NEWSLETTER

EFEE

September 2016

In this edition:

Underground liquidation blast of chamber 3930-31

Demolition of the homogenizing silos with heat exchanger by blasting in the former cement plant in Wetzlar

Assessment of shock tube systems by synchrotron X-ray computed tomography

... and much more!

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NEWSLETTER

September 2016

This Newsletter contains the above articles (Click on the headings to jump to the article)

We in EFEE hope you will enjoy the present EFEE-Newsletter. The next edition will be published in December 2016. 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.

Nigel Taylor, Chairman of the Newsletter Committee and the Vice President of EFEE

- newsletter@efee.eu

Dear EFEE members, the President´s voice

At the beginning of my autumn foreword I do hope that you have enjoyed the summer season for your well earned rest on vacations in various attractive destinations. It is really very important to keep the right balance between the business activity and rest and summer makes it possible to follow it. As the holidays season is irreversibly over and we all are back in our work let me please briefly summarize what has happened during previous months in our federation.

We were deeply grieved and shattered to hear of information that Alexander Efremovtsev, representaive of Russian National Assotiaton NOEE, passed away suddenly and tragically on 18th of June 2016. We have sent out the Condolence letter addressed to Russian National Association NOEE as well as to family of Alexander Efremovtsev in which we have expressed sincere and deep condolence. On 2nd of July we started our EFEE Board meeting in Bucharest with one minute of silence dedicated to the memory of Alexander. We publish his obituary separately in this Newsletter related to memory of Alexander. We will miss Alexander very much in our federation.

As I mentioned in previous part, the EFEE Board meeting took place in Bucharest, capital of Romania, on 2nd July. The reason to choose this place for the Board meeting was very simple. EFEE has received on 23rd of September 2015 an application for National Association Membership from newly established Romanian Association of Explosives and Blasting Engineering (abbreviation ARDE). EFEE Board has approved this application on its meeting held in Barcelona on 25th of September 2015. In Romania there was missing for a long time a National Association unifying explosive users, blasters and blasting engineers. The idea to establish the Romanian Association appeared already in 2013. It took however quite a long time to realise this association. From 30th of July 2015 the Romanian Association of Explosives and Blasting Engineering (ARDE) was registered by legal authorities and now acts in accordance with its Statutes. The representatives of ARDE participated in our Board meeting in Bucharest and we all employed mutually this opportunity to better know each other and also to discuss in detail the problems which ARDE presently is facing as well as how EFEE can support our new National Association Member.

In the beginning of August we have noted very good news from Sweden. Our application for PECCS project (Pan--European Competency Certificate for Shotfirers /Blast designers by European Federation of Explosives Engineers) was approved for funding from Swedish Erasmus plus programme. The BEF in Sweden, represented by Jan Johansson, Anette Broman and Viive Tuuna, as the PECCS manager have done a great work which was positively rewarded. More details you can read in an article of Viive Tuuna focused on this topic. This project shows how important is to have a strong will and believe in success as we after two negative answers from Estonian authorities now reached positive climax.

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EFEE Board and Council meeting took place in Stockholm, Sweden on 16th and 17th September in the same place where the 9th EFEE World Conference on Explosives and Blasting will take place 10th to 12th September 2017. More detail information about this very important event for our federation you can find out on the special web page www.efee2017.com.

Next EFEE Board meeting is scheduled on 9th and 10th December 2016 in Helsinki, Finland where the 10th EFEE World Conference on Explosives and Blasting will take place. This Board meeting will take 2 days as the first day is dedicated to visit the venue where the conference will be organized and the second day is scheduled for the Board meeting.

Finally I would like to encourage you all in our mutual productive work at our next meetings which doubtless will contribute positively to future of our federation.

Igor Kopal, President of EFEE

Alexander Efremovtsev

We were deeply grieved and shattered to hear of information that Alexander Efremovtsev passed away suddenly and tragically on 18th of June 2016. We mourn with pain in our hearts that we have lost not only a representative of Russian National association NOEE in our federation but also a very good friend and colleague.

Alexander was always full of ideas and proposals which he submitted unhesitatingly in our meetings. He was EFEE Board member since 2012 until 2014. Under Alexander´s leadership a conference was organized in cooperation with Russian National association NOEE and EFEE. This 7th World Conference on Explosives and Blasting in Moscow we rank among the most successful conferences in history of EFEE. Alexander was really an exceptional man and we will miss him very much in our federation as well as in our next meetings.

On 2nd of July we started our EFEE Board meeting in Bucharest with one minute of silence dedicated to the memory of Alexander. We want to express sincere and deep condolence to Russian National association NOEE as well as to family of Alexander Efremovtsev. He contributed very much to the work of our federation and particularly to the great success of our Moscow´s conference. We will never forget Alexander and his excellent work done for EFEE. Alexander will remain in our hearts forever.

Honour to memory of Alexander.

Igor Kopal, President of EFEE

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Annual Meeting of the Notified Bodies for Explosives

This year's annual meeting of the Notified Bodies for Explosives took place from 9th to 10th May 2016 in Sibiu. Being already the 25th meeting, it was hosted by INCD INSEMEX which is the Notified Body for explosives in Romania.

On the first day of the meeting, the debate agenda covered the following points:

-- Analysis of the round--robin tests on the topic of thermal stability of explosives
-- Status quo of implementing the European Directive for Explosives 2014/28
-- AdCo Group's report on explosives
-- Updates from the European Commission

As part of the so--called round--robin test, previously determined tests on explosives or detonators are carried out by different Notified Bodies. This is done in order toshare experiences and also to ensure that all test required are done in a comparable manner. Such is the only way to guarantee that comparable values are obtained which play an essential role in type approval (CE certification).

The last test covered the examination of thermal stability of explosives. The material's behavior when exposed to temperatures of up to 75 °C was examined. The next round--robin test will examine shock tube ignition systems.

As representative of the European Commission, Federico Musso informed about the status quo of implementing the European Directive for Explosives 2014/28 by the separate member states. Implementation is also a prerequisite for the Notified Bodies' future work. Directive 2014/28 determines that all previous Notified Bodies must be recertified. In order to be recertified, this directive must be implemented. Having to be introduced in national law by 20th April 2016, the guideline was integrated in the respective regulations except for two member states.

The AdCo Group for Explosives is a working group which mainly deals with market surveillance issues checking e.g. whether the traded explosives fulfill the respective requirements.

On the second day of the meeting the participants were able to learn about the work of INSEMEX when visiting the Notified Body in Petrosani.

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Once again it can be said that from EFEE perspective attending this meeting was quite important and helpful for both sides.

As a stakeholder for users and partly also for manufacturers of explosives, EFEE plays an immediate transferring role in both directions. This role and opportunity we will endeavor to continually use and expand in the future.

The next annual meeting will take place in Poland in May 2017.

Underground liquidation blast of chamber 3930-31

ABSTRACT: SMZ a. s. Jelšava is dealing with mining and processing of the magnesite. The mining area is determined in the deposit „Dúbravský massif", where are used mining methods opened chamber (presently not used) and overhead extraction with filling clear cut area. Deposit is horizontally consisting of several horizons from 220m above sea level up to 500m above sea level.

Excavation and mining towards depth is conditional to liquidation of the protective pillars which remained after sublevel caving – there are ceiling pillars (CP), sublevel pillars (SP), front pillars (FP) and pillars of drain system (PDS). Liquidation of mentioned pillars enables next liquidation progression of sublevel pillar from the horizon 350m a. s. l.

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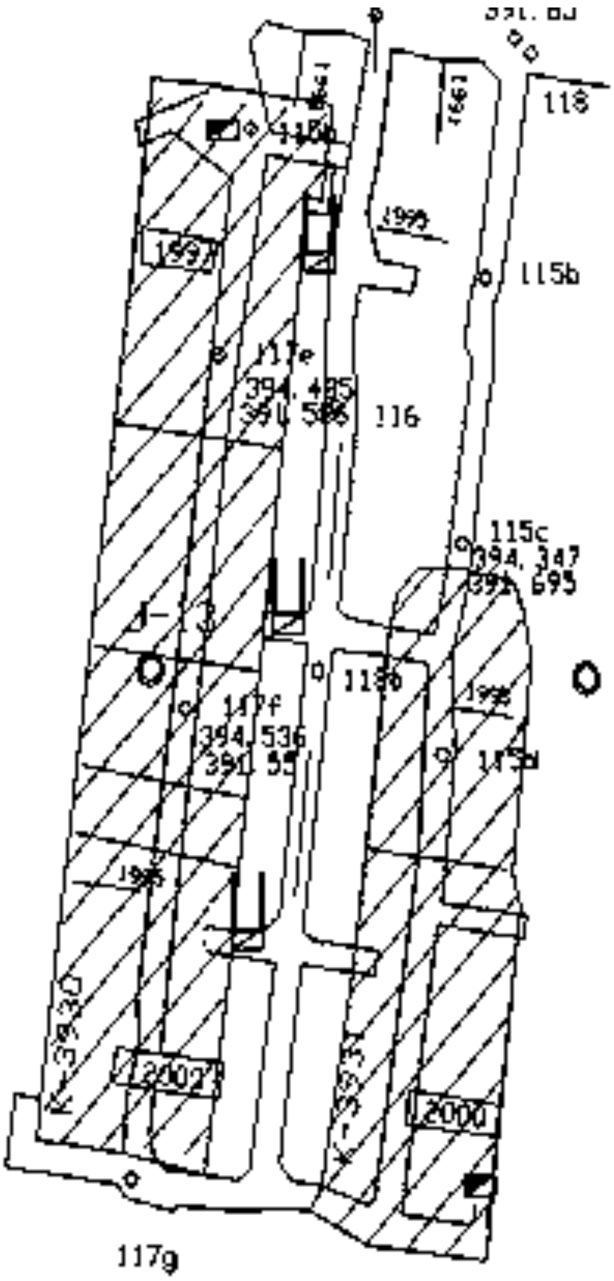
DESCRIPTION OF LIQUIDATED AREA

Chambers no. 3930, 3931 are located on horizon 390m above sea level in south east edge of the deposit. Liquidated area is displayed on the picture no.1.



