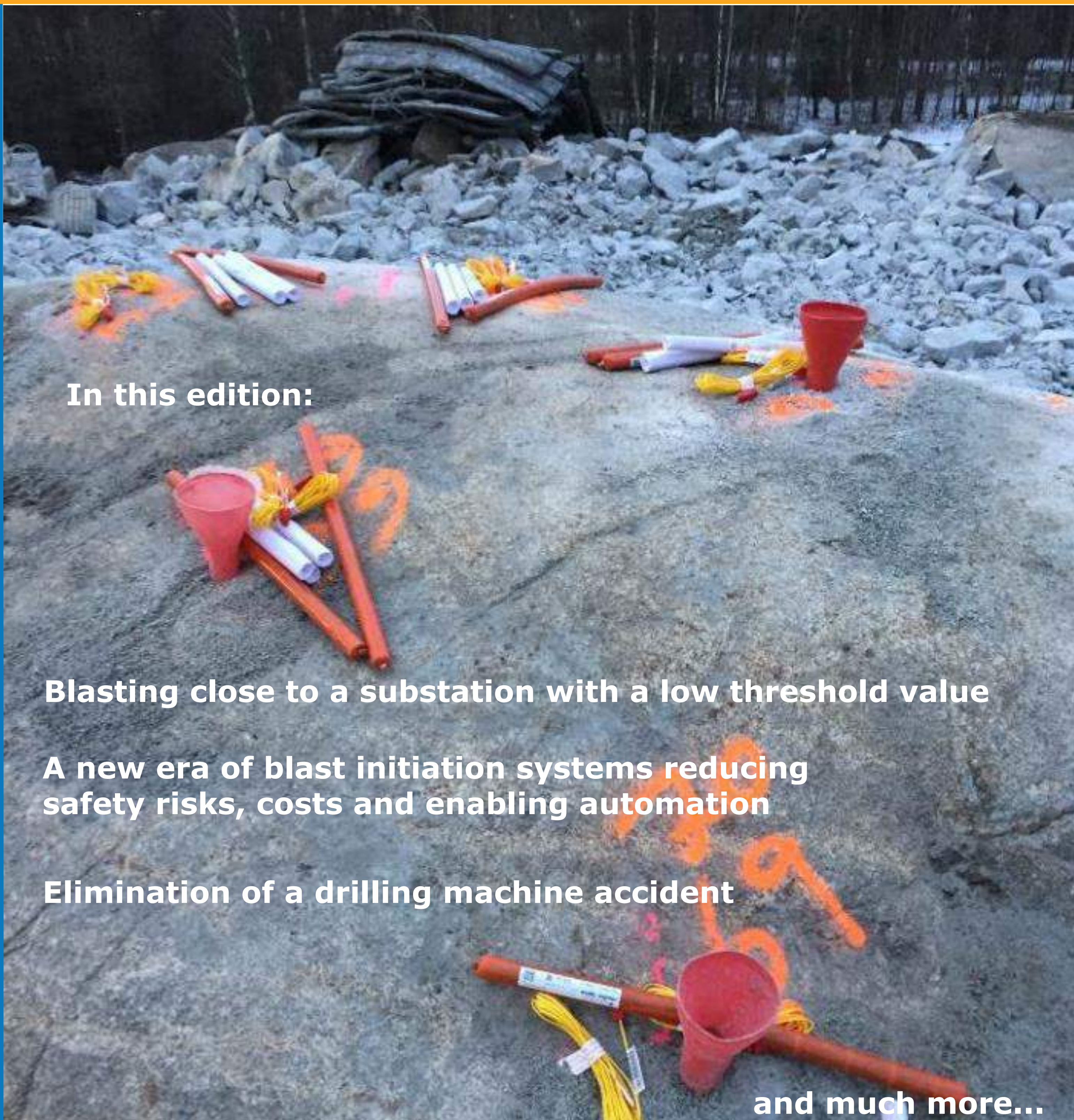
EFEE NEWSLETTER



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

NEWSLETTER

August 2018

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

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

or any other matter.

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

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

EFEE

EFEE SECRETARY GENERAL
ROGER HOLMBERG, JÄRNGRUVEVÄGEN 6
618 92 KOLMÅRDEN, SWEDEN
newsletter@efee.eu
www.efee.eu

Dear EFEE members, the President´s voice

This is your captain speaking. It is my pleasure to welcome all of you EFEE Newsletter readers back to blasting business after a long and hot summer period. This summer has been the hottest on the record and rain-free in most parts of Europe, as also up here in Scandinavia, where I reside, most of the positive weather records were beaten this summer. I hope that your summer included enough vacation time. It is important for all of us to reload our batteries to help us through the coming fall and the intensifying work period. I did so partly by cruising around the beautiful and unique Finnish archipelago.

The economy in Europe is mainly in good shape at the moment. Therefore people, businesses and governments are not afraid to make required investments and therefore the development in construction and mining business has been positive. This means an increasing amount of working opportunities and at least a fraction of wealth to all of us blasting engineers and professionals.

In the heat of economic growth we should remember to also secure our future opportunities as good as we can. After all, times will not always be so positive. Many uncertainties threaten the development of world economy as we speak. We tend to forget this while we are busy and there is less time to worry about tomorrow.

The most important assets to secure are often our skills and human resources. Our future working opportunities are dependant not only on economy but also much on the image of our work and industry. Figuratively speaking - let us not design and build bridges that fail, so we can keep on building bridges in the future. We should therefore maintain and improve our professional skills by constant updates and training. This will help us develop and hold up the quality and safety in our demanding and sometimes risky profession. Our success in enhancing the good and safe image of our industry is essential for keeping our working opportunities in good shape for the future.

There are many of us in EFEE administration who work hard in order to develop a new shotfirer training program under PECCS project. This program and all produced training material from it can be adopted free of charge by all European trainers after the completion of the project, should they choose to do so. The goal in all this is not only to take the first solid steps towards harmonization of EU-wide shotfirer training, but perhaps even more to lift the standards of our industry to a new level. This will in turn help our industry improve the safety and quality in use of explosives. We believe this will bring all of us increased and safer working opportunities, should we succeed in this effort.

We need your support in this endeavour and I hope that you will give it to us when the time comes. Our intention is to change the training of shotfirers for better and change can be sometimes hard but this time it is surely worth all hardships.

Our next council and board meeting will take place in Dresden in not so far future. The 3rd and last PECCS test training will also take place in Dresden following our meetings. I hope to meet many trainers there in order to hear your opinions on our achievements so far.

Last but not least, I am honoured to wish **EFEE happy 30th anniversary!!** EFEE was formally founded on October 20th 1988 in Aachen Germany. The council will celebrate this in Dresden by a formal dinner following our meetings. I wish to thank all the numerous people and explosives professionals who have worked for EFEE during these three decades.

It is your hard and successful work that has carried our federation so far and developed it all the way to its current standards. I wish to express special gratitude towards our three honorary members Mr. Walter Werner, Dr. Raimo Vuolio and Mr. Björn Jonsson. All of them have contributed greatly to the birth and success of EFEE and the development of our industry in general by making it safer and more professional. For example Raimo has written several great books on blasting technique and been a teacher in Technical University of Helsinki during the late 80´s for me and tens of other current Finnish explosives engineers and shotfirers. Walter has also engaged his work much around training and Björn has been an important forerunner for our industry in Sweden. They have all of course also acted as Presidents in EFEE on their turn, Walter as the first President. Thank you all!

Jari Honkanen, President of EFEE

Blasting close to a substation with a low threshold value. Test blasts, vibration prediction and execution of rock excavations

Abstract:

This paper describes a project that was performed in Västerjärva, a suburb of Stockholm. A low threshold value (2 m/s^2) at a nearby electrical substation meant that blasting for new residential buildings became a challenging task. This paper describes how test blasts were performed in the area and how the data from these test blasts was used to make recommendations regarding the excavation of the area. It also describes how the excavation was performed and discusses how accurate the predictions made were in relation to the actual result. The analysis included the charge weight scaling law equation as well as a signature wave superposition model. This was to be able to predict, not only, MIC but also delay time and the influence of blast direction, blast hole screening etc.

1. BACKGROUND

Järvastaden AB is establishing residential buildings in Västerjäva, a suburb 12 km north of Stockholm city centre. Approximately 60 000 m^3 rock must be excavated in order to create the correct level for the buildings. Rock excavations must be made just 50m from a substation (Figure 1.1) east of the area with equipment in form of gas-filled switchgear and circuit breakers. The threshold value for blast-vibrations was set to 2 m/s^2 (by the owner of the substation) which is very conservative.

During the summer of 2013 a contractor initiated rock excavations, but had to stop working when the threshold value for blast-vibrations was exceeded at a distance of nearly 150 meters from the substation. To be able to perform the rock-excavation in the area, Järvastaden AB asked Nitro Consult to perform a pre-study of the area starting with a test blast. During the autumn 2014 Nitro Consult performed test-blasting in order to investigate different options for performing full scale blasting in the area.

Figure 1.1. The Substation

The aim of the test blast was to investigate the options available for production blasting but also to investigate how close to the substation blasting could be performed. The test blast was also designed to give recommendations for production planning criteria including; drill patterns, delay-times including maximum instantaneous charge (MIC) and excavation planning.

2. METHOD

In principle two different methods were used to decide how to excavate the area. After the test blast the data was analysed using regression analysis and the charge weight scaling law equation. To further analyse the data a superposition model was used in order to make suggestions regarding delay times and geometry of the blasts.

2.1 The charge weight scaling law equation

The charge weight scaling law equation is the most common method to calculate vibrations from blasting regarding size and distance (through regression analysis). In the Superposition model however, it is just a part of the model, the equation of the charge weight scaling law equation is in this case:

$$v_{\max} = A \cdot \left(\frac{R}{Q}\right)^{-B} \qquad (1)$$

The parameter: $\left(\frac{R}{\sqrt{Q}}\right)$ is often called SD (scaled distance)

Where

v_{max} = maximum peak particle velocity (mm/s),

R= distance (m)

Q= charge weight (kg)

A= site specific constant

B= site specific constant

(Instead of $v_{max.}$, we can use acceleration (a_{max}) in the same equation to predict acceleration instead of vibration velocity. The A & B parameters will however be different and not correlated)

2.2 The superposition model

The difference between the superposition model and the way vibrations traditionally have been calculated (charge weight scaling law equation) is primarily that the concept of time is introduced into the calculations, and in this way it's possible to optimize the blast after considering different initiation plans.

The model uses Monte Carlo simulations whereby you include variability in governing parameters that cannot be exactly determined (due to geological uncertainties, delay scatter in the initiators etc.) and then you run the model many times to quantify a statistical distribution. The model is a waveform superposition model; so that the result is calculated by superposition of several charges which have similar vibration shapes but are different in time and space.

The model was originally developed by Dane Blair and have been described in several publications (Blair 1999, 2004, 2007). It's included in Orica mining services software SHOTPlus Professional. The model has been described more in detail in several papers, among others, Jern 2011.
In the calculations you use a seed wave which gives information about how the vibration changes depending on the medium it travels through between the place of the detonation and the monitoring point. The properties of the seed wave are a "finger print" that consists of information regarding the geological properties that governs the vibration. The principle of the model is shown in Figure 2.1.

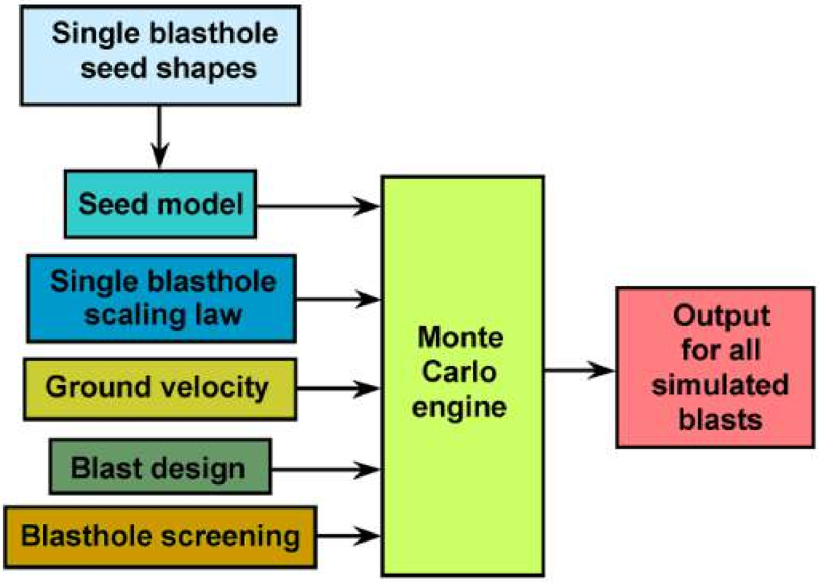


Figure 2.1. Block diagram of the Monte Carlo model

Beside the Scale distance equation (and the scatter of raw data) other input to the model includes: Blast design, the Seed wave (the shape of the recorded single hole blast curve), p-wave velocity and blast hole screening.

3. THE TEST BLAST

The test blast was performed with 6 single hole shots with different charge weights depending on the distance from the substation, see Table 3.1. The charge weights used for the test blasts were calculated with the experience from earlier blasts that had been done in 2013. The focus was to be able to use a maximum amount of charge to pick up signals in the vibration monitors but not to exceed the threshold value on the substation.

Holes were drilled in a straight line from the substation. Two holes were drilled at each distance from the substation to have the possibility to do a re-shoot. Diameter of holes were 38 mm and the depth between 6.8-7.5 meters.

Vibration monitors were mounted at six different places, see Figure 3.1. Three vibration monitors were mounted on the bedrock. Two vibration monitors were mounted on the substation, one on the outside on the foundation and of the building and one on the inside on the concrete floor. These vibration-monitors were tri-axial geophones measuring vibration velocity. Another monitor was mounted on the switch-gear with tri-axial accelerometers, see Table 3.2. Evaluation was done according to SS 460 48 66 (5-300 Hz) for vibrations and according to ISO 8596 (5-300 Hz) for acceleration.

