SAFEX NEWSLETTER
No. 32, 1st Qtr. 2010

This is your Captain Speaking

Olivier Obst – Groupe EPC

Olivier Obst is 43 years old. He started his career at the steel group Usinor (now part of Arcelor Mittal) where he worked for nearly 10 years. He joined EPC in 1998 as Managing Director of the Italian subsidiaries and later became Area Manager for the South of Europe. He was appointed CEO of EPC Group in 2008.

Regrettably we were unable to obtain a photograph of Olivier to add to his article.

People go to work to earn a living and be fulfilled and should not be exposed to hazards that may lead to serious injury or even death. A company is primarily a society of human beings. Although its aim is to grow and generate profits, its first duty is to ensure the wellbeing of the people who allow it to exist and prosper. A healthy workforce is necessary for a healthy business and therefore serves as evidence of the same.

The vision and conviction of the EPC Group is that all workplace accidents can be prevented. So a target of zero accidents has been set. To achieve this, it is vital that workers at all levels within the company are involved in Health and Safety not just the managers and safety experts. We have voluntarily chosen the long and hard way. Our belief is that safety should be a natural priority throughout the whole organisation, a natural "way of work". We have not arrived at that point - not yet.

In order for it to become natural and be sustainable we have chosen persuasion over forced implementation. This requires us to act simultaneously on 3 levels:

- Modify behaviours, to gradually implement a global and permanent state of safety awareness in the company,
- Develop and implement norms and standards which, no matter how stringent they are, will be perceived as relevant protection against hazards rather than arbitrary burdens,
- Ensure that all levels of the organisation, from top to bottom, abide by the safety system in place, make it a priority, and that management's commitment is visible.

In EPC Group, all managers and supervisors have been trained to carry out behavioural safety audits. They are required to do a minimum number of audits per month. We believe it is paramount that senior, as well as junior, management be seen as actually taking part in the implementation and continuous improvement process. This serves to demonstrate their commitment to the Group's Safety Policy. It is widely recognised, especially in our industry, that well-designed and correctly used machinery will reduce the number of accidents and incidents. However, we should always bear in mind that more than 9 out of 10 accidents and incidents occur as a result of human error, either cutting corners or doing something wrong that is perceived to be acceptable. An improvement in safety requires a CHANGE IN CULTURE. This requires, as a minimum, that the management team models safe behaviour and visibly claim ownership of the Group's Safety Policy.

Training, at all levels and on a variety of topics, is a key to improvement. A confident and competent workforce will have fewer accidents and incidents than one with low morale and low competence. Furthermore, a relevant and widely implemented training program raises standards throughout the Company. The lowest standard of work that a manager or supervisor accepts is the highest standard that his employees will work to. Managers and supervisors are expected to work permanently towards raising operating standards; provide their workforce with the means and tools both to adopt and respect these

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standards; and personally demonstrate, through their behaviour and all their actions and decisions, their own commitment to the requirements they set.

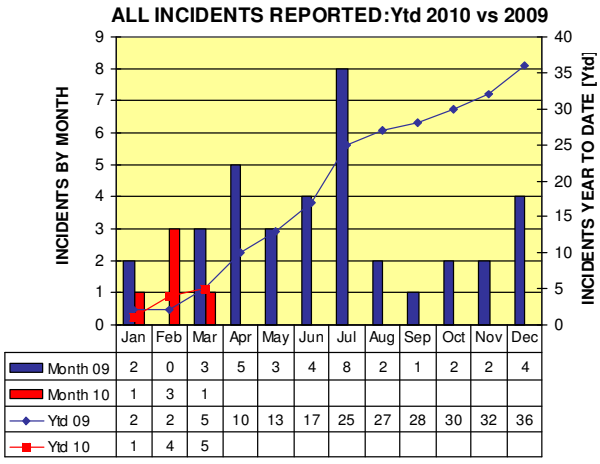
As CEO of EPC, I am in the front line when it comes to implementing higher standards of Health and Safety in our Group. Whilst it is my duty towards my shareholders to maintain and increase profitability, it is equally my duty towards the workforce of EPC to provide them with a safe and healthy work environment. As I am convinced there is no conflict between these two responsibilities, I am able to tackle them simultaneously. Although there are significant costs associated with Health and Safety, it is a prerequisite to sustaining prosperity.

Incident Reporting

Monitoring our Reporting Performance

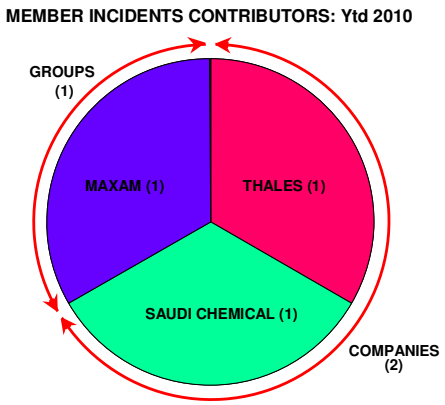
"Did you report all the explosives incidents and "near events" you had in 2009? If not, it isn't too late to do so now."

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

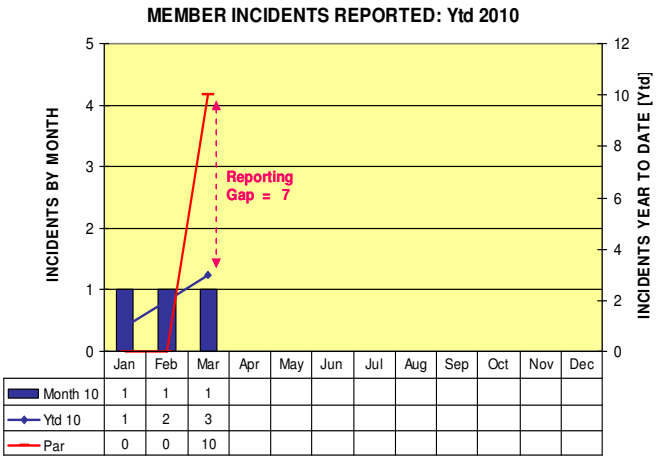


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Month 09	2	0	3	5	3	4	8	2	1	2	2	4
Month 10	1	3	1									
Ytd 09	2	2	5	10	13	17	25	27	28	30	32	36
Ytd 10	1	4	5									

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 reported. The gap between the number of MI's reported and PAR is our Reporting Gap. The Reporting Gap suggests only 30% of our MI's are being reported.



