

**ISEE  
Field Practice  
Guidelines  
For  
Blasting Seismographs  
2009 Edition**



**International Society of  
Explosives Engineers**

30325 Bainbridge Road  
Cleveland, OH 44139

# Field Practice Guidelines for Blasting Seismographs

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**Committee Scope:** This Committee shall have primary responsibility for documents on the manufacture, transportation, storage, and use of explosives and related materials. This Committee does not have responsibility for documents on consumer and display fireworks, model and high power rockets and motors, and pyrotechnic special effects.

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### **ISEE Field Practice Guidelines For Blasting Seismographs 2009 Edition**

This edition of *ISEE Field Practice Guidelines for Blasting Seismographs* was revised by the Standards Committee on February 4, 2008 and supersedes all previous editions. It was approved by the ISEE Board of Directors in its role of Secretariat of the Standards at its February 5, 2009 meeting.

#### **Origin and Development of ISEE Field Practice Guidelines for Blasting Seismographs**

In 1994, questions were raised about the accuracy, reproducibility and defensibility of data from blasting seismographs. To address this issue, the International Society of Explosives Engineers (ISEE) established a Seismograph Standards Subcommittee at its annual conference held in February 1995. The committee was comprised of seismograph manufacturers, researchers, regulatory personnel and seismograph users. In 1997, it became the Blast Vibrations and Seismograph section. The guidelines were drafted and approved by the ISEE in December of 1999. The Subcommittee completed two standards in the year 2000: 1) ISEE Field Practice Guidelines for Blasting Seismographs; and 2) Performance Specifications for Blasting Seismographs.

In 2002, the Society established the ISEE Standards Committee. The scope of the committee includes a review of the ISEE Field Practice Guidelines and the Performance Specifications for Blasting Seismographs. The Committee began its work on review of the Field Practice Guidelines in January of 2006 and completed their work in February of 2008 with this edition.

The goal of the Field Practice Guidelines for Blasting Seismographs is to develop uniform and technically appropriate standards for seismograph performance. The intent is to improve accuracy and consistency in ground vibration and air waves measurements. Seismograph performance is affected by how the seismograph is built and how it is placed in the field.

The ISEE Standards Committee takes on the role of keeping the standards up to date. These Standards can be obtained by contacting the International Society of Explosives Engineers located at 30325 Bainbridge Road, Cleveland, Ohio 44139 or by visiting our website at [www.isee.org](http://www.isee.org).

# Field Practice Guidelines for Blasting Seismographs

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**Disclaimer:** These field practice recommendations are intended to serve as general guidelines, and cannot describe all types of field conditions. It is incumbent on the operator to evaluate these conditions and to obtain good coupling between monitoring instrument and the surface to be monitored. In all cases, the operator should describe the field conditions and setup procedures in the permanent record of each blast.

**Preface:** Blasting seismographs are used to establish compliance with Federal, state and local regulations and evaluate explosive performance. Laws and regulations have been established to prevent damage to property and injury to people. The disposition of the rules is strongly dependant on the accuracy of ground vibration and air overpressure data. In terms of explosive performance the same holds true. One goal of the ISEE Standards Committee is to ensure consistent recording of ground vibrations and air overpressure between all blasting seismographs.

# Field Practice Guidelines for Blasting Seismographs

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## Part I. General Guidelines

Blasting seismographs are deployed in the field to record the levels of blast-induced ground vibration and air overpressure. Accuracy of the recordings is essential. These guidelines define the user's responsibilities when deploying blasting seismographs in the field and assume that the blasting seismographs conform to the ISEE "Performance Specifications for Blasting Seismographs".