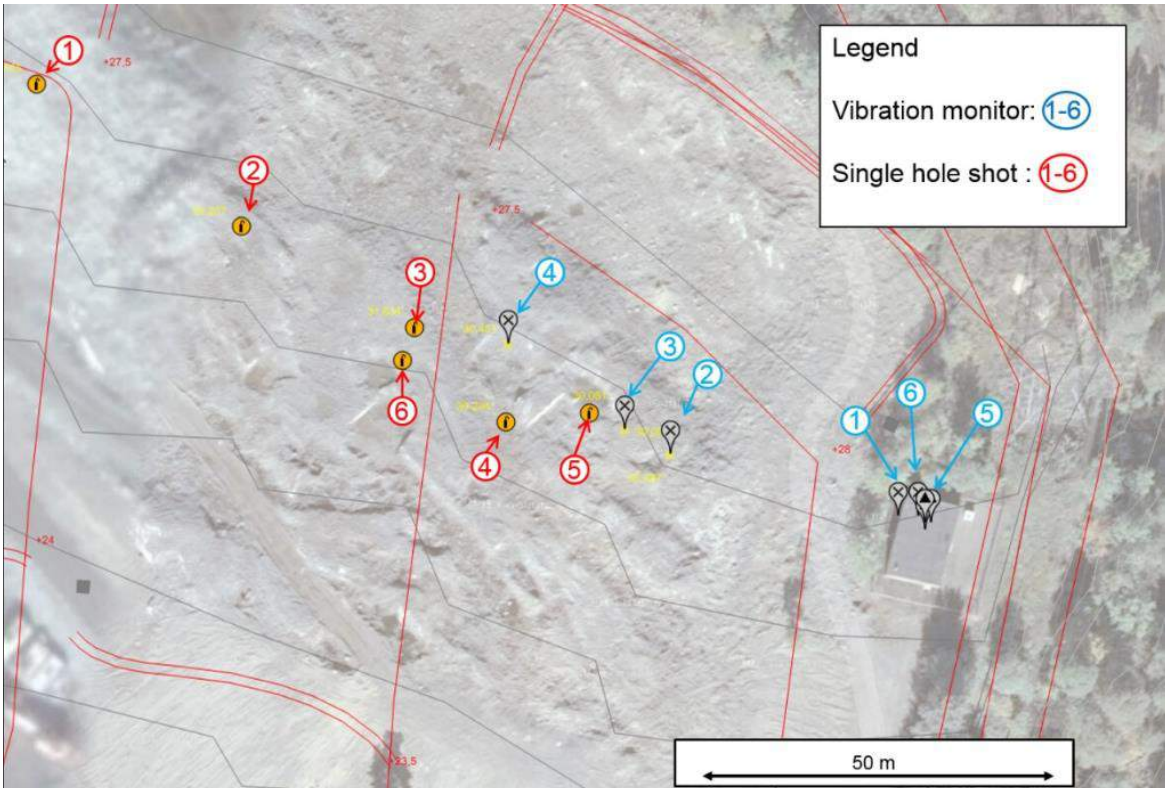


Figure 3.1. Map presenting 6 single shots in red and 6 vibration monitors in blue. The substation is the grey building on the right side of the map

Table 3.1. Charging-weight in each single-shot and distance to the switch-gear in the substation

Single - shot	Charge-Weight [kg]	Distance to substation [m]
1	1,99	151
2	0,98	113
3	0,73	82
4	0,49	65
5	0,49	53
6	1,21	83

Table 3.2. Vibration monitors and distance to the switch-gear in the substation.

Vibration monitor	Type of measure	Distance from substation [m]
1, Substation, foundation	Tri-axial, mm/s	3
2, Bedrock	Tri-axial, mm/s	40
3, Bedrock	Tri-axial, mm/s	47
4, Bedrock	Tri-axial, mm/s	69
5, Substation Switch-gear	Tri-axial, m/s²	0
6, Substation floor	Tri-axial, mm/s	1

3.1 Procedure during test-blast During the test blast, one single hole shot was fired at a time, beginning with the shot furthest away from the sub-station. The charges were initiated by pyrotechnic detonators, Exel.

After the shot was fired, recorded vibrations were analysed for obtained vibration level and quality of the signal. After this control, the next hole was charged and fired.

It was observed after shooting hole number 3, that the level of vibrations was very low. A second single-shot was fired, shot number 6, with an increased charging weight, shown in Table 3.1.

4. RESULT FROM THE TEST BLAST

4.1 Regression analysis

The charge weight scaling law equation is calculated with regard to both vibration velocity and acceleration. Since the limit value on the substation was related to acceleration that was the most important value, but vibration velocity was also considered. All analysis was done in the vertical direction only in accordance with Swedish praxis, se figure 4.1 and 4.2.

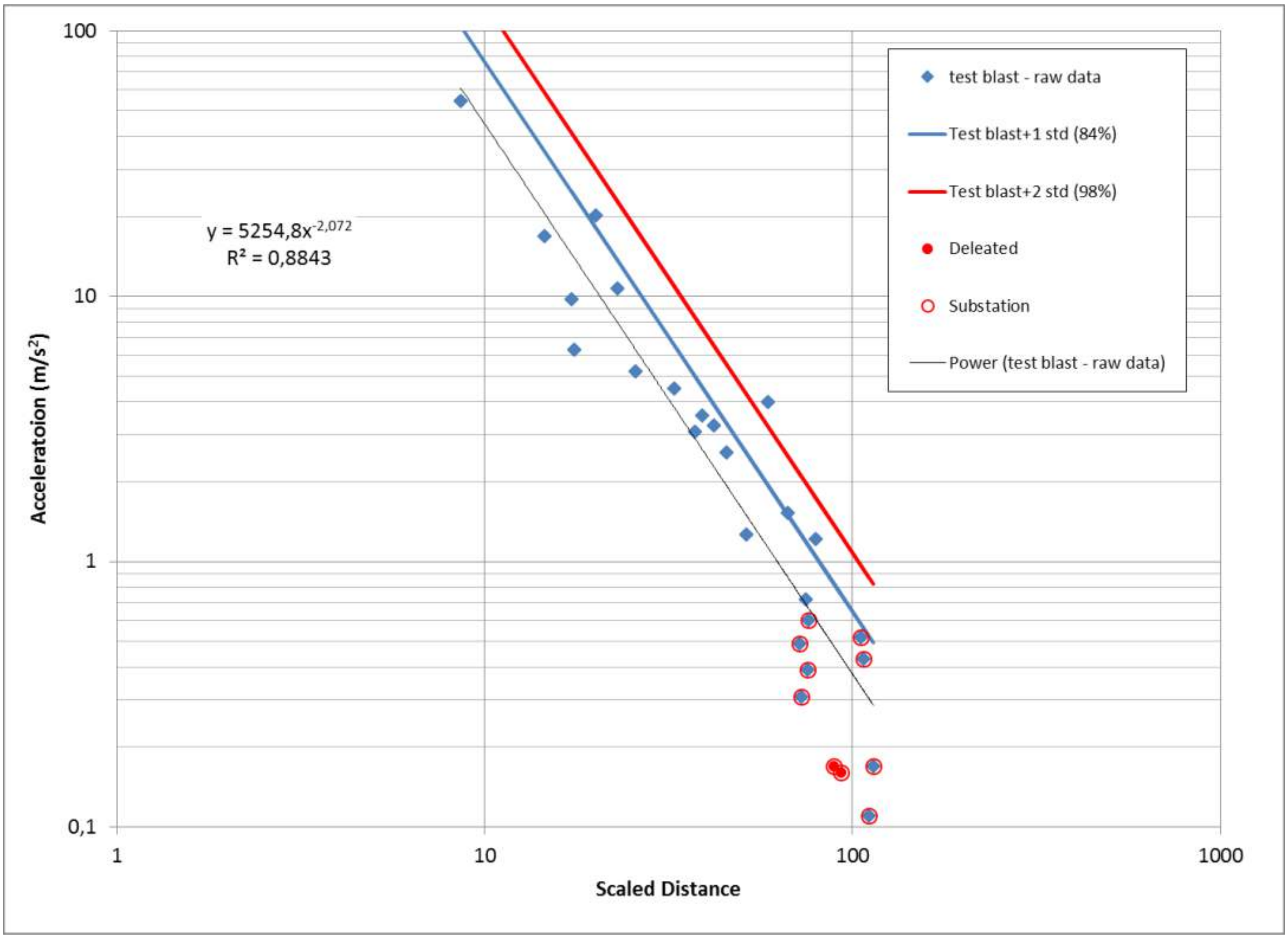


Figure 4.1 regression analysis, acceleration

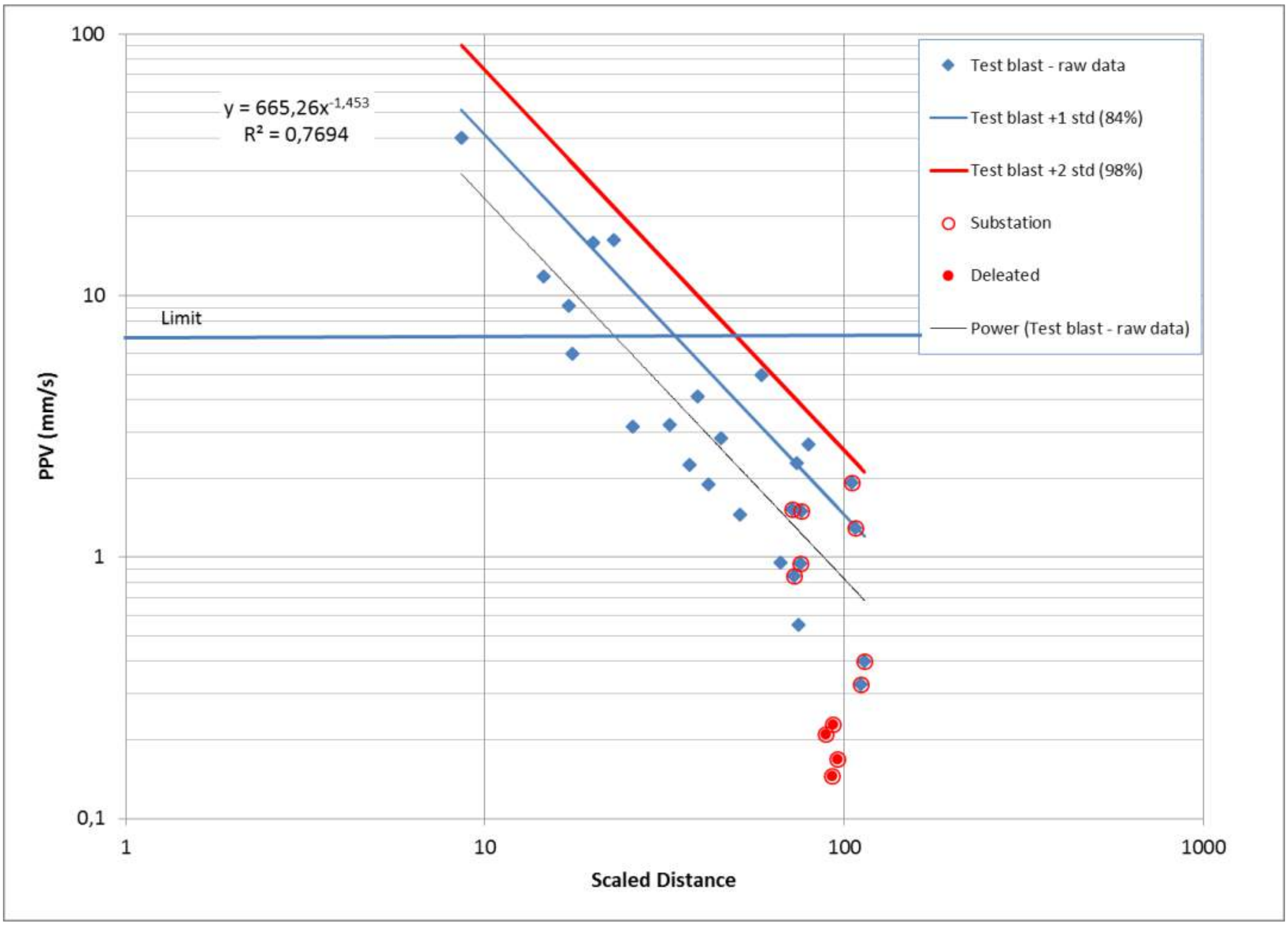


Figure 4.2 regression analysis, vibration velocity

4.1.1 Charge table – regression analysis

The regression line from Figure 4.1 and the following model parameters (Table 4.1), males it possible to create a charge table (Table 4.2). Knowing we have to remain below 0.2 g (2 m/s^2) and by using a probability of 84% (1 standard deviation), we can use a 0.75 kg charge at a distance of 50 m. However, since the monitors on the substation gave lower acceleration values (se Figure 4.1) than the one on bedrock the suggested charges wold probably be smaller than necessary. Due to this fact it was decided to repeat the analysis using vibration velocity instead.

Table 4.1. Parameters in the model

	MP
A	655
B	-1,45
v_p*	5000
COV**	0.4

*Assumed value
**Coefficient of variation (regarding raw data scatter)

Table 4.2. Charge table constructed according to model parameters

R (m)	Q (kg)	50% (m/s^2)	84% (m/s^2)	98% (m/s^2)
10	0,03	1,2	2,0	3,4
20	0,12	1,2	2,0	3,4
30	0,27	1,2	2,0	3,4
40	0,47	1,2	2,0	3,3
50	0,75	1,2	2,0	3,4
60	1,05	1,1	2,0	3,3
70	1,45	1,2	2,0	3,3
80	1,9	1,2	2,0	3,3
90	2,4	1,2	2,0	3,3
100	3	1,2	2,0	3,4

Figure 4.2 shows that the recorded values at the substation fit better with the other measurements for vibration velocity than the observations of acceleration (although the overall fit isn't as good). An explanation for this can be seen in Figure 4.3. The frequency is generally lower (and very constant) for the substation than for the monitors placed on rock.

