SAFEX NEWSLETTER

No. 46, 3rd Qtr. 2013

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This is your Captain Speaking

Basil El-Baz (Egypt Hydrocarbon Corporation)

Basil El-Baz is the Chairman and Chief Executive Officer of Carbon Holdings. He has effectively developed and financed two major industrial greenfield projects in Egypt: Egypt Basic Industries Corporation ("EBIC") and Egypt Hydrocarbon Corporation ("EHC"). The latter project, EHC, has a transaction value of approximately US$500 million and is widely considered as the first major industrial project to close in post-revolution Egypt. Construction of this project commenced in August 2011 with commercial operation scheduled for the first half of 2014.

In December 2012, Carbon Holdings concluded its US$114 million acquisition of the Oriental Petrochemicals Company. Since concluding the acquisition, Carbon Holdings has successfully restructured the company and its production of 180,000 metric tons per annum of polypropylene recommenced during the third quarter of 2013. Most importantly, Carbon Holdings is developing a US$4.84 billion Naphtha Cracker and Polyethylene Complex project that is currently in an advanced stage of financing. The project is being financed entirely by the Export – Import Bank of the United States and the Export – Import Bank of Korea.

Mr. El-Baz is a graduate of Harvard University.

As outlined above, Egypt Hydrocarbon Corporation (EHC), is a subsidiary of Carbon Holdings, an Egyptian based petrochemical company. In 2014 the EHC plant which is under construction is due for completion and will produce low density ammonia nitrate (LDAN) in an industrial zone south of Suez, Egypt.

When it comes to health, safety and the environment (HS&E) EHC, being a new company, has the advantage to build our systems from the ground up versus having to change traditions and habits you might have in an existing system that you want to improve. Carbon Holdings and EHC is committed to starting up the LDAN production facility with a proactive, strong and constantly improving HS&E program.

To "kick off" our production on the right HSE foot, EHC has taken an active role, during the construction phase, to work with the engineering, procurement and construction (EPC) contractor to ensure a safe and continually improving HSE culture during construction that will be maintained through operations. To accomplish the goal of safe plant operations, EHC has, or will, implement the following:

- Maintenance of a symbiotic relationship with the EPC contractor to maintain a proactive and positive safety culture during construction with almost 2.7 million man-hours completed without a lost time injury, to date.

- Using the momentum achieved during construction, this culture will be carried over into operations
- Excellent safety performance will be an expectation of all positions within the company with emphases being put on management commitment to safety from the upper management levels to the field supervisors
- A Behavior Based Safety Program (BBSP) will be implemented during operations to monitor trends and head off trends that could lead to an incident
- Adherence to all applicable laws as well as Best Industry Practices and following the "Good Practice Guide: Storage of Solid Technical Grade Ammonium Nitrate" published by SAFEX
- Participation in international forums related to the industry to stay abreast of changes in the industry, "lessons learned" from incidents in other companies and to maintain a strong network with other industry leaders to exchange information and learning's in the hopes of improving the industry as a whole
- Implementation of a Contractor Health Safety Environmental Management (CHSEM) program
- Implementation of an employee Health and Wellness program
- Focus on a 24/7 safety attitude

EHC recognizes the importance of the development of a 24/7 attitude towards HS&E. We don't want our employees and contractors to leave their excellent safety attitude at the gate when they leave for home. We want them carry their safety attitude with them when travelling, at home and everywhere else and bring that attitude with them when they come back to work. An excellent safety attitude should not have an "off switch"; it should be "on" at all times. We not only want our employees to leave for home in the same condition they came to work but we want them to return to work in the same condition they left: Uninjured, healthy and looking forward to a career with EHC that will enable them to provide for their families.

Someone once said: "Your system is perfectly designed to give you the results you're getting"

EHC is committed to a future of safe, secure and environmentally sound operations by implementing and maintaining systems that will produce World Class results. 100% commitment to this goal is the founding philosophy of the company as related to the HS&E culture within EHC and Carbon Holdings.

Meet our New Governor

Mark Thomas from Orica Mining Services was obliged to resign as a SAFEX Governor at the beginning of the year. At the SAFEX Board of Governors meeting on 10 February 2013, the Board co-opted Andrew Crace as a Governor to replace Mark pending ratification by the next Ordinary General Meeting of members during the XVIII SAFEX Congress in Warsaw. It is with pleasure we introduce Andrew Crace to our readers and apologise in the delay for doing so.

Andrew Crace

Andrew Crace is from Orica where his position is General Manager - Manufacturing in Australia/Asia and Africa. He is based in Newcastle in Australia and is responsible for Initiating Systems, Explosives and Ground Support manufacturing plants. Orica is an Australian company that operates in 50 countries with customers in over 100 countries. It is the world's largest provider of commercial explosives and blasting systems and the global leader in the provision of ground support to the mining industry.

Andrew studied chemistry at Deakin University and started his career as a technical officer with the University of Melbourne (Airforce Academy). He joined ICI Explosives at Deer Park (near Melbourne) in 1980 as a Development Chemist working on watergels and emulsion explosives. He then moved through a number of roles including product/process support, sales, Quarry Services, Bulk Explosives operations, safety and manufacturing with ICI/Orica.

He has lived in most areas of Australia and has also worked in Global product/process roles and global bulk operations. Andrew has recently celebrated 33 years with ICI/Orica.

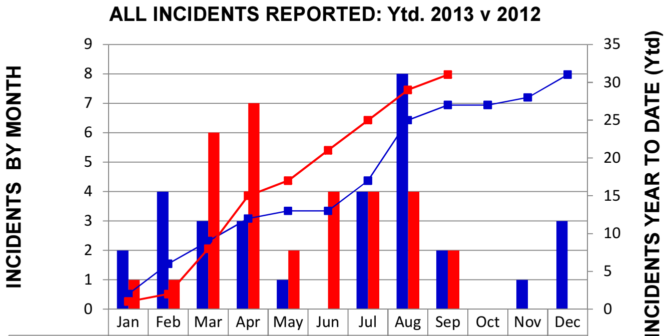
Andrew is married to Jenny and has three children. He enjoys swimming and fitness, wine collecting, military history and astronomy.

Incident Reporting

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

Monitoring our Reporting Performance

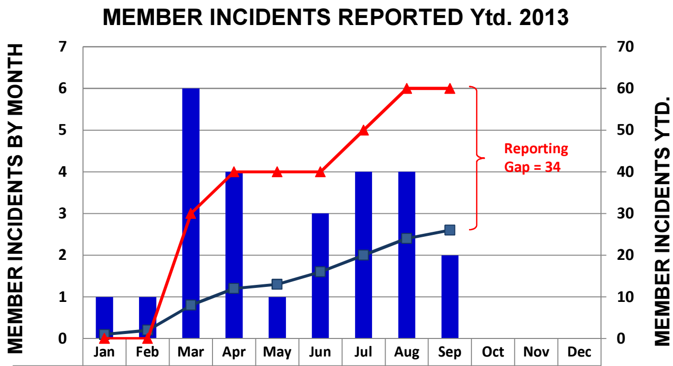
"Every incident that is reported may prevent another from occurring. You can save a life by reporting an incident - including a near-event."



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	2	4	3	3	1	0	4	8	2	0	1	3
2013	1	1	6	7	2	4	4	4	2			
Ytd 2012	2	6	9	12	13	13	17	25	27	27	28	31
Ytd 2013	1	2	8	15	17	21	25	29	31			

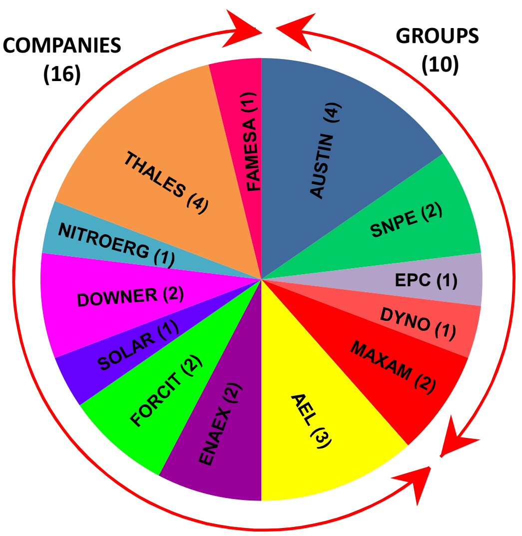
All the incidents reported. This chart compares the sum of non-member and member incidents reported to SAFEX every month this year to the previous year. We have reported 15% more incidents this year than in in the same period 2012. This does not necessarily imply we are having more events. Perhaps members have been more diligent in reporting incidents for which we are grateful. Every incident not reported is a lost learning opportunity. Remember, it's never too late to report an incident.

Member incidents reported. Because they give us the best learning opportunities, we track member incidents (MI's) separately 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 suggests that less than ½ our MI's are being reported.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013	1	1	6	4	1	3	4	4	2			
Ytd	1	2	8	12	13	16	20	24	26			
Par	0	0	30	40	40	40	50	60	60			

MEMBERS INCIDENT CONTRIBUTORS: Ytd. 2013



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. Single companies have reported 50% more incidents so far than the Groups despite the latter's superiority in operating units.

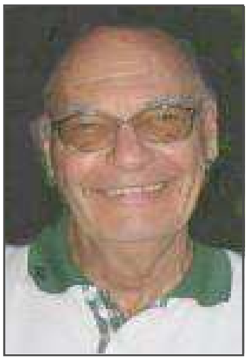
Meet our Workgroups and their Leaders

The SAFEX Workgroups are an integral part of SAFEX's service offering. One can describe them as the engine room of SAFEX's efforts to identify good explosives practices. They focus on specific areas where members have common health, safety or environmental (HS&E) concerns. In the Workgroups members pool experiences and resources to produce an outcome that reflects their collective knowledge for that area of concern. Typical outcomes include a standard, guideline or good practice that promotes ongoing safe operation in the area concerned. The Board of Governors has established the following Workgroups with the designated Workgroup Leaders. Piet Halliday is the Governor responsible for overseeing the performance of the Workgroups:

Good Explosives Practice (GEP) (Dr Martin Held – Austin International)
Explosives Traceability - Track and Trace (Dr Noel Hsu – Orica Mining Services)
Safe Technical Grade Ammonium Nitrate (TGAN) Storage (Dr Noel Hsu – Orica Mining Services)
Explosives Transport (Henry Merrick – AEL Mining Services)
Explosives Emulsion Manufacture (Dawie Mynhardt – BME South Africa)
Explosives Remediation/Decontamination (Mervyn Traut – Expert Panel Member)

Given the importance of the Workgroups, SAFEX Newsletter has been introducing our Workgroups and their Leaders to you in each edition. We have done so in alphabetical order of the Leaders and it is now the turn of Mervyn Traut.

Mervyn Traut – Explosives Remediation / Decontamination



Mervyn has his own consulting business having worked in various capacities primarily in the explosives field for more than 50 years. He occupied positions such as Explosives Laboratory Manager, Technical Officer, Explosives Production Manager and a General Manager of the AECI Somerset West site in South Africa. In this time he acquired knowledge and skills in decontamination, demolition, characterization and the remediation of explosives and chemical plants; explosives incident investigation; plant design; safety reviews of explosives operations and risk management. He has been drafting explosives operational standards/instructions and has led many audits. His intimate knowledge of the manufacture of NG, NC, PETN, Detonating Cord and Boosters has enabled him to train and mentor in these areas. His explosives characterisation and remediation work has included NG, nitrocotton, MNT/DNT/TNT, PETN, mercury fulminate, lead styphnate, lead azide, acids, asbestos and heavy metal contamination. Mervyn is a member of the SAFEX Expert Panel

The Remediation Workgroup and its Members

The Remediation Workgroup comprises the following core members:

- E van Dongen (AELMS)
- Vincent Maoeng (AELMS)
- Shane Pheasant (AELMS)
- Salah Al-Anazi (Saudi Chemicals)
- Markus Sigrist (Schweizerische Sprengstoff AG Cheddite)

The Workgroup was originally established in Madrid and although the group was small, it never really got momentum until it re-convened in Istanbul 3 years later. However, progress remained slow. Recently, the Workgroup has acquired several new members with a variety of expertise that will undoubtedly add impetus to its activities. We welcome the following new members and look forward to their contribution:

- Mick Cocks (EPC-UK)
- Padraig Gill (Irish Industrial Explosives)
- Antonin Kovarik (Austin Detonators)
- Neal Olsen (Dyno Nobel)
- Ian Swallow (BAE Systems)

Our aim is to bring together representatives of SAFEX member companies who are active in the characterisation and remediation of explosives contaminated areas/sites. While these representatives may have different background and skills, they all have a common objective. By participating in the same forum, Workgroup members will be able to share useful information with one another and their companies on the disciplines required to remediate explosives contaminated sites successfully.

Programme of Work

In Istanbul the Workgroup decided that the focus would be the development of a set of characterisation/remediation guidelines for use within the industry. Each member would contribute to the content using the knowledge and skills acquired through their experience. It was envisaged that these guidelines would be in a number of sections/ publications covering, but not be limited to, the following elements:

- Historical reviews.
- Pre-cleaning and decontamination of facilities and equipment
- Site investigation and data evaluation.
- Characterisation.
- Remedial options/techniques and the implementation and monitoring of these.
- Reporting and Land release.

Progress

At the last meeting, a concern was raised that different jurisdictions have different environmental regulatory regimes. While this may be so, remediation programmes are increasingly being based on risk assessments related to ultimate land use criteria. In the majority of cases, the basic principles and particularly the safety and health issues are very much the same. It was therefore felt by the participants that based on this, 80% of all base data could be covered in the set of guidelines.

