BLAST LOG EVALUATION PROGRAM (BLEP), VERSION 2.0

Created By:
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Overview

Blasters are required to accurately report the blast design components used in the field for every blast event. Two of the most important blast design components reported on a blast log are the distance to the nearest protected structure and the charge weight per delay. These important blast design components must be accurate to demonstrate compliance with the regulatory requirements and to ensure the control of the adverse effects of blasting. The BLEP evaluates and verifies the reported blast log data for accuracy and compliance using standard explosives engineering practices, cross tabulation of the reported data, and spatial distributions. Ultimately, the BLEP provides the reviewer (e.g. inspector or blasting specialist) a practical and comprehensive tool to quickly evaluate up to fifty (50) blast logs at a site.

The BLEP analysis is focused on the reported distance to the nearest protected structure and the reported charge weight per delay. Due to the range and complexity of blast patterns utilized in the field, the BLEP simplifies the analysis by assuming a worst-case scenario of a single blast hole within the blast pattern. The BLEP assumes the deepest hole in the blast pattern has the least amount of stemming to calculate the greatest possible charge-weight per hole. When combined with the number of charges detonating within an eight (8) millisecond period, the maximum charge weight per delay is calculated. This approach will yield the greatest charge weight possible in any blast hole within the reported blast pattern and thus, evaluate the worst-case scenario.

The BLEP works as an easy to use Microsoft Excel spreadsheet. The only data necessary to perform a BLEP analysis is obtained from the blast log. As data for each blast event is entered, the BLEP automatically performs the analysis, cross tabulates the input data, and illustrates the results on eleven (11) graphs. Each graph is intended to assist the reviewer with identifying problematic blast design components that have been reported on the blast log. The BLEP results and graphs will allow the reviewer to quickly assess if the blast events have been well designed and implemented properly in the field. The reviewer will also be able to determine if the blaster is consistently making blast design choices that ensure compliance with the regulatory requirements and control of the adverse effects of blasting.

BLEP Instructions

1. The BLEP (Version 2.0) and the corresponding BLEP instructions can be downloaded from the OSMRE Appalachian Region blasting website (ARblast: http://www.osmre.gov/resources/blasting/arblast.shtm). Go to the ARblast website and scroll down to the resource table called "Excel Tools". Click the link for the BLEP to download. BLEP users are encouraged to check the ARblast website periodically for any updated versions of the BLEP.

2. Open the BLEP spreadsheet and immediately save the file as different name. Start by clicking on the File tab in the upper left, select the save-as option, and then enter the new file name. The file should be named in reference to the mine site or permit number.

3. Select the "0. Data Input" worksheet tab at the lower left of the spreadsheet. Be aware an artificial blast log has been entered in the Blast Log #1 column. The artificial data is only intended as an example of data entry. The reviewer should delete the artificial data prior to performing a BLEP analysis of real data.

4. Blue font in the "0. Data Input" worksheet identifies required data entry by the user. Black font identifies the BLEP template text and should not be edited.

5. Select the "0. Data Input" worksheet tab at the lower left of the spreadsheet and enter the following in rows 1 and 2 of Page 1: Review Agency, Blaster, Surface Mine, Permit No., Review Date, and Reviewed by. The reviewer only needs to enter this information once. This information is very useful and will print automatically on each graph, the date input summary sheets, and the analysis summary sheets.

6. Enter the required blast log data on the "0. Data Input" worksheet. Refer to Attachment A for the *Data Input Summary and Guidance* document. This document provides guidance on how to complete the blast log data entry. All data entry is copied from a blast log except for the Distance Measured, Explosive Density, and Calculated (Calc.) Charges per Delay, which are estimated or calculated by the reviewer. The reviewer must exercise close attention to detail when entering the required blast log data; the BLEP provides no error message that indicates the reviewer may have entered data incorrectly.

7. Upon completing the blast log data entry, the reviewer may assess the analysis results by selecting the worksheet tabs numbers 1 through 11 to view each graph. Refer to Attachment B for the *Interpreting Blast Log Data and Trends* document. This document provide guidance on how to interpret the BLEP analysis results. The list numbers shown in Attachment B correspond to the BLEP worksheet tab numbers. If necessary, select the arrows in the bottom left corner to scroll through the worksheet tabs.

8. If the reviewer enters blast log data for several blast logs, the graphs should begin to illustrate trends in the blaster's design decisions and the corresponding blast event performance. Any trends in the blast log data will become increasingly defined with each blast log evaluated. The reviewer is encouraged to evaluate as much reliable data that is available.

9. If any of the reported blast log data plots in problematic or non-compliance areas on the graphs, a closer review by a qualified blasting specialist or engineer is recommended. If the BLEP results and graphs show the reported blast log data is within the expected range of performance and behavior, the reviewer may judge the blast logs to be accurate with a high level of confidence.

10. If a closer review of the blast log data is needed, the reviewer may want to review Attachment C, *Blast Design Components*. Attachment C summarizes each of the blast design components analyzed in the BLEP and provides the corresponding calculations or formulas.

11. The blast log evaluation results can also be viewed on the "12. Analysis" worksheet and the reviewer can easily perform an error check here. If any errors or negative numbers are shown in any of the worksheet columns, check the data input that corresponds to that blast log and make any corrections as necessary.

12. The "12. Analysis" worksheet contains logical comparisons and calculations to help identify the blast events that exceed the reference lines shown on the graphs. Select the "12. Analysis" worksheet tab and review the results upon completing the data entry. Data cells indicating a "Greater" or "Exceeds 10%" response exceed compliance limits or general rules of thumb for designed blasts and deserve a closer examination. Refer to the corresponding blast log number at the top of the worksheet and review the blast log again.

13. The "12. Analysis" worksheet is a protected worksheet and cannot be edited by the reviewer. This is to ensure the worksheet calculations and formulas are not changed by mistake. All other worksheets may be edited by the reviewer.

14. Printing of the BLEP evaluation results can be done in whole or individually. Refer to Attachment D for a BLEP printed workbook example. In the print window, select either in the settings dropdown menu:

    a. Entire workbook to print all the tables and graphs accordingly or;

    b. Active sheet to print the sheet being viewed.

Technical Issues and Troubleshooting

Contact the individuals listed below for technical assistance. If the spreadsheet doesn't appear to be functioning properly, the spreadsheet may have been unintentionally edited or changed. In this case, simply go to the ARblast website and download a new BLEP spreadsheet template. Also, BLEP users may send any recommendations for improvement to the individuals listed below.

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Attachments

Listed below are references created for the BLEP (Version 2.0). These references are intended to aid BLEP users and provide useful information on standard explosives engineering practices. BLEP users are encouraged to review the following references prior to using the BLEP.

Attachment A: BLEP (Version 2.0) Data Input Summary and Guidance

Attachment B: BLEP (Version 2.0) Data Interpretation

Attachment C: Blast Design Components

Attachment D: BLEP (Version 2.0) Example

Attachment A: BLEP (Version 2.0) Data Input Summary and Guidance

Required Data Input from Blast Logs

The BLEP requires the following data fields to be entered in the specified format and units. The numeric data fields are formatted in BLEP to show the appropriate decimal places. Guidance on data input is provided in the data field description below. Data fields marked with an asterisk (*****) are optional but, are recommended for completeness. Blue font in the BLEP identifies a cell that requires an entry by the user. An example blast log has been input for example in the BLEP template file.

Data Field	Units	Description
Review Agency	Text	Name of the agency or firm conducting the blast log evaluation.
Review Date	MM/DD/YY	Date of the blast log evaluation.
Reviewed By	Text	Name of the individual(s) conducting the evaluation.
Surface Mine	Text	Name of the surface mine related to the permit number.
Permit Number	Text	Permit number assigned by regulatory authority to the surface mine.
Blaster	Text	Blasting company as reported on the blast log.
Blast Date	MM/DD/YY	Date of the blast as reported on the blast log.
Blast Time	hh:mm PM/AM	Time of the blast as reported on the blast log.
Coal Seam	Text	Name or identification of the coal seam underlying the blast site. If two or more benches are needed to reach the coal seam, identify the bench on which the blast occurred. For quarries, specify the level or enter none.
Nearest Structure	Text	Name or identification of the nearest protected structure. If the nearest protected structure is a dwelling, provide the property owner's last name or address. If the nearest protected structure is not a dwelling, provide the name and type of structure (e.g., Pikeville High School, Fred's Tire Supply, St. Johns Church, etc.). Abbreviations are acceptable with a full reference provided in the reviewer's comments.

Attachment A: BLEP (Version 2.0) Data Input Summary and Guidance

Data Field	Units	Description
Distance Reported	Feet	Provide the distance to the nearest protected structure as reported on the blast log.
Distance Measured *	Feet	Locate the blast site on a map and the nearest protected structure. Measure the distance between them to the nearest tens of feet. The distance measured may be different than the reported distance for the nearest protected structure identified on the blast log. The reviewer must verify the blast location and nearest structure location on a map and then measure the distance between them. If the blast site cannot be located on the mine map, leave the entry blank. This field is optional but, is recommended for a comprehensive review.
Burden	Feet	Provide the burden length as reported on the blast log. If the blast log indicates the shot is a presplit blast event, enter a value of 50 feet for burden length.
Spacing	Feet	Provide the blast hole spacing as reported on the blast log.
Hole Depth	Feet	Provide the blast hole depth as reported on the blast log. If a range is given, use the highest value of the range. The data entered should yield the largest charge weight possible in any hole in the blast.
Hole Diameter	Inches	Provide the blast hole diameter as reported on the blast log. The diameter must be a decimal number (e.g. 7 and $^{7}/_{8}$ inches equals 7.875 inches). If a range is given, use the highest value of the range. The data entered should yield the largest charge weight possible in any hole in the blast.
Number of Holes	Number	Provide the number of blast holes in the blast event as reported on the blast log.

Attachment A: BLEP (Version 2.0) Data Input Summary and Guidance

Data Field	Units	Description
Stemming	Feet	Provide the stemming length as reported on the blast log. If a range is given, use the lowest value of the range. The data entered should yield the largest charge weight possible in any hole in the blast.
Backfill	Feet	Provide the backfill length as reported on the blast log. If a range is given, use the lowest value of the range. If no backfill length is indicated on the blast log, leave data field blank. The data entered should yield the largest charge weight possible in any hole in the blast.
Decking	Feet	Provide the length of inert decking material between charges as reported on the blast log. If no decking material is indicated on the blast log, leave data field blank. For presplit blasts with air decks, enter the air deck column length. The data entered should yield the largest charge weight possible in any hole in the blast.
Charges per Hole	Number	Provide the number of charges per hole as reported on the blast log. When holes are decked, the calculated charge weights will assume equal charges per deck. If one charge is larger than the other, note this in the comment section.
Explosive Type	Text	Provide the primary explosive charge type in each hole as reported on the blast log (e.g. ANFO, emulsion, slurry, dynamite, etc.). If known, provide the specific product trade name designated by the manufactuer (e.g. Austinite 15, HEET 30, IREMEX 664, etc.).
Explosive Density	Grams/cubic centimeter (g/cm^3 or g/cc)	Provide the density of the primary explosive charge as reported on the blast log. If not reported, ask the lead blaster or refer to the explosive manufacturer's literature. Bulk load explosive density may be assumed to be 0.85 g/cm^3 in many cases. <u>However, the reviewer must use an appropriate and representative densities because it can significantly effect the BLEP analysis results</u>.

Attachment A: BLEP (Version 2.0) Data Input Summary and Guidance

Data Field	Units	Description
Reported Explosives per Hole	Pounds	Provide the maximum explosives amount in any blast hole as reported on the blast log.
Reported Explosives per Delay	Pounds	Provide the maximum explosives amount detonated within any eight (8) millisecond delay interval as reported on the blast log.
Calculated (Calc.) Charges per Delay *****	Number	Determine the actual charges per delay from the sketch of the blast site. Do this by first calculating the firing time of each charge based the wiring of the initiation system. Then count the number of charges detonating within any eight (8) millisecond period (i.e. timing out the shot). Report the maximum number of charges that detonate within an eight (8) millisecond period. This field is optional but, is recommended for a comprehensive review.
Rock Type	Text	Provide the type of rock blasted as reported on the blast log. Choose either shale (SH), sandstone (SS), or limestone (LS). If percentages are given, report the material with the highest percentage.
Reported Total Exp.	Pound	Provide the total weight of explosive as reported on the blast log.

Data Input from Blasting Seismograph Records

When available, seismograph record data that corresponds to the blast log should be entered in the specified format and units. The numeric data fields are formatted in the BLEP spreadsheet to show the appropriate decimal places. Guidance on data input is provided in the data field description below. If only seismic summary data is provided on the blast log, report the data and make a note in the comment section.

Per Federal and State regulatory requirements, compliance with blast-induced ground vibration and airblast limits are measured at the nearest protected structure. All seismograph record data is assumed to be measured at the nearest protected structure unless otherwise noted or found to be different by the reviewer. Seismograph record data measured at a location that is not the nearest protected structure will be entered in the "Additional Monitoring" data fields.

Data Field	Units	Description
Peak Particle Velocity (PPV) Reported	inch/second	Provide the maximum PPV as reported from the blasting seismograph record. • If monitoring was not conducted, leave the data field blank. • If monitoring was conducted but, the unit did not trigger, leave the data field blank. Note trigger level in the comments.
PPV Frequency	Hertz (Hz)	Provide the corresponding maximum PPV ground vibration frequency as reported. • If monitoring was not conducted, leave the data field blank. • If monitoring was conducted but, the PPV frequency was not recorded, leave the data field blank and note in the comments. • If monitoring was conducted but, the unit did not trigger, leave the data field blank and note in the comments.
Airblast (AB) Reported	Decibels (dB)	Provide the airblast as reported from the blasting seismograph record. • If monitoring was not conducted, leave the data field blank. • If monitoring was conducted but, the unit did not trigger, leave the data field blank and note trigger level in the comments.

Attachment A: BLEP (Version 2.0) Data Input Summary and Guidance

Data Field	Units	Description
Waveform Available?	Text	Is a copy of the ground vibration and airblast waveforms from the blasting seismograph record attached to the blast log or readily available? • If monitoring was not conducted, leave the data field blank. • If the waveforms are available and the annual calibration or calibration pulse is present, enter “Yes”. • If monitoring was conducted but, the waveform is/was not available, enter “No”. • If the unit did not trigger, enter “NT”.
Comments	Text	Provide any unusual or particular notes documented on the blast log by the lead blaster. If noted, provide the type of shot or blasting technique performed (e.g. parting, lift, cast, presplitting, test hole, etc.). In some cases, the reviewer may want to provide a lot of detail regarding a blast. If so, the reviewer should provide comments an index number relating to the record number on the spreadsheet. For example: • 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. • 7: Crushed stone was used as stemming. • 10: Charge weight in unequal decks, the lower deck is 1200 pounds, the upper deck is 500 pounds.
Additional Monitoring	Text	Any additional seismograph monitoring locations will be noted here. If the additional monitoring location is a dwelling, provide the property owner’s last name or address. If the additional monitoring location is not a dwelling, provide the name and type of structure (e.g., EQT Oil Well, Columbia Gas Line, Interstate 79 Bridge, West Penn Power Pole, etc.). Abbreviations are acceptable with a full reference provided in the reviewer’s comments.

