STATE OF COLORADO

Ebert - DNR, Jared <jared.ebert@state.co.us>

Goodrich Pit Monitoring Plan

Jodi Schreiber <jodi@arycorp.com> Thu, May 16, 2019 at 10:59 AM
To: "Ebert - DNR, Jared" <jared.ebert@state.co.us>

Jared,

I apologize for the oversight. I have attached the monitoring plan for review and can overnight as well. I will check the tracking on the first package as well.

ARY CORPORATION

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"Be a yardstick of quality. Some people aren't used to an environment where excellence is expected." –Steve Jobs

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Goodrich Monitoring Plan 5-13-19.pdf
1151K

Henderson, NV 89044
Carlsbad, CA 92026
(702) 419-9210
Fax 1(702) 855-0274

Monday May 13, 2019

RE: Project: Goodrich Pit
Client: Blackwing Drilling & Blasting
Contractor: A&S Construction
Location: N37* 11.066’ W103* 28.264’ (65 Miles ESE Trinidad, CO)

1. The minimum number of seismographs utilized will be one (1) seismograph utilizing closest “Monitoring Location” based on structure location, see site map in figure 1. This location is approximately 2500’ from the construction site. *Additional* seismographs may also be used depending on the locations of certain blasts, their proximity, and/or blasting complaints. The locations of the seismographs may also vary depending on recommendations, ISEE Filed Practice and Guidelines, and field experience by VCE, Inc. Additionally, these locations could be affected by the direction of the blast as it is related to the locations of other sensitive installations, machinery, persons or property, etc.

   See site map in figure 1 for General seismograph locations.

2. The seismographs will be strategically placed near surrounding areas to measure the influence distance and direction has on ground vibrations and air-blast vibrations.

3. Blackwing Drilling & Blasting will operate the seismographs and store seismic data with blast data for the Statue of Limitations. When or if needed VCE, Inc will prepare the Blasting Seismic Log Data Reports. The guidelines in figure 2 will be followed concerning structure vibration exposure.

4. The following type of seismograph will be used. See enclosures for spec sheets:

   - PMT / ex-AD8

5. Seismograph monitoring shall be in compliance with the International Society of Explosive Engineers (ISEE) Filed Practice and Guidelines for Blasting Seismographs. See Enclosure.

6. Blasting complaints will be handled in a case-by-case basis based communicated claims to Blackwing.

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Map For General Seismograph Location

