

Seismograph Placement and New Technologies

by

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Seismic Surveys, Inc.

Adapted from ISEE Blaster's Handbook Appendix K



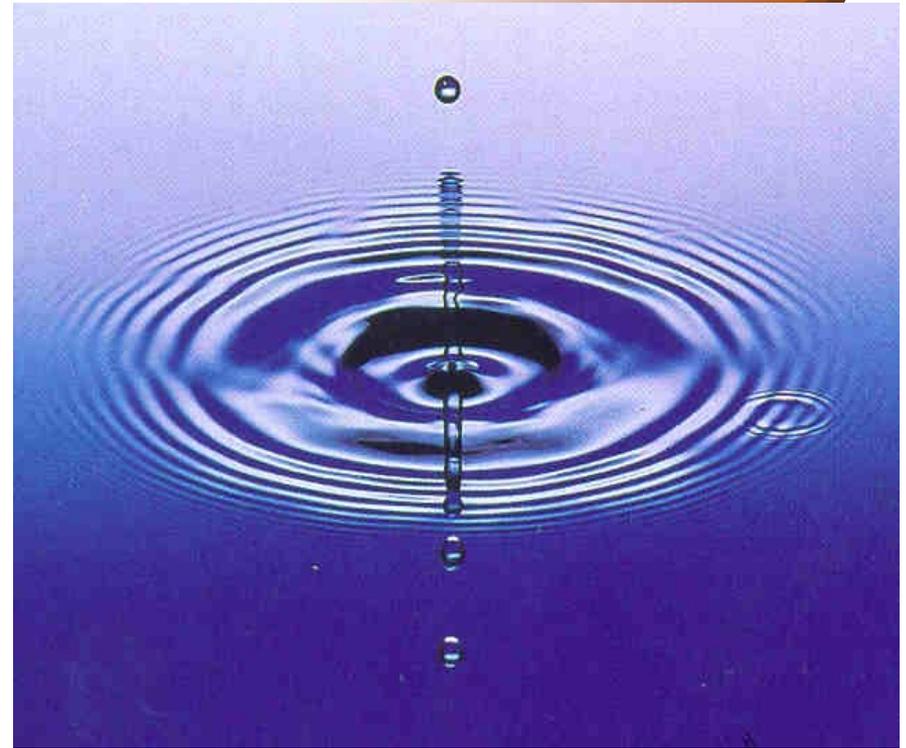
Seismographs Measure



- Ground Vibration-Geophone
- Airblast-Microphone (Linear Weighting)
- Accuracy Essential

Ground Vibrations & Airblast

- Ground Vibration is:
- Similar to Ripples in a Pond - Travel out in all directions
- Less Energy with Distance



Definition of Terms



- Vibration-Shaking of the ground caused by the elastic wave emanating from a blast
- Particle Velocity-Speed that a particle of ground vibrates when excited by a passing wave
- Frequency-Number of cycles of vibration that a particle undergoes in 1 second (cycles per second or Hertz)
- Airblast/Overpressure- An airborne shock/pressure wave. May or may not be audible.

Regulatory Limits



- DMME Safety and Health Regulations for Mineral Mining (1998)
- Vibration Limits (VAC 25-40-880)
 - Generally the Limit is 1.0 ips PPV
- Airblast Limits (VAC 25-40-890)
 - Generally the Limit is 129 dB (L)

Vibration

- Use Table or Alternative Blasting Level Criteria (OSM Regulations)

Distance (ft)	Max PPV (ips)	Min. Scaled Dist. $[D/(W)^{0.5}]$
0 to 300	1.25	50
301 to 5,000	1.00	55
5,001 and beyond	0.75	65

