*While **SAFEX International** selects the authors of articles in this Newsletter with care, the views expressed are those of the authors and do not necessarily represent the official position of **SAFEX International**. Furthermore, the authors and **SAFEX International** cannot accept any liability for consequences arising (whether directly or indirectly) from the use of any advice given or opinions expressed in this Newsletter*

SAFEX INTERNATIONAL EST•1954

CONTENTS

From the Secretary General's Desk

This is the 64th edition of the SAFEX Newsletter and at 4 issues a year we have been going for 16 years, which is quite an achievement .Over the last few years we have seen a serious reduction in interest from members to contribute to the Newsletter .I thank the few stalwarts we can always rely on to give you something of quality to increase learning in the industry. During 2017 we ran a survey to assess interest in the Newsletters and the companies came out strongly in favor of 4 issues, with the majority voting to keep the content as is. Unfortunately, this Newsletter is only as good and strong as your contributions and that is contrary to the outcome of the survey. Please assist the team that puts the Newsletter together -it is hard work and without your support becomes even more difficult. SAFEX would like to continue with the current setup but might be forced by circumstance to change the approach in future. Please take note of this within your companies, I am convinced there is a lot to share within the whole industry!

SAFEX CONGRESS XX

SALZBURG 2020

24 MAY TILL 30 MAY 2020

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A very productive Board Meeting was held at the end of January in Las Vegas. It is comforting to report back that the current leadership is keeping SAFEX International on a solid base financially, as well as strategically. We unfortunately had to say farewell to Colin Wilson and Edmundo Jiminez who both resigned from the Board due to other commitments. We are also fortunate to welcome Adolfo Sanchez from EXSA, Chile on the Board and wish him a successful tenure (more about him later in the Newsletter).

SAFEX BOARD OF GOVERNORS JANUARY 2018

At the Board Meeting it was also decided to have SAFEX 2020 Congress in Salzburg, Austria. We would like to thank Austin Powder in Austria for offering to host the Congress. Please Put the dates in your diary now, as the organization of the event is already in full swing! A summary of the Congress Programme is tabulated below:

CONGRESS ACTIVITY	DAY OF CONGRESS													
	ARRIVAL		PRE-CONGRESS						CONGRESS				SOCIAL	
	Sun 24May		Mon 25 May		Tues 26 May		Wed 27 May		Thurs 28 May		Fri 29 May		Sat 30 May	
			am	pm	am	pm	am	pm	am	pm	am	pm	am	pm
Administration														
Training														
Workgroups														
Plenary sessions														
Chairman's Program														
SAFEX AGM														
Social programme														
FEEM AGM														

More detail on the Congress will be published in upcoming Newsletters .The first call for papers has gone out early in March. This was done to give you enough time to prepare the quality papers expected by Congress attendees.

The eLearning Portal development is progressing well being led by Martin Held and by mid-2018 there will be a full suite of training programs available. There are currently 150 registered users on the site and we look forward to seeing you becoming active on the site.

IMPORTANT NOTES ON MODELLING OF INJURY HAZARD UPON BLASTING OF FRAGMENTS OF MATERIAL RESULTING AFTER A DETONATION OF EXPLOSIVE LOADS

REPRINT

1.Debra S. Satkowiak
President
Institute of Makers of Explosives

On behalf of the Institute of Makers of Explosives and APT Research, Inc. (APT), we encourage the international use of quantitative risk assessment and Institute of Makers of Explosives Safety Analysis for Risk (IMESAFR©) by global industry members and regulatory authorities. The authors of this article have consulted IME and APT, and, in recognition of IME and APT's copyrighted intellectual property, have adopted our request for revisions to this article and acknowledgement of our work. We are pleased to share our research and programs with the commercial explosives industry, and encourage use of IMESAFR in explosive operations. Should you wish to copy or disseminate this article or our work in whole or in part, please contact us prior to doing so. We are not responsible for the conclusions of the authors, and refer you to our own materials for further information.

2.Note From Authors

The work bearing the title MODELLING OF INJURY HAZARD UPON BLASTING OF FRAGMENTS OF MATERIAL RESULTING AFTER A DETONATION OF EXPLOSIVE LOADS brings out a synthesis of results following research in the field of modelling of injury/destruction hazards upon detonation of loads of explosive, which are likely to affect workers and/or industrial/civil objectives located on the premises of a ground designed for testing explosive materials. The current US scientific practice that has been developed for the specialized software in the field of security of explosives for civil use of IMESAFR 2.0 type, which has been purchased within NUCLEUS Programme – Project PN 16 43 02 15/2016-2017, applies various functions for the density of probability, which are consecrated in this field, so that the phenomenon of material fragment blasting could be modelled from a graphical and analytical point of view, concerning fragments of materials resulting from such type of explosion.

Practically, this work is intended to present the results of computerized modelling of the explosion hazard, as obtained within a case study for an explosives warehouse having a capacity of 1,220 kg ETNT, considering industrial premises designed for storing explosives of civil use as well as the progress of the American technical and scientific level of knowledge in this field, which has been materialized in a range of remarkable theoretical and practical results.

This scientific article includes theoretical and practical information on which the IMESAFR 2.0 software is based. This information has been taken over from US documents of reference that have been mentioned as bibliographical source. This article also includes an adjustment of the information to the actual conditions of use of such specialized software in case of industrial premises, as intended for a computer-based assessment of blast hazard that is specific to undesired events when dealing with hazardous substances such as explosives for civil use. We kindly note that the specialized software IMESAFR 2.0 has been purchased within a research program, which included a specialized training in Ottawa, Canada.

Apart from that, please note that we do not intend to claim any copyright on data and information that has been taken over from reference documents mentioned as bibliographical sources, as such copyright belongs to the persons who prepared the respective documents. Our purpose resides in bringing out the results of a computerized modelling that has been developed with the aid of a specialized software, for which the concept and work philosophy is based on such notions; apart from that, it also resides in our intention to promote a new generation of US IT technology, which we admire and respect.

MODELING THE DANGER OF INJURY WHEN FRAGMENTS OF MATERIAL RESULT FROM THE DETONATION OF EXPLOSIVE CHARGES

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Abstract

The paper shows a summary of the results of research undertaken in the field of modelling the dangers of injury / destruction when fragments of material resulting from the detonation of explosive charges are jettisoned on workers and / or industrial objectives from the explosives testing center. So, American scientific practice from the moment is (FRMS type) developed to improve the performance of the specialized software from the security of explosives for civil use type IMESAFR (ex. Version 2.0) which was acquired in the NUCLEU project-PN 16 43 02 15/2016-2017, using different probability functions dedicated to this field type PDF (Probability Density Functions) in order to shape the graphic-analytical phenomenon when fragments of material resulting from the detonation of explosive charges are jettisoned.

1. Overview on the mechanisms of formation of fragments of the material resulting from the detonation of explosive charges

Detonation of explosives

Detonation is a physical-chemical process, characterized by a high reaction speed and by the formation of large quantities of gases, at high temperatures, which leads to the generation of high forces of breaking and dislocation of rocks. To interpret the physical phenomenon of detonation, worldwide were expressed various theories, one of them being the hydrodynamic theory. It was accepted unanimously, considering the similarity of its mode of propagation by explosives with the propagation of the pressurized fluid. The detonation mechanism comprises three steps: **I.** The mechanical compression of each molecule of the explosive substance carried by a dynamic pulse; **II.** The thermal decomposition of each layer in the structure of the explosive, up to high temperatures, when given the rapidity of the chemical reaction, the dynamic compression process being carried out without heat exchange in the environment (adiabatic compression); **III.** The exo-thermal decomposition of the explosive due to the action of high temperatures.

The formation of craters

In figure No. 1 is presented schematically a crater produced by the detonation of an explosive (explosive charge). Dimensions associated to a crater are the following: D_2 = the apparent diameter of the crater; D_1 = the actual diameter of the crater; h_1 = the actual depth of the crater; h = berm height.

Craters are formed when there is a detonation of explosive charges that is placed as follows: below ground level (closed space); on the ground (air-ground interface); suspended in the air. Regardless of the location of the explosive charge, the crater is the destructive effect of a blasting. When initiating the explosive charge, in his mass, there is a violent decomposition reaction, the detonation wave which results is propagated at a speed of 2000 – 8000 m/s. In the detonation wave front is developed a pressure that can reach 10^4 MPa and it is transmitted in the environment in the form of a shock wave, having the same direction of propagation as the detonation wave.

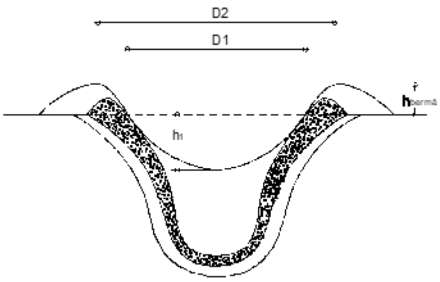

Fig.1- Defining the size of a crater

The material resulting from an explosion type event considers three types of fragments: primary, secondary and scrap resulting from the crater formed. The primary fragments are coming from the body of the explosive detonated, and secondarily from the structure of the storage room (eg. roof, end walls, side and rear). Also, other residues that are generated in the impact crater formation are fragments from the ground or the foundation structure of the storage room. In the event of an explosion type event there may result a large number of individual fragments (of the order of thousands) that can be uniquely identified by its mass and speed of the main parameters (and implicitly by the kinetic energy). The model type QRA (Quantitative Risk Assessment) consecrated to quantitative risk assessment, provides opportunities for an analysis of the whole volume of fragments designed, based on a dynamic model of meshing of the mass, using the distribution pattern of recurrent Bin n, (1). to provide a general overview of the 10 classes of results (Bin_i, i=1,10).

$$Bin\ n{:}\, DAM_n = RM_n + \left(\sum_{i=1}^{n-1}\left(DM_{[i,n]}\right)\right) + \left(\sum_{i=2}^{n-1}\left(B11DM_{[i,n]}\right)\right)$$

where[7]:
DAM – dynamic adjustment of the mass of the material fragment
RM – the residual material mass of fragment
DM – the fragment mass of material dispersion

[1]The explosive charge is the quantity of explosives prepared for detonation, in the view of displacement a volume of material (rack) for carrying out excavations.
[2]Section 3.4 of the IMESAFR Technical Manual
[3]Section 3.4 of the IMESAFR Technical Manual
[4]Section 3.4.1 of the IMESAFR Technical Manual
[5]Section 3 and then Appendix D of the IMESAFR Technical Manual
[6]According to Appendix D of the IMESAFR Technical Manual
[7]Page D-6 of the IMESAFR Technical Manual

Thus, Bin_1/Bin_{10} represents the fragments with the high / low mass and level significant / low of damage and / or destruction of the human component and / or structures[8].

Table 1 shows the results obtained for the ten classes ($Bin_1 \div Bin_{10}$) corresponding to level of damage / destruction (via kinetic energy) at the odds of maximum, medium and minimum, and average weight of each fragment designed depending on the type of material.

Table 1[9]

Class (Bin_{in} n=1,10)	Bin_1	Bin_2	Bin_3	Bin_4	Bin_5	Bin_6	Bin_7	Bin_8	Bin_9	Bin_{10}
Minimum kinetic energy (m-Kg)	100 K	30K	10K	3K	1K	300	100	30	10	3
Average kinetic energy (m-Kg)	173 K	54K	17K	5K	1,7K	547	173	54	17	5
The maximum kinetic energy (m-Kg)	³300K	100K	30K	10K	3K	1K	300	100	30	10
The average weight of fragments of steel (Kg)	16,19352	6,75864	2,875824	1,206576	0,512568	0,214553	0,090266	0,038647	0,017191	0,006441
The average weight of concrete fragments (Kg)	34,20144	14,2884	6,07824	2,544696	1,079568	0,4536	0,190512	0,081648	0,036288	0,013608

Description of the primary fragments

The primary fragments result from explosive destruction and its packaging after detonation, and their design mechanism by modelling is based on the number of fragments, by their mass and by

[8]According to the pages 39,40 of the IMESAFR Technical Manual
[9]According to Table 11 of the IMESAFR Technical Manual and DDESB TP-14

the maximum range of throwing. (Figure no.2)[10]. The number of explosive products (N_w) is determined by the relation (2):

$$N_W = \frac{W_1}{NEWQD\, of\; one\; explosive\, article} \quad (2)^{11}$$

where: W_1 – amount of explosives of the explosive product No.1; NEWQD – net explosive quantity of a single product as determined for QD purposes (v. Table 2).

