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Chairman's New Year Message

Claude Modoux

As we get older time seems to go by faster. It feels like just the other day I had the privilege of writing a New Year Message for the SAFEX Newsletter. Now it is that time of the year again and what a pleasure it is to do so once more.

Not everyone experiences the end of a calendar year and the dawning of a new year in the same way. For some it is also a festive season in which gifts are exchanged. Children, especially, can't wait to receive their gifts as they count down the days. For them time seems to drag at the end of the year whereas it comes with increasing rapidity for grown-ups. The unknown of the presents they may receive holds no fear or apprehension for children. On the contrary, they can't wait and have to be urged to be patient until it's time for the festivities to begin.

It set me thinking and I wondered whether there is something we can learn from those children as we prepare for another new year.

For children the approaching festivities means learning to wait. Waiting is an art which our impatient age has forgotten. While patience is a virtue we can all do well to adopt, it is particularly important in our industry. How many of our incidents have not been caused by people who were in a rush or impatient - unwilling to wait for the reaction to run its course; not taking the time and care necessary to decontaminate plant or equipment properly before working on it; taking shortcuts in a procedure in the hope to get the task done quicker; assigning a task to someone before he has been fully trained; and so forth. Yes, we need to be more patient. Patience is not tolerating what is blatantly wrong or errors that are repeated. Patience does not mean we accept these practices that are often the result of laziness; laziness to learn and laziness to apply what we have learnt. Patience can never be an excuse for laziness.

For children the approaching festivities also means a time of positive anticipation. It's about the way they approach the uncertainty of what is to come. Why are children not afraid of the "unknown" associated with the gifts they

expect? In fact, they feel just the opposite - they can't wait to receive them (to have their patience rewarded!). Why? Could the reason be that they only associate such gifts with "good"? They realise the gift will not harm them – if used as intended, of course. They trust the giver of the gift has their best interests at heart. Parents take great pains (you ask any parent returning from "festive shopping") to ensure the gift of their choosing is appropriate for the developmental level (knowledge and experience) of the child. Can we as an industry not learn from this? It is **not** about viewing employees as children and treating them as such. It **is** about ensuring that what we give our employees will not harm them. Do we take pains to ensure employees have the necessary knowledge and experience to use what we provide without fear i.e. with positive anticipation? This can happen if: we minimise the risk to them; they use it as intended; and each individual has the necessary knowledge and experience to work with it.

Let's learn from children this festive season; let's reflect on the patience they need and the trouble we take to make them feel "good" about what we give them. Our employees deserve the same. In this spirit I extend to you, your relatives and families, our best wishes for a joyful and festive holiday season. May 2014 be free of harmful incidents as well as a blessed and happy new year for us all.

This is your Captain Speaking

Karl Maslo (Exsa)

Karl speaks three languages and has extensive expertise in manufacturing and marketing welding, blasting, petrochemical and general industrial products and services. His multifunctional experience in company restructuring, mergers and spinoffs has led to sustained success of the businesses for which he has been responsible. The cultural transformation of such companies has been a specific challenge in which he has excelled. Karl has focused on the organic expansion of his businesses to new markets or new services and products as well as in their inorganic development.

EXSA is the leading blasting products and services company in Peru. It focuses on offering solutions for rock fragmenting in mining, infrastructure and construction. With over 60 years in this business, the leadership of EXSA is based on its high safety, quality and efficiency standards.

At EXSA, due to the high risks that our activities involve, safety is in our DNA, and our level of awareness in this regard is such, that our annual celebration schedule includes the "EXSA Safety Day" once a year. The EXSA Safety Day is the only date, other than official holidays, when the company stops work in all of its operations, so our collaborators can be trained in, strengthen and share their comprehensive safety knowledge.

As with a market that is in constant evolution and technologies adopting new forms and channels, we in EXSA have evolved accordingly. On a strategic level we have accomplished a new focus moving from services into solutions responding to the requirements of our clients. This is how EXSA provides safety solutions, where we transmit our knowhow with the expertise for which we stand out, with the goal of having our solutions generating beneficial effects in the acceptance of our customers by their communities and, in general, all stakeholders.

We have developed a responsible safety culture as our main value. Accordingly, and driven by our wish to contribute with our community and all of our stakeholders responsibly, we believe that the best way to achieve that is providing them with safety education, targeted mainly at the most vulnerable in our area of influence, that is, the children. One of our main programs is "Safe Schools with EXSA" (*"Colegios Seguros con EXSA"*), an initiative intended to take the culture of safety of EXSA to the youngest and most vulnerable, providing training to children in various schools in our area of influence. Such training consists in identifying risks and hazards in the event of emergencies or natural disasters, and in imparting evacuation strategies to prepare the little ones to cope with a crisis. This initiative is implemented by EXSA personnel together with our Retiree's Committee, which gathers former employees of ours, and the wives of our current collaborators represented by the Women's Committee of EXSA.

Other programs currently in place to further safe development of our stakeholders include "Making the Community Safe" ("*Asegurando la Comunidad*"), which consists in providing safety training to all communities in the surroundings of our operation, both production and mining, especially in the use of extinguishers, natural disaster response and other subjects. These training sessions are conducted in medical facilitates and/or in collective kitchens.

We also have the "Safe and Responsible EXSA" (*"EXSA Segura y Responsable")* program, in which authorities and leaders inside our areas of influence are invited to visit and know EXSA from within; living and learning what safety means to us on a day-to-day basis. We want to make sure that the development and safety of our communities is not jeopardized by disasters or acts with unsafe conditions.

Congress Chat.

Training Session: Register early to avoid disappointment

The Training Sessions during recent Congresses have been oversubscribed on each occasion. With *Hazard Study Leader Training* as the topic of the Congress Training Session in Warsaw, everything points to it being the case again. Since Andy Begg and Martin Held, who are co-conveners of the Training Session, announced the topic for the next Congress Training Session, we have received inquiries from a number of interested people. If you are one of those interested in the Training Session, register early and avoid disappointment as we are only able to accept the first 25 participants who register.

We asked Andy and Martin to elaborate on the topic: "A hazard study is a comprehensive, multiple-stage SHE assessment to support the design of a safe plant or operation and its execution," they said. "Most people are familiar with risk assessment and HAZOP as these are powerful tools in assessing and managing hazards. However, they are usually limited in their scope and often assume that critical information is known or available without confirming this to be the case. They also frequently look only at part of the overall process in question. The training being provided will present a comprehensive hazard study procedure based on the techniques developed by the chemical and explosives industries over many years. The methodology will include background reviews and data collection for the study, major hazards risk assessment, HAZOP, pre-commissioning reviews and post completion review. The training will include explosives specific case studies and syndicate exercises in applying the methodology."

Who should consider participating in the Training Session? Participants can be from any technical function and can include R&D, field technical, engineering, operations and SHE personnel. The training is not intended for persons already trained in the comprehensive methodology but would be suitable for those with previous training in risk assessment and /or HAZOP.

If you are experienced in Hazard Studies, the Conveners invite you to participate as a facilitator or provide relevant case studies. Your involvement would be welcomed.

Interested readers may find the following helpful:

- Number of participants will be limited 25.
- Duration of the Training Session (2 days) – 19 and 20 May 2014
- Language skills: A good working knowledge of written and spoken English is essential.
- Preparation: Pre-training material will be sent to participants.

Remember to register for the Training Session right away and avoid disappointment. Contact the Secretariat at secretariat@safex-international.org for a Registration Form—do it today!

2014 WARSAW XVIII SAFEX CONGRESS

Where are you staying for the Congress?

Make your reservation through SAFEX for the Warsaw Marriott

It will be difficult to beat the following rates for hotel accommodation of the standard offered by the Warsaw Marriott in Warsaw during May 2014:

- Single at PLN 490.00 (approx. EUR 120) per person per night
- Double at PLN 530.00 (approx. EUR 130) per person per night.

The only reason we were able to obtain such rates is on condition that SAFEX handles the hotel reservations and submit a block booking on 31 March 2014. SAFEX willingly accepted this additional task given that it will make it more affordable for delegates to participate in the XVIII Congress next year.

If you plan to participate in next year's Congress in Warsaw, you can help by:

- Deciding about your attendance as soon as possible and make your Hotel Reservation promptly.
- Making a Reservation before **30 March 2014** to be assured of the SAFEX rate if you wish to stay at the Warsaw Marriott, the Congress venue.
- Completing the Hotel Reservation Form for the Warsaw Marriott using the Form which is available from the Secretariat. An online Hotel Reservation Form should be available on the SAFEX Intranet soon for people who would prefer to do it online.

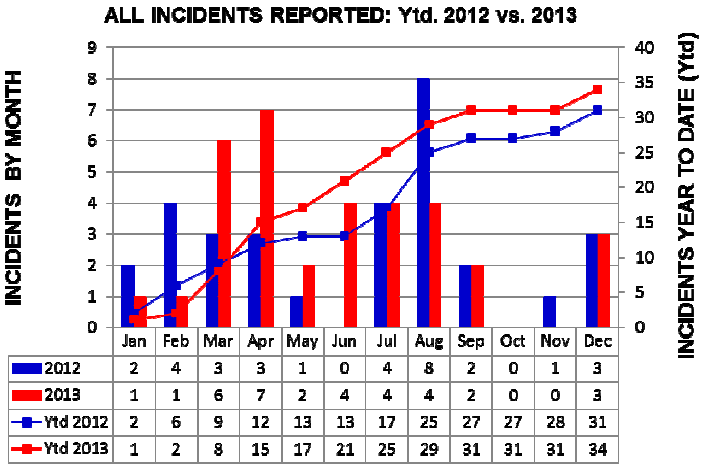
We're looking forward to receive your Hotel Reservation soon.

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."

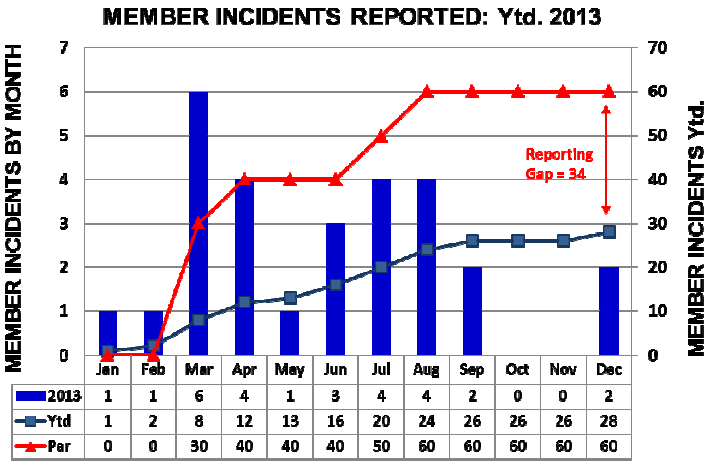
SAFEX learns from its members' experiences through the incident reports we receive. By applying these lessons we can prevent similar incidents recurring. That is why we track our incident reporting performance as follows:



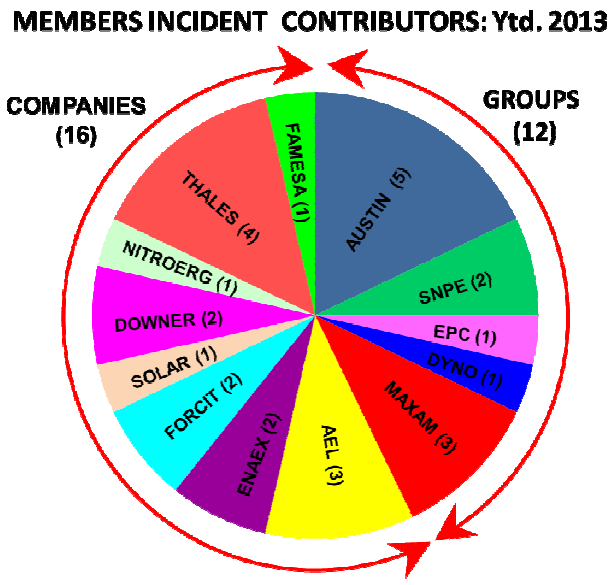
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	2	4	3	3	1	0	4	8	2	0	1	3
2013	1	1	6	7	2	4	4	4	2	0	0	3
Ytd 2012	2	6	9	12	13	13	17	25	27	27	28	31
Ytd 2013	1	2	8	15	17	21	25	29	31	31	31	34

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 about the same number of incidents this year as in the same period last year. Last year's performance was low compared to previous years. We are therefore still concerned whether the incidents we have are being reported. 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
2013	1	1	6	4	1	3	4	4	2	0	0	2
Ytd	1	2	8	12	13	16	20	24	26	26	26	28
Par	0	0	30	40	40	40	50	60	60	60	60	60



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

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.