Alternative Blasting Level Criteria

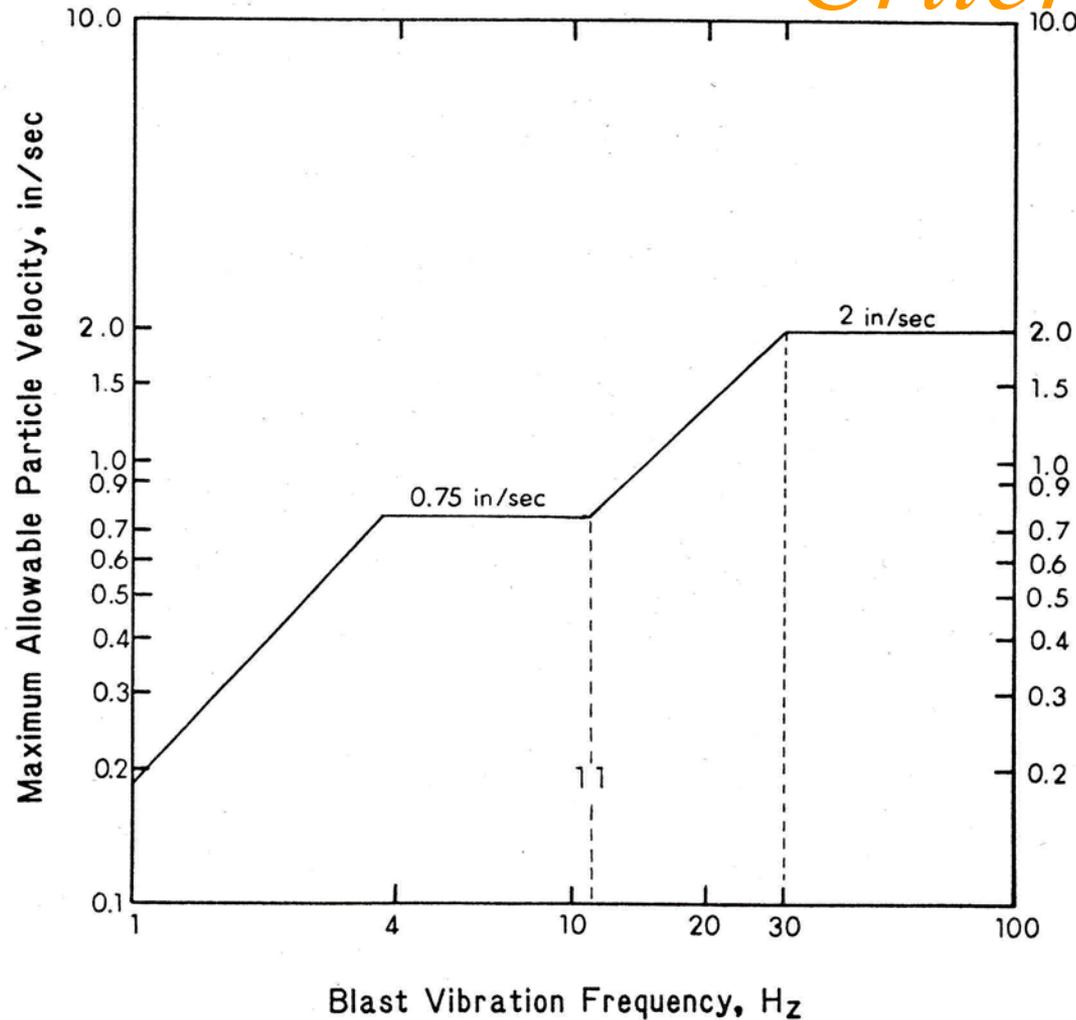


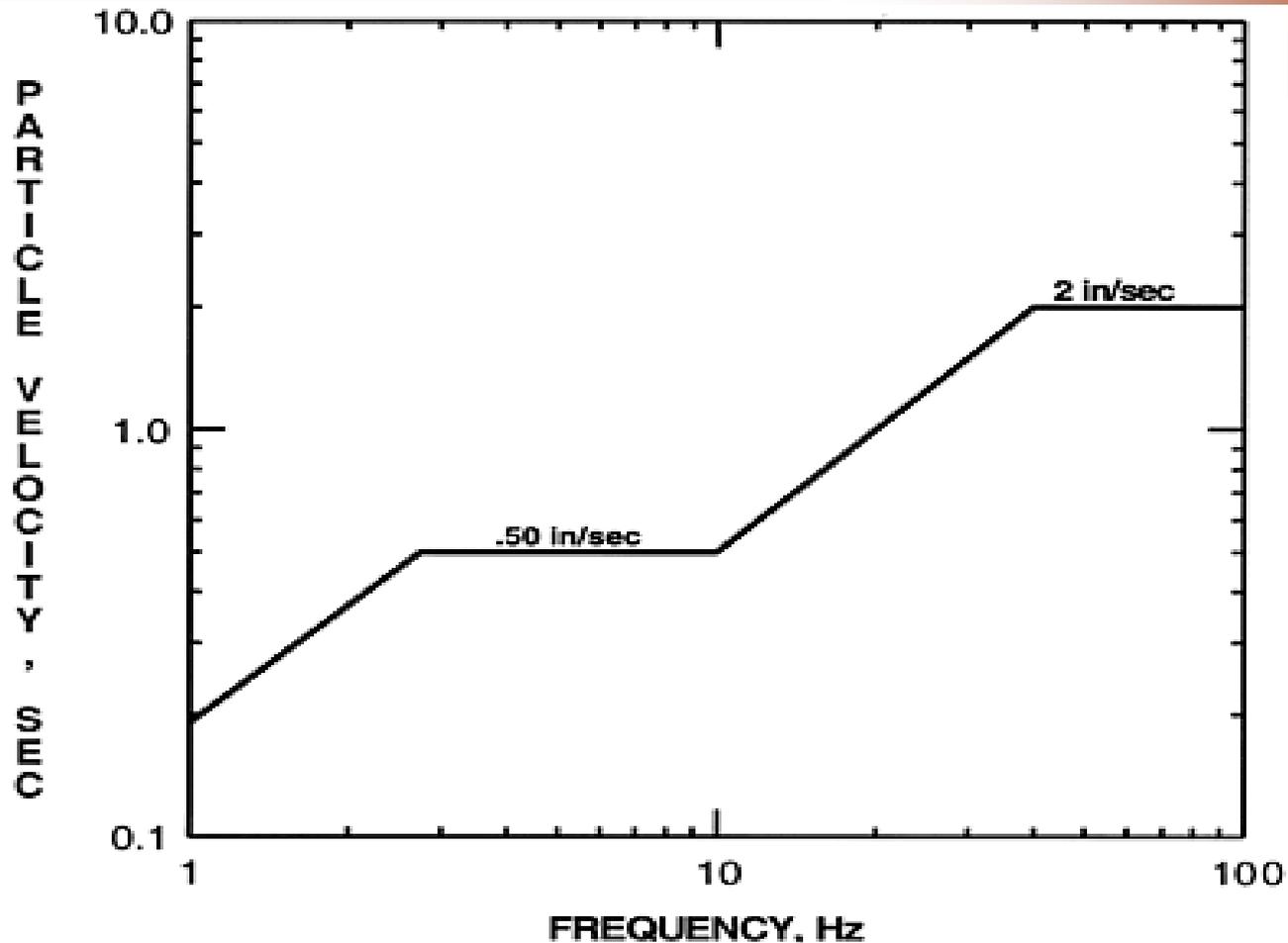
Figure 12. (Figure 1. in OSMRE Regulations)
Alternative Blasting Level Criteria.

