EFEE

NEWSLETTER

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NEWSLETTER

November 2018

We in EFEE hope you will enjoy the present EFEE-Newsletter. The next edition will be published in February 2018. Please feel free to contact the EFEE secretariat or write to newsletter@efee.eu in case:

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- You have a future event for the next EFEE Newsletter upcoming events list
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or any other matter.

Doru Anghelache, Chairman of the Newsletter Committee and the Vice President of EFEE

and Teele Tuuna, Editor of EFEE Newsletter - newsletter@efee.eu

The President's voice

The fantastic summer weather that most of Europe had the pleasure to enjoy this year is now long gone and vacation almost forgotten. Luckily, the weather during the fall has been treating us gently. Up here in the north we could be walking in snow at this time of the year, as we did last year, but now the golf courses are still open. All of us in EFEE administration have had also other reasons to grind this year as we have had a chance to celebrate the 30th birthday of our fine and valued organization that we are so proud of. There is an article in this Newsletter describing this successful evening and the 30-year-long path from the birth of EFEE until this day in more detail so I will not steal the news more here, please read the article!

Our anniversary brings me to the subject of traditions, which are important and good to have and important to maintain, unless of course they prevent you from developing. EFEE has also gathered a lot of important knowledge along the road for the past 30 years. There is therefore a lot of collective memory in our disposal. I would like to mention Walter Werner from Germany, one of three honorary members of EFEE, as a good example for this. He could be also called the father of EFEE since the organization was founded in 1988 much thanks to his initiative. Walter still works also actively in EFEE administration despite his respectable age and joins many of our meetings keeping the important collective memory from the past year in our disposal. Also our treasurer Heinz Berger from Austria has been around for a good bit. In fact, many of EFEE Council members have served EFEE for more than 2 decades and some even in the board for over a decade. That is a long time considering that this work is done without pay for the good of the industry and profession.

As it is good to have experience and recollections from the past in order to avoid making the same mistakes again, one must also be careful not to stay in the past for too long. Our surrounding keeps moving on and developing constantly and our industry with it. Even though blasting industry is probably one of the most traditional and conservative ones – which is not a bad thing at all. Generations change and techniques with it. We still charge explosives into the drill holes as we did 30 years ago, but we use tablets and mobile phones to plan and simulate the blast in advance, electronic programmable detonators to initiate it and drones to analyse the outcome. Couple of explanations come to my mind when I try to find the reasons for our industry to be perhaps more conservative than many others. The first is safety. One has to wait for a certain time before introducing the latest technology into explosives and blasting. The new stuff has to be tested and confirmed 100% safe before introducing into the markets. After that safety rules and legislation will have to be adjusted to take the novelty into account.

Also personnel has to be trained to use the latest tools in the right and safe way. You cannot only rely on manuals when you make a blast. You need to be 100% sure of what you are doing and that your technique is right for the job and location. The other reason that I can think of is perhaps not so desired. The middle age in our industry is rather high. We need (also) more young people in our industry to keep up with the latest development. This is a challenge also to EFEE as an organization. We need more young members, Council members and even Board members to keep us modern and in touch with the latest developments and demands. My aim is to try to advance this the best I can during my short two-year presidency. With this I am hoping to secure the future development of EFEE and support that for our whole industry in Europe. I would be glad to receive thoughts and input regarding this issue from all our members. Please let me know if you have any suggestions or ideas how to develop EFEE to better attract the young talents of our industry. I would like nothing more than to see a small crowd of fresh talents, perhaps challenging us older, in the next EFEE conference in Finland in September 2019!

I have another recent example of long and successful traditions. I recently joined a gala where the explosives group that I work for celebrated its 125th anniversary with all its personnel from Finland, Sweden and Norway. It was a proud moment also for me – I felt that I can honestly say "we know what we are doing, we have been at it for 125 years - since Alfred Nobel´s days!". I have of course personal working experience for "only" 30+ years, but I often recognize in my daily work that the important past experience has been passed on to the current generation in our group. All of us have picked up loads of it along the road and put it forward in return. Sometimes I am even able to bring an enlightened and experienced contribution into discussion myself. Soon I have to plan how I pass all the important knowledge that I might have to the next generations, so that it stays in the group for the next 125 years. I am also glad to see that we have managed to recruit a lot of young brilliant people into our group to whom I can pass on my experiences. They are our future.

I am writing this as I am flying to Bucharest to join my fellow board members for the last EFEE board meeting in 2018. A lot of development issues will be on the agenda. We will be also discussing our strategy and next steps in developing EFEE for the future. Perhaps slowly but surely we will develop EFEE forward to meet the challenges and demands of the next decade – and those coming from next generations.

Someday the next generation will have to join in and take the lead as it is only so far that one generation can take the development. Then it is our turn to sit back in the meetings and represent the ever so important experience and collective memory – and say "Guys, we tried that already 20 years ago and it did not work out!"

Jari Honkanen, 50+, President of EFEE

Charleroi Locks and Dam - Old River Wall Explosive Demolition – Final Stage - Phase 2

Abstract

The Army Corps of Engineers completed the Charleroi Lock and Dam in 1932 It is located on the Monongahela river approximately 22 miles (35k) south of Pittsburgh in Charleroi, Pennsylvania. It is comprised of a 420-foot (128m) gated dam, and a 720-foot (219m) by 56-foot (17m) land side lock, which provides for a 16.6 foot (5m) vertical lift.

The riverside lock chamber was removed from service in 2005. Removal of the existing locks and their replacement with new larger locks (twin 84 ft (25.6m) x 720 ft (219.4m) is part of the Lower Monongahela River Navigation Project (Lower Mon Project). The Charleroi Locks and Dam is the third of nine navigation facilities on the Monongahela River. From 2000 to 2007, the Charleroi Locks averaged 811 recreation vessels, 5,831 commercial tows, and 11.9 million tons (10795.5 million kg) of cargo.

As part of the ongoing continuing renovations for the new river chamber of the lock – the final section of the remaining old river wall, an approximately 350-foot (107m) feet section was to be removed by explosive demolition methods. As before, the Corps of Engineers put in place some strident specifications for the planned explosive demotion of the old river wall. A blasting plan was developed, reviewed and submitted to meet or exceed those specifications.

Since the first phase of the project, a new section of the locks has been added. Prior to the blasting, an updated pre-blast condition inspection was required on portions of the existing locks, dam and support structures. Two new areas of concern were the two steel cofferdam boxes which were still under construction at the time the final blasting sequence. Green concrete may also be present at the time of the remaining blasts. This fresh concrete would be as close as 60-160 (18.2m to 48.7m) feet.

The remaining river wall ranged from approximately 17 to 18 feet (5.2m to 5.4 m) in remaining depth and up to 25 feet (7.6m) wide in areas to be demo-ed. The blasting plan included the use of electronic detonators. The nearest adjacent remaining structures were approximately 65 feet (19.8m) from the old river wall being demolished. Voids and cavities in the remaining section also had to be addressed.

This case study will discuss the final blasting program to remove the remaining old river wall.

Introduction

Initially, for phase 2 of the River Wall, no blasting was permitted or specified. However, due to scheduling issues with other on-going sections of the entire project, blasting became necessary to remove the remaining river wall area. As for Phase 1, the specifications for this project were quite intense. There were new areas of concern next to the area to be removed; two steel cofferdam boxes which are still under construction at the time the final blasting sequence and green concrete may also be present at the time of the remaining blasts. This fresh concrete could be as close as 60-160 (18.2 to 48.7 m) feet.

Figure 1 - Charleroi Lock & Dam Project Overview

As with Phase 1, the specifications were the same, with the addition of air overpressure calculations and included the following items:

1. Blast plan development and review
2. Qualifications package - Blasting Contractor and Blasting Consultant
3. Pre-blast Inspections & Monitoring Plan
4. Blasting development and modifications as the work progresses
5. Protection of cofferdam boxes under construction
6. Blast monitoring during operations
7. Post-blast Inspections

Air Overpressure Calculations

For air blast/overpressures at the cofferdam boxes overpressure calculations were requested. Scaled distance (SD) is defined as the distance (D) from the blast to the location of concern divided by the cube root (1/3 power) of the maximum pounds of explosives detonated per delay period, or:

$$SD = D/W^{1/3}$$

Initially, the anticipated greatest amount of explosive to be detonated in any one delay for the blasting in question was 12.5 (5.66kg) pounds. The minimum distance to the cofferdam box will be 60 (18.2m) feet, the calculated minimum scaled distance will be 25.85. The calculations are shown below.

$$SD = 60/12.5^{1/3}$$

$$SD = 60/2.32$$

$$SD = 25.85$$

By using the Blasters' Handbook (ISEE 17th Addition, 1998), we can calculate what the air overpressure would be at a cube scaled distance of 25.85. Utilizing the equation from page 631 of the Handbook, we arrive at the following:

$P = 1.0(SD)^{-1.1}$ P is Overpressure in PSI

SD is cubed scaled distance

Utilizing the calculated minimum cubed scaled distance of 25.85 in the previous equation, an estimated overpressure of 0.0279 pounds per square inch (psi) (192.3pa) the resulting overpressure. This would be the equivalent of 139 dB(L).

The calculations are shown below:

$P = 1.0(SD)^{-1.1}$ $P = 1.0(0.0279)$

$P = 1.0(25.85)^{-1.1}$ $P = 0.0279$ psi (192.3pa)

Blasting Operations

The prime contractors for this project were a joint venture of Shaka, Inc. and Joseph B Fay Company, Inc., both Pittsburgh area contractors. The blasting contractor was Newville Construction, Inc., out of Newville, Pennsylvania. Terra-Mechanics, Inc out of Gibsonia, Pennsylvania were the blasting consultants, structural survey consultants and the seismic specialists.

Originally, blasting was not planned for the removal of this final section of the wall, however, the project schedule was accelerated, which made explosives necessary to expedite the removal of the remaining section of the River Wall; shown in Figure 2. Of particular concern was the steel cofferdam box shown in Figure 2. The updated pre-blast surveys were completed in March 2017. Problems with green concrete were avoided by moving the blast sequence.

Prior to the initial blast, vibration monitoring stations were set at five (5) required locations. Additional locations were added for additional data collection. A plan view of the locations is shown in Figure 3. Location #1 was moved to the south cofferdam box location. A sixth location was added to the old river wall next to the cofferdam box and a seventh and eighth location was added just prior to the start of blasting; the seventh location was the land wall and the eighth location was CSX railroad.

The first blast was scheduled for May 12, 2017. Below is the blast plan for Blast 1 (Figure 3). This blast plan was used for subsequent blasts. The follow are details for Blast #1; there were 285 holes. The depth of holes was 16 to 18 feet (4.8 to 5.4 m) and the maximum pounds per delay was 36.6 lbs/delay (11.1kg), using

electronic detonators. 750 mil roofing material and sand was used as a blasting mat.

