SOP FOR CONTROLLED BLASTING

Vibration monitoring involves measuring short-term movements in the ground or in a structure produced due to blasting operations using a seismograph.

Requirement:

Permission copy issued by DGMS for conducting trial/controlled blasting within 300 m beyond 100 m.

Ten copies of the plan when study has to be conducted

Vibration monitoring device

Distance measuring device

Plaster of Paris

Monitoring equipment

Measurement of vibration and Air over pressure is carried out with an instrument comprising of transducers, microphone and data recording elements.
The instrument is capable of recording both ground and airborne vibration.

Principle used in Vibration Monitor:

- The Geophone in the vibration monitor detect and measure the ground vibration by the movement of a magnet suspended in a surrounding by a coil of wire. According to the Lenz Law of physics, a current is induced in the surrounding coil in proportion to speed of movement of the magnet with respect to the coil. Electronics in the monitor then measure this current, convert it to ground motion velocities and store the raw data in memory.
- Measurement of ground vibration is done in three directions (Transverse, longitudinal and vertical) with the help of a separate measuring coil in the transducer head since vibrations often differ in important ways along different measurement directions. For accurate measurements to be obtained, the seismograph measuring head ("transducer") must move as the ground moves, i.e. it must have full "ground coupling".
- Blasting seismographs usually also have a microphone attachment which can be used to measure sound from the operations.

Parameters to be monitored:

Peak particle velocity (PPV): This is a measure of ground vibration magnitude and is the maximum instantaneous particle velocity at a point during a given time interval in

mm/s. PPV is normally recorded in 3 mutually perpendicular directions; transverse, vertical and longitudinal (T, V & L)

Frequency: A measure of the speed at which a particle vibrates, or how close the waves are to each other. Frequency is measured in terms of Hertz (Hz).

Air overpressure: A measure of the pressure waves transmitted through the atmosphere in terms of decibels (dB).

Scaled Distance: The intensity of vibration decreases with the distance. The less intensity with distance is the reason behind the calculation of scaled distance. The scaled distance is given by following equation:

$$\text{Scaled Distance} = \text{Distance} / (\text{charge per delay})^{1/2}$$

Zero Crossing Frequency: Frequency of the largest vibration component.

FFT Frequency (Fast Fourier Transform Frequency):

It is an accurate and informative method for determining all the frequency components of a complex wave. In this the entire waveform of the ground vibration is "fitted" to a whole set of wave component frequencies, so as to obtain a full analysis of both the frequencies and their intensities which contribute to the vibration.

Geological Information of the Mine:

Blast monitoring should also take into consideration the geological and topographic conditions for the area (mine) in question. Details regarding distinctive geological and topographical features must be marked on the plan of the ten copies of the mine.

Set up for Blastmate III

Blastmate III is of two types:

- Blastmate with four recording channels with a microphone
- Blastmate with eight recording channels with choice of external transducers and microphones.

Blastmate Setup for use in vibration monitoring:

a) Record Mode - Continous
Trigger Source Geophone
Trigger Levels 1 mm/sec
Record Stop Mode – 3 seconds
Time/day - Set as per the day of recording
Press the start monitoring key to monitor the readings of vibration.
Once the monitoring is done press the cancel button to stop monitoring.
Press and hold the On/Off key to turn off the instrument.

Front Panel of Blastmate –III with the function of each key is shown is figure below

