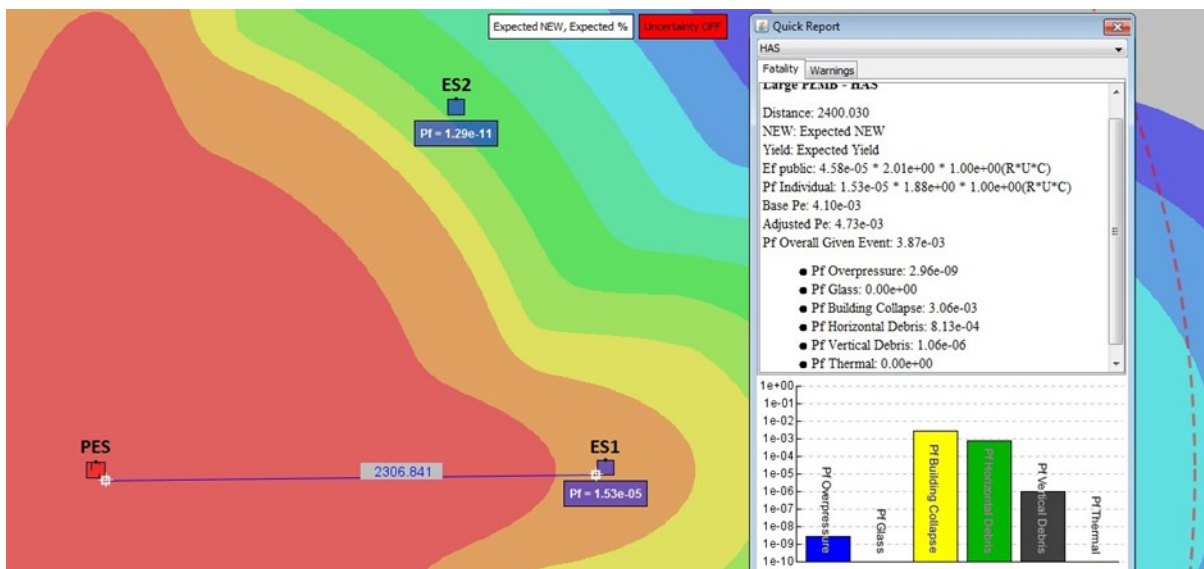
This time, over three orders of magnitude difference in risk exist between the two ES at identical distances. The PES is 300,000 lbs (136,000 kg) of boxed explosives in the open. ES1 is a large PEMB and ES2 is a small trailer. The Quick Report shows that the primary risk in the PEMB (Pre-Engineered Metal Building) is from building collapse (the yellow bar). The  $P_{f|e}$  to a person in ES1 is  $1.25 \times 10^{-2}$  (1 in 80). In ES2, the  $P_{f|e}$  is  $4.35 \times 10^{-6}$  (1 in 230,000). The only difference between the two ES is the structure type. The large PEMB acts like

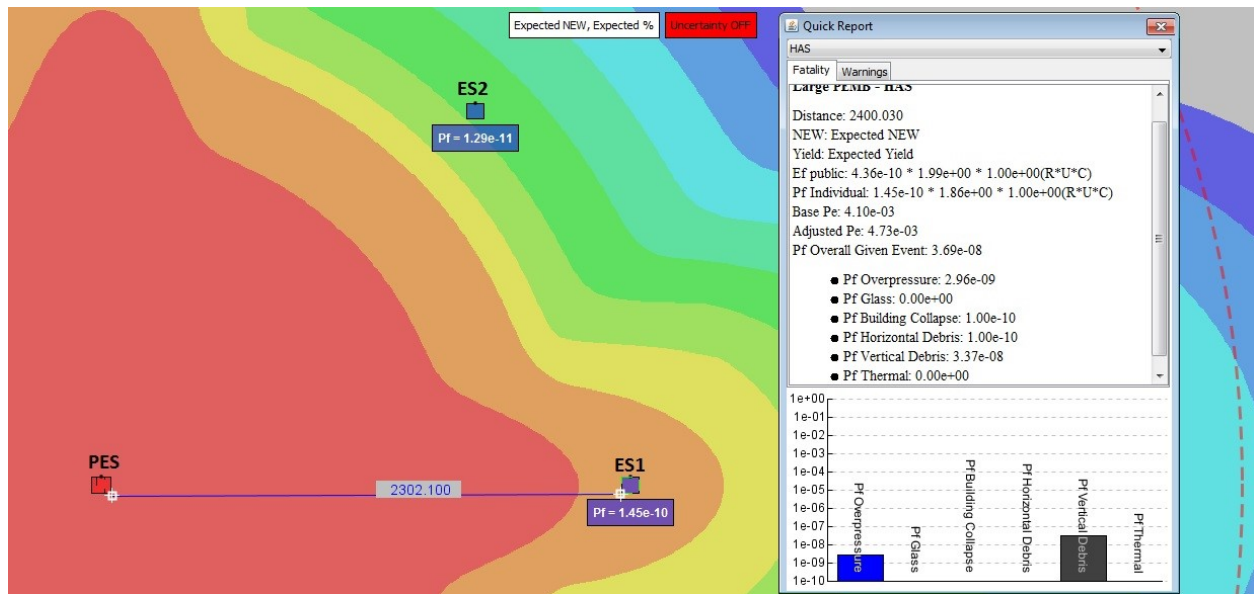
a sail and “catches” the overpressure, leading to building collapse, while the trailer remains standing -- or presents less risk to occupants if it does collapse.

Figure 3 shows how these two phenomena can combine for an even greater effect. The PES is 300,000 lbs (136,000 kg) of explosives in a large unreinforced concrete structure. ES1 is a large PEMB and ES2 is a small reinforced concrete bunker with a 14 inch (35 centimeter, cm) thick concrete roof. Except for azimuth relative to the PES, all other aspects of the two ES are identical.

The explosives event at the PES would create significant debris and overpressure. The thin metal skin and large surface area of the PEMB makes it

**Figure 3.** An extreme example of differences in risk at the same distance from a PES.





**Figure 4.** Same scenario as Figure 3 but with risk mitigating measures.

susceptible to both hazards. The small bunker, on the other hand, is hardened against both hazards. The difference in risk at the two ES is astounding: over six orders of magnitude. The  $P_{f|e}$  to a person in the PEMB is  $3.91 \times 10^{-3}$  (1 in 256). In the bunker, the  $P_{f|e}$  is  $3.26 \times 10^{-9}$  (1 in 307 million). The only differences between the two ES are the orientation to the PES and the structure type.

By most Q/D standards, both ES are acceptable, but outside that context it would be hard to justify allowing such vast differences in risk at the two ES. When still in the planning stages, many options exist, including distance, to even-out the risk at the two ES. Even when faced with an existing situation

like this, there are options to mitigate the risk at ES1.

Figure 4 shows the same scenario as Figure 3, with three changes: the installation of a barricade to shield ES1 from overpressure; changing ES1's structure type from a large PEMB to a large tilt-up concrete structure to simulate installation of a brick or concrete facade on the side of the PEMB facing the PES; and replacing the sheet metal roof of ES1 with a 4 inch (10 cm) reinforced concrete roof. (Note: Large PEMB and large tilt-up concrete structures respond similarly to overpressure and impulse.)

Each of these changes addresses one of the three primary hazards at the PEMB. The overpressure barricade eliminates

the threat of building collapse, the brick facade stops all horizontal debris and the protection added to the roof greatly reduces the threat of vertical debris. The risk at both ES is now only an order of magnitude different.

This series of modeling scenarios shows how changes to just a couple of variables can have profound effects on risk. When all the variables that can increase and decrease risk are considered, the differences can be astronomical. Distance is still a factor, but clearly it can be overridden by PES orientation and ES construction. The key is to avoid building new sites with unintentionally high risks and to recognize risk imbalances at existing sites; then taking intelligent action to mitigate the risks.

## Putting Science to Work

In this Newsletter Feature we try to publish articles with a technical bias that illustrate how our industry is putting science to work in the interests of explosives health and safety. We want to recognise those who are involved in research and development as well as encourage them to continue improving our understanding of the behaviour of explosives. While explosives have been around for millennia there are still big gaps in our understanding of how and why they sometimes behave the way they do. As long as those gaps exist we are vulnerable. This Feature is also a forum for explosives scientists to advance scientific theories on why certain incidents occurred. This can further enhance our learning from those incidents. SAFEX wants to put science to work in order to prevent the harmful effects of explosives incidents.

It is with regret that SAFEX is unable to provide an article for this Feature. We urge any readers who are able and willing to contribute appropriate material for this Feature to contact the Secretariat.

## Our Explosives Regulatory World

### The Safety Triangle

by

**Geoff Downs** (CIE, Department of Natural Resources and Mines, Queensland, Australia)

We are very grateful to Geoff Downs for his willingness to contribute to this Feature of our Newsletter. Through Geoff's kind offices, SAFEX regularly receives safety alerts and other valuable information from the Queensland Inspectorate for which we are very grateful. SAFEX regards all explosives regulators as important collaborators in its endeavours and is therefore privileged to publish this contribution from the Queensland Inspectorate.

The concept Geoff discusses in this article is the one we use to determine PAR in our *Incident Reporting* column.

Due to the inherent nature of certain explosives, we are all aware of the big incidents that are low frequency high impact events. All of us have the mission to prevent explosives incidents especially the low frequency high impact incidents. As regulators, our energies, activities and approaches are aimed at preventing incidents from occurring, and if they do occur, to minimise their frequency and severity. This is achieved through legislation, licensing, adequate knowledge of safety practices for the use and handling of explosives, suitable facilities and the person who is a fit and proper person. The strategies and approaches we use to prevent incidents for a competent and professional industry working with the hazards and properties of explosives include the reporting of explosives incidents, the investigation of explosives incidents, auditing and inspecting activities, risk management, compliant safety and security management systems, standard operating procedures, work instructions, competent industry, working to standards and codes, suitable plant and equipment, provision of information, training and education.

An explosives incident under our legislation means any of the following events involving an explosive

- An explosive is, or appears to have been, lost or stolen,
- An accidental explosion, fire or spillage,
- A death of or injury to a person,
- Unexpected damage to property, or

- An event including a misfire, with a potential to cause any of the events listed in the four dot points above, other than an event that normally happens when handling or using an explosive.

All explosives incidents must be reported to us and from the definition above, it includes near misses and high potential incidents which are types of events that had the potential to cause harm or damage but due to circumstances did not on this occasion. In addition, incident investigation identifies the nature and cause of the incident and recommendations are made and implemented to prevent that type of incident from occurring again. This is not done on an industry wide basis unless the lessons learned have been passed on. We publish monthly our *Explosives Incidents and Complaints* list of explosive incidents reported to us which is posted on our website at [mines.industry.qld.gov.au](http://mines.industry.qld.gov.au). We do this for a number of reasons. By collating the information and communicating the information back to stakeholders, the big picture and emerging trends are able to be identified and action can be taken to be proactive to be in front of the game and prevent incidents. We are one of the few explosives regulators that I am aware of that publishes the summary of information provided to it from industry.

The wide spread reporting of incidents is the sign of a mature safety culture and this has many benefits. We get

about 1100 explosive incidents reported every year. Most of these incidents are at the lower end of the safety triangle with about 80% being misfires. The degree of reporting shows a very mature safety culture. Even though we get many incidents reported, it does not mean that it is a high as it could be. As an example, at a recent industry sector group meeting, I discussed the incidents from our monthly summaries to see what we could learn and focus on as a group. The consensus from the group was the total number of incidents reported for the industry sector was less than the number of incidents each group represented informally claimed to have had.

We have all experienced difficulty in getting information, if at all, in a timely manner from a very serious incident for a variety of reasons. The lessons learned are most important for safety reasons. In addition to the lessons learned from incidents, there is other information in front of us that is readily available. This information comes from reviewing near misses and identifying "at-risk behaviours" which may come from everyday activity and behaviour. In terms of safe work practices, this can include not following them, not clearly identifying what is required, or intentionally violating the rules. Other areas include training and education, and the design, maintenance and use of plant and equipment.

I have found the safety triangle or Bird's triangle provides a very useful insight into looking at the prevention of inci-

dents and how the relative frequency of different levels of or grade of incidents, particularly lower level or minor incidents can tell us. We may expect more serious incidents may happen when there is a number of lower level incidents occurring and these can be lead indicators under the triangle . There are many explanations and articles around the safety triangle or Bird’s triangle.

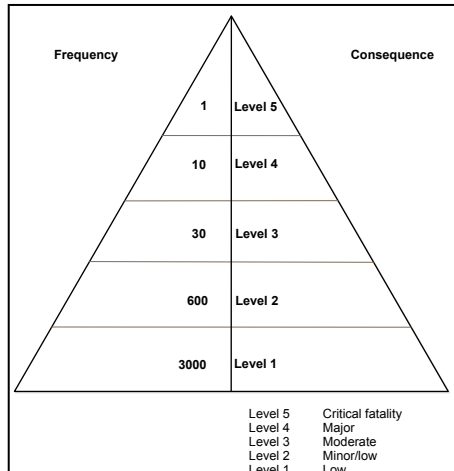
Very briefly, Frank E Bird Jr, the Director of Engineering Services for the Insurance Company of North America undertook a study of industrial accidents in 1969. He was interested in the accident ratio in the book *Industrial Accident Prevention* by H W Heinrich published in 1931. Bird and his team analysed 1,753,498 accidents reported by 297 companies from 21 different industrial groups covering 1,750,000 employees who worked 3 billions hours during the study. From the study, the ratios or relative frequencies from reported accidents were found. For every reported major injury resulting in fatality, disability, lost time injury or medical treatment, they found that there were 9.8 minor injuries reported. About half of the companies investigated major property damage accident and the majority reported major property damage accidents. They found that there were about 30 property damage accidents for every major injury. The study then evaluated incidents by conducting interviews to ascertain whether an injury or property damage could have been the outcome under different conditions and circumstances. They found that there was a ratio of approximately 600 incidents for each reported major injury. From this analysis came the ratios of 1-10-30-600 in the pyramid which most of us have come to know, as shown in Diagram 1.

