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Traditional Fireworks Endangered

Municipalities and town districts in Sweden now discuss abandoning traditional fireworks in favour of laser shows. In the municipality of Eksjö, the chairman's mallet has fallen already – despite the fact that laser shows are several times more expensive than pyrotechnics. As the Swedish proverb goes: "Does it taste, it costs". Thus, on the 31st of December 2018, if not before, the citizens of Eksjö may enjoy – in addition to a clean air free from pyrotechnic reaction products – something like this:

Unfortunately, a full-fledged laser show obtained by e-mail from Brazil could not be transferred to this WORD document, but the picture in the covering electronic letter should work all right. Playing time 2 1/6 min.

Pyroteknik och dess kommande utmaningar / Pyrotechnics and its challenges

Andreas Norberg, SAAB Dynamics
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Företagen i vår bransch har fått nya tekniska utmaningar inom pyrotekniken. Primärt gäller det att göra produkter fria från blyföreningar och hexavalent krom. Detta är i huvudsak på grund av krav från kunder och EU-förordningen REACH med sin kandidat-

The companies in our industry have some new technical challenges in the field of pyrotechnics. The main thing is to make products free from lead compounds and hexavalent chromium. This is mainly due to requirements from customers and the EU Regulation lista, över kemiska ämnen som kan komma att förbjudas.

Detta är en utmaning, då till exempel blyföreningar har många önskade egenskaper i anfyringssatser och hexavalent krom kan användas till väldigt bra låggasande fördröjningssatser. I vissa konstruktioner kan man ersätta en sats rakt av med en av dagens miljövänliga satser, medan man i andra fall kan behöva ersätta en sats med flera nya och eventuellt även göra mindre mekaniska förändringar i konstruktionen för att få samma egenskaper i produkten.

För anfyring blir det en utmaning att bibehålla lättantändligheten och den upptändande förmågan utan att använda blyföreningar. En möjlighet kan vara att ersätta en blyhållande sats med flera olika satser. Till exempel kan man försöka bibehålla lättantändligheten med en tändsats och den upptändande förmågan med en anfyringssats.

Inom fördröjningssatser så kan vi komma att se ett ökat fokus på de intermetalliska reaktionerna. De har många önskade egenskaper, men vanligtvis är det en utmaning att starta dessa reaktioner, då man måste komma upp i den ofta höga aktiveringsenergi som krävs för att legeringsreaktionen ska starta.

Många utmaningar finns, men med det så följer även ett väldigt spännande utvecklingsarbete.

REACH with its list of candidates, a list of chemical substances that may be prohibited.

This is a challenge; lead compounds, for example, has many desirable properties for ignition compositions, and hexavalent chromium can be used for getting very good low gas-emitting delay compositions. In some cases one can downright replace a composition with several of today's environmentally friendly compositions, while in other cases one composition has to be replaced with several new ones, and possibly also make minor mechanical changes in the design to get the same characteristics of the product.

For ignition, it becomes a challenge to maintain ease of taking fire and ability to ignite other substances without using lead compounds. One possibility may be to replace a lead-containing composition with several different compositions. For example, one can try to maintain ease of taking fire with a composition containing a primary explosive and the igniting ability with an ignition composition.

As for delay compositions, we can see an increased interest in intermetallic reactions. They have many desired properties, but usually it is a challenge to start these reactions because of the often high activation energy required for the alloying reaction to start.

There are many challenges, but it also comes with a very exciting development work.

Andreas Norberg is a young man of great ability in the field of pyrotechnics. He appreciates very much the privilege to work in the field of his greatest passion. He is employed by SAAB Dynamics' development unit for explosives technology at Kulltorp, Karlskoga.

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Franklin Applied Physics

Our Section enjoys a pleasant and fruitful co-operation with this institute ever since the secretary attended one of the institute's pyrotechnic courses in 1972. Exchange of information is currently brought about by newsletter exchange, but has also involved our conference proceedings.