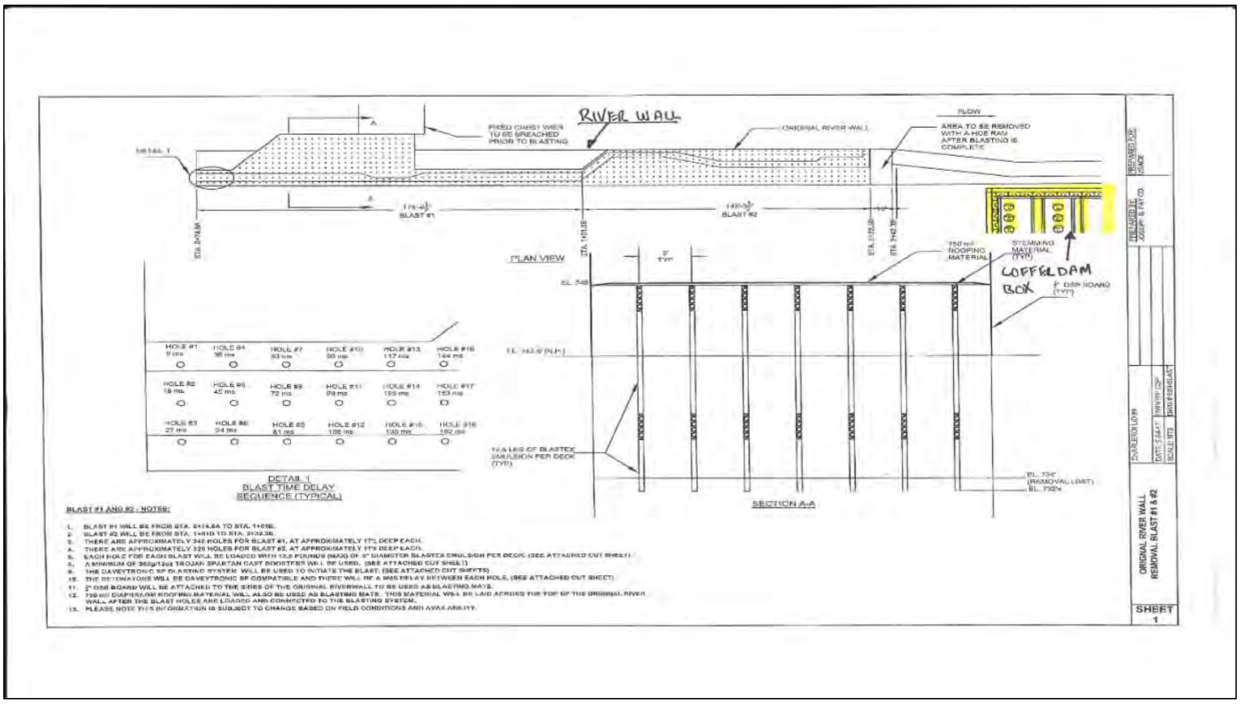

Figure 2. Project Plan View

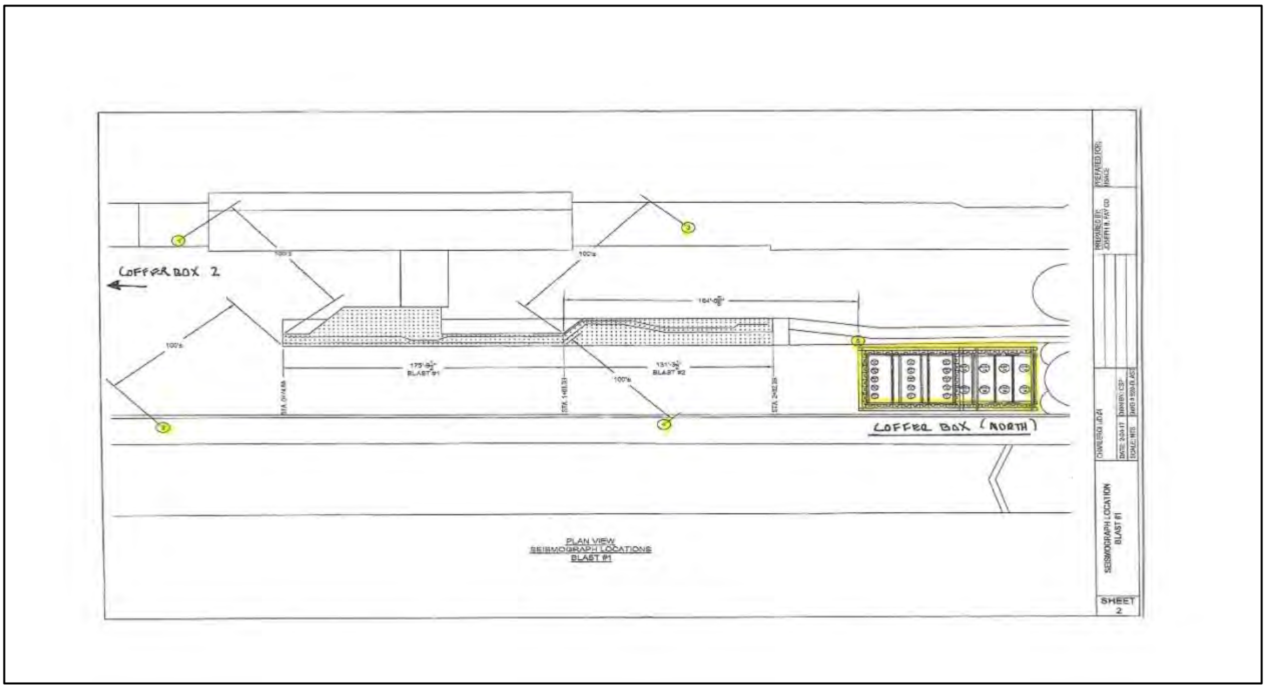

Figure 3. Blast Plan Blast #1 – Seismograph Locations

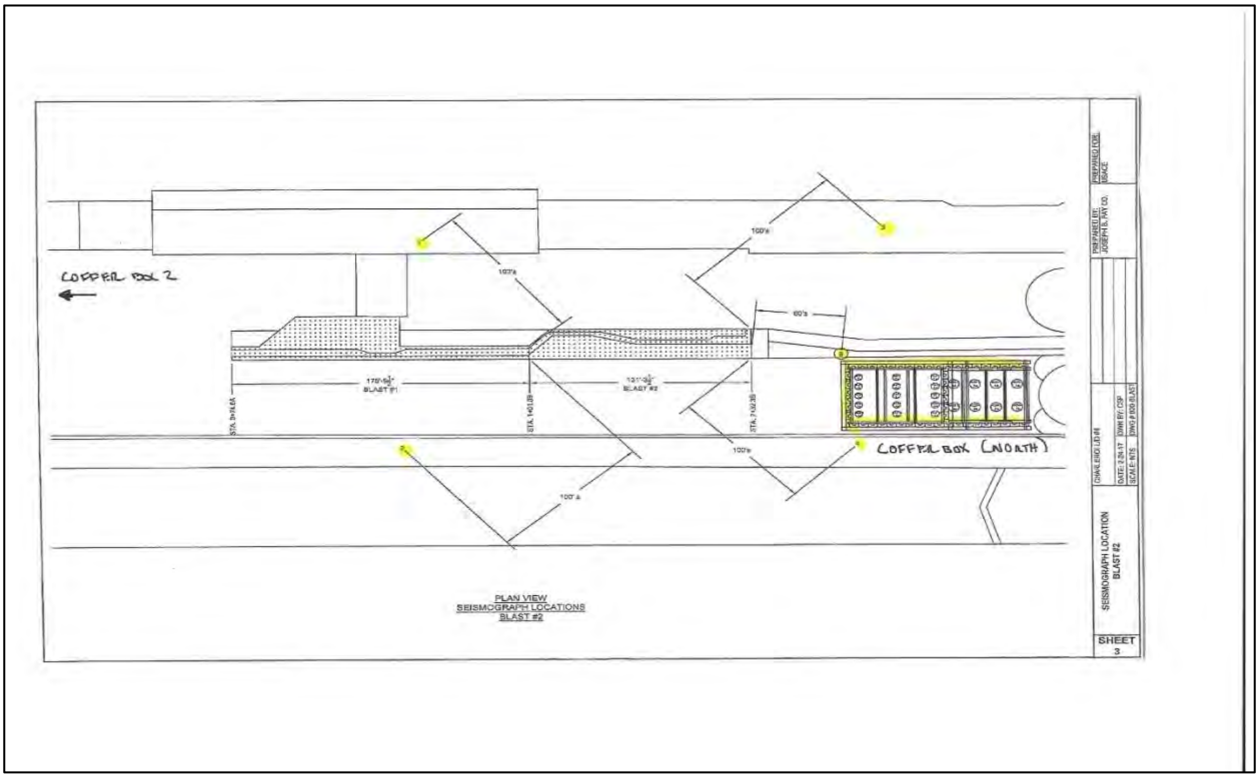

Figure 4. Blast Plan Blast #2 – Seismograph Locations

Figure 5. Blast Locations & Monitoring Locations – Blast #1 & #2

Figure 6. Overview of Blast Areas

Results

Below are the results for the first shown in Table 1. After each blast divers inspected the cofferdam boxes for any changes, and checked certain bolts at the base. No issues were found by the divers and based on the vibration data from Blast #1, plans for the second blast were made.

Seismograph Location	Serial Number	Approx. Distance (ft)	PPV (in/sec)	Air Overpressure (dB(L))
Location #1 – M7 – Cofferdam box – Geophone attached to actual steel corner member of the box	BE18190	185	0.325	131.8 (0.0112 psi)
Location #2 –Middle Wall - South	BE10412	80-100	0.895	132.0 (0.0115 psi)
Location #3 –New River Wall	BE9440	80-100	1.02	132.8 (0.0126 psi)
Location #4 – Middle Wall - North	BE16351	65-80	1.21	136.7 (0.0198 psi)
Location #5 – M-22 Cofferdam box – Geophone attached to the actual steel corner member of the box	BE9887	210	0.635	126.1 (0.00579 psi)
Location #6– M-22 Cofferdam box area – Directly adjacent to BE9887 – on old river wall – same as wall	BE9439	210	2.30*	N/A- See BE9887
Location # 7– Land Wall – River Bank North	BE11137	650	<0.05	<125 (<0.0051 psi)
Location #8 – CSX Railroad	BE10635	275	0.130	123.7 (0.0041 psi)

Table 1 - Blast #1 - May 12, 2017 – 6:44 PM
Summary of Measured Ground Vibration and Peak Overpressure

* For location #6 the vibration levels did exceed the conservative project limit of 2.0 in/sec (50.8mm/sec).
This level was recorded on the old river wall, which is eventually to be removed and it was directly connected to the wall being explosively removed. Typically, this 2.0 in/sec (50.8mm/sec) limit would apply to residential structures and not to cured concrete structures as in this case. Exceeding the 2.0 in/sec (50.8mm/sec) limit does not mean that damage has occurred. For cured concrete structures, such as location #6, an industry limit of 4.0 to 5.0 in/sec (101mm to 127mm) is typically recommended. These recorded vibration levels were considerable less at both cofferdam boxes.

Blast #2 was scheduled for May 19, 2017. The blast plan for Blast #2 is shown above (Figure 4). This blast plan was used for subsequent blasts. The following are details for Blast #2: there were 277 holes. The depth of holes was 16 to 19 feet (4.8 to 5.7 m) and the maximum pounds per delay was 43 lbs/delay (19.5kg), using electronic detonators. 750 mil roofing material and sand was used as a blasting mat. Below is a summary of the results for Blast #2.

Seismograph Location	Serial Number	Approx. Distance (ft)	PPV (in/sec)	Air Overpressure (dB(L))
Location #1 – M7 – Cofferdam box – Geophone attached to actual steel corner member of the box	BE18190	325	0.325	126.7 (0.0062 psi)
Location #2 –Middle Wall - South	BE10412	80-100	0.925	133.4 (0.0135 psi)
Location #3 –New River Wall	BE9440	80-100	0.245	131.5 (0.0109 psi)
Location #4 – Middle Wall - North	BE16351	80-100	0.425	136.7 (0.0198 psi)
Location #5 – M-22 Cofferdam box – Geophone attached to the actual steel corner member of the box	BE9887	60	1.37	125.7 (0.00559 psi)
Location # 6– Land Wall – River Bank North	BE11137	650	<0.05	<125 (<0.0051 psi)
Location #7 – CSX Railroad	BE10635	275	0.080	122.1 (0.0044 psi)

Table 2 - Blast #2 - May 19, 2017 – 5:57 PM
Summary of Measured Ground Vibration and Peak Overpressure

Discussion and Conclusion

Two (2) blasts were required to remove the remaining section of river wall. Both blasts were within the conservative project limit of 2.0 in/sec (50.8mm/sec). The vibration and overpressure levels were within predicted levels and project limits at the cofferdam boxes.

Regarding the air blast limit, initially the project limit was 129 dBL. This was later modified to cover any off-site structure, like the railroad or an off-site distance of 275 feet (83.8 m). The maximum air blast level recorded of 136.7 dBL was at a concrete wall and at a distance of 65 feet (19.8 m). The maximum air blast level recorded of 136.7 dBL was at a concrete wall and at a distance of 65 feet (19.8 m). The maximum off-site airblast level recorded was 123.7 dBL at a distance of 275 feet (83.8 m). Following the successful blasting operations, an overview post blast survey was conducted and there were no adverse effects observed on the remaining locks structures.

Acknowledgements

Newville Construction, Inc. - Blast Crew – Tim Reinhold - Blaster-in-Charge
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US Corps of Engineers - Pittsburgh District - Charleroi Locks and Dam 4 - Staff Personnel

Terra-Mechanics, Inc - David Harrison & Brian Harrison

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Harrison, D (2014). Charleroi Lock and Dam – Old River Wall Explosive Demolition. *The International Society of Explosives Engineers Annual Conference Proceedings*. Cleveland: ISEE.

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Blast Induced Vibrations in Malmberget

Abstract

LKAB operates an underground iron ore mine in Malmberget in the northern part of Sweden. Twelve different orebodies are mined today using both longitudinal and transversal sublevel caving as mining method. The town of Malmberget is located close to the mining area. The need for urban transformation, moving people and houses, is evident for many reasons. The mining methods used have inherent subsidence issues and there are also vibrations from blasting and mine induced seismic events.
The focus of this paper is on blast induced vibrations. They are recorded in the town at a total of 14 measurement stations using tri-axial geophones. The distance from the 115 mm (4.5 in) blastholes, in one of the orebodies, to the nearest buildings is today around 375-400 m (1230-1312 ft). Blasting takes place between 00:00 and 01:00 every night. The current regulation on blast induced vibrations, in use since 2017-07-01, takes human comfort into account. LKAB has, during the years, taken several measures to reduce the vibrations, such as long delays between holes in the same ring, restrictions on the number of rings that can be blasted per night in each production area, divided ring blasting and changing the initiation sequence etc. Lately, smaller diameter holes (89 and 102 mm, 3.5 and 4 in) have also been tested. In fact, smaller blastholes will be used in orebodies where blast vibrations are an issue. An in-house software has been developed, where vibration data from each measurement station is downloaded from a remote server and stored in a database. Data from seismic events, rings/boreholes etc. are also stored in the same database. All vibrations are classified based on the source type (blast, seismic event etc.). Blast vibrations are also predicted for each ring using the well-known scaling law. The maximum PPV (peak particle velocity) from numerous rings (many production areas) are calculated for each point in a grid located at the ground surface. The 95 % percentile can also be estimated using a Gaussian distribution and random numbers. The results are color coded and plotted in maps. The new regulation on blast vibrations will be a challenge for the mine together with the timing of the urban transformation. However, especially the use of smaller diameter blastholes will enable us to meet the requirements.

