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CITY COUNCIL

June 21, 2022
Council Chambers • 411 SW 9th Street

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JUNE 21, 2022 | WORKSHOP AGENDA | 6:00 PM

I. CALL TO ORDER

II. CITY MANAGER AND STAFF REPORTS

A. Draft Blasting Standards and Specifications: Worksession #2

B. Pahlisch Letter

III. ADJOURN

Regular Council meetings are broadcast live on COTV11 – BendBroadband Channel 11 beginning at 6:00 p.m. on the 2nd and 4th Tuesdays of each month. Rebroadcasts are scheduled for the non-meeting Tuesdays at 6:00 p.m.

The City of Redmond encourages all citizens to participate in its programs and activities. This meeting location is accessible to people with disabilities. Requests for accommodation may include sign language interpreter service, assistive listening devices, materials in an alternate format or any other accommodation. If any accommodations are needed, please contact the ADA Coordinator at 541-504-3036 or access@ci.redmond.or.us. Requests should be made as soon as possible, but at least 3 business days prior to the scheduled meeting.

The City of Redmond does not discriminate on the basis of disability status in the admission or access to, or treatment, or employment in, its programs or activities

CITY OF REDMOND
Engineering Department

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MEMO

TO: Keith Witcosky, City Manager
John Roberts, Deputy City Manager
FROM: Mike Caccavano, City Engineer
DATE: May 5, 2022
SUBJECT: Working Draft **-** Updated Requirements for Blasting

BACKGROUND

Recent citizen concerns about blasting in residential neighborhoods highlighted the need for the City to develop more detailed blasting standards and review procedures. Specifically in areas related to initial geologic analysis, property owner notification, pre/post blast surveys (property inspections), and the radius in which various quality and safety control measures should occur.

Following are draft changes to Engineering standards and processes that are intended to strengthen and replace the City's existing regulations and more closely align with the recently updated and implemented Fire Marshal blasting permit process**.**

The quality control measures contained herein shall be used when evaluating requests to blast within the Redmond city limits. Blast requests will be subject to these provisions and procedures.

As part of the language adoption process staff proposes an initial City Council work session where the draft can be presented and public input from citizens, developers and other stakeholders can occur.

METHODOLOGY

The Oregon Department of Transportation (ODOT) has comprehensive blasting standards (Section 0335 of the Oregon Standard Specifications for Construction) that can be incorporated into the City's Public Works Standards and Specifications. The City currently incorporates other sections of ODOT's standards such as asphalt pavement quality by reference and modifies them with Redmond specific provisions and conditions as appropriate.

A copy of Section 00335 is attached.

The mechanism for making these changes is done through what are called Special Provisions to the Public Works Standards and Specifications.

RECOMMENDATIONS
SPECIAL PROVISIONS TO THE 2010 PUBLIC WORKS STANDARDS AND SPECIFICATIONS

Development Provisions Section 18.8: This section will be deleted and replaced with the new Section 102 that follows beginning on page 3 of this document:

~~18.8.00 BLASTING~~

~~Where rock material is encountered which requires systematic drilling and blasting for removal, the Contractor shall furnish all necessary approved blasting certifications and licenses, tools, equipment, and materials required to perform the work. The Contractor shall comply with all Federal, State, and local laws that apply to the storage, handling, placement, and firing of all explosives.~~

~~The Contractor shall furnish additional insurance coverage as required by the City or any agency in addition to the basic coverage required by these specifications.~~

~~No blasting shall be permitted adjacent to any portion of exposed work or structures unless proper precautions are taken to assure that damage to adjacent property will not occur. All blasting shall be covered with blasting mats or other approved type of protective cover to prevent the scattering of rock fragments or other material to outside the excavation area and limits of the construction. The Contractor shall be responsible for any and all damage or injury resulting from the use or handling of explosives, and accidental or premature explosion that may occur in connection with Contractors' use of explosives.~~

~~Proper notification and ample warning shall be provided to all persons within the danger zone. Contractor's personnel shall be stationed at strategic locations a safe distance from the blasting zone to prevent persons and vehicles from entering the blasting area. Electrical blasting caps shall not be connected to the electrical source until the area is cleared of all personnel and the proper warning signals have been sounded.~~

~~Where blasting is proposed in the proximity of private property or residences that may be affected by vibrations, shaking, or seismic shocks, the Contractor shall be responsible to perform pre-blast surveys of all structures to determine the condition of walls, ceilings, floor slabs, or other surfaces in which cracking or movement may be induced by the blasting operations. All existing conditions shall be thoroughly documented and recorded by means of photographs and/or video recordings to establish pre-blast conditions and existing damage. Following the blasting operations, the Contractor shall perform a follow up survey of those affected properties to determine if any shifting, cracking, settlement, or other damage was induced by the blasting. Contractor shall promptly repair or replace any damaged structures to a condition equal to or better than that found in the pre-blast survey. The City will be indemnified and held harmless from any liability for damage or injury caused by the Contractor's blasting operations.~~

~~Public utilities (utilities) located within the blast area must be identified and notified 72 hours prior to blasting. Contractor shall perform pre-blast survey and inspections of identified utilities including closed circuit television (CCTV) video inspection of sanitary and storm sewer lines. Utilities damaged from blasting activities shall be repaired and/or restored at the expense of the Contractor.~~

Standards and Specifications: Propose to add the following section:

102 BLASTING

102.1.00 DESCRIPTION

This work consists of excavating in rock using controlled blasting methods to facilitate trench excavation for utilities or to remove rock for construction of road grades or structures. Minimum general standards for blasting shall meet the requirements of Section 00335 Blasting Methods and Protection of Excavation Backslopes of the Oregon Standard Specifications for Construction, current edition, with the following modifications and additions:

Section 00335.40(d) Add the following: Blasting permits shall be obtained from the Redmond Fire and Rescue District Fire Marshall. In addition to the items listed in this section, the blasting plan shall include:

- Map showing where blast will occur, distance to structures, ¼ mile notification perimeter and structures that will be offered pre-blast inspections. Distance from blast shall be the distance from the structure to the closest drillhole where blasting materials will be placed. Quarter mile perimeter for notification shall be measured from the full extent of the blasting.
- Proposed seismograph locations for all properties within 300 feet of blast.
- Boring/soil analysis at specific points to determine geologic formations and rock/substrata consistency. *(More detail on this requirement will be provided after consultation with a structural and/or geotechnical engineer)*
- Geological analysis of the potential for blast damage/impact to nearby structures. *(More detail on this requirement will be provided after consultation with a structural and/or geotechnical engineer)*
- **No blasting shall be permitted within 100 feet of residences.**

- **Section 00335.40(e) Add the following:**
  Notifications and Inspections Pre-blast notification is required to all properties in ¼ mile radius of blasting area unless geologic analysis determines that a larger radius is necessary. No pre-blast notification shall occur prior to blasting permit issuance. Offer pre-blast inspections to properties within 900 feet of blast area (see details in Pre-Blast Inspections section).
  Pre-blast notification shall occur on the following timeline:
  - No less than 21 calendar days prior to first scheduled detonation, notification shall be mailed to property owner (and to the structure address if different) and door hanger placed at each address.
  - No less than 21 calendar days prior to first scheduled detonation, information signage shall be posted on each property line.

- Seven calendar days prior to first scheduled detonation door hanger shall be placed at each address.
- Two calendar days prior to first scheduled detonation door hanger shall be placed at each address.

Door hanger placement for all above notifications to be confirmed with photo showing door hanger and property address. Door hangars should be a readily noticeable color such as yellow or red.

All notifications shall contain proposed blasting schedule, location where blasting will occur, and contact information for the developer, general contractor and blasting contractor.

Pre-Blast Inspections Offer pre-blast inspections to properties within 900 feet of blast area. Inform effected property owners of the latest date which they can request an inspection in relation to the blasting schedule. If a property owner or resident that is inside the ¼ mile notification zone but outside the 900-foot inspection radius requests a pre-blast inspection, it will be provided at the developer or contractor's expense.

- It is recommended signed waivers are obtained from any property owner or resident within 300 feet of the blasting area that declines a pre-blast inspection of their property.
- Copies of inspection(s) will be provided to owners and residents of all properties inspected.
- Recommended minimums for pre-blast inspections include:
  a. Document with written, photographic and video evidence that the inspector observed and photographed both inside and outside of the homes including the crawlspace. Clearly identify location of photo.
  b. Include sheetrock, concrete slabs, foundations and stemwalls, visible structural elements and any other relevant pre-existing cracks and displacements (front of house foundation, back of house foundation, side of house foundation). Pay particular attention to doorways and windows, room corners, grout lines, joints between slabs and foundations and any other areas that may have cracks or displacements.
  c. Document arrival and departure time at each structure/property.
  d. Note number, location and size of existing cracks and displacements in foundation, walls, visible structural elements and slabs.
- Submit affidavit to Engineering Department that the above requirements have been satisfied at least 48 hours prior to the first detonation.

  This shall include:
  a. Copy of door hangers used to notify residents.
  b. List of addresses that were mailed notifications.
  c. List of addresses that received door hangers.
  d. Copies of pre-blast inspection reports.
  e. Within 48 hours after blast i) Post-blast inspection reports and ii) seismographs.
  f. Log of calls received through notification and outreach including: name and address of caller, date and time of call, nature of inquiry and how it was resolved.

Underground Utilities Contractor shall perform pre-blast survey and inspections of identified utilities including closed circuit television (CCTV) video inspection of sanitary and storm sewer manholes, inlets and lines within 100 feet of the blast area. Utilities damaged from blasting activities shall be repaired and/or restored at the expense of the Contractor.

