SAFEX NEWSLETTER
No. 49, 2nd Qtr. 2014

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Celebrating SAFEX's Diamond Jubilee in style

SAFEX was established 60 years ago and the Gala Dinner during the recent XVIII SAFEX Congress gave us an opportunity to celebrate this remarkable milestone.

A total of 160 delegates, some accompanied by their spouses, got together in the Palace of Culture and Science (see Congress Report on p. 4). The venue is a historical landmark in Warsaw and was used as the theme for the Congress logo used to identify the Congress. The evening was kindly sponsored by Nitroerg and their principal shareholder KGHM Polska Miedz. Nitroerg is a Polish explosives manufacturer and member of SAFEX. They were proud to uphold the SAFEX tradition whereby local members sponsor the Gala Dinner. Guests were able to enjoy pre-dinner drinks in the Korczak Room before adjourning to the adjoining Marble Hall for dinner (see photograph above). After the President of Nitroerg, Mr Jozef Dulian, and Executive Vice President of KGHM, Mr Wojciech Kędzia, welcomed the guests, the new SAFEX Chairman, John Rathbun, thanked our sponsors and all the guests for joining SAFEX in its Diamond Jubilee celebration.

Dinner started with an impressive Waiters Ceremony. Waiters serve dishes at the same time to all guests at a table to the accompaniment of music and appropriate choreography. To provide guests with a better "feel" for the venue in which we were having dinner, a professional guide summarised the history of the Palace of Culture and Science after the first course. During the remaining courses guests were given a further appreciation of Polish folklore when "Masovia", the Student Song and Dance Company of Warsaw University of Technology entertained guests to Polish folk music and dances.

The feedback from guests suggested that the evening was a fitting tribute to SAFEX's 60 years of service to the explosives industry worldwide.

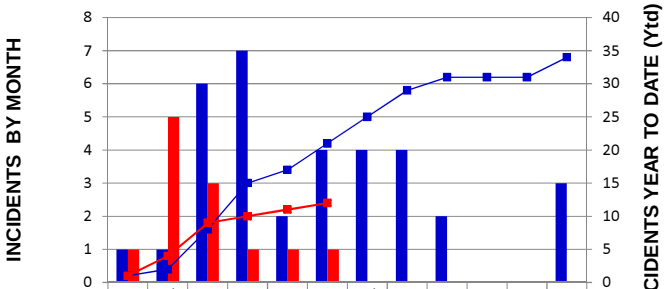
Incident Reporting

SAFEX learns from its members' experiences through the incident reports we receive. By applying these lessons we can prevent similar incidents recurring. That is why we track our incident reporting performance in the charts below.

Monitoring our Reporting Performance

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

ALL INCIDENTS REPORTED: Ytd 2014 vs 2013

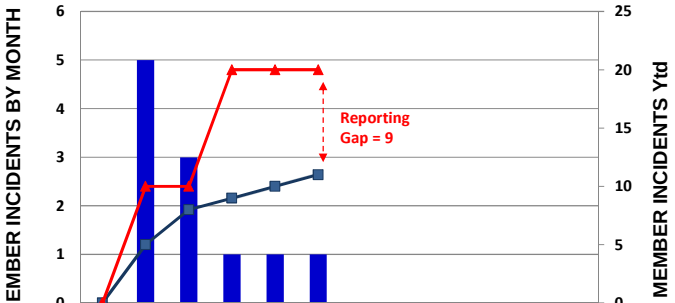


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013	1	1	6	7	2	4	4	4	2	0	0	3
2014	1	5	3	1	1	1						
Ytd 2013	1	2	8	15	17	21	25	29	31	31	31	34
Ytd 2014	1	4	9	10	11	12						

All the incidents reported. This chart compares the sum of non-member and member incidents reported to SAFEX every month this year compared to the previous year. We have reported 40% fewer incidents this year than in in the same period 2013 and the gap is widening. Are we having fewer incidents or are we not reporting the incidents we are having? Every incident not reported is a lost learning opportunity. Remember, it's never too late to report an incident.

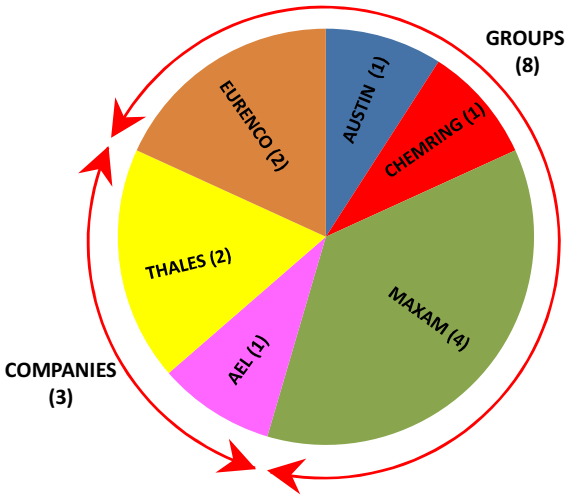
Member incidents reported. Because they give us the best learning opportunities, we track member incidents (MI's) separately in the chart on the right. PAR is an estimate of how many MI's are occurring based on the severity of the MI's that have been reported this year. The gap between the number of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

MEMBER INCIDENTS REPORTED Ytd 2014



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	0	5	3	1	1	1						
Ytd	0	5	8	9	10	11						
Par	0	10	10	20	20	20						

MEMBERS INCIDENT CONTRIBUTORS: Ytd 2014



Contributors of member incidents. This chart identifies those members who reported incidents. It shows the number of incidents each of these members reported relative to the total number of MI's received. The chart distinguishes between Groups and Companies merely to indicate the performance of the two membership categories. There are about twice as many operating units in the Groups than single Companies. So far this year Group Members have reported about twice the number of incidents Company Members reported.

Know the Expert Panel

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

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

Maurice Bourgeois

PERSONAL

Position: **Consultant**
Company: **Retired**
Location: **Laval, Québec, Canada**
Education: **Industrial Engineering, MBA, Explosives Safety course**
Affiliations **SAFEX; NFPA**
Languages: **English and French**

CAREER OUTLINE

Building Products
1973 - 1977 Maintenance Manager
Canada Wire
1977 - 1983 Maintenance Manager
Canadian Arsenals
1983 - 1987 Maintenance Manager
SNC Defence
1987 - 2006 Explosives Safety, Environment & Permits Manager
General Dynamics
2006 - 2014 Explosives Safety & Permits Manager

EXPERTISE

- Military explosives process safety; auditing; accident investigation and reporting;
- Explosive Safety Site Planning for DoD 4145.26-M for US military contracts
- Static Electricity control
- Hazard Analysis using DesignSafe software
- Safety management systems and emergency planning
- Demilitarization processes

TYPICAL ASSIGNMENTS

- Developed and implemented an explosive safety site plan for the Le Gardeur plant to meet US DoD 4145.26-M standard. The plant was built before 1941 and did not meet today's Q-D requirements.
- Led numerous risk assessment sessions for a number of production lines involving a large variety of ordnance; audited another GD-OTS division for explosive safety; conducted all major accident and incident investigations at Le Gardeur; and given courses on explosive safety to all our personnel as well as the Repentigny fire fighters.
- Designed GD-OTS' demilitarization equipment and burning ground activities including primer cap incinerator, large caliber shell melters and rinsing system, large caliber primed case demilitarization , small caliber primed case neutralization, rocket motor demilitarization, etc.
- Led the joint emergency planning group with the town of Repentigny

Congress Chat

The triennial SAFEX Congress is the forum where as many SAFEX members and associates as possible get together to exchange experiences that will make our industry across the world healthier, safer, more secure and friendlier to the environment. It is the place where we learn from each other. The fact that SAFEX Congresses have grown over the 60 years of its existence is proof of this.

The XVIII SAFEX Congress took place during the week of 19 to 24 May 2014 in the Warsaw Marriott Hotel in Warsaw, Poland. SAFEX used the logo alongside to identify the Congress. It shows the Palace of Culture and Science (also abbreviated as PKiN) which is a landmark in Warsaw. The diamond on the tower of the logo depicts SAFEX 60th anniversary.

In this section we want to give readers some feedback on selected aspects of the Congress.

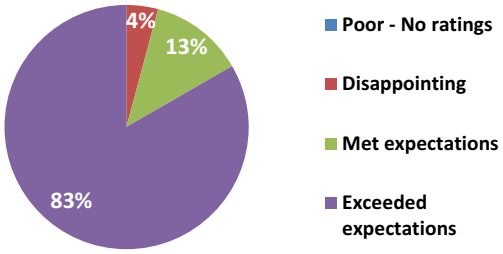
SAFEX Congress well supported

A total of 208 delegates registered for the Congress. 75 % of them were representatives of 40 SAFEX Company Members and 7 Group Members coming from 36 countries. The remainder were Associates / Expert Panel members (14%) and Visitors (11%). The roles the majority of delegates performed at work were predominantly Functional Managers / Specialists (65%) with Senior Managers (20%) and Line Managers (15%) making up the balance.

The week started with the customary Training Session that Andy Begg and Martin Held presented. It was attended by 25 delegates who were taught the essentials of Leading Hazard Studies. On the Wednesday the 6 SAFEX Workgroups met – 3 in the morning and 3 in the afternoon. The Workgroups were well attended by 113 delegates in total. Thursday was the Open Day of the Plenary Sessions in which invited Visitors participated. A total of 16 Papers were presented in four Sessions. The Plenary Session on Friday were restricted to members of the SAFEX Community. The 15 Papers were primarily focussed on a discussion of members' incidents. The Closed Day concluded with the General Assembly of Members at which the outgoing Board reported back on their term of office and a new Board was appointed.

The Gala Dinner which was held on the Friday evening to celebrate the SAFEX Diamond Jubilee formally (see front page report). A Congress Excursion for delegates and spouses on the Saturday wound up the Congress week. Delegates' overall assessment of the Congress is shown in the Chart below.