Introduction

LKAB is a mining company located in the northern part of Sweden operating currently two underground iron ore mines located in Kiruna and Malmberget respectively. LKAB also operates two open pits located in the Svappavaara area (located in between Malmberget and Kiruna). The annual production is today about 26-28 Mt of final products (about 85 % pellets) corresponding to about 42-44 Mt of crude ore. Malmberget consists of about 20 widely distributed (about 5 by 2.5 km, 3.1 by 1.55 miles) large and small orebodies, of which 12 are currently mined. Most of the deposit consists of magnetite but hematite also occurs in some orebodies. A schematic view of the orebodies is shown in Figure 1. Mining began in 1892, since that about 400 Mt of ore have been extracted. The mining method used today is sublevel caving. Longitudinal sublevel caving in small orebodies and transversal sublevel caving in larger orebodies. The town of Malmberget is located close to the mining area. The need for urban transformation, moving people and houses, is evident for many reasons. The mining method used have inherent subsidence issues. The mine became seismically active about 10 years ago. Some of the strongest seismic events causes high vibrations in the town. There are also blast vibration issues which is the focus in this paper.

Production drilling and blasting at the Malmberget mine

115 mm (4.5 in) blastholes have been used for about 25 years. They are drilled upwards in a fan, a so called ring. The number of holes in each ring varies but 7-12 holes are most common. The length of the boreholes varies but 45 m (148 ft) long holes are common. There are 6 drill rigs used in Malmberget, each having a drilling capacity of about 100-150 km/year (62-93 miles/year). These rigs are super-vised from a control room located at each production area. The actual drilling is more or less automatic but moving the rig to the next ring is still a manual operation.

Up-hole charging is carried out using micro-balloon sensitized bulk emulsion with a density of about 1.2 g/cc. The product contain 4 % Al. A typical VoD (Velocity of Detonation) in a 115 mm (4.5 in) blasthole is 5000-5300 m/s (15000-16000 fps). The holes are normally fully loaded corresponding to a charge concentration of about 11-12.5 kg/m (7.4-8.4 lb/ft). Pre-charging is applied, about 2-4 rings are normally pre-charged down to about 10-15 m (33-49 ft) depth. A ring is prepared for blasting some hours before blasting. A primer with a non-electric detonator is pushed up (10-15 m, 33-49 ft) in each borehole using a charging truck. The remaining part of each borehole is then filled with emulsion to a pre-defined uncharged depth in the borehole, no stemming is used. The shock tubes are bunched together using 5 g/m (23 grains/ft) detonating cord and an electric detonator initiates the blast. LP (Long period) detonators are used, one borehole per interval starting normally in the middle of the ring and progressing to the sides. The longest holes are about 45 m (148 ft) which corresponds to about 500 kg (1100 lb) of explosives.

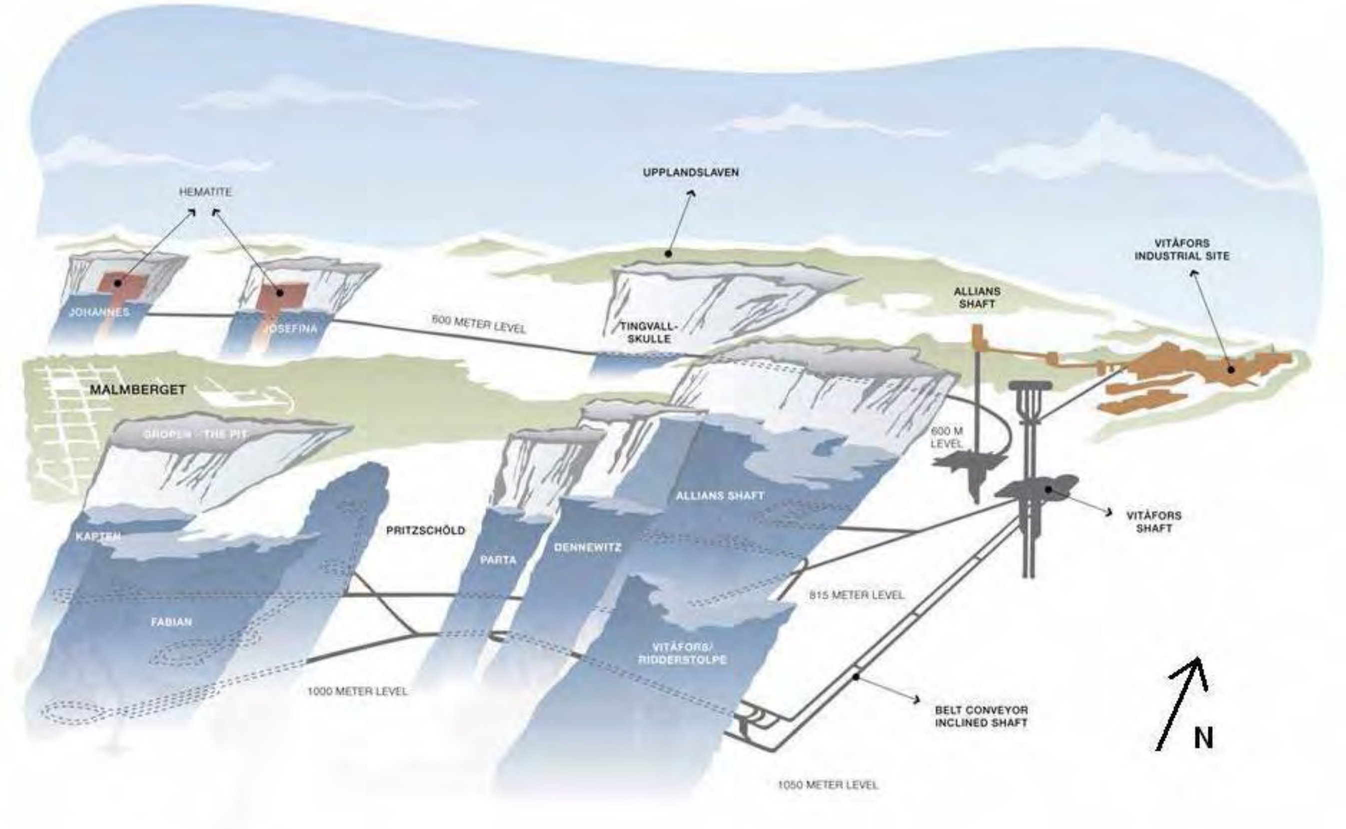

Figure 1. Schematic view of the orebodies at Malmberget Mine.

Blasting takes place during the night at 00-01 a ’clock , about 6 rings per night on average.

Urban transformation

The Malmberget mine has been in operation for about 125 years. Some of the orebodies are located close to the town area, see the aerial view in Figure 2. In fact the Fabian orebody divide the town in a western and eastern part. Urban transformation has taken place earlier in Malmberget and is also present today. The main reason is subsidence issues but new regulations on blast induced vibrations is also considered.

The current plan for urban transformation is divided in 4 stages, see Figure 3. The first started 2012 and the final fourth stage is scheduled to be completed year 2032.

Figure 2. Aerial view of the Malmberget Mine site. Colored objects are horizontal projections of the orebodies at a specific level shown above.

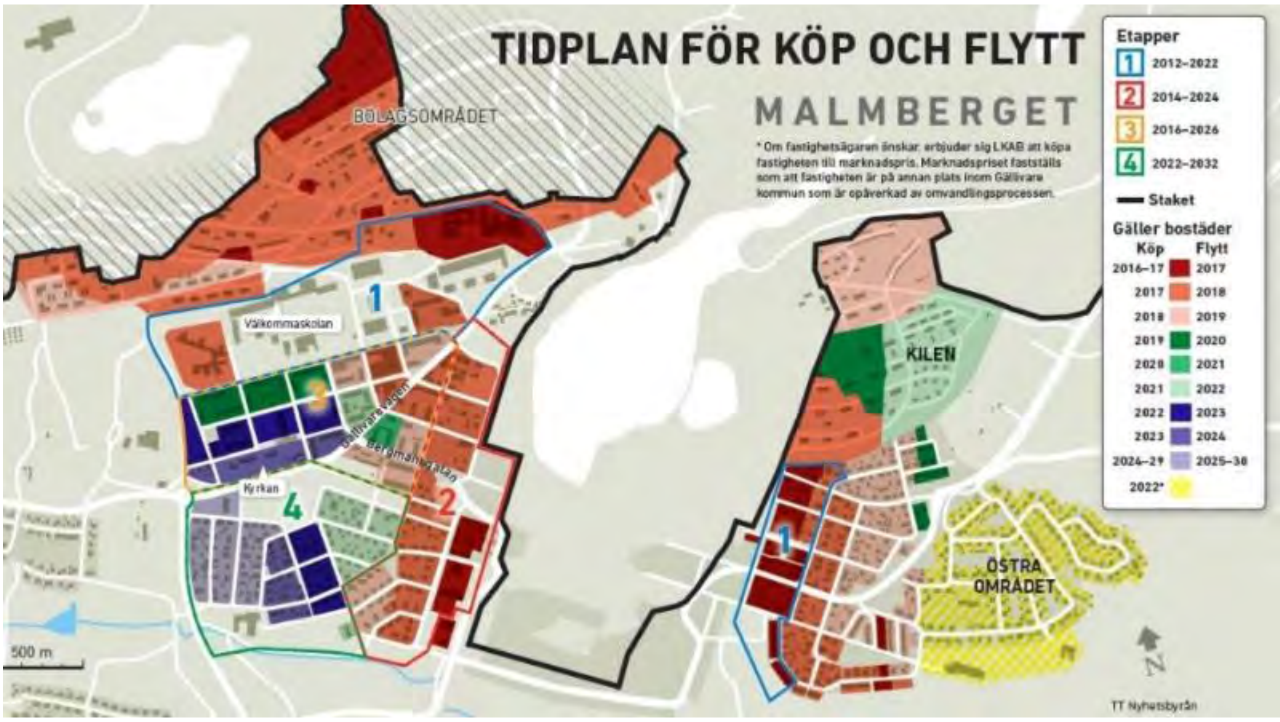

Figure 3. Current plan for urban transformation.

Recording vibrations

Nitro Consult AB monitors vibrations on behalf of LKAB including installation of instruments, inspection of houses etc. Vibrations are recorded in the town area at a total of 14 measurement stations using tri-axial geophones. NCVIB is a Web-based system designed to make the results of vibration measurements more useable. The system registers vibrations and when needed also airborne shock-waves and presents the measured results together with other interesting parameters such as temperature, noise, stresses and groundwater levels. In the Malmberget case only vibrations are recorded.

Current regulation on blast induced vibrations

Old regulations were mainly based on risks of damage to houses/buildings. Lately, human comfort has become more and more important when the authorities sets the vibration limits. The current regulation has been in effect since 2017-07-01. It requires measuring tri-axial vibrations and using the principal component particle velocity (PCPV). The regulation is based on when the blasting occur (day or night) including different target and upper limits, see Table 1. The majority (95 %) of the vibrations should be less or equal to the target limit and the upper limit should not be exceeded.

Table 1. Current regulation on blast induced vibrations, in use since 2017-07-01.

Point in time	Target limit (PCPV)	Upper limit (PCPV)
Daytime, 07-22	6 mm/s (0.25 in/s)	12 mm/s (0.5 in/s)
Nighttime, 22-07	3 mm/s (0.125 in/s)	6 mm/s (0.25 in/s)

The limits are applicable to each measurement point on a yearly basis. Measurements should be carried out according to the Swedish standard SS 460 48 66. The instrument should be mounted to the foundation of the houses/buildings and the frequency range should be at least 5-300 Hz.

Reducing vibrations

LP (long period, 100 ms) detonators and each borehole on a separate delay have been used for a long time. Besides that a number of different methods for reducing vibrations has been tested (Zhang and Naarttijärvi, 2005). Tests with vibration cancellation using electronic detonators indicated a reduction of the vibration level of about 10 %. Other methods are changing initiation sequence and divide a ring in two blasts, see Figure 4.