The plan was to have these completed by the next SAFEX Congress in 2014. The Workgroup is currently finalising the draft Good Practice Guide on Historical Reviews and work on Pre-cleaning and decontamination has commenced. Progress has been slow due to difficulties in communicating remotely, demands of core members' full-time jobs and lack of critical mass prior to the advent of the recent additions to the Workgroup.

Appeal

Whilst the Workgroup Leader can and will facilitate the co-ordination of the information it is an impossible task to do it alone. For the process to gain momentum and for the information to become useful to all SAFEX members, there needs to be a core group of dedicated persons, empowered and supported by their companies who are able to meet and or communicate regularly and efficiently and carry this task forward by making meaningful contributions. Therefore, the Leader is making an urgent appeal for those who have the skills, experience and time, to offer their services as core members or contributors to the Workgroup. Participation should not be too demanding especially if there is a good response and the workload can be shared.

Should you wish to participate you may contact Mervyn directly by e-mail at trautmd@telkomsa.net or telephonically at +27 (0)21 8523689

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, Principal, 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 the response of typical roof and wall materials to the impact of debris from in the tests that were conducted.

SPIDER—A Test Series to Determine the Response of Typical Roof and Wall Materials to Debris Impact

by

Michael Swisdak (Senior Scientist, APT Research, Inc)

In order to differentiate between exposures in the open and in different types of buildings, explosive quantitative risk assessment (QRA) models rely on being able to accurately predict the likelihood of debris penetrating or perforating the roofs and walls of exposed sites (ES). Assuming the structure does not collapse, no other factor has as much effect on the risk to occupants of an ES as the nature of its construction. In 2004, the SPIDER (Science Panel Impact Data Evaluation and Review) program was established as part of the U.S. Department of Defense Explosives Safety Board (DDESB) Project ESKIMORE to determine the degree of protection that is provided by an ES for typical construction practices in the United States. Specifically, this program was designed to examine two key questions:

1. How are the material shape, type, mass, and velocity of debris used to predict perforation of and damage to specific roof and wall types?
2. What is the resultant hazard to occupants of an ES posed by fragment perforation and damage?

Prior to the start of the program, it was decided that one of the variables, impactor shape, would not be initially addressed and that a single shape would be employed for both the roof and wall tests. To ensure that debris orientation did not affect the results and to enhance the ability to model the events (since most predictive models have a difficult time handling more realistic debris shapes) it was decided that spherical impactors would be utilized. Except for cannon balls, it is doubtful that any debris would actually be spherical; however, as a first step, this minimizes variables coming from the impactor and allows better comparison of the construction of various wall and roof types. As will be explained, the results show how important shape of the impactor is with constructions such as sheet metal.

On both the roof and wall tests, two types of material, representing the most common types of explosion-produced debris, were utilized for the impactors—steel and concrete. The steel impactors used in the tests were commercially available, while the concrete impactors were prepared by the testing organization. A minimum compressive strength of at least 20.7 MPa was specified for the concrete.

On all tests, a distinction is made between perforation and penetration. The term perforation is used to indicate that the entire impactor passed through the target, whereas penetration refers to the impactor breaking the surface plane of the front face of the target (but not exiting through the rear face of the target).

On SPIDER 1, which examined roof impacts, it was further assumed that the only way that debris could reach a roof was via a trajectory with a high launch angle. Such material would have an impact velocity no greater than the terminal velocity of the material, which in all cases would be less than about 100 m/s. SPIDER 2, which investigated wall impacts, did not have this velocity restriction. The impacts considered on these tests could reach significantly higher velocities.

The following information was collected on each test: (1) impactor mass; (2) impact velocity; (3) perforation (yes/no); (4) if perforation occurred, the residual velocity of the impactor; and (5) characterization any spall that might have occurred. Prior to the start of the program, it was decided to characterize each impact in terms of the kinetic energy of the impactor. The goal was to try and determine the minimum kinetic energy at which perforation occurred. The kinetic energy was changed by varying either the impactor mass, velocity, or both.

SPIDER 1 was conducted in 2004 at the Energetic Materials Research and Testing Center (EMRTC), in Socorro, New Mexico (USA). All impactors were launched from a breechless powder gun. The test series examined impacts on typical roofing materials. The targets were:

- 4" (101.6mm) Reinforced Concrete – 4" (101.6mm) thick, one-way, simply supported 8' x 8' (2.44m x 2.44m) reinforced concrete slab constructed with 3000 psi (20.7 MPa) concrete and #3 rebar – 60 ksi (USA specification)/#10 rebar – 414 MPa (Metric specification) on 10" (254mm) centers, each way, with 0.75" (19mm) bottom cover.
- Plywood Panel – (2.44m x 2.44m) section with 0.5" (12.7mm) exterior plywood sheathing on 2" x 6" (51mm x 152mm) wood joists at 24" (610mm) spacing. Minimum 4" x 8" (102mm x 203mm) beams support the roof joists. Typical nailing, steel connectors, and built-up roofing materials were used.
- 22 gauge (0.711mm) Corrugated Metal Panel – 3'x 12' (0.91m x 3.66m) steel panels spanned one way over typical 8" x 2.5" x 14 gauge (203mm x 64mm x 14 gauge (2.108mm)) steel channels at 5' (1.5m) (nominal) spacing. The valleys of the corrugated steel panel were bolted to the flange of each of the three supports.

Figures 1, 2, and 3 below show photographs of the three types of targets.

***Figure 1:* Concrete target**

***Figure 2*: Panelized plywood target**

***Figure 3*.: Corrugated metal panel target**

SPIDER 2 was conducted in 2009 at the Redstone Technical Test Center (RTTC) (now Redstone Test Center (RTC)), in Huntsville, Alabama (USA). All impactors were launched from an air gun. This test series examined impacts on typical wall materials. The targets were:

- 5.5" (139.7mm) Reinforced Concrete – Nominal 9' x 9' (2.74m x 2.74m), 5.5" (139.7mm) thick, one-way simply supported reinforced concrete slab, with 4000 psi (27.6 MPa) concrete constructed with #5 rebar – 60 ksi (USA specification)/# 16 rebar – 414 MPa (Metric specification) on 16" (406mm) centers, each way, centered within the slab depth. The rebar began 6" (152.4mm) from the edges (free edge and edge of channel support, top and bottom) and provided 36 - 16" x 16" (406mm x 406mm) square targets framed by the rebar.
- 22 gauge (0.711mm) Corrugated Metal Panel – 3' x 12' (0.91m x 3.66m) steel panels spanned one way over typical 8" x 2.5" x 14 gauge (203mm x 64mm x 14 gauge (2.108mm)) steel channels at 5' (1.5m) (nominal) spacing. The valleys of the corrugated steel panel were bolted to the flange of each of the three supports.
- Unreinforced Concrete Masonry Unit (CMU) – 8" x 8" x 16" (203.2mm x 203.2mm x 406.4mm) standard lightweight CMU in a running bond, with #4 – 60ksi (#13 – 414 MPa) vertical rebar @ 24" (610mm) (every third cell). The wall was 6'8" (2.03m) wide x 8' (2.4m) tall with the outside vertical cores reinforced.
- 8" (203.2mm) Reinforced CMU – 8" x 8" x 16" " (203.2mm x 203.2mm x 406.4mm) standard lightweight CMU in a running bond, with #4 – 60ksi (#13 – 414 MPa) vertical rebar @ 16" (406mm) (every other cell). The wall is 8' (2.4m) wide x 8' (2.4m) tall with the outside vertical cores reinforced.

Table 1 summarizes the results that were obtained on the SPIDER 1 and SPIDER 2 test series. The Minimum perforation kinetic energy (KE) is the highest KE that did not result in perforation of the target. The Maximum perforation KE is the lowest KE that did result in a perforation. Another way of saying this is that the maximum KE that was deflected by the target in any of the tests becomes the minimum KE deflection capacity for the target, while the minimum KE that perforated the target in any test becomes maximum KE deflection capacity for the target. Any debris with a kinetic energy greater than the Maximum perforation KE will perforate the target and hazard interior spaces. Similarly, debris with kinetic energy less than the Minimum perforation KE will not be able to perforate the target and will not pose a hazard to the interior. Between these two levels, there may or may not be perforation.

The corrugated steel panels were much more resistant to perforation than pretest predictions indicated. Looking at the structural response of these panels, it appears that they undergo a membrane action type of response with very large deflections allowing the panel to

***Table 1*: SPIDER Threshold Perforation Energy Results**

Target Type	Target Material	Impactor Material	Perforation Kinetic Energy	
			Minimum (Joules)	Maximum (Joules)
Roof	Reinforced Concrete (101.6mm thick)	Concrete	12,326	28,242*
		Steel	9,355	11,832*
	Plywood Panel	Concrete	184	305
		Steel	54	156
	Corrugated Steel (22 gauge (0.711mm)	Concrete	3,064	4,848*
		Steel	1,356	1,647
Wall	Reinforced Concrete (139.7mm thick)	Concrete	99,309	110,205
		Steel	33,466	34,787
	Corrugated Steel (22 gauge (0.711mm)	Concrete	6,294	1,564
		Steel	3,650	1,300
	Unreinforced CMU	Concrete	5,866	6,951
		Steel	2,772	2,498
	Reinforced CMU	Concrete	25,539	28,408*
		Steel	18,998	20,710

*Threshold performation obtained (entire impactor did not pass through target)

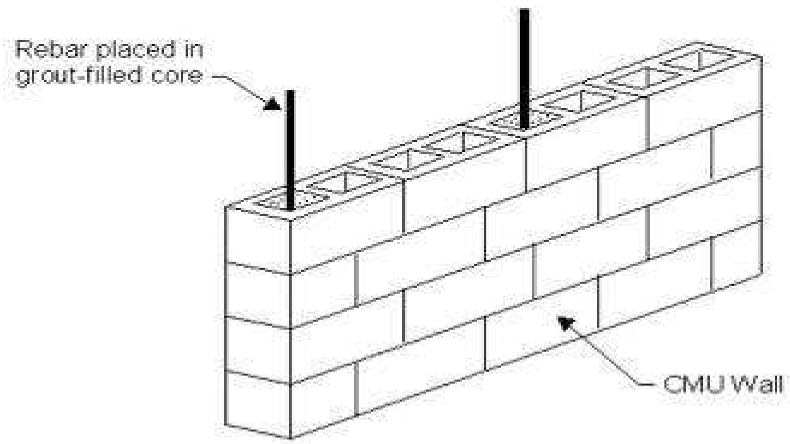


***Figure 4:* CMU Wall**

(Note: test wall used #4 rebar @ 24" (#13 @ 610mm) or 16" (#13 @ 406mm) on center as discussed above) resist perforation, given that a tear in the panel is not initiated (see Figure 5). However, in some tests the impactor perforated the panel at a much smaller KE and the damage was very localized. This seemed to be dependent on where the impactor struck the panel along the corrugation pattern (valley, ridge or transition region) and where the impactor struck the panel with respect to the support. If a tear in the panel was initiated, the impactor would perforate cleanly with minimal reduction in velocity.

***Figure 5*: Front and Back of Corrugated Metal Panel (Post-Impact)**

It must be noted, however, that all of these results are for spherical impactors; cylindrical or other shapes with sharp edges may have significantly different and variable results. Planning is already underway for SPIDER 3, which will examine the effect of impactor shape on the results that have been obtained thus far. One of the ultimate goals of this testing is to eventually develop perforation prediction models based on either unit kinetic energy or as a function of mass and velocity as independent variables.

This article has drawn heavily on the report prepared by Dr. Michelle Crull of the U.S. Army Corps of Engineers in Huntsville, AL (USA), that described and summarized the SPIDER 1 and SPIDER 2 testing (Crull, Michelle, "Science Panel Impact Debris Evaluation and Review (SPIDER) Test Program: SPIDER 1 and SPIDER 2," CEHNC-EDS-O-11-03, November 2011).

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.

SAFEX Newsletter is delighted to bring our readers another contribution from CERL, Natural Resources Canada.

Effect of Elevated Temperature on the Minimum Burning Pressure of Ammonium Nitrate Emulsions

by

C. Badeen, S. Goldthorp, C. Iyogun, R. Turcotte (CERL, Natural Resources Canada, Ottawa, ON, Canada)
S.K. Chan (Orica Ltd., Brownsburg-Chatham, QC, Canada)

Introduction

Sustained combustion in water-based ammonium nitrate emulsions (ANEs) does not occur if the pressure is below some threshold value. This is referred to as the minimum burning pressure (MBP). Within the commercial explosives industry, the MBP concept is often used to estimate safe operating pressures and to establish engineering controls for safety in the manufacturing, processing and handling of ANEs.

