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CONTENTS



HELSINKI
CONGRESS XIX

NEXT CONGRESS
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## FROM THE SECRETARY GENERALS'S DESK

At the change of season in the Northern and Southern Hemispheres, we realise that not only does nature change, but so does the global economy and with it the explosives industry . Change brings with it stress, which could have an influence on operational safety. Should the focus on this most critical part of our industry be reduced, the potential for catastrophic incidents increases. It is thus important to reemphasise that safety in all areas is paramount to a successful explosives business. The role SAFEX plays in your operation is most important to share learning, assist with safety networking and training ,but we can only be as effective as the support you give us to play this important role in our industry . Your input into making SAFEX International an effective partner in your Safety Team is the highest value a safety conscious global organisation can obtain . Thus I ask for your support, communication and timely incident notifications going forward.

Since the June Newsletter the following Incident Notifications were filed by members:

IN12-15 Propellant Incident

IN13-15 Single base propellant incident

IN14-15 PBX Incident.

Our Chairman, John Rathbun, and I visited Helsinki during July to form a preliminary view on the availability and suitability of conference facilities and hotel accommodation for the 2017 Congress . We thank Oy Forcit and specifically , Pia Holmström , for hosting and assisting us with the very fruitful visit. I will be informing members over the next year as to the details of the Congress as final decisions by the Board are taken.

In this Newsletter we again recall an incident that took place in Canada in 1998 when a truck loaded with explosives detonated . The article was written by Chris Watson, a member of our Expert Panel.

Dawie Mynhardt, the convener of the Work Groups, presents an article laying out plans and options for the Transport and Emulsion Groups . Your support of these efforts is critical to its success and I request that members send delegates to partake in these initiatives which all assist in building a safer industry.

Andy Begg explains, as convener of the Expert Panel, the recent updates on the website, regarding the competencies and skills available to the industry through the potential value the Expert Panel members can add .

The IME has supplied SAFEX with an update of the Topical Paper "IMESAFR Version 2.0: A Next Generation Tool for Managing Risk Associated with Commercial Explosives Operations – 2014 Update", which is now available on the SAFEX website.

Also new on the website is "Development and Application of Quantitative Risk Assessment Methodology" a Topical Paper by Lon Santis, Mike Swisdak and John Tatom compiled by Boet Coetzee.

A first for the Newsletters is a book review by Lon Santis : " Risk Analysis and Control for Industrial Processes – Gas, Oil and Chemicals" which assists in broadening knowledge in this very important subject.

## The Walden Incident: Explosives Truck Fire and Explosion by Chris Watson

On August 5, 1998, a tractor trailer combination loaded with 18,000 kg of blasting explosives left an explosives manufacturing plant near Sudbury, in the nickel mining area of Ontario, travelling west on the Trans Canada Highway to a distribution site some 670 km away. Shortly after departure the truck left the road and crashed into a rock wall. Fire broke out, and around 35 minutes later there was a mass explosion of the load. Fortunately there were no casualties; passing motorists including an off-duty police officer rescued the truck driver, evacuated the area and radioed for the highway to be closed in both directions.

The investigation of the incident was carried out jointly by the federal Departments of Transport (regulator for Dangerous Goods transport) and of Natural Resources (regulator for the commercial explosives industry), assisted by the Ontario Ministry of Transport and the Ontario Provincial Police. The main issues examined were:

- How and why did the accident occur?
- Why did the explosives detonate rather than burn?
- Are any regulatory changes required?
- What lessons can be learned from the incident?

The truck was the normal type used for long distance transportation of explosives; a diesel powered tractor and an aluminium-walled, plywood-lined trailer. The driver was an experienced contract hauler. The 18,000 kg load contained three different types of explosive;

- 4,471 kg of a non-cap-sensitive TNT-sensitized slurry, UN Classification 1.5D
- 669 kg of a detonator-sensitive emulsion explosive, UN 1.1D, and
- 13,052 kg of ANFO, UN 1.5D.

The slurry was cartridged in 75 mm diameter plastic chubs and packed in fibreboard boxes, the emulsion in 22 mm paper shells also packed in fibreboard cases, and the ANFO in 25kg plastic bags. There were no detonators, boosters or detonating cord in the shipment.

The accident occurred around 8:15 pm, 30-40 minutes after the truck left the plant. It was heading west on the Trans Canada (a four-lane divided highway at this point with a ditch and rock wall on the north side) travelling about 90 km/h. According to eyewitnesses, the truck veered to the right through the ditch and probably struck the rock face. The truck jack-knifed, the tractor became separated and came to rest facing east. The trailer remained facing west, with its front end broken open and cases of explosives and ANFO bags spilled on the ground. Eyewitness estimates of the separation between tractor and trailer range from 0 to 9m. The tractor was severely damaged, both doors being jammed shut. However, passing motorists were able to force open a door and rescue the driver.

Fire broke out in or around the tractor shortly after the crash. Witnesses reported the smell of diesel; the truck's 350 l tank would have been almost full, and probably ruptured in the crash. The driver was conscious and warned of the presence of explosives. Passing motorists, including an off-duty police officer, were able to evacuate the area, and radio for assistance. The road was closed 700 m east and 400 m west of the crash site. In the next 30-40 minutes police, ambulance and fire fighters arrived.

Around 20 minutes after the crash, there were bright red and orange flames that reached as high as the rock cut, over six metres above the truck. Ten minutes later, fire fighters described a large body of very bright white fire, which they assumed to be very hot due to the white colour of the flames.

The flames were described as being entirely white.

***Explosion Site Looking West***

(Examination of metallic fragments from the explosion which showed damage due to high temperatures concluded that a

***View looking west shows railway line and***

temperature of at least 1170 °C had been reached). The flames were approximately 15 to 18 m high, extending above the rock cut. The explosion occurred at 8:52 pm (time determined from seismic readings), approximately 32 to 37 minutes after the accident. Many witnesses described hearing only one large explosion. Some witnesses described hearing a small explosion and then a large bang. Other witnesses described hearing two or three small pops or small explosions within minutes of the final explosion.

The truck and its contents were almost completely destroyed by the explosion. Some pieces of the tractor were found at considerable distances, although curiously neither the engine

***Site remediation and recovery of undetonated explosives***

block nor the transmission was found in spite of an extensive search. It was thought that they may have sunk in a nearby swamp, but search by police divers failed to locate them. A small quantity of packaged explosive was found undetonated during the subsequent cleanup, but no ANFO. (As fire fighters kept the area wetted down after the explosion, any spilled ANFO would presumably have been dissolved). Eyewitnesses at the 700 m road closure point felt significant overpressure, and heard debris passing overhead. Debris was thrown a considerable distance from the explosion site. A section of axle assembly weighing 70.5 kg was found at a

***Site remediation and displaced highway***

distance of 1049 m. Due to the presence of the rock wall there was a focussing effect on the blast, with damage concentrated in a cone shaped area south of the site. The furthest damage reported was cracked windows at 2912 m, while debris was reported as thrown up to 2462 m. At the site itself a crater 3-4 m deep was formed, the rock wall damaged to a depth of 10 m, and the roadbed displaced 2-3 m. Several brush fires were also ignited in the vicinity. Fortunately, due to the swift evacuation of traffic by police, and the sparsely populated nature of the area, there were no deaths or injuries.

Cleanup began once the area was declared safe to enter, and was both laborious and time-consuming. The highway , a main east-west route, was closed for ten days. The Ontario Ministry of Transport investigated both truck and driver to ensure they met all requirements of the Ontario Highway Traffic Act and Regulations. The investigation by Transport Canada and Natural Resources Canada continued for some time. The work included examination of recovered debris to try to obtain more information on the explosion itself, including possible initiation mechanisms. Another significant project was the attempt by the Canadian Explosives Research Laboratory (CERL) to replicate the event through small scale work at their Ottawa site, and full-scale work at a military facility in Alberta.

**Ontario Ministry of Transport Investigation**

This concluded that:

- the driver had a valid Ontario driver's licence appropriate to the class of vehicle being operated;
- the tractor and trailer were registered with the province and the licence plates were currently valid;
- the company had a current dangerous goods certifi-

cate of training for the driver;
- the driver was in compliance with the provincial hours of work requirements; and,
- according to company records provided, the tractor and trailer involved in the accident had been subjected to scheduled inspections by the company in accordance with the company's preventative maintenance statement and both the tractor and trailer had been issued current annual inspection stickers as required by the periodic mandatory commercial vehicle inspection regulations.

**Natural Resources and Transport Canada Investigation**

Materials Technology Laboratory, Natural Resources Canada

Six metallic fragments recovered at the site of the explosion were sent to the Materials Technology Laboratory (MTL) of Natural Resources Canada for a metallurgical analysis. Metallurgy specialists at Transport Canada selected the fragments based on the appearance of melting or high temperature deformation. The purpose of the analysis was to determine the temperature the fragments had endured.

MTL conducted visual, optical and Scanning Electron Microscope examination of microstructure and oxide scale on the six fragments. Also, it performed an oxidation test at 1,100 °C on some fragments to compare the oxide and steel interface.

Four of the fragments were identified as ferrous alloys, steel. Two of those fragments showed extensive strain and high temperature fracture surfaces. One fragment showed fracture surfaces more characteristic of rupture at low temperature. More detailed examination of one of the ferrous fragments revealed the presence of a glassy phase at the steel/oxide interface. This led to the conclusion that the fragment had been exposed to a temperature equal to or greater than 1,170 °C. This temperature exceeds what would be expected of a diesel, wood or tire fire in the open atmosphere.

CERL Small Scale Tests

A number of proposals was put forward for how the fire progressed towards detonation;

- detonators or other undeclared explosives were on the truck,
- a compressed gas cylinder was present and ruptured,
- the explosives on the truck reacted together,
- the RXL 511 acted unusually in the high temperature environment,
- a tire ruptured,
- there was a rupture or explosion of a fuel tank,
- the air brake cylinder ruptured,
- there was a violent reaction between molten ammonium nitrate and molten aluminum,
- confinement,
- the collapse of a trailer part into liquid ammonium nitrate (or a similar physical action) provided sufficient shock,
- the detonation of gas pockets created in the decomposition of ANFO, or
- the detonation of gas pockets created by the burning of ammonium nitrate and combustible material (wood from the trailer or pallets).

The first two proposals were not considered likely. There was no reason for detonators to be present on the truck, and no evidence of detonators was found at the crash site. It was confirmed that a small camping gas cylinder was in the cab of the tractor at the time of the accident. However, given the physical environment at the time of the explosion the presence of the camping gas cylinder was not significant. A small cylinder of this size would have failed much earlier in the fire. The investigation concluded that it was highly unlikely that the camping gas cylinder contributed to the explosion.