Mervyn Traut

PERSONAL

Position: Proprietor
Company: MD Traut Consulting
Location: Somerset West, South Africa
Education: Higher National Diploma (Chem & Ind Admin)
Affiliations: NIXT and SAFEX Expert Panel
NACA (National Association for Clean Air) (RSA);
Leader, SAFEX Remediation Workgroup
Languages: English; Afrikaans

CAREER OUTLINE

With AECI / AECI Explosives / ICI Explosives

- Explosives Laboratory Manager
- Research/Development Technical Officer
- Explosives Production Manager
- General Manager AECI Somerset West

Own consulting business

- Proprietor

EXPERTISE

- Safety review of explosives operations and risk management
- Drafting of Explosives Operational Standards/Auditing
- Incident investigation
- Training/mentoring
- Plant design and Manufacture of NG/NC/PETN/Detonating Cord/Boosters
- Decontamination/Demolition/Characterization/Remediation of explosives and chemical plants

TYPICAL ASSIGNMENTS

2000 to 2013	**Redrafting explosives standards and BoS documentation; Technical training and mentoring of PETN and Booster plant operators; Decontamination of a PETN facility; Expert opinion on the impact of iron ore mining on explosives manufacture; incident investigations; Risk Assessments and Hazops**
1989 to 2000	**Decontaminated, demolished, characterized and remediated explosives facilities involving NG, NC, TNT,PETN, Hg Fulminate**
1989 to 1986	**Introduction and maintenance of the ISO 9002 systems for explosives, agrochemicals, laboratories and site remediation activities.**
1986 to 1988	**Development of new detonating cords, boosters and various grades of PETN for the local and export markets.**
1979 to 1985	**Recognized as the Company Custodian and international expert in the production of PETN, detonating fuse and boosters.**
1978 to 1979	**Introduction of a novel storage and distribution system for explosives products.**

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, Consultant with Explosives Risk Managers LLC; John Tatom, Manager, Explosives Safety Group at APT Research, Inc; and Mike Swisdak, creator of the US Department of Defense' ESKIMORE large scale test program and currently a senior scientist at APT Research. This instalment focuses on the issues to be considered in debris modelling.

Considering Accuracy and Conservatism in Debris Modelling

by

John Tatom (Explosives Safety and Testing Division Manager, APT Research, Inc)

When modelling debris generated by an explosives event, the behaviour and hazards associated with the debris can be addressed with differing levels of complexity. The most complex of models would look at each debris element and track its behaviour from origin to final resting place, considering the time-history of all debris in order to characterize the hazard. This thorough approach may provide the most accurate representation of the event, but is extremely difficult to design for a particular event, the predictions are not applicable to other situations, and would require computation power beyond the reach of most users. The simplest approach would be to devise some rudimentary tables that provide the general idea of the debris hazard, without the ability to provide any details within the predictions, and with very limited ability to distinguish between scenarios.

These limitations of the modelling extremes have lead to the development of better routines for fast-running models (FRMs). These debris models rely on probability density functions (PDFs) to characterize the debris behaviour. These PDFs are created for different categories of debris, and are ideally based on test results, but should also be in agreement with physics-based predictions. A complete debris density PDF must consider the downrange prediction (how the density varies as a function of the distance from the origin) and the cross-range prediction (how the density varies with angle, or azimuth, in relation to the origin, if applicable).

The focus of this article will not be on the overall merits of using PDFs for FRMs, nor on the cross-range aspects of a PDF, but only on the downrange component.

Thinking of a plan view of a facility, a function that behaves like a normal distribution (or a "bell curve") in X and Y (or North-South and East-West), is often referred to as a Bi-Variant Normal (BVN) phenomenon. That is, the function "varies normally" along both axes. With no azimuthal variation, a BVN PDF forms an "anthill" shape, as shown in Figure 1, with the amplitude representing debris density.

Using a BVN model to predict debris density works well for debris elements such as the roof of a donor structure, or the crater ejecta (debris) thrown from the event, or any other material that is expected to move vertically from the origin with no expectation of azimuthal variation. From an explosives safety perspective, a BVN model also seems appropriate in the sense that the answer is the highest/worst near the donor, and gets lower/better as the distance increases.

However, when predicting the behaviour of debris that is expected to have a mostly horizontal trajectory (e.g., material coming from the walls of a donor building), a BVN will almost certainly not accurately represent the expected pattern. It is intuitive that the debris from the wall will travel some distance before stopping, therefore the peak of the density cannot be at the origin. This is consistent with what has been seen in tests where the wall material has been differentiated from the roof.

Assuming the peak density to be at some distance away from the origin, and disregarding any azimuthal variation, produces a PDF with a toroid or "volcano cone" type shape, as shown in Figure 2.

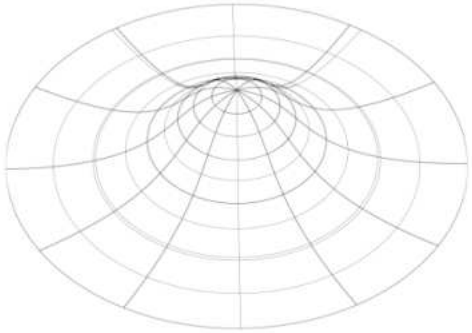


Figure 1. BVN PDF ("Anthill")

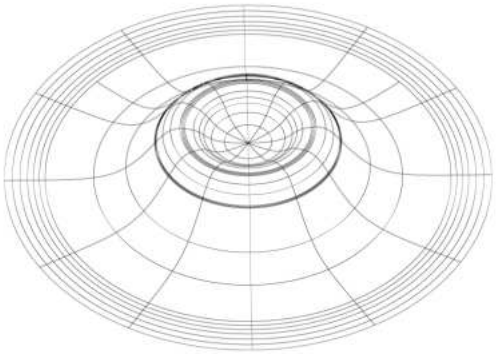


Figure 2. Toroid PDF ("Volcano Cone")

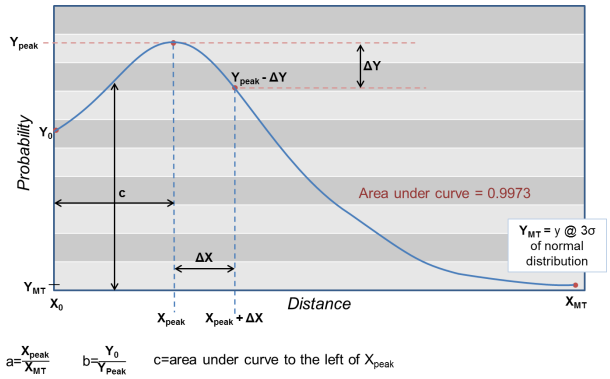


Figure 3. ISURF Model

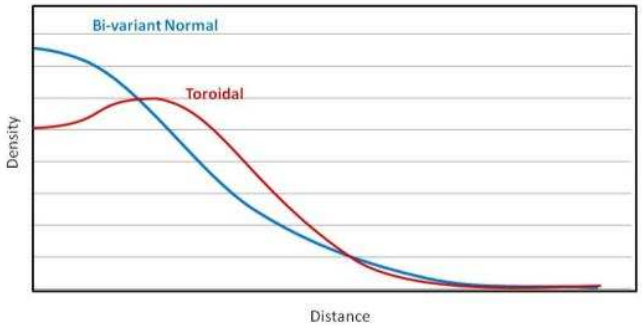


Figure 4. Comparison of Downrange Debris Density Prediction Techniques

An example of this type of downrange prediction is the ISURF model in IMESAFR 2.0, as described in a recent published paper (Reference 1). This particular toroid-type function is characterized as shown in Figure 3.

The attraction of this model is two-fold: first, the model is simple enough to be characterized by a few parameters; second, these parameters can be anchored to test results. It should be noted that modelling the debris density is not the same thing as predicting the hazard associated with the debris, so Figure 3 should not be viewed as a representation of debris hazard, but merely density (i.e., where the debris would be found on the ground after an event).

The negative connotation associated with a toroid-type prediction is that it might provide non-conservative results. It might seem problematic to have a debris prediction showing a lower answer at a closer distance, but further scrutiny shows this is not an issue. To illustrate this, Figure 4 shows a comparison of a BVN and a toroidal downrange debris density prediction. Although the values for the density and the distance are not shown, it is intended that the area under each curve is equal .

This comparison shows that the BVN curve predicts a lower debris density at some ranges, and these ranges may well be the region of interest for explosives safety scenarios. In the close-in region where the BVN prediction is higher than the toroidal curve, there are probably many other consequence mechanisms that would cause lethality. It is also critical to keep in mind that the density predictions are not hazard predictions; the toroidal curve will be treated with something like a Pseudo-Trajectory Normal (PTN) technique, which considers the hazard associated with all distances associated with the debris trajectory.

Therefore, the toroidal prediction for debris density is actually more conservative, in addition to being more accurate than a BVN prediction, when considering horizontal debris trajectories and the associated hazards.

References

Tyler Ross, John Tatom, Bob Baker, and Mike Swisdak, "Advanced Debris Probability Density Functions," Proceedings of the ISIEMS 2013 Conference

Putting Science to Work

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

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

Our Explosives Regulatory World

Investigation

by

Geoff Downs (Chief Inspector of Explosives, Queensland, Australia)

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

Our most important role is to prevent incidents from occurring and if they do occur to minimise their impacts. We use many tools in our mission for those handling explosives to meet their duty of care and to prevent incidents. The main tools being investigations, audits and inspections. It is mandatory under legislation to conduct investigations whereas audits and inspections are undertaken as a policy tool to establish that people are meeting their duty of care, following good practice and complying with legislative requirements. This approach contributes significantly to the prevention of incidents and if they do occur, to minimise their impacts.

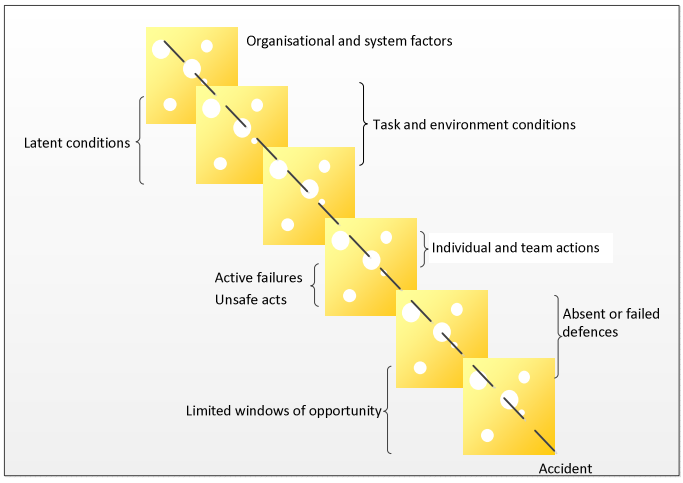
Explosives incidents must be reported to the regulator. We undertake investigations as the regulator to determine the nature and cause of incidents and to make recommendations to prevent the incident from occurring again. Investigations are also undertaken when regulatory non-compliances occur. Under certain circumstances, particularly when there are no or low level non-compliances, the regulator can also request the operator or organisation to undertake an investigation to establish the causes and make recommendations to prevent the incident from happening again. The operator or organisation must report back their findings and recommendations to the regulator and then implement their recommendations. Normally, the operator or organisation will do their own internal investigations of incidents which are not provided to the regulator. When recommendations are made from an investigation report, we are interested in the bigger picture to promote awareness which will lead to the prevention of similar incidents from occurring again with other operators and organisations. This is a challenge and a universal problem to communicate the findings and recommendations widely to prevent similar incidents from occurring beyond the organisation that had the incident. Safety alerts and security alerts provide an initial advice of what happened with recommendations but these are not based upon the recommendations of the investigation report as they precede the investigation report. We also produce a monthly summary of incidents which do not include recommendations findings etc.