All the incidents reported. This chart compares the sum of non-member and member incidents reported to SAFEX every month this year to the previous year. 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.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Month 10	1	1	1									
Ytd 10	1	2	3									
Par	0	0	10									

Contributors of member incidents. This chart identifies those members who reported their incidents. It shows the number of incidents each of these members have reported in the context of the total number of MI's received. The chart distinguishes between Groups and Companies merely to indicate the performance of the two membership categories. Each of these categories has about the same number of operating units

Know the Expert Panel

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

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

Andy Begg

PERSONAL

Position: Director
Company: Exsar Consulting
Location: Scotland, UK
Education: BSc Chem (Hons) - Stratchclyde (1970)
Affiliations: Governor, SAFEX International
Languages: English; Portuguese (Speak)

CAREER OUTLINE

With ICI Explosives:

- Research /Development Chemist
- Explosives Research Manager
- Explosives Operations Manager
- Industrial Director Explo Brazil
- International Operations and SHE Manager ICI Explosives

With ICI Group:

- Explosives Legacy/SHE Advisor ICI Group

EXPERTISE

- Safety review of explosives operations and risk management
- Auditing
- Incident investigation
- Training

TYPICAL ASSIGNMENTS

1999 – 2009	Basis of Safety Training, Plant Safety Assessments and Systems Auditing – IEL, AEL, API, EXSA, Enaex, Britanite, Solar, IDL and Nobel Enterprises
1999 – 2007	Environmental and Safety Due Diligence exercises – North America, Mexico, India and Europe
1999 – 2000	Mine Site Safety and Distribution Safety Training – IEL
2001 – 2008	Serious incident investigations and reviews – Nobel Enterprises, API and Orica
2002	Explosives Safety Awareness Training – ICI Explosives Environmental USA
2007	Explosives safety training for HSE Explosives Inspectors UK
2004 - 2008	Risk Assessment training API
2006 - 2007	Hazard Studies on new emulsion plant and cast booster plant API
2008	Expert opinion in fatal incident
2009	Paper on Emulsion Hazards, training in emulsion hazards and pumping hazards. Hazard Study Leader training

Expert Panel: Board approves two additions

At its recent meeting in Orlando, FL, the SAFEX Board of Governors approved the nominations of two more Expert Panel members. While we will publish their complete profiles in due course, readers may be interested in some preliminary information about them:

Dr Jack Hedger's expertise lies in electric and non-electric detonators and delay pyrotechnics. He has been involved with building new detonator plants as well as a pyrotechnics plant. He worked for the ICI family in South Africa and Australia before joining the Institute of Explosives Engineers (IExpE) in 1994. He retired to France near Nice and is currently involved with a new detonator plant to be built in China.

Horst Marz has been described as a "very gifted and knowledgeable mechanical engineer". He wrote the pump manual for ICI Explosives, perfected a safer PC pump and is well connected to several pump manufacturers. He also designed automated detonator assembly machinery. Horst is now the Engineering Manager for Unicast Technologies in Montreal, Quebec where he is responsible for die casting machinery and tooling.

Feedback from the Boardroom

The SAFEX Board of Governors met in Orlando, FL on Sunday, 07 February 2010. The focus of the Meeting was a review of the SAFEX Strategy. Another important meeting objective was to set the stage for the next SAFEX Congress. Regarding the Congress the Board decided that the XVII SAFEX Congress in 2011 will be held from **Wednesday, 25 May to Saturday, 28 May 2011** in **Istanbul, Turkey.** The pre-Congress activities will commence on Monday, 23 May and run through to Wednesday, 25 May 2011. The planning framework for the Congress was communicated to members earlier this month in Congress Bulletin no.1. Please contact the Secretariat for a copy.

As the Strategy Survey in which members participated was an important feature of the Board Meeting, we will concentrate on the results of the Survey in this edition of the Newsletter. Subsequent editions will elaborate on the elements of the Strategy which the Board developed.

Members make their views known in the Strategy Survey

A one page questionnaire was sent to all SAFEX and Expert Panel Members towards the end of last year. The intention was to give Members the opportunity to give the Board of Governors input on the following specific questions:

1. What benefits does SAFEX provide that makes your Company want to be a SAFEX member?
2. What are the most important health, safety and environmental (HS&E) challenges facing your organisation in the future?
3. Do you believe SAFEX can assist with those challenges and how?
4. What other organisation provides the same benefits as SAFEX?
5. If you could make one change to SAFEX what would it be?

We had a 40% response to the questionnaire for which the Board was most grateful.

Members' views: Benefits of SAFEX membership

In their rating Members placed the incident information SAFEX provides as the most important benefit. This was followed by information about good explosives practices. After that the opportunity to network with other members and events such as the Congress and proposed Interim Event were rated equally. Additional benefits, in no particular order, include:

- Training - especially the proposed development course
- The potential of the Workgroups to provide good practices based on the best available expertise
- Panel of Experts that can be accessed if needed
- Newsletter
- Help with corporate social responsibility obligations
- Opportunity to benchmark performance; standards
- HS&E Awareness

Members' views: HS&E challenges for the industry

Members identified challenges peculiar to their companies in addition to industry-wide challenges. The industry challenges can be summarised as follows:

- **Training** of personnel especially with the downsizing and loss of experience in many companies; Training at both supervisory and operational levels; Preservation of corporate memory and transferring this to 'new' members of the team; Improving safety culture within organisations; sensitising employees to safety issues; foster employee ownership and goal setting to improve safety; awareness and knowledge of explosives safety as opposed to OH&S mainstream safety
- **Standards and systems**. Updating of standard operating procedures; Process safety management (PSM) systems development; Downsizing organisations while retaining good HS&E standards in difficult economic conditions; Maintaining safety in the face of growth and the introduction of new processes and technology
- **Sustainability and Environmental issues**: Managing waste and effluent in an environmentally sustainable manner. Developing models of best environmental practice for the industry; Decommissioning of redundant assets; Demilitarisation of old ammunition; Cleaning-up TNT contamination; Identifying and addressing legacy issues; Reducing water and power consumption; Measuring and controlling Greenhouse Gasses (GHG) emissions; Eliminating lead salts in detonator manufacture; Designing and manufacturing 'greener' products; Responding to societal pressures to reduce our impact on communities and demonstrating our security, safety and environmental responsibility (i.e. maintaining our 'licence to operate').
- **Risk**. Managing risk rather than consequence – incorporates risk analysis; hazard studies; quantitative risk assessment; Reducing direct exposure of workers to explosive operations - automation;
- **Cradle to grave responsibilities.** Inspire all 'handlers' of explosives especially on customer sites to understand and practise the principles of explosives basis of safety
- **Regulatory environment**: Increased regulatory pressure; SEVESO 2; REACH (a new European Community regulation on chemicals and their safe use); Dealing with regulators with reduced overall knowledge base of the industry; Managing transport laws (Test Series 8 as it applies to emulsions); transport of explosives, AN and ANE; Tracking and tracing of explosives devices.

Members' views: Organisations offering same benefits

Members pointed out that SAFEX was the only organisation focussed exclusively on explosives HS&E. While many other organisations such as industry groups emphasise HS&E it is merely part of their portfolio. Furthermore, other organisations are regional and none takes the global view SAFEX does. It results in these organisations understandably having a strong regional HS&E focus especially as regards local regulations.

