SAFEX NEWSLETTER

No. 41 2nd Qtr. 2012

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This is your Captain Speaking

Saeed Almansouri—Burkan Munitions Systems

Saeed Almansouri has been the General Manager and CEO of Burkan Munitions Systems LLC (BMS) since September 2009. He is responsible for driving the strategic plans as well as managing the day to day business activities of BMS.

Saeed started his career in the UAE Armed Forces and moved through different roles in the land forces, logistics, finance and finally Director of Procurement in GHQ. He retired as a Colonel in August 2004 after 25 years of service. Prior to joining BMS he was involved with the Offset Venture Unit of the Offset Program Bureau as Projects Advisor before being appointed as Procurement Manager within the operation support unit.

Besides attending numerous military courses, including the Command & Staff course and Senior Officers course, Saeed holds a Masters Degree in Defense Strategic Studies and a post graduate Diploma in Business Management.

Burkan was established in November 2007 in the United Arab Emirates (UAE) as the first ever company specialising in the manufacture, assembly and testing of medium calibre ammunition and explosives for the military . This was followed by the creation of an environmentally friendly demilitarization capability in which old ammunition and explosives are destroyed. BMS is a fully UAE owned entity with Tawazun Holding LLC and Al Jaber Trading Establishment being the principal shareholders. Its products range from medium to very large calibre ammunition and conform to international (Military/NATO) standards and procedures.

The Burkan team comes from 18 different nationalities and are distinguished by their functional and technical expertise. Combined with their hands-on experience, we are ensuring our customers receive professional products and services. Given the nature of the business, our philosophy is to regard safety and product quality as being intertwined; they are the "first amongst equal" priorities. We also believe it is the best way to address our employees' wellbeing. Disregard for these priorities is met by a "zero tolerance" response. To this end we have established a "state of the art" filling plant and explosive melt cast facility supported by various assembly plants where products are prepared for delivery with safety and quality in mind. Casting quality and explosive column integrity is ensured via a 9 MeV linear accelerator equipped with a digital imaging viewer configured to image a whole 155mm shell in single exposure. To further ensure safety and quality, all incoming and in-process inspections as well as various other functions are carried out In a fully equipped chemical laboratory. Lot acceptance is done at our in-house firing range and at ranges of the Armed Forces.

Safety is also a priority in our demilitarisation operation which starts with the inspection of old ammunition, followed by the compilation of work instructions, disassembly of the pieces, washing/melting out of explosives, incineration and finally recycling of scrap.

We are very humble and fortunate not to have had any major incidents and are working very hard to prevent them. This achievement is all the more remarkable if you consider:

- Burkan is obliged to apply self-regulation including adoption and implementation of international best practice
  - There is no legal framework for explosives manufacture in the UAE
  - HSE regulations in the UAE are managed by sector regulatory authorities. An authority for the ammunitions manufacturing industry has not been allocated. However, the Abu Dhabi Environmental Agency provides some guidance.
  - No private company has ever had an import / export licence for military explosives.
- Our security is enforced by the Military without any Burkan control.
- Almost every step and procedure is the first of its kind in the UAE and external approval, mostly Military, takes time. However, we are very fortunate that the Military authorities are 100% committed to the success of Burkan and support is readily available.

Given these circumstances Burkan has been obliged to impose international accepted self-governing rules and regulations. We have now adopted the International Ammunition Technical Guidelines (IATG) from the United Nations as it is not only available in the English language but also in Arabic.

The Burkan story involved creating an explosive facility from scratch in an environment that was not necessarily prepared for it. As in all pioneering activities the road has not been without its challenges but the journey has been gratifying. We are particularly grateful for the safety record we have achieved in testing circumstances. This counts among our greatest achievements.

Meet our New Governors

At the Ordinary General Meeting of members held during the XVII SAFEX Congress in Istanbul, the following new Governors were elected:

Terry Bridgewater (Chemring Group PLC)
Carlos Orlandi (Enaex Servicios S.A.)
John Rathbun (Austin International)
Thierry Rousse (Groupe EPC)
Mark Thomas (Orica Mining Services)

We have been introducing the new Governors to our readers in recent Newsletters. It is now our pleasure to have you meet the last Governor on the list, Mark Thomas.

Mark Thomas

Mark was appointed as Orica Mining Services' Global General Manager, Sustainability beginning May 2, 2011 and is based in Denver, Colorado. Orica is the world's largest supplier of commercial explosives and blasting systems with operations positioned across the world. He has held senior roles in the Explosives Industry in North America, Latin America, Africa and Australia/Asia during his career of 28 years

In 1984, after graduating with a Degree in Mechanical Engineering from the University of Utah in Salt Lake City (USA), Mark joined a small explosives company, Mining Services International, based in the United States. Six months later he moved to Johannesburg to manage a new venture (Bulk Mining Explosives) that Mining Services International started in South Africa in order to service the burgeoning mining industry in Ghana, Zambia, Zimbabwe and South Africa. Mark served as the Managing Director of BME for much of this time in South Africa.

Sixteen years later, in 2000, Mark joined Dyno Nobel, moving to Lima (Peru) to lead Dyno Nobel's extensive operations in Latin America. When Orica acquired parts of Dyno Nobel in 2006, Mark continued on as President of Orica Latin America. Then in December 2008, Mark was appointed as the General Manager of the Australia / Asia region of Orica Mining Services and managed this challenging region during the Global Economic Crisis. In May 2011 Mark was appointed to the Global Sustainability role in OMS based in Denver Colorado.

Mark and his wife Carolyn have enjoyed the global experience of working and living on four of the five continents during his career. His family is important to him and he is still trying to keep up with his eight grandchildren. He enjoys fishing and the outdoors when not driving his vintage 1953 Ford F100. He also enjoys playing golf whenever he can and currently has a 12 handicap.

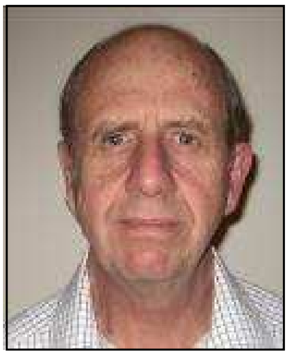
Mark comments: "I feel that my global and operational experience provides me the background to undertake the Global Sustainability role in OMS and I am excited to be able to join the SAFEX Board. I have seen both the pain that comes when Safety Principles are not followed and also the benefit that can come from learning from the experiences of others. That is exactly what SAFEX's charter seeks to achieve. I hope to be able to provide solid input as I serve on the Board of Governors of SAFEX.

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.

Paul Harrison



PERSONAL

Position: Statutory Liaison Manager
Company: Orica Australia Pty Ltd
Location: NSW, Australia.
Education: BSc (Hons)
Affiliations: Orica's representative with the AEISG
Member of the Australasia Institute of Dangerous Goods Consultants
Languages: English.

CAREER OUTLINE

With ICI Explosives:
- Research / Development Chemist
- Production Superintendent / Operations Manager (NG, Emulsion, Watergels, Boosters, Bulk)
- General Manager, Atlas Taiwan.

With Orica (Australia) Mining Services:
- Statutory Liaison Manager.

EXPERTISE

- Production understanding of a wide range of commercial explosives.
- Hazard Studies and Risk Assessments
- Incident investigation
- Statutory and legal understanding with respect to the manufacture, sales, storage, use, transport and disposal of explosives.
- Statutory and legal understanding of the requirements covering dangerous goods used to manufacture explosives (i.e. AN, ANE, combustible liquids, etc).

TYPICAL ASSIGMENTS

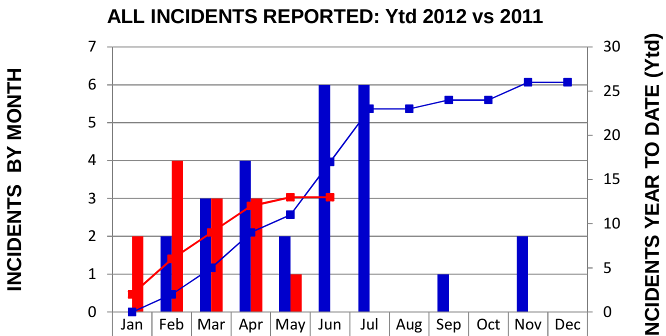
Ongoing	Involved in Hazard Studies especially involving commercial explosive operations.
1999 – 2012	Liaising with statutory bodies to ensure that regulatory requirements covering the safety and security of explosives and associated dangerous goods are to the overall benefit of society.
2005	Assisted in the re-establishment of NG Production in Germany after some serious accidents
1992 – 1999	Ensuring a range of new and existing explosives plants met statutory and Orica standards and requirements.
1991 – 1992	Introduced emulsions and non-electric detonators into the local market at Atlas Taiwan.
1980 - 1991	Safely closed down NG production in Australia and Taiwan.

Incident Reporting

Monitoring our Reporting Performance

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

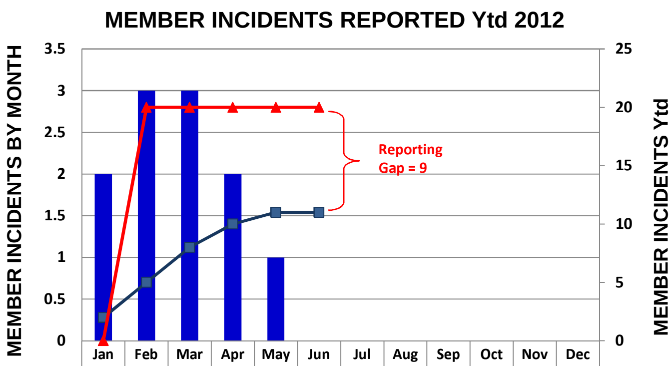
SAFEX learns from its members' experiences through the incident reports we receive. By applying these lessons we can prevent similar incidents recurring. That is why we track our incident reporting performance as follows:



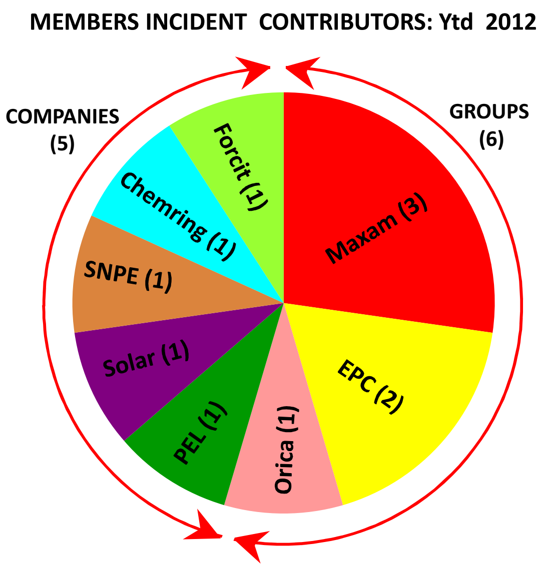
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	0	2	3	4	2	6	6	0	1	0	2	0
2012	2	4	3	3	1	0						
Ytd 2011	0	2	5	9	11	17	23	23	24	24	26	26
Ytd 2012	2	6	9	12	13	13						

All the incidents reported. This chart compares the sum of non-member and member incidents reported to SAFEX every month this year to the previous year. We have reported 25% fewer incidents this year than in in the same period 2011. 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.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	2	3	3	2	1	0						
Ytd	2	5	8	10	11	11						
Par	0	20	20	20	20	20						



Contributors of member incidents. This chart identifies those members who reported incidents. It shows the number of incidents each of these members have 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 each category has reported about the same number of incidents.

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, Manager of Technical Services of the Institute of Makers of Explosives; John Tatom, Manager, Explosives Safety Group at APT Research, Inc; and Mike Swisdak, creator of the US Department of Defense' ESKIMORE large scale test program and currently a senior scientist at APT Research. Our previous instalments comprised a series of questions and answers that often come up when the issue of QRA is first raised and the large scale testing to enhance the algorithms used. This instalment focuses on the science that goes into the model used to represent the effects of a detonation.

The Science of Quantitative Risk Assessment for Explosives Safety

by
John Tatom (Manager, Explosives Safety Group, APT Research Inc)

Quantitative risk assessment (QRA) tools, as described in the QRA Corner article from SAFEX Newsletter 39, can only be considered valid if the real-world situation can be modelled accurately. For explosives safety, the model must be able to represent the effects produced by the detonation of the donor and the consequences on the target. The science that goes into such a model must be carefully thought-out and based on as much data as possible.

In a high-explosive (HE) event, the effects that must be considered are the blast wave, the debris, and the thermal environment created by the donor item (material, article, or weapon). The consequences to the target, which is normally a human but could also be other vulnerable assets, include not only the direct results of the HE effects, but also the response of the structure where the target is located. Glass hazard and building collapse are key facets of this structural response.

The algorithms that form a model of an HE event are based on physics, certainly, but are anchored whenever possible by test and/or accident data. Although a wealth of test data already exists, new test programs are underway that will supply important information for use in models. This was described in the QRA Corner article from SAFEX Newsletter 40. The data from a test or accident can also be used to check the predictions of the model and point out areas for improvement.

There are generally three types of models: (1) physics-based, (2) empirical, and (3) semi-empirical. Although physics-based models can be developed to model explosives safety scenarios, they are, by necessity, quite complex and therefore expensive to develop. Empirical models, which report only data points available from tests and accidents, are by their nature limited in scope. Semi-empirical models, which use anchor points from available data but "fill in the gaps" with physics-based algorithms, may offer the best compromise between development cost, capabilities, and acceptance of results.

In a semi-empirical QRA model, conservatism is inversely related to the amount of available data. That is, if there are very few (or no) data points available to anchor an algorithm, the model must err on the side of caution. However, when an algorithm can be readily corroborated by test and/or accident data, the model does not need to include conservatism. This is important because the inclusion of conservatism would prevent model results from comparing well with the empirical data anchor points (i.e. reality).