City Council Worksession #2: June 21, 2022

Panel Discussions on Various Aspects and Impacts of the Blasting Process

each panel is expected to last 20-40 minutes

(all panelists are tentative based on availability)

PANEL #1: Neighborhood/Community Members Panel

- Proposed panelists
  - 3-4 Teak Ave neighbors
- Starter Questions:
  - What could be improved with how you receive information about development related blasting in your neighborhood?
  - When it comes to notification, but type of communication would you prefer (mail, door hanger, project open house meeting, etc.) and how far in advance would you want to receive it?
  - When it comes to pre and post blast inspections and the language in the City Standards and Specifications, what part of that process would you like to see changed?

PANEL #2: The Physics and Geologic Analysis of Blasting

- Proposed panelists
  - Bob Cummings, Saguaro GeoServices, Inc., Tucson, AZ
  - Bill Gates , McMillen Jacobs Associates, Seattle, WA
  - Placeholder: other structural engineer
  - Tom Mooney (tentative), Redmond Fire and Rescue, Fire Marshall
- Starter Questions:
  - What are the basic principles and the science behind blasting?
  - What are the tools that blasters use to keep the public and nearby structures safe?
  - Describe how the specific characteristics of a given blast effect/relate to decisions related to notification, radius of influence, etc.?
  - What are the various industry standards for blasting?
  - What are alternatives to blasting and what are the impacts or risks associated with them?
  - What are the components and consideration of a Blast Plan?

PANEL #3: Development Community: Homebuilders and infrastructure contractors

- Proposed panelists
  - Hayden Homes
  - Pahlisch
  - Quality Drilling and Blasting
  - Placeholder
- Starter Questions:
  - What are some of the challenges you face when building in Central Oregon?
  - Describe, in specificity, your approach to customer notification and home inspection as part of the blasting process?
  - What if the difference between a typical home inspection (for example if someone is having a pre-purchase inspection) vs. an inspection associated with blasting?
  - Over the past year, how often have you had to repair a home that was damaged by blasting? What type of damage do you typically see?
  - What specific aspects of the Draft Blasting Changes effect cost and schedule? What suggestions do you have to make them more practical, tolerable, or reasonable?

ROCK BLASTING and the COMMUNITY

The concern of damage from ground vibration, airblast, and flyrock from blasting are a major concern to both the nearby landowners and ODOT as the quarry owner. In most cases these concerns are based on misunderstandings and unsubstantiated fears resulting from a lack of information. The purpose of this handout is to help illustrate the concept of blasting, explain the science, and hopefully provide the information needed to explain what is being proposed, and what surrounding property owners can expect.

To set the stage for the remainder of this discussion, we want to first address some of the common terms and definitions related to blasting:

- Explosives – Any chemical mixture poured or placed in a borehole that reacts at a high speed to generate gas and heat, thus causing tremendous outward pressures. Some common types used are ANFO (ammonium nitrate and fuel oil), dynamite, TNT, and water gels and emulsions for boreholes filled with groundwater.
- Two basic forms of energy are released when explosives react – gas energy and shock energy. Shock energy is the pressure that is transmitted outward from the borehole into the rock, causing microfractures to form and propagate outward for a short distance. Gas energy is the pressure that is exerted on the borehole walls by the expanding gases after a chemical reaction has been completed. These gases follow the 'path of least resistance' along existing and newly-formed fractures in the rock and this causes the majority of rock breakage in quarry blasting.
- Energy from a blast which is not used for rock breakage is wasted in the form of ground vibration and airblast.
- Ground Vibration – Seismic waves that spread out from the blasthole(s) along and through the ground, much like ripples in a pond. Ground vibration is comprised of many different waves with different frequencies and travel paths. The components (frequency, displacement, peak particle velocity, and acceleration) are measured with a seismometer, and it has been found that PPV is the most predictable and indicative of damage. Vibration levels, typically far below the levels required to produce damage, can be felt by humans (Figure 2).
- Peak Particle Velocity (PPV) – A measurement of ground vibration. The maximum speed (measured in mm/sec or in/sec) at which a particle in the ground is moving relative to its inactive state.
- Airblast – An airborne wave emanating from the blast, which is observed by people and structures as sound and pressure. It is measured in decibels (dB), just like noise. The airblast from an improper blast is what can crack walls and break windows.
- Flyrock – Rock or debris that is propelled into the air by the blast. Flyrock usually originates from material on the surface or the upper free face.

- Scaled distance (on Figure 1) is a formula for reducing the combined effects of distance and weight of the explosives into a single value that can be related to PPV. Scaled distance is $d / \sqrt{w}$ where
  d = distance from blast
  w = weight of explosive per delay (if instantaneous this is the <u>total</u> weight of explosives; if delayed these are individual detonations).
- Delayed Blast – A blast in which boreholes or groups of boreholes are detonated separately, by a time interval of at least 15 milliseconds. This time has been shown to be generally sufficient to isolate the energy from individual detonations. Thus a blast can consist of a large number of holes that when fired produce vibrations approximately equivalent to firing holes one at a time.
- Free Face – The visible near-vertical wall(s) within the quarry (see Figure 3 for this and explanations for other blasthole terms)
- Burden – The distance from a blasthole or row to a free face (Figure 3)
- Stemming Height – The top portion of the blasthole normally filled with crushed rock to confine the explosion downward (Figure 3)

Ground vibrations, measured as Peak Particle Velocity (PPV), are commonly viewed as the major concern for off-site damage resulting from blasting.

Extensive research has been conducted throughout the last 40 years by the United States Bureau of Mines (USBM) and the Office of Surface Mining (OSM) [both bureaus of the U.S. Department of Interior], universities, and private groups. This research has led to the development of acceptable vibration standards, vibration damage criteria, seismographs, and techniques to predict and control blast vibrations that greatly reduce the risk of off-site impacts from blasting.

When the OSM developed regulations pertaining to ground vibration, they concluded that "if ground vibration (PPV) were limited to 1 inch per second then 95% of the damage to (surrounding) houses, etc. would be prevented." Initially the OSM made a policy decision that 95% was an acceptable level of public protection and made 1 inch per second the standard. After more recent research, both law and science have set the PPV limit at 0.5 inches per second to avoid off-site damage (which feels like, according to Figure 1, the same as a loaded truck or bus going by 50-100 feet away). As a real example, Las Vegas had used a maximum PPV of 0.25 inches per second since 1993, but as of 2000 the city has changed the criteria and raised the allowable vibration to a maximum PPV of 0.5 inches per second.

Principle factors that affect ground vibration levels at a given point of interest are:

- Weight of the explosive fired per delay period
- Distance from blast to point of concern (house, cistern, etc.)
- Blast configuration (existence of a free face, trench, confined area, etc.)
- Geology (sites with a thick layer of soil have been known to produce ground vibrations 10 times as great as locations with a thin layer of soil over rock)

The first two factors are the most influential to ground vibration, which is what most of the graphs are showing (see Figures 1, 2, 4). The distance from the blast to the point of concern cannot be controlled by the Blasting Contractor, but the weight of explosives fired per delay period can be. Some site conditions, such as removing a thick layer of soil, can also be manipulated to lessen the amount of ground vibration.

How Peak Particle Velocity (PPV) is calculated and used to design a blast:
To determine the weight of explosives that can be detonated without off-site damage, the Blasting Contractor uses the following formula that relates peak particle velocity to distance and the weight of explosives fired in a single delay period:

$$\mathbf{PPV = k * (d / \sqrt{w})^a}$$

where **k** and **a** are constants that vary depending on site conditions. Ideally, values for **k** and **a** are generally derived from blast vibration monitoring at a site and define a line that represents a relationship between PPV and the weight of explosives for those conditions. In the absence of vibration monitoring from previous shots in the quarry and to take into account variations in geologic conditions and blast patterns, the values for **k** and **a** are set to represent an upper limit to peak particle velocities relative to scaled distance (shown as Upper Limit on Figure 4, which is based on over 10,000 measurements recorded worldwide). ODOT uses the following values for **k** and **a**, which were developed by Federal Highway Administration (FHWA):

k = 100
a = -1.6

Thus, if a structure is 530 feet away from a blast (1/10 of a mile) and the peak particle velocity at that point is limited to 0.5 inches per second, then according to the formula above, the maximum weight of explosives that can be detonated during a single delay period, and still be under the limit to avoid off-site damage, is approximately 370 pounds. If a structure is 1,320 feet away (1/4 of a mile) and the peak particle velocity at that point is limited to 0.5 inches per second, then the maximum weight of explosives that can be detonated is approximately 2,300 pounds per delay period.

To illustrate the example in reverse, consider that typical blasts at quarries use a 3½ inch diameter hole approximately 40 feet deep. The explosive most commonly used is ANFO and the top part is stemmed with sand/gravel or drilling cuttings poured on top of the ANFO to help force the blast energy into the rock. The amounts of ANFO and stemming vary depending on the location of the hole in the blast pattern, site conditions, the hardness of the rock to be blasted, and of course, on PPV limitations for surrounding structures. Generally, a minimum amount of stemming for a 3½ inch diameter, 40 foot hole would be approximately 7 feet, which would leave 33 feet of hole for ANFO. The weight of explosives in the hole would be approximately 115 pounds. If a single hole is fired per delay period, at a distance of 530 feet, the PPV should be approximately 0.2 inches per second. If three holes are fired simultaneously (within the same 15 millisecond window), then the PPV at a distance of 530 feet should

be approximately 0.47 inches per second. Note that the relationship between PPV and the weight of explosives is not linear – three times the explosives do not produce three times the PPV. The PPV calculated with this formula represents a likely maximum value (the Upper Limit line); the actual PPV would generally be less than these values and be located below the Upper Limit line.