The remainder of the proposals were addressed in the CERL test program. The hypothesis examined was that the fire led to a detonation by means of one or more of the following mechanisms:
- thermal ignition, possibly enhanced by the presence of impurities mixing with molten ANFO
- initiation due to mechanical impact, and/or
- initiation due to a gas explosion

Complicating effects included the effect of contaminants on sensitivity and the effect of scenario geometry, (truck, pile and fire). Extensive work was carried out and a series of reports published in 2002-2003. The conclusions were:

- It appears unlikely that a surface burn would lead to detonation without confinement ,
- It appears unlikely that the mass of a pile of ANFO is sufficient to "self-confine" a reaction to the point of detonation ,

- Metal powders may thermally sensitize ANFO when intimately mixed ,
- Chromium, copper and lead appear to have a significant effect on the violence of ANFO decomposition ,
- Even sensitized with metals, confinement is required to cause ANFO to detonate in a fire
- Cook-off of ANFO appears to be unlikely without confinement ,
- Spring brake chambers do rupture when heated over a diesel fire ,
- The fragments may have sufficient energy to initiate molten ANFO ,
- The fragments very probably have sufficient energy to initiate molten TNT .

CERL also analysed and tested samples of the products recovered from the test site as well as samples from the same lots at the factory. The results confirmed that the explosives were all on specification and that the classifications used for shipping purposes were correct. No abnormalities were found.

CERL Large Scale Tests

At the Canadian Forces base in Suffield, Alberta, two full scale tests were carried out, where fully instrumented tractor trailers were burned in an attempt to reproduce the Walden incident.

***Suffield Test Setup***

The first trial load was 20 te of ANFO alone, the second a mixed load of ANFO, slurry and emulsion.

***Suffield Test – After***

The results were;

- Tires ruptured ,
- Spring brake chambers failed ,
- Fuel tank ruptured ,
- Cooling system ruptured ,
- Maximum temp. ~1200 $^{o}$ C ,
- No detonations or serious explosions .

It had been proposed that reducing the maximum explosives load size to 5000 kg might prevent or at least greatly reduce the possibility of an explosion caused by a fire. This suggestion was based on two facts;

- In 1978 CERL had burned three 4500 kg truckloads of slurry and ANFO as part of a transportation safety study. All burned quietly ,
- In the Walden fire up to 5000 kg of the load were probably consumed by fire prior to the explosion .

However, the tests following Walden did not support this proposition, apart from the fact that increasing the number of explosives movements by four would increase the likelihood of road accidents leading to fire and explosion.

These results reinforced the findings of a literature search. Quite a number of truck and railcar fires involving commercial explosives, ANFO or AN have been reported. Some led to explosion, some burned out quietly. In most cases, it was

not possible to identify a mechanism which led to explosion.

With regard to the four questions posed at the start of the investigation:

1. How and why did the accident occur?
2. Why did the explosives detonate rather than burn?
3. Are any regulatory changes required?
4. What lessons can be learned from the incident?

i. Driver fatigue or a medical condition were both suggested. As a court case was pending no further details were available.

ii. Simple thermal effects, or self-confinement are not supported by test results. Impact by high speed fragments on molten ANFO (or TNT) is a possible mechanism. The interview with Professor A. Bauer of Queens University, Kingston, previously unpublished and now to be found in the SAFEX Newsletter 53, is very relevant here. The CERL results agree well with Bauer's previous work.

iii. Reducing load size is not supported by test results. Requiring two drivers for all significant explosives movements is one possible change, although industry would argue that the costs involved could not be justified by a (small) possible increase in safety. One possible change could be the requirement for engine compartment fire extinguishers or an engineered fire suppression system. Such a requirement already exists in Canada for bulk explosives trucks (MMUs).

iv. The main lesson is not a new one. Since the Walden incident, there have been several fires involving AN and ANFO worldwide, in Europe, Asia, N America and Australia. Some have resulted in explosions and loss of life. The outcomes of fires involving explosives are unpredictable. Evacuation of the area rather than fighting the fire should always be the rule. Evacuation should be to as far as practicable, as debris can be projected to considerable distances. The trucking company's emergency response plan could include a requirement to inform local emergency responders of the correct action in the event of such incidents.

## THE EXPERT PANEL by Andy Begg

- Do you need an experienced investigator to give you an independent view in an incident or to conduct the investigation?
- Do you need an experienced auditor to review your operations?
- Do you need an experienced trainer to help develop and implement your explosives competencies training programme?
- Do you need specialist advice on an explosives safety issue, risk assessment or regulatory issue?
- Do you need specialist advice in establishing a new plant or operation?

If so, have a look on the SAFEX intranet at the Expert section. There you will find access to a wealth of experience in explosives safety, process and regulation from research and design through production , testing, transport and use to final disposal.

There are 2 sections on the website you can look at. The first is a matrix of the experts and their skills. So if you need an auditor the matrix will tell you which experts can provide an auditing service. Next go to the second section where you will find "Profile" sections for each of the experts who provide auditing and there you will find much more detail on their individual skills. (The latter will only be completed end October). Then you make contact with the experts who meet your requirements and discuss your requirement with them. If you are satisfied with what is offered you make direct arrangements with the expert(s) you have chosen. The expert(s) will advise you of their terms and conditions etc. SAFEX will not get involved in these discussions - they are solely between the member and the expert(s).

**Expert Presenting at SAFEX Congress**

Most of the experts on the panel have many years experience in the industry and are now retired but are available to assist and support the members. Between them they have experience in virtually all aspects of explosives operations and safety. They are a unique resource to be used.

You may be seeking just a little bit of information - perhaps a short answer to a technical question.

**Ask an expert.**

You may be looking for a visit from someone to conduct an investigation or conduct a safety audit.

**Ask an expert**.

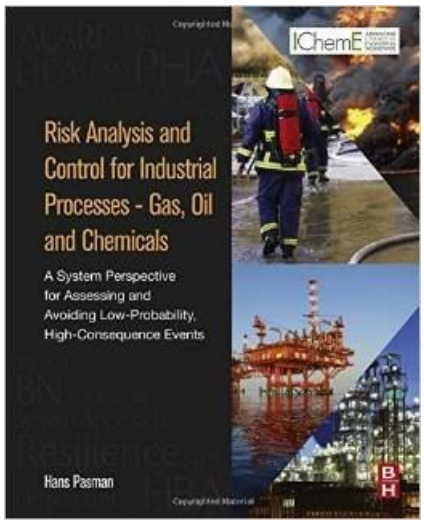
## Risk Analysis and Control for Industrial Processes – Gas, Oil and Chemicals

## *A System Perspective for Assessing Low-Probability, High-Consequence Events*[1]

## A Book Report by Lon Santis[2]

**Introduction and Overview**

This publication, further referred to as "the book", is a comprehensive and contemporary reference on risk management and should be on the shelf of every risk manager in the explosives industry. The book contains almost 500 pages and covers everything from ALARP to Zohar's Safety Climate Questionnaire (ZSCQ). The 13 chapters typically list close to 100 references or more that provide deep background on the subject matter.




Although the book is highly technical and will push the understandings of almost any reader, Hans Pasman does not forget the layman and includes a trove of information for both those above and below the typical risk manager. The book clearly places full responsibility for risk management at the feet of the highest levels of management within a company, offering time and again specific examples of where upper management failures of all sorts led to catastrophic consequences.

The book would be an outstanding text for a college course (or two) on risk management of low-probability high-consequence events (LPHCE). Much of the book is related to petro-chemical operations, but even those references have relevance to explosives activities. Pasman does spend considerable effort addressing the unique hazards of activities involving solid-state explosives. Some explosives experts may disagree with some of the finer details about explosives risks that are presented in the book. But such perfection should only be expected of a volume that only addresses explosives risks. Besides, Pasman provides enough reference material that readers could only be misled by their lack of rigor.

It would require more than all the print in this newsletter to do true justice in summarizing such a book as this. Following is a very brief summary of each chapter and perhaps a nugget or two of information that will hopefully whet readers' appetites for more of the book.

**Chapter Summaries**

**Industrial Processing Systems, their Products and Hazards**

This chapter provides an overview of the general global outlook on LPHCE risk management. The properties of the most commonly encountered hazardous materials or dangerous goods, including ammonium nitrate (AN), and notable incidents involving them are discussed. The section on AN includes discussion of the history of AN synthesis and an overview of reaction mechanisms. Major AN incidents such as West, TX, Oppau, Germany and Toulouse, France are discussed. In an impressive show of how contemporary the book is, it even mentions the September 14, 2014 AN transportation incident in Queensland, Australia.

**Regulation to Safeguard against High-Consequence Industrial Events**

An overview of the European and American regulatory systems for LPHCE is presented in this chapter. A trend appears that each progression in regulatory

burden is preceded by a catastrophic event.

**Loss Prevention History and Developed Methods and Tools**

This chapter contains over 100 pages and nearly 200 references. It is a thorough compilation of where we have been and how we got there relative to LPHCE risk management. It describes the critical elements of a Safety Management System, goes into considerable depth on explosives risks and describes risk assessment methods. Some explosive experts may take exception to some of the books' fine details in this section. For example, the book says there is no data on fragment hazards from blasts and essentially ignores this hazard mechanism. Many readers know that fragment hazards from explosives events can be quantified. But again, the book is not intended to be used as the sole reference for an explosives risk analysis.

The book makes several statements in this chapter that many readers have probably suspected but lacked the scientific basis to prove:

*Regrettably, the downward trend in personal injury rates [over the previous century] is not replicated with major accident rates.*

*[Effective hazard analyses] is by preference a team activity performed by, for example, an operator, a maintenance specialist, a process engineer, and a product expert, and is under the control of an experienced team leader.*

*[Researchers] observed social amplification of risk turning the public against an industry sector in which calamity was caused by only one member of the sector, that is, risk aversion can be indiscriminate.*

**Trends in Society and Characteristics of Recent Industrial Disasters**

A worldview of LPHCE is presented in this chapter. Following a general introduction of high level LPHCE societal dynamics, two accidents are analyzed in detail, the Deepwater Horizon platform disaster of April 20, 2010 and the Fukushima-Daiichi nuclear incident of March 11, 2011. Specific failures in decision making and how effective risk management based on a systems approach could have prevented each incident are described.

**Sociotechnical Systems, System Safety, Resilience Engineering, and Deeper Accident Analysis**

Starting with this chapter, the last 300 pages of the book delve into the cutting edge of how risk managers can accomplish their mission. This chapter introduces the discipline of resilience engineering, or as some in the industry might call it, sustainability. The book drives home the point that LPHCE risk is driven by a combination of social and technical issues so tightly coupled, non-linear and complexly interactive that mishaps are unavoidable even when all conditions are right and all work is done safely.

**Human Factors, Safety Culture, Management Influences, Pressures, and More**

This chapter's coverage of the societal or human factor (HF) side of risk management may be particularly helpful to those more familiar with the technical side. It breaks HF into three categories:

Personal factors such as knowledge, skill, stress, physical condition and motivation.

Workplace factors such as direct supervision, engineering, maintenance, training and work standards.

Organization factors such leadership the management system.

The ZSCQ is presented here and provides a way to measure the safety climate within a particular workplace.

**New and Improved Process and Plant Risk and Resilience Analysis Tools**

This chapter is a powerhouse of information, a veritable treasure trove of methods to analyze, measure and reduce risk. Readers will be familiar with some of these methods, such as the ICI classic HazOp study and FMEA tools. But new concepts such as Blended Hazid (BLHAZID) (a combination of HazOp and FMEA) are described. The latest information on HazOp automization, different types of Bayesian Statistical methods,

rare event probability estimation, and fundamentals of organizational resilience are presented. Alas though, the book recognizes that the best LPHCE risk calculations will be, at best, only within an order of magnitude for the foreseeable future.