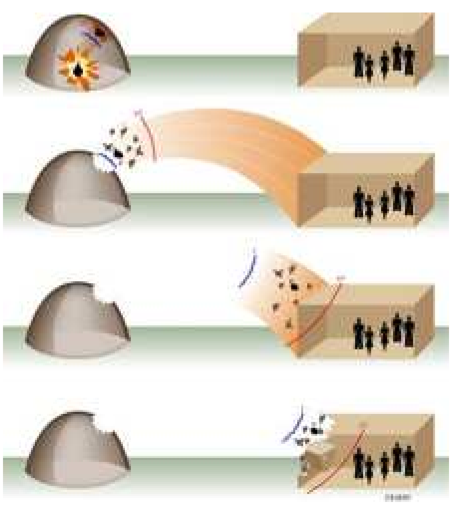


***Figure 1**: Blast Effects and Consequences*

This article intends to provide an overview of the explosives safety effects and consequences models that should be employed by QRA tools. Future articles will provide more detail (and references) on individual areas.

Effects and Consequences

To determine the effects and consequences of an explosive incident, the effective yield of the event must be determined. This is accomplished by adjusting the free-field results to account for the explosive's immediate container (if present), the explosive type, and the attenuation of the blast wave caused by the presence of the donor structure (if applicable).

For modelling purposes, the effects of an explosive incident are the changes in the environment created by the blast outside the donor structure (if one is present). Such effects include overpressure and impulse, debris, and thermal. It should be noted that ground shock is not normally considered when concerned with fatality or injury.

The consequences of a blast are the results on the target structure (if one is present), including glass and structural failure.

These effects and consequences, as depicted in Figure 1, can then used to determine the target (usually a human) vulnerability. The target vulnerability should be considered separately for each applicable effect and consequence and then summed.

Yield

The explosive yield can be determined through the algorithms and procedures in the US Department of Defense Explosives Safety Board (DDESB) Blast Effects Computer, as documented in the DDESB Technical Paper 17. Equations for a hemispherical TNT surface burst are used as the "basic airblast engine" to generate the various airblast parameters. For situations other than a hemispherical TNT surface burst, including various types of charges in the open or detonations inside a donor structure, effective TNT yields are computed and used. These yields are functions of the scaled distance (distance divided by the cube root of the explosive weight) from the centre of the event and the type of donor item and/or structure selected. The calculated effective yields are used in conjunction with the hemispherical TNT surface burst curves to generate the appropriate airblast parameters.

Pressure and Impulse

Once an effective yield has been calculated, the airblast algorithms from the Blast Effects Computer can be used to generate the pressure and impulse at the target structure. The pressures and impulses computed in this manner have been compared to all available test data and have been found to be in good agreement.

Structural Response

When the target building is "hit" by the blast wave, the structure may provide its occupants with some protection. However, as the building breaks up – the worst case being total collapse – the occupants are exposed to the additional hazards produced by the building itself.

Glass

Extensive research has been conducted, especially by the physical security community, on glazing targets to determine their response to blast loading. A "broader brush" program can use the output of these more detailed models in combination with accident data to generate results suitable for a QRA. It is important to note that while glass is a serious hazard to personnel in a building with windows, anecdotal evidence suggests that it is rare that fatalities are caused by glass in an explosives event.

Ongoing testing efforts will eventually supply enough data to expand the list of input options for QRA purposes. Safety retrofitting of existing windows is now a relatively common occurrence; consequently, more work must be done on the glass models to allow such modifications to be taken into account.

Building Failure

A great deal of testing has been conducted on the blast response of structures. However, actually determining the hazard to the building occupants is another matter. The results of accidental (or terrorist) events can be studied, but it is not always easy to reconstruct the scenario, i.e. the exact location and amount of explosives and the precise position of the people within the building.

Clearly, the first step is to understand the response of the target building to the blast load. This allows for the development of pressure-impulse (P-I) diagrams, which are then used to predict damage to a specific structure (or structural component) based on the blast load. Given the damage, the hazard to the occupants can then be predicted. These types of predictions have been compared between models and to the limited real-world data available, with encouraging results.

Debris

The debris created by the blast can be divided into three categories: primary fragments (the casing and/or immediate packaging of the donor item), secondary debris (the pieces of the donor structure), and crater ejecta (the debris from the crater formed in the ground and/or foundation of a donor structure).

Primary Fragments

The primary fragment characteristics that should be modelled (initial velocity, number of fragments, size distribution, and maximum range) are consistent with information and procedures contained in DoD literature, such as DDESB Technical Paper 16, Methodologies for Calculating Primary Fragment Characteristics. However, commercial explosives normally do not have a dominant primary fragment hazard.

Secondary Debris

Predicting the size, shape, initial velocity and angle, and maximum throw range of debris coming from the donor building is a particularly challenging task. Even if a given model can accurately predict the debris characteristics of a single event, it is still quite possible that the same model will be inaccurate for other events. This is the reason why it is highly desirable to have multiple data points (usually at different loading densities) for the same building type.

Crater Ejecta

Characterization of crater ejecta should be based on the type of soil around the donor structure; crater ejecta prediction algorithms can be based on available models and data.

Thermal

For QRA, thermal effects are usually only considered for Hazard Division (HD) 1.3 materials (mass fire). It is assumed that thermal effects from a high-explosives event would be insignificant (compared to other effects) if 1.3 items were not present. This assumption is based on the fact that, compared to other blast effects, thermal effects are extremely short ranged; i.e. the hazardous consequences from blast and fragmentation extend to significantly greater distances than do thermal effects.

Thermal models have not been developed to the level of maturity of the other algorithms discussed. However, the models are based on available data and literature, and have been compared to each other within NATO.

Vulnerability

Predictions involving the probability of fatality (or injury) for a person exposed to a given hazard are always difficult to corroborate, but some good work has been done in this area. For the human response to direct blast loading (skull fracture, lung rupture, and whole-body displacement), American and European research led to the development of probit functions to estimate the conditions required for lethality. This type of probit function has been expanded and extended for inclusion in QRA models and is widely accepted.

The range (missile launch) safety community has developed and issued standards for determining the vulnerability of people to debris impacts. This standard provides a series of "S-Curves" relating the probability of fatality to the kinetic energy of the fragment.

Models

Each scenario that can be considered by software tools must have a model for the elements that will affect the results. These elements are the donor item type, the donor structure (or PES, the Potential Explosives Site), the target structure (or ES, the Exposed Site), and any natural or man-made barricades. To the extent possible, these models are based on test data. These models will be described in a future QRA Corner article.

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. Explosives have been around for millennia but 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.

The Fracture & Shock Physics Group at the University of Cambridge's Cavendish Laboratory, has a world-wide reputation for scientific excellence in dynamic material testing & high-speed diagnostics. Our mission is to produce high-quality experimental data and develop cutting-edge and innovative techniques for understanding ultra-fast phenomena. At present the members of the group with a research interest in explosives and their interaction with other materials are: Rachel Boddy (effect of damage on energetic materials), Chris Braithwaite (novel energetic materials), Sara French (novel polymer bonded explosives), Simon Kirk (shock properties of rocks relevant to the blasting problem), Tuuli Sutinen (novel fabrication methods for pyrotechnic delay lines), Nick Taylor (temperature measurement during shocking of ammonium nitrate explosives), Stephen Walley (high rate characterization of explosives and hot spot mechanisms), David Williamson (thermophysical properties of explosives).

The group's approach is based on the conviction that experiments and modelling complement each other in the understanding of material behaviour.

In general our input can be three-fold:

- Performing simple and controlled experiments to generate data.
- Validating models against these experiments.
- Performing tests which shed light on real-life situations.

Recent research on energetic materials in the Fracture & Shock Physics Group, Cavendish Laboratory, University of Cambridge UK

by

Stephen M. Walley, David M. Williamson, Andrew P. Jardine

The Fracture and Shock Physics Group of the Cavendish Laboratory (formerly part of the Physics & Chemistry of Solids Group) has long experience of research into explosives, dating back to the 1940s firstly under the leadership of Philip Bowden & Abe Yoffe and subsequently John Field. This early work resulted in the publication of a couple of classic books on the hot spot mechanism of initiation [1, 2]. A more recent overview of the group's historic contribution to the understanding of the hot spot mechanism may be found in a review by John Field [3].

In recent years, the focus of the group has expanded to include studies of the strength properties of explosives to allow more accurate modelling of these materials in-service, for example, during the firing of a gun [4].

We have also participated in the Hybrid Stress Blasting Model (HSBM) consortium whose aim was to improve understanding of the blast/rock interaction during mining and quarrying. As part of these investigations, the response of solutions of ammonium nitrate to shock has been studied. This work continues under the sponsorship of Orica Mining Services.

Recent projects involving the novel applications of modern technology to energetic materials include new fabrication methods for delay lines and detonators [5] and use of green explosives [6].

Adhesion

One of the most important mechanical parameters in explosives is adhesion between the binder and the explosive crystals. Above the glass transition of the binder, cracks usually go around the crystals (see figure 1*a*) whereas below the glass transition the stiffness of the binder becomes comparable to the explosive so that cracks can propagate *through* the crystals (figure 1*b*). This explains why some explosives can be *more* impact sensitive at low temperature since the fractured crystals can rub against each other.

Damage

In many applications, explosives have to be transported from where they are manufactured to where they are going to be used. This opens them up to the possibility of being damaged by, for example, vibration, mishandling and temperature variation. We have therefore performed a number of studies into the effect of damage on the mechanical properties of explosives.

Although damage to materials has been studied for many years, it is still a difficult parameter to quantify. However, there are a number of medical techniques that allow the insides of opaque materials to be examined, for example X-ray tomography and magnetic resonance imaging (MRI). The images obtained from these techniques can then be analysed using standard image analysis programs. A comparison of tomographic images of pristine and damaged specimens of an explosive simulant is presented in figure 2. (0n the right)

Other methods that we have used to assess the effect of damage in these materials include measurements of density, modulus, thermal conductivity and fracture strength.

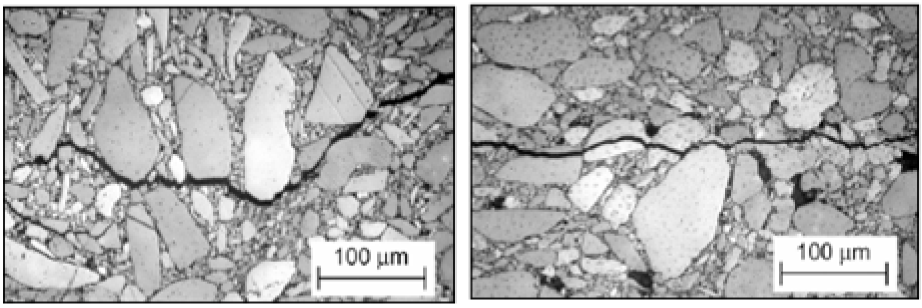
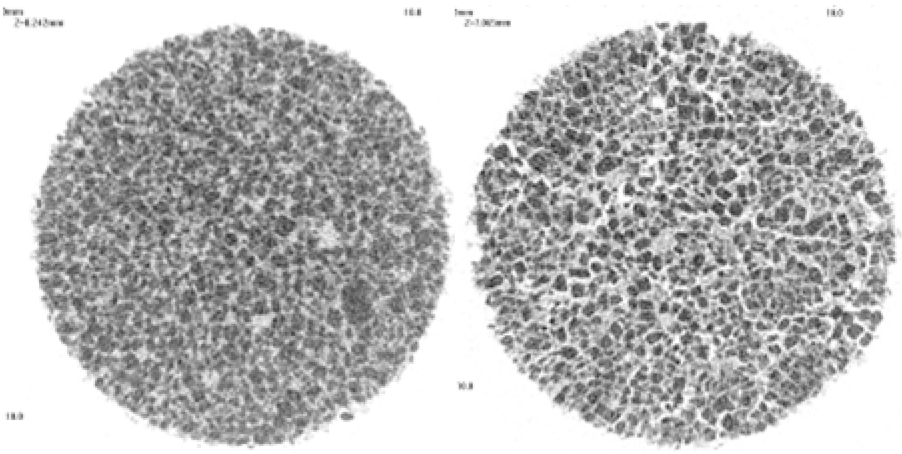


Figure 1:
(a) Micrograph of a crack propagating through an energetic material where the temperature is above the glass transition of the binder.
(b) Micrograph of a mode I crack propagating through an energetic material where the temperature is below the glass transition of the binder. From [7].

Figure 2: Comparison of (a) pristine and (b) damaged polymer-bonded sugar specimens. Images obtained by X-ray tomography. Cracks can be seen as white lines crossing the damaged specimen. From [8].



(a) **(b)**

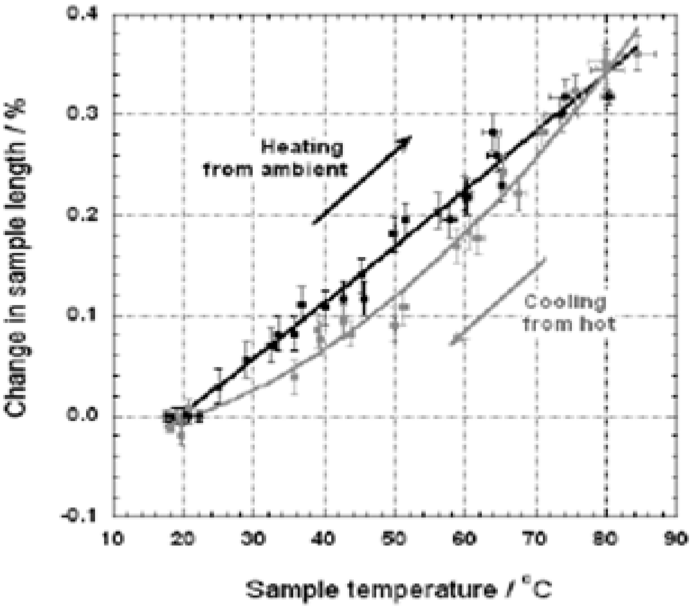


Figure 3: Plot of the change in specimen length with temperature on heating and then cooling an explosive material. The specimen does not follow the same curve on cooling due to the difference in thermal expansivity of the binder and explosive crystals. This difference produces damage to the material. From [9].