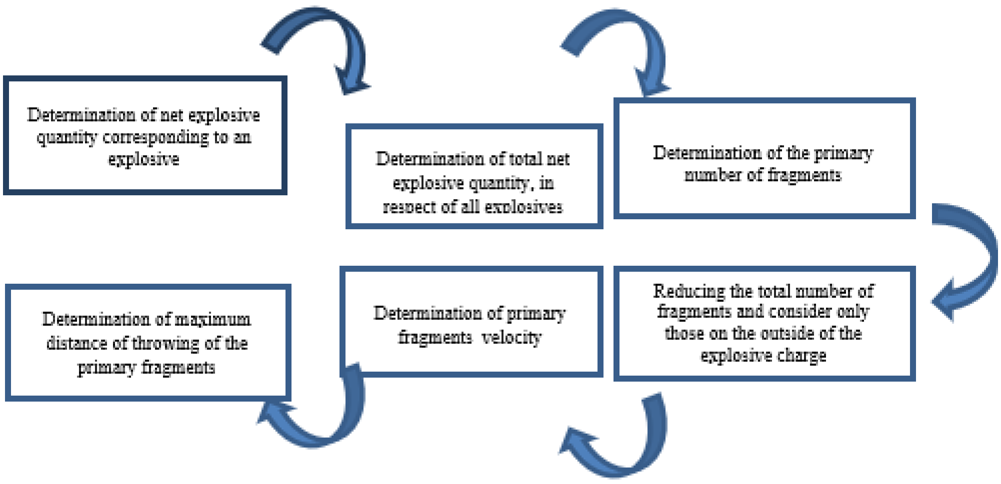

Fig.2-Process diagram for primary fragments projection[12]

Table 2[13]

Explosive charges	NEW specific for a single type of explosive product (Kg)	Fragments derived from a single product									
		Mass Bin$_n$, n=1÷10									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
explosive charges with small fragments	0,4536	0	0	0	0	0	0	0	1	5	10
Explosive charges without	0,4536	0	0	0	0	0	0	0	0	0	0

[10] Section 3.4.2 of the IMESAFR Technical Manual
[11] According to Formula 9 of the IMESAFR Technical Manual
[12] According to the Figure 25 of the IMESAFR Technical Manual
[13] According to Table 12 of the IMESAFR Technical Manual

primer fragments											
metallic container with explosive charge	4.536	0	0	0	0	0	0	80	4.111	796	319
Explosive charge confined in the metal pipe	3,901	0	0	0	0	0	0	4	19	44	79

Further are displayed in tables the maximum range values of action / projection of the primary fragments (R_{max}), which is determined for each fragment, according to the average weight, of the suitable bin and the initial rate (v. Table 3).

Table 3[14]

Explosive charges	V (m/s)	R_s(m)	R_M(m)
explosive charges with small fragments	1219,2	569,976	683,9712
Explosive charges without primer fragments	NA	NA	NA
metallic container with explosive charge	1219,2	569,976	683,9712
Explosive charge confined in the metal pipe	1219,2	569,976	683,9712

The value R_{max} is set at the maximum value for the projection, whether for one explosive product (R_S) or for multiple products (R_M), depending on the amount of explosives considered, W_1. In case of W_1 lower than the net quantity of explosive from the explosive product it is used the value of R_S, and where W_1 is greater than this quantity, then it is used the value of R_M. Usually, the value of R_M is 20% higher than Rs, taking into consideration the known spraying debris[15].

In the event of an explosion type event, product within a potentially explosive structure type PES (for storing explosives for civil uses), results a very large amount of primary fragments whose number and the initial speed is determined according to the data of presented in tables No.2 and 3. Also, the components of the PES structure, remaining after the explosion, can block and remove the primary fragments resulting from this event. At the same time, it is necessary to determine the fraction of primary fragment blocked by structural components of PES (roof, front wall, rear wall and side walls).

Thus, to determine the number of primary fragments which may be blocked by various components of the structure of the PES, they must be divided depending on the angle of projection, namely: large angular throw fragments (hitting the roof) and lower angular throw fragments (the lower) (hitting the walls).

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[14]According to Table 13 of the IMESAFR Technical Manual

[15]According to page 42 of the IMESAFR TM

The lower angular fragments are divided, at their turn, further in side impact fragments and horizontal fragments displaced in a direction nearly horizontal[16]. Also, side impact fragments have an arched trajectory, to ES-type structure (the structure exposed to explosion), but it can be blocked, in the end, the wall of this structure, by artificial obstacles (Figure 3)[17].

The primary fragments are divided as follows, 25% of the total number of the fragments is considered to be high angle fragments, 7.5% of the total is considered to be fragments of the side impact, and 67.5% is considered to be horizontal fragments. Setting these values are based on interpretation of test data, including high-speed video analysis. The primary fragments are divided into fragments that can be blocked or contained by each structure type PES. The side impact fragments and the horizontal fragments are potentially blocked by the front wall, sidewalls and the components of the rear wall structure type PES, while high angle fragments are assumed to be potentially blocked by the roof component (Figure 4)[18].

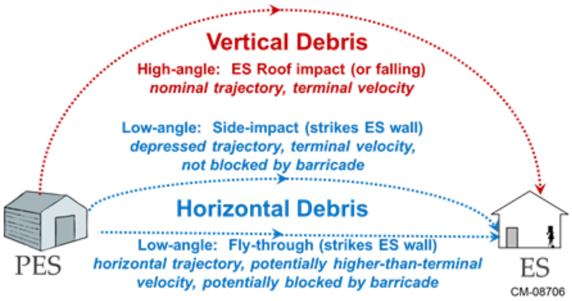

Fig.3- the design trajectories of primary fragments[17] *{figure courtesy of APT Research}*

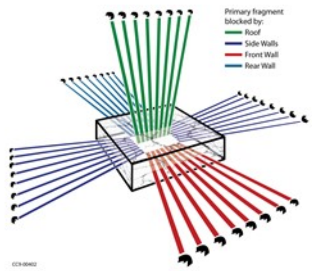

Figure 4 - Blocking the primary fragments[18] *{figure courtesy of APT Research*

2. Density estimation of the material fragments projected

The configuration estimating of the path travelled by the material thrown away, can be done by using the methodologies results within various research conducted in this domain and requires well-grounded scientific knowledge on the main parameters evaluated, namely: the speed of impact and the mass of material fragment projected. It would be ideal for determining the position and speed of impact, specific to each fragment of discarded material, to use physical laws based on differential equations that characterize the wave phenomena, however, at the moment, there do not exist proven scientific results for a specific scenario related to an explosion type event[19].

The number of fragments and individual characteristics of mass and speed are dependent both on the type of material (eg. steel or concrete), and the characteristics of explosives used to testing. Thus, the conceptual models can be developed for the production of trajectory calculations for the intervals of fragment of mass, launch angle and speed. However, Monte Carlo simulations are sensitive to present ranges assigned to each variable trajectory. Also, these models require running a series of simulations at the time of analysis, requiring extensive resources of time and the calculation result being one detailed and based only on assumptions.

Where, test results of explosives accident statistics, validated simulation data are available, then type models Fast-Running Models (FRMs) can be created for the analysis of hazards in a simplified manner, without using difficulty complex physical models based on the equation of state. So, American scientific practice from the moment (type FRMs), developed for specialized software in the field of explosives for civil uses security type IMESAFR 2.0 which was acquired in the Program NUCLEU-Project PN 16 43 02 15/2016-2017, using different probability density functions dedicated to this field type PDF (Probability Density Functions) for graphic-analytical model of the phenomenon of projecting portions of the material, which result from such explosion events. This PDF is obtained by pre- processing, simulation and / or analysis of test data in a dedicated equation (closed

[16] Section 3.4.3 of the IMESAFR Technical Manual
[17] Figure 26 of the IMESAFR Technical Manual
[18] Figure 27 of the IMESAFR Technical Manual
[19] According to page D-22 of the IMESAFR Technical Manual (Step 15)

form), after the pre-set density function can generate immediate results. Figure No. 5 shows an example of simulation test data, by a number of data-points that have been translated into a closed-form equation[20]. This PDF serves as a contour map, almost instantaneous forecasting projected portions of the material density. To represent different types of models based on the use of probability density functions, it can be designed with different levels of complexity. Thus, PDFs are composed of elements "down-range" type and azimuth (cross-range). "Down-range" component reproduces the shape of the origin of the blast outwards in any radial direction. This essential component distance determines the design portions of the material from the original location in which the explosive charge detonation occurs, and the range of their greater density. Cross range component determines the form of the tool when moving radially at a constant distance from the origin (azimuthal direction or cross-range). In the following, there will be detailed the two components of PDFs modelling practice often used in explosives security.

The most common PDFs are the uniform distributions in all directions from the origin (that is, no azimuthal variation). These distributions may be used effectively for modelling safety are evenly distributed or random in all directions around the site of an explosion such as both pieces of material resulting from the destruction of the roof that are thrown up and scattered, as well as fragments of wall structures of the various arcuate shape. The first example is a function of the type Gauss - normal of distribution (ex. a bell-shaped curve) used as component ^{2}*down-range*^{2} without azimuthal variation, producing a distribution parameter type bi-variant Normal (BVN), characterized by the highest density at the origin which resembles a hill (Figure 6)[21].

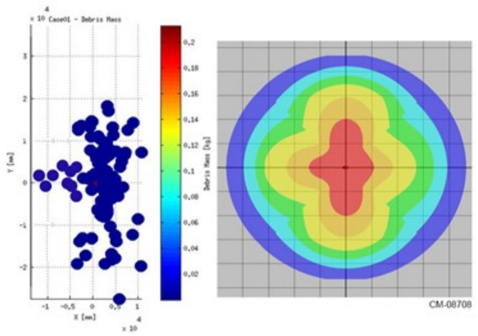

Figure 5.- Representative translation of test data to a PDF[20] *{figure courtesy of APT Research}*

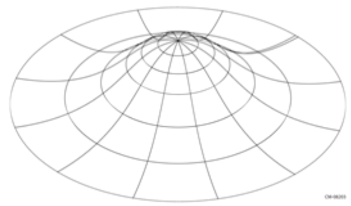

Figure 6. - Distribution type Bi-Standard version (BVN))[21] *{figure courtesy of*

The shape of PDF- for the distribution of BVN is given by the following equation:

$$P_i = \frac{1}{2\pi\sigma^2} e^{\left(\frac{-r^2}{2\sigma^2}\right)} \qquad (3)^{22}$$

where:

P_i - Probability of a single piece landing in a specified area

σ - Standard deviation of ^{2}*down-range*^{2} distance

r - Range from the origin to the point of interest

The ISURF model

[20] Figure D5 from the IMESAFR Technical Manual

[21] Figure 31 from the IMESAFR Technical Manual

[22] As shown as Equation D29 from the IMESAFR Technical Manual

Probability density function BVN is useful for substantiating the basic scenarios, in which case is available a limited number of data and information, the danger of projecting fragments of material is assumed to be higher in the vicinity of the blast origin for the production location, as a result of the detonation of the charging material. However, there may be situations under which, a lot of the fragments are thrown out of origin. This aspect is especially true for primary fragments, the residues from the explosive charge and secondary arising from pieces of wall. When the model ²*BVN down-range²* is used in these types of scenarios, the problem of the PDF is related to resolving over-prediction of throwing fragments near origin, in small amounts at intervals. Research conducted by the Institute of Explosives Manufacturers (IME) to develop specialized computer infrastructure for the security of explosives (IMESAFR), Research APT has developed a new function ²*down-range*² to improve the model ²*BVN down-range²*, resulting in a toroidal PDF with azimuthal variation (Figure 7)[23].

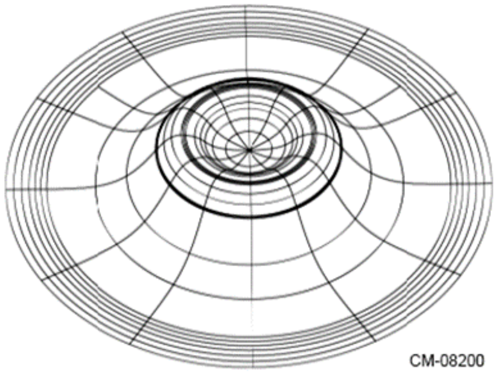

Fig.7.-PDF toroidal without azimuthal variation, type ISURF[23] ***{figure courtesy of APT Research}***

Comparative analysis of the two established models for substantiating the scenarios of projecting the fragments of material resulting after the detonation of explosive charges, respectively: *Curve ²BVN down-range²* and *Curve ²PDF toroidal down-range²*, points out that the areas occupied by the two curves are identical, and declaring the approximate representation of the same amount of total mass of the projected fragments[24]. It is also found that the model of the curve BVN is type conservative at certain intervals, compared with the curve PDF toroidal (Figure 7). The new component of the model PDF ²*down-range²* is referred to as slope (Range) and it is given by initial ascending function of the new model – ISURF, (figure no.8). The complex shape of the model ISURF is provided by the three parameters mentioned, respectively a, b and c, which may have different values depending on: size of fragments thrown away of the resulting material type after detonation by explosive charge and type of structures used \ in the scenario of the explosion (ie. the wall or roof)[25].