Picture no. 1 - Liquidated area

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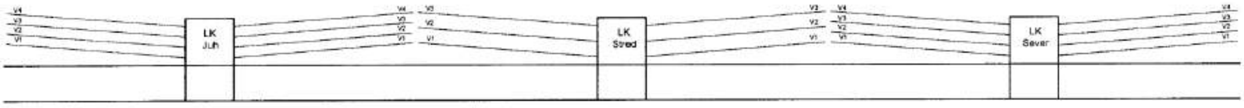
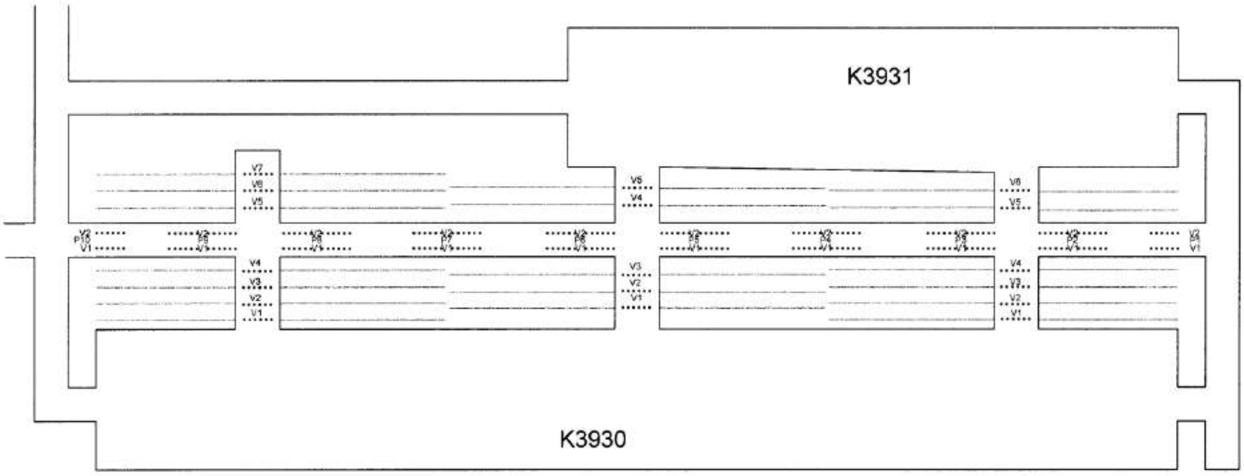
CP (ceiling pillar) is drilled horizontally with fan-shaped boreholes V1-V4 from north and south liquidation chimney and with fan-shaped boreholes V1-V3 from middle liquidation chimney, as displayed on the picture no. 2.



Picture no. 2 - Location of fan-shaped boreholes in ceiling pillar

SP (sublevel pillar) is drilled from the liquidation breakthroughs to chambers no. 3930 and 3931. Into the chamber no. 3930 are mined 3 breakthroughs – south, middle and north. Into the chamber no. 3931 is mined south and north breakthrough, north breakthrough is blind, because north part of chamber was not excavated owing to poor magnesite ore. In the south breakthroughs are in total 6 fan-shaped boreholes areas, in middle 5 fan-shaped boreholes areas and in north 7 fan-shaped boreholes areas. The difference in number of fan-shaped boreholes areas is caused by different thickness of SP (sublevel pillar) in the breakthrough areas. The location of the fan-shaped boreholes areas is displayed on the picture no. 3.



Picture no. 3 - Location of fan-shaped borehole areas

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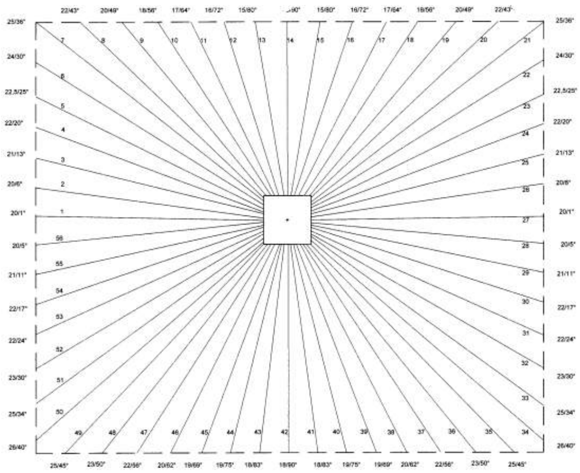
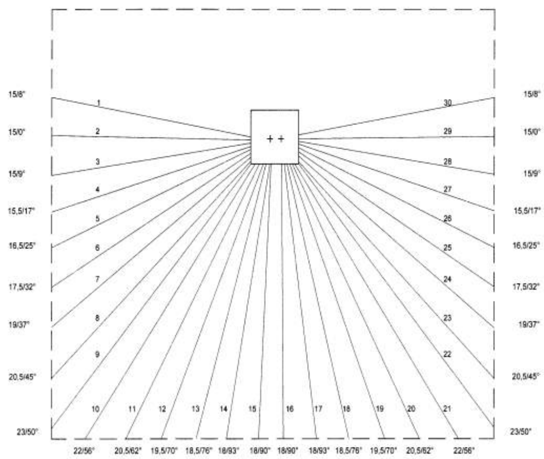
DRILLING WORKS

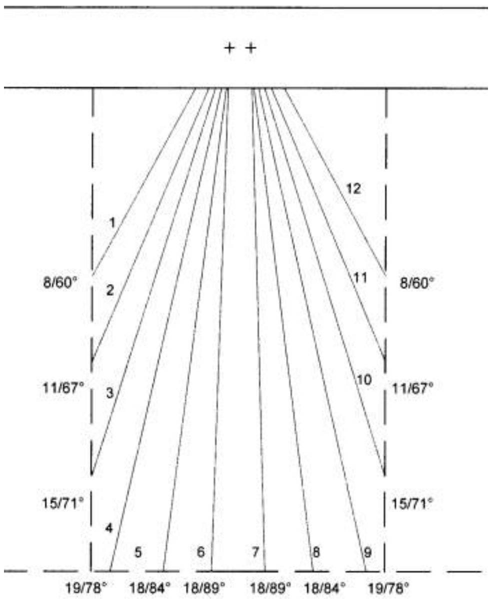
Drilling works were realised in accordance with prepared drilling patterns within the years 2009-2012. Volume of drilling works reached the level 12 860 m for liquidation of CP (ceiling pillar) and 11 600 m for liquidation of SP (sublevel pillar). In total was drilled 1 362 boreholes. Length of boreholes were in liquidation chimneys ranging from 5 to 26 m, in liquidation breakthrough from 15 to 23 m and in liquidation gangway from 8 to 19 m. On the pictures no. 4 - 6 are examples of drilling patterns used for drilling of pillars.



