BLAST LOG EVALUATION PROGRAM
OFFICE OF SURFACE MINING

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To ensure the control of the adverse effect of blasting, the blast logs must report accurate distances to protected structures and charge weights per delay. The focus of the Blast Log Evaluation Program (BLEP) is to verify the reported information based on cross tabulation of the reported data and spacial distributions. The spreadsheet works within Microsoft Excel.

This program is meant to provide the inspector or blasting specialist with a tool to evaluate from 2 to 50 blast logs. All data, are taken from the blast log. Focus is on the maximum charge weight per delay. Due to the diversity of blast patterns, BLEP is only a single hole, worse-case analysis. Once data are entered into the spreadsheet, the data are cross tabulated and graphically plotted. The graphs show how well the data cross tabulates with the reported values, helps identify blasts with flyrock potential and gauges compliance with ground vibration and airblast limits. The reviewer may or may not enter two additional fields, measured distance and actual charges per delay, to conduct a more complete evaluation.

If data points fall within expected ranges, the blast logs reviewed can be deemed accurate with a high level of confidence and can be provided to nearby residents as a summary of the blasting data. Where data points fall outside expected ranges the individual blast records need to be more closely checked by a blasting specialist to assess the discrepancy or possible violation of the rules. BLEP will help inspectors identify mines with poor record keeping and help blasting specialists focus on blasts which may be causing unusual adverse effects.

I. Loading the Blast Log Evaluation Program

Copy the following three files to your network or hard drive:

- BLEP-Instructions.wpd (.doc) — This document
- Field-Log.xls — Blank Input forms
- BLEP.xls — Spreadsheet

II. What's in the Blast Log Evaluation Program?

BLEP.xls consists of active worksheets A through M, each with its own name.

- Worksheet A is the data input page for 50 blasts (from Field-Log.xls).
- Worksheets B through L are graphs generated from the input data and/or calculations.
- Worksheet M contains logical operations to help identify outlying data points.

III. Blast Log Data Collection

Most of data are copied from the blast logs. The data can be entered directly into the computer or transposed onto the Field-Log.xls worksheet (preferred) for entry into BLEP.xls later. To print the field log data form open the file "Field-Log.xls" and print the sheet. Ten pages should print with five entry columns on each page.

This program assumes that all holes in the blast are the same as the hole with the largest charge weight. Thus the evaluation represents the worse-case.

The two most important parameters on the blast logs are the charge weight per delay and the distance to the nearest structure.

- The blast hole data entered should yield the largest charge weight possible in any hole in the blast. In the absence of a cross section, enter the most conservative value if ranges are specified.

- All compliance is gauged at the nearest residential structure. Any blast seismograph data is assumed to be <u>at the nearest structure</u> and <u>at the same distance as the structure</u>.

<u>Blast Log Data.</u> The Blast log data sheet contains the following fields and data should be entered in the specified format. Parameters marked with an "*" are optional data fields but are recommended for a comprehensive review.

Name: The mine name and permit number.

Review date: The date of the review.

Date: - (mm/dd/yy) - *3/30/00* - The date of the blast.

Time: - (hhmm) - 1127 - Military time of the blast.

Coal Seam - (aaaaa) - *GOOD* - Specify the nearest coal seam underlying the blast. If 2 or more benches are needed to reach the coal seam, identify the bench on which the blast occurred.

Nearest Structure - (aaaaa) - *Loar* - Give a specific name or number of the structure (the red brick house is not acceptable). If the nearest structure is a dwelling give the resident's name. If it is not a dwelling give name and type of structure; e.g., Pikeville High School, Fred's Tire, Columbia Gas Line. Abbreviations are acceptable with full reference given in the comments.

Distance Reported - (#### ft) - *2278* - Copy the distance reported to the nearest structure.

***Distance Measured** - (#### ft) - *2300* - Locate the blast on a map and the nearest structure. Measure the distance between them to the nearest tens of feet. If the blast cannot be located on the mine map, leave the entry blank.

Burden - (## ft) - *24* - Copy the burden from the log. If a presplit blast, no burden will be given, enter 50.

Spacing - (## ft) - *28* - Copy the spacing from the log.

Hole Depth - (## ft) - *70* - Copy the hole depth from the log, if a range is given use the highest value.

Hole Diameter - (##.# in) - *12.3* - Copy the hole diameter from the log as a decimal. Eg. 7 7/8 inches as 7.9 inches.

Stemming - (## ft) - *24* - Copy the stemming length from the log, if a range is given use the lowest value.

Backfill - (# ft) - *2* - Copy the backfill length from the log. If a range is given use the lowest value, leave blank if none.

Decking - (## ft) - *8* -Copy the length of inert decking material between charges from the log. Leave blank if no decks. For presplit blasts with air decks, enter the air deck column length.

Charges per Hole - (#) - *2* -Copy the number of charges per hole from the log. When holes are decked, the calculated charge weights will assume equal charges per deck. If one charge is larger than the other, note so in the comment section.

Explosive Type - (aaaa) - ANFO - Copy the primary explosive charge in each hole, ANFO, emulsion, slurry, dynamite, etc.