Attachment A: BLEP (Version 2.0) Data Input Summary and Guidance

Data Field	Units	Description
Distance Reported	Feet	Provide the distance to the additional monitoring location as reported on the blast log.
Distance Measured *	Feet	Locate the blast site on a map and the additional monitoring location. Measure the distance between them to the nearest tens of feet. If the blast site cannot be located on the mine map, leave the entry blank. This field is optional but, is recommended for a comprehensive review.
PPV Reported	Inch/second	Provide the maximum PPV as reported from the blasting seismograph record. • If monitoring was not conducted, leave the data field blank. • If monitoring was conducted but, the unit did not trigger, leave the data field blank and note the trigger level in the comments.
PPV Frequency	Hertz (Hz)	Provide the corresponding maximum PPV ground vibration frequency as reported. • If monitoring was not conducted, leave the data field blank. • If monitoring was conducted but, the PPV frequency was not recorded, leave the data field blank and note in the comments. • If monitoring was conducted but, the unit did not trigger, leave the data field blank and note in the comments.
AB Reported	Decibels (dB)	Provide the airblast as reported from the blasting seismograph record. • If monitoring was not conducted, leave the data field blank. • If monitoring was conducted but, the unit did not trigger, leave the data field blank and note the trigger level in the comments.

Attachment A: BLEP (Version 2.0) Data Input Summary and Guidance

Data Field	Units	Description
Waveform Available?	Text	Is a copy of the ground vibration and airblast waveforms from the blasting seismograph record attached to the blast log or readily available? • If monitoring was not conducted, leave the data field blank. • If the waveforms are available and the annual calibration or calibration pulse is present, enter “Yes”. • If monitoring was conducted but, the waveform is/was not available, enter “No”. • If the unit did not trigger, enter “NT”.

Attachment B: BLEP (Version 2.0) Data Interpretation

Guidelines for Interpreting BLEP Results

The BLEP contains eleven (11) worksheets (i.e. graphs) intended to assist the reviewer with identifying problematic components of the blast log data. Each graph plots the blast log data and spreadsheet calculations accordingly and is compared against standard explosives engineering practices, accepted standards, or compliance regulations. If the reviewer evaluates several blast logs, the graphs should begin to illustrate trends that exist in the blast log data. Any trends in the blast log data will become increasingly defined with each blast log evaluated. The reviewer is encouraged to evaluate as much reliable data that is available.

The BLEP results will allow the reviewer to assess if the blasts have been well designed and implemented properly in the field. The reviewer will able to determine if the blaster is consistently making blast design choices that ensure compliance with the regulatory requirements and control of the adverse effects of blasting. If any of the blast log data plots in problematic or non-compliance areas, a closer review by a blasting specialist or engineer is recommended. All eleven (11) graphs are discussed below and guidance is provided on how to interpret blast log data and trends. Note, the list number shown below corresponds to the same number shown on the BLEP worksheet tab.

1. **Burden / Spacing Comparison**: Proper confinement of a blast is essential to minimize the adverse effects. The Burden (B) / Spacing (S) Comparison graph identifies an optimum zone for confinement, which is defined by two reference lines. If a blast is heavily confined (i.e. burden much greater than spacing), excessive ground vibrations may result. If a blast is under confined (i.e. burden is less than twice the spacing), excessive airblast or flyrock may result. The blast log data points should fall within the expected data range defined by the two reference lines. Within the BLEP, a burden of fifty (50) feet represents a presplit blast (i.e. heavily confined).

2. **Stemming Adequacy**: Like burden and spacing, the amount of stemming (T) length also influences confinement. The Stemming Adequacy graph illustrates whether or not an adequate amount of stemming length is being properly implemented in the field. The reference line is defined by the equation T = 0.7(B). Data points below the line are prone to flyrock and high airblast levels. Within the BLEP, a burden of fifty (50) feet represents a presplit blast (i.e. heavily confined).

3. **Charge Weight Per Hole**: The Charge Weight (CW) per Hole graph compares the reported CW per hole (as reported on the blast log) with the calculated CW per hole. The calculated CW per hole value is based on the length of blast hole remaining after the stemming, decking, and backfilling material lengths are subtracted from blast hole depth. Each data point should touch the reference line, which is a 1:1 ratio. If the data points do not touch the reference line, the calculated value is considered to be greater than ten (±10) percent from the reported value and indicates blast log record keeping should be improved.

4. **Charge Weight Per Delay**: The Charge Weight (CW) per Delay graph compares the Reported Explosives per Delay (as reported on the blast log) with the Calculated Explosives per Delay. The Calculated Explosives per Delay value is based on the Explosives per Hole divided by the Charges per Hole and multiplied by the Actual Charges per Delay. The calculated value should equal the reported value and each data point should touch the reference line, which is a 1:1 ratio. Data points touching the reference line are considered to be within ten (±10) percent of the reported value. A trend that doesn't closely follow the reference line indicates the blast log record keeping should be improved or overlaps in the blast pattern exist. No graph is available if the reviewer does not provide the Calculated Explosives per Delay value in the spreadsheet.

5. **Distance Comparison**: The Distance Comparison graph compares the distance measured from the blast site to the nearest protected structure (or additional monitoring locations) to the distance reported on the blast log. The distance measured should equal the distance reported on the blast log. The reviewer must pay attention to the closest reported structure because it may not be the closest structure based on the blast site location. Data points touching the reference line are considered to be within ten (±10) percent of the reported value. Data points above the reference line indicate the blasts are closer than reported and thus, a potential for permit violations exist. If no data points are plotted, the blasts may not be located within the permit boundary or a measured distance was not obtainable. No graph is available if the reviewer does not provide the distance measured from the blast site to the nearest structure in the spreadsheet.

6. **Powder Factor By Rock Type**: Powder factor is the amount of explosive per unit volume of rock per hole. Refer to Attachment C for additional details on how the powder factor is calculated. The powder factor by rock type graph shows reasonable ranges of powder factors according to the type of rock being blasted. Soft rock (e.g. shale and sandstone) requires a low powder factor to ensure reasonable confinement. Conversely, hard rock (e.g. limestone and sandstone with high compressive strengths) may allow the blaster to use higher powder factors. If the data points fall beyond the accepted limits for the type of rock being blasted, a potential for flyrock incidents exists.

7. **Compliance With Scaled Distance**: The Compliance With Scaled Distance (SD_2) graph plots the reported and measured distances versus the reported and calculated square root scaled distances, respectively. This graph allows the reviewer to quickly assess if any of the blast events exceed the minimum Federal and State scaled distance requirements. Data points that plot above the line are in compliance and those plotting below the line are considered to be in noncompliance. The reported value data points are plotted with red squares and the measured and calculated value data points (i.e. cross checked) are plotted with blue circles. If the reported values are accurate, the cross checked data

points will hide the reported value data points. Cross checked data points are not plotted if one of the optional fields is not determined.

8. **Compliance With Peak Particle Velocity**: The Compliance With Peak Particle Velocity (PPV) graph plots the reported and measured distances versus the reported PPV. This graph allows the reviewer to quickly assess if any of the blast events exceed the maximum Federal and State ground vibration requirements. The ground vibration limit depends on the distance from the blast site to the nearest structure. Data points that plot above the line are considered to be in noncompliance. The reported value data points are plotted with red squares and the measured value data points (i.e. cross checked) are plotted with blue circles. If the reported data points are accurate, the cross checked data points will hide the reported data points. Cross checked data points are not plotted if the optional fields are not provided. If no seismic record is associated with the blast log, compliance with scaled distance requirements controls.

9. **Scaled Distance vs Peak Particle Velocity**: When seismic monitoring data is provided in the BLEP, the seismic characteristics of an area (e.g. a surface mine) can be defined. This is done by plotting the peak particle velocity (PPV) from the seismic record (or as reported on the blast log) versus the corresponding calculated and reported square root scaled distance (SD_2) on a log-log graph. Refer to Attachment C for additional details on how SD_2 is calculated. When PPV data is provided in the BLEP, the data points will illustrate how the blast-induced ground vibration amplitudes attenuate over distance.

   There are two (2) reference lines provided on the graph for the reviewer to conduct a comparison and check of the data points. These reference lines illustrate the expected (i.e. mean or best fit) and upper bound limit of vibration amplitudes representative of blasting at a surface coal mine. For additional information on how blast-induced ground vibration amplitudes are evaluated and predicted, refer to the U.S. Bureau of Mines' (USBM) publication, *Report of Investigation (RI) 8507, Structure Response and Damage Produced by Ground Vibration from Surface Mine Blasting*. The reference lines are defined by the following equations:

$$PPV_{(Best\ Fit)} = 119\ (SD_2)^{-1.52} \qquad \text{[inch per second]}$$

$$PPV_{(Upper\ Bound)} = 438\ (SD_2)^{-1.52} \qquad \text{[inch per second]}$$

   Data points that plot above the upper bound line may indicate: poor record keeping by the blaster; poor quality control implemented in the field; a blast event where ground vibrations exceeded compliance requirements; a blast event where the potential for flyrock was increased; or any other adverse effects associated with blasting. The reported value data points are plotted with red squares and the calculated value data points (i.e. cross checked) are plotted with blue circles. If the reported data points are accurate, the cross checked data points will hide

reported data points. Cross checked data points are not plotted if the optional fields are not provided. If no seismic record is associated with the blast log, compliance with scaled distance requirements controls.

10. **Compliance With Blasting Level Chart**: The Compliance with Blasting Level Chart graph plots the measured PPV versus the corresponding frequency of the blast-induced ground vibration. This graph allows the reviewer to quickly assess if any of the blast events exceed the minimum Federal and State regulatory requirements for blast-induced ground vibrations. Data points below the black reference line are in compliance with the OSMRE Blasting Level Chart. Data points below the red line are in compliance with USBM RI 8507, Appendix B. Additionally, plaster and drywall levels from the USBM criteria are referenced on the graph.

11. **Compliance With Airblast**: The Compliance with Airblast (AB) graph plots the reported and calculated AB versus the corresponding cube root scaled distance (SD_3). Refer to Attachment C for additional details on how SD_3 and AB are calculated. When AB data is provided in the BLEP, the data points will illustrate how the AB attenuates over distance.

    There are three reference lines provided on the graph for the reviewer to conduct a comparison and check of the data points. The black horizontal reference line indicates the maximum allowable AB is 133 decibels for satisfying compliance with OSMRE regulatory requirements. This requirement assumes a two (2) Hertz microphone is used when monitoring a blast event. The other two reference lines shown on the graph illustrate the expected AB (i.e. mean or best fit) that may be generated from blasting at a surface coal mine. The solid blue reference line is representative of a parting shot and the dashed blue reference line is representative of a highwall shot. For additional information on how AB is evaluated and predicted, refer to *USBM, RI 8485, Structure Response and Damage Produced by Airblast From Surface Mining*. The reference lines are defined by the following equations:

    $$AB_{(Parting)} = 169\ (SD_3)^{-1.62} \quad \text{[pounds per square inch, psi]}$$

    $$AB_{(Highwall)} = 0.162\ (SD_3)^{-0.79} \quad \text{[pounds per square inch, psi]}$$

    For parting blasts, the data points should plot near the parting reference line and likewise for highwall blasts. Other types of blasts should plot somewhere between the parting and highwall reference lines. Data points that plot above the maximum allowable AB reference line may indicate a permit violation has occurred. The reported value data points are plotted with red squares and the calculated value data points (i.e. cross checked) are plotted with blue circles. If the reported data points are accurate, the cross checked data points will hide reported data points. Cross checked data points are not plotted if the optional fields are not provided.

Attachment C: Blast Design Components

The Blast Design Rules of Thumb

The following table summarizes blast design components the lead blaster must consider prior to a blast event. These blast design components should be carefully considered to ensure compliance with the regulatory requirements and control of the adverse effects of blasting. When given a borehole depth, a rock type (e.g. shale, sandstone, limestone), and the distance to the nearest protected structure, standard explosives engineering practices (i.e. rules of thumb) can be applied to estimate these blast design components. The BLEP uses these standard explosives engineering practices as the foundation for evaluating blast log data.

Blast Design Component	Description
Borehole Diameter (d)	The borehole diameter is generally assumed to be within a range of one-fifth ($^1/_5$) to one-tenth ($^1/_{10}$) of the borehole depth. d = H / (5 to 10) d = H / 7 (typically assumed) Where, d is in inches (in) and H is in feet (ft).
Burden (B)	Burden is the shortest distance from an explosive charge to its nearest free face. Burden is generally assumed to be two (2) to three (3) times the borehole diameter. B = (2 to 3) × d B = 2.5 × d (typically assumed) Where, B is in feet (ft) and d is in inches (in).
Spacing (S)	Spacing is the distance between boreholes in a row. In bench blasting, the distance is measured parallel to the free face and perpendicular to the burden. Spacing is generally assumed to be one (1) to two (2) times the burden. S = (1 to 2) × B S = 1.5 × B (typically assumed) Where, S and B are both in feet (ft).

Attachment C: Blast Design Components

Blast Design Component	Description
Stemming (T)	Stemming is the inert material used to confined energy within the borehole at the top of the explosive charge. Stemming is generally assumed to be one-half (½) to one (1) times the burden. $T = (0.5 \text{ to } 1.0) \times B$ $T = 0.7 \times B$ (typically assumed) Where, T and B are both in feet (ft).
Powder Column (PC)	Powder column is the borehole depth (H) minus the stemming length (T), backfill length (F), and decking material length (T_d). Backfill is the distance drilled below the actual required blast depth and generally filled with drill cuttings or other material. Decking is the distance used to reduce charge load per hole or amount of explosives detonated per delay, or both. $PC = H - T - F - T_d$ Where, PC, H, T, F, and T_d are in feet (ft).
Loading Density (LD)	Loading density is a measure of the total weight of explosives in a unit length of the borehole and a measure of the energy loaded. $LD = 0.3405 \times \rho_e \times d^2$ (ρ_e = density of explosive material) Where the following units apply: LD is in pounds per feet (lb/ft); explosive density (ρ_e) is in grams per cubic centimeter (gm/cc); and borehole diameter (d) is in inches (in). Note, the constant value of 0.3405 is used for unit conversion. Always refer to the manufacturer design guide. Also, refer to the manufacturer product specification for explosive density or the ask Lead Blaster.