As from 2018, the Institute discontinuous – after 50 years – its "Newsletter of explosives, pyrotechnics and their devices". However, "*Franklin Applied Physics, Inc. is not closing its doors at this time. We will continue to teach our safety courses, perform testing on EEDs and related items, investigate incidents and accidents, and all the other things we have been doing for many years*". In the future, reports and information will be posted on the website www.FranklinPhysics.com from time to time.

Testing of Electro-Explosive Devices, EEDs, has been extensive at the institute. In the November 2017 Newsletter (No. 11, Vol. 50), for example, users of electric detonators – *who are rightly nervous near powerful radio transmitters* – are informed that the institute's investigation showed "*that only 37 millivolt could possibly be induced into our detonator. That is certainly not enough to fire it*".

Fredsteknik/Peace Technology

Editor: Hans Wallin

1. UN SaferGuard. Securing ammunition, protecting lives

The United Nations General assembly have recognized two dangers associated with unsecure ammunition stockpiles:

1. Diversion

Unsecured or poorly-monitored national ammunition stockpiles also lead to massive diversion into illicit markets. Diverted conventional ammunition is increasingly used to assemble improvised explosive devices (IEDs).

2. Explosions

In over 60 countries during the last decade, poorly-stored ammunition stockpiles have inadvertently exploded. Thousands of people have died, and the livelihoods of entire communities were disrupted.

Since 2009, The United Nations office of disarmament affairs, conventional arms branch, has been working to develop guidelines for storage and administration of military weapons and ammunition, called the *International Ammunition Technical Guidelines* or IATG.

The guiding principles of the IATG recognise that: all the United Nations Member States have the right to determine the size of their stock of ammunition and weapons that best suits the country's national defence and security purposes; and that each nation also has the right to design the laws and regulations applicable to the country.

Trade across national borders with weapons and ammunition is governed by the *Arms Trade Treaty*, ATT. It is also a commitment to store weapons and ammunition under conditions safe enough to prevent them from being stolen or otherwise diverted. Thus the ATT requirement for having auditable and transparent management and storage systems, and for maintaining a system of traceability throughout their lifetime.

It is also advisable to maintain technical data and technical specifications until the ammunition is destroyed. One should also consider archiving these details for a sensible period just in case there are complaints or further finds of the same type of explosive articles.

Finally, it is each nation's responsibility to demilitarize any excess of weapons and ammunition with environmentally acceptable and long-term sustainable methods.

2. CBRNE

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Vad är CBRNE? CBRNE är den internationella förkortningen för *Chemical, Biological,*

What is CBRNE? CBRNE is the international abbreviation for Chemical, Biological, Radio-

Radiological, Nuclear and Explosive substances och används vid beskrivning av verksamhet inom området skadliga kemikalier, allvarliga smittämnen, radioaktiva ämnen, nukleära ämnen och explosiva ämnen. Nedan följer en översiktlig beskrivning av de olika ämnesgrupperna:

C-ämnen är kemiska ämnen som kan orsaka skada på växter, djur och/eller människor och kan exempelvis vara toxiska industrikemikalier eller kemiska stridsmedel.

B-ämnen avser de mikroorganismer, cellkulturer, toxiner och parasiter som kan orsaka infektion, allergi eller förgiftning hos människor, djur eller växter. En egenskap som skiljer B-ämnen från övriga CBRNE-ämnen är att de kan vara smittsamma.

R&N-ämnen består av radiologiska och nukleära ämnen. Dessa kan orsaka strålskador och är i många fall även starkt giftiga. Beroende på halveringstid kan strålning finnas kvar under lång tid efter utsläpp eller spridning.

E-ämnen är explosiva ämnen och explosiva blandningar. De kan förorsaka direkt skada genom tryckvåg, splitter och/eller värmestrålning, men de kan också användas för att sprida farliga ämnen, exempelvis genom så kallade smutsiga bomber där t. ex. **E**-ämnen och **R**-ämnen kombineras.

