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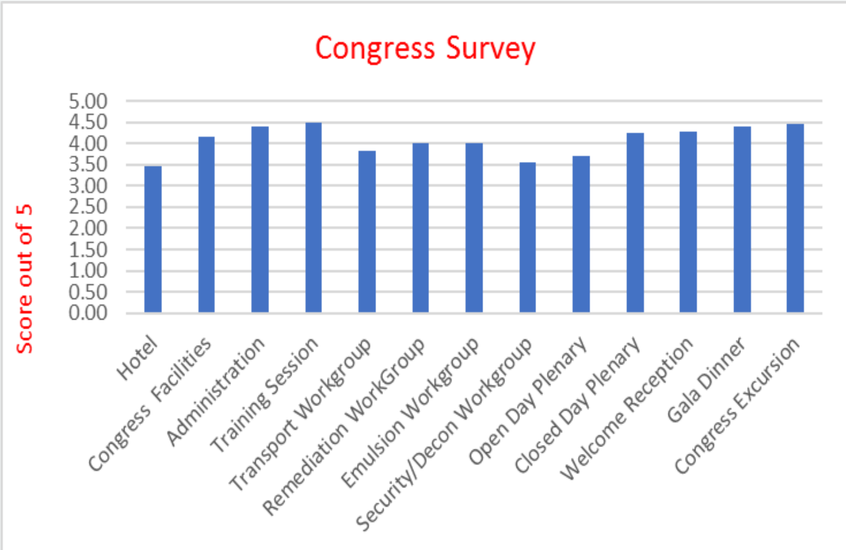
FROM THE SECRETARY GENERAL'S DESK

Well, we are halfway through the year with the Helsinki Congress behind us. What a success it was,a total of 206 attendees from 36 countries were represented. The summary results of the survey run after the Congress are presented in the graph below,indicating the overwhelming support for this very important event in the SAFEX calendar.



The training Session on Incident Investigation was fully booked and highly rated by everyone, thanks to Andy and Martin for their hard work. All the Workgroup sessions were overbooked and exciting progress was made towards a whole series of GPG's,to augment those already available on the SAFEX website. The hard work done by Noel, Colin and Mervyn is acknowledged by everybody. The Open and Closed day again showed a lot of interaction and sharing of incidents-the openness by companies to share sensitive information is commendable,as this learning will definitely save lives and property in future.

Watch this space for news about the next Congress in 2020.

SAFEX International also welcomes the following new Governors to the Board:

- **Dany Antille from SSE as the new Treasurer**
- **Ulf Sjöblom from Oy Forcit**
- **Martin Held from Austin International**

We look forward to their active roles in meeting SAFEX's objectives.

Attendees at Plenary Session

The Gala dinner hosted by Oy Forcit (Ulf Sjöblom) brought everybody together to celebrate and informally enjoy each other's company. Recognition was given to several Governors who retired from the Board after serving for many years:

- **Claude Modoux** who served the longest as Board Member, Chairman and Treasurer
- **Boet Coetzee** who served as Chairman and Secretary General ,
- **Rahul Guha and Enrique Barraincua** who were active Board Members for more than eight years.

Ulf and Charlotte Sjöblom with Boet Coetzee at Gala Dinner

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The Congress ended on a high note with the excursion to the historic city of Helsinki and a boat trip to the island of Soumenlinna.

Helsinki Harbour and City

Soumenlinna Island

The work to identify and start arrangements for the next Congress has already commenced. So watch this space!

The following incidents were reported by our members since the last Newsletter:

- IN17-06 Styphnate Explosion -UK
- IN17-07 Smoldering Waste -Australia
- IN17-08 Press Explosion – Sweden.

The lack of reporting of incidents was discussed by Senior Executives at the Congress and the following was proposed to increase reporting and learning from incidents and potential incidents:

- **Level 1.** Normal incident reporting. As it is today. Company shares a detailed description of the event in question with explanations as to its cause and remedies. Company's name, location, etc. are all identified. Inclusive must be the reporting of those near misses that could have resulted in injury to people or damage to property.

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- **Level 2.** Anonymous member report: This would be where a company could report an event and the investigative outcomes but do so anonymously. Only the Secretary General would be privy to who had the event and where it happened. However, the member company would announce that it would be open to be contacted by another member company for perhaps a verbal review or an informal discussion. This connection would be facilitated by the Secretary General.

- **Level 3**. Anonymous No Contact report: This would be similar to level 2 type of reporting, however, the submitting member company specifically states that it does not want to be contacted by any member and wishes to remain anonymous to the event. Only the Secretary General would be privy as to who sent the incident report.

In this issue we continue with the series on Safety Management Systems by an article on Permit to Work. The feature on "Did you know" is also continued. Members are requested to send SAFEX their contributions to both Incident Reports and Safety Management Systems—remember what you consider as trivial might be very important to somebody else.

FLYROCK: FRENCH EXPERIENCE

by

Anne Charline SAUVAGE, EGIDE Environnement Sarl

The work of the EFEE's Environment Committee has shown in the last few months that it is still very difficult to obtain feedback about incidents or accidents occurring during blasting operations. In France, this information should however be declared in a database managed by the State (www.aria.developpement-durable.gouv.fr), which regroups technological accident feedback.

Although everyone agrees that this feedback is fundamental for preventing probable future incidents and therefore for risk management, the incidents and their causes are still badly indexed. However, civil society, elected officials and especially residents, increasingly demand that these incidents be accounted for by public authorities, companies, and sometimes request information directly via the press or television. Unfortunately, when such situations occur, the company has a duty to provide a pragmatic response and to manage information and communication. We have noticed that the way in which these points are carried out influences the way operations are resumed and their conditions, therefore the financial costs.

We have decided to share our research office experience in incident management pertaining to rocks being projected beyond site roads and quarries in France.

Flyrock cases in France

Indeed, France still has some rare cases of flyrock beyond the safety zone of planned blasting area.

A number of factors particular to France could be at the root of this observation:

- It is possible that our country is one of the few that declares such cases to the

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responsible authority, and in which investigations are carried out!

- All types of rocks can be found in France, in all possible states of weathering
- The majority of French quarries are of a small to average size, spread over the whole territory and often close to housing. In the last few years, the development of road networks and residential housing on the outskirts of cities and villages has contributed to the arrival of residents less than 300 m from blasting operations.

In the case of an incident involving pieces of rock being ejected from a quarry or building site, the French Administration generally orders all or part of blasting operations, and therefore production, to stop as a protective measure. Before allowing blasting activities to be resumed, the authorities require that the operator submit proposals on how to improve blasting operations and blasting control processes. Depending on the requests from the local residents mainly affected, this notably requires that the operator is able to guarantee a high level of safety for the duration of future operations.

In this case, as in the examples below which occurred over the last ten years, we become involved by way of an emergency intervention at the request of the operator, after confirmation by the relevant state department. This also implies that our expertise is paid for

Example 1: Secondary school in the vicinity of a quarry with blocks landing in the playground approximately 300 m in front of the blast

by the operator, unless the case comes under a judicial framework.

In these situations, our work consists of:

1. making an independent study,
2. to draw up a sound diagnosis and justify each of the points included,
3. and to make proposals for the resumption of operations in the very short term,
4. and for the continuation of the operating site in the long term.