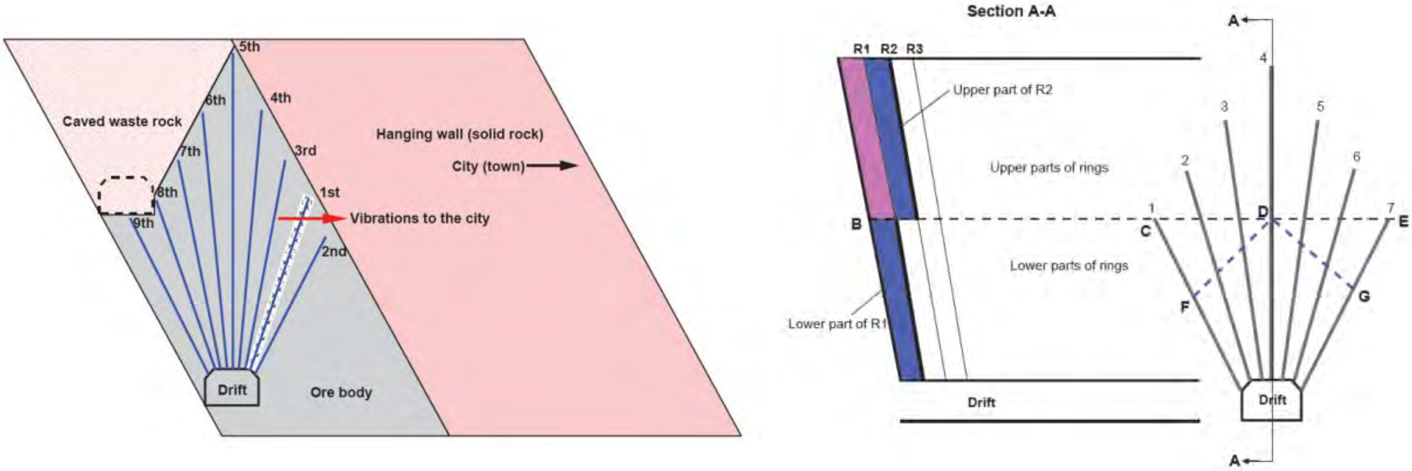

Figure 4. Changed initiation sequence (left) and divided ring blasting (right), from Zhang (2012).

The normal procedure to blast a ring is to start in the middle and proceed towards the sides. When changing the initiation sequence the blast is initiated at the second hole from the side. This borehole is shorter than the middle holes (and less confined than a sidehole), the fracture network created by the detonation will have a screening/attenuating effect on vibrations from the long middle holes (Zhang and Naarttijärvi, 2005). This effect is however directional and may not be applied with success in all situations. Zhang (2012) reported a reduction of the vibration level by almost 50 % in one orebody in Malmberget ("Johannes") during 2004-2010. However the distance between the blasts and the measurement point has increased during that period from a minima at about 280 m (919 ft) to 325-350 m (1066-1148 ft), see Figure 5. A significant part of the reported reduction of the vibration level is probably related to increased distances. Using the scaling law, assuming constant charge weight W and an exponent of -1.7 gives a reduction of about 22-32 % for these increased distances.

In divide ring blasting the lower part of a ring (R1 in Figure 4) and the upper part of the next ring (R2 in Figure 4) are fired in the same blast with each borehole on a separate delay thereby reducing the "pound per delay" by about 50 %. The main drawback with this technique is possible damage at the brow when blasting the upper part of the ring. Especially the charging crew will face this issue when preparing the lower part of the ring for the next blast. Another issue is possible damage in the boreholes after blasting the upper part. This can result in clogged boreholes and difficulties to charge the holes to the pre-defined depth. These problems limits the use of this technique. This method has also been used in the Kiruna mine in the beginning of the 1990s but for other reasons. In Kiruna the method was applied in remnant roof situations but with limited success and was therefore abandoned.

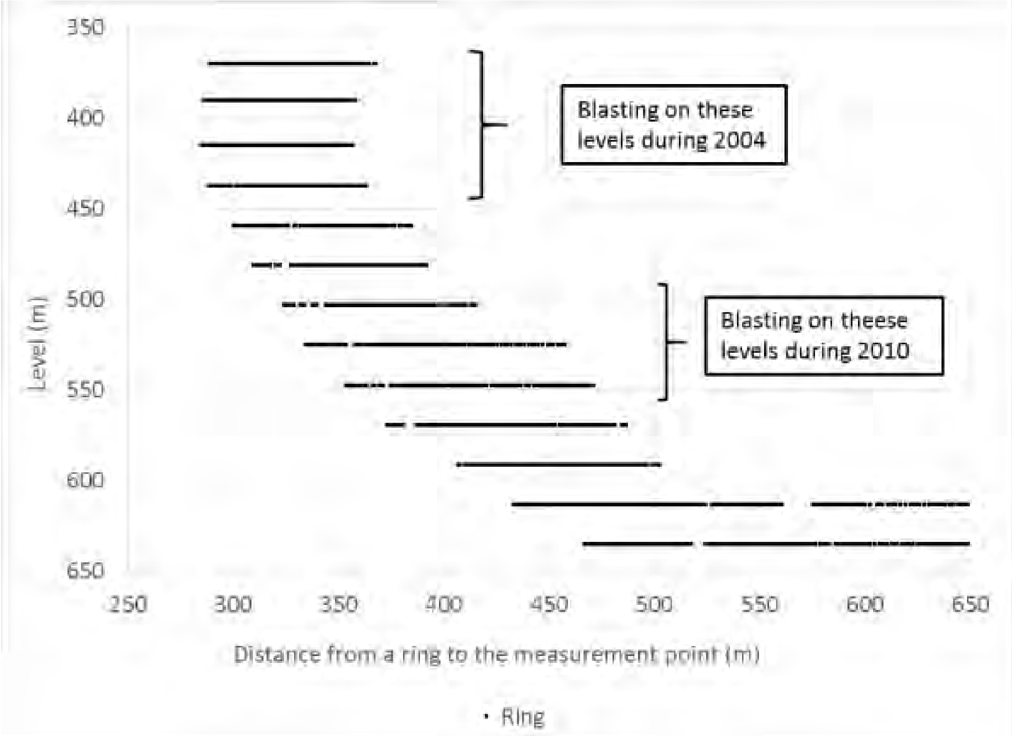

Figure 5. Distance from rings in orebody "Johannes" to the measurement point.

Large scale sublevel caving requires accurate drilling of long holes (about 45 m, 148 ft) in the Malmberget case). 115 mm (4.5 in) holes have been used for a long time, the drill string is stiff and therefore suitable for drilling fairly long holes without having major problems with borehole trajectory deviations. Tests with 89 and 102 mm (3.5 and 4 in) holes has been carried out lately. The main reason for that is reducing vibrations. It appears that the vibrations have been reduced as expected. Measurements of the borehole trajectory deviation shows, so far, that 89 mm (3.5 in) holes could be a problem when drilling holes longer than about 30 m (98 ft) but 4 in holes seems to be comparable with 115 mm (4.5 in) holes. Smaller diameter holes will be further used in the mine in orebodies were vibrations is an issue.

In-house developed software

An in-house software has been developed to handle vibrations recorded both in Kiruna and Malmberget. The software enables to:

- Download vibration data (including waveforms when needed) using NcVib API (Application programming interface).
- Import data from LKABs mine system Giron (boreholes, rings, blasting date etc.).
- Import data from seismic events with a local magnitude larger than 0.5. Smaller seismic events will most likely not be recorded on the surface since the trigging level is about 0.4-0.5 mm/s (0.02 in/s).

All data is stored in a PC type of database.

Recorded vibrations are classified into 5 classes, see Table 2. The classification is done automatically by the software but manual editing is also carried out when needed.

Class #	Description	Remark
1	Blasting event	The event is recorded during the time period (00-01at night) when blasting occurs. No corresponding seismic event is present.
2	Seismic event	The recorded vibration coincide in time with a recorded seismic event in the mine. The event is recorded outside the blasting time period.
3	Blasting or seismic event	A seismic event is recorded during the blasting time period and corresponds in time to the vibration. A more detailed study of the signals is needed to clarify the actual event type.
4	Probable seismic event	Vibrations are recorded in the town area by two or more geophones. No corresponding event is recorded by the underground seismic system. This occurs rarely and is often related to caving fairly close to the surface.
5	Other event types	All other types of events, some examples are road work, traffic etc.

Table 2. Classification of recorded vibrations.

Prediction of vibrations

PCPVs are predicted using the well-known "scaling law", see equation 1 below.

Equation 1 $$V = A \cdot \left(\frac{R}{\sqrt{W}}\right)^{-B}$$

Where,

V =particle velocity (mm/s) (in/s), in this case the PCPV
W =charge weight per 8 millisecond delay (kg) (lbs)
R =distance from the blast to the measurement point (m) (ft)
A,B ="Constants" varying with foundation and rock conditions, blasting geometry, type of explosives

$\frac{R}{\sqrt{W}}$ is often referred as scaled distance (SD).

V (PCPV in this case) can be plotted versus SD in a log-log diagram, A and B can then be estimated using a regression line. This line can be used to predict the average vibration. By shifting the line vertically until all data points are below the line a new line is derived (the slope of the line should remain the same). This line describes the expected maximum vibration versus scaled distance, see Figure 6.

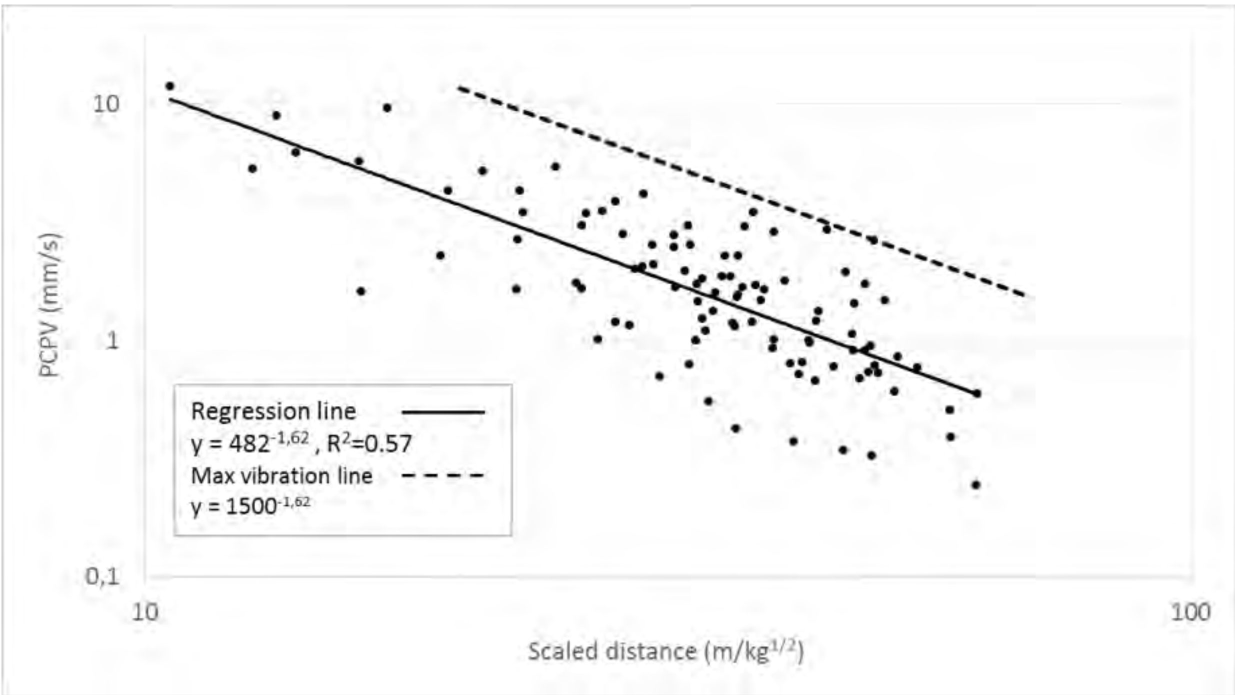

Figure 6. Principal component particle velocity (PCPV) versus scaled distance. The data points are randomly generated and not measured.

The estimate is, of course, based on available data. A long series of data results in a more reliable prediction than a short series. In the Malmberget case we have almost 50000 recordings in the DB starting at year 2002. However only a part of these recordings is useful for predicting maximum vibrations. Many recordings are related to blasting in orebodies located far away for the city. Another issue is the mining method and possible screening effects. In some situations we have more or less intact rock all the way between the blast and the measurement point besides soil on surface. In other cases we might have entirely broken rock or fractured rock situations on parts of the direct seismic ray path. The seismic waves cannot pass through broken rock effectively. They will “go around” these obstacles, a screening effect is present. We observe, as expected, reduced vibration levels in these cases.

The in-house software mentioned earlier uses this method to predict maximum PCPV. The user defines the extension of a grid on surface including the grid cell size (typical 20 m, 66 ft)). The distance between the center of each grid cell and the center of the longest charge column (planned data) in a ring is calculated. The charge weight is estimated using the density of the used bulk emulsion, planned borehole diameter and the planned length of the charge column. The maximum PCPV can then be estimated for this single borehole and grid cell center. By repeating the calculation for all rings of interest (hundreds or even thousands) and all grid cells a color coded map can be plotted showing the maximum PCPV in each cell.