Varför behövs ett arbete inom CBRNE-området? Gemensamt för CBRNE-ämnen är att de kan orsaka skador på människor, djur, växter, egendom och miljö. Ämnenas egenskaper skiljer sig åt, liksom på vilket sätt de kan orsaka skada. I kombination med att händelser med dessa ämnen kan uppstå av en mängd orsaker och att effekterna kan få stora efterverkningar under lång tid, blir den potentiella hot- och riskbilden inom området mycket bred.

Nedan följer en beskrivning av tänkbara CBRNE-händelser.

C-händelser: Skadliga kemikalier utgör en fara oavsett om de härrör från:

• en olycka vid transport, lagring eller tillverkning av kemikalier;

• avsiktlig spridning genom terrorism eller annan kriminalitet;

• insats med kemiska stridsmedel.

B-händelser: Sjukdomsframkallande mikro-

Logical, Nuclear and Explosive Substances, and is used for describing activities in the field of harmful chemicals, serious contaminants, radioactive substances, nuclear substances and explosives. Below is a brief description of the different subject groups:

C substances are chemical substances that can cause damage to plants, animals and/or humans and may, for example, be toxic industrial chemicals or chemical munition.

B substances refer to the microorganisms, cell cultures, toxins and parasites that can cause infection, allergy or poisoning in humans, animals or plants. A trait that separates the Binder from other CBR subjects is that they can be contagious.

R&N substances consist of radiological and nuclear substances. These can cause radiation damage and, in many cases, are also highly toxic. Depending on the half life, radiation may remain for a long time after release or spread.

E-substances are explosives and explosive mixtures. They can cause direct damage through pressure wave, splitter and/or thermal radiation, but they can also be used to spread hazardous substances, for example through so-called dirty bombs where, for example, **E** and **R** are combined.

Why is a work in the CBRNE area needed? Common to CBRNE substances is that they can cause damage to humans, animals, plants, property and the environment. The properties of the substances differ, as well as the way in which they can cause damage. Combined with the fact that events with these substances can occur for a variety of reasons and that the effects can have major after-effects for a long time, the potential threat and risk image in the area becomes very wide.

Below is a description of possible CBRNE events.

C events: Harmful chemicals pose a danger, regardless of whether they originate from:

• an accident in the transport, storage or manufacture of chemicals;

• deliberate dissemination through terrorism or other crime;

• action with chemical combatants.

B events: Disease-causing microorganisms pose a danger, regardless of whether they ori-

organismer utgör en fara oavsett om de härrör från:
• naturlig spridning;
• olycka som förorsakar spridning;
• avsiktlig spridning genom terrorism eller annan kriminalitet;
• insats med biologiska stridsmedel.
R&N-händelser: Joniserande strålning utgör en fara oavsett om strålningen härrör från:
• en olycka vid kärnteknisk anläggning, andra olyckor med radioaktiva ämnen eller joniserande strålning;
• avsiktlig spridning genom terrorism eller annan kriminalitet;
• insats med kärnvapen.
E-händelser: Tryckvåg, splitter, kaststycken och värmestrålning från en explosion utgör en fara oavsett om den härrör från:
• en olycka vid transport, lagring, tillverkning eller användning av explosiva ämnen,
• avsiktligt framkallande av explosion genom terrorism eller annan kriminalitet.

ginate from:
• natural spread;
• accident that causes spreading;
• deliberate dissemination through terrorism or other crime;
• efforts with biological munition.
R&N events: ionizing radiation poses a danger irrespective of whether the radiation originates from:
• an accident at a nuclear facility, other accidents involving radioactive substances or ionizing radiation;
• deliberate dissemination through terrorism or other crime;
• Nuclear weapons intervention.
E events: Pressure waves, splits, throws and heat radiation from an explosion pose a danger, regardless of whether it originates from:
• an accident in the transport, storage, manufacture or use of explosives,
• Intentional development of explosion through terrorism or other crime.