**Extended Process Control, Operator Situational Awareness, Alarm Management**

This chapter presents a very high level academic dissertation on fault diagnosis. Whereas risk managers typically focus intently on what to do after the alarm goes off, much is made in this chapter about what makes the alarm go off, rightly or wrongly.

**Costs of Accidents, Costs of Safety, Risk-Based Economic Decision Making: Risk Management**

Up to this point, the book examines the building blocks of risk management but now takes on that sometimes uncomfortable subject of making decisions based on the risk assessment. Once again, the point is made through data that despite orders of magnitude improvements in personal safety, there is no convincing downward trend in major accidents with huge losses. If the reader is looking for specific criteria expressed in fatalities per year and so on, they will have to wait. Instead, the chapter discusses how to set and use criteria. Superb data is presented on how to measure the cost of injuries and fatalities and even the use of game theory is discussed.

**Goal-oriented versus Prescriptive Regulation**

This fascinating chapter may change readers' opinions on this classic subject of debate that inevitably occurs whenever groups of individuals come together to write standards. The debate goes something like: Should we say "X meters" or "a safe distance?" A strong case is made that the most effective standards are a delicate combination of both approaches.

**The Important Role of Knowledge and Learning**

In this relatively brief chapter, the importance of knowledge and the pursuit of greater knowledge is intimately linked and shown to be fundamental to risk management of LPHCE.

**Risk, Risk-Perception, Risk Communication, Risk Acceptance: Risk Governance**

This chapter couples well with Chapter 9 and gets into setting specific criteria for risk-based decisions. Readers will find the information helpful in setting criteria and discussing LPHCE risk with others. For example, a method of estimating the public's perception of risk based on psychometric research is presented. The method uses two scores, one based on "dread" factors and the other based on "unknown" factors. The different risks considered in the research fall rather neatly into groups correlated by their voluntary and involuntary nature. Dynamite and Handguns are scored very similarly, receiving the lowest scores possible on the unknown scale and slightly above average dread scores. In the same neighborhood of public perception of risk are auto accidents and auto racing; things we understand are risky and fear enough to respect. On the opposite end of the scale of public perception are risks from Water Fluorination and Microwave Ovens; things we don't understand well or fear much at all. At the high ends of the dread and unknown scales one finds DNA Technology and Radioactive Waste. Bicycles are at the outer fringe of the group of low-dread, well-known risks.

**Conclusions: The Way Ahead**

This chapter summarizes the primary message of each previous chapter. It finishes with the point that transparency is the best way to gain the public's trust in regards to LPHCE risk. The book's final words are profound indeed:

***Honesty and integrity will always be invaluable components of risk management.***

[1]Hans Pasman, Published by Butterworth Heinemann in 2015, ISBN: 978-0-12800057-1.

[2]Principal at Explosives Risk Managers LLC, Frederick, MD, USA.

**SAFEX ARTICLE 11:**

***SAFEX SERIES OF ARTICLES: Improving explosives competence (Safex introduction) by Denise Clarke***

*All explosives manufacturers recognize the importance of training and developing people who work in and are responsible for explosives operations. SAFEX recently responded to a perceived need to develop leaders of explosives operations by embarking on the development of the SAFEX Explosives Management Course in an e-learning format. We are not alone in trying to support SAFEX members in their quest for improved workplace competence. SAFEX is willing to partner with anyone or use any technology that can contribute to the competence of people working with explosives and thereby make our workplaces safer. In this Newsletter feature we propose presenting a series of articles that explain the UK's National Occupational Standards (NOS) in Explosive Substances and Articles (ESA). In the coming editions of the Newsletter, each article will examine a different aspect of the ESA standards and explain how they can be used for a range of purposes.*

**Title: Skills-related issues in the UK explosives industry**

As the final article in this series, we thought it would be interesting to look back over the last twelve years when work first began to develop the Explosive Substances and Articles National Occupational Standards (ESA NOS) and consider what developments there have been in this field since then, the future skills issues that the industry is likely to face and how these challenges might be met.

In 2000, the Standards Setting Body for Explosives, Munitions and Search Occupations (SSB for EMSO) was set up to develop National Occupational Standards (NOS) in Munition Clearance and Search. The UK Ministry of Defence (MoD) took a keen interest in this work and asked the SSB to expand its work to cover all the uses of explosives (this has been described in earlier articles in this series). In summary, the MoD's primary concerns were:

- a need to assure competence as one means of avoiding accidents by providing an objective method of assessment of training inputs;
- recruitment difficulties: ESA is a shrinking specialism within the MoD and a high level of commitment is required of applicants who will need to fulfil their training programme;
- a need to put in place objective criteria by which contracts placed with commercial companies can be assessed and managed;
- a desire to provide formal accreditation for individuals' competence;
- the imperative of enhancing and maintaining safety standards[1].

[1] *Occupational Map of the Explosive Substances and Articles (ESA) Occupations* (Clarke, 2004): http://www.homelandsecurityqualifications.co.uk/documents/

**Future path of the explosives industry**

With advances in technology in so many different directions, you might ask if we need an explosives industry at all. However, the explosives industry remains a solid base as part of the UK's defence strategy and the delivery of competence has an essential role in supporting this. Although the UK continues to buy explosives from overseas, it still needs to retain its own strategic defence capability. Explosives will be a requirement as chemical energy remains an effective method of delivering an effect on a target (for commercial as well as military applications). Defence energetics requirements remain unchanged e.g. propulsion technology and the technology to make flares, distress and signalling equipment, ejector seats and so forth remains static and, as there are no alternatives, so there will continue to be a need for an energetics industry into the foreseeable future.

Weapons technology is changing constantly – for example, with the development of cyber warfare and directed energy weapons such as lasers. In the future, energetic delivery methods will be more reliant on remote technology – using drones and mobile technology – and this will require different skills. Even though some explosives workers (such as those involved in R&D, manufacture, through life support and maintenance) will require IT skills, others will remain very much "hands on" as people will still need to arm aircraft and place explosives into storage. Dave Winterborne agrees: "For the foreseeable future, there will be a need to be able to handle new materials, to understand new formulations, their properties and the functioning of new effects delivery systems and how to dispose of such systems. For example, the disposal of Insensitive Munitions is more challenging than the disposal of current conventional munitions. Both corporately and individually, there is a need to keep abreast of customers' changing needs to keep up to date with the need for changes in people's technical knowledge and skills. However, the skills needed for the storage and transport of explosives will remain the same". Designers of weapons and explosives delivery systems will need complex electronic skills for safety, arming, fuzing and guidance systems but these are immaterial without the propulsion and warhead systems, i.e. the energetic components. The development of novel energetics and the use of exotic materials in these components will test the skills of explosives workers at all stages of new munitions' life, requiring talented people for the foreseeable future. Advances in IT will enable the creation of smaller, faster systems which will require sophisticated IT. At the same time, innovation in warheads and propulsion systems will require sophisticated plant and engineering processes.

Historically, the UK has maintained large stockpiles of ammunition. These are no longer required nor are they affordable. There are a number of reasons for this: the development and use of precision-guided weapons has enabled targeting with far greater accuracy so fewer munitions are needed to achieve the desired effect; the introduction of LEAN and JIT processes mean that fewer items need to be kept at any one

time; and last - but not least - the issue of cost means that it is not cost-effective to manage large stockpiles. Obviously, smaller stockpiles means fewer staff are needed to manage and subsequently dispose of them; which in turn raises questions of redeployment and re-skilling.

Beyond the defence industry, there will be a continuing need for explosives for use in mining, quarrying, special effects, in the manufacture of rocket engines for use in space, in car air bags and so on. Most demolition in the UK is now carried out mechanically but sometimes the most cost-effective method is still to use explosives. In theory, all tunnels and cuttings for roads, railways and other construction could be achieved mechanically but the duration of the operation will not always meet the client's requirements. Using explosives is much quicker.

**Stimuli for change**

The last ten years have been witness to a number of changes. The aging workforce and industry's concerns as to the future lack of explosives skills coupled with the criticisms raised in *The Nimrod Review*[2](colloquially known as the *Haddon Cave Report*) have all led the industry to the realization that the "gentleman amateur" is no longer tenable. The Nimrod incident (a mid-air fire on board an RAF Nimrod plane) took place in 2006 over Afghanistan and resulted in the deaths of 14 people. Charles Haddon Cave found in his report:

> *…the Nimrod Safety Case was a lamentable job from start to finish. It was riddled with errors. It missed the key dangers. Its production is a story of incompetence, complacency, and cynicism…The Nimrod Safety Case process was fatally undermined by a general malaise: a widespread assumption by those involved that the Nimrod was 'safe anyway' (because it had successfully flown for 30 years) and the task of drawing up the Safety Case became essentially a paperwork and 'tickbox' exercise.*

Further criticisms were levelled about inadequate project management; the dilution of airworthiness due to financial cuts and massive organizational change; a shift in MoD culture and priorities at the expenses of functional values … and so on. Ken Cross makes the point that the report highlights a number of areas about the weaknesses inherent in the area of personnel that were factors in the Nimrod incident and which can be extrapolated to explosives engineering, the key points being:

- undervaluing and dilution of engineers and engineering skills;
- engineers are not required to have professional status;
- decline in the ability of the MoD to act as an "intelligent customer";
- a lack of trained Safety Engineers;
- a shortage of manpower and skills fade.

"There is a trend toward increasing amounts of partnership working as it is often too expensive for companies to 'go it alone'" explains Ken Cross which has an implication for the way that business is conducted, to ensure that all parties involved are working to the same standard. Phil Hilton agrees: "There is an increasing amount of partnership working across the UK explosives industry and between UK and overseas explosives organizations. In such cases, particularly the latter, companies need assurance that staff are trained and that their competence has been measured to a recognizable standard".

Jon Baker commented that "Personally, I would see the future of the explosive industry as one of increasing collaboration between organizations. There has been a significant reduction in facilities and experienced staff over the last 20 years, (across the industry) and whilst the ESA NOS route allows for a solid framework for training and competence, there are facility gaps that can only really be cost-effectively plugged through collaboration, where another organization has a suitable facility. Using the ESA NOS also allows for organizations to be confident that any outside staff using their facilities are fully competent in the handling and processing of ESA, and the host organization can then focus any additional training requirements on localization (e.g. local range rules, local emergency procedures etc.). "However, cultures, behaviours and working practices may vary between partners and management "floorwalking" is needed to ensure that standards of quality and cleanliness, for example, are maintained. The ESA NOS can be used for this purpose when checking on the conduct of a business process" explained Adrian Lovell.

Dave Winterborne points out that some of the drivers to change may be positive: "Insurance requirements are bound to drive change eventually. In the case of payments due to failures and incidents, insurance companies as well as regulators are seeking confirmation that the explosives workforce is competent from organizations' managements and premiums may be reduced if that assurance can be provided" he says.