XVIII SAFEX Congress Overall Assessment:
(% Respondents Rating)



A new Board of Governors appointed

The XVIII Ordinary General Meeting of Members held at the conclusion of the Congress on Friday, 23 May 2014, unanimously approved the SAFEX Board of Governors for a term of office ending with the Congress in 2017. The new Board comprises:

Enrique Barraincua (MAXAM)
Andy Begg (Individual Associate)
Terry Bridgewater (Chemring PLC)
Alexander Chernilovskyi (Azot Vzryv Group)
Steve Dawson (Dyno Nobel Asia Pacific)
Rahul Guha (Solar Industries India)
Dr Noel Hsu (Orica USA Inc)
Edmundo Jimenez (Enaex Servicios)
Claude Modoux (Poudrerie d'Aubonne)
Dawie Mynhardt (BME South Africa)
John Rathbun (Austin International)
Thierry Rousse (Groupe EPC)

These nominations were based on the recommendation of the Nomination Committee which the outgoing Board of Governors appointed last year. The Committee cast its net wide to make sure that the principal regions in the world such as Africa, Americas, Asia and Europe are represented on the Board. The Board retains considerable experience by including 9 of the Governors from the previous Board. It also incorporates some new blood in Dr Noel Hsu, Edmundo Jimenez and Dawie Mynhardt. SAFEX Newsletter hopes to profile our new Governors in future editions.

After the General Assembly, the new Board of Governors met to elect a Chairman as required by the Articles of Association. As Claude Modoux, the outgoing Chairman was not available for nomination, John Rathbun from Austin International was unanimously elected as the new SAFEX Chairman.

SAFEX Newsletter congratulates John on his appointment and wishes him every success during his term of office. We will tell you more about John in our next Newsletter.

Gala Dinner Sponsors Salute SAFEX

SAFEX Newsletter believes readers may be interested in the speech Mr Jozef Dulian, President of the Nitroerg Board, made in welcoming guests to the Gala Dinner at which SAFEX formally celebrated its Diamond Jubilee.

"On behalf of NITROERG- the company belonging to KGHM PM Capital Group I have a pleasure to welcome all participants of our "explosive family" as well as the honorable guests at tonight's SAFEX GALA DINNER.

SAFEX International 60th anniversary makes us extremely happy to celebrate it in Poland, here in Warsaw. Year 2014 is very important to all Polish citizens. We have been celebrating both 25th anniversary of the first independent elections and 10th anniversary of entering the European Union. Those events definitely improved Poland's development.

NITROERG is the company with more than 140 years of tradition. Probably not all of you know that our company started explosive production just 3 years after dynamite was first invented by Alfred Nobel. This fact places us among world's top explosive materials pioneers. We are very proud of having such tradition and by occasion we would like to share the memories with you. NITROERG with its headquarters in the mining heart of Poland - Silesia - is a manufacturer of explosives and initiating systems. Our products are used worldwide in more than 40 countries. Since 2011 NITROERG has belonged to Polish Capital Group KGHM PM. We concentrate on technology innovation and improvement that can guarantee us the highest quality together with high level of safety . Our long term strategy is initially to build a blasting services network in Europe. As a member of KGHM PM it will extend further afield in due course.

As a member of SAFEX International we do appreciate belonging to this organization. SAFEX is a perfect area to exchange the experiences concerning safety but it refers to other activities as well. This Jubilee is a great occasion to thank all SAFEX Managers and all our colleagues working for this useful organization.

I'm pleased to be chosen by you as a sponsor and a host of tonight's Gala Dinner together with our main shareholder KGHM PM especially by the fact that the conference location is in our capital—Warsaw.

Thank you for your attention and let me wish you a nice evening."

Thank you, Claude

Claude Modoux has been Chairman of SAFEX International for an unprecedented 9 years. He decided to hand over the baton to John Rathbun at the conclusion of the most recent SAFEX Congress. It is not the only record Claude holds as this was the 10th Congress in which he participated. As far as we can establish none have achieved this milestone before. The first Congress Claude attended was back in 1987 when it was held in Casablanca.

This means Claude has been actively involved in SAFEX for more than 27 years. SAFEX has indeed been blessed to have had the service of someone like Claude for so long.

Besides being our Chairman, Claude is also the Treasurer and runs the SAFEX head office in Switzerland. As someone who has been associated with the explosives industry all his life, Claude has developed a worldwide network among explosives manufacturers that is second to none. He has used these contacts unashamedly to promote SAFEX and its interests. Many of our members have become involved in SAFEX as result of Claude's encouragement.

It has been the Secretary General's privilege to have worked with Claude throughout his period as Chairman. At the General Assembly of Members which was held at the conclusion of the Congress he paid tribute to Claude and said: "Few people realise how much time and effort Claude has devoted to SAFEX without expecting anything in return. He is the embodiment of the selfless service that has sustained SAFEX during its 6o years of existence. The only reward he expected was that it will inspire the next generation of leaders to follow this example. Claude has taken an active interest in the Secretariat's work always encouraging and expressing appreciation for the work it does. He has never been reluctant to get involved and we could always depend on him for support and wise counsel."

Claude, you have made your mark in SAFEX. We salute you and thank you. Our members are grateful for your willingness to stay on as a Governor and Treasurer.

QRA Corner

Welcome to another instalment of the SAFEX Newsletter series called the QRA Corner. Each column will examine a particular aspect of state-of-the-art applications, large-scale testing, and algorithms associated with Quantitative Risk Analysis (QRA) models. Your authors will rotate between Lon Santis, who runs his own consulting business, Explosives Risk Managers LLC; John Tatom, Vice President at APT Research, Inc and Manager of their Explosives Safety and Testing Group; and Mike Swisdak, creator of the US Department of Defense' ESKIMORE large scale test program and currently a senior scientist at APT Research.

This instalment focuses on testing to address the consequences of explosions inside ISO containers.

ISO — A Test Series to Determine the Consequences of an Explosion Inside an ISO Container

by

Michael Swisdak (Senior Scientist, APT Research, Inc)

ISO containers are steel shipping containers used around the world. Their standard design specifications ensure their compatibility with handling equipment, storage areas, and replacement parts in almost any country. ISO containers used for explosives are usually 2.44m (8 ft) wide, 2.44m high and 6.1m (20 ft) long (external dimensions), although 12.2m (40 ft) long containers are also available. The top, bottom, and sidewalls of the containers are made of corrugated steel panels 1.5 mm thick, joined to steel structural members at the panel intersections. Double-leaf steel panel doors are usually located at one end of the container. Many other configurations and customized designs are available worldwide, but the ones described in this paragraph are the most common. It should be pointed out that the ISO containers tested are not the same as tanktainers, which are tanks, usually built on an ISO container frame, used for transporting liquids.

In 2005, US military operations were intensifying in multiple conflict regions. With this increased tempo, in addition to their being used for shipment, ISO containers were increasingly being used to store and protect explosives. As a result, questions were being raised about the effects of detonations inside these containers. A test series known as ISO was designed and implemented to address these issues. Specifically, the test series attempted to address the following questions:

- How much debris is produced?
- What is the mass distribution of the debris (i.e., what sizes of debris are produced)?
- How far does the debris get thrown?
- What is the azimuthal distribution of the debris?
- How much airblast attenuation is provided by the ISO container?

As the testing progressed, additional questions were raised:

- What is the source of each piece of debris that is cataloged? Specifically, where on the ISO container does each piece of debris originate?
- What are the effects on the structural break-up of the ISO container when using energetic materials with differing TNT equivalences and brisance?
- What is the effect of loading density (explosive weight/volume of container) on debris generation and airblast attenuation?
- Are there differences in the debris distribution/ characteristics produced by a detonation of a typical explosive load inside a standard ISO container that has no interaction with other structures (such as a truck) or no effects from primary fragments (i.e., using bare charges)?

Thus far, there have been five test series that have examined the effects of detonations inside ISO containers. Four were sponsored by the United States Department of Defense Explosives Safety Board (US DDESB) and one was sponsored by the Klotz Group, an international body of explosives safety experts whose main objective is to improve the knowledge of and to reduce the risk associated with the storage, processing and transport of ammunition and explosives for both the military and the civilian community. Table 1 provides a summary of these ISO container test series. The ISO-4 series was composed of two events—ISO-4 and ISO-4 Retest. The retest detonation was conducted to obtain high speed photography missed on the ISO-4 event. A limited debris recovery effort was conducted on the retest. The Klotz Group series, although considered a single test, consisted of three separate detonations inside ISO containers; only the container orientation was changed on each test. An extensive debris recovery was conducted on Test 1, while on Tests 2 and 3, only selected sectors were cataloged.

Table 1. ISO Container Testing Summary

Test Series	Test Name	Test Date	Primary Sponsor	Explosive Weight/Type	Test Description
ISO-1	ISO-1	May 2006	US DDESB	1,054kg ANFO	ISO container on truck
ISO-2	ISO-2	May 2007	US DDESB	4,000kg ANFO	ISO container on truck
ISO-3	ISO-3	March 2009	US DDESB	1,054kg Projectiles and Propellant	ISO container on ground
ISO-4	ISO-4	September 2010	US DDESB	1,000kg C4 Plastic Explosive	ISO container on ground
	ISO-4 Retest	December 2010	US DDESB	1,000kg C4 Plastic Explosive	ISO container on ground
ISO Klotz	ISO Klotz Test 1	August 2011	Klotz Group	100kg Plastic Explosive	ISO container on ground
	ISO Klotz Test 2	August 2011	Klotz Group	100kg Plastic Explosive	ISO container on ground
	ISO Klotz Test 3	September 2011	Klotz Group	100kg Plastic Explosive	ISO container on ground

Figure 1: ***ISO Container on Truck***

Figure 2: ***Crater***

Figure 1 shows the truck/ISO container just prior to the detonation of the ISO-1 event. Superimposed on this figure is an outline of the explosive charge that was used. Figures 2, 3 and 4 show the remains of the truck and other debris located within 100 meters of ground zero (GZ).

As an example of the types of information collected during this test series, consider these results for the ISO-4 event. Over 9,500 pieces of debris were located and catalogued during the recovery effort. Each piece of debris that was collected was identified as either originating from the skin of the container, from the bracing of the container or from the floor of the container. A total of 20 pieces of debris traveled beyond 500 meters. Of these 20 pieces, 11 were door bracing, which tend to form dense, compact debris that have low drag properties, four were other brace components, and five were skin pieces. Despite the preponderance of brace pieces beyond 500 meters, the furthest fragment recovered was actually a piece of skin found at 663 meters from GZ. This piece only had a mass of 47 grams and was heavily scrutinized to ensure that it was indeed a valid piece. The smallest piece of debris to travel beyond 500 meters was also a piece of skin that weighed only 16 grams. At the time of the test, the wind was coming from the S/SW direction at 1.9 m/s, which would have aided the travel of these two pieces.

Figure 3: ***Near-Field Truck Debris***

Figure 4: ***More Near-Field Truck Debris***

The ISO-4 debris data are displayed over an aerial photograph of the test range in Figure 5. The colors correspond to the source of the debris (when identifiable), while light gray data points were debris with no color identified. The three circles evident in this figure represent 100-meter (red), 300-meter (orange) and 500-meters (yellow) radii circles from GZ .