3. Shelf life and Stabilizers, a Safety Issue that Must Be Controlled

Torbjörn Lindblom, PhD

Many terrible accidents have occurred when stored ammunition for “no reason” start burning ending in an explosion. This is due to a poor understanding of the reactions taking place in a propellant. Since propellants based on nitrocellulose (a nitrate ester) undergoes a hydrolysis where NO_2 is liberated forming an acid with water present. In this acid environment the hydrolysis proceeds with an ever-increasing speed enhanced by the heat produced during the reaction. In the end this leads to an autocatalytic reaction.

To diminish this decomposition of the propellant, a stabiliser is added to take care of the liberated NO_2.

Shouldn’t have happened!

To find out if a propellant can still be used, different safe life tests have been developed. Many are simple heat tests, where the time to red fuming at different temperatures is measured. If the temperature chosen is too high (*e.g.*, 90 °C) it is difficult to extrapolate down to normal storage temperatures.

Modern surveillance test methods include, *e.g.*, liquid chromatography (HPLC), micro calorimetry (MC), gel permeation chromatography (GPC), FTIR with chemometry. In HPLC, the amount of remaining stabilizer and its derivatives (also acting as stabilizer) is measured.

In MC the heat evolution at 3 different temperatures is measured. Since this method is very sensitive, temperatures close to storage temperatures can be used. From the heat evolved a plot of Heat = f(1/T) is made from which the activation energy (E_a) can be calculated (Arrhenius equation). E_a is a good measure of the temperature dependence of the decomposition. With FTIR, combined with chemometry, the amount of stabilizer can also be measured. With this method the decrease of nitrate groups in the propellant might be followed – a measure of energy content.

Many of these methods have been discussed at the stability conferences arranged by Sektionen för Detonik och Förbränning (*The Swedish Section for Detonics and Combustion*).

A summary of results can be found, *e.g.*, in my thesis: *Reactions in the system Nitro-cellulose/Diphenylamine with special reference to the formation of a stabilizing product bonded to nitrocellulose*. http://publications.uu.se/abstract.xsql?dbid=3989

Chemical Mathematics. No. 23.

The Black-Powder Process. A Thoughtful Study.

The chemical transformation of black powder in action is a very complicated process. How far will strict reaction-formula writing take us?

As reported in Ref. 1, p. 165, the French Chemists Gay-Lussac (1778-1850) and Chevreuil (1786-1888) burned 1 g black powder of the following composition:

KNO_3:	789.9 mg
S:	98.4 mg
C:	76. 9 mg
Charcoal, H:	4.1 mg
O:	30.7 mg
Total:	1.0000 g

The composition does not, of course, contain elemental C, H and O (here we have one of not so few textbook examples of "one does not understand what is meant, unless one knows it beforehand"[1]). What one needs to know beforehand is that the composition of charcoal is $C_xH_yO_z$. But why give the atomic composition instead of the molecular formula? So, what we now have to do is to find x, y and z:

$$n_C = \frac{0.0769}{12.011} = 0.0064 \text{ mol}; \quad n_H = \frac{0.0041}{1.0080} = 0.00407 \text{ mol}; \quad n_O = \frac{0.0307}{15.9994} = 0.00192 \text{ mol}.$$

Dividing through by 0.00192, we get x = 3.33, y = 2.12, z = 1 and thus $C_{3.3}H_{2.1}O$. Multiplying by 3 gives x = 10, y = 6.36 and z = 3. Doing it again gives x = 30, y = 19.08 and z = 9. Thus, $C_{30}H_{19}O_9$ seems to be a reasonable molecular formula of charcoal in this black-powder composition. The initial state of the burning process is then:

S_0: KNO_3(c), S(o-rh?), $C_{30}H_{19}O_9$(s), air(?).