Since explosives may also be damaged by in-service thermal cycling produced both by the normal daily changes and also by being transported in cold and hot environments, we have developed techniques for measuring their thermal expansivity. During these experiments it was noticed that specimens follow a different path when cooling to that which they follow on heating (see figure 3). This is due to the difference between the thermal expansivity of the binder and the explosive crystals. Such differences are the origin of damage due to thermal cycling.

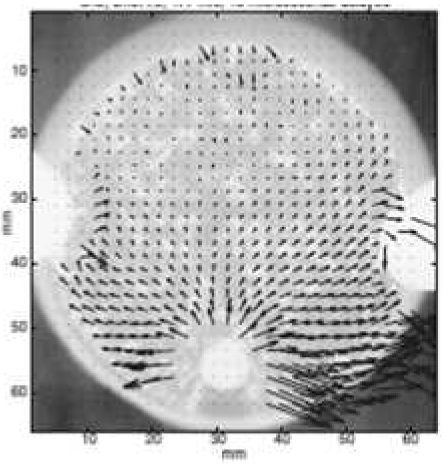


***Figure 4**: Plot of the movement of material within a cylindrical specimen of an explosive simulant 40 microseconds after impact by an 8mm diameter hardened steel ball fired at 477 m/s. From [10].*

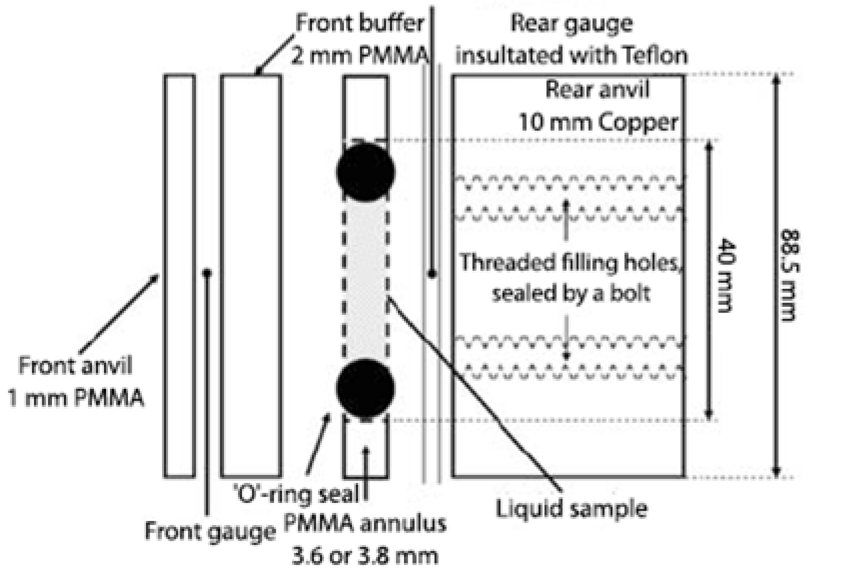


***Figure 5**: Schematic diagram of target cell used in shock studies of AN solutions. From [12].*

Optical techniques

Over many years, members of the group have developed optical techniques for studying the deformation of materials. From the beginning of these studies, they were applied to explosives. Originally they were surface-only methods designed to obtain strain fields that could be correlated with microstructure. More recently, X-ray methods have been used which allow the deformation of a plane *within* an opaque specimen to be determined (see figure 4)

If two flash X-ray sources are used, stereoscopic analysis allows three-dimensional information about the event to be obtained.

The group also has an extensive range of high-speed cameras, which can achieve framing rates up to 10^8 s^{-1} [11].

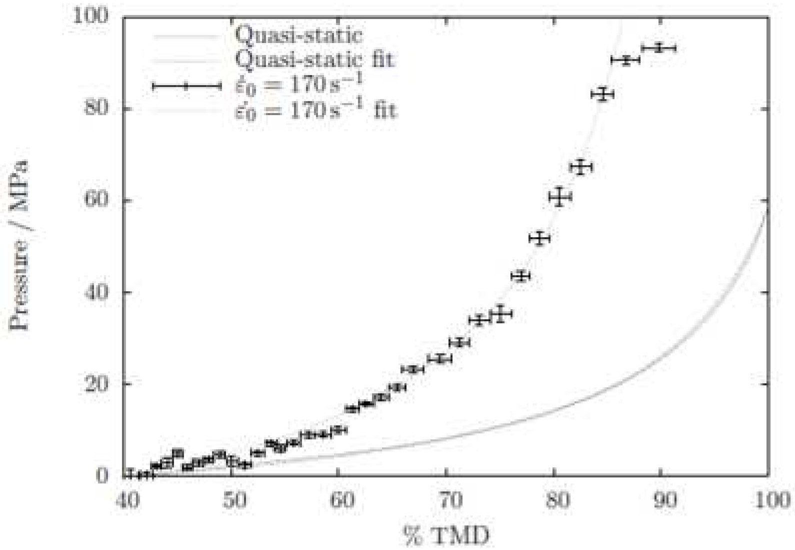


***Figure 6**: Plot of compaction pressure against density for quasistatic (continuous line) loading and dynamic loading of an AN prill. From [13]*

Shocking of explosives and rocks

The group has the capability of shocking materials using a number of different techniques. One method that we have used extensively with ammonium nitrate solutions and with rocks is the so-called 'plate impact' method, where a plate is fired down a laboratory light gas gun to impact a target (see figure 5). The impact generates a shock within the target material. Measurements of the shock strength give a great deal of information relevant to understanding and modelling of the interaction of rocks with the blast wave produced by an explosive charge.

Other recent studies on AN include a comparison of how compressible prills of this material are at different rates of loading (figure 6). It can be seen that AN prills are *less* compressible at high rates of deformation.

Fabrication of energetic delays

An ongoing project in our group is into the application of various technologies to the fabrication of energetic delays.

Following fabrication, high-speed photography in conjunction with filtering allows the burn properties to be measured (see figure 7). This image also gives information about variation in the temperature of the burn along the line.

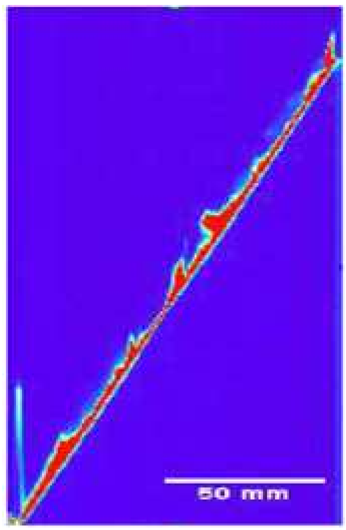


***Figure 7**: Thermal 'streak' image of the combustion of a printed line of a pyrotechnic ink. Total burn time 4.2s. From [5].*

For more information …

The group maintains extensive searchable bibliographic databases on published papers and reports on topics the group researches. For example, the index on blast loading of structures (including mining and quarrying) has 18,000 entries, that on energetic solids has 29,000 entries, and that on energetic liquids has 3,000 entries. For more information on these resources, contact Dr Stephen Walley (smw14@cam.ac.uk).

More information on the group's capabilities and publications may be found on our website: www.smf.phy.cam.ac.uk

An overview of explosives projects we have recently been involved with may be found in [14].

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Transparent shields for protecting personnel from the unintentional reaction of explosives, propellants and pyrotechnics are common in the manufacturing and laboratory environments. Their effectiveness was evaluated by the Naval Surface Warfare Center (NSWC), Indian Head Division in a report published in 1994. The work still seems relevant today and when a SAFEX Members brought it to our intention we obtained permission from the NSWC to publish their report in our Newsletter. We are doing so in two parts: The first part, which appeared in the previous Newsletter, introduced the work and described the experimental arrangement. This, the second part, provides the experimental results, discussion and conclusion. For convenience some of the tables and figures which appeared in the first part have been reproduced here. We trust you will find it of interest.

Effectiveness of Transparent Shields in Protecting Explosive Operations Personnel – Part 2: Experimental results, Discussion and Conclusions

by

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Experimental Results

A summary of the times of blast wave arrival (t_a) and peak blast overpressure (p) at the head positions of a standing operator, sitting operator, and standing observer are listed in Table 2 for the detonating charges and the exploding shotshell. The values of p are associated with the first or primary wave; reflected or secondary waves were of lower but often significant amplitude. The secondary waves were not as reliably measured by the pencil gauges because of errors associated with disturbance by the primary wave of the mounts for the transducers and their high-impedance cables. This was observed by changing the mounting arrangements of the pencil gauges and comparing their output with the measurements from the PCB 102A transducer, which has a low impedance cable. The response of this transducer in the MSP to the primary blast wave was basically an average of the responses from the pencil gauges located 4" above and below it at the head positions of a standing and sitting operator, respectively; although, the MSP transducer trace was more characteristic of that from the pencil gauge above it. This verifies that the pencil gauges had reasonably recorded the overpressures even though the gauges were not oriented normal to the blast wave propagation, as will be discussed.

Pressure-time (p-t) records from selected tests at the head position of a standing and sitting operator are shown, respectively, in Figures 5 and 6 on the next page. The primary waves behind the shield were very complex, being the composite of multiple waves arriving at the transducers nearly simultaneously. Especially at the head position of the standing operator, two major peaks were sometimes associated with the primary blast wave, as listed in Table 2. Increasing the charge size from 1.3 to 2.8 to 11.5 g in front of Brazil's shield (Figures 5D, 5B, 5E,respectively) or protecting the operator with a different shield for the same charge size (comparing Figures 5B and 5C for 2.8 g charges in front of Brazil's and Labgard shield and comparing Figures 5E and 5F for 11.6 g charges in front of Brazil's and Wing2 shield) changed the p-t traces at the head position of a standing operator. Relative to an unconfined 2.8 g charge in Tests #1,3,5, (e.g., Figure 5B) increasing the charge mass to 3.0 g in

Table 2. Summary of Blast Times of Arrival and Overpressures Behind Shields at the Head Position of a Standing Operator, Sitting Operator, and Observer for Detonating Charges and an Exploding Shotshell

Test	Shield	Charge Size & Mass/ Confinement, if any	Standing Operator t_a (ms)	Standing Operator p (psi)	Sitting Operator t_a (ms)	Sitting Operator p (psi)	Observer p (psi)
#1	Bazil	0.5" dia. x 0.5", 2.8 g	1.2, 1.6	1.0, 3.7	N/A	N/A	1.1
2	Bazil	0.5" dia. x 0.5", 3.0 g	1.1, 1.7	1.3, 3.2	N/A	N/A	1.3
3	Bazil	0.5" dia. x 0.5", 2.8 g	1.2, 1.7	1.5, 3.5	N/A	N/A	1.7
4	Bazil	1.25" dia. x 0.35", 11.5 g	0.8	9.2	0.9	5.0	4.2
5	Bazil	0.5" dia. x 0.5", 2.8 g	1.2, 1.7	1.5, 3.6	1.1	2.5	2.0
6	Bazil	0.5" dia. x 0.5", 2.8 g 0.628 O.D. steel sleeve	1.1, 1.6	2.1, 1.2	1.1	2.3	1.3
7	Bazil	0.5" dia. x 0.5", 2.8 g 0.628 O.D. steel sleeve	1.0, 1.6	2.3, 1.5	1.1	2.2	1.5
8	None	0.5" dia. x 0.5", 2.8 g	1.0	N/A**	0.7	8.0	3.7
** Transducer axis at too great of an angle relative to direct line to charge for valid data							
9	None	0.5" dia. x 0.5", 2.8 g	1.0	N/A**	0.7	8.0	3.6
10	Bazil	0.5" dia. x 0.5", 2.8 g 0.626 O.D. steel sleeve	0.9, 1.5	3.0, 1.1	1.0	1.9	1.9
11	Bazil	0.5" dia. x 0.5", 2.8 g 0.754 O.D. steel sleeve	0.9, 1.7	1.9, 0.9	1.0	1.6	1.3
12	Groves	0.5" dia. x 0.5", 2.8 g	1.6	2.7	1.3	2.9	1.6
13	Double	0.5" dia. x 0.5", 2.8 g	1.7	2.6	1.3	2.9	1.7
14	26x26	0.5" dia. x 0.5", 2.8 g	1.2, 1.9	1.2, 1.2	1.5	1.9	1.1
15	25x49	0.5" dia. x 0.5", 2.8 g	1.9, 2.4	1.4, 1.2	1.6	1.5	1.1
16	Wing1	0.5" dia. x 0.5", 2.8 g	1.9, 2.1	1.0, 1.4	1.3	1.0	1.1
17	Bazil	0.5" dia. x 0.25", 1.3 g	1.3, 1.7	1.1, 1.7	1.2	1.5	1.2
18	Bazil	0.5" dia. x 0.25", 1.3 g	1.3, 1.7	0.9, 1.8	1.2	1.3	1.2
19	Wing2	0.5" dia. x 0.5", 2.8 g	1.9, 2.3	0.8, 1.2	1.3	1.2	1.1
20	Wing2	1.25" dia. x 0.35", 11.7 g	1.4, 2.0	0.9, 3.1	1.4	2.1	3.0
21	LabGard	0.5" dia. x 0.25", 1.3 g	1.4	1.7	1.3	1.6	0.8
22	LabGard	0.5" dia. x 0.5", 2.8 g	1.2	3.1	1.2	3.0	1.9
25	Bazil	Shotshell, 2.0 g powder	7.9	1.1	7.5	0.8	0.6

Test #2 or confining the charge in Tests #6,7,10,11 also significantly changed the p-t profiles. Confining the charge increased the amplitude of the first wave and decreased the amplitude to the second wave. Also, the two waves were distinct for the confined charges, compared with the connected waves for the unconfined 2.8 g charges. While multiple waves are evident in the p-t traces for the primary blast to reach the head position of a sitting operator (Figure 6), these waves arrive nearly simultaneously, resulting in a broad pulse compared to the free-field (no shield) measurement in Figure 6A.