**Significant skills issues**

"The UK attitude to qualifications remains a sticking point" explains Ken Cross "We still seem to want the "gifted amateur" rather than qualified professionals". This attitude pervades many UK industries: for example, a job in a British bar or restaurant is often seen as temporary and unskilled – quite the opposite from France, Germany and many other countries where such a position is seen as a profession with recognized training, qualifications and a career structure.

One of the biggest skills issue is a lack of recognition of a clear

[2] https://www.gov.uk/government/uploads/system/uploads/

career path through the industry. Because of this, people do not see a worthwhile future career in the industry and this makes recruitment difficult. "The industry should promote itself better as a profession" said Peter Honey "and the Institute of Explosives Engineers' efforts through Chartership will help to achieve this. What we still need to do though is to promote other routes into and through the industry such as the Apprenticeship route" he added. Such an aspiration would be facilitated by solving the problem of the shortage of sufficient numbers of qualified assessors and verifiers who can also act as champions of the ESA NOS within organizations so that they can explain the construction, demands and uses of the standards.

"Since so much more can be automated, there is the potential for a loss of skills - for example, there may be a loss of manual dexterity, for example, when connecting firing lines and circuits and fitting detonators which could be carried out by automation in the future" said Dave Winterborne. He is not alone in being concerned about such issues as Shaun Dooley and Adrian Lovell agreed: "Our concern is that of skill fade across the industry. Understandably, customers want more benefit from each trial, so fewer trials need to be run. Hence, staff have less opportunity to keep their skills up to date. At AWE, we recognize that experience and growth in knowledge and skills could lead to complacency of the risks from the task. Routine assessment [i.e. using the ESA NOS] is a tool to identify this behaviour, coupled with demonstrations through simulated operation as part of the process".

**Solutions to explosives skills issues**

In the early 1980s, the UK explosives industry was fragmented when the MoD relinquished it supplier status and privatized its in-house manufacturing facilities. Consequently, over the last thirty years, defence companies have worked in isolation. Whilst companies still compete with each other, senior managers are now happier to see their companies collaborate on skills issues. The ESA NOS have provided a framework for such collaboration in the shape of industry-recognized role profiles and explosives qualifications. All these sorts of initiatives should make recruitment easier across the industry.

There is general agreement that there has been a recognition amongst explosives organizations of common issues and common solutions that has been brought about the use of the ESA NOS. By using them, organizations' managements can be sure that their workforce has met a certain standard and they provide the basis for future recruitment since they have been used to clarify the company's explosives role profiles – whether recruits need to have previous explosives experience or not.

There is a drive towards the formalization of professionalism in the UK explosives industry which is being achieved in a number of ways. The Institute of Explosives Engineers (IExpE) professional registration as Chartered or Incorporated Engineer or as Engineering Technicians (CEng, IEng, EngTech) helps to align military and civilian skills and expertise and contributes to the increasing parity of esteem between graduates and professional experience. One area where the IExpE has been a driving force within the professional engineering institutions (PEI) is in bringing into the realm of professional registration those highly experienced explosives engineers, some with world-wide reputations, but who have little in the way of academic qualifications. This approach is supported by the UK's Engineering Council and partner PEIs. The introduction of HSQ's competence-based explosives qualifications (which are based on the ESA NOS) and, more recently, the development of an explosives apprenticeship all provide mechanisms to achieve professionalism.

As with other industries, the explosives workforce is aging and few organizations have a comprehensive succession plan. Whilst many see the benefits of such an approach, the long term investment that would be needed is often not seen as a priority in this challenging economic climate. "The best time to train a workforce is when business is slow … people can be upskilled so that they can meet future challenges but organizations are not doing this because of immediate affordability issues and because they lack the long term vision" explains Dave Winterborne.

On behalf of the SSSG, the MoD has led the establishment of the Early Careers Forum as an aid to recruitment and retention across the industry. The Forum is open to anyone of less than ten years' service in the explosives industry and it hosts fora, symposia and provides opportunities for the exchange of ideas and information so that members can get to know the business better which will contribute to their continuous professional development. There is cooperation across the industry in relation to explosives skills. The MoD seconds its graduates to other organizations so that the graduates gain experience, the receiving organization gains an extra member of staff and the MoD gains better developed staff through the experience.

There is a lot of good will for people to undertake training but the problem remains of making the workforce available to do that training due to operational pressures and due to lean staffing which makes it difficult to release people to carry out training. "Some organizations do not understand that they can build competence development and workplace assessment into the job. With some upfront investment, you can develop a system that will run itself" said Dave Winterborne. "Customers now have expectations that their suppliers' explosives workforce will be demonstrably competent – that is to say, not just that it is competent, but that it can be proved to be competent through the lifetime of a project. New technologies and government emphasis on Apprenticeships are encouraging some organizations to join the "Five Per Cent Club[3] " he went on to say.

[3]The 5% Club is focused on creating momentum behind the recruitment of apprentices and graduates into the workforce. Its members consist of public and private companies in the UK who want to make a difference and support the UK's ability to compete in increasingly tough global markets (http://www.5percentclub.org.uk)

**Training versus qualifications**

Whilst many UK explosives organizations use the ESA NOS, not all use them to qualify their personnel: some do not see the value of investing in qualifications for their people and others even fear that, once they have gained a qualification, the individuals may even leave the organization and move on. However, some companies most definitely see the benefits of qualifying their people as Peter Honey explains: "A qualified person means that you have independently validated, demonstrable competence. Training is the input but the qualification is the output".

Some UK companies want to train workers only on exactly what they need to do in a given task on a given day. Whilst this approach might meet an organization's immediate requirements, there is also a down side as it risks reducing operational capabilities to meet customers' changing needs and renders organizations inflexible and therefore less able to cope with fluctuating demands for different types of work. "'Suitably Qualified and Experienced' people are likely to be of more value in more scenarios than those who are trained by rote" said Ken Cross.

"Competence is a combination of knowledge, skills, attitudes and behaviours. Training is the transfer of knowledge but it does not prove competence – you still need proof that that knowledge is applied in the workplace and that appropriate behaviours are exhibited all the time. The independent validation that is a characteristic of an explosives qualification ensures that quality control has been achieved" said Phil Hilton.

Dave Winterborne summed up with the response: "When you are ill, do you want to see a trained doctor or a qualified doctor?"

**Using the ESA NOS to meet skills challenges**

The ESA NOS have provided a strategic system against which people can be recruited, trained and developed. Whilst it was the MoD that commissioned the Standards Setting Body for Explosives, Munitions and Search Occupations (SSB for EMSO) to develop the standards, industry has recognized that it should be using the standards too. All MoD contracts expect suppliers to be able to provide demonstrations that their staff are competent, so an option for bidders is to use the standards as a way of providing such proof.

"The ESA NOS have contributed to the entire existence of the EUExcert Programme" said Ken Cross "and they are being used in the current project by five pairs of partners for a variety of purposes." These are:

- in Sweden KCEM AB is the project partner and SAAB Bofors Test Centre AB the industry partner. BTC will use the NOS in a management role, to identify the skills of their explosives workers on their HR system as part of their ISO 17001 compliance management framework;

- for the United Kingdom PICRITE Ltd is the project partner and Event Horizon Pyrotechnics Limited the industry partner. Event Horizon is going to redesign their existing SFX courses, mapped to the NOS and to develop and deliver qualifications in concert with the UK's prime customer for SFX technicians (the British Entertainment and Cinematographic Trade Union (BECTU));

- in Germany, Dresdner Sprengschule GmbH is the project partner and MAXAM Deutschland GmBH has taken on the position of industry partner;

- for Portugal, the University of Coimbra was the project partner, working with G.J.R. - Pirotecnia e Explosivos, SA as the industry partner. GJR intends to implement manufacturing qualifications for its staff. Scale and scope have yet to be defined but it is looking very positive;

- in Estonia, the Tallinn University of Technology was the project partner with Voglers Eesti OÜ as the industry partner. Voglers intends to use UK qualifications in explosives safety management to be able to demonstrate their workers' competence to their international customers.

**Investment in developing the ESA NOS**

There is general agreement that the investment in developing the ESA NOS was worthwhile and people refer to the ESA NOS on a regular basis. Managers and workers alike recognized that they will be measured against them and the biggest reason for this is that there is a requirement for this that has now been written into UK MoD Regulations. Equally important, in 2009, HM CIE[4] said that, in the event of an explosives incident, the ESA NOS would be used by his inspectors to measure competence and competence management. UK MoD Explosives Regulations states that:

> "*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)*[5]*."*

[4]Her Majesty's Chief Inspector of Explosives
[5]Temporary Explosives Bulletin 008/2009, published in July 2009 and incorporated into Joint Service Publication (JSP) 482 (edition 4, published January 2013).

"I am heartened by the amount of pan-industry collaboration on training" said Phil Hilton. The ESA NOS have provided a common language across the industry. They have provided a framework for greater cross-industry collaboration (e.g. on trials projects); enabled the development of industry -wide explosives role profiles; provided the basis for the recognition of explosives skills through the attainment of explosives-related qualifications and have formed the basis of explosives Apprenticeships. Most defence manufacturers deliver their own in-house training (and some contract with external providers) using the ESA NOS as a training framework. The implementation of the ESA NOS has enabled the development of HR tools which means that people's skills are more transferable. For example, it is now a far smoother transition for someone retiring from the Forces and going into civilian employment because their skills as easily recognized because they have been aligned to the ESA NOS.

"The use of the ESA NOS has enabled our company and its explosives workforce to have pride in their work by demonstrating a route through which all explosives workers can excel in their chosen career and to be able to recognize their own value" said Shaun Dooley. Whilst this might sound "motherhood and apple pie", there is a business benefit as Shaun went on to explain that the use of the ESA NOS ensures that opinion is measured through individual assessments which are standardized across the company and nationally. They are being used to provide a guide to the 'health and robustness' of explosives worker competence, manage skills for forward planning (portability), improve the cross-company assessment process and demonstrate capability. This enables career development, providing flexibility within the workforce, which could extend internationally where the business demands it because the UK NOS is adaptable. The AWE can demonstrate capability and this enables its stakeholders to trust that the explosives business will be safe, secure and clean. AWE's performance will ensure that it is financially successful whilst retaining brand and reputation, in keeping with the company business model.

But the value of the ESA NOS goes beyond the UK. In addition to bringing the industry together to discuss skills issues and create routes to recognition through common role profiles, the ESA NOS also provides the basis for a lot of EUExcert's work, particularly with a view to the transferability of labour across Europe. The UN is now also making progress in this direction.

**Making the most of the workforce**

Historically, in the UK, many companies have been reluctant to invest in training and qualifying older workers. However, this is beginning to change. Ken Cross pointed out that there is legislation in place in the UK to prevent age-related discrimination. However, industry recognizes that it also needs to retain the skills and expertise held by older workers. Companies should be considering how they might get more from all their workers and QinetiQ has already demonstrated that if someone achieves a qualification, it motivates them to deliver more and better.

QinetiQ itself has recognized the need to qualify all its explosives workers and this includes people in their fifties and sixties because it sees a clear business case for the retention of skilled and experienced personnel who could continue to make an active contribution to the company past what used to be seen as retirement age in that continuing investment in skills means better productivity.