In Queensland, employers are held accountable for providing employees with a safe work environment, which includes a fully documented safety and health management system (including standard operating procedures, work instructions, equipment maintenance schedules/ records, emergency procedures, etc.), sufficient training (usually competency based) for personnel to perform the task, along with appropriate PPE controls in line with the risk control hierarchy.

When we undertake a major nature and cause investigation, it is quite often for the Coroner or a compliance policy matter. These investigations are different in focus. The following discussion is directed to nature and cause investigations. Our approach to investigations includes doing the normal approach to investigation and in most cases we include an ICAM analysis as a part of our investigation. Most explosives and mining companies in Australia undertake an ICAM or equivalent analysis of their own investigations of incidents. ICAM stands for Incident Cause Analysis Method. It is a propriety product but it does bring benefits in addition to the normal approach to investigation. The ICAM approach uses similar tools for information and data collection. It does add an extra dimension to the investigative process through the methodology of analysing and reviewing the information and data.

As a background, ICAM draws on the work of Professor James Reason and the Swiss Cheese Model as discussed in the last SAFEX Newsletter article. Briefly, ICAM has adopted the Reason Model to be proactively used by safety managers and reactively by accident investigators. The model as shown below using the Swiss Cheese Model combines latent conditions such as management decisions and practices identified in the diagram as Organisation and System Factors; and Task and Environmental Conditions. In addition, active failures by individuals or teams for an incident to occur are identified as individual and team conditions in combination with errors or violations made by workers.

For an incident, accident, near miss or failure to occur under the Reason model, failures in the factors, conditions and defences in the "Swiss Cheese" line up.

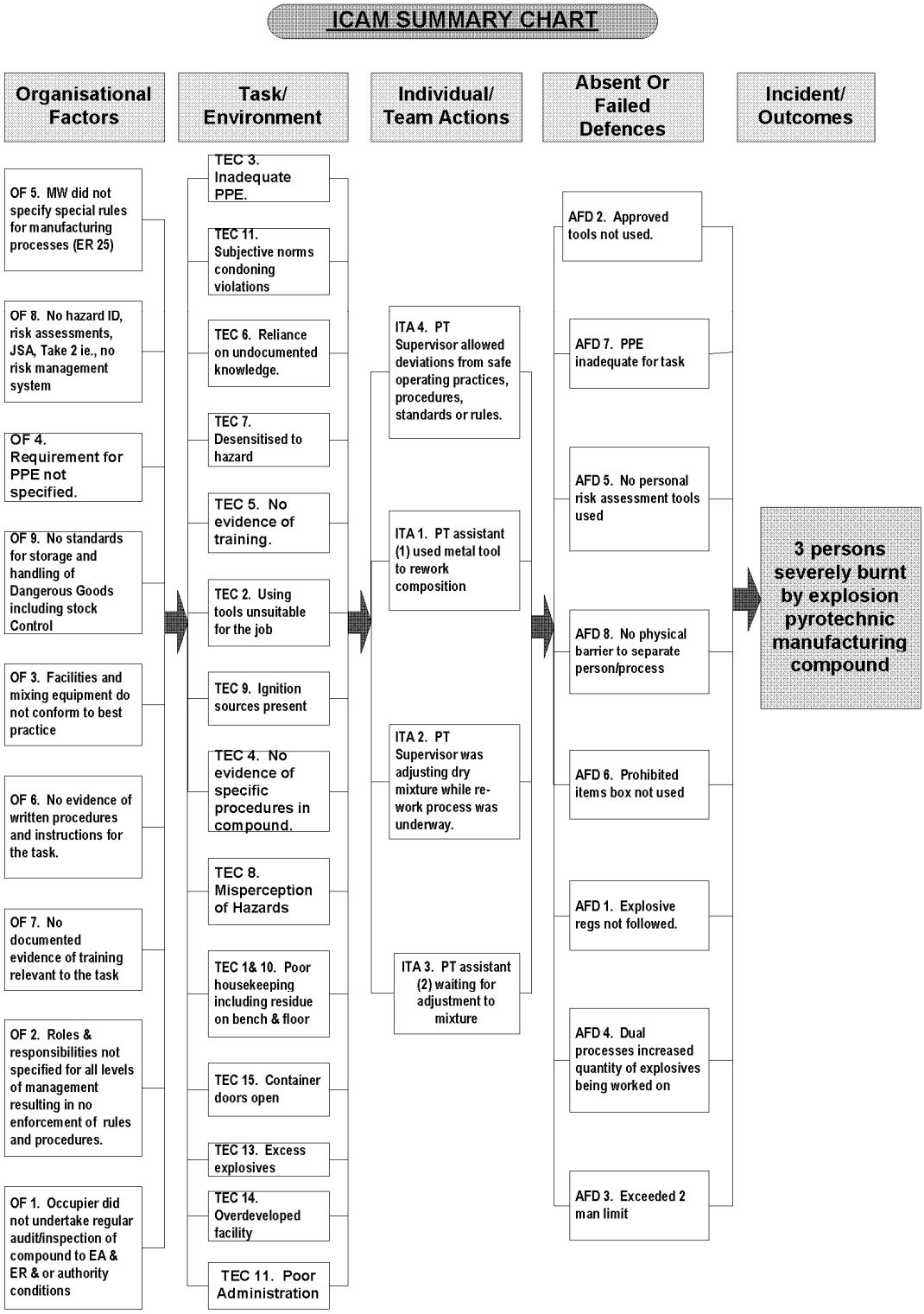


The ICAM investigation model encompasses the same four stages as the normal approach described above, however, the ICAM approach isolates and identifies missing or failed barriers in the safety and health management system, along with providing investigators with the ability to identify human and environmental factors as causes and contributing factors, not just machinery or equipment failures and lack of training.

Once all of the data has been collected, a 5 column table is utilised to display the breakdown of the critical events leading up to the incident. The columns are headed (from left to right):

- Organisational Factors
- Task and Environmental Conditions
- Individual/ Team Actions
- Absent or Failed Defences
- Incident / Outcomes

The following diagram is an ICAM analysis conducted by us for an incident that actually occurred where pyrotechnics for special effects were being made and three people were seriously burnt.



Data collection is the most important stage of the investigation process to ensure all of the necessary information is gathered enabling investigators to form sufficient recommendations to prevent a re-occurrence. A useful tool to use to collate the data is under the heading for PEEPO (People, Environment, Equipment, Procedures and Organisation).

During the data collection process, the ICAM framework delves into why each decision was made at every step in the lead up to the incident and possibly the emergency response to the incident, revealing holes in the risk management barriers of the Safety and Health Management System and/or emergency response capabilities.

Once a simple or parallel timeline chart has been developed for the series of lead up events, then the "5 Why's" are applied to key events. The process is:

1. Ask "Why" an event happened or a condition was present.
2. Continue asking "Why" until the question can no longer be answered.
3. When "Why" can no longer be answered you have reached:
   a. A control point (organisational factor)
   b. A point that is beyond organisational control
   c. A point where more data needs to be collected to answer "Why".

The "5 Why's" technique of root cause analysis is a very simple but exceptionally successful method of establishing the root cause of a problem and identifying the Organisational Factors.

Human factors could be described as fatigue, physical limitations, operator competency of the task being performed or communication skills. Examples of environmental factors include weather conditions at the time of the incident, visibility levels due to light exposure or excessive dust.

By taking into account human and environmental factors, this investigation framework has the ability to determine that certain work practices may have developed over an extended timeframe, which have enabled hazards to breach multiple risk management barriers, eventually leading to an incident.

One of the key fundamentals of ICAM is not to apportion blame but to provide recommendations. As this process shows, once actual causes and contributing factors are identified, investigators can determine the findings, conclusions and recommendations based on the identified "Organisational Factors" and "Absent or Failed Defences" to remove the holes from existing risk management barriers or insert additional barriers to re-establish an acceptable level of risk. Recommendations can be assessed on ease of implementation versus pay off and impact against the risk control hierarchy.

The final stage of the investigation process is to distribute any key learnings across industry to prevent a similar incident occurring.

In all investigative processes, a rigorous process has to be undertaken to identify the essential evidence, data and information. Tools such as such as fault trees, event trees etc are in common use and are effective. The difference here is the approach used in the summary chart to explicitly capture the information using a wider focus than normal focus in a structured way that clearly identifies the human and organisational issues and presenting it in a manner that is most effective. The aircraft industry has included human factors in the investigation of aircraft accidents for a considerable period of time.

In conclusion, it is essential to ensure that there is a good outcome to every investigation. It is important to establish the root cause through good evidence and the use of the tools available to deliver credible findings, conclusions and recommendations and pass the lessons learned onto others who need to know. While it is important to identify the detail and measure what we can measure, there are more abstract things such as human behaviour and organisational issues that are more challenging to identify but are equally as important. No matter what tools and approaches we use, the prevention of incidents is essential and the explicit use of risk control hierarchies, the Swiss Cheese Model, good practice and risk management provides fundamentals to achieve the target.

To quote the Aircraft Digest "To have an accident and learn nothing from it is unforgivable."

References to the ICAM have been reproduced with the permission of Safety Wise Solutions.

Improving Explosives Competence

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

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

Using the Explosive Substances and Articles National Occupational Standards – What results?

by

Denise Clarke (Managing Director, Homelands Security Qualifications)

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

In the previous article of this series, we looked at the practical applications of the Explosive Substances and Articles (ESA) National Occupational Standards (NOS). In this article, we consider some of the changes resulting from the implementation of the NOS.

Proof of competence

There are numerous reasons that organizations implement NOS – it might be to provide a framework for a systematic and objective process that provides for the recruitment, training, development and management of explosives workers within an organization or industry so that future business needs can be met by a technically skilled workforce. It might be because people are expected to demonstrate competence (as does the UK's Ministry of Defence (MoD)) of its explosives workers; it might be because the company may be able to negotiate reductions in its insurance premiums if it can prove the competence of its staff (which can be done through the achievement of a qualified workforce); it might be because an organization wants to standardize its systems, processes and quality standards or it might be because a customer plans to audit its suppliers and the consistent quality of work may be enhanced by implementing working to standards. The UK's Health and Safety Executive has also stated that if it carries out an investigation following an explosives incident, one of its first priorities will be to assess the competence of the people working a process as measured against the ESA NOS. All very diverse reasons for implementing standards and no doubt, there are many other reasons too.