Effects of Blasting on Groundwater:

- Studies have shown that significant fracturing in the rock around a blast hole is generally limited to a distance of 20-40 blasthole diameters. Thus, for the typical 3½ inch drill hole, the zone of damage would generally be 6-12 feet.
- Studies have concluded that there are little to no significant long-term mechanical changes in an aquifer that could be attributed to blasts detonated at distances greater than 500 feet from the observation wells.
- Blast vibrations are not believed to permanently degrade groundwater quality, but can sometimes cause local and temporary turbidity that can extend for hundreds of feet beyond the blast zone. These sediments can remain in suspension for days or weeks; however, this is only temporary and aesthetic, and not suggestive of physical damage to the aquifer or well.
- In tests directly on wells, steel well casings remained intact even after 25 pound charges were detonated as close as 10 feet from the well screen (a PPV=33 inches per second derived from the equation).
- Blast vibrations have been shown in a number of cases to improve the long-term water yield in aquifers due to the "flushing out" of fine sediments from between joints, allowing more permeability and overall storage.

Principle factors that affect airblast levels at a given point of interest are:

- Distance from blast to point of concern
- Orientation of the free face
- Presence or absence of temperature inversions (commonly exist in the morning and evening)
- Burden distance
- Stemming height and/or material used
- Weight of explosive detonated per delay period

All but the first two or three factors can be adjusted by a Blasting Contractor to reduce airblast.

Principle factors that affect the amount of flyrock landing near point of concern:

- Distance from blast to point of concern
- Orientation of free face
- Zones of adverse geology (voids, decomposed seams, large joints)
- Weight of explosive detonated per delay period
- Burden distance

- Stemming height and/or material used
- Bench height
- Delay Configuration (when individual holes are detonated in relation to each other, which controls the direction and degree of rock displacement)

Again, all but the first two factors can be adjusted or designed for by a Blasting Contractor to reduce the amount of flyrock.

What ODOT and the Blasting Contractor can do to keep ground vibration, airblast, and flyrock at acceptable and safe levels:

- Require an approved Blasting Consultant to design/approve the blasting plans
- Perform pre-blast surveys. These are done either by or through the Blasting Contractor prior to the blast to document the condition of structures, foundations, windows, etc. prior to exposure to vibration from blasting.
- ODOT review the submitted blasting plan(s) prior to allowing the blast(s) to proceed
- Require ground vibration monitoring during the blasts(s)
- Require that blast mats be laid upon the blast area(s) to help contain flyrock
- Blasting contractors are licensed and bonded
- Place safeguards in the Special Provisions of the contract

  Example: Contractor Responsibility and Liability: Oregon Standard Specifications for Construction

  00170.94 Use of Explosives – The Contractor shall comply with all Laws pertaining to the use of explosives. The Contractors shall notify anyone having facilities near the Contractor's operations of Contractor's intended use or storage of explosives. The Contractor shall be responsible for all damage resulting from its own, its agents' and employees', and its Subcontractors' use of explosives. (See 00330.41 (e) and Section 00335.)

CONCLUSION:

Blasting is an inherently dangerous activity which can result in serious injury, death, and/or damage if not designed and performed professionally. With the safeguards and technology employed in this industry today, many of the concerns of the past are exactly that – concerns of the *past*.

Today's Blasting Contractors are professional. They have the knowledge and technology to make this dangerous task safe, for themselves and the surrounding property. The key to making sure blasts are carried out successfully and safely is knowing what the issues and concerns are up front. For example, a blast design cannot take into account potential impacts to wells and springs if their existence is not known.

When ODOT or a Contractor working for ODOT is preparing for the blasting phase of a project, they try to be thorough in identifying all elements of concern; but sometimes things are not obvious. This is why ODOT and the Contractor need to rely on local knowledge of the surroundings.

It is in the best interest of ODOT and the Contractor to complete this work in a timely, efficient, and safe manner. This can and will be the end result as long as all factors of concern are known and taken into account.

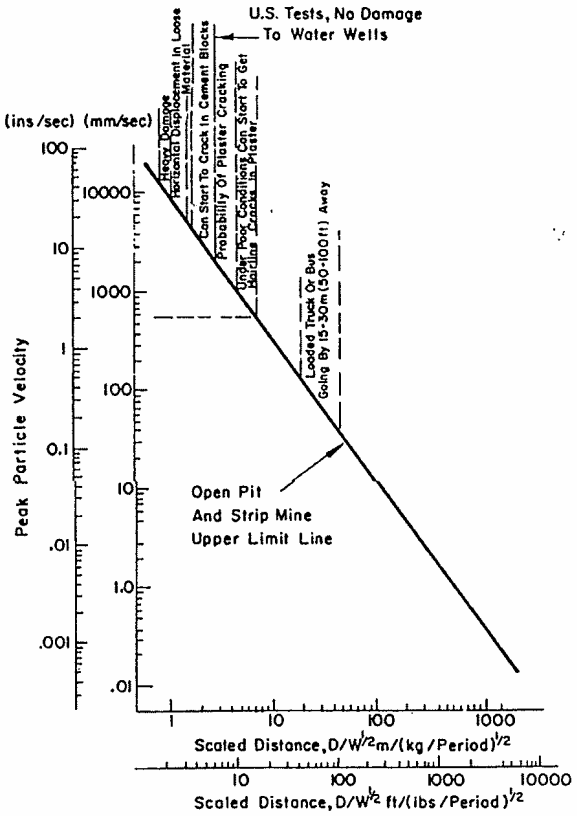


Fig. 1. Structural response at different scaled distances from pit blasts.

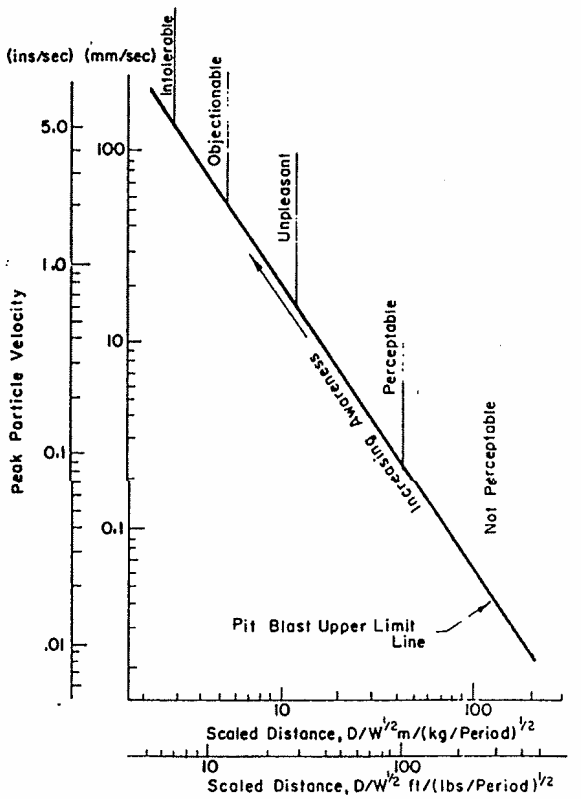


Fig. 2. Anticipated human response to blast vibrations at different scaled distances from pit blasts.

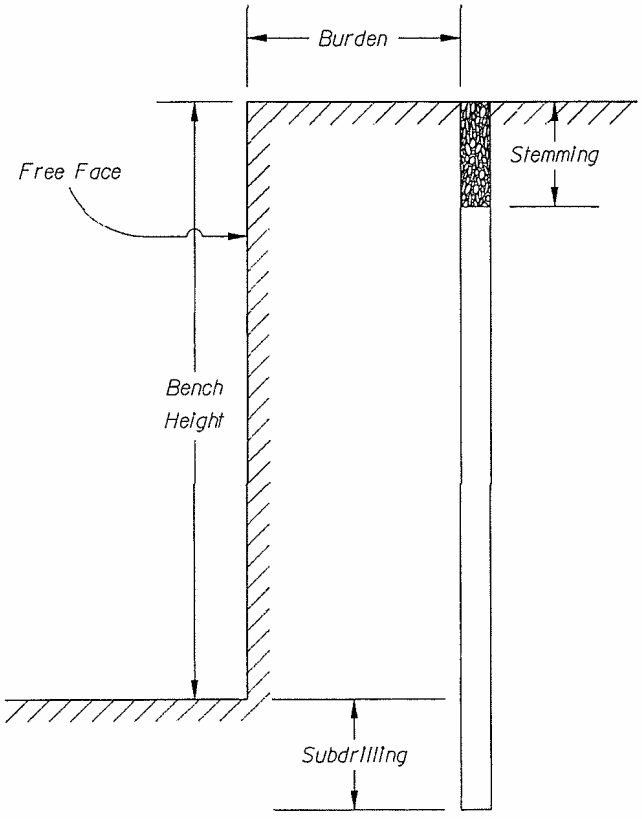


Figure 3. Profile of a Typical Quarry Blast Hole

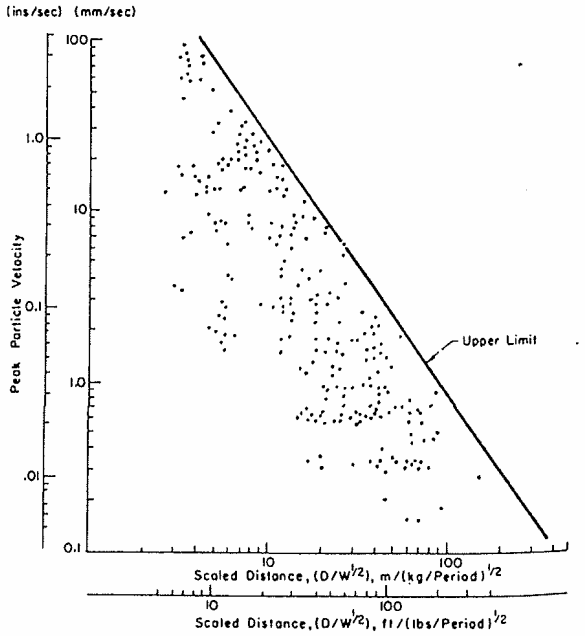


Fig. 4. Typical vibration data from multiperiod delay blasts in open pits and strip mines.