The presentation chart of the model highlights the following elements of structure[26]:

- parameter "a" is the ratio of the horizontal coordinate of the maximum likelihood (X_{peak}) and the maximum horizontal distance of throw (or "full-throw") the density of fragments (X_{MT}), it is used to determine the maximum range;
- parameter "b" the relation between probability density at origin (Y_0) and the maximum probability density (Y_{peak}) is used to determine the maximum magnitude;
- parameter "c" is used for controlling the shape of curves which are joining the set points and represents the percentage of probability generated by the surface under the curve, which is bounded by the horizontal distance from the origin to the maximum value of the curve, determining the percentage of the area under the curve. Knowing the percentage by calculating the area under the curve will result in the determination of both the inner face of the slope and the slope of the outer surface.

[23] Figure 33 from IMESAFR Technical Manual
[24] IMESAFR Technical Manual, page D-24
[25] According to page D-25 of the IMESAFR Technical Manual
[26] According to page D-26 of the IMESAFR Technical Manual

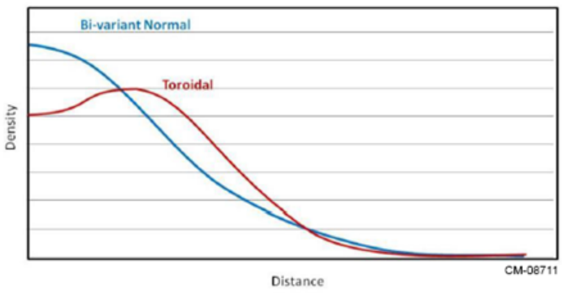

Fig.7.-Graph of curves *BVN down-range* and *PDF toroidal down-range* [27]*{figure courtesy of APT Research}*

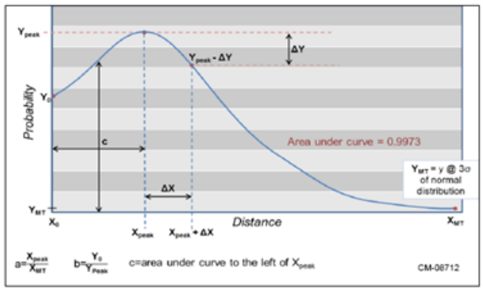

Fig.8.- graphics details of the model *ISURF down-range*[28] *{ figure courtesy of APT Research}*

The ISURFGAD model

This model is characterized by a zero change in azimuth (they produce the same results in all directions), being used for modelling uniform of the directional hazard, both for fragments by the roof, the circular crater effect at warehouses of explosives and for scenarios of explosion where fragments are thrown in random directions. Because, in the case of centrally located loads in rectangular buildings, it has been observed that the density of the thrown material is strongly affected by the azimuth (debris of material tend to "move along the normal" and not in the "corners") generating an effect type Cloverleaf (PDF with azimuth zero – transversely range) shown in Figure 8, Figure No. 9 presents a new type of PDF (ISURFGAD) based on a model range transverse that take this type of effect into account[29].

PDF derivation type ISURFGAD is performed independently for functions ^{2}*down-range*^{2} and the transverse radius. The function is represented for one dial of 90^0, probability density of the portions of the material characterized by independent parameters, respective interval of the range (r) and the throwing angle (θ), thus:

$$PDF = f(r) * g(q) \qquad (4)$$ [30],

in which[31]:

$f(r) = f_1 = A^{¢} + B^{¢}r + C^{¢}r^2 + D^{¢}r^3$, out of range $[0,R_{P+}]$,
$f(r) = f_2 = k_1 exp[k_2*(r-R_{P+})]$, out of range $[R_{P+},R_{max}]$
$g(q) = [1/(2pR_c s_q)]exp[-0,5(q/s_q)^2]$

where:
R_{p+} - peak value of probability density
R_{max} - the maximum radius of the throwing portions of the material
R_C - the centroid radius

[27]Figure D8 from the IMESAFR Technical Manual
[28]Figure 32 from the IMESAFR Technical Manual
[29]According to page D-26 of the IMESAFR Technical Manual
[30]According to Equation D30 of the IMESAFR Technical Manual
[31]According to pages D27-31 of the IMESAFR Technical Manual

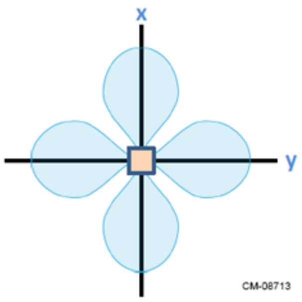

Fig.9- The model Cloverleaf of the dispersion of the fragments of material [32]*{figure courtesy of APT Research}*

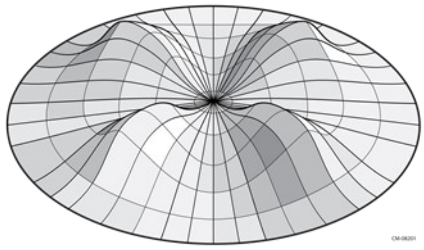

Figure 10. New PDF-type ISURFGAD [33]*{figure courtesy of APT Research}*

3. Human vulnerability assessment under the action of portions of the material resulting from the detonation of explosive charges

In previous sections were presented technical aspects of modelling portions of the material resulting from the detonation of explosive charges from structures type PES (for the storage of explosive materials) which can destroy structures exposed to explosion type events ES (for specific activities), with serious effects on the health and integrity of staff, and the population in surrounding areas[34]. For modelling the degree of damage to the human component using probability equation (of the impact between the human body and thrown fragment) configured based on Poisson probability distribution (5), respective:

$$P_{impact} = 1 - e^{-EN^*} \qquad (5)^{35}$$

where:
E - It is the human exposure (0.278 m^2)
N* - is the number of fragments which may damage the integrity of the human component

For solving the equation of probability, the model provides the estimation possibility of fatality areas with major and minor injuries based on the kinetic energy of the fragments projected (6), respectively[36]:

$$P_{f(d)} = \text{Lethality} \times P_{hitv} \quad (6)^{37}$$

The lethality value is obtained from the curve shown in Figure No. 11, highlighting the likelihood of fatality for an event $P_{f|e}$ compared with the kinetic energy of the fragments projected. Finally, the model calculates the overall probability of fatality caused by projected fragments, $P_{f(d)}$, by summing the projecting path, corresponding to the angular projection, of the large fragments and to the displacement of small angular, and the total probability of death is obtained by using the additive rule applied in the case of events which are not mutually exclusive (7), respectively[38]:

$$P_{f(d)} = P_{f(d)\ low\text{-}angle} + (1 - P_{f(d)\ low\text{-}angle})P_{f(d)\ high\text{-}angle} \quad (7)$$

[32] Figure D-10 of the IMESAFR Technical Manual
[33] Figure D-11 of the IMESAFR Technical Manual
[34] Section 3.4.9 of the IMESAFR Technical Manual
[35] Equation 10 of the IMESAFR Technical Manual
[36] According to the page 55 of the IMESAFR Technical Manual
[37] Equation 11 of the IMESAFR Technical Manual
[38] Equation 12 from page 58 of the IMESAFR Technical Manual

where:

$P_{f(d)}$ - probability of death of a person due to the impact with a projected fragment,

Completely analogous is determined the likelihood of major damage / minor injuries $P_{maji(d)}/P_{mini(d)}$.

To substantiate the danger of the mechanism of thrown fragments is using a pattern type SCIFM (Simplified Cose-In Fatality Mechanism) all scenarios specific to this phe-

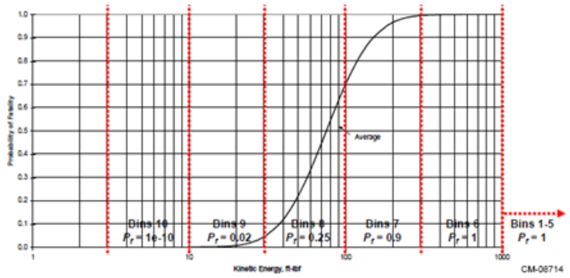

Fig.11- The probability of exposure of the human component by kinetic energy [39] ***{figure courtesy of APT Research}***

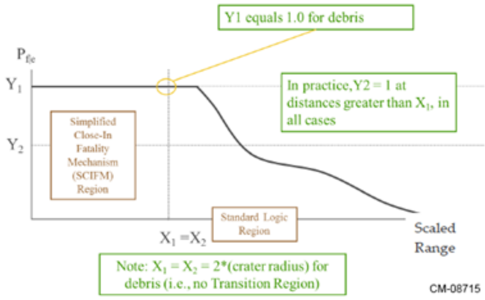

Fig.12- The Model SCIFM for fragments projected[40] ***{figure courtesy of APT Research}***

4. Examples of application of the presented models

An example of surface PDF with the following characteristics: a = 0.330, b = 0.038, c = 50%, d = 10%, maximum range extender = 579 m and σ = 20^0,and it is presented in Figure No.13[41].

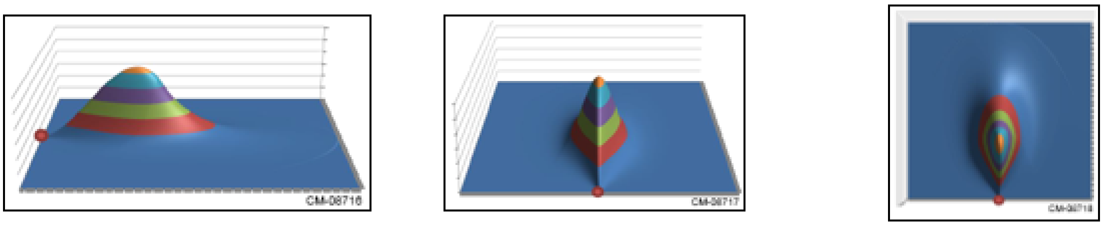

Fig.13-PDF surface - ISURFGAD PDF[42] ***{figures courtesy of APT Research}***

The results obtained after modelling the risk of injury from projected fragments of the material resulting from an explosion type event, can be highlighted graphic-analytical, both through the associated diagrams of the contour maps of the destructive capacity, specific to the thrown fragments (kinetic energy of impact from fragments of the material), shown in Figure No. 14, and on the histograms of probability values of damage on the human component that define the following areas of interest, respectively: the area of fatality (the degree of mortality), area of major injuries (the extent of damage irreversible) and area of minor injuries (the extent of damage reversible), shown in Figure no.15[43].

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[39] Figure 37 of the IMESAFR Technical Manual
[40] Figure 38 of the IMESAFR Technical Manual
[41] According to the IMESAFR Technical Manual Appendix D
[42] According to Figures D-12 and D-13 of the IMESAFR Technical Manual
[43] IMESAFR User's Manual

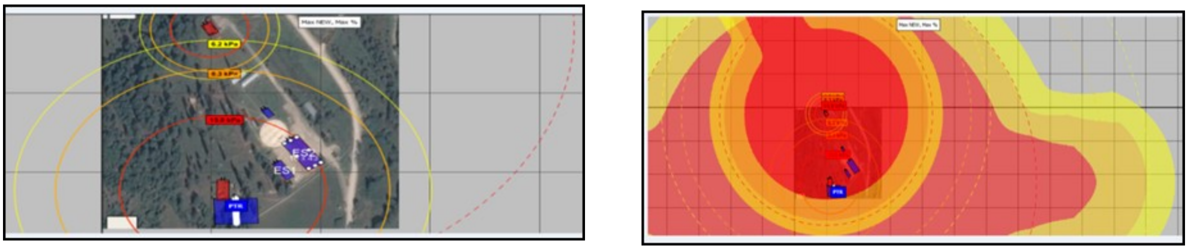

Fig.14-Contour map for a deposit of explosives with a capacity of 1220 kg ETNT[44].