Operational improvements

For many, the benefits lie in the development of people and we often hear of the growth in confidence that comes with greater understanding of what is expected. People's ability to meet increasing challenges which comes from increased confidence in turn can lead to people seeking out more responsibility, developmental opportunities and setting themselves new and more challenging career goals. However, many of the benefits of working to standards are reflected in the bottom line. In 1996, I visited Hydro Polymers, a chemical company based in the north east of England to find out about their experiences in implementing National Vocational Qualifications (NVQs) that were based on NOS (these were largely in Process Operations and Engineering Maintenance), Investors in People and other initiatives focused on enhancing the skills of its workforce. The story remains relevant to today:

> *… A combination of very out of date equipment, rigid job demarcation, too many links in the production chain and laboriously slow processes had all conspired to threaten the future of the company.*
>
> *Over an eight year period, the company was restructured into teams, the terms and conditions were reviewed, and the company embarked on a massive culture change. Employee numbers dropped from 700 to a current level of 500. But by introducing a number of initiatives – including Investors in People and NVQs – to achieve all staff's active participation in improving business efficiency, Hydro Polymers has found enormous business benefits.*

- *Savings of £7 million have been made in 5 years*
- *Productivity has risen site-wide (i.e. including non-production staff) from 174 tons per person employed to 450 tons per person*
- *A suggestion from a Process Operator has resulted in improving efficiency by charging agents simultaneously (instead of consecutively): this has reduced the charging time from one hour to 25 minutes, and the whole reaction cycle has reduced by 25%*
- *These reductions have meant that production has increased from 10 tons of resin per hour to 16 tons per hour*
- *Suggestions from staff put forward under the TQ Reward and Recognition scheme have resulted in savings in one project alone of £250K.*

For one company, numerous changes have resulted from using the ESA NOS even though their implementation is still in its infancy. First, the implementation of the ESA NOS on such a grand scale (around 600 of explosives workers across three UK sites) necessitated the appointment of a manager which was incorporated into the specific role of Explosives Training. Second, the terms of reference for all explosives workers were aligned directly to the ESA NOS for explosives storage operators, supervisors and managers.

Driven by the need to comply with MoD and HSE regulations, the implementation of the ESA NOS has influenced how the ranges look at the competence of range staff and, as a result, 13 Trials Conducting Officers and related staff are currently working toward a L4 Diploma in Defence Range Safety. The company is therefore now able to show that its senior range staff can demonstrate their competence as required by the MoD's published requirements (see the article in SAFEX Newsletter 46).

The company's implementation of the ESA NOS has identified the need for more training and development and existing training has been rewritten to accommodate ESA NOS terminology. Consequently, it is easier to identify training gaps – for example, a need has been identified for more training on explosives awareness that will meet the requirements of the ESA NOS.

The company runs a scheme that is designed to encourage people to identify and rectify things that might improve workplace efficiency and safety and report them, in so doing, share best practice. It is noticeable that the quality of items reported has improved of late. As a result of the investment made by the company in its staff, people feel valued which in turn has boosted their self confidence and workers now feel more confident about making suggestions for improvement. The company also runs a staff suggestion scheme that is a business-wide scheme and to which all employees can contribute. This scheme provides a useful vehicle for the suggestions identified through the implementation of the ESA NOS. For example, people's suggestions on long established processes have resulted in their becoming more safe and efficient.

Work structures are already tightly specified but now the company has the assurance and proof that its processes are operated correctly. However, as the Hazardous Area Work Instructions come up for review, they are being reviewed with the ESA NOS in mind and adapted where necessary to meet the standards.

Safety Performance Indicators (SPIs) show that, historically, of the safety control measures that have failed, one of the top four points to competence issues. Now, it is easier to target the failures and understand the reasons for them, in turn, making it easier to address them. There are now fewer competence-related failures as a result of implementing the ESA NOS because it is easier to take preventive action. When managers investigate instances where a process went wrong, it is now done with the ESA NOS in mind: as they are written as specifications of the outcomes of best practice, this can therefore lead managers to making recommendations of better ways of working.

A further use of the ESA NOS has been to complement the achievement of other accreditation standards, such as the ISO xx001 series.

The human dimension

For the MoD, the ESA NOS have been used for altogether different purposes. Historically, the competence of explosives workers was often assumed and was retained within a small and shrinking community; it is now defined, is openly available and therefore offers opportunities for wide engagement and growth.

The ESA NOS have provided the catalyst to 'brigade' employers within a small sector to work collaboratively in sustaining explosives skills capability. The NOS focus on outcomes which employers generally recognize, which offer a common language or a bridge by which they can link their diverse businesses objectives to common issues and collaborative opportunities. Evidence of this is the continued work of the Standards Setting Body for Explosives, Munitions and Search Occupations (SSB for EMSO), the creation of the Sector Skills Strategy Group (SSSG) and the Development Office for Explosives Skills (DOES).

A collaborative approach to sustaining the UK's explosives skills provides the sector with resilience and cost-effective skill development solutions i.e.:

- resilience: it offers a national strategy and is therefore relatively immune to individual organizational changes while offering vocational and professional careers across the industry to help attract and retain talent;
- cost-effective: this is achieved through joint training, education and worker exchange opportunities.

A common theme amongst those interviewed for this article is that the use of the ESA NOS has also raised awareness across a wide employee base of the need for people to demonstrate their explosives competence and the need to recognize and reward achievements. For many, the post assessment feedback process has helped users to gain a

clearer understanding of what is expected of them and the expected quality standards. By making clearer what happens next and the consequences of their actions, it has also "woken them up to the processes and protocols they must follow" and helped them to gain a team focus so that they understand their own contribution to the team and the achievement of its goals. One manager said that working to the ESA NOS had "given the workers a pride in what they do because the ESA NOS recognizes their contribution". Conversely, managers are more aware of how work is structured and what might be improved - for example, the overlaps and distinctions between Ammunition Workers and Explosives Inspectors. As a result of mapping these roles to the ESA NOS, the standards are now being used to cross-train both groups which will ultimately result in a more flexible workforce.

One company has produced terms of reference (ToR) for all its explosives workers which are linked to the ESA NOS as well as a "Competence certificate". These documents set out what is required of each worker (as described by the ESA NOS) and provides a scale for the extent to which they have achieved the requirements. The scoring system is as follows:

1 (works under supervision)
2 (works unsupervised) and
3 (supervises others).

An extract of the ToRs is shown below.

Another company has found ESA NOS to be useful when auditing the competence of staff across the various business areas and to standardize the level of assessment. Conversely, it has also been useful to Team Members undergoing training to be aware of the standards that define and underpin competence in order to give transparency across the business. The use of the standards has also given a common goal to the staff who work with explosives although sometimes they do so in isolation. Using the common language of the NOS has allowed staff to communicate easily and simply in an otherwise technical environment. Or, to put it simply, "using the common standard of the ESA NOS allows us to look for training and development opportunities without getting too tangled up in the how, what and why".

This company has also found that the ESA NOS have been found to be particularly helpful in assessing the competence of staff under training, in particular, in assessing the competence of the role holder of Explosives Practitioner – Team Member. A manager assessing someone observed that a process did not go as well as had been expected. Working with the ESA NOS relevant to that process enabled him to explain simply where the team member had done well and exactly where he had not done so well. This enabled future development needs to be pinpointed. However, it also meant that the individual knew what it was that he did not know and the manager was absolutely clear about the capabilities and areas for development of his staff.

The use of ESA NOS in the UK is progressing slowly but their uptake is improving as more companies see the benefits that the ESA NOS provide for their workforce and the business. Whilst the UK Regulator expresses interest in explosives competence, the main drive is from within the explosives community.

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

Terms of Reference (ToR's) for a Range Worker
Role holder is accountable to the Manager
Assist with preparation of battery's and equipment for trials, disposals and proof
Assist with the firing of trials, disposals and proof as required
Assist with post-preparation of battery's and equipment following activities, including cleaning and returning of stores
Carry out area/stop-gate sentry duties when required
Assist the Foreman with road closures when required
Ensure you comply with instructions within Risk Assessments, Task Instructions and Trials paperwork
Carry out duties in a safe and compliant manner
Etc. etc.

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.

Eco-efficiencies in Explosives Manufacture

by

Clare Luehman (Incitec Pivot Limited - General Manager Global Sustainability & Carbon)

Clare is a Chartered Accountant charged with carrying Incitec Pivot's carbon and sustainability strategies across its global operations, including its explosives manufacturing and distribution business, Dyno Nobel. Clare has worked in the explosives industry for close to ten years, having worked in Finance and Strategy at Orica Limited before joining IPL in 2008 to take on the role of the company's first Sustainability Manager. Within five years, the company has achieved a number of sustainability and carbon milestones, and in 2012 was recognised as a leading chemical company by the Dow Jones Asia Pacific Sustainability Index.

Clare views sustainability through the people/planet/profit lens. She acknowledges that many shy away from highlighting economic sustainability but believes it is a critical part of the sustainability equation.

SAFEX newsletter has asked me to share some of IPL's experiences in sustainability, and in particular, eco-efficiencies in explosives manufacture and delivery. As a global manufacturer of explosives, we seek to be more efficient in our use of non-renewable resources. This is a key pillar of our 'Use Less, Get Close, Be Responsible' Sustainability agenda.

Our first Sustainability Strategy was agreed by the Board back in September 2010. The strategy included defining:

- sustainability in IPL's terms
- our first three-year agenda; and
- five keystone projects that would drive the agenda, which were focussed on resource efficiency (Use Less), community engagement (Get Close) and product stewardship (Be Responsible)

A very important step in this process was defining what the term *sustainability* means for our business and communicating it to our people. In essence, sustainability is '*the ability to endure'*: it involves building a business in such a way that it will still be operating for many years to come.

At IPL we define Sustainability as the creation of long term economic value whilst caring for our people, our communities and our environment.

In order to achieve this, the triple bottom line of sound social, economic, and environmental actions must combine to preserve people (our workforce and communities), profit (for our shareholders) and planet (so that the resources we need are not wasted).

An important component of this is re-

source efficiency or, more specifically, our commitment to 'Use Less'.

Resource efficiency target setting, or keystone project 1, as it's known within IPL, has embedded responsible and sustainable use of resources across both our explosives and fertiliser businesses, beginning in Australia. The success of this project has been largely due to our bottom-up approach. We avoided imposing set top-down targets for reductions in energy, emissions, water and waste on sites for two key reasons. Firstly our sites are diverse in terms of the products they produce (for example bulk products vs initiating systems) and secondly we wanted to create sustainable change.

In the beginning of the process, key personnel at each of our Australian sites were interviewed, encouraged to look at their resource use and given the task

of identifying areas where they could improve. Once projects were identified, the resulting reductions formed the basis of site related reduction targets. Importantly, the targets and savings derived from each project, both in resource and dollar terms, belong to each site.

While results have varied across our sites, they have proven rewarding overall.

Case Study: Energy Efficiency Targets at Helidon

Our Helidon Dyno Nobel Nonel Assembly plant is located in Queensland, Australia, where both temperatures and humidity are high. The site produces approximately 7-8 million detonator units per annum for mining customers in Australia and requires electricity for compressed air, motors, lighting and climate control in order to deliver a safe and effective production process. The enthusiastic team at the site suspected that significant energy reductions could be made by examining the efficiency of the climate control system.

A Supervisory Control and Data Acquisition system (SCADA) was installed, which uses an expensive, high quality set of sensors to track temperature and humidity conditions in real time. This new system highlighted large errors between real conditions and control input values, showing that the climate control system was not operating in a steady state, but was wasting significant energy in fighting itself to maintain conditions. The site set a target to reduce energy use and related emissions by 10% within a year. Because the site ex-

amined its opportunities and set its own target, it was realistic, achievable, and most importantly, owned by those at the site who could make the difference.

The outcomes form a great example of hitting the sustainability triple bottom line. The site demonstrated to the community our commitment to reducing energy use and carbon emissions (people); it achieved an ongoing 10-12% reduction in energy use and carbon emissions (174,944 kWh and 156 t CO2e in the first year - planet) and saved the company over $10,000 dollars a year in energy costs (profit).

Case Study: **Waste Reduction at Warkworth**

The Warkworth Dyno Nobel Emulsion Manufacturing site supplies explosives to the Hunter Valley, one of Australia's largest producers of both Thermal and PCI coal.

When given the challenge of examining where the site could become more sustainable in its use of resources, the team identified a very different opportunity. 30,000 single use AN bulk bags per year enter the Warkworth site filled with AN prill for making emulsions. The site proposed the target of 'Zero AN bags to landfill by 2013, regardless of where the bag is removed in the supply chain", in order to divert these bags from landfill to a plastics recycler. In the process, a significant reduction in costs and handling was also achieved, as the bags were being collected uncompacted by a waste contractor and sent to landfill at significant cost.