Preparing for a Blast

The key to making sure blasts are carried out successfully and safely is to know what the issues and concerns are when designing the blast.

When ODOT or a contractor is preparing for the blasting phase of a project, workers try to be thorough in identifying all elements of concern, but sometimes things are not obvious. This is why ODOT and the contractor need to rely on local knowledge of the surroundings. It is in the best interest of ODOT and the contractor to complete this work in a timely, efficient and safe manner.

Other methods that ODOT employs to ensure a successful and safe blasting operation:

- Require an approved blasting consultant to design/approve the blasting plans
- Perform pre-blast surveys. These are done either by or through the blasting contractor prior to the blast to document the condition of structures, foundations, and windows prior to exposure to vibration from blasting.
- ODOT reviews the submitted blasting plans prior to allowing the blasts to proceed
- Require ground vibration monitoring during the blasts
- Require that blast mats be laid upon the blast area to help contain flying rock
- Blasting contractors are licensed and bonded

For related information about the technical aspects of blasting, visit:

https://www.oregon.gov/odot/geoenvironmental

(click “Material Sources”)

Oregon Department of Transportation

For more information about a specific project, contact “ASK ODOT” at:

1-888-275-6368 or
www.oregon.gov/ODOT/

Oregon Department of Transportation

Rock Blasting and the Community

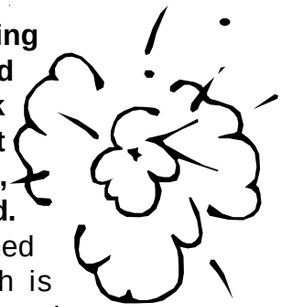
Oregon Department of Transportation

The Oregon Department of Transportation maintains quarries as part of a statewide material source network in order to obtain rock material used for construction, maintenance, and emergency repair projects.

This material is crushed and sorted for use in building and paving state highways and other public projects. The process to excavate the rock often requires blasting in the quarries. The potential damage from ground vibration, airblast (sound) and flying debris is a major concern to both ODOT and nearby residents.

Every effort is taken, however, by both ODOT and its blasting contractors to greatly minimize and eliminate potential impacts on neighboring properties from this type of work.

What is Blasting?



The purpose of blasting is to loosen and fragment in-place rock materials to a size that can be removed, transported or crushed. Often the rocks are turned into aggregate, which is used to build and pave roads.

Within the quarry, holes commonly 3½ inches in diameter are drilled down into the rock mass. The holes are filled with an explosive, which is a chemical mixture that reacts at a high speed to generate gas and heat. Upon initiation, this reaction causes tremendous outward pressures and energy.

Two basic forms of energy are released when explosives react: shock and gas. Shock energy is the pressure transmitted outward from the hole in the rock and causes microfractures to form and travel outward for a short distance. Gas energy is pressure caused by expanding gases, created by the chemical reaction. These gases follow the path of least resistance along existing and newly-formed fractures in the rock and cause the majority of rock breakage in quarry blasting.

Energy not used for rock breakage is wasted in the form of ground vibration and airblast. Ground vibrations are seismic waves that spread out along and through the ground from the drill hole and are measured with a seismometer. Vibrations, typically far below the levels required to produce damage to plaster or windows in houses, can be felt by humans.

Airblast is an airborne wave created by the blast and is observed by people as sound and pressure. Again, sound and pressure below the levels required to damage walls and windows, can be felt by humans.

Blasting & Groundwater

Blast vibrations are highly unlikely to permanently decrease groundwater quality, but can sometimes cause local and temporary cloudiness as sediments are dislodged.

These sediments can remain in suspension for days or weeks, but this is only temporary and aesthetic and does not suggest physical damage to the aquifer or well. In fact, **blast vibrations have been shown in a number of cases to improve the long-term water yield in aquifers** by “flushing out” fine sediments from between joints, allowing more permeability and overall storage.

What About Safety?

Extensive research about blasting has been conducted by the United States Bureau of Mines (USBM) and the Office of Surface Mining (OSM), universities, and private groups for more than 40 years. This has led to the development of acceptable vibration standards that greatly reduce the risk of off-site impacts. **Ground vibration levels have been set by law to avoid off-site damage and should feel the same as a loaded truck or bus going by 50 to 100 feet away.**

Studies have shown that significant fracturing in the rock around a typical blast hole is limited to a distance of 20-40 hole diameters, which is 6 to 12 feet for the commonly used 3½ inch hole. This short distance of fragmentation is evidenced by most quarry blastholes being spaced 6 to 14 feet apart; the explosive energy is insufficient to fracture the rock at any greater distance from each blasthole. When a confined explosive charge is detonated, the zone of permanently deformed material is ideally cone shaped with the point down, with very little fracturing below the blasthole.

Damage and injury from vibration, airblast and flying debris is still a concern. However, ODOT and its blasting contractors use a variety of safeguards, technology and knowledge to make this inherently dangerous task safe for themselves and surrounding property.

BLASTING FACTSHEET

FACTSHEET

Updated: 11-16-2015

In order to construct new roads, bridges and associated drainage, a large amount of earth and rock typically must be excavated. Blasting operations are used to remove rock/ledge that cannot be removed by other means, breaking the rock/ledge into smaller pieces that can then be handled by construction equipment and hauled away. 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.

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), and air blast is measured in decibels (dB). Vibration effects on structures can be caused by both ground vibration energy and air blasts. In order to prevent damage to buildings and property, 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.

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.

New Hampshire DOT
Department of Transportation

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.

New Hampshire DOT
Department of Transportation

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.

Vibration	Effect, source, or human response
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
0.75 in/s	**Lower threshold of government standard safe vibration limits for blasting**
0.15 - 1.9 in/s	Slamming a door
2.0 in/s	**Upper threshold of government standard safe vibration limits for blasting**
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
4.0 in/s	**Minor superficial cracking at drywall joints**
1.1 - 6.7 in/s	50 mph wind
8.0 in/s	**Damage to a structure**
10.0 in/s	**Damage to concrete slab or driveway**

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.

Sound Level	Pressure (psi)	Equivalent Wind Speed Low	Equivalent Wind Speed High	Specification or Structural Effects Based on Sound Levels
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	**NHDOT Sound Level Limitation**
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 17th Edition, R. Hopler, 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.

New Hampshire DOT Department of Transportation

City of Redmond
Proposed Blasting Standards

Comments presented by

Robert A. Cummings, P.E.

- Blasting Consultant
- Member, International Society of Explosives Engineers
- Senior Project Manager, Call & Nicholas, Inc.

Proposed Blasting Regulations

Blasting regulations should

- ensure public safety and convenience
- guard against property damage from blasting operations.

The proposed measures go too far:

- Discourage efficient and safe energetic rock fragmentation
- Decrease opportunities to benefit the public and private sectors:
  - Unnecessarily increasing costs
  - Extending project construction time
  - Expanding nuisance to the adjoining property owners and residents.