I have presented frequency against the consequence relative to the level for a critical/fatality being 1. The levels shown against Bird’s findings are levels 2, 3, 4 and 5 where level 2 is minor/low, level 3 is moderate, level 4 is major and level 5 is critical/fatality. In addition I have added a level 1 to this diagram at risk behaviours. In some derivations of

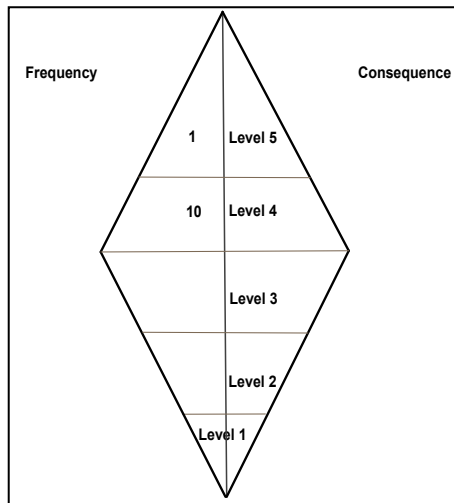
the safety triangle, at risk behaviours have a relative frequency of about 3000. I find that the addition of at-risk behaviours an extremely valuable addition as it opens up new way of looking at things.

I have seen in other explanations of the

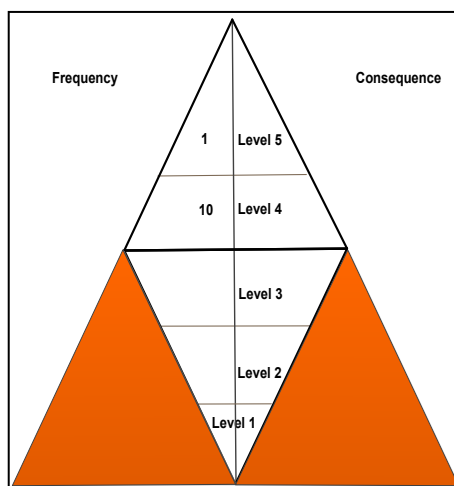
**Diagram 1:**



**Diagram 2:**



**Diagram 3:**



safety triangle, different ratios presented with different descriptors and different ratios and even the inverted pyramid. Some of these have used lost work days, recordable injuries, major injury, minor injury, near misses, equipment damage, at-risk behaviours, etc. Whatever the terms we use and the relative ratios are for these terms, it is apparent that these triangles are giving us a valuable insight into the nature type, severity and frequency of incidents. The derivation of the safety triangle and the relative frequencies has been gathered over many industries and hence, it is important to understand that these relative frequencies may be different across our industries and should be different between individual organisations. While the relative frequencies are very interesting, an important thing to remember is the triangle is based upon information from incidents that are reported and to get incidents at all levels and the potential for incidents to be reported at all levels is a major challenge and achievement.

The triangles are based upon the degree of reporting and what one can expect to see in a less than ideal reporting culture is for the frequencies versus consequence to look more a diamond as shown in Diagram 2. Non-reporting cultures can prevent near miss or minor injury events from being recorded or reported. It is well understood that a near miss event or even an at risk behaviour can become a fatality or major injury given a small change in conditions and circumstances, such as location of a person at the time when the event occurs. Reporting of incidents is not as wide spread as we would like and is much higher in organisations with an advanced safety culture and this seem to be higher in countries where the regulatory environment not only is mandating reporting but also encouraging the reporting of incidents. Naturally, the reporting of at risk behaviours is not mandated. This could be identified through different approaches and valuable information is lost. In Diagram 3, the diamond has been pasted into the triangle. The orange coloured section represents the information that

is lost or not reported or not captured. This represents a huge loss of information which is not captured and analysed which could be used to prevent incidents from occurring.

The orange shaded area represents areas traditionally under reported such as near misses, property damage, minor injuries etc. At risk behaviours are events that are not required to be reported because they are not incidents and have not led to a reported incident yet. Information on at risk behaviours can typically be obtained from activities such as audits, inspections, observation of daily activities, walking around and seeing what is being done, analysing records, etc.

Our safety alerts and security alerts are raised not only when incidents or near misses occur but also when at risk behaviours that could quite easily become an incident are identified. While our inspectors are undertaking audits and inspections, at risk behaviours are seen and acted upon. It is important to communicate the lessons learned and the underlying principles involved for the industry to understand and review their systems and actual practices.

What are the behaviours that have led to a near miss or incident. Are they reported or acted upon? Near misses and at risk behaviours provide valuable lessons when identified and reported accurately and missing the opportunity they provide is a waste of an opportunity.

The lessons learned can be actioned through reviewing safety and security management systems including standard operating procedures and work instructions to see if they are suitable and to see if they are being followed and understood.

The barriers and defences in the Swiss Cheese model of Professor James Reason and the risk control hierarchy are valuable tools to establish and maintain effective risk management. The higher up the control hierarchy we go the better the outcome and if we rely on

lower level controls, a series of barriers and defences to provide the desired outcome or reliability we are seeking. The next step is to ensure that the safety and security management systems are being followed. To have a documented system without ensuring that it being followed can lead to downgrading the reliability of the system that is believed to be in effect and giving a false sense of security.

The following is a list of selected at-risk behaviours, some of which have led to incidents:

- Not tagging out machinery and using it in the conflict of production over safety
- Exclusion zone breaches
- Mistreatment of explosives, handling detonators and boosters like a lasso
- Driving over loaded shots
- Not understanding safety signs
- Not understanding the hazards and properties of explosives and even understating the hazards
- Throwing boxes
- Fitness for work
- Dropping boosters rather than placing them
- Re-blasting misfires without extra overburden or redesigning the blast
- Use of cell/mobile phones and tablet devices in areas not approved
- Control of ignition sources
- Not following manufactures' recommendations
- Accepting or condoning non-compliant and at risk behaviours
- Incorrect stock counts and accepting stock without counting
- Unsecured loads
- Overloading of magazines
- Poor housekeeping
- Incompatible activities
- Exceeding person limits
- Leaving explosives unsupervised

Due to the inherent nature of some explosives and the culture around safer explosives, mishandling of explosives and in particular initiating and accessory explosives will not lead to an initiation



## There is still time to Register for the Congress

If you missed the deadline for doing your Hotel Reservation through SAFEX, it does not mean you cannot come to the Congress.

In the first place you can still do your hotel reservation directly with the Warsaw Marriott. It just means after 31 March the Hotel does not guarantee any more rooms for SAFEX at the special SAFEX rate. Therefore, the longer you wait the less likely you will be to obtain a room.

Secondly, you can still register for the Congress. It will help us a lot if you can do so no later than 15 April 2014. As with the Hotel Reservation you can do it in one of 2 ways. Either by:

- e-mailing your completed Congress Registration Form to the Secretariat in MS Word format; or
- registering online at the SAFEX Home Page provided you have your own individual access codes to the SAFEX Intranet (See "First Congress deadline is upon us" on p. 2 for details)

If you require a Congress Registration Form, please contact the Secretariat ([secretariat@safex-international.org](mailto:secretariat@safex-international.org)) right away.

each time they are abused, but one day they will function.

It is a challenge to be effective in the communication of information internally and externally from the lesson learned. The question is, what should be reported, what should be communicated, how much is too much and how much is too little and how often should

it be repeated. Is passing information once at a tool box meeting effective? Collecting data is one thing, analysing and evaluating what is happening, understanding it and focusing on the objective to underpin the safety culture is the objective.

The safety triangle together with our other tools for risk management can

give us a valuable and intuitive insight into the prevention of incidents and if they occur minimising their impacts. In the pursuit of a safe culture, we need to be vigilant moving forward and look in all directions for the lessons learned in what is happening around us.

## Improving Explosives Competence

All explosives manufacturers recognise the importance of training and developing people who work in and are responsible for explosives operations. SAFEX recently responded to a perceived need to develop leaders of explosives operations by embarking on the development of the *SAFEX Explosives Management Course* in an e-learning format. We are not alone in trying to support SAFEX members in their quest for improved workplace competence. SAFEX is willing to partner with anyone or use any technology that can contribute to the competence of people working with explosives and thereby make our workplaces safer.

In this Newsletter feature we propose to present a series of articles that explain the UK's National Occupational Standards (NOS) in Explosive Substances and Articles (ESA). In the coming editions of the Newsletter, each article will examine a different aspect of the ESA standards and explain how they can be used for a range of purposes.

### Making ESA role profiles work for you

by

**Denise Clarke** (Managing Director, Homelands Security Qualifications)

Homeland Security Qualifications (HSQ) is a British-based awarding body that specializes in the award of explosives-related qualifications. Denise has spent the last twenty years specializing in the specification and measurement of competence, working in a wide range of industries. Working with the industry, she has developed UK National Occupational Standards in Munition Clearance and Search and in Explosive Substances and Articles, creating qualifications and supporting assessment materials. HSQ now has five qualifications assessment centres, delivering a range of bespoke, industry-recognized and nationally regulated competence-based qualifications. Please visit [www.homelandsecurityqualifications.co.uk](http://www.homelandsecurityqualifications.co.uk) for more information.

In this series of articles, we have looked at various aspects of the construction and uses of the UK's Explosive Substances and Articles (ESA) National Occupational Standards (NOS) and in the third article, we touched on ESA-related role profiles. In this article, we look in a little more detail into the construction and uses of explosives role profiles built on the ESA standards.

The UK explosives industry has been pressing for the development of common role profiles so that training that will meet these common needs can be commissioned, developed and delivered. However, role profiles are specific to an organization or a group of individuals within an organization although

there may well be some commonality across the industry as we have already found with the Trials Conducting Officer role profile (SAFEX Newsletter NL46).

#### **Distinctions between job descriptions, role profiles and qualifications specifications**

There are many definitions of job descriptions and role profiles but essentially, they can be defined as follows:

- job descriptions are detailed descriptions of job inputs, responsibilities, reporting lines and performance parameters;
- role profiles are summaries of a role, described in terms of its outcomes. They cover a number of jobs and they specify the compe-

tences required by role holders;

- both job descriptions and role profiles provide an overview of the scope and key accountabilities associated with a job or role;
- both may list relevant training and qualifications.
- role profiles are sometimes described as blend of a job description and a person specification.

Role profiles:

- provide clarity on what is expected, particularly when mapped to NOS (which specify standards of performance);
- facilitate job evaluation (because there is greater consistency amongst roles described by role

- profiles rather than lots of individual job descriptions);
- facilitate career progression (because of the reduction of job descriptions, this means that there is a reduction in the number of job titles which in turn provides greater transparency of career opportunities).

#### What does a typical role profile look like?

The table below shows an explosives role profile for an explosives storage operator that was developed by the UK's Explosives Storage Expert Working Group which comprises a number of explosives industry experts.

*Table: Typical role profile for an explosives storage operator*

<b>Role title</b>	<b>Explosives Storage Operator</b>	
<b>Career level</b>	Band xyz	
<b>Role purpose</b>	To ensure the safe and correct storage, receipt and issue of explosives.	
<b>Responsibilities required by this role</b>		<b>Source</b>
1	Comply with safety and security procedures, plans and control measures in all areas of work and activities	
2	Store, receive, issue and transport explosives within site boundaries	
3	Maintain the condition, cleanliness and condition of storage facilities	
4	Maintain accurate and complete documentation and marking	
5	Reject items for storage that do not have an assigned and authorized custody holder	
<b>Authorities</b>		<b>Source</b>
1	Cease work that does not or might not conform with safety procedures and bring this immediately to the attention of the appropriate person	
2	Issue explosives only to authorized personnel	
3	Specific to task authorities as required	
<b>Technical competences relevant to this role</b>		<b>Source</b>
	Put explosive substances and/or articles into storage	ESA 7.3
	Maintain the quality of explosive substances and/or articles in storage	ESA 7.6
	Dispatch explosive substances and/or articles	ESA 7.8
	Carry out stock checks of explosive substances and/or articles	ESA 7.15
	Work effectively in a team involved in activities for explosive substances and/or articles	ESA 13.1
	Prepare and care for equipment in an explosives environment	ESA 13.15
	Work safely	ESA 12.20
<b>In addition, some organizations may require competence in the following<sup>1</sup>:</b>		<b>Source</b>
	Select and prepare explosive substances and/or articles for dispatch	ESA 7.7
	Operate specialized plant and machinery to performance requirements for explosive substances and/or articles	ESA 7.17
	Load the vehicles with explosive substances and articles	ESA 8.4
	Unload explosive substances and articles from the vehicle	ESA 8.6
<b>Qualifications relevant to this role</b>		<b>Source</b>
	ICM/HSQ L2 Certificate in Explosives Storage Operations	HSQ
	ICM/HSQ L2 Diploma in Explosives Operations	
<b>Training relevant to this role that supports demonstration of competence</b>		<b>Source</b>
	Add appropriate organization-specific training courses	

**Note 1:** This is an industry-wide role profile. Organizations developing their own in house role profiles would not need these additional functions

#### What are the uses of a role profile?

You have seen the diagram on the next page before! Imagine a role profile sitting at the heart of the circle which is mapped to the ESA standards as shown above. You would

have the tools to recruit, select, train and develop people against the same objective specification. You would have the same criteria by which to measure people's performance, appraise, promote and release them (if you have to) because

you would have a specification of the outputs that people are expected to achieve (as opposed to the responsibilities usually listed in job descriptions). These outputs – in the shape of the ESA standards i.e. containing performance criteria, contexts and knowledge - are measurable, observable and objective.

You would have a clear view of the skills and competence strengths and weak-



nesses in your organization which you could substantiate with evidence so you would be able to develop systematic and resource-focused plans for the development of the workforce.

