Craig Yr Hesg Quarry

Proof of Evidence Relating to the Environmental Impact of Blasting

Dr Robert A Farnfield

EPC-UK

On behalf of: Hanson UK

Planning Inspectorate Reference: APP/L6940/A/20/3265358 (S78 Extension Appeal)

Planning Inspectorate Reference: APP/L6940/A/21/3282880 (S.73 Appeal)

Local Authority Reference: 15/0666/10 (S78 Extension Appeal)

Local Authority Reference: 21/0720/15 (S.73 Appeal)

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APP9/1

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1 Introduction

1.1 Qualifications and Experience

My name is Dr Robert Farnfield and I am a Consultant Explosives Engineer employed by EPC United Kingdom PLC (EPC-UK). I hold a BSc (Hons) degree in Mining Engineering from the University of Leeds and a PhD relating to the Environmental Impact of Blasting Operations also from the University of Leeds. I am a Fellow of the Institute of Quarrying and a Member of the International Society of Explosives Engineers.

I have been working in the field of the environmental impact of blasting operations for more than 30 years and have published more than 20 technical papers on the topic. I have also served on two British Standards committees covering vibration induced structural damage (BS7385 Part 2) and human response to vibration (BS6472).

My employer, EPC-UK, carries out drilling and blasting operations at Craig Yr Hesg Quarry under contract to Hanson UK.

2 Declaration

The evidence which I have prepared and provide for these Appeals is true to the best of my knowledge and I confirm that the opinions expressed are my true and professional opinions in the matters to which they refer.

3 Preamble

The extraction of rock from most quarries in the UK requires the use of explosives in order to fragment the rock sufficiently to enable safe and efficient extraction. Quarrying of the rock at Craig Yr Hesg Quarry would not be possible without the use of explosives.

The environmental impact of blasting can be considered in four aspects as outlined below:

3.1 Ground Vibration

When explosives are detonated in a quarry blast hole most of the generated energy is consumed in the process of fragmenting and moving the rock. The remaining energy moves away from the blast area as stress waves through the rock mass generating ground vibration. Such ground vibration will travel away from the blast area attenuating with distance at a rate depending on the geology of the area.

3.2 Air Overpressure

When a blast is initiated the rock blasted will move away from the blast area to a distance of about two times the original face height, this movement results in a vibration wave being generated in the air generally known as air overpressure. The air overpressure will travel away from the blast area attenuating with distance at a rate depending on atmospheric conditions. Most of the energy in the air overpressure wave is sub-audible with only a limited amount being in the range audible to human beings.

3.3 Fly Rock

Fly rock is defined under the Reporting of Diseases and Dangerous Occurrences Regulations 2013 and is defined as material from a blast being projected beyond the declared danger zone for that blast. Whilst such incidents are very rare the possibility of such an incident can be of concern for residents.

3.4 Dust

Dust can be generated during the drilling of blast holes and during the blast itself. All modern drilling equipment is provided with a means of capturing any dust generated in the drilling process. During the blast itself the rock fragmentation and movement process inevitably result in the generation of some air borne dust. Dust can also be generated from the broken rock landing on the quarry floor as well as being liberated from the surface area of the blast.

4 Legislation, Relevant Guidance and Standards

4.1 Quarries Regulations 1999

The use of explosives in quarries is covered by the Quarries Regulations 1999. These regulations are primarily concerned with health and safety and as such have little impact on the control of the environmental impact of blasting operations other than where safety precautions have a coincidental impact on such impacts as is the case with flyrock and air overpressure.

4.2 Mineral Technical Advice Note (Wales) 1 : Aggregates (MTAN1)

This document includes a part on the environmental impact of blasting under sections 78 to 84. In this document the impacts are listed as vibration and fly rock with the term vibration covering both vibration through the ground and vibration through the air (air overpressure).

4.2.1 Ground Vibration

MTAN1 notes that the level of ground vibration likely to generate complaints varies considerably from person to person and from site to site and quotes research that suggests that the level of complaint depends to a large degree on the relationship between the quarry operator and the local residents.

The document also notes that people are relatively sensitive to ground vibration and are likely to have a threshold of perception as low as 0.5 $mm.s^{-1}$. The document also notes that local residents are often concerned about the possibility of structural damage to their properties.