A bag baler was successfully trialled an installed at the site, allowing a plastics recycler to collect the bales at minimal cost. Again, the results show benefit to the community (preserved community landfill space), shareholders (ongoing savings of $31,000 per year in landfill and handling costs), and the environment (diversion of 69 tonnes of recyclable plastics from landfill to market, which also saves significant amounts of energy and water that would be taken to make virgin plastics).

The individual efforts of our sites combine to make a significant contribution to our triple bottomline. Most importantly, the bottom up involvement of our sites in the target setting process is helping build a culture of business sustainability right across our organisation.

Our first three-year Sustainability agenda will come to an end this year, but eco-efficiency targets and projects will remain part of the Sustainability equation for IPL in the years to come.

Pondering the Profession

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

Dynamite Factory at Ardeer Scotland Making Dynamite Nitroglycerin: Part II

by

H. J. W. Dam, published in Mc Clure's Magazine, Vol. IX (1897), No. 4, pp. 823 – 836 and published at http://archive.org/details/mccluresmagazine08newy . Rights with the National Library of Scotland.

submitted by

Martin Held (Director SHES, Austin Powder International)

Martin came across this article when he was looking for a picture showing an operator carefully watching the thermometer of a NG batch reactor. The intention was to compare inherent safety 100 years ago with today's process safety. At that time the operator would fall off a one-legged milk stool he was sitting on if he becomes tired and falls asleep. Martin goes on to say: "When I was reading through the article, I could not take my eyes off it. There is so much in it which today we would say is obvious Basis of Safety (BoS). Perhaps it will be a useful exercise to sit down and review all BoS related activities."

Because of the length of the article, we have decided to serialise it and will publish it in 3 parts. Part I covered the Introduction, Nitroglycerine Hills and the Danger Area. In this second Part the authors talks about his experiences with the Nitrating and Cartidging Houses. Be sure to look out for the final Part in the next edition.

Preface by Martin Held

Ardeer at that time was perceived as being world class compared to other (non-explosives) industrial business. Today we manage access and security control with card readers and monitor hazardous activities and have CCTV witnessing if employees would carry and use non-permitted articles with them, but do we physically search people for foreign bodies and prevent those form being smuggled in? Work clothes in different colours to identify people in the wrong (or to confirm being in the right) place. Very simple and obvious! We will definitely use relevant parts of this article for training or workshop classes to have folks identify the useful (BoS) information in it and how this compares to our present environment.

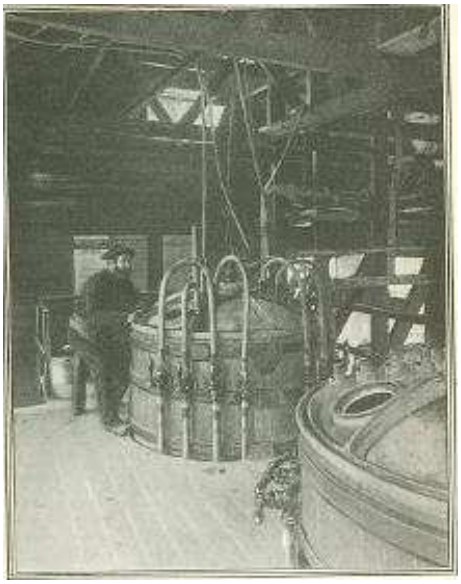
The Nitrating Houses

Having passed the searcher, you mount the "hill," an artificial one, built of sand, and perhaps sixty feet high. On the top of it are two "nitrating-houses." They

are of thin clapboards painted white, and are about twenty feet square. These houses are always placed on the tops of "hills," in order that the nitroglycerine, passing from process to process, may flow by its own weight downward. It is not exactly the kind of liquid that one wants to pump. At the door of the house you are confronted by two pairs of yawning rubber shoes. Large shoes of rubber, indeed, and sometimes even larger ones of leather confront you at the door of every danger house. No shoe which touches the ground outside is allowed to touch the floor of a danger department. The least amount of grit might cause friction and lead to an explosion. In all departments the girls are compelled to change to slippers or work barefooted, the majority, in summer, preferring the latter. Having stepped into the overshoes, you begin to flop like a great auk over the lead sheet which covers the floor. The shoes are trying, particularly as you have other things to worry you. Snowshoes, ski, and stilts can all be practiced on with advantage before endeavouring to get about in a pair of overshoes which do not fit your own shoes and are ceaselessly trying to trip you up.

As you enter the nitrating-house your eye is caught by two lead cylinders, five feet in diameter and six feet deep, which are sunk in the floor. They have closed, dome-shaped tops, over which many lead pipes curl and into which they enter.

At the farther cylinder sits a man in scarlet watching a thermometer. He neither moves, looks up, nor betrays any sign of your presence. The thermometer which he is watching is five feet in length. Only the top or marked portion extends above the cylinder, the tube which carries the mercury reaching down to the hot acids and nitroglycerine. In the cylinder has been placed about a ton and a half of sulphuric acid mixed with a ton of nitric. Into this mixture are now being sprayed 700 pounds of glycerine, the glycerine injector pipe being joined by another carrying compressed air. As fast as the glycerine spray enters the mixture it seizes the nitrogen of the nitric acid and combines to nitroglycerine, and the sulphuric takes up the water which is thus set free. The process requires fifty-five minutes, during which the 700 pounds of glycerine becomes about 1,500 of nitroglycerine. Great heat is caused by the chemical action, and the absolute necessity is that the heat shall be kept down or it will explode the newly formed nitroglycerine. To this end the cylinder is surrounded by a water-jacket, through which cold water is rushing constantly, and four concentric coils of lead pipe occupy the interior of the cylinder, carrying four steady rushes of cold water.



Man and thermometer in one of the nitrating houses

If the heat, through vagaries in the glycerine, rose above the danger point, the thermometer would instantly reveal this to the man on watch. If the thermometer rose ever so little above twenty-two degrees centigrade, the man would turn on more air and shut-off the inflow of glycerine. If it continued to rise slowly and he could not stop it by more air and water, he would give a warning shout, "Stand by," to a man watching below. If it continued, he would shout "Let her go," and the man would open a valve; this would sweep the whole charge down to a "drowning-tank " lower down the hill which would drown the coming explosion in excess of water. The two men the meanwhile would bolt to a safe position behind banks. If the heat rose rapidly, too rapidly for "drowning," the man would pull the valve, give a warning shout, and run. So would everybody, you included. You might run on one side to the protecting arms of a dynamite magazine holding twenty tons, or on the other to the soothing shelter of a house where guncotton is baking at 120 degrees Fahrenheit. Failing these, there is the pond. This is a sweet, placid pond which is formally blown up once a week because some dregs of nitroglycerine have drained into it and collected at the bottom, making it unsafe. It is comforting to feel, in the hour of danger, that you have havens of perfect security such as these.

Now that the glycerine has become nitroglycerine, you flop down the stairs to another department, to witness its separation from the acids with which it is now mixed. It comes shooting down a lead gutter, and falls, a cream-coloured stream, to the bottom of a lead tank, eight feet in length and two in width. As soon as the tank is full, the nitroglycerine, lighter than the acid, rises to the surface like oil. It is skimmed off in an aluminium skimmer resembling a tin wash-handbasin with a handle, and is poured into a lead pocket at the end, whence it flows through pipes to a tank, where it receives its first washing with cold water. Thence it goes through gutters farther down to another department, where it is washed with warm water and carbonate of soda. Every particle of the free acid must be removed, as remnants of it might cause chemical action, heat, and explosion in the dynamite or blasting gelatine later on. A sample is taken of each lot of nitroglycerine when made. This is placed in a small clear glass bottle and covered with blue litmus solution, to detect the presence of any remaining free acid, which would colour the litmus red. *En passant*, your guide mentions that some years ago one of the foremen was carrying a little felt-lined box of these samples to one of the sample magazines when he unfortunately stumbled and fell. He was blown to pieces.

You have now reached the bottom of the "hill" (all nitroglycerine factories are called "hills"), and are in a wooden cabin, with a floor of loose sand, where the making of dynamite and blasting gela-

tine actually begins. Dynamite consists merely of liquid nitroglycerine which has been absorbed by some porous material. The liquid was discovered by Sobrero, an Italian, in 1846. Its transport and use were attended with such danger, however, that the late Alfred Nobel conceived, in 1867, the plan of absorbing it in some non-explosive medium. After experimenting with sawdust, brick dust, charcoal, paper, rags, and kieselguhr, he finally settled upon the last named as the best material. Kieselguhr, known in the factory as "guhr," is a siliceous earth, mainly composed of the skeletons of mosses and microscopic diatoms, which is found as a slaty black peat in Scotland, Germany, and Italy. Before being used it goes to the "guhr-mill," where it is calcined in a large kiln, rolled, and sifted, the result being a very light pink powder of the consistency of flour. In the house you have entered, twenty-five pounds of kieselguhr, with about one pound of carbonate of ammonia, are weighed into a wooden box about three feet square and eighteen inches deep. Upon it is drawn seventy-five pounds of nitroglycerine from the filter tank by a man in scarlet. Another man in scarlet, with his arms bare to the shoul-ders, takes the box to a table, and gives it a preliminary mix, to see that all the nitroglycerine is roughly absorbed. Then a man in blue seizes it, places it with other boxes on his handcart or "bogie," and pushes the load off to the "mixing-houses."

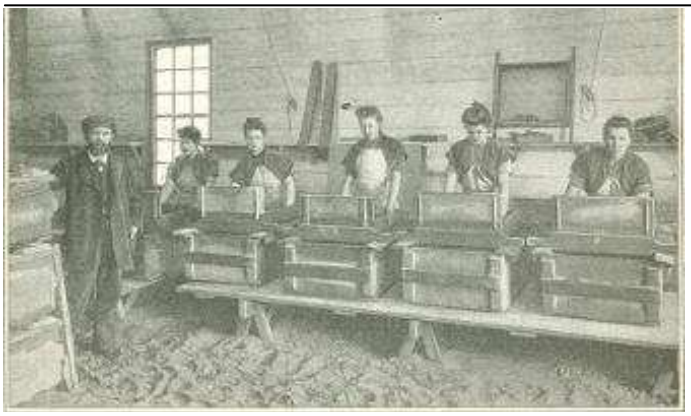
At half-past six on the morning of the 24th of February, one week after the writer's visit to this house, it was the scene of a very disastrous explosion. Twenty-four hundred pounds of nitroglycerine was collected here, in the tanks and boxes mentioned, and exploded from some cause which may never be known, killing six people—a chemist, a foreman, and four workmen. A few other employees were slightly hurt by flying debris. The sound was of course tremendous, and the effects of the explosion, which were very clear at Irvine, three and one-half miles away, are said to have been so strong in a town ten miles away that the gas-lamps were extinguished by the air concussion. A disaster such as this, whose suddenness is not its least painful characteristic, cannot of course be minimized in its tragic importance. At the same time, it serves as the best possible testimony to the value of the system of protection employed. That over a ton of nitroglycerine can explode in the heart of a factory where 1,300 people are at work, and only the six men, within a few feet of it, los their lives, shows better than any other evidence the meaning and value of the Ardeer mounds.