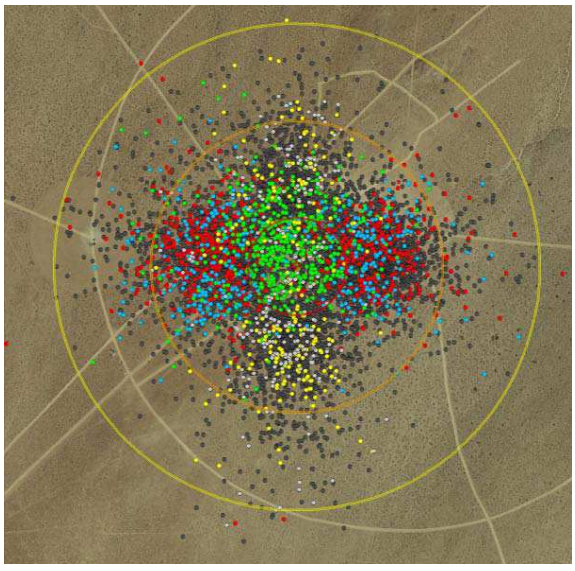


Figure 5: ***Scatter Plot of ISO-4 Debris***

Figure 6 (next page) shows the debris density generated on the ISO-4 event out to a radius of 300 meters. It uses an incremental angle of 1° and an incremental depth of 5 meters to display the debris densities. The manner in which plots such as this are constructed is highly dependent upon the desired fidelity. If less fidelity is desired, larger incremental angles and depths could be chosen.

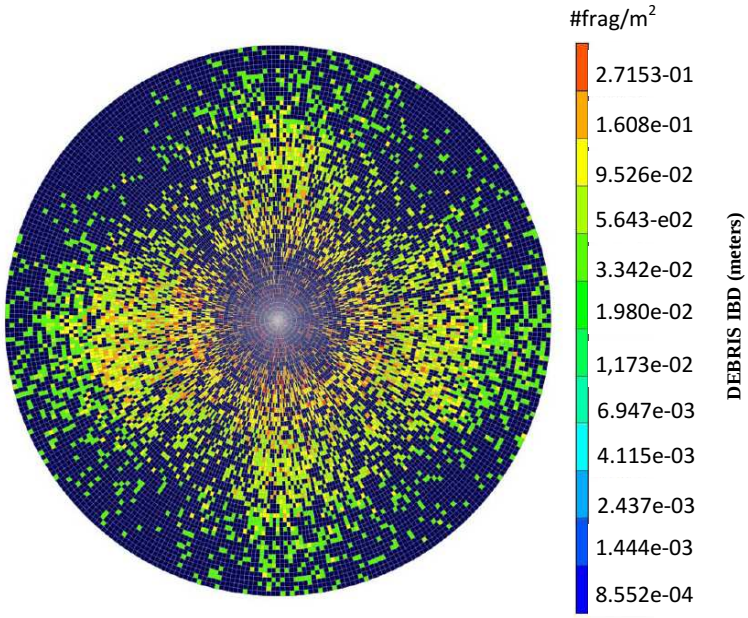


Figure 6: ***ISO-4 Debris Density Visualization (300 meter radius)***

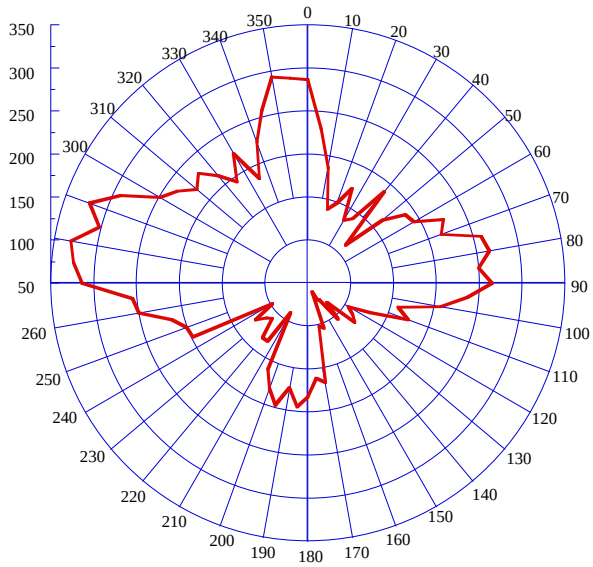


Figure 7: ***Container Debris Inhabited Building Distance—ISO 3 Event***

Another example of the types of information that are being generated by this test series is the determination of the Pseudo -Trajectory Normal (PTN) Debris Inhabited Building Distance as a function of azimuth. The PTN debris density is defined as all debris in or passing through a given zone divided by the area of that zone. The PTN debris IBD is defined as the range at which the PTN density of hazardous fragments falls below a value of 1 per 55.7 m^2, where a hazardous fragment is defined as a fragment with an impact kinetic energy of at least 79 Joules. Figure 7 shows such a plot generated for the ISO container debris on the ISO-3 event.

One feature that is common to Figures 5, 6, and 7 is a well-defined cruciform pattern, such as those that been observed on other high explosive tests.

The information generated by the entire ISO test series represents a start to the ongoing task of understanding and modeling the debris and airblast produced by explosions inside ISO containers. It has been used to update and improve existing quantitative risk assessments tools such as IMESAFR. It can also be used to better assess existing Explosive-Safety Quantity-Distance regulations and enhance the state-of-the-art in other debris prediction models.

Putting Science to Work

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

Don't be Snared by the Internet

While we don't have a contribution for you this month, **Tony Rowe**, the author of *Tony's Tale-piece* has a warning about the world-wide web, "a real arachnid's snare for the unwary" he calls it. "The internet is a source of all knowledge, but then anyone can have a website. Young persons, or the unwary, perhaps searching around for 'forbidden fruit' will sometimes stumble onto such illicit or rogue sites often describing the apparent 'How's' around the manufacture of a number of potentially dangerous reactions and reaction products. There are sites, for instance, describing, illegal and dangerous combinations of communications equipment and explosives. There are even videos claiming to show connection detail. That they do so without even a word of caution to those accessing the information is, to me at least, extraordinary. The trauma that inevitably results from just a single detonator going off in a human hand is truly a terrible sight to behold. But that's not all. The accidental ignitions of pyrotechnics or gunpowder can cause horrible burns and that damage too is usually permanent. There is just no good side and the end result is always misery and heartbreak. ***It doesn't have to happen!***"

Our Explosives Regulatory World

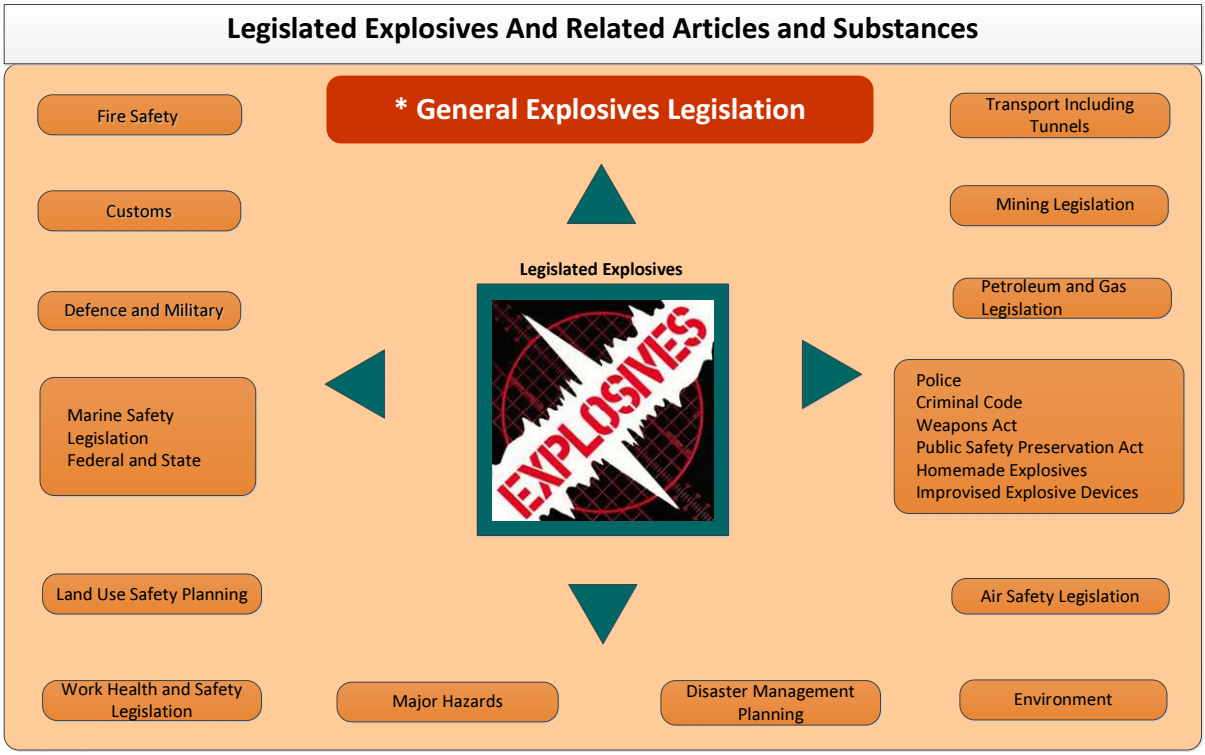
Regulators' challenges with explosives legislation

by

Geoff Downs (Chief Inspector of Explosives, Department of Natural Resources and Mines, Queensland, Australia)

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

The role of the regulator is enforcement of legislation and the role of the industry or the regulated is compliance with legislation. Explosives legislation applies to the safety and security of explosives with a level of protection for the community for the hazard and risk throughout the whole of life cycle. Explosives legislation is different from other types of complementary legislation because it regulates the whole of life cycle rather than sections of the life cycle such as environmental, workplace handling etc. The explosives life cycle includes manufacture, import, export, store, transport, use, disposal and sale. In addition to the traditional or conventional general explosives legislation, explosives are legislated in many different specialised areas beyond the general explosives legislation. The diagram below provides an insight other types of legislation which are complementary to and side beside traditional explosives acts. Each set of legislation is administered by a different jurisdiction and the coordination between different jurisdictions to achieve consistency and a seamless transition is always a challenge. This is in addition to the many jurisdictions that administer the general explosives legislation across the planet at different levels of government.



