EFEE

NEWSLETTER

EFEE

12th WORLD CONFERENCE ON EXPLOSIVES AND BLASTING

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IMQS

September 2022 edition

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We in EFEE hope you will enjoy the present EFEE-Newsletter. The next edition will be published in November 2022. Please feel free to contact the EFEE secretariat or write to newsletter@efee.eu in case:

- You have a story you want to bring in the Newsletter
- You have a future event for the next EFEE Newsletter upcoming events list
- You want to advertise in an upcoming Newsletter edition

or any other matter.

Mathias Jern, Chairman of the Newsletter Committee and the Vice President of EFEE and Teele Tuuna, Editor of EFEE Newsletter - newsletter@efee.eu

Dear esteemed members of EFEE, friends and colleagues

It has only been a few months since we gathered for a very successful and enjoyable 11th EFEE World Conference in the Netherlands - Maastricht.

I was incredibly happy to see so many of you in attendance and I must say that the NVEE- the Dutch Society of Explosive Experts did a great job making us all feel extremely welcome.

Everyone agreed that the conference was very interesting, informative and engaging, with lots of opportunities to connect and network.

As the newly elected President I would like to start with saying a big 'Thank You' to our previous President; Doru Anghelache, for leading our organisation through an unprecedented period of change over the last two years.
Doru really rose to the challenge and brought our organisation online, introducing virtual meetings, communication platforms and newsletters, all to keep our organisation connected and working. This was not an easy task.

Thank you to the EFEE council and board for supporting my election as President and for placing your trust in me. I promise I will do my best to lead EFEE into the future, develop our organisation and increase our cooperation with industry.

Congratulations to Mr Mathias Jern, Doctor of Technology for being elected to Vice President and also the Chairman of the Newsletter Committee.

Now to this year - 2022, for me it was a hectic spring.

However, being newly elected as President of EFEE made up for the turmoil. I am, as always, honoured to be part of this wonderful long standing community of explosive & mining experts.

Spring was then followed by a complicated summer. I know it has been the same for many of you, with costs changing overnight, problems with logistics and a constant worry over the situation in world politics. Let's not even talk about the weather.

Even with everything going on, we at EFEE are still standing strong, we know we have a lot of work to do, and we are approaching it with a positive mindset.

As this is my first foreword, I would like to introduce myself for those who don't know me yet – I am a mother of 3, I take part in the governance of our local parish, I love to sing in our local choir, and I am an owner and a manager of a medium sized drilling-blasting company in Estonia- Voglers Eesti OÜ.

Besides providing the drilling-blasting services in Estonia since 1996, we also have had many international experiences working in Brazil, Norway, Sweden, and Australia, and now since 2018 managing a long contract in Lithuania. I love my work and I take great interest in this industry. In EFEE I represent the Estonian Association of Mining Enterprises – EMTEL.

I have been part of EFEE since 2013, in 2014 I became a partner and coordinator of EFEE's shot-firer education project, which is now known as the Pan-European

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Competence Certificate for Shot-firers and blast designers – PECCS. Today as the President of EFEE , I welcome conversations relating to problems and worries from you, our members, so we can work towards providing the most needed assistance for explosives and blasting associations, companies and individuals in this industry.

In EFEE we work with legislation, environmental problems, education, and sharing best practices. We have two big projects ongoing right now with education and the environment, and we still have big plans for the future. We don't get paid to do this work, we do it because we care and it matters. I am hopeful that we will increase our membership going forward by introducing new training programs and technology platforms to engage similar companies within our industry.

Our next big event is already taking place in 2023, a year from now in September, it will be our 12th EFEE World Conference and I am very happy to say that it is going to be held in Dublin, Ireland. The preparations for this conference are taking place as we speak through various channels, and I must say, Irish Mining and Quarrying Society -IMQS have already contributed a lot. We are very excited and can't wait.

Before that I hope to meet you all in San Antonio, Texas for the ISEE Annual Conference. Hopefully by then we will have a more stable economy, and we can get back to normal prices and schedules. If not, at least we have a chance to share ideas and experiences about how to better tackle our common problems.

I am very grateful for the trust put in me and all the support by EFEE Members, Council and Board by electing me as the EFEE President. I will do my best for the next two years to continue the good work that our previous presidents have already completed. It will be 10 years in EFEE for me next year, and it has been such an insightful and interesting journey. I am sure, it can only get better.

Cheers to that!

Viive Tuuna
President of EFEE

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Testing constructive variants for arranging a mobile explosives depot

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Abstract

The execution of the blasting works involves the management of the problem of storage of explosive materials. This aspect is easier to solve in the case of mines activities with long exploitation time and where storage capacities are arranged, according to the legislation that provides constructive and safety criteria depending on the type and quantity of explosive materials stored. In the case of isolated blasting works, those for road construction, building demolition, underwater or forestry, etc., storage facilities must be arranged for shorter periods of time and smaller capacity, but which must comply with security, environmental and risk requirements, such as high- capacity deposits with long duration of activity. Considering that for the execution of such blasting works, the national legislation provides the possibility of arranging temporary explosive depots, of small capacity, but without specifying the constructive details and the necessary safety requirements to be observed, mentioning only that they must be executed on the basis of a specialized project. This paper presents a series of tests conducted by INSEMEX, in order to establish recommendations regarding the constructive and safety requirements that must be observed when designing and building mobile explosive depots.

1 Introduction

The blasting techniques today experience a wide area of applicability, exceeding the field of the mining industry. Due to the diversity of the conditions in which they are executed, they often require a special organization regarding the transportation and storage of the explosive goods near the blasting field. Typical cases are the isolated blasting works, those for road construction, building demolition, underwater or forestry, where the storage facilities must be arranged for shorter periods of time and smaller capacity, but which must comply with security, environmental and risk requirements.

At EU level, the method of possession and storage of explosive materials is very well regulated, but there are also certain peculiarities, especially regarding the method of storage in the case of blasting works performed in the above-mentioned applications. In Romania, the manner of possession, use, transport and storage of explosive materials for civil use is regulated according to Law 126/1995 and the Technical Norms for the application of the law, including the completions and modifications appeared after the publication of these documents. If for explosive storage arranged for long- term use such as those of the producers or the basic ones, there are detailed regulations regarding the constructive and security requirements that they must meet, for the temporary storage facilities, there are not enough details regarding the constructive requirements that they must comply with.

Considering the specificity of the activities in the field of pyrotechnics, respectively for destruction of ammunition left unexploded during armed conflicts, there was a need to arrange temporary mobile depots to store explosive products in the immediate vicinity of the place where war ammunition is identified and destroyed. A specialized company was contracted in order to arrange ISO 1C type containers or similar as temporary explosive and war ammunition depots and INSEMEX was conducted the resistance tests of this type of depot against to an accidental detonation of the stored explosive products.

The article presents the tests performed by INSEMEX, of some constructive variants of explosive material storage pockets in order to identify the most adequate constructive solutions which, in case of an accidental detonation, should not lead to the initiation of the rest of the deposited explosives. Subsequently, these tested variants can become the basis for recommendations on how to design and build temporary explosives depots.

2 Methodology

2.1 Legislative requirements regarding the construction and arrangement of explosives depots

According to the destination, the period of use and location, the explosive deposits are classified as follows:

a) at the producer - from which the customer deposits are supplied;

b) basic - from which the supply of customer deposits is made;

c) for consumption - from which blasters are supplied;

d) complexes - in which one part is arranged as a basic depot, and the other, as a consumption depot;

e) permanent - which can be basic or for consumption, with a use time of more than 2 years;

f) temporary - which can only be for consumption depot, with a use time of up to one year;

g) at surface - consisting of one or more buildings or rooms arranged on the hillside;

h) underground - consisting of mining constructions for access, storage, handling and distribution, including installations, accessories and auxiliaries, necessary for servicing the depot;

i) mixed - consisting of surface buildings and underground chambers.