The topic of structural damage is addressed in MTAN1 by reference to the British Standard BS7385 : Evaluation and Measurement for Vibrations in Buildings Part 2 : 1993.

4.2.2 Air Overpressure

MTAN1 notes that because air overpressure is transmitted through the atmosphere weather conditions have a controlling influence on the levels received at residential properties and that, in view of this unpredictability, planning conditions to control air overpressure are unlikely to be enforceable. It is however noted that blasts should be designed to minimise air overpressure levels and that such details are sufficiently covered by the requirements under the Quarries Regulation for blasting to be carried out safely.

4.2.3 Fly Rock

MTAN1 correctly notes that the control of fly rock is primarily a safety issue and is as such addressed by the Quarries Regulations 1999 and Approved Code of Practice and Guidance associated with these regulations. As such the control of the risk of fly rock is a standard part of the proper blast design process undertaken at all quarries in the UK. The use of appropriate technologies and design processes ensures that sufficient confinement of the explosives is assessed before the firing of any blast. A robust post-blast review process is also undertaken to address any potential issues that may have come to light during the loading and firing of each blast. The design, loading and firing of all blasts can only be undertaken by fully qualified and competent individuals.

Any fly rock incident is reportable under the Reporting of Diseases and Dangerous Occurrences Regulations 2013, no such incidents have been reported at Craig Yr Hesg.

4.3 British Standard BS7385 : Evaluation and Measurement for Vibrations in Buildings Part 2 : 1993

This standard addresses the topic of structural damage from ground borne vibration including that from blasting. The guidance outlined in the standard was compiled from a wide-ranging review of research undertaken in this field of study. The research projects reviewed included one in South Wales relating to blast-induced damage.

The criteria recommended to predict the likelihood of structural damage is the Peak Particle Velocity (PPV) measured at foundation level. The standard details a lower bound for the possibility of structural damage via a PPV level that changes with the frequency of the ground vibration. The lowest possible PPV, irrespective of frequency, for cosmetic damage (minor cracks in plaster) is 15 $mm.s^{-1}$.

4.4 British Standard BS6472 : Guide to the Evaluation of Human Exposure to Vibration in Buildings Part 2 : Blast-Induced Vibration

This standard addresses the issue of the response of people in structures subject to blast induced ground vibration. Table 10.1 in this standard suggests a maximum satisfactory vibration level in residential properties of 6 to 10 $mm.s^{-1}$. As with BS7385 the recommended location for the vibration limit is at foundation level.

4.5 ISEE Blasters' Handbook

There are no standards for blast-induced air overpressure in the UK giving guidance on the levels likely to cause structural damage. The International Society of Explosives Engineers publishes the Blasters' Handbook and this has recommendations relating to air overpressure quoting work carried out by the United States Bureau of Mines. The recommended limit in this case is 133 dB(Linear) or 89 Pascals (Pa)

Air overpressure levels are often quoted in terms of dB which relates the pressure level to the threshold of hearing on a logarithmic scale which can often be confusing. Relevant values in both dB and Pa for Craig Yr Hesg are :

Current Craig Yr Hesg ROMP Condition Limit : 120 dB = 20 Pa

USBM Recommended Limit : 133 dB = 89 Pa

5 Compliance of the Existing Operation with the Current ROMP Planning Conditions (Permission Ref. 08/1380/10, dated 24.04.2013)

5.1 Peak Particle Velocity

As part of the current planning conditions, limits on permitted levels of ground vibration at any property are specified in terms of an absolute Peak Particle Velocity (PPV) of 10 $mm.s^{-1}$ with a requirement that 95% of blasts, over a six month period, have a PPV level not exceeding 6 $mm.s^{-1}$.

Also, as part of the permission the quarry operator must monitor the vibration and air overpressure levels from each blast as detailed in an agreed monitoring scheme. The results of this monitoring are available for inspection by the local authority and have been provided by Hanson UK to the author for analysis.

Figure 1 below shows a distribution of the vibration monitoring data from August 2018 to March 2022. Each column represents the number of recorded measurements made at the correspond PPV. It can be seen that there have been 4 recordings made with PPV values between 5 and 6 $mm.s^{-1}$ with no recordings above 10 $mm.s^{-1}$ thus proving complete compliance with the planning conditions. It can also be seen from Figure 1 that for a total of 12 events the monitoring equipment did not trigger indicating that the PPV value was below 0.5 $mm.s^{-1}$.