The burning (deflagration) process occurred in open air at atmospheric pressure and resulted in the following products/residues (volume of H_2(g) obviously misprinted as 2.34 ml):

K_2SO_4	422 mg	
K_2CO_3	126 mg	
$K_2S_2O_3$	32 mg	
K_2S	21 mg	
KSCN	3 mg	
KNO_3	37 mg	
C(hex?)	7 mg	Graphite or amorphous carbon? Surely not diamond.
S	1 mg	

$(NH_4)_2CO_3 + NH_4HNO_3$ 28 mg

N_2(g) 99.0 mg, 79.40 ml (0.7) The T/°C values within ( ) are calculated with the

[1] The obscurity might have been done away with by the writing mode (still a bit strange, though): Charcoal:
C 76,9 mg
H 4.1 mg
O 30.7 mg

CO_2(g) 201.0 mg 101.71 ml (-1.7) ideal-gas equation. The expected value is 25 °C, *i.e.*,
CO(g) 9.0 mg, 7.49 ml (10.9) "room T". Why this spread and variation?
H_2(g) 2.0 mg, 23.4 ml (14.3) Note the presence of nitrogen, hydrogen and oxygen!
O_2(g) 1.8 mg, 1.16 ml (-21.8) Here is another obscurity; "burning at atmospheric pressure
H_2S(g) 1.4 mg, 1.00 ml (23.5) implies an open system and that O_2 is a reactant and, then,
Total 193.10 ml not a product emanating from nitrate and/or charcoal.

Further information given in Ref. 1 is: Flame T in free air: 2993 °C; T in a closed system: 3340 °C and heat of "explosion": 619.5 cal g^{-1}. "Explosion"? Where are we now? The actual process is a deflagration, *if* it does occur in an open system, not a detonation in a closed system. More likely than not, these processes ought to occur in different ways giving different products. If so, "heat of deflagration" ought to be different from "heat of detonation".

If the information given in Ref. 1 is correctly understood, the process under scrutiny seems to be (note the stringency difference between "process" and "reaction"!):

$\mathbf{S_0}$(1 atm, 25 °C): KNO_3(c), S(o-rh?), $C_{30}H_{19}O_9$(s), O_2(g)(?) → $\mathbf{S_\infty}$(1 atm, 25 °C): K_2SO_4(s), K_2CO_3(s), $K_2S_2O_3$, K_2S(s), KSCN(s), KNO_3(s), C(hex?), S(s), $(NH_4)_2CO_3$(s), NH_4HNO_3(s), N_2(g)?, CO_2(g), CO(g), H_2(g), O_2(g)?, H_2S(g).

"*From these results, Kast has calculated the following equation*[2] *for the occurred reaction* (translation from Danish)*:*

$74KNO_3 + 30S\ 16C_6H_2O \rightarrow 56CO_2 + 14CO + 3CH_4 + 2H_2S + 4H_2 + 35N_2 + 19K_2CO_3 +$
$+ 7K_2SO_4 + 2K_2S + + 8K_2S_2O_3 + 2KSCN + (NH_4)_2CO_3 + C + S$". (No O_2 to the left of →!)

This is not a reaction formula, but a stoichiometric-looking account of reactants and products (Ref. 3, p. 3). As to products, C(s) might be graphite or C(am) (deflagration) or diamond, C(cub) (detonation in closed system); what is it? Sulphur is a reactant; if it appears in the final state, it must be a left-over from the process. Free oxygen does not appear in the Kast formula; rightly so. But what about N_2? How can one tell what comes from the air and what comes from the nitrate? Moreover, C_6H_2O does not agree too well with the "analytical" $C_{30}H_{19}O_9$ (miscalculation from the same data above?). Another observation is that the expected, stable product of H_2O is absent.

Regarded as a true reaction formula, it is in striking conflict with the Grand Rule (Ref. 3, p. 7). Obviously, the process is a poly-reaction; let us see if we can sort it out.

