



## Virginia Department of Mines Minerals and Energy

# **"My house is shaking!"**

## **A citizen's guide to mine blasting**

### **Why do mines have to Blast?**

Blasting remains a crucial element in the production of minerals and stone products throughout Virginia and the rest of the world. Since stone deposits occur naturally in large consolidated formations, blasting remains the only method capable of efficiently producing the large volumes of materials required to meet the needs of our society.

Blasting is an evolved science born from many years of research and effort. Modern explosive products and techniques assist the blaster in designing safe blasts that protect the welfare and property of the citizens who live around quarries and mines. The Virginia Division of Mineral Mining (VA DMM) regulates quarry and mine blasting, and has specific regulations that limit the effects of blasting on neighboring houses and buildings.

### **Effects of Mine Blasting**

The principal effects of mine blasting are ground vibration and air overpressure. There also can be a very rare, but potentially hazardous effect called flyrock.

Ground vibration is the actual movement of the ground caused by the energy of blasting. It is measured, using a seismograph, in inches per second of particle velocity. The actual ground movement is typically measured in thousandths of an inch. Vibrations from blasting move from the blast site through the earth in all directions similar to the rings caused by dropping a pebble into a pond of water. Ground vibrations travel through the earth, and rapidly decrease in intensity with distance from the blast site. To protect the interests of the public, Virginia mining regulations restrict the amount of offsite vibration that result from mine blasting to levels that prevent possible damage to structures.

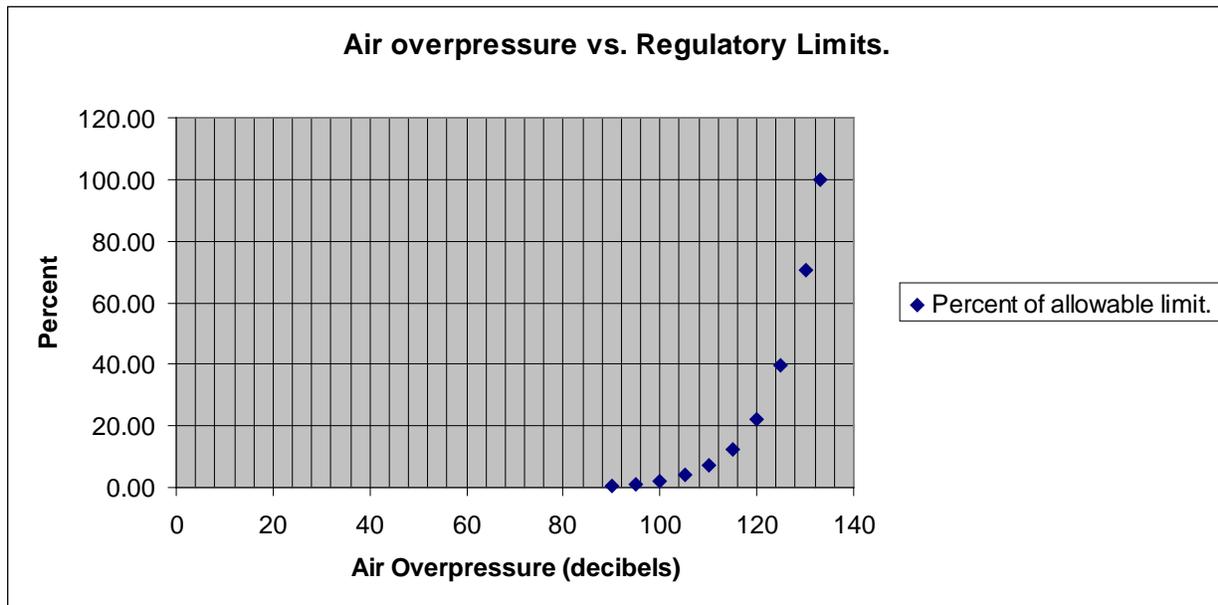
It is logical, and expected, that persons living near mines that utilize blasting will feel something when a blast is detonated. Research has shown that humans can perceive ground vibrations at levels as low as 0.02 inches per second, a level much lower than the allowable blasting vibration limits. In most cases, perception of ground vibrations resulting from mine blasting does not indicate ground movement that is harmful to offsite structures.

