Blast Log Evaluation Program (BLEP)

Office of Surface Mining

Appalachian Region
And
Technical Innovations and Professional Services (TIPS)
Administratium
(Heaviest element known to man)

- Welcome
- WR Facilities
- Hotel
- Breaks
- Vouchers
- Notebook
- Class Agenda
- Sign-in
- Introductions
  - Who, Where, What do you do?
  - Experience with blast logs?
Blasting Logs and Adverse Effects

Ken Eltschlager
(412) 937-2169
Keltschl@osmre.gov
What we are here to review

- Important components of the blast log to control the adverse effects of blasting
  - Flyrock
  - Ground vibrations
  - Airblast
  - (Fumes)
Why is this important?

- Prevent injury to people
- Prevent damage to property
- Required by SMCRA
Global overview
Review – Blasting, Seismology and Acoustics
Overview of Blast Logs

- The Blast

![Image of a blast site dated August 22, 1993]
Bad News…
Good News....
Confinement

(a) $B = 15'$
- Completely contained, only failure is pulverisation near the charge and radial tensile failure running out from it.

(b) $B = 12'$

(c) $B = 9'$
- Surface and subsurface failure almost meet. There will be a shelf of unbroken rock between the two. Doming or surface bulging.

(d) $B = 6'$
- Full crater, burden completely broken out. Surface and subsurface failures run through to the surface.

(e) $B = 3'$
- Full crater, lower volume than optimum fine fragmentation. Noise, flyrock, bowl shaped crater.

Assume Explosive = 40 lb. ANFO
Charge weight per delay

4 ROWS WITH 5 HOLES

DETONATOR WIRES

STEMMING

BLASTING AGENT

BLASTHOLE

SPACING

BURDEN

HIGHWALL

PRIMER
(DETONATOR AND BOOSTER)
Delay Sequence (surface and down hole)
### Vibra-Tech Blast and Seismograph Analysis

**Company:** R&D Copper

**Operation:** Coal Mine Job

**State:**

**Shot No.:** 16

**Date:** 11/7/57

**Time:** 2:30 PM

**No. Holes:** 40

**Depth:** 55 ft

**Exact Blast Location:**

### Blast Data

<table>
<thead>
<tr>
<th>Burden</th>
<th>ft</th>
<th>Total Explosives</th>
<th>lbs</th>
<th>Max. Explo./Delay</th>
<th>lbs</th>
<th>Delay Nos.</th>
<th>Del Dr.</th>
<th>Exp. Mfr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td></td>
<td>9240</td>
<td>231</td>
<td></td>
<td></td>
<td>40</td>
<td>ATLAS</td>
<td>NO. 1</td>
</tr>
</tbody>
</table>

**Delay Mfr.:** ATLAS

**Type of Delay:** NO. 1

**No. of Timer Circuits:** 600

**No. of Timer Mtr:** 600

**Timer Interval:** 600

**Blasting Comments:** #217

### Seismograph Data

**Exact Location of Seis.:**

**Seis. No.:**

**Cassette No.:**

**Operator:**

**Trigger Level:**

**Witness:**

### Vibration Measurements

- **Transverse:** in/sec.
- **Vertical:** in/sec.
- **Longitudinal:** in/sec.
- **Overpressure:** in/sec.

**Peak Ground Vibration:** (in excess of) 100

**Peak Air Overpressure:** (in excess of) 100

**Analysis By:**

---

(USE REVERSE SIDE FOR BLAST DIAGRAM)

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**Blast logs #1 piece of evidence**
Why Should Blasters Keep Good Logs??