When a transducer was positioned just behind the shield at charge height, an overpressure of 0.8 psi was recorded for the barrier without arm cutouts in Test #15 versus 2.8 psi for a shield with arm cutouts in Test #16. While some of the difference is attributable to the different widths of the barrier and shield, much of the increased overpressure in Test #16 is due to the cutouts. As shown in Table 2 for Test #16, the overpressures at the position of a standing and sitting operator were only about half of the 2.8 psi measured at charge height. Prior to the peak in both tests, there was an earlier wave of insignificant pressure that was associated with direct transmission of blast through the shield.

Free-field measurements at various distances from detonating 2.8 g charges were obtained in Tests #1,3,8,9. In Tests #1,3, the reflected wave from the shield had almost caught the first wave recorded at the far transducer (GS) in front of the shield, whereas the two waves had coalesced for the slightly larger 3.0 g charge in Test #2. In Tests #8,9, the pressure profiles were less complex (e.g., Figure 6A) than in the shield tests and more typical of blast waves observed in field tests at a large number of radii from the charge. However, the response of G3 at the head position of a standing operator in Tests #8,9 (Figure 5A) was an unrealistic two pulse waveform because the transducer axis was at too large of an angle (65°) relative to the path of the blast wave.

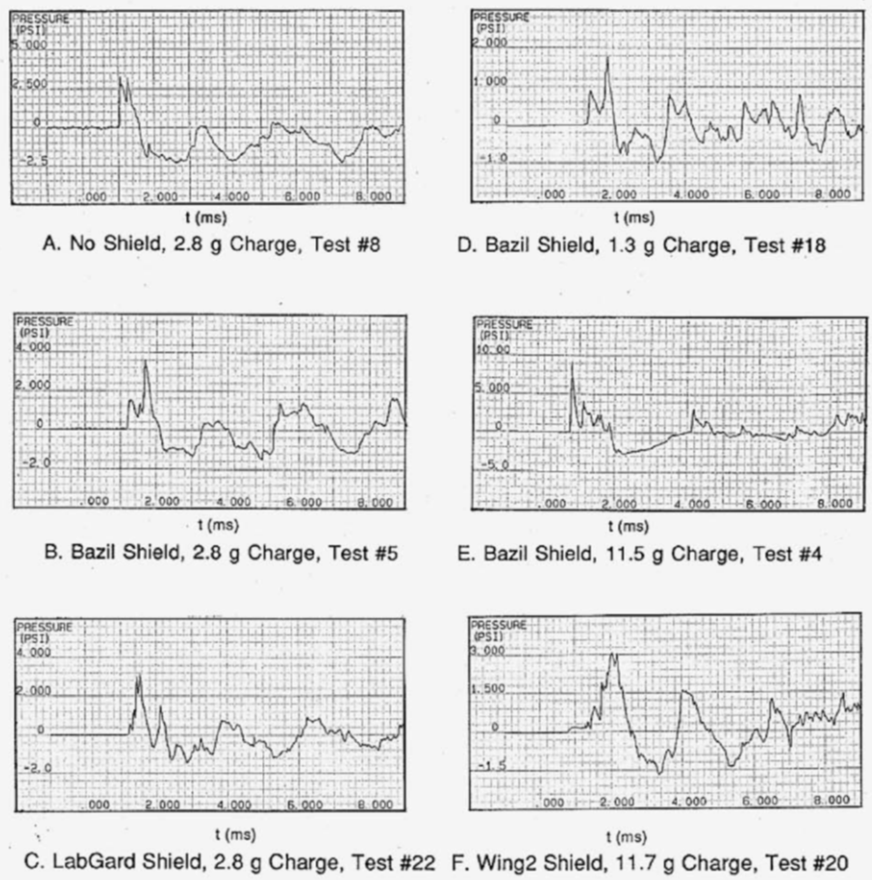


FIGURE 5. Blast Overpressure at Head Position of Standing Operator With and Without Shielding From Various Detonating Charges

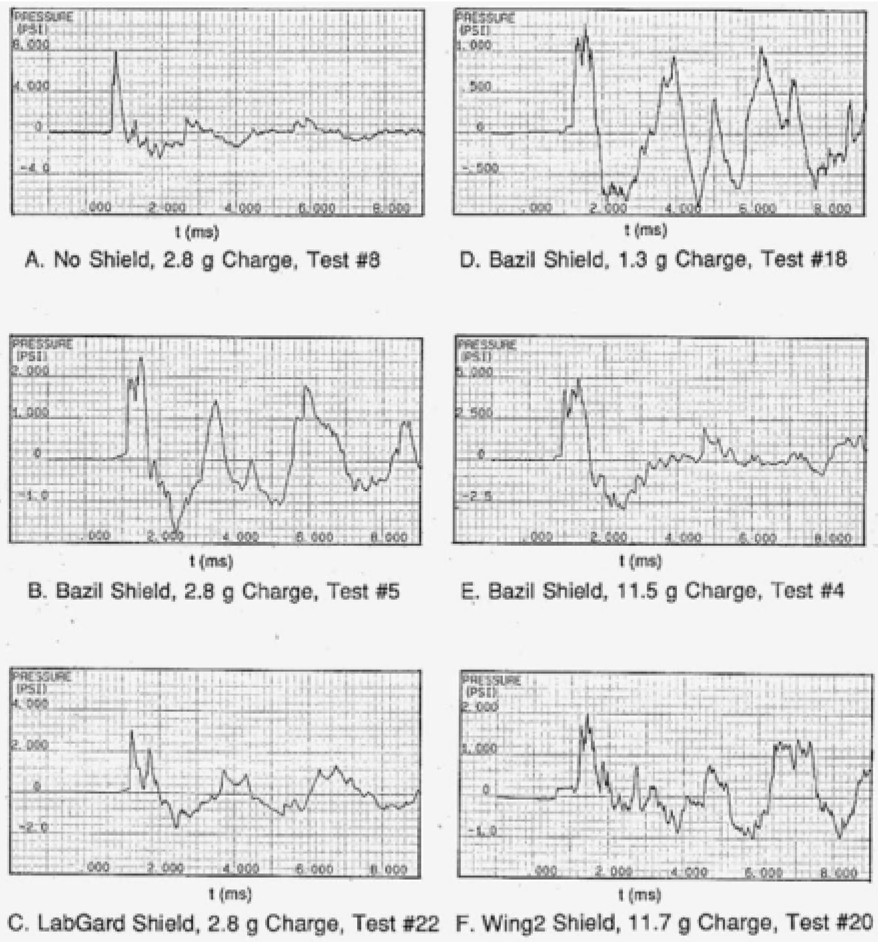


FIGURE 6. Blast Overpressure at Head Position of Sitting Operator With and Without Shielding From Various Detonating Charges

When plotting transducer locations versus arrival times from the free-field measurements, the average wave velocity was 365 m/s. This velocity was used to predict arrival times of the blast wave to the transducer by various paths for comparison with the measured values in Table 2.

In Test #6 and 7, the ½" thick PC shield stopped all fragments, but several fragments from the 1/16" sleeves nearly exited the backside. By comparison, the 3/4" plywood sheet that simulated a wall at the back of the table had numerous holes through it from fragments. In these tests, the primary fragments struck the shield at the charge height (2.5 to 3.0") above the table, where the shield is backed by a wooden wedge (Figure 1). In Test #10 the base of the charge was raised to 4" so that the primary fragments would strike a section of the shield not backed by the mounting arrangement. The fragments did not penetrate any further. Next to the simulated back wall in this test, a large coffee can with a pair of safety glasses taped on the outside was filled with water to simulate an operator's head. The glasses and can were penetrated by several fragments. The PC lenses, just like the shield, had little peripheral damage beyond the small hole through which the fragment passed. The damaged zone appeared as though a hot object had melted through the plastic. One of the larger fragments that was recovered intact had a mass of only 80 mg. By contrast, the larger fragments produced from the thicker sleeve in Test #11 had just begun to enter the front surface of the shield.

Essentially no measurable temperature increase was recorded from the detonating charges at a position between the head of a standing and sitting operator, although there was a bright momentary flash which was too fast for either the thermocouples or heat flux sensors to respond to. The only measurable heat flux was from the 11.7 g charge in Test #20; a peak flux of 0.1 cal/cm2-s was obtained at 18 ms from the sensor with the 100 ms response time. The much faster sensor did not

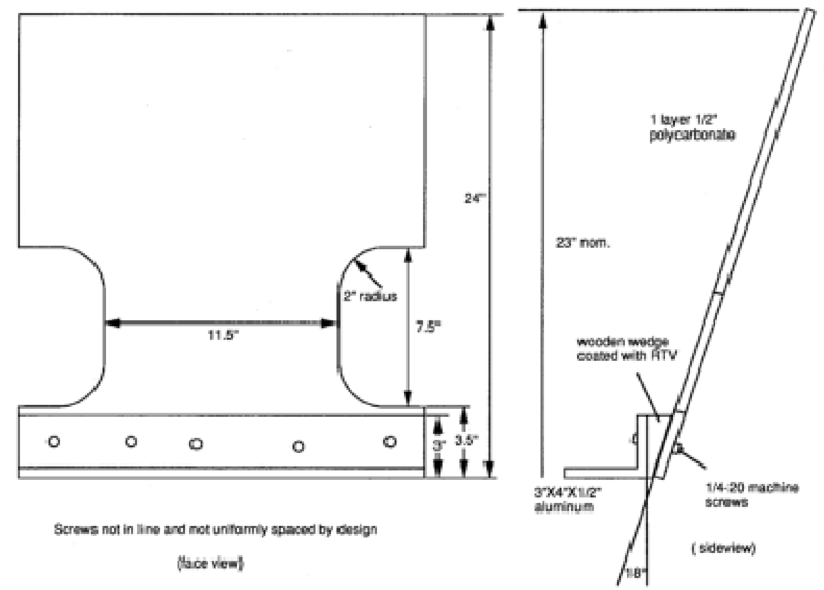


Figure 1. Bazil's Polycarbonate Shield.

record any heat flux from the 2.8 g charge in Test #22. The highspeed films verified that all of the flame remained in front of the shield, except for the two ~11.6 g charges, where some flame came back through the arm holes. In a real accident, these passages would have been mostly blocked by the operator. On the front surface of Brazil's shield (i.e., unprotected surface closest to the charge), from 80 to 120 0C occurred at times ranging from 20 to 60 ms after the detonation of ~2.8 g charges in Tests #1-3,5. In Test #4 with a 11.5 g charge, on the front of the shield went off-scale at 200 0C. This verifies the shielding of the operator from the hot detonation products, since the same instrumentation was used on both sides of the shield.

The C-clamp mounting of the shields was satisfactory and there was only minor (il/2") displacement of the top of the shields from <3.0 g charges. A similar deflection is easily achieved by hand pressure on the top edge of these shields. The 11.5 g charge in Test #4 caused large shield deflection in addition to translating the table to which the shield was mounted. The high-speed photographs showed that the shield struck twice the transducer corresponding to the head of a sitting operator For the Wing2 shield subjected to a 11.7 g charge in Test #20, there was ~l" deflection at the top of the shield. As noted in the previous section for this test, the table was weighted and the top of the shield was restrained by a cable. The bottom of the LabGard shield did move ~2" toward the operator in Test #22.

In the exploding shotshell test, the brass shell broke into several pieces from the interior pressure associated with the combusting WC 231 powder. The 8.0 g PBXN-103 sample was recovered intact with no indication of damage, and was subsequently used in a burning test. The blast overpressures listed in Table 2 from the 2.0 g of powder were less than those from a detonating 1.3 g charge in front of the same shield (Tests #17,18).

The shields, types of energetic material, and their amounts used in burning tests are listed in Table 3. No significant overpressures (>0. 1 psi), nor any significant temperatures nor heat fluxes, were recorded at the position of the operator. The video camera showed the flame and heat going primarily up, and no flame came around the sides of the shields or over the top. Except for Tests #23,24 with B/KNO3, the burning required seconds to complete. The front surface of the PC shield was charred and pitted near its base after Tests #30,31 with the composite propellant, and the shield was warm to the touch afterwards, but otherwise in usable condition. Most of the damage from these two tests was due to at least one piece of burning propellant being ejected from the original site, striking the shield, and then burning at the base of the shield. Without the shield, the clothing of the operator would have probably been set afire. There was considerably more charring to the wooden table top than the shield. After burning 50 g of RDX in front of the Lab-Guard shield in Test #34, it was only necessary to clean some soot from the shield with a tissue.

The overpressures to a standing and sitting operator from various unconfined charges in front of Brazil's shield are plotted in Figure 7. The fits through the data points are only for the purpose of interpolation. Dissimilar fitting functions were required because different waves superimpose at each operator position, as discussed below. For charge masses <2.8 g, however, a linear function passing through the origin is sufficient to represent both data sets. A 2.0 g charge satisfies the 2.3 psi limit for both a standing and sitting operator. The maximum 2.3 psi overpressure permitted at the operator's head, whether sitting or standing, was not exceeded for Test #11 with a 1/8" sleeve around the explosive. The thinner 1/16" wall sleeve also reduced the measured blast pressures, but not by as much as the thicker sleeve.