Air overpressure, sometimes referred to as airblast, is a compression wave that travels through the air. The air is compressed by the movement of the material being blasted, and that compression wave moves through the atmosphere away from the blast. Air overpressure is measured with a specialized microphone attached to a seismograph, and is measured in decibels, or pounds per square inch. Weather, wind, distance and direction from the blast can all affect air overpressure. As with ground vibration, air overpressure diminishes with distance from the blast, but is usually the most noticeable blast effect, especially from within structures. Concerned neighbors often relate that the windows of their house shake, or that items on shelves vibrate when blasts occur. More often than not, these types of effects are the result of air overpressure, and not ground vibration. Damage to structures due to air overpressure is easily identified. As window glass is the structural component most susceptible to air overpressure damage, it will be cracked or broken by excessive air overpressures. Research indicates that occasional window breakage occurs at about 151 decibels. For comparison, a 20 mph wind equates to an air overpressure of about 134 decibels. (Table 1. below)

Sources of sound	Decibel level
Very calm room	20-30
Normal talking	40-60
Traffic noise, 30 feet away	80-90
Jackhammer, 3 feet away	100
Air Overpressure/Airblast Limit	133
20 mph wind	134
Damage threshold for structures (glass breakage)	151

A person's location greatly determines their perception of blasting vibration and air overpressure. Someone standing outside of a home may notice minimal vibration and noise due to a blast, while a person inside the home may report excessive amounts of vibration. The differing perceptions can be due to the way a structure responds to the vibration and air overpressure associated with the blasting. Human perceptions are unreliable when determining the compliance of blasting operations. Therefore, as of spring 2009, virtually all mines utilizing blasting in Virginia are required to monitor their blasts with a seismograph to ensure accurate measurement of offsite effects.

The following chart represents the relationship between air overpressure in decibels and the percent of the allowable regulatory limit.



Flyrock presents the most serious potential effect of blasting to persons or private property at or near the blast site. By definition flyrock is “any uncontrolled material generated by the effect of a blast that was hazardous to persons or property not owned, or controlled, by the operator”. Although flyrock represents a serious potential hazard, occurrences are rare. All incidents involving flyrock are required to be reported, and are thoroughly investigated by VA DMM.

### **What does the Commonwealth of VA do to control these effects?**

#### **Blaster Certification**

The first measures taken are designed to ensure that people who are conducting blasting operations are experienced and knowledgeable about the safe use of explosives.

All persons who are in charge of blasts at mineral mines are required to be certified by VA DMM. Requirements for certification are proof of experience in mine blasting, and the ability to pass a written examination dealing with blasting and blasting regulation. The certification is issued for a period of five years, and requires additional training and verification of work experience before it can be renewed. Violations of Virginia laws and regulations have resulted in penalties to blasters, including suspension or revocation of his or her certification.

Virginia mining regulations limit the amount of vibration and air overpressure that persons and property are exposed to outside of the mine.

#### **Vibration**

The U. S. Bureau of Mines studied blasting vibration for most of the last century, and their studies indicated that the best measurement unit for vibration was the velocity of the ground movement. In the 1970's, the Bureau proposed vibration limits that depended on the distance from structures to the blast. These limits were selected to prevent damage to structures, and have been widely adopted. Numerous studies done since then have proven the validity of that standard, and the Division of Mineral Mining regulations are based on that work. DMM blasting limits range from 0.75-1.25 inches/second, when based solely on the distance from the blast to the nearest structure.

In addition, research has found that the frequency of ground vibrations also affects structures. These frequencies are measured in cycles per second, just like radio waves or musical notes. If the blasting frequencies are very low (in the 6-12 cycles per second range), they can match the natural frequency of a structure, and increase the vibration of that structure. This effect is addressed in the regulations by a graph that changes the maximum allowable ground vibration velocity as a function of the frequency. Basically, this graph allows a variation in the allowable ground vibration velocities as the frequency of that ground vibration increases, from a minimum of .2 inches per second up to a maximum of 2.0 inches per second. (Figure 1.)

With the exception of very low energy blast events, the mine operator is required to measure ground vibrations, using a seismograph, at the closest structure to the blast site that the company does not own. The information is required to be kept by the operator for at least three years. The VA DMM also has its own seismographs, which are used to investigate complaints and provide independent verification of mine operator data.