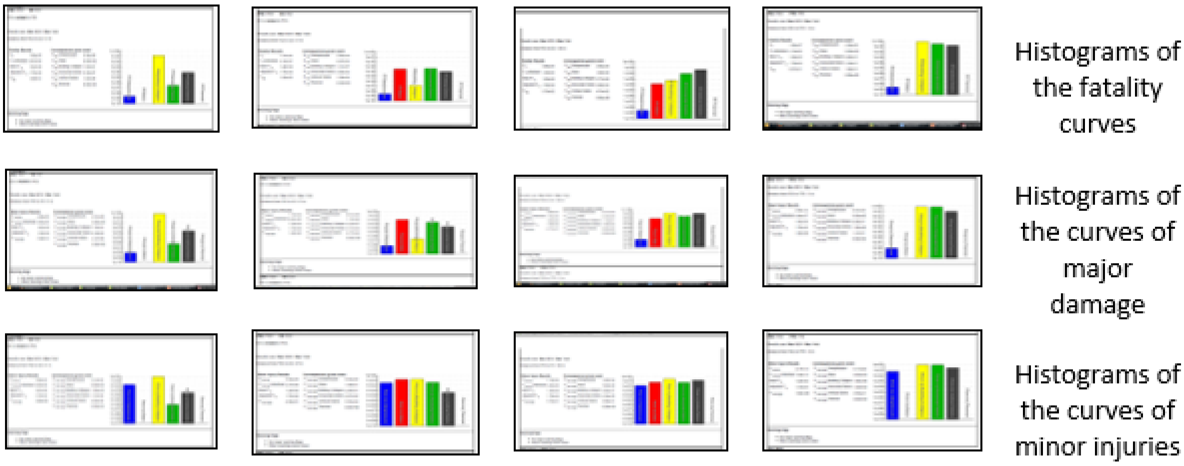

Fig.15- Histograms of areas of damage on the human component and structures[45]

The results shown in Figures 14 and 15 are needed to establish the areas of interest, in the case of an explosion type event as a result of detonation of explosive charges, resulting in the following planning areas: **area of high mortality**, defined as the area in which it accrues the death of approx. 50% of the exposed population; **the area of irreversible injuries,** defined as the area in which the exposed population is suffering serious harm to somatic level and lung, serious illness, first and second degree burns. Light buildings, suffer major damage becoming unusable. Heavy structures may undergo minor damage; **attention area,** defined as the distance that the effects of the accident can be felt and can cause a mild illness, of short duration, or superficial burns easily curable. When explosion accidents occur, light buildings existing in the area of attention, may suffer minor damage.

5. Conclusions

5.1. Estimating the route configuration of the fragments of material projected can be achieved using model type Fast-Running Models (FRMs), created for hazard analysis in a simplified manner, using different functions for probability dedicated to this area (ex. model type ISURFGAD with the azimuthal variation), for graphic-analytical modelling of the phenomenon of projected pieces of material resulting from explosion type events.

5.2. The model of projecting the resulting material after an explosion considers three types of fragments: primary, secondary and scrap resulting from the area of the crater formed. Thus, primary fragments come from the detonated explosives body, and the secondary ones are coming from the structure of the storage room (ex. roof, front, side and rear walls). Also, the other debris of impact which are generated in the area of crater, are fragments coming from the ground or from the foundation structure of the storage room.

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[44]Screen captures from IMESAFR v.2.0
[45]Screen captures from IMESAFR v.2.0

5.3. This paper has presented the technical aspects of material fragments modelling resulting from the detonation of explosive charges coming from potentially explosive structures, type PES (for the storage of explosive materials) which can destroy the structures exposed to explosion type, ES (for specific activities), with the serious effects on health and integrity of the working staff, and the population from surrounding areas.

5.4. The final results of modelling the risk of injury from projection of the material resulting from an explosion event, may be highlighted graphic-analytical, through the associated diagrams of the contour map and histograms of probability values of damage of the human component (death, major injuries and minor injuries).

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Reflections on Management of Change

By

Gordon Morgan

I sincerely hope that people reading this article will toss their heads, and click their tongues, because they consider what has been written to be obvious. For those people will be experienced and acutely aware of the pitfalls that can plague an explosive manufacturing operation. One of the biggest of which is loss of corporate memory.

Most of the safety procedures that are in place in manufacturing plants across the globe have arisen from accidents that have occurred. They are attempts at preventing a reoccurrence. The procedures remain fresh in the memory of operators and management who survived the experience unscathed or, investigated the incident and saw the after affects. These lucky people are unlikely to repeat the sequence of events that preceded the incident. Attempts to record the incident by way of the investigation report, photographs and changes to operating procedures will be made and archived for future reference. Often though, the best way to ensure that the information is transferred to “new starts” is by word of mouth from experienced plant personnel.

The current employment trend is for people to gain a breadth of “experience” by “frequent” changes in employment positions or even employment sectors. Gone are the days where people saw a job as a career and were prepared to remain gaining knowledge and expertise for 30 to 40years. I remember working at a Blackpowder plant where an operator with the least experience had worked on the plant for over 20 years. These people would now be labelled as unambitious.

We also live in a time where plants run with a "lean" workforce. The downside of this is that often there is no experienced person to step up when an "ambitious" person resigns, moves on or retires. Worse still, if there is no obvious replacement within the organisation, external recruitment is required. Position advertising, application deadlines, interviews, selection, job offers, position acceptance and the selected candidates notice period all take time. This inevitably means that the incumbent has left the organisation and no "handover" or transfer of knowledge can take place. Of course, if no suitable applicant is found the exercise is repeated, further lengthening the process.

The replacement is required to get "up to speed" as quickly as possible and is inundated with information required to "make production". Available "Operating Instructions" must therefore be well written, unambiguous and comprehensive with thorough explanations, covering the safety reasoning of why a task is performed in a designated manner. Other procedures that are essential in a manufacturing environment, particularly an explosive manufacturing plant, such as permits to work procedures, maintenance procedures, emergency procedures and the need for a system to monitor and authorise changes to plant equipment and operations, also need to be learned and understood.

It is unlikely therefore, that time will be available to visit the archived previous incident reports or plant Hazop studies, certainly not until the "new start" has attained a certain level of familiarity with his/her new responsibilities. "New starts" are often keen to make their mark within the organisation and frequently "decision makers" are the preferred candidates. Potentially this can be a dangerous combination because decisions can be made without the requisite knowledge.

A disciplined and mandatory method of monitoring changes to plant and procedures is essential. The authorisation of any change should only occur following thorough consideration. Any, and all changes must be considered and signed off by designated and identified experienced personnel across all disciplines, from manufacturing, engineering, safety, technical, procurement etc.

So, what options are there for limiting the effects of loss of experience and retaining past and future knowledge?

The compilation of a "Plant Dossier" that captures the history of the plant from cradle to grave, in a format that is easily retrievable and searchable is an ideal situation. This dossier should be a living document that is diligently and constantly updated with all changes to the plant or process. It should capture all Hazop studies, proposals for changes to plant equipment (whether approved or rejected), changes to operating procedures, raw material specifications and suppliers etc. Rejected proposals for change are as important, if not more so, than changes that are accepted. They were, after all, rejected for a reason and the reason may be lost if not recorded. It is almost guaranteed that a few years down the line the same or a similar proposal will be made again. At that stage the proposal must be reviewed again to see whether the original rejection reason is still valid or whether advances in technology now make the proposal a desirable option.

Changes to operating parameters and control systems and the effect that these may have on maintenance procedures must also be considered and included. If a part of the plant was initially used for a different purpose to its' current use this must be recorded. This may have significant implications for maintenance and repairs. For instance, a process involving a sensitive explosive material may have ceased and the building purpose changed, for instance to raw material storage. Its' original function must be recorded as there could still be traces of the sensitive material remaining.

Modern computerised data capture software will facilitate this system, and the ability to search the data will allow the "new start" to get access to important safety information and the experienced reasoning behind the operating procedures employed.

Of course, changes and improvements are an essential part of an operating plant and must be allowed to happen. They must however be "considered changes" and should have undergone a rigorous evaluation via a Hazard and Risk Assessment process. This process should be thorough enough to withstand scrutiny should any incident lead to external legal challenges. Often HAZOP Studies, Risk Assessments and Operating Instructions are a starting point for incident investigations. Investigators will have the benefit of hindsight and an actual incident to evaluate. The cause of which often appears so obvious that its' omission from the HAZOP can be seen as negligent.

Lastly never consider that, having done a thorough Hazop or Risk Assessment, a manufacturing process is accident or incident free. The Hazop or Risk Assessment is only as good as the knowledge and experience of the people present, and they do not have access to a crystal ball or all-seeing eye. There will invariably be incidents that occur from circumstance that were not envisaged or where approved procedures were not followed. Then of course there is the unpredictable human factor and its' predisposition to taking a short cut ----.

Regular unscheduled audits of the plant and process are a means of constantly evaluating that standards are not slipping, and these should be part of any well run explosive manufacturing process.

Meet Adolfo Sanchez Medina

Our new Governor

Adolfo Sanchez is the Regional Sustainability Manager of EXSA S.A. a South American Company that operates facilities in Chile and Perú and exports to many countries in the Latin and North-American market. The company manufactures high explosives and initiating systems. Adolfo is a Peruvian Chemical and Safety Engineer and holds a Master's Degree in Environmental Management. He has more than 20 years of experience in the explosives industry and has always worked in that field. Adolfo is married to Jessica and they have a son, Fabrizio, who is pursuing an engineering degree as well.

Adolfo led EXSA to win the "Recognition for Work Safety" prize given out by the insurance company RIMAC for two consecutive years. He also works in the national committee in charge of preparing the national technical standards for the explosives industry. Adolfo has worked in four different companies inside the explosives industry, and in various areas such as quality assurance, research and development, business process improvement, risk management, integrates management systems and the processes area.

For the last fifteen years, Adolfo has taken on a number of managerial and strategic roles related to safety, firstly with Dyno Nobel – Samex, as the safety manager, then in Orica Mining services where he was the Latin American risk Manager, leading and participating in the risk assessment of the most important projects in the region, after that he became the SHEC Latam Manager for the manufacturing plants, before finally moving to EXSA.

SAFETY MANAGEMENT SERIES

By

Andy Begg

In this Newsletter we are looking at **Site Emergency Plans.** This is a safety procedure which we hope will never be needed, but if it is needed it has to work immediately and effectively as it is likely that peoples' lives will be at risk. An emergency could happen at any time from construction/commissioning a new plant to routine operation after many years. This means that the emergency plan must be prepared along with operating instructions - or even sooner in some cases. Personnel must be trained and the plan tested not just once but on a routine basis to ensure that if the alarm sounds at any time personnel take the correct course of action without hesitation. Their lives and the lives of others may depend on this initial response. Seconds in evacuation delay can be the difference between life and death.

Location Emergency Plans (EP)

General principles

The nature and scale of all reasonably foreseeable on-site and off-site emergencies should be identified. Appropriate arrangements should be made to deal with these situations including the involvement of public emergency services. The plans should be reviewed and rehearsed at a minimum once per year to ensure their adequacy and effectiveness

Scope

The procedure should deal with emergency situations on plants and other fixed installations. It does not cover transport emergencies that should be dealt with by specific transport emergency plans.

Site preparedness for emergency situations

There are several factors that should be considered in plant layout and plant operation that could have a significant impact on the effectiveness of subsequent emergency actions. These could include the following:

1. Road layouts, traffic movement, parking arrangements (e.g. reverse parking to ease emergency evacuation)
2. Position of emergency exits and access routes for emergency services
3. Audible/visual alarms in multi-compartment buildings that can be heard/seen by all employees as soon as an emergency button is pressed.
4. Communication between adjacent buildings and to and from a central control room.
5. For larger factories with many separate production buildings it can be helpful to have a board/screen in the control room that automatically identifies which building has activated the emergency system.
6. Operating buildings should have escape doors for each compartment that ensure all personnel can exit the building as directly as possible – for example workstations should not enclose operators with packing cases, conveyors etc
7. Escape doors must not be locked during operations must be kept clear at all times and should open outwards into an unobstructed escape route to the designated assembly point(s). Doors should be fitted with push-type opening mechanism so that personnel do not have to stop to open the doors.
8. Emergency alarm and emergency plant stop buttons should be located at emergency exits so that they can be activated as personnel exit.
9. Closed-Circuit TV cameras, very common nowadays, are a helpful source of information on the control room and can provide invaluable information to the investigation team in the event of an incident.
10. Good and independent lighting of the plant is essential for evacuation during the night shift.
11. People trained, trained and re-trained.

Procedure

1. General requirements

Each facility will have a documented EP that:

1. Is current, readily available to all personnel and tested on a regular basis.
2. Has been made available to and discussed with the local emergency services.
3. Clearly designates individual responsibilities in the event of an emergency.

The EP will be based on the Major Hazards Scenarios raised from Risk Assessments that will be carried out to identify and assess the possible major incidents and their consequences on:

1. Employees and other personnel on-site (Contractors and Visitors)
2. The public
3. Sensitive environmental areas
4. The business

2.Specific requirements

Due to the wide variety of activities carried out on plants and locations each plant will have to develop its own specific EP. However, there are a number of factors that need to be considered and these include the following:

2.1.Risk Assessment

a. Fire
b. Explosion
c. Chemical/toxic release
d. Natural disaster – flood, earthquake, etc.
e. Likely and worst case scenarios (including ma licious act)

2.2.Organization

a. Clear line of command
b. Involvement of local emergency services – fire, police, ambulance, hospitals
c. Review and updating EP
d. Site EP has a link with Company Crisis Management Plan

2.3.Communication

a. Alarms to advise personnel of problem
b. Internal communications to manage the situation including back-up
c. Internal communication with head office and authorities

2.4.Rescue, shelter and evacuation

a. Each building has a tried and tested evacuation procedure
b. Escape routes are clearly identified and kept clear at all times
c. Escape doors open outwards and lead away from the hazard
d. Assembly points identified and main-

tained

e. Personnel head count system in place

f. Emergency escape equipment is available and in working order, and personnel are trained in its use.

g. Gas release plume model to **indicate likely affected areas on and off site** if appropriate

h. "Safe rooms" identified and equipped for use in the event of toxic gas release when there is no means of direct escape.