Picture no. 4 - South chimney drilling pattern



Picture no. 5 - Middle breakthrough drilling pattern



Picture no. 6 - Liquidation gangway drilling pattern

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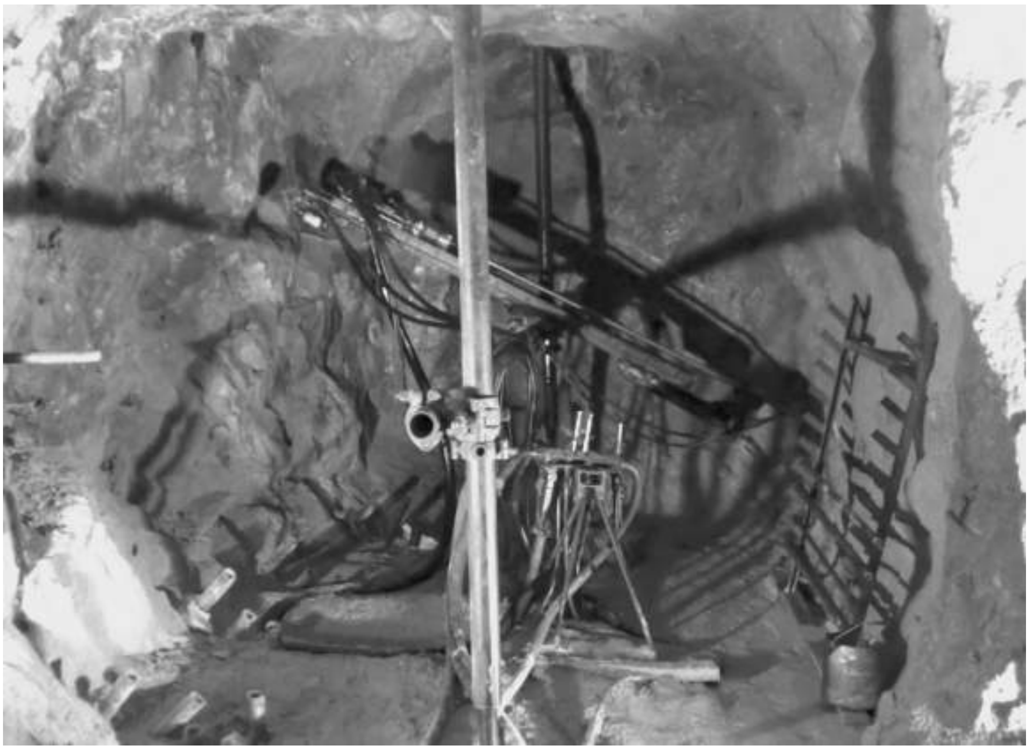
Drilling works were realised during 33 months in 2 shift operation with one drillery BUA-21 with diameter of drilling bit 57 mm.
Drilling machine BUA-21 with nickname "Bizon", is very simple construction and is used mainly for drilling of medium and long length boreholes. Drilling machine consist of following main parts:

a) stand
b) lafette with sliding device
c) drilling hammer
d) distributor of air pressure and control levers
e) lubricating device - lubricator

Lafette has spindle sliding device. There is mounted drilling hammer BBC 120F. Button swivel enables turning of lafette to both directions. With this drilling machine is possible to drill the horizontal as well as the vertical boreholes. Drilling machine BUA-21 is displayed on the picture no. 7.



Picture no. 7 - Drilling machine BUA-21

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TECHNICAL PROJECT OF LIQUIDATION BLAST

Calculation of charge

For calculation of total charge were considered following parameters:

- volume of disintegrated rocks - O_r [m^3]
- maximal burden of fan-shaped boreholes
  - W_{max} [m]
- magnesite density - ς = 3 [$t.m^{-3}$]
- average consumption of borehole - p = 1,7 [$kg.m^{-1}$]
- average consumption of explosives - q [$kg.m^{-3}$]
- rocks disintegration – q_d
- factor of blast arrangement – a
- factor of ore properties – b

Formula for calculation of total charge in fan-shaped boreholes:

$N_c = O_r \,.\, q_d \,.\, a \,.\, b$ [kg] [1]

Formula for calculation of average explosives consumption:

$q = \frac{N_c}{O_r}$ [$kg.m^{-3}$] [1]

Formula for calculation of maximal burden W_{max}:

$W_{max} = \sqrt{\left(\frac{p}{q}\right)}$ [m] [1]

In the table no. 1 are displayed determined parameters necessary for calculation and calculated values.

	SP Sublevel pillar	CP Ceiling pillar
O_r [m^3]	34020	40448
q_d	0,75	0,6
a	0,7	0,7
b	1,1	1,1
N_c [kg]	19663,5	18687
q [kgm^{-3}]	0,578	0,462
W_{max} [m]	1,71	1,92

Table no. 1 - Blast parameters

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For liquidation of SP (sublevel pillar) was determined according to local conditions the burden 1,71 m and the consumption of explosives 19 663,5 kg and for liquidation of CP (ceiling pillar) was determined the burden 1,92 m and the consumption of explosives 18 687 kg, that means total determined consumption reached level 38 350,5 kg.

Calculation of initiation circuit resistance and initiation certitude

For initiation were used millisecond electric detonators DEM-S with 25ms delay and copper wires with length 3m. Connection of initiation circuit was serial-parallel. Firing place was situated from place of liquidation app. 1300m. As a firing line was used double conductor PK 2 led to firing place in two branches. Total number of boreholes was 1362. For priming was used 1 371 electric detonators and blasting machine Schaffler 942.

Parameters of blasting machine:

firing voltage U	- 3000V
capacity C limit	- 80μF
resistance	- 1290Ω
energy	- 360J

Detonators:	type	- DEM-S, 25ms
	Initiation pulse L_{zr}	- 18mJ/Ω
	detonator resistance R_r (after cutting length of wires)	- 0,8Ω

Firing line (double conductor PK 2) $R_{hv} = 1300m \,.\, 0.035\Omega m^{-1} = 45.5\Omega$

Number of parallel branches n_{vt} - 3

Number of detonators in branch n_r - 457

Calculation resistance of initiation circuit:

$R_1 = R_2 = R_3 = R = n_r \,.\, R_r$
$R_{vt} = 457 \,.\, 0{,}8 = 365{,}6\Omega$
$1/R_S = 1/R_1 + 1/R_2 + 1/R_3 = 3/R$
$R_S = 121{,}9\Omega$
$R_o = R_s + R_{hv} = 121{,}9\ \Omega + 45{,}5\ \Omega = 167{,}4\Omega$

R_{vt} = resistance of detonators in one branch (Ω)
R_o = total resistance of initiation circuit (Ω)
R_S = resistance of initiation circuit (Ω)
R_r = resistance of detonator (Ω)

n_r = number of detonator in one line

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Calculation of initiation pulse:

$$L_z = \frac{U^2.C}{2.(n_{vt}^2.R_{hv}+R_S)} . \left(1 - e^{-\left(\frac{2.t}{\tau}\right)}\right)$$, where:

$$\tau = C . \left(R_{hv} + \frac{R_S}{n_{vt}^2}\right)$$

$\tau = 0{,}0047$, $t = 4ms$ a $R_S = 121{,}9$, then:

$L_z = 0{,}56J.\Omega^{-1} = 560mJ\Omega^{-1}$

Calculation of initiation certitude:

$B = L_z / L_{zr} \geq 1$
$B = 560/18 = 31{,}1$

$B > 1$

The result of quoted calculations is that blasting machine Schaffler 942 will ensure reliable initiation of connected detonators.

Calculation of seismic effects of blast

Calculation of seismic effects of blast was carried out in accordance with national standard STN 730036 – Seismic burden of construction objects, at which the closest object possibly affected by seismic waves is building of main ventilator situated on surface in altitude 530 m above sea level. The distance from place of liquidation blast is 290m.
In accordance with table 13 quoted standard we can include building of main ventilator into the class of resistance C and according to type of ground earth also to group C.
For designed blast was calculated maximal speed of oscillation for the ground according to formula:

$u_{max} = K.\frac{\sqrt{m_{ev}}}{1000\,.l}$ (1), where K is factor of energy transmission , which amounts in our case according to table 7 of quoted standard for distance 290m,

120kg-1/2m2s-1

m_{ev} equivalent weight of charge, in our case it is sum of two biggest partial charges 3570 kg.

l - distance from centre of blast, in our case 290m.

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After completing the values to formula (1) maximal value of oscillation

$$u_{max} = 120.\frac{\sqrt{3570}}{1000\ .290}\text{mm} = 24{,}72\text{mm}$$

Degree of damage we shall determine from Table 18 quoted standard. In our case for frequency range 10 Hz < f < 50Hz, u_{max} = 24,72mm.s^{-1}, for building resistance class C and type of ground earth C is damage degree 0.

LOADING OF BOREHOLES

Used explosives and accessories

ANFO explosives:	DAP-K, producer MATRIX SLOVAKIA, s. r. o., Slovakia
Dynamite:	Ergodyn 30E, producer ERG Bieruň, Poland
Detonators:	Electric millisecond DEM-S, producer Austin Detonator, s. r. o., Czech rep.
Accessories:	Blasting machine Schaffler 942, ohmmeter PO-02, firing line PK-2, wooden load stick, pliers, insulation tape, connectors, wooden stick, loading equipment JET-ANOL, antistatic loading hose

Loading

Loading of liquidation blast started after conducting of preparation works. Preparation works included the cleaning of boreholes with pressed air from residues of water and drilling powder. There were erected the working platforms for safe loading of boreholes and to ensure open spaces against fall of miners as you can observe from the picture no. 8.

Picture no. 8 - Working platform in chimney

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Picture no. 9 - Loading of boreholes

At first the boreholes were loaded with ANFO explosive "DAP-K" with loading equipment JET-ANOL, which consist of pressure vessel of pearl shape. On the waist is mounted ejector with operation valves and remote pneumatic control. Pressure vessel is mounted to chassis with tires. On the chassis is mounted equipment for supply and distribution of compressed air. Remote controlled valve is use for loading of ANFO explosive through antistatic hose. On the picture no. 9 is shown loading of boreholes – inserting of antistatic loading hose into the borehole.

Picture no. 10 - Completing of explosive into the loading device

The picture no. 10 shows completing of ANFO explosive "DAP-K" into the loading device. Boreholes loaded with ANFO were primed with dynamite explosive "Ergodyn 30E", for one borehole was used minimally 2 kg primer charge.