The policy objectives are to prevent harm to anyone and those in control of explosives meet their duty of care for safety and security. The challenge for the regulator is to adopt a style and approach under the policy objectives in harmony with current practices and the changing practices evolving under the market system and the way the community operates to be effective while being efficient within available resources.

The current issues facing regulators are many and varied. They should take cognizance of the emerging issues and trends and how technology, industry practices, community standards and expectations will be into the future. The identification of the issues should shape the style and approach of explosives legislation and should also serve as a checklist. Each of the dot points identified below could have its own discussion section for a clearer understanding of the intent and meaning.

- Wide diversity of types of explosives and sectors handling explosives across many sectors throughout the lifecycle
- Risk based approach for certain activities and certain explosives
- Obligations and accountabilities for all persons undertaking an act involving explosives and plant across the lifecycle
- Streamlining processes
- Regulatory efficiency versus regulatory effectiveness
- Mutual recognition of other administrative decisions
- Red tape reduction
- Volatility within industry – boom and bust
- Very mobile workforce
- General security issues arising from the security crisis of early 2000's
- Consistency of approach, enforcement, decisions and advice
- Clearly defined explosives safety and security criteria for all types of explosives throughout the life cycle
- Consistency of competency, experience, knowledge and skill requirements
- Criteria for suitability of persons (fit and proper)
- Information sharing on accidents, incidents, compliance, licensing refusals, suspension and cancellation across and between jurisdictions
- Lessons learned from incidents and investigations
- "Corporate memory"
- Accommodate/compatible with contemporary industry and community practices and arrangements and emerging trends
- Increased international activity e.g. imports/exports
- Recognition of global scene
- Recognition/accommodate emerging trends
- Consistency of legislative regimes and approaches for all explosives, explosives activities and associated plant and equipment
- Lag with implementing contemporary safety and security management issues relative to changing legislative styles and approaches, emerging trends and changing practices
- Differences between jurisdictions, approaches and legislative regimes nationally and internationally
- Different approach nationally for promulgation and ratification of consistent standards and criteria
- Codes and standards not available for all lifecycle activities
- Levels of monitoring (audit and inspection) varies
- Level of compliance and enforcement varies
- Availability of recognised standards and codes for all activities
- Competency standards for all explosives activities
- Statutory appointments
- Unnecessary imposts upon operators outside their intended and normal activities
- Recognition of role and work status and obligations in line with those roles etc
- UN and GHS issues
- Consistency in approach with other similar dangerous goods and high risk industries
- Characterising the hazards and properties of explosives
- Estimating the risk and the tolerability of the risk
- Employing current and emerging technologies and tools

There are different styles and approaches to legislation in effect and being proposed. Regardless of these approaches, the broad policy issues, principles and practices should be aimed at achieving the outcomes of preventing incidents and establish an acceptable level of risk for safety and security across the board. In order to achieve the desired safety and security culture, the legislation including subordinate legislation should be aimed at addressing the fundamentals. The list of dot points below provides a cascading list of fundamentals that could be covered directly or indirectly at agreed levels. Even though the list of dot points is quite long, it must be remembered that we are covering the whole of life cycle of all explosives ranging from broad policy issues to detailed technical issues.

- Cover whole of lifecycle of explosives
- Access to explosives for those who should have explosives and not for those who shouldn't (security bubble)
- Limit/restrict accessibility to explosives needed for activity
- Good practice as a minimum for all activities, best practice is for best of breed
- Risk based approach where applicable (safety and security)
- Focus on restricted explosives
- Not cover terrorist or criminal activities
- Licensing applies to lifecycle activities involved directly with explosives handling and supply safety and security grounds to control the risk
- Those in control of explosives are licensed or equivalent
- Access control of explosives not for third parties
- Fees applicable to scale of operations and activities
- Licences limited to intended scope of activities
- Individuals, companies and partnerships in control of activity can undertake those activities. Obligations and licensing as applicable
- Different security clearance criteria for supervised and unsupervised access to restricted and unrestricted explosives
- Explosives are characterised
- High rate of compliance
- Regulatory approach and controls support high rate of compliance
- Boundaries of legislation and regulatory control defined as to what is and is not covered and what it ap-

plies to and does not apply to
- Explosives activities limited to activities covered in Safety Management System + Security Management System
- Those conducting activities must be competent/ knowledgeable for those activities
- Competencies to be current. Organising users and transporters must be experienced
- Persons conducting high-risk safety and/or security activities unsupervised and in control of their activities must be licensed (e.g. similar to forklift, asbestos)
- Applies to explosives, related substances, articles, related plant and handling throughout the life cycle , packaging and containers
- Level of controls applied are appropriate to the risk (safety and security) and are not over stated or under stated with unintended consequences
- Recognised standards and codes provide safety and security minimums
- User licenses based on available national competencies
- Competency standards or defined levels of knowledge and skills to be available for activities undertaken
- Level of control measures is commensurate with the risk and the exposure to the community. High risk explosives exposed to the community and proximate audiences including transport, fireworks, demolition, special effects, etc
- Person must be compliant at the time of licensing (fit in all aspects of safety and security) and continue to be compliant
- Obligations of all players explicit and clear
- Roles clearly identified – controls only appropriate to the role
- Level of control for safety and for security is commensurate with the level of risk for safety and also for security
- Combined contractor/user approach for small operators
- Limit to the general explosives legislation boundaries. Coverage of each jurisdiction is different

The role of the regulator is enforcing legislation not making it. That is done by parliament. Industry expects the regulator to be competent. As we can see from the challenges, change management is a major issue in the range of issues in our ever changing world. There are expectations that we have to do more with less, we also have the "burning platform" for change and to strive for increased effectiveness and efficiencies with budgetary pressures.

The challenge for industry is complying with legislation. The regulator has a leadership role in the administration of the safety and security legislation while industry manages its own risk. It is necessary for regulators and industry alike to know and understand their legislation. For the people who are not in the management levels of an organisation, they are generally reliant on following safety and security management systems prepared by select people in the organisation. The regulatory requirements should be incorporated into these systems. I have addressed a forum with explosives company management. I have asked the question "Who has seen the Explosives Act?" and "Who has read the Explosives Act?" The number responding is about 5% but certainly no higher than 10%. The challenge for industry and the regulator is to have a shared understanding of the same requirements for the same outcome.

Improving Explosives Competence

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

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

Using the ESA standards: What value to supervisors?

by

Denise Clarke (Managing Director, Homelands Security Qualifications)

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

In this series of articles, we have looked at various aspects of the construction and uses of the UK's Explosive Substances and Articles (ESA) National Occupational Standards (NOS). The case as to why they should be used has been made in previous articles. In this article, we have case studies of three organizations that focus on the perspective of supervisors.

Unfortunately, it has not been possible to name all the organizations referred to in this article. For ease of reading, we will refer to the anonymous organizations as Organization A and Organization B.

Organization A has been using the ESA NOS for some time now and these have been part and parcel of an organization-wide project to standardize explosives processes across the company. One of the outcomes of this exercise has been the rationalization of role profiles for all explosives workers. At the beginning of this process, there were 43 role profiles but, following a systematic process of analysis, this has been reduced to just three and the commonality of all functions (e.g. safe working practices and team working) has been identified. This standardization has enabled the mapping of all explosives processes and roles to the ESA NOS.

Experienced supervisors were selected to participate in the project and were trained in the principles of assessment and the tools and techniques to assess staff. This has made supervisors more confident about dealing with those individuals who could perform better, by helping to analyse gaps in training. Also, in developing the supervisors more systematically, Organization A now has the evidence that means that it can more easily identify those with greater potential.

Line managers are responsible for ensuring that their staff are "SQEP" (suitably qualified and experienced personnel). Often, this can be done by observing an individual carrying out his or her work. However, what happens if the line manager is not technically competent at working with explosives (because his or her expertise lies in another discipline)? In such cases, managers are reliant on the advice of others. Using the ESA NOS has meant that managers now have objective evidence of their staff's competence by examining their portfolios of evidence. The process of carrying out SQEP interviews (aided by individuals' portfolios) has prompted some managers to recognize their own training needs in people management topics and giving appraisals.

Historically, SQEP "checklists" existed for each individual explosives process and focused on the technical outcomes of each task being undertaken. Now, however, the attention is on occupational competence, and in particular, transferable outcomes, because the SQEP checklists have been mapped to the ESA NOS. For example, an explosives process worker may be working to ESA NOS 3.16 *Contribute to conducting a trial or test of explosive substances and/or articles*. Performance criterion 'd' states that, to demonstrate their competence, users must *use the equipment, consumables and services correctly during the task.* In addition, amongst other relevant requirements, knowledge 'ix' requires them to explain *the equipment, consumables and services needed to complete the task* and knowledge 'x' requires them to explain *how to use the equipment*. Of course, the requirement to use equipment correctly applies to all Organization A's explosives processes. However, the process work instructions tell operators *what* to do but not necessarily *how well* things might be done. For example, a work instruction might require them to set up the equipment such as to test the functioning of an initiator, to set up equipment for EMTAP tests or indeed any other test right up to those dealing with novel and complex explosives or the development of explosives themselves. However, it is the ESA NOS – not the work instruction – that specifies how well it must be done and appropriate training can be given. As a result, work instructions are now being mapped to the ESA NOS and reference to the latter is made in the SQEP documentation. This has closed the loop between assessing adherence to procedures, training and the assessment of the competence of the individuals operating the process.

An extract of a revised SQEP checklist that is now mapped to the ESA NOS is shown below.

Exhibit 1: ***Extract of a revised SQEP checklist mapped to the ESA NOS***

Task Description		**Ref. No. (Work Instruction No.)**	
Transfer of Explosive Articles within the Firing Area		2301	
Building and Storage of Explosives Assemblies in Buildings 'X' and 'XX'		2101	
Step within Task	**Record of Observations undertaken**	**Performance Criteria**	**Knowledge Requirements**
(WI2301) Procedure 1 – Step 1.2	Attended local weekly and daily planning meetings to inform the WCC of the intention to move explosives.	4.4 – b, d 7.1 – a	4.4 – i, vi 7.1 – i, v
(WI2301) Procedure 1 – Step 1.2	Signed the explosives move into the facility task log to gain WCC approval	4.4 – b, d, m 7.1 – a, g	4.4 – i, vi, xiii 7.1 – x
Etc.	Etc.	Etc.	Etc.