At an individual level, the role profile can be used to assess someone’s performance, identify development needs and create a Personal Development Plan (PDP). Here is an extract of an example:

**Table:** Example of a Personal Development Plan (PDP)

Development objective	ESA standard(s)	Action(s) to be taken	By when	Manager’s remarks
eg Improve my capability with detonators to enable me to carry out proof testing without supervision	ESA NOS 3.14	Attend and pass Detonators training course at Institute of Detonators  Carry out proofing twice under supervision  Carry out proofing by myself whilst being watched  Carry out proofing without supervision	October 14	Approved  Review after 2 <sup>nd</sup> supervised proofing whether 3 <sup>rd</sup> time is needed
etc				

**Examples of the uses of ESA role profiles**

As we have seen, the role profiles can be used as part of a systematic process for training and developing staff who work with explosives. How might this be done?

Having defined the role profiles and mapped them to the ESA NOS, the next step is to map existing training courses to the ESA NOS. This will pinpoint any gaps in the training so that courses can be revised and new training commissioned where necessary.

The next step is to map the role profiles to existing qualifications and to available training courses, commissioning

bespoke training where it is needed to meet any specialized requirements.

Some organizations put the role profiles and ESA NOS onto their intranets so that when individuals are assessing themselves against the NOS, they can gain easy access to the detail of the standards. This process facilitates appraisal discussions between managers and individuals.

All the information defined in the role profiles can be added up to form a snapshot of an organization’s skills strengths and areas for development. You will also be able to distinguish the requirements of a role and the role occupant’s ability to meet the demands of

the role. This information can then be interrogated for a range of different purposes e.g.:

- How many people are competent at storing explosives?
- How many teams are competent at disposing of explosives by mechanical breakdown?
- How many people need training in writing explosives trials plans?
- Etc etc.

Below is an extract of a spreadsheet that can summarize this sort of information which can be used not just for training purposes but also for operational purposes such as allocating projects and particular responsibilities.

Team members					Qualifications		Internal training			External training	
Name	Team	Role	Assessed as competent 2014?	Assessed as competent 2013?	Defence Range Safety Dip	Explosive Storage Ops Cert	TCO training	TM training	ESO training	Exp Foundation Practice	Hazards, risks & safety
Helen Back	A	TCO	Y	N	D	N/A	E	E	N/A	E	E
Rose Bush	C	TM	Y	Y	E	N/A	E	E	N/A	E	E
Justin Case	B	TCO	N	N	E	N/A	E	E	D	E	E
Stu Dapple	A	ESO	Y	N	N/A	E	N/A	N/A	E	E	E

**Legend:**

Colour code	Roles	Remarks
High priority	RSO – Range Safety Officer	Essential (E) – operationally-related training for new starters, safety training and training required by regulation are essential
Medium priority	TCO – Trials Conducting Officer	Desirable (D) – other training e.g. developmental training for existing personnel is desirable
Low priority	TM – Trials Manager	Vocational Qualifications are based on workplace learning (although attending a course may be a practical way of providing evidence)
Training in progress	ESO – Explosives Storage Supervisor	
Training completed		

Once the information has been collected in this way, other documents can then be created that amplify any restrictions or caveats on an individual's ability to carry out specific tasks. See example on the right

We hope that you have found this little foray into the construction and use of explosives role profiles helpful. Should you wish any further information, please get in contact with the author.

Note to readers: the ESA standards are available free of charge and can be downloaded from:

[www.homelandsecurityqualifications.co.uk/documents](http://www.homelandsecurityqualifications.co.uk/documents)

TEAM MEMBERS				
Name	Team	Role evidence submitted	Agreed by assessment board?	Remarks
Helen Back	A	TCO	TCO, TM	On and off site
Rose Bush	C	TM	TM	Restricted to HME
Justin Case	B	TCO	Not assessed	On site trials only
Stu Dapple	A	ESO	ESO	Resubmit FFE evidence

## Pondering the Profession

This column is devoted to our 'Safety Professionals' in recognition of the important role they play in the explosive industry's health, safety and environment efforts. It is intended to be a forum in which we can talk about the Profession. Our aim is that this column will be read by all but that the Safety Professionals in our industry will make it their own.

### Occupational Hygiene: An Essential Safety Program Element

by

**Jackson Shaver** (Director of Pyrotechnic Processes, Special Devices Inc /Daicel)

Jackson has a PhD and has been associated with Special Devices Inc. (SDI) since 2000. SDI is a member company of SAFEX International with operations in North America, Europe and Asia. The company specialises in precision engineered energetic devices including gas generants, ignition compositions and propellants. While Jackson focuses on the manufacture of pyrotechnic and explosive ordnance, he is passionate about Occupational Hygiene. Prior to joining SDI he worked in fields such as mining / chemical refinement; automotive safety products; thermal treatment of hazardous materials as well as Aerospace and Defense products. With expertise in Process Safety Management for energetic operations, Occupational Hygiene, HAZCAT / First Response and Six Sigma, Jackson is well placed to "Ponder the Profession".

Several years ago while visiting a new explosive manufacturing facility I, along with a team of explosive engineering professionals, examined the facility siting, building construction and production processes connected with this new state-of-the-art explosive production facility. The team was impressed with the care taken by the company to en-

sure this new production facility was in general compliance with facility construction and siting requirements applied to the manufacture of energetic materials. Company representatives were well versed and could readily explain the separation distances and potential explosive effects of the energetic materials produced at varying stages of

the manufacturing process.

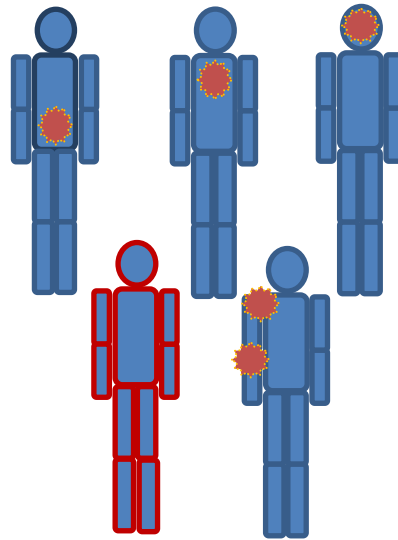
When the engineering team entered the company break area, we were surprised to observe that the level of care applied to the facility design was absent from the implementation of proper hygienic practices that should have been present to limit potential occupational

exposure. Employees with contaminated protective apparel walked down a pathway from the manufacturing buildings, over a roadway, along another pathway and then entered the employee locker rooms to change out of the protective apparel by walking through the company lunch room. No other access to the locker rooms was readily available and employees walked between the lunch tables to enter the locker room.

Company representatives were familiar with potential toxic effects of the chemical precursors and energetic materials produced by the manufacturing process. However, very little forethought had been applied to limit the potential for occupational exposure and environmental harm with effective engineering controls and hygienic practices. In addition to commentary regarding the facility design and construction, the engineering team presented company representatives with recommendations for more effective environmental and hygienic control measures. Company representatives responded favorably and promptly, and, addressed the situation with more effective controls and hygienic practices.

It should not require a visiting engineer with an occupational hygiene background and training to recognize the adverse conditions at this company and the potential for occupational exposure and environmental harm. However, it is possible that qualified explosives industry professionals may overlook the potential toxic effects energetic materials while focusing exclusively on the explosive effects. Energetic materials may present acute and chronic health hazards and workers employed in the manufacturing, transport, storage and use of energetic materials are not strangers to either consequence. Headaches or rashes resulting from contact with energetic compounds may occur too frequently and potentially remain unreported when proper hygienic practices are not exercised.

The ignition of energetic materials presents an immediate health hazard where symptoms of occupational dis-



ease may not be recognized or manifest for several years, perhaps even after the employee retires or leaves employment. Companies should not forget the occupational hygiene component when conducting a process hazard analysis or a safety evaluation of new and existing facilities and processes.

#### **Occupational Hygiene:**

The specialty of occupational hygiene is focused on the anticipation, recognition, evaluation and control of workplace environmental stressors (chemical, biological, physical or ergonomic). When applied properly, the occupational hygiene discipline and methodology can be used to assess and control potential hazards in the workplace or community that could cause injury or illness. The effective evaluation and control of potential occupational exposures in the workplace is essential to managing an effective safety program.

Pioneers in the field of occupational hygiene and the recognition of occupational illnesses can be traced back for centuries. The American Conference of Government Industrial Hygienists (ACGIH), originating in the United States in 1938, was one of first associations to bring the science to the forefront. The ACGIH found acceptance internationally and today the science of industrial hygiene (occupational hygiene) is a key component of many well-respected academic, government and international industry associations.

There may be some confusion with the

terms industrial hygiene and occupational hygiene. However, there really isn't a difference between the function of an Industrial Hygienist and an Occupational Hygienist. The term Industrial Hygiene is more common, but not limited to the United States. In many other parts of the world the science is known as Occupational Hygiene and in some ways this term is probably more applicable. Occupational Hygiene is a better description for workplaces that are usually not associated with industrial work sites (for example; custodial, entertainment, farming, hospitals, restaurants and retail stores).

#### **Occupational Hygiene Workplace Evaluation:**

Conducting a workplace evaluation is an essential first step to determine what tasks, work areas and work stations are sources for potential problems. During the workplace evaluation, the Occupational Hygienist can identify and take measurements of potential occupational exposures, problem tasks, and the associated risks. A workplace evaluation includes inspection, research and analysis of the potential chemical, physical, biological and ergonomic hazards at the worksite that may affect worker health. Occupational Hygienists will also examine non-routine work activities that may also be of sufficient duration to affect worker health. When a potentially hazardous situation is discovered, appropriate corrective action can be implemented.

#### **Occupational Hygiene Workplace Controls:**

The occupational hygiene Hierarchy of Controls is a good place to start when considering controls for potential occupational exposures. The model is similar to traditional process safety controls. The Hierarchy of Controls is also not unlike the Cardinal Rule for Explosive Safety where the ideal situation exposes the minimum number of persons to the minimum quantity of explosives for the minimum amount of time. The occupational hygiene hierarchy of controls includes:

- Control the source
- Control along the path

- Control at the worker

Controlling the source includes engineering, isolation and substitution of hazardous materials for less hazardous materials. Controls along the path might include ventilation, limiting employee access and housekeeping. Control at the worker would include training, proper hygienic practices and personal protective equipment.

#### Occupational Hygiene Benefits:

Companies should view occupational hygiene as an essential element of the safety program and ensure qualified in-house or consultation services are readily available to assist with workplace evaluations. The occupational hygiene

discussion presented by the engineering team caused the company in the example to re-examine safety, quality and environmental controls more closely. Corrective action instituted by the company improved employee safety and productivity by controlling contamination sources.

#### References:

American Conference of Government Industrial Hygienists (2014), website accessed February 16, 2014.

[www.acgih.org](http://www.acgih.org)

Bisesi, Michael S. (2003), Industrial Hygiene Evaluation Methods, 2<sup>nd</sup> Edition. Lewis Publishers, CRC Press, Inc.

British Occupational Hygiene Society,

website accessed (2014); website accessed February 23, 2014.

[www.BOHS.org](http://www.BOHS.org)

Information Booklet on Industrial Hygiene, OSHA 3143 (revised 1998). US Department of Labor, Occupational Safety and Health Administration

International Occupational Hygiene Association (2014), website access February 23, 2014. [www.IOHA.net](http://www.IOHA.net)

Senn, E., (2000), Controlling Chemical Exposure Industrial Hygiene Fact Sheets: Concise Guidance on 16 components of Industrial Hygiene Controls. New Jersey Department of Health and Senior Services, Occupational Health Service

## Dynamite Factory at Ardeer Scotland Making Dynamite Nitroglycerin: Part III

by

H. J. W. Dam, published in Mc Clure's Magazine, Vol. IX (1897), No. 4, pp. 823 – 836 and published at <http://archive.org/details/mccluresmagazine08newy>. Rights with the National Library of Scotland.

submitted by

**Martin Held** (Director SHES, Austin Powder International)

Martin came across this article when he was looking for a picture showing an operator carefully watching the thermometer of a NG batch reactor. The intention was to compare inherent safety 100 years ago with today's process safety. At that time the operator would fall off one-legged milk stool he was sitting on if he becomes tired and falls asleep. Martin goes on to say: "When I was reading through the article, I could not take my eyes off it. There is so much in it which today we would say is obvious Basis of Safety (BoS). Perhaps it will be a useful exercise to sit down and review all BoS related activities."

Because of the length of the article, we have decided to serialise it and will publish it in 3 parts. Part I covered the Introduction, Nitroglycerine Hills and the Danger Area. In the second In this second Part the authors talked about his experiences with the Nitrating and Cartidging Houses. In this final part the author described the manufacture of nitrocotton, its use in the production of other products and some of the supporting activities. The article concludes with a comment on Ardeer's safety record. We hope you found this series of interest.

### Preface by Martin Held

Ardeer at that time was perceived as being world class compared to other (non-explosives) industrial business. Today we manage access and security control with card readers and monitor hazardous activities and have CCTV witnessing if employees would carry and use non-permitted articles with them, but do we physically search people for foreign bodies and prevent those from being smuggled in? Work clothes in different colours to identify people in

the wrong (or to confirm being in the right) place. Very simple and obvious! We will definitely use relevant parts of this article for training or workshop classes to have folks identify the useful (BoS) information in it and how this compares to our present environment.