2.5.Emergency services

a. Aware of nature of materials

b. Hazards on the plant – residual ex plosives, unsafe building structures

c. Special precautions to be taken - **fire service not to fight fires directly involving explosives and ammonium nitrate.**

d. Scale and type of likely injuries - burns, poisoning, shrapnel impacts, shock wave impacts etc.

e. Operating procedures include emergency shut-down.

2.6.Equipment

a. Personal Protective Equipment (PPE) specified and accessible without exposing personnel to unacceptable risk. Personnel will be trained in the use of PPE. Requirement for rescue equipment from confined spaces and the use of SCBA Self-contained breathing apparatus in case of toxic gas release.

b. First aid and other emergency medical equipment (sufficient to attend more than one person injured simultaneously).

c. Plant emergency vehicles

d. Containment equipment - spill control, water hydrants, sprinklers systems

2.7.Training and drills

a. All personnel trained in EP for their building

b. Joint drills with emergency services

c. EP tested at least once per year for:

- Practicability
- Effectiveness of communica tions
- Effectiveness of equipment
- Emergency first aid and rescue procedures
- Emergency services response
- Evacuation
- Head count
- Report and review of drill for learning points.

e. EP is communicated to new employees during induction.

2.8.Isolations

a. Services to be isolated are identified - gases, steam, acids, etc.

b. Critical valves clearly identified and easy to access by operators in case of emergency

Audit checklist Emergency plans

Is there a documented EP that:

Is current, readily available to all personnel and tested on a regular basis?

2. Is the EP compliant with local regulations in the area of jurisdiction?

3. Has been made available to and discussed with the local emergency services?

4. Clearly designates individual responsibilities in the event of an emergency?

Is the EP based on the findings of Risk Assessments carried out to identify and assess the possible major incidents and their consequences on:

1. Employees and other personnel on-site?
2. The public?
3. Sensitive environmental areas?
4. The business?

1 .What risk assessments have been done?

a. Fire?

b. Explosion?

c. Chemical/toxic release?

d. Natural disaster – flood, earthquake, etc.?

e. Have likely and worst case scenarios been considered?

2.Is the organization of the plan clear?

a. Clear line of command?

b. Involvement of local emergency services – fire, police, ambulance, hospitals?

c. Routine review and updating EP?

d. Site EP has a link with Company Crisis Management Plan?

3.Are there effective communication systems?

a. Alarms to advise personnel of problem?

b. Internal communications to manage the situation including back-up?

c. Internal communication with head office and authorities?

4.**Are there facilities for rescue, shelter and evacuation?**

a. Each building has a tried and tested evacuation procedure?

b. Escape routes are clearly identified and kept clear at all times?

c. Escape doors open outwards and lead away from the hazard?

d. Assembly points identified and maintained?

e. Personnel head count system in place?

f. Emergency escape equipment is available and in working order, and personnel are trained in its use?

g. Gas release plume model to indicate likely affected areas on and off site if relevant?

h. "Safe rooms" identified and equipped for use in the event of toxic gas release when there is no means of direct escape?

5.Have local emergency services been integrated into the plan?

a. Aware of nature of materials handled?

b. Hazards on the plant?

c. Special precautions to be taken - **fire service not to fight fires directly involving explosives**

d. Scale of likely injuries?

6.Have specific equipment requirements to deal with the emergency been considered?

a. Personal Protective Equipment (PPE) specified and accessible without exposing personnel to unacceptable risk? Personnel will be trained in the use of PPE?

b. First aid and other emergency medical equipment?

c. Plant emergency vehicles?

d. Containment equipment - spill control, water hydrants, sprinklers systems?

7.Has appropriate training been given and drills conducted?

a. All personnel trained in EP for their building?

b. Joint drills with emergency services?

c. EP tested at least once per year for

i. Practicability?

ii. Effectiveness of communications?

iii. Effectiveness of equipment?

iv. Emergency first aid and rescue procedures?

v. Emergency services response?

vi. Evacuation?

vii. Head count?

8.Isolations

a. Services to be isolated are identified - gases, steam, acids, electricity etc?

9.Inspection guide for the auditor

- Do emergency doors have push open mechanism, open outwards, are routes clear both inside and outside?
- Are emergency alarms buttons positioned at emergency exits
- Are emergency exits clearly marked?
- Do operators know what to do in the event of an emergency?
- Can an operator indicate the nearest emergency

alarm buttons?

- Can alarm be heard in all parts of building?
- Where is the "safe" room and is it equipped with basic survival equipment?
- Test some of the fire water systems.
- Are buildings - especially stores – clearly identified with contents/hazards/special firefighting precautions?
- Check that the list of emergency telephone numbers is up to date.

Chemical synthesis- The methodology of scaling up

By

Dr.N.V.Srinivasa Rao, Hyderabad.

ABSTRACT:

All chemical reactions are initiated in the lab. During the lab scale synthesis, many of the reaction conditions may go unnoticed. Basing on the lab trials, a decision can't be taken regarding large scale manufacture. Hence to evaluate lab process and to generate data for scale up to commercial scale, pilot plant studies are very essential.

This paper describes in detail the methodology for scaling up and various steps involved in scale up.

INTRODUCTION:

Any chemical processing will get initiated in a chemical laboratory. The product quality and yield will be established at lab scale by changing various critical parameters in the lab and optimize the reaction conditions basing on the quality and quantity. The reaction will be repeated to see the reproducibility and reliability. These laboratory experiments will give information about the process roots, yields and quality of the product.

But many points may go unnoticed in lab scale synthesis. Lab scale trials are conducted at a very low grams level. Raw materials are of different grade. By-products including gases emission may go unnoticed. Temperature changes and thermochemistry of the products are not understood fully. Time of the reaction may also vary a lot. Generally, glass equipment is used for all chemical reactions.

Because of all the above factors, it is very difficult to scale up production to the commercial level, basing only on the lab trials result.

To have a better understanding of process parameters and to obtain a correct proposal for commercial scale, a study at a bigger level than that of laboratory scale is very important. This study is known as pilot plant scale study.

ADVANTAGE OF PILOT PLANT SCALE-UP:

We can evaluate the results of laboratory studies and make corrections in the process for commercial production by conducting pilot plant study. Product specifications can be finalized by pilot plant study. The market acceptance of the product can also be studied by introducing the product obtained in a pilot plant to market. Costing and viability of the product will also be evaluated much better, by the data obtained in pilot plant scale. The effluents obtained, their quality, their disposal methods and cost involved in disposal will also be understood properly. Basing on these facts the viability of the project can be decided. The results and data obtained in a pilot plant can be studied for designing the commercial plant.

STEPS IN SCALE-UP:

- Conducting laboratory scale studies is the first step. Study the data to understand & define the key rate-controlling steps in the proposed process.
- To understand the equipment required at the pilot plant to conduct larger than laboratory size trials. It will aid in plant design.
- Design and construction of the pilot plant is the next step in the process. While designing the pilot plant provision for process and environmental controls, cleaning and sanitizing systems, packing and waste handling systems and meeting regulatory agency requirements are also to be taken into consideration.
- Operate the pilot plan, understand the quality of the product, yields percentages, process controls, product costing and process economics, basing on the pilot plant trials.
- This study will give us an insight into taking a decision whether or not to go for plant scale and if yes at what scale.

SAFETY IN SCALING UP

A Risk assessment is to be carried out to address the safety issues in scaling up. This should be undertaken at the concept stage. It is advisable to do this before designing the pilot plant itself.

This study should involve the consideration of the following:

- The physical and chemical characteristics of materials used in the process, formed during the reaction and products. Products involve the desired product as well as the by-products including waste generated.
- The effect of chemical reaction if deviated from set parameter. The effect may be very severe or minimal.
- The health hazards and requirement of personal protective equipment.
- Heat output and thermochemistry of desired potential reactions and undesired potential reactions. Thermochemical studies involve, data collection, Calculation basing on the available information and investigation of all new processes by techniques like DSC etc.
- This study will be helpful to decide the safer methods. If the risks associated are unacceptable an alternative route should be developed. Even though with high risk, if the reaction has to precede the assessment studies should specify the control measures and safety procedures to be adopted.
- This information obtained from each step should conform to the decisions made from risk assessment stage in relation to process parameters, reactor design, and material of construction, material handling & sampling problems, analytical problems & effluent & waste disposal problems.

Once the scale-up process is completed, the decision on the following can be taken:

- Which route is safe.
- What control systems are required to initiate automatic remedial actions.
- Protective measures.

"Oh, they took detonating cord..."

A double misfire with a happy end

By

Walter Werner

After the reunification of Germany a power station in Berlin became obsolete. It was to be demolished. The power-station had been fired by coal. (Fig. 1 + 2)

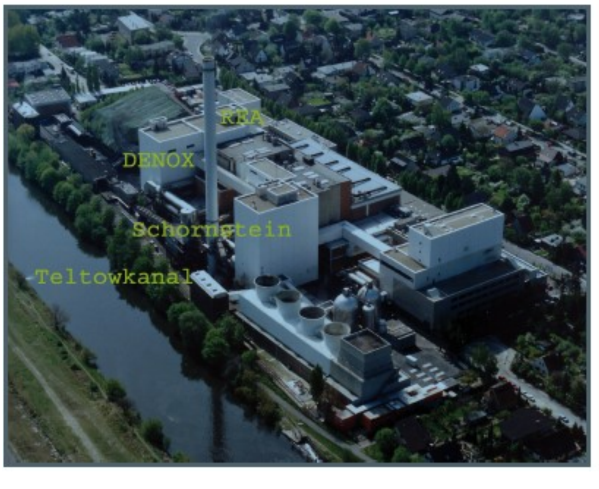


Fig.1 Power Station-View One

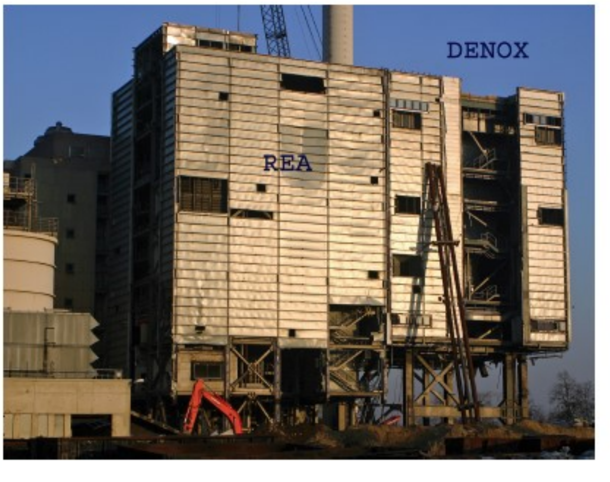


Fig.2 Power Station View Two

A one-man-company was engaged for this job. He used 2x50.9 kg of linear shaped charges to cut the 13 beams and 25 kg ammon gelignite for kick-charges. The charges were initiated by 292 delay shock-tube-detonators.

The results of the first blast and a second blast two days later were disastrous. Only a stairwell (1st blast) and an elevator (2nd blast) came down. But shrapnel scattered up to 400 m in living areas. Fortunately, nobody was injured.

An analysis showed that several shaped charges had not initiated.

The main reasons for these misfires have been:

- The shaped charges had been put on the beams in a wrong way. They formed a too flat angle to allow to form a gap. Some charges had been fixed on the beams nearly horizontally. Therefore, the kick-charges could not work, but they caused scattering of steel splinters.

Fig.4 Nearly Horizontal Cut

Fig.3 Cut after two Blast attempts

Fig.5 Improper Cut

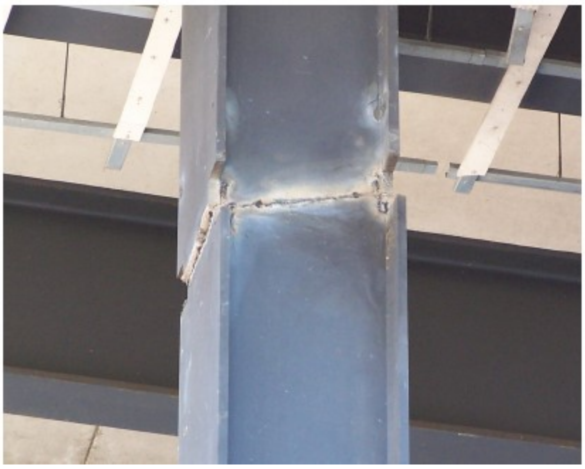


Fig.6 Improper Cut

Fig.7 Insufficient Cut After Blast Attempt

- the application of 292 shock-tube detonators is not appropriate for such an operation. The tolerances of the delays may have led to the cut-offs.