There was a significant reduction in blast pressure to <2.3 psi from both confined and unconfined 2.8 g charges if a standing observer was positioned just 12.5" behind and 5', to the side of an operator.

The various tests revealed the paths of the blast waves to the operator. The impedance difference between a plastic or glass shield and air would dictate that little blast pressure would be transmitted by the shield. This was verified in Test #13 with the Double shield and in Test #15, in which a transducer at charge height behind the shield recorded an insignificant wave associated with direct transmission. Also, for any of the shielded 2.8 g charges, t_a for the first wave was too long if it had arrived by transmission through the shield when comparing t_a from the free-field tests.

Table 3. Description of Burning Tests

Test	Shield	B/KNO_3 Ignition Aid	Test Material
#23	Bazil	None	B/KNO_3, 3.0 g
24	Bazil	None	B/KNO_3, 10.0 g
29	Bazil	1.0 g	PBXN-103, 8.0 g
30	Bazil	1.0 g	FS-25-C composite propellant, 50 g
31	Bazil	1.0 g	FS-25-C composite propellant, 255 g
33	Bazil	1.0 g	Class A RDX powder, 10.0 g
34	LabGard	1.0 g	Class A RDX powder, 50.0 g

The arrival time of blast waves from unconfined 2.8 g charges at the head position of a standing operator behind the taller shield of Groves in Test #12 when compared with Brazil's shield in Test #5 (Figure 5B), revealed that first wave (t_a= 1.2 ms) came over the top of Brazil's shield. Also, the first wave (t_a= 1.2 ms) in Test #14 for a 26" wide by 26" high PMMA shield did not exist in Test #15 on a similar width shield that was much higher. While the amplitude of the first wave from an unconfined 2.8 g charge was <1.5 psi for Brazil's shield, it was a long duration pulse on which the second wave was superimposed. In Test #5, as shown in Figure 5B, the first wave had declined to 0.8 psi by the arrival of the second wave (t_a= 1.7 ms). If the first wave had been eliminated, the second wave would have had an amplitude of ~2.7 psi, as did the t_a = 1 6 ms wave in Test #12. This ~2.7 psi and the remaining ~0.8 psi from the first wave nearly add to the 3.6 psi peak for the second wave in Test #5.

The waves with t_a = 1.6 to 1.7 ms arriving at head of a standing operator, which is the second wave for Brazil's shield and the first wave for Grove's shield, had come around the shields. The side wave was predictably delayed to 1.9 ms by increasing the shield width to 26" in Test #14 and 25" in Test #15.

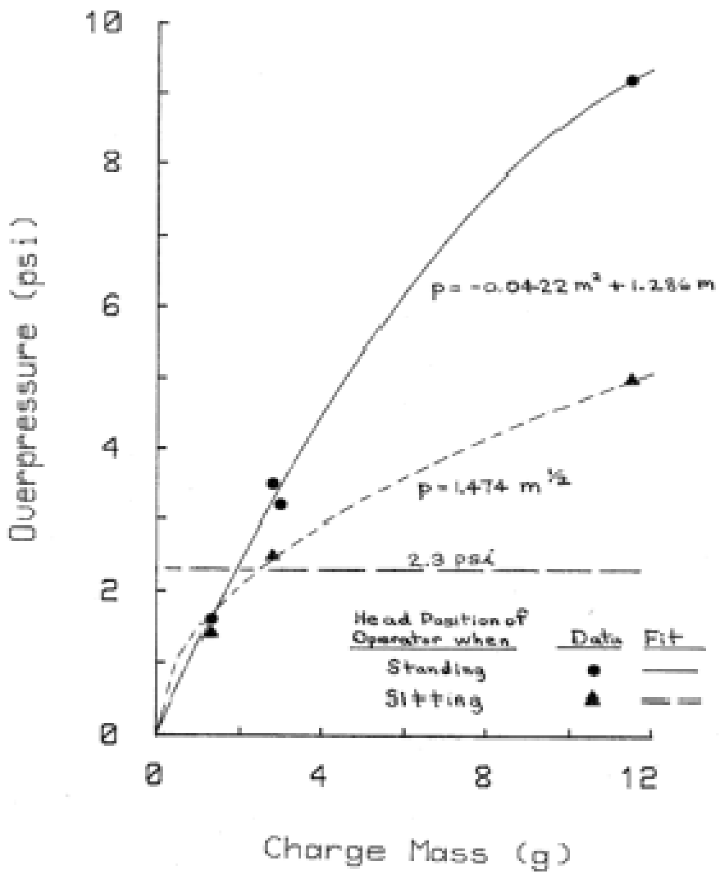


Figure 7. Blast Overpressures Behind Bazil's Shield from the Detonation of Unconfined Charges

Since blast pressure is attenuated simply by increasing the distance through the air from the charge to the operator, side extensions were added to Groves' shield, as shown in Figure 2, to make Wing1 and its variation Wing2. The relatively minor modification resulted in an overpressure for a sitting operator that was just below the 2.3 psi limit for a 11.7 g charge

The ability of the shields to attenuate blast is depicted on the pressure-distance plot in Figure 7. The distances around the side of the various shields to a sitting operator are listed in Table 1. When comparing free-field (8.0 psi at the position of a sitting operator) and shielded measurements for 2.8 g charges, all shields offer significant attenuation of the blast wave that is enhanced with increased shield width. The attenuation of the blast wave occurs from both the increased path length to the operator and from the blast wave turning a corner. The overpressures behind Brazil's shield and Wing2 from an ~11.6 g charge are less than from an unshielded 2.8 g charge. The fits through the data for the various charge masses should not extrapolated. The fits in Figure 6 for the three charge masses can be approximated by p (psi) ~ $11.2\, m^{0.5} e^{-0.007x}$, where p is the overpressure, m is the charge mass in grams, and x is the distance from the charge in inches.

CONCLUSIONS

The relatively simple shield design of Brazil and the commercial Lab-Guard shield are only effective for protecting against blast overpressure from small (<2 g) detonating charges. Blast overpressure to the operator came from around the shield versus direct transmission through the shield. Simply increasing the width and height of the shield, even with the cutouts for arms, greatly reduced the blast overpressure to the operator. Clamping the shields at only their base on an unanchored table was sufficient to prevent the shields from impacting the operator for charge masses <3.0 g, whereas the top of the shield had to be restrained and the table weighted or anchored for ~11.6 g charges. A shield of ½" PC was nearly

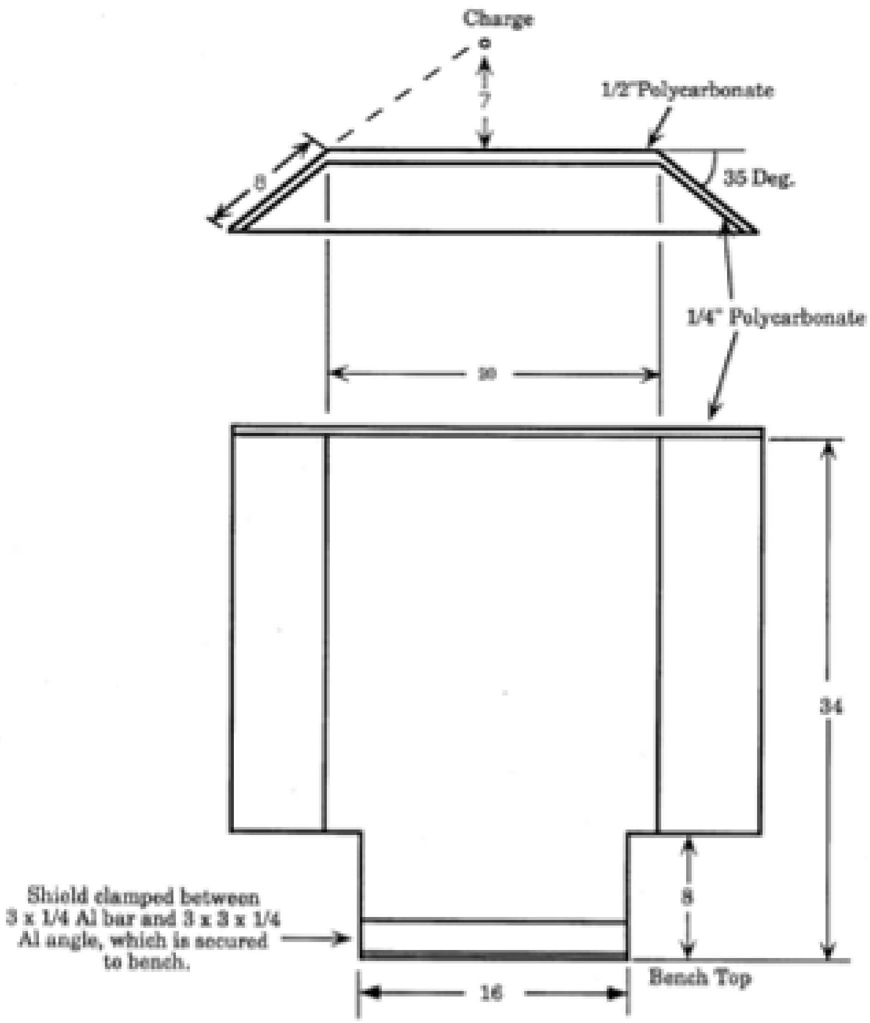


Figure 2. Polycarbonate Shield with Side Extensions and Top (Wing2)

Table 1. Description of Shields

Descriptor in Table2	Dimensions+ W (in)	H (in)	T (in)	Mat'l*	D^ (in)	Comments#
None	-	-	-	-	20.75	Free-field measurements
Bazil	20	24	1/2	PC	29.0	18° tilt from operator, 4 1/4" wide x 7 3/4" high cutouts for arms
Groves	20	34	1/2	PC	28.2	8" high x 2" wide cutouts for arms
Double	20	34	1 1/2	PC	-	Bazil's shield mounted in front of Groves' shield with 1/2" air space between them and flush at the top
26x26	26	26	2 1/2	PMMA	-	3° tilt from operator
25x49	25	49	1/2	PC	37.2	
Wing1	33	34	1/2	PC	42.4	Groves' shield with side extensions of 1/4" PC angled 35° toward operator
Wing2	33	34	1/2	PC	42.4	Wing1 with 1/4" PC top
LabGard	15	29	1/8 PC+1/4 PMMA		26.5	Lab-Guard Model D, semi-circular PC shield with weighted base and PMMA liner

+ W = width, H = height, T = thickness

* PC = polycarbonate, PMMA = polymethylmethacrlylate

^ D = minimum distance from charge to head position of a sitting operator (distance around side of a shield)

Shields vertically mounted unless otherwise noted

penetrated by some of the fragments from 1/16" thick steel sleeves around 2.8 g charges. Larger charge weights will require more shield thickness to protect against fragments. The shields nearly totally protected the operator from heat and direct contact with burning material for even the largest (11.7 g) detonating charge and the largest (244 g) burning charge. Obviously, shield protection only pertains to the parts of the operator's body behind the shield, and protection for hands and forearms must still be considered. While these results provide some guidance in developing a shield, it should still be tested with a minimum safety factor of 25% above the maximum expected charge.

References

l. NAVSEA OP-5, Vol. 1, 5th Rev.; Ammunition and Explosives Ashore; Safety Regulations for Handling, Storing, Production, Renovation and Shipping

2. Military Standard 398; Shields, Operational for Ammunition Operations, Criteria for Design of and Tests for Acceptance

3. American Society for Testing and Materials Standard E511-73; Measurement of Heat Flux using a Copper-Constantan Circular Foil, Heat Flux Gage

Our Explosives Regulatory World

Government and Industry – A Partnership to Secure Explosives

by

Mike O'Lena (Explosives Program Manager, ATF)

We are very grateful to Mike O'Lena from the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) in the United States Department of Justice for his willingness to contribute to this Feature of our Newsletter. The ATF performs a vital role in regulating the USA explosives industry. SAFEX regards all explosives regulators as important collaborators in its endeavours and is therefore privileged to publish this contribution from the ATF. This is the first article received from a regulator and we hope it will be the first of many.

Within the United States of America's Government stands an agency—small in numbers but responsible for protecting communities from arson, bombings, violent criminals, criminal organizations, the illegal use and trafficking of firearms, and the illegal use and storage of explosives. The Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) is a unique law enforcement agency that relies upon both criminal and regulatory enforcement to achieve its mission. ATF special agents and explosives enforcement officers investigate the criminal misuse of explosives, while ATF industry operations investigators enforce the Federal explosives regulations that prescribe, in part, explosives licensing, recordkeeping, and storage requirements.

ATF has made it a strategic objective to partner with the explosives industry and other government agencies to ensure the safe and secure storage of explosives while not placing undue regulatory burdens on the explosives industry. Ambiguities in regulations—and regulatory agencies' desire to clarify these ambiguities—often lead to new regulations, rulings, and decisions that can change the way industry members conduct business. ATF believes that education is one of the most effective methods to ensure compliance with regulatory standards. After all, if someone is unaware of or unclear on a particular requirement, they are unlikely to comply with it.

Over the past several years, ATF has worked extensively with explosives industry organizations and has participated in explosives industry conferences while continuing to inspect the approximately 11,000 holders of explosives licenses and permits. This two-fold approach has enabled ATF to fulfill its public safety mission while establishing a forum to educate and communicate with explosives industry members, ensuring they have the information necessary for compliance.