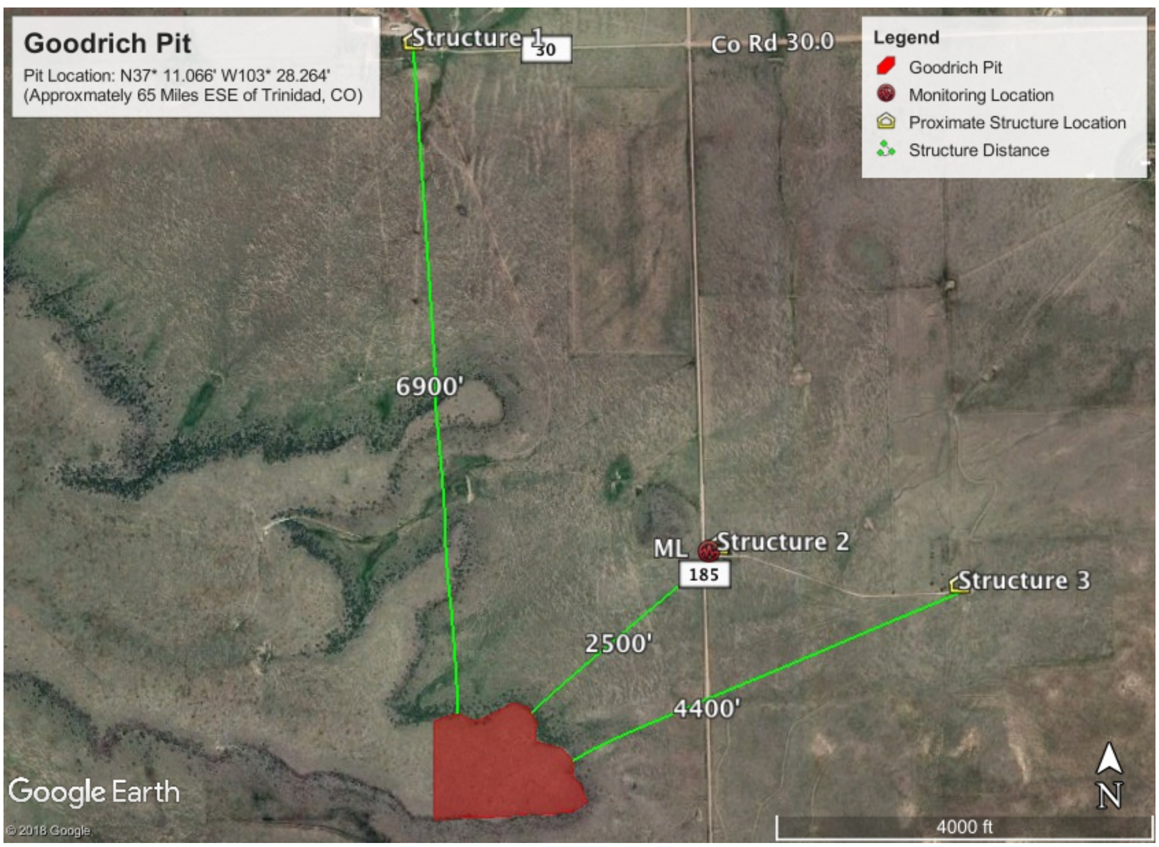

Figure 1.

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Blast Vibration Requirements

Rule 6.5, Geotechnical Stability Exhibit

10. Rule 6.5(4) requires an operator who proposes blasting to provide an appropriate blasting, vibration, geotechnical and structural engineering analyses that off-site areas will not be adversely affected by blasting. While the Rules do not provide details of the exact type of analysis or demonstration that needs to be conducted, the DRMS Minerals program typically follows the protective standards accepted by the Office of Surface Mining, Reclamation and Enforcement for airblast and ground vibration. Regarding airblast, it should be controlled so that it does not exceed the values specified below at any significant structure (home, building, etc.) outside the permit area:

Lower Frequency Limit of Measuring System, Hz (3dB)	Maximum Level in dB
0.1 Hz or lower – flat response[1]	134 peak
2 Hz or lower -- flat response	133 peak
6 Hz or lower -- flat response	129 peak
C-weighted, slow response	105 C

For ground vibration, the maximum peak particle velocity should not exceed the following limits at any significant structure (home, building, etc.) outside the permit area:

Distance (D) from the Blasting Site (in feet)	Maximum Allowable Peak Particle Velocity (V max) for Ground Vibration (in inches/secondH)	Scaled-Distance Factor to be Applied without Seismic Monitoring (DsI)
0 to 300	1.25	50
301 to 5000	1.00	55
5001 and beyond	0.75	65

H Ground velocity shall be measured as the particle velocity. Peak particle velocities shall be recorded in three mutually perpendicular directions from the blasting site. The maximum peak particle velocity shall be the largest of any of the three measurements.

The applicant may either provide an appropriate demonstration that offsite areas will not be adversely affected by the proposed blasting operation in accordance with Rule 6.5(4) or commit to conducting blasting in such a manner that the above referenced standards will not be exceeded. If the latter option is chosen, please provide a monitoring plan that will be used to document compliance with the above referenced standards.

Figure 2

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Please call if I can assist in any way. (702) 419-9210.

Sincerely,

AARON **jones**
Manager of Field Services
VCE, Inc.
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(702) 419-9210

Enclosures:
ISEE FPG
ex-AD8 Spec Sheet

ISEE
Field Practice Guidelines For Blasting Seismographs
2009 Edition

TM

International Society of Explosives Engineers
30325 Bainbridge Road
Cleveland, OH 44139

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Randall Wheeler, White Industrial Seismology
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**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. A key to classifications is found at the back of the document.*

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.

ISEE Field Practice Guidelines For Blasting Seismographs

International Society of Explosives Engineers
30325 Bainbridge Road
Cleveland, OH 44139

International Society of Explosives Engineers

ISEE Field Practice Guidelines
For
Blasting Seismographs
2009 Edition

This edition of *ISEE Field Practice Guidelines for Blasting Seismographs* was revised by the ISEE Standards Committee on February 4, 2008 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 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, the Committee became the Blast Vibrations and Seismograph Section. The Guidelines were drafted and approved by the Section in December of 1999. The Section 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. 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 of 2006 and was completed in February of 2008 with this edition.

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 ground and air vibration measurements. Blasting seismograph performance is affected by how the blasting 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.

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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.

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.

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.