It was gratifying to note that members appreciated the HS&E contribution Associate Members of SAFEX such as FEEM, IME, ISEE, EASSP, NIXT, VISFOTAK, AEISG and JEIA make. Other "non-explosives" groups that were acknowledged included: US Chemical Safety Board, AIChE, the Explosive Industry Group based at CBI London, National Fire Protection Association (NFPA) and Swiss Society for the Chemical Industry (SGCI).

Members' views: What will you change in SAFEX?

Some members felt there should be no change to SAFEX in case it moves in the wrong direction. Others suggested improvements like:

- Develop a generic, global HSE management framework that all member companies can adopt and verify that their current management system embodies good practice
- Adopt an industry metric - be it Recordable Rates, Fatalities etc – we can use to establish whether SAFEX is able to help improve the overall HS&E performance of its members and the global industry
- Include the international harmonisation of explosives security requirements and standards to ensure the lack of it does not have a negative impact on the Public and our industry. Security failures will lead to public harm. Safety and Security are inextricably linked
- SAFEX has focussed only on explosives. Consider including TGAN as our Articles of Association makes provision for the manufacture of raw materials dedicated to explosives to be part of SAFEX.
- Continue to develop and improve links with regulatory bodies and authorities
- The Workgroups are a great idea but we have seen very little output from them. We are particularly keen to see what the Transport and Emulsion Workgroups will produce. They should be expanded and be encouraged to produce good practice guides

- Many members have done a lot to improve the quality of their Investigation Reports. We need more in-depth information and recommendations from the safety incidents as well as tracking the effectiveness of measures incorporated after incidents
- Improve the Newsletters by including examples of good practice; statistics and trends; topics for safety meetings; etc.
- Consider more frequent meetings, issue specific meetings possibly at regional level. Establish regional chapters in other countries. Encourage more military explosives members to join. We need to attract more industry players especially from India and China.

Interim Event: On track for after 2011 Congress

Members' response to an explosives operations management development training course as the first interim event after next year's Congress was very positive. As a result the Board asked the Sub-Committee it established to develop a syllabus for such a course. The Sub-Committee identified the target population and training needs it should address. Two courses are proposed: The first will cover the fundamentals of HS&E in explosives operations and deal with a lot of its theoretical aspects. By covering the essential principles of explosives operations, this course will provide explosives managers and supervisors with the necessary background for their work. It should also be useful to managers at all levels who are new to the explosives industry. The second Course will build on the first Course and concentrate on effectively applying the HS&E fundamentals in explosives operations. The Sub-Committee has identified a framework for the content of both Courses and will meet later in the year to finalize the Course syllabi, define the resource requirements and indentify possible facilitators and sources for the Course materials.

The Sub-Committee wants to have a complete outline of the Courses available by next year's Congress in order to introduce it to members. Please note the Courses will not be presented at the Congress but later as an interim event between Congresses.

Research Notes from CERL

Demonstrating the Effects of Detonating Small Quantities of Explosives Inside Magazines

Dr Phil Lightfoot

Introduction

In most jurisdictions, the safe distance between an explosives magazine and vulnerable structures such as occupied buildings is determined using quantity-distance (Q-D) tables (e.g., [1,2]). In Canada, these tables are based on the NATO Q-D tables; the approaches used in other countries vary. The tables are fairly straightforward to use for large quantities of explosives, where the distances are largely based on overpressures. However, for small quantities of explosives, the hazards due to overpressures drop quickly and fragments become relatively much more of a concern. The issue of appropriate safe distances for explosives quantities below about 50 kg is quite problematic in practice; if fragments can be contained, safe

distances can be small, but it is difficult to ensure that fragments would be contained. Explosives storage magazines are solidly built structures designed to protect their contents from theft, fire and projectile impact. However, despite appearances, magazines are not designed to contain the effects of accidental detonations. Incidents around the world where explosives have detonated inside buildings, either accidentally or by design, have demonstrated that even a relatively small explosion inside a structure can completely destroy it and potentially create very dangerous fragments.

There are many of applications where relatively small amounts of explosives are used on an ongoing basis, requiring the safe and secure storage of limited quantities of explosives. Examples include construction, demolition, law enforcement and the manufacture of perforating guns for the oil and gas industry. In such cases, it can be difficult from a regulatory point of view to ensure the safety of the public while not imposing a burden on the industry. In some sectors where fairly small amounts of explosives are used, the consequences of an accidental detonation in storage are not always well understood.

This article briefly describes two trials we performed in Canada in December 2009, demonstrating the effects of detonating relatively small quantities of high explosives in a magazine, with fairly spectacular results. The trials were primarily intended for educational purposes, to underline the need for adequate distances from explosives storage to vulnerable targets.

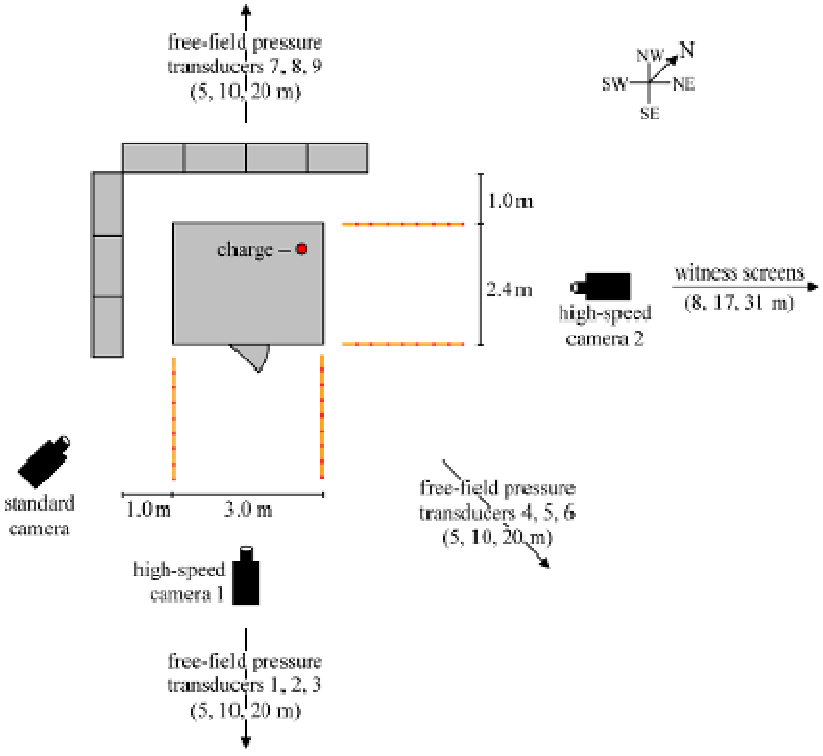


Figure 1: ***Plan view of the test site for Trial 1.***
The icon for each camera indicates its direction of view rather than its actual position. The yellow bars represent striped wooden stakes placed near the magazines as a reference for distance measurements.

