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International Society of Explosives Engineers

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ISEE FIELD PRACTICE GUIDELINES FOR BLASTING SEISMOGRAPHS 2025

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This edition of *ISEE Field Practice Guidelines for Blasting Seismographs* was revised by the ISEE Standards Committee in 2025, and supersedes all previous editions. It was approved by the Society's Board of Directors in its role of Secretariat of the Standards at its 2026 meeting.

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[1]This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred.

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

Origin and Development of ISEE Standards for Blasting Seismographs

One of the goals of the ISEE Standards Committee is to develop uniform and technically appropriate standards for blasting seismographs. The intent is to improve accuracy and consistency in vibration and air overpressure measurements. Blasting seismograph performance is affected by how the blasting seismograph is built and how it is placed in the field.

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, the Committee became the Blast Vibrations and Seismograph Section. The initial standards were drafted and approved by the Section in December 1999. Subsequently, the ISEE Board of Directors approved 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. A review of the ISEE Field Practice Guidelines and the Performance Specifications for Blasting Seismographs fell within the scope of the committee. Work began on a review of the Field Practice Guidelines in January 2006 and was published in 2009. Revisions to the Performance Specifications were completed in 2011, 2015, 2020, and 2025.

The ISEE Standards Committee takes on the role of keeping the standards up to date every 5 years. This document is the result of the latest effort by the ISEE Standards Committee to keep the standards up to date with current field techniques and technology.

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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 important that the operator evaluate these conditions and obtain good coupling between the monitoring instrument and the surface to be monitored. In all cases, the operator is responsible for the monitoring equipment and documenting the field conditions and setup procedures in the permanent record for each blast.

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PREFACE

Blasting seismographs are used to establish compliance with federal, state and local regulations and to evaluate the effects of blasting. ~~explosive performance~~. Laws and regulations have been established to prevent damage to property and injury to people. The disposition of the rules is strongly dependent on the accuracy of ground vibration and air overpressure data. In terms of ~~explosive~~ blasting 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.

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" [3].

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 and may be required by the manufacturer, regulations, or project specifications.

3. Keep proper blasting seismograph records. A user's log should note: the user's name, date, time, place, method of deployment, and other pertinent data and notes.

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 1,000 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 2.5 horizontal:1 vertical, the true point to point line distance ~~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 1,000 samples per second, but the user should evaluate blast characteristics for conditions that may warrant a higher sampling rate.

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.

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 setup 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 no closer than 1 meter (3 feet) and within 3 meters (10 feet) of the structure or less than 10% of the distance from the blast, whichever is less.

2. Soil density evaluation. Where possible, the soil should be undisturbed or compacted fill. Loose fill material, unconsolidated soils, flower-bed mulch or other unusual mediums should be avoided. ~~may have an adverse influence on the recording accuracy.~~

3. The sensor must be nearly level.

4. Typical practice is to point the longitudinal/radial channel towards the blast site. However, other sensor orientations are allowed.

> **a.** For single blast ~~blast-by-blast~~ sensor deployment, the longitudinal/radial channel should be pointed towards the closest blast hole. Records should indicate if this condition is met.
>
> **b.** For multiple-blast sensor deployment or permanent installations, the azimuth (0-360 degrees, +/- 5 degrees) of the longitudinal/radial channel relative to true north should be recorded. Magnetic north may vary from true north, and orientation to true north is most appropriate.

5. Where access to a structure and/or property is not available, the sensor should be placed on the side of the structure closest to the blast and as close to the structure as possible. ~~closer to the blast in undisturbed soil.~~

B. Sensor Coupling

1. The preferred method of coupling is burial into the ground to accurately record ground motions: To bury the sensor: ~~If the acceleration exceeds 1.96 m/s² (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.~~

a.Excavate a hole no less than three times the height of the sensor and provide lateral room for the cabling.

b. Ensure the bottom of the hole is reasonably flat and level.

c. Place fill completely around the sensor with native soil or soil similar to the native soil, by compacting in 0.5 to 1-inch (13 to 25 mm) lifts, until the sensor is covered, and the hole is refilled to near the original grade.

d. If properly buried, the use of sensor spikes is not necessary.