1. Read the instruction manual and be familiar with the operation of the instrument. Every seismograph comes with an instruction manual. Users are responsible for reading the appropriate sections and understanding the proper operation of the instrument before monitoring a blast.
2. Seismograph calibration. Annual calibration of the seismograph is recommended.
3. Keep proper blasting seismograph records. A user's log should note: the user's name, date, time, place and other pertinent data.
4. Document the location of the seismograph. This includes the name of the structure and where the seismograph was placed on the property relative to the structure. Any person should be able to locate and identify the exact monitoring location at a future date.
5. Know and record the distance to the blast. The horizontal distance from the seismograph to the blast should be known to at least two significant digits. For example, a blast within 1000 meters or feet would be measured to the nearest tens of meters or feet respectively and a blast within 10,000 meters or feet would be measured to the nearest hundreds of feet or meters respectively. Where elevation changes exceed 2.5h:1v, slant distances or true distance should be used.
6. Record the blast. When seismographs are deployed in the field, the time spent deploying the unit justifies recording an event. As practical, set the trigger levels low enough to record each blast.
7. Record the full time history waveform. Summary or single peak value recording options available on many seismographs should not be used for monitoring blast-generated vibrations. Operating modes that report peak velocities over a specified time interval are not recommended when recording blast-induced vibrations.
8. Set the sampling rate. The blasting seismograph should be programmed to record the entire blast event in enough detail to accurately reproduce the vibration trace. In general the sample rate should be at least 1000 samples per second.
9. Know the data processing time of the seismograph. Some units take up to 5 minutes to process and print data. If another blast occurs within this time the second blast may be missed.

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10. Know the memory or record capacity of the seismograph. Enough memory must be available to store the event. The full waveform should be saved for future reference in either digital or analog form.
11. Know the nature of the report that is required. For example, provide a hard copy in the field, keep digital data as a permanent record or both. If an event is to be printed in the field, a printer with paper is needed.
12. Allow ample time for proper setup of the seismograph. Many errors occur when seismographs are hurriedly set-up. Generally, more than 15 minutes for set-up should be allowed from the time the user arrives at the monitoring location until the blast.
13. Know the temperature. Seismographs have varying manufacturer specified operating temperatures.
14. Secure cables. Suspended or freely moving cables from the wind or other extraneous sources can produce false triggers due to microphonics.

## **Part II. Ground Vibration Monitoring**

Placement and coupling of the vibration sensor are the two most important factors to ensure accurate ground vibration recordings.

### **A. Sensor Placement**

The sensor should be placed on or in the ground on the side of the structure towards the blast. A structure can be a house, pipeline, telephone pole, etc. Measurements on driveways, walkways, and slabs are to be avoided where possible.

1. Location relative to the structure. Sensor placement should ensure that the data obtained adequately represents the ground-borne vibration levels received at the structure. The sensor should be placed within 3.05 meters (10 feet) of the structure or less than 10% of the distance from the blast, whichever is less.
2. Soil density evaluation. The soil should be undisturbed or compacted fill. Loose fill material, unconsolidated soils, flower-bed mulch or other unusual mediums may have an adverse influence on the recording accuracy.
3. The sensor must be nearly level.
4. The longitudinal channel should be pointing directly at the blast and the bearing should be recorded.
5. Where access to a structure and/or property is not available, the sensor should be placed closer to the blast in undisturbed soil.

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## B. Sensor coupling

If the acceleration exceeds  $1.96 \text{ m/s}^2$  (0.2 g), decoupling of the sensor may occur. Depending on the anticipated acceleration levels spiking, burial, or sandbagging of the geophone to the ground may be appropriate.

1. If the acceleration is expected to be:
  - a. less than  $1.96 \text{ m/s}^2$  (0.2 g), no burial or attachment is necessary
  - b. between  $1.96 \text{ m/s}^2$  (0.2 g), and  $9.81 \text{ m/s}^2$  (1.0 g), burial or attachment is preferred. Spiking may be acceptable.
  - c. greater than  $9.81 \text{ m/s}^2$  (1.0 g), burial or firm attachment is required (RI 8506).

The following table exemplifies the particle velocities and frequencies where accelerations are  $1.96 \text{ m/s}^2$  (0.2 g) and  $9.81 \text{ m/s}^2$  (1.0 g).