Example 2: Damage to a factory roof and blocks landing approximately 200 m in front of the blast

Our experience firstly strengthened by analysing flyrock cases reported as part of the quality process for a civil explosives producer who was periodically involved in explosives implementation and blasting. This experience then developed with operators' specific requests. As time passed, we were able to study flyrock cases closely in a variety of blasting contexts, with variable levels of gravity and multiple causes.

Parameters of Flyrock control

Flyrock, or 'wild flyrock' if we refer to the terminology used by Little & Blair (2010, "Mechanistic Monte Carlo Models for Analysis of Flyrock Risk". Sandrichian (Pub.) *RockFragmentation by Blasting*.), corresponds to the propulsion of a rock fragment of varying size over a large distance from the blast, more precisely exceeding

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the acceptable distance or 'exclusion zone limits' that have been determined or estimated by the blaster.

This propulsion depends on the explosive energy used, the geometry of the confining rockmass and the explosive charges as well as the way the rock mass controls the explosive detonation. The detonation timing of the different explosive charges used in the blast is also an important factor in the occurrence of flyrock in as far as it is likely to modify the way the explosive charges function and to affect the geometry of the faces developed during the blast dynamics.

Of all the parameters that make it possible to control flyrock, explosive energy and the use ofdelays are the most controllable. On the other hand, even if the height of the benches is generally an easily controlled parameter, it is not the same case for rock thickness around (confining) explosive charges. These varying thicknesses depend on the structure of the massif and on the orientation of the faces within this discontinued volume, on the blasting plan being adapted to these conditions, and also, on the accuracy of the drilling already carried out.

Controlling these variations mainly depends on the level of equipment used to check the burdens for every blast. But even the best type of equipment does not stop variations in the use of the system from one operator to another: for example, from which bench thickness (more or less) does an operator decide to change the explosive loading?

Initial blasting condition audits make it possible for us to quantify the explosive energy used and the variability of the geometric confinement of the charges.

Flyrock risk is therefore linked to controlling these different parameters throughout the entire operation.

The right reflexes in the event of incidents related to flyrock

The process of carrying out an investigation must begin promptly after the incident, in particular so as to record the impacts, if they are numerous, and information pertaining to the projected blocks in detail (figure 3). This fundamental step should be carried out rigorously, but this task is often made difficult because the operator has the internal and exterior roadways cleaned up quickly, (which can be understood) without necessarily locating the impacts or preserving the blocks. In the last few years, the wider application of electronic photographs has become a good ally when recording information, but this alone cannot suffice. In the best cases, it had become an established routine to take a video of the blasting

systematically: if the video frame covers the whole blasting zone, the number of hypotheses regarding the mechanisms of the cause of the flyrock can be reduced considerably.

All this information is very important as it allows the flyrock to be mapped, to link the blocks to a particular area of the rock mass, and to propose the most probable reasons for the incident.

The purpose of the on-site investigation is therefore to record:

1. the position of the projected rocks
2. the blocks
3. the characteristics of the blasted rock mass

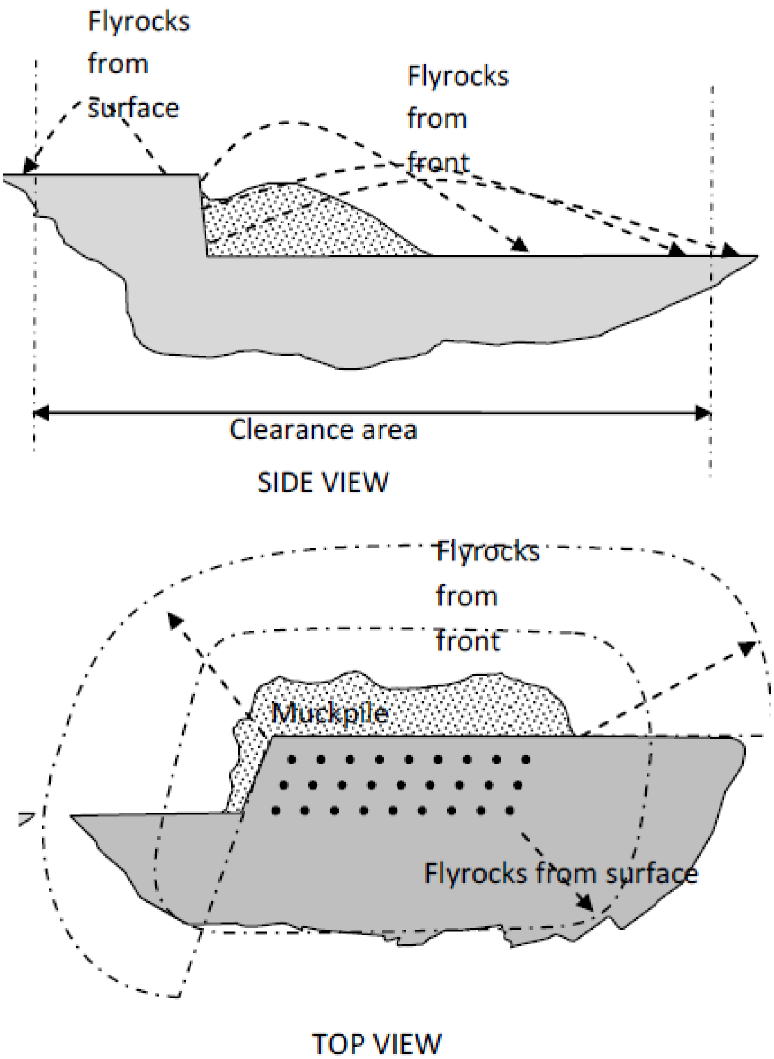

Figure 3: Zones affected by flyrock resulting from blasting

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4. the actual positions of the blast holes

5. the actual charges

6. the succession of drilling-blasting operations and the materials used

This information completes the more general data:

- Theoretical and implemented blasting designs
- Planned drilling and blasting equipment
- Procedures for drilling-blasting and evaluation
- Timing scheme
- Previous blasting designs baked up by measurements of their impact (vibration and overpressure/flyrock)
- Residents and their activities

The blaster is the person incriminated immediately following the incident. In these situations he is responsible for the whole blasting operation, since in France, even if he is not the designer, he is responsible for the final adaptation of the blasting design in order to respect internal procedures (set up, loading and priming and safety clearances).

His presence, time and expertise is required after the incident and he must collate all the technical evidence (state of the faces, drilling report, details of the loading and priming, detail of the explosives used, a possible 2D or 3D survey, evaluations of the drilling deviation, bench thicknesses, misfire handling procedure…).

All of the assembled data is then analyzed in order to draw up a list of the possible to probable causes of the flyrock that exceeded the expected safety zone (diagram 4).

Justifying the resumption of blasting "under acceptable conditions"

Considering the urgency to provide a quantified flyrock risk report to the authorities and to be able to resume quarrying operations promptly, there is a great temptation to set up flyrock calculation and checking tools for every blast.

But the computational tools of isolated blasting operations, even very sophisticated ones, do not take into account the variation in the functioning of explosives, blasting geometries or charge confinement, there being so many different parameters which are the source of flyrock risks during operations.

In addition, day-to-day blasting calculations do not make it possible to anticipate future risks. This situation cannot satisfy the residents or the authorities, neither can it help the blasting organization to diminish their risk over the long term or to control costs.