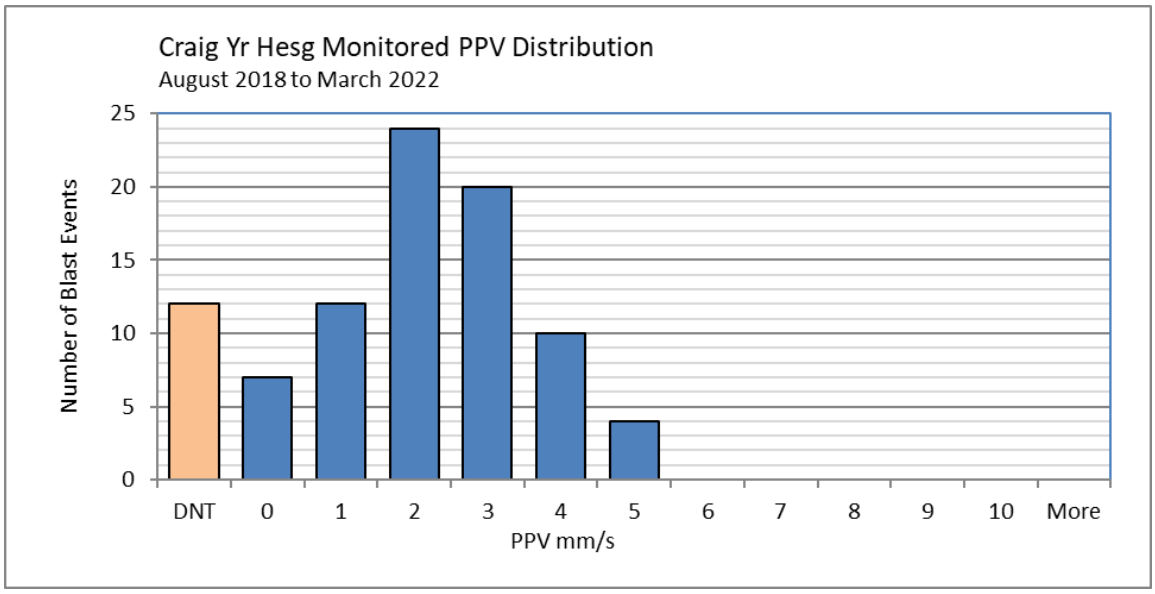

Figure 1 : Distribution of Monitored Peak Particle Velocity values at Craig Yr Hesg Quarry over the period August 2018 to March 2022.

5.2 Peak Air Overpressure

As part of the monitoring process Peak Air Overpressure readings are also taken and reported to the local authority under an agreed monitoring scheme.

In the previous ROMP review of the planning permission a limit for peak air overpressure was placed on the site against the guidance given in MTAN1. The level set is 120 dB(Linear) which is a very low level and will often result in apparent breaches of the condition when monitoring takes place in windy conditions.

Figure 2 below shows a distribution of the peak air overpressure recordings made in the period August 2018 to March 2022. It can be seen that the 120 dB(Linear) limit was exceeded on 11 occasions with a typical value being 114 dB(Linear) or 10 Pa.