Airblast

***OVERPRESSURE LIMITS RECOMMENDED
BY BUREAU OF MINES FOR SURFACE MINING
(Bureau of Mines RI 8485)***

- 134 dB - 0.1 Hz high pass measuring system
- 133 dB - 2.0 Hz high pass measuring system
- 129 dB - 6.0 Hz high pass measuring system
- 105 dB - C-slow weighting scale on a sound level meter
(events less than or equal to 2-sec duration)

Pennsylvania Code Title 25, Chapter 211.151, Subchapters F and G



User Responsibility



- Read Manual
- Calibration Annually
- Good Record Keeping
- Record Blast

User Responsibility Cont.

- Check to ensure every seismograph bag has the appropriate components
- Accessories include, but are not limited to:
 - Geophone
 - Spikes/Stand
 - Microphone
 - Battery/etc.



Record the Blast(Cont.)



- Use Appropriate Trigger Levels
- Record Full Waveform
- Document Location
 - Name or Address of Structure
 - GPS
- Document Serial Number
- Include Calibration Date
- Document Trigger Levels

Record the Blast (Cont.)



- Document Accurate Distance and Direction
 - Within 2 Significant Digits
- Know Data Processing Time
- Know Memory or Record Capacity
- Know Nature of Report Required
 - Digital
 - Printed

Verifying Distance to Blast



- Speed of Sound ~ 1,100 feet/sec
- Rule of Thumb
- Therefore a blast that is indicated as being 1,100 feet from the blast should be around 1 second from start of vibration event.
- Examples @ 350 feet and 650 feet

Distance to blast 650 feet



Date/Time Vert at 12:31:13 November 21, 2007
 Trigger Source Geo: 0.0500 in/s
 Range Geo :10.00 in/s
 Record Time 3.0 sec at 1024 sps

Notes
 Job
 Company
 User
 Selsmograph

Extended Notes
 BC7696, BH6636. Internal MM+

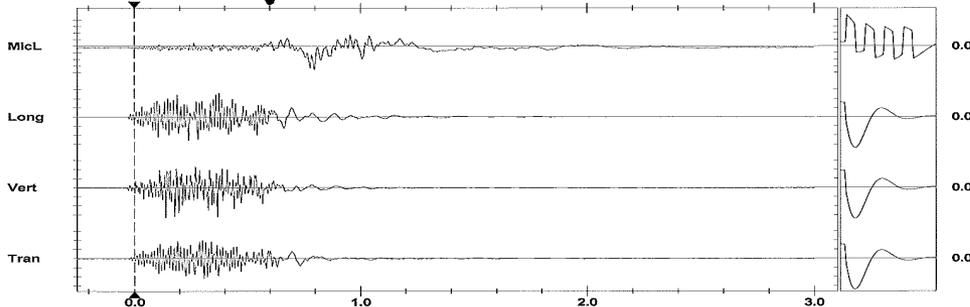
Post Event Notes
Dist. to Shot ~ 650'

Microphone Linear Weighting
 PSPL 121.8 dB(L) at 0.797 sec
 ZC Freq 3.4 Hz
 Channel Test Passed (Freq = 20.5 Hz Amp = 540 mv)

	Tran	Vert	Long	
PBV	0.220	0.330	0.260	in/s
ZC Freq	73	85	73	Hz
Time (Rel. to Trig)	0.309	0.140	0.375	sec
Peak Acceleration	0.239	0.451	0.305	g
Peak Displacement	0.00107	0.00083	0.00118	in
Sensorcheck	Passed	Passed	Passed	
Frequency	7.5	7.4	7.5	Hz
Overswing Ratio	3.8	3.6	3.6	

Peak Vector Sum 0.351 in/s at 0.140 sec

0.60 SEC.



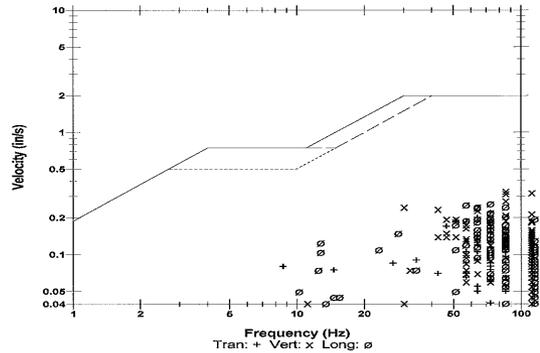
Time Scale: 0.20 sec/div Amplitude Scale: Geo: 0.100 in/s/div Mic: 0.00100 psi(L)/div
 Trigger =

Sensorcheck

Event Report

Serial Number BC7696 V 8.12-8.0 MiniMate Plus
 Battery Level 6.1 Volts
 Calibration October 16, 2007 by InstanTel Inc.
 File Name I696BY0L.G10

USBM RI8507 And OSMRE



Distance to Blast 350 feet



Event Report

Date/Time Vert at 11:34:49 May 15, 2008
Trigger Source Geo: 0.0500 in/s
Range Mic: 125 dB(L)
Record Time Geo: 10.00 in/s
 3.0 sec at 1024 sps

Serial Number BE9110 V 8.12-8.0 MiniMate Plus
Battery Level 6.4 Volts
Calibration December 14, 2007 by InstanTel Inc.
File Name K110C72G.610

Notes

DIST. TO SHOT ~350'