MBP related research has been ongoing at the Canadian Explosives Research Laboratory (CERL) [1]. The technique to determine the MBP was originally pioneered at C-I-L Inc. in the 1970s [2] with the current MBP methodology being established for ANEs more recently at CERL [3-11]. The MBP for a number of typical commercial ANEs have been

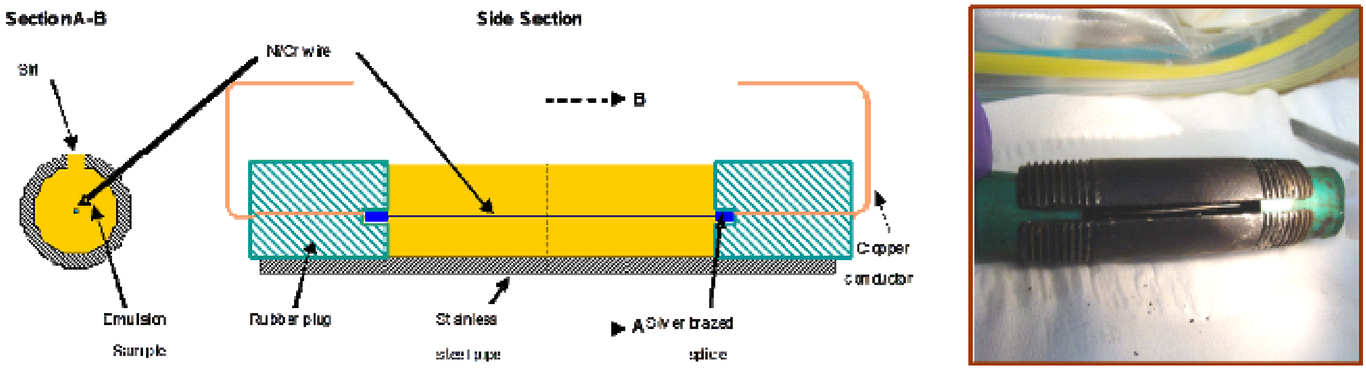


***Figure 1**: Room temperature MBP test cell configuration*

quantified using this newly developed methodology and it has been determined that the MBP depends critically on major ingredients and a variety of physical characteristics [7, 9, 10]. With respect to process hazards, it is important to identify any variable that may influence the MBP. Presently, MBP testing is conducted at or near room temperature using a localized source of thermal ignition. It has been demonstrated that the MBP does not vary appreciably when testing is conducted at temperatures in the range from 20 to 75 °C [9]. There is, however, uncertainty whether the MBP of an ANE at or near room temperature ignited locally is different than that of an ANE ignited at somewhat elevated temperatures upon exposure to a much larger thermal source such as a fire. Fire engulfment scenarios are very real possibilities within the industry so it is important to establish how product temperature can influence the MBP.

In a recent study, three typical ANEs, representative of those commonly used within the industry, were selected and manufactured in small quantities at CERL. In a first step, the room temperature MBP for each of the freshly prepared ANEs was determined. These measurements were followed by measurements of the MBP of the same emulsions heated in-situ to an elevated temperature of 150°C. This paper outlines the modifications made to the testing apparatus and peripherals and changes to the current MBP methodology to accommodate heating the sample in-situ to elevated temperatures. Some experimental challenges encountered will be highlighted and procedural modifications to overcome them will be discussed. Room temperature MBP data will be presented and the influence of elevated temperature on both the MBP and the observed burning rate will be discussed.

Experimental

The three ANEs (labeled A to C hereafter) investigated in this study were prepared in-house using a procedure already described elsewhere [1, 4]. Emulsion A and B are representative of bulk emulsions typically used in surface mining applications. Emulsion C is more representative of a packaged type commercial product used in a variety of mining and construction applications. All three emulsions had the same overall mass percentage of oil phase in the finished product but varying oil phase ingredients. The ingredients comprising the oxidizer phase for Emulsion A and B were nearly identical. For the packaged type Emulsion C, some of the ammonium nitrate was substituted for sodium nitrate in the oxidizer phase and the overall water content was significantly lower than for A and B. Each of the ANEs prepared were characterized to compare with physical properties of previously manufactured and tested emulsion products. Density, viscosity, water content and refinement were measured using standard methods [1, 4]. To closely replicate conditions of manufacture and handling, MBP testing was conducted on freshly manufactured product.

As developed at CERL in recent years, the room temperature MBP test cell is a cylindrical stainless steel nipple 7.6 cm in length with an inside diameter of 1.6 cm (see Figure 1 above). Each test cell has a 3-mm wide slit machined along the axis to allow combustion gases to escape during testing. Each test cell is painted with non-conductive high-heat paint. The hotwire ignition assembly, which has been described in detail elsewhere [7-10], is held firmly within the test cell by pre-drilled Neoprene stoppers (No. 0) placed in the ends of the test cell. The copper conductors and splice connector of the hotwire ignition assembly are imbedded in the plugs and only the ignition hotwire is in direct contact with the emulsion sample. The test cell and ignition assembly is positioned horizontally within the pressure vessel.

For the elevated temperature MBP measurements, a new test cell was fashioned to permit in-situ heating of the emulsion (see Figure 2 on next page). The test cell was machined from a block of 316 stainless steel having a cylindrically shaped internal diameter identical to the standard room temperature MBP test cell (1.6 cm dia.) machined lengthwise through the block. Similar to the room temperature test cells, a 3-mm wide slit is machined along the length of this test cell to permit placement of the ignition wire assembly and to allow combustion gases to freely exit the test cell.

The two exterior sides of the elevated temperature MBP test cell block are each outfitted with a like dimensioned polyimide film insulated flexible heater rated to 200°C capable of providing 1.55W/cm^2 at 115VAC. Each heater is adhered to the test cell by spreading a thin coating of thermally conductive paste on each of the side walls and

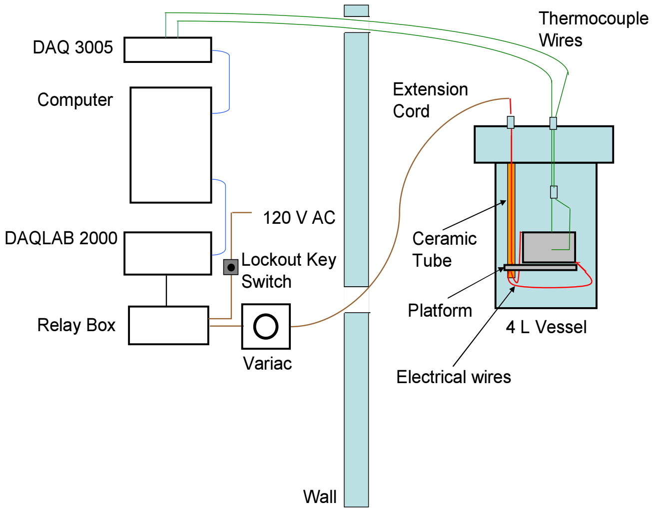


***Figure 2**: elevated temperature MBP test cell configuration*

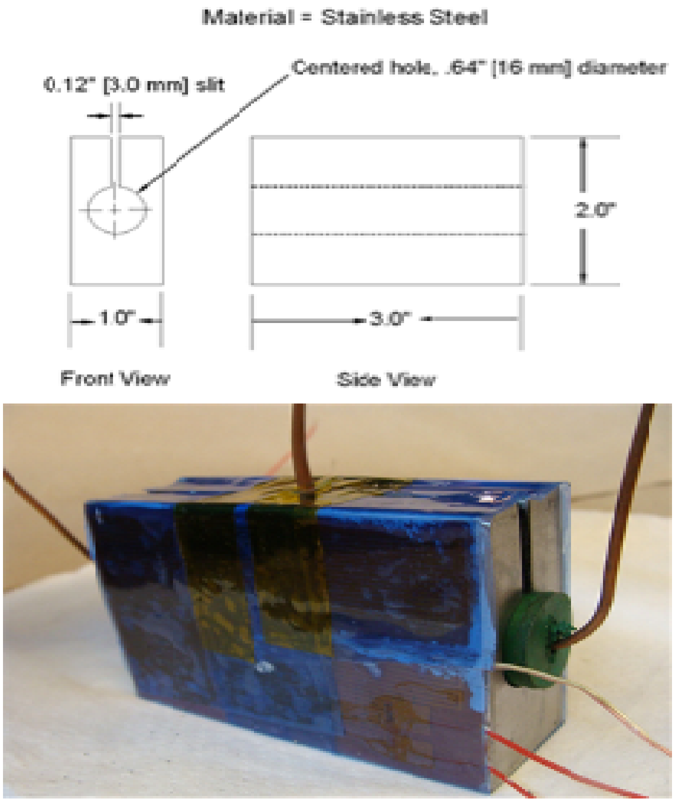


***Figure 3**: Elevated temperature MBP apparatus and heating system (The ignition system was omitted for clarity).*

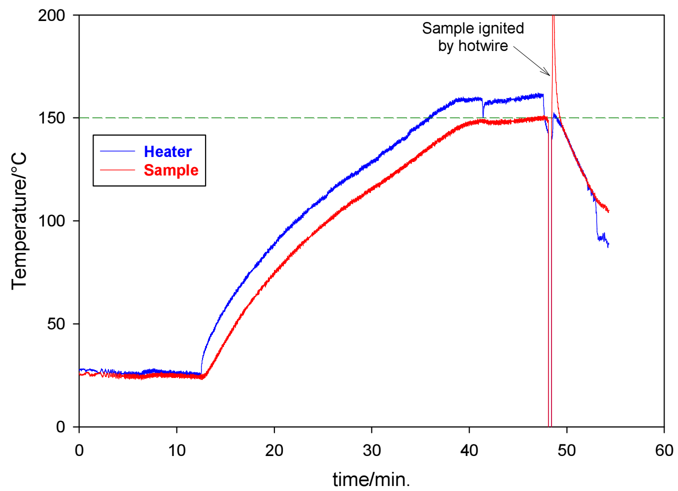


***Figure 4**: Typical heating curve obtained for Emulsion A maintained at 2.86 MPa (400 psig)*

pressing the heater in place ensuring that the lead wires are positioned at the bottom of the cell. The heaters are then taped in place using a high temperature polyester tape rated to >200°C. The same pressure vessel is used for both room temperature and elevated temperature MBP measurements; however, some modifications to the vessel were required to facilitate elevated temperature MBP testing. A schematic of the testing apparatus and heating system is presented in Figure 3. A multi-element electrical feed-through was installed to supply power to the heater assembly. Inside the pressure vessel, the electrical conductors are threaded through a long ceramic sleeve which provides protection from the hot combustion products. The electrical leads from each of the heaters are connected to electrical conductors which are connected outside of the pressure vessel to a VARIAC variable voltage transformer. For safety, AC power to the VARIAC is locked out with a key controlled relay so that power cannot be supplied to the heaters while an operator is inside the room that contains the pressure vessel. Also, a thermocouple feed-through was installed to permit monitoring of both the sample and heater temperatures, which served as input to the heater control program. The sample and heater thermocouples positioned within the pressure vessel are connected to the thermocouple feed-through which is connected to a data acquisition system using thermocouple extension wires.

The ignition assembly and ANE are loaded into the test cell as described elsewhere [8]. The test cell is seated and secured on the vessel's platform in a horizontal position. The sample thermocouple is inserted into the centre of the sample and secured in place. The heater thermocouple is placed and secured onto one heater face between the tape and the heater, at the centre of the sample corridor in proximity to the sample thermocouple. Thermocouple data is collected using a DAQ 3005 series data acquisition module (Omega) interfaced with a computer. Temperatures are logged separately and can be used for diagnostic purposes and to determine heating rates during the test. A typical heating curve for Emulsion A is shown in Figure 4. The room temperature MBP data acquisition program (Dasylab® software) has been enhanced to incorporate heater controls. Sample and heater temperature and the heating rate are displayed in the program, allowing the user to manually control the sample temperature and heating rate by adjusting the VARIAC's voltage supplied to the test cell heaters.

The MBP measurement methodology has been described in detail elsewhere [3]. With respect to elevated temperature MBP measurements, the methodology is nearly identical except that the sample is preheated to 150°C (at 5 – 10°C min-1 up to 130°C and 1 - 2°C min-1 from 130 to 150°C) prior to igniting the sample with the hotwire. The MBP is taken as the average between the pressure of the highest no-go event and that of the lowest go event [3].

Results and Discussion

MBP results for Emulsion A, containing 16.9 mass % of water, are presented in Figure 5. It should be stressed again that only events for which the sample burns fully are considered positive in the MBP determination. At room temperature, the measured MBP was therefore 7.52 ± 0.18 MPa. From Figure 5, it is obvious that this MBP value was significantly lowered by elevating the testing temperature to 150°C. The elevated temperature MBP is 3.27 ± 0.09 MPa, about 60% lower than the MBP at room temperature for the same sample.

Emulsion B had a water content of 15.3%. Its room temperature MBP was consistently measured to be lower than that of Emulsion A at 6.22 ± 0.10 MPa (see Figure 5). This was expected due to the lower water content [10]. This value was also significantly lowered by elevating the initial testing temperature to 150°C. The elevated temperature MBP is 3.43 ± 0.10 MPa, almost 45% lower than the MBP at room temperature for the same sample.

Emulsion C is a packaged type ANE product with lower water content (9.3 mass %) than Emulsion A and B. The results for this product are shown in Figure 6. Its room temperature MBP was 1.57 ± 0.09 MPa. In the present study, the MBP of Emulsion C, preheated to 150°C, was very low (~0.45 MPa). Recent work at CERL quantified the vapour pressure of a number of ANEs using accelerating rate calorimetry (ARC). Since the vapour pressure of the emulsion at 150°C is expected to be close to the MBP testing pressure for Emulsion C, it was apparent that appreciable water losses would occur and could measurably influence the MBP. To quantify water losses expected when testing at elevated temperature, the water content of Emulsion C was assessed experimentally at various testing pressures. Firstly, it was verified that when Emulsion C was pressurized to 2 MPa and was heated and maintained at 150°C for a few minutes, no water losses resulted. When the same experiment was repeated with the sample pressurized to 0.70 MPa, about 1 % water losses were measured after the sample was let to cool down and was depressurised. It was therefore decided to pressurize the sample to 2 MPa while heating to 150°C, then depressurize the sample to the testing pressure (0.4-0.7 MPa) and quickly ignite it. This procedure was found to limit the water losses at the moment of ignition to about 0.5%. The water content was determined by the Karl Fisher titration method.

It is therefore evident that some water loss did occur at testing pressures near the vapour pressure of the emulsion at 150°C. Therefore the measured MBP value in this case would appear artificially lower than it would be without water losses. In the case of Emulsion A and B, the MBP for both ANEs was well above the vapour pressure of the emulsions at 150°C so it is expected that negligible water losses would occur and the MBP measured would not be duly influenced by this effect.