- a structural engineer was engaged to calculate the stability after pre-weakening. But he was neither a specialist for demolition nor especially for blast operations.

For retrieval of the honour of the demolition company is to say that they cancelled the contract with the "lonesome cowboy" and engaged an experienced structural engineer and a well-respected blast contractor for the continuation of this job, which now have become very difficult. Some charges had worked, others did not.

Some of the cuts had to be closed again by welding because the building was now very unstable. (Fig. 8).

Fig.8 Insufficient Cut Caused by Splitting of Shaped Charges

Another problem was the uncertainty of the neighbours.

Thanks to a proficient design and years of experience the third blast was a convincing success.

The 100 m tall chimney (reinforced concrete) was tilted by an application of steel hinges. (Fig. 9)

Fig.9 Steel Hinge

With about 20% of the quantity of explosives which had been used for the first two blast attempts the buildings came down as perfect as a textbook.

The unhappy "cowboy" visited his former site and was interviewed by a TV-team. His answer when regarding the initiation system:

"Oh, they use detonating cord to ensure the simultaneity. Nobody has told me to do that. I did not get instructions from the manufacturer about this!"

His answer to the question about his meaning and feelings:

"I feel to be fooled, really fooled" (Remark: he used an expression we did not translate word for word ****).

The quintessence: Someone who is competing for such a demanding job should be informed and educated for it. The "cowboy" never was seen on our seminars and meetings. But he must have argued convincingly.

It is to underline that quality seals (like RAL 509 "Blast operations") find more appreciation and acknowledgement.

Epilogue: This is a shortened version of a report from Dr. Rainer Melzer (Project office of structural demolition, Dresden, Germany) published in the German magazine "SprengInfo", 3/2008.

SAFETY in DRILLING and Blasting, and BEYOND.

By

Paulo Couceiro, Manuel Lopez Cano & Asim Jafa - MAXAM

Drilling and Blasting are essential for mining, quarries and civil works. A good blast design can affect costs and efficiencies of downstream operations, and safety significantly. Blasting results can have an important impact on safety beyond just drilling and blasting operations. Consequences of a bad blast can lead to unsafe conditions in downstream operation, due to problems generated in these operations as a consequence of the blast quality. Most of these problems can be minimized or eliminated by a proper blast design process.

Safety when using the energy of explosives

Energy optimization is important for long term mining cost optimization; and inefficient and unsafe uses of available energy sources in the mine are not acceptable. In these processes, the explosive energy has been gaining more relevance since high flexible energy blasting techniques have been shown to drive mine energy optimization projects.

The energy released by explosives during a blast is the lowest cost and highly efficient energy source in the mine for breaking rock, when compared to other energy sources in the mine, for example fuel or electricity. As the explosive is the source of all energy released in a blast to fragment and move rock, it is important to ensure that this energy is used safely and efficiently.

Undesirable effects from blasting include ground vibrations, air-blast overpressure, dust, noise, and flyrocks. Flyrocks, for example, are especially hazardous and a leading cause of fatal accidents in mining. The safe use of the energy released during rock blasting processes involves several aspects, such as rock mass, blast geometry and timing design, type of explosive, blasting protocols (priming, loading, stemming, etc.) and safety.

A strong culture of safety and methodology is required for a safe and sustainable blasting process. Several tools and documentation are available to help the blaster and explosive engineer to use explosives safely - such as the Material Safety Data Sheets, Product User Guidelines, and others. Additionally, pre-blast risk analysis is an indispensable tool for a safe blast.

Safe Blasting

Safety is a permanent issue and must be considered in all phases of blast design, planning and execution. During the planning and design phase, all phenomena from blast must be predicted in advance as part of the blast design. These predictions include the expected fragmentation of the rock, ground vibrations, flyrocks safety distance, etc. In case any predicted result is out of specification, adjustments are made to the design until the desired outcome meets specifications. The final blast design must be documented in a Blast Plan, which will guide the execution of the blast.

After blasting, the rock is normally excavated, transported and crushed as part of the downstream mining operations. When blasting is does not produce desired results, the outcome of some of these activities in terms of performance and safety can change. Possible undesirable outcomes include:

- cut-offs and/or misfires during the blast
- presence of an undetonated blasthole in the muck pile hinders rock excavation
- Secondary blasting or hammer are needed to break large boulders
- The wall slope loses stability (backbreak)
- Handling and carrying oversize rock
- Blockage in the Crusher by oversize rock
- Others

In order to solve some of these problems, special – and generally more hazardous – works are required. Most of these problems could be minimized if a proper technical blast design and execution processes were carried out. As an example, figure 1 and 2 shows the use of a hydraulic hammer to break oversize rock produced in a blast, also known as secondary breakage operations. Figure 1 represents a very high risk operation since the operator is driving the hammer over the muck pile or loose rocks, without criteria to carry out the hammering activity. In Figure 2, in comparison to Figure 1, the difference in terms of efficiency and safety is evident, as the hammer is working safely and with a clear view of the scope of the work to be done. In case of oversize rocks, it is recommended to first proceed with their identification, move them to a designated site and systematically break down the oversize rock safely.

Figure 1: wrong and unsafe oversize hammering treatment.

Figure 2: Recommended boulder hammering procedure.

The basic aim of blasting is to reduce the rock mass to fragments of a desired size distribution. This fragmentation is critical to positively impact downstream unit operations. A balance of large and small fragmentation size, together with the muckpile disposal and swelling, are necessary in order to achieve optimal results in term of cost and energy consumption in downstream operations. However, when blasting generates a deficient rock fragmentation and poor oversize control, these large rock boulders can enter downstream processes and block the system. An example is shown in Figure 3, where a boulder is blocking the primary crusher. These types of stoppages are critical since all operations must stop until the crusher is cleared. In order to clear the crusher, a hazardous rock clearance task must be carried out, a task which could have been avoided by a proper blast design and execution.

Figure 3: Secondary blasting inside a crusher to remove boulder blockage

Conclusion

Sustainable mining strategies require a conscious safety. Safe blasting is not only restricted to drilling and blasting operations, can produce effects far beyond of this initial step, affecting downstream mining operations such as loading, hauling and crushing. The safe and efficient use of the explosive energy requires the practitioner to model, predict, measure and control the outcome of the blast phenomena. **Safety is a matter for all of us.**

COMPROMISES AND OPPORTUNITIES AN UNORTHODOX PERSPECTIVE

By Tony Rowe

Before going any further I have to tell you that I was deeply appreciative of the kind words expressed by Bill Evans in the SAFEX Newsletter No. 63. Thank you Bill, thank you very much.

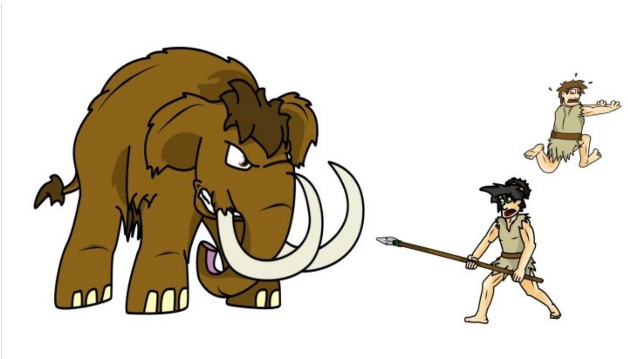
This article is somewhat longer than usual. I would recommend finding a nice armchair, a cup of something hot and a box of biscuits. Comfy?

Right, here goes:

Let's begin the conversation with a discussion about human nature and the human condition in general. Firstly, I'll advance the theory that human beings are programmed to take risks. It seems to be fairly self-evident. From the time of the first humanoid clambering over a nearby hill or some prehistoric (Quaternary Period) sea voyager grabbing his log and paddle, people have been taking risks. Could our sailor guy even swim? It didn't and doesn't matter, RISK is in our DNA.

Pesse Dugout Canoe
~ 8,000 BCE
Found in Holland

Now picture a few guys dressed in skins and fur taking ona woolly mammoth. They're armed with nothing more than sharpened wooden sticks. OK, so perhaps some of the sticks have a bit of flint stuck to one end. I wouldn't take on a sleeping hamster with those, never mind a mammoth. Without doubt, some of those guys were injured in the struggle. One or two were probably killed on scene, a few were horribly maimed and it's likely that some died later. The survivors though ate well and told stories. The death of 'UgOg the bold' was glorified in song, paint and charcoal. The cave walls paid tribute to his courage and his missus got an extra-large chunk of mammoth rump and a nice loin chop.



Today's workforce does not have to face such risks. The mammoths are all gone and there's no requirement for self-sacrifice. Food comes from the supermarket. Children aren't pressed into slavery. They don't have to work their young lives away in coal or salt mines, nor are they tending unguarded heavy machinery. Today, workers are first rolled in bubble wrap. They're then put into a box and surrounded with small, funny shaped bits of expanded polystyrene. Cossetted and protected from the world at large, there must be no chance of injury.

In the workplace there are gloves and goggles, face masks, training regimes and pass outs, signatures and a colourful certificate just so we can make tea safely in an insulated cup. So why are we surprised when people do dangerous things. Many still seek the adrenalin pumping excitement of risk. They need it. It makes them feel alive. They climb mountains, ride bulls, base jump and set deep diving records. They ski down mountain slopes and race powerboats. Then there's bungee jumping, hang gliding, skydiving, para-gliding, naked polar bear wrestling and single-handed, around the world yacht racing, to name, but a few. Watch what people post on social media. Are you horrified?
They crave what they are denied.

We are warned of the dangers of bacon and processed foods. Soft drinks are bad for us and artificial sweeteners guarantee an early demise. Talcum powder causes cancer and smoking kills.
"Speed Kills" or the uniquely South African, "Don't Fool Yourself Speed Kills" signage is posted all over our highways

Do all those signboards make one jot of difference? I doubt it. As a species, we drive fast. We like it. It gives us a buzz, a thrill we get nowhere else. We glory in squealing tyres and the stench of burning rubber. Once, when I was younger I almost reached 30 kph. Engine howling, steam jetting out of every joint, the cab echoing to the cries of "More coal, more coal."
Human beings need danger, sometimes we even seek death, not because we want to die, but because we just might. There are those who question if 'life without risk' is even 'life' at all?
In the modern workplace, people are therefore attempting to function in direct denial of their DNA heritage. It's the double helix facing a double standard. A struggle between ourselves and a code of behavior we are genetically ill-equipped to face.

If we even half accept the above, Isn't it strange then to find an old adage that states "An ounce of prevention is worth a pound of cure?" It is not really about the perils of work though. It's a simple phrase that has been hijacked, turned around and now used to explain why businesses today spend huge sums of money trying to prevent accidents. Accidents quite frankly, from any perspective, are wholly undesirable, detrimental to morale and expensive. In most cases they are also entirely avoidable, but whilst profit is certainly a motivation for running any company it is not the sole criterion for success. The health and safety of the workforce are easily of equal importance. The two enterprises are inextricably linked. From one side intelligent and sympathetic cooperation are clearly the keys to success and from the other is the requirement to look after the comfort and well-being of the workforce itself. The connection with a live and caring employer and not some soulless machine might be expected to pay off handsomely in the long term, yet despite best efforts, accidents continue to occur.

The process is similar to lending someone money. It's a give and take. In the short term, "all is well," but try to get the money back and it will quickly become apparent that the lender is always the 'bad person' in the relationship. The employer/employee alliance is exactly the same. Whenever bad things happen, it is always the employer's fault.
What seems slightly odd is that while areas processing extremely sensitive substances get their fair share of incidents, plants manufacturing highly insensitive emulsion and watergel explosives also feature strongly. Why?

Because, where routine operations involving energetic materials are concerned, <u>you can't trust people</u>, although in general, individuals are more trustworthy than groups. Groups, whether formal or informal can, almost overnight, become radicalised and malignant. All may seem well on the surface, but deep within the tissue, a cancer cell may have taken root and is growing.

