Dounreay Site Restoration Ltd

Potential Use of Blasting During Excavation for New LLW Facilities – Non-Technical Summary

Introduction

Blasting is the use of explosives to break up/loosen rock in order to ease excavation. Construction of the New LLW Facilities will involve the excavation of large quantities of rock. Blasting during excavation can have significant potential benefits compared to breaking out the rock using just industrial plant and equipment.

DSRL need to obtain permission from Highland Council in order to undertake blasting and local residents want to understand how the use of blasting is likely to affect them.

This document is non-technical summary, intended to provide local residents with an appreciation of issues associated with blasting and how they may be of relevance to them.

Benefits of Blasting

Blasting during the excavation of the New LLW Facilities could bring a number of benefits, including:

- Shorter timescales for excavation
- A reduction in the duration of nuisances associated with the excavation, e.g. noise.
- A reduction in the use of rock-breaking breaking equipment and associated noise.
- A reduction in the costs associated with excavation
- A reduction in the likelihood of unforeseen ground conditions impacting on the project; increasing excavation timescales and costs

An example of Caithness flagstone following blasting

Excavation of Caithness flagstone

How do DSRL know whether blasting is safe or not?

In order to assess whether blasting can be undertaken in a safe and environmentally responsible manner DSRL have undertaken a detailed programme of work. This programme has involved a desk based study, followed by both offsite trial blasts at Ruther Quarry and onsite trial blasts at the New LLW Facilities site. As well as providing data to support the conclusions of the desk study, the various trials have also provided local residents with an important opportunity to witness blasting first hand and develop an understanding of what this technique involves.

Local residents at Ruther Quarry

Independent monitoring of trial blasts

In order to build confidence in the outcome of work DSRL have utilised an independent consultant to review the desk study and undertake additional monitoring during the trial blasts.

It is noted that desk study draws on the Scottish Government planning advice note for controlling blasting at surface mineral works, referred to as PAN 50, and also the guidance provided within relevant British Standards.

This non-technical summary draws on the desk study and the outcomes of the trial blasts.

What are the Main Issues Associated with Blasting?

There are a number of issues associated with blasting that should be considered:

- Ground Vibration
- Air Overpressure
- Noise
- Flyrock
- Livestock
- Dust

These issues and how they affect local residents are considered in the following sections of this document.

Ground Vibration

During a blast the adjacent area of rock is distorted and fractured. Further away from the blast the rock does not fragment but transmits the blast energy as waves, resulting in vibration of the ground. This effect is broadly similar to the ripples produced when a stone is thrown into water. The ground vibration rapidly decreases, or attenuates, as distance from the blast site increases.

Ground vibration has the potential to be experienced outside the direct vicinity of a blast and even small levels of vibration are perceptible to humans. Ground vibration is therefore often the issue of most concern to people living close to blasting operations.

PAN 50 highlights that it is in the best interest of operators to reduce ground vibration, as increased vibration is associated with less rock fragmentation at the actual blast site and therefore a less efficient blast.

Vibration levels can be expressed in a variety of different ways, for example frequency, amplitude, peak particle acceleration and peak particle velocity. Peak particle velocity, or PPV for short, has been found to be the vibration parameter best correlated to the effects experienced by structures in response to ground vibration. PPV is therefore commonly used to describe the predicted vibration levels from blasting operations and is also used to define limits for controlling blasting operations.

The table below provides examples of the PPV experienced in different building types for different types of everyday activities which are measured in millimetre per second mm/s (taken from Transport and Road Research Laboratory, Ground Vibration Caused by Civil Engineering Works, Research Report 53, 1986).