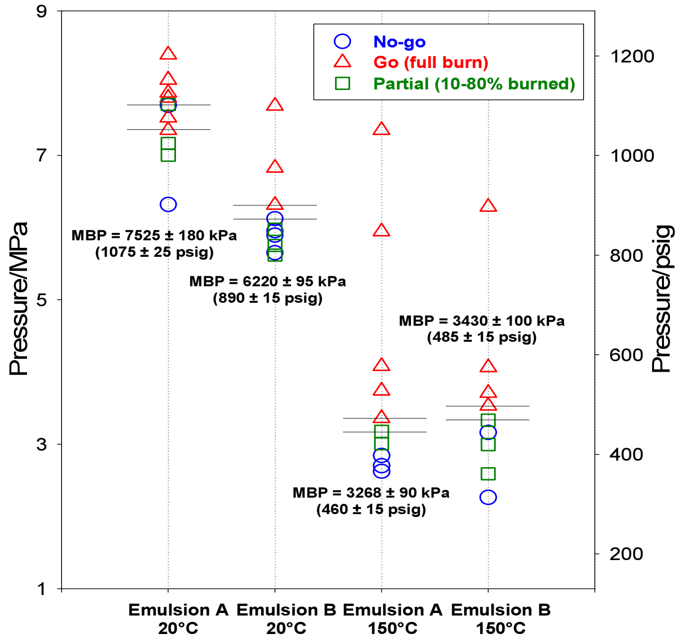


***Figure 5** (above): MBP of Emulsion A and B*

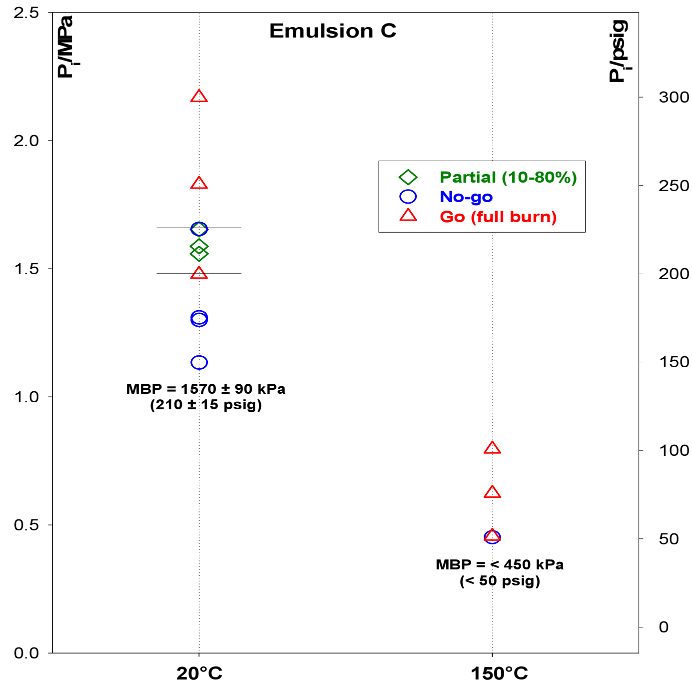


***Figure 6** (above) : MBP of Emulsion C*

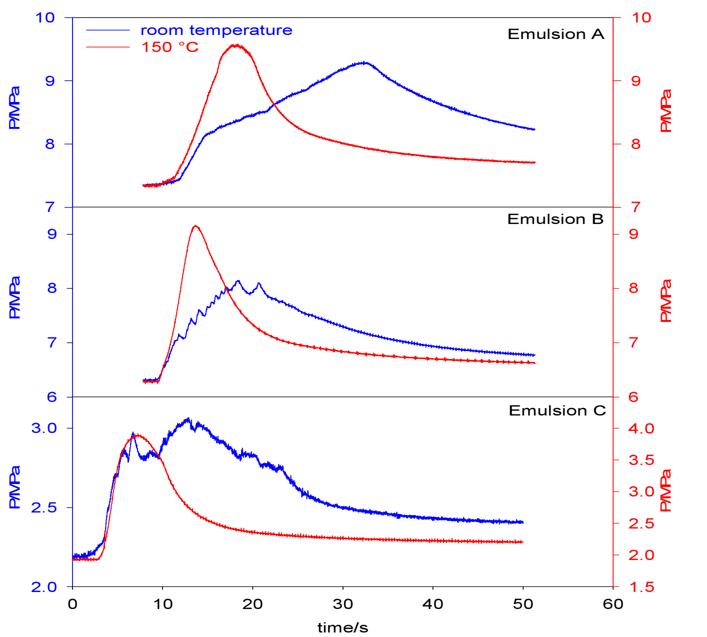


Figure 7: Combustion profiles for ANEs at room temperature and 150°C

Since the elevated temperature appeared to have a large effect on the measured MBP, it was though that maybe some of this effect was caused by the different test cell at high temperature which possibly offered somewhat higher confinement. This was verified by performing repeated room temperature MBP tests on Emulsion A using the high temperature cell. These tests were performed at an initial pressure of 6.3 MPa (900 psig) and, in all cases, Emulsion A could not be ignited to sustained burning. This result is consistent with that obtained in the room temperature test cell at room temperature (Fig. 5). Therefore, the decrease in the MBP appears to be due mostly to the elevated temperature (150° C). It appears that the elevated temperature increases the ability of the emulsion to propagate a deflagration.

When the pressure is above the MBP and ignition has occurred, ANEs undergo normal combustion with a measurable burn rate. In Figure 7, combustion profiles (pressure vs. time) for all three emulsions tested above their MBP's are presented. From Figure 7 on the previous page, it is evident that, at a given initial pressure, the burn rate is much faster when the sample is ignited at 150°C. The time to ignition (t_{ig}) is comparable for both initial sample temperatures in each emulsion but the time to achieve the maximum pressure (P_{max}) or full combustion of the sample at rom temperature is a factor of 2 or greater in all three emulsions tested

Conclusions

Three ANEs were manufactured at CERL and the MBP at room temperature and an elevated testing temperature of 150°C were determined. These measurements were performed through the design of a new in-situ heating test cell (Fig. 2) having identical internal dimensions as a different room temperature MBP test cell (Fig. 1) which was used in routine MBP measurements over the last few years [7-11.] A modified MBP methodology for heating samples above room temperature was developed and evaluated.

Water losses for ANEs heated to elevated temperatures while maintained under pressure were quantified. For the ANE product (Emulsion C) with an MBP near the vapour pressure of the product at the testing temperature of 150°C, a modified heating and pressurization regime was used to limit water losses at the lower pressures being investigated. Using a modified heating andpressurization procedure, water losses in Emulsion C tested at 150°C were determined to be less than 1%. The other ANEs being investigated had MBPs well above the vapour pressure of the products at 150°C; water losses at higher testing pressures were expected to be negligible and did not influence the MBP as reported.

For all three ANEs a large decrease in the MBP value was observed in tests conducted at 150°C. Complementary tests have demonstrated that this large effect was not due to the fact that a different test cell had been used. Therefore, it appears that elevated temperature increases the ability of the ANEs to propagate a deflagration. Since no such effect was observed earlier between 20 and 75 °C [9], it appears that some temperature threshold is required before this effect becomes significant and, therefore, measurable.

Since the MBP is presently used by the industry as a measure of process and handling safety, it is important to identify any variable which may influence the MBP of ANEs. The elevated testing temperature of 150°C could be representative of temperatures encountered in the early stage of a fire. In the present tests, the elevated temperature of 150°C reduced the MBP by more than 40% for all three emulsions. Also, initial temperature clearly affected the burn rate. Based on pressure data, each of the ANEs, when preheated to 150°C, exhibited much faster burn rates than the same product tested at room temperature at identical testing pressures. In a fire scenario, ANE product ignited at elevated temperature could undergo rapid decomposition with catastrophic consequences. The significant reductions in MBP and the increases in burning rate were not anticipated and the mechanism for these effects has not yet been explained. Further work will be conducted to quantify the effects of intermediate temperatures on the MBP in an attempt to explain the observed effects.

Acknowledgements

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Our Explosives Regulatory World

Different jurisdictions often have different regulatory issues which are best dealt with at a local level. Therefore, SAFEX believes its Corporate Associate Members that represent local manufacturers are best placed to attend to such issues in conjunction with local regulatory authorities. Nonetheless, SAFEX sees regulators as vital collaborators in its quest to eliminate harm from explosives incidents and encourages contributions from them which it will publish in this feature. This feature will also include correspondence and regulatory material that may be of general interest to readers.

Risk Management and the Risk Control Hierarchy

by

Geoff Downs (Chief Inspector of Explosives, 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.

I attended the International Chief Inspectors conference in Spain in early April this year where there were many good presentations on incidents and investigations. In some of the presentations the recommended solutions did not appear to be using the principles and approaches of risk control measures. The recommendations were using what we call lower level risk control measures. As we should always be striving to recommend a suite of risk control measures that are as effective as possible, it means identifying the highest level of risk control measures from the Risk Control Hierarchy.

The Queensland approach is based on using the Risk Control Hierarchy as an essential tool for determining, promulgating, reviewing and assessing the appropriateness of risk control measures. The Risk Control Hierarchy is very powerful for determining the most effective control measures because the concept is so simple and yet so effective. It has wide application across the board from the simplest of tasks to the more complex of risk assessment studies in the design of complex manufacturing processes. As I recall, the Risk Control Hierarchy had its beginning about 20 years ago in occupational health and safety where risk assessments were being applied in the area of hazardous substances.

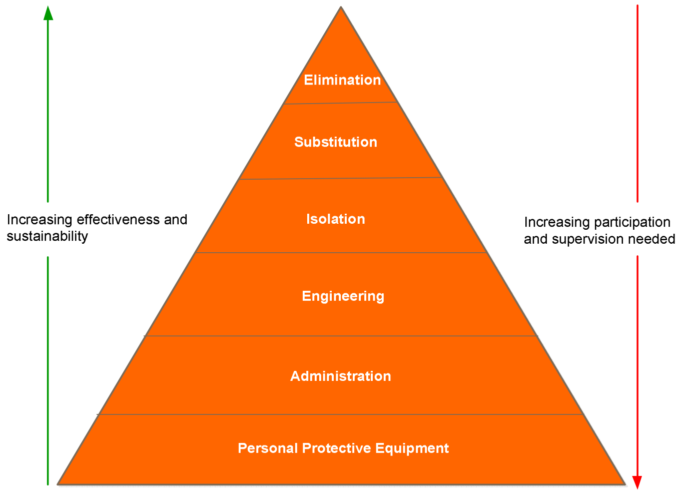
The Risk Control Hierarchy we use is the six level risk control hierarchy that can be diagrammatically illustrated in Figure 1 on the next page and summarised as follows:

- **Elimination** - the most effective method is to remover the hazard completely
- **Substitution** - replace the hazard with a lesser hazard
- **Isolation** - isolate the hazard
- **Engineering** - make changes to the process, equipment or plant to reduce the hazard
- **Administration** - establish policies or procedures to minimise the risk
- **Personal Protective Equipment** - provide a barrier between the wearer and the hazard

The principle is that the higher up the Risk Control Hierarchy one goes in determining the controls, the better the outcome. The higher up the hierarchy we go, the better the effectiveness and sustainability and the lower down the hierarchy we go, the more participation and supervision is needed. A brief discussion on the elements of the six element risk control hierarchy is:

- **Elimination** is difficult to achieve if we need explosives, but the elimination of an explosive and using a substance that is not an explosive can be a form of elimination. It can also be seen as a form of substitution also.
- **Substitution** can involve finding an alternative with lesser hazards, i.e. safer from the perspective of response to stimuli from friction, impact, static and heat. An example is using safer explosives such as emulsions. Substitution can also include using products with reduced impacts and consequences, lower velocities of detonation, or reduced quantities.
- **Isolation** is about keeping people and explosives, dangerous goods, hazardous materials, etc. apart. Distance is your friend. Examples of isolation include self-closing boxes to minimise exposure of heat sensitive compositions, barriers, shields and walls. In a manufacturing process, people in unrelated processes must not be exposed to the hazard from the adjacent process. Maintaining separation distances of process buildings and magazines is also about isolation.
- **Engineering.** Machines are more reliable, accurate and don't fatigue as quickly as people. The use of tools, plant machinery, equipment, gates, locks, fences, sensors, alarms, etc. are more effective control measures than administrative controls.
- **Administration** involves procedures and work instructions to be followed by people. We know that humans make mistakes and at times do not follow the approved procedures. The reliability of people dictates that going higher up the risk control hierarchy will give a more successful control measure.
- **Personal Protective Equipment** (PPE) is regarded as the lowest level of control. Direct exposure of people to risk by the use of PPE is not sustainable particularly when the people are exposed to the risk for long periods.

The brief explanation of the principles of the Risk Control Hierarchy is only applicable to the six level control hierarchy described. There are many risk control hierarchies in existence. A search within literature and even on the web will show that there are many different types of risk control hierarchies. There is no right or wrong control hierarchy as it depends upon the nature of the activities and its appropriateness and suitability to the activity in review. There are five level hierarchies, two different six level hierarchies, and so on. In the Bray Park Fireworks Tragedy investigation report, a 13 element risk control hierarchy was published. However, the six element risk control hierarchy described above seems to be the most common in use.



<u>Figure 1</u>: Diagrammatic representation of the Risk Control Hierarchy

When we use the Risk Control Hierarchy in conjunction with other risk management strategies such as the Swiss Cheese model, we find that we have a very robust underpinning approach to managing risk effectively. When we are determining the risk control measures for an activity, we employ a number of risk control measures. These can involve a combination of a number of administrative controls, engineering controls, isolation and perhaps substitution. For this part of risk management, we have embraced the Swiss Cheese Model of Professor James Reason. The principles behind this are that to prevent accidents and incidents, we must employ a number of barriers and defences. Each barrier or defence is not inherently reliable and like a piece of Swiss Cheese has holes in it but these holes are dynamic. The holes can shrink and expand or appear and disappear depending upon the prevailing conditions and circumstances. When the holes line up, an accident or incident occurs. The more barriers and the better control on the holes in the Swiss cheese, the less likely an incident or accident will occur. Each barrier and defence should be determined in terms of the risk control to arrive at the optimised set of barriers and defences to ensure the acceptable level of risk for the activity or process.