New or old buildings, chambers buried in a hillside or mobile depot can be used as temporary depots. When designing the depot, the studies and specialized documentation regarding the location are taken into account, as well as the minimum safety distances from the objectives in the vicinity. Mobile deposits can be assimilated with niche for storing explosive materials underground and at the surface. Thus, for activities carried out in quarries or blasting engineering works, the explosive materials can be stored in mobile metal or concrete niches, executed on the basis of a project approved by the territorial labor inspectorate within which the respective companies operate. The means of initiation and ignition are kept both underground and at the surface in specially arranged niches, located at a distance of at least 6 m from the niche intended for the storage of the explosives.

Explosive niches must be lined with timber or concreted and have steel sheet doors at least 3 mm thick, provided with locks. Niches for detonators must be lined at the bottom with felt or rubber mat.

2.2 Requirements regarding the arrangement of a mobile container type depot

One of the options for arranging a mobile depot is to use an ISO 1C type container so as to allow the storage of both explosive materials and initiation means.

According to the requirements, the pyrotechnic container must be dimensioned in order to be able to store 50 kg TNT equivalent and 1000 detonators, the dimensions of the container being 6058 x 2438 x 2 438 mm. The container is divided into two compartments, with two individual doors and armored inside with steel plates so as to ensure that it can withstand the accidental detonation of a load of 1.5 kg. TNT equivalent. The first compartment will have arranged on the wall opposite the access door, a number of 20 pockets for storing explosive and detonators, arranged in five pieces in four rows (Figure 1).

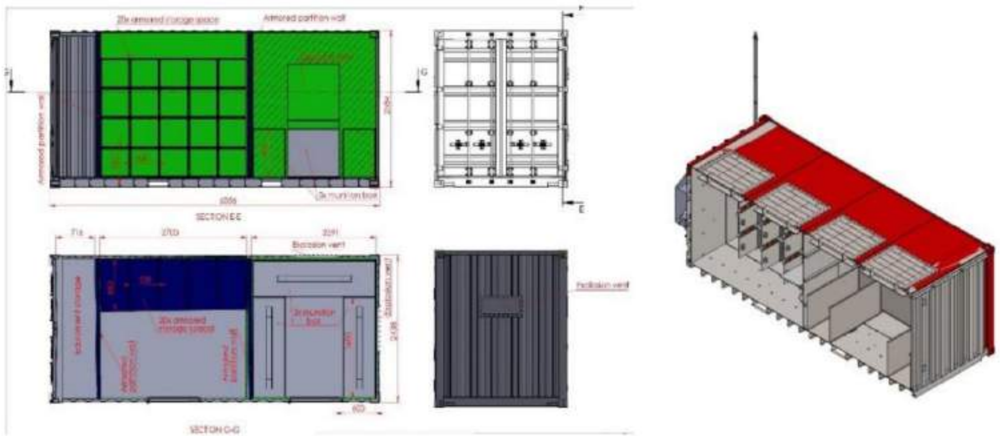


Fig.1. Modification of a container in a mobile explosives depot

The pockets will be provided with doors and will be arranged at a distance of 100 mm from each other. The storage capacity of the container compartment is 25 kg TNT equivalent, (explosive materials as well as detonators), distributed of 1.3 kg TNT equivalent per pocket.

The second container compartment will have a storage capacity of 25 kg TNT equivalent, and can be stored unexploded ammunition, for which purpose the compartment will be equipped with three boxes arranged along the length of the side walls inside, with a height of 0.8 m and a width of 0.6 m.

The two compartments, in the ceiling area, will be provided with pressure relief and for the realization of a natural ventilation system, the side walls will be provided with slots. Also, the floor of the container and the inside of the pocket boxes will be covered with anti-spark material (tego). The access doors will be provided with two locks in special construction, and the hinges will be of buried type.

The container will be provided with an alarm system against unauthorized intrusions, smoke detectors, lightning rod installation, perimeter lighting installation - LED type as well as with fastening elements for loading and unloading on a load runner.

2.3 Constructive variants for arranging the mobile container type depot

The mobile container type depot will be lined on the inside with armor steel type ARMOR S-500 of 6.5 mm thickness. For the arrangement of the 20 pockets for storing the explosive materials, several constructive variants were designed and tested, aiming at minimizing the effects of an accidental detonation of the explosive materials on them.

It is mentioned that the most important element in the construction of the mobile container depot is the storage pockets for explosive materials, because, depending on how they withstand the effects of an accidental detonation, depends the integrity of the container and security in its vicinity. For this reason, special attention was paid to the construction of the pockets, establishing 3 variants that were tested at the explosion, and depending on the observed effects, changes were made to contribute to increasing their resistance.

The arrangement of the pockets on the wall of the container compartment is shown in Figure 2.

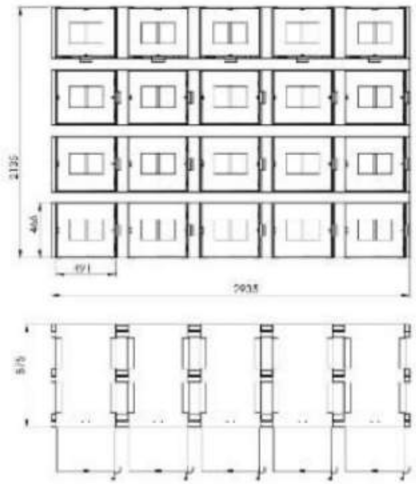
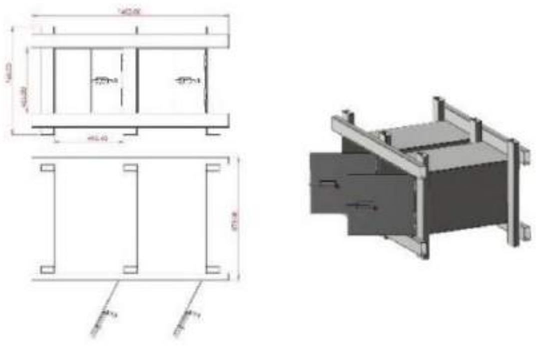


Fig. 2. The arrangement of the pockets on the wall of the container



One of the constructive solutions proposed for testing has a rectangular shape with a steel frame made of rectangular profiles of 50x100x4 mm made of S355 steel and the side closures made of ARMOR S-500 steel 6.5 mm thick (Figure 3, a).

Fig. 3. a)

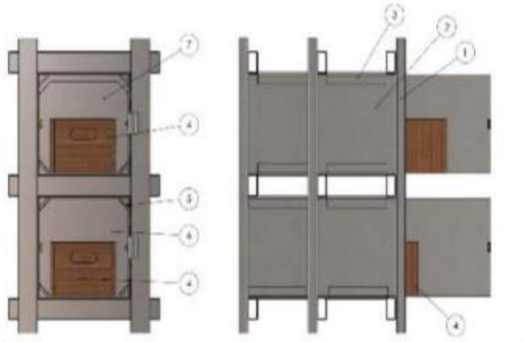


Fig. 3. b) Storage pocket with rectangular frame

Following the tests performed with this constructive variant, it was proposed to stiffen the body of the pocket box by welding on its outer edges some corner reinforcements. Also, in order to avoid the direct contact of the explosive materials with the floor and the walls of the pocket box, a storage box was made with three compartments made of tego type material, inserted in each pocket. (Figure 3 b).

Another constructive variant was the introduction of a steel tube inside the pocket, with the role of reducing the destructive effects of an accidental denotation on the body of the pocket and implicitly on the storage container. This alternative is shown in Figure 4.