Therefore, we have fine-tuned statistical studies resulting in calculating the definition of safety clearances depending on the initial flyrock area (originating from surface or the face).

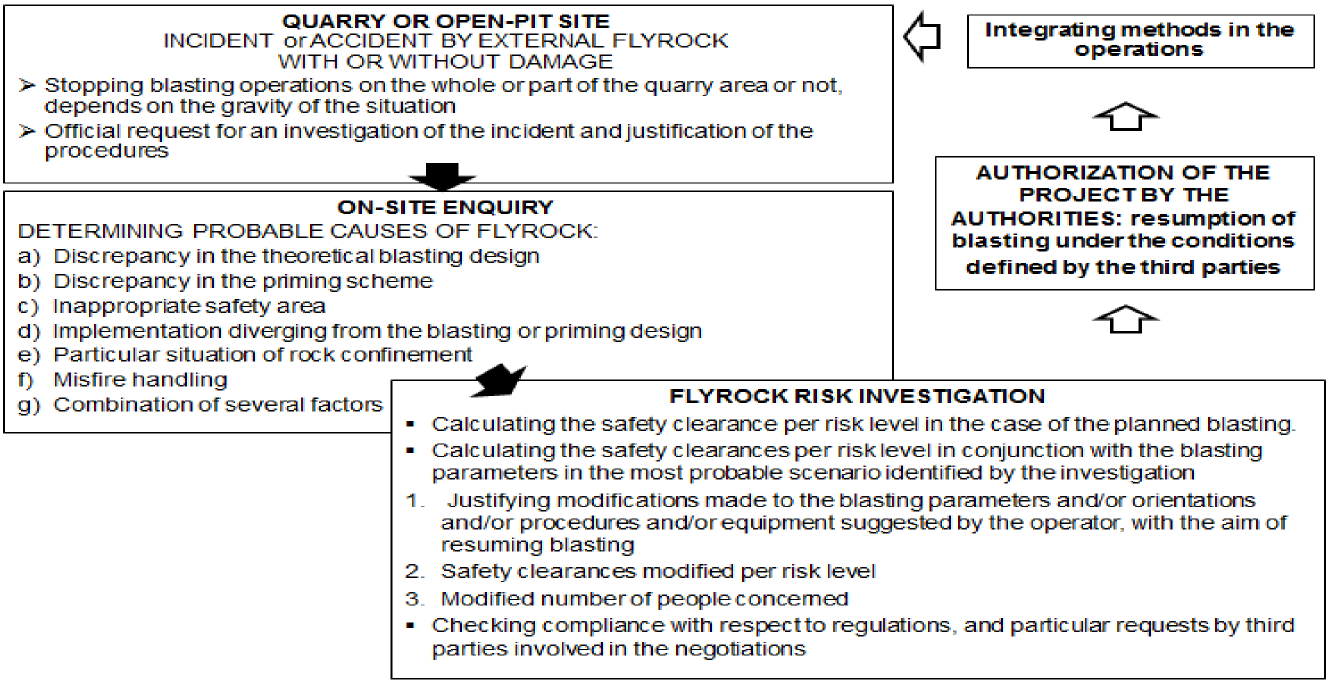

Diagram 4: analysis process of an accidental flyrock incident and conditions of blasting resumption

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Impact probabilities

Our studies use a method of calculation that takes into account the parameters and the associated variations: it was described in several international publications (see A. Blanchier,Quantification of the Levels of Risks of Flyrock, Proc. of ISEE Conference 2013)

By using the blasting parameters and data specific to the operation, the model makes it possible to determine successively:

- the distance of maximum flyrock for each hole depending on the level of probability;
- the probability that a person be impacted by flyrock from this hole;
- the annual probability of impact.

Risk and acceptability

In classic risk analyses, the probability of an accident occurring and the effects of this accident on people are analyzed separately. These effects decrease in relation to the distance from the accident area.

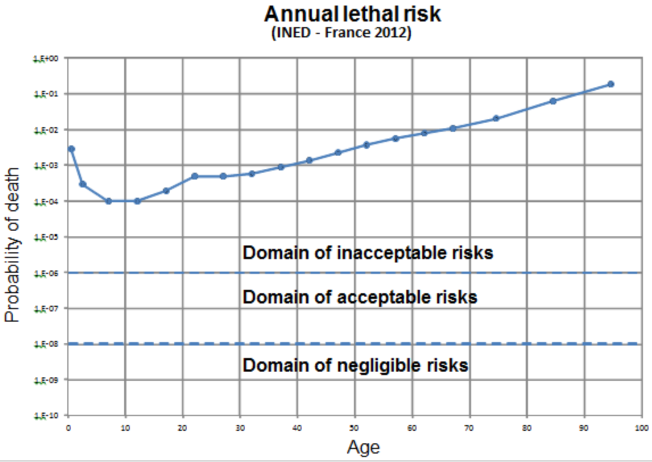
In the case of accidental flyrock, the triggering factor is the blasting, meaning that this incident is not random. In addition, the effects of flyrock do not decrease with distance: a 200-gram projectile can be fatal at 20 m, as it can at 1,000 m.

Consequently, the approach to risk is noticeably different from those of other hazards: the effect of flyrock does not change markedly according to the distance; it is only the probability that changes.

In fact, the risk of fatality, being the product of the probability of an accident per the fatal probability in a defined danger zone, knowing that an accident has occurred, corresponds in our case to the probability of impacting a person at a given place, presuming that each impact is fatal.

These risks are compared to the risk of annual 'natural' mortality. In the case of France, the probability of death is given in Graph 5. The values are similar to those from other European countries.

The lowest annual risk of death (between 5 and 14 years of age according to French statistics) is in the region of 10-4. Added-on risks that increase the probability of death by less than 1% are considered as being unacceptable. Levels of negligible risk can also be defined.



In this way, the NATO rulings integrated in the main

Graph 5: Probability of death in France - INED 2012

into different European regulations accept a maximal risk of 10-6 for the external environment. These limits are reinforced for areas with a high-density population for which the maximal risk of 10-8 is generally accepted.

Flyrock leading to significant effects on people only leads to minor damage on infrastructures:

The main risks are indeed risks of glazing breakage or damage to roofs or unsteady partitions.

Utilization of identified flyrock causes under conditions of blasting resumption

Initially, our calculations were carried out in studies of incidents to compare the risks originating from the theoretical blasting design and those affiliated to the real blasting designs, which were reconstituted after investigation. We run a simulation of the situations under consideration based on gathered evidence: the data entered into the calculations is information from real blasting operations and it is understood that the logical continuation of the analysis consists of proposing adapted modifications to the procedures of these operations and/or to the blasting parameters, depending on the causes of the incident, with a quantified justification of their effectiveness.

Proposals of conditions to resume blasting are all the more relevant, as the information retrieved on site is precise and thorough: the operator therefore may find it beneficial to cooperate as soon as the data-gathering begins, in order to then find an acceptable solution for the operations or the site.

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Example 5: Houses bordering a site road and blocks projected onto the frontage approximately 200 m from the blast

Example 6: Blocks landing in a field and another impact on a dwelling more than 430 m from the blast

Any person having experienced an incident linked to blasting outside the operating site involving the intervention of a third party, apart from official representatives of the State, can testify to the complexity added to "crisis recovery". Indeed, different actors become involved in the bounds of comprehensible safety requirements, but these are disconnected from the regulations and technical rules specific to our field.