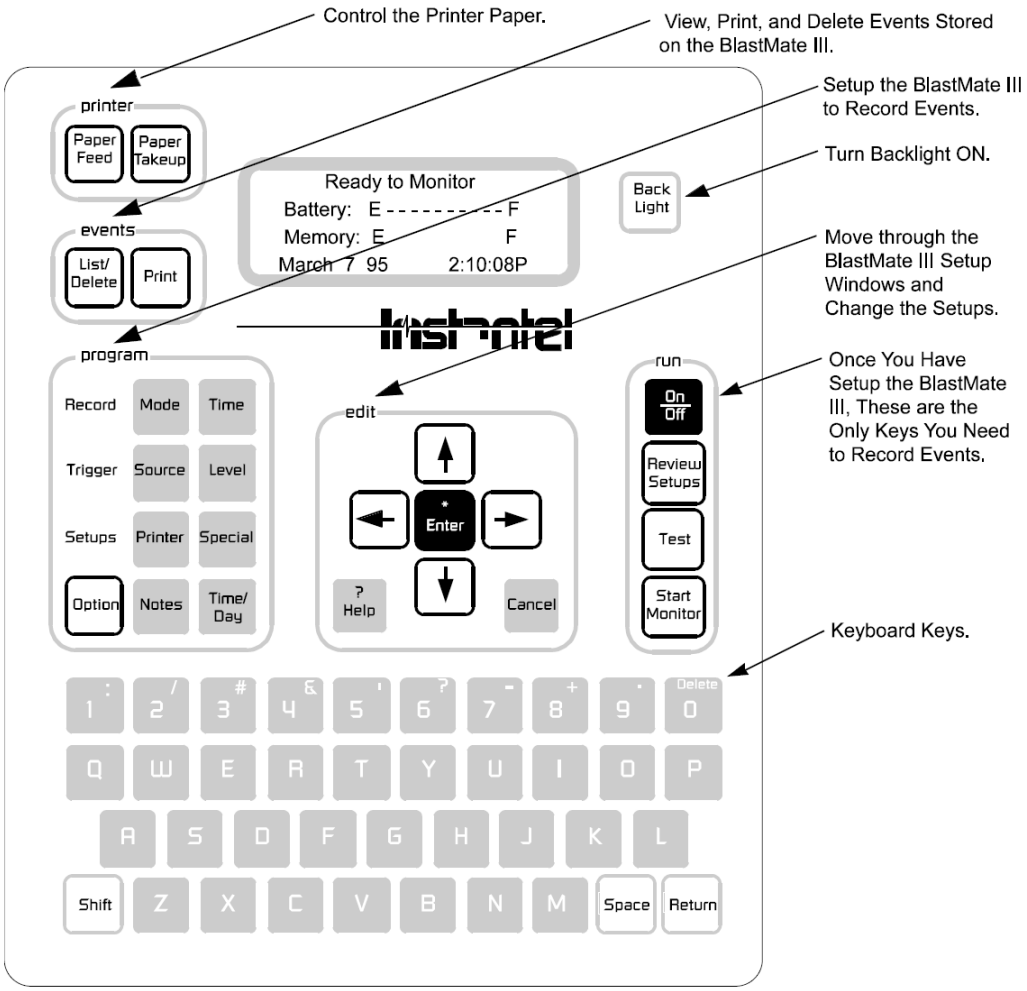


Figure 1.2 The BlastMate III Keys.

Locating and using Blasting Seismograph:

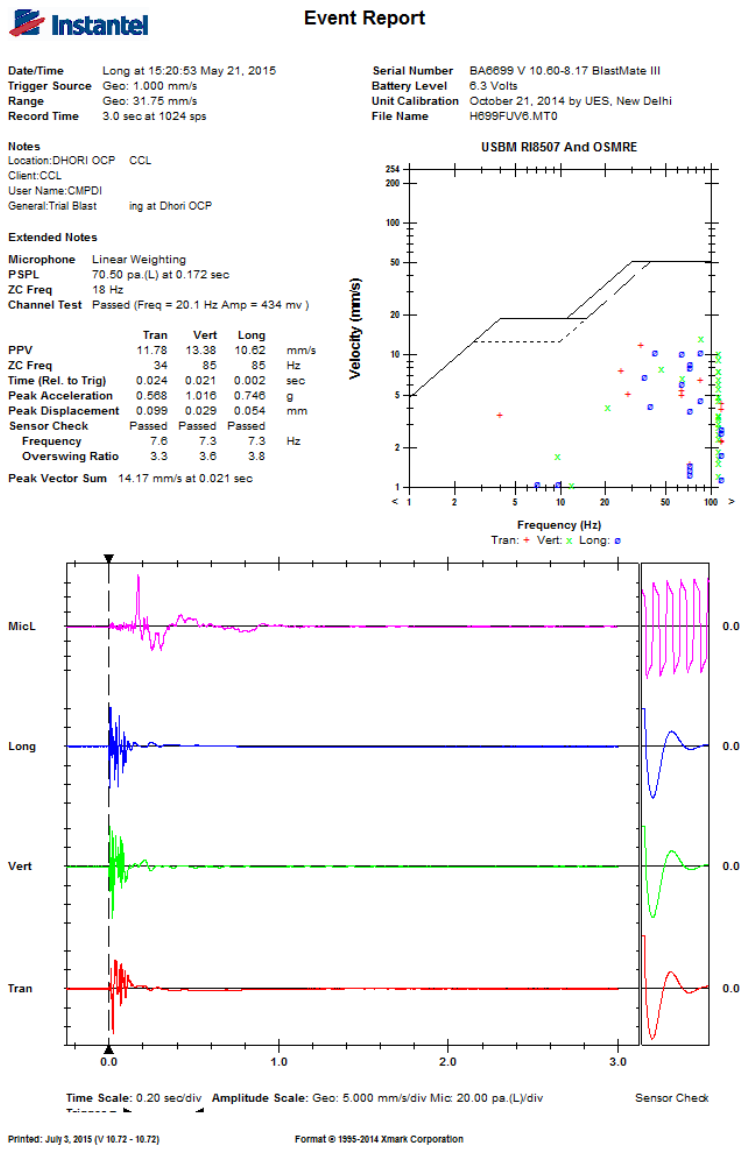
- The choice of the location and number of the monitoring points should take into consideration the main sensitive location from the area where the mineral is being extracted. Sensitive locations are those structural areas, buildings, historical monuments, buffer zones, residences, sites of geological, archaeological and ecological importance, and any other structures and sensitive land uses which could be affected by vibrations resulting from blasts in mines.
- For good measurement of the vibration two or more vibration monitors should be used in tandem, one placed within 100m and the other within 300m.
- The second seismograph should be placed to avoid interference from vibrations from any additional operations going on at the same time.
- The intensity (velocity) of vibrations at the distant seismograph will be lower, but the point of the second seismograph is to detect and quantify the low frequency

wave trains. Their frequency distribution and duration are at least as important as their measured velocities (peak particle velocities, PPV's).

- The location of geophone must be decided in such a way that it measure the resultant wave of vibration produced from the blasting operation.
- The seismograph transducer must be coupled well with the ground surface. The transducer/geophone must be kept on a hard surface.
- In case of a loose soil dig a hole to a certain depth or use plaster of Paris for mounting the geophones.

Method to analyse the Event Report obtained after monitoring the vibration:

Event Report:



The event report shows the PPV measured at three different directions.