#### MAKING NITROCOTTON ON A MAMMOTH SCALE

Nitrocotton, which by itself and in combination with nitroglycerin as cordite and ballistite is rapidly displacing gunpowder in every direction, is made and

used by the ton at Ardeer. It is made from cotton-waste, the waste left on the spindles in the cotton-mills. This comes to Ardeer in bales, like bales of finished cotton, and is first washed, to remove all grease and dirt, carded, and reduced to a homogeneous mass in a big mill devoted to these processes. Then it goes to a great barn-like building where it is turned into soluble nitrocotton or insoluble guncotton, as may be desired, the process taking place in small iron pans or hundreds of earthenware jars. Half the floor is taken up by



**Interior of building where nitro-cotton is made**



**Man and thermometer in one of the nitrating houses**

these jars, which sit side by side in a shallow tank of cement about a foot deep. The object of this tank is to keep the jars cool by surrounding them with water during the nitration. Along one side of the room are the acid taps and lead pans. Four pounds of cotton are placed in a pan, and one hundred and fifteen pounds of mixed sulphuric and nitric acid are added. In a few minutes the chemical combination takes place, the acid is poured off, and the nitro-cotton receives its first washing. From this point, until every particle of the acid has been washed out of it, it is liable to burn spontaneously at any instant. As one of the workmen dumps the pan load into the "centrifugal" or acid separator, it may go up with a flash and a great column of yellow smoke; and this not unfrequently happens, but does no great harm except, perhaps, to beards and eyebrows. It takes fire slowly and gives full warning. It now goes to another department and is washed repeatedly, kept for a week in water tanks, pulped in ordinary pulping-mills, and dried in rotary centrifugal machines until all but thirty per cent, of the water is eliminated. The remainder is dried out of it on the shelves of a great drying-house, where a temperature of about 120 degrees Fahrenheit is maintained by hot air through fans.

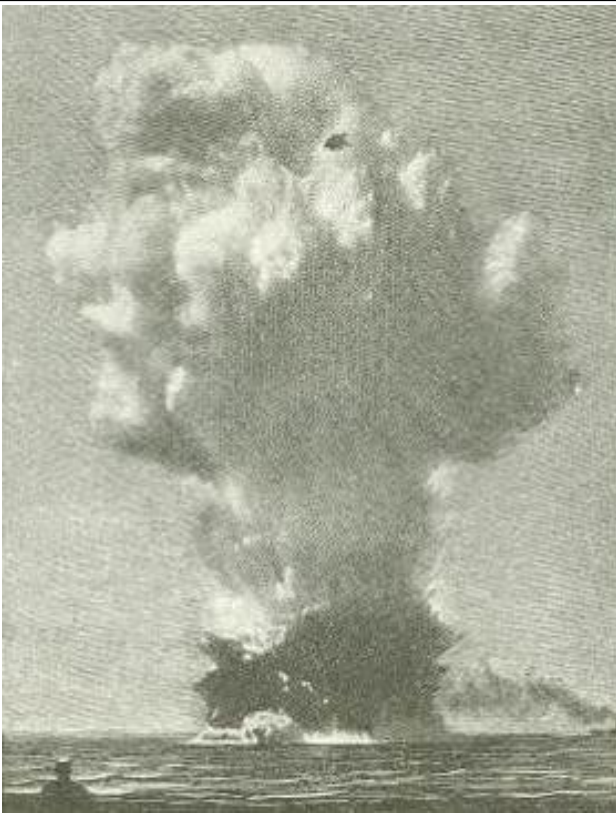
At Ardeer this nitro-cotton is used in enormous quantities in combination with nitroglycerin to make blasting gelatin, of which it contributes seven per cent; forty per cent cordite; and ballistite, which consists of sixty per cent of soluble nitro-cotton and forty per cent nitroglycerin. The extraordinary affinity of soluble nitro-cotton for nitroglycerin is a curious chemical fact. No matter how much water is present in the mixing-tank, every particle of gun-cotton will find and absorb the nitroglycerin, and this "wet-mixing process" as invented and carried on at Ardeer is admirable of its kind. The material for cordite, in the form of cordite paste, is made in large quantities at Ardeer, and sent to the government factory at Waltham, where the government smokeless ammunition is made. Ballistite is a specialty at Ardeer, and is rapidly displacing the other smokeless powders for sporting purposes. Its admirers claim that it is stronger than any other, cleaner in the gun, perfectly smokeless, and entirely unaffected by heat or dampness. It can be soaked in water and

fired without any loss of efficiency. Since the professional pigeon shots have largely adopted it, and the weekly scores in the sporting papers show the majority of kills to its credit, the shot-gun fraternity, so numerous in England, have taken to it *en masse*. Ballistite is made in three forms: in cubes for cannon, in minute rings for rifles, and in square flakes for shot-guns. As first made and dried, it is a light brown elastic paste. This is run through steel rollers which are heated to 120 degrees till it becomes as thin as tissue paper and transparent. It is like thin, elastic sheets of silky horn. Then it is cut up in cutting-machines into grains of various sizes for rifles or shot-guns, as the case may be.

These processes are most ingenious and mechanically interesting, and occupy several large mills by themselves. In all are the thermometers and the shoes. The machinery in nearly all cases represents original inventions, either conceived in Ardeer or invented by Mr. Nobel, who was the originator of smokeless powders. Absolute cleanliness reigns. Dust is never allowed to collect, and the small quantity of sweepings from the leaden floors is daily burned.

The subsidiary departments are full of interest. "India" and "Siberia" are two magazines where the company's explosives and others from all sources are tested through long periods under high heat and severe cold respectively. "India" is of course the more dangerous, and before entering it your guide climbs a ladder on the embankment which surrounds it and peeps through a three-inch hole to read the thermometer projecting from the roof of the house inside. "India" caught fire in 1895, and would have harmed nothing but itself had not some over-eager firemen gone inside the banks and attempted to extinguish the fire. In the explosion which occurred two were killed and two other employees injured. To avoid a repetition of this occurrence a huge sprinkler now rises in the center of the hut, by means of which at the first sign of fire the whole interior can be deluged from a safe distance. A thermo-electric "tell-tale" also runs from "India" to a laboratory.

In the packing-houses the cartridges are packed by girls into five-pound cardboard boxes, which in turn are grouped in



**Explosion of 10,000 lbs. of blasting gelatin**

fifty-pound wooden cases. These cases are taken in hand-cars to the magazines and thence to the beach, the railways running into the sea. The cases are transferred to boats and loaded into the company's own steamers, which carry them to all the Channel and neighbouring ports for shipment all over the world. There are also sample magazines, an armory containing all the ancient and modern small arms; a shooting range, with its attendant officers and experts, where the explosives for rifles and shot-guns are carefully tested; laboratories, and contributing departments of all kinds.

#### **REMARKABLE FREEDOM FROM CASUALTIES**

Having now inspected the factory in all its interesting entirety, you are confronted with a statement so extraordinary as to be almost incredible, viz., that despite the manufacture by the ton of all these deadly explosives, Ardeer is one of the safest factories that you could possibly be in. In the whole period of its existence, about twenty-five years, the entire loss of life by accidents, including the sad occurrence of Feb-

**Shipping at Ardeer Beach**



ruary 24th, has been only twenty-one. This, compared with the number of people employed, is lower than the death-rate in any cotton-mill, woolen-mill, foundry, boiler-shop, shipyard, or other large manufactory. The main cause of this excellent showing is the admirable character of the discipline imposed and the firm and careful system of management. But the rigid, intelligent, and systematic way in which explosive factories are guarded by government regulations and government inspectors undoubtedly also plays a large part in this result.

The nitroglycerin compounds, however, are far from being as dangerous as is generally supposed. Nitroglycerin itself is always a possible source of explosion, but up to this year no accident had ever attended its manufacture at Ardeer. The accidents that have occurred have been due to the handling of it after it has been made. With regard to dynamite, its actual safety as an explosive was ever the pride of its late inventor, Mr. Nobel. He claimed that dynamite could not be exploded by being thrown to the ground from any height; that it could sustain any degree of shock without explosion. He claimed for blasting gelatin that, in addition to being the strongest, it was absolutely the safest explosive known. In proof of this he devised a series of experiments which have been often performed at the factory and which have never failed. They may be seen at any time by a visitor whom the company desires to convince, and as given on a late occasion were as follows:

1. A cube of iron weighing 420 pounds was hoisted on crossed poles above an ordinary packing-box containing fifty pounds of dynamite cartridges, the box resting on a board on the ground. The rope was cut by electrically exploding a cartridge against it, and the weight fell twenty-five feet, smashing the box completely and pulverizing some of the cartridges; but there was no explosion.
2. The same experiment was repeated with a box of blasting gelatin cartridges, the fall being twenty-five feet and the iron weight 470 pounds. Box and contents were crushed and scattered, but there was no explosion.
3. A one-pound tin of gunpowder was placed on an open five-pound box of dynamite cartridges and exploded. The dynamite caught fire and burned up, but did not explode.
4. The same experiment was performed with a five-pound box of blasting gelatin cartridges with the same result.
5. A dynamite cartridge was set on fire by a fuse, and burned rather rapidly. It would have burned away completely, but a detonator had been placed in the middle, and when the flame reached this the other half of the cartridge exploded.
6. To show the strictly local force of dynamite, a one-pound cartridge was hung eight inches above a three-

eighths of an inch boiler-plate, which was lying on two bits of wood, and exploded. The plate was only slightly bent.

7. A similar cartridge was laid flat upon the same plate and exploded, the result being a hole torn in the plate about the size of the cartridge.
8. A similar cartridge was then placed on a similar plate and covered with sand. Upon exploding, it tore a large hole in the plate

Dynamite and blasting gelatin when set on fire will merely burn. If the dynamite is in a loose form, it will entirely burn away without danger. If compressed, both will burn until the heat reaches a point high enough to explode the remainder, but this always requires sufficient time to give bystanders full warning and enable them to reach a point of safety. All the nitroglycerin compounds are exploded by detonation; that is, by means of explosive caps like percussion caps which fit on the ends of the fuses. The cap explosive is a mixture of fulminate of mercury and chlorate of potash, and the Nobel Company have a large and separate factory in Scotland which is devoted to the manufacture of fulminate of mercury and various kinds of detonators. The explosive force of No. 1 dynamite, weight for weight, is four; times that of gunpowder. Bulk for bulk –the dynamite being much heavier, it is over seven times as powerful as gunpowder. Blasting gelatin has nearly six times, weight for weight, and a fraction less than ten times, bulk for bulk, the power of gun- powder. Gun-cotton and No. 1 dynamite are about equal in explosive strength. Dynamite is not allowed on passenger trains in Eng-

land, but is transported with great freedom on the Continent, and thirty thousand tons of it have been shipped on the English and Continental railways without accident up to date. Of course, every package and case carry explicit instructions, but that the danger is small the immunity from explosions in transport clearly shows.

The moral of which is, that dynamite is with safe and blasting gelatin is safer if they are treated with only reasonable care. "The accidents do not occur here but in the use of it," says Mr. Johnston. "If the company's explicit printed instructions were followed, accidents would scarcely be known." Accidents often occur in thawing after an explosive has been frozen but these arise from the incredible recklessness of miners. Small accidents, also, transpire at Ardeer in the repair of pipes. A drop of nitroglycerin which has secreted itself in a crack or crevice in the metal is sometimes struck by a hard tool, and costs a plumber one or more fingers.

These facts concerning dynamite are well known, and they are very reassuring. As you enter the train to leave Ardeer, however, the old habit of doubt reasserts itself. A bit of white fluff on your coat –sleeve is viewed with the greatest suspicion. The question arises, "Is it cotton or gun-cotton?" Nerving yourself to the ordeal, you deliberately pick it off. You then carefully throw it out of the window to wreak its fell purpose, if it has one, on the landscape. Then you settle back a vague desire to look at a thermometer. You have acquired a respect, an admiration, for any and all thermometers, which will abide with you to the end of your days.

## Congress Chat

### SAFEX Workgroups are waiting for you



The 6 SAFEX Workgroups will be meeting during the SAFEX Congress in Warsaw, Poland in two Workgroup Sessions on 21 May 2014. Delegates who wish to participate in the Workgroups can choose to attend ONE Workgroup in the Morning and ONE in the Afternoon.

The Morning Sessions are:

- \* Good Explosives Practice (GEP)
- \* Explosives Transport

- \* Technical grade ammonium nitrate (TGAN) Handling

The Afternoon Sessions are:

- \* Site Remediation / Decontamination
- \* Emulsion Manufacture
- \* Traceability / Security

In a series we have called *Congress Updates* we provided information on what each Workgroup plans to do during its meeting. As delegates do not have to be core members of a Workgroup to participate in a Workgroup's meeting, the *Updates* should help you decide which Workgroups you wish to attend. Furthermore, there is no limit to the number of attendees Member companies may send to the Workgroups. Workgroup participants may also stay on for the rest of the Congress without affecting Member Company's quota of delegates.

If you require more information on any or all of these Workgroups please contact the Secretariat at [secretariat@safex-international.org](mailto:secretariat@safex-international.org) and we will rush a copy of the relevant Update(s) to you.

## Explosives Eco-talk

The impact explosives and explosives manufacture has on the Environment fall squarely in the SAFEX domain. We are committed to publish the experiences members of the SAFEX community (Members, Associates and Expert Panel) have in minimising explosives' environmental impact. 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 want to 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.

### Remediation of a magazine containing obsolete lead styphnate and tetrazene

by

**Dirk Kotze** (Explosives Remediation Manager, Rheinmetall Denel Munitions)

In September last year SAFEX sent out a Request for Information on behalf of Rheinmetall Denel Muniton in Somerset West, South Africa. The company was in the process of relocating one of its sites and remediate the site completely for property development. A magazine in which lead styphnate and tetrazene had been stored without wetting-down for 4 years had to be demolished as part of the remediation. The concern was how to do it as any disturbance of the tetrazene crystals could lead to detonation. The responses from the following individuals helped RDM arrive at the process described in this article: Frank Barker (Expert Panel); Andy Begg (Individual Associate); Clark Bonner (Dyno Nobel); Maurice Bourgeois (Expert Panel); Terry Bridgewater (Chemring); Peter Cartwright (Expert Panel); Ken Cross (Corporate Associate); Janusz Drzyzga (Nitroerg); Rahul Guha (Solar India); Piet Halliday (AELMS); Jack Hedger (Expert Panel); Ian Swallow (BAE Systems); Peter Swinton (Expert Panel); Stuart Tough (Expert Panel); Mervyn Traut (Expert Panel); Richard Turcotte (Corporate Associate); Claire Vieillard (Davey Bickford); David Vince (Expert Panel); Gerhardus Vosloo (Burkan) and Jerry Wallace (Corporate Associate).