Experimental

In Canada, like elsewhere, we have very specific design standards that a structure must meet to be licensed as an explosives storage magazine [3, 4]. The magazines used in the present testing were based on two different standards which are summarized below:

- Type 4 magazines are fabricated from 6-mm metal plate. The walls shall contain at least 7.6 cm of bullet-resistant material and the roof must be 4.7-mm or heavier metal plate.
- A Type 2 magazine is a wood-frame building using 5 x 15 cm studs and sheathed and roofed with metal-reinforced lumber or plywood and lined with wood. The space between the studs is filled with bullet-resistant material. The walls and roof are metal clad to provide fire-resistance.

Both trials were instrumented with free-field pressure transducers, as well as standard and high-speed video cameras. Fragmentation was also evaluated using aluminum witness panels. Large metal fragments were mapped, weighed and photographed manually

Trial 1

A plan view of the test site for Trial 1 is shown in Figure 1. Figure 2 shows the magazine used in Trial 1, a Type 4 (Metal Plate) structure with exterior dimensions 3.0 x 2.4 x 2.2 m (L x W x H). The body of the magazine stood on two 0.2-m rectangular metal beams. The door was centred in one of the longer walls. The roof was slanted slightly so that the door side was 0.20 m higher than the rear.

An L-shaped wall of concrete blocks was constructed 1.0 m away from two of the walls of the magazine, in order to evaluate the effectiveness of such an

inexpensive structure as a barricade. The wall is visible extending past the sides of the magazine in Figure 2. Each block measures 0.6 x 0.6 x 1.2 m and weighs approximately 1000 kg.

The explosive charge consisted of 5 kg of pentolite boosters. The charge was placed in the north corner of the building, 0.5 m from the walls and was raised 1.0 m from the floor, to simulate a roll of detonating cord on a shelf in the magazine.

Trial 2

A plan view of the test site for Trial 2 is shown in Figure 3. Figure 4 shows the magazine used for Trial 2, a Type 2 (15 cm Stud-Frame) structure with exterior dimensions 4.9 x 3.0 x 2.6 m (L x W x H). The body of the magazine stood on two 0.15-m square metal beams. The door measured was centred in one of the smaller walls. To facilitate identification of fragments after the shot, each wall was painted with stripes of a different colour.

An L-shaped wall of concrete blocks was constructed 1.0 m away from two of the walls of the magazine. The wall is also visible extending past the corners of the magazine in Figure 4.

The explosive charge for Trial 2 consisted of 20 kg of pentolite. The charge was placed in the north corner of the magazine, 0.5 m from the walls, and was raised 1.0 m from the floor, to simulate a case of boosters resting on a shelf in the magazine.

Results

Trial 1

The magazine failed to contain the explosion and was demolished completely, as shown in Figure 5. The plywood panels inside the magazine were reduced to small pieces which were not carefully surveyed. The metal outer

Figure 2: ***Exterior view of the magazine used in Trial 1***

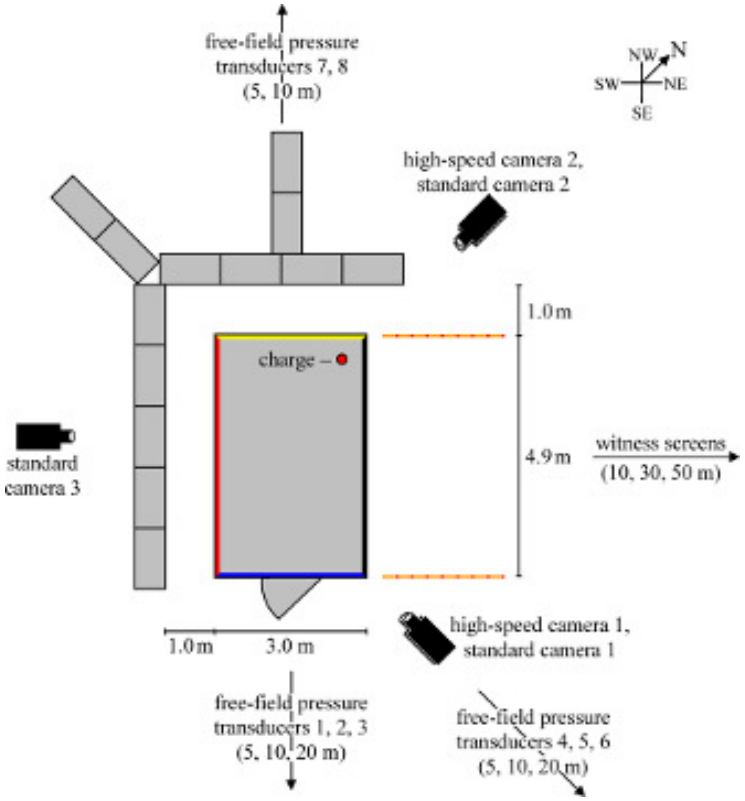


Figure 3: ***Plan view of the test site for Trial 2.***
The camera icons and yellow bars are used as in Figure 1.

Figure 4: ***Exterior view of the magazine in Trial 2***

Figure 5: ***Ground zero, Trial 1, viewed from the east.***

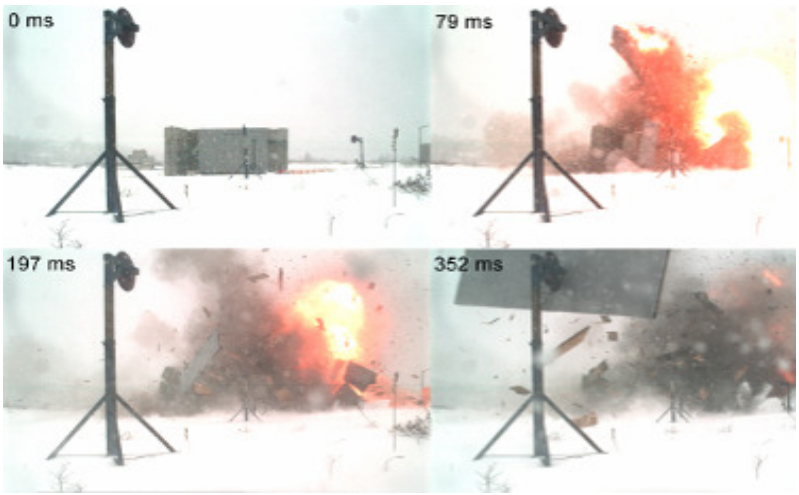


Figure 6: ***Four frames from the video recorder by high-speed camera 1 during Trial 1.***

The roof is visible at the top of the frame marked 79 ms, and the NE wall can be seen emerging from the fireball at the right side of the frame marked 197 ms. The frame marked 352 ms show the magazine door colliding with a free-field pressure transducer.