Post Event Notes

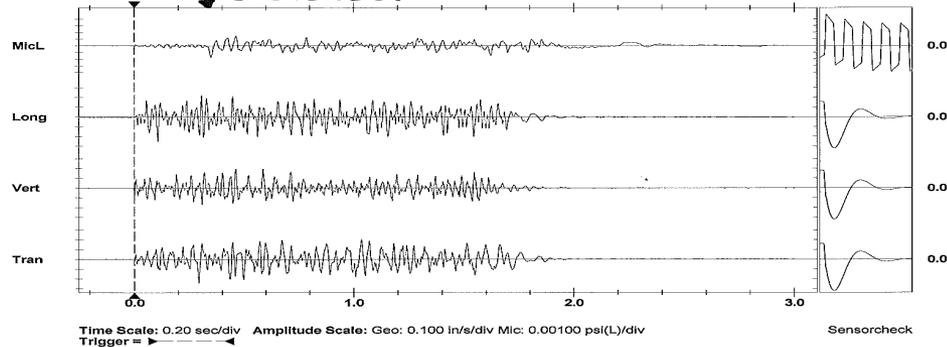
User: Dave Harrison - SSI
 [Redacted]

Microphone Linear Weighting
P SPL 115.4 dB(L) at 0.349 sec
ZC Freq 16 Hz
Channel Test Passed (Freq = 20.1 Hz Amp = 481 mv)

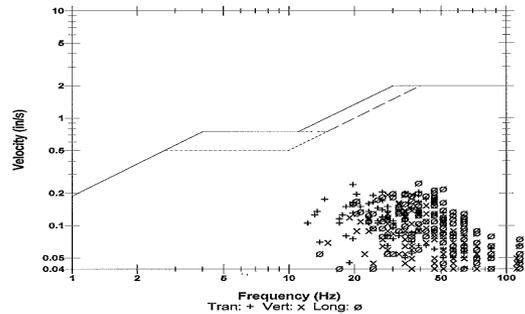
	Tran	Vert	Long	
PPV	0.240	0.195	0.250	in/s
ZC Freq	20	37	39	Hz
Time (Rel. to Trig)	0.295	0.463	0.107	sec
Peak Acceleration	0.172	0.172	0.186	g
Peak Displacement	0.00153	0.00088	0.00129	in
Sensorcheck	Passed	Passed	Passed	
Frequency	7.3	7.2	7.2	Hz
Overwing Ratio	3.9	4.1	4.1	

Peak Vector Sum 0.308 in/s at 0.448 sec

0.375 SEC.



USBM R18507 And OSMRE



General Guidelines (cont.)



- Allow Ample Setup Time
 - Avoid Errors
 - 15 Minutes at Location
- Know Temperature/ Operating Range of Machine
- Secure Cables
 - Avoid Swinging or Suspending
 - Cable ties good on extension cords

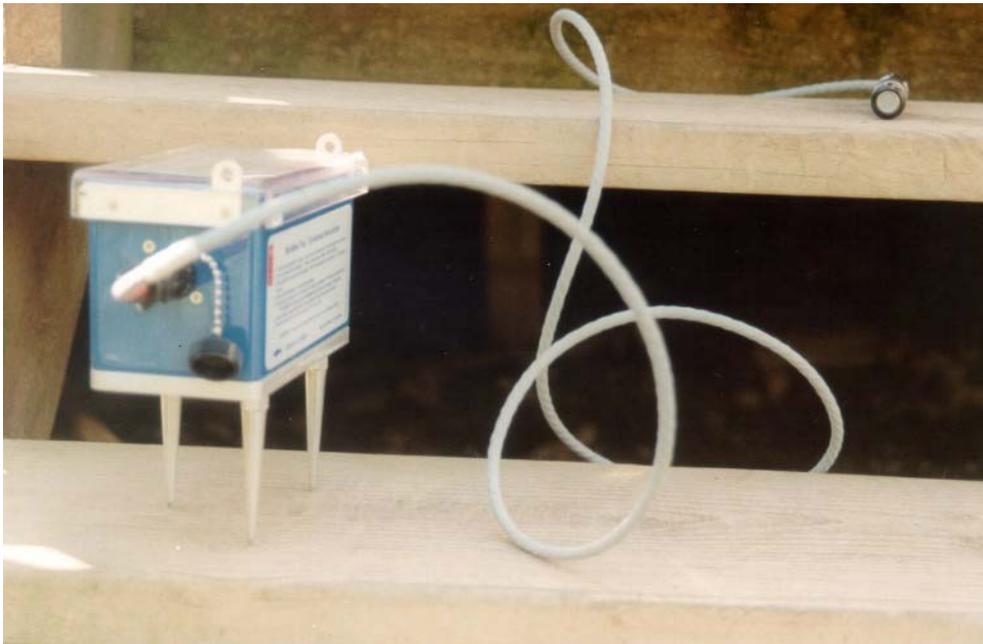
Ground Vibration Monitoring



- Placement and Coupling - Two Most Important Factors
- Sensor Placement
 - Location
- Coupling