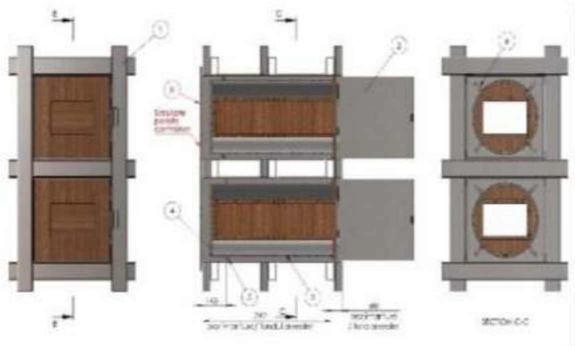


Fig. 4. Storage pocket with rectangular frame and steel tube placed inside

3 Results and discussions

3.1 Computer simulation of an explosion inside an ISO 1C container

In order to estimate the effects produced by the accidental detonation of an explosive charge, a computer simulation was performed by detonating a high-power explosive charge, placed inside an ISO 1C type container.

To solve the event scenario, a specialized software application - IMESAFR v2 Bundle was used, which allows a probabilistic assessment of the risk situations generated by the detonation of explosive charges of different types, based on graphic-analytical quantification results of specific associated hazards. in order to determine the level of safety or the corresponding degree of insecurity.

Following the simulation of the detonation inside the container, of a suspended explosive charge of 1.5 kg. TNT equivalent, as shown in Figure 5, results in a shock wave with values of 6.2 kPa (0.062 kg / cm2) over a radius of 18.0 m (minor injury area), 15.9 kPa (0.159 kg / cm2) over a radius of 8.0 m (fatality area).

Considering that the simulation was done on an ISO 1 C container, it can be stated that following its interior arrangement with armor material with a thickness of at least 6.5 mm and the arrangement of the container with pressure relief, the estimated values of the above pressures presented are reduced to non-hazardous values (approximately 0.03 - 0.07 kg / cm2).

According to Annex no. 3b): The degree of damage caused by the overpressure in the shock wave front on the various external objectives, in the Norms for the application of Law 126 /1995, these values of the overpressure in the shock wave front of 0.03 - 0.07 kg / cm 2are not lethal, generating insignificant damages on the constructions - partial or total breakage of the windows.

3.2 Test of explosive storage pockets

Until a constructive variant was established that corresponded from the point of view of the resistance requirements to the action of the explosions, the pockets were subjected to a series of tests by detonating explosive charges inside them, monitoring the effects produced by the explosion.

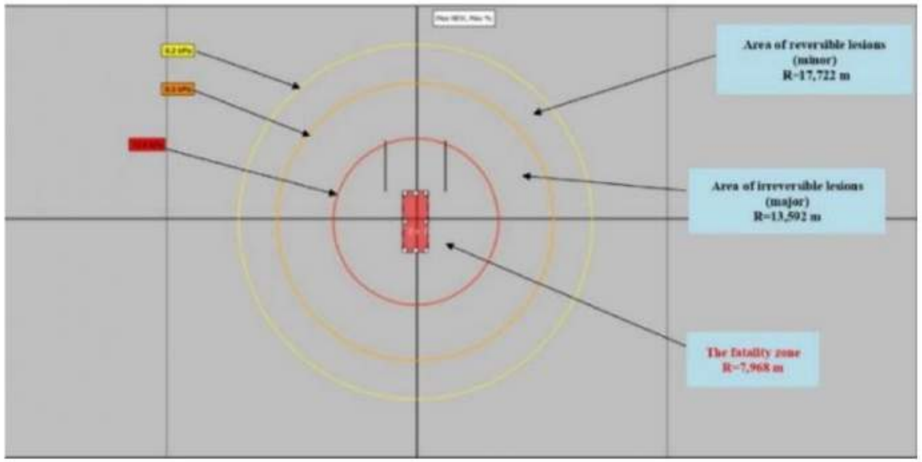


Fig. 5. Effects generated when a 1.5 kg. TNT equivalent load detonates inside the container

The tests were carried out under the coordination of the specialized personnel within INSEMEX, both in the explosive field of the institution and in a field of IGSU.

3.2.1 Tests performed in the INSEMEX testing facility – first phase

In the INSEMEX Explosives Polygon was tested a set of 2 rectangular pockets (Figures 3 and 6 a). These were positioned on the access hall inside a reinforced concrete structure, and in each pocket was introduced a quantity of 1.3 kg of TNT explosive (Figure 6 c), the load from the pocket marked with 1 (Figure 6 b) being primed with an electric detonator and the one in the pocked marked with 2 not being primed, this having the role of a control sample, in order to see if it is influenced by the detonation of the load from the adjacent box.

a)

b)

c)

Fig. 6. Testing the pocket boxes at the INSEMEX polygon

Following the test, it was found that the pocket box in which the detonation occurred was almost completely destroyed, its ceiling and door being projected at 100 - 200 m distance from the reinforced concrete structure. (Figure 7).

<- Fig. 7. The results of the pocket boxes testing at the INSEMEX polygon

Also, the side wall of the second pocket box was deformed and moved inwards, the door being projected outside the reinforced concrete structure and the control explosive was sprayed, not detonated.

These results highlighted the need to rigidify the areas between the pockets by adding an additional element in the support frame of the box, strengthening the welding line, strengthening the inner corners of the pocket by adding deflectors at 45° and the outer edges of the pocket by welding steel corner type elements (Figure 8 a).

Also, the padding of the pocket with wood / tego material was considered, as well as the introduction of a box made of the same material to keep the explosives at a distance of at least 100 mm from the walls of the pocket (Figure 8 a).

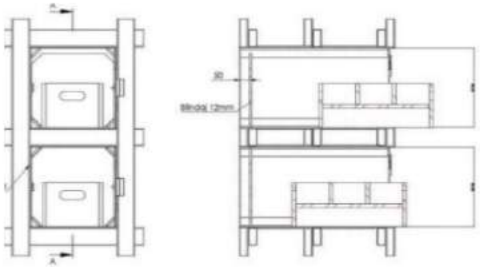
3.2.2. Tests performed in the INSEMEX testing facility – second phase

Considering the effects found during the first test regarding the dynamic phenomena and the design of the metallic elements of the pocket under the effect of the explosion, the decision was made to choose a testing area that would have a much larger surface and provide additional safety if these effects would be repeated.

The tests were performed on two assemblies of two pockets arranged according to the proposed modifications following the first test.

In Figure 9 a) and b) is presented the first variant of the pocket with the lifts carried out both inside and outside it as well as the box of tego material that is inserted inside the pockets and in which the explosive materials will be placed.

The test was done by inserting in the two pockets two loads of 1.3 kg TNT explosive (Figure 10 a), the load at the top pocket being primed with an electric detonator cap and the second load was used as a control sample, being inserted in the lower pocket (Figure 10 b).



a) b)

Fig. 8. Constructive modifications proposed following the explosives test

a)

b)

Fig. 9. Testing the variant of the alveolus strengthened inside and outside

a)

b)

Fig. 10. Set up of the explosive charge

Following the detonation of the explosive charge, the dynamic and throw effects of metal fragments under the detonation pressure were much lower compared to the effects observed in the first test, the only projected element being the pocket door in which the explosion occurred (Figure 11). The walls of the pocket were deformed and broken, they also yielded on the welding line and the dynamic effect also deformed the walls of the neighboring pocket. The control explosive charge, located in the second cell, was not initiated.

In the second stage, the testing was done with the pockets variant in which a steel pipe was inserted and the facade and the inside walls of the pocket were lined with tego type material (Figure 12 a). Explosive charges of 1.3 kg TNT explosive each were introduced into the two pockets similarly to the previous test (Figure 12 b).

Fig.11. The results of testing the strengthened pocket variant

a)

Fig.12. Testing the pocket variant with the inserted pipe

b)

Following the detonation of the explosive charge, the only throw effect was that of the apocket door in which the detonation occurred, and the dynamic effects were reduced, limiting to the lateral rupture of the steel pipe and deformation in the same area of the neighboring pocket wall. (Figure 13 a).

The neighboring pocket did not show any deformation inside it, and the control explosive charge remained unblasted. (Figure 13 b).