Contrary to expectations, it has not proved time-consuming to generate the evidence that shows that both SQEP requirements have been met as well as those of the ESA NOS, and, after all, this is what supervisors and managers are doing anyway! The revised SQEP documentation simply provides the structure for doing this

Operators have also been encouraged to participate by writing their own 'Reflective Account' of their recent work - a technique which leads on to the 'Review, Learn and Improve' cycle. The reflective accounts are incorporated in their portfolios of SQEP evidence (which are not currently used for qualifications purposes at Organization A). In addition, operators are encouraged to challenge existing processes and suggest possible improvements. Supervisors question the operators about encountering and reporting problems and the answers help them to see more clearly what are an individual's development needs.

Using the ESA NOS has brought supervisors out of their offices and into the workplace and they are now interacting to a greater extent with operators. Line managers (i.e. supervisors' managers) regularly undertake "process walkdowns" to check on facilities and equipment and to ensure operators' adherence to procedures. The use of the SQEP checksheet mapped to ESA NOS has given the walkdown more focus. The operators are pleased that managers are showing such an interest and that managers have an accurate knowledge of each individual's achievements which, in turn, can facilitate their staff appraisals at the end of the year. As a result, management has a far clearer understanding of exactly what is happening and also have the evidence to back up their judgments.

What next for the Organization A? It is is keen that people see that they have a career pathway and plans are being considered for staff to achieve professional registration through the Engineering Council (ECUK). The portfolios that operators have already created should help them to achieve Eng Tech [1] registration, for example.

Other functional areas have seen the benefits of having role profiles and these may be rolled out to other technical specialist areas (such as those who work with lasers, x-rays and high voltage electricity).

Through the standardization project and the mapping of explosives processes to the ESA NOS, Organization A has achieved three major benefits:

1. Its processes to prove the "SEQP" of its explosives workers have been improved;
2. The boundaries between different business areas have faded as people can now see that they all share the same practices, standards and processes albeit in different technical environments;
3. A combination of the outcomes of the standardization project has enabled Organization A to develop a far more flexible workforce as explosives workers can now identify the portability of their experience and expertise and are therefore able to work in different process areas.

Organization A therefore plans to continue to build on the excellent work that it has already done to develop a flexible and SQEP workforce in its explosive business.

The **Ministry of Defence (MoD)** is very much aware of the diminishing pool of people with explosives skills who could be recruited to work as Explosives Safety Advisers. It has taken an important step to counter this by "growing its own talent" by creating a post so that role occupants can be developed into the job relatively quickly. A role profile mapped to the ESA NOS has been created and the individual components (the performance criteria, contexts and knowledge requirements) can be used to identify suitable projects and tasks that can be used as development vehicles for the individual. Both the supervisor and the individual being developed share the same role profile. However, whilst the supervisor will be assessed on the extent to which he has met the requirements of the standards and can therefore be considered to be competent, the standards are used for the "developee" as training standards. Therefore, the extent to which he has grown and how much he has learned are the important considerations rather than any kind of assessment of competence (that will come later in his career). From the supervisor's perspective, this has facilitated the choice of work allocated and enabled a clear view of the individual's achievements and areas for further development.

This approach has also made it straightforward to create training and development plans for the individuals under development (both initial and ongoing). An interrogation of the performance criteria of each NOS in the role profile has enabled supervisors to identify not just what development is needed but also how it could be met. For example, ESA NOS2.*3 Review the factors affecting the safety of specific explosive substances and/or article*s performance criterion *(*d) *(establish the design, intended use and operation/ functioning of the explosive substance and/or article)* and (g) *(establish the intended environments of the explosive substance and/or article throughout its life)* could be delivered through training courses (remembering that this individual is undergoing a development process – for the assessment of competence, the successful completion of a training course would not be acceptable for these criteria).

In the same standard, performance criterion (e) (*establish the intended environments of the explosive substance and/or article*) and (f) (*identify hazards and assess risks associated with the environments and/or use of the explosive substances and/or articles*) can be achieved through an existing project to review the plans for a new piece of equipment that is currently in the concept phase. Amongst other things, the individual being developed is examining the intended environment in which the equipment will be used and the pro-

posed safety measures. He will comment on these, highlighting strengths and inadequacies of the proposals. The final outcome of the review will be the safety advice given – which can be used as evidence of competence.

Performance criterion h (*give your customer timely advice or feedback on developments during the course of your review*) and i (*inform your customer promptly of the findings of your review*) can be met through the final report.

The 'contexts' of the ESA NOS are seen as helpful in specifying the degree of depth of what is expected of an Explosives Safety Adviser. For example, the *test methods* referred to in NOS3.2 *Determine the existence of a suitable trial or test procedure for explosive substances and/or article*s could be interpreted as the requirement to examine how a test is conducted, the methodology and validity of the test design, the extent of tailoring a test and divergence from STANAGs and DefStans etc – all highly complex and technically demanding areas. Achievement of such considerations will show that an individual will be ready for the next level of challenge.

The ESA NOS in the role profile will also be used for ongoing informal performance discussions. The "developee" will read and assess himself against the components of each NOS and will then meet his supervisor for an informed discussion on his achievements and development needs. The standards can therefore be used to measure how an individual is progressing from a starting point of gaining knowledge toward performing competently and being able to apply that knowledge to practical effect. The process will be facilitated if "developees" collect evidence of having met the requirements of the NOS and mapping them to the tasks that have been completed.

From the perspective of supervisors' own development, there was a general view that "the ESA NOS look as though they have been written for my job". As such, the NOS could not be attributed as the reason for any difference to supervisors' development. However, they are seen as providing a useful adjunct to the MoD's published protocols on the analysis, development and giving of explosives safety advice. In addition, whilst the appraisal process may (and has) changed, the ESA NOS are seen "as a constant".

For new staff, however, the ESA NOS "are useful pointers … to help understand what has to be done and how well to do it". For more experienced staff, they are seen as helpful in pointing the way to what an individual needs to do to develop into the next role and achieve a promotion.

Organization B has made a significant investment in explosives workers' professional development at all levels across the organization by ensuring that they all become qualified with an explosives-related qualification that is based on the ESA NOS. The financial investment is seen as minimal when weighed against the benefits of a demonstrably competent workforce which will reduce the likelihood of an incident and its potential impact on the business. In the first instance, the most significant effort to qualify range staff is being concentrated at one site where an incident occurred recently and where the numbers of explosives trials and demilitarization activities are by far the greatest of all Organization B's sites.

Organization B has taken an interesting approach to the assessment of range personnel in that a series of "assignments" has been developed which cover all the knowledge requirements of all the units in the L4 (UK) Diploma in Defence Range Safety. Candidates must fulfil each assignment by completing a dissertation of up to 3,500 words on a scenario that relates to a trial of explosives. The application of this knowledge in all the "performance criteria" and "contexts" of the NOS is tested through workplace observation, witness testimony and work products that are assembled into a portfolio in the usual way.

Adam Baines [2], Trials Delivery Manager commented that working in this way "… felt constructive … it made you think about what you do and how you do it". So, the mechanistic approach (even "box-ticking") used by some historically in the UK has been replaced by something that is "a wholly educational experience … it felt like you were doing accredited learning from a university …" as Adam put it. He made the point that achievement of the Defence Range Safety qualification is "the validation of what I do and the methods I have adopted." The most striking thing that he says that he has carried away from the experience of working to the standards and qualifying himself is that "it makes you stop and think before doing anything." This might be a life saver and is an approach that Adam is encouraging his staff to adopt.

As a supervisor, he is more able to pick up on potential problems and to have the confidence to question practices and possible unplanned events because, through working to the assignments based on the ESA standards, he is more knowledgeable about what is required and is more focused as a result. Adam now feels that he is "better able to think things through and to be more analytical … the ESA NOS are written as outcomes so it focuses you on wanting a positive outcome."

As a supervisor of range workers who are working to the standards, he has found that they are now talking to each other more and sharing information in preparation for doing their qualifications as they recognize their own personal responsibility for developing their competence and proving it.

Many supervisors say that their staff find it difficult in the face of urgent operational priorities to find the time to collect and organize evidence of their competence. However, since Organization B has mandated the requirement for all explosives workers to become demonstrably competent[3], this has now been written into each explosives worker's job description. Therefore, time will be found to collect evidence of competence which is now an integral part of someone's daily work.

Historically, running trials and demilitarization activities were managed sepa-

rately. However, they have now been brought together. Whilst this is beneficial to the business, it has also brought its own challenges, namely, the cross-training of people who will be competent and flexible enough to carry out work in both fields whilst maintaining their own identity (a strong motivating factor). In this respect, the ESA NOS are seen as particularly useful so that people can be cross-trained. The next challenge to be surmounted then is to maintain the continuity of individuals' development. For example, a range worker may have mastered the trial of a particular kind of weapon system or ammunition nature, but how can management develop that knowledge and competence into a capacity to deal with other systems whilst juggling other operational tasks that must be completed to meet customers' needs? The individual may need a particular kind of opportunity at a particular time but operational priorities may not allow for this. The risk then of course is that the individual may suffer from skills or knowledge fade whilst waiting for a suitable project that could enhance his or her development.

Organization B has developed a range of documentation that supervisors find useful in both planning operational tasks and developing/measuring the competence of their staff, for example, the spreadsheet that shows which team members are competent to carry out particular tasks and any caveats attached to them[4]. In addition, practical task assessment forms have been developed to aid supervisors in checking that the requirements of a task have been fulfilled correctly; that supervisors themselves are carrying out their work correctly (e.g. giving task safety briefings) and that evidence of competence is available for inclusion in people's portfolios. Here is an extract of the form:

Exhibit 2: ***Example of Task Assessment Form used by Supervisors***

Please grade the following areas	Below expectations	Meets expectations	Above expectations	U/C*
1 Set up of activity with correct equip-		YES		
2 Clear logical instruction and briefings		YES		
3 Ability to explain process clearly with a		YES		
4 Interaction with group: gained their		YES		

* **U/C** Please mark this if you have not observed the behaviour and therefore feel unable to comment.

Please use this space to record what went well and why:

- xx was able to dispose of a UXO found on the sea wall before the xxx burn prep commenced. This provided an opportunity for xx to devise and inform the crew with an additional safety brief to cover this task.
- Use of the briefing boards and munitions hazard data sheets combined for the first time, promoted more discussion than previously seen amongst the crew
- Good post brief test results, most recording 10-11, one with 12 correct answers
- Briefing has become part of normal routine, better understood and delivered over this week. The crew were visibly more engaged with the new way of working and most seem to be more interested than previously seen
- Two good stops by range workers, when encountering difficulty with split inner packaging on the xxx and an xxxx round whose fuze protector remained in the packaging, when the round was pulled clear and had to be fished out and replaced before placing it the burning bag.