Attachment C: Blast Design Components

Blast Design Component	Description
Charge Weight (CW)	The charge weight is the maximum weight of explosives detonated within an 8-millisecond delay period. The charge weight equals the powder column times the loading density. $CW = PC \times LD$ Where the following units apply: CW is in pounds (lb); PC is in feet (ft); and LD is in pounds per feet (lb/ft).
Powder Factor (PF)	Powder factor is the amount of explosive per unit volume of rock per hole. $PF = CW / [(B \times S \times H) / 27]$ Where the following units apply: PF is in pounds per cubic yard (lb/yd^3); CW is in pounds (lb); and B, S, and H are all in feet (ft). Note, the value of 27 is used for unit conversion.
Square Root Scaled Distance (SD_2)	SD_2 is defined as the distance from the blast site to the seismograph location (D), divided by the square root of the maximum weight of explosives detonated within an 8-millisecond delay period (CW). The equation for square root scaled distance is commonly represented several ways. $SD_2 = D / \sqrt{CW}$ $SD_2 = D / CW^{0.5}$ $SD_2 = D / CW^{(½)}$ Where the following units apply: SD_2 is in feet per the square root of pounds ($ft/lb^{½}$); D is in feet (ft); and CW is in square root of pounds ($lb^{½}$). Note: An SD_2 value of fifty-five (55 $ft/lb^{½}$) for distances between 301 to 1,000 feet provides a high level of confidence that damage to structures will not occur.

Attachment C: Blast Design Components

Blast Design Component	Description
Cube Root Scaled Distance (SD_3)	SD_3 is defined as the distance from the blast site to the seismograph location (D), divided by the cube root of the maximum weight of explosives detonated within an 8-millisecond delay period (CW). The equation for cube root scaled distance is commonly represented several ways. $SD_3 = D / \sqrt[3]{CW}$ $SD_3 = D / CW^{0.33}$ $SD_3 = D / CW^{(1/3)}$ Where the following units apply: SD_3 is in feet per the cube root of pounds ($ft/lb^{1/3}$); D is in feet (ft); and CW is in cube root of pounds ($lb^{1/3}$).
Peak Particle Velocity (PPV)	The PPV is the absolute highest zero to peak value measured from a seismograph time-history waveform. Research has resulted in approximations that can be used, in lieu of site-specific data, for predicting PPV from SD_2. For blasts conducted at a surface coal mine, the following equations may be used to estimate the expected (i.e. mean or best fit) and highest expected (i.e. upper bound) ground vibration levels. The highest potential ground vibration level is estimated with at least ninety-five percent (95%) confidence. These equations assume the blast has been well designed and implemented properly in the field. Additional information on the research for these ground vibration equations can be found in: U.S. Bureau of Mines, Report of Investigations 8507, Structure Response and Damage produced by Ground Vibration from Surface Mine Blasting, Siskin et. al., dated 1980. $PPV_{(Best\ Fit)} = 119\ (SD_2)^{-1.52}$ $PPV_{(Upper\ Bound)} = 438\ (SD_2)^{-1.52}$ Where PPV is in inches per second (in/sec) and SD_2 is in feet per the square root of pounds ($ft/lb^{½}$).

Attachment C: Blast Design Components

Blast Design Component	Description
Airblast (AB)	Seismic monitoring of a blast event typically includes a measurement of air vibrations (i.e. air overpressure). Air overpressure or AB is the additional pressure generated from a blast above the normal atmospheric pressure. AB is measured as a pressure and reported in units of decibels. Research has resulted in approximations that can be used, in lieu of site-specific data, for predicting AB from SD_3. For blasts conducted at a surface coal mine, the following equations may be used to estimate the expected (i.e. best fit or mean) AB levels. One equation is representative of a parting shot and the other equation is representative of a highwall shot. These equations assume the blast has been well designed and implemented properly in the field. Additional information on the research for these AB prediction equations can be found in: U.S. Bureau of Mines, Report of Investigations 8485, Structure Response and Damage Produced by Airblast From Surface Mining, Siskin et. al., dated 1980. $AB_{(Parting)} = 169\ (SD_3)^{-1.62}$ $AB_{(Highwall)} = 0.162\ (SD_3)^{-0.79}$ Where AB is in pounds per square inch (psi) and SD_3 is in feet per the cube root of pounds ($ft/lb^{1/3}$).

Attachment D: BLEP (Version 2.0) Example

BLEP (Version 2.0) Printed Workbook Example

The following pages illustrate: 1) an example of BLEP data entry for a faux surface coal mine; 2) the corresponding BLEP results for the faux surface coal mine; and 3) the corresponding BLEP analysis summary.

OSMRE Blast Log Evaluation Program (BLEP)

Blast Log Data Input		Review Agency:	OSMRE			Surface Mine:	Pittsburgh Mine		Review Date:	1/1/2019	
Component	Units	Blaster:	Top Flight Blasting			Permit No.:	D1977		Evaluated By:	Brian Farmer, P.E.	
Blast Log	#	1	2	3	4	5	6	7	8	9	10
Blast Date	mm/dd/yy	01/06/15	01/07/15	01/08/15	01/09/15	01/12/15	01/13/15	01/14/15	01/15/15	01/19/15	02/02/15
Blast Time	hh:mm PM/AM	12:00 PM	12:00 PM	12:00 PM	12:00 PM	12:00 PM	12:00 PM	12:00 PM	12:00 PM	12:00 PM	12:00 PM
Coal Seam	Name or ID	#6	#6	#6	#6	#6	#5	#5	#5	#5	#5
Nearest Structure	Name or ID	D. Soles	D. Soles	D. Soles	D. Soles	D. Soles	ER Bosler	ER Bosler	D. Soles	D. Soles	D. Soles
Distance Reported	feet	1,852	1,817	1,674	1,576	1,579	2,000	2,026	2,039	1,936	1,779
Distance Measured*	feet	1,796	1,769	1,627	1,526	1,536	2,101	2,147	1,991	1,891	1,733
Burden	feet	19	19	20	20	20	19	19	19	19	19
Spacing	feet	20	20	20	21	21	20	20	20	20	19
Hole Depth	feet	45	46	46	52	53	26	26	26	26	26
Hole Diameter	inches	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75
Number of Holes	#	23	15	25	27	16	70	84	88	59	56
Stemming	feet	12.0	12.0	10.0	12.0	12.0	9.0	9.0	9.0	9.0	9.0
Backfill	feet	4.0	4.0	4.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0
Decking	feet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Charges per Hole	#	1	1	1	1	1	1	1	1	1	1
Explosive Type	Name or Product	IREMEX	IREMEX	IREMEX	IREMEX	IREMEX	IREMEX	IREMEX	IREMEX	IREMEX	IREMEX
Explosive Density	g/cm^3	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32
Reported Exp. / Hole	pounds	650.5	663.5	703.0	782.0	797.0	338.5	326.0	339.3	335.5	329.5
Reported Exp. / Delay	pounds	650.5	663.5	703.0	782.0	797.0	1354.0	1304.0	1357.0	1342.0	1318.0
Calc. Charges / Delay*	#	1	1	1	1	1	4	4	4	4	4
Rock Type	SH, SS, LS	SH	SH	SH	SH	SH	SS	SS	SS	SS	SS
Reported Total Exp.	pounds	14,957.3	9,951.3	16,973.8	19,640.5	12,744.0	23,672.5	27,343.0	29,846.0	19,794.3	18,452.0
PPV Reported	inch/second	0.07	0.05	0.12	0.21	0.20	0.08	0.08	0.10	0.14	0.18
PPV Frequency	Hz	13.1	13.1	11.1	13.1	11.6	56.8	64.0	15.5	26.9	28.4
Airblast Reported	dB	122	123	120	120	120	112	116	120	122	120
Waveform Available?	Yes, No, or NT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Comments							Lift Shot	Lift Shot	Lift Shot	Lift Shot	Lift Shot
Additional Monitoring	text	M. Schafer	M. Schafer	M. Schafer	M. Schafer	M. Schafer	D. Soles	M. Schafer	M. Schafer	M. Schafer	M. Schafer
Distance Reported	feet	1,899	1,872	1,771	1,682	1,704	2,301	2,167	2,048	1,955	1,830
Distance Measured*	feet	1,945	1,919	1,826	17,825	1,746	2,316	2,308	2,091	2,011	1,882
PPV Reported	inch/second			0.08	0.22	0.15	0.07	0.13	0.11	0.11	0.21
PPV Frequency	Hz			8.6	13.8	12.2	22.2	18.2	18.9	25.6	25.6
Airblast Reported	dB			116	118	116	116	116	116	116	118
Waveform Available?	Yes, No, or NT	NT	NT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

OSMRE Blast Log Evaluation Program (BLEP)

Blast Log Data Input		Review Agency:	OSMRE			Surface Mine:	Pittsburgh Mine		Review Date:	1/1/2019	
Component	Units	Blaster:	Top Flight Blasting			Permit No.:	D1977		Evaluated By:	Brian Farmer, P.E.	
Blast Log	#	11	12	13	14	15	16	17	18	19	20
Blast Date	mm/dd/yy	02/19/15	02/20/15	06/19/17	06/20/17	07/10/17	07/10/17	07/11/17	07/12/17	08/14/17	08/16/17
Blast Time	hh:mm PM/AM	12:00 PM	12:00 PM	12:00 PM	12:00 PM	12:00 PM	12:00 PM	12:00 PM	12:00 PM	12:00 PM	12:00 PM
Coal Seam	Name or ID	#5	#5	#6	#6	#6	#6	#6	#6	#6	#6
Nearest Structure	Name or ID	D. Soles	J. Dietz	Lambert	Lambert	Lambert	Lambert	Lambert	Lambert	Lambert	Lambert
Distance Reported	feet	1,624	1,580	1,230	1,205	1,173	1,227	1,243	1,263	1,189	1,111
Distance Measured*	feet	1,570	1,657	1,208	1,180	1,155	1,207	1,220	1,239	1,161	1,086
Burden	feet	19	19	18	18	17	17	17	17	19	19
Spacing	feet	20	20	19	19	18	18	18	18	20	20
Hole Depth	feet	23	23	60	61	41	42	42	42	74	74
Hole Diameter	inches	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75
Number of Holes	#	65	81	21	15	18	15	24	27	15	18
Stemming	feet	9.0	9.0	14.0	13.0	10.0	10.0	10.0	10.0	13.0	13.0
Backfill	feet	3.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Decking	feet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0	7.0
Charges per Hole	#	1	1	1	1	1	1	1	1	2	2
Explosive Type	Name or Product	IREMEX	IREMEX	IREMEX	Bulk/Emulsion	IREMEX	IREMEX	Bulk/Emulsion	Bulk/Emulsion	IREMEX	IREMEX
Explosive Density	g/cm^3	1.32	1.32	1.32	0.93	1.32	1.32	0.99	1.07	1.32	1.32
Reported Exp. / Hole	pounds	274.0	274.0	753.0	770.3	591.0	608.0	610.0	610.0	1027.5	1031.0
Reported Exp. / Delay	pounds	1096.0	1644.0	753.0	770.3	591.0	608.0	610.0	610.0	513.8	515.5
Calc. Charges / Delay*	#	4	6	1	1	1	1	1	1	1	1
Rock Type	SH, SS, LS	SS	SS	SH	SH	SH	SH	LS	LS	SH	SH
Reported Total Exp.	pounds	17,808.8	22,180.8	15,301.5	10,297.5	8,802.0	8,322.5	11,876.0	13,551.5	15,412.5	18,557.0
PPV Reported	inch/second	0.17	0.19	0.25	0.29	0.21	0.14	0.07	0.08	0.26	0.23
PPV Frequency	Hz	17.6	25.6	51.2	64.0	56.8	18.9	25.6	56.8	14.2	12.2
Airblast Reported	dB	122	123	116	123	118	118	118	116	118	118
Waveform Available?	Yes, No, or NT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Comments		Lift Shot	Lift Shot								
Additional Monitoring	text	M. Schafer	D. Soles	ER Bosler	ER Bosler	JD Carns	JD Carns	JD Carns	JD Carns	ER Bosler	ER Bosler
Distance Reported	feet	1,713	1,605	1,793	1,756	1,749	1,749	1,800	1,863	1,905	1,946
Distance Measured*	feet	1,759	1,601	1,810	1,815	1,746	1,742	1,789	1,857	1,976	1,983
PPV Reported	inch/second	0.26	0.20	0.12	0.10	0.18	0.13	0.06	0.08	0.11	0.16
PPV Frequency	Hz	20.4	26.9	8.5	7.1	56.9	51.2	34.1	51.2	7.5	6.4
Airblast Reported	dB	118	123	116	116	112	112	118	106	100	112
Waveform Available?	Yes, No, or NT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

OSMRE Blast Log Evaluation Program (BLEP)