To illustrate the Swiss Cheese Model, I have provided the example of the approach the Queensland Explosives Inspectorate adopts as illustrated in (Figure 2 on the next page)

What do we expect in the pursuit of an acceptable level of risk.

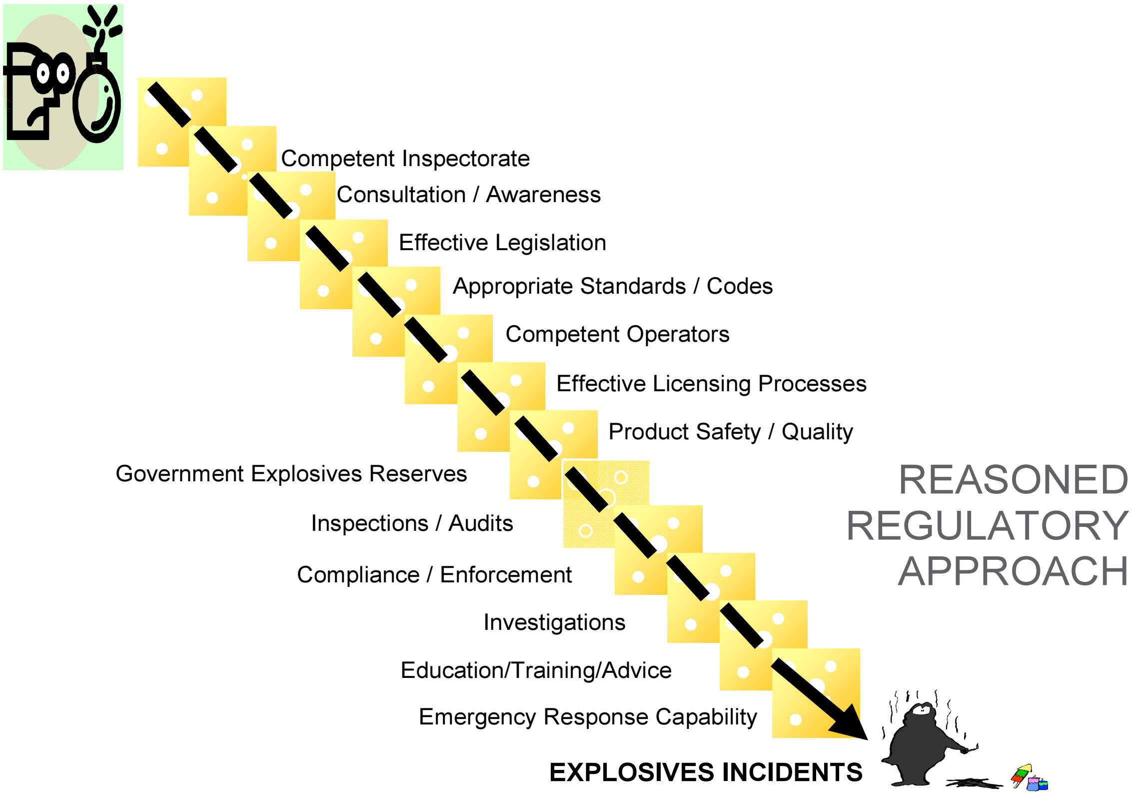
When you are developing a safety management system and security plan for your explosives related activities, we are looking to see that you have applied suitable and appropriate risk control measures adopting the higher level of control measures where appropriate in conjunction with the Swiss Cheese Model.

When we publish safety alerts and security alerts and we recommend that you review your safety management system and security plan, we are saying you should be using the Risk

Control Hierarchy in conjunction with the Swiss Cheese model to review and if applicable update your practices to re-establish an acceptable of risk.

In conclusion, we believe by following this approach, you will make a significant contribution to good practice in the management of risk in the explosives industries.

Figure 2: Queensland Explosives Inspectorate strategies for explosives incident prevention and risk minimisation



IME Asks CRS to Correct Report on Ammonium Nitrate

SAFEX Newsletter has from time to time published articles and correspondence on the use of technical grade ammonium nitrate (TGAN) in explosives manufacture in an attempt to dispel the notion that pure ammonium nitrate is an explosive. This is in addition to the sterling work the SAFEX TGAN Workgroup is doing in developing good practices for the handling of TGAN.

Recently the Institute of Makers of Explosives (IME) wrote to the director of the Congressional Research Service (CRS) to request that statements in a recent report, entitled "Regulation of Fertilizers: Ammonium Nitrate and Anhydrous Ammonia" be corrected or clarified. The report misstated facts about commercial use and hazards associated with ammonium nitrate. CRS is the research arm of Congress. Its reports are valued for synthesizing information about issues before Congress. As a further contribution to the ammonium nitrate discussion we are grateful for permission to publish the IME letter in full:

IME

institute of makers of explosives

The safety and security institute of the commercial explosives industry since 1913

July 29, 2013

Mary B. Mazanec
Director
Congressional Research Service
Library of Congress
Washington, DC

Dear Ms. Mazanec:

On behalf of the Institute of Makers of Explosives (IME) *(Note 1)*, I am writing to alert you to incorrect, misleading or incomplete statements in a report prepared earlier this year by the Congressional Research Service (CRS) entitled, "*Regulation of Fertilizers: Ammonium Nitrate and Anhydrous Ammonia*" (Report) *(Note 2)*. The report was written in the aftermath of the industrial accident at the West Fertilizer plant in West, TX.

Interest of the IME

IME member companies use billions of pounds of ammonium nitrate (AN) annually in the production of high explosives and blasting agents. There is no viable substitute for this material short of reverting to the use of nitroglycerine-based explosives, which the industry transitioned from on a wide scale in the last century for reasons of safety. The "technical grade" AN (TGAN) used in our industry has the same chemistry as the AN used by the agricultural industry; both are classified as a Division 5.1 oxidizer. Managed properly, AN is a stable, reliable raw material that has played a significant role in our industry's quest to produce less sensitive, more effective explosives.

We have felt the tragedy of West, TX in a personal way. Two of the emergency responders who perished in the West, TX incident were an employee and the son of another employee of one of our member companies. We are as anxious as any to learn from this event and to take action to ensure that a similar tragedy never again occurs.

Reported Incorrect, Misleading or Incomplete Statements

The report states that AN is "primarily used as a fertilizer." Our industry used approximately 73 percent of all AN consumed last year in the United States. This number, in comparison to the amount used by the agricultural sector, has been increasing. Of the eight plants that manufacture AN in the United States, six produce only TGAN for our industry, and two split production between the agricultural and explosives markets.

The report states that Department of Homeland Security (DHS) lists two formulations of AN in the list of chemicals of interest (COI) under its Chemical Facility Anti-Terrorism Standards (CFATS); "one used as a blasting agent, the other as fertilizer." While the COI list includes these two entries, the statement that the first is used as a "blasting agent" is incorrect. There is no commercial market for this classification of AN. DHS took this entry from the list of materials the US Department of Transportation (DOT) classifies as "hazardous." DHS included on its COI list all specifically named materials that DOT classifies as Division 1.1 explosives. DOT provides a hazard classification of Division 1.1 for AN "with more than 0.2 percent combustible substances." The Division 1.1 classification is the highest risk classification for explosive materials. It would only be used if AN had been contaminated with an unknown substance. In this instance, DOT would require the Division 1.1 classification. DOT classifies AN-based blasting agents as Division 1.5, and as noted above, there is no chemical difference between the AN used by our industry and that used by the fertilizer industry; both are classified as Division 5.1 oxidizers. The one distinguishable difference between the two commercial forms is that the density of TGAN is lower.

The report references the tragic 1947 AN explosive in Texas City, TX. However, the report fails to note that the AN fertilizer involved in this incident was coated with wax and stored in paper bags; both sources of fuel. As a result of this accident, industry ceased using this type of wax coating. Additionally, TGAN is not marketed in paper bags. The smallest packaging used for TGAN is a 1-ton, non-paper intermediate bulk container.

In our view, the most relevant rules that we believe would have made a difference in the West Fertilizer plant explosives are those promulgated by OSHA at 29 CFR 1910.109(i). While the report includes a one-paragraph summary of the regulatory paragraph, it fails to note that this is the one paragraph in OSHA's standard that applies to the storage of fertilizer grade AN and that "all persons storing [AN] in quantities of 1,000 pounds or more" are subject to the requirements.

Conclusion

We understand the high level of congressional interest in AN following the West, TX tragedy. We recognize the important role of CRS in providing actionable information on pressing issues of the day. We ask that you make editorial corrections to the referenced CRS report. Please consider IME a resource if additional research concerning AN or explosive materials is needed.

Please contact me if you have any questions.

Respectfully,

Cynthia Hilton

Cynthia Hilton
Executive Vice President

Note1: IME is the safety and security institute of the commercial explosives industry. Our mission is to promote safety and the protection of employees, users, the public and the environment; and to encourage the adoption of uniform rules and regulations in the manufacture, transportation, storage, handling, use and disposal of explosive materials used in blasting and other essential operations. The Institute does not sponsor trade shows or other marketing events.

Note 2: CRS 7-5700, R43070, May 14, 2013.

IME Responds to Agency Best Practice Request for Handling Ammonium Nitrate

In the aftermath of the West, TX tragedy, a USA interagency task force is looking for recommendations of best practices to ensure the safety and security of ammonium nitrate. At the request of EPA, IME prepared Guidelines covering regulations and best practices for the manufacture, storage, and transportation of ammonium nitrate. In the transmittal letter to EPA, which SAFEX Newsletter is pleased to publish below, the IME also offers to distribute the work product of the interagency task force to members and those with whom it conducts ammonium nitrate business. The Guidelines can be viewed on the IME website at http://www.ime.org/userfiles/files/AN%20Guidelines30July13(Final).pdf . The IME makes the point: "One of the messages that should be understood from the Guidelines is that there are a lot of rules already in place on AN. We don't need a new program to keep this material safe."

At this point it may be relevant to remind readers of the SAFEX publication "*Good Practice Guide: Storage of Technical Grade Ammonium Nitrate*" produced by the SAFEX TGAN Workgroup which has enjoyed widespread acceptance. If you require a copy kindly contact the SAFEX Secretariat at secretariat@safex-international.org

IME
institute of makers of explosives

The safety and security institute of the commercial explosives industry since 1913

July 30, 2013

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Washington, DC 20460

Dear Mr. Stanton, Mr. Matthiessen, and Ms. Jennings
On behalf of the Institute of Makers of Explosives (IME), I am responding to your request for recommendations based on industry best practices that could be used to further the work of an interagency task group engaged in updating the "Chemical Alert on the Explosive Hazards of Ammonium Nitrate" (Alert) issued by the US Environmental Protection Agency (EPA) in 1997.

We appreciate your invitation inasmuch as IME member companies use billions of pounds of ammonium nitrate (AN) annually in the production of high explosives and blasting agents. There is no viable substitute for this material short of reverting to the use of nitroglycerine-based explosives, which the industry transitioned from on a wide scale in the last century for reasons of safety. The "technical grade" AN (TGAN) used in our industry has the same chemistry as the AN used by the agricultural industry; both are classified as a Division 5.1 oxidizer.

As mentioned at our meeting on July 8, 2013, our industry used approximately 73 percent of all AN consumed last year in the United States. This number, in comparison to the amount used by the agricultural sector, has been increasing. Of the eight plants that manufacture AN in the United States, six produce only TGAN for our industry, and two split production between the agricultural and explosives markets. Managed properly, AN is a stable, reliable raw material that has played a significant role in our industry's quest to produce less sensitive, more effective explosives.

Lessons Learned from West, TX

We are as anxious as any to learn from the industrial accident at the West Fertilizer plant in West, TX and to take action to ensure that a similar tragedy never again occurs. While we await the results of investigations to assess the adequacy of current rules and industry best practices for the safe and secure handling of AN, the West Fertilizer incident did uncover a disturbing lack of compliance by this facility. According to reports, inspections by the Occupational Safety and Health Administration (OSHA), the U.S. Department of Transportation (DOT), and EPA revealed noncompliance with certain key chemical safety requirements; and had the U.S. Department of Homeland Security (DHS) been aware of the facility, additional charges of noncompliance with chemical security rules would have resulted.

Our historical review of accidental detonations of AN and the absence of definitive findings from on-going investigations into the West Fertilizer incident suggest that, had the facility been compliant with existing regulations, the tragedy would not have happened. While we have no reason to doubt the sufficiency of rules at this time, the incident does raise the specter that there may be any number of chemical facilities in the country, known or unknown to federal regulators, where a pattern of habitual noncompliance is the modus operandi – facilities we term "outliers."

The regulated community expects that federal agencies will enforce the requirements they impose through regulation. It is the government, not the private sector, that has the ability through its regulatory authority to level the playing field so that competitive advantage is not a reward for cutting safety and security corners. Identifying chemical facility outliers and ensuring that that they are compliant should be a priority task for government.

Guidance for the Safe and Secure Storage and Handling of Ammonium Nitrate

Regulatory "enforcement" should be comprised of options ranging from compliance assistance, to warning letters, to civil fines and criminal penalties. The Alert's use as a compliance assistance tool will be enhanced by the interagency task group's effort to update and distribute the document to the regulated community. We support this initiative and commend you for your effort to incorporate industry best practices related to the safe and secure storage and handling of AN.