Please use this space to record what areas need further development:

- We need to accelerate the one day explosives training course programme - range worker absence could result in insufficiently trained staff being used on task at short notice.
- Ammo did not arrive on btty until 09:10
- Over time, improve munitions pictures on briefing boards with photographs of specific natures seen in xxx rather than more generic types we have currently included.

Please use this space to record what areas need further development:

WORKPLACE OBS: xx delivered a clear and comprehensive main brief, followed by a shorter brief on his other task of UXO disposal. All hazard types to be seen today, with particular emphasis on xxxx and xxx flares whose hazard type will change to Type 2 when unpackaged. There was good Q&A from the crew. All staff passed the written test and xx provided good feedback and clarification to one particular question on mitigation.

I observed xx demonstration of unpacking one of each type being processed today, followed by at least an hour observing the crew conducting the processing in accordance with the brief and as demonstrated.

Overall, over the past week or so staff engagement has visibly improved as we develop the new way of working. Very good effort by everybody.

To sum up Adam's views on the usefulness of the ESA NOS from a supervisor's perspective, "the NOS allow me to put the right people in the right place at the right time."

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

Notes:

1 Engineering Technician
2 Names have been changed
3 As required by the Ministry of Defence (see newsletter NL46, 3rd Quarter, 2013)
4 See newsletter NL48

Pondering the Profession

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

Selecting Fashions for Living

by

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

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

Examining personal protective equipment (PPE) selected to safeguard workers in the explosives industry has taken me to many unique operations and sophisticated laboratory test facilities. A common discussion with the safety professionals at the operations and the test facilities was to ensure that an effective hazard assessment is completed before PPE is selected for an operation. The most successful PPE programs they said included a proper work place hazard assessment and when feasible the ability for workers to choose from a variety of equally effective PPE options.

Workplace Hazard Assessment

With respect to PPE, the following considerations should be included in the workplace hazard assessment process:

- Do become familiar with potential process hazards
- Do include a review of mishaps and experience from similar industries
- Do involve workers in the hazard assessment and PPE selection process
- Do select PPE that exceeds the minimum required to protect workers
- Do follow-up on the effectiveness of the PPE selected
- Do examine PPE selection when changes impact the process
- Do not overlook relevant standards and PPE specifications and limitations
- Do not overlook ergonomics and worker capability to perform tasks with PPE

Selecting PPE, the First Option?

Companies should not rely on PPE exclusively for protection. PPE cannot provide protection to the worker against all hazards and conditions. The use of PPE itself may create additional hazards for the worker including heat stress; reduced mobility, dexterity, and tactility; and impaired vision or hearing. PPE must be selected not only for the level of protection that it provides, but also for the specific hazards that it may create for the users.

Unfortunately, some companies are too quick to outfit workers with PPE while overlooking engineering controls or administrative solutions that can eliminate the need for PPE. One regulator described seeing PPE listed as the first safeguard for every potential hazard identified on a Failure Mode Effects Analysis (FMEA) supplied by an explosive manufacturer during an audit. PPE should not be the first consideration to protect workers.

Sometimes PPE selected provides over-protection or under-protection of the worker which can increase risk and present adverse consequences. For example, a safety team mandated greater than 480 minute permeation rate solvent resistant gloves for the company chemical laboratory. After several mishaps involving dropped chemical containers and expensive instruments, the safety team was forced to reconsider the initial mandate. In this situation, four mil solvent resistant gloves suitable for incidental splash protection would have been sufficient. In another situation, a supervisor selected a medical glove for chemical handling with the expectation workers would change them out if the gloves began to degrade during the shift. Degradation of PPE is not an acceptable metric for replacement. The safety team made the proper correction.

Another problem that can arise with PPE selection is scope creep. Meaning, PPE selected for an activity expands beyond the intended application. For example, during a site walk-through, inspectors noted that a worker was donning a large shop coat over another shop coat that he was wearing. When questioned about the additional shop coat, the worker stated that he did want to use the time-consuming engineering control and the additional shop coat would keep him safe if anything happened. Caution should be exercised to ensure PPE selected is not used beyond the original scope or intent.

Fit Factor

Surveys suggest workers are more likely to accept and use PPE that is comfortable and fashionable. Manufacturers often follow consumer fashion and sporting apparel trends for the latest styles. When workers at one facility were provided equally protective choices for trial use, the PPE selected by a majority of the workers was described as comfortable and fashionable. Worker comfort and PPE style should not be overlooked as both may contribute to proper use of PPE. Recently, a supervisor introduced PPE bearing the logo of a popular local sports team to the work team. The supervisor and company safety representative reported the work area no longer had issues with workers using PPE properly .

PPE Selection Resources

Many regulatory agencies have excellent resources for the development and implementation of PPE programs and the PPE selection process (e.g., CPL 02-01-050; OSHA 3151). In addition, protective equipment manufacturers and trade journals provide professional assistance and guidelines addressing the intended use and limitations of PPE.

Conclusion

Selecting fashions for living should;

1. start with a proper hazard assessment; and
2. connect workers to the PPE by allowing workers to select acceptable, company approved options

The right personal protective equipment may not be a fully encapsulated suit or gloves with infinite permeation break-through times. Selecting fashions for living involves finding the right balance between the hazard assessment, PPE protection factors and real-world fit, form and function.

Explosives Eco-talk

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

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

Under Lock & Key

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

The evolution of the threat from Improvised Explosive Devices

by

Capt Michael Richardson (Royal Engineers, JIEDAC)

Introduction

In recent years, there has been an increase in the number of new emerging threats to security around the world. Governments and industry now face challenges such as cyber attack, organised crime and international terrorism on a scale not seen before.[1] Much of the technology which has enabled these threats to emerge has been developed for a legitimate use, but has been adapted and used in an illicit way by those who pose a threat. The same is true for Improvised Explosive Devices (IEDs) and the components that can be used to make them. IEDs constructed from components, which are generally available for legitimate reasons, have become a key weapon for terrorist groups around the world.

The use of IEDs against International Security Assistance Force (ISAF) troops in Afghanistan, as well as high profile events such as the Oklahoma bombings in 1993 and the London 7/7 bombings in 2005, have ensured that dealing with the IED threat has been a high priority for some governments. Indeed, this is not an isolated problem. Events such as the recent bombings in Nigeria, attributed to groups such as Boko Haram; the use of improvised "Barrel Bombs" by regime forces in Syria; and a number of attacks in China, attributed to Uiygur groups, have shown that the use of IEDs continues to proliferate around the world. The US Military Joint Improvised Explosive Device Defeat Organisation (JIEDDO) reported that in the last year there were over 40,000 casualties caused by IEDs globally, not including those in Afghanistan and Iraq.[2]

Under the UK government's counter terrorism strategy (CONTEST) it is committed to engaging with industry to assist them in managing their products with possible illicit uses responsibly. As part of this engagement, the Joint Improvised Explosive Device Analysis Centre (JIEDAC), a UK Ministry of Defence organisation which investigates ways to inhibit the licit to illicit exchange of IED components and precursor chemicals, has been collaborating with SAFEX in order to ensure that appropriate measures are taken. This is the first of four articles, which detail: i) the evolving threat from IEDs; ii) how an IED is made; iii) how we have tried to fight this threat; and iv) how industry can help in this fight.

A Historical Perspective

The use of explosives by terrorists is not new. Every autumn in the UK, large bonfires are constructed to celebrate the foiling of a 1605 plot to blow up the reigning monarch and his parliament as part of an ongoing religious conflict by Guy Faulks. In the late 19th century, a range of terrorist groups in Europe and North America, identified that products being developed in the new field of commercial explosives could be used in their campaigns. Across the Atlantic, America experienced one of its first major criminal explosive incidents when, in 1886 during a Chicago Labour dispute, anarchists exploded bombs in a public meeting.[3]

2014 marks the centenary of the outbreak of the First World War. This conflict, fought principally between 2 groups of European states, has been seen, along with the Second World War, as the pinnacle of the state vs state conflict which had evolved over the previous 400 years. It is

tempting to contrast the "simplicity" of this conflict with the complex security situation we are involved with today. In 1914, a range of countries, bound together by mutual security agreements, faced each other on the battlefields of Europe and in their overseas colonies. The entire national will and the power of nations (and their colonies) were mobilised in a fight which led, over a 4 year period of attrition, to the collapse of 1 group.

The nature of conflict has evolved significantly over the past century. Conflicts are now often fought between states and non state groups, such as those seeking a change of government or the secession of a region from a country. Nation states are no longer the only players on the world stage. They are joined by a range of groups with interests spanning borders and conflicts.[4] These include international organisations, such as the UN and EU; global Multi National Corporations; and industry groups. They also include terrorist groups and crime networks, who operate across traditional state borders. For example, the Irish Republican Brotherhood (IRB), campaigning for the independence of Ireland from Great Britain, used low and high explosives to target British Police and military targets from 1867. They benefitted from being able to operate across borders, receiving support from within the US where a large emigrant community was able to provide finance, as well as receiving a measure of expertise through American Civil War veterans.

In order to counter this, an approach that helps prevent countries becoming safe havens for people to plan, supply and mount attacks is required. One way to do this is by helping those countries of concern develop controls on activity and access to the material that could be used as weapons.

In looking at how the global security situation has changed since the end of the First World War 1, some parallels do emerge. Although the First World War took place between two groups of states, it was sparked by the activity of a small previously unknown terrorist group with a limited agenda. Gavrilo Princip, a Serbian nationalist shot Arch Duke Franz Ferdinand, heir to the Austro-Hungarian throne, to highlight the plight of Serbian Nationalism, but in doing so sparked a global conflict. This was not the first attempt by non state groups to use acts of terror to implement political change: in 1881 members of the "People's Will", a left wing terrorist group, assassinated Tsar Alexander II, the ruler of Russia, with an IED.[5]

Illustration 1: ***Assassination of Tsar Alexander II*** [6]

Following the end of the Cold War, conflicts in Europe, the Middle East and Africa continued to cause casualties. This development of conflict has shown that small conflicts, often pitting groups within state groups, have continued alongside major changes in the world order. To slightly mis-quote the Australian counter insurgency expert, David Kilcullen, people have continued to fight their small wars, often motivated by local issues and grievances, even in the midst of the much larger struggles.[7] In all these cases, access to weaponry for belligerents has been a key factor in sustaining the conflict. Often, access to weapons, particularly for non state actors, has been difficult. In these cases the ability to improvise weaponry, particularly in the form of IEDs, which can have a disproportionate effect on a better equipped enemy, has been key. The simplicity of some of the IEDs and the ability to procure precursors by legitimate means make it even harder to try and counter them. Whilst recognising the potency of commercial explosives, the IRB experimented with creating their own Home Made Explosives (HME). In one example from the 1880s, a large amount of chemicals were purchased by members of the IRB using the cover of a paint factory.[8] This was discovered by alert suppliers raising concerns to the police about the amount of pure glycerine that the shop was purchasing for no apparent reason.