It can be seen that the dominating frequency at the substation was around 50 Hz (Figure 4.3), independent of the distance from the detonation. We can then use the relationship:

$$a = v \cdot 2\pi f \qquad (2)$$

If the permissible acceleration level is 2 m/s^2 and the frequency is 50 Hz this gives a permissible vibration level of 6.4 mm/s. Table 4.3 shows the charge table according to this relationship.

Table 4.3. Charge table for 6.4 mm/s as limit vibration level

R (m)	Q (kg)	50% (mm/s)	84% (mm/s)	98% (mm/s)
10	0,07	3,4	6,0	10,5
20	0,36	3,7	6,3	10,5
30	0,8	3,6	6,2	10,4
40	1,4	3,6	6,1	10,2
50	2,3	3,8	6,4	10,7
60	3,3	3,7	6,4	10,7
70	4,5	3,8	6,4	10,7
80	5,8	3,7	6,3	10,6
90	7,5	3,8	6,5	10,8
100	9	3,7	6,3	10,5

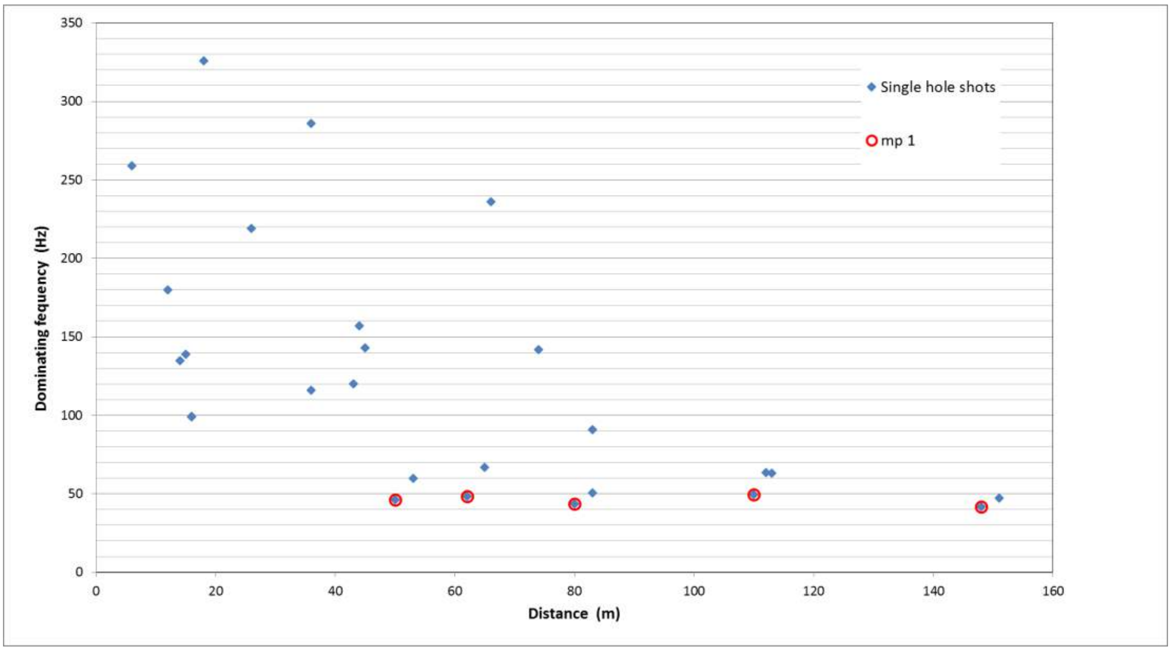


Figure 4.3. Dominating frequency verses distance, the red circles comes from MP1 at the substation

The result of this calculation is that we can charge 3 times as much: 2.3 kg at a distance of 50 m. The reason for this being, the acceleration levels are generally lower at the substation compared to the other monitoring points on the rock. A possible reason for this was that the substation is likely not built entirely on rock and that a thin layer of soft soil reduces the frequencies at the substation.

In general the vibration levels are lower at the sub-station but even more so when it comes to recorded acceleration. This has a big impact on our final recommendations.

4.2 The Seed wave

It is critical that the signature wave form is monitored at exactly the same spot as the modelling will be performed at, this due to the fact that the wave form is highly affected by how far the wave travels between place of monitor and place for detonation and also due to the response in the constructions monitored.

A condition in order to be able to use the signature wave form is that each blast hole in the modelled blast is similar to the seed hole. In Figure 4.4 an example of three different signature waveforms monitored at the same spot (MP 1) are shown. What we can see is that the three curves are similar both regarding duration and dominating frequencies. However, you can see that they are not identical, in the model a certain amount of randomization is introduced to the seed wave form in order to compensate for this variation.

In the simulation made for this project the same seed waves has been used for all distances, it is important to note that the risk of errors increases when the difference between that simulated blast and the original distance for the seed wave increases.

5. USING THE MODEL

Data from the single hole shots were used as inputs to the simulated blasts, the parameters in Table 5.1 were used, together with the seed wave. This enabled us to decide upon the optimal delay times.

Table 5.1. Parameters in the model

	MP
A	655
B	-1,45
v_p*	5000
COV**	0.4

*Assumed value

**Coefficient of variation (regarding raw data scatter)

A simple blast was then simulated, 1 row, 14 holes 3 kg of explosive in each hole (see Figure 5.1 & 5.2). This blast was simulated with different delay times (from 1 ms to 60 ms, electronic detonators, see Figure 5.3).

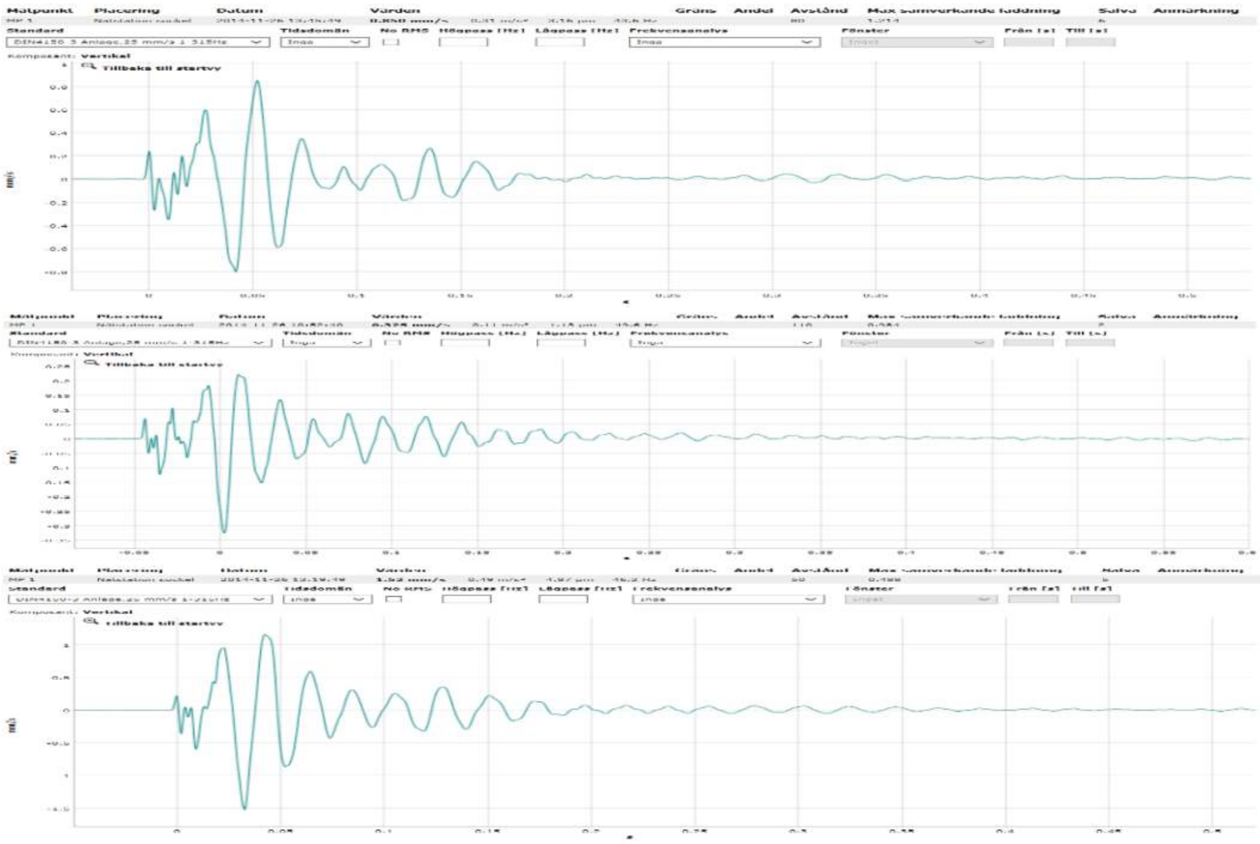


Figure 4.4. Example of three single hole curves, MP 1

Figure 5.1. A single row blast at 60 m distance from MP 1, this setting was used to optimize the delay time

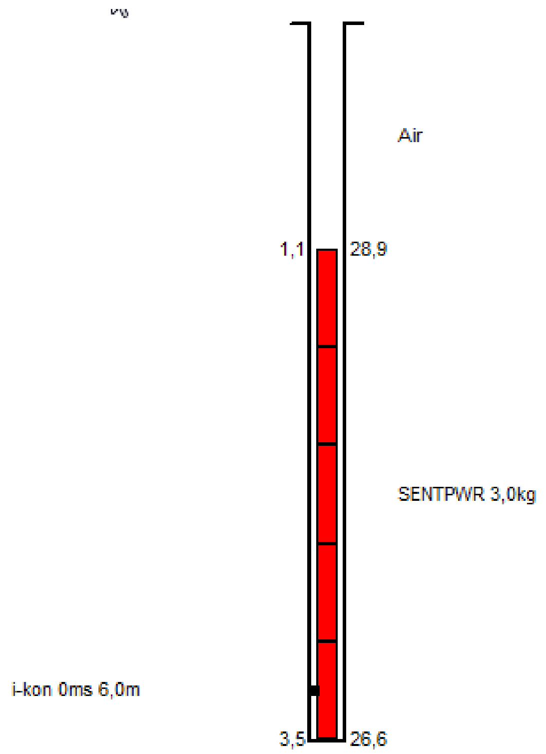


Figure 5.2. Charged bore hole, 3 kg charge, 3.5 m depth

The result from modelling different delay times can be seen in figure 5.3. The recommendation from this was to use delay times between 15 and 18 ms, 29 to 42 ms or greater th an 45ms. It was likewise important to avoid using delay times of less than 5ms and between 19-27ms.

5.1 Recommendations for excavation

The recommendation for excavation was to start by blasting a "wide trench" from south to north according to Figure 5.4 and 5.5 called zone 1. By doing so, the first part of the excavation wold create a buffer zone for vibrations from any subsequent blasts in the project and possibly enable the use of a higher MIC.

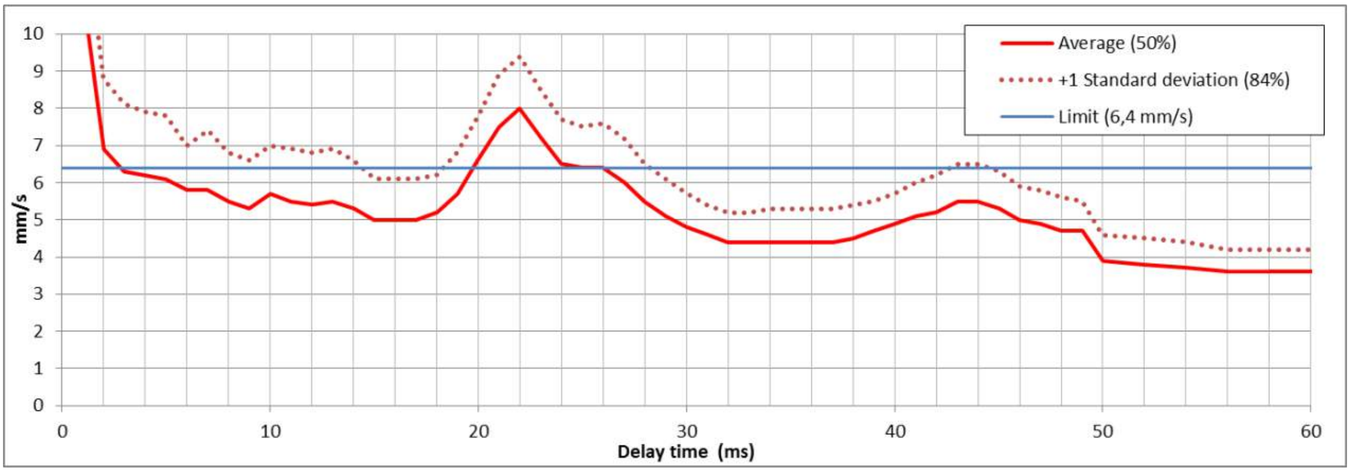


Figure 5.3. Delay times 0-60ms between holes

It was also important to start each blast at the side towards the substation in order to create a buffer zone within the actual blast.

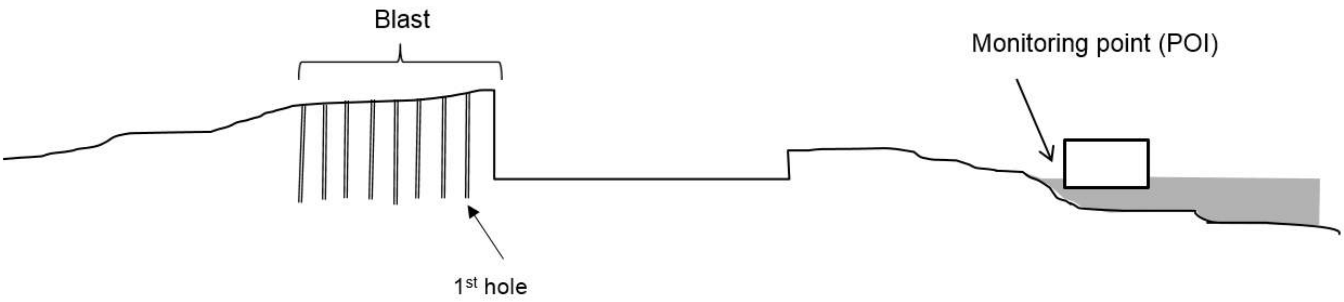


Figure 5.4. Cross-section of the excavation plan

Figure 5.5. View over the zones. Excavation starts in zone 1, the zone closest to the substation (MP 6)

From this plan it is possible to test different blasts according to the superposition model. Three different distances 50, 75 and 100 m were modelled according to Figure 5.6. The condition here was that the level 6.4 mm/s (corresponding to 0.2 g) was a maximum value.