Blast Log Data Input		Review Agency:	OSMRE			Surface Mine:	Pittsburgh Mine		Review Date:	1/1/2019	
Component	Units	Blaster:	Top Flight Blasting			Permit No.:	D1977		Evaluated By:	Brian Farmer, P.E.	
Blast Log	#	21	22	23	24	25	26	27	28	29	30
Blast Date	mm/dd/yy	08/17/17	08/18/17	08/21/17	08/22/17	08/22/17	09/26/17	09/27/17	10/05/17		
Blast Time	hh:mm PM/AM	12:00 PM	12:00 PM	12:00 PM	12:00 PM	12:00 PM	12:00 PM	12:00 PM	12:00 PM		
Coal Seam	Name or ID	#6	#6	#6	#6	#6	#6	#6	#6		
Nearest Structure	Name or ID	Lambert	Lambert	Lambert	Lambert	Lambert	Lambert	Lambert	Lambert		
Distance Reported	feet	1,164	1,092	1,154	1,073	1,162	1,175	1,128	1,101		
Distance Measured*	feet	1,163	1,064	1,132	1,044	1,134	1,152	1,108	1,082		
Burden	feet	19	19	19	19	18	13	14	18		
Spacing	feet	20	20	21	21	18	14	15	20		
Hole Depth	feet	74	75	74	75	46	13	15	58		
Hole Diameter	inches	6.75	6.75	6.75	6.75	6.75	6.75	6.75	6.75		
Number of Holes	#	16	18	20	17	18	20	30	16		
Stemming	feet	13.0	12.0	13.0	13.0	12.0	8.0	8.0	13.0		
Backfill	feet	4.0	4.0	4.0	4.0	4.0	2.0	2.0	4.0		
Decking	feet	7.0	7.0	7.0	7.0	6.0	0.0	0.0	7.0		
Charges per Hole	#	2	2	2	2	2	1	1	2		
Explosive Type	Name or Product	IREMEX	IREMEX	IREMEX	IREMEX	IREMEX	IREMEX	IREMEX	IREMEX		
Explosive Density	g/cm^3	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32		
Reported Exp. / Hole	pounds	1071.5	1129.0	1070.5	1102.0	562.0	90.8	130.5	744.0		
Reported Exp. / Delay	pounds	535.8	564.5	535.3	551.0	281.0	90.8	130.5	372.0		
Calc. Charges / Delay*	#	1	1	1	1	1	1	1	1		
Rock Type	SH, SS, LS	SH	SH	SH	SH	SH	SH	SH	SH		
Reported Total Exp.	pounds	17,144.0	20,317.0	21,410.0	18,730.5	10,102.0	1,815.0	3,912.5	11,364.0		
PPV Reported	inch/second	0.21	0.26	0.21	0.29	0.12	0.07	0.16	0.16		
PPV Frequency	Hz	11.3	13.8	12.8	13.4	14.6	19.6	19.6	12.8		
Airblast Reported	dB	123	125	122	120	120	116	118	123		
Waveform Available?	Yes, No, or NT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Comments											
Additional Monitoring	text	ER Bosler	ER Bosler	ER Bosler	ER Bosler	ER Bosler	ER Bosler	JD Carns	ER Bosler		
Distance Reported	feet	1,858	1,918	1,854	1,913	1,933	1,781	1,617	1,861		
Distance Measured*	feet	1,916	1,970	1,879	1,973	1,969	1,823	1,599	1,906		
PPV Reported	inch/second	0.08	0.16	0.11	0.13	0.05		0.05	0.09		
PPV Frequency	Hz	6.0	7.2	7.1	6.5	7.4		24.4	6.1		
Airblast Reported	dB	116	112	112	112	112		112	112		
Waveform Available?	Yes, No, or NT	Yes	Yes	Yes	Yes	Yes	NT	Yes	Yes		

OSMRE Blast Log Evaluation Program (BLEP)

Blast Log Data Input		Review Agency:	OSMRE			Surface Mine:	Pittsburgh Mine		Review Date:	1/1/2019	
Component	Units	Blaster:	Top Flight Blasting			Permit No.:	D1977		Evaluated By:	Brian Farmer, P.E.	
Blast Log	#	31	32	33	34	35	36	37	38	39	40
Blast Date	mm/dd/yy										
Blast Time	hh:mm PM/AM										
Coal Seam	Name or ID										
Nearest Structure	Name or ID										
Distance Reported	feet										
Distance Measured*	feet										
Burden	feet										
Spacing	feet										
Hole Depth	feet										
Hole Diameter	inches										
Number of Holes	#										
Stemming	feet										
Backfill	feet										
Decking	feet										
Charges per Hole	#										
Explosive Type	Name or Product										
Explosive Density	g/cm^3										
Reported Exp. / Hole	pounds										
Reported Exp. / Delay	pounds										
Calc. Charges / Delay*	#										
Rock Type	SH, SS, LS										
Reported Total Exp.	pounds										
PPV Reported	inch/second										
PPV Frequency	Hz										
Airblast Reported	dB										
Waveform Available?	Yes, No, or NT										
Comments											
Additional Monitoring	text										
Distance Reported	feet										
Distance Measured*	feet										
PPV Reported	inch/second										
PPV Frequency	Hz										
Airblast Reported	dB										
Waveform Available?	Yes, No, or NT										

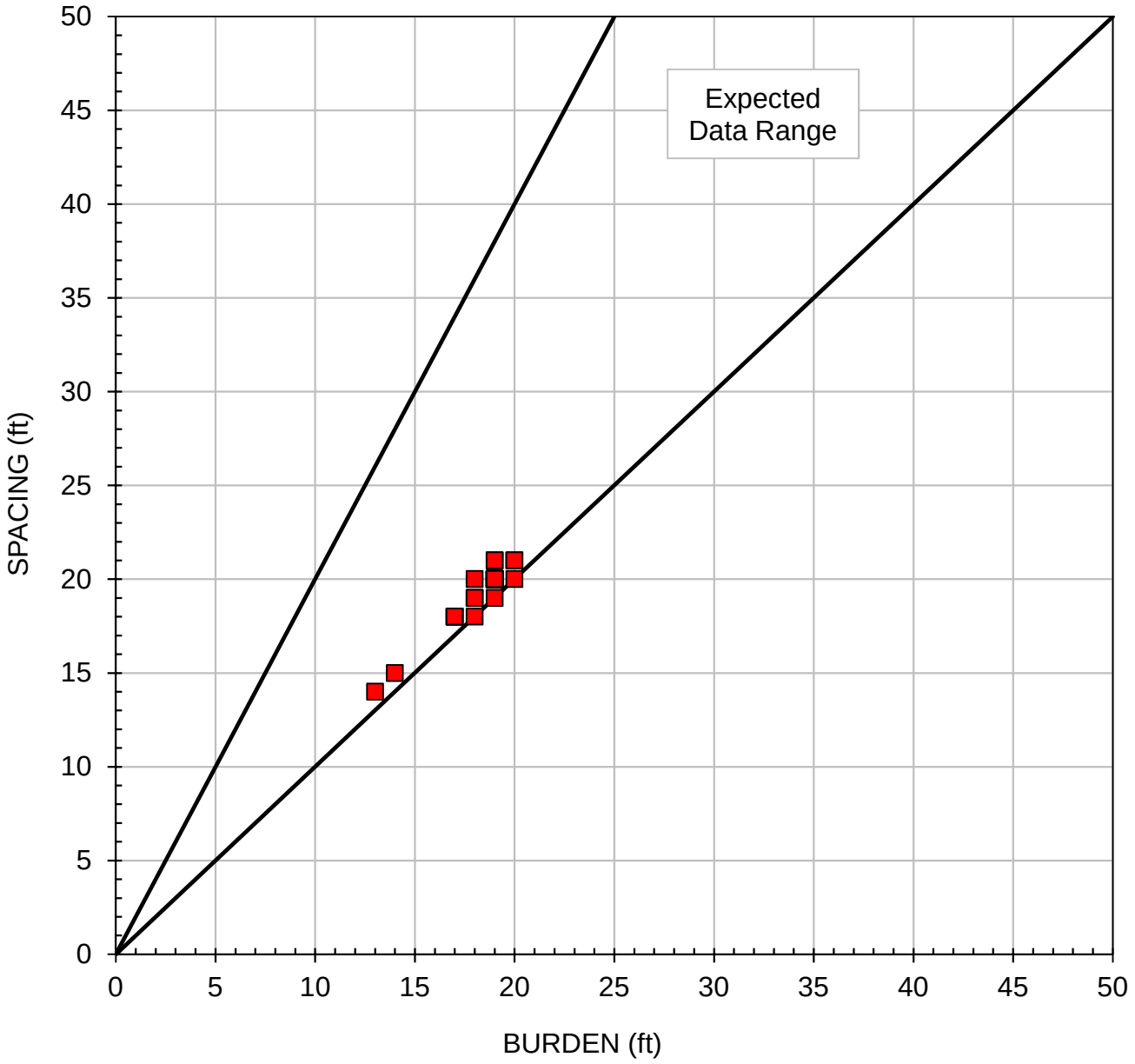
OSMRE Blast Log Evaluation Program (BLEP)

Blast Log Data Input		Review Agency:	OSMRE			Surface Mine:	Pittsburgh Mine		Review Date:	1/1/2019	
Component	Units	Blaster:	Top Flight Blasting			Permit No.:	D1977		Evaluated By:	Brian Farmer, P.E.	
Blast Log	#	41	42	43	44	45	46	47	48	49	50
Blast Date	mm/dd/yy										
Blast Time	hh:mm PM/AM										
Coal Seam	Name or ID										
Nearest Structure	Name or ID										
Distance Reported	feet										
Distance Measured*	feet										
Burden	feet										
Spacing	feet										
Hole Depth	feet										
Hole Diameter	inches										
Number of Holes	#										
Stemming	feet										
Backfill	feet										
Decking	feet										
Charges per Hole	#										
Explosive Type	Name or Product										
Explosive Density	g/cm^3										
Reported Exp. / Hole	pounds										
Reported Exp. / Delay	pounds										
Calc. Charges / Delay*	#										
Rock Type	SH, SS, LS										
Reported Total Exp.	pounds										
PPV Reported	inch/second										
PPV Frequency	Hz										
Airblast Reported	dB										
Waveform Available?	Yes, No, or NT										
Comments											
Additional Monitoring	text										
Distance Reported	feet										
Distance Measured*	feet										
PPV Reported	inch/second										
PPV Frequency	Hz										
Airblast Reported	dB										
Waveform Available?	Yes, No, or NT										

OSMRE BLAST LOG EVALUATION PROGRAM (BLEP)

Mine:	Pittsburgh Mine	Review Agency:	OSMRE
Permit No.:	D1977	Review Date:	1/1/2019
Blaster:	Top Flight Blasting	Evaluated By:	Brian Farmer, P.E.

BURDEN / SPACING COMPARISON

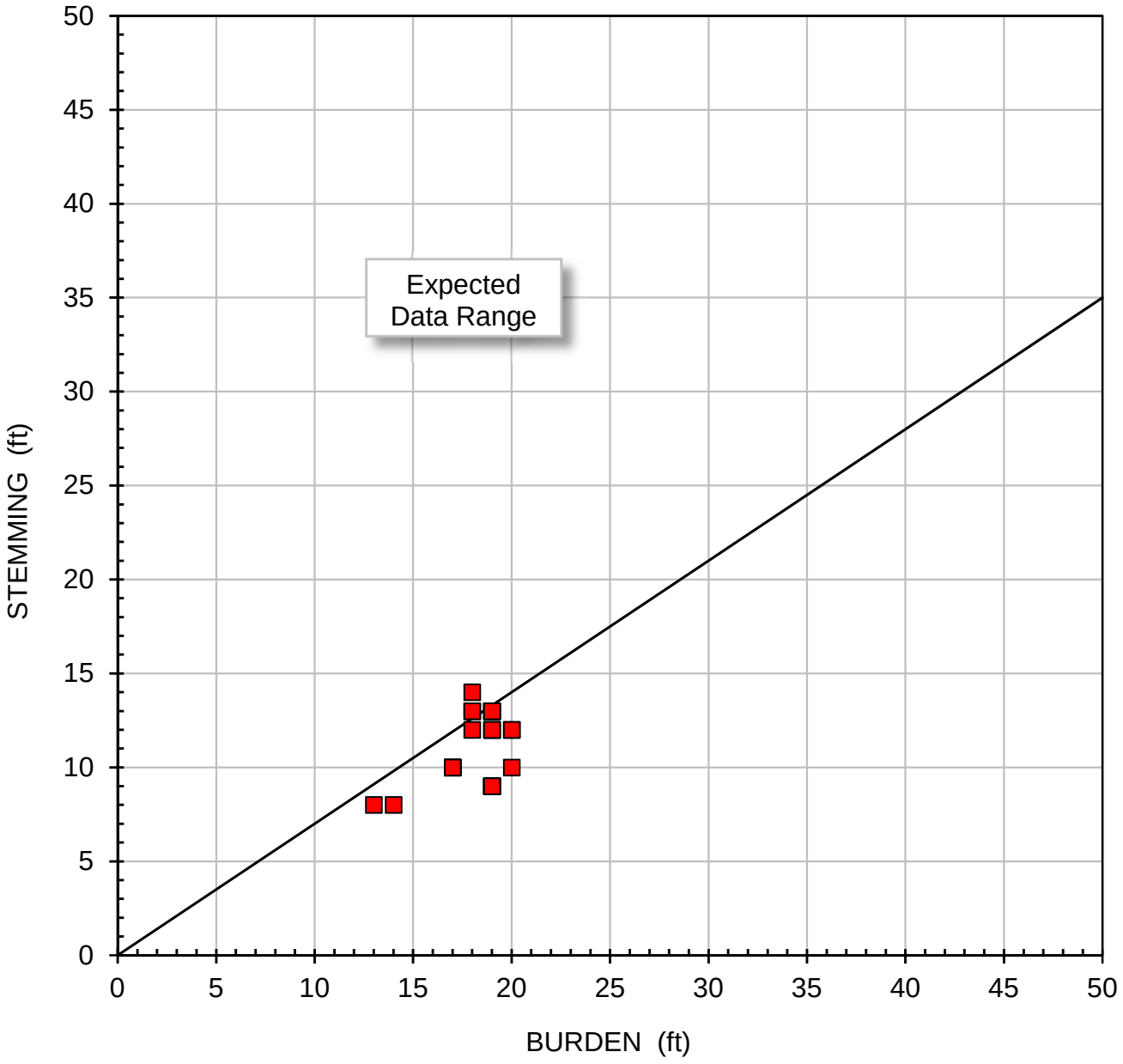


Note: If the burden is much greater than the spacing, excessive ground vibrations may result. If the burden is less than twice the spacing, excessive airblast or flyrock may result. This blast event data was collected intermittently between: 01/06/2015 and 10/05/2017.

OSMRE BLAST LOG EVALUATION PROGRAM (BLEP)

Mine:	Pittsburgh Mine	Review Agency:	OSMRE
Permit No.:	D1977	Review Date:	1/1/2019
Blaster:	Top Flight Blasting	Evaluated By:	Brian Farmer, P.E.