5 Conclusions

One of the most important aspects taken into account when designing and arranging a mobile explosive depot is the limitation to the maximum of the dynamic action and the throw effect of pieces of material under the pression of an accidental detonation. Tests performed on several constructive variants of pockets have proved that the solution of inserting a steel tube in the pocket with a rectangular frame gives a good enough resistance to limit the effects of an explosion

The tests will continue by trying a variant of steel tube inserted in a tubular cell (Figure 14 a) following that after they will be mounted in the container, to make a series of tests by detonating explosive charges inserted in the cells as well as freely suspended inside the container. On this occasion, both the values of the pressures produced by the explosion and the possible effects on the construction of the container will be monitored.

The use of these pockets/cells can be a viable solution in order to arrange a mobile depot, they can be joined like cells (Figure 14 b) and form an assembly that can be fixed inside a container or a concrete construction.

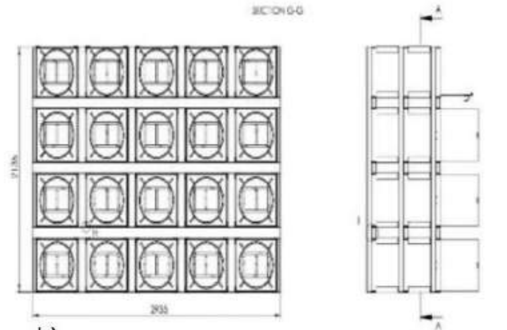
a)

b)

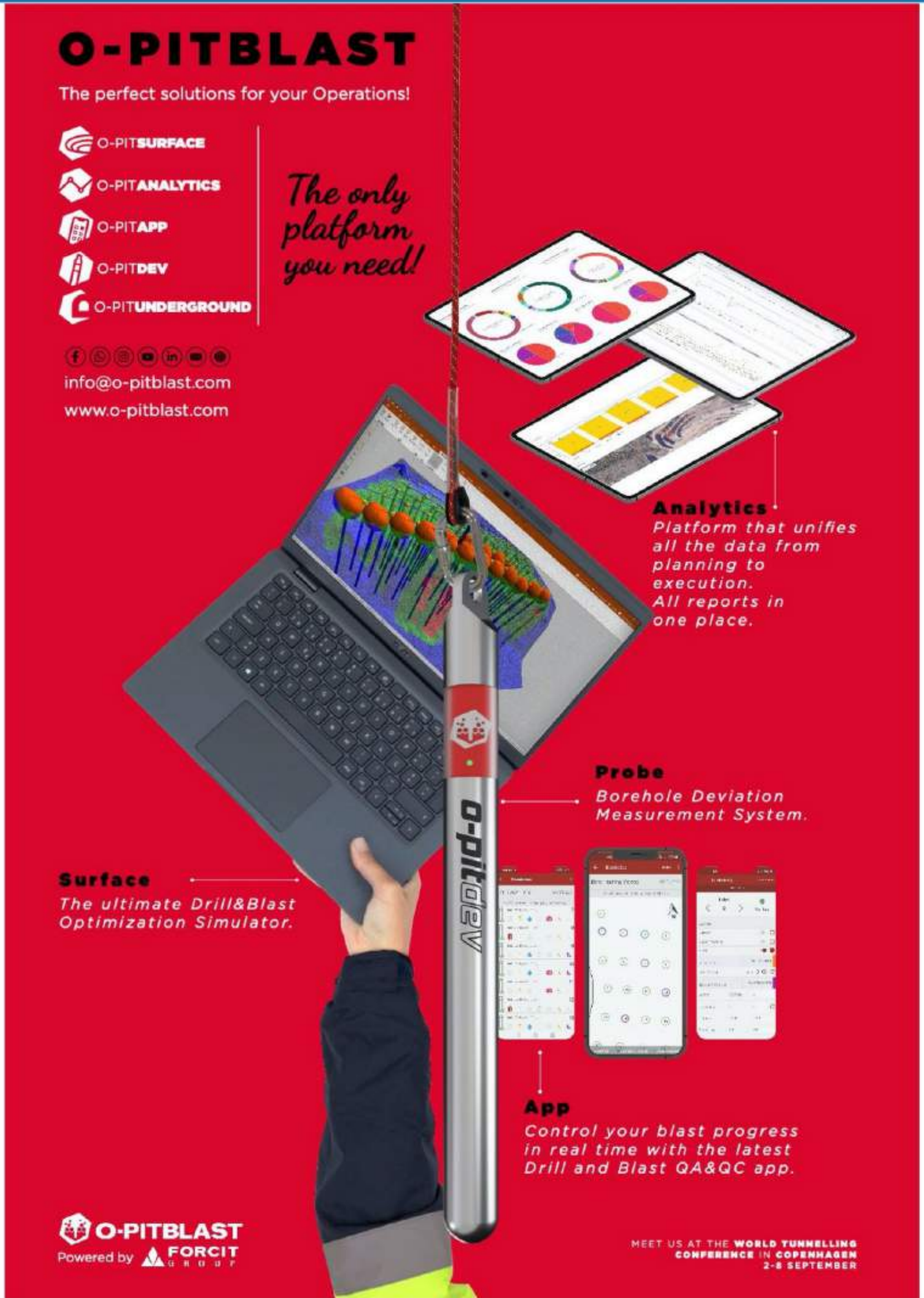
Fig. 13. The results of testing the pocket variant with the inserted pipe

a)

Fig. 14. Tubular cell with a steel tube placed inside



b)



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Improved sensitising agent = improved performance of bulk emulsion explosives?

Bartlomiej Kramarczyk, Mateusz Pytlik, Piotr Mertuszka, Katarzyna Jaszcz and Tomasz Jarosz

March 2022

1. Introduction

Emulsion explosives (EEs), despite being one of the youngest classes of blasting agents, have found wide application around the world. EEs are typically produced as cartridged charges and as bulk explosive. While the former is a fairly standard product, the latter is typically shipped as two separate components - the EE matrix and the sensitising agent. The key selling point of bulk EEs is that neither the matrix nor the sensitising agent is a standalone explosive. Such a feature is beneficial in terms of safety, regardless of whether transportation, storage or handling is considered.

The trade-off, as there always needs to be one, is that in contrast to cartridged EEs, which come presensitised (e.g. via the addition of glass microspheres), the bulk EE is sensitised through a chemical reaction taking place when the EE matrix and sensitising agent are mixed together. When this reaction takes place, microscopic gas bubbles form all throughout the bulk EE, lowering the density of the EE and making it sensitive to initiation.

Although much is known about this chemical reaction, many factors (e.g. temperature) can affect how fast it is taking place and once the two components are mixed and injected into a blast hole, there are no longer any means of controlling that reaction. Since the reaction is constantly taking place, the properties (e.g. density) of the EE will also be gradually shifting.

This results in the issue of blast holes, which were loaded at different times and left to sit prior to the blasting operation, containing bulk EE exhibiting varying levels of performance. Such variation is an obvious issue that needs to be taken into account, lest the entire blasting operation go awry.

Another trade-off of bulk EEs compared to their cartridged counterparts is that of slightly lower power. This stems due to the rheology necessary and therefore there is more water in bulk EE.

2. What have we done?

The key drawback of bulk EEs stems from the chemical reaction taking place between the EE matrix and the sensitising agent. Although this reaction cannot be entirely stopped, it can be controlled to some extent via the modification of the EE matrix or the sensitising agent formulations. The EE matrix formulation is a complex system that needs to conform to multiple stringent requirements. First of all, it must be durable and resistant to changing external factors, such as temperature changes, pumping, transport, etc. The sensitising agent formulation, on the other hand, can be viewed as a glorified diluent, as it is composed primarily of water (approx. 95 % by weight) and sodium nitrite - the reagent responsible for the production of gas bubbles (approx. 5 % by weight).