In the beginning constant elevation were used in the grid since elevation data were not easily accessible. Today the elevation is based on accurate laser scanning data which improves the estimate.

There are two limits in the current regulation, target and upper limit. The predicted maximum vibration is compared with the upper limit which must not be exceeded. The target limit can be exceeded up to 5 % of the cases (corresponds to 95 % percentile) on a yearly basis for each measurement point. Since blasting is carried out almost every day this corresponds to a total of 18 times/year.

The deviation from the regression line, $\log(V_m)$-$\log(V_{rl})$, for a measured particle velocity can be expressed as follows, see Equation 2.

Equation 2

$If\ \Delta V = \frac{-}{-}$ then $\log(\Delta V) = \log\left(\frac{-}{-}\right) = \log(V\quad) - \log(V_{rl})$

Where,

V_m =Measured particle velocity (PCPV in this case)

V_{rl} =Particle velocity (PCPV in this case) estimated from the regression line

According to the scaling law formula it is reasonable to assume a log-normal distribution for ΔV. If so then ln(ΔV) is normally distributed and also any base, except 1, of the logarithmic function i.e log(ΔV) can also be used. The method used to estimate the 95 % percentile uses a normal distribution for log(ΔV) and a random generator. Many (tens or even hundreds) random numbers are generated for each combination of borehole and grid cell. The PCPVs are calculated for each case, $V_m=\Delta V \cdot V_{rl}$, and stored in a sorted list. The calculation is then repeated for all rings of interest and all grid cells. The 95 % percentile is then plotted in the grid using color coding. Examples of two log-normal distributions are shown in Figure 7.

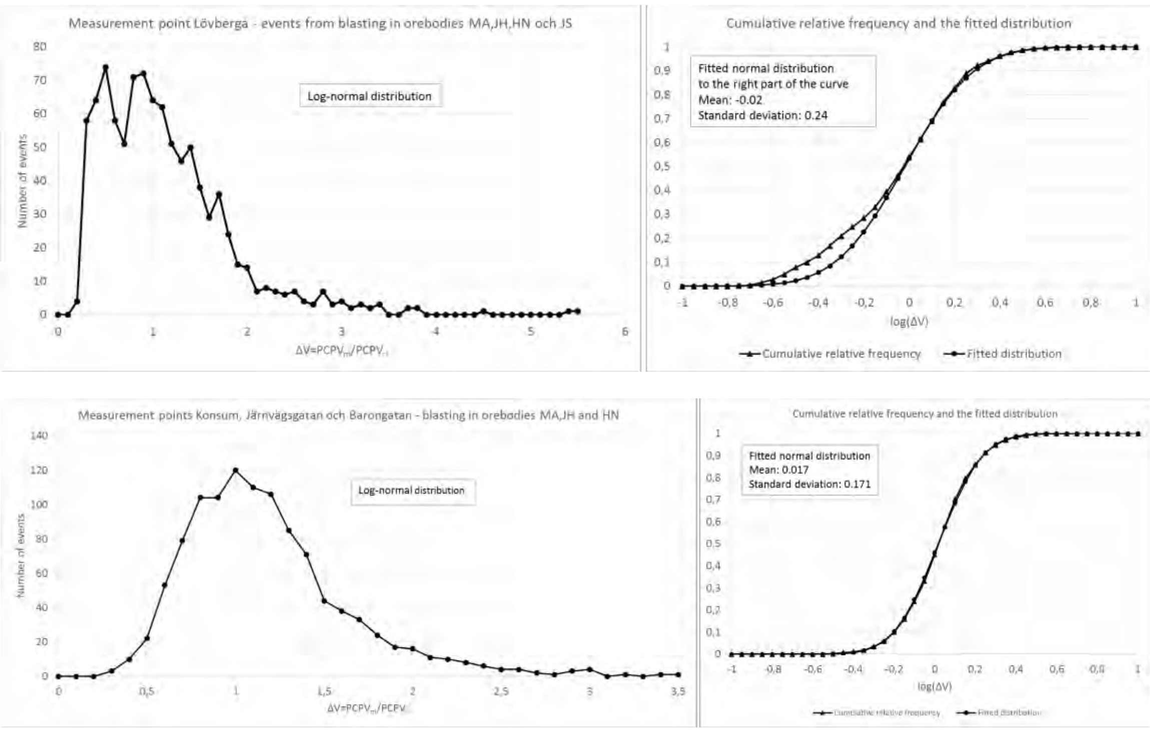

Figure 7. Examples of log-normal distributions.

Linking recorded vibrations to a specific blast

Automatic linking, using the in-house software, of the recorded vibrations to a specific blast is, so far, carried out by calculating the scaled distance using the longest charge column in each blasted ring together with the measurement points of interest. The ring with the lowest scaled distance is linked to the highest recorded vibration and so on. Other recorded signals corresponding to the same event are also linked to the same ring. This technique works reasonably well for rings located fairly close to a measurement point but there are situations where it fails. One example are rings located far away from the closest measurement point another example is screening effects where reduced vibrations are recorded. There is a need to improve the automatic linking of recorded vibrations to a specific blast. One possibility could be utilizing the underground seismic network data. Another possibility is to locate the events using recorded vibrations on surface.

Evaluating the blast performance

A newer type of vibration monitoring units have been installed starting about 6 years ago. The entire waveform is stored and also accessible via NcVib. This opens up the possibility to use these signals for evaluating the blast performance. Figure 8 shows a 9 hole blast using LP 0-8 delays, the uppermost diagram is the recorded signal and the other processed signals. It appears that the charge corresponding to LP1 is not detonating as expected in this particular case. It should however be pointed out that only a part of all blasts and only some measurement points are suitable for this simple analysis. It is often a question of the distance from the blast to the measurement point. Sharp signals with fairly short duration are expected close to a blast. Low frequencies dominates at larger distances and the arrival time lag for the S-wave reaches the LP (long period) delay of 100 ms at a distance of about 800 m (2625 ft).

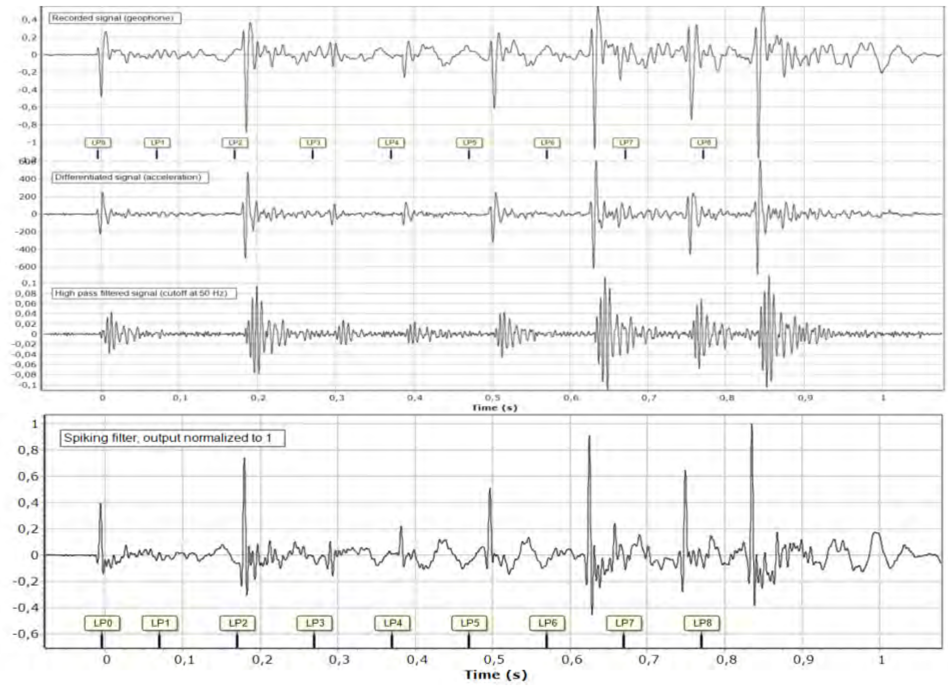

Figure 8. Example of using vibrations recorded on surface to evaluate blast performance.

Conclusion and Future Work

The current regulation on blast induced vibrations will be a challenge for the Malmberget mine together with the timing of the urban transformation. A number of different methods to reduce vibrations has been tested and reported earlier and some also still adopted when applicable. Lately, smaller diameter blastholes has become another alternative to reduce vibrations. Borehole trajectory deviation issues may limit the use of especially 89 mm (3.5 in) holes but 102 mm (4 in) holes appears to be more promising so far. Further trials will give a definite answer. The number of recorded vibrations is large in Malmberget. There are not only blasting events but also seismic events. There is a need to classify all recorded vibrations. It is also important to handle all data in an efficient way. The in-house software uses a PC type of a database and can be used to predict vibrations.

Improved automatic linking of recorded vibrations to a specific ring is an area of future work. Another area could be improved signal processing when using vibrations for evaluating the blast performance.

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Anders Nordqvist, LKAB, Sweden

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Meeting of The Group of Experts on Explosives 2018

The annual meeting of the group of experts concerning explosives from the member states of the European Union occurred in Brussels the 22nd October 2018. Since Mr. Federico Musso, the former leader of the working committee transferred to a different remit at the beginning of this year, Mrs. Lina Karbauskaite, the new leader of the department for explosives of the European union, conducted this year's meeting.

The agenda of the meeting included without limitation following points:

- Which consequences is the approaching Brexit, the withdrawal of the United Kingdom from the European union going to have the 30th March 2019?
- Report about the work of the standardization committee for explosives under taking account of the following topics:
  - Electronical Detonator systems
  - Mobile Explosives Manufacturing Unit (MEMU)
- Report of AdCo-Group for explosives
- Report about the work of the Notified Bodies for Explosives (ENB)

The topic Brexit and the associated consequences for the department of explosives have to be observed for the further planning/organization and their business activities by the affected firms (manufacturer, merchants, end-users).

There are basically two possible scenarios to regard:

1. *Contractual withdrawal of the United Kingdom from the European union*

   In this case exists the possibility of the sorted regulation of all questions concerning the former existing Notified Bodies for Explosives (ENB) of the United Kingdom - the Health and Safety Laboratory (HSL) who granted the EC type-examination for explosives. With the withdrawal from the EU every EC type-examination granted by the Health and Safety Laboratory (HSL) loses its validity if no contractual regulation about the management of the in future granted decrees are made. In this case the production and end-use (blasting industry) would not be possible anymore even though a HSL - EC type-examination is present.
   A possible solution to this problem could be the transmission of the now existing decrees granted by the HSL to a different Notified Bodies for Explosives (ENB) of the EU. This could be regulated with an applicable contract.

2. *Withdrawal of the United Kingdom from the EU without contractual regulation (no-deal-Brexit)*

   In this case the production, trade and use of explosives that hold an EC type-examination by the HSL would not be possible anymore. This would have the consequence for the affected companies of not being able to produce for the EU market and so the products could also not be used anymore.

It's clear to see that the topic Brexit has extensive consequences for the department of explosives too. That's why there is an existential importance for the affected companies to dispute with this topic. Otherwise there is a huge problem for the companies and their business after the 29th March 2019.

The item of the agenda "standardization of explosives" did not only deal with ideas for the steady development of the standardization but also with the creation of a standard for electronical detonators and the production of explosives using Mobile Explosives Manufacturing Unit (MEMU). Since there is no EU-wide standard for electronical detonators, the creation of one is desirable. In this context it has to be discussed to which extent the standard defines the requirements for the equipment and the programming and release of the electronical detonators. Concerning the production of explosives using Mobile Explosives Manufacturing Unit we have to pay attention to the question of quality management. Since this affects certain parts of Mobile Explosives Manufacturing Unit facilities and this topic is really new concerning a standardization, it has to be dealt with a norm. It is blatant that the produced explosives trough the MEMU possess an EC type-examination and a CE-Sign when they are provided at the EU market. Hints and ideas for the standardization and the creation of the norm by the industry are welcome.

The can be transmitted over the European Federation of Explosives Engineers (EFEE) and passed on to the committees. It's clearly recognizable that the attendance of all national groups of interest concerning the department of explosives over the European Federation of Explosives Engineers (EFEE) in Brussels is more than important so that the active creation of laws, norms and regulations can be done regarding every group of interest.

Jörg Rennert - Member of the Board, EFEE

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May You Use Any Explosives in Europe?

Introduction: Risks of Blasting

Engraved by seldom, spectacular incidents and accidents plus the showing of that by media, but also the presentation of explosions in the art i.e. any kind movies, television and computer games, blasting is perceived to be dangerous to our societies in general. Therefore there are not only very positive impressions from that on the image[1] of occasional very valuable activities[2], which have blasting as precondition.

