

Sound Level	Pressure (psi)	Equivalent Wind Speed		Specification or Structural Effects Based on Sound Levels
		Low	High	
128 dB	0.007286	14 mph	20 mph	Not shown to cause window breakage or structural damage.
134 dB	0.0145	20 mph	29 mph	<b>NHDOT Sound Level Limitation</b>
140 dB	0.029	29 mph	40 mph	Not shown to cause window breakage or structural damage. (long-term history of application as a safe project specification)
151 dB	0.1	53 mph	75 mph	Occasional window breakage
171 dB	1.0	169 mph	237 mph	General window breakage
180 dB	3.0	293 mph	411 mph	Some structural damage possible.

### **BUT THEN WHY AM I ONLY NOTICING THIS DAMAGE NOW?**

As previously stated, and outlined in the table above, human beings can perceive vibrations as low as 0.02 in/s and typically find vibrations between 0.2 and 0.4 in/s unpleasant. Couple this with sudden and unexpected blasting, and of course people will take more notice of their surroundings. The general thinking is “If I can feel it, what is it doing to my house?”

### **WHERE CAN I GET MORE INFORMATION?**

More information can be found in any of the sources listed in the bibliography below.

#### **BIBLIOGRAPHY:**

“Public Relations: A Practical Means to Control Blasting Complaints”, G.A. Foster, The Journal of Explosive Engineers, November/December 2009.

ISEE Blasters' Handbook 17<sup>th</sup> Edition, R. Hopley, The International Society of Explosives Engineers, Cleveland, OH, 1998.

Background and Frequently Asked Questions about Blasting, Florida Lake Belt Project, Miami-Dade (Video), Limestone Products Association, Miami-Dade County

2010 NHDOT Standard Specifications for Road and Bridge Construction, Supplemental Specifications - Amendment to Section 203, dated 4/7/15

## BLASTING FACTSHEET

In order to construct new roads, bridges and associated drainage, typically a large amount of earth and rock must be excavated. Blasting operations are used to remove rock/ledge that cannot be removed by other means. The blasting operations break the rock/ledge into smaller pieces that can then be handled by construction equipment and hauled away. Roughly two million cubic yards (four million tons) of rock will need to be excavated to complete the improvements to the I-93 Salem to Manchester corridor. The bulk of this rock excavation (80—90%) will be in the Exit 3 area. Blasting operations create ground and air vibrations that can be felt in surrounding areas. Some of the most common questions regarding blasting are addressed below. Please see the project website at [www.RebuildingI93.com](http://www.RebuildingI93.com) for more detailed information on blasting and its effects.



**ROCK & LEDGE REMOVAL OPERATIONS**

### **WHY DOES MY HOUSE SHAKE DURING BLASTING?**

During blasting, energy waves are transmitted through the ground as vibrations, and through the air as overpressure or air blast. Ground vibration is measured in inches per second (in/s). Air Blast is measured in decibels (dB). Vibration effects on structures can be caused by both ground vibration energy and air blasts. The New Hampshire Department of Transportation (NHDOT) has set Standards for allowable ground vibrations and air blasts from blasting that are at or below federal government and industry standards, to prevent damage to buildings and property.

### **WHAT IS THE NHDOT STANDARD FOR ALLOWABLE GROUND VIBRATION FROM BLASTING?**

The NHDOT Standard for allowable ground vibrations from blasting for homes is based on the frequency of the blast wave, measured in Hertz (Hz), and the type of interior walls of the home. If you have a modern home, with drywall interior, the allowable ground vibration is 0.75 in/s, for frequencies below 40 Hz. If you have an older home, with plaster on wood lath interior (eg. horse-hair plaster), the allowable ground vibration is 0.5 in/s, for frequencies below 40 Hz. The allowable ground vibration is 2.0 in/s for all homes, regardless of interior, for frequencies at or above 40 Hz, and for non-residential structures and buried utilities, regardless of frequency. The allowable values can also be lowered to protect historic structures and older buried utilities.

**WHAT IS THE NHDOT STANDARD FOR ALLOWABLE AIR BLASTS?** The NHDOT Standard for allowable air blasts is 134 dB.

***BUT IF THESE LIMITS ARE KEPT BELOW ALLOWABLE LIMITS, HOW COME I CAN STILL FEEL THE BLAST?***

Unfortunately, human beings are extremely responsive to ground vibrations and air blast effects from blasting. The human body can feel vibration effects as low as 0.02 in/s, which is 25 times smaller than the lowest allowable ground vibration limit for older homes. In addition, many structures have natural resonant frequencies within the same range of frequencies as the pressure wave from air blasts, which produces vibration effects normally associated with ground vibration only.