Keeping the above in mind, we have attempted to fine-tune the sensitizing agent formulation, in order to make the reaction between the EE matrix and sensitising agent less vulnerable to external factors, such as temperature. If the fine- tuning of the sensitising agent formulation could simultaneously improve the performance of the bulk EEs, the two proverbial birds (drawbacks of bulk EEs) could be hit with a single research effort.

To this effect, we attempted reducing the sodium nitrite content of the sensitising agent formulation, so as to slow down the aforementioned reaction. Simultaneously, we have also replaced a portion of the water content (acting essentially as ballast) of the "standard sensitising agent formulation" with oxidising agents - ammonium nitrate and sodium perchlorate.

The relevant details of the composition of the EE matrix and tested EE formulations are given in Tab. 1.

3.The results

3.1. Evolution of EE density over time

The standard formula of bulk EE sensitizes slowly and is spread over time up to several hours, the density value changes, which causes differences in detonation parameters. The new formulas BK-1 and BK-2 learns much faster and stabilizes its parameters faster. Fully stabilized density is obtained up to 30 minutes, while the standard formula changed this parameter even up to 24 hours (Fig. 1).

EE Matrix	
Component	**Concentration (wt.%)**
Ammonium nitrate	**55-60**
Calcium nitrate	**15-20**
Organic phase	**5-7**
Water	**12-15**

Tested EE formulations		
Component	**Concentration (wt.%)**	
	BK-1	**BK-2**
Ammonium nitrate	30	47
Water	61.6	41
Sodium perchlorate	4	8
Sodium nitrite	3	3.3
pH modifier and dye	1.5	0.7

Table 1: Summary of the components of the tested explosive formulations [1]

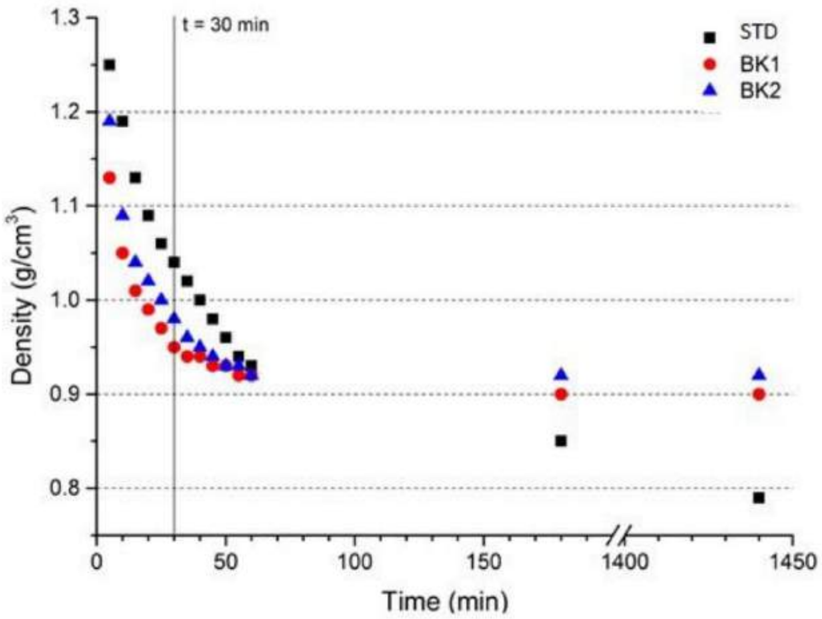

Figure 1. The density of the EE samples over time 3.2. Microscopic observations

In the case of BK-1 and BK-2 (Fig. 2), larger crystalline species are present. These particles are ammonium perchlorate, which has formed within the oxidising agent phase through a reaction of sodium perchlorate with ammonium salts.

The precipitated crystals of this salt are hypothesised to act as additional "hot spots", further sensitising the explosives and facilitating their detonation.
e ability of the EE charges to perform mechanical work was evaluated using a ballistic mortar.

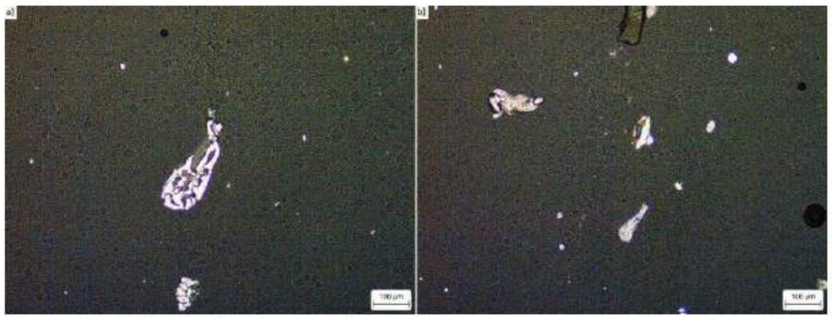

Figure 2. Polarised light micrograph

of a) BK-1; b) BK-2 [1] 3.3. Ability to perform mechanical work

In terms of the ability to perform mechanical work, the BK-1 and BK-2 formulations achieved noticeably higher performance than standard formula and were even comparable to the performance of TNT.

3.4. Shock wave parameters and velocity of detonation (VoD)

The air blast positive phase duration of BK-1 and BK-2 increasing by 0.9 % and 1.4 % respectively in comparison with standard formula. In terms of VoD, the BK-1 and BK-2 formulas show very good performance in comparison to standard bulk EE. In the case of BK- 1 and BK-2, the observed VoD values were higher by 9.8 % and 18.9 % respectively than the VoD observed for reference sample.

3.6. Composition of post-detonation gases

Due to better distribution of hot spots and a certain content of ammonium perchlorate microcrystals, compositions BK-1 and BK-2 are characterized by better detonation and better conversion of reagents. As a result, the amount of harmful gases is partially reduced (Tab. 2).

3.7. Brisance via the Hess method

One of the tests to determine the rock breaking capacity is the Hess test, also known as the brisance test. In this case, the differences are particularly noticeable for BK-1 and BK-2 formula, where the obtained brisance values are 20.7 % and 31.9 % respectively higher than for standard formula of bulk EE (Fig. 3).

Bulk EE – standard formula	CO_2	CO	NO_2	NO
Concentration [ppm]	4583±45	162±11	1.4±0.2	20,0±7.4
Unit mass emission [dm^3/kg]	114.8±1.1	4.11±0.28	0.04±0.01	0.51±0.19
BK-1	CO_2	CO	NO_2	NO
Concentration [ppm]	4664±6	100±4	1.5±0.2	11.6±2.8
Unit mass emission [dm^3/kg]	117.1±0.9	2.51±0.12	0.04±0.01	0.29±0.07
BK-2	CO_2	CO	NO_2	NO
Concentration [ppm]	4553±24	136±18	1.2±0.2	11.0±5.3
Unit mass emission [dm^3/kg]	115.3±0.4	3.45±0.46	0.03±0.01	0.28±0.13

Table 2: the average composition of post-detonation gases [1]

Figure 3. Comparison of brisance using the Hess test

References

The content was reproduced from Kramarczyk, B.; Pytlik, M.; Mertuszka, P.; Jaszcz, K.; Jarosz, T. Novel Sensitizing Agent Formulation for Bulk Emulsion Explosives with Improved Energetic Parameters. Materials 2022, 15, 900. https://doi.org/10.3390/ma15030900 under a CC-BY licence

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Improved safety with remote blasting Assarel-Medet JSC, Panagyurishte copper mine, Bulgaria

Ingemar Haslinger, Stephen Barnett, Sonia Yurukova
Case Study, March 2022

Site Profile

Assarel-Medet JSC Mining and Processing Complex is the first, largest and leading Bulgarian company for open pit mining and processing of copper and other types of ores. The mine is located at 11 km northwest from the town of Panagyurishte in Bulgaria and has approximately 1.200 employees and 400 contractors.

The Situation

The copper grade is very low in the mine and therefore it is very important to run a safe and cost- efficient operation. The appetite for continuous improvements is high. In 2020 the mine asked Orica for a drill & blast review to propose improvements of the blasting practices with regards to safety and blasting efficiency. The review presented approximately 50 suggestions for improvement and one of them being a shift from blast initiation with safety fuse and convert to a remote firing blast box with an electronic starter detonator.