Figure 7: ***Ground zero, Trial 2, view from the east.***

The brown material spread over the snow is sand from the magazine walls.

structure came apart at the seams to form eight major steel fragments, namely the base, the roof, the door, and five wall fragments. Each piece was heavily distorted by the force of the blast. The base remained at ground zero, though it was rotated and displaced several metres from its original position. Two walls were also found at ground zero, having been effectively contained by the concrete block wall, which was knocked over by the force of the blast. Parts of the other walls travelled up to 30 m, and the door was found over 50 m away. The roof, weighing 269 kg, traveled the furthest, coming to rest 131 m from its original location. The high-speed video recording clearly showed the door, walls, and roof flying away from the magazine, as illustrated in Figure 6. Analysis of the video data indicates initial velocities of the roof and wall fragments of around 80 km/h, with the 108-kg door initially travelling at over 200 km/h.

Trial 2

The second magazine also spectacularly failed to contain the explosion and was reduced to the pile of wreckage shown in Figure 7. Fragments of the wooden inner structure of the magazine did not, in general, travel far from ground zero and were not carefully surveyed. The fragmentation pattern was very different from that observed in Trial 1. The Type 4 magazine used in Trial 1 was a sturdy 6-mm steel plate structure with non-structural wooden components inside, and broke into eight large, readily identifiable metal fragments. In contrast, the Type 2 magazine used in Trial 2 was a wooden structure clad with at least twenty separate sheets of 3-mm steel. During the blast these sheets came apart at the seams and folded into convoluted shapes, creating fragments that were difficult to trace to a specific point in the original structure. Fortunately, the spray paint markings could be used to identify at least which side

of the magazine each fragment came from. The base of the magazine remained at ground zero, though it was rotated and displaced several metres from its original location. As in Trial 1, the concrete block wall was knocked over by the blast, but it still prevented any metal fragments from escaping on the protected sides. Most of the sheet steel fragments from the walls of the magazine adjacent to the concrete blocks were retained at ground zero. Large metal fragments from the roof and other walls were found as far as 135 m from ground zero. The 71-kg door travelled exceptionally far, as it cartwheeled away on its edges; it was eventually located 313 m from ground zero by following a line of impact craters that were formed in the snow. The high-speed video recording again provided a good view of the door and roof flying away from the magazine. The initial velocity of the roof was close to 500 km/h (!); that of the door over 200 km/h. Note that the initial velocity of the door in Trial 1 was similar to that in Trial 2, so the distance travelled by the door in Trial 1 could presumably also have been much more than the 50 m observed if the door had also struck the ground in a fashion to allow it to continue on in a cartwheeling motion.

Discussion

In this article we have provided a brief summary of this very recent work, along with the key results. We plan to write up and publish the work more fully in the near future.

The results vividly demonstrate that explosives magazines, while designed to resist fire, break-in, and projectile impact, do little to protect against the effects of even small detonations occurring within their walls. It is well known that it is very difficult to contain an explosion. For example, our blast chambers at CERL are made of at least 19-mm steel and are only rated to a few kg of high explosives.

In both trials, extremely dangerous large metal fragments were propelled well beyond 100 m. This figure is significantly greater than the value of 30 m specified in Canada's Quantity-Distance manual for the distance the nearest process building must be from a magazine containing up to 50 kg of high explosives [1, 2].

Of particular interest was the behaviour of the magazine doors in these trials. There are standards for magazine doors in Canada that are designed to ensure that magazines are difficult to break into [3]. The resulting doors are very sturdy, as demonstrated by the fact the doors remained intact in both trials, creating heavy, high-velocity projectiles.

In both trials, concrete block walls were shown likely to be an effective means of protecting the area surrounding a magazine from some fragments created by an explosion. In both cases, the wall collapsed, but not before preventing any major fragments of the facing magazine walls from escaping the blast site. However, it should be noted that the current trials were for demonstration purposes only, so the concrete block walls do not represent an optimized or recommended solution. Furthermore, a concrete block wall does nothing to protect against fragments originating from the roof of a magazine, which in both trials were observed to be particularly dangerous. For example, the large roof fragment in Trial 1 landed on the far side of one of the concrete block walls.

In conclusion, these trials demonstrate how even fairly small amounts of high explosives could create very dangerous fragments in the event of a detonation inside a storage magazine. When siting magazines with low explosives loadings close to vulnerable structures, very careful consideration needs to be given to mitigating the risk associated with such fragments. In particular, in such cases, it is not sufficient to use barricades to contain fragments from the walls of the magazine, as very dangerous projectiles can be generated from the roof of the magazine also.

Videos

With this sort of work, we find that video clips, particularly high-speed clips, are very useful. In addition to providing a very graphic illustration of the dynamic event, they allow us to extract much useful information that would be otherwise very difficult to obtain, such as the initial velocity of large fragments, or fireball size. Recognizing that video clips might be of interest to the SAFEX community, they have been uploaded onto the SAFEX website as Windows Media files. You can access them by clicking on the following links or copying and pasting it in your browser:

Click here to download videos of:

Trial 1 (11 MB): http://www.safex-international.org/VIDEO/video-magazine-trial-1.wmv

Trial 2 (29 MB): http://www.safex-international.org/VIDEO/video-magazine-trial-2.wmv

The clips are fairly large, so it might be advisable to download them and run them on your own computer, rather than running them directly. If you have difficultly in downloading the files, we would be happy to provide copies on CD; send an email to Phil Lightfoot at plightfo@nrcan.gc.ca. Please note that the clips are copyrighted and are provided for information purposes.

Acknowledgements

The magazines used in the trial were kindly donated by the Austin Powder Company.

References

[1] http://www.nrcan-rncan.gc.ca/mms-smm/expl-expl/qua-eng.htm
[2] Quantity-distance Principles, User's Manual, Explosives Branch, Natural Resources Canada, 1995.
[3] Storage Standards for Industrial Explosives. Natural Resources Canada, Explosives Regulatory Division, 2001.
[4] Magazine Standards for Blasting Explosives and Detonators, Second Edition. Natural Resources Canada, Explosives Branch, 1982.

Our Explosives Regulatory World

Mobile Explosives Manufacturing Units (MEMU's) in ADR

Ben Barrett

Ben Barrett, an Expert Panel member, is an independent consultant specializing in regulation of explosives. DG Advisor, Ben's consultancy, is dedicated to participation in the development and modification of international dangerous goods regulations and helping clients comply with US and international regulations. Ben also provides training in the handling of dangerous goods including that required by ICAO.

In Europe, "hazardous materials" are called "dangerous goods" and quad trucks or mobile manufacturing units are called MEMU's – mobile explosives manufacturing units. These are covered by the ADR, which is L'Accord Européen Relatif Au Transport International Des Marchandises Dangereuses Par Route. In English it is the European Agreement Concerning The International Carriage of Dangerous Goods by Road. The ADR is closely based on the UN Model Regulations, however like any modal regulation, it layers on specific requirements applicable to the mode, in this case road.