B. Sensor coupling

If the acceleration exceeds 1.96 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 m/s^2 (0.2 g), no burial or attachment is necessary
    b. between 1.96 m/s^2 (0.2 g), and 9.81 m/s^2 (1.0 g), burial or attachment is preferred. Spiking may be acceptable.
    c. greater than 9.81 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 m/s^2 (0.2 g) and 9.81 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 1.96 m/s^2 (0.2 g)	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 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.

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.

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).

References:

1. American National Standards Institute, Vibration of Buildings – Guidelines for the Measurement of Vibrations and Evaluation of Their Effects on Buildings. ANSI S2.47-1990, R1997.

2. Eltschlager, K. K., Wheeler, R. M. Microphone Height Effects on Blast-Induced Air Overpressure Measurements, 31st Annual Conference on Explosives and Blasting Technique, International Society of Explosives Engineers, 2005.

3. International Society of Explosives Engineers, ISEE Performance Specifications for Blasting Seismographs, 2000.

4. Siskind, D. E., Stagg, M. S., Kopp, J. W., Dowding, C. H. Structure Response and Damage by Ground Vibration From Mine Blasting. US Bureau of Mines Report of Investigations RI 8507, 1980.

5. Siskind, D. E., Stagg, M. S. Blast Vibration Measurements Near and On Structure Foundations, US Bureau of Mines Report of Investigations RI 8969, 1985.

6. Stachura, V. J., Siskind, D. E., Engler, A. J., Airblast Instrumentation and Measurement for Surface Mine Blasting, US Bureau of Mines Report of Investigations RI 8508, 1981.

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eXAD-8

eXPeak Seismograph

Physical Measurement Technologies, Inc., introduces the eXAD-8 seismograph and eXAD Vibration/Sound Analysis Tools software as the new standard in motion and sound measurement. Utilizing our entirely new eXPeak architecture, the eXAD-8 is designed to eliminate the inaccuracies associated with existing older seismograph designs. The eXAD-8 system was created to measure, analyze, and document blast/construction/structural vibration and sound, absolutely, easily, and at a **very low cost!**

Design Concept Overview – The eXad-8 system is a data collection system that is designed to overcome the inherent weaknesses associated with traditional sampling seismographs. PMT has created a new combined analog/digital concept that ensures that peak measurements are captured accurately and are repeatable. All standard sampling seismographs have the same problem; **repeatability**. Specifically, when two seismographs are placed side by side in a field situation, the **difference in the peak measurements can be as much as 100%**. However, when placed on a shake table, seismographs will generally be within 5% of each other. **This is a problem!**

PMT has solved these problems by creating the unique eXPeak architecture. This is an entirely new synthesis of analog & digital electronics, and steep slope anti-aliasing filters. The system tracks and stores the signal between samples and eliminates high frequencies that have no effect on structural damage. This new approach provides better than 95% coverage (960 out of every 1000 microseconds) and an equivalent sampling rate of greater than 20,000 samples per second. This is truly an amazing feat! **Accuracy is not compromised!**