Figure 1: Assarel-Medet JSC copper mine in Pangyurishte

The mine recognized this to be a good suggestion since it would improve safety substantially for the blast crew. Several blast fields are normally blasted in sequence where the blast crew initiates the safety fuse at the first blast field normally located in the bottom of the pit. Then they drive to the next, and so on. Normally there are 6-12 blast fields initiated. This is done twice per week. There is always a risk when using a safety fuse that something unforeseen happens between the point of initiation and firing of the blast putting people at risk. Also, the stand-off time is 30 minutes after the last blast fired. So, blasting the fields remotely and more or less the same time, could reduce the time for return and thereby same time for re- start of operations after blasting.

Mainly due to the Covid Pandemic, the implementation of the project started in December 2021. As a first step a signal survey was carried out to secure good communication of the radio signal throughout the whole pit. Secondly the entire blast crew was theoretically trained. The project then moved to practical training and finally the shotfirers conducted the firing themselves under Orica supervision and was signed off.

Technical Solutions

The blast box is the firing device for the electronic detonators. Normally a logger is used for assigning the delay times to the detonators but a newly developed feature in the blast box makes it possible to avoid having a logger when only firing starter detonators.

The starter detonator is only used to initiate the blastholes with non-electric detonators. It is now also possible for the Assarel Medet mine to use electronic detonators in full scale blasts when the need arises. The blast box can handle up to 7 boxes where one is used as the firing box and the others as receivers or repeaters when having long distances, relaying the signal between the firing box and the receiver. Each receiver can initiate up to 10 starter detonators. This means up to 60 blast fields can be fired in sequence. The Blaster 3000 can communicate via radio, leaky feeder, LAN, WLAN, Wi-Fi or LTE.

The Result

The whole implementation from signal test to certification of the blast crew, running the remote firing equipment themselves took 5 days in total. The solution enables a safer operation and faster total firing sequence. All the blasts fields trialed, fired as planned and the radio signal could reach all fields in the pit, without use of the repeater function. The longest distance between the firing box and the receiver (Radio) was 1750 meters, and it worked excellent. Since implementation was done in only 5 days, the time saving for return to the mine after blasting, could not be measured. However, would the saving be only 5 minutes per blasting day, this would add up to 1 more production day per year. If saving 15 minutes, it would equal >3 days. 5 min x 2 days per week x 52 weeks/year = 8,7 hours.

Testimonial

"The implemented remote blasting method is an improvement at the Assarel mine which enhances the blasting operations safety at an uncompromisingly high level and on the other hand, it significantly reduces the blasting time at the Assarel mine. The saved time will be used for operations and repair activities which means that it is, directly and indirectly, manifested in an increased economic result.

The achieved results for the full blasting time after the new system delivery, training of the Blasting unit staff and starting independent work by them firmly stamp the endeavor of our colleagues from the mine to improve the occupational safety conditions in the company and reduce the production prime cost through implementing the best world practices".

Engineer Delcho Nikolov
Executive Director of Assarel-Medet JSC

Figure 2: Mine blasters successfully and remotely firing off one blast field.

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More information on
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Introducing the EFEE Members

DSF Denmark

Dansk Sprængteknisk Forening (abbreviated DSF) or in English Danish Federation of Explosives Engineers, in German Dänischer Sprengverband or in French Fédération Danoise des Spécialistes de Minage et Dynamitage was founded on the 25th of May 1989. The association was founded by active blasters, suppliers, contractors, insurance companies and authorities as well as people with an interest in blasting in general.

DSF is a federation for registered companies in Denmark, Greenland and the Faroe Islands, where Greenland and the Faroe Islands are part of the Kingdom of Denmark and can be admitted as members of DSF. There is no production of explosives in Denmark and the industry has just a few players.

The association was initially run by Erik K. Lauritzen and Poul Erik Hansen was appointed as the Danish representative in EFEE, acting as an observer at meetings in EFEE until a Danish association was established and DSF could become a full member of EFEE.

The association was quickly identified by the Ministry of Justice, which in Denmark is the one who sits on regulations of dealing with explosives, and the association became organisation to whom to talk to about upcoming new legislation. In parallel with the work on new legislation, DSF developed a set of instructions for the Danish, Greenlandic and Faroese blasters. The instructions are continually updated and compared with input from the work that EFEE has delivered.

Those who have been to Denmark are aware that there are rocks on the island of Bornholm and that the rest of Denmark is moraine clay and sand with limestone sticking up here and there. The Danish limestone is relatively soft and is mined mechanically. It is of course different in Greenland and the Faroese islands where there is a lot of rocks. Both countries are geographically large, with a small and scattered population.

Just two years before DSF was founded, in Denmark, for the first time, investment was made in establishing a basic course in blasting, the legislation that had to be followed was from 9 April 1899 and there were only military blasting manuals and Swedish and Norwegian teaching materials. Therefore, a huge job was done to clean things up and set a new line for the industry. Rock blasting and blasting in connection with the demolition of concrete and other constructions naturally characterizes the approach to the entire area.

Since joining as a full member of EFEE, DSF has participated in all meetings and has contested the post of EFEE president twice. Initially with Mr. Jørgen Schneider and latest with Mr. Johan Finsteen Gjødvad. DSF has been a member of the EFEE Board of Directors for many years and is actively contributing to EFEE.

Through the work of EFEE and EFEE's conferences, DSF tries to focus on the approach to blasting, which is always the prerequisite for us to have a society like we have. This means ensuring access to new resources, ensuring safe blasting and dismantling of constructions, good working environment and the control of environmental emissions such as noise, pressure, vibrations, CO_2, etc.

Presently DSF is challenged with unrealistic control and rules for our trade. On a global level, terror and crime is high on the political agenda. The limitations of these factors are very much setting the agenda. This constantly leads to how to administer rules which are often shaped by academics who have a theoretical approach to things but lack real insight in the business. The changes are often not supported by facts but rather on feelings and public society trends. This makes day to day working life more challenging for our members.

This is further undermined by social media and public opinion which is often misled by self- appointed and self-taught experts. Which is amplified by the media's eternal search for sensations. We are trying to stick to professionalism.

Today DSF is an association working under The Confederation of Danish Industry DI (Dansk Industri), which is Denmark's largest business organization and employers' association. The organization looks after the member's employers and political interests - both locally and globally. DI is a private business and employers organisation representing approximately 19,000 companies in Denmark. The aim is to provide the best possible corporate conditions for our member companies.

DSF is in its 33rd year and in a good state. We are looking forward to a future which, as always, will need the use of explosives to solve complicated matters.

For more information on Danish Federation of Explosives Engineers contact:

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Jørgen Schneider
Jorgen.Schneider@dabtaps.dk

DSF Vice-President and EFEE delegate
Johan Finsteen Gjødvad
johan.gjodvad@sigicom.com

DSF Secretary
Henrik Stig Sørensen
hss@di.dk


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Enhancing shot-firer mobility through Pan-European education

How to solve problems which reach all over Europe? One way and possibly the best way to do it is trough EFEE. The aim of EFEE is and has always been to help the civil explosives industry forward, especially for those who are the users of civil explosives. One mayor problem, we are tackling is the harmonisation of shot-firer mobility in Europe. But the problem begins with education. It still differs quite a lot in European countries, this is the reason EFEE created the shot-firer competence certificate called PECCS – Pan-European Competence Certificate for Shot-firers and blast designers. The emphasis is on the word competence.

PECCS is a package of educational materials supporting shot-firer competence, consisting of 9 chapters, a Guidebook for trainers and examining questions. It has been created by specialists all over Europe and it is now free to use by all shot-firer trainers, educational entities and universities.