Leaving out the air component N_2, we have 3 reactants and 11 identified products; O_2 appears in the list of products but does not appear in Kast's "equation".

Starting with atom balances, we notice that S is reduced to -2 and oxidised to +6 and +2. Etc. Listing the products in order of amount found (*cf.* list above), we get:

S: S(0) → $K_2S(6)O_4$, $H_2S(-2)$, $K_2S(2)_2O_3$, $K_2S(-2)$, KSCN[3]

K: KNO_3 → K_2SO_4, K_2CO_3, $K_2S_2O_3$, K_2S, KSCN

N: $KN(5)O_3$ → $(N(5)H_4)_2CO_3$, KSCN

C: C_6H_2O → $C(4)O_2$, $K_2C(4)O_3$, C(2)O, KSCN

H: C_6H_2O → $(NH_4)_2CO_3$, H_2S (valence +1 throughout; note that the concept does not apply to charcoal – presumably it does not take part in ordinary redox reactions).

Using the *donac* method (Ref. 2, p. 5) and O as the principal bartering item, we find that nitrate is the O donor, *i.e.*, the oxidizer:

[2] Should be pronounced "chemical reaction formula".

[3] The thiocyanate ion has a so called Lewis structure, most likely S(0)=C(0)=N(-1).

$KNO_3 \rightarrow K + N + 3\,O$.

The major product is potassium sulphate:

$\underline{2\,K + S + 4\,O \rightarrow K_2SO_4}$

$2\,KNO_3 + S \rightarrow K_2SO_4 + 2\,N + 2\,O$.

The nitrogen and oxygen atoms may, indeed, form N_2 and O_2 (the presence as products may make sense in an air-free system). Expected were rather NO, but nitrogen oxide was not found. The "next" product is potassium carbonate:

$KNO_3 \rightarrow K + N + 3\,O$

$2\,K + C + 3\,O \rightarrow K_2CO_3$

$\underline{C_6H_2O \rightarrow 6\,C + 2\,H + O}$

$2\,KNO_3 + 1/6\,C_6H_2O \rightarrow K_2CO_3 + 2\,N + 20/6\,O + 2/6\,H$. N_2, O_2 and H_2 or the "absent" N_2O_3 and H_2O?

Further:

$KNO_3 \rightarrow K + N + 3\,O$

$\underline{2\,K + 2\,S + 3\,O \rightarrow K_2S_2O_3}$

$2\,KNO_3 + 2\,S \rightarrow K_2S_2O_3 + 2\,N + 3\,O$ (again, N_2, O_2 or N_2O_3?)

$KNO_3 \rightarrow K + N + 3\,O$

$\underline{2\,K + S \rightarrow K_2S}$

$2\,KNO_3 + S \rightarrow K_2S + 2\,N + 3\,O$.

Carbon, C, must come from charcoal:

$C_6H_2O \rightarrow 6\,C + H_2O$ maybe.

Finally:

$KNO_3 \rightarrow K + N + 3\,O$

$K + C + S + N \rightarrow KSCN$

$\underline{C_6H_2O \rightarrow 6\,C + 2\,H + O}$

$KNO_3 + 1/6\,C_6H_2O \rightarrow KSCN + 1/3\,H + 19/6\,O$ ($1/6\,H_2$ and $19/12\,O_2$?).

So far, this *qualitative* account of the process appears possible – but not a *quantitative* one[4]. The amount of, *e.g.*, hydrogen (2 mg) is much less than the stoichiometric one expected from the reaction formulas above. Thus, it seems to be about time to give up! But perhaps this "Shakespearean" (*Much Ado about Nothing*) exercise taught us and made us realise that black powder – and pyrotechnic compositions in general – is a chaotic system in which the product distribution is rather unpredictable. Naturally so, because such systems are mechanical mixtures in which "who is neighbour of whom" varies, and so do grain size and quality of the commercial ingredients – all factors that influence the solid reactions at play. As a consequence *the* stoichiometric composition does not exist. Hopefully, the power of the *donac* method of chemical reaction formula writing was satisfactorily demonstrated and – above all – that a particular product distribution should not be presented in the misleading form of stoichiometric "equations", *i.e.*, fake reaction formulas.

