CITIZEN'S GUIDE TO COAL MINE BLASTING IN INDIANA

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ROLE OF THE DIVISION OF RECLAMATION BLASTING SECTION

The Indiana Department of Natural Resources (DNR), Division of Reclamation (DOR) is responsible for regulating the mining of coal and the restoration of lands disturbed by coal extraction. The Blasting Section is comprised of two specialists who monitor all aspects related to coal mine blasting including permit reviews, inspections, monitoring and special studies including Blasters' Certification Program. The DOR also employs a structural engineer to investigate complaints of blasting damage. The DOR has more monitoring equipment and personnel devoted to blasting, per number of operations, than any other coal regulatory agency in the Nation.

Why do mines have to blast?

After the topsoil and subsoil layers are removed, blasting may be necessary to loosen the rock above the coal seam. Mine operators drill holes in which to load explosives to fracture the rock layers. The blasting agent commonly used in coal mines is called ANFO, which is a mixture of Ammonium Nitrate (a common fertilizer) and FUEL OIL. Dynamite is not typically used in surface coal mining to fracture the rock. After blasting, a dragline, trucks, shovels, or other heavy equipment remove the rocky overburden to expose the coal seam. The mine operator must develop a detailed blasting plan demonstrating how the blasting operation will be conducted to comply with Indiana's regulations to prevent damage. A certified blaster must either conduct or directly supervise the loading and detonation of all surface coal mine blasts.

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REGULATIONS

✓ ***Ground Vibration***

The ground vibration limits found in Indiana regulations were derived from considerable research conducted by the United States Bureau of Mines and the Office of

Surface Mining, both of which are federal agencies. Much of this research was conducted in Indiana. These limits are based on the distance a structure is located from a blast. They are:

DISTANCE TO STRUCTURE	PEAK PARTICLE VELOCITY	SCALED DISTANCE FACTOR
0 TO 300'	1.25 in/sec	50
301 to 5,000'	1.00 in/sec	55
5,001' and beyond	0.75 in/sec	65

The vibration limits, measured as peak particle velocity (ppv), are designed to prevent even the slightest damage, called cosmetic damage, from occurring to dwellings, public buildings, schools, churches or community or institutional buildings. Peak particle velocity is how fast a particle of soil may move and not how far the structure or ground will move. ***This does not mean citizens living near a mine will not feel vibration from a blast.*** The laws are not designed to address annoyance caused by a mine.

The regulations allow an operator to use several methods to demonstrate compliance with the ground vibration limits. One way is by using a seismograph to monitor every blast. Or, an operator may choose to use the Scaled Distance Equation to prove compliance with the ground vibration limits. This method is a mathematical equation which allows an operator to prove compliance with the vibration limits without using a seismograph. The equation determines how many pounds of explosives may be detonated in any 8 millisecond (ms), or 8 one thousandths of a second, time period. This is often referred to as the "maximum pounds per delay". While 8 milliseconds does not sound like very much time, it actually separates the total charges of the blast into many smaller blasts and allows the blaster to control the shot and its vibrations. The key factor in the equation is the distance between the blast and the nearest dwelling or other protected structure. As the distance to the nearest structure decreases the number of pounds of explosives also decreases. The Director have require an operator to conduct seismic monitoring of any or all blasts.

DOR technicians install seismographs near homes to monitor ground vibrations.

The intensity of ground vibrations depends on several factors. The most important are how close the person or house is to a blast and how many pounds of explosives are detonated per delay period. The magnitude of ground vibrations generally decreases as the distance from the blast increases. For example, dropping a stone into a lake or water puddle produces waves that travel away from the point of impact and eventually disappear. Similarly, the farther a person or house is from a blast generally the less the ground vibration amplitudes or waves will be.

✓ ***Airblast***

When a blast is detonated some of the energy may be released into the atmosphere as air pressure. This air pressure, or airblast, must be monitored with a seismograph and there are limits that may not be exceeded without enforcement action being taken by the DOR. Unlike ground vibration limits, where compliance must be demonstrated for every blast, airblast monitoring occurs at least once every calendar quarter. A minimum of seven consecutive blasts or all blasts occurring in a period of one week, whichever provides the most readings, must be monitored. While airblast may be the most annoying aspect of blasting, it is the least damaging. The first sign of damage resulting from airblast will be glass breakage. Research has shown that damage from airblast does not occur until approximately 140 dB. The maximum airblast limits are 129 dB or 133 dB depending upon the type of microphone in use with the seismograph.