The idea behind PECCS is simple and logical – to give possibility to enhance and prove one's existing knowledge and competence as an active shot-firer, who already has experience and a national certificate. By going through a comprehensive training material, the shot-firer can update knowledge, and verify the ability to work all over Europe.

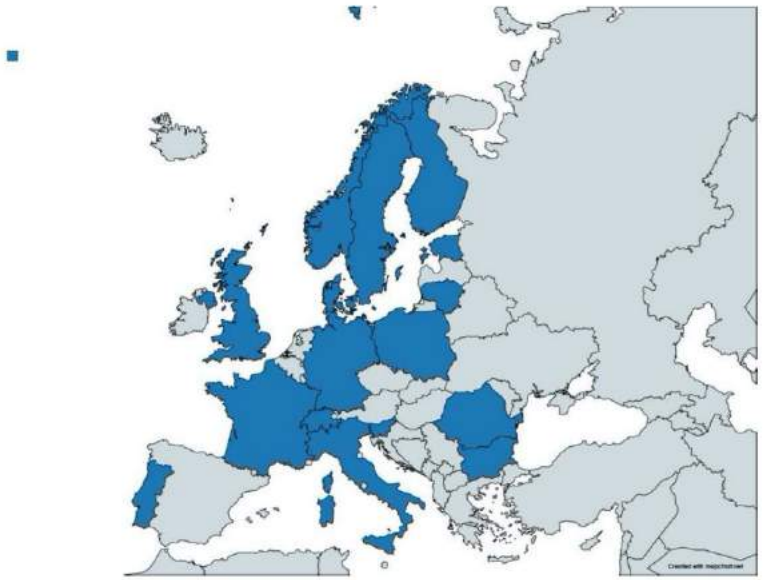
PECCS

EFEE

If the problem is connected to Europe as a whole, the solution must also include Europe as a whole. So you may ask, how has it been going since 2019 when the European Commission grant period ended for PECCS. The pandemic did slow us down, but by June 2021, the PECCS Working Group was created and together with EFEE Board and Council, a specific plan for the PECCS to reach all corners of Europe, was made. We also created a basic agreement for the usage of the material, to ensure that the education is given as it has been intended, and that all the efforts put into the knowledge of the material reach shot-firers as professional as possible.

So how is it going?

By now, we have more than 20 signed agreements for using the PECCS material. There are authorities, educational entities, universities and all these organisations have accepted the contents, have confirmed the necessity of this kind of certificate in Europe and are working towards a more international workforce. In order to reach EU directive, to simplify the mobility of shot-firers, the number of shot-firer trainers who have access the PECCS material should be much bigger. But now that the pandemic is over, we are very positive, that EFEE is soon issuing many Pan-European Competence Certificates for Shot-firers and blast designers, as most of EFEE national members have accepted the idea of a more harmonised education and a Pan-European Certificate.



PECCS material is being used in all coloured countries, also including Brazil.

The PECCS training materials can also solve local problems, for example broaden shot-firers horizon on various technologies and blasting techniques. Not all countries have a long history of Tunnelling acitivites, but nowadays it might be needed. Also urban blasting is more and more accepted when it comes to buildings or ground works, which means a shot-firer must have knowledge about blasting close to existing structures. As demolition with explosives is also coming more and more actual and needed the PECCS Working Group is actually preparing to organise an additional chapter to the material on this subject.

As PECCS has already developed into more practical and realistic education, we have also had a lot of contact with specialists, practitioners, national associations and educational entities. And often we get similar questions about PECCS.

- Does PECCS say anything about national regulations of European Countries?
  - PECCS includes best practices and knowledge from various countries in Europe, but it does not include any information about local regulations. If a shot-firer has gained access to PECCS training and applied for PECCS certificate, he/she should be able to travel to other countries to work as a shot-firer, but the local regulations must be learned either way.
- What is the language of the material?
  - PECCS is created and checked in English, but EFEE strongly suggests to translate the material into local language, to make sure that even details will be clearly understandable and that specific industrial vocabulary will be clear. If the translation of the whole material is too hard to organise, turn to EFEE and there will be help on this matter.
- If the PECCS certificate is Pan-European, then all the workforces will leave the country after gaining the certificate!
  - Many countries do have a lack of workforce in this area and there are also many international companies who need a possibility to work over borders. So we have heard a lot of worries that the workforce will leave. But as the PECCS material should be accepted and used in each European country, then the certificate also gives opportunity to bring in workforce from other countries, possibly neighbouring countries.
- Who can get access to PECCS materials?
  - The materials are free of charge and indented to be used by educational entities all over Europe. In order to get access, we ask to see the certificate which allows for training shot-firers (or a company registration document on same subject).
- Is PECCS meant for all shot-firers?
  - PECCS material is not basic shot-firer education, which means that previous experience and a local national certificate is needed to gain the PECCS certificate. The education in these materials is on level 4-5 EQF.

- How long is the validity of the PECCS certificate?
  - As the shot-firer, who applies for PECCS certificate, must have a national shot-firer licence, the PECCS Certificate will be accepted only together with valid national shot-firer certificate. The PECCS material itself is updated in every two years, organised by EFEE as a Workshop with outside specialists going through the material and changing anything that has become old knowledge. All the useers, who have access for the materials, will always have access the the most updated version. The next Workshop is planned for Autumn 2023.
- Do all the chapters need to be worked through in order to move towards the PECCS certificate?
  - It is possible to skip some chapters, but this information will be put on the PECCS Attendance Certificate.
- Is the educational entity free to choose the training system.
  - It is possible to divide the chapters into training modules to make shorter training periods in between working times. EFEE does not have very strong rules on how the material should be used, but each Trainer will have a Guidelines document and the shot-firer must go through training before exams, in order to gain the PECCS Attendance Certificate from the trainer. Also, online trainings are allowed, but it is important that questions could be asked directly from the trainer and that the slides are clearly shown.

By becoming PECCS trainer,

1) you have a possibility to cooperate in enhancing the mobility of European shot-firers
2) You have free access to high quality materials for at least one weeklong training session
3) You have always access to the most modern and updated education system for shot firers in Europe.
4) The material will include demolition chapter in future
5) The educational entitites and trainers, who are users of PECCS materials have a possibility to be shortlisted on PECCS website for shot-firers who are looking for a possibility to attend PeCCS trainings.

Write to us at info@shotfirer.eu to become PECCS Trainer. More information www.shotfirer.eu