It is usual and correct to evaluate risks[3] as a "*product of negative consequences and probability of occurrence*". When evaluating the risk of blasting it could occur that the risk is due to the very low probability of occurrence evaluated as very low. But this meets no truth. The main component of the risk in blasting is the negative consequence. And that is driven by a huge mass of (negative consequence creating) energy inside the explosives. Also the dynamic of the occurrence of negative consequences is decisive. It is a difference between a sudden accident and a slow moving incident. So it is very clear that the good performing explosives bring so much energy and so much dynamic, that - when blasting – you always have to take into account and minimize the risk of fatal or very serious accidents[4].

All with blasting and explosives involved persons need a proactive approach[5] to safety themes.

[1] The social acceptance of blasting is decisive for blasting. The overwhelming wish of our societies for integrity of the nature is in evidence. The field of tensions created by economy, ecology and social items creates high requirements for blasting. Good risk management should not only create better safety and better environmental protection, but also lead to better functionality and better competitiveness.

[2] A lot of building-materials can be produced only by blasting, so motorways, bridges, factories, power plants, buildings need blasting. Most of the metal ores can only be produced by blasting, so, no metals without explosives. The same fits for industrial minerals. Most of the underground infrastructures like tunnels for roads and railways or for hydro power plants are not possible without blasting. So, mobility and energy supply are depending on explosives.

[3] No paralysis by analysis. Realizable results are needed in practice.

[4] When operation in (and with) the nature (earth crust), always not calculable sources of hazards can occur. It is not possible to live without hazards and risks; therefore it is necessary to find good ways of coexistence with hazards. Respect and discipline is of utmost importance. Blasting should not be reduced on technology, but also taking the human factors into account.

[5] Three resistance lines should be helpful for enhanced safety:

- Perfect design and implementation: perfect risk assessment with excellent planning of production processes and routines, organisation with a clear allocation of tasks and clear structure of responsibilities, deployment of trained personnel, always following of rules and standards, excellent implementation of the excellent planning. But unfortunately humans are not perfect, and if, than not every day.
- Mindfulness and flexibility: Concentration on failures, aversion to simplifications, sensitisation of operational processes, quest for flexibility, respect for expert knowledge. But unfortunately humans are not perfect mindful, and if, than not every day.
- Overcoming each and every crisis with an effective crisis management. But unfortunately humans are not perfect stress resistant, and if, than not every day.

Systematic risk management normally tries first to reduce the negative consequences and second tries to reduce probability of occurrence of damage.

- The expected level of damage requires considerable respect, especially since the damage severity of blasting cannot be easily influenced[6]. The (potentially damaging) energy contained in the system (explosives) and released arbitrarily is needed for the blasting work and should therefore not be eliminated.
- The probability of occurrence[7] of personal injury is low because of the low frequency of incidents (showed by accident statistics). However, this must not lead to a low estimate of the risk. To reduce the likelihood of occurrence, first and foremost, qualified attentiveness by qualified specialists is necessary. Supports for the qualified specialist are optimized processes of blasting work and optimal, handling-safe explosives, blasting and detonating agents.

[6] One of the commonly used strategies in blasting involves the removal of people (items of protection) from the danger area. Partly it is also worked with the covering of blast sites with protective mats.

[7] With regard to the likelihood of occurrence, one must confidently adhere to Aristotle: "It is probable that the improbable can happen." And even the most unlikely things happen. Whether one adheres to the thesis "accidents arise from the accidental interaction of unfavorable circumstances" or the thesis "accidents are carefully prepared by human action, otherwise it could not get that far", only plays a role insofar as that only human behavior can be changed.

Although today it is practically always assumed that only the best blasting means are used, the question of the importance of optimal, handling-safe explosives will be examined below.

CE-Mark

The European Union[8] concept of CE marking was aimed at eliminating barriers to trade in products while respecting the minimum safety and health aspects. Historically, this European concept was very innovative, today it is effective reality. Here is, however, the economic component or the free movement of goods in the foreground. Who meets the minimum safety level, has free movement in the internal market. This applies to the placing on the market of machinery, equipment, Teddy bears, explosives, etc. In the obligatory case of national implementation[9] of

[8] The European Union (EU) is a political and economic union (work in progress) of 28 member states (i.e. France, Germany, Finland, Portugal etc.) that are located primarily in Europe. It has an estimated population of over 510 million. The EU has developed an internal single market through a standardised system of laws that apply in all member states. EU policies aim to ensure the free movement of people, goods, services, and capital within the internal market, enact legislation in justice and home affairs, and maintain common policies on trade, agriculture, fisheries, and regional development. Within the Schengen Area, passport controls have been abolished. A monetary union was established in 1999 and came into full force in 2002, and is composed of 19 EU member states which use the euro currency.

[9] A small digression: Within the European Union, all 28 member states basically have sovereignty with a separate legal system (legislation, government and jurisdiction). So there are 28 historically evolved legal systems that can be grouped into 4 groups because of similarities: Anglo-Saxon legal system, Romanic legal system, German legal system and post-communist legal system. Now, all EU directives must

such EU directives, the scale is 1: 1; Deviations up or down are not provided. Thus, if there is a valid CE marking, explosives may be placed on the EU market. This applies, for example, to black powder and gelatinous explosives as well as to modern emulsion explosives. With regard to the use of explosives, however, a differentiated consideration of what the CE marking (intended use) and what the manufacturer's instructions show, is necessary. But, with regard to a specific application, can it really be allowed to work with less safe explosives?

Restrictions on the Use of Explosives

In a differentiated consideration of the use of explosives, a turn to other provisions of the complex legal system is necessary.

- The central regulation[10] in European workers' protection is the identification and assessment of risks and the definition of measures (workplace evaluation) and their documentation in a health and safety document in a control cycle (... to evaluate the risks ...).
- A hierarchy of measures is legally provided for the use of hazardous substances for the protection of workers.
- Limit values for maximum concentrations of air pollutants for workers are legally standardized[11].
- In water protection, limit values for the pollution of waters by explosives residues in dumps and heaps are relevant.
- In much legislation relevant to mines or quarries or tunnels compliance with the best of technology or the best state of the art is provided for.

Evaluation of Risks

From a historical point of view, everything that is of interest to society around the subject of explosives and detonators has been and still is regulated by law. Production, processing, trade, acquisition, possession, shipment, import and transit, storage, transfer, disposal of explosives, storage of explosives, quality of explosives, blasting, blasting and transport are regulated by law. However, when it becomes concrete with blasting work, the employer is assigned very essential tasks (= responsibility) with regard to the evaluation of risks. The employer is responsible for the performance in health and safety when blasting. Delegation of this task to the shot firer is possible, but requires scrutiny!

be adopted by each member state into its own legal system. Over the years and decades, this process will gradually lead to a good harmonization of legal systems. So EU is a complex process, maybe – or not – on the way to create a unified state construction.

[10] This is implemented in all European Member states.

[11] The determination of the concrete limit values takes place in the European concert. Accordingly, the limit values for nitrogen oxides (NO and NO_2) relevant for explosive work will be significantly reduced in Austria as well.

Part of the risk evaluation is, of course, the selection of suitable explosives. Basically, the selection of explosives - taking into account the state of the art - is also about avoiding risks and reducing potential hazards. In the preferred combat at the source (= explosives) is

- greater handling safety (lower sensitivity to mechanical stress, for example, in the case of (without this being prohibited) re-drilling of boreholes or, for example, in securing and clearing the working face and elms or quarry face,
- or a reduced load of vapors and gases from the explosive,
- or a reduced absorption of harmful substances through the skin,
- or in underground applications a reduced load from swaths to be preferred.

Use of working substances

When determining and assessing the hazards of working substances, the first duty is to ascertain whether they are hazardous agents. For explosives, this can generally be said to be in the affirmative, but the properties of the explosives have to be assessed and the dangers that explosives may pose due to their properties or the nature of their use must be assessed. And here it all depends on the actual explosive, whereby it is logical[12] that explosives, which exhibit less dangerous characteristics, are to be preferred; if an equivalent work result can be achieved.

"MAK Values" (Maximum Workplace Concentration)

Of course, the MAK values (Maximum Workplace Concentration) apply equally regardless of the location, but underground days MAK values are actually of high practical relevance[13]. The MAK values for carbon monoxide (CO = 30 ppm), nitric oxide (NO = 25 ppm), nitrogen dioxide (NO_2 = 3 ppm), which are applicable according to the national limit value regulation, are replaced by the necessary transposition of Directive (EU) 2017/164 Commission of 31 January 2017 (fourth list for the establishment of indicative occupational exposure limits) must be significantly reduced in national law. The new MAK values will then become

- for CO - 20 ppm (previously 30 ppm),
- for NO - 2 ppm (previously 25 ppm) and
- For NO_2 - must be 0.5 ppm[14] (previously 3 ppm) [15].

[12] If one now uses § 42 (3) in conjunction with (1) and (2) Austrian Workers Protection Act, then - provided that the associated expense is justifiable - it is also legally required to use explosives with less danger.

[13] Typically, carbon dioxide (CO2), carbon monoxide (CO), nitrogen oxide (NO), nitrogen dioxide (NO2), hydrogen sulfide (H2S), sulfur dioxide (SO2) are the focus of attention. For explosives also MAK values for nitroglycol, nitroglycerine, 2,4,6 trinitrotoluene or the TRK value for 2,6 dinitrotoluene are relevant. In any case, there is general awareness of the fatal consequences of inhaling toxic carbon monoxide and poisonous nitrous gases among all shot firers.

[14] Germany and USA: 5 ppm.

[15] First, there are concerns about the technical feasibility of workplace directivity limits for NO and NO_2 in tunneling and for CO, NO and NO_2 in underground construction. Another challenge is that

These massive legal changes mean that all underground activities where explosive work is carried out require a drastic change, the feasibility of which is uncertain. For tunneling NO and NO_2 and for underground mining, CO, NO and NO_2 will become challenging. The contribution of mining equipment (Diesel engines) also will be very challenging. As regards the transitional period for tunneling and underground mining until 21 August 2023 and the prospective review of these new limits by the European Commission, the outcome of this examination is uncertain. In addition to the technical questions (technical feasibility, measurability), concrete occupational medical evidence from tunneling and underground mining will also play a role. In any case, this development - not only, but also - has a significant impact on the selection of explosives for underground use. Here already the Austrian Construction Worker Protection Act leaves no room for misguided evaluation results and normalizes that in the underground construction with explosive propulsion such explosives must be used, which have in the swaths the smallest possible portion of poisonous gases, like emulsion explosives.

there are problems with the availability of measurement methods to demonstrate compliance with the new limit values for CO, NO and NO_2 in underground mining and tunneling. Therefore, Member States may apply a transitional period until 21 August 2023 for these thresholds for tunneling and underground construction. Before the expiry of this deadline, a review of the concerns (technical feasibility, measurability) by the European Commission is foreseen.

Water Protection

Essentially it is about swaths in the heap and the effects of explosive remnants[16] that enter the water as eluate[17]. Again, the right explosives can achieve better results. Austrian emulsion explosives have about no toxic components. The "drop-drop" of pump able emulsion explosives is a matter of order and cleanliness.

State of the Art

About the state of the art in explosives a differentiated consideration is necessary, even black powder have a state of the art, which must comply with it, even gelatinous explosives have a state of the art, they must comply, which then also applies to TNT booster and for modern emulsion explosives. The realization of the state of art is probably also the prerequisite for the CE marking of individual explosives. However, this analysis does not provide any support for the selection of the right explosive according to the principles relevant to the safety of blasting operations. This is about the best handling safety and in underground for the best swath result.

[16] Remains of explosives in the heap result from the quality of the blasting work in conjunction with the explosives used. Non-working of the explosives may be the cause here.

[17] Especially the dumping of large amounts of tunnel excavation material plays a role.

Black Powder

Of course, the historical significance[18] of black powder (Berthold Schwarz[19]) is considerable. However, black powder is particularly sensitive to shock, impact, friction, sparks and flame, and accordingly the most dangerous explosive in terms of handling safety. Here, the Austrian Blasting Ordinance leaves no room for misguided evaluation results, for blasting with black powder workers may not be employed. The outdated application of black powder plays neither a role in constructive civil engineering nor raw material extraction, it is industrially insignificant, but it is very likely to continue to exist in crude block extraction, for example in granite quarries, in pyrotechnics and in poaching and adventurous areas.