Making dynamite cartridges

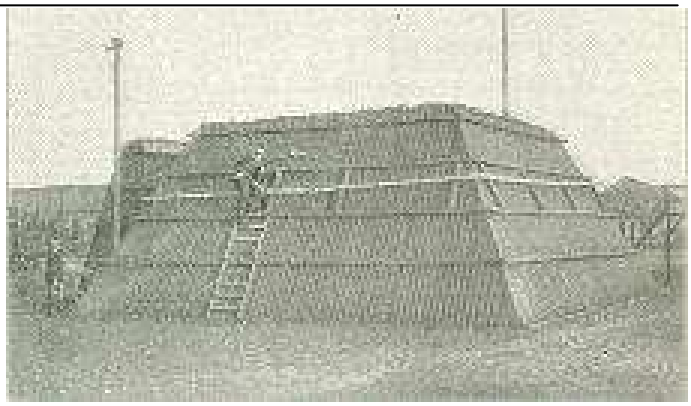
You follow the box to a "mixing-house." This, in the case of dynamite, is a large wooden cabin, containing a long narrow table on each side. In it six girls are at work. The runner sets the open box of the mixture down in the doorway. A girl hoists it to a table, and flies at it with bare-arms as if it contained only flour and water. She mixes it thoroughly. Then she takes a big wooden scoop, jabs it into the box, and dumps the scoopful into a raised box of the same size, with a brass sieve bottom. She then, as if the sieve bottom were a washing-board, rubs the dynamite with all her strength against the sieve, forcing it through the small holes. A few of the girls use a leather hand flap to rub with, but most of them prefer their bare hands. You view the process with consternation. Hitherto you have looked upon dynamite as something to be regarded politely from a safe distance as if it were a rattlesnake. The girls handle it, however, as coolly as if it were the sand on the floor. Some of it is continually spilt, of course, and mixes with this sand, but the sand is all removed at short intervals and buried. One of the few fatal accidents in the history of Ardeer took place near this house. A cartridge but wherein four girls were working exploded, killing the girls. Burning dust from this but fell into the open boxes of dynamite in three other huts. The dynamite began to blaze, and the deadly smoke from it, which consists of hyponitricacid fumes, immediately filled the huts. Two girls in each but had the courage to jump over the blazing boxes, and escaped; but the others, six in number, were suffocated in a few minutes. Thus, ten persons lost their lives. When the huts were entered, the six girls were found seated in perfectly natural attitudes, their faces showing no trace of agony or fear. It was evident that, having been stunned by the sudden explosion, they had been suffocated before recovering from the shock. It will be noted that the loose dynamite burned and did not explode. This is one of several curious facts concerning dynamite which will be considered later.

Making blasting gelatine cartridges

It may be well to state at this point that the two hundred and odd young ladies employed in this dangerous work are all strictly beautiful. Everybody who visits the factory admits this at once. Nobody, in fact, seems inclined to invidious comparisons among strong and courageous girls, when each of them has enough dynamite in her possession to blow a hole in Scotland. Moreover, there is some reason for the statement. The breathing of nitroglycerine by the workers gives them a universal clearness of skin, and among the fairer girls the con-



Interior of a mixing house



Reading thermometer before entering testing room "India"

trast of scarlet and white in their faces is most unusual. You learn that (perhaps in consequence of their complexions) the girls marry quickly after entering the factory.

The Cartridge Houses

After being rubbed through the sieves the dynamite becomes a finely divided, greasy, coffee-coloured earth. It is now the dynamite of commerce, and is ready to be made into cartridges. As you approach one of the cartridge houses, which are small white one-story buildings, you hear a tremendous thumping. You ask your guide in some perturbation if it is a good day to look at cartridge houses, but he smiles and says that the noise is merely the cartridge machines. The hut is about ten feet square, with a single door. Four girls are at work. Against the right and left walls are four spring pump handles about the height of a girl's head. Each pump-handle when pulled down forces a brass rod through a small conical hopper of loose dynamite fixed to the wall, and jams a portion of the dynamite down a brass tube at the bottom of the box. The girl wraps a small square of branded parchment paper around the bottom of the tube, folding it at the lower end. Then, holding the paper with one hand, and jumping up and down as she works the pump-handle with the other, she pushes dynamite down the tube till the paper cylinder is filled to a depth of about three inches. She then removes it, folds down the top of it, drops it through a slide in the wall, whence it rolls down into her own special box a finished cartridge. She replenishes her stock of dynamite with a scoop through a sliding door in the wall, from a box of loose dynamite which the runner has placed in a closed chest immediately outside. The girls work with the greatest rapidity. The sliding brass rod is actually lubricated with nitroglycerine. To see this operation—the brass rods flying up and down, damp with nitroglycerine and dynamite being forcibly jammed down a brass tube—entirely destroys your appetite for further knowledge. It is incredible, and you want to go away, outside the "Danger Area," and think it over. But your guide takes you instead to a blasting gelatine cartridge hut. Here blasting gelatine, a yellow, tough, elastic paste which consists of about seven per cent of nitrocotton and ninety-three of nitroglycerine, is being forced through a sausage machine, chopped, by hand, into three-inch lengths with a wooden wedge upon a lead-covered table, and wrapped into cartridges, at the greatest speed. Blasting gelatine is fifty per cent more powerful than dynamite, and the effect on your mind is to make you exactly fifty per cent more uncomfortable than before; to multiply by one and one-half your desire to get away before any contretemps occurs which you would be in no position to either explain or avoid.

There are forty-five cartridge huts, all heated by steam to not less than fifty degrees Fahrenheit. Nitroglycerine congeals at forty-three Fahrenheit and freezes at forty, so the huts must be kept warm. If the dynamite were allowed to rest against a steam pipe an explosion might follow, and the pipes are carefully boxed, and the thermometer is always watched by the eye of authority.

In addition to dynamite and blasting gelatine cartridges, the company manufactures cartridges of gelatine dynamite and gelignite, combinations of nitroglycerine, nitrocotton, nitrate of potash, and wood meal.

The gelatine explosives are specially adapted for use under water, being entirely unaffected by dampness of any kind. The company also makes "Ardeer powder" and "carbonite" explosives for blasting purposes in fiery coal mines, with a lower percentage of nitroglycerine than dynamite. The output of explosives of all kinds is an average of about one hundred tons per week.

From our Workgroups

The SAFEX Workgroups can be described as the engine room of SAFEX's efforts to identify good explosives practices. They focus on specific areas such as Good Explosives Practice (GEP); Explosives Traceability; Safe Technical Grade Ammonium Nitrate (TGAN) Handling; Explosives Transport; Explosives Emulsion Manufacture; and Explosives Remediation/ Decontamination. Here Workgroup members pool experiences and resources to produce an outcome that reflects their collective knowledge in that area. Typical outcomes include a standard, guideline or good practice that promotes ongoing safe operation in the area concerned.

Internationally Harmonised Explosives Track and Trace Markings

SAFEX Explosives Traceability Workgroup supports IME and JIEDDO

From IME News Alert dated 10 Jun 2013

submitted by

Noel Hsu (Leader, TGAN Handling Workgroup)

Noel thought the following report may be of interest to readers.

IME is honoured to have the Joint Improvised Explosive Device Defeat Organization (JIEDDO) in its delegation at the UN Subcommittee of Experts on the Transport of Dangerous Goods (TDG) 43rdsession in June. Other members of the IME delegation to the 43rd Session are David Boston, IME's UN Safety Consultant, Noel Hsu of Orica USA who is also the SAFEX Explosives Traceability Workgroup Leader, and Tim Golian of Hunting Titan. TDG is the international organization that develops and maintains the UN Model Regulations and the UN Test Manual that form the basis for hazardous materials transport regulations around the world. IME participates in the work of the TDG as a non-governmental observer (NGO).

Recently, the European Union and other international authorities have adopted requirements for marking of explosives devices and packages to facilitate tracking and tracing of recovered lost or stolen explosives to their last legal owner. This information can be crucial to law enforcement efforts to deter criminal use of explosives. While supportive of these requirements, IME is concerned that these unilateral requirements are divergent in several aspects, especially the meaning of the markings that may be required. IME believes that this effort would be enhanced if an internationally harmonized system were developed and adopted by law enforcement around the world.

Before such a system can be developed, an international forum must be identified that can take on this work and obtain international acceptance and implementation of the resulting harmonized system. Because the TDG is a recognized leader in developing internationally harmonized and accepted regulations, and because TDG already addresses the security of hazardous materials in Chapter 1.4 of the Model Regulations, IME has submitted an informal document to the TDG's 43rd session requesting that the TDG take on this effort in its work plan or, if that is not possible, to assist IME in determining what international forum might be best to direct this request to.

Such a harmonized system is also a crucial element in the efforts to eliminate threats coming from improvised explosives devices. Because this is so important in this effort, JIEDDO has offered a representative from its ranks to join the IME delegation to the 43rd session of the TDG later this month. IME is pleased to welcome Col. Daniel Vasenko of JIEDDO to its delegation and looks forward to his contributions at the 43rd session as we continue our efforts towards development of an internationally harmonized system for explosives traceability markings.

Noel, Tim, and Dan will be assisting David as subject matter experts. IME's informal paper on explosives traceability markings, UN/SCETDG/43/INF.18, may be obtained at: *http://www.unece.org/trans/main/dgdb/dgsubc3/c3inf43.html* .

Safety Snippets

Is My Facility Safe With a Low K_{st} Dust?

by

Steven J. Luzik, PE, CFEI (Senior Process Safety Specialist, Safety Consulting Engineers)

Steven J. Luzik has over 30 years experience in the area of fire and explosion hazards including gas/vapour explosions, dust explosions and fire and explosion protection strategies. He graduated from the University of Notre Dame with a BS degree in Chemical Engineering. He is a registered Professional Engineer in the State of Pennsylvania and a Certified Fire and Explosion Investigator (CFEI) with the National Association of Fire Investigators (NAFI). As a former Mine Safety and Health Administration [MSHA] manager and technical specialist, he has investigated a multitude of incidents involving flammable vapours, gases and dusts that have included surface and underground mining facilities and industrial facilities where fires and explosions have occurred. He has conducted dust explosion hazard assessment at several coal-fired power plants.

He also has served as a moderator of a flammability and dust explosibility laboratory, processing requests from MSHA and other Federal agencies for testing to determine the flammability and explosibility properties of solids, liquids, dusts and vapours. In this capacity, he has been called upon to provide expert testimony on the explosibility hazards associated with the manufacturing, processing and handling of these materials. He has authored numerous publications in the areas of fire and explosion prevention, protection and investigation.

This article appeared in the October edition of SAFETY WATCH, a Dekra Newsletter, and is published with the kind permission of Safety Consulting Engineers Inc.

Introduction

K_{st}, the dust deflagration index, is used by researchers, consultants, explosion protection system designers, Authorities Having Jurisdiction (AHJs), plant management and engineering personnel as a measuring stick of the relative explosiveness of a combustible dust. Laboratory testing can be performed to determine this index. The standard test method used in the United States is ASTM E1226. The index is calculated by performing a series of trials, using increasing concentrations of dust, inside a closed steel combustion chamber. The dust is suspended inside the chamber and ignited using high energy chemical igniters producing up to 10,000 joules of energy. For each trial, the rate of pressure rise (dP/dt) and highest pressure developed inside the chamber are recorded. The maximum rate of pressure rise (dP/dtmax) and maximum pressure (Pmax) developed over the test series are reported and the (dP/dtmax) is inserted into to the following equation which is used to calculate the Kst index:

$$K_{st} = (dP/dt)_{max} * (V)^{0.33} \text{ [bar m/sec]}$$

The cubic root of the chamber volume is inserted to normalize test results for testing conducted in different volume chambers. The standard requires use of at least a 20 liter vessel for this testing. A 1 m3 test chamber is also frequently used to conduct this test.

What does the Dust Deflagration Index (K_{st}) refer to and what does it tell us?

Dusts are typically categorized as indicated in the table below.

Since the K_{st} value is a measure of the speed of the explosion, it is used by engineers to size explosion protection systems like deflagration vents or chemical suppression. The categorization of a Class St 1 dust as weak to moderately explosible can lead to a false sense of security, with regard to the potential for explosion, in the industrial plant. This is especially the case where K_{st} values may be 50 bar·m/sec or less, for example. It is important to understand that any explosion can cause burn injuries and structural damage, if the structure is not strong enough to withstand the maximum pressures possible. Typical flame temperatures generated from a dust explosions, even of slow burning dusts, are in excess of 2000°C (3630°F) and pressures can easily exceed 6 bar (90 psig) if the deflagration is not adequately vented. The difference between a dust that exhibits a K_{st} value of 20 bar·m/sec and one with 200 bar·m/sec is only about 70 milliseconds in the time it takes the explosion to build up peak pressure in an average sized room!