It is at this time that the independent design office that we are and the statistical method chosen, have their full use in establishing a climate of confidence, in justifying the technical blasting choices and in supporting the resumption of blasting operations, if this is requested.

Anticipation of the risks for effective prevention

In the last ten years in France, we have seen methods for evaluating risk in industrial activities as a whole become generalized and harmonized, and this has led to flyrock risk studies becoming formalized in the initial stages of a project using explosives.

Our flyrock investigations inevitably begin by examining the actual or planned blasting conditions. This includes not only drilling equipment, the choice of explosives, priming and geometrical parameters, but also methods for evaluating these parameters and the teams' working methods.

Diagram 7 describes the process of a flyrock risk study in blasting operations in the case of extraction which is in progress or planned. It results in checking compliance with the legal blasting requirements established in the local context. It is not only the people concerned and their activities which are taken into account, but also the nearby facilities and infrastructures depending on their respective strategic importance.

These studies, undertaken in the early stages of the works when the operating schedule is being organized, when procedures are being drawn up, when the choice of equipment and the last negotiations with local public bodies and project supervisors are being discussed, reduce the risks and contribute to a better cohesion between all the stakeholders during the operational working phase.

At this stage, choices to be made often concern the

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orientation of the faces which would be advantageous to risk management when considering external activity, adapting the height of the benches, programming the closure of a road during the blasting phase, or more simply deciding on a higher top stemming after having checked that the charge does not lead to a blasting dysfunction.

Once the highest risk levels have been reduced during the operations, the blasting manager can focus on the residual hazards, such as the modification of confinement around the charges (through a variation in the quality of the rock or in its structure, for example), a change of explosives or initiation system, or an operator or a type of equipment.

dents in our profession, in the opinion of our parent ministries themselves.

Flyrock does not occur frequently, however, each time it does take place, it can have significant consequences and occur over a large distance. Consequently, it has a strong impact on the perception of explosives use.

With risk level computational tools now being available, no one can be satisfied with studying these cases without working on a daily basis towards their prevention.

Over and above dealing with a specific incident, preventing flyrock risk requires that this aspect of the environmental impact of blasting be explicitly integrated into blaster and blasting designers training, as well as

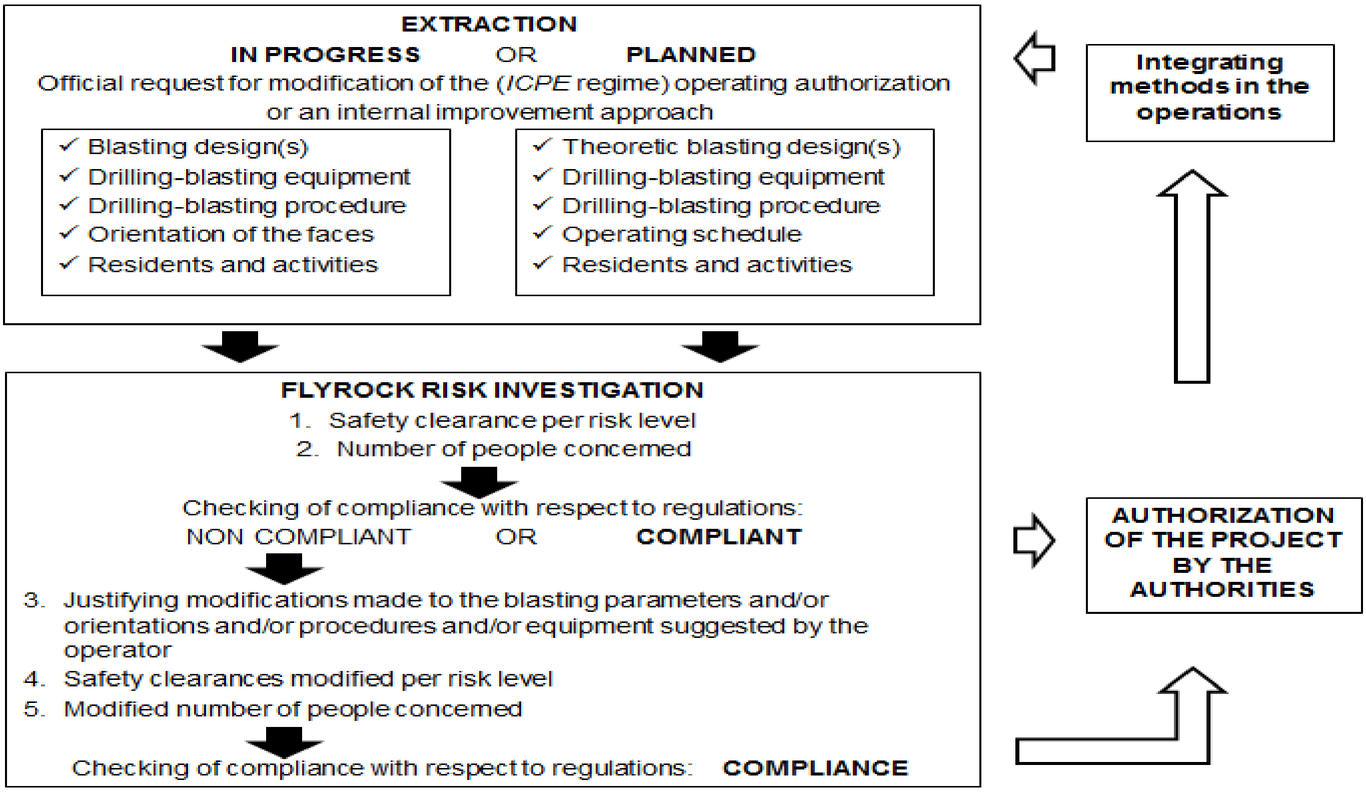

Diagram 7: Process of flyrock risk study and blasting conformity study with respect to regulations pertaining to environmental risks

When modifications call the calculation hypotheses into question, prompt, complementary investigation is necessary.

Conclusion

Without the experience of detailed analysis of the origins of flyrock beyond the safety zone ,the work relating to the prevention and justification of controlling the risks would have been much more difficult to promote in critical blasting situations.

Declaring an incident such as flyrock, analyzing the causes of the incident and justifying anew organization, are industrial processes that are commonly used in other sectors.

Thanks to accident prevention practices in the pyrotechnical sector, there is a very small number of acci-

into regular meetings on work safety organized in accordance with labour legislation.

All technical elements that make it possible to improve the control of blasting parameters and confinement can contribute to reducing flyrock frequency.

However, our experience enables us to assert that an increase in blasting technicality (e.g. carrying out 3D surveys of the faces coupled with measuring drilling deviations, or putting in place electronic priming that are easier to implement and presenting results on a more regular basis) does not solely guarantee an absence of flyrock, neither does it alter its range of projection. It is necessary to identify situations at risk in the early stages and to work in anticipation of eliminating occurrences at a critical range.