Loading of ANFO explosives with loading device JET-ANOL started on 22nd of June 2012 during the 1st shift and has finished on 28th of June 2012 during the 1st shift.

Picture no. 11 - Loading of borehole

Loading of priming charges started on 28th of June 2012 during 2nd shift and finished on 29th of June 2013 during the 3rd shift. On the picture no. 11 is example loading of borehole.

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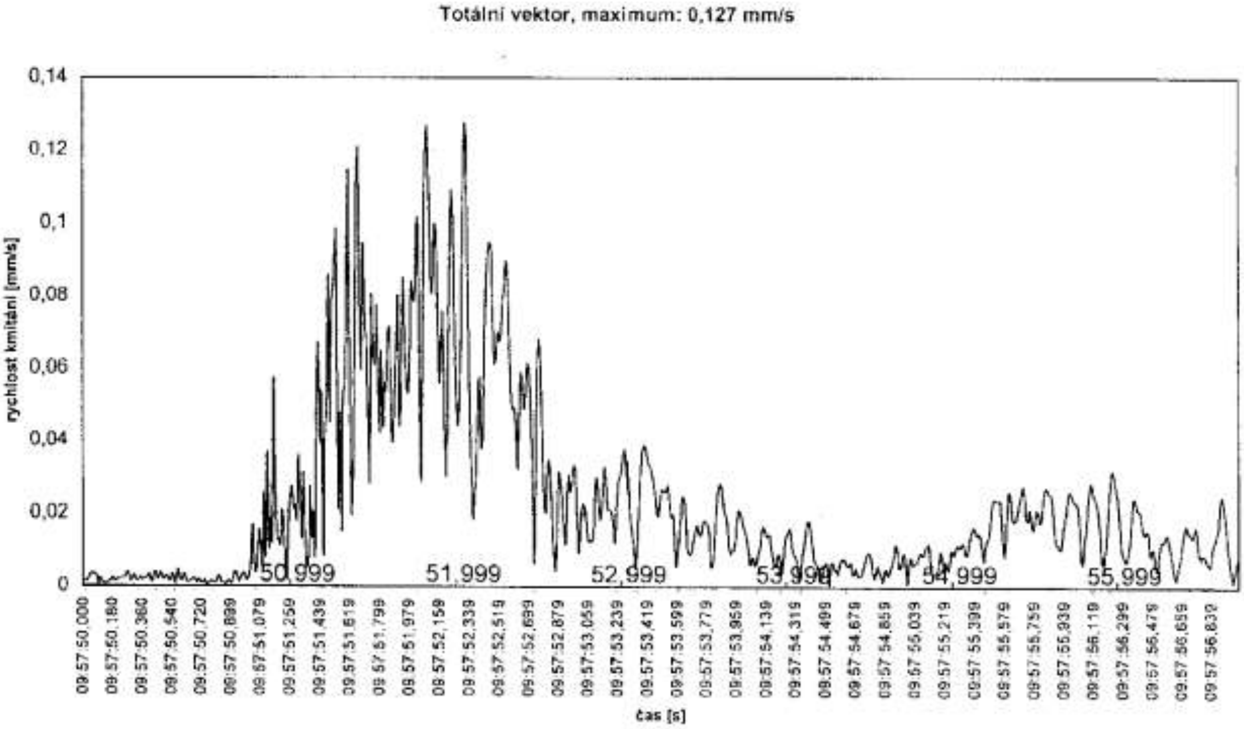
At the liquidation blast was loaded in total 38 998 kg of explosives, consisting of ANFO explosives "DAP-K" - 35 950 kg and dynamite explosive "Ergodyn 30E" - 3 048 kg. For priming were used 1 371 pieces of detonators "DEM-S" with 25ms delay in 22 time delay degrees at which charge in individual delay was moving in range 1 500 – 2 300 kg. The blast took place on 30th of June 2012 at time 1200 from surface horizon 400m m. above sea level.

MEASUREMENT OF SEIZMIC VIBRATIONS

Seismic vibrations were measured on two places. The first one on place of firing (cca 1 200m from liquidated pillars). This measurement was done by Ing. Igor Kopál from company Austin Powder Slovakia, s. r. o., with equipment NOMIS Supergraph having one seismic sensor. Maximal speed of vibrations reached level 0,88 mm.s-1. Second measurement was realised by Ing. Július Kvetko, CSc. from company SLOVMAG, a. s., with equipment RUP2004 with 3 seismic sensors SM-6D. The place of measurement was situated 2 400 m far from blast. Maximal speed of vibrations reached the level 0,127mm.s-1, as shown on the picture 12.



Picture no. 12 - Horizontal part of vibration speed

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CONCLUSION

In terms of SMZ, a. s. Jelšava it was the biggest liquidation blast in last 30 years, where only drilling works took longer than 2 and the half year. There was drilled more than 24 000 m of boreholes and loaded more than 40 000 kg of explosives. The excellent results of the blast are indicating precise and professional project preparation. The measurements of seismic vibrations were deeply below values allowed by national standard. Ceiling and sublevel pillars were completely disintegrated and surrounding of liquidated pillars was not affected respectively damaged by the effect of liquidation blast.

Ing. Milan Birka, Ing. Igor Kopál
SMZ, a. s. Jelšava, Slovak republic

Literature:

Bauer, V.: Drilling and blasting techniques by underground magnesite mining at Slovakia. 10th International Symposium on Rock Fragmentation by blasting - FRAGBLAST 10. Conference proceedings 2012, New Delhi, Taylor and Francis Group – ISBN 978-0-415-62142-7, CD published 2013.

Bauer, V., Beňovský, M., Pandula, B.: Seismic measurements of bench blasting operations in Slovakia. Lisbon conference proceedings 2011. European Federation of Explosives Engineers, ISBN 978-0-9550290-3-5, pages 25-35, published 2011.

Bauer, V., Zelenak, F. : Environmental impacts of mining and processing of gold in Slovak Republic
Source: METALURGIJA Volume: 40 Issue: 3 Pages: 181-183 Published: JUL-SEP 2001

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Demolition of the homogenizing silos with heat exchanger by blasting in the former cement plant in Wetzlar

Initial situation

Heat exchanger
The heat exchanger tower built after 1972 has a base of 15.0 m x 30.0 m and is 65.5 m high. The tower is a well--braced nine--storey reinforced concrete wall or frame construction with 7 pillars. The outer wall is generally 30 cm thick.

Homogenising silo
The three homogenising silos "North", "Centre" and "South" built after 1966 are round silos made of reinforced concrete completely separated from each other by vertical joints. The two outer silos "North" and "South" have the same structure except for one silo base and both are 77.1 m high. The external diameter is 14.7 m and the walls are 35 cm thick. The lower silo bases are positioned each on 20 pillars 60/80 cm.

Fig. 1 Source: Internet

Heat exchanger

The well--braced heat exchanger is upended in the direction north--north--west in its building axis by a falling direction blasting. A demolition blasting concept was drawn by Dr. Dipl.--Ing. Melzer. This concept was used as background for the attenuations and drillings. A specific round plan was drawn containing descriptions for the employees. It helps to orientate oneself more quickly and without confusion and guarantees an efficient transfer of information. e.g. WT1 = heat exchanger 1 with falling direction to the left. All building parts to be demolished were given such an abbreviated designation.

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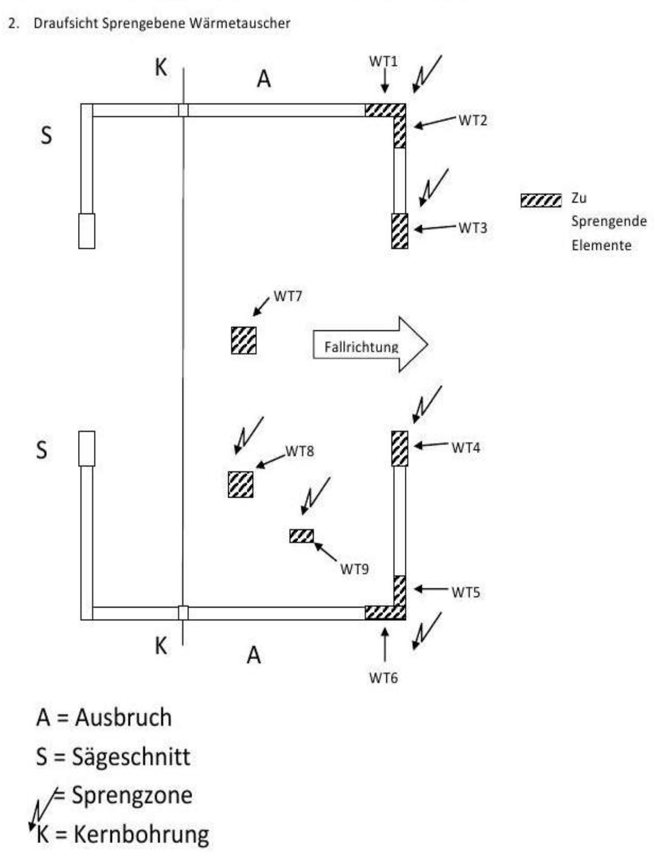

Fig. 2 Source: Lankes Richard

The blasting mouth is formed directly by the walls and the pillars. WT1--WT9. The walls in the falling direction are demolished to a height of 8 m and the pillars in the interior to a height of 4.80 m. All drilling operations were done with Tamrock Commando 100 and 120 using a drill hole diameter of 36 millimeters. All examined drill holes were marked yellow;; all holes to be drilled or drilled again were marked with red colour.