**Globalization of skills**

The demographic issue of an aging workforce and the incipient loss of explosives skills is shared by many countries across the world – for example, Australia, Singapore, the US and many countries within Europe and the EUExcert project is working toward the Europe-wide certification of explosives skills. Whilst much has already been achieved with regard to transnational recognition of competence in working with explosives, this is sometimes hindered by political boundaries in that in some countries, explosives competence requirements are written into legislation which may make their adoption difficult.

Looking beyond Europe, Ken Cross pointed out that "A lot of global companies' people work worldwide and could easily use the ESA NOS to qualify them as this would provide the assurance that common standards have been reached and provides for the transferability of labour which is especially useful to management grades. The issue is getting those countries and organizations to understand the construction and uses of the standards and the necessary assessment structures."

"There is a huge need for certification of explosives skills internationally in much the same way that hotel chains all work to the same standards wherever they are located in the world" explains Dave Winterborne. "The ESA NOS are relevant and usable all over the world and people working in global companies need to work in accordance with them. Think of them as "Global Harmonized Standards " he added.

The issue arises within military coalitions working around the world as to whose standards should predominate? Dave Winterborne explained that "The UN has explosives standards for military coalitions operations. Adopting fully the UK's ESA NOS will help to ensure consistency of practice". Indeed, the United Nations has referenced the ESA NOS in the International Ammunition Technical Guidelines (IATG) 01.90 Staff Competences to be published in version 2 of the IATG this October[6].

[6]http://www.un.org/disarmament/un-saferguard/guide-lines/

**Conclusion**

When we set out to develop the ESA NOS, there were a number of objectives to be achieved. However, in addition to reaching these goals, a number of unintended outcomes resulted. A key feature that cropped up again and again in my discussions with industry representatives was the increasing amounts of cross-industry collaboration that has been facilitated by the ESA NOS. As Phil Hilton put it: "The ESA NOS provide a competence framework that is recognized as industry-wide and we would not have made the progress that we have without them".

Essentially, the picture seems to be emerging that the skills involved in the more complex aspects of working with explosives are likely to require more sophisticated IT skills. However, those skills involved in explosives storage and transport are likely to remain the same. What is more likely to change is that organizations may need to multi-skill their staff to give them the flexibility needed to meet changing customer needs.

An interesting feature of the explosives industry is the parallel between it and the UK chemical manufacturing industry which both share some common characteristics and issues. This makes me cast my mind back to the work I did in the latter industry some 20 years ago. Many of the UK chemical industry companies were globally owned. Since the prices of raw materials were fixed globally, the only way that companies could gain a competitive edge was to get more from their workforces. This was achieved through investment in a range of HR-related initiatives including training and education; working to National Occupational Standards (in the case of the chemical industry, these were mostly in Process Operations and Engineering Maintenance); the attainment of competence-based, workplace-assessed qualifications; Apprenticeships, Investors in People and so on. The result of this sort of investment was to render companies leaner, smarter and more productive by multiskilling their staff. I draw your attention to the Hydropolymers case study described in this column in Safex newsletter no. NL 47 (4$^{th}$ quarter, 2013) where, following such investment in its whole workforce, the output tonnage per person (including non-production staff) increased from 174 tons per person employed to 450 tons per person.

We have witnessed the beginning of a groundswell in cross-industry collaboration and resource-sharing, particularly in training. Back in the 1990s, the chemical industry identified a value in such cross-industry collaboration. ICI, Shell and Associated Octel came together and established Technical Training Enterprise (TTE) in the north west of England where there was a concentration of big multinationals in order to deliver the skills that the industry needed. TTE[7] is still going strong, and indeed, it has expanded its operations worldwide. Whilst the UK explosives industry is more diffuse than the chemical industry, there are definite parallels to be drawn around the benefits of cross-industry collaboration and training. It might be a step too far at present, but who knows whether there may be a similarly successful venture in the future as TTE to deliver the skills that the explosives industry needs to an industry standard, not just in the UK but perhaps overseas too.

Throughout this column, we have looked at different aspects of the ESA NOS and shared our experiences with readers in the hope that they may be able to benefit from them. We hope that you have enjoyed these articles and that they may have provided food for thought on how staff can be developed to meet the explosives skills challenges of the future. Competence is inextricably linked to safety and the ESA NOS provide the tools to achieve assurance that industry standards have been met. As Peter Honey put it: "We do a safe job with dangerous materials. We don't do a dangerous job and demonstrable competence is a way of achieving that safe job".

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

www.homelandsecurityqualifications.co.uk/documents

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[7]http://www.tte.co.uk

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**A note about the author**

Denise Clarke is the Managing Director of Homeland Security Qualifications (HSQ) – a British-based awarding body that specializes in the award of explosives- and defence-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 seven qualifications assessment centres, delivering a range of bespoke, industry-recognized and nationally regulated competence-based qualifications. Please visit www.homelandsecurityqualifications.co.uk for more information.

## Countering the IED Threat – Industry's Role in the Fight

## Prepared by UK Ministry of Defence Attack the Network

**Introduction**

While the conflicts in Afghanistan and Iraq are no longer the size and scope of the last decade, their signature weapon, the Improvised Explosive Device (IED), endures not just in these regions, but globally. From June 2014 to May 2015 there were 55,950 casualties from 23,335 incidents globally[1].

With cunning and adaptive terrorists operating on an ever changing battlefield, IED design is constantly evolving as counter measures are developed against them . IEDs are often designed according to the target, the skill of the manufacturer and the person emplacing them, and the resources available. Terrorists often make use of items that have a legitimate use and are readily available or easy to procure, such as agricultural grade Ammonium Nitrate (AN) for the production of Home Made Explosive (HME). However, terrorists usually prefer to acquire Commercial Grade Explosive (CGE) products due to the increased reliability for the operator, compactness, and explosive efficiency.

Many explosives and HME chemical precursors originate from, or transit through, states and territories neighbouring those where IEDs are deployed. Vulnerabilities in the control of energetic materiel increase the opportunities for legitimate products to be diverted to illicit ends. In response, good practices by industry, backed by robust law enforcement are instrumental in disrupting and deterring the illegitimate use of explosives and HME precursors.

Robust controls on explosives and HME precursor chemicals are beneficial, enabling the protection of ordinary people and the security forces that protect them . However, due to the dual-use nature of many precursor chemicals and commercial explosives there is a need to ensure that regulatory controls do not negatively affect commercial industries.

The UK Ministry of Defence's (MoD's) Attack the Network (AtN) Team (formally the Joint IED Analysis Centre (JIEDAC)) exposed the history of the threat, the construct of a typical IED and the approach to countering this threat in three past articles. The last article focused on how governments, particularly within NATO countries, are working together to combat the threat of IEDs. This article will focus on initiatives that affect industry, including oversight and accountability of products as well as how governments can better work together to find solutions that benefit all parties.

**Oversight and accountability**

The importance of maintaining oversight and accountability of commercial explosives and HME precursors cannot be overstated. Simply put: knowing where these products are; where they are destined; who has access to them; and how they are accounted for is the foundation upon which the security of dangerous goods is based.

Oversight and accountability is therefore closely associated with good practices in supply chain management. Maintaining effective management, from the point of manufacture to end-user, aims to keep legal materiel within legal channels and reduce the risk of illegitimate acquisition. Responsibility for ensuring good supply chain management lies with both government and industry and can be achieved through a combination of regulatory and voluntary actions.

The basis of most of these actions is the improvement of practices relating to oversight and accountability. Europe has taken steps to improve oversight and accountability of explosives and HME chemical precursors. Several initiatives are worthy of mention as being examples of regional and international cooperation:

[1] Joint Improvised Threat Defeat Agency (JIDA) (formally the Joint IED Defeat Organisation (JIEDDO))

- The European Commission (EC) Directive 2008/43/EC and its interpretation into UK law - the Identification and Traceability of Explosives Regulations 2010 (ITOER):

  This Directive led to the development of ITOER 2010, both of which have subsequently been revised[2]. The revised ITOER legislation came into force in April 2013. It is significant because it will improve end-to-end oversight of the commercial explosives supply chain by requiring explosives producers to use identification markings and to maintain records in order to ensure proper stock accountability. This Directive is an example of a regional approach as it requires each member state to develop similar controls for commercial explosives.

- The European Union (EU) Action Plan on Enhancing the Security of Explosives:

  This EU Action Plan was enacted in response to the Madrid terrorist attacks. It forms the basis of the EU approach to impeding the terrorist use of explosive materiel. The action plan focuses on three key areas:

  ◊ Prevention – Aims to address the traceability of explosives and precursors, awareness and security issues.

  ◊ Detection – Aims to establish a regional consensus on detection standards and to introduce a European wide certification scheme.

  ◊ Response – Aims to improve the exchange of information and sharing of good practice in addition to developing specific preparedness and response measures for terrorist threats using explosives.

  It is proposed that these aims will be achieved through a mixture of voluntary activities and regulation[3].

The Regulation of the European Parliament and the Council on the Marketing and use of Precursor Chemicals:

This regulation seeks to control the sale of a list of eight precursor chemicals in certain concentrations[4], to members of the public. A further list of seven concentrations requires suspicious transaction[5] reporting.

The application of technology to commercial explosives and HME precursor chemicals can support regulation and oversight. Such voluntary activities undertaken by industry can be used to improve controls over the supply chain and in some cases support investigations into terrorist IED events. Technology that aids in the identification of materiel involves the application of labelling or markings onto the product or product packaging to assist in traceability.

Traceable markings also assist in forensic investigations where such products have been misused. The use of traceable markings or unique identification numbers (UINs) enables better stock management, accountability, and oversight of the supply chain. Examples of these markings include alpha-numerical marks and pictorials or barcodes that are applied to numerous product types such as detonators and detonating cord.

Simultaneously, computerised stock management and identification systems improve the traceability of explosive products and HME precursor chemicals. This can be a localised system, for example stock management within an explosive magazine, or part of a wider traceability framework that tracks materials from manufacturer to end-user.

For example: A fertiliser company has trialled a system that uses Radio Frequency Identification (RFID) technology combined with a Global Positioning System (GPS) to provide oversight and control of their stock distribution; not unlike the technology used to track and trace items through a postal system.

**Government to industry outreach**

There is growing awareness that industry can be the first line of defence in the fight against IEDs due to their daily interaction with trading partners, understanding of the networks (i.e. when something is out of the ordinary) and wider expertise through the manufacture, development and sale of products.

Several nations have developed systems of energetic materiel control that rely on a combination of regulation by government and good practices by industry. These systems aim to prevent dual-use items from entering the illegitimate supply chain and highlight possible nefarious activity. Through governments working together with industry, they can understand the industry's concerns and work towards mutual and reasonable solutions.

Examples of initiatives to which industries voluntarily abide include:

- 'Know Your Customer' schemes[6]:
- These schemes aim to raise awareness among business owners and industry customers about the potential misuse of some of their products and to give

[2]European Commission Directive 2012/4/EU and ITOER

[3]Amendment 2012, respectively.
Commission Directives 2008/43/EC and 2012/4/EU, the UK's Identification and Traceability of Explosives Regulations 2010 and Amendments 2012, and the EU Action Plan on Enhancing the Security of Explosives are freely available online.