The prognosis showed that it ought to be possible to use 10 kg MIC at 100 m distance. However a few facts contradicted this. These included; when the earlier project in 2013 exceeded the allowed values the distance was 150 m and the MIC was 5.4 kg and secondly; during test blast 1 at 148 m distance the values at the substation were much higher than during the other test shots.

Due to this it was decided to recommend the usage of a maximum 5.8 kg MIC (burden×spacing then became 1.6×2 m, which would work fine in bench heights up to approximately 5 m).

If the "wide trench" (zone 1) closest to the substation was shot first the possibility to increase the MIC after that could be evaluated at a later stage.

So blasting was thus planned to start at 50 m distance from the substation (closer than that would have been problematic, due to the small charges involved), blasting from south to north.

6. PRODUCTION

In November 2016 the production contractor, Gnesta Bergbyggare AB started production with blasts in Zone 1. They then made a drill and blast plan with charging and delay times according to the recommendations from the pre-study. Table 6.1 shows the given MIC and proposed drilling pattern based on the pre-study.

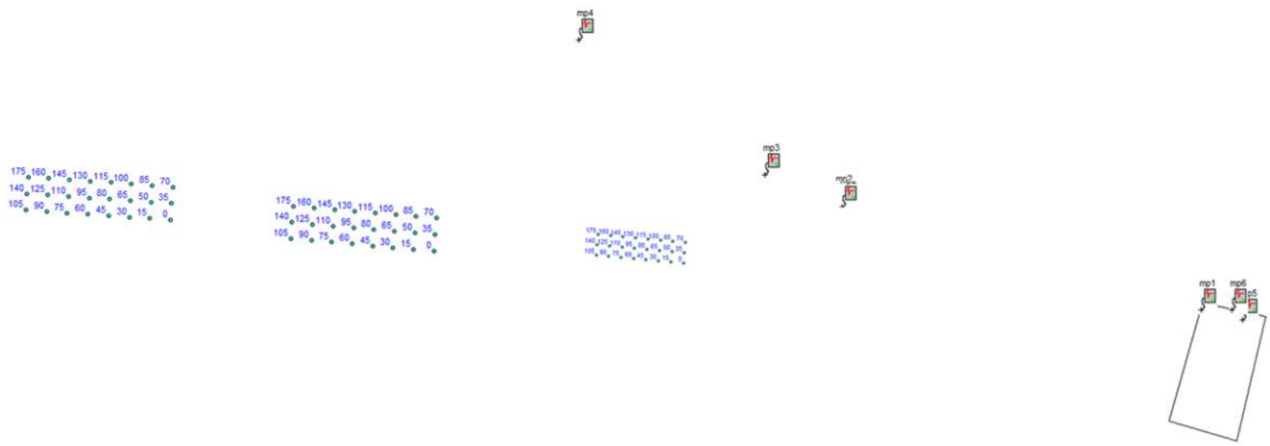


Figure 5.6. Simulated blasts at 50, 75 and 100 m distance from the substation

Table 6.1. Drilling pattern and MIC for different distances to the substation

Zone	Distance to substation [m]	Drilling pattern, BxS (m)	MIC (kg)
1	50-75	1,0x1,2	2
2	75-100	1,65x2,05	4,5
3	>100	1,65x2,05	6

6.1 Procedure development for production blasting.

The first design of the production blast were done according to the recommendations from the pre-study.

Before the first blast the real tie-up was modelled in the SHOTPlus signature wave superposition model to simulate expected vibrations.

Then immediately before the blast, the initiation plan was marked on the rock to be excavated and noted on paper, (see figure 6.1). All holes throughout the blast were initiated by unitronic electronic detonators which make it possible to choose a specific delay time for each hole and ensure only one detonator detonates for each delay time. Having the ability to adjust the blasting plan to reduce vibration levels was an important part of the production procedure. Coordinates for the blast were documented together with the charge load for each detonator and delay time. Hole-depth, water, difficulties with the drilling and geological aspects were also noted.

After the first blast was fired, monitored vibrations were analysed with regard to relevant parameters.. By looking at the waveform and the time of the peak-values the specific holes and charges for the peaks were determined.

Figure 6.1 Left: The numbers of detonators for that hole together with the charge for lower deck. Right: The documented tie-up together with all charges for the blast

6.2 Production blasting

The blasting started in the zone closest to the substation, zone 1, at a distance of 50-75m meter away from it. The maximum charge was limited to 2 kg throughout the whole zone. The drilling pattern had a burden and spacing of 1x1.2 metres.

The first production blast was located 81m from the substation and consisted of 21 holes, drilled at a diameter of Ø48mm and dipping 10°off vertical. The total length of the holes were 0.8-1.2 metres. Maximum charge per delay time and hole was 300 grams. The tie-up was made with a 15ms delay time between each hole. The blast resulted in a vibration value of 0.33 m/s^2 for the substation.

After ten successful production blasts, a higher bench with deck charges was simulated in SHOTPlus to estimate if the vibration level would stay low, which it appeared to do in the results. The 11th production blast was the first to consist of deck charges, located 76 metres of the substation. Total length of these holes was 3.2-5 metres and had a charge per delay of 1.3-1.8 kg. The blast resulted in a vibration value of 0.67 m/s^2

Zone 1 was then divided in two zones with a maximum bench height of 6.5 metres, to make it possible to blast one full bench height with two decks. The top bench was carried out for the entire zone before production started on the bottom bench.

6:3 Production blasting improvements
The success of blasting higher benches and maintaining low vibration values made it possible to try even bigger production blasts. This meant that as production got closer to the substation the blasts got bigger. The key learning being, when we approached the 50m limit to the substation, the two rows closest to it only got charged with a maximum of 1.5 kg to ensure low vibrations.

The biggest production blast in zone 1, consisted of 98 holes, 480 m^3, charged with a total of 240 kg over two decks.

This blast included 193 detonators initiated with a 15ms delay time and a maximum charge of 2 kg per delay. The blast resulted in an acceptable vibration value of 1.5 m/s^2.

These larger production blasts sometimes resulted in undetonated explosives and big blocks at the surface. To eliminate undetonated explosives and achieve better fragmentation and heave from blasting the idea of using shorter delay times was proposed. A subsequent initiation plan was run in SHOTPlus where the delay time was lowered from 15ms to 7ms without increasing vibration values. The 7ms delay time was then used as the new standard for further blasting and the amount of undetonated explosives appeared to decrease.

In the beginning of May 2017, 120 blasts had been made in the area at distances between 50 – 160 m from the substation. Figure 6.2 shows charge per delay for all blasts.

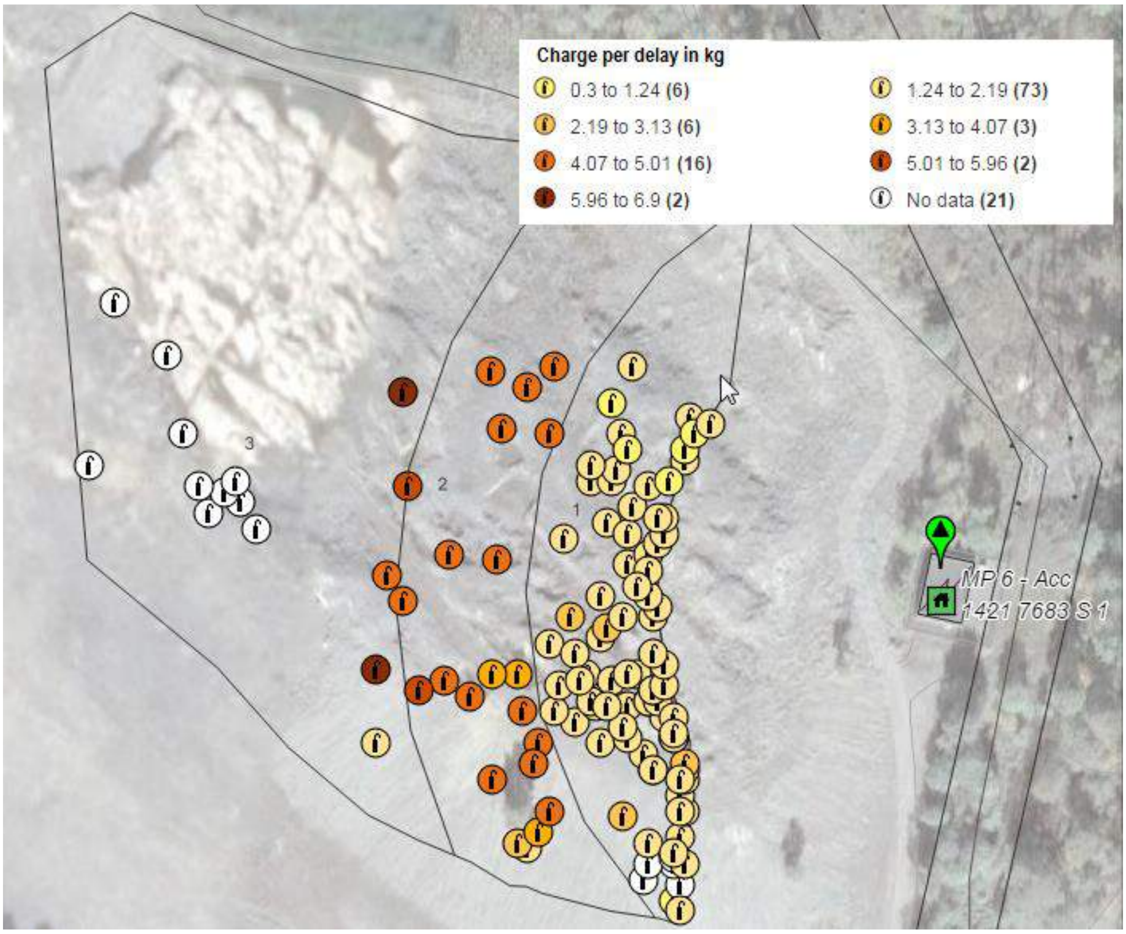


Figure 6.2 Location of the 120 production blasts. Charge per delay is shown with different colours accordingly to the legend in the figure

The only exceedance of the threshold value occurred during blast 92 in April, 2017. This exceedance resulted in a few days stop in production while the waveform and vibration values of the blast were analysed. The key aspect of the analysis being to determine the reason for the high acceleration. Figure 6.3 shows that there was only one peak that exceeded the threshold value of 2,0 m/s^2. The delay time and specific hole could be estimated by looking at the documented tie-up for the blast.

The frequency for the top value was around 60 Hz and Figure 7.3 shows PPV and PPA for all 120 blast monitored before May 2017. If the relationship between acceleration had been strictly linear (according to the relationship used when calculating the MIC), the acceleration would be around 1.7m/s^2. We believe the geology in that area probably contributed to the exceedance.

When blasting resumed the new MIC for the two rows closest to the substation was decreased to 1 kg. The rest of the blast got charge the same way as earlier blasts in the same zone.

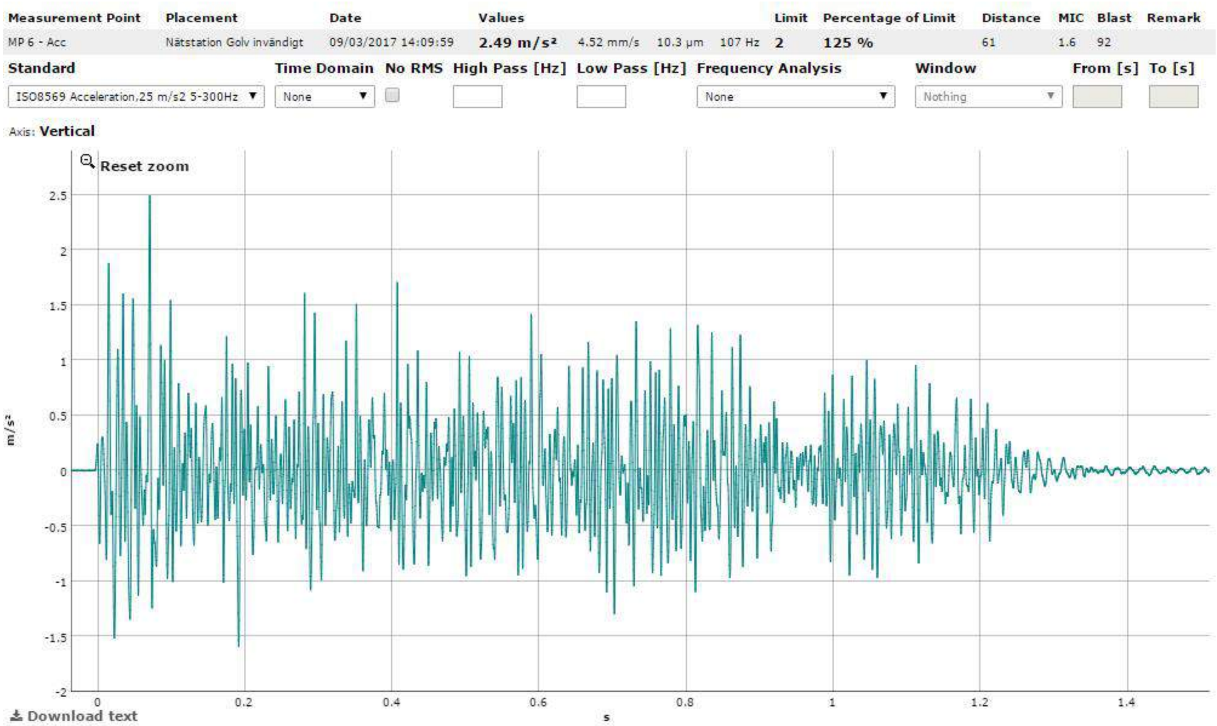


Figure 6.3.Waveform of the acceleration from blast 92

7. DISCUSSION

In general the project can be seen as a success. Only one of 120 blasts has recorded a vibration level above the threshold at the substation. Comparing the production blasts with the single hole shots we can see that the correlation is good. This can be seen in figure 6.1 and 6.2 where we have plotted the individual blasts in the same diagram as the regression analysis for the single hole blasts. What we can see is exactly as predicted the results are in good agreement with the PPV prediction (6.2) while the acceleration levels plot low in the diagram (6.3).