***HOW DOES SOMEONE MEASURE THE ALLOWABLE GROUND VIBRATIONS AND AIR BLASTS, AND WHERE ARE THEY MEASURED?***

Ground vibrations and air blasts are measured with a device called a seismometer. These results are then plotted on a seismograph and the highest value of ground vibration, also known as the Peak Particle Velocity, or PPV, is obtained, as well as the peak air blast overpressure. These results are then compared to the allowable limits set by NHDOT to verify that the Contractor is in compliance. It is the Contractor's responsibility to ensure that he is within the allowable limits for ground vibration and air blast, however the NHDOT typically employs an independent consultant to verify the Contractor's seismograph readings by taking readings of their own on a random basis.

A seismometer is typically set up at the closest occupied structure to the blast location. Variations in geology and topography may also dictate placement of seismometers, as well as proximity to concentrated residential or commercial areas. It is impractical to set up seismometers at every occupied structure, so the structure closest to the blast is chosen to represent a concentrated area since ground vibrations and air blasts reduce in intensity as they travel further away from the blast site.

***WHAT HAPPENS IF THE CONTRACTOR EXCEEDS THE ALLOWABLE GROUND VIBRATION OR AIR BLAST?***

If the allowable ground vibration or air blast is exceeded, the Contractor is required to change his blasting methods to reduce these effects. In addition, if the exceedance sparks written public complaint, the Contractor is responsible for following up with the complainant. Several exceedances may warrant cessation of blasting operations.

***WHY DOES THE BLASTING SOUND LOUDER ON SOME DAYS THAN ON OTHERS?***

Aside from the blast location itself being moved, air blasts are unpredictable due to local weather conditions. Lower temperatures and pressures, along with cloud cover, tend to focus and intensify air blasts. This tends to make smaller blasts sound much larger.

***DOES REPETITIVE BLASTING CAUSE DAMAGE TO MY HOME, EVEN IF THE VIBRATIONS ARE WITHIN THE ALLOWABLE LIMITS?***

No. The federal government has conducted studies where they have vibrated entire houses for several days. Their conclusions have shown that repetitive blasting kept below 0.75 in/s will not cause damage.

***IF BLASTING IS NOT CAUSING DAMAGE TO MY HOUSE, THEN WHAT IS?***

There are several other factors that have been proven to cause damage equivalent to vibrations, some man-made and some natural. Actions as simple as slamming a door can cause vibrations between 0.15 in/s and 1.9 in/s, whereas a moderate 20 mph wind can cause vibrations between 0.6 in/s and 2.6 in/s. A comparison of common occurrences to measured vibration damage levels is provided in the table below.

<b>Vibration</b>	<b>Effect, source, or human response</b>
0.02 - 0.06 in/s	Range where vibrations are perceptible to humans
0.2 - 0.4 in/s	Range where vibrations begin to be unpleasant to humans
0.02 - 0.58 in/s	Fireworks at 1,500 feet
<b>0.75 in/s</b>	<b>Lower threshold of government standard safe vibration limits for blasting</b>
0.15 - 1.9 in/s	Slamming a door
<b>2.0 in/s</b>	<b>Upper threshold of government standard safe vibration limits for blasting</b>
0.2 - 2.1 in/s	Driving a nail
1.0 - 2.4 in/s	10 percent change in humidity will cause small cracks to expand
0.6 - 2.6 in/s	20 mph wind
1.0 - 3.2 in/s	10 degree temperature change will cause small cracks to expand
<b>4.0 in/s</b>	<b>Minor superficial cracking at drywall joints</b>
1.1 - 6.7 in/s	50 mph wind
<b>8.0 in/s</b>	<b>Damage to a structure</b>
<b>10.0 in/s</b>	<b>Damage to concrete slab or driveway</b>

From the table above it can be seen that cracks appearing in a concrete slab or asphalt pavement would occur long after essentially all of the drywall joints in a home had cracked from the same vibration. So, where are the cracks in your foundation coming from? Temperature and humidity changes listed above can be a main cause for basements located in areas with a high water table. Additionally, improper foundations constructed on poor soils or muck can cause uneven settlement of houses.