- Regulations say so
- Quality control
- Liability protection
Overview of blast energy

- Seismic speed – 3,000 – 25,000 ft/s
- Air or sound speed – 1,100 ft/s
- Flyrock – Faster than you can run!
**SAFEGUARD SEISMIC UNIT 2000DK**

**SN: 2243**

**DATE: 09/12/95**

**TIME: 15:18:06**

**Event: 009**

**Recording Time: 10**

**Client: ROBERTSON**

**Operation: BUCKEYE IND. MINING CO.**

**SSU Location: ROBERTSON YARD**

**Distance to blast: 1385**

**Operator: M. MANN/ODNR**

**Comments:**

**Trigger Level: .05 IN/SEC**

**SUMMARY**

<table>
<thead>
<tr>
<th>LPPV (in/sec)</th>
<th>T</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>0.14</td>
<td>0.07</td>
</tr>
</tbody>
</table>

| PD (in x.001) | 2.39 | 2.97 | 1.38 |
| PPA (g)       | 0.02 | 0.02 | 0.02 |

<table>
<thead>
<tr>
<th>FREQ (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.0</td>
</tr>
</tbody>
</table>

| RESULTANT PPV (in/sec): 0.15 |
| PEAK AIR PRESSURE: (dB) 114 |
| (psi) 0.00145 |

**VELOCITY WAVEFORM GRAPH SCALE**

<table>
<thead>
<tr>
<th>TIME = 100 MSEC PER MARK</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>SEISMIC = +/- .64 IN/SEC</th>
</tr>
</thead>
</table>

| SOUND = +/- 0.00232 PSI |

**SHAKETABLE CALIBRATED: 06/20/95**

By GeoSonics, Inc.

Box 779, Warrendale, PA 15095 U.S.A.

TEL: 412.934.2900  FAX: 412.934.2999
Vibrations arrive at a house
Structure Response

- Ground vibrations and airblast make homes shake or vibrate.
Blast Log Review
and
Blasting Seismograph Data
Scaled Distance Relationship

- To evaluate ground vibrations and airblast
- GV – Square root scaled distance
  \[ SD_2 = \frac{D}{CW^{1/2}} \]
- AB – Cubed root scaled distance
  \[ SD_3 = \frac{D}{CW^{1/3}} \]
Spatial Relationships

Complaint House, 550'

Complaint House 2, 1500'

Compliance House, 450'
Ground and Air Vibrations

- Know the location of the blast
- Check the distance!!

Permit Area

Jones Residence

690 Feet

North
Ground and Air Vibrations

- Know the charge weigh per delay
- Check the explosives per hole
- Check for overlaps – time the blast out!!
**SHOT REPORT**

<table>
<thead>
<tr>
<th>Location</th>
<th>Waterville 4th Bench</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>10:14</td>
</tr>
<tr>
<td>No. of Rows</td>
<td>3</td>
</tr>
<tr>
<td>No. of Holes</td>
<td>30</td>
</tr>
<tr>
<td>Diameter</td>
<td>61/4</td>
</tr>
<tr>
<td>Burden</td>
<td>121</td>
</tr>
<tr>
<td>Spacing</td>
<td>12'</td>
</tr>
<tr>
<td>Depth</td>
<td>30' Aug</td>
</tr>
<tr>
<td>Water</td>
<td></td>
</tr>
<tr>
<td>Material Shot</td>
<td>Sandstone</td>
</tr>
<tr>
<td>Firing Method</td>
<td>Rods/815</td>
</tr>
<tr>
<td>Weather</td>
<td>Rain</td>
</tr>
<tr>
<td>Temp.</td>
<td>75°</td>
</tr>
<tr>
<td>Wind</td>
<td>N WEST</td>
</tr>
<tr>
<td>Stemming</td>
<td>13 to 18'</td>
</tr>
<tr>
<td>Blasting Mach.</td>
<td>Rods/815</td>
</tr>
<tr>
<td>Distance</td>
<td>620' W.</td>
</tr>
<tr>
<td>Scale Distance</td>
<td>31/3</td>
</tr>
<tr>
<td>Bulk ANFO</td>
<td>4150</td>
</tr>
<tr>
<td>HDP #1</td>
<td>7000</td>
</tr>
<tr>
<td>Total EXP.</td>
<td>14,800</td>
</tr>
<tr>
<td>Total lbs.</td>
<td>6,320</td>
</tr>
<tr>
<td>#20 CONN. WIRE</td>
<td>25</td>
</tr>
<tr>
<td>FT. PRIMA CORD</td>
<td>14</td>
</tr>
<tr>
<td>MAX LBS./DELAY</td>
<td>396</td>
</tr>
<tr>
<td>MAX. HOLES/Delay</td>
<td>2</td>
</tr>
<tr>
<td>CU. YDS.</td>
<td>4,800</td>
</tr>
<tr>
<td>LBS. EXP./CU. YD.</td>
<td>1.3</td>
</tr>
<tr>
<td>SHOT NO.</td>
<td>445-10</td>
</tr>
</tbody>
</table>