We can also note that although some blasts have been large with almost 200 separate charges it has been possible to keep the vibrations at the same level as the one single hole shots.

The reason why the threshold level (2 m/s^2) was exceeded one time (Blast# 92), despite the calculated threshold level (6.4 mm/s) never been breached was that the acceleration level had been higher than predicted and the reason for that was that the dominating frequencies was higher than the predicted 50 Hz, not only in that blast, but in most blasts.

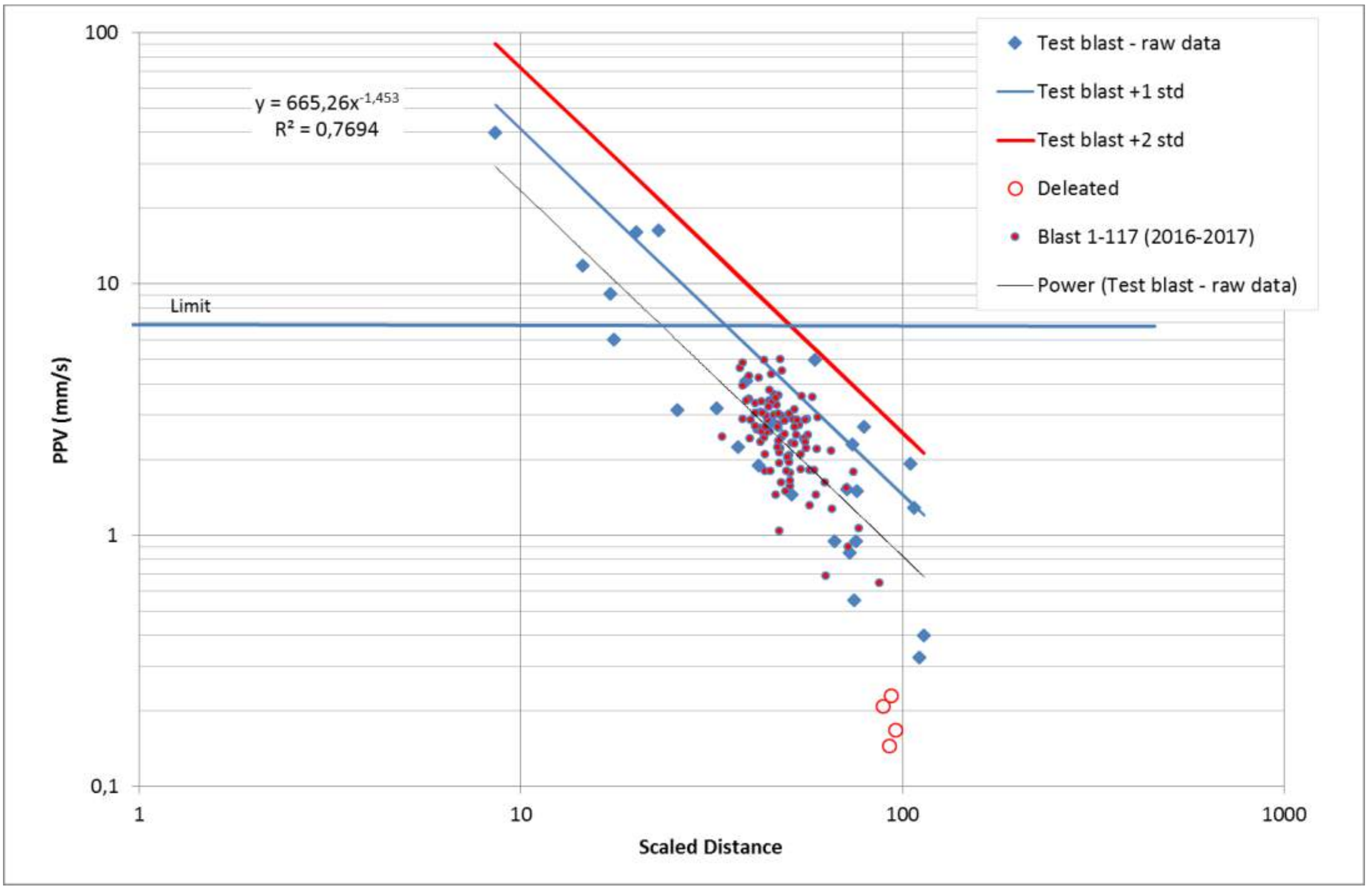


Figure 7.1

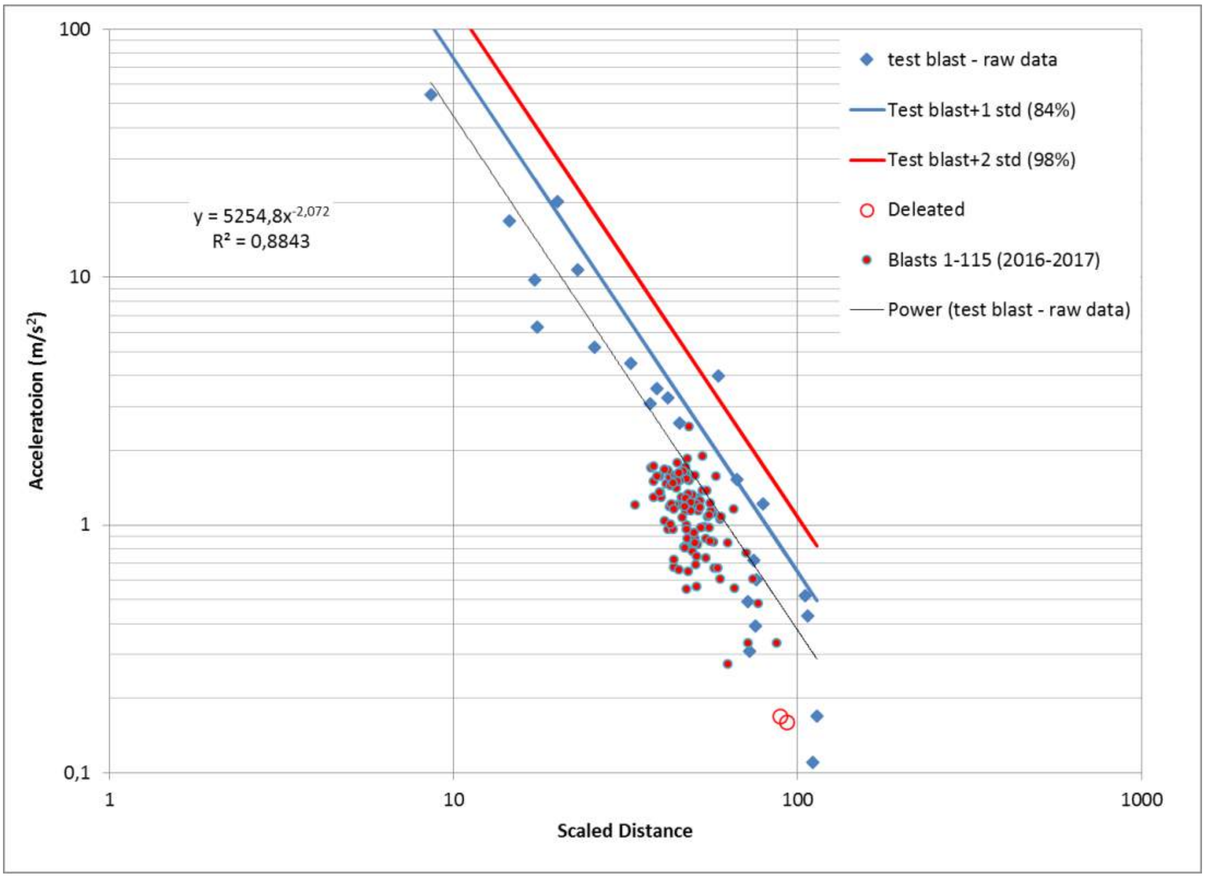


Figure 7.2

The spread in dominating frequency between the different blasts were large and as a result it was difficult to establish a clear reason. The average dominating frequency for all data (using the relation a=v×2πf) was 67 Hz, leading us to believe that this was due to the 15ms delay time (1/0.015s =) 67 Hz. However when we looked more closely at the data we noticed that also blasts with a 7ms delay had an average frequency of 67 Hz, informing us that differences were in fact due to how the blasts were shot.

Due to the size of the allowed MIC (2 kg), zone 1 had to be divided into 2 benches (where each bench was shot with 2 decks). If we compare these 2 benches we can see that the acceleration values were higher in the lower bench and this appears valid by just looking at the 7ms delay times. However the understanding that the acceleration (frequency) is higher than the predicted 50 Hz being solely dependent on an effect from the delay timing is not accurate. Another reason is that when the lower bench was being excavated this gave an even higher frequency due to an improved contact (for wavelengths to propagate) between the lower bench rock and the substation than for the upper bench, see figure 6.5.

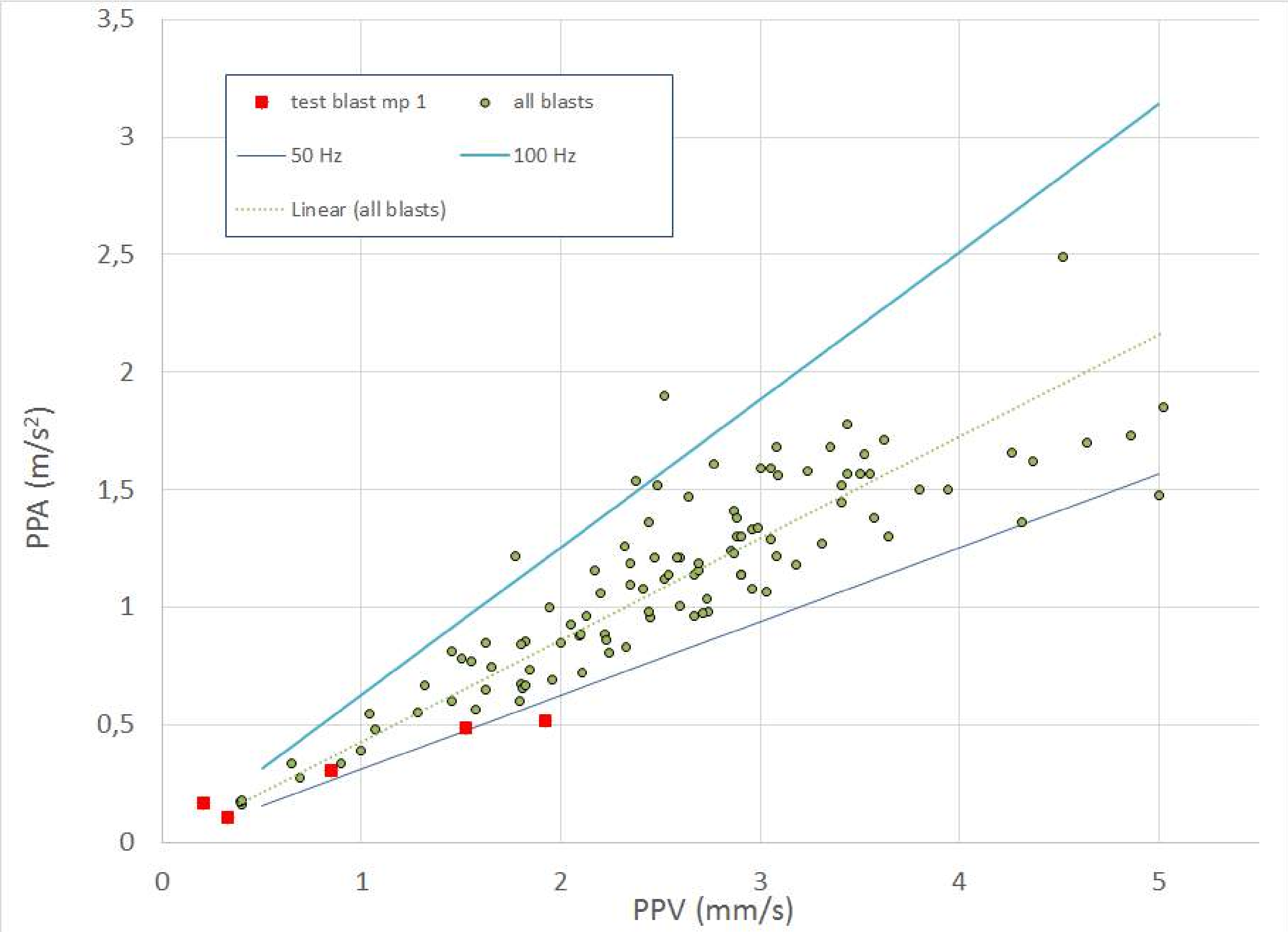


Figure 7.3 The relation between PPV and PPA. The lowest line shows the predicted line (50 Hz) corresponding to the test blast (red squares), while it can be seen that the actual relation between PPV and PPA varies between 50 and 100 HZ averaging at 67 Hz (the dotted line)

8. FINAL CONCLUSIONS

In conclusion, the recommendations put forth regarding vibration velocity have worked well in this project.

In all: out of 120 blasts that were recorded in the project the vibrations have been within acceptable limits every time except once. The superposition model, our recommendations and the possibility to include delay timing has been very helpful in ensuring this occurred.