**Above:** Magazine Q4 with the obsolete drums of lead styphnate and tetrazene visible

During 2008 Rheinmetall Denel Muniton (RDM) was founded and necessitated the relocation of the previously known Swartklip Products factory (now known as Philippi factory site) to the Somerset West factory site. The Philippi site has been remediated and this creates now possibilities of a mixed zoned development.

The challenge was to relocate a working pyrotechnic facility and plant within the guidance of the environmental approval and EMP for both relocation of the 64 year old factory site and to remediate it to levels acceptable to the new planned

end-uses. Huge modifications were made to the underutilised recipient explosive buildings at Somerset West.

RDM successfully executed the relocation of the Philippi site via a small dedicated team. The landowners of Philippi site, Denel SOC Ltd, appointed via Denel Industrial Properties members of RDM to demolish all explosive buildings at the Philippi site and to remediate all land.

The remediation entailed the clean-up, demolition and remediation of soils of more than 223 explosive buildings, various grenade and other pyrotechnic test facilities, burning grounds and surface treatment plants to mention just a few.

Part of the remediation included the remediation of a magazine containing old obsolete and redundant lead styphnate and tetrazene explosives, previously used for the manufacturing of power cartridges and .22 Ammunition by the then Swartklip Products.

Like most of the sites and plants, earmarked for closure, focus and attention is normally given to the reduction of personnel and the decommissioning of processes. Obsolete and redundant inventory are normally carried for a few more years until these dated inventories become the focus of the day. In our instance the closure and remediation of the entire site required that something had to be done urgently with all obsolete and redundant stores.

The primary explosive magazine was built as a soft roof magazine with reinforced concrete mound walls. The magazine contained 50 kg lead styphnate and 27 kg Tetrazene packed

in five separate drums on top of copper plates and a wooden flooring to provide proper earthing and anti static characteristics.

Situated on the Cape Flats, known for its dampness and long long winter rains, the surrounding area was drenched with freestanding water in winter times due to shallow calcrete layers and a vlei area in the proximity. The magazine was situated in close proximity to public roads (109m), school (353m) and residential housing. The magazine was also situated in the approach route to Cape Town International Airport.

Due to concerns that the drums of lead styphnate, already opened, will become more sensitive additional water was added in 2008 to all the opened lead styphnate drums. However at the time of handling two things were observed a) lead styphnate colouration on drums and b) galvanic corrosion has started to form between the drums and the copper plate below the drums. We wanted to remove the lead styphnate at the time but the lead styphnate has already indicated signs of caking preventing removal. The existing drums were then only placed inside new drums.

Needless to say that further requests for remedial action were placed on hold until such time that formal risk assessments could be conducted in detail. It has always been part of planning but only gained momentum when the demolition of the lead styphnate Magazine was being planned

A serious attempt was made by our AIA team to assess all risks and gather additional information from all sources. During this time a new risk were noted i.e. pit corrosion that has started on the tetrazene drums resulting in tetrazene oozing out of the drum and running down the sides and underneath the drum. At this time it became clear that opening of the drums becomes a definite "no-no" and that chemical treatment of the lead styphnate is out of the question. Disposal through blasting became the only alternative. This was confirmed through the communication of the SAFEX community and mails received from members.



**Galvanic corrosion formed between drum and copper plate**



**Dried out lead styphnate tarnishing on drums**



**Tetrazene oozing out of drums running down on side and underneath drums due to pit corrosion.**



**Tetrazene Drums after desensitization with light oil**

Originally it was decided to subcontract the whole demolition task to an external contractor but safety concerns and environmental risks noted by the RDM team necessitated the placement of the demolition on hold.

It was then decided to run the project internally as the expertise existed within the company to do blast design and building preparation.

### Building Preparation

Building preparation and blast execution were based on three main focuses:

1. Risk reduction,
2. Blast and noise deflection/ reduction and
3. Fragmentation control and deflection.

Risk reduction was achieved by conducting building reviews on all close proximity buildings as well as the testing of charge design. Blast and noise reduction were achieved making use of minimal quantities of explosives, deflection of sound and pressure waves away from public buildings by specific placement of gum poles and soil piles in pre planned areas. Damage to building structure was prevented by covering two thirds of the roof area with a combination of diamond mesh, gum poles, 10mm cable, conveyer belting and mattresses filled with water. (Each mattress containing approximately 1000 lt of water).

Different size mattresses were used in the other third of the roofing area to provide weight and to form a water blanket over the entire blast area. This not only assisted in blast dissipation but also in the reduction of explosive contamination of the area. Scabbing of walls and fragments were prevented making use of a 2m wide soil layer next to all external walls and the placement of gum tree poles and conveyer belting on the roof area.

### Charge Design

For reasons clear in detonation train design, the demolition charges were designed making use of military explosives, instead of mining explosives, in the form of a mask, enabling the blasting team to place the charge from



**Above and Below:** Preparation of building to withstand blast and direct sound away from community



**Above:** Water mattresses placed on top of gum poles and conveyer belting to resist blast and to form a water barrier during detonation



**Above:** A mask consisting of detonating cord and RDX pellets was designed to assist with the placement of the charge over the drum from a distance making effective use of explosive force.

a distance, without touching the open tetrazene. Explosive power to weight ratio is also more beneficial compared to mining explosives.

Prior to detonation of the lead styphnate and tetrazene, the charge design and setup was tested in it's current state i.e. inside two different size drums with an air gap between drums and charges. Detonating cord rolled up in the form of a pig tail was used as a representing charge.

Although the mask design prevented touching of tetrazene on the drum surface, all visible explosives were desensitized making use of an abundance of light oil sprayed on top of visible explosives on the drums.

As Messrs Milcom is licensed to do blasting in residential areas with access to additional seismographs, they were contracted to detonate the charge. Maximum vector vibrations recorded was 7.21 mm/s @18.29 Hz whilst blast measurements recorded was 0.30321 kPa with a sound measurement of 144dbl @8.8 Hz. Directional travel of conveyer belting and roofing material were ejected as planned. Maximum distance to conveyer belt and soft roof roofing material were found 60 meters from explosion.

Structural damage was minimal and restricted to cracking of supported walls and one parapet wall sliding into the building. The other two parapet walls were damaged outward due to no support it received from the back. No sand were placed behind the parapet walls as concerns were that loose sand on top of undetonated explosives can increase risk during clean-up.



**Above and Below:** Charge set up for testing and verification of effectiveness



**Above and Below:** All five Charges connected without a delay



**Below:** Detonation of the Explosive magazine (Photo: AEL Mining Services)



A light yellow /brown colouring were visible in the corner of the most southern wall closest to the Lead Styphnate drums whilst a wet greenish colour were visible on the soil surrounding the building to a max distance of approximately 15meters from the blast centre. This followed planned deflection directions.

### Remediation and Clean-up

Prior to entry of the building, a pre-burn with a paraffin / diesel mixture, sprayed onto all surfaces and ignited by means of igniter cord were done. As detonations occurred during the pre entry burn activity, due to entrapped explosives in cracks and underneath copper plates, the pre burn should be considered one of the most important actions prior to re-entry of any building being remediated by means of detonation.

As a safety precaution a secondary burn were also done whereby all remnants of soft roofs and broken wood were placed inside the building and burned. Only after this burn personnel were allowed to enter the facility.

Samples of the concentrated green precipitate were scraped together from the soil (in it's wet state) in front of the entrance to the building, and send for analysis of energetic matter to the RDM Chemical Laboratories. No lead styphnate or tetrazene were present in the samples.

As it was found that the green precipitate disappeared when flamed by means of a gas lance, the lance were used to burn all soil and polystyrene granules (from the soft roof covering) found lying on the soils.



**Above:** Unsupported parapet walls toppled to sides.



**Above:** Lead styphnate coloration in one corner of building after the blast.



**Above:** Flaming soft roof remnants and colorations observed



**Above:** Greenish colouring on soil (non explosive) flamed by means of gas lance



**Above:** Levelled land ready to be developed, given a new life to contaminated land

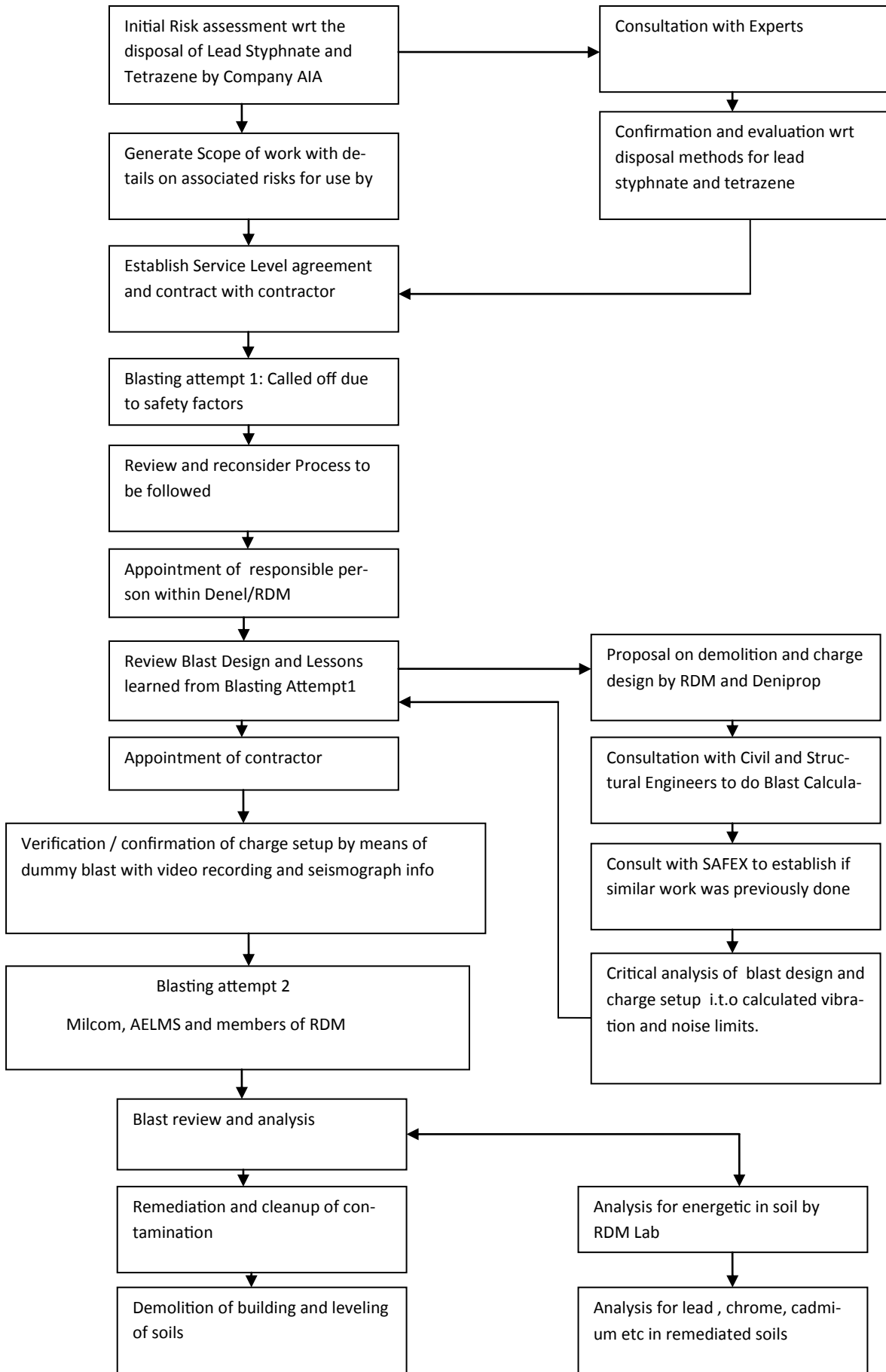
In order to check remediation effectiveness, an area 0.5 m x 0.5 m, badly stained with green precipitate, were marked prior to flashing and send for soil analysis by a certified laboratory (SGS) to analyse for the existence of lead and other heavy metals. Analytical results has shown that lead metals were present after remediation at 112 mg / kg, well within the remediation requirements of 230 mg/kg for residential and 1900mg/kg for commercial industrial use.