It may also be worthwhile to realise that, depending on the application, a black-powder process may be in form of deflagration (quick-match, propellant, open air burning) or of detonation (rock blasting) and that the product distribution ought to differ. So, what is really meant by "heat of explosion", for example (*cf.* Ref. 2, p. 211)?

[4] For an alternative, tentative poly-reaction process, *cf.* Ref. 2, p. 14.

References

1. L. Hoffmann Barfod & J. C. Balling Jensen: *Bogen om krudt. Fordums krudtværker i Norden og folkene bag dem*.
   Politikens Forlag, Copenhagen 1992.
2. S. R. Johansson: *Elementary Chemical Mathematics. Chemistry in a Broader Setting.*
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Sprängtekniska Museet/*Blasting Technical Museum* Zakrisdal, Karlstad

Nils Örnemark

Sprängtekniska Museet Zakrisdal värnar om att bevara kunskapen om ammunition och äldre produkter främst inriktat på tillverkning av primärsprängämne, tändhattar, sprängkapslar och tändrör samt övriga explosiva produkter som tillverkats av företaget från 1942 fram till 1992. Genom att dåvarande ägaren, efter nedläggningen av fabriksområdet 1994, välvilligt ställde lokaler och resurser till förfogande för ett museum, så kunde invigningen av museet ske den 31 januari 1997. Museet firade 20-årsjubileum den 31 januari 2017. Endast ett liknade museum finns i Sverige och det är Alfred Nobels Laboratorium i Karlskoga. Detta museum visar en tidigare epok av försvarsmaterieltillverkning.

Bakgrund

Initiativtagaren till museet var Rolf Öström, som var med vid flytten från Marieberg. Han uttryckte, att resterna av verksamheten vid Zakrisdals-fabriken inte skulle få fötter och skingras för vinden, såsom skedde vid Mariebergs-fabrikens nedläggning i Stockholm.

Museet har till största delen byggts upp med ideellt arbete. Ammunitionsfabriken Zakrisdal byggdes under 2:a världskriget 1940 och fram till 1950. Den tidigare i Stockholm befintliga Ammunitionsfabriken Marieberg, som börjat sin verksamhet 1826, ansågs av flera skäl behöva ersättas med en ny fabrik, där Karlstad valdes som lämplig ort. Ammunitionsfabriken Zakrisdal hade under 2:a världskriget del i uppbyggnaden av vårt försvar och hade därefter stora framgångar med export av främst ammunition till vapensystemet 8,4 cm granatgevär Carl Gustaf. Sedan det kalla kriget upphört hade efterfrågan på försvarsmateriel sjunkit så mycket att en nedskärning och sammanslagning av den svenska försvarsindustrin ansågs nödvändig. Vid Zakrisdals-verken avslutades den sprängtekniska verksamheten då den överflyttades till Karlskoga 1992-1994. Idag ägs c:a 60 hektar av det inhägnade området av företaget Zakrisdal Fastigheter av Bröderna Wingefors AB. De nuvarande ägarna har stort intresse för svensk industrihistoria och är mycket måna om museets fortsatta existens. Det är detta industriområdets historia som museet har försökt att bevara i sina utställningar.

Museet

Museet bedrivs helt ideellt av pensionerade före detta anställda och visar bevarad kunskap om:

- delar av den produktionsutrustning som använts vid Zakrisdals-verkens tillverkning av sprängkapslar och tändhattar;
- delar av produktionssortimentet såsom tändrör, patronhylsor, ammunition, m.m.;
- fotografier, kartor, tavlor, facklitteratur, m.m., från 1800-talet till nutid;
- verkskyddsmateriel, civilförsvarsmateriel;
- en del material, fotografier, m.m., från fabrikens driftvärn.