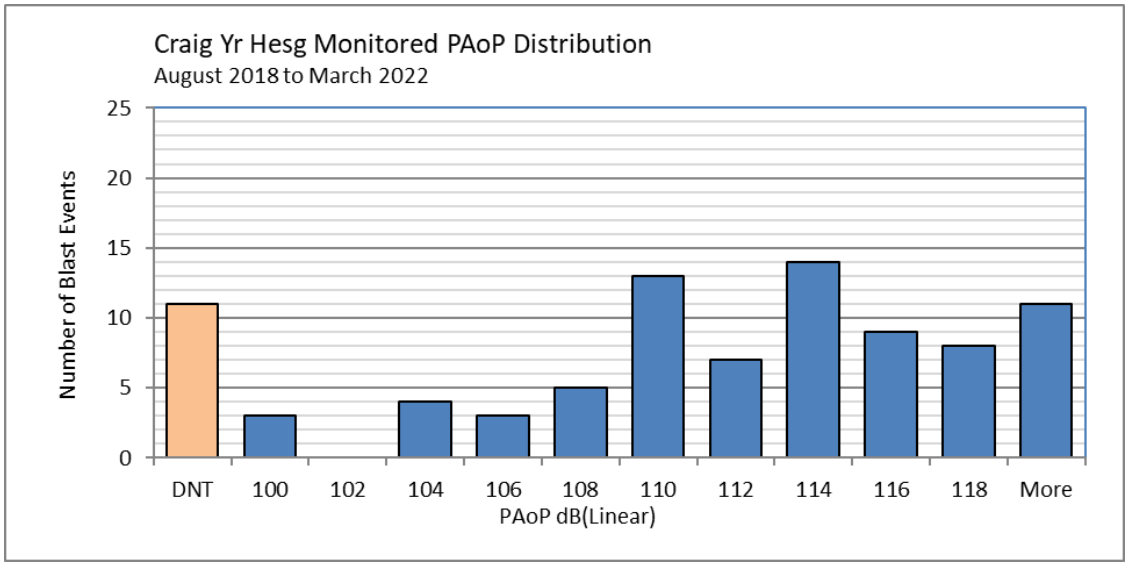

Figure 2 : Distribution of Monitored Peak Air Overpressure values at Craig yr Hesg Quarry over the period August 2018 to March 2022.

6 Environmental Control Strategies

6.1 Ground Vibration

Levels of ground vibration from blasting operations, as received at a location, are known to be related to the distance of the location from the blast and the maximum instantaneous charge weight (MIC) employed in the blast. These two parameters are combined to form a parameter known as scale distance as follows:

Scaled Distance = Distance / √ MIC

Using the calculated scaled distance values and corresponding vibration levels a graph can be compiled relating scaled distance to vibration levels – often known as a regression line. The regression line itself represents the best fit relationship between the two parameters also known as the 50% confidence line as half of the data will be above the line and half below. An example regression line is given in figure 3.

The fact that only some of the data lies directly on the regression line simply reflects variability induced by factors such as geology. This scatter about the regression line can be used via classic statistics to generate additional lines with higher levels of confidence and this is typically done to match any planning condition – for Craig yr Hesg the confidence level to match the current ROMP planning condition would be 95% (shown on the example regression line in red).

6.1.1 Control by MIC

The MIC is taken to be the maximum mass of explosive fired at any single delay time. The primary method of control over vibration levels in quarry blasting is implemented by means of controlling the MIC value mainly using the technique known as decking. This technique is already employed at Craig yr Hesg and is the reason why vibration levels have been fully in compliance with the current planning conditions as shown in figure 1.