U.S. Explosives Violations

The following are the six most frequent cited violations during ATF inspections from fiscal years 2006 to 2011 in descending order from most to least cited:

1. Failing to maintain accurate explosives magazine inventory records vital in tracing explosives in the event of a theft or loss.
2. Failing to meet housekeeping requirements that ensure explosives storage magazines, in part, are kept clean, dry, and free of volatile materials within 50 feet.
3. Failing to maintain accurate explosives acquisition records.
4. Failing to report changes to responsible persons authorized to direct the explosives management and policies or employee possessors authorized to possess and handle explosives during the course of their employment.
5. Failing to ensure sufficient distance between explosives storage magazines and inhabited buildings, public highways, passenger railways, and other explosives storage magazines.
6. Unlawful storage.

An analysis of the violations disclosed during ATF explosives inspections between fiscal years 2006 to 2011 revealed:

1. The most frequently cited violation (#1 above) has been the same every fiscal year. It accounted for approximately 25 percent of the total violations cited in fiscal year 2011 (which is down 37 percent from fiscal year 2007 violations).
2. The second and third most frequently cited violations have been from the same two regulations (#2 and #3 above) each fiscal year. They accounted for approximately 15 percent of the total violations cited in fiscal year 2011 (which is down 55 percent from fiscal year 2007 violations).
3. The aforementioned six violations have remained in the ten most frequently cited each fiscal year, and have accounted for over 50 percent of the total violations cited each fiscal year since 2007.

Further analysis of these violations generally showed decreases of explosives violations over the 6-year period. Fiscal years 2006 and 2009 were evaluated separately from fiscal years 2007, 2008, 2010, and 2011 because of licensing requirements implemented in 2003 that significantly increased the explosives licensee and permittee population, resulting in an increase in the number of inspections every third year thereafter.

ATF saw significant decreases (between 26 and 61 percent) in five of the six violations between the high inspection fiscal years 2006 and 2009. Further, ATF saw decreases (between .50 and 55 percent) in four of six violations between fiscal years 2007 and 2011, with minor fluctuations in 2008 and 2010. However, ATF saw an increase in violations cited in both data sets for failing to notify ATF of changes in responsible persons and employee possessors. This is of significant concern to ATF because these individuals are required to pass background checks to ensure they are not prohibited from possessing and receiving explosives.

ATF attributes much of the decline in violations to companies' increased awareness of the benefits of better compliance (e.g., fewer violations, less time and money spent on man-hours during regulatory inspections). However, we also believe ATF's outreach efforts (education and communication) during the same time period have directly contributed to the violations decline. Examination of the explosives violations has allowed ATF to focus outreach efforts and educational/informational material on those issues that cause industry members the most difficulties in complying with regulations.

The Positive Side of Violations

Although most explosives industry members strive to comply with regulatory standards, even the most diligent operators may be cited for violations on occasion. However, the discovery of violations during inspections provides an opportunity for companies to further evaluate their internal controls and implement changes that can improve operations and facilitate future inspections. Further, it's an opportunity for regulators to work with industry members and offer suggestions to better secure and account for the explosives.

It is important to note that regulations are only the minimal standards set by Government agencies and often become outdated by new technologies. Industry members and regulators can and should look beyond these minimal standards to better conduct explosives operations. Through its decades of inspections and discussions with explosives industry organizations, ATF has accumulated a wealth of knowledge that can be used by explosives industry members to better prepare for the inevitable regulatory inspection.

What can explosives industry members do?

1. If you have a question about a particular requirement, contact your regulator before a problem develops. Don't assume that you're doing something correctly just because you've been doing it the same way for the past 30 years.
2. Don't assume you're doing something correctly just because you've made it through an inspection without a violation. The regulator at your next inspection may examine different processes or records than previously examined. Further, industry members may occasionally interpret regulations differently than regulatory agencies, who commonly address these interpretations through new rulemakings, rulings, and determinations. Decisions regarding your operations may have been made since the last inspection that might affect your compliance with the regulations.
3. Educate your employees on the regulations and requirements. In many cases, the employees responsible for day-to-day operations did not attend the last industry conference or seminar. It is up to you to pass along the information disseminated at such events to those in your organization responsible for these explosives operations. Decisions your employees make during these operations will ultimately affect your regulatory compliance.
4. You probably cannot send all (or any) of your employees to industry conferences. What should you do? Invite your regulators to conduct an educational seminar for your employees at your premises. ATF commonly meets with individual explosives companies for educational purposes and finds the experience beneficial for industry member and regulator alike.
5. Establish standard operating procedures for all of your explosives operations. Industry members doing the same process more than one way are likely to create confusion among employees. As a result, they will probably encounter more issues during inspections. If something goes wrong, it will be much easier for you and the regulator to find the source of an issue if you have a standardized process. These procedures should be re-evaluated on a regular basis and updated when improvements can be made.
6. Conduct more frequent inventories! If you are having accountability issues with your explosives inventory, then establish a more frequent inventory cycle. The more frequently

you conduct inventories, the more quickly you'll discover discrepancies, and the less paperwork you will have to review when an inventory discrepancy is found.

7. Invite your regulators to work sites so they can see exactly what you are doing with the explosives. Although this advice might seem counterintuitive to invite a regulator anywhere near your operations, keep in mind that many regulators have not worked for explosives companies and are not thoroughly familiar with your explosives operations. The more a regulator knows about your business operations, the more likely they will be to offer constructive suggestions if problems occur.

This is not a one-way street though. It is also important that Government agencies provide industry members with the knowledge and tools necessary to succeed in securing and accounting for their explosives.

What can explosives regulators such as ATF do?

1. Make an effort to know the industry you regulate. Sign up to receive explosives industry publications to stay abreast of new developments and issues.
2. Attend industry conferences and seminars. This is a great way for industry members to "put a face" to your regulatory agency; and vice versa. Industry members are more likely to contact you with questions or concerns if they have met you in person and can potentially prevent problems before they occur.
3. Accept invitations from industry members to train their employees on the regulatory requirements (see #3 and #4 above). This can be done in a number of ways, including teleconferencing and telemeeting. Of course, meeting in person is always the preferred method.
4. Share your knowledge with other regulators within your agency and with other regulatory agencies. Dispersing information within your agency regarding new products or processes encountered during inspections will likely prevent surprises for your co-workers during future inspections. ATF has also found it extremely helpful to meet with other agencies to better stay abreast of explosives developments and issues.

We should all remember that industry and government alike are responsible for public safety and securing explosives. Partnerships between industry and regulators will continue to ensure these goals are met without negatively affecting public safety or placing overly burdensome regulations on the explosives industry.

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.

Frank Barker is a member of our Expert Panel and was a SAFEX Governor from 2003 before retiring in 2008. He is one of the most experienced Safety Professionals in the SAFEX community as the following biography illustrates. Frank was in the ICI family and its successor, Orica, since graduating with a B.Sc. (Chem.) from the University of Manitoba, Canada. He started in the explosives industry in 1976 as a research chemist developing paint fine aluminium water gels for the South African market. Since then he has had various assignments in research, development and manufacturing before becoming a health, safety and environmental (HS&E) professional. After entering this field in 1988 as the Canadian Industry Limited's (CIL) Safety and Emergency Planning Manager, he acquired extensive loss prevention and risk management experience especially in HS&E systems, policies and standards. This included the decontamination, demolition and remediation of explosives plant as well as the conduct of due diligences for acquisition and divestment. During his more than thirty years in the explosives industry, Frank has had several international assignments in South Africa, Canada and the USA.

We are delighted Frank heeded our call for a contribution to this Feature and appreciate his willingness to share his considerable experience with our readers.

Too Big to Fail

by

Frank Barker (Retired SAFEX Governor and Expert Panel Member)

The term '"too big to fail" has been used to describe certain financial institutions as so large and so interconnected that their failure would be disastrous to the economy, and therefore government has a responsibility to support them when they face difficulty. It can also apply to other large organizations such as car manufacturers, as the financial meltdown in the U.S. of late 2008 necessitated the propping up of both General Motors and Chrysler.

In reading a local newspaper recently, I noted another use of the term "too big to fail". The article was about the cruise ship Titanic and it commemorated the 100th anniversary of its maiden sailing on April 14th, 1912. At first I was lost in the statistics – eg the ship was built at the cost of $ 8 million, while the 1997 movie The Titanic cost $ 200 million to make. The ship was 4 city blocks long and needed 44,000 lbs. of soap, grease and oil to slide the massive craft into the water at its launch. 29 boilers fueled the 159 coal burning furnaces. The two reciprocating engines were giants, each 63 feet long and weighing 720 tons.

The iceberg that the Titanic struck was 500,000 tons in weight, with only 50 ft. above water and showing. The ice field itself was 128 km. long. The Titanic was moving at near its maximum speed of 22 knots. The captain ignored 7 iceberg warnings, the last one of which was never delivered to the bridge. The final command from the bridge to turn took 30 seconds to reach the rudder crew. The ship was equipped with 1178 lifeboats – half the number required for the full complement of passengers.

The belief that the ship was too big to fail was, in part, due to the fact that the Titanic had sixteen watertight compartments. But the compartments did not reach as high as they should have; the White Star Line apparently did not want them any higher because this would have reduced living space in first class. Similarly the inadequate provision of lifeboats was allegedly due to the opinion that the deck would look too “cluttered”.

And about three million rivets were used to hold the sections of the Titanic together. Some rivets have been recovered from the wreck and analysed. The findings show that they were made of sub-standard iron. When the ship hit the iceberg, the force of the impact caused the heads of the rivets to break and the sections of the Titanic to come apart.

Also too Big to Fail?

Just recently another large cruise ship wrecked off the Italian coast. The Costa Concordia was twice as long as the Titanic, with around the same complement of passengers. It cost 450 million euros to build.

On 13 January 2012, in calm seas and overcast weather, the Costa Concordia struck a rock in the Tyrrhenian Sea which tore a 50 m gash on the side of the hull. Parts of the engine room were immediately flooded causing loss of power to the propulsion and electrical systems. With water flooding in and listing, the ship drifted back to Giglio Island, where it grounded, lying on its starboard side in shallow water. Despite the gradual sinking of the ship, its complete loss of power, and its proximity to shore in calm seas, an order to abandon ship was not issued until over an hour after the initial impact. Although international maritime law requires all passengers to be evacuated within 30 minutes of an order to abandon ship, the evacuation of Costa Concordia took over six hours and not all passengers were evacuated. There were over 30 fatalities with several others missing.

The ship's owners are currently investigating but say "preliminary indications are that there may have been significant human error on the part of the ship's master". In a statement, it said: "The route of the vessel appears to have been too close to the shore."

It had apparently become tradition for the Costa Concordia, which uses the same route on a weekly basis, to sail past the island of Giglio and blast its siren by way of salute. But on January 13th the vessel is said to have been as little as 150 yards from the shore rather than several miles out, putting it in the area of the rocks known as Le Scole. Italian prosecutors claim the captain approached the coast in an "apparently clumsy manner". Residents on the island said they had never seen the liner come so close to the rocks.

Another “too big to fail” failure? Certainly in both cruise ship disasters, the emergency actions were not performed in an optimal manner. But prior to the evacuations being required, there were many other non-optimizations, including inadequate design, poor communications, and risk-taking behavior.

Pound Pressure

Let’s move on to another very large organization that’s currently making some design decisions in an area where the risk is well known – Boeing Airlines. (Ref 3.) On April 1, 2011 Southwest Airlines Flight 812, en route from Phoenix to Sacramento with 118 passengers aboard, was completing its climb to its cruise altitude of 36,000 feet, when the controller became aware that Flight 812 was in some kind of trouble. The messages were garbled until, finally, he heard the pilot clearly: “declaring an emergency we lost the cabin.”(ie this meant the airplane had suffered a sudden and extreme loss of cabin pressure). They were diving to 10,000 feet, where the pressure inside the cabin would begin to equalize with the air outside.

When Flight 812 touched down safely a few minutes later, the reason for the emergency was a hole 59 inches long and 9 inches wide in the roof of the cabin. The skin of the airplane had peeled away. The failure was worryingly familiar: there had been a similar episode involving another Southwest airplane in July 2009; additionally, the airplane type involved, the Boeing 737, had a history of weaknesses in its fuselage skin. When the NTSB analysed the damaged part of the cabin roof, they found serious manufacturing flaws. Forty-two rivet holes at joints where the fuselage skin overlapped, called lap joints, were so far out of alignment that the lower holes had become oval, not round, causing fatigue cracks, and paint had leaked from the outer skin into the joints. The CEO of Boeing Commercial Airplanes asserted that the problem was poor manufacturing of one airplane, not a broader design issue.

The 737 Classics were supposed to have a safe service life of 60,000 flights. In fact, to meet that standard, they must be judged to be capable of flying twice that number, 120,000 flights—a safety margin, supposedly, of 100 percent. But the Southwest 737 had accumulated 39,781 cycles, a number so alarmingly below the bar set for safety that it has thrown into question the entire safety regime.

The safe working life of any jet is determined to a critical degree by how many times it can go through the repeated cycles of cabin pressurization. In order to fly in comfort at the cruise altitudes of a modern jet—between 36,000 and 40,000 feet—the air in the cabin is pressurized so that it feels like one is flying at the equivalent of 8,000 feet. As the airplane climbs to cruise altitude—and into progressively thinner air—the difference in pressure inside and outside the cabin increases. At cruise, the outward force on a typical window is equal to half a ton.

The trouble is, if the skin of the airplane is weakened, the pressurized air in the cabin will always find that weak point and attempt to escape. (When smoking was allowed on airplanes, inspectors looking for nascent failures in the skin could spot them as rings of nicotine deposits left as air leaked out). There are two consequences of skin failure: either a rapid decompression, as in the case of the two Southwest flights, during which the crew are able to retain control and make a rapid descent to a safe landing, or an explosive decompression, where the structural failure is extensive, instantaneous, and fatal.