Given the scope of the regulatory authorities represented by the agencies participating in the interagency task group, we view EPA's instant request as an attempt to identify appropriate "cradle to grave" management practices for AN. As originally written, the Alert was a response to a manufacturing plant accident. West Fertilizer, however, was a storage facility.

Rather than "redline" the Alert, we have prepared the attached is document, "*Safety and Security Guidelines, for Ammonium Nitrate*" (Guidelines). The Guidelines were developed to capture existing regulations related to AN and to supplement them, as necessary, with industry best practices applicable to AN manufacturing, storage and transportation. Again, it is IME's position that existing regulatory programs, if complied with, are adequate to control the hazardous properties of AN and to ensure the safety of workers and the public. That said, the Guidelines contain recommendations outside of the current regulatory scheme that may further enhance safety and security. All recommendations indicate their source. Whatever form the revised Alert takes, we do ask that if a section on "Information Resources" is retained, that IME be listed as a source of information. This would be particularly appropriate given our dominant use of the product and our safe and secure handling record.

Incidents

EPA's request also indicated that the summary of AN incidents contained the Alert would be expanded to include more recent events. Specifically, EPA will include information about the West, TX and Toulouse, France incidents. As stated above, we would urge caution in making definitive statements about the West, TX incident until the findings and recommendations from investigations have been released. With regard to the incident in Toulouse, France, we rely on a report by ITSEMAP, a company that provides technical services in the areas of workplace safety and environmental risk to public and private sector clients. According to the report, the AN involved had become contaminated with chlorine compounds.2

Conclusion

While it appears from the EPA request that the interagency task group is focused on AN, we think that the government is missing a huge opportunity if this effort to develop compliance assistance tools is limited to one chemical compound. We would hope that agencies involved would see this interagency engagement as an occasion to develop compliance assistance tools covering all chemical safety and security programs.

Finally, we are happy to assist in the dissemination of the task group's final revised Alert to our members and any nonmembers that we are aware of.

Please contact me if you have any questions. Meanwhile, we thank you again for the opportunity to assist in this effort and hope you will find our Guidelines useful.

Respectfully,

Cynthia Hilton

Cynthia Hilton
Executive Vice President

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 *SAFEXplosives 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). This is the third article in the series that examines a different aspect of the ESA standards and explain how they can be used for a range of purposes.

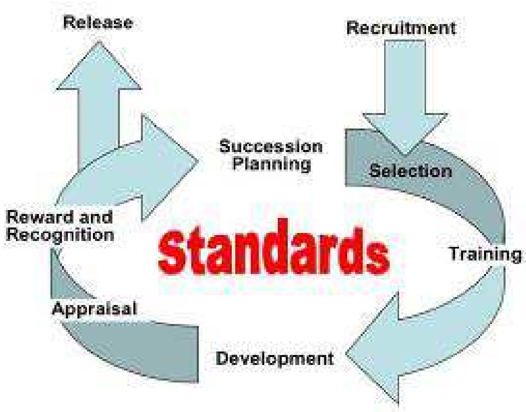
Practical applications of the Explosive Substances and Articles National Occupational Standards

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. For more information please visit : www.homelandsecurityqualifications.co.uk .

In the first article of this series (SAFEX Newsletter NL44), we looked briefly at the possible uses of the UK's Explosive Substances and Articles (ESA) National Occupational Standards. These are represented by the following diagram :



By describing what an organization expects of its staff, this diagram shows that standards can be used for many different purposes such as:

1. recruitment and selection – e.g. job adverts, interview aide memoires, job descriptions, role profiles;
2. appraisal – standards amplify an organization's expectations so appraisals can be more objective & evidence-based;
3. training needs analysis – through self-assessment, development discussions, 360° feedback, Personal Development Plans, audits of team strengths and development needs;
4. training syllabus design – based on the requirements of the standards;
5. career management – e.g. career maps, career planning tools;
6. succession planning – systematic approaches to talent management based on an organization's analysis of development needs;
7. demonstration of a commitment to known quality standards, investment in people and the ability to comply with legislation, regulation and codes of practice;

and many more specific applications within each part of the HR cycle.

In this article, we will look in a little more depth into how the standards can be used.

In 2008, one UK-based organization decided to make use of the ESA standards to identify, measure and develop the explosives competence of its explosives workers across the organization. To achieve this, it first developed role profiles for all explosives workers at all levels. The role profiles were mapped to the ESA standards, available training and qualifications. Table 1 on the next page is an extract of one of the role profiles – that of the Trials Conducting Officer (TCO). For each of the ESA standards titles listed, there is a set of performance criteria, knowledge requirements and contexts that specify the standard that the role holder is expected to meet (see SAFEX Newsletter NL45).

Table 1: Example of a Role Profile for a Trials Conducting Officer (Explosives) (TCO)

Role title:	Trials Conducting Officer (Explosives)
Responsibilities required by this role	**Source**
Ensure that suitable and sufficient plans, safe working procedures and effective control measures are implemented to cover all areas of work and activities.	UK MOD publication
Ensure that all staff involved in the trial are competent and authorized to carry out the relevant work and are aware of their responsibilities for SHEF and security.	
Conduct and manage the trial.	
Ensure that all work areas, equipment and materials are made safe at the conclusion of all work and at the end of the trial.	
Authorities	**Source**
Suspend any work that does not conform to the plans or safety procedures or at their own discretion for other reasons.	UK MOD publication
Is accountable for the conduct of the trial.	
Technical competences relevant to this role	**Source**
Assess the suitability of explosives facilities	ESA 2.8A
Implement risk control measures for explosive substances and/or articles	ESA 2.9A
Contribute to the investigation of explosives safety incidents	ESA 2.12A
Establish the performance criteria for explosive substances and/or articles	ESA 3.1
Determine the existence of a suitable trial or test procedure for explosive substances and/or articles	ESA 3.2
Design new trial procedure for explosive substances and/or articles	ESA 3.3
Validate trial or test procedure for explosive substances and/or articles	ESA 3.7
Plan the trial of explosive substances and/or articles	ESA 3.8
Manage the trial of explosive substances and/or articles	ESA 3.10
Carry out trials of explosive substances and/or articles	ESA 3.14
Evaluate the results of trials of explosive substances and/or articles	ESA 3.17
Carry out post trial or post test tasks relating to explosive substances and/or articles	ESA 3.19
Move explosive substances and/or articles manually	ESA 7.1
Put explosive substances and/or articles into storage	ESA 7.3
Dispose of explosive substances and/or articles by non-complex burning procedures	ESA 11.13A
Dispose of explosive substances and/or articles by non-complex detonation procedures	ESA 11.16A
Conduct an assessment of the risks in the workplace	ESA 13.8
Provide explosives technical or safety advice and/or guidance to others	ESA 13.9
Manage equipment in an explosives environment	ESA 13.14
Manage explosives safety	ESA 13.16
Certify as Free From Explosives (FFE)	ESA 13.17

Interestingly, subsequent research across the industry showed that, whilst this role profile had been developed for one particular organization, all organizations consulted agreed that it met their expectations for their TCOs too (although the job title might have differed slightly). So, effectively, this role profile has set an industry standard in what it expects of its TCOs and how their competence can be measured.

A recent survey showed how three organizations in the UK are making use of the standards. These are:

- QinetiQ,
- Cranfield University Shrivenham
- Atomic Weapons Establishment (AWE).

The business reasons for all three making use of the standards were similar.

For QinetiQ, a major Ministry of Defence (MoD) contractor, it was the need to demonstrate that it was meeting the requirements of the MoD's Temporary Explosives Bulletin (TEB) which was published in July 2009 i.e.:

1.6 Competence

1.6.1 The competence of those working in Weapons, Ordnance, Munitions or Explosives (WOME) shall be demonstrated against the standards of best practice set by the sector; these are the National Occupational Standards (NOS) for Explosive Substances and Articles (ESA).

1.6.2 Line management is responsible for:

1 ensuring competence can be demonstrated to at least that required in the ESA NOS;

2 where skills gaps exist, ensure positive action is taken to resolve them;

3 ensure appropriate records of competence are maintained;

4 provide reports to the DOSB on the progress of implementation of the NOS.

For Cranfield University, it was to satisfy itself and the UK regulator, the Health and Safety Executive (HSE), that Cranfield's staff were trained and developed to the required level of competence to undertake the work required of them. This includes Cranfield's own staff and students who carry out practical work with explosives.

For the AWE, it was the need to determine systematically the explosives safety competence requirements within its explosives business so that it would have a comprehensive picture of the workforce's competence both in terms of the individual processes carried out and as measured against the standards.

A summary of what these organisations did is provided in Table 2 below:

Table 2: Summary of what organisations typically did using the ESA National Occupational Standards

Recruitment and selection	Mapped all job applications against the standards
Performance management	Mapped the standards against explosives job roles Aligned current role competences against the standards for explosives roles in R&D, trials and testing, manufacture, assembly/disassembly, storage/transportation and disposal. The standards were then adopted as a method of recording competence during staff performance appraisals to identify gaps in performance Trained assessors and delivered national qualifications so that they
Training and development	Used the standards to carry out analyses of training gaps Mapped training materials against the Knowledge Requirements of the standards
Career management	Aligned career processes with the standards
Succession planning	Based succession processes on the standards

Typical outcomes of this work found by these organizations are summarised in Table 3 :below

Table 3: Typical outcomes of using the ESA National Occupational Standards

Recruitment and selection	A direct focus on the job requirements resulted
Performance management	By identifying common ground, the plethora of existing job titles and descriptions could be reduced into three roles: Explosive Worker Practitioner/Team Member, Explosive Worker Controller and Trials Conducting Officer Clearer guidance was available to line managers as to the required standards of performance
Training and development	Training could be standardized Precise areas could be identified where training materials needed to be updated
Career management	Clear guidance was available that informed career paths
Succession planning	Demonstrations of where to focus training

It is clear to see some of the practical benefits that resulted from implementing the standards.

For QinetiQ and the AWE, the overriding benefit was that they could prove that they met the requirements of competent performance and therefore, they had control over their explosives operations in a safe and measurable manner. There were also a number of specific benefits including:

- a focus on selecting qualified personnel
- enabling staff to focus on their own Continuous Professional Development
- reductions in training budgets and time needed
- standardization of career paths across the organization
- clear guidance to line managers and the HR function
- provide a stable platform to assess future skills gaps
- demonstrations to the regulator that explosives workers have the required competence
- sufficient evidence to measure the effectiveness of competence
- organizational brand being synonymous with best practice in working with explosives
- providing a framework to map training and development for staff new to job roles.

For Cranfield, whose focus was on developing knowledge rather than measuring competent performance, it found that there was a clear analysis showing that all the knowledge requirements of key role 2, Explosives Safety Management (see Newsletter No.45), were met comprehensively so that their students would be fully knowledgeable in this area. In other areas, a need was identified to consider how best might their training packages be modified to provide full coverage of the knowledge specifications of the standards.

The only adverse effects reported was that Cranfield found the analysis of its training materials against the knowledge components of the standards proved a resource-intensive exercise and QinetiQ discovered that there was a need for retraining and refocusing some of its managers and a need to review training for some of its specialist staff.

All three organizations plan to make greater use of the standards including:

- assess workforce against tasks mapped and standardized to meet competence requirements
- provide development and guidance for those who carry out assessment
- extend annual assessment of individuals' competence (resulting in individual Personal Development Plans) across the whole organization
- identify suitable development activities
- synchronize best practice across the organization (i.e. identify, record and share best practice)
- present evidence of workforce's competence to stakeholders
- enable "portability" of workforce across the organization's explosives processes
- develop professional mentoring process
- provide graduate intake specifications
- provide vehicle for self-certifying competence to qualification requirements, using real products of work (which would make the implementation of qualifications a comparatively simple step)
- formalize arrangements so that they meet demonstrably the relevant explosives industry practice.

For those of a mathematical turn of mind, the AWE has developed an impressively neat summary of how it sees the definition of competence:

$$\mathbf{C = f(K,S,E) \times f(A^3,B)}$$

i.e. competence is the product of two function sets: knowledge, skill, and experience multiplied by attitude, ability, aptitude and behaviour.

Having already made extensive use of the ESA standards, it will be interesting to see how each of these organizations makes use of these tools available to them to develop further the competence of their workforces.

For more information, please contact:

- AWE: Shaun Dooley, Shaun.Dooley@awe.co.uk
- QinetiQ: Brian Wilson, BTWilson@qinetiq.com
- Cranfield: Geoff Hooper, G.hooper@cranfield.ac.uk

Note to readers: the ESA standards are available free of charge and can be downloaded from: http://www.homelandsecurityqualifications.co.uk/documents/ .

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.

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.

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.

Dynamite Factory at Ardeer Scotland Making Dynamite Nitroglycerin: Part I

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. His 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 will cover the Introduction, Nitroglycerine Hills and the Danger Area. Be sure to look out for Parts II and III that will follow.

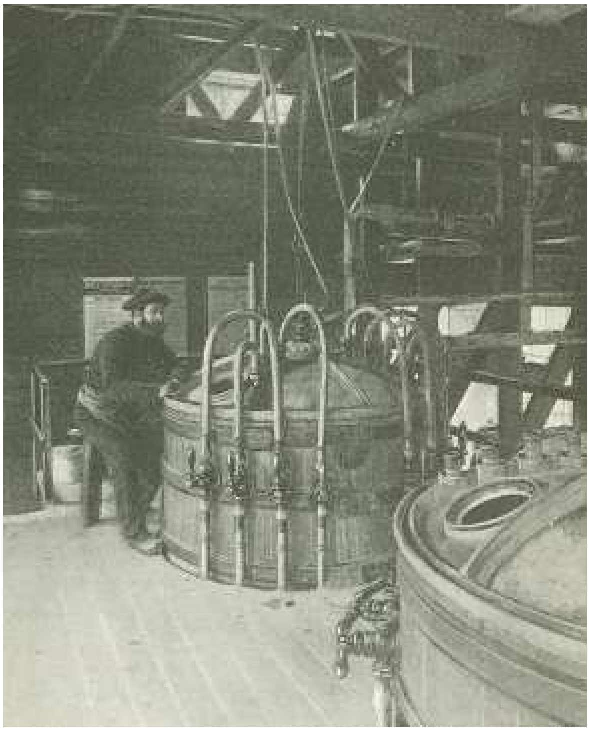
Preface by Martin Held

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 form 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.