This, amongst other examples, has led to the cooperation between industry, retailers and governments that we work towards today, like initiatives that encourage industry and retailers to raise concerns around suspicious chemical purchases, such as 'Know your Customer' schemes.

The illicit use of goods available on the open market remains a key tactic of terrorists, particularly those operating in areas where commercial grade explosives may be hard to acquire. The terrorists who exploded bombs on public transport in London in 2005 constructed them from chemicals purchased in low quantities on the open market and distilled in a kitchen.[9]

The development of technology, in particular the internet, has had a significant effect on terrorist activity. Sharing information on how to use explosives has been seen from an early stage. In 1887 a "Professor Mezzeroff" lectured in New York on the power of Nitro-glycerine and encouraged those attending to support the IRB by providing them with men.[10] More recently, terrorists have been able to use the internet as a means to quickly share information on IED technology and motivation around the world.[11] The idea of terrorists using explosives and the way they share information is, therefore, not a recent phenomena.

Efforts by governments to control information in this area, such as by banning the Anarchists' Cookbook and similar qualifications show how governments can help prevent the spreading of knowledge.[12] Industry also bears a responsibility, in line with the laws in their respective countries to en-

sure those with access to information on explosives and precursors are effectively vetted.

Terrorism and IEDs

The evolution of the threat from terrorists and IEDs has led to a number of conflicting definitions for both terms. The UK Governments defined terrorism in its 2000 Terrorism Act as:

> *The use or threat of action designed to influence the government or an international governmental organisation or to intimidate the public, or a section of the public; made for the purposes of advancing a political, religious, racial or ideological cause; and it involves or causes:*
>
> - *serious violence against a person;*
> - *serious damage to a property;*
> - *a threat to a person's life;*
> - *a serious risk to the health and safety of the public; or*
> - *serious interference with or disruption to an electronic system.*[13]

A further clarification could be that terrorism is generally something carried out by non state or proxy actors against a state, rather than state on state violence. This is not to belittle the role of criminal elements that may use IEDs, but the distinction between motivations is stark. . The UK government identifies international terrorism as the principle current national security threat.[14]

Many definitions for an improvised explosive device (IED) exist, originating from political, military and academic sources. NATO military doctrine defines an IED as:

> *A device placed or fabricated in an improvised manner incorporating destructive, lethal, noxious, pyrotechnic or incendiary chemicals and designed to destroy, incapacitate, harass or distract. It may incorporate military stores, but is normally devised from non-military components.*[15]

A more comprehensive definition from academia, which also includes the motivation of the perpetrators, describes it as follows:

> *An explosive device is considered an IED when any or all of the following—explosive ingredient, initiation, triggering or detonation mechanism, delivery system—is modified in any respect from its original expressed or intended function. An IED's components may incorporate any or all of military grade munitions, commercial explosives or homemade explosives. The components and device design may vary in sophistication from simple to complex and IEDs can be used by a variety of both state and non-state actors. Non-state actors can include (but not be limited to) terrorists, insurgents, drug traffickers, criminals and nuisance pranksters.*[16]

Illustration 2: ***IED, military exhibition made by the Israeli Defence Force (IDF), Jerusalem 2009, August 8th***

Terrorist Objectives

The objectives of those who use explosive devices are varied. In areas of conflict they may be used by an adversary as a way to strike at an opposing force, possibly to cancel out an overmatch of weaponry. It may be used to restrict the activities of an opposing force; protect their own locations and equipment; prevent the opposing force engaging with the population; and to inflict casualties. The use of IEDs as a reaction to Western interventions in Iraq and Afghanistan is an example of the deployment of such tactics. In other cases, however, the intended target is not another armed group but the civilian population. Terrorist campaigns have frequently targeted civilian populations with the aim of inflicting casualties, causing fear and applying pressure to governments. The Madrid Train Bombings of 2005, taking place shortly before an election, are believed to have put pressure on the Spanish Government to withdraw troops form Iraq. Civilian aviation has been a frequent target of terrorist

Illustration 3: Ambulances at Russell Square, London after the 7th July bombings [17]

attacks in events such as the Lockerbie Bombings.[18] These attacks not only caused large amounts of casualties in a spectacular fashion but also, through increased security measures, have had a lasting impact on how we travel by air.

Groups may also combine the use of IEDs with other weapons to increase their potential effect. Terrorist "spectacular" attacks include the Mumbai Bombings in 2008 in which around 164 people were killed and the Beslan School Siege in the Southern Caucasus region of Russia, in which 380 people were killed.[19] In both occasions perpetrators used IEDs as well as a range of other weapons including assault rifles and machine guns to ensure maximum casualties.

Summary

The threat posed by IEDs is not new and an enduring problem globally not just within Afghanistan and Iraq. The IED due to its simplicity and relative low cost and potential to cause vast amounts of damage has made it the weapon of choice for international terrorism, claiming both military and civilian lives worldwide. Developments in technology have had a significant impact on the way conflicts are fought. Through the internet, ideas can now be shared more easily, making it easier to operate across borders.

In combating the threat, governments and industry can work together in order to use a range of measures including improved controls and regulations around the supply and storage of commercial explosive material and pre cursor chemicals in order to prevent the illicit use of such elements by terrorists. Initiatives such as the 'Know your Customer' scheme which encourage retailers to raise concerns around suspicious chemical purchases have proved successful and should be utilised more in the future to help to reduce the threat.

Future articles will expand on how an IED is made; how we have tried to fight this threat; and how industry can help in this fight.

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Safety Snippets

Is their a training problem here?

A reader sent us this photograph of a fire hose which was run-out with all the measures necessary for road vehicles to cross the hose without impeding the flow of water. As you can see it wasn't implemented in the way management probably envisaged! The reader was not convinced the measures were appropriate for a train and asks whether this could be a training problem!

Is this a case of "scope creep"?

Do you have a problem shipping explosives safely?

"We understand from our own involvement with SAFEX that the Association's primary purpose is to promote the safe use of and eliminate accidents in the field of explosives, from design right through the supply chain to the disposal of goods," wrote one of our Members. They have a dedicated Class 1 transportation, storage and disposal facility which they believe may be unique and of interest to readers. It comprises dedicated sailings from Europe to the UK for Class 1 Explosives only, both in fully loaded containers and part loads. Their vessels berth at their dock in Harwich which has an extensive NEQ limit of 125t, with on-site storage in their magazines able to accommodate 700 tonnes NEQ at any given time.

The Member believes this would support SAFEX's efforts to promote safety of goods in transit, storage and distribution. The facility has all the required licences from relevant government authorities, approved sites and buildings for this operation. They are willing to make their extensive experience and qualification in the management, handling, disposal and recycling of all grades of Class 1 explosives available to readers in a variety of sectors – civil, military and commercial.

Any readers who may wish to find out more about this service in order to enhance the safety of their supply chain can contact the Secretariat (e-mail secretariat@safex-international.org). We will be happy to put you in touch with the Member concerned.

Inbox @ SAFEX-International.org

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

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

Maintenance: The Achilles heel in many operations

It is suspected that a deflagration in an ammunition plant occurred during maintenance operations. Regrettably, the incident resulted in fatalities.

Maurice Bourgeois (GD-OTS Canada) noted: We don't know what the cause was but some possibilities come to mind: Permits to Work; decontamination; and the erroneous belief that tradesmen are knowledgeable about process or equipment hence don't need training or safe work procedures. Obviously, you can't have Standard Operating Procedures (SOP's) for every maintenance job because of their diversity. However, it is the raison d'être for the Permit to Work. In our case a knowledgeable safety inspector, who is independent of production pressures, determines the safety precautions to be taken. This includes things such as emptying a hopper before undertaking a major maintenance job but can extend to any other precaution he considers appropriate. In this way we prevent maintenance personnel from taking shortcuts.

Tony's Tale-piece

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

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

Basis of Safety (Part 3) – Friction

by

Tony Rowe (Retired from AEL Mining Services)

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

PRAELOCUTIO (Prologue)
CAUSA:

I. CONLISIO (Impact)
II. ATTRITION (Friction)
III. INCENDIUM
IV. SCINTILLA ELECTROCUTUM
V. CHEMICA INSTIBILITATEM

In this edition we continue the study of the FUNDAMENTUM SALUTIS ("The Fundamentals of Safety"). In the last issue we explored the first element. It was entitled "CONLISIO" which means Impact This time we open the book at Chapter Two, ATTRITIO, which can be translated as SCIENCE FRICTION - note F**R**ICTION not FICTION

"**THE FUNDAMENTUM,"** an example of early Middle Western technical literature explains that although friction is a relatively short word, its connotations and effects on our world are immense. Friction opposes movement and is thus the declared enemy of all motion.

Friction also means abrasion, rubbing, chafing, grating, rasping, scraping, but there are other meanings too. These include conflict, disagreement and dissent, words describing some of the most negative aspects of human relationships. Is this a clue to the true nature of friction?

What is friction? Friction is simply the resistance to movement or motion. It allows us to pick up a fork or lift a glass. Without friction such simple acts would be impossible. It stops our cars and also helps them accelerate. Without friction a car could not safely negotiate a bend, flies wouldn't get caught in the spider's web and geckos wouldn't be able to climb walls.

"THE FUNDAMENTUM," clearly one of the world's greatest technical achievements, urges us to consider in this regard the "drag" that occurs when a slave galley or a swimmer moves through water or when air passes over an eagle's wings during flight.

Let's think about that a bit. In order to maintain forward motion, a galley must constantly apply power. This can be achieved by the vigorous application of the lash or by hoisting the sails. I can hear the slaves shouting at the top of their voices to "**Hoist the sails Hoist the sails**!" Can't imagine why. Oh! Now I see. The captain wants to go water skiing.

Putting such philosophical questions aside for now, whether or not oars or sails or even both are applied, the propulsive forces generated will demonstrably drive the galley forwards. Stop the oars and/or lower the sails and the galley will rapidly come to a halt. A galley at rest with its oars stowed - even for a couple of minutes - was the probably the equivalent of a long weekend for its rowers. "Row, Row, Row your boat, gently down the stream" was apparent-

ly a popular song of the period, but in general the lot of a galley slave was not a happy one.