The ultimate indicator and success of the method being that, we are able to produce large blasts consisting of a large number of holes with two decks while still succeeding to keep the vibrations on the same level as the single hole shots. This being largely due to the contribution of electronic detonators and the possibility to calculate optimal delay times.

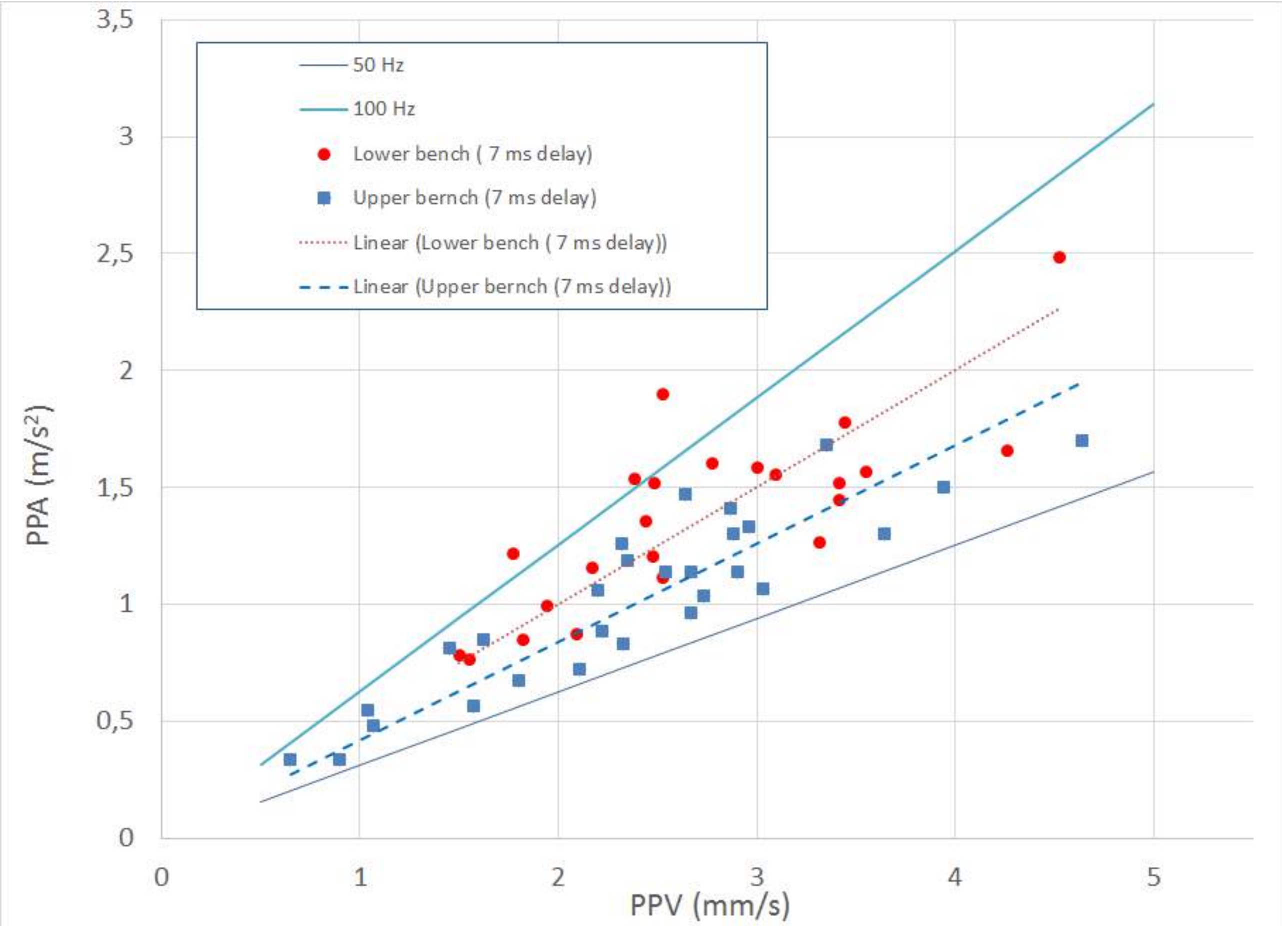


Figure 7.4 The relation between PPV and PPA. For just the 7ms delay shot. The upper bench (blue squares) gives an average frequency of 67 Hz while the lower bench (red circles) gives 80 Hz

The observed accelerating values were higher than predicted due to the driving frequencies from the delay time of the detonators, this was not properly included in the initial predictions. However, the consequence of this was small and not a limiting factor to the success of the project.

S. Ahrengart, E. Malmquist &
M. Jern, Nitro Consult, Sweden

REFERENCES

Anderson, D.A. 2008. Signature Hole Blast Vibration Control – Twenty Years Hence and Beyond. Proc of the annual conf. of explosives and blasting technique. V 34(2): 27-38.

Blair, D.P. 1999. Statistical models for ground vibration and airblast. Fragblast, The International Journal for Blasting and Fragmentation. V 3: 335-364.

Blair, D. P. 2004. Charge Weight Scaling Laws and the Superposition of Blast Vibration Waves, Fragblast, The International Journal for Blasting and Fragmentation. V 8: 221 – 239.

Blair, D.P. 2007. Non-Linear superposition models of blast vibration. Int. J. of Rock Mechanics and Mining Sciences. V 45: 235-247.

Jern M. 2011 Test blast and vibration prediction AVM project Klinthagen Quarry, Gotland, Sweden. Proc. of the 6th conf. on Explosives and Blasting. Lisbon Portugal EFEE pp 91-116.

Spathis ,A.T. 2009. A brief review of the measurement, modelling and management of vibrations produced by blasting Workshop on vibrations from blasting 12-13 September 2009 Granada, SPAIN: 1-11.

ISO 8569:1996 Mechanical vibration and shock -- Measurement and evaluation of shock and vibration effects on sensitive equipment in buildings.

SS 460 4866:2011 Swedish Standard SS 460 48 66 Vibration and shock – Guidance levels for blasting induced vibration in buildings.


THE ALL NEW
AvaTrace M80
Simple, remotely controlled vibration monitor.
Now with 8 month battery life!
• Online monitoring and remote control of field instruments – all from your web browser!
• Field instruments made for harsh outdoor conditions – perfect for your infrastructure projects!
• Fully automatic system with no manual attendance required – simple and easy to handle.
AVA monitoring®
avamonitoring.com

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

ABSTRACT: This paper will discuss the history and development of wireless blasting, describe the verification, and validation performed and introduce the advantages of the next generation of blasting to the market; including safety, cost and automation.

1 HISTORICAL

The first known commercial interest in wireless initiation, found in the literature by the author, was in 1945 and authored by Imperial Chemical Industries, previously a parent company to Orica. The early patent describes a control system for detonating a charge, which upon reception of multiple wireless signals initiates said charge.

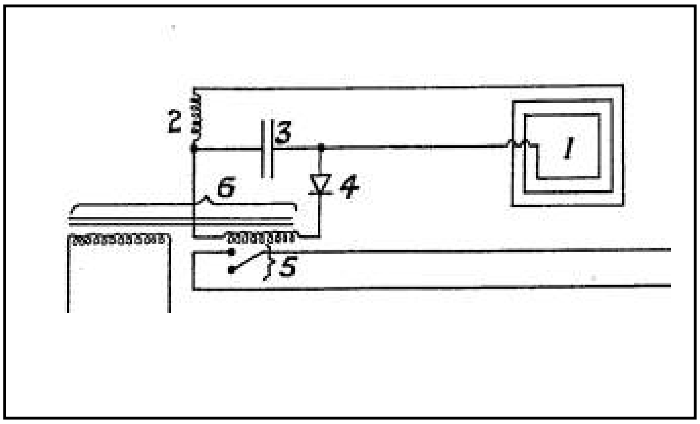


Figure 1. An image illustrating the wireless receiver from an early patent for a directly initiated detonator

Further progression of wireless blasting and the development of a commercial wireless initiation system received only limited interest until recently, when remote blasting capability was developed and in 2003 commercialised.

In such a remote blasting system, the blast is controlled from a remote location by 2-way radio communication with the in-hole primers connected by wire to radio transceivers on surface. This is the predominant wireless initiation system used in mining systems today.

Orica has been developing WebGen™100 for over a decade; a more advanced, true wireless system, capable of directly initiating in-hole primers via one-way communications that penetrates rock, water and air. This system is the first commercial initiation system to incorporate the initiation energy and ability to initiate completely within the device. To achieve this fundamental change significant investment and an evolution of the functional safety and design of initiation systems was required with substantial increase in verification and validation activities.

Figure 2. Evolution in the design of the directly initiated wireless booster

The prototypes generated during the development of the wireless booster are shown in Figure 2. The initial prototype design was a comparatively larger cylindrical device focusing on larger surface boreholes and, as the development matured, the design was refined and reduced through a number of iterations. The final design was chosen as its size and performance affords the ability to target the majority of blasting applications

2 INTRODUCTION TO SYSTEM

The wireless system consists of three different categories of components; the blast management computer; the wireless in-hole primers, encoder controller and accessories; and the transmission system; shown in Figure 3.

Prior to introducing wireless blasting to a mine site a wireless survey is conducted. The survey qualifies the suitability and performance of the wireless system at the site. The information from the survey is used to identify a suitable location for the transmitter, recommend a preferred antenna to be used; identify any anomalies, which may significantly attenuate the signal; and sources of noise, which may interfere with the signal.

As per current practice, the blast is initially designed with blast design software such as SHOTPlus™. The blast design is then exported to the blast dongle and loaded into the Code Management Computer (CMC); a dedicated tablet PC that hosts and manages blast codes for a blast site. Each set of codes consists of a blast group identifier, mine specific identifier and firing codes specific to each blast and is required to initiate the blast.

The wireless in-hole primer consists of a disposable receiver (DRX), a booster and detonator. Prior to encoding the detonator and DRX are mated energising the assembly. To encode the assembly, the Encoder Controller, a hand-held device connected to an encoder cradle is used. The assembly is placed into the cradle where communication of required blast parameters and interrogation of the unit are performed. The performance of the DRX and detonator are then evaluated and verified, encoded with the blast codes, and the timing and the detonator are recorded. Finally, the detonator, DRX, booster and components are assembled at the loading bench to create the primer, before being loaded into the required position.

The transmission system creates the electromagnetic signals that enable firing of the wireless primer. During the blasting sequence, the user controls the transmitter via transmitter controller. The system supports a short-range and long-range antenna, either a quad-loop or cable-loop type. The user enters the fire command into the transmitter controller, enabling the firing signal to be sent via transmitter to all corresponding primers in range.

During the trials, the long-range cable-loop antenna was deployed. The radiation pattern for the antenna is shown in Figure 4. The specified range of this antenna, when operating in a standard environment confirmed by a survey, is 720 m in the vertical direction and 800 m in the horizontal plane.

①	Booster	⑤	Transmitter Controller
②	PlugIn detonator	⑥	Transmitter and battery pack
③	Disposable receiver (DRX)	⑦	Quad loop antenna
④	Encoder Controller with attachment	⑧	Code Management Computer (CMC)

Figure 3. WebGen™ 100 blasting system

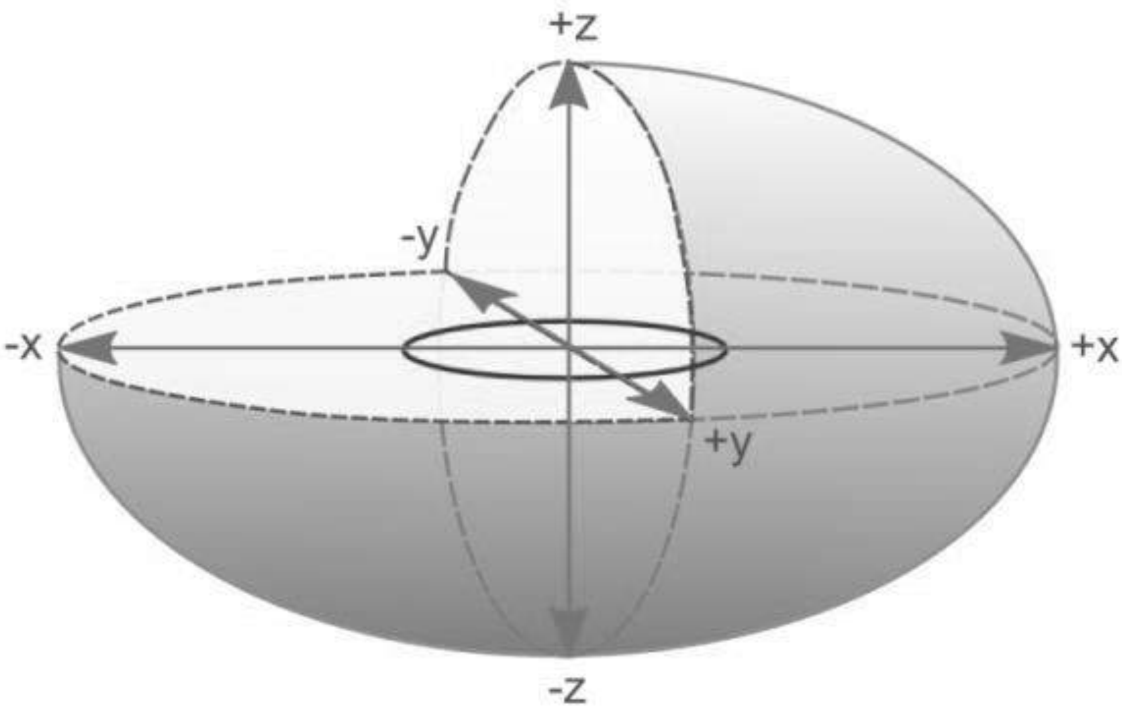


Figure 4. Transmission range of system

3 INCREASED SAFETY THROUGH REDUCED OR ELIMINATED RISKS

There are so many mining methods to recover ore from underground and they all rely on the basic premise to break the ore into a manageable fragmentation size for extraction and then to stabilise the resultant void with fill material.