Over and above boilerplate requirements, MEMU's get special treatment in ADR in two places. Chapter 6, which covers requirements for construction and testing of bulk and non-bulk packagings, has a dedicated sub-chapter for MEMU's. Secondly, Chapter 9 on the construction and approval of vehicles also has a

dedicated sub-chapter for MEMU's. This article elaborates the requirements of these two sub-chapters for bulk explosives trucks.

Note 2 of ADR Chapter 6.12 explains that some of its requirements may be used instead of other requirements for Chapter 6 on packaging. This applies to tanks, bulk containers and special compartments intended for the carriage of dangerous goods on MEMU's. Tanks must meet the standard tank requirements. Bulk containers must meet the requirements for type BK2. When a single tank or bulk container contains more than one substance they must be separated by two walls with a drained air space between them.

Chapter 6.8.2.1 covers the general requirements for construction of tanks. The following requirements apply to tanks of 1,000 liters or more. Per 6.8.2.2.7, tanks intended for the carriage of liquids having a vapor pressure of not more than 110 kPa at 50°C and a boiling point of more than 35°C, or just a boiling point less than 35°C, must have a safety valve. MEMU regulations require that where a safety valve is required, the tank must also have a bursting disc or alternative means of pressure relief approved by the competent authority (CA).

Tanks with other than circular cross-section can't have the permissible stress calculated by the method in 6.8, and this may instead be demonstrated by a pressure test approved by the CA. MEMU's are not subject to many requirements in 6.8, including shell thickness calculations or construction in accordance with technical codes or standards. Instead they have prescribed thicknesses as follows:

Material	Minimum Thickness
Stainless austenitic steels	2.5 mm
Other steels	3.0 mm
Aluminum alloys	4.0 mm
Pure aluminum of 99.8%	6.0 mm

Tanks do not need to be marked with the tank code and special provisions as applicable.

The following requirements apply to tanks with a capacity of less than 1,000 liters. Weld quality and steel strength do not need to meet the same requirements as those on larger tanks. Welds must still be skillfully made by a process which has been demonstrated by test. Unlike larger tanks, the fittings and accessories on the upper part of the tank do not need to be protected against damage in a rollover. The shell thickness requirements are the same as for larger tanks. Small tanks are not subject to the general leakproofness testing or visual inspections for conformance to type in 6.8.2.4. However they are subject to periodic inspections by the owner; visual internal and external examination and leakproofness testing is required at least every 3 years. General requirements for type approval and marking do not apply.

The following requirements apply to equipment for all sizes of tanks. Bottom discharges of UN 1942 and UN 3375 must have two closures, one of which may be the product mixing or discharge pump or auger. Any piping after the first closure shall be of a meltable material (e.g. rubber hose) or have meltable elements. To avoid leaks from external pumps or pipes in an accident, the first closure must be protected against or designed to withstand external impacts. Filling and discharging flanges or plugs and caps must be securable against unintended opening. Venting systems on tanks for UN 3375 may be substituted by "goose necks" which are protected against damage by external forces.

IME SLP 22 containers are commonly used in the US to transport detonators and assemblies on the same truck as Compatibility Group D materials. In Europe they are termed "special compartments for explosives". For MEMU's, these must be designed to prevent detonation propagation between these products. This is achieved by the use of separate compartments or a special containment system. In either case, the segregation must be approved by the CA. Metal inside the compartment must be covered with materials providing suitable fire resistance (including Class B-s3-d2 in the European standard EN 13501 1:2002). The compartments must be located on the vehicle where they are protected from impact in case of accident, rough terrain, incompatibility with other dangerous goods on board and ignition sources such as the vehicle exhaust.

Chapter 9.8 gives additional requirements concerning the construction and approval of MEMU vehicles. Metal or fiber-reinforced plastic packages must be bonded to the chassis. Metal contact enabling electro-chemical corrosion or reactions must be avoided. Stability requirements state that the width between tire bearing surfaces on an axle must be at least 90% of the height of the laden center of gravity. In a combination vehicle, the weight on the axles of a semi-trailer shall not exceed 60% of the entire combination vehicle.

The rear bumper of sufficient resistance must cover the full width of the tank at the rear of the vehicle. The tank must not be closer than 100mm to the bumper. Tilting shells may have alternative means of collision protection, and MEMU's which have machinery or piping without dangerous goods need not comply with the rear bumper requirement.

Combustion heaters are allowed when meeting special requirements. ADR requires that MEMU's have automatic fire extinguishers for the engine compartment. Thermal shields must be provided to protect the load against tire fires. Process equipment and special compartments must be fitted with locks

Explosives Eco-talk

The impact explosives and explosives manufacture has on the Environment fall squarely in the SAFEX domain. We are as interested in the experiences members of the SAFEX community (Members, Associates and Expert Panel) have in minimising explosives' environmental impact as in safety and health. While most of our explosives incidents concern the safety and health impact, we are eager to learn about the environmental side of our activities. By way of this Feature we 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.

Combination of Bioremediation Strategies as a Tool for Efficient Biodegradation of Explosives

Dr Olga Muter

We are indebted to **Dr. Olga Muter** from the Institute of Microbiology & Biotechnology, University of Latvia for this article and for Hans Wallin from KCEM (Associate Member of SAFEX) who kindly arranged it for us.

Soil contamination with explosives is a serious environmental problem worldwide. 2,4,6-trinitritoluene (TNT) is one of the most commonly used explosive for military and industrial applications. Nitroaromatic explosives and their transformation products have toxic, carcinogenic and mutagenic properties.

The aim of our work is to test various bioremediation strategies in order to work out the most efficient way for TNT degradation in soil. This study, financially supported by the Ministry of Defence, the Republic of Latvia, was started in 2004.

At the beginning of this work, field inspection and soil sampling was performed at Adazhi military camp. The demolition sites were used as the main source of the microorganisms with explosives-degrading activity (Figure1). Microorganisms were isolated and characterised. Afterwards, the best isolates were tested for their activity in the presence of various explosives.

Technological solutions on soil

Figure1: ***Sampling site at the military camp***

remediation embrace a wide spectrum of approaches in various combinations in order to achieve the most efficient biodegradation result and to prevent further contaminant dissemination. To choose the most appropriate solution, it is necessary to take into consideration the specific characteristics of the site to be cleaned up. Among them are soil properties, climatic conditions, content and history of contamination etc. Combination of biotechnological approaches is a crucial moment for the process of biodegradation. Three large groups of tools are known to achieve the most efficient process, i.e. biostimulation, bioaugmentation and phytoremediation. Experiments were performed at laboratory and pilot scale, as well as under field conditions. Pure TNT and RDX were kindly provided by the National Armed Forces. Besides, a brown powder (remaining from the partial detonation of munition), which was sampled at the military polygon, was further identified by HPLC as a mixture of nitroaromatic compounds and used for plant toxicity and bioremediation studies (Figure.2).