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Permit to Work (PTW)

By

Andy Begg

Most activities undertaken in a site will be of a routine task type and will be covered by appropriate detailed Operating Instructions – operating a plant, routine maintenance of a standard piece of equipment, driving a fork lift truck, test firing explosives and so on. However, there will be jobs that need to be done on an irregular basis or in case of breakdown and for which there are no formal written procedures for example dismantling a PETN nitrator stirrer, a welding repair on an ammonium nitrate solution transfer pipeline, cleaning out an explosives sump. The purpose of the PTW procedure is primarily to ensure that such an activity is correctly assessed before the job is started and that appropriate safety measures are put in place so that the job can be done safely and the piece of equipment taken back into operation. The basic rule is **"If there is no formal operating procedure then the job must only be done under the PTW system".**

The PTW is a very widely used procedure and may need to relatively comprehensive depending on the scope of operations on the site or location. It will normally be applied when a piece of plant is being handed over from operating personnel to maintenance personnel for repair work or modification – but can also be used in offices, magazines, laboratories etc. The PTW procedure will ensure that:

- Job is fully described
- Hazards identified
- Necessary precautions in place
- Personnel trained in job skills and PTW system
- Personnel aware of issues and any residual hazards
- Hand over and hand back of plant is agreed

The typical PTW will have several sections that must be completed by trained and authorised personnel. The permit will take a form of a checklist that must be completed by "the issuer" – a plant supervisor for example – and "the acceptor" – the maintenance specialist. The Issuer has to be competent to ensure that the plant is "safe" for the work involved and the Acceptor has to be competent to understand the risks have been adequately assessed and controlled. The Permit will be signed by both and dated with an expiry date – the Permit is now regarded as "Open". Once the permit has been "Opened" the plant is out of operation and stays as such until the Permit has been "Closed" – meaning the work has been completed, the plant has been inspected by the "Issuer", deemed safe to be taken back into operation and both Issuer and Acceptor have signed confirmation of this. If the necessary work cannot be completed within the expiry date the job must be re-assessed and the permit must be re-issued for another period.

The hazards that may need to be dealt with by the PTW vary from site to site but could include but not be limited to the following:

I. Hot work – welding, flame, cutting/abrasive discs and blades

II. Impact/friction – hammering, use of wrench

III. Electrical sparks from power tools

IV. Opening lines under pressure – static pressure from head of liquid in pipeline, compressed gas

V. Stored energy – spring loaded equipment, charged electrical systems

VI. Explosives contamination

VII. Chemical exposure

VIII. Noise

IX. Work at height

X. Confined space

XI. Live electrical conductor

For each hazard type, there will be a detailed procedure that must be followed to manage it. For example, if there is explosives contamination present then there will be a procedure that instructs on how the decontamination will be carried out. Similarly, for confined space there will be methods for gas testing, safe access and exit so on

There are different models on how to structure the PTW procedure depending partly on how many of the hazards previously listed are considered to be present. In one model, all the hazards are covered in a single permit which would be several pages long whereas in another the PTW consists of a "general" permit which asks which of the hazards are present then only if a specific hazard is present is the issuer then required to go to the detailed procedure which would be on a supporting permit. So, in this latter model a job could require a general Permit and also a Confined Space Entry Permit and a Decontamination Permit. And each one signed by the appropriate (trained) persons.

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Key responsibilities of Issuer

- ensure that personnel under their control understand the risks and precautions involved, as well as any special permit requirements
- ensure that the nature and extent of work does not differ from that agreed
- determine the impact on the other activities of the plant
- establish that the work does not constitute an unauthorized modification
- confirm completion of permit form and conditions by their signature(s) – **all sections must be completed.**
- inform all people involved before work starts and make necessary arrangements at handover to acceptor
- define hazards expected and proper precautions to be taken

Issuing the PTW

- Discuss the job with the acceptor and ensure that the job, hazards, and permit conditions are fully understood. The discussion about the job must be done in the field, not inside the office.
- Request the acceptor to sign the permit to confirm acceptance of plant or equipment.
- Post a copy of the completed permit at the workplace or suitable location nearby.
- Original copy remains in issuer location with a second copy to central file

During the work

- Issuer may inspect the job to ensure that job conditions have not changed and that permit is still valid and complied with
- If job is not going to be completed within permit time then formally countersign the permit after inspection and review and extend for another period.
- If permit runs into next shift ensure the next supervisor is aware of the permit.

At completion

- Issuer inspects the workplace to ensure that the job has been completed
- Discusses the job with the acceptor and agrees that the job is complete.
- The issuer confirms that all tools, equipment, spares, wastes etc have been removed
- Issuer inspects the workplace to confirm the above
- Acceptor and Issuer sign the permit to confirm that the job is complete and that the equipment/area is accepted back for normal operation.
- The completed closed out permit is returned to issuer permit file and retained for specified period. A copy of the closed permit is also sent to central file for attachment to the copy there.
- The records will be available for audit.

Key points of the PTW procedure

1. Authorised personnel only
2. All sections to be completed
3. Unique number for each permit
4. Reference to other PTW's open on the same or associated piece of plant
5. Time expired permits must be re-issued
6. Post at workplace
7. Retain copies
8. Formal closure and hand-over/hand-back
9. Routine inspection/audit of system

An audit protocol for the PTW system

1. Is there a standard format for the PTW system that complies with at least regulatory requirements?
2. Is there a training programme for all permit issuers and permit acceptors?
3. Does the training include contractors?
4. Is there a formal register of trained issuers and acceptors and does the register state when re-training will be required?
5. Are records of completed permits retained for at

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least 6 months and are these accessible?

6. Is the PTW being fully and correctly implemented?
   a. Are forms completed – all sections filled in?
   b. Are forms completed correctly – are precautions consistent with hazards?
   c. Are issuers and acceptors on the authorised lists
7. Are there local procedures for hot work, work at height, work in confined spaces, work on live electrical systems, lock-out/tag-out, decontamination of process equipment and has appropriate training been given in each?
8. Hot Work
   a. Is "hot work" clearly defined?
   b. Are precautions taken to ensure fire cannot spread and area concerned is given restricted access to prevent injury to others
   c. Are precautions taken to ensure that there is no passive/smouldering fire after the work has been completed?
9. Working at height
   a. Is "working at height" clearly defined and includes working on fragile roofs, pipe-bridges, scaffolding etc.
   b. Are appropriate fall prevention and fall arrest systems in place and are harnesses, safety belts and lanyards registered and inspected on a regular basis to ensure they are fit for use?
   c. Are personnel trained in the use and care of this equipment?
10. Work in confined spaces
   a. Is "confined space" clearly defined?
   b. Is there a register of known confined spaces and are these clearly marked "Confined space – do not enter without a Confined Space permit"?
   c. Are gas testing facilities available or can be made available?
   d. Are personnel formally trained in confined space entry?
   e. Is there adequate equipment available for the prompt and safe extraction of personnel who are injured while in the confined space?
   f. Are the site-specific hazards of confined space working assessed – e.g. hazardous vapours that may require specialist medical treatment?
11. Work on live electrical conductors
   a. Has training been given on working on live conductors?
   b. Are PPE requirements clearly specified – e.g. non-conductive footwear?
12. Lock-out/tag-out (LO/TO or electrical isolation)
   a. Are personnel who are authorised to use the LO/TO provided with personal locking systems and are the keys kept in a secure location?
   b. Are plant electrical switches designed to accept the locks?
   c. Are warning notices provided stating "Do not operate"?
13. Decontamination of equipment
   a. Are there clear procedures for the decontamination of process equipment prior to being cleared for maintenance work or removal from the site?
   b. Do these procedures take the specific hazards of different contaminants into account – e.g. different explosives types and the hazardous wastes that may be produced and how they should be disposed of?