Regulations should

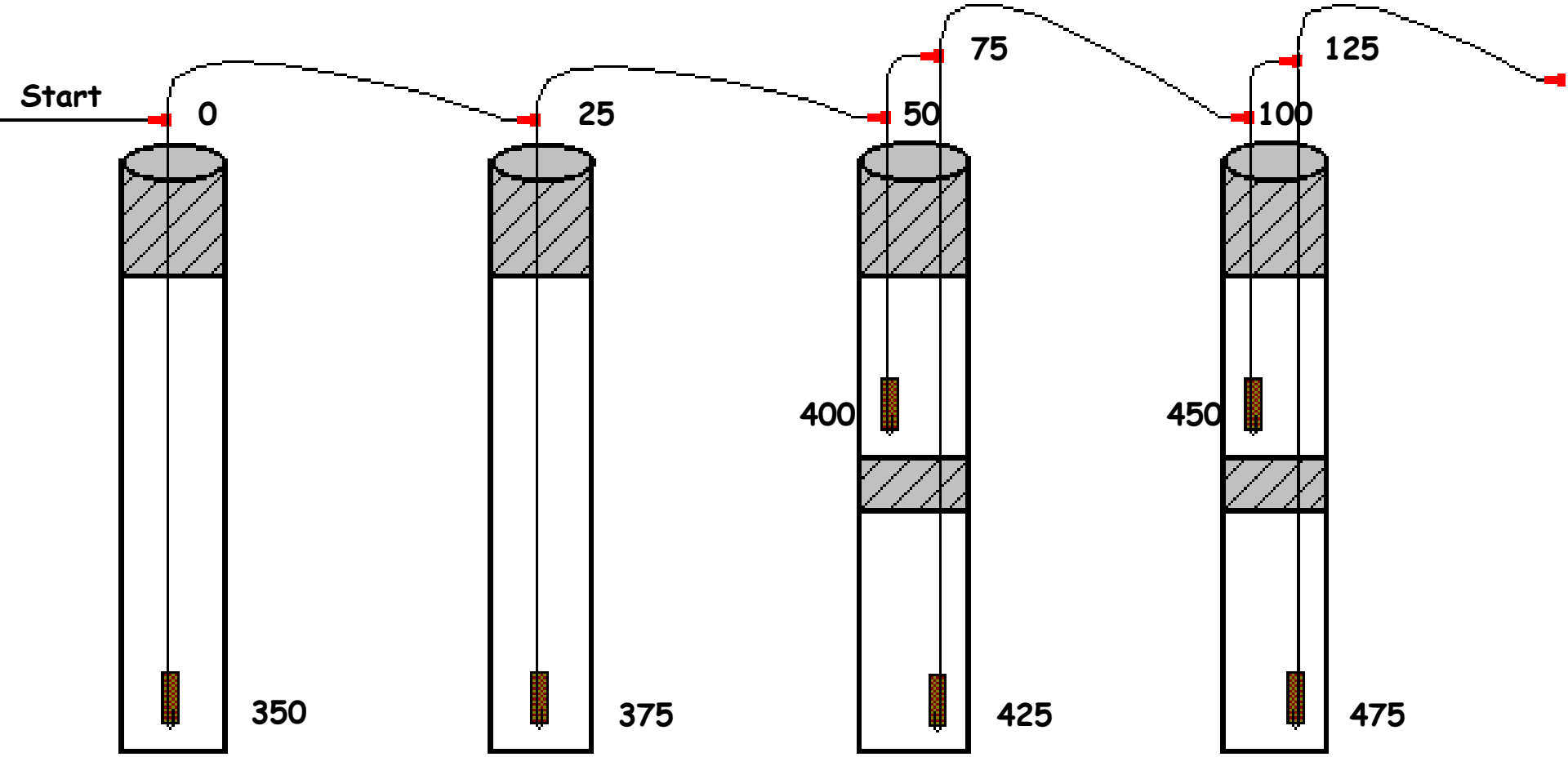
- ***Incorporate current scientific and engineering research and principles***
- ***Reflect input from sources knowledgeable and experienced in blasting dynamics.***
- ***Link the regulatory constraints to blast designs that conform to industry standards***

Modern Scientific Blast Design

- Blasts are designed to fragment and move the rock while limiting vibration and air overpressure.
- A specific amount of energy is needed to break a given amount of rock.
- The energy and its distribution are precisely controlled.
- Holes are detonated on separate intervals using millisecond timing (1/1000th second). Individual timing increases fragmentation and movement and lessens vibration and air overpressure.

Hole-to-Hole Connection

EZ Det® Hookup



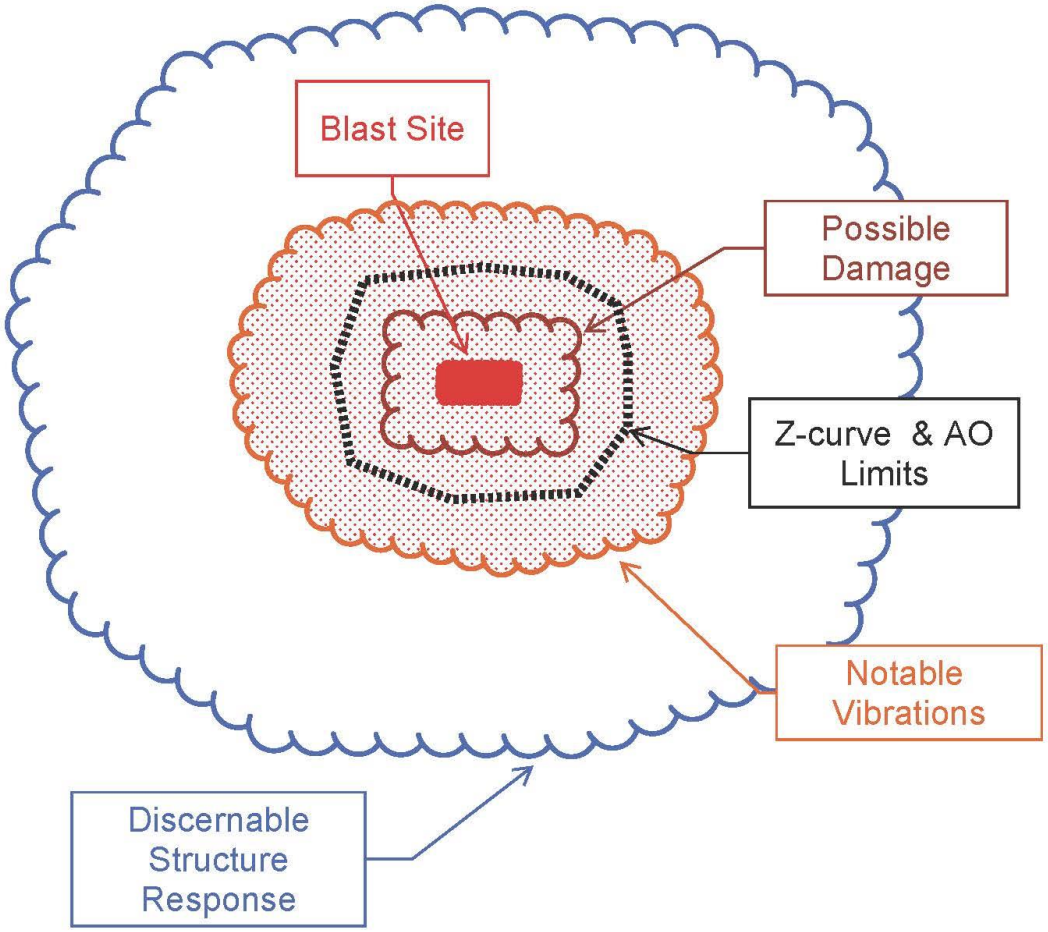
Solid Column Holes

Deck Loaded Holes

Why We Use Delays

- Individual detonation of holes provides greater blast control.
- Controls the direction of rock movement.
- Improves fragmentation and displacement.
- Provides vibration control.
  - By reducing the weight (pounds) of explosives detonating at the same time.

Area of Blasting Influence:
The affected area radiates from the blast site. Closest to the blast site is the zone of possible damage. Outside this is a safety limit defined by PPV below the Z-curve limit and below the recommended air overpressure (AO) limit. Beyond this is an area where vibrations are still notable but which attenuate with distance toward the edge of discernable structure response.



THESE RADII ARE CONTROLLED THROUGH THE SCALED DISTANCE

NOTE:
Special Provisions using the Z-curve and ecommended AO limits will provide protection to sensitive structures. Structures outside the Z-curve & AO limits and inside the notable vibrations regions, may experience phenomena such as windows rattling, dishes clinking, doors and hanging objects moving, however, these responses are not damaging to the structure.

Vibration Formulae for Blast Control

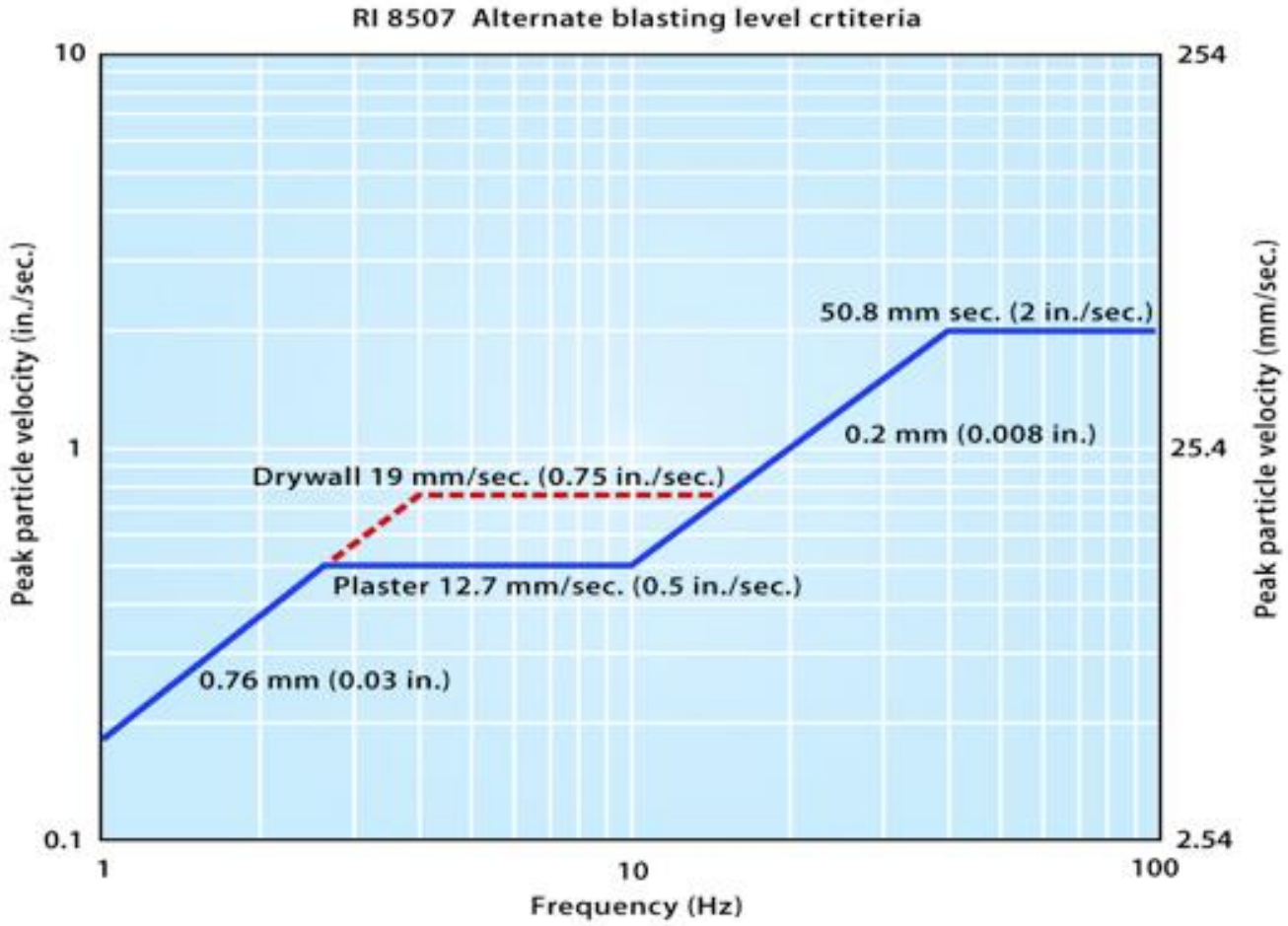
(Common values. Similar approach is used for air overpressure)

$$\text{S.D.} = \frac{Distance}{\sqrt{lbs./delay}}$$

Formula is based on the statistical correlation between several shots and monitored locations.