STEMMING ADEQUACY

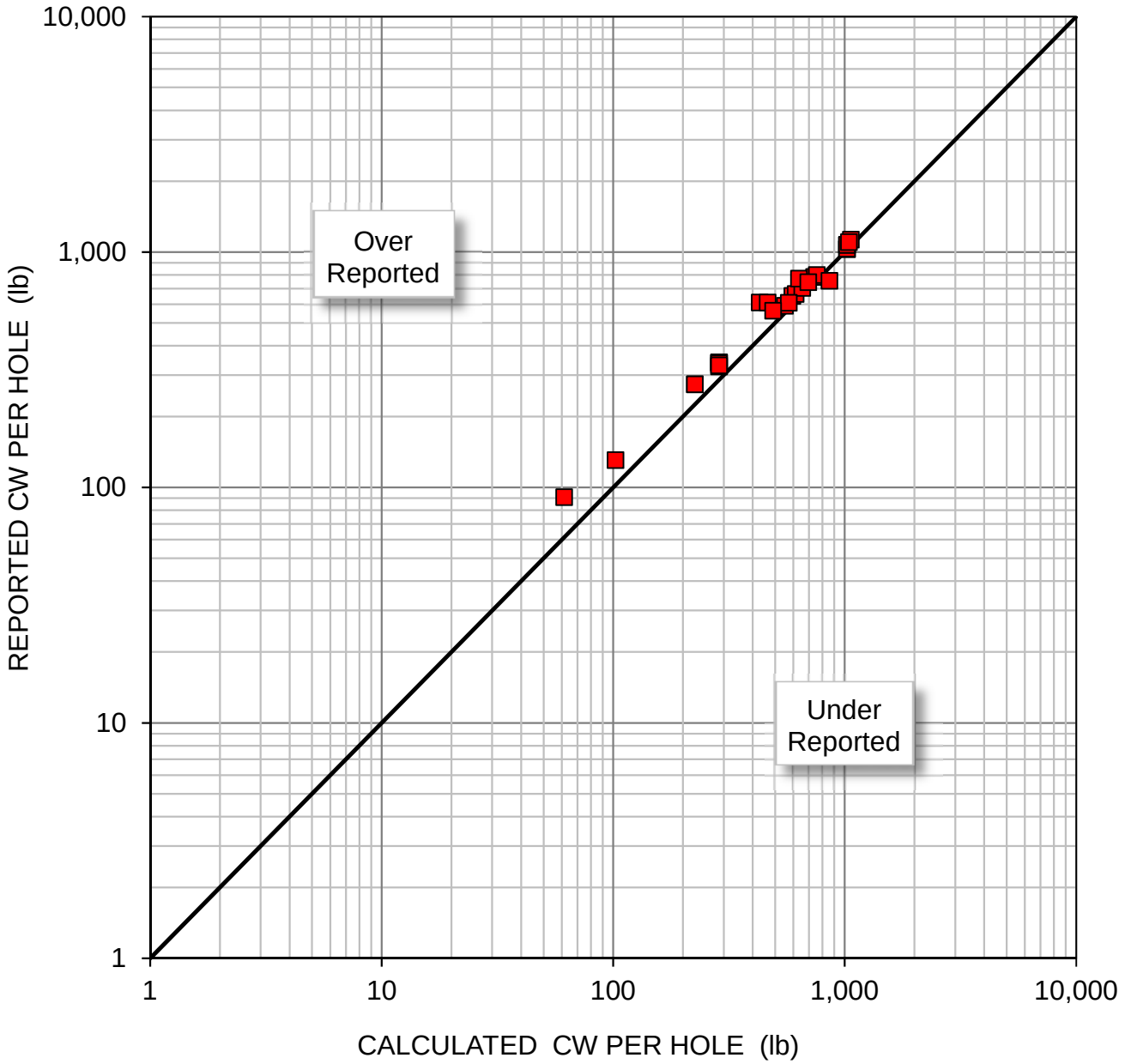


Note: Adequate stemming is generally greater than seventy (70) percent of the burden. Data points below the reference line are prone to flyrock and high airblast levels. This blast event data was collected intermittently between: 01/06/2015 and 10/05/2017.

OSMRE BLAST LOG EVALUATION PROGRAM (BLEP)

Mine:	Pittsburgh Mine	Review Agency:	OSMRE
Permit No.:	D1977	Review Date:	1/1/2019
Blaster:	Top Flight Blasting	Evaluated By:	Brian Farmer, P.E.

CHARGE WEIGHT (CW) PER HOLE



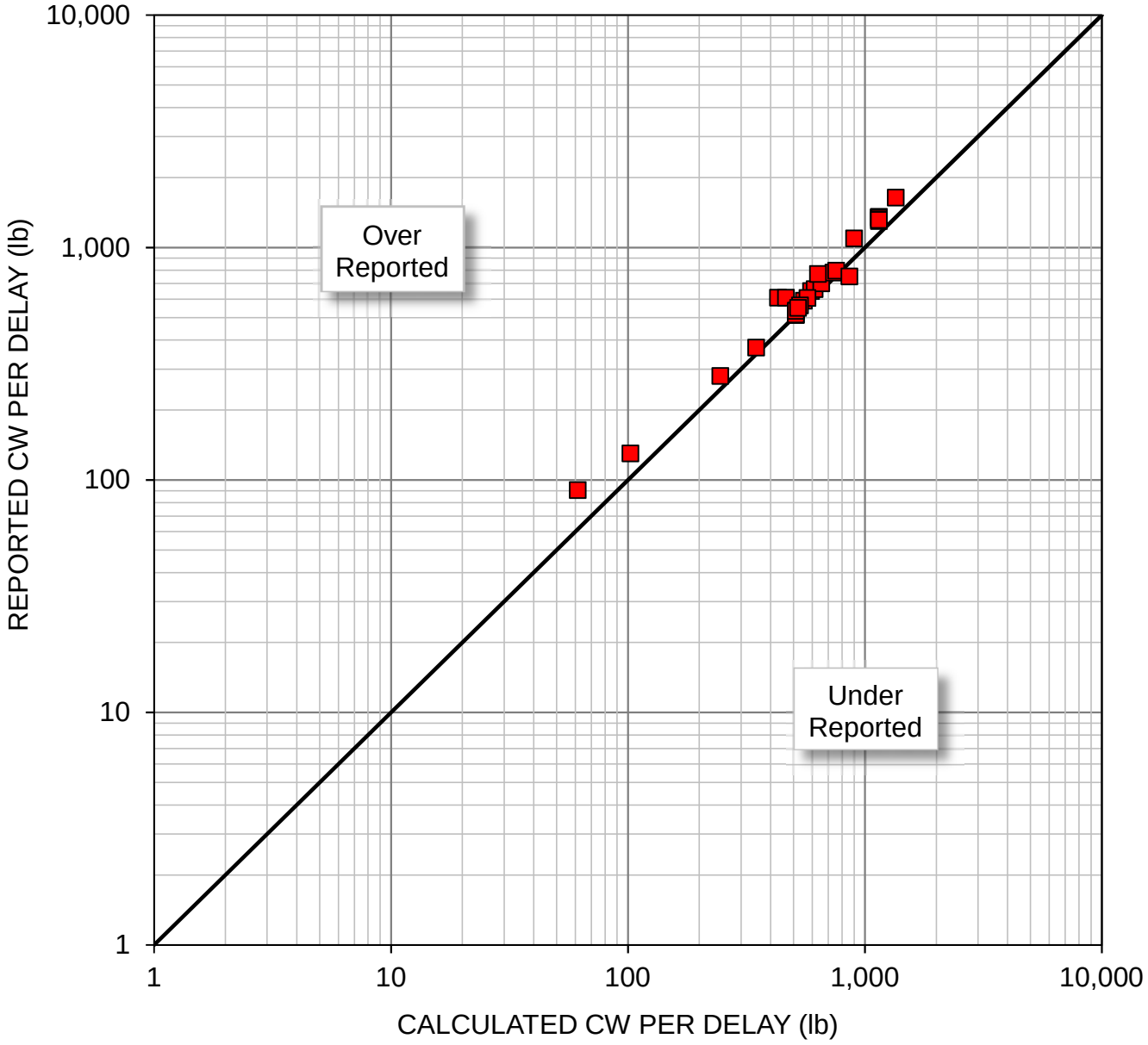
Note: The calculated CW per hole should match the reported CW per hole. If a data point touches the reference line, the variation is less than ten (10) percent. This blast event data was collected intermittently between: 01/06/2015 and 10/05/2017.

OSMRE BLAST LOG EVALUATION PROGRAM (BLEP)

Mine:	Pittsburgh Mine	Review Agency:	OSMRE
Permit No.:	D1977	Review Date:	1/1/2019
Blaster:	Top Flight Blasting	Evaluated By:	Brian Farmer, P.E.

CHARGE WEIGHT (CW) PER DELAY

(Assumes Equal CW Per Deck)

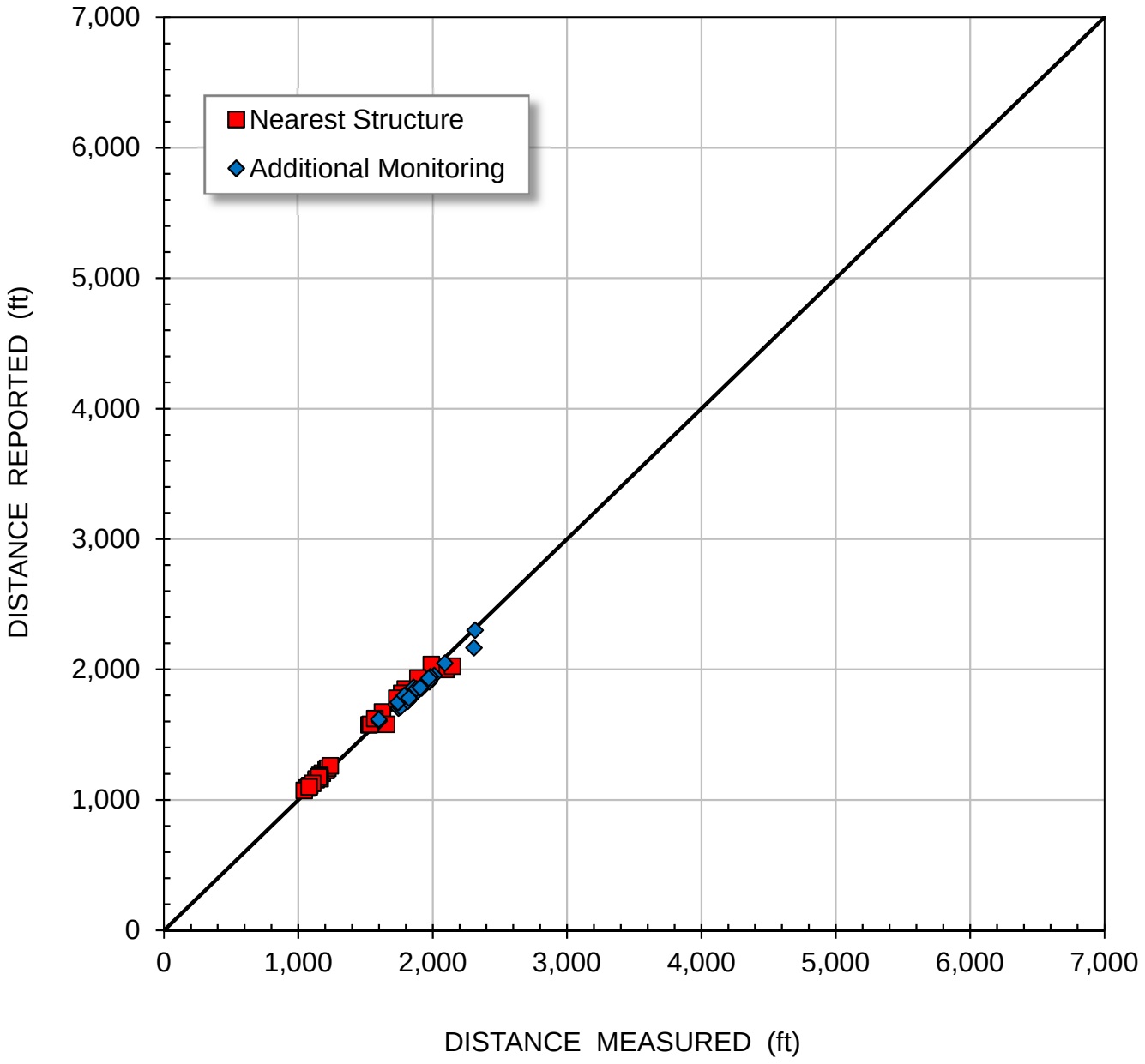


Note: The calculated CW per delay should match the reported CW per delay. If a data point touches the reference line, the variation is less than ten (10) percent. This blast event data was collected intermittently between: 01/06/2015 and 10/05/2017.

OSMRE BLAST LOG EVALUATION PROGRAM (BLEP)

Mine:	Pittsburgh Mine	Review Agency:	OSMRE
Permit No.:	D1977	Review Date:	1/1/2019
Blaster:	Top Flight Blasting	Evaluated By:	Brian Farmer, P.E.

DISTANCE COMPARISON

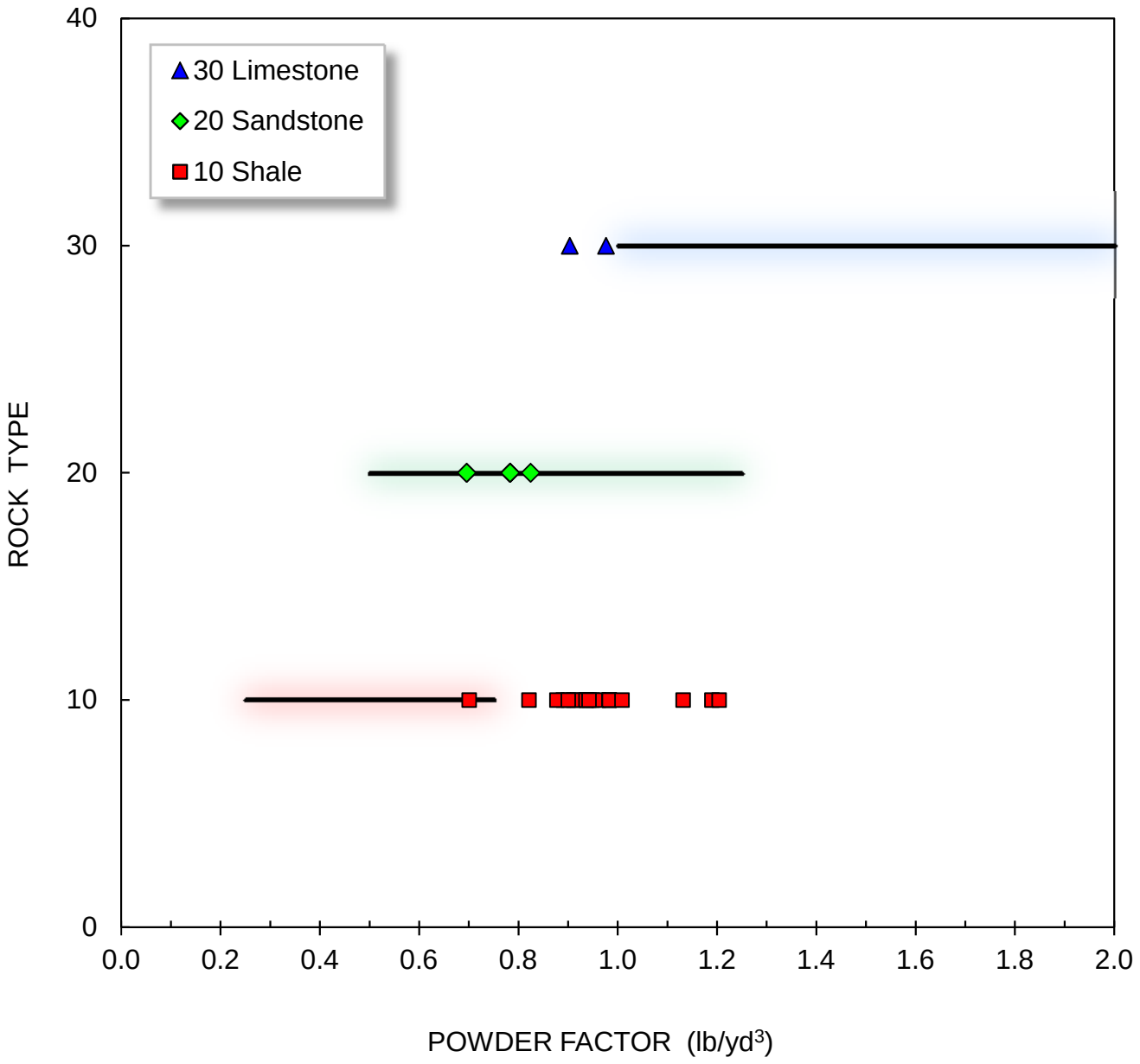


Note: The distance measured should equal the distance reported on the blast log. If a data point touches the reference line, the variation is less than ten (10) percent. This blast event data was collected intermittently between: 01/06/2015 and 10/05/2017.