The Director has the authority to impose lower limits for ground vibration and airblast if determined necessary to provide damage protection.

✓ ***Blast Schedule***

An operator must publish a blasting schedule in a newspaper of general circulation in the vicinity of the blasting site at least once a year ***(See Figure 1, Page 4)***. The blasting schedule must be distributed to each residence, utility, etc. within one-half (1/2) mile of blast area. This schedule includes information regarding the specific blasting areas, days and time periods when blasting may occur, how the blasting area will be controlled and the types and patterns of blast warning and all clear signals. Unless otherwise specified by the Director or approved in a permit, a mine may only detonate blasts between the hours of sunrise and sunset.

✓ ***Preblast Survey***

At least 30 days before the initiation of blasting at a new mine, the operator must notify, in writing, all residents or owners of dwellings or other structures within one-half (1/2) mile of the permit area how to request a preblast survey. ***The operator must also notify the public, by publication in a newspaper, that they will conduct a preblast survey upon the request by a resident or owner of a man made dwelling or structure located within one (1) mile of the permit area.*** The mining company is responsible for ensuring the survey is completed and that all copies have been distributed. The operator may conduct the survey or hire an independent contractor to do the survey. The preblast survey is intended to provide documentations of the existing physical condition of the structure. The rules allow that the structure owner be provided a copy of the survey and an opportunity to disagree with results of the survey. If a person disagrees with results of a survey, the person may notify, in writing, both the mine operator and the DOR of the specific areas of disagreement.

FIGURE 1

PUBLIC NOTICE

In accordance with Section(s) 310 I.A.C. 12-5-35 of the Indiana Administrative Code, XYZ Coal Company, hereby announces its intention to detonate explosives during its mining operations at the Company Mine, Permit Number S-00000 located in This Proper Township, Sullivan County, in the State of Indiana.

Blasting will occur in the following location(s); Sections 14, 15, 16, 21, 22 and 23, T7N, R0W, 2nd P.M. at the Company Mine, in an area more particularly described following: Sectoin 14 – S/2 S/2, Section 15 – S/2 S/2: NW/4 SW/4, Section 16 – E/2 SE/4, Section 22 – Part of the NW/4 NW/4; NE/4 NW/4; N/2 NE/2, Section 23 – N/4 N/4; SE/4 NE/4, containing in all 838 acres, more or less.

Any blasting done at the above location will occur Monday through Sunday during daylight hours between the time of sunrise and sunset, except where emergency situations or other unavoidable hazardous situations require unscheduled detonation. All standard warning and safety procedures will be followed during any such unscheduled detonation.

Access to the blasting area will be controlled by mine guarding the access roads to the area prior to the start of blasting. Control of access to the blasting area will be in effect until an inspection of the area can be made and access to and travel in the area can safely resume.

One (1) minute prior to detonation of a charge, an audible warning signal will be sounded consisting of three (3) short sounds on a horn or siren. When detonation of explosives has concluded, an all clear signal consisting of one (1) long sound on a horn or siren will be sounded. This notice will be published one time. Any questions regarding the information in this notice should be directed to the following addresses or telephone numbers: Community Relations Representative, XYZ Coal Company, 123 Main Street, Anytown, Indiana 46123 (Toll Free Telephone 1-800-772-6463). Any residents or owners of dwellings or structures located within one (1) mile of the permit area may request a preblasting survey by contacting the Blasting Section Personnel of the Indiana Division of Reclamation at the aforementioned addresses or the telephone numbers.

The DOR recommends that anyone eligible to receive a preblast survey, request this service. A citizen should make the preblast survey request in writing, either to the mining company or the DOR, and include the name, address, telephone number of the person requesting the survey and the name of the company, mine and the permit number, if available.

✓ *Blast Sites*

There are limits on where blasting may occur. It may not be conducted within 300' of a occupied dwelling unless permission is granted by the owner of the structure allowing closer blasting. Blasting may not be conducted within 300' of a school, church or hospital, public building, community or institutional building.