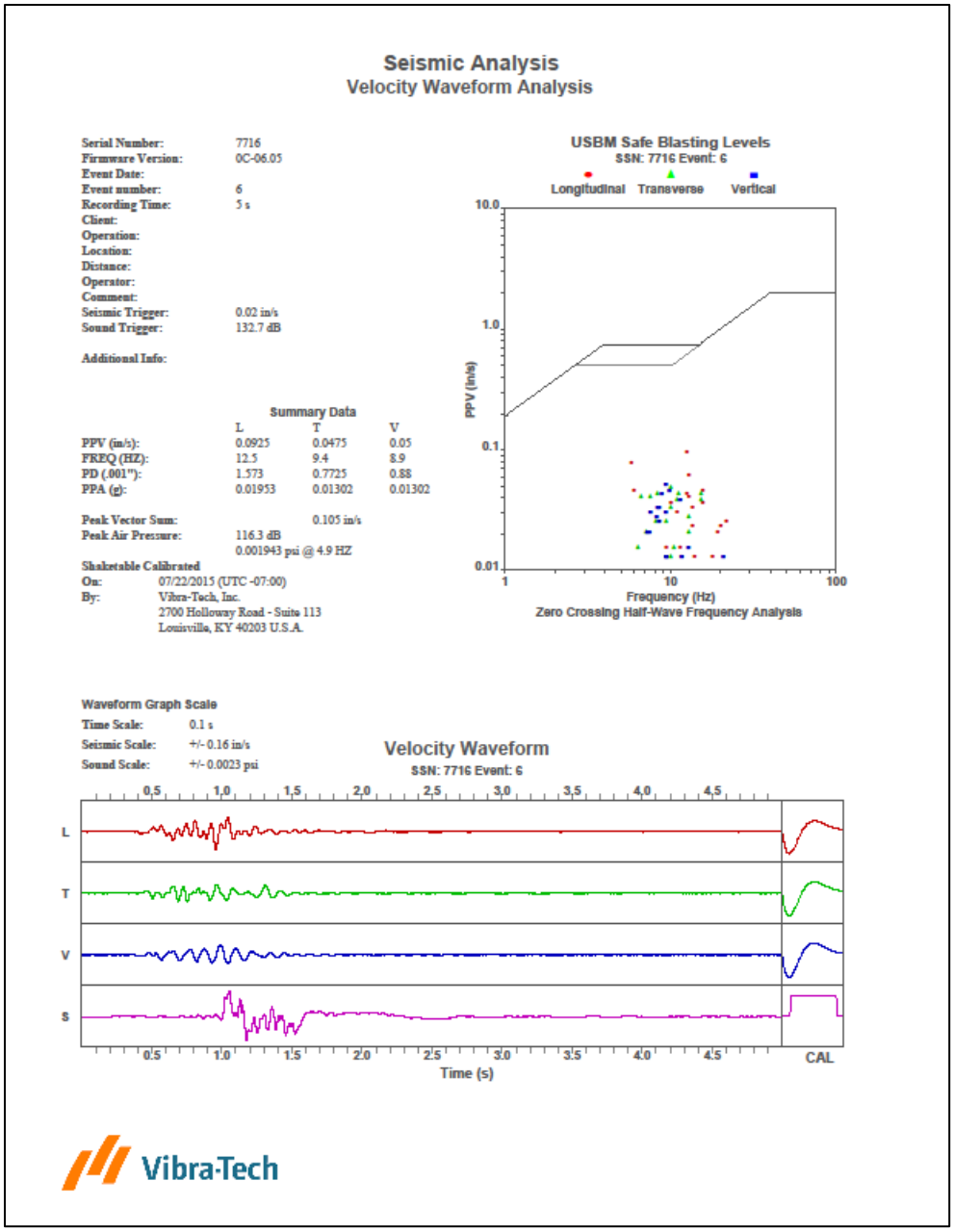
$$\text{PPV} = \left(\frac{Distance}{\sqrt{lbs./delay}} \right)^{-1.6} \text{x } 160$$

"Z-Curve" Blasting Level Criteria Based on Peak Particle Velocity



Example Seismograph Report:

- Ground vibrations readings
- Air overpressure readings



Seismic Analysis
Velocity Waveform Analysis

Serial Number: 7716
Firmware Version: 0C-06.05
Event Date:
Event number: 6
Recording Time: 5 s
Client:
Operation:
Location:
Distance:
Operator:
Comment:
Seismic Trigger: 0.02 in/s
Sound Trigger: 132.7 dB

Additional Info:

Summary Data

	L	T	V
PPV (in/s):	0.0925	0.0475	0.05
FREQ (HZ):	12.5	9.4	8.9
PD (.001"):	1.573	0.7725	0.88
PPA (g):	0.01953	0.01302	0.01302

Peak Vector Sum: 0.105 in/s
Peak Air Pressure: 116.3 dB
0.001943 psi @ 4.9 HZ

Shaketable Calibrated
On: 07/22/2015 (UTC -07:00)
By: Vibra-Tech, Inc.
2700 Holloway Road - Suite 113
Louisville, KY 40203 U.S.A.

USBM Safe Blasting Levels
SSN: 7716 Event: 6
Longitudinal Transverse Vertical
PPV (in/s)
10.0
1.0
0.1
0.01
1
10
100
Frequency (Hz)
Zero Crossing Half-Wave Frequency Analysis

Waveform Graph Scale
Time Scale: 0.1 s
Seismic Scale: +/- 0.16 in/s
Sound Scale: +/- 0.0023 psi

Velocity Waveform
SSN: 7716 Event: 6
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5
L
T
V
S
CAL
Time (s)

Vibra-Tech

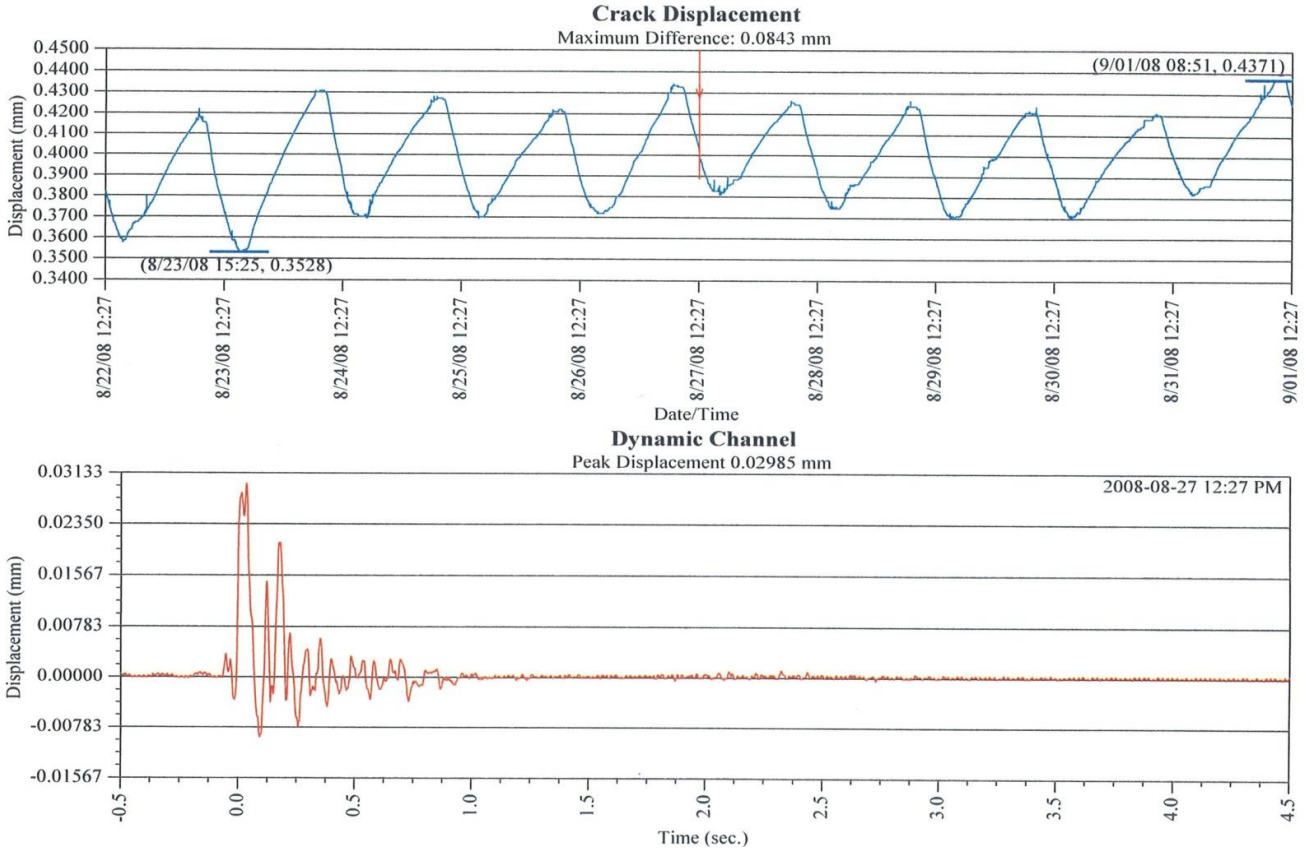
Human Response is not a Measure of Structure Damage