OSMRE BLAST LOG EVALUATION PROGRAM (BLEP)

Mine:	Pittsburgh Mine	Review Agency:	OSMRE
Permit No.:	D1977	Review Date:	1/1/2019
Blaster:	Top Flight Blasting	Evaluated By:	Brian Farmer, P.E.

POWDER FACTOR BY ROCK TYPE

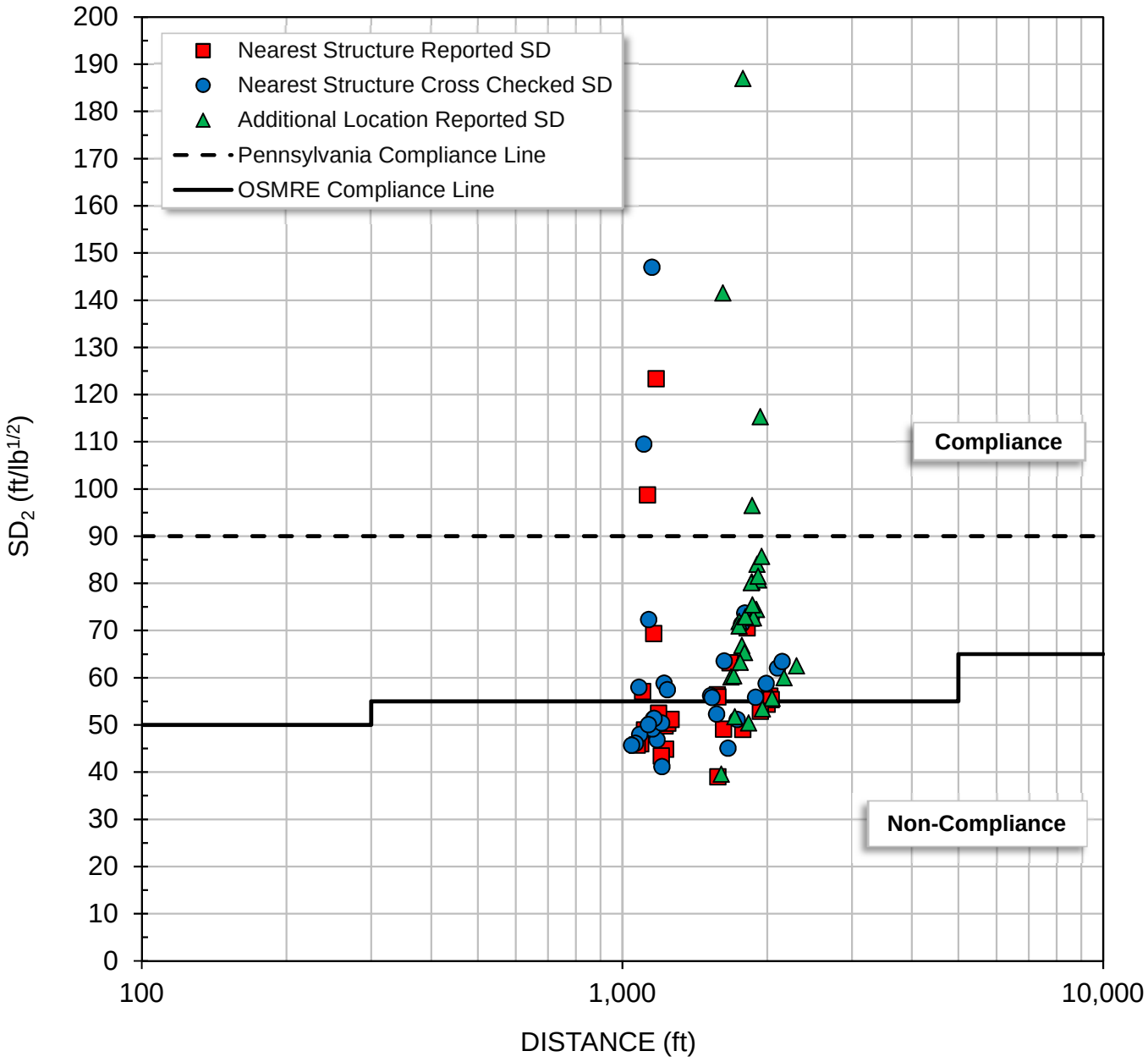


Note: The lines represent reasonable powder factor ranges for different rock types. If the data points exceed the ranges, a potential for flyrock incidents exists. This blast event data was collected intermittently between: 01/06/2015 and 10/05/2017.

OSMRE BLAST LOG EVALUATION PROGRAM (BLEP)

Mine:	Pittsburgh Mine	Review Agency:	OSMRE
Permit No.:	D1977	Review Date:	1/1/2019
Blaster:	Top Flight Blasting	Evaluated By:	Brian Farmer, P.E.

COMPLIANCE WITH SQUARE ROOT SCALED DISTANCE (SD_2)

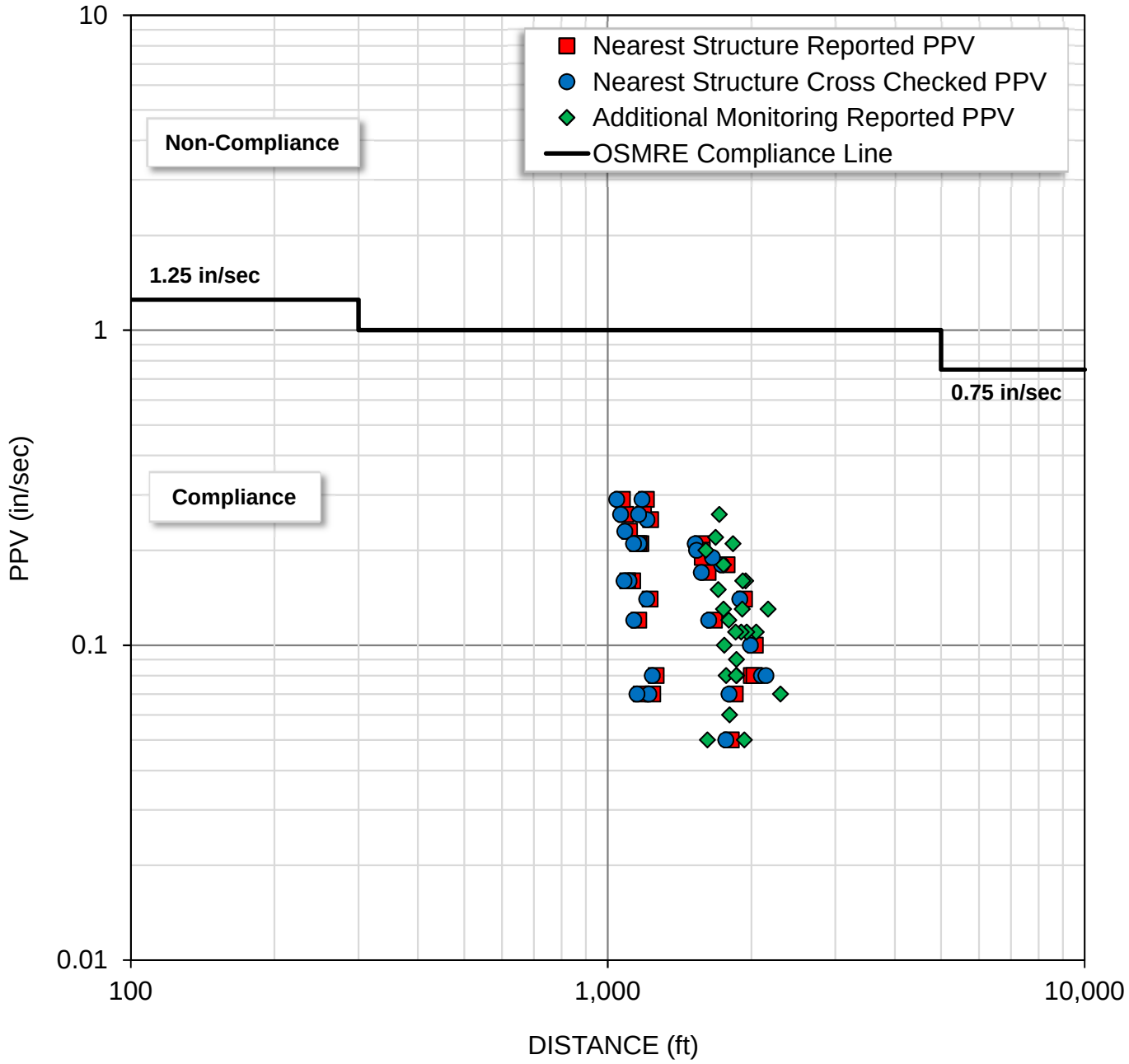


Note: OSMRE compliance lines are based on 30 CFR 816.67. If the reported values are accurate, the cross checked data points will hide the reported data points. This blast event data was collected intermittently between: 01/06/2015 and 10/05/2017.

OSMRE BLAST LOG EVALUATION PROGRAM (BLEP)

Mine:	Pittsburgh Mine	Review Agency:	OSMRE
Permit No.:	D1977	Review Date:	1/1/2019
Blaster:	Top Flight Blasting	Evaluated By:	Brian Farmer, P.E.

COMPLIANCE WITH PEAK PARTICLE VELOCITY (PPV)

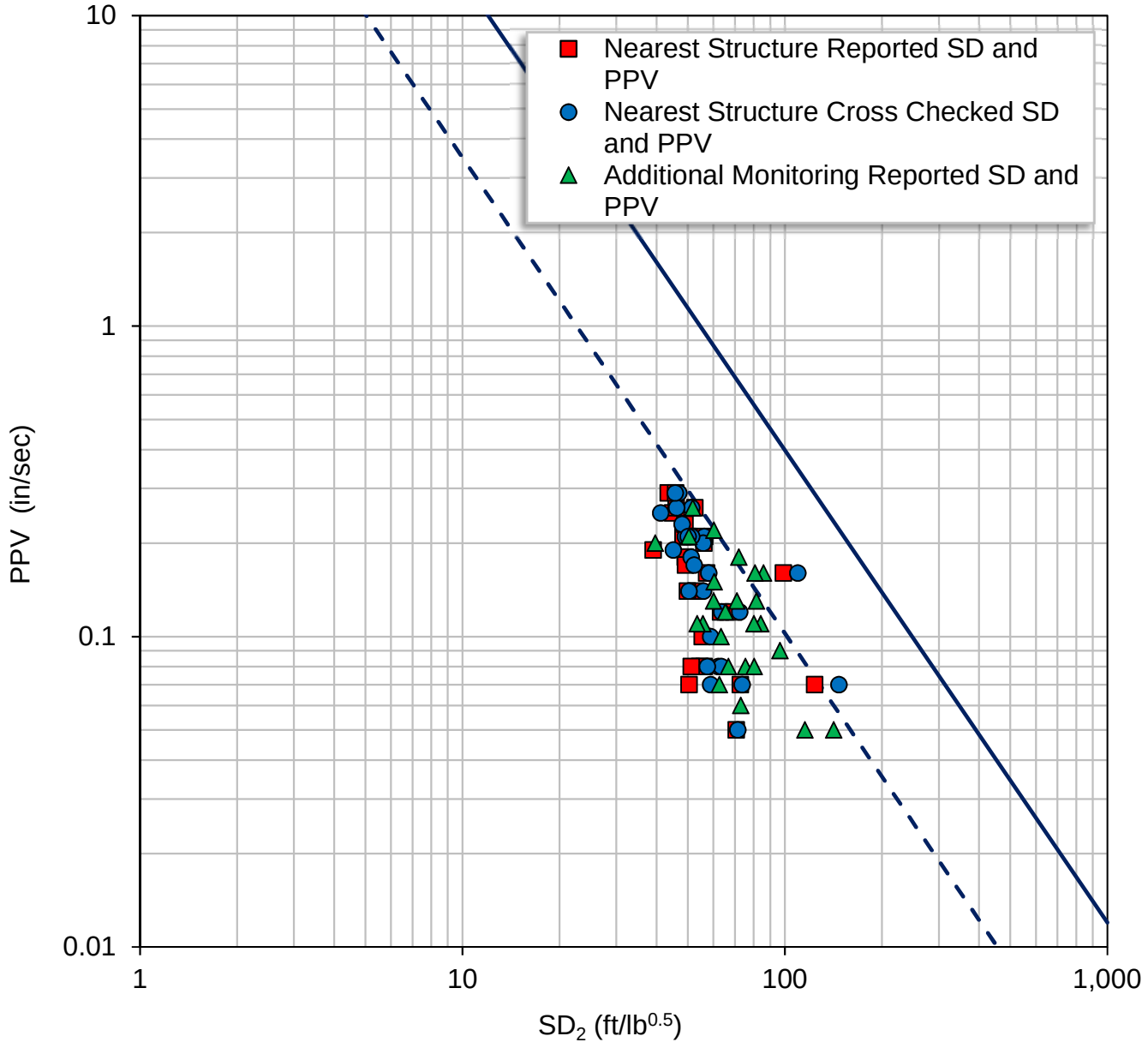


Note: OSMRE compliance lines are based on 30 CFR 816.67. If the reported values are accurate, the cross checked data points will hide the reported data points. This blast event data was collected intermittently between: 01/06/2015 and 10/05/2017.