Calculation basis for heat exchanger:
e.g. WT1

Length	2.0m
Wall thickness	0.3m
Height	8.0m
Drill holes	24
Drill hole diameter	36mm
Drill hole spacing	33cm
Drill hole length	170cm
Tamping	20cm
Charge column	150cm

Fig. 3 Source: Hick Michael

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Calculation

As per charge calculation formula for demolition blastings by Jeschek/Lippok (2006) according to chart 8.6 page 429

Blasting calculation

The specific charge loads for detonating cord in reinforced concrete are between 0.300 and 0.500 kg/m³. It is required less than for gelatinous ammonium nitrate explosives (Dynamite).

When detonating cord are used in long drill holes, e.g. in thin walls, usually 2 to 3 charges per wall (see fig. 8.40) are sufficient, applied to the bearing wall. Wall thickness squared and multiplied with drill hole length is the respective formula.

Although the blasting effect theoretically has a circular form, wall thickness squared is an approved simplification.

$L_B = s^2 \times l_B$

$L_B = charge\ load\ per\ drill\ hole$

$l_B = drill\ hole\ length$

$s = thickness\ of\ builing\ part$

$s\ \ L_B = 0.30^2 \times 1.70$

$L_B = 0.09 \times 1.70$

$L_B = 0.153kg$

$L_M = L_B \times a_B$

$L_M = 0.153kg \times 24 = 3.672g$

Calculating the explosive amount per m³

$V = L * W * H$

$V = 8.0 * 2.0 * 0.3$

$V = 4.8m^3$

$q = L_M / V$

$q = 3.672kg / 4.8m^3$

$q = 0.765kg\ nitropenta / m^3$

Homogenising silo

The process of demolishing the three silos commences the same way as for the heat exchanger. Thereby, also pillars measuring 0.8m times 0.6m were to be blasted at a height of 4.8m. The semi--circular shear wall being 6m wide and 6m high with a wall thickness of 0.35m in falling direction also had to be demolished.

The pillars 6, 7 and 8 were not demolished. They were used as support in order to prevent collapse of the pedestals. All further pillars were drilled out and prepared with Eurodyn 2000 and the non--electric initiation system Excel by Orica. It was started using time interval 3 guaranteeing an advance initiation from the electronic bunch connector through to the drill hole. Thus, damage to the shock tube can be prevented. The pillars were charged with approx. 1.6kg Eurodyn per m³.

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The pillars were divided in lines. Initiation was started at the shear wall and pillars 12, 1 and 2. They were followed by pillars 11, 20, 13 and 3 with a delay of 5 ms. These were followed by pillars 10, 19, 14 and 4 with another delay of 10 ms. Finally, pillars 9, 18, 17, 16, 15 and 5 followed with a delay of 15 ms so that the falling mouth was opened from the front.

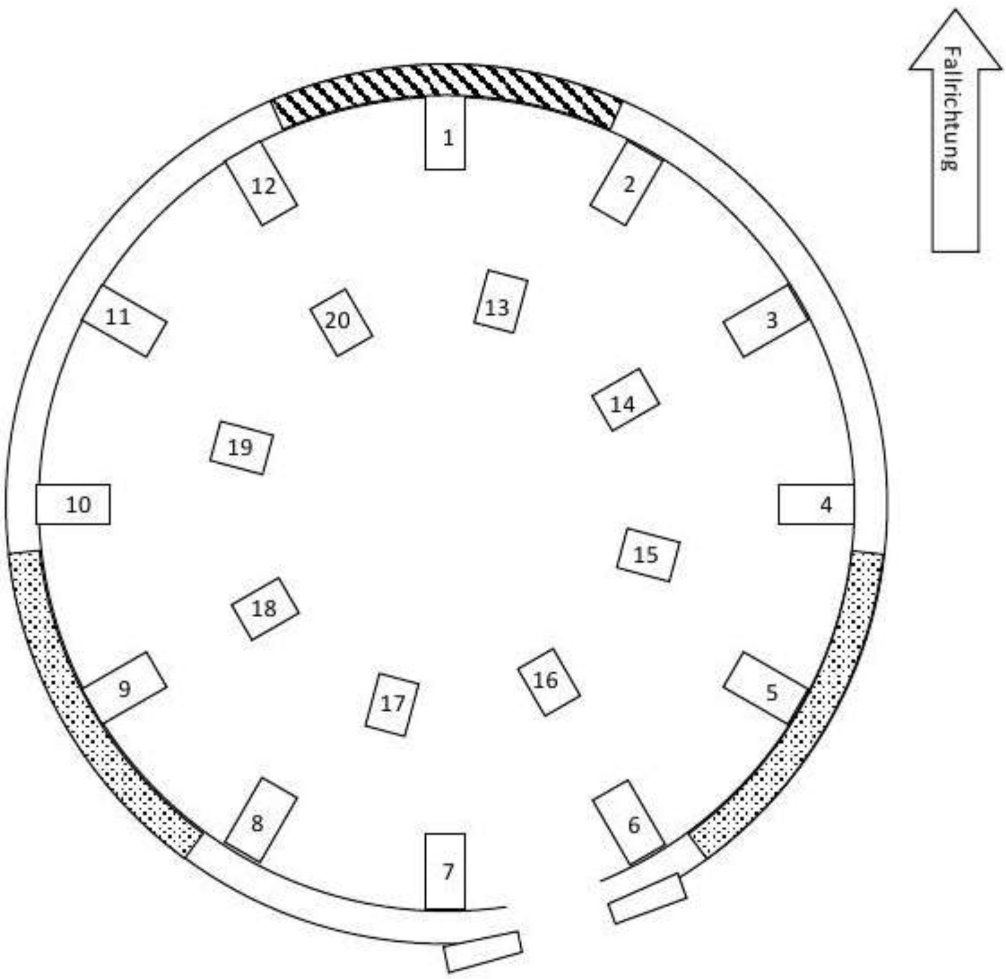

Fig. 4 Source: Lankes Richard

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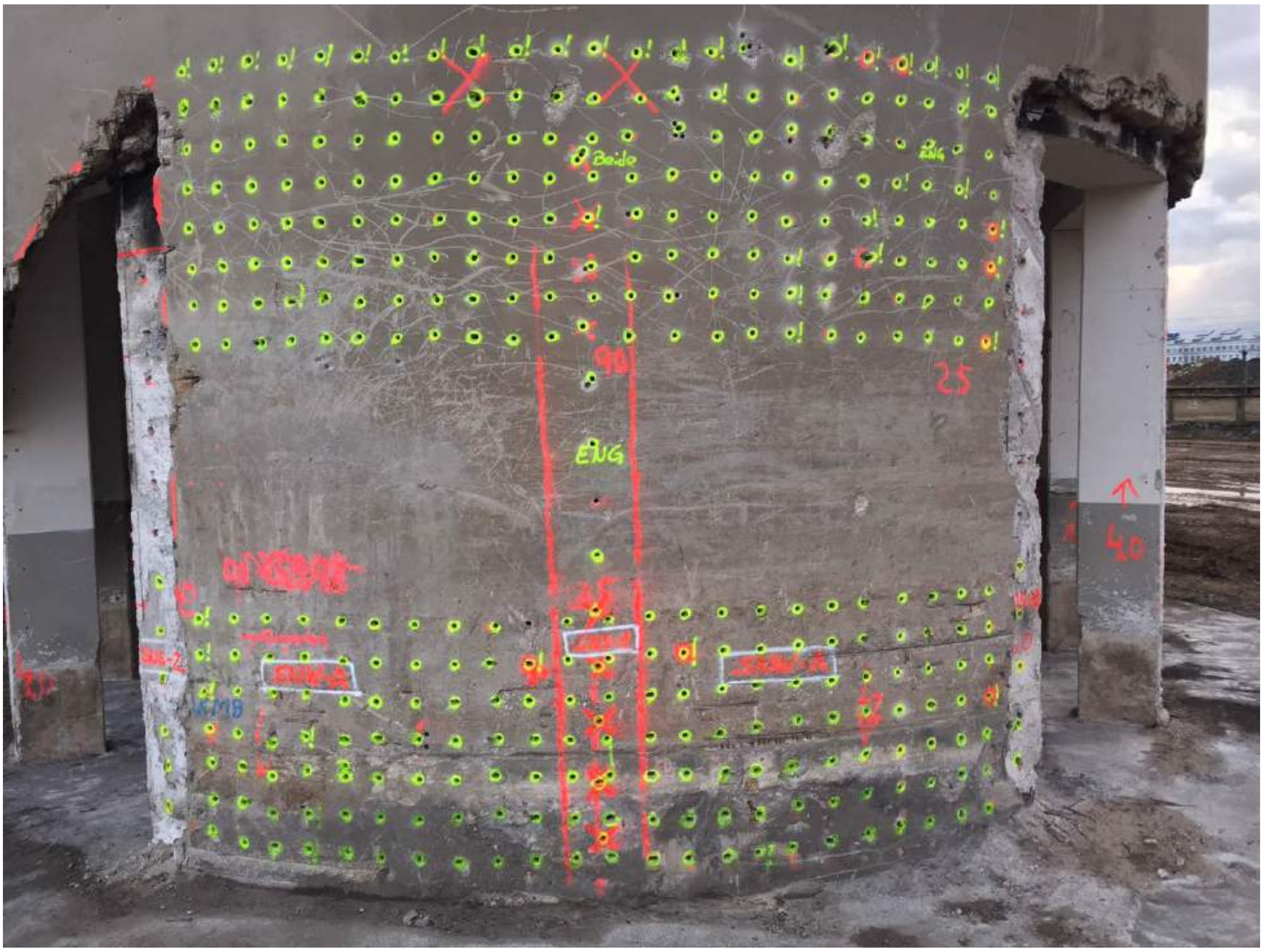

Fig. 5 Source: Lankes Richard

The curved shear wall was divided into two blasting zones and drilled down. Eurodyn 2000 was used as well as the non--electric initiation system Excel. The shear wall was charged with 0.066 kg per drill hole.