What Do Emulsion Explosives Mean the Use of Gelatinous Explosives

Historically, gelatinous explosives have been a great story that has fueled the industrial development of the world, be it the construction of infrastructures or the extraction of solid mineral resources (metals, industrial minerals, construction minerals, ...), a tribute to *Ascanio Sobrero* (nitroglycerin) and *Alfred Nobel* (dynamite, blasting gelatin) is quite appropriate. For then conditions, the handling safety was a significant advance; these were once well-functioning explosives. For today's applications, however, there are some limitations according to current knowledge:

- Even in the safety-optimized, industrial production of gelatinous explosives[20], there have always been serious accidents.
- The transport risks are higher for gelatinous explosives compared to pump able emulsion explosives, which are produced only in the borehole. Explosive substances are transported.
- Usage risks are higher with gelatinous explosives[21]:
    - Absorption of blasting oil by breathing;
    - Absorption of blasting oil through the skin;
    - Handling safety – higher sensitivity due to blasting oil;
    - Drilling or re-drilling into explosives in boreholes[22] as serious risk;

[18] On 16 February 1627, the first demonstrable blast in mining took place in the former upper Hungarian mining town of Schemnitz (today Banská Štiavnica in Slovakia) by the Tyrolean Caspar Weindl.

[19] Schwarz is the name of the monk, but Schwarz has in German also the meaning of black as a color.

[20].The sticking point remains the very sensitive to friction, spark and shock sensitive blasting oil! One example is the serious accident in St. Lambrecht in 2008. Also basically acceptable-small residual risks can be realized.

[21] Dangerous substances should be replaced by less dangerous substances!

[22] Or other mechanical stress on explosive remnants, for example, when securing and clearing the working face and elms or break walls. For example, in Austria in 2012 a 54-year-old excavator driver succumbed to his severe injuries sustained in an explosion in his home district at the end of October. According to expert opinion, the excavator has triggered the explosion of a residual charge "dynamite", which came from a blast in the week before and had not gone up (source: Oberösterreich Heute.at). For example, from Safety Allert No. 62/22 January 2013,

- Swath risk is not only high in the light of the new limits.
- Risk of aging - the exudation of explosive oil or other signs of decomposition impairs the handling safety of the then spoiled gelatinous explosive.
- The storage risks are higher in the case of gelatinous explosives compared to pump able emulsion explosives, which are formed only in the borehole. Explosives are stored, blasting agent storage is necessary.

The better explosive is the enemy of the good explosive. The emulsion explosives, as "new", alternative, handling-safe explosives are very well available on the market. And emulsion explosives can blast everything[23]

Queensland, Explosives Inspectorate: Drilling Vehicle Drills on Residual Explosives - Nobody Discovered the Borehole Box Because It Was Covered Under the Shotcrete. For example, Geilo, Norway 2014: 3 dead and several injured in dynamite explosion in railway construction. For example, explosion accident in Valdres, 2016, An excavator cleaned the tunnel wall after blasting, he hit an explosive charge that remained in the wall and exploded. The stones have broken through the cabin and it indicates that the driver died immediately. Next time - next example?

[23] Emulsion explosives offer not only more safety but also other benefits:

- Transport, handling and storage easier
- Universal explosive - can "everything"
- "String Loading"
- Different density
- Excellent water resistance
- Full loading of the space in the borehole
- Meanwhile improved detonation speed
- Meanwhile improved working conditions
- Accurate record of spent explosive

that is required for a good blasting performance and they are safety superior:

- Low mechanical and thermal sensitivity - high handling safety
- No toxic components
- Practically no unintentional implementation by drilling in explosives remnants in the borehole[24]
- Significantly lower levels of toxic components in the swaths.

Conclusion

The use of gelatinous explosives is technically outdated and legally questionable at least. Replacement by emulsion explosives is possible and useful. Any serious hazard or risk evaluation indicates that the emulsion explosives are to be preferred over the gelatinous explosives. The owner of the first case will probably have to deal with it criminally in detail.

Also gelatinous explosives will fall from the industrial market like before black powder.

For both civil engineering and resource extraction, there is a need for improvement in all areas: better planning, better facilities, better equipment, better feedstock, better processes, and

[24] In contrast, an emulsion explosive loses its properties as an explosive by "dead pressing" or segregation.

ultimately, the best-skilled employees.

Room for improvement is available in daily practice. A simple, inexpensive and effective improvement is the optimal use of the best explosives.

Good luck!

Alfred Maier

glueckauf.maier@gmail.com

30 Years of EFEE

This autumn, the Annual Counsel Meeting of EFEE was more festive than usual. On a very fine evening of September in Dresden, the members of EFEE Board and Counsel and their spouses gathered to a beautiful place called Blasewitz & Loschwitz in Alstadt Centre, Dresden. Thanks to a great help and organisational skills of Jörg Rennert we were able to celebrate the jubilee of the European Federation of Explosives Engineers all together in a beautifully suitable place, looking down from a terrass on wine yards and river Elbe.

Before the formal dinner we raised glasses - to the sunset, to friendship and of course to a long lasting unity of explosives engineers in Europe. It was a moment of remembering how it all started, how the federation has grown and what would the future look like. Walter Werner, one of the founders of EFEE shared his memories about the first meetings, Jari Honkanen, the President of EFEE gave insight to great hopes for the future and Jörg Rennert, Member of the Board of EFEE and our host talked about the historical connection of EFEE and Germany and invited us all to enjoy the dinner.

The Board members, Counsel members and their spouses gathered for the celebration

Walter Werner, Jöerg Rennert and Jari Honkanen

30 years is a good reason to celebrate

A beautiful evening together with friends from EFEE

A look at the past 30 years (1988 to 2018)

During the conference of the American Society of Explosives Engineers in 1988, now named ISEE, At Anaheim/California several colleagues from Europe met, among them Roger Holmberg and Walter Werner (Germany). The conference of the American Society of Explosives Engineers was good, even though the thought and idea was obvious; that the Europeans could manage something similar. Werner had earlier been in contact with several explosives specialists he had met at the international conferences at Linz/Austria and Budapest/Hungary.

W. Werner being the president of the German Blaster's Association invited his colleagues to Aachen in West- Germany to establish a European institute of explosives engineers. Aachen was chosen by Werner because it was situated in the center of Middle-Europe close to the Netherlands and Belgium.

Picture of lineup from EFEE foundation meeting 1988, in Aachen. Witzgall, Becker, Fink, Broadhurst (GB), Ebner, Grünfeld (NL), Böking, Peeters (NL), Dell, Werner, Fardel (CH), Gysin (CH), Groves (GB), Vogt-Sasse, Roller and also Raimo Vuolio (Fin) included.

Five nations were present at October 20th, 1988 when EFEE was founded: Finland (Raimo Vuolio), the Netherlands (Henk Grünfeld and Joep Peeters), Switzerland (Didier Fardel and Hans Gysin), UK (Ken Broadhurst and Mike Groves) and Germany with nearly the complete board of the German association. Roger Holmberg, Sweden showed interest, but sent an apology as well as Austria. Both countries joined EFEE later. After long discussions regarding the English name of the organization, with suggestions as "European Explosives Engineering Institute", the name was finally decided to be the present name "European Federation of Explosives Engineers" (EFEE). The German name easily followed "Europäischer Sprengverband", copying the German Blaster's Association. Fortunately there was with Didier Fardel a French speaking colleague and the French name was found as "Fédération Européenne des Specialistes de Minage". The difficulty with finding a suitable name was an indication of one of EFEE´s and EU´s future challenges in the big variety of languages.

Different EFEE logos through time.

FIRST MEETING OF THE
EURPEAN EXPLOSIVES ENGINEERINGS INSTITUTES
AND RELATDE ORGANISATIONS IN AACHEN
ON SATURDAY 22 OCTOBER 1988
AT THE NOVOTEL AT 110o HOURS
(OFFICIAL ENGLISH VERSION)

Present:

Chairman: Herr Walter WERNER , Germany

Delegations: Germany Deutscher Sprengverband:

Mr. Laszlo Ebner (Dipl.-Ing.) Vice-President
M. Christiane Dell Secretary
Mr. Wilfried Vogt-Sasse (Dipl.-Ing.)
Mr. Wilhelm Witzgall
Mr. Konrad Fink
Mr. Karl-Heinz Böcking
Mr. Kurt Becker

Germany Deutscher Abbruchverband:

Mr. Helmut Roller (Dipl.-Ing.)

Netherlands Nederlands Verenigung van Springmeesters:

Mr. Henk Grünfeld (President)
Mr. Joep Peeters (Secretary)

Switzerland Verband der Schweizerischen Sprenfachleute (VSSF):

Mr. Hans Gysin
Mr. Didier Fardel

Finland

Mr. Raimo Vuolio Lic, SC

United Kindom Institute of Explosives Engineers

Mr. Ken Broadhurst FIExpE, President IExpE
Mr. Mike Groves MIExpE, Council Member (Europe)

Apologies were received from the following delegation:

Austria

ACTION

Telephone: 0533-538915
Telex: 342200MKLERN G
FAX: 0533-511754

22. **Finance from Community Sources (EEC)**

a. **The Netherlands Delegation** offered to investigate methods of funding Federation meetings/market research.
Note: All present thanked the Netherlands Delegation

Note: All present agreed to seek advice on a National basis — All

23. Publicity

a. **Each Nations Delegation** to publish details of the Federation in its own Journals. — All
Note: UK Delegation offered the Federation space in its Journal. Articles (in English, French, German) by 1 December 1988 to Secretariat (UK).

b. **Each Nation** to circulate details of the Federation to Government departments. Official Federation announcements to be made once Logo is agreed and paper is printed. — All

Item 10 **DETAILS OF NEXT FEDERATION MEETING**

25. **Place:** **Falcon Hotel**
Chapel Street
Stratford-upon-Avon
CV37 6HA
ENGLAND

Telex: 312522
FAX: 0789-414260

26. **Date:** Saturday 21 April 1989

27. **Time:** to be arranged

Signed: Walter Werner
President of EFEE

Signed: K. G. Broadhurst
President of IExpE

Signed: M. Groves
European Member for IExpE

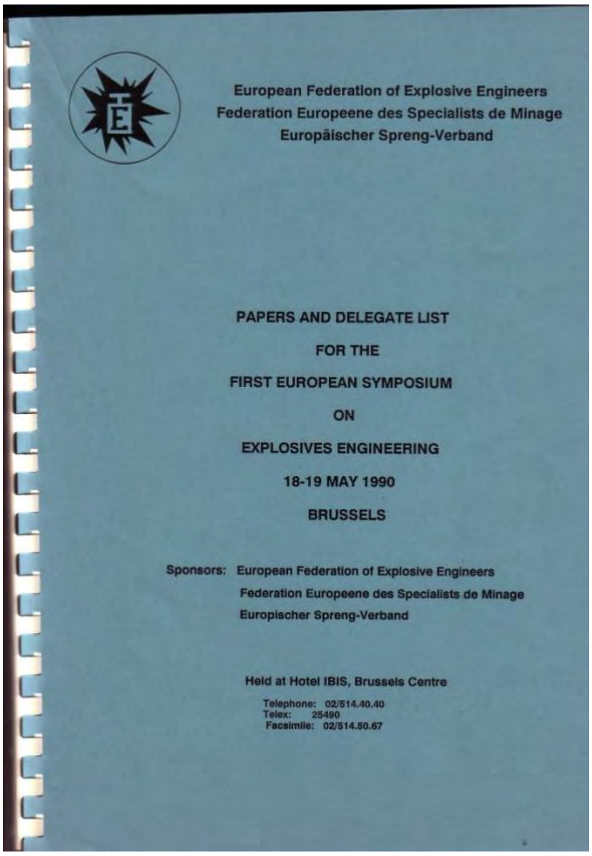
The First and last page of the first minutes of an EFEE meeting, Aachen 1988.

Walter Werner was elected as the first President for the period 1988-1999. The presidents of EFEE until 2014 are listed below:

Period	President	Country
1988-1989	Walter Werner	Germany
1989-1991	Ken Broadhurst	UK
1991-1992	Henk Grünfeld	Netherlands
1992-1993	Hans Solenthaler	Switzerland
1993-1994	Björn Jonsson	Sweden
1994-1995	Herbert Holluba	Austria
1995-1996	Jørgen Schneider	Denmark

1997-1998	Raimo Vuolio	Finland
1998-2000	Rolf Schillinger	Germany
2000-2002	Aslak Ravlo	Norway
2002-2003	Remy Müller	Switzerland
2003-2004	Heinz Berger	Austria
2005-2006	Mark Hatt	United Kingdom
2007-2008	Roger Holmberg	Sweden
2008-2009	José Carlos Gois	Portugal
2010-2011	Donald Jonson	Sweden
2012-2013	Jörg Rennert	Germany
2014-2016	Johan Finsteen Gjødvad	Denmark
2016-2018	Igor Kopal	Republic of Slovakia
2018 -	Jari Honkanen	Finland

In May 1990 a first EFEE – conference was held in Brussels with, now counting 9 nations and more than 90 participants.