OSMRE BLAST LOG EVALUATION PROGRAM (BLEP)

Mine:	Pittsburgh Mine	Review Agency:	OSMRE
Permit No.:	D1977	Review Date:	1/1/2019
Blaster:	Top Flight Blasting	Evaluated By:	Brian Farmer, P.E.

SQUARE ROOT SCALED DISTANCE (SD_2) VERSUS PEAK PARTICLE VELOCITY (PPV)

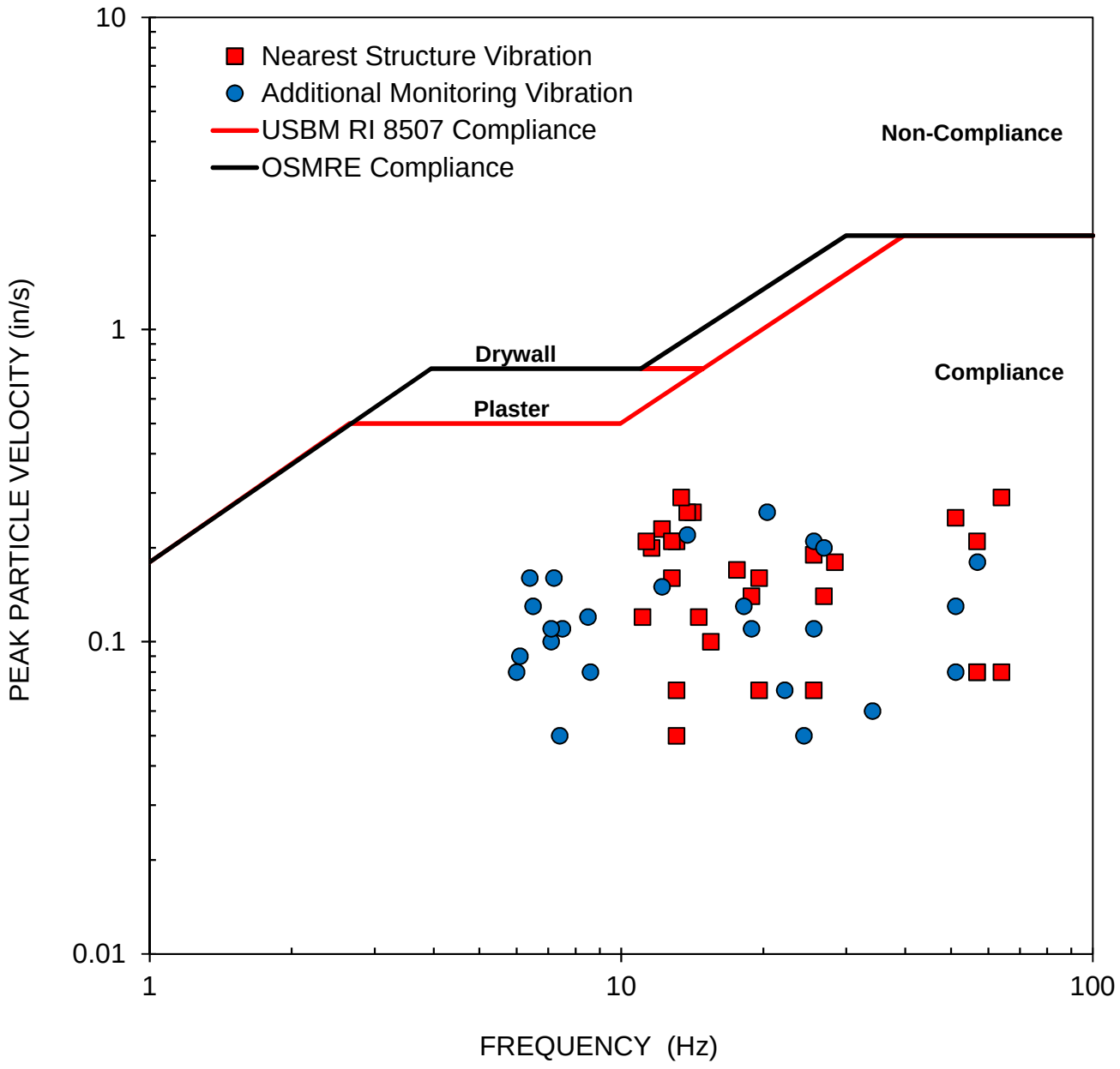


Note: Data points that plot above the Upper Bound PPV line are problematic. If the reported values are accurate, the cross checked data points will hide the reported data points. This blast event data was collected intermittently between: 01/06/2015 and 10/05/2017.

OSMRE BLAST LOG EVALUATION PROGRAM (BLEP)

Mine:	Pittsburgh Mine	Review Agency:	OSMRE
Permit No.:	D1977	Review Date:	1/1/2019
Blaster:	Top Flight Blasting	Evaluated By:	Brian Farmer, P.E.

COMPLIANCE WITH BLASTING LEVEL CHART

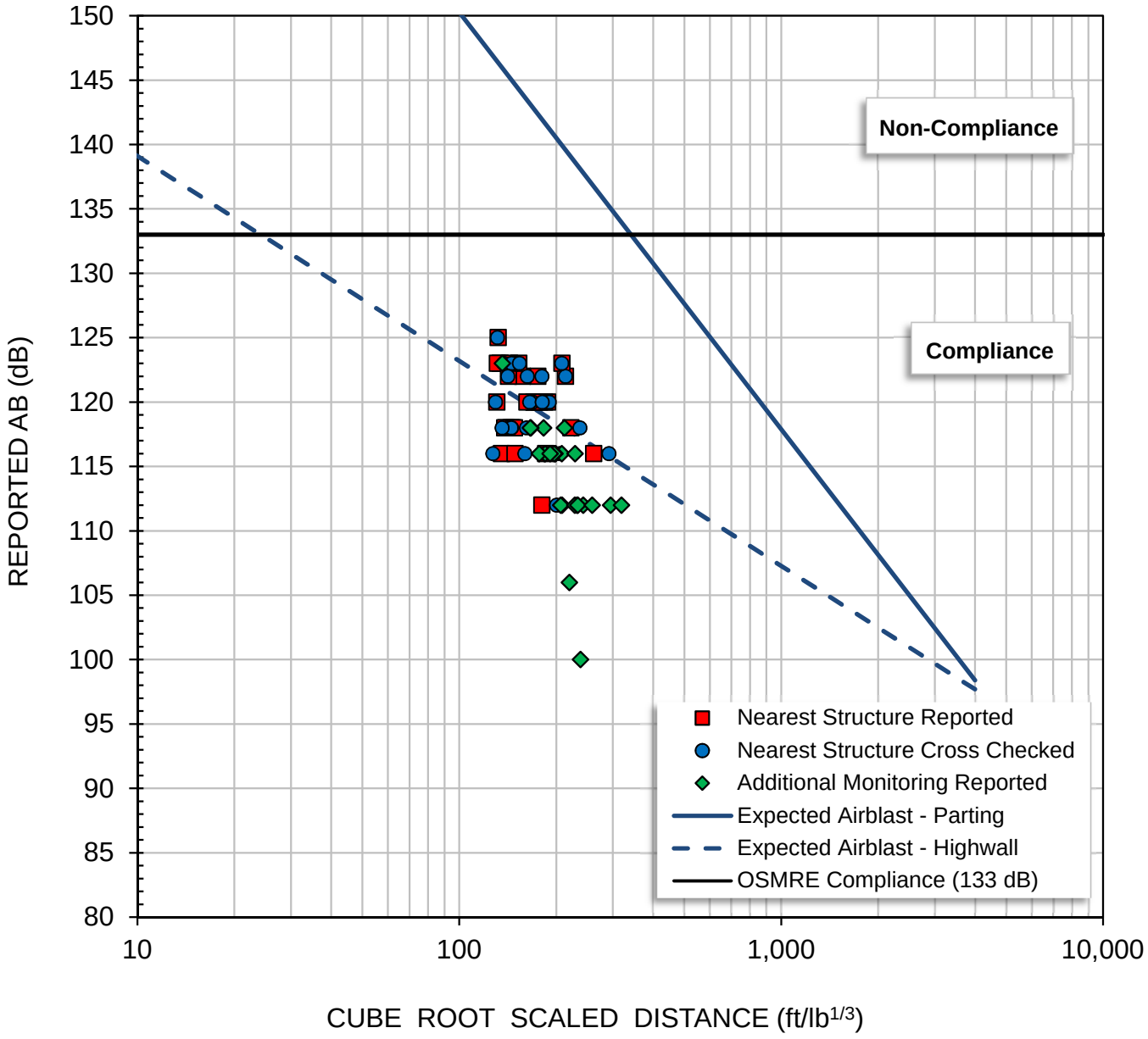


Note: Data points that plot above the compliance lines are problematic. This blast event data was collected intermittently between: 01/06/2015 and 10/05/2017.

OSMRE BLAST LOG EVALUATION PROGRAM (BLEP)

Mine:	Pittsburgh Mine	Review Agency:	OSMRE
Permit No.:	D1977	Review Date:	1/1/2019
Blaster:	Top Flight Blasting	Evaluated By:	Brian Farmer, P.E.

COMPLIANCE WITH AIRBLAST (AB)



Note: Compliance is based on 30 CFR 816.67 and a 2 Hz microphone. Reference lines are based on USBM RI 8485. Cross checked data points will hide accurate reported data points. This blast event data was collected intermittently between: 01/06/2015 and 10/05/2017.

OSMRE BLAST LOG EVALUATION PROGRAM (BLEP)

BLEP ANALYSIS WORKSHEET	**Units**	**Mine:**	Pittsburgh Mine			**Permit No.:**	D1977		**Review Date:**	1/1/2019	
Blast Log	#	1	2	3	4	5	6	7	8	9	10
Blast Date	mm/dd/yy	01/06/15	01/07/15	01/08/15	01/09/15	01/12/15	01/13/15	01/14/15	01/15/15	01/19/15	02/02/15
POWDER FACTOR											
Rock Volume	yd^3	633	647	681	809	824	366	366	366	366	348
Powder Column	feet	29	30	32	36	37	14	14	14	14	14
Loading Density	lb/ft	20	20	20	20	20	20	20	20	20	20
Powder Factor Calculated	lb/yd^3	0.94	0.95	0.96	0.91	0.92	0.78	0.78	0.78	0.78	0.82
CHARGE WEIGHT (CW) PER HOLE											
Calculated CW per Hole	lb	594	614	655	737	758	287	287	287	287	287
Reported CW per Hole	lb	651	664	703	782	797	339	326	339	336	330
Is calculated CW within 10% of the reported value?		Within 10%	Within 10%	Within 10%	Within 10%	Within 10%	Below 10%	Below 10%	Below 10%	Below 10%	Below 10%
CHARGE WEIGHT (CW) PER DELAY											
Calculated Charges per Delay		1	1	1	1	1	4	4	4	4	4
Reported Charges per Delay		1	1	1	1	1	4	4	4	4	4
Calculated Charges > Reported Charges?		Less	Less	Less	Less	Less	Less	Less	Less	Less	Less
Calculated Explosives per Charge	lb	594	614	655	737	758	287	287	287	287	287
Calculated Explosives per Delay	lb	594	614	655	737	758	1147	1147	1147	1147	1147
Reported Explosives per Delay	lb	651	664	703	782	797	1354	1304	1357	1342	1318
Is calculated CW within 10% of the reported value?		Within 10%	Within 10%	Within 10%	Within 10%	Within 10%	Below 10%	Below 10%	Below 10%	Below 10%	Below 10%
SQUARE-ROOT SCALED DISTANCE (SD_2)											
SD_2 Reported (Nearest Protected Structure)	$ft/lb^{1/2}$	73	71	63	56	56	54	56	55	53	49
SD_2 Calculated (Nearest Protected Structure)	$ft/lb^{1/2}$	74	71	64	56	56	62	63	59	56	51
SD_2 Reported (Additional Monitoring)	$ft/lb^{1/2}$	74	73	67	60	60	63	60	56	53	50
SD_2 vs PEAK PARTICLE VELOCITY (PPV)											
$PPV_{Best\ Fit} = 119(SD_2)^{-1.52}$ (SD_2 Reported)	in/sec	0.18	0.18	0.22	0.26	0.26	0.27	0.26	0.27	0.29	0.32
$PPV_{Upper\ Bound} = 438(SD_2)^{-1.52}$ (SD_2 Reported)	in/sec	0.65	0.68	0.80	0.96	0.97	1.01	0.96	0.98	1.05	1.18
PPV Reported > $PPV_{Upper\ Bound}$? (SD_2 Reported)		Less	Less	Less	Less	Less	Less	Less	Less	Less	Less
$PPV_{Best\ Fit} = 119(SD_2)^{-1.52}$ (SD_2 Calculated)	in/sec	0.17	0.18	0.22	0.26	0.26	0.22	0.22	0.24	0.26	0.30
$PPV_{Upper\ Bound} = 438(SD_2)^{-1.52}$ (SD_2 Calculated)	in/sec	0.64	0.67	0.80	0.96	0.97	0.83	0.80	0.90	0.97	1.11
PPV Reported > $PPV_{Upper\ Bound}$? (SD_2 Calculated)		Less	Less	Less	Less	Less	Less	Less	Less	Less	Less
CUBE ROOT SCALED DISTANCE (SD_3)											
SD_3 Reported (Nearest Protected Structure)	$ft/lb^{1/3}$	214	208	188	171	170	181	185	184	176	162
SD_3 Calculated (Nearest Protected Structure)	$ft/lb^{1/3}$	214	208	187	169	168	201	205	190	181	166
SD_3 Reported (Additional Monitoring)	$ft/lb^{1/3}$	219	215	199	183	184	208	198	185	177	167
SD_3 vs AIRBLAST (AB)											
$AB_{Highwall} = 0.162(SD_3)^{-0.79}$ (SD_3 Reported)	dB	118	118	119	120	120	119	119	119	119	120
$AB_{Parting} = 169(SD_3)^{-1.62}$ (SD_3 Reported)	dB	140	140	142	143	143	142	142	142	143	144
$AB_{Parting} = 169(SD_3)^{-1.62}$ (SD_3 Calculated)	dB	140	140	142	143	143	141	140	141	142	143
AB Reported > $AB_{Parting}$ (SD_3 Reported)?		Less	Less	Less	Less	Less	Less	Less	Less	Less	Less
AB Reported > $AB_{Parting}$ (SD_3 Calculated)?		Less	Less	Less	Less	Less	Less	Less	Less	Less	Less

OSMRE BLAST LOG EVALUATION PROGRAM (BLEP)