All building parts to be demolished by blasting were cladded and encased with heavy blasting protection mats, fibrous web as well as chain link fence in order to prevent fragments from scattering and thus any collateral damage.

The blasting itself took place at 5 am geared to the real life support of Wetzlar so that in case of any unforeseen incidents there was enough room for manoeuvre.

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After the blasting, the blasting site was checked first and then the adjacent railway from Deutsche Bahn. The building parts did not show any non--detonated detonating devices. The railway remained undamaged. Thus blasting signal three was given.

"Again a blasting to everyone's satisfaction because good planning and the respective safety measures pay off," says Richard Lankes, certified explosives expert of Reisch GmbH.

Fig. 6 Source: Max Wild

By Eduard Reisch

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Assessment of shock tube systems by synchrotron X-ray computed tomography

Abstract

Shock tube systems are non-electric explosive fuses employed in blasting and demolition applications to trigger the detonation of explosive charges. Their working principle is based on the explosive reaction of a fine explosive powder on the tubing´s inner surface, generating a shock wave travelling at a velocity of 2,100 m/s along the length of the tube, without destroying it. One of the key aspects of the manufacturing process of these shock tubes is the size and morphology of the explosive powder grains and their distribution on the inner wall of the tube, in order to propagate the shockwave efficiently and reliably. For the first time, synchrotron X-ray computed tomography has been used to characterize non-destructively the explosive powder grains, typically Al/HMX between 10 and 20 μm in size, in terms of morphology and 3D distribution but also to characterise the presence and location of defects within the shock tube walls.

Keywords: explosives, nonel, shock wave, blasting, energetic systems

Introduction

Shock tube systems are non-electric explosive fuses, used in blasting, mining, excavation, and demolition applications to transport an initiating signal to a detonator. Shock tube systems are composed by several concentric polymer tubes, each of which has different properties, as can be seen in Figure 1. The outermost layer has good abrasive resistance and is also UV- protected to withstand extended exposure to sunlight without the ability to initiate being affected. The middle layer gives the tube the mechanical properties required (good tensile and radial strength) to prevent it from bursting from the strain caused by the shock wave propagation. The innermost layer has good adhesive properties for the reactive powder material to adhere. The internal surface of the shock tube (Figure 1b) is coated with a given weight per metre of an explosive HMX (Octahydro- 1,3,5,7-tetranitro-1,3,5,7-tetrazocine or $C_4H_8N_8O_8$) and aluminium powder which can carry a shock wave through the tube with a velocity of 2,100 m/sec [1]. At the end of the tube, the shock wave emits a flash which is strong enough to initiate a detonator (explosive charge).

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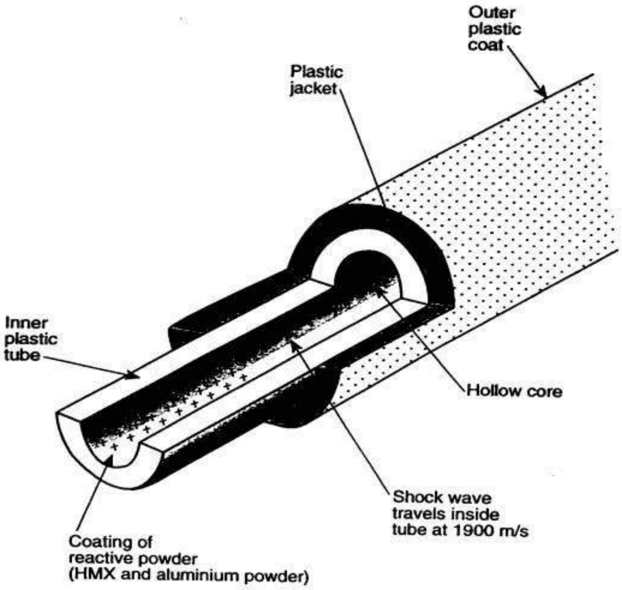
a) optical 3 mm shock tube cross section



b) schematic of shock tube, from [2]

Figure 1: Pictures of shock tube systems.

Shock tube systems were invented by P.A. Persson from Nitro Nobel AB, patented [3], and sold by them under the registered trademark Nonel [4] from 1973. They provide a very safe detonation system, easy to handle, and resistant to rupture, friction, water and other liquids. In addition, being non-electrical and non-metallic, shock tubes are less sensitive to static electricity and radio frequency energy and thus have replaced many uses of electric detonators and are safer to handle and store than detonating cord (risks of unintentional initiation). It is estimated that over 600 million meters of shock tube are used each year worldwide, in applications covering commercial blasting, military demolition, theatrical special effects, automobile airbags, aircraft escape systems, IED initiation and professional fireworks.

Experiments

Segments of shock tubes with an outter diameter of 3 mm and an inner diameter of 1.5 mm have been scanned at the BESSY II synchrotron in Berlin on the BAMline beamline [5]. There were about 20 mg/m molecular explosive with aluminium on the inner side of the shock tube. The density of the explosive was around 1.6 g/cm3. The shock tube segments were scanned with monochromatic parallel beam of 10 keV, with a field of view of 4 x 2.7 mm (4008 x 2672 pixels) and a pixel size of 1 µm.

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Results

The data have been processed with FEI AvizoFire version 9.1 [6] and the analysis focused on the detection of defects within the shock tube walls (Figure 2) and the assessment of the 3D distribution and morphology of the explosive particles on the inner tubing's surface (Figure 3). Cracks were detected, mainly at the interface between the innermost layer and the middle layer. Regarding the explosive powder grains, the most relevant morphological parameters can be determined (volume, equivalent diameter, and surface area) and their distribution along the direction of wave propagation can be quantified. The particle size distribution is given in Figure 4, the minimum equivalent diameter was 9 µm and the maximum diameter was 63 µm. The average equivalent diameter of the explosive powder grains was determined to be 24 ± 7 µm.

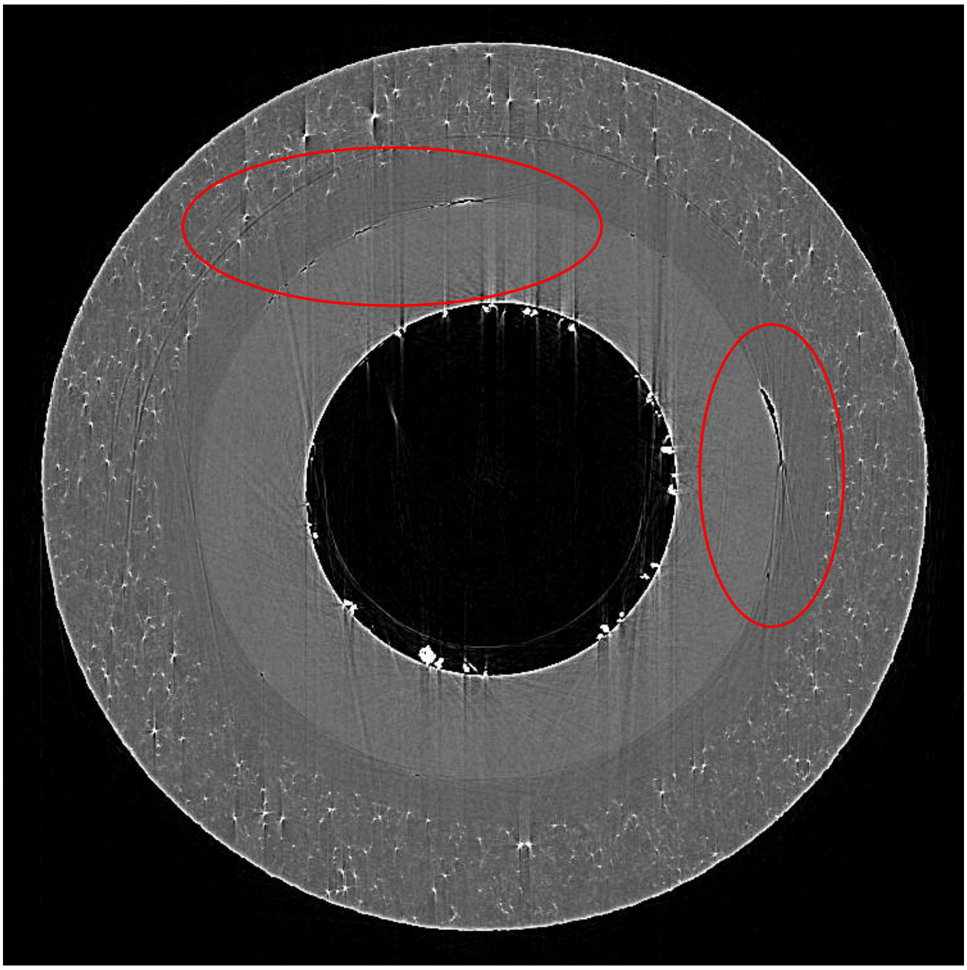

Figure 2: Examples of defects (cracks) on a 2D CT slice.