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✓ *Blast Records*

Records of all blasts, including required seismograph recordings and reports, must be maintained for a minimum of three years from the date of the blast. These records are available for public inspection at the mine site. If a citizen wishes to review the blast records, the DOR recommends the person make an appointment with the operator. This ensures an individual from the mine will be available to provide access to the records. The DOR may be contacted to assist the public in obtaining names and phone numbers of the mine operators. A representative of the DOR may be available to accompany the citizen during the review of the records.

✓ *Flyrock*

Flyrock is not to be cast from the blasting site more than one-half (1/2) the distance to the nearest dwelling or other occupied structure, beyond the boundary of the bonded area or beyond the area of regulated access. Public input concerning flyrock is very important. The DOR does not recommend an individual venture onto a mine site. ***However, should anyone witness material thrown as described above or find rock from a mine off of the permit area, notify the DOR Blasting Personnel as soon as possible.***

✓ *Structural Investigations*

Indiana is the only state coal regulatory program in the nation that employs a structural engineer to investigate damage caused by blasting. If a citizen believes that blasting damage has occurred to his/her residence, they may request an investigation by the Division's Structural Engineer. The Structural Engineer will determine whether the

damage is blasting related or caused by factors unrelated to blasting. ***Monetary claims of damage, however, are a private matter to be settled between the mine operator and the citizen.***

✓ *Seismographs*

The DOR independently operates and maintains twenty-three (23) seismographs to monitor effects of blasting at citizens' homes. These instruments are virtually in constant use in the field. Upon request from a citizen, a seismograph, if available, can be installed on the property to monitor blast vibrations.

✓ *Complaints*

If you have a complaint regarding blasting activities at a mine, write a letter stating these concerns to the Division. **The letter should include the name of the mine, dates and times of the blasts in question (if possible) and your name, address, and telephone number.** A blasting specialist from the Division will then conduct an inspection of the blasting activities and respond to you in writing. The response will document the onsite investigation and whether any violations of the Act or regulations were found. The individual filing a written complaint will be notified that they may accompany our inspector during the investigation.

The complaint letter will be included in the public file unless a person specifically asks that the complaint remain confidential. If a person wishes to participate in the inspection the complaint cannot be kept confidential.

QUESTIONS and ANSWERS

Why does my house shake?

Blasting is often used to fragment rock above the coal seam for removal by mine equipment. When the explosives are detonated the rock is fractured by the release of large amounts of energy. Unfortunately, not all of the energy is used and some will be transmitted to the surrounding environment.

Blasting can account for approximately 25% of the operating cost of the coal mine. Any ground vibration that is transmitted to surrounding areas, homes, etc. is essentially wasted energy and, in the eyes of a mine operator, wasted money. As such, blasters at a mine do not overuse explosives to merely irritate the neighbors.

Unless a person inside a house is expecting a blast to occur, it is usually startling when the vibration reaches the structure. How a person perceives a blast will vary.

As the ground vibration impacts a house, the structure will begin to respond or shake. Unless a person inside a house is expecting a blast to occur, it is usually startling

when the vibration reaches the structure. How a person perceives a blast will vary. It can depend on where the individual is in the structure when the blast is detonated, what the person is doing and how sensitive that person is to vibrations. As a general rule of thumb, a person will begin to feel blast vibrations at levels as low as 0.02 in/sec. This level is well below the level at which research has shown that damage may occur, and consequently, well below the level at which an operation would be considered out of compliance with ground vibration limitations.

What is cast blasting?

Cast blasting is a type of blast design which utilizes the explosive energy to move overburden material across the pit. This technique allows approximately 25% to 50% of the rock to be moved without the use of mine equipment. This is a major cost savings to the mine. Although cast blasting requires more pounds of explosive for each cubic yard of rock to be moved it does not necessarily mean that ground vibration intensity will increase. More of the explosive energy is used in moving the rock across the pit. Blast design is very important to the performance of the cast blast. A properly designed cast blast often generates less vibration than a conventional blast design. This is because the explosive energy is moving the rock across the pit and less energy is available to be transmitted to the surrounding environment. A poor cast blast design can lead to the rock not moving across the pit as it should and, consequently, higher ground vibrations.

What is a seismograph?

A seismograph is a very sensitive instrument designed to measure the intensity of ground vibrations and airblast. The seismograph records ground vibrations in three directions, or channels, and the airblast on a microphone, which is a fourth channel. If a ground vibration or airblast exceeds the maximum limits on any of these channels a Notice of Violation will be issued.