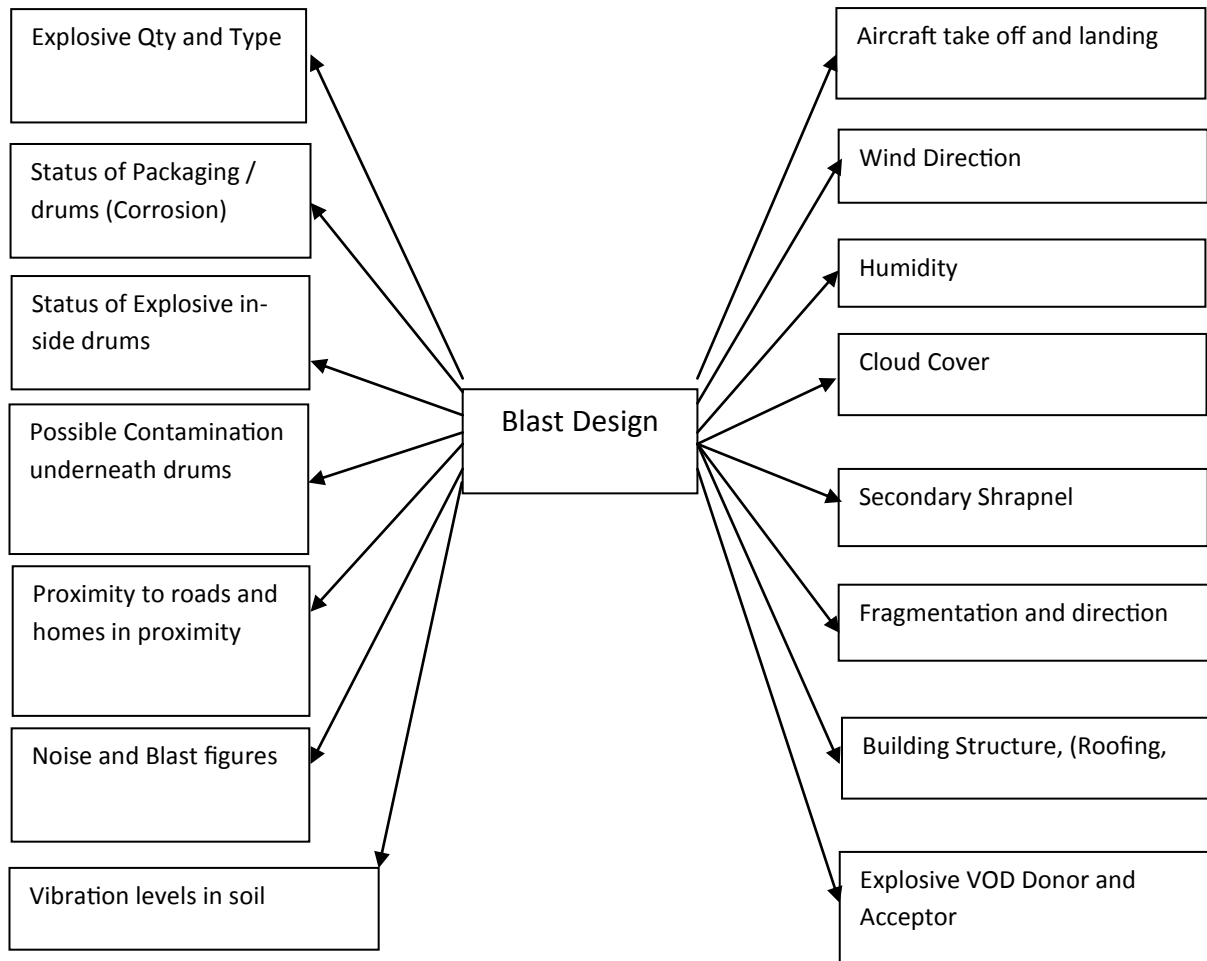
### Thanks and Acknowledgments

The remediation team would like to thank the following personnel and industries for their involvement and assistance during the execution of the project.

- Management of Denel and Denel Properties for the opportunity, beliefs and attendance on the day. Creating a total new meaning for community involvement by CEO's.
- S Lapage for professionalism of services rendered
- Representatives of AELMS and AEL for services rendered and also for making high speed video equipment available during the execution phase.
- Milcom, Shotmaster, G Kroeger consulting engineers, members of the RDM AIA team for assistance, support and contributions during planning and execution of the project.
- MD Traut Consulting for inputs, recommendations, risk reviews and interest in the project
- SAFEX management and members for their contributions and feedback when called upon.

**Diagram 1:** Schematic review of the main planning and decision making behind the clean-up action



**Diagram 2:** Risks considered during blast design and execution

## Under Lock & Key

SAFEX's purpose is to eliminate harm to people, property and the environment from unplanned explosives events. It does so by helping members share relevant experiences and information that will prevent the recurrence of such events or incidents. We have traditionally focused on incidents in the development, manufacture and distribution of explosives. However, there is an increasing awareness of the harm events involving the illegitimate use of explosives can cause. The SAFEX Board has long realised the importance of sharing information about how better to secure our products and broadened the SAFEX domain to "health, safety, security and the environment (HSSE)". Explosives security is about preventing conventional explosives or precursors from falling into unauthorised hands. In this vein SAFEX Newsletter wants to encourage readers to contribute articles that will increase awareness to help our industry counter those intent on causing harm through the unauthorised use of explosives.

### Is Industry the Missing Link?

#### ***Finding Upstream Solutions To The Illicit Acquisition Of Commercial Explosives For Use In Improvised Explosive Devices***

by

**JIEDAC, UK MoD**

This article was first published in the IExpE's Journal of Explosives Engineering , March 2013 and is reproduced by kind permission of JIEDAC and the IExpE. The IExpE is a Corporate Associate Member of SAFEX International

#### **The Issue at Hand**

The Improvised Explosive Device (IED) is routinely employed by terrorists, insurgents and criminals who value it for its ease of manufacture and its devastating

effect. Its proliferation can be partially attributed to the availability of commercial explosives, which are illegitimately diverted from their legal uses and incorporated into deadly weapons. Their

diversion from legitimate ends indicates that there are weaknesses in the legitimate supply chains. The development of a robust system of materiel accountability for commercial explosives is

therefore critical in order to prevent violent actors from accessing vital IED components.

The Ministry of Defence (MOD) is particularly concerned about the effect of IEDs in Central and South Asia. This is not simply because British and allied troops are engaged in Afghanistan, but also because IEDs are used as a tool by violent local groups with extremist agendas to destabilise whole territories and threaten UK domestic and international interests.

There can be huge variations in how IEDs are constructed, however in the main they consist of a container with a fill of homemade explosives and certain commercial explosive products, including detonators and detonating cord. These commercial products are dangerous items, but they are not manufactured for use as weapons with the main non-military usage of explosives being mining. Nevertheless their use in IED construction represents failings in the control measures normally applied to these items.

Governments and industries, local and international, have a mutual interest and responsibility in preventing the diversion of commercial explosives and explosive-containing products.

#### **What is the UK Government Interest in Explosives Security?**

The UK's strategic context is encompassed in three main documents: *The National Security Strategy (NSS)*; *CONTEST: The United Kingdom's Strategy for Countering Terrorism, July 2011*; and *the Building Stability Overseas Strategy (BSOS)*.

Essentially the UK's interest in explosives security covers three areas: to address the risks violent groups and contested territories pose to our national security, to reduce the threat of terrorism both domestic and international, and to uphold the UK's commitment to international development. The UK is heavily invested in developing 'upstream' methods in order to preventatively deal with these topics and seeks to work in cooperation with non-

governmental bodies and the private sector.

Under the NSS, the UK seeks to work upstream to predict, prevent and mitigate risks to our security and national interests. The NSS recognises the active contribution that industry makes to national security, and it therefore seeks to develop closer relationships between the private sector and government <sup>1</sup>. One of the UK's responses to the potential security risks is to enforce domestic law and to strengthen international norms <sup>2</sup>. Engagement with international industry on their standards of responsibility and good practice would therefore contribute to achieving these objectives.

Similarly, under the Pursue and Protect work streams of CONTEST, the UK seeks to work with multilateral organisations, such as industry associations and institutes, in order to better negate terrorist threats early <sup>3</sup>.

Finally, under BSOS, the UK seeks to invest in upstream prevention in order to reduce the cause and effects of instability and violent conflict in countries overseas. Strong economies are vital to development, stabilisation, and post-crisis recovery. However, in order to provide a benefit, these economies must be well-functioning. Building strong non-governmental organisations and a responsible private-sector are key elements of this strategy <sup>4</sup>. Under BSOS the UK has an interest in creating a culture of robust good practice which resists corruption and illegal associations.

Within these three key UK Government strategies lies the clear intent to engage with industry and seek its assistance in contributing to domestic and overseas security, and overseas stability.

#### **What does the UK Government seek to do?**

The UK has an interest in the development and implementation of concepts such as 'responsible retailing' and 'supply chain oversight', in addition to the improvement of product custodianship standards in overseas countries. It is believed that a solution to the prob-

lem of commercial explosives in IEDs could be found in the form of an initiative that promotes explosive materiel control, which starts at the manufacturing source and continues through to the end-user. In order for these controls to work a system of traceability and accounting would be required; this would provide an effective means of strengthening the supply chain and raising the alarm if explosives went missing.

This system of accountability could be supported by further measures which provide the means of overseeing and managing explosive products, such as developing a means of product traceability and effective licensing for custodians of explosive materiel. Additionally, the promotion of a culture of 'good practice', where responsible industries work with government and to their own voluntary Codes of Conduct, would strengthen the system, making component acquisition more difficult and risky and thereby suppressing IED use by illegitimate actors.

These types of initiatives are not unusual to the explosives industry; in 2010 the UK passed legislation that mandated the development of a traceability regime including the marking of explosives <sup>5</sup>. Furthermore, being a responsible sector, it is common-place for industry to have self-imposed policies and Codes of Conduct.

#### **How can Industry and Industrial Groups Help?**

The UK industries that manufacture or handle explosives have already made significant contributions to the disruption and deterrence of terrorist plots within the UK. They have done this by reinforcing standards of good practice, good conduct, and responsibility. It is these UK standards which, if exported internationally, could reinforce industry good practice overseas and make a tangible difference to safety and security.

The UK recognises that industry is best placed to advise on, and contribute to, the building of an international industry consensus that prevents, at source, legal commercial explosives from being illegitimately diverted to illegal ends.

Industry may well approach the IED issue from a different angle than government, therefore providing previously unexplored avenues to investigate in the fight against IEDs.

Outreach by *Government to Industry* in order to develop our understanding of the problems faced in ensuring product security, control and oversight would undoubtedly prove invaluable: we understand that the best people to advise us on industrial matters and issues are the industry experts themselves. The UK seeks to learn about the nature of the legitimate industries concerned and their associated business models and controls. We are keen to work with industry in order to improve our understanding of the industries and trading bodies worldwide, with a particular focus on the central and southern Asian region, as well as those who routinely trade with these industries.

*Industry to industry* cooperation is also encouraged. British companies and their international partners have developed robust systems of oversight and governance of their products. We



would welcome any proposal by industry to promote better ways of working, or to encourage the proliferation of best practices with regards to explosives safety and security in overseas countries.

#### In Conclusion

Industry has always supported good governance and oversight of explosive products within the UK; it well deserves its reputation as a responsible industry. Around the world, in those countries and regions where security measures are not as well developed, commercial explosives products are being used in IEDs. The UK believes that there is mutual benefit to be had in developing explosives safety and security with overseas countries through information

and expertise sharing.

The Explosives Associations and their members can act as champions of good practice and responsibility and can potentially assist in the spreading of this culture of explosives security within international industry circles. Our ultimate goal would be to assist industries worldwide to develop robust codes of practice that protect themselves, and prevent their legal explosive products, produced for legitimate purposes, from making their way into IED supply chains.

#### Notes:

1. HM Government, "National Security Strategy", 2010, p. 10
2. HM Government, "National Security Strategy", 2010, p. 33
3. HM Government, "CONTEST: The United Kingdom's Strategy for Countering Terrorism", 2011, p. 45 & 82
4. HM Government, "Building Stability Overseas Strategy", 2011, p. 24
5. See the Identification and Traceability of Explosives Regulations 2010 and amendments 2012 for further details.

## Safety Snippets

On a lighter note (although it was no laughing matter to the farmer concerned), here is an extract of a report that appeared on the internet earlier this year. It shows that electrostatic discharge (ESD) is not only of concern to explosives manufacturers. Ref: <http://www.reuters.com/article/2014/01/27/us-germany-cows-idUSBREA0Q1HY20140127?feedType=RSS&feedName=oddyEnoughNews>

## Flatulent cows start fire at German dairy farm - police

BERLIN | Mon Jan 27, 2014 2:22pm EST

14 COMMENTS

Tweet

2,501

Share

13

Share this

155

Email

Print

#### RELATED TOPICS

[Oddly Enough »](#)

(Reuters) - Methane gas from 90 flatulent cows exploded in a German farm shed on Monday, damaging the roof and injuring one of the animals, police said.

High levels of the gas had built up in the structure in the central German town of Rasdorf, then "a static electric charge caused the gas to explode with flashes of flames," the force said in a statement.

One cow was treated for burns, a police spokesman added.

(Reporting by Erik Kirschbaum; Editing by Andrew Heavens)

## ***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](mailto: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.

### **Product Stewardship: Post-blast fume**

**Knowing the concerns that exist about the impact of post-blast fumes, Geoff Downs (CIE Queensland, Australia) brought to our attention the following incident. It was published in *Mining Accident News No. 1312, 01 Nov to 20 Dec 2013* and we reproduce it with acknowledgment.**

#### **USA: Colorado mining accident kills 2, injures 20** (Extract from BuzzFeed.com)

Two workers were killed and 20 others were injured Sunday in a mining accident at the Revenue Virginius mine in Ouray, Colo. The Ouray County Sheriff's Office was called to the Revenue Virginius mine at about 7:20 a.m., county spokeswoman Marti Whitmore said. The two miners were underground and were confirmed dead Sunday afternoon. The sheriff's office and the Colorado Department of Public Safety told CBS News that all the other workers were above ground and had been accounted for.

Rory Williams, project manager for Star Mining Operations, the operator of the Revenue- Virginius, told the Ouray Watch newspaper that accident was not related to a cave-in or mine collapse. He said apparently a "powder- smoke incident" and the release of chemicals injured the affected miners. Whitmore said 20 people were taken to area hospitals, and all but two had been treated and released as of Sunday evening.

Officials from the U.S. Mine Safety and Health Administration were at the accident site, which is about 270 miles

southwest of Denver.

The last major mining disaster in Colorado occurred when an explosion killed 15 people at the Mid-Continent Dutch Creek No. 1 Mine near Redstone on April 15, 1981. Over the past 10 years, there have been 15 deaths related to mining in Colorado, the Denver Post reported. Before Sunday's Revenue Virginius incident, there were 34 fatalities at mines in 2013 across the United States.