Is the re-design of the fuselage the answer then? Perhaps, but . . when Boeing switched from the old 737 Classic to the Next Generation series, they stayed with the old fuselage design. This was as much a financial decision as a technical one, for two reasons: a new fuselage would not have delivered quantifiable improvement in operational efficiency; and a wholly new airplane would have been far costlier because the old production line would be obsolete. And, since the NG series was a mixture of old and new, the FAA was not required to treat it as an all-new airplane, which would have involved a long, expensive, and rigorous test program. Instead, it cleared the new model by allowing it what is called an Amended Type Certificate.

What are Boeing designing now? They are now bringing out yet another edition of the 737, the 737MAX, which will have a new engine promising to be 10 to 12 percent more fuel efficient. The fuselage will, however, remain much the same—and the MAXes are likely to be flying well beyond 2025. In December 2011 Southwest gave Boeing the fattest order in its history—for 208 new 737s, 150 of them to be the 737 MAX. And in January Boeing won its largest European order ever when a Norwegian airline ordered one hundred and twenty-two 737s.

An industry authority on aging airlines and metal fatigue has been quoted as saying . . everything goes back to the original problem, the thin skin. "The skin thickness remains constant throughout the series. You can't change that without changing everything that mates with the skin—it would constitute a radical redesign which has never been done."

What do these three stories have in common?

The Dupont company used an expression "pound pressure" and it referred to the pressure to make pounds of product, that is to keep the production lines going at all costs. Not to say they were advocating it! Only that they were aware that sometimes safety considerations get lost in the shuffle, and this had to be recognized and addressed.

Certainly speeding through a 128 km. long ice field at maximum speed to get to New York in record time (less than 6 days) does not seem wise in retrospect. The Captain said years before the Titanic's voyage, "I cannot imagine any condition which would cause a ship to flounder. Modern shipbuilding has gone beyond that." It appears knowledge of the risk was limited, and all warning signs ignored.

Sailing the 600 meter long Costa Concordia 150 meters from shore to give islanders a salute was certainly risky behaviour; it seems more like lunacy! However, did it happen just the once? Were there preceding incidents that may have alerted ship owners to the risk-taking tendencies of the ship's staff?

And what about the known hazard, the allegedly thin and antiquated fuselage design of the 737, that Boeing has indicated in not a design issue? It appears the technology of fuselage design has evolved over several decades, the 737's has not. As a result, the final responsibility for safety has moved from Boeing to the maintenance and safety checks carried out by the airlines and supervised by the FAA. So far this final safety net has mostly worked—the flaws have been caught before they've caused a fatal crash.

Note: Over the years, the Boeing 737 has been the world's most popular airliner for intercity routes. One takes off or lands every 2.5 seconds. Its accident rate, compared with other aircraft, is relatively low: one for every 2.5 million hours flown.

And these operational problems, and the considerable costs of fixing them, have not diminished the airlines' appetite for the 737's. It is the bestselling airliner in history: almost 10,000 have been sold, and the demand is so great that Boeing aims to deliver 42 a month by 2014.

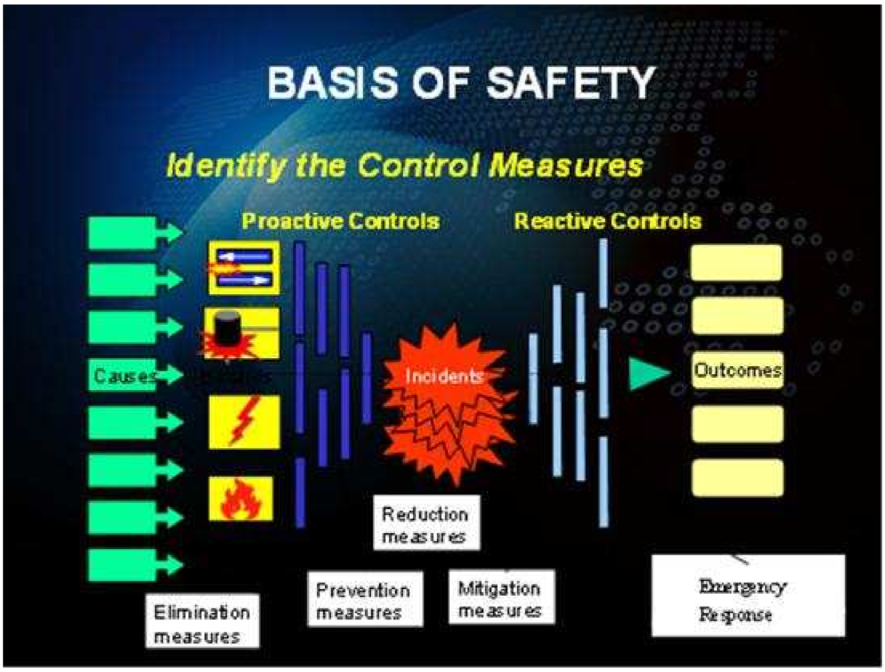
Pound pressure driving design decisions in a hazardous area with severe consequences?

Closer to Home

Let's move on to our industry . . . making explosives and explosive devices, transporting and distributing them to our customers, and in some cases loading and shooting them in the field. The list of incidents is long, and is faithfully documented by SAFEX in its database.

In some cases the consequences are less significant, such as the Argyle incident in Australia where a container of waste emulsion exploded injuring two operators seriously, but non-fatally. In this case the hazard was unrecognized but, as the incidents involving sodium nitrite and emulsions multiplied, the situation eventually led to a detailed Basis of Safety document being developed and several control and management activities identified. In other cases (Porgera, Lorena) the number of casualties were much larger, and the subsequent investigations indicated that possible pumping problems had led to the explosions. In these and other similar cases with pumps the risks were known and understood; however the control measures and mitigating procedures were inadequate and were not followed.

In a paper to the SAFEX Congress in Amsterdam in 2002 Andy Begg was concerned that "the Basis of Safety was collapsing" He went on to say " In recent years I have had the opportunity to look at a number of incidents involving explosives. I have also had the oppor-



tunity to visit and inspect a large number of explosives facilities in many countries. All of the facilities involved have had safety management systems in place, some more comprehensive than others, yet in all cases failings, often serious, have been observed in attention to basic explosives safety controls. We are not talking here about major modifications to plant — what we are talking about is deterioration in explosive practices, that is to say that the initial "good practices" are no longer being consistently followed."

What causes this decay in safety controls? Certainly the risks of the manufacturing operations are the same. Explosives are meant to explode. As Tony Rowe of AEL once famously said "We're not making sweeties here". If they explode in the wrong place in sufficient quantity people will get hurt.

Risk Metrics

Summing up some of the consistent themes from the cruise ship and air ship disasters and from our industry, we notice :-

- "pound pressure" driving inappropriate design and behavior,
- evidence of complacency,
- lack of understanding of hazards and of overall risk,
- poor application of control measures,
- poor communications and
- a collapsing Basis of Safety.

How can this these shortcomings be addressed?

In the past we've talked about how to assess the SH&E health of an organization. (Developing a Diagnostic to Assess the SH&E 'Health' of an Organization, SAFEX Congress 2005).

In this article I'd like to narrow the focus and talk about tracking the risk 'health' of an organization and what's needed to address the gaps. How do we know when the risk focus of an organization is skewed or at least incapable of warning when a significant incident will occur? How can we "make the diagnosis"?

We could consider using leading indicators in the risk area, and also raising the level of awareness of risk and consequences throughout the organization. The more people are aware of what can happen, what has happened in the past (inside and outside one's local operation), and what controls are in place to avoid the consequences, and how rock solid these controls are, the better the risk profile of the operational environment will become.

To track this area effectively, it requires first of all a consistent focus in the organization on risk assessment, with many "cuts" at the risk crocodile. This starts with hazard studies on projects, followed by risk reviews of modifications to the process once implemented, and then 'evergreen' periodic hazard studies/risk assessments on operational activities as they mature and as technological improvements facilitate better controls & safer operations. Supplementing this focus is training and auditing - to ensure people do not forget the lessons of the past and that all controls are robust and in place. No better training can come from the reporting and investigating of incidents, from minor to significant, and the implementation of any required imprtovements.

Perhaps we could develop some SPI's (Strategic Performance Indicators) to determine if the risk profile is solid and improving in an organization. What might they look like?

At the local level, they can be the number of Take 5 risk assessments or JSRA's performed against plan. Or the number of Basis of Safety audits completed. BOS audits can be as simple as a daily check of controls against requirements, which serve the dual purpose of ensuring they are working and that operators are aware of their importance. (I have seen these daily checklists used very effectively on the back of daily production run sheets/Q.C. reports, which are normally required in daily operations anyways.). Or BOS audits can be far grander, with a team of technical 'fundi' descending on a plant and looking at all processes and all safeguards.

At the technical level, SPI's can be the percentage of hazard studies completed vs. requirements, the % completion of hazard study training and new leaders, the level of completion of the periodic hazard study process (if in place) against target, etc. The latter is a very important tool in the risk avoidance arsenal, and a SPI based on this bit of process will be a good indicator of the required risk profile.

And at the management level, it can include some measure of senior management participation in the risk assessment process, such as managers leading annual Basis of Safety workshops, helping with local Take 5 reviews or JSRA's, doing Face to Face audits with local managers on the rigor of their risk assessment process and action follow-up . . in other words "showing the flag" in this important area.

The Role of the Safety Professional

And the role of the safety professional is to drive this process of measurement, to be the 'town crier' or advocate of risk awareness, and to keep the focus on the right areas.

Also it is critical that the appropriate professional resources are in place to assess the risk properly and that the professionals are empowered to implement the required control measures.

This was stated clearly by Toby Louw of AEL in a recent SAFEX newsletter: " The general simple model and principles I've adopted to take the message into the workplace is based on two fundamental capabilities: The professional capability within an organisation to set the required safety level; and the behavioural capability of the organization to not only embed it in but continually improve it.

A company's professional safety capability is the quality of its professionals and line management upon whom it relies to set all safety standards; to ensure that all assets and processes are capable and safe; and to lead and drive further improvements. They include the safety experts, engineers, process technologists and product designers to mention a few. If the professional capability is not in place you fight a losing battle to get the behavioral capability right.

Professionals are, therefore, the foundation of an organization's safety efforts which makes investment in professional development critically important. Any deterioration in safety professionalism will not show in your safety statistics until it's too late. When Warren Buffet was asked how large companies fail he replied "slowly, slowly, suddenly".

I'd like to finish off with 3 further quotes that sum up for me the type of long-term focus required in this critical area.

"Managers must be in a state of mindful paranoia"
Phil Wieckhardt, Orica CEO

"Be concerned if you not hearing anything about safety from your operations. There's always news on safety; and some of it is not always good"
Brian Appleton, chairman Piper Alpha enquiry

"A long period of successful outcomes in the safety area should result in equal measures of satisfaction for the achievement, and concern for the future."
Graham Liebelt

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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.

AECI's Green Gauge Programme: AEL Mining Services Responds

by

Ellen van Dongen

(Group Environment Manager, AEL Mining Services)

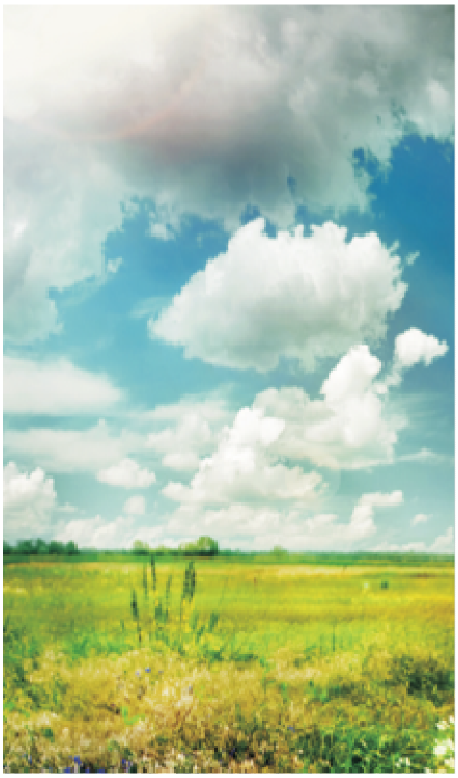
It is widely acknowledged in business that good environmental management is no longer a "nice to have" but is an integral part of good business. Globally companies are expected to report not only on their financial position but also on their environmental performance. In addition governments are placing more requirements on business to report on environmental indicators such as carbon emissions and some impose taxes on emissions such as carbon.

As a constituent of the Johannesburg Stock Exchange (JSE) Limited's Socially Responsible Investment Index, AECI strives to integrate the principle of the Triple Bottom Line (people, planet, profit) and good governance in all its business activities in a progressive manner.

Being able to manage environmental impacts and issues is becoming increasingly important as knowledge and understanding of the global environment becomes more pronounced. In October 2011 AECI took another step forward in entrenching its values and business practices when it launched its Green Gauge programme across the Group. Green Gauge is a framework of environmental objectives and targets.

As a subsidiary of AECI, AEL Mining Services launched Green Gauge at its senior leadership meeting in March 2012. Green Gauge adds another dimension to AEL's environmental management programme by formalising the alignment of AEL's environmental management system with the targets and objectives of its parent company.

Green Gauge has six key focus areas that include resource and water conservation and recycling, energy conservation including global warming prevention, chemical substances management, remediation, communication and awareness and management aspects. Progress on actions to achieve targets in of each of the focus areas will be reported annually.



Within AEL Green Gauge will create further awareness of the need to operate in an environmentally responsible manner and encourage the design of products and processes that minimise the use and generation of hazardous substances, or reduce AEL's carbon footprint or that of its customers. The roll out of Green Gauge will require AEL sites to identify opportunities for improvements associated with the key focus areas and to implement plans to achieve these.

Green products and processes already been implemented include the manufacture of AEL's Eco anfex and ECO surface bulk emulsion products and the design of blasting patterns that obtain optimal rock fracture to ensure improved energy efficiency in a mine's rock processing chain.