Explosive Density - (#.## g/cc) - *0.90* - Copy the density of the primary explosive charge. Ask the blaster or refer to the explosive manufacturers literature if not reported.

Reported Explosives / Hole - (#### lb) - *1700* - Copy the maximum explosives in any hole as reported on the log.

Reported Explosives / Delay - (#### lb) - *1200* - Copy the maximum explosives detonated within any 8-ms delay interval as reported on the log.

***Actual Charges per Delay** - (##) - *1* - Determine the actual charges per delay from the sketch of the blast. Do this by first calculating the firing time of each charge based the wiring of the initiation system. Then count the charges detonating within any 8-ms window and report the maximum number on the same delay.

Number of Holes - (###) - 3 - Copy the number of holes in the blast from the log.

Material - (aa) - *SH* - Copy the type of material blasted from the log. Choose either SH, SS, or LS. If percentages are given, report the material with the highest percentage.

Reported Total Lbs. - (###### lb) - *5000* - Copy the total weight of explosive reported on the log.

Blasting Seismograph Data. If a blasting seismograph was used for the blast, a seismograph printout of the summary data and waveform should be attached to the blast log. Report all the following data from the seismograph record. If only summary data is given on the blast log, report the data and make a note in the

comment section. **Do not enter blasting seismograph data if the seismograph was not at the nearest structure.**

PPV Reported - (#.## in/s) - *0.25* - Copy the peak particle velocity from the blasting seismograph record.

- Leave blank if not monitored with a blasting seismograph.
- If monitoring was conducted, but the unit did not trigger, leave blank. Note trigger level in comments.

AB Reported - (### dB) - *100* - Copy the airblast from the blasting seismograph record.

- Leave blank if not monitored with a blasting seismograph.
- If airblast was monitored, but the blasting seismograph did not trigger, leave blank, but note trigger level in comments.

PPV Frequency Reported - (### Hz) - *22* - Copy the vibration frequency for the peak particle velocity from the blasting seismograph record.

- Leave blank if not monitored with a seismograph.
- If monitoring was conducted, but frequency was not recorded, leave blank.
- If monitoring was conducted, but the unit did not trigger, leave blank.

Seismograph Record Avail? - (aa) - Y - Is a copy of the ground vibration and airblast waveforms from the blasting seismograph attached to the log or readily available?

- Leave blank if the blast was not monitored.
- Enter Y if the waveform is available and the annual calibration or calibration pulse is present.
- Enter N if a blasting seismograph monitored the blast, but the waveform was not available.
- Enter NT if there was no trigger.

Comments - Give comments an index number relating to the record number on the spreadsheet.

- 5: the blast has production holes and parting holes (or presplit holes). The data reflects the production blast because it will have the most explosives per delay.

- 10: Charge weight in unequal decks, the lower deck is 1200 lb, the upper deck is 500 lb.

IV. Inputting the Blast Log Data

Open Excel and then open the file “BLEP.xls" from the hard drive or floppy drive.

<u>Immediately save</u> the File under another name. Start by clicking on “File, Save as” in the upper left drop down title bar. Then enter the new file name. The file should be named in reference to the mine site. This will preserve “BLEP.xls" as a template for the next use.

If not already open, click the “Data input” tab at the lower left of the spreadsheet.

Enter the company and mine name in cell F4 to the right of the print button, and the date of the review in cell K9. This will print the name and review date automatically on all report sheets.

Enter data in the same format as the "SAMPLE" column for each blast by typing in each cell and pressing the down arrow key to get to the next, and so on. Enter each blast the same way.

BE CAREFUL AS THERE IS NO WARNING THAT YOU MAY HAVE ENTERED DATA INCORRECTLY. CHECK EACH ENTRY TO THE "SAMPLE" COLUMN TO BE SURE YOU ENTERED NUMBERS WHERE NUMBERS BELONG AND TEXT WHERE TEXT BELONGS.

The data input area will scroll upwards, downwards and sideways as necessary or desired by clicking or sliding the boxes and arrows in the spreadsheet corners. The headings and criteria will remain on screen at all times.

After you have entered the data, view the graphs by clicking each tab at the bottom of the screen. If all tab titles are not visible, simply click on the appropriate arrow in the left side of the tab line to move them. You can also view the calculated fields by clicking on the "Analysis" tab.

Note: If ERR, or negative numbers show in any column, please double-check your input in the "Data input" screen (tab) for that blast. You may have accidentally entered text, or accidentally entered a number as a "label". In these cases simply delete the entry and re-enter the correction. ERR may also indicate missing data on the blast log.

V. Printing the Results

Printing of the spreadsheet can be done in whole or part under "File, Print". In the print window select:

- Entire Workbook to print all the tables and graphs, or
- Active Sheet to print the sheet being viewed

VI. Interpreting the Graphs

The graphs are designed to graphically show problematic components of the blast logs and illustrate trends in the data. If any of the points plot in problematic areas, a closer review is warranted by a blasting specialist or violations maybe appropriate. Each of the worksheet graphs are discussed below.