[4]Hydrogen peroxide, Nitro methane, Nitric acid, Potassium chlorate, Potassium perchlorate, Sodium chlorate , sodium perchlorate

[5]Hexamine , Sulphuric acid, Acetone, Potassium nitrate, Sodium nitrate, Calcium nitrate, Calcium ammonium nitrate, Ammonium nitrate ( in concentration 16% by weight of Nitrogen or higher)

[6]For further information see www.nactso.gov.uk/hazardous-materials

basic advice on how they can ensure that they supply those products only to known and trusted customers. They also encourage them to be more enquiring of new customers and to report suspicious enquiries to police. Awareness and education with business owners is managed by dedicated Police Counter Terrorism and Security Advisors (CTSAs) who develop relationships with the local business community.

- United Nations (UN) Transportation of Dangerous Goods (TDG):

  UK MoD's AtN team is working alongside US Department of Defense's Joint Improvised-Threat Defeat Agency (JIDA)[7] to support the Institute of Makers of Explosives (IME). IME has put forward a proposal to the United Nations Sub-Committee of Experts on the Transport of Dangerous Goods (UNSCETDG) to introduce a new section to the sub-committee's model regulations Chapter 1.4 for a globally harmonised standard for explosive security marking. Although the model regulation's implementation is not mandatory, it provides countries that do not currently have a marking scheme with a best practice model. The proposed marking scheme is based upon the format of European Commission Directive 2008/43/EC with certain exclusions specified for bulk material, ammunition and pyrotechnics. Should this proposal be implemented and countries adopt the standard, it will provide explosives manufacturers with the ability to put a single marking on a product whether destined for home country use or international export. It will significantly improve the ability of international law enforcement agencies to trace commercially manufactured explosives materials recovered on the battlefield to the point from where the explosives were diverted and addresses any issues of security and accountability in the supply chain.

- Industry Awareness Programmes:

  UK MoD along with international partners have conducted a number of presentations and written articles to inform industry of the threat posed by the misuse of explosive products by nefarious actors. Partners have also organised IED awareness days where industry are able to view recovered IEDs, understand how they were made and procured, and the destructive power they yield. Industry awareness programmes have been tailored and localised according to the audience to ensure that both industry and government understand each others problems and can work together.

- Specific Industry Outreach:

  UK MoD and its international partners have reached out to companies whose products have been found on the battlefield in order to identify and rectify weak links in the supply chain. Often the problem lies outside the company's immediate area of control, either with distributers or at the end user level. By working together the parties have found a potential solution that will revolutionise how explosives are managed not just by the company but by the country of origin as a whole. The company has implemented an internal tracking system that will be mirrored by a government system tracking items to the point of detonation supported by the US DoD and the UK MoD.

**Industry to Industry Partnerships**

Industry partnerships provide a key enabler in the battle against IEDs by providing forums where best practise can be shared and encouraging self regulation to avoid potentially invasive regulation and controls that could ultimately undercut operations and profit margins. Voluntary activities include those actions that are undertaken by industry to improve their own security and safety and can be undertaken by all elements along the supply chain, from manufacturers, distributors and end users. These activities may be conducted for reasons of reputation, the smooth running of operations and, ultimately, commercial performance.

A good example of industry self regulation that has had an impact on the effort against IEDs within the UK is the Fertiliser Industry Assurance Scheme (FIAS).

FIAS was launched in early 2006 following a request from the UK Home Office to develop a system of best practice to manage the safety, security, and traceability of fertilisers. Of particular concern were fertilisers containing AN, including those below the oxidiser threshold. The Agricultural Industries Confederation (AIC), the trade association which represents the fertiliser manufacturers and merchants in the UK, was approached to lead in developing the scheme, under the oversight of a "Steering Group" which included representatives of several UK government departments as well as other stakeholders such as farmers' representatives. The brief for development was simple: The fertiliser supply chain needed to adopt best practice in relation to security of fertilisers containing AN, or run the risk of legislation which could involve licensing of all steps in the supply chain, or even an outright ban.

During the initial development process AIC received substantial input from the National Counter Terrorism Security Office (NaCTSO) in developing the correct approach to managing security and public support for the scheme from UK government ministers.

[7] Formally the Joint IED Defeat Organisation (JIEDDO)

As well as drafting a workable and effective standard, the other crucial element in developing FIAS was to establish a robust verification procedure to monitor compliance. This was achieved by engaging an independent certification body who committed to achieving EN45011 (ISO Guide 65) accreditation for the scheme. This was granted by the UK accreditation Service (UKAS) in 2006 and ensures that assessors are trained and monitored and certification decisions are made in a consistent, fair and impartial way. Due to the sensitive nature of issues the FIAS covers, clear rules on confidentiality are also extremely important, and trust between some scheme participants and the certification body took some time to develop.

Nine years after the launch of FIAS there are now over 680 sites certified covering the operations of approximately 450 companies representing well in excess of 90% of the fertiliser produced in and imported into the UK.

**Conclusion**

IEDs are likely to remain a weapon of choice for terrorists worldwide and therefore the implementation of measures to disrupt and deter illegitimate acquisition of dual-use energetic materiel will have long-lasting benefits. End-to-end traceability, such as the indelible marking of commercial explosives at source; the use of RFID tags on products; and the implementation of effective record-keeping systems can assist the oversight, accountability and traceability of commercial explosives and HME precursor chemicals along the supply chain. To benefit industry, monitoring commercial explosive products and dual-use precursors in this fashion improves stock management and product custodianship throughout the commercial supply chain. Additionally, improved traceability assists in the investigation of misuse of such products, allowing attribution of component sources, supporting investigations and prosecution through exploitation capabilities.

Responsibility for the security of commercial explosives and dual-use chemicals lies not only within governments but also within the industries that produce these goods. Overt government outreach to these industries that aims to raise awareness, both of the dual-use nature of particular materials and of the industries' roles and responsibilities regarding the security of these products, encourages self-regulation, reducing the requirement for formal government intervention in the form of legislation. The promotion of good practice, alongside the introduction of voluntary codes of conduct, allows industries to be recognised as responsible entities, therefore benefiting from the positive association.

This article has outlined regulatory action, technical options, and industry-led initiatives which collectively assist in addressing the issue of diversion of licit energetic materiel to illicit channels in the UK. It is acknowledged that many of these solutions may not be effective or appropriate in other countries or regions. However, the concepts which these solutions are based on, i.e. the development and implementation of good practice may be applied to problem sets encountered globally. Crucially, industry and government working collaboratively can make a tangible contribution to reducing the threat of IEDs.

## Establishing an Operational Shielding Program in an Explosive Manufacturing Environment

**Prepared by Dr Tyler Ross,PE (APT –Research) and Dr JK Shaver (SDI/Daicel)**

**INTRODUCTION**

MIL-STD-398A *Shields, Operational for Ammunition Operations, Criteria for Design of and Tests for Acceptance* was approved for public release 29 January, 2014 with little notice or fanfare by the explosive manufacturing community. Originally released in 1976 this document has been the "go-to" reference for nearly four decades and provides a solid basis for the design and acceptance of explosive operational shielding for manufacturing environments.

The operational shielding design themes presented in MIL-STD-398A to prevent overpressure, fragments and heat form causing harm to people, products and property have proven effective for decades. In summary; explosive operational shielding should limit blast peak overpressure to 2.3 psi [15.9 kPa], fragments to energies of less than 58 ft-lbs [79 joules], and thermal fluxes to prevent the onset of second-degree burns. The fact that MIL-STD-398A has experienced little if any changes in the last forty years pays tribute to the authors and recommended design and acceptance criteria. When establishing a blast shielding program it would be wise to place the design and acceptance criteria of MIL-STD 398A as the starting point.

**REGULATORY AND RECOMMENDED GUIDELINES**

Process safety programs in the explosive industry should include mechanical integrity assessments of the operational protection. The US process safety management standard requires employers first to collect process safety information including information related to the equipment in the process.

Employers must document the codes and standards used to design protective equipment and document that the equipment complies with recognized and generally accepted good engineering practices (RAGAGEP) to reduce the potential risk and limit consequences. This activity includes documentation related to the ability of blast resistant operational shielding to withstand explosion hazards. The employer must evaluate any changes to be made and update the design information as appropriate to ensure that the operational shielding is consistent with RAGAGEP.

Blast shielding should be included as a support for the mechanical integrity function and MIL-STD 398A provides a very good starting point. There are other recommended and required guidelines that also should be included in the company operational protection program. The National Fire Protection Association (NFPA 495, Section 5.5) provides guidelines for operational workstation protection and shielding which includes construction guidelines for shielding and supports to withstand the maximum amount of explosive materials intended. The International Fire Code recommends that workstations be separated to prevent an ignition in one workstation from transition to another and the operational shielding shall be capable of withstanding the maximum amount of explosives intended for the workstation.

**OPERATIONAL SHIELDING TERMS OF INTEREST**

*Blast Mitigation* – the application of engineering controls designed to attenuate, contain or resist the severity of a maximum credible event.

*Maximum Credible Event* – An event involving the maximum amount of energetic material intended for the operational shielding.

*Operational Shielding* – A barrier intended to protect personnel, material or equipment from the effects of a maximum credible event.

*Safety Factor* – The capacity of a system beyond the designed or intended loads.

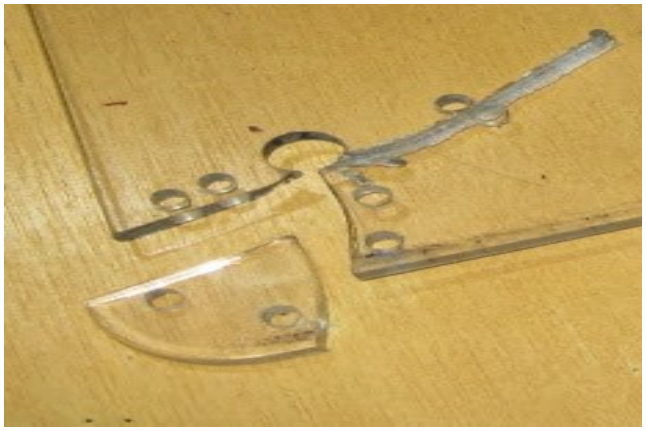
*Test to Failure* – The maximum capacity of a system assessed by actual or calculated testing and analysis.