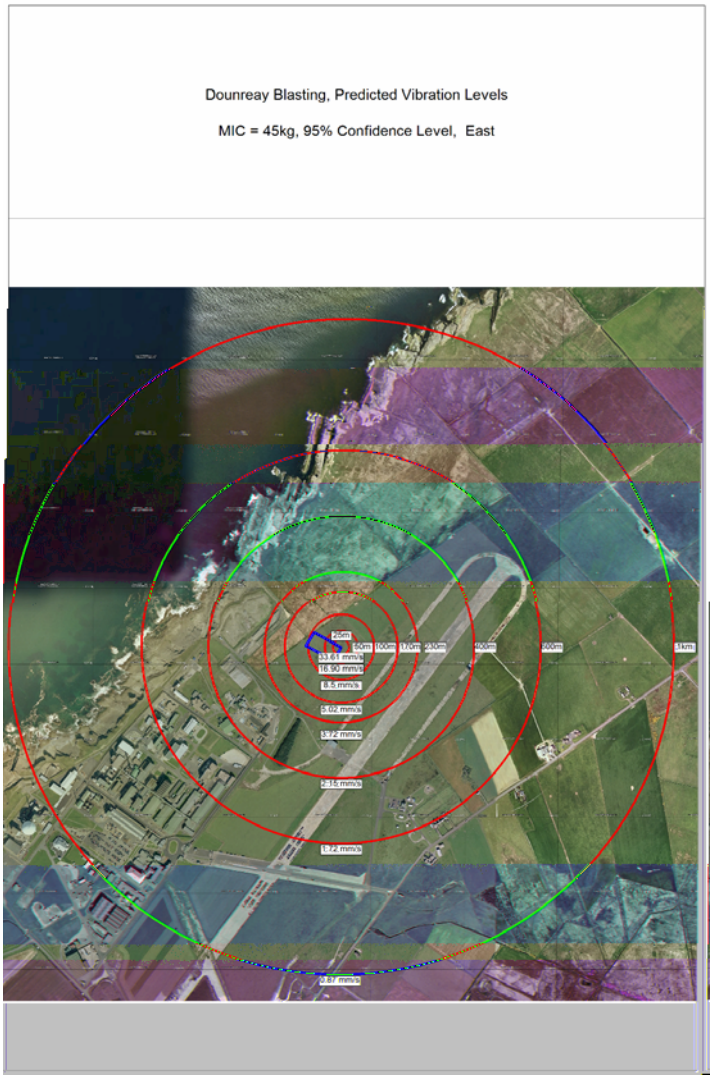
Vibration source	Resultant PPV (mm/s)		
	Modern steel framed office	Modern masonry dwelling house	Old dwelling house (Thick lime-mortar masonry)
Normal footfalls	0.02-0.2	0.05-0.5	0.02-0.3
Foot stamping	0.2-0.5	0.3-3.0	0.15-0.7
Door slams	10-15	11-17	3-9
Percussive drilling	5-25	10-20	10-15
Example vibrations (PPV) in building during normal use			

Humans will often perceive vibration levels as low as 0.2 to 0.3mm/s. British Standards identify that 15mm/s is the lowest vibration levels above which

cosmetic damage to a building, for example cracking of plaster, has been credibly demonstrated. Minor damage is possible at vibration magnitudes that are twice those for cosmetic damage. The British Standards note that structures below ground are known to sustain higher levels of vibration and are very resistant to damage unless in very poor condition

The Scottish Government planning advice note, PAN 50 recommends that generally, PPV at residential properties will not usually be below 6mm/s in 95% of all blasts, average levels should not exceed 10mm/s and maximum levels should not exceed 12mm/s.

The trial blasts undertaken by DSRL has allowed an understanding of how the local bedrock attenuates the ground vibrations arising from blasting. Data collected during these trial blasts has allowed predictions of vibration levels associated with full scale blasting to be developed. A blast design which involves 45kg of explosives being detonated in any one instance is typical of a design that could be used during the excavation for the New LLW Facilities. The results of the trial blasts have been used to predict how the ground vibration from this size of blast would attenuate with distance from the New LLW Facilities site, as shown on the diagram below.



It can be seen that at the nearest residential properties the PPV experienced would be less than 2.15mm/s. These vibration levels are well below the guidance levels recommended by PAN 50. The effects of ground vibration at neighbouring residential properties as a result of blasting are therefore not likely to result in any significant impacts. If utilised, all blasts conducted on the site would be monitored to ensure that vibration levels were as predicted and remained below the limits recommended by PAN 50. A staged approach to blasting, whereby explosive weights would be gradually increased would also be adopted in order to build confidence in the vibration predictions.