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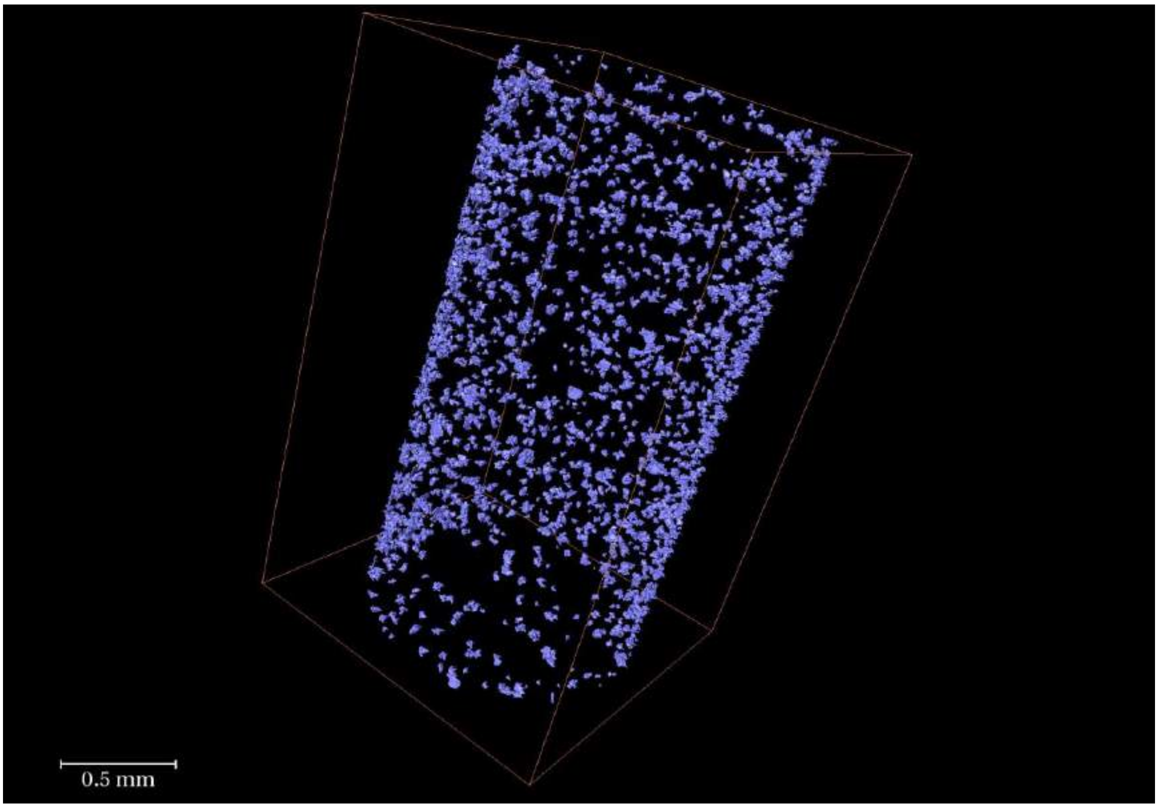

Figure 3: 3D rendering of explosive particules showing particle distribution.

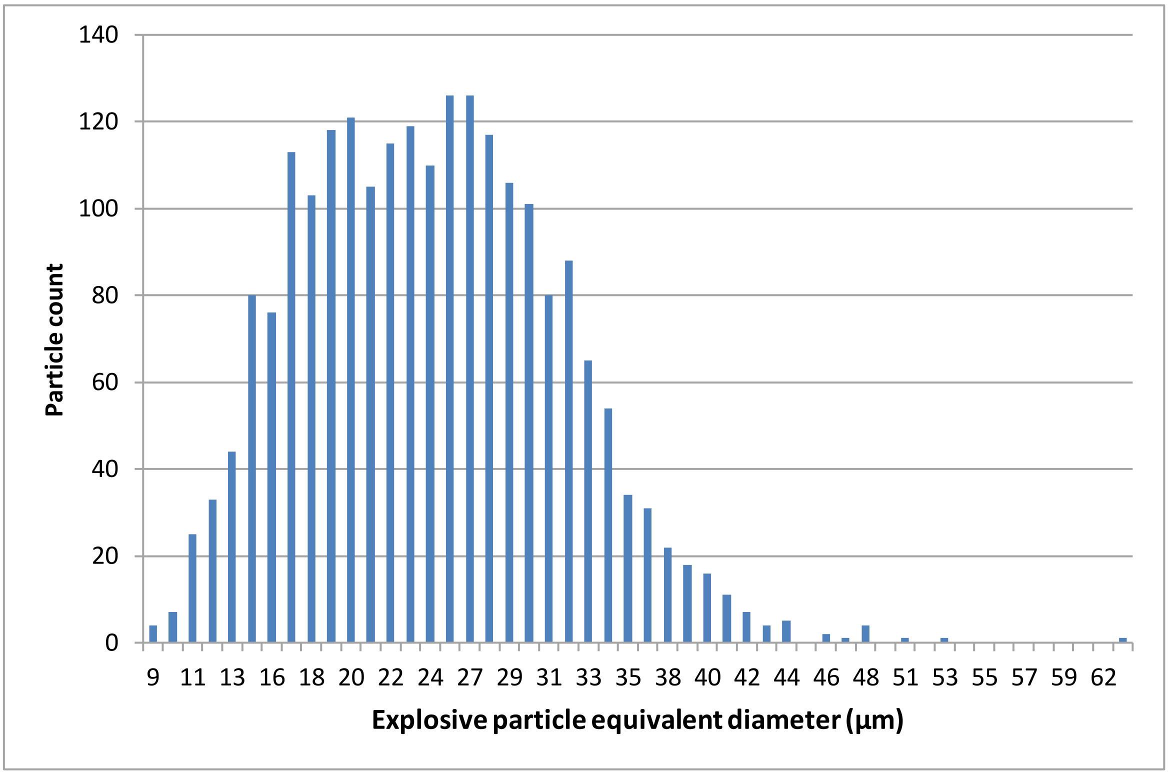

Figure 4: explosive particule size distribution.

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Conclusions

Synchrotron X-ray computed tomography can be used for quality assessment and quality control of shock tubes. With this technique, defects in the tubing walls can be detected and the explosive particle size can be characterised. The influence of the particle distribution to the shock velocity should be measured in future. Other important parameters that can be quantified non-destructively using using synchrotron X-ray computed tomography include: tubing dimensions and thickness, and explosive powder grain morphological parameters such as volume and surface area.

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[1] **N. Muravyev, Y. Frolov**, et al., Combustion of energetic systems based on HMX and aluminum: Influence of particle size and mixing technology, Central European Journal of Energetic Materials, Vol 6(2), page 195-210, 2009.

[2] Explosive Training Australia, Australia's Primary training organization for Blasting Explosives website: http://www.explosivestraining.com.au/Signal_Tube.htm#, visited on the 14/07/2016.

[3] **P.A. Persson**, US patent 3590739, assigned to Nitro-Nobel AB, "FUSE", issued on 6/7/1971.

[4] **J.T. Thurman**, Practical bomb scene investigation, CRC Press, ISBN 9781439819593.

[5] HZB website: https://www.helmholtz-berlin.de/pubbin/igama_output?modus=einzel&sprache=de&gid=1625&typoid= , visited on the 14/07/2016.

[6] FEI website: https://www.fei.com/software/avizo3d/, visited on the 31/03/2016.

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Pan-European Competency Certificate for Shot firers/ blast designers

For two years, on behalf of EFEE, Voglers Eesti from Estonia among with 7 other partners from Norway, Portugal, Sweden, Germany, United Kingdom, Czech and France tried to get funding from EU Erasmus + program in Estonia. The purpose of the project is to put together a modernised learning program for a **new** EFEE Shot firer and Blast Designer Certificate.

Since the process for the grant application started, EFEE has stopped issuing certificates for shot firers and blast designers. The certificates were going for 5 years.

That was an old version of EFEE certificate, which was based on the national certificates that a person already had. It was just for confirmation that the person had gone through an education in one of the EFEE member countries.