Am I operating safely?

The main concern with regard to accumulations of combustible dust is the risk of flash fire or secondary explosions inside of your plant. Secondary explosions have been cited as a major contributing factor in a high percentage of major industrial dust explosions in our country in the last 30 years. A primary explosion inside of the plant can produce both a pressure wave and a source of ignition. The pressure wave serves to loft accumulated dust into suspension, particularly dust that has accumulated in the higher areas of your plant such as on structural members, equipment surfaces, piping and conduit. The ignition source ignites the dust cloud that is produced, frequently resulting in a major secondary dust explosion. This process can be repeated in a chain reaction of secondary explosions that can travel throughout the plant, injuring or killing personnel and causing major damage to the plant.

In order to determine if you are a candidate for an event of this nature, it is necessary to understand something about the term “risk”. Your risk of explosion inside the plant will be the product of the likelihood and the severity of the event.

$$R = L*S$$

The likelihood will be determined by examination and understanding of several factors including: housekeeping, the ease of creating a combustible dust dispersion, the bulk density of the dust, potential ignition sources inside the plant and the ignition sensitivity of the particular dust that you are handling. Ignition sensitivity properties, such as Minimum Ignition Energy (MIE), Minimum Ignition Temperature (MIT) and Minimum Explosible Concentration (MEC), of a dust cloud can be measured in the laboratory. Important questions that need to be addressed in order to quantify the likelihood factor include whether or not credible ignition sources exist inside your plant or whether they could be produced under an abnormal condition. For example, do you have dust collectors inside the building that are not protected against explosion or are fitted with an explosion vent that could vent directly into the room?

The severity component is principally determined by understanding the burning characteristics of the dust (K_{st}) and the nature of any accumulations which may exist inside the building. Segrega-

Table: Typical characterisation of dusts by Dust Explosion Class

Dust Explosion Class	K_{st} (bar·m/sec)	Characterization
St 0	0	Nonexplosible
St 1	$0 < K_{st} < 200$	“Weak” to Moderately Explosible
St 2	$200 < K_{st} < 300$	Strongly Explosible
St 3	$K_{st} > 300$	Very Strongly Explosible

* *Based on testing using either 1 m^3 or 20 liter test vessels and 10 kJ (10,000 joules) ignition sources.*

tion and separation of dust accumulations inside the building will both serve to reduce the Severity of a potential event. As we have shown above, even low K_{st} dusts will generate high pressures and extreme temperatures that will put your employees and property at risk. A dust with a low K_{st} can actually result in more accumulated dust being raised into suspension since the pressure wave will be of a longer duration when compared to a higher Kst dust.

What can I do to manage my risk?

A three pronged approach to dust control is strongly recommended.

- Reduce/Eliminate Dust Generation
- Limit/Restrict Dust Migration
- Remove/Clean Dust Accumulation

The NFPA combustible dust standards require that dust aspiration (collection) systems be installed where dust is being generated. Do you have these systems in place at your facility and are they being maintained to prevent dust leakage into the plant? There may also be opportunities to segregate areas of your plant where dust is being generated through the use of physical barriers. Separation of areas where dust is accumulating can also be very beneficial in reducing your risk of secondary explosions. Finally, a good housekeeping program should be developed and implemented inside of your plant. The plan should include the evaluation of dust accumulation rates and housekeeping frequencies needed to prevent unacceptable accumulation levels from developing inside your plant. It should also include requirements establishing time to clean local spills or short term accumulations. The NFPA standards provide strategies for separation, segregation and preventing dust accumulations that could trigger flash fires or explosions inside the plant. You should refer to these standards to help you formulate your combustible dust fire and explosion management program.

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CEMTA delegation visits EPC-UK

by
Ashley Haslett (Head of Operations and HSEQ, EPC-UK plc)

Having recently joined SAFEX, the Chinese Explosives Manufacturing Trade Association (CEMTA) led a delegation of 16 of its members to the UK and requested SAFEX to arrange a visit to a world class emulsion manufacturing facility. EPC-UK graciously agreed to host the delegation and organised a visit to the Alfreton Rough Close Works site where they shared lessons learnt over many years of being a SAFEX member.

Following a lunch at the Venture Crescent Head Office in Alfreton on Monday 23rd September, the 16 delegates were welcomed to the company by Mr. Ben Williams, Managing Director of EPC-UK plc. The presentations commenced as all meetings do within EPC with a Safety Pause being delivered. This was provided by Mr. Ashley Haslett (Head of Operations & Safety, Health, Environment and Quality) on the concept of Visible Felt Leadership to emphasise the importance that leadership has in creating and developing of effective safety culture. This was followed by Mr. Ian Davies (Head of Commercial Activities) providing an overview of EPC which included the history of the Groupe, the activities and locations where the Groupe operate and how the market is serviced within the UK and the resources deployed. Ashley Haslett

then advised on the European Directive on traceability of explosives currently being implemented throughout the European Union and the EPC Groupe solution to this, Euro iTrace.

After a short break, Dr. Mark Pegden displayed a series of short videos from around the world illustrating issues that have arisen within industrial explosives applications. He then presented evidence of the advantages of using electronic detonators to control blasts in specific circumstances. The session closed with Mr. Andrew Varney (RCW Works Manager) providing an induction to the site that they would visit the following morning, including the hazards, precautions and emergency provisions.

On Tuesday 24th September, the delegation arrived at the Rough Close Works site in Alfreton and received a short Safety Pause on the effects of mishandling explosives. This comprised of a series of video clips using a high speed camera to demonstrate the effects that detonators and explosives have on the body when initiated in close proximity. The delegates were then allocated into one of four groups who had time touring the RCW factory to see the detonator assembly process with track and trace in operation, the manufacture of emulsion matrix, with particular attention given to process safety and the observation of safety critical equipment status. A visit to the laboratory explained the quality procedures in operation to maintain ISO 9001 and finally a demonstration of EPC Innovations variable density technology in practice. A question and answer session over lunch provided the opportunity to provide further explanations through an Interpreter prior to closure and departure of the CEMTA delegates.

Comment by SAFEX Newsletter. CEMTA provided SAFEX with feedback on the visit and expressed immense appreciation for the trouble EPC-UK took to arrange a very meaningful experience for CEMTA delegates. The visit was professionally organised and provided the delegation with valuable insights into good practices. It supports SAFEX's view that efforts such as these are invaluable in propagating the safety message by demonstrating what good practice looks like.

On behalf of all SAFEX Members we thank EPC-UK for carrying the banner for SAFEX in this way.

IMESAFR v2.0 Training prior to the 40th ISEE Conference

Hampton Inn and Suites, Denver CO, USA from 6 to 8 February 2014

by

Dean Nichols (IMESAFR Coordinator, A-P-T Research, Inc.)

There are already many reasons to be making plans to attend the 40th Annual International Society of Explosives Engineers (ISEE) Conference scheduled for February 9-12 and now there is one more. What is it? It's the Institute of Makers of Explosives Safety Analysis for Risk (IMESAFR) v2.0 training being offered at the Hampton Inn and Suites Denver Downtown Convention Center three days before the ISEE Conference.

IMESAFR v2.0 is the product of years of collaborative effort between the Institute of Makers of Explosives (IME) and A-P-T Research (APT) and is the most recent version of the versatile and dynamic IMESAFR risk assessment tool the explosives community has been using for years. IMESAFR has always been a powerful tool for calculating individual and group risk associated with explosives facilities using detailed information such as donor structure and activity, the structure of exposed sites and the duration of exposures for personnel. Now, however, the 2.0 version of IMESAFR also can be used to check for Quantity Distance (QD) compliance, referencing the American Table of Distances (ATD) or other QD regulations. The software now has a powerful Geographic Information System (GIS) based interface, as well as the option to perform site risk analysis in metric units.

IMESAFR v2.0 also has new features requested by those using earlier 1.x versions:

- Visual output of debris density and overpressure/impulse as a function of range and bearing
- Improved debris hazard models
- Additional user options to customize a scenario

For more details, please contact Dean Nichols directly by phone at +1 (256)327 -4017 or by e-mail at dnichols@apt-research.com .. You can also visit the APT Research website at http://www.apt-research.com/products/models/IMESAFR.html, where you will find registration forms, course logistics and cost details. IMESAFR v2.0 is significantly different from earlier versions of IMESAFR, therefore the IME requires students trained in 1.x versions to attend the IMESAFR v2.0 training before obtaining the new software.

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.

Networking works – Why don't you try it?

Two of our member companies had a similar experience while crimping non-electric detonators onto shock tube in their separate locations. While the details were slightly different in both cases the crimper they used did an unplanned double crimp which could have had serious consequences. This prompted the two companies to decide to share their experiences in order to maximise their learning from these incidents and prevent a recurrence.

Martin Held (Austin Powder International - API) thought that member companies may be able to learn from their networking experience and kindly shared elements of the process they adopted on behalf of Thierry Rousse (EPC UK and France): EPC and Austin Powder decide to arrange a web conference between the relevant personnel in the two Groups who could contribute to such a discussion. Thierry and his team kindly prepared the infrastructure necessary for the web conference.

We can summarise the elements of the process we adopted as follows:

- Date: October 22nd, 2013
- Participants:
  - EPC: 5 participants from UK and France at their UK office
  - API: 2 participants from the Czech Republic, 3 from Argentina and 1 from Cleveland all at their local offices
- Hardware: PC with webcam and landline phone at each location
- Agenda:
  - Introduction
  - Contents
  - Presentation API, PPT slides
  - Presentation EPC, PPT slides
  - Discussion and questions
- Time: 1 hour

Presentations which were prepared prior to the session were projected on the PC's and contained a description of the incident, circumstances, discussion and findings. The presentations were followed by a very open discussion which proved to be a great learning experience for everyone. It helped us review our own processes with the help of the contribution of 'outsiders' who were experts in their own right. As a result we were able to consider additional safety measures from each other's findings and implementation experiences.

The participants agreed that this positive experience was worth sharing with other SAFEX members in the hope that it will encourage more networking in the interests of improved safety.

SAFEX Newsletter wishes to compliment API and EPC on this initiative and thank them for sharing their experience with our readers. It is great to see SAFEX Members implement one of SAFEX's key strategies: Networking – internally as in this case but also externally with other collaborators. We hope it does encourage others to do the same

Two Workgroups "Theme-up" at Congress

The **Good Explosives Practice (GEP)** and **Remediation Workgroups** are planning to work on a common theme, albeit in two different Sessions – one in the morning and the other in the afternoon.

Martin Held, Leader of the GEP Workgroup, tells me: "We plan to focus on safe decontamination of assets as the topic of our next Good Practice Guide (GPG). A number of incidents occur because plant and equipment aren't adequately decontaminated and such a GPG may help our Members. We plan to pool the experiences of Members and consolidate the inputs for such a publication during the GEP Workgroup Session at Congress."

Mervyn Traut leads the Remediation Workgroup which will meet in the afternoon. They plan to apply the same theme to facilities and ground contamination. A series of Papers on the Workgroup's site remediation experiences will be presented during their Session. As Mervyn puts it, "I see this Workgroup Session as a specialist Plenary Session. Most participants will be interested in remediation and probably actively involved therein. The Papers will cover actual cases. The in-depth discussion of each Paper that follows will maximise the learning for the participants but also refine the information for the series of GPG's on the characterisation and remediation of explosives contaminated sites we are producing."

The two Workgroups will have a common theme in a logical progression: the GEP Workgroup Session will identify the general principles applicable to both decontamination and remediation in the morning. In the afternoon, the Remediation Workgroup Session will dwell on the practical application of such principles to site remediation.

If you are interested in one of these topics you may find it useful also to register for the other. For that reason we have arranged them back-to-back and not in parallel

PETN drying incident – Potential causes?