Air Overpressure

Air overpressure is when the energy associated with a blast is transmitted through the atmosphere in the form of pressure waves. It is air over pressure that results in the rattling of windows often associated with blasting. PAN 50 advises that routine blasting operations might generate air overpressure levels at adjacent properties of around 120 dB. This is broadly comparable to a gentle breeze (wind speed of 5 m/s or Beaufort force 3).

Monitoring during the on-site trial blast did not identify air over pressure levels in excess of 120dB. Monitoring of air pressure during the production blast at Ruther quarry was also undertaken. At distances greater than 175m air over pressure was also less than 120dB. It is noted that the nearest residential property from the New LLW Facilities is greater than 500m.

Air overpressure is, however, strongly affected by weather conditions and, consequently, it is very difficult to predict. In particular, still calm days may exacerbate air over pressure, while windy conditions may “mask” the effects. In addition, monitoring will often measure the wind rather than the actual pressure wave arising from the blast. PAN 50 recommends that air over pressure should be controlled by careful blast design, rather than by defining limits.

It is highlighted that air over pressure waves generally dissipate over far shorter distances than the pressure waves associated with ground vibration. The control of ground vibration therefore tends to be the limiting consideration in blast design and when discussing the potential impacts associated with blasting. The effects of air overpressure at nearby residential properties, as a result of blasting, are therefore not considered to be a concern. DSRL would ensure careful blast design and would also monitor air over pressure during any blasting on the New LLW Facilities site to provide confidence that it was within the levels described within PAN 50.

Noise

PAN 50 identifies that peak noise levels from blasting are comparable to the levels generated by passing traffic. The noise associated with blasting is, however, of shorter duration and is much less frequent. PAN 50 identifies that noise is generally managed as a component of air over pressure and the same control measures are therefore adopted.

Flyrock

Flyrock is an unexpected projection of blast debris. PAN 50 recognises that this issue is also best managed through careful blast design. In addition, British Standards require that blast areas and exclusion zones must also be defined. While neighbouring residential properties are considered to be sufficiently far away from the New LLW Facilities site not to be affected by flyrock, it is acknowledged that some neighbouring fields may be sufficiently close to fall within the potential exclusion zones for some blasts. Consultation and agreement of exclusion zones with neighbouring farmers would be required in this situation.

Livestock

DSRL's blasting contractor routinely undertakes blasting adjacent to fields of livestock, with little, or no response from the animals noted. During the on-site trials, sheep in the adjacent field and horses in a nearby field were observed not to respond to the various blasts. DSRL, however, recognises concerns relating to this issue. The risk of flyrock for fields in very close proximity to the potential blast, as discussed above, must also be considered. Further consultation with neighbouring farmers will be required in order to agree suitable measures if required, e.g. moving livestock to an alterative field.

Dust

PAN 50 identifies that dust from blasting can arise from the actual detonation within the rock and from drilling of the associated boreholes. PAN 50 recognises that such dust can controlled through the use of appropriate dust management measures. A dust management plan will be produced for the construction phase of the New LLW Facilities and agreed with Highland Council. If blasting was to be utilised measures for controlling dust generation will be developed.

Conclusions

If DSRL were to utilise blasting during the construction of the New LLW Facilities, there are a number of issues associated that must be considered:

- Ground Vibration
- Air Overpressure
- Noise
- Flyrock
- Livestock
- Dust

Trial blasts have demonstrated that ground vibration, air overpressure and noise can be controlled to minimise impacts on local residents. These factors would be monitored to demonstrate the impacts of any blasting operations.

While flyrock does not pose a risk to local residences, appropriate exclusion zones will have to be established around the blast sites. This may mean that agreement will have to be reached with neighbouring farmers for the

establishment of these zones during blasting operations to ensure their safety and the adequate protection of livestock.

Dust arising from the excavation will be managed using a series of standard procedures that will be detailed in a dust management plan. This plan will be developed prior to construction commencing and will require agreement with Highland Council.

The use of blasting during excavation will reduce the overall environmental impacts of the construction of the New LLW Facilities. It will reduce the duration of the programme, while also reducing the associated nuisances, including noise and dust.