European Federation of Explosive Engineers
Federation Europeene des Specialists de Minage
Europäischer Spreng-Verband

PAPERS AND DELEGATE LIST
FOR THE
FIRST EUROPEAN SYMPOSIUM
ON
EXPLOSIVES ENGINEERING
18-19 MAY 1990
BRUSSELS

Sponsors: European Federation of Explosive Engineers
Federation Europeene des Specialists de Minage
Europischer Spreng-Verband

Held at Hotel IBIS, Brussels Centre
Telephone: 02/514.40.40
Telex: 25490
Facsimile: 02/514.50.67

European Federation of Explosive Engineers
Enclosure
Federation Europeene des Specialists de Minage
Europaischer Spreng-Verband

Please reply to:

M P GROVES MIExpE
Academic Registrar
RMCS
Shrivenham
SWINDON
Wiltshire SN6 8LA
United Kingdom

SUBJECTS AND PRESENTING COUNTRIES

1.	Transportation and Security	Austria
2.	Quarrying Systems	Switzerland
3.	Initiation Systems	Sweden
4.	Precision Blasting	Denmark
5.	Shaped Charge Design	UK
6.	Decommissioning Nuclear Power Plants	Germany
7.	Collapse Mechanisms	Netherlands
8.	Environmental Aspects	Belgium
9.	Blasting Software and Sequential Blasting	France
10.	Vibration Effects, Standards	UK

11. **Note:** Visiting Speakers would be invited by Council from:
(a) **FEEM**, to speak on "Reliability, Safety and Management as applied to the Design of Explosive Systems".
(b) **The Commission**, to speak on their problems and how the Federation can help them.

Proceedings and program, Symposium at Brussels April 1990.

Even though the next conference the 1st "EFEE World Conference on Explosives and Blasting Technique" was held in Munich with 16 member countries and 450 participants, the Brussels conference was an important event which lifted EFEE to a higher level. Between these first two conferences EFEE was developing through regular meetings all over Europe and through national conferences with international guests.

Since 2000 nine "EFEE World Conference on Explosives and Blasting Technique" has been held around Europe with increasingly success. The conferences are listed with year and location below:

Location	Year
Munich, Germany	2000
Prague, Czech Republic	2003
Brighton, United Kingdom	2005
Vienna, Austria	2007
Budapest, Hungary	2009
Lisbon, Portugal	2011
Moscow, Russia	2013
Lyon, France	2015
Stockholm, Sweden	2017

The location of the10th and 11th "EFEE World Conference on Explosives and Blasting Technique" is already decided and will be held in 2019 in Helsinki, Finland and 2021 in Romania. The planning for Helsinki is in full process and information about the conference is already available here: www.efee2019.com/

Council meetings have been held in numerous member countries and cities, ensuring the steady successful development of EFEE. Today EFEE has grown to a well-represented organization listing 24 member nations from Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Kazakhstan, Liechtenstein, Netherlands, Norway, Poland, Portugal, Slovenia, Slovak Republic, Spain, Sweden, Switzerland, Turkey, Ukraine, and UK, followed by 36 corporate members, 100 individual members and one associated member.

In between the conferences, council meetings and board meetings EFEE have initiated research projects, communicated with the authorities of European countries and EU on legislation and directives. Recent project called PECCS, Pan-European Competence Certificate for Shot-firers, with 8 partners around Europe working to enhance the education of shot-firer profession is already on the finish line. During this project a full EFEE learning course with 7 chapters about blasting and explosives has been modernized and put together including a Guidebook and an Online Learning environment as an addition. More information is also available here: www.shotfirer.eu

PECCS
Pan-European Competency Certificate for Shotfirers

Erasmus+

The Pan-European Competence Certificate for Shot-firers / Blast designers, by EFEE financedin cooperation with the Erasmus + programme

The latest initiative is a survey about environmental monitoring during blasting works by EFEE, which is about collecting data about blasting works in different countries in Europe. EFEE will use the information to improve the common knowledge of similarities and differences between national legislation, standards or guidelines on vibration monitoring during blasting in Europe.

The results about these activities will be presented at the next 10th EFEE World Conference on Explosives and Blasting in Helsinki 2019. The respondent will be part of a lottery for a single seat at the gala dinner of the 10th EFEE conference on explosives and blasting in Helsinki in 2019.

Also several EFEE Newsletter have been published over the years. Now the Newsletter is given out 4 times per year in February, May, September and November, besides good technical articles it gives and overview about legislation changes and other news from the EU Explosives Working Group of Specialists. It is a modern online magazine, which can be read from any device connected to internet. Below are examples of the Newsletter over time.

EUROPEAN FEDERATION OF EXPLOSIVES ENGINEERS

NEWSLETTER

ISSUE NO. 8 SEPTEMBER 2000

NEXT MEETING

THIS ISSUE

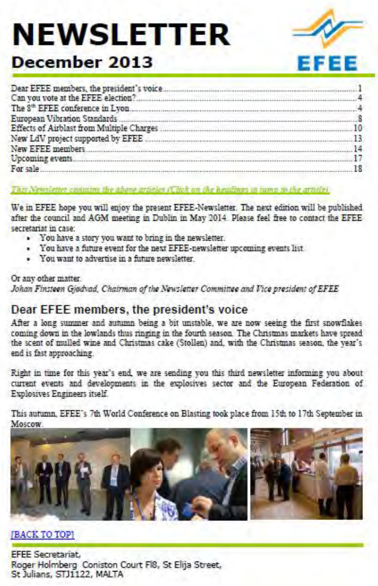
- The Munich Conference
- Are we ready for the next Conference ?
- News from the members
  CROATIA
  FRANCE
  PORTUGAL
  NORWAY
- Shotfirers Certificate
- EFEE and days ahead
- Conference Calendar
- EFEE Structure
  Members
  Committees
  Secretariat

The 2nd World Conference.
Are we ready ?

First World Conference on Explosives and Blasting Technique

Technical Program

EDITORIAL BOARD



NEWSLETTER
December 2013

EFEE

Dear EFEE members, the president's voice 1
Can you vote at the EFEE election? 4
The 8th EFEE conference in Lyon 4
European Vibration Standards 8
Effects of Airblast from Multiple Charges 10
New LdV project supported by EFEE 13
New EFEE members 14
Upcoming events 17
For sale 18

We in EFEE hope you will enjoy the present EFEE-Newsletter. The next edition will be published after the council and AGM meeting in Dublin in May 2014. Please feel free to contact the EFEE secretariat 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 a future newsletter.

Or any other matter.
Johan Finsteen Gjødvad, Chairman of the Newsletter Committee and Vice president of EFEE

Dear EFEE members, the president's voice

After a long summer and autumn being a bit unstable, we are now seeing the first snowflakes coming down in the lowlands thus ringing in the fourth season. The Christmas markets have spread the scent of mulled wine and Christmas cake (Stollen) and, with the Christmas season, the year's end is fast approaching.

Right in time for this year's end, we are sending you this third newsletter informing you about current events and developments in the explosives sector and the European Federation of Explosives Engineers itself.

This autumn, EFEE's 7th World Conference on Blasting took place from 15th to 17th September in Moscow.

[BACK TO TOP]

EFEE Secretariat,
Roger Holmberg Coniston Court Fl8, St Elija Street,
St Julians, STJ1122, MALTA

EFEE NEWSLETTER

In this edition:

Blasting close to a substation with a low threshold value

A new era of blast initiation systems reducing safety risks, costs and enabling automation

Elimination of a drilling machine accident

and much more...

August 2018

Left: EFEE Newsletter Nr. 8 in 2000 edited by Rolf Schillinger and José Carlos Góis.
Middle: EFEE Newsletter 3rd edition in 2013 (December). Edited by Johan Finsteen Gjødvad.
Right: EFEE Newsletter September 2018. Edited by Jari Honkanen and Teele Tuuna.

It is a great challenge to get a united Europe, but we owe it to future generations and the growth of EFEE to proof that it is worth the efforts. The newsletter congratulates EFEE for the successful 25 years, and hope for many more to come.

Walter Werner, First EFEE President,
Roger Holmberg, Secretary General of EFEE,
Johan Finsteen Gjødvad, Member of the Board
Teele Tuuna, EFEE Newsletter editor

EFEE Membership

<u>Become an EFEE member and take use on the following benefits:</u>

Reduced fee for attending EFEE Conferences.

Reduced fees on workshops in conjunction with EFEE conferences.

On-line access to proceedings from all earlier EFEE Conferences except 2000 and 2003.

Access to the EFEE web page with information and possibilities to interact with members.

Gain access to list of European standards on vibrations and air blast through the member section of the EFEE website.

Gain information of and possibilities to influence the EU shot firing procedures and attend standing committees like EU-directives, Environmental and Newsletter.

Supporting of professional explosives engineers.

Network of professional explosives engineers.

A possibility to be part of the EFEE Council and influence the EU explosives society.

Four electronic Newsletters per year.
Information on conferences and professional courses.

SAFEX information on incidents in the explosives industry.

Corporate Members also have the benefit of a 25% discount on ads in the EFEE Newsletters

Visibility on the EFEE website.

There are different types of membership in EFEE: National Association membership, Corporate membership, Individual membership and Student membership - more information info@efee.eu.

The Czech national Conference on Blasting and Pyrotechnics

In Valec there is a wonderful castle, renovated into a comfortable and cosy spa hotel with attractive renaissance surroundings. Valec is a beautiful place in south-west Czech, where the landscape sings a beautiful melody. In Czech there is a lot of castles, but the castle of Valec is really different. Once in every year since 2015 in late September it becomes the headquarters of the Czech Society for Blasting Techniques and Pyrotechnics – it is time for the annual meeting and conference.

Heinz Berger bringing greetings from EFEE

Besides of formal dinner and meetings, the conference consists of very interesting presentations of most important events and new technologies from the last season – for example how a coal mine suffered from around 300 protesters who were all young people protesting against expanding the mine; or a landslide which happened right next to a quarry and covered a big part of public road, the mine was cleared from accusations after thorough investigations; and also an update about how to weld different metals with explosives. All together it takes a whole long day to go through with all the presentations and end the day with drinks and dinner. Personally I was very delighted for the opportunity to deliver paper about EFEE PECCS project which was well appreciated by the conference audience.

The "attack on a coal mine"

All participants have a possibility to warm up connections or make new ones as The Society for Blasting Techniques and Pyrotechnics is also a member in the European Federation of Explosive Engineers and the Czech Federation of Scientific and Technological Societies, there are quests also from

Conference giftbag

outside Czech. The organization itself stands for sharing knowledge of modern technologies, innovations in area of blasting equipment, blasting and drilling technology, blasting works and fireworks, helping with education on this area of expertise and connecting companies inside and outside Czech Republic.

After three days in Valec the guests, being much smarter and richer in contacts, leave just to come back next year. Maybe then it the annual conference will be later in wintertime, as it is still a high season in Czech in September for blasters and pyrotechnics.

Teele Tuuna, Editor of EFEE Newsletter

New EFEE members

EFEE likes to welcome the following members who recently have joined EFEE.

Individual Members

Bjarki Laxdal, IAV / Marti, Iceland Gints
Rutkis, BalRock Latvia, Latvia

Upcoming International Events

45th Annual Conference on Explosives and Blasting Technique, ISEE
January 27-30, 2019
Nashville, Tennessee, USA
mangol@isee.org

2019 SME Annual Conference & Expo
February 24-27, 2019
Denver, CO, USA
http://www.smeannualconference.com/index.cfm/register/

WORLD TUNNEL CONGRESS
2019 May 3-9, 2019
Naples, Italy
www.wtc2019.com/

UNDERGROUND CONSTRUCTION PRAGUE 2019 (UC PRAGUE 2019)
June 3-5, 2019
Prague, Czech Republic
www.ucprague.com

Europyro 2019 / 44th International Pyrotechnics Society
June, 3-7, 2019
Tours, France
www.europyro2019.org

EFEE 10th World Conference on Explosives and Blasting
September 17-19, 2019
Helsinki, Finland
www.efee2019.com/

WORLD TUNNEL CONGRESS 2020
May, 15-21, 2020
Kuala Lumpur, Malaysia
www.seacetus2017.com/4/443/welcome-to-malaysia/

Upcoming National Events

Excavation and rock technology days
January 17-18, 2019
Place: Best Western hotel Haaga, Helsinki
Official language: Finnish (foreign presentations in English) Website/Contact info regarding the conference: ari.kahkonen@infra.fi

Bergsprängardagarna
January 24-25, 2019
Place: Radisson BLU Royal Park hotel, Stockholm
Official language: Swedish (foreign presentations in English)
Website/Contact info regarding the conference:
www.bergutbildarna.se/bergsprangardagarna, berg@bergutbildarna.se

Bergdagarna
March 19-20, 2019
Place: Münchenbryggeriet, Stockholm
Official language: Swedish (foreign presentations in English)
Website/Contact info regarding the conference:
http://www.svbergteknik.se

Informationstagung für Bohr-, Spreng- und Ankertechnik
Place: CAMPUS SURSEE Bildungszentrum Bau, CH-6210 Sursee LU, Switzerland Date: 13. / 14. September 2019
Official language: German
Website/Contact info regarding the conference:
www.sprengverband.ch

41. Informationstagung Sprengtechnik
April 26-27, 2019
Place: Siegen
Official language: German
Website/Contact info regarding the conference:
www.sprengverband.de