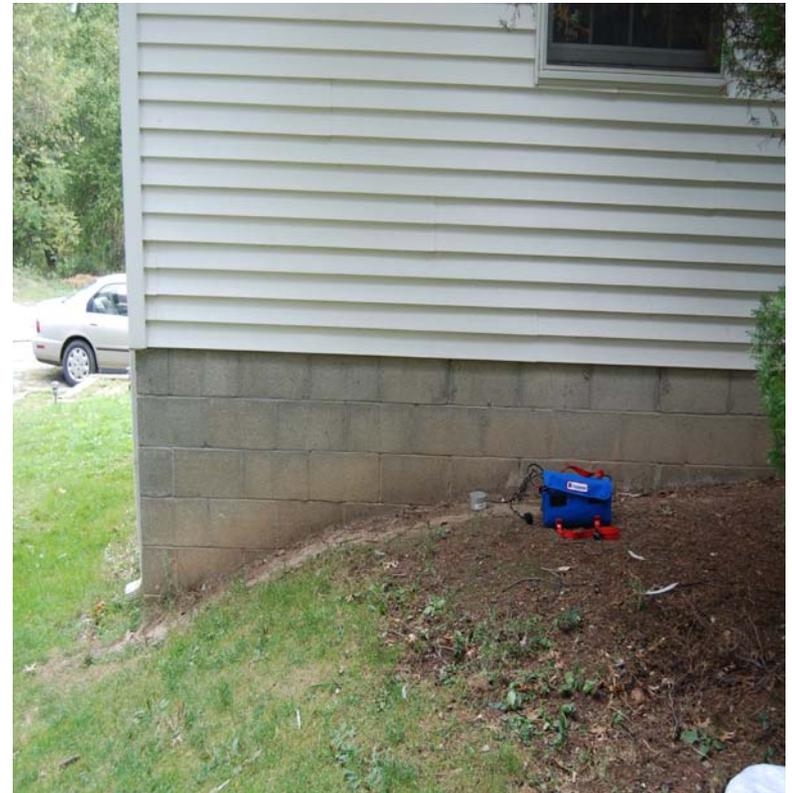
Avoid Driveways, Slabs, Walkways

- **DONT'S**



Improper Installations

- **DO NOT** Place Geophone On Ground Near Structure
 - Over the Footer
 - In Front of the Structure
 - Or Lay Microphone on the ground



Better Site Selection for Previous Example



Areas to Avoid – Buried Structures



Other Areas to Avoid – Trees and Tree Roots



Special Coupling Considerations Necessary

- **DO** Place On Ground at Side/Corner of Structure
 - Outside Backfill
 - Within 10 feet or 10 percent



Soil Density

- Greater Than Sensor Density
- Remove Sod
- Avoid Mulch/Loose Materials



Sensor Level/Firm Ground



Point Longitudinal Toward Blast

- Record Bearing (N, S, E, W)
- Place Sensor Between Blast and Structure



Sensor Coupling



- Essential for Accurate Measurement
- Additional Precautions for Accelerations over 0.2g
 - Spike
 - Bury
 - Sandbag

Guidelines for Sensor Coupling

- $<0.2\text{g}$ - No Burial or Attachment
- 0.2 to 1.0g - Burial or Attachment
 - Burial Preferred
 - Spiking Acceptable
- $>1.0\text{g}$ - Burial or Firm Attachment Required (USBM RI 8506)
- See Table 1 for PPV Equivalents

Ground Vibration Monitoring (cont.)



- Guideline

table 1

Frag (H_z)	4	10	15	20	25	30	40	50	100	200
PPV at 0.2g	3.07	1.23	0.82	0.61	0.48	0.41	0.31	0.25	0.12	0.06
PPV 1.0g	15.4	6.15	4.10	3.05	2.45	2.05	1.55	1.25	0.60	0.30

Burial or Attachment



- Preferred Method is Burial
 - 3x Sensor Ht. Minimum (ANSI 52.47-19.90, R1997)
 - Spike
 - Compact Soil Around and Over

Burial



Replace Your Divot



Attachment to Rock or Concrete

- Bolt (Drop-In Anchor)
- Clamp
- Glue/Plaster of Paris

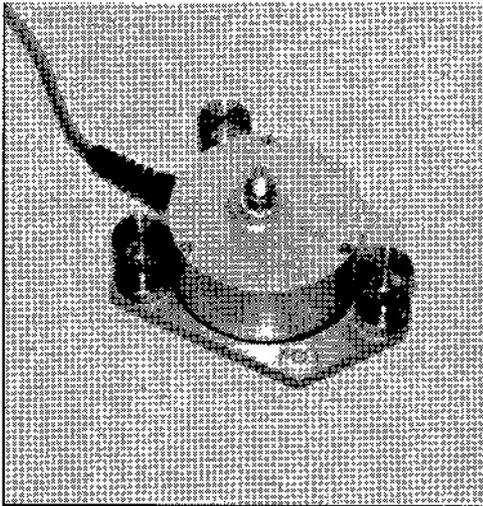


Figure 3.12 Bolting the Standard Transducer to a Surface using the Leveling Plate.

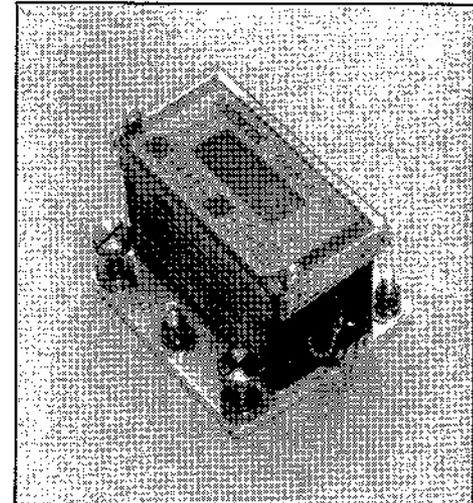


Figure 3.10 Bolting the MiniMate Plus to a Surface using the Fastening Plate.

Burial or Attachment (cont.)