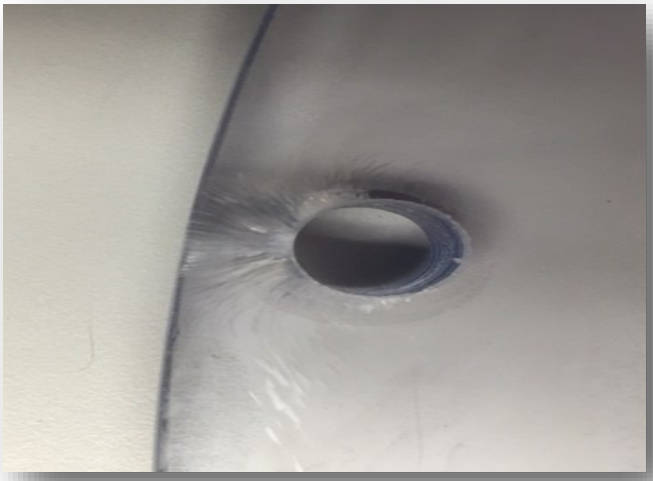
**MONITORING OPERATIONAL SHIELDING**

After the operation shielding has been assessed and installed, monitoring the operational shielding should be a conducted at least annually to ensure that changes do not adversely impact or compromise the mechanical integrity. Examiners should assess and be aware of:

- Changes to energetic materials
  - Quantity of material(s)
  - Output performance
  - Fragmentation potential
- Changes to the activity or task
  - Invasive versus non-invasive activity
  - New equipment, instruments or tools that may present potential secondary fragments that were not addressed by the initial assessment
- Changes to the shielding integrity
  - Holes drilled for utilities
  - Damage from fastening systems (cracks, bending)
  - Degradation or damage from cleaning or solvent use
  - Accumulation of energetic material in crevices, joints and cracks from migration or cleaning activities
  - Environmental factors (cold or hot weather, exposure, humidity, etc.)
- Changes to the facility
  - Placement or position of the workstation or shielding in the facility

It would be well to retain drawings and photographs of the operational shielding and include them in the mechanical integrity assessment process to ensure that any changes are examined and recorded at least annually.





***Damaged and Compromised Shielding***

The operational shielding should be examined cautiously following any mishap to ensure that it performed as expected and that the mechanical integrity has not been compromised by the mishap. One company interviewed discussed the internal policy to replace operational shielding components following any mishap where the shielding was impacted by overpressure, fragmentation or the thermal event.

**OPERATIONAL SHIELDLING CONSIDERATIONS**

Validate the Application

One manufacturer placed portable operational shields proximal to an explosive article during a quality assurance test activity. The operational shields were rolled into position by Technicians and then removed to another area in the shop when the test activity was concluded. Given the size of the explosive article, it was suspected by the engineering team that a maximum credible event (MCE) may overwhelm the portable operational shield and that the shield should be tested for that specific application. Validating that operational shielding is effective for each application where it is applied should be a high priority to ensure the shielding is acceptable for a MCE and not undersized or oversized for the application.

Validate Durability

Following the successful test of a blast mitigation fixture at 125% of the MCE, the engineering team requested an analysis of the fixture welds, polycarbonate panels and fastening systems in preparation for a retest of the system at the same over capacity level. Some of the company engineers believed the additional testing was questionable for a fixture that was already tested and validated. However, the engineering team recognized the operations team would likely plan to place the production process back on line and the team was repeating the test to determine how many times the blast mitigation fixture would sustain a MCE. Determining the long-term viability, or the need for the potential replacement of the blast mitigation fixture or components, should be a high priority to ensure mechanical integrity is sustained.

Validate Capability

Test-to-failure of operational shielding may be necessary to ensure the blast mitigation fixture has sufficient capacity to withstand a MCE from a variety of energetic materials and parts. A company producing or handling a wide variety of energetic materials should be prepared to examine the highest MCE to ensure the safety factors are in harmony with the company objectives. The outcome of a test at 125% of the maximum credible event may or may not provide an acceptable safety factor. Conducting test-to-failure protocols can provide an understanding of the maximum capacity and limitations of the operational shielding or workstation.

**OPERATIONAL SHIELDLING CONTINUOUS IMPROVEMENT**

Facility, manufacturing and safety professionals have many additional choices and resources available to provide cost-effective blast mitigation solutions. Some of the technology developed to mitigate terrorist attacks and IEDs may be assessed for manufacturing, storage or transit applications. The listing presented in Table 1 is not an endorsement for any company or product and is only provided for consideration.

Transferring test results from commercially available blast mitigation technology to manufacturing, storage and transportation applications can be augmented by a comprehensive risk-

| | | |
|---|---|---|
| BlastGard, Inc. | Blast mitigation material - Blastwrap | www.blastgardintl.net |
| CINTEC | Systems to increase the blast resistance of masonry walls and windows | www.cintec.com |
| Cymat | Blast mitigation material - SmartMetal | www.cymat.com |
| Energetic Technology Ltd | Blast resistant material | www.energetics-technology.com |
| Firexx Corp. | Blast mitigation material – Firexx Fortification | www.firexx.com |
| Holdfast Systems Pty Ltd | Bomb Suppression Blanket | www.holdfastsytems.com |
| Linex Protective Coatings | Blast mitigation material - PAXCON | www.linex.com |
| Mistral Security | Blast mitigation material - Panels | www.mistralsecurity.com |
| Radiation Shield Technolo- | Blast Shield - Demron | www.radshield.com |
| SJH Projects | Blast resistant material | www.sjhprojects.com |

**Table 1**

based decision framework. Blast analysis and assessments should be conducted by qualified companies and individuals to ensure the operational shielding program is robust and takes advantage of new blast resistant technology. It would be well to examine commercially available blast mitigation products and services to determine whether new technology and testing can be applied to new or retrofitted to operational shielding.

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IFC Chapter 33, Explosives and Fireworks, 2006 International Fire Code, International Code Council, Inc., Washington, DC

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## SAFEX TRANSPORT AND EMULSION WORKGROUP SESSIONS

### By DAWIE MYNHARDT

Incidents in the industry over the recent past forced a discussion around where the Transport and Emulsion Workgroups should focus their attention and what their outputs to the SAFEX members they serve , should be .As a result of this it was decided to hold interim Work Group Sessions before the 2017 Congress.

**We thus invite your participation in the following workgroup meetings to be held at the 2016 ISEE Conference Venue, Las Vegas, Nevada:**

**3 February 2016 – Workgroup session on emulsion pump protection**

**4 February 2016 – Workgroup session on truck fires**

The Emulsion and Transport Workgroups are seeking inputs from stakeholders on the manufacture and transportation of emulsion explosives.

Recent incidents and forum discussions identified the need to review current best practices, and to provide the opportunity to learn from each other through case studies pro-

vided by SAFEX members. It is common knowledge that both pump incidents and truck fires may lead to disastrous consequences, and must be prevented at all costs. Hence, these subject areas will be the focus of the respective Work Groups over the foreseeable future .

Your inputs and sharing of best practices on the above safety critical aspects will play a significant role in preventing repeat incidents or possible fatal events. Information from both work sessions will be used to generate best practice guidelines that will be made available to all SAFEX members.

Please share your knowledge and let us prevent these incidents from happening. Hope to see you there!

Please indicate your interest in attending any of the above Workgroup sessions by contacting **Dawie Mynhardt**. Any suggestions would be highly appreciated.

Dawie Mynhardt

e-mail: dmynhardt@bme.co.za

## MORE VILLAINS by TONY ROWE

You are possibly expecting another long and rambling monologue. Clearly, you know me too well and are probably right.

Someone once told me that life is mainly made up of arrivals and departures. For instance in the morning we leave the bedroom and arrive in the bathroom then leave the bathroom and arrive at the kitchen. We arrive at the car and depart from the car. We then depart from home and arrive at work and vice-versa. Arrive at the office and leave the office. Hey! I think I'm getting the hang of this already. Arrive at the canteen, drink coffee and leave. This is really clever stuff.

Time to move on? Yes, I thought so too…….

Living deep within the south coast of Kwa-Zulu Natal in South Africa as I do, the pace of life is slow. The days come and go and anything made of steel or untreated wood steadily rusts or rots away. Runners and/or the odd canoe bring news from the outside world. The latest crop of rumours claim that colour TV will soon become available and that portable telephones have reached the outskirts of Port Shepstone already. Probably all stuff and nonsense, but we are nothing if not optimistic and look forward to experiencing such wonders.
I personally lead a quiet life, a bit like a hermit I suppose. No caves or pole-sitting though. Well at least not yet and I still change my underwear every six months whether I need to or not.

In this part of the world it's the shoreline that provides both interest and entertainment. The coarse sand massages the feet and at the same time provides a wonderful dermal scrub, but beyond that it's a life of austerity, mitigated at intervals by liberal applications of a trusted, but dark and bitter, Irish medicinal potion deemed to be good for what ails you.

It was during that sublime and transcendental moment when white froth first meets dry lips that the man first appeared on the TV screen. I should perhaps mention that our television set runs on bottled gas and sea water. It is an unfathomable process that I cannot discuss; at least that's what I tell everybody. My wife claims that I have an inverter concealed somewhere. Whatever the truth, it works during load shedding.
On this occasion, as I stared at the screen, this particular man, clearly far more learned than myself, said something; well, pretty learned. What he had just articulated struck a chord deep within my decrepit and somewhat wrinkly old soul.
It's a funny thing, but when you are old, odd bits keep falling off. No, that's not what he said, but still, thank goodness for superglue.

You know I like to surround myself with familiar things. One of them is my wife of 43 years; another is my 15 year old Maltese poodle and speaking of superglue, my old pocketknife. You remember; it's the one made in Switzerland with the red bolsters. Ten years ago I broke one of those bolsters off – can't remember how – abuse probably and stuck it back on using superglue. It's still stuck.

I've had that knife for more than 25 years. Two blades, a big one and a small one, both razor sharp when purchased. They still are, thanks to the assistance provided by a miraculous ceramic sharpening tool.
The knife itself has a corkscrew – fast becoming redundant in a world of screw-topped wine bottles, but it's a real doozy for earwax and nasal foliage – and a saw. We cut a pretty substantial tree down with that saw once. There is also a sharply pointed pokerator sort of thing that tends to fold up on your fingers when used, plus a pair of can-opener / screwdriver / wirestripper / bottle cap spanner / combo tools.
I use that knife for something at least once a day. That's because it is always in my pocket. You see, if I don't have it, I can't use it. There is a lesson there somewhere, maybe the title of a song too? Unfortunately I have van Gogh's ear for music and carry a tune pretty poorly.

An erstwhile colleague once confronted me at the photocopier over my rendition of the Dwarf's signature tune "Whistle While We Work" from the original 1937 Disney movie, "Snow White and the Seven Dwarfs," claiming it to be unrecogniseable.

Ah! Today those memories of yester-year although still vivid all feel like a long time ago in a land far, far away.

Anyway day dreaming aside, I seem to recollect that the last article discussed some of the lesser, but equally life changing hazards that lurk around the perimeter of most production environments. I propose in this document to expose a few more.
The first one is a real sweetheart.

**1.Vibration**

Vibration though can only cause damage to your body by direct contact. Where does the vibration come from? It comes from the handle(s) of operating power tools like a drills, brushcutters, chainsaws, pneumatic road drills and rotary rock drills, but vibration damage can also result from hours spent sitting on or leaning against a larger piece of vibrating machinery. It's simple enough, the longer the contact is maintained, the higher the risk. The frequency and amplitude of the vibration are also major role players.
Whole body vibration for instance can make you sick. It can also mess up your back, (the spinal column in particular) it can interfere with other bones and joints and also play havoc with your digestive system.
Then, of course, there is Whitefinger. The name perfectly describes the disease. It is called Deadhand by Americans, they even sing about it. Listen to the opening few bars of The Pink Panther theme tune: "Deadhand, deadhand…..deadhand, deadhand, da da ta ta da da de de etc," but whatever the name, it remains a singularly unpleasant ailment, one brought about entirely by vibration.
The symptoms of Whitefinger usually first appear on some cold, damp, winter's morning. One or more fingers may turn white and stay that way for anything up to an hour or so. The affected parts possess little or no feeling and movement is clumsy. As the blood circulation re-establishes itself, the affected parts may become horribly painful.
Whitefinger, once acquired, is likely to be permanent. It does not respond well to any current treatment regime and is thus no fun at all. Indeed, it can comprehensively ruin your life. Attacks are unpredictable and agonizing. It rarely gets better, but can and usually does, get worse. Be on the lookout for the warning signs, tingling fingers followed by periods of numbness.