The breakage of the ore spans from 'drill and blast' to using the stresses of the void to break ore to enlarge the void, as in block caving. Practically all hard rock mining requires the drill and blast process for a large part of the setup or production stages.

Blasting is, by its nature a cyclic process that requires digging, drilling and blasting processes. The digging and drilling processes have been principally controlled with large-scale equipment that allows automation or the operator to be protected in a cabin where the conditions can be controlled. The blasting process, while options to automate the charging exists, has always required a very manual approach to the connection of th belast to a firing system and in most methods this occurs in the area of highest potential risk of injury due to rockfall and or unstable workplace due to movement of the floor.

3.1 Sub-level cave

Underground production blasting requires a level of exposure to situations of increased risk. This is especially apparent during connection of the wire network of the initiation system. Sub-Level Caving (SLC) operations in particular require this hook up within close proximity to the edge of the excavation and commonly above a bank of rock prone to movement. A number of SLC mines have had rushes that have resulted in fatalities in recent years.

Orica's Wireless Electronic Blasting System eliminates these high-risk hook-up processes and facilitates the development of automated charging. The system enables blasting techniques whereby in-hole primers initiate directly by communication though rock without the requirements of physical connections. Elimination of the wire network and connectors removes the need to have access to the collar of the hole after charging. This enables increased pre-charging of underground blast patterns, whereby a larger number of holes are initially charged, and the flexibility to initiate a group in each blast event.

SLC mines have situations where the edge of the excavation has retreated, or broken back, past the next ring to be blasted. If this occurs, either the next ring is fired, wasting primary draw and causing potential bridges/ oversize, or re-drilling is required in these locations. Having an operator re-enter these areas and re-drill is both a costly exercise, and an activity with higher safety risk and slowing productivity.

The loading procedure for wireless initiation uses packing tape that hangs out of the bottom of the hole to indicate that the ring has been charged, and as an indicator for the loader operator to determine if the charges have been moved by ground pressure of earlier fired rings. Further details of production blasts are found in Liu *et al.*

There are many papers and case studies, including S.Steffen *et al.*, that show that having the primers in the correct place and reliable initiation; will improve primary recovery and minimise dilution. Wireless will enable every blast to be reliably initiated; with electronic timing, the blasting sequence for the near-optimal fragmentation can be achieved.

Figure 5. Underground vehicle at SLC mine after an inflow

Figure 6. Hook-up for a single SLC ring with risks partially controlled with backfill, shotcrete and bunding

Figure 7. Multiple wireless charged rings are ready to fire as soon as needed, note strapping indicators

3.2 Sub-level open stoping

Sublevel Open Stoping (SLOS) has exposures due to the open stope. Ground within the open stope is normally not supported and uncontrolled falls of rock can be expected, which is why they have barriers to protect personnel entry. Mines use bunding and other means to protect potential falling rock into the work area, but the edge of the next blast packet requires charging and hooking up for the start of the next blast. Furthermore, where stress and ground conditions create unstable or squeezing conditions, the next blast can be delayed due to blast hole closure or dislocation.

This is a major delay cost and a heightened safety risk to control in recovering, re-drilling and correcting before charging can be undertaken.

Wireless allows the next blast section to be loaded and pre-charged before the previous section is fired, thereby eliminating the influence of dislocated and squeezing holes, and the high- risk process close to an open stope, on the charging process. Obviously, the priming frequency should, as it is now, be chosen to allow for primers to initiate the most of the explosive charge in the blast hole. The type of initiation does not change the frequency and position of primers in a blast hole. The frequency is decided from the level of discontinuities in the rock, the powder factor in the blast and the criticality of the blast hole.

Another example of this use is in an opportunity to leave isolated pillars to improve the stability of Open Stopes and the recovery of ore by leaving these pillars behind in the centre of a stope after it has been charged with the wireless initiated explosives.

This method can increase the size of stopes and reduces the frequency of slots. It increases the recovery of the ore body and reduces costs. Extra support from these pillars can assist the clean ore recovery before the isolated pillar is extracted.

3.3 Seismically Active Mines

Further difficulties may arise within mine locations prone to seismic events. These active areas require further management controls including exclusion zones to limit the exposure of personnel to rock bursts and closures.

Traditional blasting methods in these areas will require an operator to access the hazardous area and hook up the initiation system prior to blasting. An example would be a block cave mine which is newly establishing the cave or due to high stresses on the Undercut Level. Pre-loading several rings away from the high stress 'active' areas can mean that these areas can be remotely dug and fired when wireless initiation systems are used.

The wireless system is uniquely suited to this use as the detonator complex can be made up and loaded into a cassette for use in an autonomous charging vehicle capable of making up the primers, inserting them into the blasthole (either up or down) and charging.

Figure 8. Charging complete for the hook-up process to tie it into the detonating cord at the open stope brow

4 SYSTEM VALIDATION AND VERIFICATION

Wireless Electronic Blasting technology is being introduced into production environments following the successful product development and verification stages. During these stages, the system validation was performed by leading internal experts and external authorities; in laboratory, underground and surface operating environments.

The five stages of testing performed on the system are described in this section; consisting of System Lab Tests performed during development; Internal Field Trials, Customer Trials, Live Trials and Production Trials performed during the final system tests in the first half of 2015.

4.1 System lab validation and verification

Orica teams located in Troisdorf, Germany, and Brownsburg, Canada, and five independent external organisations located in Germany, Canada and the USA performed the design and lab testing. The external organisations included our design, functional safety and independent lab verification partners. A summary of the battery of validation and verification tests performing on the system in order of ascending system design level is included below.

Firmware, module, and unit testing, verified and validated the smallest individual testable blocks of the system, and was performed both internally and by the project design consultant, and included complete code coverage testing of the firmware, individual module and unit testing via both software and interfacing with hardware firmware.

Figure 9. Early remote-control charging equipment with smart vision systems to identify blastholes

Design, integration and system tests were performed to verify that the integration of the software and hardware tested modules performed as specified. As the lower level functionality has previously been tested a 'black box' testing methodology against the system requirements was performed.

Figure 10. System testing of wireless units

Fault-Insertion testing was performed by both our functional safety partners and by ourselves. Within this testing regime, faults were injected into the firmware and hardware of the device to increase the coverage area and investigate the robustness of the system. The injected faults were triggered by modified source code and via external electrical stimulus.

Finally, assembly and finished device testing were performed on the finished device aiming to provide the best possible test coverage by only exercising the functionality present in the device. Qualification testing was also performed on the finished device, including water ingress, dynamic shock, and electro-static discharge performed by external certified authorities to assess the product for introduction to market.

In total, more than 240,000 tests were performed during the verification and validation of the system. A summary of the overall documented number of tests performed at each stage of verification and validation is shown in Table 1.

Table 1. System lab validation and verification of system

Stage	Number of Unique Tests	Number of Times Performed	Total Tests Performed
Firmware, Module, Unit	104	>1,145	119,080
Design	47	>4	188
Integration	17	>3	51
System	169	>3	507
Fault-Insertion	28	1	28
Assembly	5	>1,000	5,000
Finished Device	22	5,303	116,666
External Lab	3	1	3
Qualification	22	1	22
Shock and Dynamic	18	40	720
Shock Pentex™ W	12	135	1,620
Booster Accessories	4	20	80
Totals	>>450	-	>>240,000

4.2 Internal field trials

Wireless internal field-testing trials occurred at Orica Kurri Kurri Technical Centre near Newcastle, Australia, throughout January 2015. The trials involved further functional verification of the entire system in a field environment and also included feedback for the refinement of the design. Measurements were taken across a large forested geographical area with only limited infrastructure. Within the 2,500-meter radius of the trial environment the infrastructure included an emulsion plant, explosive testing ground, magazines, workshops and a number of commercial office buildings. The system was initially validated with dummy explosives with the range of the devices starting at 300m and increasing gradually to 2,500m. It was verified that system performed as expected, successfully receiving the signal to a range of 1,650 meters. A number of further test were performed at longer ranges between 2,000 and 2,500 meters, but no signal was received at these distances. A summary of the testing and figures are shown in Table 2.

Figure 11a. Lab testing of wireless units

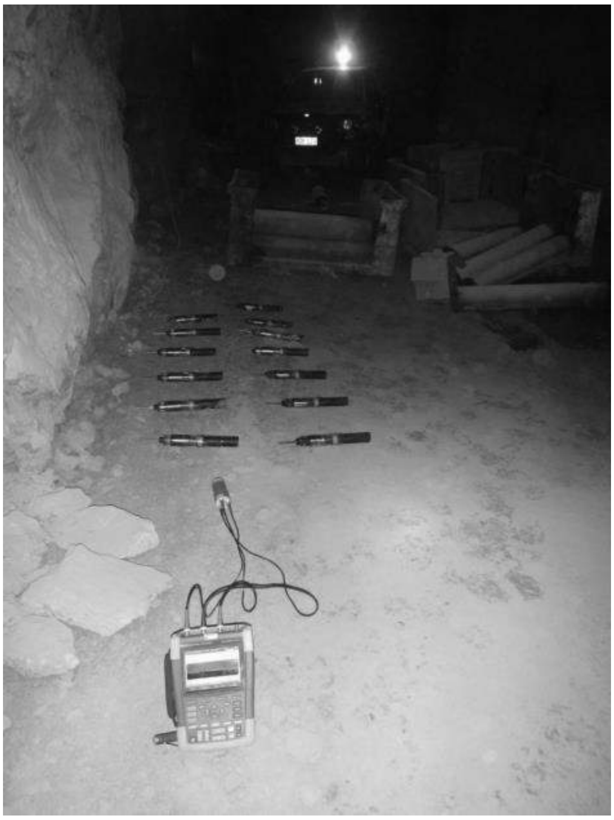


Figure 11b. Lab testing of wireless units

Table 2. Summary of internal field trials

Range (m)	Number of Trials	Number Units	Number Fired	Percentage	Notes
300 - 1650	15	386	386	100%	Dummies
2000 - 2500	2	30	0	0%	Dummies
500	1	2	2	100%	Detonators

Figure 12a. Orica internal testing of wireless units

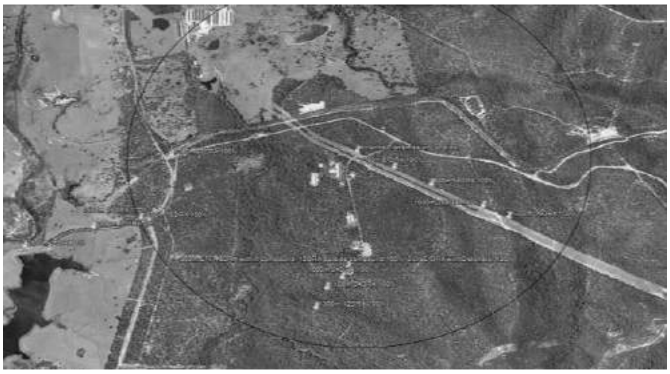


Figure 12c. Orica internal testing of wireless units

4.3 Customer trials

Initial trials on customer sites were conducted at a customer range in NSW, Australia, during January and February 2015. The aim of the trials were to gain further understanding and data of the field performance of the system, and to introduce the wireless boosters to boreholes loaded with bulk.

The customer site was a quarry adjacent to a cleared field with limited surrounding Infrastructure, outside of the crusher and engineering workshop. The firing range used during the customer trials was limited to approximately 600 meters due to the geology and size of the site. The transmitter was deployed near the boundary fence and a pattern of boreholes was drilled at the opposite boundary of the site.

During the initial week of the trial, dummy units placed on the surface to confirm the system was deployed and functioning correctly. Once the system was validated the units were positioned in the base of the blastholes and again verified.

Figure 12b. Orica internal testing of wireless units

Table 3. Summary of customer field trials

Range (m)	Number of Trials	Number Units	Number Fired	Percentage	Notes
500	21	204	204	100%	Surface
500	21	110	110	100%	Dummies In-
570	5	40	40	100%	Hole Dummies
500	4	9	9	100%	Dummy Boosters
555	1	8	8	100%	Bulk
500	1	2	2	100%	Bulk

Figure 13. Customer field-testing of wireless units

Table 4. Summary of production trials

Distance (m)	Number of Trials	Number Units	Number Fired	Percentage	Notes
450	4	104	104	100%	Dummy
450	3	32	32	100%	Production
400	1	88	88	100%	Production

BACK TO TOP

4.4 Production trials

Following the successful lab, field and customer site testing the wireless system was introduced to a customer's production blasting. The introduction occurred at a different customer quarry site from the previous tests, though also in NSW, Australia, during February 2015.

As all previous blasts were successful, the final larger production blast, of 88 wireless units, was initiated. All units performed as expected and the blast initiated as designed. Images and details of the blast results are presented in Table 4.

A simulated blast was initially performed to ensure the functionality and correct setup of the system which was successful. For the production blasts, blast holes were double primed with wireless units at the top and bottom of the holes. A number of smaller limited production shots were initiated to gauge the performance differences between wireless and i-kon blasting.

Figure 14a. Production testing of wireless units

Figure 14b. Production testing of wireless units

5 SUMMARY AND CONCLUSIONS

This is an introductory paper and a precursor to a number of further production trials. Some of the actual and potential applications, details of the testing and preliminary results of introductory production trials in operational mines are presented.

6 ACKNOWLEDGEMENTS

The authors wish to acknowledge their gratitude to the following colleagues for their assistance and support throughout the wireless development and trials including: Orica Brownsburg Technical Centre, Canada, including Dawn Goosen, Daniel Mallette, Francois Guillemette, Yves Hamel, Pascal Durand, Marc F Green, Gabriel Gaudreau; Orica Kurri Kurri Technical Centre, Australia, research team, including Richard Goodridge, Johann Zank, Matthew Craft, Maciej Ciez, Tuan Nguyen, Emma Cook, Geoff Stevenson, Laurie Simpson; Orica Troisdorf Technical Center, Germany, including, Dirk Hummel, Thomas Boos, Christian Juenger, Jan Lindenau, Walter Piel, Margit Fischer-Michely, Ulrich Steiner; Orica Gyttorp Technical Center, Sweden, including Johan Lind; and our external consultants from Germany, Canada, and the United States.