Museet har öppet torsdagar kl. 9.15-12.00 (stängt under semesterperioden, påsk, jul & nyårshelg). Frivillig entréavgift. Visning av museet kan ske för grupper med 8 - 12 personer.

Adress: Zakrisdalsslingan 5, 653 42 Karlstad. Kontakt: Nils Örnebring, Tel. 073 994 38 64, nils.ornebring@gmail.com. (Även Meddelande 1/2014, sid. 3-4.)

Conferences

2018

04-18--20 New Trends in Research of Energetic Materials (NITREM 2018).
Pardubice, Czeck Republic. www@ntrem.com.

04-20--22 The 10th Asia-Pacific Power and Energy Engineering Conference (APPEEC 2018).
Guilin, China. Jenny09157@163.com.

06-26--29 49th International Conference of the Fraunhofer ICT.
Karlsruhe, Germany. www.ict.fraunhofer.de.

07-08--13 43rd International Pyrotechnics Seminar.
Fort Collins, Colorado, USA. www.ipsusa-seminars.org.

07-14 Workshop on Pyrotechnic Combustion Mechanisms.
Fort Collins, Colorado, USA.

07-29--08-03 37th International Symposium on Combustion. .
Dublin, Ireland. Further details: CombustionSymposia.org.

10-21--25 First International Conference on Defence Technology.
Beijing, China.
China Ordnance Society, http://icdt.cos.org.cn; defence001@163.com.

Hans Wallin har blivit speciellt inbjuden av professor Feng och kommer att hålla ett föredrag betitlat "*Safe and Secure Storage, Transportation and Administration of Weapons and Ammunition. Stockpile Management and Physical Security*".
Ni som planerar att delta, tala med Hans!

Education and Training

Sverige

KCEM. För aktuella konferenser och kurser, se www.kcem.se.

FOI. Grundkurs i explosivämneskunskap. http://www.foi.se.

Del 2: 2018-04-09--12. FOI Grindsjön. Praktiska moment på skjutfält.

Anmälan senast 31 januari till sofia.sandstrom@foi.se.

Kursavgift SEK 44 000.

U. K.

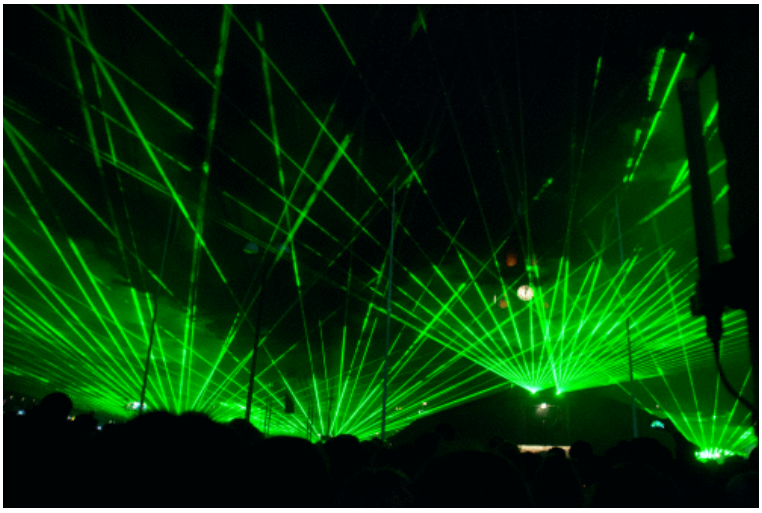
University of Leeds. www.leeds.ac.uk.

The Royal Military College of Science. www.rmcs.cranfield.ac.uk.

U. S. A.

Franklin Applied Physics. Visit info@franklinphysics.com.

International Society of Explosives Engineers. Visit https://www.isee.org/ for the society's newsletter *Explosives Industry News*.



Just another non-pyrotechniv firework

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