FFT Report

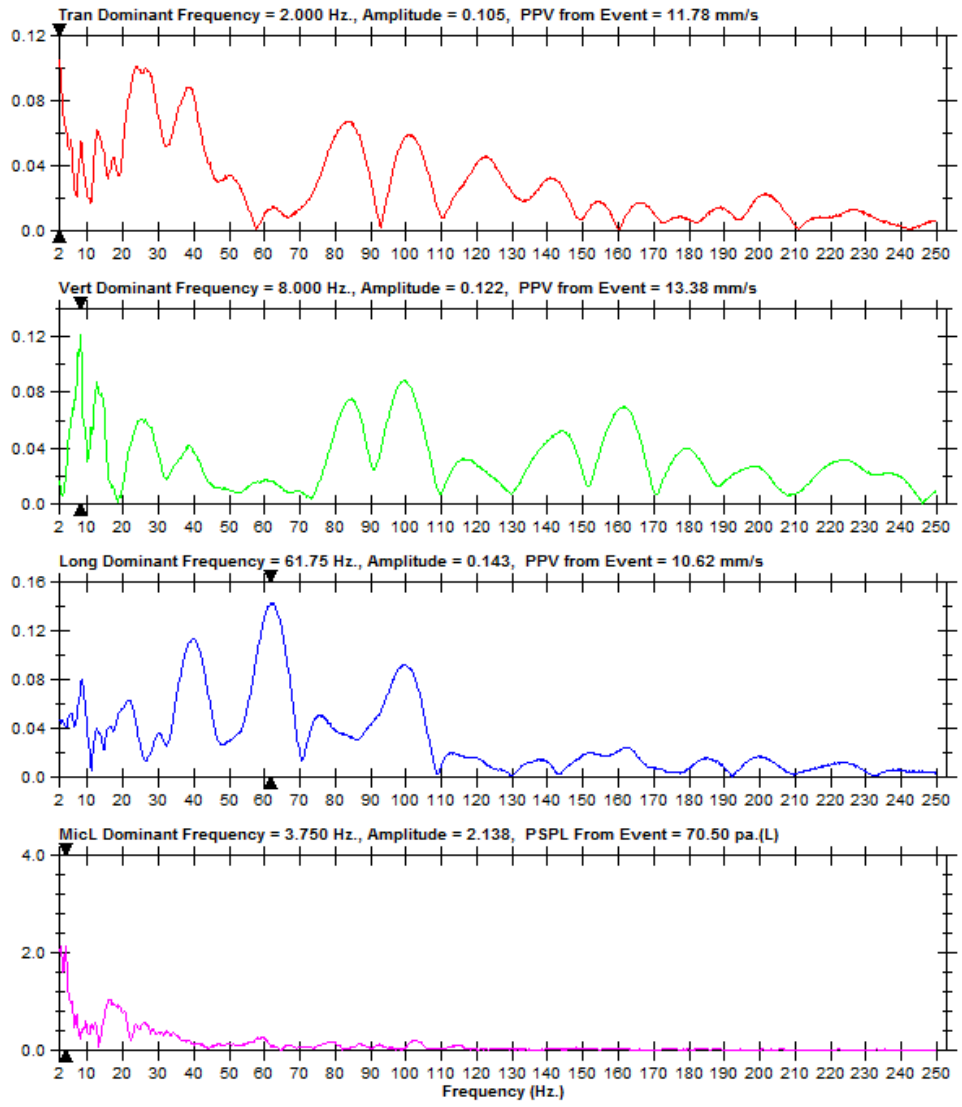
Instantel

FFT Report

Date/Time	Long at 15:20:53 May 21, 2015	**Serial Number**	BA6699 V 10.60-8.17 BlastMate III
Trigger Source	Geo: 1.000 mm/s	**Battery Level**	6.3 Volts
Range	Geo: 31.75 mm/s	**Unit Calibration**	October 21, 2014 by UES, New Delhi
Record Time	3.0 sec at 1024 sps	**File Name**	H699FUV6.MT0

Notes
Location:DHORI OCP CCL
Client:CCL
User Name:CMPDI
General:Trial Blast ing at Dhori OCP

Extended Notes



Printed: July 3, 2015 (V 10.72 - 10.72)

FFT report provides the full waveform of the vibration resulted due to blasting.

Acceptable Limits in term of PPV and Frequency:

As per DGMS Circular No.7 dated 29.8.97, depending on the type of structures and the dominant excitation DOMINANT FREQUENCY, the peak particle velocity (PPV) on the ground adjacent to structures should not exceed the values given in the following table.

TYPE OF STRUCTURES		DOMINANT EXCITATION DOMINANT FREQUENCY (Hz)		
		< 8 Hz	8-25 Hz	> 25 Hz
(A)	Building/structures not belonging to owner			
	(i) Domestic houses/structures (Kuchha, Brick in cement).	5	10	15
	(ii)Industrial building (RCC) framed structures.	10	20	25
	(iii) Object of historical importance and domestic structures.	2	5	10
(B)	Building belonging to owner with limited span of life			
	(i) Domestic houses/structures (Kuchha, Brick in cement)	10	15	25
	(ii) Industrial building (RCC) framed structures	15	25	50

DATA PRESENTATION:

- The data collected during the monitoring session shall be presented in a report, which shall include data tables and collection sheets, graphs (monitoring curves for both ground and air overpressure vibrations) and an executive summary.
- The exact location and number of blast monitoring stations must be shown on the ten copies of plan of the mine, date, time and duration for each blasting operation should be included in the report which is to be submitted to the Authority.
- The resultant vibration monitoring data should be compared to relevant (vibration) limit values stipulated in DGMS Circular No.7 dated 29.8.97.