PECCS
Pan-European Competence Certificate for Shot-firers

Erasmus+

EFEE

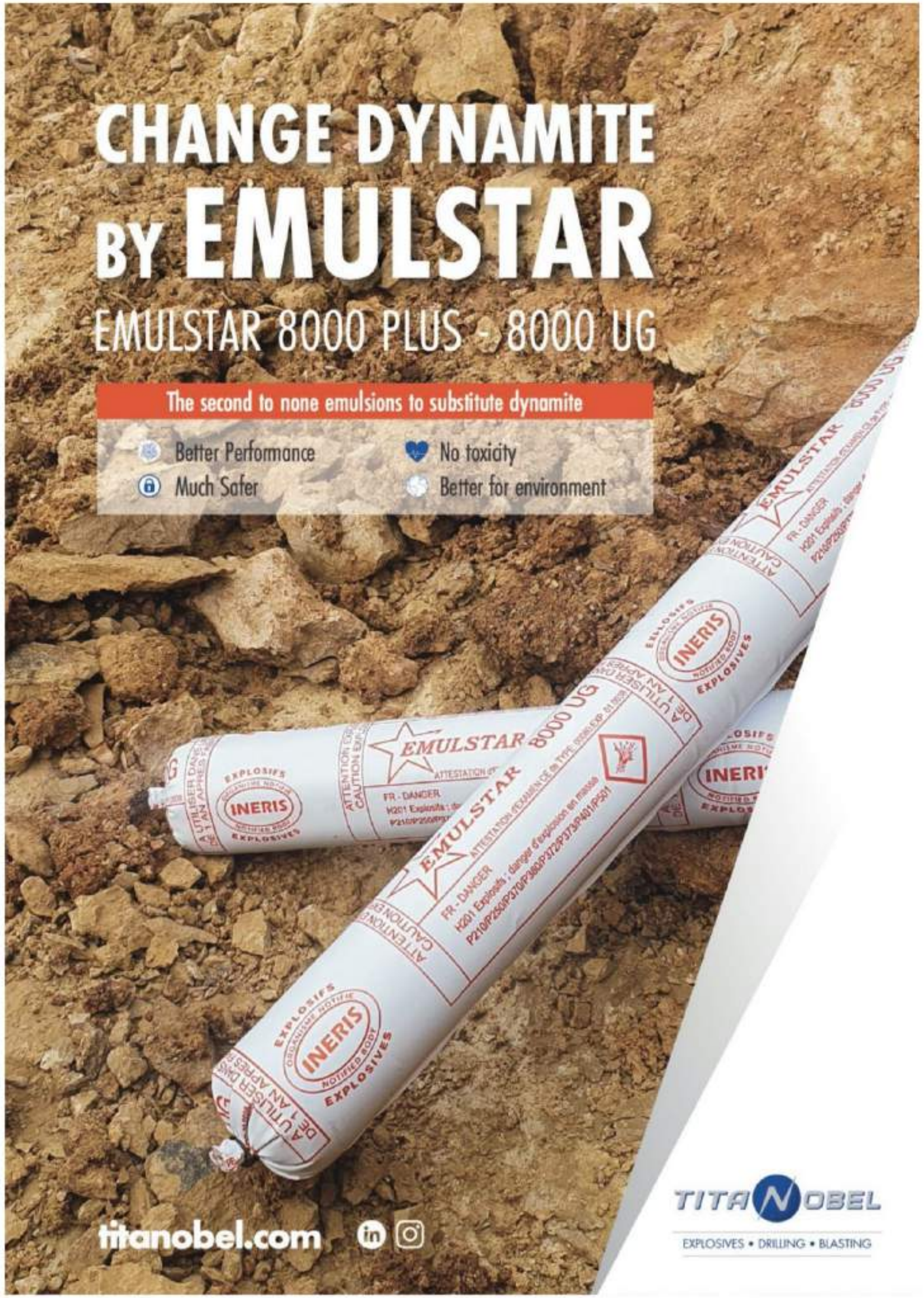
The Board of EFEE held the board meeting in Milan, Italy and finally met with GEAM

EFEE searched for a national member association to represent Italy in EFEE for several years. Finally, the board was able to find interested people in 2019 and planned to meet with them in March 2020, but this meeting had to be cancelled due to the outburst of COVID. The meeting was moved forward many times and finally held on-line in December 2020. After that it finally became clear that GEAM - Associazione Georisorse e Ambiente (Georesource and Environment Association) was perhaps the most suitable association to represent Italy in EFEE. In September 2021 GEAM became the 25th national member association in EFEE and Prof. Marilena Cardu from University of Turin was appointed the national Council member representing GEAM and Italy in the EFEE Council. The association was introduced in more detail in the EFEE newsletter in November 2021.

The EFEE board had a chance to finally meet face to face with the President of GEAM Cesare Castiglia, Prof. Marilena Cardu and PhD Salvatore Peralta on Friday 16th of September. The meeting was very informative as both parties first introduced their associations in more detail. After introductions the discussion concentrated in the most potential areas of co-operation like harmonized shotfirer training, EU directives and conferences to name a few.

The EFEE board is very thankful to GEAM and its representatives for the warm welcome and constructive meeting we had in Milan. We are looking forward to all future co-operation with Italy!

EFEE- GEAM meeting was joined by (left to right) VP of EFEE Mathias Jern from Sweden, Prof. Marilena Cardu, Johan Finsteen GjØdvad, President of EFEE Viive Tuuna, President of GEAM Cesare Castiglia, Salvatore Peralta, Espen Hugaas, Jari Honkanen, Doru Anghelache and General Secretary of EFEE Roger Holmberg.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New EFEE members

Congratulations and a warm welcome for joining EFEE as a member.

Individual Members

Dean Thompson, Specialist explosives services, Nottinghamshire, UK

Henrik Karlsson, Yara AB, Malmö, Sweden

Efthymios Kechagias, Demcon Smpc, Thessaloniki, Greece

Ilias Raptis, Demcon Smpc, Thessaloniki, Greece

Stefanos Scaini, Senior Safety & Security Advisor Advisory, Felino S.m.t., Italy Igor Giavitto, High Energy Technologies S.r.l., Udine, Italy

Mohamed Manzour, As Salam, New Cairo, Egypt

Pavlos Vantolas, Vagexco Shpk, Gjirokaster, Albania

Will Aspinall, SIP Ltd, London, UK

Alexander Bihlar, EPC Sverige AB, Eskilstuna, Sweden

Travis Davidsavor, Barr Engineering Co, Esko, Minnesota, USA

Diego De Fuentes Merillas, Sibelco, Dessel, Belgium

Ben Elvidge, Infineum Uk Ltd, Abingdon, UK

William Gates, Mcmillen Jacobs Associates, Auburn, Washington, USA

Eleni Giannouli, Eltek Ltd, Grevena, Greece

David Hác, STV MINING, Prague, Czech Republic

Luis Hilgert, Explotrade Sac, Lima, Peru

Othmar Janowitz, Astotec Pyrotechnic Solutions Gmbh, Winzendorf, Nö, Austria David Jung, STV MINING, Prague, Czech Republic

Daniel Kornfehl, Astotec Pyrotechnic Solutions Gmbh, Winzendorf, Nö, Austria Michael Lyttle, SIP Specialty Oils and Fluids, London, UK

Simon Moizan, Infineum, Berre L Etang, France

Carl-Eric Onema, Croda, Lund, Sweden

Michael Schatzer, Astotec Pyrotechnic Solutions Gmbh, Winzendorf, Nö, Austria Sunilkumar Radheshyam Somani, Beezaasan Explotech Pvt Ltd, Himatnager,Gujarat, India

Alan Tordoir, Anglo American, London, UK

Rüdiger Triebel, K+S Aktiengesellschaft / MSW-Chemie GmbH, Kassel, Germany Jaap Van Duijn, Sibelco, Valkenburg, Limburg, Netherlands

Patrick Wanlin, New Lachaussée, Milmort, Belgium

Timo Kettunen, Kenttäkoira, Hyvinkää, Finland

Gohar Alam, Wah Nobel Ltd, Wah Cahntt, Pakistan

Student Members

FURKAN Karabekmez, Karyapi, Cumming, Ga, USA

Lauri Kütt, Consumer Protection And Technical Regulatory Authority, Talinn, Harjumaa, Estonia

Noelia Valencia, Ecole Centrale de Nantes, Nantes, Loire-atlantique, France

Upcoming International events

FRAGBLAST 13 October
15-21, 2022 Hangzou,
China
www.fragblast13.org.cn

Mining World Congress 2022
Dec 14-15, 2022
London, UK
www.miningconferences.org

ISEE`s 49th Annual Conference on Explosives and Blasting Technique
Feb. 3–8, 2023
San Antonio, Texas, USA
https://isee.org/conferences/2023-conference

World Mining Congress
June 26-29, 2023
Brisbane, Australia
www.wmc2022.org

EFEE 12th World Conference on Explosives and Blasting
September 10th to 12th, 2023
Royal Dublin Society, Dublin, Ireland
www.efeeworldconference.com
For further information, please contact
info@efeeworldconference.com

Upcoming National events

"Louhinta- ja kalliotekniikan päivät"
(Rock excavation and -mechanical days")
on 13.-14. of October 2022 at Tampere, Finland Oma
INFRA | Louhinta- ja kalliotekniikan päivät 13.–
14.10.2022

Bergsprängardagarna
19.20 January in Sweden
https://bergutbildarna.se/bergsprangardagarna/

EFEE