**SHOT #1**

- **Typical Load**
  - 40 Lbs. ANFO
  - 4 Lbs. HDP #1
  - 40 lbs. Rods/815
  - 400' W. Rods/815

- **Foot EBC's Used**
  - 500' 20
  - 275' 50
  - 300' 20600
  - 325' 50
  - 300' 20600
  - 375' 100
  - 250' 350
  - 350' 100
  - 400' 200
  - 400' 400
  - 350' 50

- **Total Lbs.** 1,410

**SHOT #2**

- **Typical Load**
  - 0 Lbs. ANFO
  - 4 Lbs. HDP #1

- **Foot EBC's Used**
  - 250' 50
  - 275' 50
  - 300' 600
  - 325' 50
  - 350' 100
  - 375' 100
  - 400' 200
  - 325' 50
  - 400' 400
  - 350' 50

- **Total Lbs.** 475

**REMARKS**

- Typical Load
- Foot EBC's Used
- Lbs. ANFO
- Lbs. HDP #1
- Rods/815
- 250'
- 275'
- 300'
- 325'
- 350'
- 375'
- 400'
- 350'
- 400'

**INSTR. NO. 2231**

**SEISMOGRAPH/LOC.**

**V.**

**T:**

**L:**

**D-3100**

**HOME OFFICE:**

**OFFICE:**

**Date:** June 30, 1995
Explosives / Hole

\[ LD = 0.34(d^2) + \rho \]
\[ = 0.34(6.75^2) \times 0.92 \]
\[ = 14.616 \text{ lb/ft} \]

\[ CW = 14' \times 14.6 = 205.16 \text{ lb} \]
**Ground vibrations**

<table>
<thead>
<tr>
<th>Distance</th>
<th>SD</th>
<th>PPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 301</td>
<td>50</td>
<td>1.25</td>
</tr>
<tr>
<td>301 – 5000</td>
<td>55</td>
<td>1.00</td>
</tr>
<tr>
<td>&gt; 5000</td>
<td>65</td>
<td>0.75</td>
</tr>
</tbody>
</table>
Airblast

2 Hz microphone  133 dB

All seismographs manufactured today have 2 Hz lower frequency response range.

No Scaled Distance counterpart.
If seismograms are available -

- Plot the data $SD_2$ vs PPV
- Plot the data $SD_3$ vs dB
- Does the data plot as a group or in a straight line?
SD vs Ground Vibrations

The graph shows the relationship between Peak Particle Velocity (PPV) and Scaled Distance. The data points indicate a general trend of decreasing PPV as the Scaled Distance increases.
SD vs Airblast

![Graph showing the comparison between SD and Airblast dB levels. The x-axis represents scaled distance, and the y-axis represents AIRBLAST dB levels. The data points show a trend line indicating a decrease in AIRBLAST dB with increasing scaled distance.]

- AIRBLAST
- MAX airblast
Flyrock Damage - 1995 - KY

* Children playing outside   -   Cost $1.5 million
Flyrock Death – 1993 - TN

- Passenger in a car on I-75

- Blaster
  - 5 months in jail
  - 5 months house detention
  - 1 year probation

- Superintendent
  - 3 months halfway house
  - 5 month house detention
Flyrock control items

- Stemming
- Powder Factor
- Rock Type
- Confinement
Key blast log parameters

- Blast location
- Charge weight
- Stemming
- Rock type
Blast Log Evaluation Program

- All data obtained from the blast logs
- Cross tabulates data fields
- Plots the data for visual comparison
- Lumped or linear data are good
- Scattered data are bad
- Outlying data must be investigated further
What does BLEP buy you??