Introduction

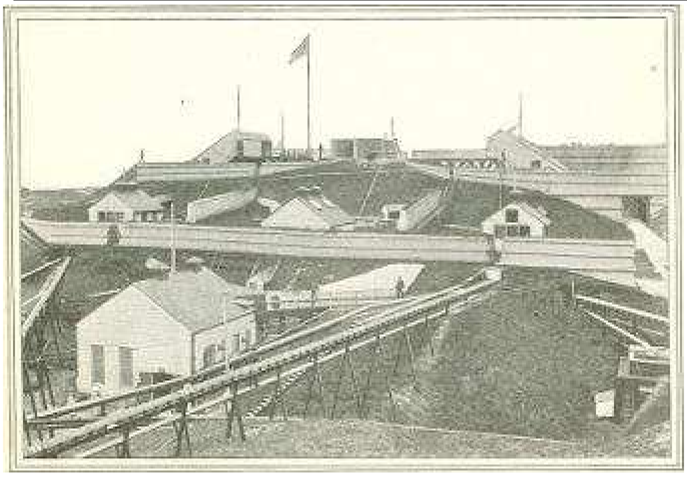
The great dynamite factory at Ardeer in Scotland, the largest of its kind, is one of the most picturesque places in the world. Considering the unique and dramatic conditions that prevail among its workers, the neglect of Ardeer hitherto by novelists and dramatists is surprising. This may be due, however, to the fact that it is exceedingly difficult for a stranger to obtain access to the factory, while, once inside, the surroundings are rather trying to sensitive nerves. For six hours a day and two days in succession your life depends, at every moment, upon a thermometer.

Great is the thermometer at Ardeer! Nitroglycerin, a teaspoonful of which would blow you to fragments, surrounds you in hundreds and thousands of gallons. It is making itself in huge tanks, gurgling merrily along open leaden gutters, falling ten feet in brown waterfalls, so to speak, into tanks of soda solution, and bubbling so furiously in other cylinders,

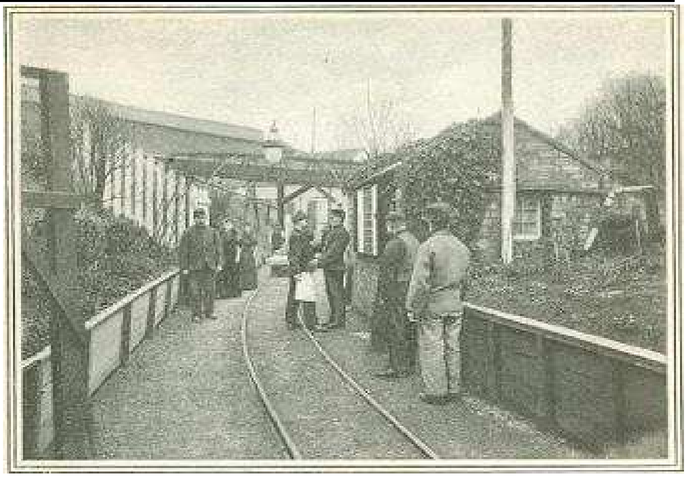


Man and thermometer in one of the nitrating houses

through the in-rush of cold air from below, that it seems to be boiling. It is being drawn off from large porcelain taps like ale, poured into boxes, and rattled along tramways. In the form of dynamite, it is being rubbed with great force through brass sieves, jammed into cartridges, and flung into boxes; and in the form of blasting gelatin, it is being torn by metal rods, forced through sausage machines, and cut, wrapped, and tossed into hoppers—all these processes proceeding as rapidly as if it were ordinary olive-oil instead of the deadliest explosive known to man



A Nitroglycerin Hill at Ardeer



Everyone going in to a Nitroglycerin Hill is searched

All around you are big cotton mills and storehouses as full of fleecy, white cotton as ordinary cotton mills and storehouses, but every pinch of the cotton, still white and fleecy, has been nitrated into guncotton, and would suffice, if exploded, to cut you off in the beauty of your youth. Death, instantaneous and pulverizing, encircles you, in fact, by the ton; but the man and the thermometer surround you also. The man's eyes never leave the instrument. Both are chosen for their perfect reliability; and endless precautions, innumerable rules, and the strictest discipline maintain Ardeer in a state of busy and peaceful security, and prevent it from being scattered periodically over the calm blue sea that widens endlessly on one side, or the hungry brown acres of Scotland which stretch away to the horizon on the other.

The Nitroglycerin Hills

From the top of one of the nitroglycerin "hills" the factory looks like an enormous and eccentric landscape garden. In every direction rise green embankments, square, conical, or diamond-shaped, from fourteen to seventy feet in height, and cov-ered with long rank grass. Many of them are faced with corrugated iron, and look like high fences. From the top of each mound peeps the red canvas roof of a white wooden house—a house within a hill —which is from one to four stories in height. Every explosive structure is surrounded by artificial banks, so that in the event of an accident all the others will be protected from concussion or flying fragments. There are three nitroglycerin "hills"; and on the one before you the nitrating-houses, two in number, in which the nitroglycerin is made, stand out in clear relief at the top. They are frail wooden cabins, which were expected by Mr. Nobel when he built them to last six months, but which have not yet been blown to pieces after twenty-five years of constant use. Tunnels through the banks open everywhere. Tramways and lines of pipes on trestles cross each other diversely. This is the "Danger Area," the wide expanse in which the explosives are made and moved about. It is surrounded in an irregular semicircle by fourteen large groups of structures, from which rise fourteen high chimney-stacks. These include the nitric-acid works, acid recovery, ammonia-mill, potash-mill, "guhr"-mill, steam and power houses, box factories, washing, carding, and bleaching departments for the cotton, pulping-mills, and other contributing industries, connected by steam railway tracks which join the Glasgow line. There are 450 separate structures, now occupying 400 acres out of the 600 owned by the company, which were, when the site was chosen by Mr. Nobel in 1871, a barren waste of sand dunes, stretching for a mile and three-quarters along the sea.

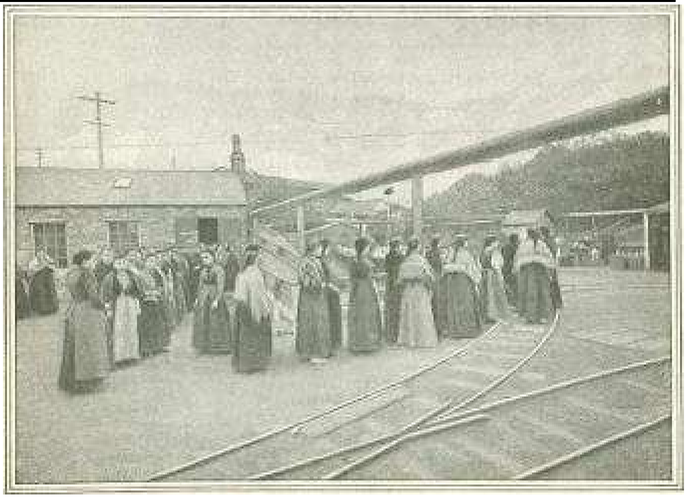
Into this kingdom of high explosives you enter by the courtesy of Mr. C. 0. Lundholm, the works manager, under the guidance of the engineer of the works, Mr. E. W. Findlay. The strain upon your nerves begins mildly. Your hair is quite ready to rise, so ready that you can feel it awake and stretch itself at every spot of grease—which may be nitroglycerin—and every stray pinch of cotton—which may be guncotton. You now understand for the first time the psychological condition of a shying horse. You go along just as the horse does, with eyes strained at every small object and a lurking predisposition to bolt.

The acid-works are soothing, however. They are quite safe. Nitroglycerin is made from glycerin, the sweetish adjunct of the dressing table, and nitric acid. The glycerin is bought by hundreds of tons from various sources. In this big barn which you enter the nitric acid is manufactured. In two rows stand fifty-eight steel retorts about six feet in diameter and four feet deep, which are bricked up like ovens. Here sulphuric acid, or oil of vitriol, from Glasgow is combined with nitrate of soda from Chili, and the nitric acid thus set free passes over in pipes to a high framework carrying numberless brown earthenware jars in which it condenses. As it passes over it gives off reddish fumes which are suffocating—a whiff of them gives you a fit of coughing, and a full breath of them would choke a locomotive. Mr. Findlay explains that the nitric acid thus made is mixed with a larger quantity of sulphuric acid, and moved in steel pony-cars to a station at the foot of each nitroglycerin "hill." Thence the acids are drawn up by cable or blown up through pipes to a tank at the top of the "hill" by compressed air. You mentally compare the advantages of being blown up with compressed air to being blown up by other means, and smoothing down your hair, enter the "Danger Area."

The "Danger Area"

To enter the "Danger Area" you must pass the "searcher." He stands in front of his cabin, and you will find one of him always blocking the way at the four entrances to the explosive district. He is a tall, military-looking man in a blue uniform faced with red, and he takes from you all metallic objects—your watch, money, penknife, scarf-pin, match-case, matches, and keys. None of these are allowed to be where nitroglycerin is. He searches every man who enters, no matter how often the man may come and go. The girls, 200 of whom are employed, are not permitted to wear pins, hair-pins, shoe-buttons, or metal pegs in their shoes, or carry knitting, crochet, or other needles. These regulations are the outgrowth of experience and the long-ago discovery in dynamite cartridges of buttons and other foreign substances calculated to make trouble at unexpected moments. The girls are searched thrice a day by the three matrons who have them in charge. From the lack of hair-pins, they wear their hair in braids, tied with ribbons, which gives them all an unduly youthful look. The searcher tells you that his chief trouble is with matches. Some of the lower-class male employees—there are 1,100 men in the factory—are willing at times to smuggle in matches for a quiet smoke in a secluded corner. This quiet smoke may of course produce a much louder smoke in a, corner not secluded, and is therefore rigidly banned. The discipline in the factory is most extraordinary, and to it must be attributed the marvellous immunity from accidents.

At this point, too, you get your first glimpse of the "costumes." A man in a Tam o' Shanter cap comes up clothed from head to foot in vivid scarlet. He belongs to a nitroglycerin house. Then comes a man in dark blue, a "runner" or carrier of explosives. Then comes a man in light blue, who belongs to a smokeless-powder factory. All the girls are in dark blue. The different colours are used so that a superintendent at any distance can always tell if a man is on his own ground and attending to his own work. A few weeks since, a cartridge lassie in dark blue said to a man in scarlet; "Gi'e us a kiss," and he promptly "gi'ed" her one. This unlawful combination of colours caught the eye of an overseer hundreds of yards away, and the pair were instantly removed from the works and the payroll. Kissing and skylarking are absolutely prohibited during working hours, but on Saturdays and Sundays the workers make full amends. If reports are to be believed, the workers are more than usually romantic in their tendencies, the alleged cause being the constant breathing of nitroglycerin; and inquiring Pickwicks have taken many notes there-upon, in which the statistics of marriage and population are not entirely neglected.



Factory girls undergoing search by matron

Part II describes the Nitrating and Cartidging Houses and will appear in the next SAFEX Newsletter.

Inbox @ SAFEX-International.org

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

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

Neglect the Permit to Work discipline at your peril

According to a SAFEX report a detonation occurred while one of the workers was trying to remove the remnants of di/mono PETN with the tip of a metallic screwdriver from a bend in a waste line. He did this when the prescribed application of steam to the line failed to dislodge the blockage. As a consequence three people were injured.

Martin Held (Austin Powder International) found the report very interesting and will use it to review their PETN nitration operations. He did have one comment: Was there a clear instruction that a Permit to Work (PTW) would be required for cleaning the pipe if steam/water failed assuming the task was not covered by an operating instruction? The report says that using a screwdriver was ‘perceived’ as being ‘routine’. Do existing PTW forms cover such operations in detail? Furthermore, is equipment that is taken out of service and dismantled declared and labelled as ‘contaminated’?

About commissioning custom-made equipment

Two near-events on Mobile Processing Units (MPU) were reported in which the operators smelled a burning smell while working with emulsion explosives. In the first case the incident was caused by the unit not being supplied according to the company's specifications; and in the second the supplier of the unit left redundant electrical equipment in place

This caused Maurice Bourgeois (General Dynamics-OTS Canada) to comment: In my opinion both these incidents relate to commissioning of explosive processes even though the equipment involved was trucks. We cannot take for granted that equipment suppliers will comply with company standards in one case or remove unnecessary equipment in the other case. An inspection checklist should be written for the commissioning of such vehicles. Any unnecessary equipment should be removed because if it is never used, it is never inspected during preventive maintenance routines or during the operator daily inspection. Unnecessary equipment degrades to the point where it creates a dangerous condition.

Corrective actions commended

During the routine manufacture of shock tube a blockage occurred with the flow of HMX. After adjusting the HMX feed, the operator turned on the equipment and an explosion occurred. As result of this incident the company modified the dosing equipment to incorporate a torque regulator; provide additional protection for the operator; and reduce the amount of explosive.

Maurice Bourgeois (General Dynamics-OTS Canada) commended the corrective actions taken: Loaders like this create friction, produce confinement. In my view they should be operated behind a substantial shield that is properly vented to a safe area with baffles to prevent debris throw. It should be tested with the reduced quantity of HMX. The over-torque sensor is a good idea provided it is adjusted to a safe value which may not be easy to determine.