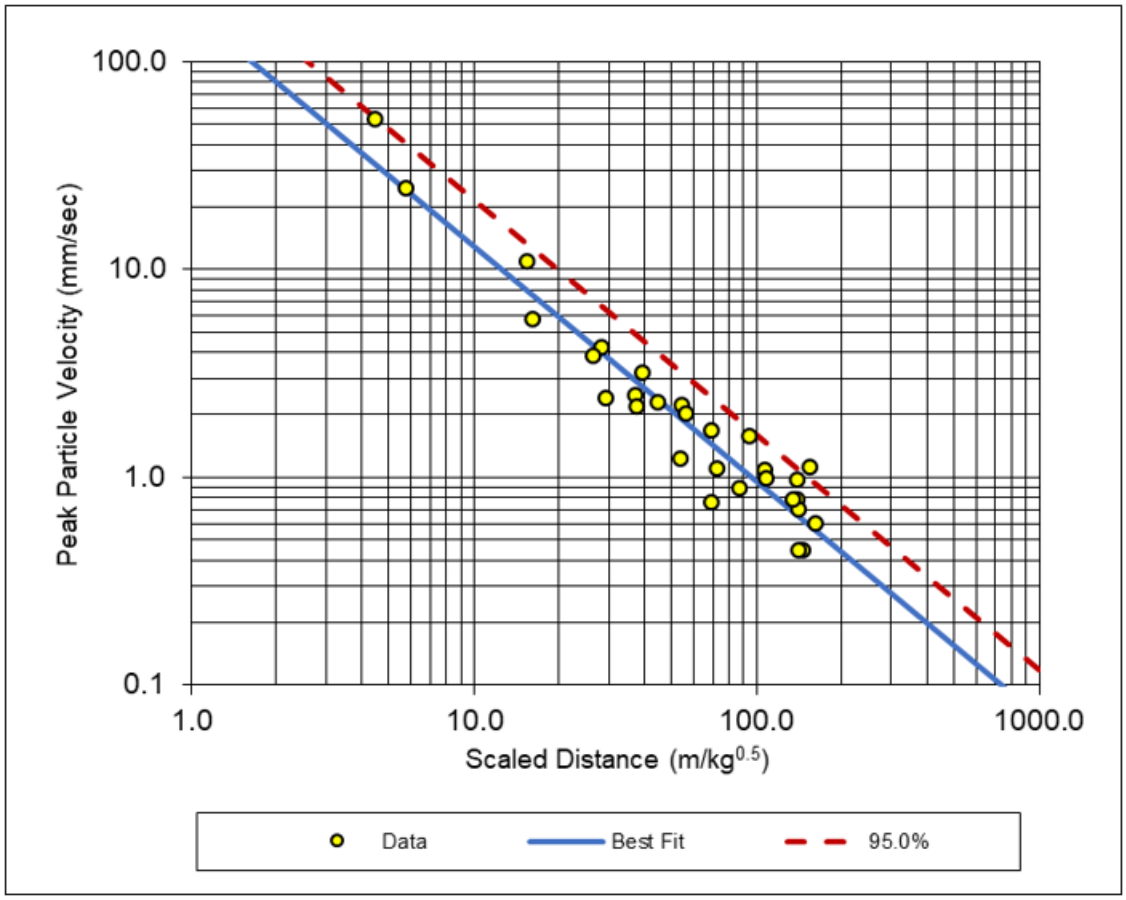

Figure 3 : Example Regression Line.

The process employed determines the required MIC by reference to a site-specific regression line and using a combination of the 95% line and the required vibration line to determine a limiting scaled distance. Having determined a scaled distance value, the required MIC can be calculated from the distance to the nearest property.

This method of control is also known as 'planning to comply' and allows blasts to be designed to meet the planning permission irrespective of distance.

6.1.2 Use of a Stand-Off Distance

The use of a planning to comply system as outlined above effectively removes distance from the process making the implementation of a stand-off distance redundant. It is therefore technically possible to design a blast to comply with the vibration limits within any planning permission at any distance. However, a reduction in distance will mean a reduction in MIC. The lower the MIC the greater the number of decks required in each blast hole and the greater the number of decks the greater the cost. There will therefore be a distance at which the blasting operation will become uneconomic – the process itself therefore determines an economic limit. The limits of excavation given in the planning application for the extension of the workings require a limited number of blasts to be carried between 175m and 200m of existing properties and this is considered to be both technically and economically feasible whilst keeping within the proposed planning conditions.

6.1.3 Use of Optimised Initiation Timing

Each blast in a quarry consists of a series of blast hole fired in a sequence with a time delay between each hole. Typically, the delays employed are in the range 10 to 50 milliseconds between holes in a row and 50 to 100 milliseconds between rows.

There will be an optimum delay pattern for any blast that will give both the lowest vibration level and the best fragmentation. This optimum timing can be determined via a technique known as linear super positioning and then implemented by employing electronic detonators.

Such a process has previously been undertaken at Craig yr Hesg and was demonstrated to have lowered vibration levels considerably.

6.2 Air Overpressure

The control of air overpressure levels is a relatively straight forward process as the techniques required are also those used to control the risk of fly rock as required by the Quarries Regulation 1999. The process of fly rock control, such as face profiling, blast hole surveying etc., will thus automatically minimise the levels of air overpressure.

Additional control measures outside of those required for the control of flyrock would include:

- The prohibition of exposed explosives charges for secondary breaking.
- Ensuring the delay times across a face are slower than 300 $m.s^{-1}$ to avoid the risk of matching the speed of sound.

6.3 Fly Rock

As previously noted, the control of fly rock is a standard part of any blast design process in the UK quarrying industry and is effectively controlled under the Quarries Regulations 1999.