A seismograph cannot be “fixed” to read only what the mine operator wants it to read. When a seismograph is installed, either by the DOR or a mine operator, a trigger, or threshold level is programmed into the instrument. The trigger level is the point at which a vibration event will cause the seismograph to record the event. If a blast vibration does not exceed this threshold level the instrument will not activate to record the blast. A trigger level is necessary because the instrument would continually record vibration events that may not be a blast and will eventually use all of the storage space the seismograph has to hold vibration data. If all of this storage space is used by non-blasting events valuable blast vibration data could be lost. The trigger level will normally be set just high enough to filter out some normal environmental vibrations, but well below the level at which a violation or damage would occur. A seismograph may be activated by anything that will produce a vibration higher than the preset trigger level. Examples of items that may cause a vibration high enough to trigger a seismograph are lawn mowers, weed trimmers, kids playing near the seismograph, etc.

A seismograph cannot be "fixed" to read only what the mine operator wants it to read.

The seismographs used by coal mines are manufactured to specifically measure the vibrations from a mine blast. The resulting measurements are on a different scale from those used for monitoring earthquake vibrations. As such, the particle velocity measured by coal mine seismographs ***cannot*** be compared to earthquake measurements made on the Richter Scale.

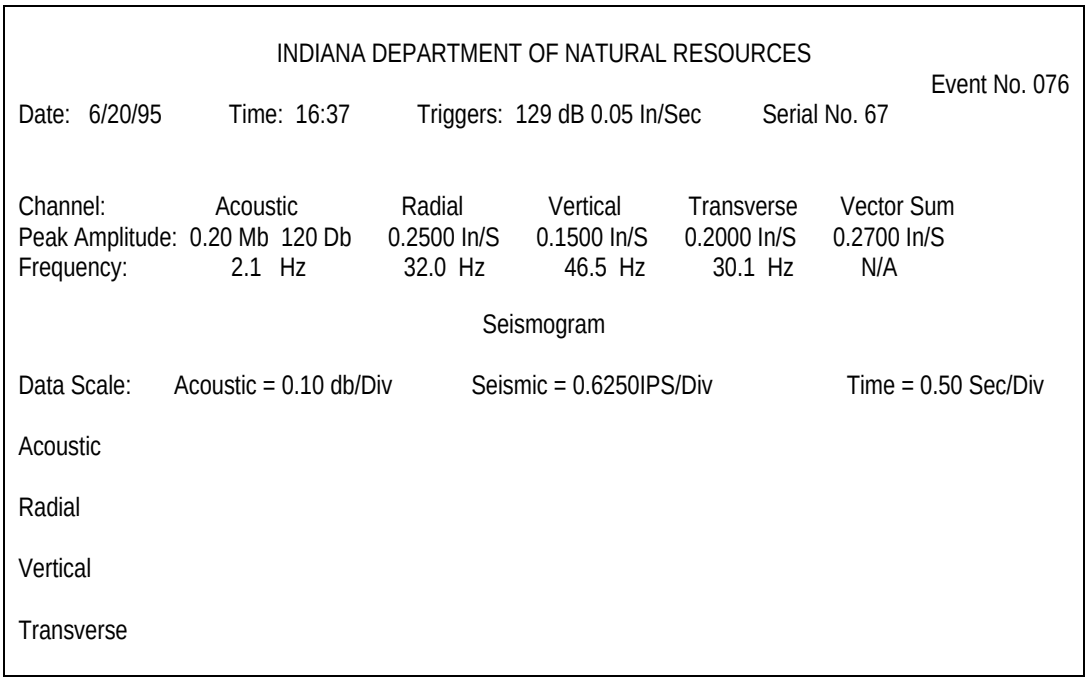
What do the seismograph readings mean?

Figure 2 is a vibration waveform from a blast recorded on a DOR seismograph. The waveform is divided into three sections. The top section will contain the name of the mine and the residence where the instrument is located. Also in this section is the date and time of the blast and the trigger, or threshold levels at which the seismograph will begin to record a vibration event.

The middle section contains the actual peak particle velocities of the vibration event, the corresponding frequencies that the vibrations contained and the four channels actually doing the recording. As discussed earlier, the peak particle velocity is the ***velocity*** at which a particle of earth may move and ***not*** the distance of movement.