- Foundation
 - Within 1 foot of Ground Level (USBM RI 8969)
- Other Methods
 - Shallow Burial
 - Combination of Spiking and Sandbagging
 - Spiking (Remove Sod)
 - Sandbagging (Large/Loosely Filled)

Programming Considerations



- Site Conditions Dictate
- Depends on Desired Data

Ground Vibration Monitoring



- Geophone Trigger Level Low Enough to Trigger from Blast
 - High Enough to Not False Trigger
 - 0.05 ips a Good Start
- Air Trigger
 - High Enough to Not Trigger on Wind
 - Airblast Will Record if Triggered on Ground Vibration in Most Cases
 - Dynamic Range/Resolution
 - Some Auto Range
 - Choose Appropriate Range to allow Resolution of Waveform

Ground Vibration Monitoring (cont.)



- Programming Considerations (cont.)
 - Recording Duration
 - 2 Seconds Longer Than Blast
 - Add 1 Second for Each 1,100 feet

Airblast Monitoring

- Placement of Microphone Relative to Structure Most Important Factor
 - Microphone Placement
 - To Side of Structure Nearest Blast
 - Mounted near Geophone
 - Used Windscreen
 - Preferred Height 3 feet Above Ground (USBM RI 8508) (ANSI S12.18-1994, ANSI S12.9-1992/Part 2) – Do not Lay on Ground
 - No Shielding
 - Distance from Shield Greater Than Height
 - Avoid Reflections/Place Microphone Near Corner

Airblast Monitoring (cont.)



Airblast Monitoring (cont.)



- Programming Considerations
 - Site Conditions Dictate
 - Trigger Level
 - Above Background
 - 120 dB/(L) a Good Start
 - Recording Duration
 - Follow Guidelines for Ground vibration
 - Allow 1 Second for Each 1,100 feet

Steps in Monitoring an Event



- Place Instrument Properly
- Turn Unit On
 - Cal Check OK!
- Verify Trigger Levels
- Arm Instrument (5 Minutes Ahead)
 - Do Not Transmit on Radio
- Record Measurements
- Disarm!
- Turn Off

Summary



- Proper Seismograph Placement and Programming Necessary
- Accurate Measurements and Record Keeping Essential
- Keep Equipment Maintained and Calibrated
- Will Result in Better Liability Protection and Accurate Information

New Technologies - Web-based Remote Monitoring Sites



Web-based Site – Monitoring at Historical Home



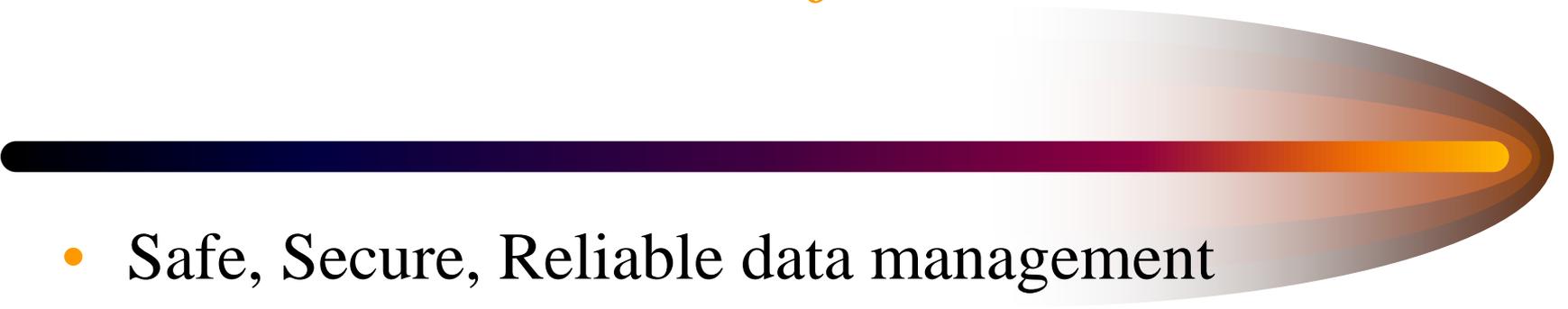
**Your work is in
many places.
*Now you can be
too!***



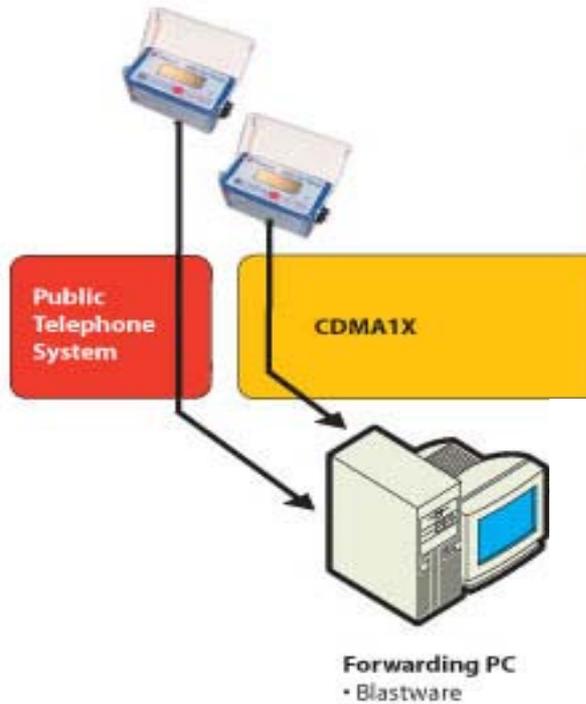
Why was Instalink created?