6.4 Dust

Transient dust can be an issue from blasting operations due to the rock breaking process, the rapid movement of faces and the impact of the broken rock on the quarry floor. The most effective practical minimisation process is by damping down the area of the quarry on which blasted rock is expected to land.

7 Proposed Planning Conditions

In a report to the Rhonda Cynon Taf, Planning and Development Committee, dated 6th February 2020 the Director of Prosperity and Development recommended a number of planning conditions relating to blasting operations in relation to the western extension of Craig yr Hesg Quarry (Application No 15/0666/10). These conditions, outlined below, are entirely within national guidelines as detailed in MTAN1 apart from condition 24 relating to air overpressure. However, condition 24 is considered to be a sensible approach to air overpressure which recognises that there are technical difficulties in reliably monitoring data due to weather conditions whilst ensuring that every possible step is taken to minimise the impact. Condition 22 relates to vibration limits that apply to any apparatus belonging to Dwr Cyrmru Welsh Water and was the subject of a separate agreement between the parties concerned.

7.1 Condition 20
Except in the case of emergency to maintain safe quarry working, no blasting shall take place at the site except between 10.00 a.m. – 16.00 p.m. Monday to Friday inclusive and there shall be no blasting on Saturdays, Sundays, and Public Holidays.

7.2 Condition 21
Blasting shall be undertaken in such a manner to ensure that ground vibration at any vibration sensitive building, measured as a maximum of three mutually perpendicular directions taken at the ground surface, does not exceed a peak particle velocity (ppv) of 6mms per second in 95% of all blasts measured over any continuous six-month period, and no single blast shall exceed a ppv of 10mms per second. The measurement is to be taken at or near the foundations of any vibration sensitive building in the vicinity of the quarry existing at the date of this permission.

7.3 Condition 22
Blasting shall be undertaken in such a manner to ensure that ground vibration at the site of any Dwr Cymru Welsh Water apparatus, measured as a maximum of three mutually perpendicular directions taken at the ground surface, does not exceed a peak particle velocity (ppv) of 50 mms per second for any blast. The measurement is to be taken at the closest point of the blast to any DCWW apparatus.

7.4 Condition 23
No secondary blasting shall be carried out on the site.

7.5 Condition 24
All individual blasts shall be designed, managed, and implemented to minimise the extent of air overpressure resulting from blasts. If air overpressure exceeds 120dB at any nearby sensitive residential property (not owned by the applicant) the Local Planning Authority shall be informed within 7 days and the design, management and implementation of the blasts must be reviewed prior to any further blasting being undertaken at the site, with all future blasting being undertaken in accordance with the findings of the review.

7.6 Condition 25
Each individual blast shall be monitored in accordance with the Blast Monitoring Scheme submitted on 30 July 2018. All monitoring shall be undertaken in accordance with the terms of the approved scheme for the duration of quarrying operations at the site. In addition:
(a) Blasting times shall be clearly advertised at the Quarry;
(b) A warning, audible at the site boundary, shall be sounded prior to any blasting operations taking place, and shall be sounded again immediately after blasting has finished.

8 Conclusions

Blasting operations at Craig yr Hesg have and can be controlled to comply with the limits recommended in MTAN1 relating to ground vibration and enforced via planning conditions. This is not to say that the levels of vibration currently experienced are not perceptible but that they are certainly well below those levels likely to cause even cosmetic damage. The imposition of a stand-off distance for blasting is irrelevant to the control of vibration levels as the impact is controlled by imposing a vibration limit within a planning condition. Such a planning condition implies that the quarry should continue to keep an up to date database of blasting information along with the associated environmental monitoring results. This database can then be employed to design future blasts to comply with the planning condition via the use of the planning to comply technique previously described in section 6.1.1.

The proposed planning condition relating to air overpressure is a sensible combination of control and review, with a requirement to design and manage the blasting operation to minimise air overpressure levels whilst at the same time using a relatively low air overpressure level of 120dBL as a trigger for a design review. Any such review should include information relating to weather conditions at the time of blasting, including wind conditions.

Transient dust from blasting has clearly been an issue and it is recommended that a planning condition be added relating to the damping down of the area of the quarry where the blasted rock is expected to land provided safe access is available.

Dr R Farnfield – 23rd May 2022