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.

Is the PPE you provide "Type Tested"?

Two operators suffered burns (one of them was severely burnt) when a solvent fire occurred during the kneading operation of recycled single based propellant material in the facility of one of our members. The sprinkler system activated promptly preventing damage to the facility and equipment. The incident raised questions about the Personal Protective Equipment (PPE) that the operators used.

The Incident Notice prompted Andy Begg (Individual Associate and Expert Panel Member) to make the following observations: Yes, the fact that their PPE did not offer adequate protection is of note. I am sure the investigation will not only deal with the initiation but also with the adequacy of the PPE. As we know from experience, providing PPE is only part of the requirement. Making sure that it is "type tested" under the likely worst case scenario is the first part and I wonder how often this is done. Furthermore, some change is made to the operation but the PPE requirement is not reviewed.

On the design of Road Tankers for Precursors

Last year the rear trailer of a type 1 road train combination in Australia became unstable and rolled after the train left the roadway. 300 kg of emulsion was spilled. The investigation revealed that the tank manhole hatch covers had not been secured before the vehicles started their journeys. Hatches are designed to prevent loss during rollovers but are only effective when secured. Tanker hatches have protection to prevent damage during rollovers. It prompted the Explosives Inspectorate in Queensland, Australia to issue a Safety Alert recommending that hatches on the tankers must be secured before transporting cargoes.

Dr Martin Held (Austin International) found the Advisory very relevant and commented: Securing hatches on AN and ANE bins in transportation addresses the risk and potential consequences of spillage/environmental damage. My question concerns the risk of explosion in case an accident is accompanied by a fire. I agree that securing diesel/fuel hatches is always a must both from an environmental perspective as well as representing additional fuel for a potential fire. I am not familiar with the material used in Australia for tank walls (aluminium and/or stainless steel) or if pressure relief valves are required on top of tanks. However, standard pressure relief valves can only operate properly when they are not blocked or corroded (internal parts often contain brass that starts to react with ammonium nitrate leading to malfunction if not properly maintained). In case of a rollover a blockage of these devices by emulsion is almost unavoidable and in case of a fire pressure cannot be released. Comparing the release area of such devices with the tank size and volume sometimes appears to me like emptying a bath tub through a straw.

If it is a legal requirement to secure hatches, suitable pressure release devices should be provided in case a truck and its load become involved in a fire after an accident. These could be large rupture discs that are incorporated in the hatches but do not break in case of rollover. However, if there is a fire an increase in pressure needs to be released and require safety discs that rupture or melt at a certain temperature to release pressure.

Some countries' philosophy is to use only aluminium as wall material for tanks and prohibiting the use of stainless steel for this purpose. However, I still would not recommend waiting beside an aluminium tank filled with emulsion or AN which is involved in a fire to watch if the aluminium bursts or melts. It is always best to evacuate.

To conclude, it is good that this Safety Alert reminds people about securing hatches to prevent an environmental impact from spilled material. However, my concern is the impact on people when emulsion or AN is exposed to fire and explodes after an accident and not only the spillage. In addition, the Safety Alert refers to AN, emulsion and fuel only. Spillage of chemical gassing reactants such as acetic acid and nitrite solution and mixing with AN or emulsion can start a violent reaction followed by decomposition and explosion at worst.

Mr Geoff Downs, Queensland's Chief Inspector of Explosives, kindly replied as follows: My comments are in 2 sections: one on the general tanker requirements and the other general comments on the enquiry/feedback:

General Tanker Requirements

Tanker construction in Queensland is guided by a tanker approval process which links directly to the requirements of Australian Standards AS 2809 Part 1 through AS 2809 Part 4. Part of this process ensures that the main openings for tanks maintain integrity at low level impacts but fail at a predetermined pressure which is dependent on the manufacturer and product to be carried but usually peaks at around 30kPa. Construction of these tank hatches also is captured under Australian Standard AS1210. Periodic pressure testing is required to ensure compliance.

Pressure relief devices are also installed for tanks carrying process fuels and effect chemicals. Shut off valves are fitted within these pressure relief valves for prevention of spills in a roll over. These minimise cross contamination in rollover of mixed loads such as those carried by mobile explosive manufacturing units but still maintain that upper level failure of 30kpa in the event of tank heating or deformation etc. Large bulk explosive precursor class 5.1 loads such as UN1942 and UN3375 are not permitted to cart incompatible materials such as process fuels and effect chemicals under controls embedded in the Australian Dangerous Goods Code. This code can be downloaded from the web http://www.infrastructure.gov.au/transport/australia/dangerous/dg_code_7e.aspx and http://www.ntc.gov.au/viewpage.aspx?AreaId=35&DocumentId=1147 .

Material of construction in tank vehicles is also linked back to AS 2809 and addresses the corrosive and integrity requirements relating to the substance to be carried and limits the operational life of the tank. The requirements look at aluminium, steel, and stainless steel grades and thicknesses and require engineer assessment of the loadings and stresses on that material. Minimum standards of material thickness, grade, construction and tank integrity protection are also set. Compatibility of piping and transfer components with the carried product is also captured to prevent corrosion and failure of tank components.

Lastly any events such as accidents, fires, rollovers and structural failure are reviewed jointly by the manufacturer and operator and the learning's are rolled back into future construction. A copy of our tanker checklist is available from the SAFEX Secretariat in case you are interested.

General Comments

Most of the tanks in Australia are stainless steel. The alert was general by nature and addresses all transport scenarios whether they are in a mobile manufacturing plant or general transport.

I agree that the risk of explosion resulting from fire and confinement (pressure and heat) is an issue from the design and maintenance perspective and the points you make are important. The use of aluminium can be seen to be preferred to steel (stainless) due to the risk of explosion issues raised and the current designs. However, this should in principle depend upon other design features employed and the maintaining of these features. There are classic competing priorities between safety and economics particularly when the standards allow both. The designs (or the selection of existing plant) for these types of uses and applications should include safety features which address these issues of the potential for explosion caused by fire after roll over. These are credible scenarios and the designs should address these events. While it may be argued that leaving a hatch open provides a safety solution to this type of event, I believe that this is not the intended feature of the design to address the hazard and the risk of explosion. Therefore, the design should be based upon hazard identification and risk assessment adopting risk analysis techniques including fault tree analysis, HAZOP, HAZAN etc. This would allow the hatches to be closed and address the risk of explosion from fire and rollover scenarios. There are credible design solutions that could address this issue.

The presence of brass in the pressure relief valves is a concern as TACN which is a sensitive explosive will be formed.

The spillage of chemical gassing reagents is also raised. The comments raised about the potential for explosion are valid questions. The information I have is these chemicals do not have an affinity to mix readily with ANE etc. to create a dangerous situation in accident situation. Again, the risk can be assessed through hazard identification and risk assessment techniques on the case by case situation for the identified transport scenarios for the scenarios with the effect chemicals under the circumstances identified.

All hatches where the contents are security sensitive explosives must be properly secured with tamper evident seals or locks. AN and ANE are security sensitive explosives under our system. Unlocked and unsecured hatches from our perspective are an unacceptable security risk.

Ignore Burning Grounds at your Peril

The most probable cause of a burning ground explosion one of our members had late last year was some stray detonator cord that landed unintentionally among the waste emulsion cartridges being burnt. The report emphasized the need for good burning ground practices such as sorting of explosives waste and not confining the material to be burnt. It also recommended the waste explosive material should be laid on top of the fire. In the incident the wood for the fire was stacked around the cases of emulsion that were being destroyed.

Maurice Bourgeois (GD-OTS Canada) endorsed the recommendations and commented: Boxes should not be stacked inside the wood used to lay the fire because the heat generated by the wood can bring the center of the stack to auto-ignition temperature. In our view boxes should be opened and the explosives spread out so they burn unconfined and don't create a hot spot in the middle of a stack.

Ashley Haslett (Kemek and Groupe EPC) is the SAFEX Contact for his unit and brought this report to the attention of his team in an exemplary manner. **Here is his feedback**: Please convey our appreciation to the member concerned for sharing their experience in this report. I am using it to reiterate again the importance of ensuring this high risk activity is conducted with diligence each and every time. I'm sure most of us have experienced this type of incident in some form and it illustrates we need to keep focused on the Do's and Don'ts.

In addition to the report, I've circulated the following to my team:

- Explosives and waste explosives can and will explode!,
- The area used for burning should be suitable for the quantity being burnt from a safety and environmental perspective, and must be cleared of previous ashes prior to any new burn being laid;
- The quantity being destroyed must be limited (licence quantity is the absolute max);
- When waste is burnt, it should only be done with compatible products;
- It should be known what is in each "burn" and the quantity / type and condition of each article recorded – nothing metal or any other kind of waste should be included;
- The individual articles should be spread around the burning pad. In the event of cartridges, they should be broken down into small pieces;
- The ignition should be done remotely, with no return after the burn is ignited or failure;
- Access to the burning area must be prevented during a burn;
- Only persons trained, competent and authorised should carry out the burning activity. Any assistance provided must be closely supervised;
- Ideally, monitoring of the burning should be conducted remotely, by CCTV, and should be undertaken during daylight hours, such that it can be confirmed via CCTV that it has extinguished prior to the day shift leaving site.

Henry Merrick (AEL Mining Services) forwarded the following comment from his colleague Kobus Theron: It is good to modify the waste burning method. In our experience before burning the cartridges they must be taken out of the cardboard box as well as the plastic in which they are packed. If you burn the waste while still packed, the additional confinement may promote the onset of a detonation. We also go so far as to cut open large cartridges before burning them.

Ponder this if you will:

If you see a mistake and don't fix it, it becomes your mistake.

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 from AEL Mining Services has 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!

Is it fine to ignore a sign – Not on your life!

by

Tony Rowe (AEL Mining Services)

I recently had a new title bestowed upon me. I don't know if it is better than my last one, but it's certainly longer, lots of letters. You can rearrange them to make other more interesting words; some of them quite rude!

I am old, probably almost old enough to warrant the term decrepit. When I look out across the narrow passageway that links my office with the outside world I can see a small sign with a green background. I don't know why, but it's getting a bit blurry these days. When I stand closer to it I can see, picked out in white, an image of what my brain tells me is a man running. He is running from right to left. I often wonder if he is there to encourage me or to mock me? You see I haven't run in years. If I do have to move quickly I grab my Harry Bolt walking sticks, not the wooden ones, but my collapsible carbon-fibre specials with the go-faster stripes and high-traction ferrules. They're dear to me so I always keep them close by.

I'm actually looking at the white runner while I'm typing this on my Remington, streamlined home portable, de-lux. Is that a smile on that bland white circle he has for a head? He is laughing at me I'm sure. Have you ever noticed though that he doesn't have hands or feet or even a neck for that matter? His head is a free-floating disk, so it's no wonder he doesn't talk and what is it that leads me to assign the male gender? He is part of a safety sign - there to indicate to myself and perhaps others who may be unfamiliar with the geography of the building, the most direct way out in the case of an emergency. Actually the quickest way out is through the window, but remember you have to either open it or break it first.

Why am I twittering on like this, well it's all about attention to details. Nobody really looks at signs any more, we've become immune; I mean how many have you walked by today and what was each trying to tell you

Traffic signs are a good example. We see them, but it's almost a subliminal experience. They sort of register briefly and are gone. We rarely study them closely unless they carry directional information which is pertinent to us at that moment. Street and road names are the same. Some get stuck in our memories due to continuous repetition, (we pass them every day). Others may strike a particular chord that resonates peculiarly and uniquely with us. Sandy Bottom is my own personal mnemonic. Sandy was a young lady of my acquaintance and no - I never found out.

Sandy Bottoms aside, what about safety signage? Is it the same?

We have a few such signs in the corridor I mentioned earlier. One shows images of various primary explosives. Mustard, shades of pale cream, lilac/purple, turquoise/blue and coffee colours are all exhibited. Some are not the natural colours of the particular explosives, but rather the colour that results from a dyeing step (you see at AEL Mining Services, we dye some of our primary explosives to make identification easier). Personnel – involved with explosives – but perhaps not directly with the primaries pass these images many times a day, 5 days per week. Stop any of these people at random (male or female) and ask "Hi Bob or Carole, what colour is sodium chloropop?" They usually don't know and will often counter with a question of their own, "Why are you asking me? I don't know and it's got nothing to do with me anyway!"

In the explosives industry as with a few others, these are words that can kill. The dead person(s) might only be themselves, but their demise could include others - perhaps even you.

Maybe you think that I am talking scribble, but surely we need to be able to recognise things and situations that can harm us. Snakes and spiders seem to stir an almost visceral reaction in some people, but a kilo or two of coffee coloured powder on the floor, provokes no reaction at all. I suppose it depends on which floor, but you get my drift I hope.

Safety signage in particular aims to provide us with information that is useful. It aims to either keep us alive or at least prevent serious injury. “Wear Your Safety Glasses” is perhaps a typical message. Why would you choose not to is what I don’t understand.

That 55% nitric acid is corrosive is the underlying message in another. This is true as exposure to 55% nitric acid can certainly be a life altering experience. Why then do people not heed the warning?

Back to cars again. Seat belt signs are everywhere. Wearing a seat belt undoubtedly improves your chances in a crash situation. Yet every day I observe drivers and passengers in vehicles who aren’t wearing theirs.

This is a simple plea. See the signs. Read the signs. Pay attention, internalise the teachings then do what it says. You’ll have a longer and happier life.

Is it fine to ignore a sign? Only if you are a queer bird.

You know it makes sense

Boet Coetzee

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May I leave you with some final thoughts:

The best gift you can give your family is YOU. Be Safe!

Broken equipment can be replaced. YOU can't.

(Don’t ever underestimate your worth to others)

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