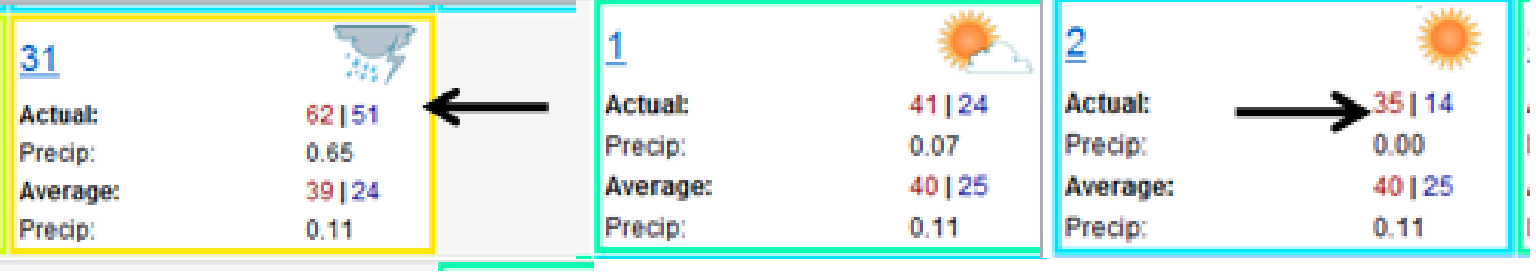
- Structures are far less vulnerable to blasting disturbance than what people may intuit them to be.
- The occurrence of blasting damage cannot be estimated by the perceptions of occupants. Occupants often feel vibrations and note windows and dishes rattling, picture frames shifting, doors and hanging objects swinging, and infer damage.
- Decades of scientific research has evolved precautions that will protect structures. Well-designed blasts produce vibrations below the threshold of damage even to the weakest elements of the home.
- ***It is critical to understand structure response according to scientific and engineering principles.***

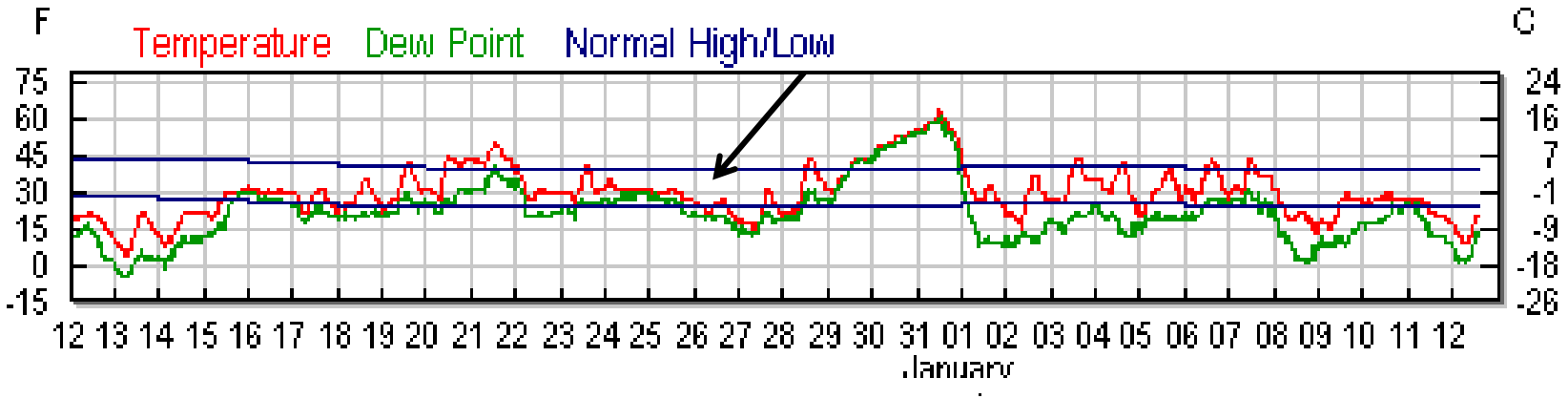
Structure Response

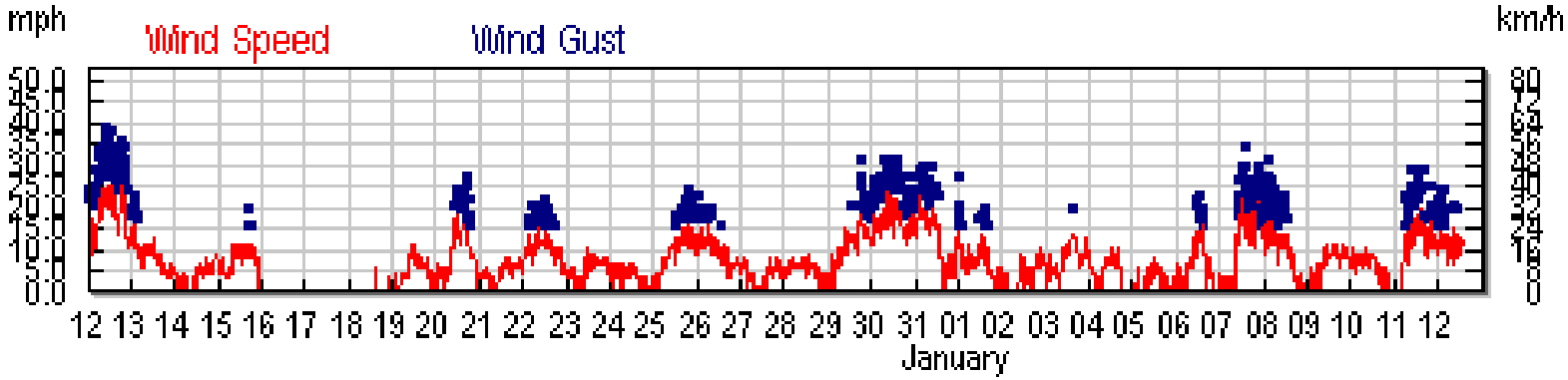
- Structures will respond to blasting.
- Even with this independent movement, damage is rare
  - Structures are inherently flexible
  - Ground motion is actually small
    - Typically less than the thickness of piece of copy paper.
- Environmental effects place a much larger strain on structure
  - Forces applied 24/7
  - Strain relief (cracking) is gradual
  - Strain can be measured