I thought I had it too, but then discovered that I'd just closed my fingers in the car door. Phew! That was a relief. A splint, a sling and a few dozen sutures and I was fine again.

**2.Fire**

Fire itself is not the slayer that you might expect. It is rather Mr. Fires' little friends who you really must look out for.
Who are these guys? They're called Smoke, Fumes and Poisonous Gases. Fire is friends with them all and together they can serve up some unbelievably rich combinations and cocktails. Some mixtures cause throat and lung irritation, especially the acid gases. Some do not. These quiet guys are kinda sneaky though, creeping up to catch you unawares. Even the most benign – if they displace all the available oxygen – will shut you down - and mighty quickly too. They are "homies," big buddies and usually work together. For instance, thick smoke can obscure the escape routes whilst inhaled gases and fumes set to work on your metabolism. So don't hang about. In the event of fire: sound the alarm and make your escape.
Should you need to deploy a fire extinguisher there are 4 main types as follows:

Water: Not to be used on electrical or liquid fuel fires especially those involving oil. Often found inside office buildings, they are really intended for use only on solid fuel fires like wood, rags paper waste etc.

Dry Powder: Ideal for fires involving flammable liquids, but can also be used for any other type of fire. When used indoors, the discharging cloud of dry powder can obscure vision and will additionally cause damage to goods and equipment. They're incredibly messy too and the after-fire clean-up will take a long time.

Carbon Dioxide ($CO_2$): Used mainly on fires involving electrical equipment. One drawback however is that $CO_2$ is an oxygen diluent. Being heavier than air, in closely confined spaces, a build-up of the gas can be dangerous for the user of the extinguisher. There are also electrostatic and freezing hazards associated with the use of $CO_2$. Prevent re-entry into areas where $CO_2$ has been discharged until adequate venting has taken place.
Be aware that carbon dioxide offers no long term security effect, however, and once the

gas has cleared, fires can spontaneously re-ignite.

Foam: A good all-rounder, but not recommended for use on electrical fires, but can be used if no alternative is immediately available.

**3. Compressed Air**

Air is all around us, so how can it be dangerous? Certainly the absence of air is pretty bad as we are unlikely to survive for very long without it, but surely air itself is pretty harmless.
Not when it is compressed, however.
We are not discussing underwater (scuba) diving with air bottles or working in pressurised environments like caissons, shafts and tunnels. These activities have their own unique set of hazards. We are talking about the sort of compressed air that is available in many workplaces. It might be used for re-inflating a car tyre or to operate the pneumatic cylinders on a machine.
Compressed air blown directly into the mouth at only 5 psi (35 kPa) can burst the lungs. At 40 psi (276 kPa) it can rupture an eardrum from 10 cm away and potentially at least, cause irreconcilable brain damage. Twelve psi (83 kPa) can blow an eyeball right out of its socket.
Air forced through the skin or navel can cause an embolism (air bubbles in the blood). This can be fatal if the bubble(s) reach the lungs, heart or brain.
Certain forms of horseplay can result in inflation injuries to the lower intestines, raising the possibility of a horrifying human explosion with all its consequences.
Secondary particles picked up by the airstream from within the hoses, the compressor itself or the immediate environment readily become high velocity shrapnel and should they strike the human body can result in cuts, bruises and - if the hit the eyes, blindness.
The dust clouds resulting from the use of compressed air to clean may be extremely toxic and if inhaled may create a serious respiratory hazard for any exposed personnel. Such dust clouds may also produce unwelcome electrostatic hazards. In addition, dusts can not only ignite explosively, but the process can deposit fine dust particles much higher up than normal where they begin to accumulate on suitable surfaces. Light fittings, shelf tops, fixed pipework and conduits are typical areas. Once there and out of sight, they steadily age and dry out.
I know that it is difficult for the ordinary person to comprehend the explosive power of dust deposits, but once initiated either by heat, spark, flame, static electricity, impact or friction, the consequences can be appalling. Dust explosions account for a significant percentage of the industrial fire deaths that occur every year – and most of those dusts in the record are relatively benign - in other words not in themselves energetic (explosive) materials.
Convection currents do similar things. I have personally witnessed a layer of fine lead styphnate more than 1 cm thick and 2 cm wide deposited all around the upper rim of an armour-steel chimney. It turned out that each time the access door in the middle of the chimney was opened, an upward flowing current of air was temporarily created. This current then lifted, carried and deposited a percentage of its load of explosive around the chimney's rim.
So:

- Ensure that personnel with access to compressed air undergo awareness training around the hazards of its improper use and are signed off.
- Place suitable and conspicuous signage warning of the hazards of compressed air in all areas where it is available.
- Never use compressed air to clean clothing or hair.
- Don't direct the airstream towards any person including you yourself.
- There are noise and projectile hazards associated with the use of compressed air. Always use appropriate eye and hearing protection.
- Do not use compressed air for general cleaning purposes.
- Do not clean clothing with compressed air.
- Beware of the tripping hazards created by trailing pneumatic hoses.
- Avoid placing air hoses on the floor where they can be damaged by vehicles, falling tools or service trolleys.
- Air hoses must be kept in good condition.
- Should a hose suddenly become disconnected or burst it may lash around violently. Do not try to secure a whipping hose. It can break bones and cause serious injuries to human tissue. Isolate the air supply and allow the hose to come to rest before securing.

**4.People**

Some years ago a Volvo engineer said "Our philosophy is that any operating or handling mistake that can be made, sooner or later will be made." It is a statement that puts the emphasis on human error.

At the beginning of the article I mentioned a learned gentleman I had seen on TV. He was clearly knowledgeable and knew his subject well. He spoke at some length saying all manner of meaningful stuff that I have interpreted as follows:

He said that in most situations people are the weakest link. He said that people make mistakes. He then proceeded to elaborate on the theme still further, stating that under pressure, they make even more. I agreed - we are indeed horribly fallible. It is a human problem. In fact, in many potentially hazardous situations **your worst enemy may be yourself**. It appears that the relentless and ever-opportunistic spectre of human error continues to dog our footsteps even now, in the 21st Century.

As a species we respond to dangers very efficiently, but those dangers have to be both recognisable and immediate. "A snake, a sabre-toothed tiger, a giant centipede or spider are exactly the sort of dangers that we humans are designed to respond to." The mechanism is so well tuned that we may already have started to react before even being consciously aware of what we are actually responding to. It's built in apparently; hardwired, whatever that means and it works pretty well. It's a behavior deeply rooted within our fear and defense mechanisms.

There is though, a downside. Any guesses? The answer is pretty logical and goes something like this:

If the danger, however imminent, fails to press any of the specific buttons required, we may then either react too late or not at all. Errors first cascade somewhat tentatively, then avalanche destructively.

This simple fact may help to explain why we so often fail to see those perhaps less pressing, but just as life threatening hazards that we humans so often fall prey to. As a society we have become lazy, increasingly tending to play the odds and trusting in our inbuilt defense mechanisms to get us out of trouble, while all the time turning a blind eye to commonsense.

We learn about danger either from being taught or from direct personal experience. I call it the easy way and the hard way. The hard way is bitter, often painful, perhaps life changing or even directly life threatening. There is no doubt that experience makes a good teacher, but at what cost?

The alternative is not free either. It too involves effort. Reading intensively and remembering what you have read, listening to the older and wiser, watching movies or slideshows or simply being shown. It is sometimes a bit boring, but it rarely involves trauma, hospital or a few centuries rotting in a box.

Quick unthinking responses can be life savers, but they can be life-enders too. For example, a cleaning cloth suddenly snagged by some high speed rotating machinery may elicit the immediate response of "**The Grab**." In the scenario of the "grab response," an operator reaches out unthinkingly and in the twinkling of an eye catches hold of the cloth. The operator's action is based purely on reflex. Reflex actions bypass the brain and are thus incredibly fast, but they occur without the input of conscious thought. What happens next is entirely predictable. Before the operator can release the cloth, his/her own hand and arm are drawn into the machinery. Crunch, crunch, rip, rip, rip. The results can be truly terrible. You see, life is not a chess-game, but a deadly snare for the unwary. One wrong move and you've lost not only the set, but the match, the game and possibly even your life. The trap was always there, you just didn't understand the rules.

There simply aren't any.

Here's another example of "The Grab." I know the story is true because I was its victim.

I once dropped an extremely sharp knife, handle downwards. It hurtled downwards at some 10 meters/second towards a floor made from steel-reinforced and very ugly old concrete. The knife had cost me a lot of money and as a hand-crafted piece of hardware, damage was unthinkable. My immediate response was to grab for it. I had good reflexes in those days so I caught it – unfortunately by the blade. A nice feature about that knife was that it possessed a long and tapering, double serrated-edged blade which was razor sharp to boot. It was also quite heavy. With momentum on its side the oiled steel of the blade slid through my fingers like the golden glow of a setting sun and just about as painlessly too. I will spare you the gory details, but there was blood. There was phlegm. There was lots of yelling and shouts for cloths and medical assistance mostly in what sounded like a high-pitched and amazingly girlie version of my own voice.

The knife hit the floor anyway.

I dropped the same knife again a few years later. I was wiser this time around or maybe I was just slower. This time it fell straight down, hitting the floor without any intervention. Another expensive notch took its place in the spine of the blade, but there was no blood, no pain and no stitches. I had learned something.

As it was for me so it is for others. Within the explosives industry the improper handling of sharp objects or tools is one of the major causes of injury. While instruments and tools are essential to many kinds of work, sharp edged or pointed objects can be hazardous often causing painful injuries such as, cuts, punctures and deep gashes. Medical attention and stitches may follow. Serious infections or severe life threatening blood loss can also result.

Such injuries are always preventable. Therefore……

- Know the risks.
- Follow safe handling procedures.
- Select the right tool for the job.
- Always let sharp falling objects fall, don't grab at falling cutting tools rather get your feet out of the way.
- Wear protective gloves when necessary.
- Use sharp items only as they were designed.
- Sharpen cutting tools on a regular basis.

- Dispose of sharp objects safely.
- Use 2 thicknesses of damp towelling to pick up bro ken glass.
- Don't carry sharp objects in your pockets.
- Beware of sharp material or objects poking through the walls of plastic rubbish bags.
- Report all injuries and get proper medical treatment immediately**.**

You know it makes sense.



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## ARTICLES FOR NEWSLETTERS

This is a reminder that through the Newsletters we share knowledge in the areas of Safety, Health, Environment and Security pertaining to the Explosives Industry. SAFEX thus call on all members to submit articles on these subjects within their own companies and countries. **The deadline for articles for the December Newsletter is 30 November and I look forward to your support** .