And what about the eagle I hear you ask? Any eagle whose wings are folded and not working, becomes what the Hemasini peoples of Illyria in Southern Greece loosely call "a brick." A brick cannot fly and neither can the lazy eagle and so it falls from the sky. Not too many eagles make that final ugly **SPLAT** sound as they impact terra firma, so most are managing the aerodynamics quite well. Even when gliding and not actively flapping its wings, even an eagle cannot escape the effects of friction and is thus also subject to drag. First understand that an eagle with its wings extended has only to generate sufficient lift to overcome the weight of its body. By using momentum, the eagle can trade speed for height, gliding for up to 15 kilometers of horizontal distance for each 1000 meters of altitude lost. As long as it can find and use thermals to regain the losses in altitude, the eagle can soar, apparently effortlessly, repeating the climb and dive sequences many times and perhaps travelling scores of horizontal kilometers in the process. Eventually though, drag wins out and the eagle must either return to powered flight or land.

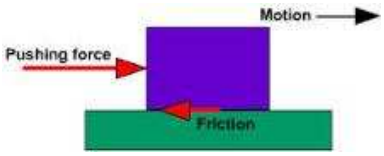
Drag then is not about boy eagles dressing up as girl eagles and squawking out ABBA songs, it's a word associating friction with air resistance. Consider falling stars for a moment. They're not stars at all, - sorry if I cause disappointment - they are actually meteors, bits of stellar debris; hunks of stone or iron that become incandescent (white hot) from the friction with the air as they enter and pass through the Earth's atmosphere. A bright trail in the night sky often marks their all too brief passage.

Not even the fastest creature in the world can do that. The fastest creature is a bird and like the eagle, a predator and a carnivore. It dives and catches its prey on the wing. In a dive (stoop) it routinely reaches speeds of around 320 kilometers per hour. It is of course the magnificent, Peregrine Falcon.

By the way, a swimmer who stops "swimming" will come to a halt in just a few feet. When confirming the truth of this statement, swimmers must always be aware of the host of other perils that may suddenly beset them when in the water. Learned travellers speak of floating logs that miraculously transform into ravenous dragons. These monsters, we are told, are great eaters of men. In rivers and lakes live the great water horses whose enormous tusked jaws can bite a chariot in twain whilst in the great salty oceans are found not only Krakens, Djinns and Skoffin, but also the boneless and black-eyed Tiburon, powerful hunters with many teeth.

As for friction, it is everywhere, but not all the sources are obvious. For instance, there is the sort of resistance encountered between a wheel rim and its point of contact with the ground. Despite the relatively small point of contact, friction creates what is termed "rolling resistance". Rolling resistance is expensive and explains why wider wheels on carts, wagons and chariots, whilst improving grip no end, (greater friction) also require more horses to pull them and when loaded, tend to wear the animals out much faster. Whether horses are best harnessed abreast or in span we will leave for another day.

Friction is also the force that must constantly be overcome when moving anything. We can show this by using say a heavy, but flat-faced object such as a wooden box filled with sand (see the illustration below)



Place the box on to a wooden table top and push. Do not use the dining table for this experiment. Nature has no fury like a wife or mother who finds her table top all scratched up! Repentance is a poor substitute for common sense.

Inertia or momentum is friction's best friend, but even when the effect of inertia is overcome, keeping the box moving across the table will still require a significant and ongoing expenditure of energy.

Whilst impacts are essentially extremely short term, single contact events, friction is a little different. Not only does friction involve sliding surfaces in actual physical contact with one another, the sliding surfaces themselves may be actually pressed or forced together. The time frame or window of opportunity for a friction related initiation is also much longer than that available to a simple impact event. We know that the action of rubbing two surfaces against one another creates heat, but there is worse to come.

No surface is ever truly flat and as you zoom in ever closer, surface irregularities begin to appear. At the nano-scale even the smoothest of surfaces such as those possessed by optical lenses or even porcelain will be seen to comprise largely of peaks and valleys. Mountain ranges, broken glass and saw-teeth are everywhere. It's like looking into a box of cornflakes.

What's not apparent to the casual observer is that friction can cause superheating of just the extreme tips of these

protrusions. This phenomena results in the creation of thousands of extremely localized and transient hotspots, each one sticking out like a mini Everest or K2 from the substrate. I suppose we could liken it to snow on mountain tops, but in such cases the tops are white with heat, not from a covering of cold ice and snow. Such hotspots can reach temperatures in excess of one thousand degrees Centigrade. Now that is pretty hot. At 1000 degrees Centigrade, gold melts whilst lava, fresh from the factory is still molten. Iron though, is merely white hot.

Of course such tiny hotspots don't last for very long, merely a few 10,000 of a second, but sometimes, not long can be just long enough. The mathematicians, alchemists and sorcerers amongst us have calculated and mooted the existence of such hotspots for centuries, but beyond a few flashes, bangs, burned out buildings and of course the heaps of dead and injured people, they have so far been unsuccessful in providing solid evidence.

The authors of **THE FUNDAMENTUM** understood the difficulties for the lay person to comprehend the existence of such hotspots, but as the wise ones used to say "Just because we cannot detect them does not mean they are not there."

Small particles of course, once superheated, may then be emitted as clusters of incandescent sparks. The phenomenon can be seen on a larger scale by observing the high speed grinding of a ferrous metal.

There, that's friction for you.

Authors note:
Today for instance, without specialized instrumentation or a receiver of some kind, we as individuals, cannot unaided, detect the presence of radio waves, microwave radiation, low intensity infrared and/or ultra violet light. Does this mean that radio, television, cellphones and remote controls do not and cannot exist? Of course it does! Such things aren't real. Fabrication and artifice that's all they are. It's all downright lies, pretence and imagination. Don't believe in them.

In a similar way, the ancients could not have imagined a world without friction, but what follows would probably gain their approval. You see I too am ancient. Picture me for a moment, a dumb old pensioner who knows more about sleeping and old-timers disease than the intricacies of a frictionless world, yet here I am attempting to describe something far beyond my own understanding. C'est la vie!

I imagine that a world without friction would be an unhandy place. Striking a match would become an interesting exercise, as without friction, matches won't light

The creation of fire would demand the development of new technologies entirely. Our imaginary frictionless world would thus be a very cold place indeed. Just swallowing food and perhaps even the act of respiration itself would demand a new set of disciplines. As for relationships, the simple action of rolling over in bed would be so fraught with danger we would probably choose to sleep alone - perhaps within high-sided and well-padded bunks. The sounds of violins, cellos and all the other stringed instruments played with a bow would never have been heard.

Sports like football, rugby, motor and horse racing and even swimming would be impossible. The Olympic Games could not exist. Mechanical devices though, would run (virtually) forever. Clothing would hardly ever wear out, although strong colours might fade significantly over time.

We couldn't walk, drive, start or stop. There would still be momentum though and should one of us to become trapped between a solid object and any significant moving mass, the results might be somewhat messy. We as a species are sort of soft you see, a bit like a bag of warm bananas and like a bag of bananas we also squish quite well!

According to "**THE FUNDAMENTUM**" friction causes wear and wear costs lots of talents, denarius or drachma (all early terms for money). It wastes energy and creates heat! What friction actually achieves is the transformation of kinetic energy into thermal energy. That is really important, something to remember. Hopefully, for those of us involved with energetic materials our understanding of friction has just become a little clearer.

Here is Constantine in the kitchen demonstrating the transformation of kinetic energy into a cooked supper.

The authors of **THE FUNDAMENTUM** understood all of the above and so recommended the use of leather, wood, papyrus or vellum for containers and non-sparking bronze, brass or copper for tooling. Leather was a common ma-

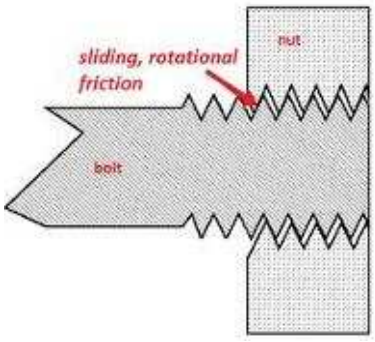
terial for the manufacture of powder scoops, funnels and containers used to measure out sensitive powders or to transfer or store energetic mixtures. Wooden shovels too were a commonplace. Damp papyrus or vellum was ideal, as like leather, it could be moulded to form shallow bowls perhaps reminiscent of today's papier-mâché egg boxes.

These essentially non-sparking artefacts and tools didn't do away with the problems caused by friction, but were simply weapons in the arsenal against it. To use them, just follow the directions on the box.

Chamois leather pockets for either feeding or dosing of flowable powders also worked perfectly. No valves, no complex pneumatic or hydraulic systems. No moving parts at all, just a narrow neck that could be manually pinched closed. Easy-peasy.

So where else does friction negatively affect us?

Screw threads for one! Screw threads are a nightmare, Screw topped bottles, wood screws, nuts and bolts all rely on



good old friction for them to work and they are everywhere. Should any sensitive energetic materials find their way onto those threads and I have to tell you that they all too often do, they create a booby trap for the unwary, Turn that screw, undo that top, rotate that bolt and the possibility of a BANG or his blood brother FLASH is ever present.

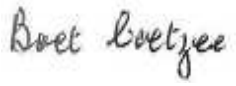
Where else? Sliding boxes or cases across floors or shelves, opening doors, (the hinges remember) rooting around in boxes of bits and pieces, (a gentleman of my acquaintance was severely injured when an old 20mm cannon projectile, long deemed inert and stored in a box of brass and steel oddments suddenly detonated). Don't forget to include grinding, screw-feeding, blending and mixing operations, especially those small, lab scale activities, or where a hand-operated mortar and pestle is involved. Horizontal and vertical conveying systems, especially those employing endless belts are also in the frame. Even roller conveyors can be sources of significant friction. Axles and rotating pulley's, worn bearings, the actions of filing, cutting, abrading, sanding, sawing too all create lots of friction and so, potentially at least, given the right set of circumstances, ignition. Vibration is also a form of friction.

Yes, I know you have done all of those things a thousand times before and nothing has happened, but ignition, as **"THE FUNDAMENTUM"** patiently explains, is subject to probability considerations. If a particular stimulus is very small the probability of ignition is also small. Small, not zero!

With larger levels of stimulation the probability of ignition increases hugely, but even here there is uncertainty; nothing in life comes with a guarantee. Maybe thus far you have simply been lucky. Luck can run-out.

Best then to treat all energetic materials as gently and as carefully as possible.

Next time: INCENDIUM



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