For most of us there are no thrills at work. Life has become routine and predictable, flat and boring. Everything is prescribed. There might well be a Work or Operating Instruction for every task, but somehow mistakes <u>are not catered for</u>. A mistake, by the way, is an unintentional error or blunder. Some we may come to regret, but just sometimes a mistake can snowball out of all proportion to the initial error. Let's call it unforeseen collateral damage. For example, what if a plane was not properly refueled and as a result crashed into the middle of a city, killing hundreds? The original and perhaps minor error, compounded many times.
Sometimes mistakes are hard to live with and at other times impossible to feel responsible for, yet there are no Work Instructions for a mistake and everybody makes them. **Everybody!**

Work is usually a place where people may perform the same set of operations day after day, year after year. Nothing ever happens. They may not even be required to think, just do. Is it any surprise then that boredom breeds complacency?
What is complacency? It's essentially, feeling smug or uncritically self-satisfied with one's job or life. There may be a sense of disengagement and frustration. Complacency often leads to shortcuts too. People 'switch off' and don't think. They become unhappy and in extreme cases, may even lose hope.

The opposite of complacency is of course responsibility, but responsibility often comes with consequences, so should things ever go pear-shaped, don't expect any sudden true confessions.
In the single-person scenario, the individual is generally in better control of his or her own destiny than a member of a group. There is though a qualification clause to that statement. The longer a person has been performing in a particular role, the greater are the levels of complacency likely to be exhibited. A worker may have had the same job for years and during that time nothing has gone wrong. Sometimes folk are just plain lucky, but whatever the source of their good fortune they will naturally be viewed both by themselves and their fellows as "the expert," the go-to person

for that job. They may not be technically competent, their knowledge and understanding might be deeply and seriously flawed, yet within their peer group, experience guarantees credibility.

Groups do exactly the same, but become even more narcissistic. The group leader, (sometimes natural, but perhaps appointed) can apply pressure to persons within the team forcing them to conform to the perceived needs of the others. To "stay on the bus," so to speak, an individual may be coerced into performing actions that he/she would never have carried out on their own. Intimidation by a peer group is an incredibly powerful tool.

Let me attempt to better illustrate what I'm trying to say.

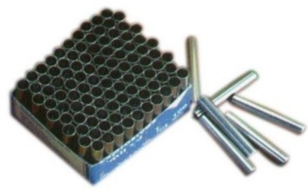
When I was younger and could stand up without making strange involuntary noises, one of the operations where accidents, appeared to be almost inevitable was the packing of plain detonators. This was the operation that taught the world the wisdom of elasticated leg incontipants.

Plain detonators, as a species, look pretty scary but in actuality, are remarkably tolerant of abuse. If we are talking about 8D's here, each aluminium tube may contain a little less than 1 gm of high explosives. One tube going **POP** is therefore more than enough to completely ruin your day.

The pressed, but still highly sensitive primary increment, usually consisting of 4:1 lead azide/lead styphnate is clearly visible about a centimeter down from the open mouth of the tube.

During manufacture, detonators travel together like herd animals. They're not herbivores in the way of horses, bison or wildebeest, but scavengers, stalkers and potential killers. They're meat eaters just like the wolves and wild dogs of old. If one snaps and bites, it's almost certain the rest will follow. Best to tread softly.

Even the name smacks of this herd philosophy. "Pack Houses" as they were called were pretty unremarkable places. Single storey, long and grey, the buildings themselves were made up of a number of single occupant cubicles, each one apparently hewn out of solid concrete. Within each cubicle, hundreds of rumbled, open ended, plain detonators were placed on tables. These were then picked through by operators apparently possessing the physical embellishments and manual dexterity of Kali (the Hindu deity with all the arms). The detonators were orientated appropriately, examined and packed manually into a 50mm square cardboard carton. A sprinkle of sawdust and Voila! One hundred detonators made up a carton and one hundred cartons made up a case. Clearly, any detonation within a packing cubicle was likely to result in a fatality, yet in at least 60 years of operation it never happened. **Never!**



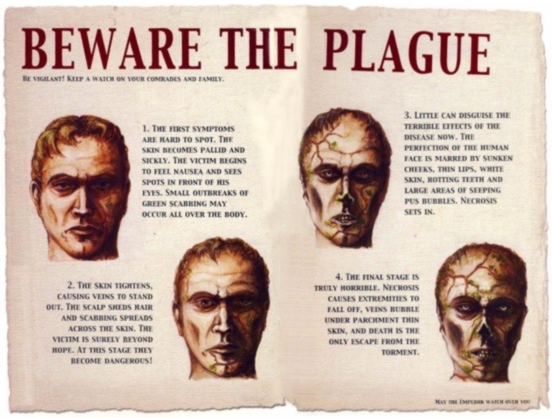
I confess to going weak at the knees every time I entered a pack house. The statistics were interpretable as either "safe as houses" or "a place best avoided." I always viewed it as the latter, but as the numbers of detonators packed over the years probably added up into the billions, I have to say – against all odds – that it was a pretty safe process after all. In a pack house, the potential for an accident was always high. Everyone knew it, but if the rules were followed, there was little, if anything, that could actually go wrong. Of course, any occupant of any one of the cubicles could make a serious error, but if they did, the consequences were both clear and intensely personal.

What I'm trying to say is that where the accidents took place was often less remarkable than how they took place. The resources and ingenuity displayed by members of the workforce in modifying or ignoring basic safety guidelines is often surprising and groups or teams possessing a common goal, do it best of all.

Let me share another example, this one discusses groups or teams, but before we do I have to point out that what follows is entirely my own opinion. It's allegorical, a fairy story set in a sweet factory. It's a tall tale, told of course, to make a point.

Once upon a time in a land far, far away there was a handsome Prince. He owned a confectionary company called "Divine Sweets." In the portion of the factory known as Sugarland they made the now infamous Fiery-Hot gob stopper, with its "Liquid Lava Centre."

Deep within the Sugarland complex was a mysterious machine that was employed to press the occasionally explosive, but always fiery-hot, gob stopper paste into moulds.
Acne-like pits and burns were etched deeply, not only into the press itself, but also into the surrounding walls, evidence no doubt of previously popped gob stoppers. Alongside was an even stranger device. It was used to empty out or de-plate (technical jargon in gob stopper terminology) the pressed and now hardened sweets. For some reason or other it was called Tipper. Both machines operated behind thermonuclear resistant, blast shields. This was necessary because in the past, the unpacified and ever restless, Fiery-Hot gob-stoppers had been known to explode. In terms of cycle time though, Press was quick, but Tipper was slow.
Unknown to the Prince, a spell cast by a wicked witch from the land of Ego had taken hold. An alien work ethic was now silently infiltrating and infecting the workforce. I have elected to call it "Job and Finish." It comes in many guises and a host of names, but whatever the name, "Job and Finish" is both toxic and destructive. It spreads like a plague. It is at its most pernicious wherever a financial incentive to reach a production target is on offer. It doesn't need this though; the disease thrives on any form of opportunistic advantage. It works best with shiftwork; afternoon and nightshifts being most favoured.



Seen initially as benign, the sickness comes with some particularly nasty side-effects. It spreads unseen, quietly, but relentlessly taking over. With the benefit of hindsight, the practice was probably the root cause of a number of incidents. Only later, when the individual occurrences were viewed from the armchair of experience did realisation actually dawn. There had been an absence of certain critical facts. There was always the 'feeling' of something missing. This meant that few if any of the incidents were in any way predictable or even properly solvable. There was stuff we didn't know and we didn't know that we didn't know.
When applied to the manufacture of gob-stoppers, the words, 'Job and Finish' means exactly that. Its adoption meant meeting the factory's bonus requirements in a significantly shorter time than was deemed professionally possible. It was a calculated conspiracy in which a sub-unit within the greater workforce could collectively benefit. It meant breaking a few rules of course. The fact that it would seriously compromise both collective and individual safety was apparently deemed justifiable by those groups or teams who chose to apply it. It was a small price to pay. The benefit to the team would not only financial, but was also advantageous in hours saved; hours to be used to the groups own advantage. With the foreman/team manager safely on board 'senior management' need not be informed. There was no need. As long as production was meeting or exceeding the allotted targets and the workforce profited from the shorter working hours, surely that's a win/win for everybody?
Fiery-Hot gob stoppers poured out of the Sugarland facility.
Health and Safety? Don't worry guys, nothing can go wrong; WrOng; wRong; wr0nG; rong?
Let us be clear, it was entirely a self-serving and collectively selfish effort by a team gone rogue, just as the 'bonus' was the group reward. Once the 'bonus target' was achieved a team could relax until it was time to go home. A hot drink in the convivial atmosphere of the factory canteen and maybe some shared nicotine. Catch up on some Zeds or possibly spend some time in the handmaiden's quarters learning the secrets of embroidery, origami or flower arranging? Photostats of ID card bar codes could also be advantageously employed to circumvent the then optically-based gate security system. The fly in the ointment though was Tipper. Tipping was the slowest operation in the whole process and thus the 'Rate Determining Step' in Fiery-Hot gob stopper manufacture. Tipper though was obstinate, even grumpy and refused to operate any faster.
In order for the group to meet the bonus driven production targets and finish early demanded that Tipper be bypassed and that gob stoppers be tipped by hand. Although clearly unsafe, this became common practice. Years passed and all was well. There was nothing to fear after all. The routine became thoroughly and deeply entrenched.
When do bad things happen? Always when you least expect it. Always.
One dark night there was a loud report. **BNAG!** Golly Gosh! A whole pile of gob-stoppers had exploded. A worker was seriously injured.
Of course, the Prince got hold of his father (The King) and an investigation followed. The gob stopper or stoppers at the heart of the incident were gone. For the investigators the underlying causes remained unclear. There was soul searching and much speculation.
Like Dad, the team kept Mum. No disclosure. No mention by word or deed of their under the counter "Job and Finish" scheme. Another consequence – the mafia-like regime of enforced silence came into being. Omerta was reborn.

Later on, sensing uncertainty within the management structure of Divine Sweets, the group became extremely aggressive, demanding not only answers, but also a pay increase amidst claims of unsafe gob stoppers. Under enormous pressure, a host of changes were made. Amongst them was a physical change. Tipper was interlocked to Press. Now, only one of the two machines could operate at a time. Tipper or Press. Press or Tipper. Easy-peasy. A worker was then assigned to operate each machine. With a full team all was tickety-boo.

It didn't take long before the group realised that the current set-up had bestowed upon them yet another advantage. Aha! One member of the Press/Tipper duo could be elsewhere, perhaps out shopping, maybe reading the latest ballast tank maintenance manuals or enjoying a quick chicken dinner. Anything was possible. Team members would reap the benefits of the new arrangement. They even organized a Rota and took it in turns to enjoy some extra paid time off.

The one shortcoming was that it left only a single operator to perform both functions. Oh dear. This would be really slow. The other members of the team were unhappy and demanded that the requirements of "Job and Finish" be met once more. With one operator short, keeping up the work rate once again demanded that Tipper be bypassed. As before, the solution was to tip the gob stoppers by hand. The fate of the previous operator was conveniently forgotten.

A year went by.

One dark night there was another loud report. **Pop!** went the weasel.

A much reduced inventory (fewer gob stoppers) meant that this time the worker was only knocked about a bit. Battered and bruised and with a belly full of splinters, he was in pretty good shape, all things considered.

Despite overwhelming evidence to the contrary, the injured person together with all the other members of the team loudly proclaimed that the gob stoppers had popped within Tipper. This was clearly and demonstrably untrue. Once again the group became highly aggressive, but this time the evidence could not be disputed. It was not in their favour and failed to reflect well upon them.

Sugarland was later closed down permanently. Fiery-Hot gob stopper manufacture ceased forever. No more Liquid Lava Centres. Divine Sweets went into liquidation, the Prince married his sweetheart and everyone, with the possible exception of the two injured workers, lived happily ever after.

***

Why do such things happen? It happens because a selfish group of individuals see themselves as in control. In their collective arrogance they become the sole arbiters of what is right and what is wrong. Whether they choose to accept it or not, they are all guilty of a perilous subterfuge. Team loyalty is directed inwardly towards the group rather than the employer. I suppose, in such cases, if you want loyalty, you'd best get a dog. Best of all the behavior is hidden. It may not be apparent to either the casual observer or the employer, but can be identified whenever production outputs can be discretely audited against a timeline. The scheduling of such audits need - for obvious reasons - to be kept highly confidential and disciplinary action must be taken if a 'Job and Finish' scenario is detected.

Other parts of the problem might be as follows:

As a general rule, grass root level employees have no direct access to the findings from an incident investigation.

If they were close to the scene or even peripherally involved employees may have been questioned or asked to provide a written statement, but that would be all. Counselling and/or hearing tests may have additionally been authorised. The investigation might recommend disciplinary action, but the deeper issues are rarely shared or discussed in an open forum.

To try to stop the same accident endlessly repeating itself, many of the more organized and well directed manufacturers of energetic materials have developed excellent incident investigation teams. In addition, they have tried and tested systems for the distribution of the final reports.