The bottom section displays the vibration wave on each of the four channels. A coal mine blast will have a distinct wave which enables the blasting specialists to distinguish the difference between a blast or some other type of vibration event.

Figure 2



Won't the constant shaking eventually damage my house?

The U.S. Bureau of Mines built a house in advance of a large surface mine in southern Indiana to determine the effects of repeated blasting. The house was subjected to vibrations from 587 production blasts with peak particle velocities ranging from 0.10 to 6.94 in/sec. One blast with a peak particle velocity less than 1.0 in/sec produced an extension in a drywall tape joint crack located in a corner. However, the blasts prior to this had particle velocities ranging up to 3.0 in/sec. This should not happen in Indiana as blasting is closely regulated and, considering the large numbers of blasts occurring daily, the 1.0 in/sec limit is rarely exceeded. Upon completion of the mine blasting, the house was mechanically shaken in an attempt to produce fatigue cracking of the building materials. The first crack occurred after what was the equivalent of 28 years of blast-generated vibrations of 0.50 in /sec twice a day. ***No house in Indiana is ever expected to be subject to this amount of shaking.***

GLOSSARY

AIRBLAST: An airborne shock wave resulting from the detonation of explosives.

ANFO: An explosive material consisting of ammonium nitrate and fuel oil.

BLASTING: The operation of breaking or fracturing rocky overburden. The process involves boring a hole into a rock, inserting an explosive charge and detonating the charge. Once loosened, the material may be removed leaving the coal seam exposed for extraction.

CAST BLASTING: A type of blast design which utilizes the explosive energy to move overburden material across the pit.

CERTIFIED BLASTER: A person who has 12 months or more experience in blasting operations; has completed the approved training course in blasting technology and safety; has successfully passed the blaster certification examination; and holds a valid certificate issued by the Director.

CONVENTIONAL BLASTING: (See BLASTING).

DECIBEL (dB): The unit for measuring sound intensity. When sound or noise is created, it gives off energy which is measured in decibels.

IDNR: Indiana Department of Natural Resources.

DOR: Division of Reclamation; one of the divisions of the DNR. Regulates the mining and reclamation activities for the extraction of coal and restores land abandoned by coal mining conducted prior to 1972.

FLYROCK: Rock and material that is propelled through the air from a blast.

GROUND VIBRATION: A shaking of the ground caused by the elastic wave emanating from a blast.

INDIANA LAW: The Indiana coal regulatory program is fully established in Indiana Code 14-36 et seq, Indiana Code 14-34 et seq and 312 Indiana Administrative Code 25 et seq. Any reference to "the Act", "regulations"' or "policy" are based in one or all of the referenced citations and carry the force of law.

NOTICE OF VIOLATION: Document used to inform the coal operator of noncompliance of a certain regulation.

OVERBURDEN: All of the soil and rock that lie above the coal seam.

PEAK PARTICLE VELOCITY (PPV): A measure of ground vibration. Describes the velocity at which a particle of ground vibrates when excited by a seismic wave.

PREBLAST SURVEY: A documentation of the existing condition of a structure. The survey is used to help determine whether subsequent blasting has caused damage to the structure.

PRODUCTION BLASTING: (See BLASTING).

PROTECTED STRUCTURE: Any dwelling, public building, school, church, community or institutional building, gas line, water, power line, etc., that must have an approved ground vibration or airblast limit.

SCALED DISTANCE EQUATION: A ratio used to predict ground vibrations. Scaled distance equals the distance from the blast to the point of concern, in feet, divided by the square root of the charge weight of explosive per delay, in pounds.

SEISMOGRAPH: An instrument that measures and records the intensity of ground Vibration and airblast.

MISSION STATEMENT

We, the employees of the Division of Reclamation, are dedicated to professional public service through effective administration of Indiana's mine reclamation laws. We are committed to ensuring optimum management of natural resources and public protection both during and after mining.

This document is being provided as a public service and is intended to provide a general overview of the Division of Reclamation's regulatory program. Current Division policy is fully established in IC 14-36 et seq, IC 14-34 et seq and 312 IAC 25 et seq. Because it is impossible to fully delineate the requirements imposed by these provisions in a document of this limited scope, any inconsistencies with statue or regulation are due to a concern for brevity and clarity. Therefore, this document cannot and does not replace or modify any statutory or regulatory requirement nor serve as a formal or informal statement of Division policy.