*SAFEX Newsletter picked up the following report on this incident from the MSHA website (<http://www.msha.gov/FATALS/2013/FAB13m1617.asp#Uyw5C4XDXTQ>) On November 17, 2013, a 33-year old powderman trainee with 5 weeks of experience and a 59-year old shift supervisor with 36 years of experience were killed at a silver mine. The two miners were in an area of the mine where explosives had been detonated the day before. Other miners working in the area were able to evacuate. Mine rescue teams entered the mine, found the two victims, and brought them to the surface. During the recovery operation, rescue teams*

*detected fatal levels of carbon monoxide. Twenty miners were taken to the hospital and three were kept overnight.*

*The report goes on to recommend the following best practices in such situations:*

- *Conduct effective workplace examinations. Identify all hazards and take action to correct them.*
- *Ensure all active working areas are ventilated prior to allowing miners to work in those areas.*
- *Monitor gasses as frequently as necessary to determine the adequacy of control measures.*
- *Use properly maintained and calibrated gas detection instruments with alarms for concentrations outside of safe limits that are audible and visual.*
- *Ensure all miners are trained to recognize all potential hazards and emergency procedures, including evacuation procedures.*
- *Dispose of damaged or deteriorated explosive material in a safe manner in accordance with the instructions of the manufacturer.*

### **On exiting from an elevated level in an emergency**

**An operator was injured when she tried to escape from the mezzanine floor of a propellant pressing / cutting building after an ignition occurred. She had to climb through a handrail and jump to safety but broke her leg in the fall on the ground. Several comments were received as result of this incident**

**Maurice Bourgeois (GD-OTS Canada) noted:** Second story operations should be equipped with chutes or poles for rapid escape. They should be properly located away from the

source of the deflagration so that they can be easily reached.

**Gerard Chaloyard (Expert Panel) pointed out:** In France, the regulations forbid multiple floors in explosives operating

buildings (explosives workshops) unless "the effects of a pyrotechnic incident arising on one of the levels cannot seriously affect operations situated at the other levels". When different floors are necessary (for example, for extremely tall explosive objects), simultaneous pyrotechnic operation at the two different levels are forbidden. Another option that can be considered in this case is to put a "sandbox" under the hand rail.

**Massimo Berti (Simmel Difesa) was concerned about the root cause of the ignition:** We have a similar operation in our propelling powders production plant. During 60 years of operation we recorded 3 incidents; the root causes were always identified in an initiation on the cutting machines. It will be very useful to know exactly what happened in order to improve our operations.

### Spontaneous ignition in ash

**A fire seemed to ignite spontaneously in a drum used for the storage of ash generated from the kiln at a member's Confined Burn Facility (CBF). The fire burnt for approximately 10 seconds generating a ball of flame of about 3 m in diameter. There were no injuries or damage.**

**Two possible explanations were offered by Gerard Chaloyard (Expert Panel):**

1. Combustion of a pyrotechnic product by simple contact with the hot ash as a result of human error.
2. "Cook-Off effect" of unburned active product, concentrated and imprisoned in a "shell" of ashes and cast / burnt products, not having reacted in the CBF. Only

after removal from the CBF ignition occurred by simple "Cook-Off effect" in hot ashes. This hypothesis should be taken seriously because it occurs from time to time in our activities. I saw this type of phenomena myself in my pyrotechnic test centre during a UN test 6C: an explosion occurred in a heap of ashes more than 15 minutes after the end of the test.

### On maintaining screw conveyors

**An ignition of an energetic material occurred while the material was being conveyed in a screw conveyor. The resulting fire caused damage to the building and equipment. The investigation determined that the screw was too long and this resulted in friction between the screw and the bottom plate**

**Maurice Bourgeois (GD-OTS Canada) commended the member for an honest finding:** Such commissioning flaws occur when the millwright does not check the operation of the screw before turning it to production. It should be part of the work permit closure. If it was the wrong spare part, then spare parts should be properly identified to make sure there is no mix-up. It may even have been an out of tolerance screw from the supplier in which case inspection at reception should be improved. There could be many root causes to this incident; perhaps it may be another cause altogether. The latter cause reminds me of a terrible accident which involved a hollow screw in a screw pump. The screw used to be solid SS and the supplier without notice supplied a hollow screw welded assembly. A crack developed in the weld, the emulsion penetrated the crack and a detonation occurred killing

several researchers. Hence verification and inspection of spare parts is of the outmost importance especially for equipment in close contact with energetic materials.

**Gerard Chaloyard (Expert Panel) also commented as follows:** As I understand it the initiation came from metal / metal friction. Clearly, the risk of metal / metal contact must be avoided in screw conveyors as in augers. Another potential cause can be bearings. In my experience one must avoid packing glands, use special seals and avoid contact between product and bearings. This can be achieved by locating if possible the bearings outside of the conveyor and must be designed to avoid overheating.

Generally, validation by a safety expert of any modification, adaptation or "technical improvement" of the process should be required on the basis of a written safety analysis

### Cleaning pyrotechnic equipment

**An operator died as a result of burns sustained when an energetic mixture ignited during the cleaning of a mix Muller.**

"This is a very unfortunate accident" **said Maurice Bourgeois (GD-OTS Canada):** "Presumably the operator was not wearing an aluminized suit While I realise the investigation has just started may I bring up one important good practice for cleaning pyrotechnics: proper wetting with alcohol or a compatible solvent of the dry powder and particularly the dry

crust is a must. If the powder leftover is dry, and more so the crust, then any stimuli can create ignition (friction, impact, static electricity.) As long as there is good ventilation solvent vapors do not pose a threat but dry powder does. The operator must make sure that powder crust is soaked."

### Why did this propellant detonate under water?

There were no injuries but the damage was severe when single base propellant granules detonated under water while being pumped. However, the member is at a loss to explain the cause as they have not encountered underwater detonation of a single base propellant before.

**Gerard Chaloyard (Expert Panel)** agrees that this is an unusual incident: Under water single base powder usually does not detonate itself. I do not know of any examples of transition from combustion to deflagration to detonation of single base occurred under water. Deflagration can occur but not detonation. In my opinion it needs “something else” that initially detonated in the pump which then transmitted the

detonation to the single base powder.

**Erik Nilsson (Corporate Associate)** recalled the following: A similar accident occurred in Sweden in 1984, when an operator was killed in an explosion that occurred while propellant slurry was being pumped. Perhaps there is something to be learnt from this incident that could help the investigation.

## 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, recently retired from AEL Mining Services, 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!

### Basis of Safety (Part 2) – Impact

by

**Tony Rowe** (Retired from AEL Mining Services)

You may recall that in the previous edition of the Newsletter Tony told us about an ancient Latin manuscript entitled **FUNDAMENTUM SALUTIS - MALLEUM NIQUITIAE, MALA CONSUETUDINE** which being translated means “The Fundamentals or Basis of Safety – Hammer of Wickedness and Bad Practice”. It consists of several sections as outlined in the Contents page:

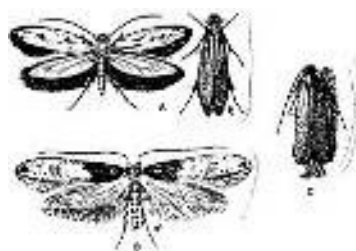
**PRAELOCUTIO** (Prologue)

**CAUSA:**

- I. CONLISIO (Impact)
- II. ATTRITIO
- III. INCENDIUM
- IV. SCINTILLA ELECTROCUTUM
- V. CHEMICA INSTABILITATEM

In this edition we continue the study of the FUNDAMENTUM SALUTIS (“The Fundamentals of Safety”). In the last issue we explored the opening or introductory element. It was entitled “PRAELOCUTIO”. This time we open the book at Chapter One, CONLISIO

Inside, the vellum pages are fragile, stained and yellowed with age. Spit-moth maggots and the destructive vellum fly larvae have been at work within. Adult, fly, moth and maggot tunnels have penetrated deeply into the pages. Indeed, some of the holes are wide enough to accommodate a modern



pencil with room to spare. (Vellum by the way was made from the treated skins of calves or goats. After treatment in vats of urine, steeping in calcium hydroxide solution and finally clean water, the skins were stretched, polished with pumice and rubbed with talcum powder. Vellum was used exclusively in ancient times for important documents

intended for preservation)

The FUNDAMENTUM SALUTIS (Fundamentals of Safety) is undeniably old. Precisely how old remains unclear. Radioactive carbon dating (a technique developed by Willard F Libby) has served only to increase the controversy. The reason for the inconsistencies is that the pages contain finely ground sea shell, possibly conch, introduced way back in antiquity, probably as a replacement for talcum powder when the vellum was being finished. The mineral based shell particles apparently interfere with the decay rate of the Carbon 14 isotope, changing the numbers and depending upon interpretation, adding or subtracting hundreds of years.

Suffice it to say that whatever its real age, repeated generations of vellum fly and spitmoth maggots have enjoyed an active lifestyle within its pages. They have grown old, fat and sassy on a mixed diet of animal protein and in-depth knowledge. Sadly, not only have they caused irreparable damage to the leaves and text, but to the binding as well. Today, the book is in real danger of falling apart. Its restoration will be difficult and expensive, but vital for the future. The chapter heading though is still legible. In the brown, iron-based, protein packed ink of the period (a composite of iron salts, nutgalls, egg yolk and gum) it reads "CONLISIO".

CONLISIO (Impact).

I have condensed and modernized the original Latin text, turning lengthy and somewhat tedious descriptions into the following, (hopefully) easy to read chapter. Any errors that may have resulted during this process remain mine alone:

The word *Conlisisio* means impact or perhaps collision. Other similar meanings are bang, bash, blow, bump, clash, crash, hit, knock, percussion, smack, smash, shock, strike, wallop. The chapter opens with a statement. The language is Latin and reads: *Ne ferire explosives, Explosives ferire backium* which translates to something like "Don't hit explosives, they might hit you right back"

From the outset, Chapter One of the



FUNDAMENTUM (Fundamentals) encourages workers to familiarise themselves with the exact nature and properties of any energetic material they are handling or proposing to handle. It counsels persons to work with the minimal quantities possible and not to let in-house inventories exceed the agreed/regulated maximum. The number of souls (persons) permitted to be present in any licensed building must also be limited. Further, Paragraph 22, sub-section 11 urges caution against the sin of letting familiarity breed contempt whilst sub-section 12 encourages overseers to train and motivate subordinates to maintain a constant lookout for changing conditions.

The very next passage advises the reader that it doesn't matter how benign or insensitive any particular energetic material may appear, hit it hard enough and it can react with terrifying violence. The opening lesson then is always to avoid creating any form of impact in the first place.

Then there is a warning. There is a piece of cautionary text that appears to be directed specifically towards the *novitius incipiens* (beginner, novice or perhaps less experienced person). It warns such workers that impact sensitivity is a remarkably difficult characteristic to quantify reproducibly. Test conditions and criteria, sample size, sample content, crystal shape, sample geometry and sample mass vary, as well might the diligence, patience and skill of those engaged to carry out the tests (which

are claimed by the FUNDAMENTUM to be boring in the extreme).

In order to stay alert, workers tasked with the undertaking of impact test regimes were "encouraged" to introduce handfuls of *Flamicus Formicans* - a ferocious species of fire ant - into their nether garments. The *Flamicus Formicans* species were feared for their aggressive behaviour as much as for their powerful mandibles and agonising stings. Ants never sleep. If the constant patter of thousands of tiny feet around the generals was not enough, a real wake-up could be achieved via a judicious tug or tap against an offenders loincloth. House overseers were equipped with a light, bentwood cane specially designed for precisely this purpose. The antics and leaps that resulted led to recalcitrant workers being referred to in the FUNDAMENTUM as "Fleas".

The practice is frowned upon today.

A test method used by the Hittites (an appropriate name don't you think?) and one still in use today, attempted to establish impact sensitivity by dropping a 6g (six gram) metal ball onto a sub-sample of the substance in contention. For testing purposes, each sub-sample was spread onto a hardened metal plate placed directly beneath the point where the ball would strike. Ignition sensitivity was deemed to be acceptable when a predetermined number of samples failed to ignite after the ball was dropped from a particular height. For one fairly sensitive substance this could be around 28 cm.

The same bulk sample tested using a different instrument - this time one employing a 500g (five hundred gram) metal ball, would typically record a 50% ignition height greater than 90 cm. Remember, the energetic material used in both tests was exactly the same. It was the same batch, same sub-sample mass, same everything. The tests whilst, theoretically similar are, however, dynamically very different. The outcome is that the results appear wildly at odds with one another. Understanding and interpreting such data correctly is therefore

critical to maintaining safe working practice.

In a second real example, one primary explosive when sprinkled with a tiny pinch of fine brick dust would reliably and repeatedly alter its impact sensitivity characteristics from around 100 centimetres with a 535 g ball (when uncontaminated) to less than 5 centimetres once the dust was added. Scary!

Remember it was the same test and the same bulk sample (no other changes besides the necessary use of fresh subsamples took place). Contamination may not only affect sensitivity, but perhaps other properties also - and not always in a good way. Indeed, some energetic materials are just as sensitive when wet as when dry. Heated or hot explosives are also likely to be far more sensitive than perhaps anticipated and should be allowed to cool before any handling is attempted. Rust, grit, sand, hollow microspheres and even sawdust can sensitise explosives making them much, much easier to initiate.

Projectile impact is also a mechanism to protect energetic materials against. Whether it be arrows, spears, bullets or bricks, shrapnel, broken glass or even a carelessly tossed bunch of keys or cheap ballpoint pen. Being struck by even a low velocity projectile can initiate an unwelcome reaction in many energetic materials. For this reason, what the FUNDAMENTUM calls *equus ludis* (horseplay) was strictly forbidden. Workers found guilty of playing at horses would be whipped with long bamboo rods. This was no schoolboy beating, but a brutal assault continued for 30 minutes or more. Afterwards, the usually unconscious offender would be taken to the infirmary to recover. Unfortunately, the punishment was not yet complete. About a week or so later the offender would be subjected to a second and mercilessly similar caning. It was certainly cruel, but did tend to leave a lasting impression on both victim and witnesses. It was fully supported by the laws of the time which demanded that the second flogging be completed before the wounds caused by the first had fully healed.

It would appear that not everything in the FUNDAMENTUM is civilised or enlightening.