Inspection guide for the auditor

Check

- records of completed forms that are in the file for correct filling in – all sections completed and consistent with the procedure
- where PPE is required it is appropriate for the job and hazards
- names of issuers and acceptors are on the list of authorised personnel
- all permit reference numbers are accounted for (e.g. withdrawn permits should still be in the file)
- if possible examine an open permit for a job that is in progress – check that the permit has been issued, is correctly filled in, is posted at the workplace and that the person/s carrying out the work is/are aware of the hazards and precautions to be taken

The PTW itself is not an assurance that accidents will not happen. It is necessary that all those involved in the job, perform their tasks with discipline, following the procedures and aware of any change in the work conditions till the end of job.

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Did you know that - - - ?

Did you know that explosives can hide in unexpected places? There was a small explosion that occurred while a maintenance fitter was performing a grinding operation to repair a hand tool which had been used in booster production. The handle of the tool was made of hollow stainless pipe and had a hole in it to allow the tool to be placed on the shadow board. Even though the hand tool was decontaminated prior to the repair work being carried out, there were still accumulated explosives hidden inside the handle. The explosion caused the distortion of the tool and generation of shrapnel; fortunately, the fitter was unhurt. There were similar incidents previously reported and in some of those incidents the people involved were not so lucky. Energetic material can enter cracks / cavities where it can't be cleaned easily and can be initiated during maintenance, renovation or demolition.

The key learnings from these incidents are:

Design tools, equipment, floors, etc. which may be in contact with explosive materials to not only fit the job, but also to prevent it from forming cracks/cavities. These should be made such that they are easy to clean or decontaminate.

Before any maintenance task is carried out, make sure:

The equipment is FULLY decontaminated and double checked by competent people.

Maintenance personnel understand the task and associated hazards, and select the correct tool/method for the task.

The "Hot Work Permit" system is effective, the task is reviewed and authorized regardless of it is being large or small.

Submitted by Wen Yu

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Did you know that the pallets used can be an important issue in the storage of explosives. During my inspections of magazines which by the way I think are sometimes overlooked but are critical because of the amount of explosives involved, I observed flimsy black powder pallets where black powder cardboard boxes overhung the edge. With time the cardboard box edge sagged. I imagined that if black powder collected in the sagged area, it could create a pinch point during pallet handling. Another issue was the use of press-wood pallets for transport of propellant cardboard drums. The corners of these pallets are sharp and can puncture the drums during turning manoeuvres; the corners may exceed the payload footprint and are hidden from lift-truck operator view. We had the corners cut off.

Also damaged pallets can be a major issue in stack stability or package integrity. There was an incident in a PETN boat shipment where a nail or a piece of protruding board pierced the cardboard box and inner packaging bag. PETN leaked under the pallet and desensitising water evaporated. During the unloading process a small explosion occurred without fortunately initiating the payload. Check the condition of pallets before use.

This leads to the necessity of having proper procedures to deal with explosive spills in magazines which means the handlers stop their operation and get assistance to deal with the spill using methods dependent on the sensitivity and the quantity of explosive; usually wetting is preferable to chemical desensitisation of explosives but not in all cases. Hence spill retrieval kits may need to be provided with non sparking, non-static generating dustpans or shovels, static free brooms (corn or horse hair brooms), wetting dispensers (sprayers, containers) depending on the product being handled.

If others have special spill procedures in magazines, please input your experience

Submitted by Maurice Bourgeois
More about pallets in the next issue !

QUESTIONS FROM READERS

Does cracked steel increase risk?

During hazard reviews of ammonium nitrate plant the possibility of cracked steel occurs frequently. This can either be by chloride cracking on stainless steel or nitrate cracking on mild steel.

Although often identified as an issue I cannot remember seeing any work about what the increased risk is.

When I was researching ammonium nitrate prill head explosions I came across a reference (Laurant 2001) to cracking in the stainless in a head house in Belgium, prior to an explosion. Again, although cracking was recognised as an issue, cracking was not mentioned in the final report of the causes.

- Does anyone have a view on this?
- What is the danger of cracked steel?

Reference:Laurant, Benard. 2001. "Confined space decomposition test of ammonium nitrate fertilizers in KEMIRA Tertre lab in Belgium." *ANNA proceedings 2001.* Tucs

Submitted by Ron Peddie

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KNOW YOUR BLAST PROTECTIVE ENCLOSURE

BY

Maurice Bourgeois

Blast protective enclosures are used to isolate the effects of a detonation or deflagration within the confines of the enclosure by venting the overpressure to a safe area in order to protect personnel and other operations from higher risk operations like explosive reaming or machining, pyro granulation or screening, propellant extrusion etc. I would like to share some experiences, observations and comments on this topic.

Unexpected find

Many capping machines for small caliber munitions were transferred from another division to our division in a rationalization program. No one suspected that the enclosures were not strong enough to contain a primer cap mass detonation maybe because over twenty years no such event occurred. One day, military customers were due to visit the area in the afternoon. Just before lunch, there was a massive detonation which blew the back of the enclosure projecting parts of it and shrapnel across an aisle; fortunately no one was in that area. We had been living on borrowed time and never questioned the capacity of the enclosure. A more robust enclosure was designed and tested with 1.5 X the maximum NEQ present in normal operation. The distance of center of explosive load to enclosure walls and doors was measured and made part of design intent.

Also, during the site planning , old cubicles resistance to blast were assessed; to our surprise, one cubicle was added much later than the original construction of the plant; there was no rebar interlock between walls and floor and the walls were much thinner than the other cubicles originally built. A remote operation with a steel enclosure 60 feet away from the cubicle had to be built.

Although objections from operators (for easy access to the tooling) to extend tabletop of the machine to the enclosure walls and doors to eliminate any gap and prevent shrapnel from being projected outside the enclosure, we decided to extend the tabletop. A second detonation proved that it was a good decision. The operator was seated in front of the door with feet up resting on the machine tabletop. If the gap had been accepted the operator would have been hit with large amounts of shrapnel in lower part of body.

Management of change

Another word of caution is to always refer to design intent for modifications. For example, engineering proposed to install an automatic feeding system of cap batches compliant with NEQ but where center of detonation to walls or doors was shortened hence increasing overpressure on a particular enclosure wall or door. They had to review the installation to comply with center of stack distance to walls and doors.

Access door control

During a safety audit in another division, I noticed that the enclosure door was almost always kept opened for ease to supply primer caps to the capping machine while in operation. No sense of having an enclosure if its door is opened during operation. The cap feeding process where the operator fed the capping machine with small 100 caps trays, hence for obvious efficiency issues the door had to be kept open. Hence, the feeding system exposed operators to high risks.

There was a SAFEX major accident report with casualties where the operators attempted to correct some type of anomaly while the equipment was operating in a cubicle. Access door was not interlocked. Here again operators were regularly going inside the enclosure to intervene while the high risk operation proceeded until Disaster Day.

Access doors or openings should be interlocked with the equipment so operators don't expose themselves to higher risk equipment or processes while in operation. The purpose of heavy enclosures is to protect operators from risky processes so operators should not be able to keep equipment operating when the enclosure door is open. Also with CCTV there is no longer a need for portholes that could reduce blast resistance; CCTV also enables different angle views of the equipment in operation.