~~**1.** If the acceleration is expected to be:~~

~~**a.** Less than 1.96 m/s² (0.2 g), no burial or attachment is necessary.~~

~~**b.** Between 1.96 m/s² (0.2 g), and 9.81 m/s² (1.0 g), burial or attachment is preferred. Spiking may be acceptable.~~

~~**c.** Greater than 9.81 m/s² (1.0 g) , burial or firm attachment is required [7].~~

2. ~~Burial or attachment methods~~. If unable to excavate a hole for the sensor as defined in Part II B1, spike and sandbag the sensor to the prepared ground surface with the following considerations:

~~**a.** The preferred burial method is excavating a hole that is no less than three times the height of the sensor [1], 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.~~

The following table exemplifies the particle velocities and frequencies where accelerations are 1.96 m/s² (0.2 g) and 9.81 m/s² (1.0 g).

Remove Table

Frequency, Hz	4	10	15	20	25	30	40	50	100	200
Particle Velocity mm/s (in/s) at 1.96 m/s_2 (0.2 g)	78.0 ([illegible])	31.2 ([illegible])	20.8 ([illegible])	15.6 ([illegible])	12.5 ([illegible])	10.4 ([illegible])	([illegible])	([illegible])	(0.12)	(0.06)
Particle Velocity mm/s (in/s) at 9.81 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)	(0.31)

~~**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 [5]. This should only be used if burial, spiking or sandbagging is not practical.~~

a. Remove the sod or other surficial materials to reach the soil.

b. Ensure the spikes are tightly attached to the sensor and press the spikes into the ground until the sensor is reasonably level and firmly seated against the ground surface.

c. The sandbag should be filled with loose, free-flowing, granular material.

d. Overlay the sensor with a sandbag containing a minimum of 9.10 kg (20 lbs.) of sand.

e. 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.

f. Coupling the sensor to the soil ground surface using spikes alone, or overlying a sandbag on the sensor without spikes, should be avoided.

~~**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.~~

~~**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.~~

3. If unable to excavate a hole for the sensor as defined in Part II B. 1. or spike and sandbag the sensor as defined in Part II B. 2., the attachment of the sensor to hard surfaces such as rock, concrete, a structure foundation wall, or frozen ground is acceptable with the following considerations:

a. General hard surfaces - For sensors supported by mounting brackets or other manufacturer-provided devices, firmly secure the sensor with appropriate bolts, screws, or threaded rods, ensuring the sensor remains level.

b. For rock or concrete - Attach the sensor directly to rock or concrete using bolts or appropriate mounting adhesive that achieves a strong bond.

c. For attachment to frozen surfaces – Mechanical attachment, appropriate construction adhesives, or cements designed for freezing conditions may be necessary.

d. For structures - Attachment of the sensor to the foundation of a structure within 0.305 m (1 ft) above or below ground level is only acceptable in cases where the previously described methods cannot be used or when required by monitoring specifications or regulations.

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 at least 2 seconds longer than the blast duration plus 1 second for each 335 meters (1,100 feet) from the blast. If the blast duration is unknown, a minimum record time of 10 seconds should be used.

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 [2].

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.

4. If placed too close to a structure, the air overpressure 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. [7].

5. The orientation of the microphone is not critical for air overpressure frequencies below 1,000 Hz [7].

6. The microphone element must be kept dry to help maintain proper calibration and minimize the potential for corrosion. A common practice is to place a windscreen (typically provided by the manufacturer) on the microphone and cover it loosely with a thin plastic bag, or "rain shield." Other methods can be used to protect the microphone from moisture; however, the pressure around the microphone sensing element must be able to change in relation to the pressure change caused by the blast overpressure.

a. When using a plastic bag as a rain shield, the bag should be tied loosely around the microphone, allowing some exchange of air between the inside and outside of the shield. Completely sealing a rain shield could result in the following:

i. Condensation – water accumulates inside the shield. A small hole in the bottom of the shield can help mitigate this issue.

ii. Static Pressure – over time pressure could build in the shield.

iii. Rain Triggers – rain drops striking a tightly sealed shield will cause pressure pulses that could trigger the seismograph.

b. It is acceptable to keep microphones inside security boxes or other protective covers as long as the pressure change in the enclosure reflects the pressure change outside of the protective cover in the surrounding environment.

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).

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