Biostimulation, i.e. addition of nutrient amendments to soil was used in this study. In particular, cabbage leaf extract was shown to be efficient in biodegradation process [1,2]. Besides, addition of buffered salt composition to the soils contaminated with nitroaromatic compounds, resulted in decrease of redox potential, which is known to play an important role in the degradation of explosives [3].

Bioaugmentation, i.e. addition of microorganisms with explosives-degrading activity, could noticeably promote the process of biodegradation, especially at the initial stage of soil treatment. However, there are many factors in contaminated soil, which influence viability and activity of the amended microbial biomass, e.g. soil type, pH, moisture, content of contamination, climatic conditions, indigenous microorganisms etc. Inoculation of soil samples with a mixture of bacterial isolates had a strong effect on microbial community composition revealed by 16s rDNA-DGGE analysis. Several bacterial strains presented in inoculum became dominant in TNT and RDX amended samples [3].

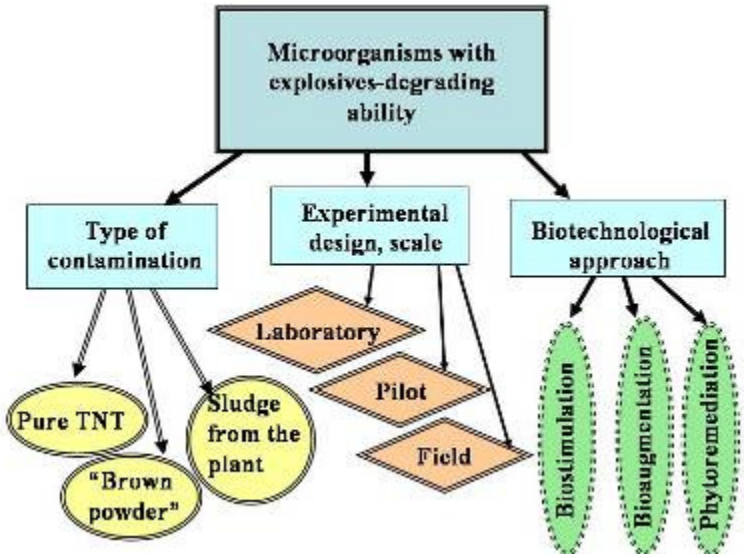


***Figure 2**: Combination of experimental tools for testing of microorganisms with explosives-degrading activity.*

Phytoremediation (use of plants to treat environmental problems - Ed) is known to be an efficient tool for soil treatment. In this study, higher plants were used as test-organisms in toxicity evaluation, as well as additional approach for soil treatment. Visual inspection of flora distribution near detonation crater at the military polygon provided the additional information on plants resistance to toxic nitroaromatic compounds. For example, *Koeleria glauca* was the sole plant species, which grew close to detonation crater in the medium coarse sandy soils contaminated by explosives (Fig.1). This fact could indicate to the resistance of this plant to nitroaromatic compounds and further use in phytoremediation process [4]. This finding requires a further investigation. Further experiments with *Koeleria glauca* could provide additional data on a resistance mechanism of this plant, which plays a "pioneer" role in the soils have been freshly contaminated by explosives.

The study on optimisation of bioremediation approaches in the context of explosive-contaminated soils is supposed to continue in future, taking into consideration the findings mentioned above, as well as using new methods. The experiments will be done under laboratory conditions and in the field.

References

1. Muter O.; Versilovskis A.; Scherbaka R., Grube M.; Zarina Dz. Effect of plant extract on the degradation of nitroaromatic compounds by soil microorganisms. J. Ind. Microbiol. Biotechol. 2008, 35: 1539-1543.
2. Grube M.; Muter O.; Strikauska S.; Gavare M.; Limane B. Application of FT-IR for control of the medium composition during biodegradation of nitro aromatic compounds. J. Ind. Microbiol. Biotechol. 2008, 35: 1545-1549.
3. Limane B., Juhanson J., Truu J., Truu M., Muter O., Dubova L., Zarina D. Changes in microbial population affected by physico-chemical conditions of soils contaminated by explosives. In: "Current Research Topics in Applied Microbiology and Microbial Biotechnology", Ed.Antonio Mendez-Vilas World Scientific Publishing Co. 2009, 637-640.
4. Dubova L., Limane B., Muter O., Versilovskis A., Zarina D., Alsina I. Effect of nitroaromatic compounds to the growth of potted plants. In: "Current Research Topics in Applied Microbiology and Microbial Biotechnology", Ed.Antonio Mendez-Vilas World Scientific Publishing Co. 2009, 637-640.
5. Dubova L., Limane B., Muter O., Versilovskis A., Zarina D., Alsina I. Effect of nitroaromatic compounds to the growth of potted plants. In: "Current Research Topics in Applied Microbiology and Microbial Biotechnology", Ed.Antonio Mendez-Vilas World Scientific Publishing Co. 2009, 24-28.

Perchlorate contamination from explosives: Out of court settlement

Peter Costa

This article written by Peter Costa, Editor of the Westford Eagle, GateHouse Media, New England USA was posted on the internet on 20 Jan 2010. We thank Peter for permission to reproduce it in its entirety. It provides a real-life example of how explosives can contaminate the environment and result in possible litigation and adverse publicity. (http://www.wickedlocal.com/westford/news/lifestyle/health/x745469016/Perchlorate-agreement-reached)

For years, an underground plume of perchlorate has been advancing silently toward Westford's well water like some monster from a Japanese horror movie. Now, a recent legal agreement may help clean up the polluted water. The town of Westford and Maine Drilling and Blasting have agreed to a settlement in connection with the release of perchlorate from the Town's Highway Garage site, according to a statement released last Wednesday by the town.

"The Board of Selectmen and I are pleased that Maine Drilling and Blasting agreed to share the costs of cleaning up the perchlorate plume," Town Manager Jodi Ross said in an e-mail to the Eagle after the statement was released. "The cleanup process has been underway for a couple of years now, and will continue for the next several years too." Both parties agree that their and the public's interests will be better served by expending resources to address the perchlorate contamination, rather than in protracted legal proceedings resolving who is responsible for the clean up. "In good faith, Maine Drilling & Blasting has agreed to contribute to the Town $1 million to facilitate this clean-up," according to the statement.

The US Environmental Protection Agency (EPA) defines perchlorate as a water-soluble chemical made up of "salts of ammonium, potassium, magnesium or sodium." It is used in rocket and missile fuel, certain fireworks, blasting devices used for development, automobile air bag inflators, in leather tanning, and as an additive in 'lubricating oil. According to the EPA, when perchlorate is used in a blasting operation, the granular residue can leach into underground aquifers or into surface water, depending on the soil type in the vicinity.