Crack Response: Blast-Induced vs. Weather-Induced





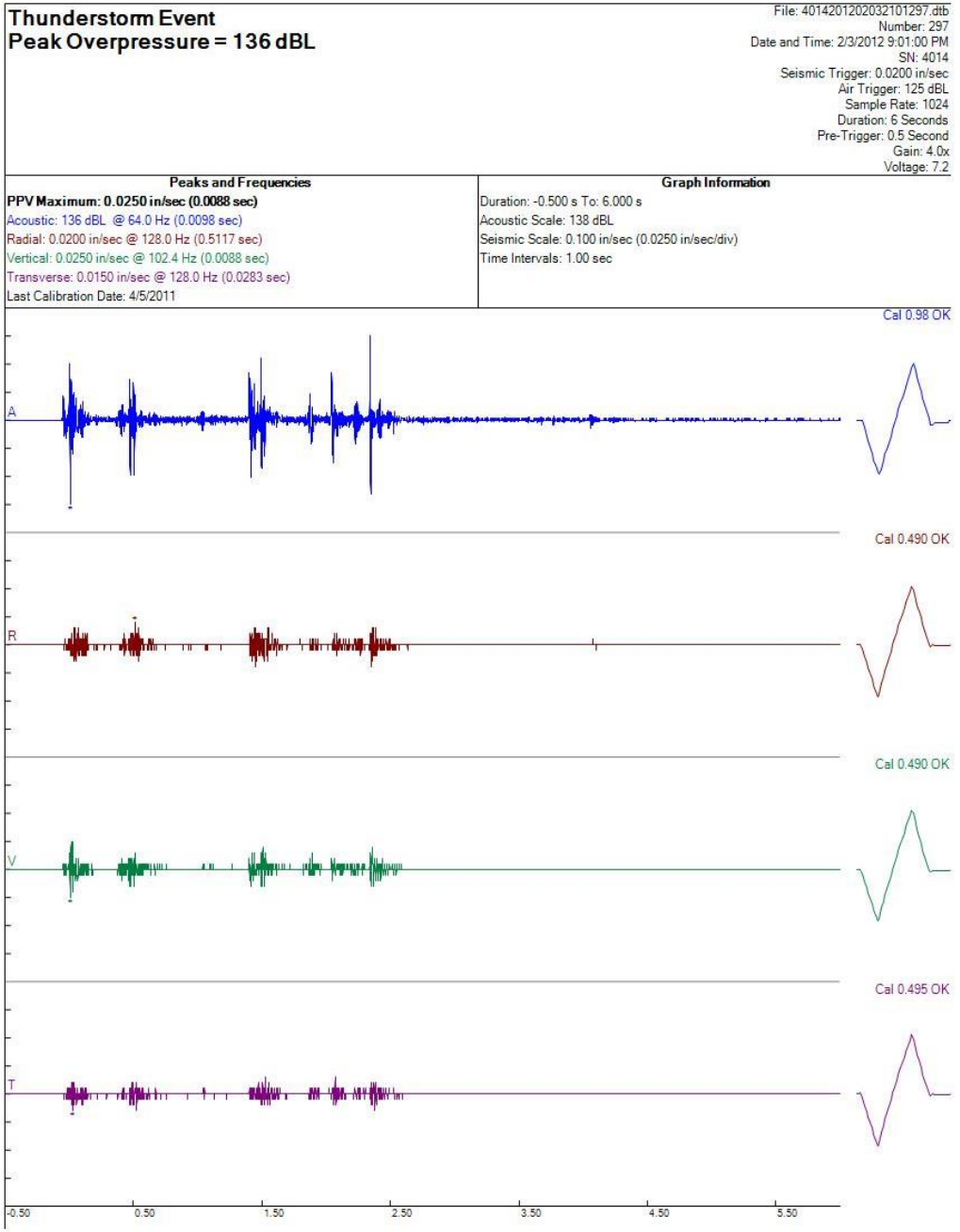




- 20 mph wind is equivalent to ~128 dB
- 40 mph wind is equivalent to ~140 dB

U.S. Weather Bureau data show all regions of the U.S. have the potential to experience winds up to 60 mph

Seismograph recording of a thunderstorm



Blasts Don’t Have to Be Spectacular

(and can be controlled so as not to)

Example 1: Responsible Trench Blasting Protecting Public Road

Example 2: Protecting 230 kV Power Lines

Example 3: Protecting Homes

Example 4: Large Blasts

Example 5: Earthen Cover

Example 6: Close to House

Example 7: Deep Trench Blasting

Recommended Standards for Blasting

- Regulations should consider the blast design
- Scope of Pre-Blast Surveys and Notifications based on blast design (Scaled Distance), not arbitrary and overly-conservative, uniform radii
- Use of Test Blasts to demonstrate regulations are met
- Use of email and websites rather than door hangers and mailings after the initial notifications
- Third-party professional for pre-blast surveys which retains custody of records
- Should not introduce conflicts with other, cited regulations
- Assure that blasting supervisors, pre-blast surveyors, blasting monitors, and blasting plan reviewers are qualified.

Blast Monitoring

Seismograph deployment requirements should be based on:

- the Blast Plan
- the area affected by the blast
- the location and direction of susceptible structures

It is suitable to require seismographs at various (at least two) distances and in different directions (at least two, when appropriate) in accordance with the approved Blasting Plan. An attenuation relationship can be developed that permits calculation of blasting effects at any desired location.

Requirements According to the Blast Plan

- Requirements for protecting property should be based on susceptible structure relationships to the blast area and the blast plan (max pounds per delay or Scaled Distance)
- Limit PPV & AO at susceptible structures to the recommended levels defined by the Z-curve for ground vibrations and 134 dB for air overpressure (OSMRE & UMBM limits).
- Requirements for notifications, seismograph monitoring and pre-blast inspections should based on the affected blast area

Close-In Blasting (within 100 feet)

- Blasting can be safely conducted very close to susceptible structures when special care is undertaken.
- Additional measures are needed to protect property within 100 feet of blasting.
  - Reduced charge weights
  - Covering with mats or earth
  - Reduced blast patterns (burdens), hole sizes and depths
  - Deck Loading
  - Specialty explosives

Public Education

Address public concerns about blasting through education.

You want the public to know:

- Blasts are designed to meet ppv & AO limits to prevent property damage
- Expect phenomena if you are near a blast zone
  - Phenomena can include window rattling, dishes clinking, doors swinging, picture frames shifting, and the like
  - Even though these phenomena can disturb occupants, these vibrations are below levels causative of damage when they meet the limit criteria
- Blasts are monitored to demonstrate compliance
- Pre-inspection surveys will be offered to those within a suitable distance to document pre-blast conditions.
- There is a process to promptly and objectively respond to damage allegations

THANK YOU

541-385-6762 pahlischhomes.com 210 SW Wilson Ave
Suite 100
Bend, Oregon 97702

pahlisch HOMES

June 21, 2022

Via E-mail

Mayor George Endicott
Redmond City Council
Redmond City Hall
411 SW 9th
Redmond, Oregon 97756

Re: ***Proposed Blasting Regulations; Testimony by Pahlisch Homes, Inc("Pahlisch Homes")for Second City Council Work Session on June 21, 2022***

Dear Mayor Endicott and Redmond City Council (the "City Council") Members;

I am the Director of Government and Legal Affairs for Pahlisch Homes. I am writing to comment on the proposed blasting regulations to be considered in the second City Council Work Session on June 21, 2022. I submitted a letter to the City Council dated May 24, 2022 and testified to the City Council at the first Work Session on June 7, 2022. Thank you for using both the Work Session and the panel discussion formats to gather information from residents, blasting experts, builders, and contractors. Pahlisch agrees with the City Council that the proposed regulations should keep the City safe but also requests that the proposed regulations should allow blasting to continue and that the proposed regulations should not make blasting cost-prohibitive.

Pahlisch has four comments for the City Council to consider. These comments are based on the three standards announced in the June 7, 2022 Staff Report to the City Council that the proposed blasting regulations should be reasonable, practical, and tolerable.

First, Pahlisch agrees with the oral and written testimony submitted by the blasting experts, including Mr. Robert Cummings, a recognized blasting expert with forty years of experience, builders and contractors as to the impacts of the proposed blasting regulations. The focus of their testimony is not on a specific blasting event, as Mr. Cummings said, nor is it to discredit the resident's comments but is instead focused on the impact of the proposed regulations and the ability to reasonably and cost-effectively conduct blasting which is a necessary part of construction in Redmond.

Second, Pahlisch agrees that it is prudent for the City to periodically review blasting standards and make reasonable changes but these changes should be tailored to specific needs. In this case, the proposed ¼ mile inspection and notice standards, requirements for seismographs for all properties within 300' of the blast, geologic analysis and prohibition on blasting within 100' of residences are not reasonable, practical or tolerable based on the testimony to the City Council. The result of these changes may be that blasting will either be prohibitively expensive or, if conducted, the additional costs will be added to the cost of housing.

Third, Mr. Cummings told the City Council that the proposed blasting regulations should require pre-blast surveys based on the type of blasting, just as the Oregon Department of Transportation("ODOT")Standard Specifications provide for(City Council June7, 2022 Packet Pages 277 and 278; ODOT Standards 00335.40(c), "Preblast Survey" and 00335.40(e), "Blasting Notification"). The proposed blasting regulations require pre-and post-blast inspections and notices for a ¼ mile radius regardless of the amount of explosives used. The ODOT Standards are tailored to the proposed blasting plan, whereas the proposed blasting regulations adopt a standard unrelated to specific blasting plans. Additionally, the two sets of standards conflict with one another. In this case, the ODOT Standards are more reasonable, practical, and tolerable.

Fourth, not all of the proposed blasting regulations are reasonable, practical or tolerable based on testimony submitted by the builders and contractors because of their cost and the ability to implement them. These include the ¼ mile notice radius, pre-and post-blast inspections for all properties within ¼ mile of the blast if requested by a resident, the requirement that seismographs be located at all properties within 300' of the blast, and the pre- and post-blast inspection requirements. As to the inspection requirements, Pahlisch agrees that the requirements for inspections should be meaningful but the proposed blasting regulations require photos ***and*** videos whereas only one means of documenting the inspection might be reasonable. The notice requirements should be tied to the permitting schedule and the two-door hangers requirements, mailed notice to each address within the ¼ mile radius and posted notice on each property line twenty-one days before the blast may be excessive. Additionally, the ODOT Standards and the proposed regulations conflict with one another. The City Council should resolve potential conflicts ambiguities now so that the proposed blasting regulations are as clear and objective as possible. City Council approval of blasting and blasting monitoring by City staff should not be included in the adopted blasting regulations.

Finally, the ODOT Standards can keep the City safe and allow blasting to occur without unreasonable cost and conflicting regulations. The ODOT Standards include provisions that limit and control flyrock, require a pre-blast survey based on the amount of explosives used, a blasting plan, a post-blast report and contain other reasonable provisions that assure reasonable, practical, tolerable, and safe blasting. The proposed blasting regulations can be revised to address issues not contained in the ODOT Standards.

Thank you for considering Pahlisch's testimony. Pahlisch does not profess to have all of the answers and that is why we think the City's methodical approach to finding the right approach is laudable. If the City Council directs that the proposed regulations be revised, Pahlisch requests that the blasting experts, builders, contractors and residents be allowed to work collaboratively with City staff to create final blasting regulations that are reasonable, practical and tolerable so that necessary blasting can continue while keeping the City safe.

Thank you.

Very truly yours,

Michael C Robinson
Director of Government and Legal Affairs for Pahlisch Homes, Inc.

CC: Mr. Keith Witcosky (via email)
Mr. John Roberts (via email)
Mr. Mike Caccavano (via email)
Ms. Jessica MacClanahan (via email)
Mr. Jerry Jones (via email)
Mr. Chad Bettesworth (via email)
Mr. Jacob Clark (via email)
Ms. Deb Flagan (via email)
Ms. Karna Gustafson (via email)
Ms. Morgan Greenwood (via email)
Mr. Bob Cummings (via email)