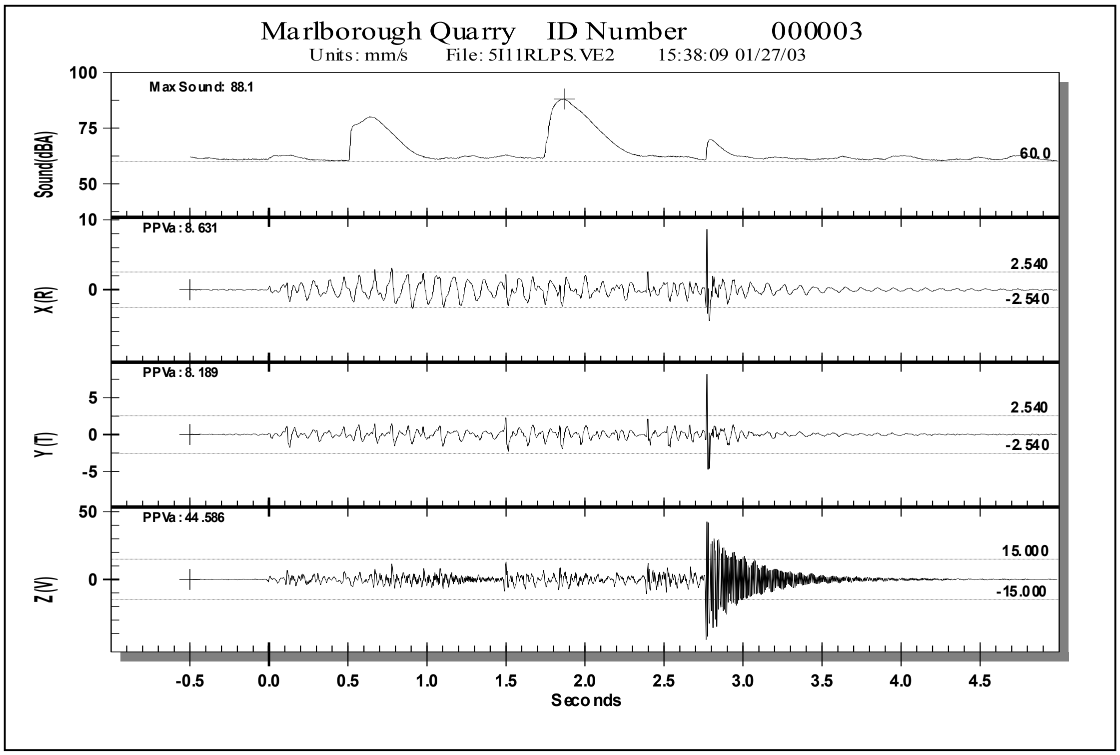
High Accuracy Vibration and Sound Measurement, at Low Cost - The eXAD system is designed to be highly accurate in the short and long term. The system architecture (Division of Data Collection & Analysis/Printing) ensures against obsolescence and reduces costs. By separating the data analysis from the instrument, software upgrades keep the system current, and on the leading edge of vibration analysis. PMT is committed to continuous improvement and minimal cost. PMT will provide **technical support and software upgrades at no charge!**

PMT

Physical Measurement Technologies, Inc.
P.O. Box 400, 4 Ling Street
Marlborough, NH 03455 USA
Voice: 603.876.9990
Fax: 603.876.9995

Field Operations with a Field Tough Instrument - The eXAD system is particularly easy to operate, both in the field and in the office. About the size of a notebook computer; operation is simple and fast. The system can be configured for use on-site, without having to carry a PC with you. Simply connect the geophone and microphone, turn it on and select monitor. The data is automatically stored in non-volatile memory with room for over 300 seconds of data. The eXAD-8 is rugged enough so that it can go anywhere at anytime with few concerns. Shipping and field operations with a high accuracy instrument are no longer a worry. Geophone cables can be replaced in seconds.

eXAD Vibration/Sound Analysis Tools - *Science in the Software* - The included eXAD Vibration/Sound Analysis Tools software is a powerful suite of analytical tools for vibration and sound measurement, in a fully integrated Windows™ based environment. It offers unmatched analysis of all motion and sound levels, yet is easily used by almost anyone. Analytical capabilities include time history zoom of data, comparison of data with respect to user defined vibration limits, spectral analysis (FFT), and RMS vibration and sound level measurement (A-weighted, fast response). Of course, the eXAD software also prints standard reports on your office printer.



eXAD-8 Specifications

Microprocessor: 8XC52 Family
Display: 4 Line by 20 Column Liquid Crystal
Keyboard: 1 X 4 Sealed Membrane
Communications: Serial RS232, 57600 Baud
Clock: Integrated Battery Backed Real Time Clock
Battery: 6 V, Rechargeable Lead Acid Cel, 200 Hrs/Charge
Battery Charger: Universal Voltage
Sensors: 3 Geophones (x,y,z Triaxial arrangement)
1 Condenser Microphone
A/D Converter: 13 Bit Self Calibrating
Anti-Aliasing Filters: (Velocity Channels)
Software Selectable Cutoff : 250 to 2500 Hz

Sample Storage Rate: 1024 SPS/Channel to 5000 Hz (Switchable)
Frequency Response: Velocity 3 to 250 Hz (2 to 250 Software)
Frequency Response: Mic. A-Weighted Fast Response 8 KHz
Type 2S True RMS Sound Level Measurement, or Linear 2 - 250
Range: Geophone +/- 80mm/s, Mic: 40 to 90db(A), 90 to 140dB (Linear)
Resolution: Vibration 0.02 mm/s, Mic: 1 dB
Repeatability: Vibration: +/-5% Impulsive Input, Sound: 1dB
Base Level Noise: 0.1 mm/s
Data Storage: Over 300 Events, 2MB memory standard
PC Requirements: Windows 9X, Windows 2000, Windows XP

Specifications Subject to Change Due to Continuous Improvement