It doesn't hurt to point out here that in the case of explosives, investigators must have the fullest understanding of the process they are about to examine. Lack of understanding, poor powers of observation or an absence of sound common sense may stand in the way of correct interpretation.

If, as a result, inappropriate measures are put into place, the accident will simply happen all over again. The time and date may be unknown, but its inevitability is never in doubt.

Any countermeasures being put into place also need to be thoroughly scrutinised before being subjected to their own searching HAZOPs. Sometimes the proposed cure can make matters worse. It can carry the hidden seeds of its own destruction. As a consequence, these secondary HAZOPs must be carried out by experienced personnel.

During any investigation - if it is safe to do so - there is nothing wrong with investigators getting their hands dirty or actually carrying out as many of the manual processes involved as may be deemed necessary. (*Best to do so using dummy materials though as this will avoid a re-creation of the original accident.)* They are, after all, seekers after truth. By doing so, better judgement may be exercised and an intelligent understanding of the plant and its processes obtained.

Let me state from the outset that it remains my opinion that the cause or causes of <u>most</u> unforeseen energetic events in the workplace can be laid firmly at the door of the person or persons most directly involved in the accident. This may not be a view shared by everyone and - of course - there are always exceptions.

It might be that someone has deliberately neglected the prescribed safety procedures and whilst that particular someone may have a whole host of reasons for doing so, what he or she may have failed to understand is that, like it or not, they are paid to follow laid-down safety procedures, not substitute their own. Not one of the many operating and production personnel I have spoken to over the years ever quite grasped the concept. On the contrary, most felt that they had the right to change things.

Taking shortcuts are another common cause of accidents. At one company I visited I came across a "Handbook of Shortcuts." It was an unofficial booklet found circulating amongst some middle managers. Rather oddly the document sported pink coloured covers. It turned out to be a misguided attempt to advise foremen and supervisory staff of the various malpractices known to be carried out by workers at each stage of production. The booklet merely pointed out the safety deviations. There was no attempt to either design out or otherwise address any of the issues described within. The booklet was used simply as a disciplinary tool. Yes, it was withdrawn.

Back at grass roots level though, I seriously doubt that safety is first in anyone's thoughts. The most critical priorities are probably soccer, money, money, female companionship, cars and beer. I know this to be true because the examples listed are entirely my own.

As one legendary football club manager once said:

"Some people think that soccer is a matter of life and death, but it's much more serious than that."
That's exactly right. That is the true nature of people. From my own personal experience I have long come to realise, that even the best training is useless if the people at which it is aimed, fall asleep. At every single safety talk where I've been present, what was clearly apparent was that the guys with the heavy lidded eyes weren't with us anymore. The shutters had come down and they were no longer paying attention. Long past pretense, they were bored out of their skulls. The only things happening within their bodies were the barest of instructions for life itself. "Lungs, breathe in." "Heart, beat." "Lungs, breathe out." It's as close to a state of complete hibernation as any human being can achieve. Lives placed on hold, metabolisms barely ticking over, but mention Kaizer Sundowns, Manchester Rovers, Orlando Chiefs, Tottenham Lockjaw, Merseyside Black Mombassa and/or Everton Valley Wanderers and, in the blink of a jaundiced eye, the throttles are suddenly wide open again. Unseen engines roar, shutters are lifted, eyes brighten and faces become animated as the fast pedal is pressed hard down. What's that phrase? "Nothing sucks like an Electrolux," well these biological engines are all sucking in air like a 747 on its take off run. Normal service has been restored. Communication channels are wide open. We have found what lies closest to hearts and minds, but quite frankly, most safety talks are boring.
It is not that the workforce doesn't care about "Safety" it is just that in their lives "**SAFETY**" has no real meaning. Many of the workers live in a violent world where drugs, guns and gang culture are a commonplace. At home, in order to climb onto a roof, an empty drum, an old chair, a plank and a couple of bricks will quickly be pressed into service. Electrical wiring may be simply pushed into a socket, or worse, attached directly to an illegal power source. Car tyres no longer capable of inflation may be stuffed with newspapers or wrapped with garden hose to extend their working lives. A vice-grip spanner may serve as a steering wheel for a vehicle and pieces of cardboard provide a semi-serviceable set of brake pads. Tape is a permanent "fix" for most things. Exhaust pipes are cut off and re-welded at the side of the road by a guy with a wet sack over his head. It is a world where the watchwords are "Make Do." In essence it's a place where the devil takes the hindmost.

On the road there is little or no discipline. Drivers will 'undertake' on the hard shoulder and go straight through red traffic lights at speed. They will cut other drivers off, drive on pavements and even deliberately drive directly into oncoming traffic. I know it is their hereditary right to do so, but it is scary to meet a refuse truck driving at high speed the wrong way down a side road and the only other lane available to you is blocked with bumper to bumper traffic. That actually happened to me. The name of the road is indelibly etched in my memory "Northway"! On that occasion I had to drive off the road to avoid being turned into sticky compost. Like an egg and bacon breakfast, where the hen is involved and the pig is committed. Mr. Bin-Lorry was done with his sunny-side up and was now 100 per cent on the side of the porker.

In South Africa, I've watched pedal cycles on the highway. I've seen pedestrians leisurely pushing shopping trolleys on the edge of the slow lane. I regularly used to see taxi's stopping in the slow lane of the N3, a three lane and very busy highway. What were they doing? Discharging and/or taking-on passengers of course. Meanwhile other road users were zipping on by at speeds often well in excess of the posted 120 kph limit. I sometimes went fast too. You are right, on the road, I was no angel either. Mea Culpa. My bad.

I have personally witnessed cars reversing on a busy roundabout (circle) or carrying out a five point turn before driving directly into the oncoming traffic. On the N1 and N3 highways I've been horrified by vehicles reversing directly into the face of approaching, high-speed traffic. The reason? In all the above cases, they had simply missed their turn off.

You are trying to tell these dudes that ***explosives*** are dangerous?

Welcome to our world and the insanity of Jo'burg.

How do you convince someone 'not to do something' he has been doing at every opportunity – perhaps for years – simply because you say that it is dangerous. He already knows that it is not because nothing has ever happened. He can still count to ten. He has all his fingers and toes and anyway, his way is demonstrably quicker. Detonators are impact sensitive you say, but he knows they are not. He has dropped hundreds over the years and not one has ever gone pop. Explosives manufacturers are therefore trying to teach safety to an audience who simply know better. How do they know?

One word. Personal Experience. Sorry, I know. That was two!

Ask the average person working for an explosives manufacturer about serious incidents. Not one will mention 'the 'Enschede Disaster' which occurred in the Netherlands during May of the year 2000. It killed 23 people and injured nearly 1000 more. Nor will they know anything about the Sivakasi incident which occurred at a fireworks factory in southern India in 2012. This one killed 40 persons. Another explosion in 2017 happened outside the city of Jakarta in Indonesia and killed 47 persons. How about the 1998 explosion at the 'Sierra Chemical Company' in Nevada, USA? Admittedly this one only killed four persons and injured six, but how many of the workers in your TNT or booster plants are aware of either the incident or the findings of the investigation? After the Sierra event, the US Chemical Safety and Hazard Investigation Board issued a number of recommendations designed to prevent similar accidents taking place in the future. How many workers at production operator level have ever had access to the information and what about supervisors and managers? There are many, many, many other examples.

There are other anomalies too. I always find it odd that personnel working with explosives are constantly bombarded with posters, talks and videos about safety, yet so little is actually industry specific. I seem to recollect videos and discussion forums around the Piper Alpha Disaster which involved an Oil Platform in the North Sea. OK so there were parallels, mostly around 'the permit to work' systems, but it was an oil and gas rig, not a plant manufacturing explosives.

Even worse, there is a tendency these days towards the gruesome. Close-up images of mangled hands and limbs compete with one another for awfulness. I have never seen anyone actually stop and study such posters or in any way take on board the message they are trying to share. At best they desensitise people to the horrors of amputation and minimise the lifelong suffering that such injuries bring. With safety posters, less is often more.

From the Managing Director down, we live in the NOW. The paper-based time machine that once gave us those glimpses into the past has been rendered unserviceable and can never be fixed. It's broken. The present now consumes us. The past is no more. Events that occurred a mere 10 or 15 years ago have been erased from corporate memory.

It is not deliberate. The ravages of time, the reduction and turnover of experienced personnel and the general instability of human resources are probably to blame.

There is now so little interest in past events that vital learning points have been lost; possibly forever.

For instance, a number of years ago I learned of an explosion within a detonator service magazine located elsewhere on the continent. The incident was thoroughly investigated. A report was issued and recommendations made.

In fact a number of changes were made to the magazine's operating conditions and a document entitled 'Special Rules' was issued. By 2012 though, all was forgotten. Attempts to reinstate some of those rules met with a brick wall of resistance. The report itself was nowhere to be found, probably copied to microfiche and mislaid (microfiche was flat piece of transparent celluloid covered in tiny hieroglyphics. It required a complex, optically-based machine to visualise and decipher).

The accompanying typewritten folder containing the 'Special Rules' had also been lost. Unfortunately, commonsense does not always prevail especially when it is contentious, a little unpopular and unsupported by documentary evidence. I believe that the same service magazine might still in use today, probably performing the same functions that it has always done, but without its hard-won 'special rules.' The same accident that destroyed its counterpart is waiting in the wings. The scene is set. The actors are all on stage. The curtain is going up soon.

The loss of a report or three - while not yet the end of the world - is just another manifestation of corporate amnesia and by the way, it is a problem that continues to grow. Reports are being lost every day. It's easier now as the use of CD's and bulk storage systems continue to replace hard copy, paper records. Pretty soon the present state of severe absent -mindedness will morph into full blown dementia.

So, what about the old incidents and even the old folk? My memory though is not what it once was. Worse still, I drool. Sometimes I also snore ... Loudly. I would be of little value, but I'd still make a great doorstop. The records though remain an untapped source of meaningful information. Where are they? They're stored in the remote cellars and dusty old cupboards of corporate memory. Old reports often lurk unseen within the depths of dirty old filing cabinets. In time-faded dust covers rest priceless documents and photo's setting out the real tragedies of lives lost or changed forever. There they wait, unread and decaying. The wonderful part is that many contain real treasure. There are images of buildings damaged or destroyed. Alongside and in great detail are the perceived underlying causes together with the mitigation put into place to stop it ever happening again.

That funny fitting you threw away yesterday, could be such a lifesaver. There is a story about a length of plastic hose, a centrifuge and an NG manufacturing plant. Maybe I'll tell it one day. It's not just the story, it's the lessons learned and shared. There is also the responsibility to make sure that those lessons are never forgotten.

It's a Pandora's Box of information. It explains the peculiar brass strip on that door or why a foam washer was included into a detonator's construction. The why's behind the addition of calcium stearate to a recipe for a sensitive pyrotechnic. There are explanations about the incompatibilities of lead dioxide and TNT and what happens when 3000 fuseheads are initiated under conditions of light confinement. The death of an engineer is explained and precisely why the use of sand floors in firing chambers was forbidden. You may find an infamous story about a stainless steel pipe, some Pentolite, plus a hammer and a screwdriver. The dynamics of the snap and shoot phenomenon are explained as are the demonstrable perils of electrostatic discharges. You may learn too that PETN is actually more impact sensitive than say lead azide. All these things are real and relevant.

I urge the industry to root out these old reports and to extract their various vital essences. Use them as case studies and/ or incorporate the information in both training and discussion type forums. Do whatever is necessary to further disseminate the learning points. You couldn't make this stuff up and you can't argue with history. I'll leave it with you…………………And please

Thank you

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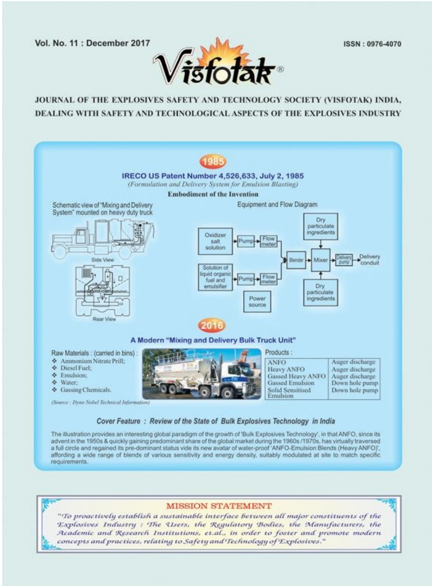
ARTICLES FOR NEWSLETTER

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 June Newsletter is 10 June 2018 and I look forward to your support** .

SAFEX thanks all the authors and contributors as well as the editing team for their for their valuable support.

Link to Corporate Associate VISFOTAK Newsletter No 11:



Corporate Associate Member ABIMEX Conference in Brazil :