This new certificate will be based on a learning program created by EFEE and the member countries. The learning program and the lessons will eventually be available in all national languages as well as the examination that the applicant has to pass to get a Pan-European Competency Certificate for Shot firers/ blast designers by EFEE.

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The certificate will be designed to prove ones technical skills and knowledge of the shot firer profession in order to enable workers to move across the borders within EU without essential courses and payments except for learning the local law.

After the second negative decision for getting the grant, the partners were not really ready to give up on the mission. A small review was conducted to understand why wouldn't the project be funded and it was decided that Estonia was just a too small country with not enough money to spare between different projects. Fortunately BEF from Sweden was ready to help. We thought of a plan B and decided to take the Project, modify it according to suggestions made by Swedish Erasmus bureau and represent it in Sweden instead of Estonia. The third is the charm, the result was positive.

The Project has now granted a support from the European Commission. The Grant Agreement has been signed by both sides, the Swedish UHR bureau and BEF. The official start of the project will be September 2016. It will last for three years. During this time the partners from the 8 countries will work together to create a modernised learning program that will result in a new Pan-European Competency Certificate for Shot firers and blast designers issued by EFEE. In order to do that, we use the materials composed in Power Point program, which were put together by different authors in Europe within the ESSEEM project in 2008 to 2010, under the leadership of The Norwegian Tunnelling Association (NFF). The project was mainly financed by EC through the Norwegian Leonardo da Vinci program. NFF reorganized the ESSEEM Power Point Programs in 2012 and presented it in Zandvoort, Netherlands in 2013 where teachers and representatives from 24 European countries were present. That audience expressed that they wanted EFEE to continue with the education project.

As the time has moved on, these materials need to be updated and modernised now. There are 6 chapters at the moment and the 7th, about tunnelling, will be written form scratch. We will write exercises and exams to every chapter, then we will transfer this package to an online course program. All this will be done mainly during the first year of the project, except for the online course.

In the second year we will already start trying out the training means and the education methods in test courses. In order to reach out to more people and make the courses more available all over Europe, we use the online course, which will work like an Open University formula, but shorter in time and simplified systems for users. This way of learning will also after some time give possibility to gain the Certificate for those who cannot travel much. In order to have good quality and credibility, it is planned to renew and evaluate the courses and the training materials by specialists every third year.

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The outcomes of this project: the materials with examining questions, exercises, the course based on these materials and the online courses, will during and also after the project period be available on the internet for free on www.shotfirer.eu. In order to maintain a good quality and appropriate educational outcome of the courses we will create a Guidebook based on the learning material for trainers and shot firers who want to learn independently online, this will be our task for the second and third year. The examining questions and courses will be tested and validated by specialists before the end of the project. Those who successfully pass exams after they have followed the course, can apply for a Pan-European Competency Certificate issued by EFEE.

Meanwhile all the partners work in cooperation to spread the word of our goals and the work we are doing. The more organisations support our work, the better will be the outcome of the project and the more there will the benefits for the blasting industry in over all.

If you want to learn more about the project please visit the European Commission website-link. A Multiplier event for the project will take place in October 2018 in Germany, when the courses are ready for public testing. The PECCS management, the Partners and the Board of EFEE will ask for specialists and authorities and everyone who takes interest to attend the Multiplier event to meet the project, get to know our goals and try the online program.

Information about progress and materials used in the PECCS project can be found in the official web site *shotfirer.eu,* the website will be created during September and October 2016.

Viive Tuuna,
Member of the Board,
EFEE

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New EFEE members

EFEE likes to welcome the following Members who recently have joined EFEE

Corporate Members

Chemical & Mining Industries co., Jordan
http://cmiltd.bloombiz.com/

Individual Members

Karl Kure, KURE-FJELLSPRENGNINGSTEKNIKK, Norway

Catherine Aimone, Aimone-Martin Associates, LLC, USA

Jerry L. McMahan, McMahan Drilling and Blasting, Inc., USA

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Upcoming Events

MINExpo
International 2016
September 26-28, 2016
Las Vegas, USA
http://nma.org/

24th World Mining Congress
October 18-21, 2016
Rio de Janeiro, Brazil
http://www.wmc.org.pl/?q=node/127

ISEE 43rd Annual Conference on Explosives and Blasting Technique
January 29 – February 1, 2017
Orlando, USA
www.isee.org

IExpE AGM and Conference 2017
Monday 3rd April 2017 and Tuesday 4th April 2017
QHotels, Norton Park, Sutton Scotney, Winchester, SO21 3NB,
please contact Vicki Hall by email: secretariat@iexpe.org

World Tunnel Congress 2017
June 9-16, 2017
Bergen Norway
www.wtc2017.no

EFEE 9th World Conference on Explosives and Blasting
September 10-12, 2017
Stockholm, Sweden
www.efee.eu and http://efee2017.com/

Fragblast 12
2018
Luleå, Sweden
http://www.ltu.se/research/subjects/Mining-and-Rock-Engineering/Nyheter/FRAGBLAST-to-Lulea-2018-1.143098?l=en

EFEE 10th World Conference on Explosives and Blasting
2019
Helsinki, Finland

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EFEE
9th WORLD CONFERENCE
THE BREWERY,
STOCKHOLM, SWEDEN
BERGSPRÄNGNINGSKOMMITTEN
STOCKHOLM 2017
10th – 12th September
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CONFERENCE ON

EXPLOSIVES & BLASTING TECHNIQUE

January 29 – February 1, 2017

Orlando, Florida USA

Deadlines

May 13, 2016
Last day for submission of abstracts.

June 15, 2016
Notification of abstract acceptance.

August 15, 2016
Last day to submit completed papers.

November 1, 2016
Notification of final acceptance of papers.

December 1, 2016
Conference registration deadline for authors.

January 29 - February 1, 2017
Annual Conference - presentation of papers.

Call for Papers

The International Society of Explosives Engineers is issuing an industry wide Call for Papers to be presented at the 43rd Annual Conference and published in the Conference Proceedings.

Ideas should be submitted in the form of a 200-400 word abstract (summary) highlighting the major points of your 8 to 10 page paper. Papers may not be commercial in nature.

Abstracts must be submitted by completing the online abstract submission by May 13, 2016. The submission site, guidelines, instructions and deadlines can be viewed at www.isee.org. Please contact us if you do not receive confirmation within two weeks of submitting your abstract.

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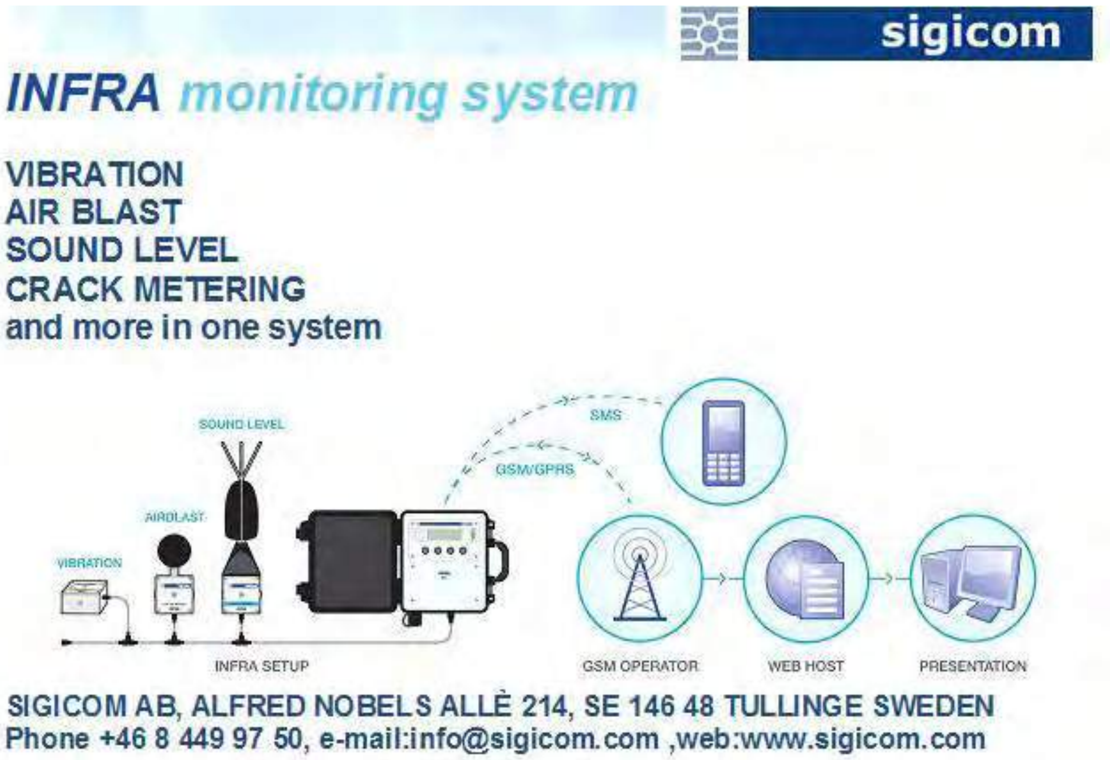
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