The importance of venting

Another issue is venting. One enclosure was designed with a large elbow with a large frangible panel; a mass deflagration demonstrated that it was not a good idea because there was not a direct evacuation path. What happened? Overpressure blew the frangible panel out, reflection pressure built up as well as impulse which deformed the enclosure and its weakest point the door. The elbow was replaced with a full frangible panel from top to bottom of the equipment which performed as expected on a second incident.

During a safety audit in another division, a door was used as a venting device for a cubicle. The door was held in place with two eye bolts tied with a thin tie-wrap. The door was far from

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the explosive stack at the opposite corner of the cubicle. The first question that came to mind is how the tie-wrap was controlled; a stronger tie-wrap would require a greater overpressure to open the door. Also, weather conditions could adversely affect the force to open the door e.g. strong head winds or freezing rain and ice accumulation could greatly hinder the door opening; also the surface area for evacuation of the gases seemed inadequate. A door cannot be used as a venting device for the obvious reasons above.

Another example of failure to properly vent the overpressure occurred with a cap which was loosely fitted at the top of a venting stack used for a propellant feeding system; snow and ice accumulation on the cap retarded its pop-out causing bulging of the stack and deformation of the door with gas wash.

Four inch pipes can be used on pressure vessels to relieve overpressure with a pressure safety valve but cannot be considered a vent for an explosion or deflagration. Depends on quantity???Reflection pressure builds up very quickly, time delay of evacuation is greatly increased thus increasing impulse pressure and destructive forces.

There was a blast in the granulation of igniter composition; the frangible wall of the cubicle was too strong and operator access door bulged. The frangible wall design was reviewed to weaken it.

Another consideration for good venting is the prevention of congestion where ancillary equipment such as hydraulic pumps etc. reduce the free volume and can interfere with the venting by reflecting the overpressure. They should not be located between the higher risk equipment and the frangible wall. Finally, electrical conduits or piping should not be attached to the frangible wall.

On a capping machine, the venting port evacuated hot gases onto a cable tray; a redesign was made to direct venting in a safe area.

<u>Lessons learned:</u>

1. Reinforced protective enclosures should be rated in the same manner as crane capacity with NEQ TNT equivalent or NEQ of explosive used for the design with center of stack distance to closest wall or door. Preferably, a sign indicating the capacity should be located on the enclosure; if not, the enclosure should be identified and records should indicate its capacity.
2. Doors should be interlocked to prevent operation of the equipment when they are open.
3. Don't take reinforced protective enclosures for granted; make sure that their blast capacity is well documented.
4. If possible, blast testing with 1.5X NEQ should be conducted to make sure everything is contained: fragments and overpressure.
5. Care should be taken to design frangible walls that will have a *design safe loading resistance of not less than 10 and no more than 20 pounds per square foot; no electric conduits or piping should be attached to the frangible wall. Weather conditions should be accounted for in the design to prevent interference with its proper functioning. For example, where there is a risk of ice or snow build-up, vertical frangible walls should be preferred to horizontal.*
6. Venting must be directed toward a safe area.

Tony's Talepiece in this Newsletter highlights a very important issue regarding the materials of construction when building structures that are destined to house explosives production facilities, or used to store explosives; an incident involving a spill of lead styphnate and the response of the person involved, is also presented in this article.

STICKS AND STONES MAY BREAK YOUR BONES, BUT BRICKS?

By

Tony Rowe

You know that I am, but a foolish old man. My memory is not what it once was and I don't even see so good anymore. Goodness me, I can no longer even tie my own shoelaces. Sometimes my underwear goes on backwards or inside out or more often than not, both. My wife just laughs. At mealtimes, with my teeth worn down to mere nubs or missing altogether, there's either watermelon, baby food or the homogenised and tasteless gruel called "Beef and Plum Duff." This sticks to the ribs, doesn't need chewing and comes in a large 'toothpaste-like' tube for easy squeezing. but Hey, enough about me and my troubles.

What if I asked you the question, 'What comes into your mind when someone uses the word "safe"? Is it perhaps a great underground vault, concrete walls, steel grills and a huge steel door bristling with combination locks or is it a rather small iron box with a keyed lock and hidden hinges? Maybe it conjures an image of a small child held either in a parents arms or tucked up in bed. Certainly the word seems to imply an element of security, Could it equally mean the act of keeping oneself and others free from harm and out of danger, but is there more to it than that? I feel that it also implies awareness, some knowledge of the immediate environment, training and maybe also a level of competence?

For instance, are buildings safe?

We know from news reports and video footage that if they were poorly constructed, they can occasionally fall down, but what if they are strong and well-built, but merely used inappropriately? What if the materials used in their construction are entirely unsuitable for their present purpose or their design was not properly thought through? Would you know and do something about it or would you simply accept things at face value and walk on past?

We are about to enter the land of Catastrophe.

I was busy contemplating all of this when I was reminded of a story from long, long ago. It is a true story. It was told to me by a co-worker; let's call him Henry Hobson (far enough away from his real name to ensure anonymity).

I suppose it all started during the month of July in the year of our Lord 1986. It was around 6am on a bitterly cold morning in Johannesburg, South Africa.

I know, I know, back then, most of you were still a twinkle in your old man's eye, but I remember it like it was yesterday. The place where the tale was told was a tearoom not far from a fence. The tearoom sported nine or ten 1960's era kitchen chairs. They were well worn, but what made them so memorable was that they were all covered in the same hideous, green vinyl. There were also two rectangular, aluminium edged, Formica-topped tables all of a type similar to the set pictured below.

A brown, woodgrain patterned, Toshiba fridge stood almost directly opposite the door, while an ancient water cooler propped up one corner. There was also an electric urn that supplied boiling water. I clearly remember the sink too. It sported a single brass tap that delivered lukewarm water - that's water that looks warm, but is actually hot (in the summer at least) and delivered an iron tasting, ice-cold slush in the winter. The ergonomics of the structure were appalling, yet despite these and other shortcomings, my recollections of the place remain overwhelmingly positive.

Henry was by then already in his sixties and no longer as young as he used to be. As for myself, I was but a lad, a mere stripling of around thirty-something summers and despite what you may have heard, I wasn't yet fat, bald, wrinkled or even particularly lazy.

It was early in the morning and few people had thus far braved the freezing weather. Henry and I were drinking coffee (Ricoffy, I suspect - 5 sugars please) and in between sips, we were talking rubbish and telling stories as people engaged in this form of socialising tend to do. I should perhaps mention that when guys do this, there is one absolute guarantee and here it is: "if you have a black cat the other guy will have a blacker one". It was certainly true on that day.

We were talking close encounters with Blue-Eyed Mr. Bones, He of the scythe and hood. The dude you are thinking of is Mr. Leprosy. He's got a bell and hood. Ding, ding, "unclean" and all of that stuff. Anyway I had just told Henry my best story. It involved spear guns, blood and some barracuda in the Dubai Creek. I bet by now that you have figured out that I talk – a lot!

Henry did eventually have his turn and this is what he told me.

At the time of the incident Henry was employed within a factory complex known as Commercial Section. His role revolved around a group of three buildings called 'Drying Houses.' These were ill-favoured places where bulk primary explosives were spread out to dry.