- Shows compliance with vibration limits
- Saves you the trouble of calculating by hand
- Creates a permanent record of your review
- Identifies outlying blasts relative to typical blasting at the mine
- Allows statistical analysis of the data
Break!
BLEP operates as a spreadsheet in Excel
First, we will explore the use of Excel
Launch Excel and discuss the menus and components of the spreadsheet

Go to Tools/Customize, check the boxes:
  - Show standard and Formatting toolbars on two rows
  - Always show full menus
Data Entry

- Numeric data
- Alpha numeric data
- Copy feature
- Numeric operators
  - +  Addition
  - -  Subtraction
  - *  Multiplication
  - /  Division
  - ^  Exponential
Data Entry

- Column A  Distance: 450, 550, 650, 750, 900, 2000
- Column B  Charge Weight: 100, 100, 100, 100, 100, 100
- Column C  Addition: A + 10
- Column D  Subtraction: B – 10
- Column E  Multiplication: A * 2
- Column F  Division: B / 2
- Column G  Exponent: A ^ 2
- Column H  Scaled Distance: A / B ^ .5
- Column I  PPV: H ^ -1.52 * 438
Graphing

- Save as Test 1
- Graph columns A and B
- Graph columns C and D
- Graph Columns A and E
- Headers
- Axis editing
- Scale editing
  - Normal
  - Log-log
Data Entry/Graphing

- Sheet 4
- Example 1 in notebook
- Enter distance, charge weight and PPV
- Calculate scaled distance and worse-case PPV
- Graph log-log SD vs PPV
- Add worse-case line
- Add trendline
Timing

- Save Test 1
- Sheet 2
- Illustrate 100 x 17 ms timing
  - Generate array
  - Copy / Paste Special (values)
  - Sort A-Z
  - Bottom ms – top ms in adjacent field
- Save
Timing

- Sheet 3
- 6 x 7 pattern,
- Zig-zag 42 ms up one side with 17 ms down the row
- Overlaps?
Break!
Downloading BLEP Files

- Create desktop folder called BLEP
- [www.osmre.gov](http://www.osmre.gov)
  - Research and Technology
  - Blasting Information
- Copy all BLEP files to the desktop folder
- Open and reference BLEP-Instructions
- Open and discuss Field-Log
  - (DO NOT copy data into this spreadsheet!!)
Sky Haven Example

- Use field log to transpose log data
- Five records
- Review first two records and discuss the data input required for each field as outlined in the instructions
- Alpha, Numeric or Date?
- Numeric fields will be used in formulas or plotted
BLEP

- Launch BLEP
- Save Template As SkyHaven.xls
- Data Entry ..... 5 records
- Discuss results
Full Sample.xls

- Discuss each graph
- Discuss notes
- Discuss graph interpretation
Grace Example

- Use Field Log
- Data entry
- Discuss findings
- Instructor add Measured Distance and Timing to show red squares
- Discuss graph coupling for flyrock, ground vibration and air blast
Scaled Distance Sample

- Emphasis importance of:
  - Getting a Measured Distance
  - Timing the blast
- These will get the red square verification points that should overlay the blue circles
- Discuss utility
Old Hickory Exercise

- Data entry
- Time each blast
- Enter Measured Distance based on Airblast arrival time
- Discuss results
Emphasis minimal data entry when vibration data is available
Rinker Exercise

- Single blast monitoring
- Enter
  - Date, Time
  - Charge Weight
  - Distance on each waveform
  - PPV, Frequency, Airblast
- Illustrate directional effects
- Regression analysis with Trendline – Power function
  - Add equation
  - Add $R^2$
- Modified scaled distance methodology
Question??