- 
- Reduction of travel time and costs for onsite visits
 - Safe, secure area to post data online, without:
 - having to create and maintain your own data hosting web site
 - A 3rd party with integrity and privacy controls

Benefits

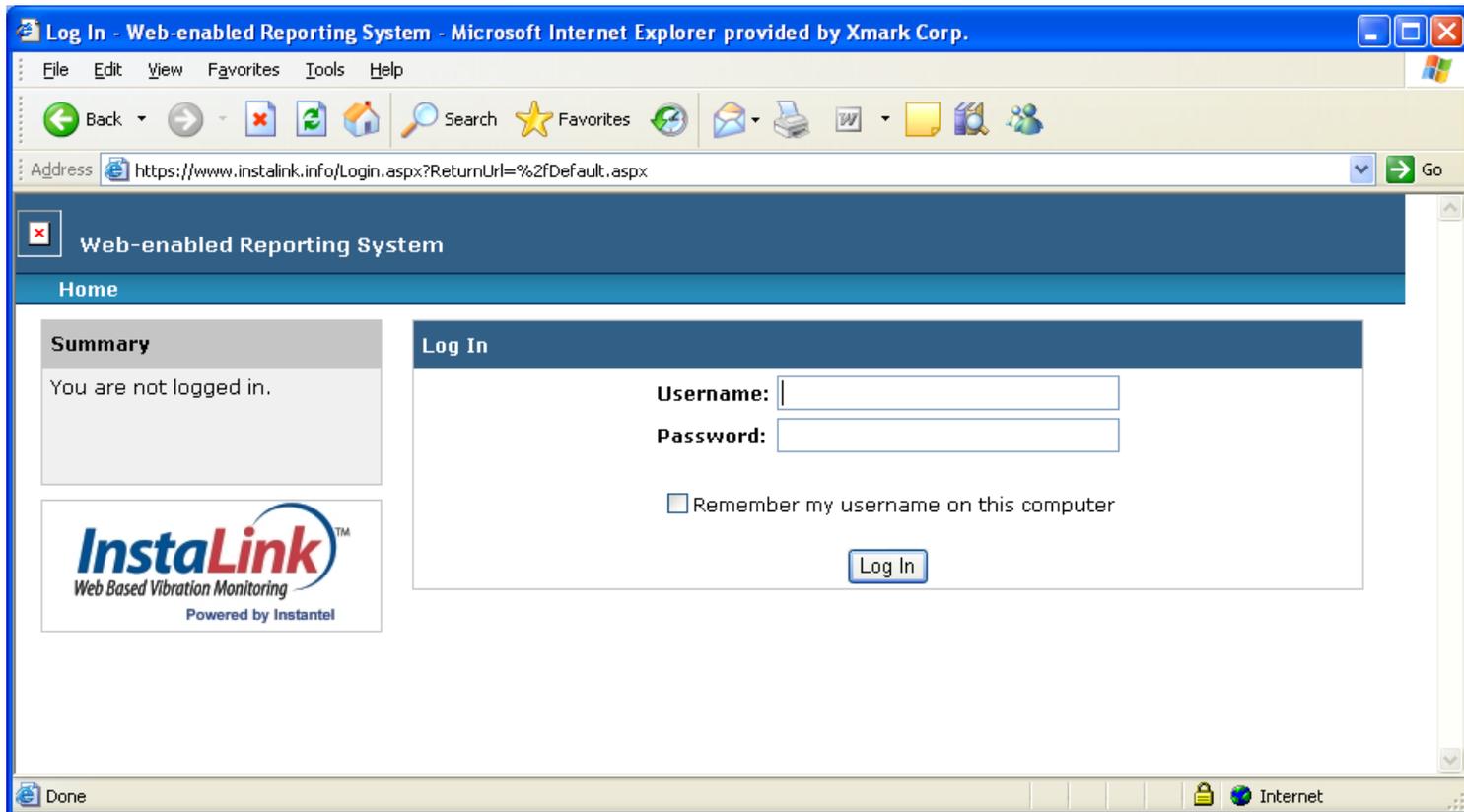


- Safe, Secure, Reliable data management
 - Only you and your clients see the data
 - You control who has access to YOUR web site
 - Your customers have 24/7 access to the data
 - Redundant backup server
- Automatic Collection and Distribution of information
 - No need to travel to retrieve event data
 - No need copy, print, photocopy, fax or email reports
- Cost effective
 - Nominal monthly fee per active point



Login Screen

- <http://www.instalink.info/group/yourwebsite.aspx>



Main Screen of Your Site

The screenshot shows a web browser window titled "Projects - Web-enabled Reporting System - Microsoft Internet Explorer provided by Xmark Corp." The address bar displays "https://www.instalink.info/ProjectList.aspx". The page content includes a navigation menu with "Projects" and "User Management" tabs. The main area is divided into "Active Projects" and "Inactive Projects" sections, each with a table. The "Active Projects" table has columns for Project Name, Summary, Start Date, Active Mon. Points, and Actions. The "Inactive Projects" table has columns for Project Name, Summary, Start Date, End Date, and Actions. A left sidebar contains sections for Group Summary, Group Management, Project Management, Downloads, and Preferences. The InstaLink logo is visible at the bottom left.

Web-enabled Reporting System
webbinar User: Eric Gagne | Log Out

Projects User Management

Group Summary
Place your address here.