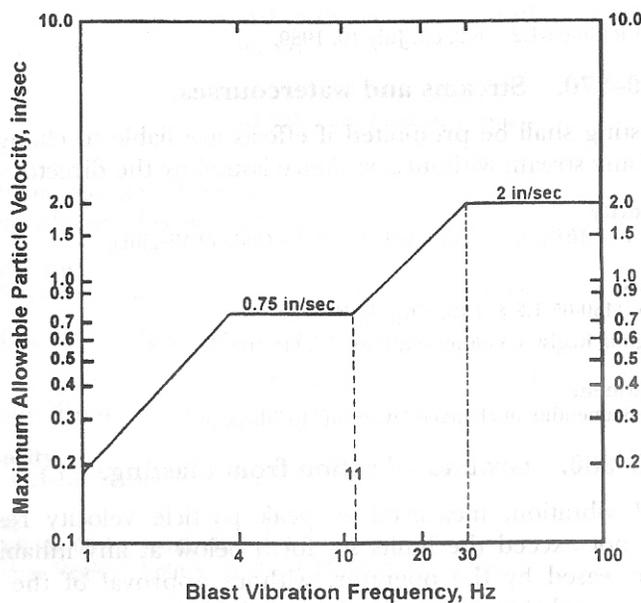


Figure 1

### Air Overpressure

VA DMM regulations concerning air overpressure are designed to prevent damage to structures, and again are based on research done by the U.S. Bureau of Mines. Current regulations allow for a maximum air overpressure of 133 decibels. It is important to remember that the decibel scale is a logarithmic scale, meaning that each increase of one unit on the scale is actually ten times higher than the previous unit (i.e. 120 db is ten times higher than 110db). Air overpressure data is recorded by the seismograph, along with the vibration data. The data must be retained by the operator for at least three years.

### Flyrock

As noted earlier, flyrock incidents are very rare. Virginia mine safety regulations require certified blasters to design shots to prevent flyrock or other dangerous effects. The VA DMM continues to work with the mining community to prevent flyrock. The effort has included changes in regulations that require additional information to be made available to the blaster to assist in better blast design, increased focus on flyrock prevention in required training programs, and requirements for specific

blasting plans at sites which have experienced problems. Certified blasters involved in flyrock incidents face violations, possible additional training, and possible suspension or forfeiture of their certification.

The VA DMM continues to stress flyrock prevention in blaster certification training, and in safety enforcement. If a mine operator has a flyrock incident, VA DMM will halt all blasting at the site until the operator provides a mine blasting plan that details how flyrock will be prevented during future blasts. The blasting plan must be reviewed by VA DMM, and approved before blasting activities can resume. It is important to note that flyrock is preventable through the application of sound blasting practices and adherence to the VA DMM safety regulations.

### **What you can do if you think there is a problem.**

If you feel there is a problem, VA DMM recommends that you contact the company you believe to be responsible. The company should be able to provide you with information on their blasting program. This would include where they are currently blasting and why you may be experiencing effects from the blasts. Blasting can be monitored at your location and seismograph readings provided. These readings will allow you and the company to determine the level of vibration and air overpressure that are occurring at your location, and what steps could be taken to reduce the impact on you and/or your possessions.

If this does not resolve the problem, or if you would prefer not to contact the company, then you may contact the Division of Mineral Mining at 434-951-6310. You may file a complaint with the Division and your information will be kept confidential. The Division will assign an inspector to investigate the complaint. The inspector will examine the company's blasting records and current blasting practices. The inspector will determine if the blast(s) are in compliance with VA DMM regulations. Blast monitoring may be done at your location and seismograph readings recorded. The readings will be reviewed by the inspector, the findings examined, and remediation discussed if needed. A complaint investigation report will be completed, and a copy will be provided to all parties.

We hope this brochure is helpful in providing information on blasting in Virginia mineral mines. If you have further questions, concerns, or problems, please contact the Division of Mineral Mining at 434-951-6310. Our address is: 900 Natural Resources Drive, Suite 400, Charlottesville VA 22903. We can also be reached via email at [DmmInfo@dmme.virginia.gov](mailto:DmmInfo@dmme.virginia.gov). For additional information about the regulation of mineral mining activities, visit our website at [www.dmme.virginia.gov](http://www.dmme.virginia.gov).