In a tragic incident recently reported to SAFEX, employees of a non-member company were killed in an explosion that occurred during a PETN drying operation. Drying was completed at the end of the previous day and it is presumed the incident occurred when the dried PETN was being removed the next morning for bagging. This incident has prompted a lot of interest among SAFEX members who are eager to learn from this unfortunate experience.

Mervyn Traut (Expert Panel Member) specialises in PETN and ventured the following thoughts about possible causes of the incident: While the company concerned is probably addressing these concerns in their investigation, allow me to share some thoughts about potential causes for what they are worth:

- The PETN may have contained nitric acid (>2.0%). A previous SAFEX Incident report found that "PETN that had been sourced from an outside supplier had a high acid content. As the PETN dried it decomposed and caused a fire which under confinement resulted in a detonation".
- The PETN could have been kept at an elevated temperature for too long. There is evidence that a drop in pH occurs over a 6 hour period at 120°C.
- The drying temperature may have been too high causing partial degradation/decomposition of the PETN. It is considered good practice not to exceed 80°C
- There could have been some form of contamination (such as rust or other foreign matter like sand) which would have increased the impact and friction sensitivity of the PETN.
- If metal drying pans were used, impact from dropping or banging/bumping could initiate the PETN.
- When pouring (transferring) PETN there is a possibility of dust generation. During movement (including pouring) PETN generates considerable electrostatic charges. In some literature, fine PETN dust is considered to be far more sensitive to static than coarse material. However, Morris and Jones claim that PETN is not ignited by a condenser spark having an electrical energy of less than 2,5 joules and that the liability to ignition is not increased at this value by light confinement or reduction in particle size. Since this would require a voltage of 1.3 x 10^5 volts on an average man, it is concluded that there is no industrial hazard of initiation of PETN due to electrostatic discharge during manufacture PROVIDED ALL EQUIPMENT IS ADEQUATELY EARTHED. In addition, any transfer flexible tubing should be conducting, any cloth used as filter socks, bags or drying clothes should be non-static (e.g. calico) and it is good practice to keep the floors wet in PETN drying facilities.
- Needle shaped (acicular) crystals are known to be more sensitive than hexagonal prismatic shapes. This is a function of re-crystallisation parameters. It would be useful to examine the crystal shape of the PETN the plant is drying and handling.

I table these thoughts not to pre-judge the investigation. On the contrary, I have every confidence that the company concerned will well be considering these and other issues in trying to get to the bottom of this very sad event.

Register now for Congress

Congress Bulletin (5) invites prospective delegates to register for next year's XVIII Congress in Warsaw at the earliest opportunity. Anyone wishing to participate in the Congress or pre-Congress activities must register his/her intent to do so. This includes invited visitors and members of the SAFEX community which comprises representatives of Member companies and Corporate Associate Members; Individual Associate Members; and Expert Panel members. In short, if you want to be at the Congress, you must register

Remember, there is no charge for the Congress. However, your company will be expected to pay your travel and accommodation costs to attend the Congress. Our rules allow every member company to send 2 delegates of their choice to the Congress. Group members are allowed 10 delegates from the Group. Presenters of Papers as well as participants in the Training and Workgroup Sessions are not included in this quota and are at liberty to attend the Plenary Sessions as well.

How can I register, you may ask? Complete the Registration Form that accompanied Bulletin (5) or contact the Secretariat for a copy. We are busy finalizing an online Congress Registration Form on the SAFEX Website which should be available soon.

Tony's Tale-piece

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

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

Basis of Safety – It isn't Greek (or Latin)

by

Tony Rowe (Retired from AEL Mining Services)

Just suppose you personally could discover all the possible causes of the accidental or unforeseen initiation of explosives or pyrotechnics and thereby know how to prevent it. What would you do with it?

It could be a real lifesaver. You could share it. You could employ it to save lives, prevent injuries and reduce damage to fixed assets and installations. Used wisely, the information could improve safety standards immeasurably . Wow! How good is that?

But hey! Where do you find it such knowledge? Well imagine this…….

It's a dark and miserable night. Rain is falling and a bitter north-easterly wind is blowing, but you don't care. You are on a mission. If things turn out well you will soon be in sole possession of great knowledge. It may change your life forever. Arming yourself with a lantern you begin the dangerous descent into the dusty tunnels hidden beneath the once great city. After stumbling through the murk for what seems like hours, the narrow passage begins to widen. As the walls recede into the gloom the passageway grows even darker and scarier. Suddenly, out of the darkness a brace of ancient, bronze-clad wooden doors emerge. They are closed and seem to forbid further progress. But their once formidable locks and hammer forged hinges have crumbled under the twin onslaughts of time and moisture. A powerful kick and you are through. In the sudden silence that follows, you

realise that death and perhaps something even worse is relentlessly approaching. Time is short. If you are to claim what is rightfully yours, it must be now. There, in the flickering yellow light of the lantern, a golden chest is revealed. Your hand spasms and fastens onto a book bound in pale leather. You snatch it up and run for your life. A book of great knowledge now belongs to you, but only if you can hold on to it. You run and run, bouncing off walls as you hurtle blindly through the gloomy tunnels. After what seems an eternity there is daylight ahead. You break out into the light and safety. Days later, still feverish, both sick and sore, you decide to examine the book itself.

It is a not a large book and doesn't seem to have that many pages, but it contains much power. You know, too, that with great power comes great responsibility. From the ancient scrolls you learned of the book's existence. They taught that in return for following its teachings would come peace. In return for commitment would come the assurance that at the end of every day of your entire working life the odds against you returning home to the bosom of your friends and family would always be stacked in your favour. However, there is a condition: I must pass on and share its secrets. Is this too much to ask?

Despite some initial fears, the book nevertheless feels warm and reassuring in your hand. It contains no threat, no malice, only wisdom and comfort. On the front cover are the words:

FUNDAMENTUM SALUTIS - MALLEUM NIQUITIEA, MALA CONSUETUDINE

I stop reading; it's all Greek to me – Latin actually! What does *Fundamentum Salutis* mean? I persevere and open the cover to the first page just to be confronted by what must be the Contents page:

PRAELOCUTIO

CAUSA:

I. **CONLISIO**

II. **ATTRITIO**

III. **INCENDIUM**

IV. **SCINTILLA ELECTROCUTUM**

V. **CHEMICA INSTIBILITATEM**

I am desperate; I've got to find out what this means if I am to uncover the precious secrets within these hallowed pages. At last with the help of some of the best scholars I am now able to honour my commitment.

Roughly translated the title means "The Fundamentals (or Basis) of Safety – Hammer of Wickedness and Bad Practice". As the current holder of this book I must share it with others which is what I am doing now and will continue to do in the next four Newsletters. Each of the Newsletters will contain a translation of one section of the *Fundamentum Salutis*.

Praelocutio

In this Newsletter I shall start with the first section. It is titled *Praelocutio*. When translated from the Latin it means "introduction" or perhaps "prologue". I have condensed and modernized the text, wherever possible, turning lengthy and somewhat tedious descriptions into the following, easy to read chapter. Any errors that may have resulted during this process are thus mine alone*:*

Malleum Niquitiea (The Hammer of Wickedness)

This section of the book starts by explaining that most people learn best by building on their own personal experiences. When people are new to any particular environment, they may not possess much in the way of job-related experience. When this happens it is vital to find common ground. All of us have skills and previously acquired knowledge. It follows that every learner possesses lots of other relevant or meaningful life experiences on which to draw. Learners learn at their own pace - not yours. Good teachers simply manage the process. Reward and praise each success. Provide safe, but relevant activities to keep minds alert. Doers learn faster than don'ters.

Mala Consuetudine (The Hammer of Bad Practice)

It draws attention to the organization or structure that must be developed. We live in an ever-changing world. Corporate memory is short, probably around ten years, perhaps less. People come and go. Few stay very long. Experience is in decline. Yet despite these negatives, the lessons of the past must still be captured, shared and incorporated into our defensive strategies. A failure to do so creates gaps that can be exploited. But beware. Here be Tygers (ancient spelling of tigers). Failure requires that history repeat itself.

Like the system of trenches that came to characterize the strategies of the first truly international conflict, organized lines of defence must first be set-up. They must be aimed specifically at preventing hazards becoming incidents. While no longer made up of a series of interconnected holes in the ground, such defences strive to establish two simple principles

- The first is to eliminate unintentional explosions by preventing ignition.
- The second is to manage the consequences of an unintentional explosion should the first principle fail.

Defence in depth is thus fundamental. A single trench line filled to the brim with defenders looks good, but once breached it can be rolled up like one of those fancy spring-loaded measuring thingy's. A strong, multi-layered defence is better. This type of defence consists of layer upon layer. It's like an onion. The more layers the better. Caltrops (anti-personnel devices) followed by ditches and lilies (deep conical holes lined with sharpened wooden stakes); more caltrops, this time supported by artillery (catapulta and ballista), then the massed archers and slingers. Behind the archers we might place the light infantry – at least ten ranks deep - plus their support personnel whose role it is to supply disposable weapons, provide refreshments and succour the wounded. Next would be the heavy infantry, grizzled old experienced fighters wearing heavy armour and equipped with heavy weapons and large shields. Men we can count on. When hard pressed, the light infantry can retreat through the ranks of armoured heavy infantry before returning to the fray. On the flanks lie the cavalry, butchers, every man-jack of them. Then come the fixed fortifications; curtain walls, the higher and thicker the better, moats, towers etc. The picture is clear. The *Fundamentum Salutis* (remember it means "Basis of Safety") therefore does not stand alone, but rather compliments and supports existing quality and safety management systems and practices.

When things go wrong as they will, they always do so in a well understood sequence. If we apply the wisdom contained in the *Fundamentum Salutis* to the manufacture of explosives we find exactly the same rules. They're called the three steps to having a blast. It's simple enough; Explosives, they explode. It's a given. So…

> First Step: For an explosion to occur, explosives must be present. No explosives, no explosion.
> Second Step: There must be a source of ignition.
> Third Step: There must be both reaction and propagation.

Meet all three requirements and Step Four immediately follows: **We're having a blast**!!!

Aha! But did you spot the flaws? They are hidden in the last four words of the first step. What are they?

- Firstly I forgot to include sensitive raw materials in the statement. Why? It made the sentence too long so I left it out. I include it here instead. The *Fundamentum Salutis* doesn't discriminate between explosives, pyrotechnics or sensitive raw materials; nor between vapours, liquids and solids. It refers only to energetic materials. I will henceforth do the same.
- Secondly then, the smaller the mass of energetic materials that are initiated; then the smaller any resulting explosion.

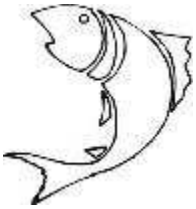
Makes sense.

Therefore, the learning point is always to limit the mass of energetic materials necessary for any operation to the absolute minimum required.

Another flaw is that the phrase "ignition source" is undefined. Here we must trust The *Fundamentum Salutis* which defines an ignition source as "any process or event capable of causing a fire or explosion." Clearly there are a number of such processes capable of causing initiation. The authors of the *Fundamentum Salutis* knew this and thus made the symbol of the fish their own.

Question: Why a fish? Answer: FISH is an acronym, each letter of the word F.I.S.H stands for a process or processes capable of causing the ignition of energetic materials:

- F = Friction (between surfaces)
- I = Impact (between colliding surfaces locally raising temperature and pressure)
- S = Static (electrostatic discharge)
- H = Heat (fire, flame, incendive spark, chemical decomposition and adiabatic compression)



The Latin word for fish is PISCIS and its fourth letter is "C." *Conlisio* begins with a "C" and is also Latin for "impact". Did you know that explosives can be initiated by impact?

The first CAUSA or Chapter entitled ***Conlisio*** follows in the next Newsletter.

Steer carefully and remember, it's not only cars that can be recalled by their Maker.

Boet Coetzee

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