PLC's need some back-up system

During the crimping of detonators onto shocktube, the crimping machine crimped the detonator for a second time as the operator was removing it. A basic process logic controller (PLC) program that had not been updated was thought to be the problem.

Andy Begg (Expert Panel Member) made the following observation: PLC systems can be a problem because it is very difficult for the average person to understand all the possible failure modes - like spurious signals. For this reason in ICI where we had a critical safety system that was protected by a PLC we had a requirement for an additional "hard wired" system to be in place.

Maurice Bourgeois (General Dynamics-OTS Canada) also recalled the implication of moving to sophisticated technology: In the old days, we had sensors (limit switches, photocells, etc.) and sequencers; now we have encoders, limit switches and PLC's. Everything was hard wired in the old days, now we are in cyberspace. Cyberspace offers a lot of versatility but coding errors are likely to go unnoticed. In this case I would have thought that the position sensor should have prevented a second crimp because the detonator was not properly in place. Could the "inquisitive commissioning" requirement I mentioned in a previous note have helped here as well?

Unusual occurrences can be a death trap

In a similar incident at another facility, the detonator was not released after crimping. Contrary to the prescribed procedure, the operator pushed the crimping button a second time to release the detonator. She tried to extract the detonator quickly but the detonator was crimped a second time lower down the cap when the extraction coincided with the delay interval set for crimping

Maurice Bourgeois (General Dynamics-OTS Canada) thought this incident demonstrates an important principle: This particular incident reminds us of the necessity to write un-jamming procedures that are unambiguous. For example in this case the procedure may have said: press emergency stop; turn the power off; if the detonator does not release, call the manager who will determine the following course of action.

Determining unusual situations such as blockage, jamming or unusual noise in equipment is of the outmost importance because un-jamming or intervening on malfunctioning equipment is often the cause of major accidents. We have had an un-jamming incident with injury. We had to develop for each piece of equipment or process un-jamming procedures. With the operators help, we had to identify the different jamming modes, the areas where they could occur on the equipment and take pictures of simulated jams. This helped us described the course of action clearly and unambiguously. Any new jamming mode necessitates a work order and is added to the procedure.

More often than not, un-jamming is a high risk operation because it is performed with the protective shields removed or inside cubicles. Sometimes management takes for granted that the operators know their equipment or process sufficiently well not to get in harm's way.

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!

From Davy Crockett to Detonators – It's about knowledge!

by

Tony Rowe (Retired from AEL Mining Services)

As regular readers will appreciate, I am old and long past my sell-by date. In fact I am so old that I can remember Davy Crockett hats, Bill Haley and the Comets, Hula Hoops and, because in those days I lived in England, free school milk. By the way, I was a total failure at hula hooping, but despite all the years in between I can still carry both the tune and the words to the Ballad of Davy Crockett. Davy Crockett by the way was a genuine American folk hero. He was killed alongside Jim Bowie at the Battle of the Alamo.

The legend of Davy Crocket or at least the version marketed by the Walt Disney organization somehow struck a chord in the English social scene of the time. There were few TV sets around back then and so all of Davy's incredible adventures had to be viewed at the local movie theatre. In my case, this was the Palladium. I was lucky, both my mum and my dad had a job. Remember, this was a time of massive unemployment and by the standards of the day to have both parents getting a wage, made me a posh kid. I used to sit upstairs in the theatre's balcony. It cost a full nine old pence to enjoy the range of luxuries on offer. For instance, there were carpets on the floor. Discrete lights illuminated the rows and walkways and the seats had padded armrests. A lady wearing a starched white coat and a small round cap on her head would endlessly circulate, selling choc-ices, drinks and tubs of ice cream from a small illuminated tray slung from her shoulders.

The rabble sat downstairs in the stalls. The seats in the stalls cost sixpence, but you sat there at your peril. Once the lights went out, all manner of Kia Ora cartons, cold orange squash, Twicer wrappers, chunks of Orange Maid, sucked and sticky Butterkist Popcorn and sundry fruit juices would rain down onto the anonymous heads of the poor unfortunates packed tightly together in the stalls below. The screams were truly terrible. They still haunt me to this day, but best of all you couldn't miss!

It was absolutely wonderful.

On the screen, Davy's character was played by an actor named Fess Parker whose claim to fame was not his flintlock rifle, but rather the trademark ginger tomcat that he wore on his head.

Fess I suppose was the first Justin Bieber as he inspired us kids in a similar way. Whatever Davy (Fess) did or said, we, the faithful did too. Heaven forbid that any red-blooded male child of the period might not actually possess his own dead-cat hat. Such a shortcoming, if detected, would inevitably lead to banishment and the hell of total isolation. For a young boy that's like death! Overnight one could become the social equivalent of tub of stale vomit; a leper doomed forever to carry the bell and wear a hood. If you couldn't beg, borrow, steal or rent the necessary headgear, you became an outcast! Ring a Ding! Ring a Ding!

Here is Davy (Fess) complete with cat.

It couldn't last of course and didn't. It all came to a sad end, but for me at least, the song lives on. By the way, the actor Fess Parker died during 2010.

Just in case you were unaware, my wife and I have been contemplating making a move to the South Coast of Kwa-Zulu Natal for some time now. We have learned to hate the Gauteng winters and had long ago resolved to make this one the last. Packing for our projected move began in earnest at the end of May 2013.

Do you realize how much stuff accumulates after 20 years in the same house? It is scary. The home that we battled to furnish when we first moved in is now literally stuffed to the rafters with all sorts of bits and pieces that we either don't use or don't want. Most of it you can't even give away. Video tapes for instance. Hundreds of both stiffy and floppy computer disks. Eight track music cassettes, early dot-matrix printers and old Mnet decoders. We placed 3 large boxes containing a range of such desirable items outside our front gate secure in the knowledge that it would all disappear. The next morning, not only were the 3 original boxes still there, but there were also 6 additional boxes full of stuff that other people didn't want either. Eventually for a cash consideration the refuse collectors were persuaded to take all 9 boxes away.

We have since packed a further 48 boxes with stuff that we both want to keep, but despite the lack of access to the contents of those boxes, our lives so far remain virtually unchanged. Stuff we once thought of as important like DVD players, sound systems, flat screen TV sets, and play stations have been packed, strapped and forgotten. In their enforced absence they have proved to be entirely non-essential to life as we know it.

In life as I have suddenly realised, you can do without things. What is, however, absolutely essential though is KNOWLEDGE. There is no good or bad; right or wrong to knowledge. Morality only enters the argument when you use or apply what you have learned.

Knowledge is good when moving house, but even better where explosives are concerned. Knowledge, once acquired is difficult, short of damage or death, to lose and once you've got it, nobody can easily take it away.

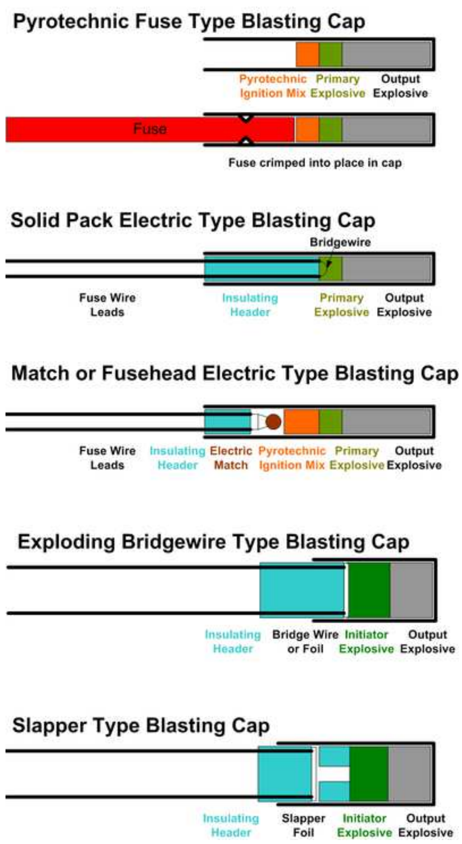
Most of us who use explosives on a daily basis know what a detonator is, but the less experienced may be confused by the phrase, "blasting cap". There's no need to stress, they're the same thing. Whatever you choose to call them, the basic design is very old. Alfred Nobel actually took out the first patent for a detonator (blasting cap) during the 1860's. He later made a number of improvements, but the reality is that the basic design has been around for more than 150 years.

In the world of surface or underground commercial blasting operations there are essentially only 4 types of commercial detonator, each type differentiated by the mechanism used to achieve its initiation. The first and oldest is the plain detonator for capped fuse. The next most venerable is the electric detonator. In the late 1970's the first shock-tube detonator made its debut while the most recent addition is, of course, the electronic detonator.

In recent years various hybrid detonators systems have also appeared. For those unfamiliar with the word, hybrid means something like "offspring from parents of different species". For example, the mythical "Griffin" was a hybrid. Griffins, it was said, were half lion and half eagle, a sort of flying meat mincer and usually very hungry. Pegasus, the flying horse of Greek and Roman myth was also clearly a hybrid. Pegasus though ate mostly grass with the odd apple or carrot thrown in by grateful heroes.

More recently and specific to the world of American firearms, 'hybrid" has been replaced with the word "Wildcat". In this context "Wildcats" are generally non-standard and therefore commercially unavailable bullet to case combinations brought together, perhaps by a single lone designer, to achieve a particular outcome. The famous - or is that infamous .357 and .44 magnum handgun rounds started life as Wildcats. Thanks Elmer

Hybrid initiating systems may thus employ clever mixtures of known or existing initiating mechanisms, but com-



bined in novel or innovative ways. For instance, shock tube and piezo-electric crystals or shock tube/fusehead designs where the electro-magnetic pulse (EMP) from shocktube detonation is first harvested then redirected. None thus far have proved particularly game changing, but don't lose faith, rather think about wolves. Wolf hybrids have proved incredibly successful. Think about it. Every species of dog in the world today is a actually a hybridised wolf. It remains entirely possible that something that started out as a mere mongrel, hybrid, wildcat - call it what you will, might yet take the world by storm. Elmer Keith's .357 and .44 certainly magnums did!

On a totally different level, however, detonators are first and foremost male-magnets, appealing on some fundamental gut level to both man and boy. Boys, teenagers and young men are the most vulnerable to their overwhelming, but ultimately perilous allure. There is something in the blood of most healthy males that recognizes - on sight and without any foreknowledge whatsoever - the ability of such devices to do damage. Don't ask me how we males know such stuff, we just do. Maybe it's genetic or perhaps it's caught like the measles, inherited like acne or found under rocks. Whatever the mechanism, we males instinctively KNOW!! Older men, whilst still drawn to the shiny cylinders, have usually managed to develop some experience-based survival instincts that sometimes, but alas not always, serve to avert or at least mitigate disaster.

Modern commercial detonators, in trained hands, are by the way, entirely safe to handle and use, but for the uninitiated or simply unknowing, that may not be so true. What the novice doesn't know is just how deep the wellspring for harm actually is. Detonators in untrained or unskilled hands are simply canned dynamite, a 100% proof distillation of trouble for the unwary. To illustrate this one must simply refer to the many instances where disabling or life threatening injuries resulted after normally safe-to-handle detonators were subject to extreme abuse.

Detonators have been struck with hammers, cut or broken open and probed internally. They have been thrown onto fires, chewed by human teeth, heated up on metal plates. Electric dets have been attached to various unauthorized electrical sources (car batteries, cap lamp batteries, mains current, cellphones to name, but a few). They have been pushed into car exhaust pipes, wrapped in ignitercord which is subsequently ignited with extremely unpredictable results.

In another case, a live electric detonator was even used as a replacement knob to tune a radio. When it eventually detonated, several human fingers were instantly transformed into a bloody confetti. To use a “live” and full strength electric detonator in such an application beggars belief, but speaks volumes about the user’s lack of knowledge about such things. In this case while the protruding legwires of the electric detonator employed had been cut short, the bare ends of copper conductors were left exposed. Eventually and rather sadly whilst operating the improvised tuning knob, they touched a live internal connection. BANG !!!!

The radio never worked again either.

There is even a story telling of how a necklace constructed of 40 or so, plain copper “Carrick” detonators, each one painstakingly drilled and threaded onto a brass wire loop, detonated unexpectedly while its wearer was enjoying some unusual outdoor pursuits. The “fun” stopped with the bang.

A warning thus follows: Never tamper with any detonator! Don’t cut or break them open and never poke around inside. Why? Because most commercial downhole detonators - upon detonation - release an amount of energy, so disproportionate to their size that it is difficult to truly comprehend. It is unbelievable that something so small can unleash such violence and do it so quickly. Even Chuck Norris agreed that there is no time to drop or throw a reacting detonator away. You see, Chuck was taught by his Mom. She employed subtle forms of banter to instill safety. Chuck! She’d bellow, “If you blow your legs off with those damned detonators, don’t come running to me”. Chuck understood. No time to drop the thing, but plenty of time for both reflection and for counting up to five. Why five ? “Cos Chuck”, his Mom used to say, “that’s all the fingers you may soon have left”.

Any detonator, for all intents and purposes, detonates instantly upon the initiation of its base charge. For instance should one go off in your hand, expect substantial portions of bone, muscle and skin to be thrown some meters from their original anchoring structures.

It’s not a good look!

The event will be traumatic, painful and cause unwelcome mutilation, but in most instances it may not actually be life threatening, but it may well be life changing. Undertaking those fundamental bathroom activities with the paper pressed on the end of a pointy little steel prosthesis (`a la Captain Hook) is unlikely to provide much in the way of confidence, comfort or security.

The fact is that the evolution of the modern detonator parallels that of the crocodile. Both designs have remained virtually unchanged since they were first conceived and both of them bite!

Stay safe. You know it makes sense

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