Group Management
Edit Group Information

Project Management
Click Project Name to View Details
Add Project

Downloads
InstaLink Forward Agent

Preferences
Edit Your Profile

Active Projects

Project Name	Summary	Start Date	Active Mon. Points	Actions
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Inactive Projects

Project Name	Summary	Start Date	End Date	Actions
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InstaLink™
Web Based Vibration Monitoring
Powered by InstanTel

Event Listing



Web-enabled Reporting System

Home

Group Summary



Date	Time	Serial Number	Type	Max. Vibration			Max. Sound Level		Actions
				PPV	CH	FREQ	PSPL	FREQ	
2007-02-15	16:07:11	BE8086	Full Histogram	7.83 mm/s	Vert2	22 Hz	91.5 dB(L)	27 Hz	View Download Delete
2007-02-15	15:58:12	BE8086	Full Waveform	15.3 mm/s	Vert	***	91.5 dB(L)	12 Hz	View Download Delete

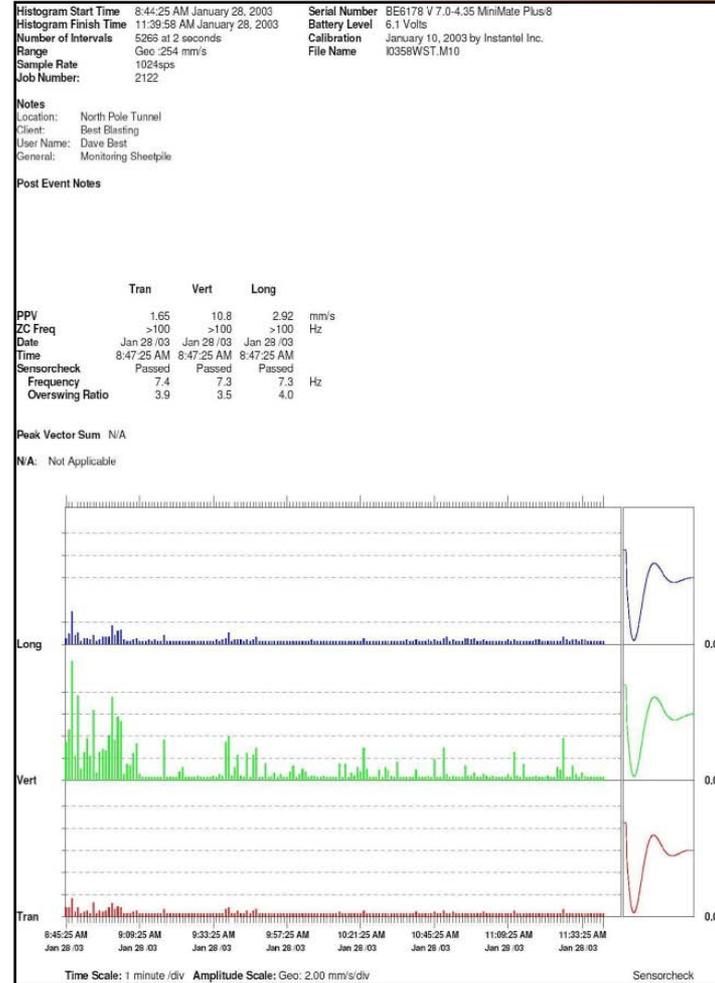
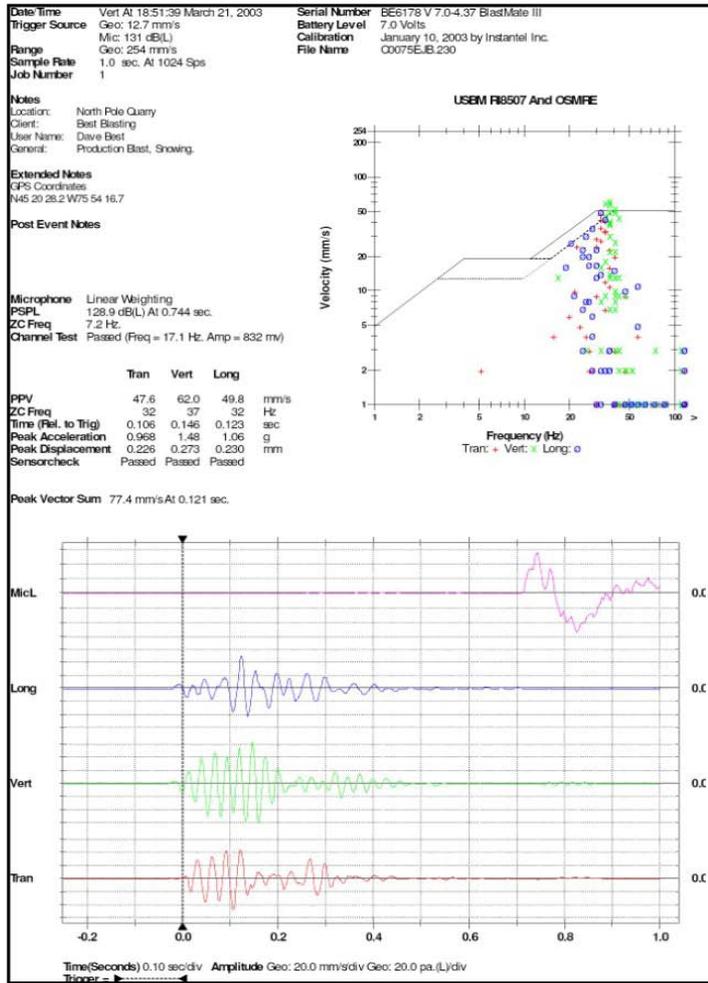
- User accounts can be set up to view only or view and download events

Actions

[View](#)
[Download](#)
[Delete](#)

- Only a Group Owner has the option to delete the event from the system

Typical Event Report



Testimonial

- This has enabled us to operate our business more efficiently and to provide our Clients with faster, more cost effective service. It has also made us more competitive.
- The site is password protected and is totally safe. We are very excited about having this capability!



*David K. Miller, P.G., President,
Seismic Surveys, Inc.*

Remember...

- 
- Safe, Secure, Reliable Data Management
 - Automatic Collection and Distribution of Information
 - Cost Effective



Questions