Frequency, Hz	4	10	15	20	25	30	40	50	100	200
Particle Velocity mm/s (in/s) at $0.2 \text{ g}$ ( $1.96 \text{ m/s}^2$ )	78.0 (3.07)	31.2 (1.23)	20.8 (0.82)	15.6 (0.61)	12.5 (0.49)	10.4 (0.41)	7.8 (0.31)	6.2 (0.25)	3.1 (0.12)	1.6 (0.06)
Particle Velocity mm/s (in/s) at $9.81 \text{ m/s}^2$ (1.0 g)	390 (15.4)	156 (6.14)	104 (4.10)	78.0 (3.07)	62.4 (2.46)	52.0 (2.05)	39.0 (1.54)	31.2 (1.23)	15.6 (0.61)	7.8 (0.31)

2. Burial or attachment methods.
  - a. The preferred burial method is excavating a hole that is no less than three times the height of the sensor (ANSI S2.47), spiking the sensor to the bottom of the hole, and firmly compacting soil around and over the sensor.
  - b. Attachment to bedrock is achieved by bolting, clamping or adhering the sensor to the rock surface.
  - c. The sensor may be attached to the foundation of the structure if it is located within +/- 0.305 meters (1-foot) of ground level (RI 8969). This should only be used if burial, spiking or sandbagging is not practical.
3. Other sensor placement methods.
  - a. Shallow burial is anything less than described at 2a above.
  - b. Spiking entails removing the sod, with minimal disturbance of the soil and firmly pressing the sensor with the attached spike(s) into the ground.

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- c. Sand bagging requires removing the sod with minimal disturbance to the soil and placing the sensor on the bare spot with a sand bag over top. Sand bags should be large and loosely filled with about 4.55 kilograms (10 pounds) of sand. When placed over the sensor the sandbag profile should be as low and wide as possible with a maximum amount of firm contact with the ground.
- d. A combination of both spiking and sandbagging gives even greater assurance that good coupling is obtained.

## **C. Programming considerations**

Site conditions dictate certain actions when programming the seismograph.

1. Ground vibration trigger level. The trigger level should be programmed low enough to trigger the unit from blast vibrations and high enough to minimize the occurrence of false events. The level should be slightly above the expected background vibrations for the area. A good starting level is 1.3 mm/s (0.05 in/s).
2. Dynamic range and resolution. If the seismograph is not equipped with an auto-range function, the user should estimate the expected vibration level and set the appropriate range. The resolution of the printed waveform should allow verification of whether or not the event was a blast.
3. Recording duration - Set the record time for 2 seconds longer than the blast duration plus 1 second for each 335 meters (1100 feet) from the blast.

## **Part III Air Overpressure Monitoring**

Placement of the microphone relative to the structure is the most important factor.

### **A. Microphone placement**

The microphone should be placed along the side of the structure, nearest the blast.

1. The microphone should be mounted near the geophone with the manufacturer's wind screen attached.
2. The microphone may be placed at any height above the ground. (ISEE 2005)
3. If practical, the microphone should not be shielded from the blast by nearby buildings, vehicles or other large barriers. If such shielding cannot be avoided, the horizontal distance between the microphone and shielding object should be greater than the height of the shielding object above the microphone.

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4. If placed too close to a structure, the airblast may reflect from the house surface and record higher amplitudes. Structure response noise may also be recorded. Reflection can be minimized by placing the microphone near a corner of the structure. (RI 8508)
5. The orientation of the microphone is not critical for air overpressure frequencies below 1,000 Hz (RI 8508).

### **B. Programming considerations**

Site conditions dictate certain actions when programming the seismograph to record air overpressure.

1. Trigger level. When only an air overpressure measurement is desired, the trigger level should be low enough to trigger the unit from the air overpressure and high enough to minimize the occurrence of false events. The level should be slightly above the expected background noise for the area. A good starting level is 20 Pa (0.20 millibars or 120 dB).
2. Recording duration. When only recording air overpressure, set the recording time for at least 2 seconds more than the blast duration. When ground vibrations and air overpressure measurements are desired on the same record, follow the guidelines for ground vibration programming (Part II C.3).

# Field Practice Guidelines for Blasting Seismographs

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