B. Wicks
Orica Europe, Troisdorf, North Rhein Westfalia, Germany

M. Lovitt
Orica Australia, Subiaco, Western Australia, Australia

REFERENCES

Orica. *WebGen™100 User Manual*. Orica.

AusIMM Underground Operators conference in Australia in October 2017.

Liu, Z., te Kloot, C., Purvis, T., Thomson, S. & Lovitt, M. Improving safety through technology: Orica wireless electronic blasting system trials at Ernest Henry mine. *13th AusIMM Underground Operators' Conference, Paper Number: 30*.

Steffen, S. & Kuiper, P. 2014. Case study: Improving SLC recovery by measuring ore flow. *Caving* 2014.


The art of successful blasting
Nitro Consult
www.nitroconsult.se


INFRA
A complete solution for remote construction site monitoring
Blast application available
INFRA Net
Sigicom
Project: Blasting Stockholm
sigicom.com
Sigicom

Elimination of an incident, SMARTROC C50

The Sliding of a drilling machine SMARTROC C50 from a quarry bench due to collapse of a wall.

On 21st june, 2016 at 4.09 p.m. I was informed by a production foreman that an incident occurred in Vcelare Quarry – i. e. the sliding of a drilling machine from the nech IV (northern part of the western quarry wall, at workplace P7). At that time, I did not have information about the operator's health condition.

Based on information received, I issued the following instructions:

I authorized the production foreman (Mr František Máté, as a deputy person responsible to solve exceptional situations) to ensure the following precautions until my arrival:

- to check the operator's health condition and to call the Emergency Medical Services
- to ban entry to the area where the incident happened
- I instructed the dispatch to contact and inform the Country Coordinator, Quarries Manager, Safety Manager and the Mining Authorities about the incident

At 4.25 p.m. dispatch called and informed me that the drilling machine operator hadn't been injured.

The Emergency Medical Service arrived to the workplace at 4.30 p.m. and checked the operators health condition. The Service left at 4.50 p.m.

Then I contacted the maintenance manager to try to ensure a heavyweight crane with the necessary lifting capacity.

Upon my arrival at the quarry 4.42 p.m. I contacted the ambulance staff to get more detailed information about the operator health condition.

After that I shut down the production and I authorized the production foreman to call the "emergency team" and I also contacted the maintenance foreman to get back on to the workplace.

Then I went to the place of the incident. At the same time the head of maintenance informed that a crane with 80 ton capacity was on the way from Kosice to Vcelare quarry.

Facts:

There was a collapse of a quarry wall in the northern part of the quarry, approximately 6000 t of rock (on the same place where drilling operations were carried out according to a drilling passport nr 086/16)

The drilling machine was approximately 5 meters below the level of the bench IV, on an inclined position, it leans on a rock and seems to be on a stabilized position.

The rock massive seemed to have stabilized, further sliding or rock material was not observed.

Finally a crane arrived on the site of the incident and we started to prepare to pull up the drilling machine. We contacted a company named ISOP Zvolen to obtain required information regarding the machine's anchoring system.

The first attempt to pull the drilling machine failed and were finished at 7.50 pm as the crane's capacities were not sufficient for this task. Subsequently, the Felbermayr crane was transferred from Vcelare quarry.

I then contacted several other companies who would be able to provide us with a large crane but since there was no cranes available on that day we ceased the works.

On 21[st] of June 2016 we had a meeting with the Žeriavy Košice crane company and an inspection of the incident site was carried out. A new solution was proposed – the company would provide two cranes, but since there was only a 70 ton and a 40 ton crane available, the outcome of the solution was uncertain.

At 12.30 p.m. the Žeriavy Košice informed me that the 70 ton crane will be available only after 7.00 p.m. so I consulted with our internal team and we decided to refuse this solution.

Then we contacted the Felbermayr again and asked them, whether they could provide us with two cranes, 70 tons and 100 tons.

Then the following things happened: The Felbermayr stated that they could only provide the cranes next week, approximately on Wednesday. The Žeriavy Košice stated that they will try to ensure a second crane until Friday, but theres a high probability tht they will be able to provide the crane only next week. They have a 120 ton crane in Czech republic but the transport to Slovakia would be complicated.

At 5.00 p.m. I consulted the problem with a company called Ćesmad, they proposed to use two tow cars in combination with one crane. We agreed on a visit to the site on the 23rd of June, 2016 at 12.00 p.m.

23.06.2016 Thursday

9.30 a.m. we started to secure the drilling machine. We used tandem ropes which were anchored to the drilling rod, the drilling rod was inserted into a drillhole approximately 20 meters from the edge of the bench. The rescue of the drilling machine was supervised by a person who's responsible in solving exceptional sitations in a quarry according to Mining Act.

10.30 a. m. – We visited the site of the incident with Ćesmad company. It was stated that under the current state it was not possible to pull the drilling machine up by using two quarry truck, as the edge of the bench would damage the ropes and cause a breakage of the ropes.

11.20 a.m. – I agreed on a procedure with a production foreman – to make a road behind the drilling machine by using a hydraulic crusher. The works would start on Friday morning and we would continue throughout the weekend (until the road with necessary parameter would be done)

2.30 – I made an agreement with the Ćesmad that they would be pulling the drilling machine. The provisional date – on June 27th 2016 (Monday), but I had to wait for them to confirm the date,

2.50 p.m. – The Ćesmad confirmed the date and promised to provide us with 2 trucks. I Also confirmed the date with ISOP company to quarantee the presence of their technician.

24.06.2016 Friday

6.00 a.m. Briefing of the employees about the procedures, a supervisor was designated.

6.25 a.m. An excavator with hydraulic crusher has been transfered to the incident site.

7.00 a.m. We started with creating the road behind the drilling machine.

25.06.2016 Saturday

6.25 a.m. – Creating the road continues.

7.30 a.m. – Transport of the rocks by dumpers.

9.00 a.m. – Checking the progress of the work, a road with a width of 3.4 m , length of 8-9 m, depth of 0.9 meters has been made. The edge of the road is 3.5 m from the anchoring point of the drilling machine.

4.50 p.m. Checking the progress of the work. A road with a width of 3.4m, length of 8-9 m and depth of approximately 1,4 meters has been made. The edge of the road is 3.5m from the anchoring point of the drilling machine.

5.20 p.m. We designated the spot for placing the securing ropes. The channel was 2m in northerly direction from the edge and had the dimensions of 6.0 x 0.4 x 2.5m.

5.40 We had to relocate the securing ropes due to widening of the road in northerly direction – it was agreed with the maintenance manager. The works were carried out on 26th of June, 2016, at 8.00 a.m.

26.06.2016 Sunday

6.25 a.m. – We created a channel for ropes and continued the work with hydraulic crusher to make a road.
8.00 a.m. – We place the ropes to the channel
8.26 a.m. – We relocated the safety ropes

8.30 a.m. – We Deepened the road by using the hydraulic crusher.
12.00 p.m. – The external company, who works in hights, arrived and we agreed on the following steps.
Clearing away the rocks from around the drilling machine and ropes.

3.18 p.m. – We relocated the protective sheets.

3.30 p.m. – We continued with the works for the road.

4.00 p.m. We made an agreement on a date, when will the drilling machine be pulled out, using two tow car from Ćesmad, the date was set to 27th of June, 2016 at 8.00 a.m.

27.06.2016 Monday

6.30 a.m. - We cleaned the road from rocks.

6.55. a.m. – Checking the progress of the works. A road with the width of 4.5m, length of 8-9m and depth of approximately 2.8m had been made. The edge of the road was 0,76 meters from the anchoring point of the drilling machine.

7.00 a.m. - We removed the protective sheets.

8.00 a.m. – The two tow cars arrived to the site of the incident.

8.10. a.m. – Two dumpers arrived on the site of the incident

8.20. a.m. – we started with the preparations of pulling the drilling machine out, securing the tow cars with dumpers

8.30 a.m. – 10.45 a.m. – We pulled the drilling machine out.

10.55. a.m. We made some preliminary checks to the drilling machine and after that put it into sfe distance to hand it over to the ISOP technicians.

11.00 a.m. The works were finished.

The process was managed and supervised by Mr Jozef Ruska (a person whos is responsible of solving exceptional situations) and by Mr Kraćunovský, Mr Belák, Mr Máté (deputy persons for solving exceptional situations).
The works were carried out from 21st of June (4.08 p.m.) 2016 to 27th of June, 2016 (11.00 a.m.)

During the incident and the process of rescuing the drilling machine no personal injuries or damages to the property occurred.

Josef Ruska, Slovakia

PECCS III Test Course

What is PECCS you ask? Well, quite many people already know. PECCS is the Pan-European Competence Certificate for Shotfirers / blast designers by EFEE. And we in EFEE have been talking about this already for many years now. The Project is made to harmonize the European shotfirer standards by levelling up the know how in different countries in Europe and it has now been running already for 2 years.

In order to reach out to as many people as possible we have been visiting conferences and organising 2 Test Courses with our materials and written many letters to many authorities in Europe. All that with the support from the European Commission and of course our brilliant partners from EFEE.

What we have learned so far is that this problem does not only concern Europe. It is recognised in Canada, Australia, Greenland, and US. Many places have been trying to renew existing regulations or create brand new.

Our work is also strongly connected to the development of explosives industry. We have new tools, modern programs, new types of explosives and not all of us know exactly how to use all that. So this means that people handling the explosives must always be up to date with the know how. Most countries have regulations to make the shot firers renew their licences with upgrading skills and knowledge in every few years.

This means extra training about the development of the industry, changes in procedures or other regulations connected to the explosives industry like ADR or Track and Tracing. Development is always a good thing, but it also means that you cannot do the same job the same way as you did 10 years ago. We are now learning during all our life.

When PECCS, the project for a Pan-European Competence Certificate for Shotfirers /blast designers was created, the idea of a life long learning just became a subject of discussions. Since then, European Qualification Framework has been updated, developed and the conditions for a worker to prove their competences and eligibility has become much more tangible. But it is still not good enough for the explosives industry. Shotfirers are still not able to take their one certificate and have a blasting job elsewhere inside EU, there’s still too many differences between the education of shot-firers in different countries.

Well, PECCS will have the III Test course on 10-14th of September in Dresden, after that the materials are considered ready and will go through a quality control before we can say that the project has ended and the Competence Certificate will become available. If the member countries of EFEE will accept the certificate then things in Europe might start changing very soon and pretty quickly.

So please, come to the III Test Course, if you are a teacher of shot firers, or a similar trainer, if you own an education entity or if you are a shot firer who would like to have such a certificate one day – cause we need feedback on our materials in order to make it even better as it already is.

The III Test Course will take place in Dresden, 10-14 September. In order to register write to anette@bef.nu or info@shotfirer.eu Until then, have a blast!

About PECCS, visit our website. www.shotfirer.eu

Teele Tuuna, PECCS project technician

Some of our PECCS partners on a transnational project meeting in Jakobsberg, Sweden, preparations for the Test Courses. From the left: Doru Anghelache, Jörg Rennert, Jose Carlos Gois, Jan Johansson and Anne Charline Sauvage

Announcement

12th EFEE Conference 2023

The National Association who will have the conference must be selected at the 2019 Autumn Council Meeting in Helsinki.

With this announcement the EFEE Board is informing all National Associations about their possibility to hold the 2023 EFEE Conference.

New EFEE members

We would like to welcome new members who have recently joined EFEE.

Individual Members

Björn Arndt. Poly-clip System GmbH & Co. KG, Germany

Upcoming International Events

Mining Expo International
September 6-8, 2018
Las Vegas, NV, USA
www.MiningExpoIntl.com

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

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

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

Upcoming National Events

Blasting technique and pyrotechnics 2018
September 25 – 27, 2018
Place: Hotel Chateau Valeč, Czech republic
Official language: Czech (foreign presentations in English)
Website/Contact info regarding the conference: www.sttp.cz

Iternationale Tagung fur Sprengtechnik
November 8-9,2018
Place: WIFI Linz, Austria
Official language: German
Website/Contact info regarding the conference: www.wifi-ooe.at/kurssuche/-/kurssuche/kurs/2019_5725-internationale-tagung-fur-sprengtechnik

Fjellsprengningskonferansen
November 22, 2018
Place: Radisson BLU Scandinavia hotel, Oslo
Official language: Norwegian (foreign presentations in Swedish or English)
Website/Contact info regarding the conference: siri.engen@tekna.no

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

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

EFEE is looking for a part time MARKETING ASSISTANT

whose main tasks will be:

- **marketing of advertisement space in our Newsletter**
- **marketing of EFEE memberships**
- **finding additional advertisers and members**

The applicant should be self-motivated and have adequate written and verbal English and an enthusiasm for sales work. Knowledge of the explosives engineering industry is an advantage. The position is also suitable for a student.

This position is for part time work with estimated working time of 10-20 hrs / month with potential to increase.

Enquiries and applications with CV and salary request should be sent to Mr. Doru Anghelache chairman of the Newsletter and Marketing & Membership committees at office@ar-de.ro before 15th of October 2018

European Federation of Explosives Engineers
Fédération Européenne des Spécialistes de Minage
Europäischer Sprengverband

Registered in Austria No. (ZVR-Zahll) 635276217

Erasmus+

EFEE

PECCS

Pan-European Competency Certificate for Shotfirers

With this project called PECCS – Pan European Competence Certificate for Shot firer/blast designers, EFEE's aim is to create a course, according to the valid EFEE European Shotfirer Requirement, to be used for standardized assessment of technical competencies for the shotfirer/blast designer profession in Europe.

We welcome specialists and authorities of this industry to participate on our final Test Course in Dresden, Germany: Restaurant Coschütz, Kleinnaundorfer Str. 1, 01187

www.shotfirer.eu

The project is funded by European Commission under the Erasmus+ program.

PECCS
www.shotfirer.eu
info@shotfirer.eu