Blasting operations occurred at the Westford site for the purpose of constructing a new municipal building, the Westford Highway Department Garage at 28 North St., the town statement said. The site is surrounded by a number of active and inactive rock quarrying operations, which have presumably used a variety of explosive materials for decades. The Massachusetts Department of Environmental Protection (MADEP) alleged that perchlorate had been released to the environment as the result of blasting for the garage using explosives containing perchlorate. The town statement said, "at the time Maine Drilling & Blasting blasted at the Highway Garage, perchlorate was not regulated by the Massachusetts DEP as a hazardous substance. Moreover, the explosives manufacturer did not warn Maine Drilling that there was any risk of ground water contamination associated with

these products. MD&B immediately removed explosives with perchlorates from their inventory as soon as the MADEP identified its regulatory concerns."

As a result of the discovery of perchlorate contamination found in the Cote Well, a public water supply owned and operated by the town, both the Town of Westford and Maine Drilling & Blasting were identified as Potentially Responsible Parties in separate Notices of Responsibility (NOR) issued to each in October 2007 by the MADEP. Since the issuance of the NOR to Westford, according to the town statement, the town has incurred response action costs consisting primarily of the services of a licensed site professional, the construction of a waterline, source area treatment, and providing bottled water to affected residents. Westford has determined that additional response actions, consisting primarily of constructing, operating and maintaining a water treatment facility for the Cote and Stepinski public water supply wells owned and operated by the Town will be necessary to address perchlorate contamination and to protect the town's public drinking water supply. Settlement funds will be utilized to further these initiatives.

"These funds will help offset prior and future costs related to the remediation effort," Ross said. "The $1million will not cover the total costs, however. Some of the costs we are presently incurring also relate to upgrading the public water supply. "It is unknown what the total costs will be as that is dependent upon when the perchlorate levels drop below DEP safe-drinking water standards," Ross said. "We are doing everything we can to protect the town's private and public drinking water, and this settlement certainly helps."

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.

Forklift truck punctures explosives containers

SAFEX was notified of an incident in which a harbour employee was using a forklift to load cardboard barrels containing water-wet PETN onto a truck at a port. He punctured one of the barrels causing a spill of the PETN on the wharf.

Maurice Bourgeois (GD-OTS Canada) commented:
Our forklift trucks have steel forks with brass cladding. There are two advantages with these forks:

1. The tip of the fork is much thicker because the 0.125" bottom and top cladding increases the tip thickness by at least 0.25", if not more, thereby reducing the probability of puncturing the containers.
2. Brass is non-sparking and has lower coefficient of friction than steel. It is not 100% proof against accidental ignitions but it is putting the chances on your side to prevent ignitions.

Explosives must have "No place to Hide"

It was reported to SAFEX that while workers were working on the floor of a building in a PETN plant, a cement mortar slab exploded. It is suspected that dissolved PETN had leaked into the floor and accumulated at the spot where it re-crystallised.

Maurice Bourgeois (GD-OTS Canada) commented:
As you mentioned migration of contaminants during cleaning operations is critical. Crevices, cracks and cavities must be filled. Also concrete or mortar should be sealed with a good coating which will resist chemical and thermal attack during wash-downs. PETN is a tough customer and care should be taken to prevent infiltration in cracks and soaking of porous concrete with PETN laden wash water.

Safety Snippets

BAE systems fined after explosion kills Lancashire worker

Andy Begg sent us this HSE Release (no. HSE/NW/038BAE) dated 14 Jan 2010 and we publish it with acknowledgment to the UK HSE. Andy points out "This is a warning shot regarding management responsibility. It is interesting that although they did not find the root cause, they still nailed the management. A good investigation will frequently identify other safety management issues in addition to those directly associated with the incident in question."

A leading global defence company has been fined £80,000 after a worker was killed in an explosion at its Lancashire site.

The Health and Safety Executive (HSE) prosecuted BAE Systems Land Systems (Munitions and Ordnance) Ltd following Lynda Wilkins' death at the company's explosives plant on Central Avenue in Chorley. Liverpool Crown Court heard that Mrs Wilkins was working with lead styphnate, a sensitive primary explosive, on 2 March 2005 when she was killed. HSE has been unable to establish the exact cause of the explosion as Mrs Wilkins was working alone.

The BAE systems site after the explosion

The HSE investigation found that the company allowed unsafe working procedures to develop by providing too little supervision and monitoring. BAE Systems, of Farnborough Aerospace Centre in Hampshire, pleaded guilty to breaching Section 2(1) of the Health and Safety at Work etc Act 1974 by failing to ensure the safety of its employees. It was ordered to pay £118,000 towards the cost of the prosecution, in addition to the fine, at Liverpool Crown Court on 14 January 2010.

HSE Inspector Colin Hutchinson said: "This was a tragic incident and my sympathies go to Lynda Wilkins' family. Although we have been unable to conclude what caused the explosion, it is clear that BAE Systems' failings contributed to her death. The substance she was using is known to be extremely sensitive and must be handled carefully. BAE Systems failed to ensure the process was properly supervised and monitored.

"Explosives companies must learn from this incident by making sure their safety procedures are both sufficient and rigidly followed to avoid needless loss of life in the future."

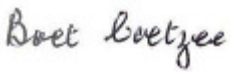
ISEE honours SAFEX Governor

At the ISEE's 36th Annual Conference in February 2010, SAFEX Governor Dr. Piet Halliday was recognized with the ISEE's President's Award. This award acknowledges those who have contributed their time and talent to the organization - for commendable volunteer effort to the Society. He is a past member of the ISEE Board of Directors where he served as the first director from South Africa and a co-chair of the International Committee. The ISEE Industry News says: "Piet Halliday has used his contacts in the industry and his work environment to promote the goals of ISEE in education, and in safety and security in our industry. His ongoing support of ISEE has been regularly demonstrated and he has never refused to take on a responsibility in supporting programs by putting his personal time into the Society's

Dr Piet Halliday receiving the ISEE's President's Award (Photo: Courtesy of the ISEE)

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

- **Olivier Obst,** CEO, Groupe EPC
- **Andy Begg,** SAFEX Expert Panel member and Individual Associate
- **Dr Phil Lightfoot,** Manager, Canadian Explosives Research Laboratory
- **Ben Barrett,** President, DG Advisor
- **Dr Olga Muter,** University of Latvia
- **Peter Costa,** Editor**,** The Westford Eagle, GateHouse Media New England,
- **Neil Morton,** HM Chief Inspector of Explosives**,** UK Health and Safety Executive (HSE)
- **Maurice Bourgeois,** GD-OTS, Canada



Boet Coetzee
Secretary General, SAFEX International

REGISTERED OFFICE
SAFEX International

c/o Modoux Services Sárl
Route du Village 13
CH – 1807 BLONAY. Switzerland

Tel: + 41 21 943 0101
Fax: + 41 21 943 0109
Web: www.safex-international.org

CONTACT US
Secretary General

Tel: + 1 919 342 5848
Tel/Fax: + 27 21 854 4962
e-mail: secretariat@safex-international.org