The FUNDAMENTUM then alerts us to be on guard against carrying loose objects in the breast pockets of shirts or overalls. A metal spatula, a ruler, a steel cased pen or a spectacle case falling out of such a pocket to strike any sensitive substance stored beneath can cause embarrassment, various degrees of cremation or even dismemberment. The FUNDAMENTUM is at great pains to stress that what it calls the "Chinese Powder" (assumed by the translator to be gunpowder) can be exploded by a blow and they don't mean exhaled air either. The larger, denser grained powders are deemed most vulnerable.

The FUNDAMENTUM goes to great lengths to stress to the student or reader that sensitivity data for any bulk explosive is first and foremost entirely test dependent. Sensitivity results, we are advised, even those engraved on tablets of stone are simply a guide. Workers are therefore cautioned never to allow the contamination of any energetic material with anything whatsoever, even water.

The underlying message appears to be this: When assessing how carefully to handle any particular energetic material it is always far, far safer to err on the side of caution.

Common sense tells us that a glancing blow is more likely to occur than direct impact. In a glancing blow, the colliding surfaces strike one another at an angle. Two components are involved, impact and friction. Glancing blows are thus extremely complex events often combining the physics of mechanical energy transfer with pseudo-adiabatic compression and frictional hot-spots. Glancing blows, the FUNDAMENTUM asserts, are especially to be avoided, but besides direct "hammer" type blows, a mechanism for direct, "head on" impact does exist. It is so commonplace. We call it gravity. Think about it, the simple act of dropping something is usually quickly followed by an impact event, but it's not the fall that does the damage, it's the sudden stop at the end.

For instance, have you ever dropped a glass onto a stone floor? Usually the glass breaks when it strikes, but amazingly sometimes it doesn't. Explosives follow a similar trend, but in reverse. Usually they don't go off. Probably just as well. BGNA (where nothing happened) might sometimes be preferred to BANG, (where something did) although survival can lead to a false sense of security.

Can you as the reader remember your own reaction the first time you dropped something that could potentially bite and the relief afterwards when nothing happened? Generally though, such moments, while increasing the pulse rate can also encourage further careless behaviour. Within a manufacturing environment where a person may be handling thousands of explosive or explosive related items per shift, such incidents are not uncommon. As a result, natural wariness is quickly replaced with a false confidence which, when given the smallest degree of nurturing, can grow spectacularly.

How do you convince a person who handles perhaps millions of such items per annum and has personally witnessed and perhaps even perpetrated impact events themselves, that such behaviours carry a high level of risk? Their own experience - sometimes decades long - tells them something different. They are at the sharp end. You Jimmy, all dressed up in your nice white lab coat, are just blowing smoke.

When testing energetic materials, a "fire" (ignition) result is always judged to be a recordable event. On the other hand a non-ignition ("no-fire") outcome, where nothing happened, is not a "No". Indeed, "no-fire" results are viewed as neither positive nor negative, they're rather deemed to be neutral. It's like flipping a coin. Nine consecutive heads can be followed just as easily by a tails or yet another head. It's always a 50/50 call. Best then to judge "a no-fire" as a maybe!

Despite this clear message, would you have guessed that by the time any energetic material or assembly has been

dropped or struck by the same person 3 or 4 times without result, he or she feels that they, to coin a phrase, “know the powder?” Armed with this newly acquired “knowledge”, they often not only continue the undesirable behaviour, but in some cases even escalate the abuse. Shocked? Don’t be, it is simply human nature. Should a serious incident ever occur, then the FUNDAMENTUM SALUTIS (“Fundamentals of Safety”) predicts that the person likely to be most surprised is the perpetrator (if he/she survives that is).

Whenever there is collision the impact forces release energy in the forms of shock and heat. Generally, the harder the colliding surfaces, the more likely the probability of ignition. Diamond is probably one of the hardest natural materials around, but it isn’t commonly found in explosives manufacturing plants. Carborundum, some ceramics and agate are also very, very hard. Glass is, so is silicon and tempered carbon steel. Sand is pretty hard as well. Sand was used as a hand cleaner in ancient times especially in those lands, where, apart from the odd oasis, water was in short supply. The FUNDAMENTUM goes so far as to warn personnel to ensure all sand particles are removed from the hands and bodies of those about to enter any production house. Somewhat surprisingly, some proprietary hand cleansers in use today continue the desert trend as they contain up to 40% river sand. I wonder where all that sand ends up?

Sand and grit can be pretty hard and abrasive, but because the various particles are small and irregularly shaped, an additional phenomenon called point initiation can begin to raise its rather ugly and strangely jagged little head. The glyph below attempts to demonstrate the basic principle of point ignition:



Look around your own workplace. Do you see signs of collisions? For instance,



*Sand particles photographed under a microscope*

do any of the walls, doors or doorways show signs of localized damage, perhaps low down where trolleys going in and out repeatedly strike the same place? Are there any similar marks on the floor or around workstations where objects are perhaps repeatedly dropped? Examine shielding for signs of chipped paint. Are there heavy objects around? In the normal environment they perhaps may provide a legitimate function, but in the hands of a risk-taker can be turned into useful hammering devices should the need arise!

On the plant, screwdrivers are one of the most common tools of abuse.



Screwdrivers can be used as levers, hammers, chisels, picks, scrapers, sampling devices and much, much more. A particularly undesirable feature of many screwdrivers is that the shaft and tip are often chrome or nickel plated. Unfortunately, this coating sometimes chips off during use. If such chipping or flaking occurs within an explosive environment it can create:

- a hard, sharp edge around the perimeter of the chip
- a hard, foreign object, destined to end up somewhere it should not be.

Within a production environment, the screwdriver also offers a host of

(dubious and often even reprehensible) applications most of them extending far beyond the tools primary function, but it is when used in combination with a hammer that the screwdriver achieves the absolute peak of its hazardous potential. It does so by concentrating the force of the hammer blow into an area the size of the actual contact area of its tip. Should the tip itself be damaged or the edge in contact irregular, then the force can be amplified still further. The FUNDAMENTUM thus advises the removal of screwdrivers completely from the workplace and to account for all those introduced necessarily, but temporarily by artisans.

Impact can even be created by personnel directly using their own bodies. The FUNDAMENTUM SALUTIS discusses the case of a person observed repeatedly striking a jammed metal collection tray with the heel of the hand. The fact that at the time the tray was supporting around 5 kg of a freshly dried primary explosive known as Plumbum (word illegible - no translation available) counted for nothing. It was stuck fast. From the worker’s personal perspective, the excessive use of force was probably entirely justified! The jammed tray was observed being struck, not just once, but a number of times. Fortunately for his legion and all in his cohort, nothing happened. The tray was eventually released and safely withdrawn. Life continued.

Hitting or striking vessels or trays containing energetic materials – especially fine powders or liquids can result in their dispersal. Fine dust or tiny droplets can fly about. Where they go nobody knows, but if they happen to end up between a pair of nearby colliding surfaces and there happens to be more of those sensitive materials close by, a recipe for a whiz-bang has inadvertently been created where none previously existed. More to the point, after such a bang, would you ever know?

Such incidents aside, even the mildest of people can resort to violence when things don’t work perfectly. Consider how many times you personally have hit the TV or the radio when the picture or

the sound isn't just so. Have you ever smacked the computer screen or bashed that helpless little mouse onto the top of the desk and what about the telephone? Who hasn't walloped the receiver back down in a hissy-fit of barely suppressed rage?

Impact though doesn't only result from dropping things. Any collision between surfaces constitutes an impact event. Because the consequences include a local increase in both pressure and temperature, striking one hard object against another in the presence of explosives is maybe all it takes. Unfortunately energetic materials are not always predictable. The author of the FUNDAMENTUM SALUTIS (Fundamentals of Safety) talks about striking a small sample of a particularly sensitive and nasty pyrotechnic mixture spread onto a thick, hardened steel plate. The percussive tool of choice was a one pound hammer. It is not quite as terrible as it sounds as a number of sensible precautions were in place as mitigation. The mixture, apparently recovered from an incident scene, had failed to ignite during an earlier impact testing process. The testing had been ordered by the local Patrician in order to determine its level of sensitivity. The "Fleas" of course had complied. We are later told that it also failed to ignite during the frantic hammering session set out in the SALUTIS.

The author tells us that he had decided (words unclear) to gently tap the composition using the end toothed edge of an unused *hacksawrum metallicum* (we would call it a hacksaw blade today). Instant ignition resulted followed shortly thereafter by a pressing need for a new loincloth (underpants). The startled old soul walked away with a bit of a trot. The technical reasons for the event are all about force over area, but we won't get into all that. Simply learn the lesson. Explosives are never your friend.

The FUNDAMENTUM also tells us of a test where a great stone is dropped from a range of heights onto an energetic material supported upon the upper surface of a blacksmiths anvil placed

appropriately beneath. Loose powders were reported to ignite far more readily than their compressed counterparts. Air or gas occlusions trapped within the energetic materials were blamed. A more modern example of such a device is shown below.



It would seem that energetic materials employ a host of different ignition strategies. Best to be careful!

Pyrotechnics though are the true momzers, the plug-ugly and fatherless relatives of high explosives. They are, however, seldom taken quite as seriously. This, according to the FUNDAMENTUM, is a serious mistake. In an attempt to redress the balance, I have elected to quote the FUNDAMENTUM literally, point by point.

In the words of the FUNDAMENTUM SALUTIS: Pyrotechnics *liberabitur* (set free, liberate, unleash) tremendous amounts of heat for a small mass of material. They can also evolve large

quantities of superheated gases that while expanding, exert pressure within their immediate environment. Dry delay powders once ignited and - if in sufficient quantity - can cause potentially fatal external burns to personnel. The inhalation of superheated gases can cause additional damage to airways and lungs. The gas cloud or fireball resulting from any indoor and large scale pyro/thermal ignition will always expand faster than even the best of the Grecian trained athletes can run. The provision of roof vents offers a means of reducing the expansion rate of any fireball by allowing its rapid escape to atmosphere.

Pyrotechnics can promote the spread of fire through the projection of burning fragments or hot metallic slags. It follows that no thin or fragile combustible decorations, paper/plastic signage or combustible conveying equipment that could assist in the spread of fire should be used within any compartment employed in the processing or storing of pyrotechnic materials. A loose or aerated powder will generally burn much faster than its pressed counterpart. This effect may be worsened because high temperature reactions often self-accelerate as the combustion process proceeds.

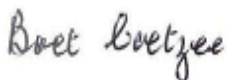
Finally, whatever the energetic material involved, impact avoidance plans have first to be drawn up for each manufacturing facility. The strategy must then be individually tailored for each separate operation. It is a time consuming process, but once completed, its rewards always include a regular good night's sleep for the dedicated and wise management personnel involved in its implementation. Don't become complacent though. Review and if possible, improve the strategy regularly!

Please find below a few suggestions around impact mitigation in a production environment:

- Train personnel around the principles of safe working practice in their language of choice. Test understanding before allowing any sign off

- Treat all energetic materials with respect. Don't drop them or handle them roughly
- Develop and maintain a safe attitude toward working with explosives
- Define and understand each of the potential hazards involved
- Teach the correct skills for safe performance of the task
- Prepare workers for unexpected hazardous conditions
- Prohibit the introduction and/or use of "Flamicus Formicans" the Mesopotamian Fire Ant.
- That pinch-points or any metal-to-metal contact between the agitator blades of stirrers, reactors and mixers be eliminated and that all such machinery be inspected for the proper clearances at regular intervals.
- Use soft bumper boards on trolley's, walls, passage corners
- Use soft floors/surfaces
- Use the softest most resilient material practical for powder containers, lids and/or tools
- Prohibit the use of chrome or nickel plated hand tools
- Keep the number of shelves in powder compartments both as low and as few as possible
- Use lists and shadow boards to control loose articles
- Avoid collisions between metal objects even when they are constructed from proven non-sparking materials. Despite the non-sparking characteristic of materials like brass and phosphor-bronze, impact ignition can still occur if the collision is hard enough
- Be aware that the addition of even "soft" materials like sawdust, PETN, graphite or molybdenum disulphide can result in enhanced sensitivity to impact

Next time: ATTRITIO



Boet Coetzee

**Secretary General, SAFEX International**

Tel: + 1 919 342 5848

Tel/Fax: + 27 21 854 4962

e-mail: [secretariat@safex-international.org](mailto:secretariat@safex-international.org)

## ACKNOWLEDGMENTS

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

**Ulf Sjoblom,**

Forcit

**David Vince,**

SAFEX Expert Panel member

**Lon Santis,**

Explosives Risk Examiners

**Geoff Downs**

Explosives Inspectorate, Queensland

**Denise Clark**

Homelands Security Qualifications

**Jackson Shaver,**

Special Devices Inc

**Martin Held,**

Austin Powder International

**Dirk Kotze,**

Rheinmetall Denel Munitions

**JIEDAC,**

UK Ministry of Defence

**Alan Morley and Diane Hall,**

I Exp E, Corporate Associate

**Maurice Bourgeois,**

GD-OTS, Canada

**Gerard Chaloyard,**

SAFEX Expert Panel member

**Massimo Berti,**

Simmel Difesa

**Erik Nilsson,**

KCEM, Corporate Associate

**Tony Rowe,**

AEL Mining Services

## BOARD OF GOVERNORS

**Claude Modoux** (Poudrerie d'Aubonne);

**Enrique Barraincua** (Maxam);

**Andy Begg** (Individual Associate);

**Terry Bridgewater** (Chemring Group);

**Alexander Chernilovskiy** (Azot-Vzryv)

**Andrew Crace** (Orica)

**Steven Dawson** (Dyno Nobel);

**Rahul Guha** (Solar Industries India);

**Dr Piet Halliday** (AEL Mining Services);

**Carlos Orlandi** (Enaex Servicios S.A.);

**John Rathbun** (Austin International);

**Thierry Rousse** (Groupe EPC);

## REGISTERED OFFICE

SAFEX International

c/o Modoux Services Sàrl

Route du Village 13

CH – 1807 BLONAY. Switzerland

Web: [www.safex-international.org](http://www.safex-international.org)