B. Burden (B) / Spacing (S) Comparison (Spacing Tab): Proper confinement of a blast is essential to minimize the adverse effects. If a blast is heavily confined excessive ground vibrations may result. If a blast is under confined, excessive airblast or flyrock may result. This graph identifies an optimum zone for confinement. The two reference lines are defined by the equations $S = B$ and $S = 2B$. If $B > S$, the spacing is really the burden. If $B << S$, the blast is under confined. A burden of 50' represents a presplit blast (heavily confined).

C. Stemming (T) Adequacy (Stemming Tab): Stemming also influences confinement. The reference line is $T = 0.7B$. Points below the line are prone to flyrock and high airblast. A burden of 50' represents a presplit blast (heavily confined).

D. Explosives per Hole (CW per Hole Tab): The graph compares the Reported Explosives per Hole vs the

Calculated Explosives per Hole. The calculated value is based on the empty footage of hole remaining after the Stemming, Decking, and Backfilling are subtracted from Hole Depth. Each point should touch the reference line (1:1). If the points do not touch the reference line, the calculated value is + or - 10% from the reported value. Record keeping needs to be improved.

E. Charge Weight per Delay (CW per Delay Tab)): The graph compares the Reported Explosives per Delay versus the Calculated Explosives per Delay. The calculated value is based on the Explosives per Hole divided by the Charges per Hole and multiplied by the Actual Charges per Delay. Each point should touch the reference line (1:1). If the points do not touch the reference line, the calculated value is + or - 10% from the reported value. Record keeping needs to be improved or overlaps in the pattern exist. **No graph is available if the reviewer does not calculate the Actual Charges per Delay.**

F. Distance Comparison (Dist. Comp. Tab): The distance measured from the blast to the nearest structure should equal the reported distance + or - 10%. Points touching the reference line (1:1) are + or - 10%. Points above reference line indicate blasts closer to a structure than reported. Thus the potential for violations exist. If no points are plotted, the blasts could not be located within the permit and a measured value was not obtainable. **No graph is available if the reviewer does not measure the distance to the nearest structure.**

G. Powder Factor by Materials (Powder Factor Tab): The powder factor is calculated from the Calculated Explosives per Hole divided by the bank cubic yards (B x S x Hole Depth / 27). The powder factor should be in line with the type of rock being blasted. Softer rock requires a low powder factor, and hard rock a high powder factor. If the powder factor is high for the type of rock being blasted, flyrock is possible. The reference lines show reasonable powder factors for the material being blasted.

H. Compliance with Scaled Distance (SD Compliance Tab): Compliance with the scaled distance limitations is gauged by the Reported and Distance Measured versus Reported and Calculated Scaled Distance, respectively. Points above the line are in compliance and those below the line are noncompliant. Reported values are plotted with circles and the calculated valued are plotted with squares. The calculated values will hide reported values. Calculated values are not plotted if one of the optional fields is not determined.

I. Compliance with Peak Particle Velocity (PPV Compliance Tab): Compliance with the PPV limitations is gauged by the Reported and Distance Measured versus Reported Peak Particle Velocity. Limits are dependant on the distance from the blast. Points above the line are non compliant. Reported values are plotted with circles and the calculated valued are plotted with squares. The calculated values will hide reported values. Calculated values are not plotted if one of the optional fields is not determined.

J. Reported and Calculated SD vs PPV Analysis (SD vs PPV Tab): Reported and Calculated Scaled Distance is plotted with the Peak Particle Velocity. The reference lines are from RI 8507 for coal mines nationally: PPV mean = $119(SD2)^{-1.52}$: and PPV max = $438(SD2)^{-1.52}$. Any points above the PPV max line represent bad blasts, poor records or poor quality control in the field. Reported values are plotted with circles and the calculated valued are plotted with squares. The calculated values will hide reported values. Calculated values are not plotted if one of the optional fields is not determined.

K. Compliance with Blasting Level Chart (BLC Compliance Tab): Peak Particle Velocity is plotted against Frequency of the vibration. Points below the reference line are in compliance.

L. Airblast Analysis (Airblast Tab): Reported and Calculated Airblast are compared to the Cubed Root Scaled Distance . The allowable limit with a 2 Hz microphone is 133 dB (horizontal reference line). The other two reference lines are from RI 8485 for airblast from highwall ($AB_HW = 0.162(SD3)^{-0.794}$) and parting blasts ($AB_PART = 169(SD3)^{-1.623}$). For highwall blasts the points should be near the highwall reference line and likewise for parting blasts. Other types of blasts should fall in between. Reported values are plotted with circles and the calculated valued are plotted with squares. The calculated values will hide reported values. Calculated values are not plotted if one of the optional fields is not determined.

VII. Analysis Sheet

The analysis worksheet contains logical comparisons to help identify the blasts that exceed the reference lines shown on the graphs. Fields that are answered as "YES" fall outside the envelopes of the graphs and warrant closer scrutiny. Refer to the appropriate record number at the top of the sheet. The sheet also contains calculated fields that supplement the graphs.