In those days, a mechanical mixture comprising of two primary explosives, (lead azide & lead styphnate) was supplied to the drying houses in the form of a damp paste. This was spread out to dry on sheets of brown paper, which were supported in turn on canvas-floored wooden trays. By the way, both lead azide and lead styphnate are extremely sensitive, violent and powerful initiating explosives.

Each tray held about 1.5 kg (dry weight) of the mixture which, I must say, because of the colour always reminds me of English mustard, but possessing a far more wicked bite. There were ten drying cubicles in each building and each cubicle accommodated six trays. Drying temperatures were maintained between 40 to 45 degrees Centigrade. Drying time was twenty-four hours.

To cut a long story short, one day whilst removing the dried powders for further processing, Henry apparently managed to empty the entire contents of a full tray and perhaps more over his head and body. The dried and treacherously detonable, bright yellow powder poured over his hair, down his neck, under his overalls and continued straight on south. Now, for those who don't know much about lead styphnate, just remember that it is never your friend. Remember too that in the presence of moisture, it is an exceedingly powerful dye.

It didn't take long and within minutes Henry was a bright yellow colour from head to toe.

I asked him breathlessly "So what did you do?"

"I made like a #$%^@* statue" he replied. (I had to take a particularly rude word out of that sentence in case a young person should be somehow negatively influenced)

I didn't doubt him for a second. He stayed there (he said) like

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The Statue of #$%^@* Liberty for around two hours before somebody found him (I took that rude word out again). It was probably an interesting and philosophical conversation touching perhaps on the meaning of life, how to explain the colour red to someone born without sight or what happens to us when we die.

Being a working drying house, the interior would have been kept at around 40 degrees Centigrade and the air, would have been thick with alcohol fumes. The perspiration trickling down Henry's face would have cut rivulets through the yellow powder, no doubt further dyeing his skin, but without a mirror Henry couldn't know. He was a courageous soul and kept his mental state under control throughout.

Once Henry's plight was discovered, things began to happen. Cooler heads soon arrived and Henry was first very carefully hosed down and given something cold to drink. Later, with all the explosives carefully removed from the cubicles Henry was hosed down again. He was then carefully stripped naked and hosed yet again. Fire hoses don't generally deliver warm water and it was July in Johannesburg. Brrrrrrrrrrr!!!! Now fast turning blue, Henry finally walked away.

Rudyard Kipling got it exactly right when he wrote

If you can force your heart and nerve and sinew
To serve your turn long after they are gone,
And so hold on when there is nothing in you
Except the Will which says to them: 'Hold on!'

Good Man Henry! (I just wrote that)

Henry did everything right. He didn't panic, but simply stood still and waited for the assistance he knew would come. I suspect that as a religious man he also probably prayed a little along the way. Who in his situation would not?

He had been well trained and clearly knew the properties of the products he was working with. He was entirely competent despite things going so terribly wrong and, as we say these days, was environmentally aware. Or was he?

How much better would it have been if the incident had never happened? That is what real safety is all about. It is not about a safe recovery, (though in itself that is not a bad thing) but rather about preventing it from happening at all.

But this story is not about Henry, it's rather about the buildings. In this case, there existed for a number of hours the very real potential for a bang involving some 90 kg of high explosives, yet nobody in the vicinity was even remotely aware that just a few tens of meters away such an intensely critical situation had suddenly developed.

What if Henry had panicked or done something foolish?

Very fortunately the area had little pedestrian or vehicular traffic, but no doubt the other drying houses continued to operate. All three were built from brick and all were well within the factory area. Vehicles would have continued to come in and out; explosives would still have been transported between buildings and the open walkways were probably well used.

In reality, there were few places within the factory area where masses of plunging debris consisting predominately of bricks and chunks of metal could land safely and, if I may point out, there are lots of bricks in a drying house.

Today, it is if nothing had ever happened. No-one remembers, knows or even cares. Just water under the bridge and in any case the factory is all, but closed down. One day the same ground may support homes, shopping centers and a petrol station or two? In the meantime, these old buildings silently await their fate.

Henry unfortunately passed away a number of years ago and I don't know if the incident was ever reported in a written format. I have certainly never seen such a document, but I absolutely believed what Henry told me and I still believe the story today. I never did find out how the incident occurred, Henry himself became somewhat reticent and never mentioned the incident in my presence ever again and for my part, I never pursued it.

Another incident occurred in the mid 1970's and yet again involved a brick-built building, this time a detonator service magazine. Bricks and detonators flew, but this building was mounded and around 80% of the debris fell back to earth within the mounded area.

Another occurrence (a fatality this time) involved a brick-built firing chamber provided with a floor of what was essentially river sand. The presence of a sand floor was later reported to be a major issue, but there was no mound. This structure was almost totally demolished by an internal explosion. Bricks were strewn everywhere. What was left was later levelled.

I remember other incidents too. A house where detonating cord was undergoing the over-extrusion of a plastic coating also had an incident when a 10 g/m semi-fuse undergoing over-extrusion suddenly detonated. The propagating detonation travelling at four to five thousand meters a second began hurtling towards its own off-reeling spool, a spool fully wound with the same product, but this time in bulk.

It's all right you can breathe again. The big bang never came. As luck would have it, there was a gap in the explosive core of the semi-fuse which brought matters to a dead stop almost as quickly as they had begun. All was quiet, but that is not the point. The entire building was brick-built. It could have been a disaster.

And again, yet another example, here is an incident recorded from around 1910. More than a hundred years ago.

Is it still relevant today? I believe so. What about you?

"According to Major Cooper-Key who recorded that, following an explosion at the Granville Colliery Company at Swadlincote, Derbyshire, England where a magazine that had received a special commendation at the time of its erection, proved under the acid-test of accident to possess defects which, in the fullness of time, came to reflect poorly on other existing magazines of similar construction.

Major Cooper-Key pointed out that the stout construction and thick brick walls were an excellent aid in the prevention of accidents as well as a means of providing increased security, but the internal explosion that subsequently occurred produced conditions that he likened to "that of a bursting shell."

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***Major Cooper-Key called attention to the use of alternative materials less likely to bombard the neighbourhood and that the use of such alternative materials be coupled with the construction of high, protective earth moundings*."

It all seems pretty sensible to me!

How many non-mounded and brick-built structures still exist as licensed explosive buildings or even worse, explosive magazines, today. Just for interest, were you aware of the propensity for bricks to be distributed far and wide by a suitably sized internal explosion?
For the folk on the ground the problem is simply one of gravity. What goes up, will come down. Picture the effects of a couple of thousand house-bricks returning to earth and their impact (literally) on buildings, vehicles and most of all, the personnel.

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ARTICLES FOR NEWSLETTER

This is a reminder that through the Newsletters we share knowledge in the areas of Safety, Health, Environment and Security pertaining to the Explosives Industry. SAFEX thus call on all members to submit articles on these subjects within their own companies and countries. **The deadline for articles for the September Newsletter is 31 August 2017 and I look forward to your support** .

SAFEX thanks the following authors for their valuable support:

- **Anne Charline Sauvage, EGIDE Environnement Sarl**
- **Maurice Bourgeois –Expert Panel**
- **Andy Begg, Convener-Expert Panel**
- **Wen Yu -Expert Panel**
- **Ron Peddie -Expert Panel**
- **Tony Rowe, AELMS Retired**

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