BLEP ANALYSIS WORKSHEET	**Units**	**Mine:**	Pittsburgh Mine			**Permit No.:**	D1977		**Review Date:**	1/1/2019	
Blast Log	#	11	12	13	14	15	16	17	18	19	20
Blast Date	mm/dd/yy	02/19/15	02/20/15	06/19/17	06/20/17	07/10/17	07/10/17	07/11/17	07/12/17	08/14/17	08/16/17
POWDER FACTOR											
Rock Volume	yd^3	324	324	760	773	465	476	476	476	1041	1041
Powder Column	feet	11	11	42	44	27	28	28	28	50	50
Loading Density	lb/ft	20	20	20	14	20	20	15	17	20	20
Powder Factor Calculated	lb/yd^3	0.70	0.70	1.13	0.82	1.19	1.20	0.90	0.98	0.98	0.98
CHARGE WEIGHT (CW) PER HOLE											
Calculated CW per Hole	lb	225	225	860	635	553	573	430	465	1024	1024
Reported CW per Hole	lb	274	274	753	770	591	608	610	610	1028	1031
Is calculated CW within 10% of the reported value?		Below 10%	Below 10%	Exceed 10%	Below 10%	Within 10%	Within 10%	Below 10%	Below 10%	Within 10%	Within 10%
CHARGE WEIGHT (CW) PER DELAY											
Calculated Charges per Delay		4	6	1	1	1	1	1	1	1	1
Reported Charges per Delay		4	6	1	1	1	1	1	1	1	1
Calculated Charges > Reported Charges?		Less	Less	Less	Less	Less	Less	Less	Less	Less	Less
Calculated Explosives per Charge	lb	225	225	860	635	553	573	430	465	512	512
Calculated Explosives per Delay	lb	901	1352	860	635	553	573	430	465	512	512
Reported Explosives per Delay	lb	1096	1644	753	770	591	608	610	610	514	516
Is calculated CW within 10% of the reported value?		Below 10%	Below 10%	Exceed 10%	Below 10%	Within 10%	Within 10%	Below 10%	Below 10%	Within 10%	Within 10%
SQUARE-ROOT SCALED DISTANCE (SD_2)											
SD_2 Reported (Nearest Protected Structure)	$ft/lb^{1/2}$	49	39	45	43	48	50	50	51	52	49
SD_2 Calculated (Nearest Protected Structure)	$ft/lb^{1/2}$	52	45	41	47	49	50	59	57	51	48
SD_2 Reported (Additional Monitoring)	$ft/lb^{1/2}$	52	40	65	63	72	71	73	75	84	86
SD_2 vs PEAK PARTICLE VELOCITY (PPV)											
$PPV_{Best\ Fit} = 119(SD_2)^{-1.52}$ (SD_2 Reported)	in/sec	0.32	0.45	0.37	0.39	0.33	0.31	0.31	0.30	0.29	0.32
$PPV_{Upper\ Bound} = 438(SD_2)^{-1.52}$ (SD_2 Reported)	in/sec	1.18	1.67	1.35	1.42	1.21	1.15	1.13	1.11	1.07	1.18
PPV Reported > $PPV_{Upper\ Bound}$? (SD_2 Reported)		Less	Less	Less	Less	Less	Less	Less	Less	Less	Less
$PPV_{Best\ Fit} = 119(SD_2)^{-1.52}$ (SD_2 Calculated)	in/sec	0.29	0.36	0.42	0.34	0.32	0.31	0.24	0.25	0.30	0.33
$PPV_{Upper\ Bound} = 438(SD_2)^{-1.52}$ (SD_2 Calculated)	in/sec	1.07	1.34	1.54	1.27	1.18	1.13	0.89	0.93	1.10	1.22
PPV Reported > $PPV_{Upper\ Bound}$? (SD_2 Calculated)		Less	Less	Less	Less	Less	Less	Less	Less	Less	Less
CUBE ROOT SCALED DISTANCE (SD_3)											
SD_3 Reported (Nearest Protected Structure)	$ft/lb^{1/3}$	158	134	135	131	140	145	147	149	148	139
SD_3 Calculated (Nearest Protected Structure)	$ft/lb^{1/3}$	163	150	127	137	141	145	162	160	145	136
SD_3 Reported (Additional Monitoring)	$ft/lb^{1/3}$	166	136	197	192	208	206	212	220	238	243
SD_3 vs AIRBLAST (AB)											
$AB_{Highwall} = 0.162(SD_3)^{-0.79}$ (SD_3 Reported)	dB	120	121	121	121	121	121	121	121	121	121
$AB_{Parting} = 169(SD_3)^{-1.62}$ (SD_3 Reported)	dB	144	146	146	147	146	145	145	145	145	146
$AB_{Parting} = 169(SD_3)^{-1.62}$ (SD_3 Calculated)	dB	144	145	147	146	146	145	144	144	145	146
AB Reported > $AB_{Parting}$ (SD_3 Reported)?		Less	Less	Less	Less	Less	Less	Less	Less	Less	Less
AB Reported > $AB_{Parting}$ (SD_3 Calculated)?		Less	Less	Less	Less	Less	Less	Less	Less	Less	Less

OSMRE BLAST LOG EVALUATION PROGRAM (BLEP)

BLEP ANALYSIS WORKSHEET	**Units**	**Mine:**	Pittsburgh Mine			**Permit No.:**	D1977		**Review Date:**	1/1/2019	
Blast Log	#	21	22	23	24	25	26	27	28	29	30
Blast Date	mm/dd/yy	08/17/17	08/18/17	08/21/17	08/22/17	08/22/17	09/26/17	09/27/17	10/05/17	01/00/00	01/00/00
POWDER FACTOR											
Rock Volume	yd^3	1041	1056	1094	1108	552	88	117	773	#N/A	#N/A
Powder Column	feet	50	52	50	51	24	3	5	34	#N/A	#N/A
Loading Density	lb/ft	20	20	20	20	20	20	20	20	#N/A	#N/A
Powder Factor Calculated	lb/yd^3	0.98	1.01	0.94	0.94	0.89	0.70	0.88	0.90	#N/A	#N/A
CHARGE WEIGHT (CW) PER HOLE											
Calculated CW per Hole	lb	1024	1065	1024	1044	491	61	102	696	#N/A	#N/A
Reported CW per Hole	lb	1072	1129	1071	1102	562	91	131	744	#N/A	#N/A
Is calculated CW within 10% of the reported value?		Within 10%	Within 10%	Within 10%	Within 10%	Below 10%	Below 10%	Below 10%	Within 10%	#N/A	#N/A
CHARGE WEIGHT (CW) PER DELAY											
Calculated Charges per Delay		1	1	1	1	1	1	1	1	#N/A	#N/A
Reported Charges per Delay		1	1	1	1	1	1	1	1	#N/A	#N/A
Calculated Charges > Reported Charges?		Less	Less	Less	Less	Less	Less	Less	Less	#N/A	#N/A
Calculated Explosives per Charge	lb	512	532	512	522	246	61	102	348	#N/A	#N/A
Calculated Explosives per Delay	lb	512	532	512	522	246	61	102	348	#N/A	#N/A
Reported Explosives per Delay	lb	536	565	535	551	281	91	131	372	#N/A	#N/A
Is calculated CW within 10% of the reported value?		Within 10%	Within 10%	Within 10%	Within 10%	Below 10%	Below 10%	Below 10%	Within 10%	#N/A	#N/A
SQUARE-ROOT SCALED DISTANCE (SD_2)											
SD_2 Reported (Nearest Protected Structure)	$ft/lb^{1/2}$	50	46	50	46	69	123	99	57	#N/A	#N/A
SD_2 Calculated (Nearest Protected Structure)	$ft/lb^{1/2}$	51	46	50	46	72	147	109	58	#N/A	#N/A
SD_2 Reported (Additional Monitoring)	$ft/lb^{1/2}$	80	81	80	81	115	187	142	96	#N/A	#N/A
SD_2 vs PEAK PARTICLE VELOCITY (PPV)											
$PPV_{Best\ Fit} = 119(SD_2)^{-1.52}$ (SD_2 Reported)	in/sec	0.31	0.35	0.31	0.36	0.19	0.08	0.11	0.25	#N/A	#N/A
$PPV_{Upper\ Bound} = 438(SD_2)^{-1.52}$ (SD_2 Reported)	in/sec	1.14	1.30	1.15	1.31	0.70	0.29	0.41	0.94	#N/A	#N/A
PPV Reported > $PPV_{Upper\ Bound}$? (SD_2 Reported)		Less	Less	Less	Less	Less	Less	Less	Less	#N/A	#N/A
$PPV_{Best\ Fit} = 119(SD_2)^{-1.52}$ (SD_2 Calculated)	in/sec	0.30	0.35	0.31	0.36	0.18	0.06	0.09	0.25	#N/A	#N/A
$PPV_{Upper\ Bound} = 438(SD_2)^{-1.52}$ (SD_2 Calculated)	in/sec	1.10	1.30	1.14	1.31	0.65	0.22	0.35	0.91	#N/A	#N/A
PPV Reported > $PPV_{Upper\ Bound}$? (SD_2 Calculated)		Less	Less	Less	Less	Less	Less	Less	Less	#N/A	#N/A
CUBE ROOT SCALED DISTANCE (SD_3)											
SD_3 Reported (Nearest Protected Structure)	$ft/lb^{1/3}$	143	132	142	131	177	261	222	153	#N/A	#N/A
SD_3 Calculated (Nearest Protected Structure)	$ft/lb^{1/3}$	145	131	142	130	181	292	237	154	#N/A	#N/A
SD_3 Reported (Additional Monitoring)	$ft/lb^{1/3}$	229	232	228	233	295	396	319	259	#N/A	#N/A
SD_3 vs AIRBLAST (AB)											
$AB_{Highwall} = 0.162(SD_3)^{-0.79}$ (SD_3 Reported)	dB	121	121	121	121	119	117	118	120	#N/A	#N/A
$AB_{Parting} = 169(SD_3)^{-1.62}$ (SD_3 Reported)	dB	145	147	146	147	142	137	139	145	#N/A	#N/A
$AB_{Parting} = 169(SD_3)^{-1.62}$ (SD_3 Calculated)	dB	145	147	146	147	142	135	138	144	#N/A	#N/A
AB Reported > $AB_{Parting}$ (SD_3 Reported)?		Less	Less	Less	Less	Less	Less	Less	Less	#N/A	#N/A
AB Reported > $AB_{Parting}$ (SD_3 Calculated)?		Less	Less	Less	Less	Less	Less	Less	Less	#N/A	#N/A

OSMRE BLAST LOG EVALUATION PROGRAM (BLEP)

BLEP ANALYSIS WORKSHEET	**Units**	**Mine:** Pittsburgh Mine				**Permit No.:** D1977			**Review Date:** 1/1/2019		
Blast Log	#	31	32	33	34	35	36	37	38	39	40
Blast Date	mm/dd/yy	01/00/00	01/00/00	01/00/00	01/00/00	01/00/00	01/00/00	01/00/00	01/00/00	01/00/00	01/00/00
POWDER FACTOR											
Rock Volume	yd^3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Powder Column	feet	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Loading Density	lb/ft	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Powder Factor Calculated	lb/yd^3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
CHARGE WEIGHT (CW) PER HOLE											
Calculated CW per Hole	lb	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Reported CW per Hole	lb	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Is calculated CW within 10% of the reported value?		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
CHARGE WEIGHT (CW) PER DELAY											
Calculated Charges per Delay		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Reported Charges per Delay		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Calculated Charges > Reported Charges?		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Calculated Explosives per Charge	lb	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Calculated Explosives per Delay	lb	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Reported Explosives per Delay	lb	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Is calculated CW within 10% of the reported value?		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
SQUARE-ROOT SCALED DISTANCE (SD_2)											
SD_2 Reported (Nearest Protected Structure)	$ft/lb^{1/2}$	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
SD_2 Calculated (Nearest Protected Structure)	$ft/lb^{1/2}$	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
SD_2 Reported (Additional Monitoring)	$ft/lb^{1/2}$	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
SD_2 vs PEAK PARTICLE VELOCITY (PPV)											
$PPV_{Best\ Fit} = 119(SD_2)^{-1.52}$ (SD_2 Reported)	in/sec	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
$PPV_{Upper\ Bound} = 438(SD_2)^{-1.52}$ (SD_2 Reported)	in/sec	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
PPV Reported > $PPV_{Upper\ Bound}$? (SD_2 Reported)		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
$PPV_{Best\ Fit} = 119(SD_2)^{-1.52}$ (SD_2 Calculated)	in/sec	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
$PPV_{Upper\ Bound} = 438(SD_2)^{-1.52}$ (SD_2 Calculated)	in/sec	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
PPV Reported > $PPV_{Upper\ Bound}$? (SD_2 Calculated)		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
CUBE ROOT SCALED DISTANCE (SD_3)											
SD_3 Reported (Nearest Protected Structure)	$ft/lb^{1/3}$	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
SD_3 Calculated (Nearest Protected Structure)	$ft/lb^{1/3}$	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
SD_3 Reported (Additional Monitoring)	$ft/lb^{1/3}$	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
SD_3 vs AIRBLAST (AB)											
$AB_{Highwall} = 0.162(SD_3)^{-0.79}$ (SD_3 Reported)	dB	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
$AB_{Parting} = 169(SD_3)^{-1.62}$ (SD_3 Reported)	dB	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
$AB_{Parting} = 169(SD_3)^{-1.62}$ (SD_3 Calculated)	dB	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
AB Reported > $AB_{Parting}$ (SD_3 Reported)?		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
AB Reported > $AB_{Parting}$ (SD_3 Calculated)?		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

OSMRE BLAST LOG EVALUATION PROGRAM (BLEP)

BLEP ANALYSIS WORKSHEET	**Units**	**Mine:** Pittsburgh Mine				**Permit No.:** D1977			**Review Date:** 1/1/2019		
Blast Log	#	41	42	43	44	45	46	47	48	49	50
Blast Date	mm/dd/yy	01/00/00	01/00/00	01/00/00	01/00/00	01/00/00	01/00/00	01/00/00	01/00/00	01/00/00	01/00/00
POWDER FACTOR											
Rock Volume	yd^3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Powder Column	feet	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Loading Density	lb/ft	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Powder Factor Calculated	lb/yd^3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
CHARGE WEIGHT (CW) PER HOLE											
Calculated CW per Hole	lb	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Reported CW per Hole	lb	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Is calculated CW within 10% of the reported value?		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
CHARGE WEIGHT (CW) PER DELAY											
Calculated Charges per Delay		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Reported Charges per Delay		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Calculated Charges > Reported Charges?		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Calculated Explosives per Charge	lb	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Calculated Explosives per Delay	lb	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Reported Explosives per Delay	lb	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Is calculated CW within 10% of the reported value?		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
SQUARE-ROOT SCALED DISTANCE (SD_2)											
SD_2 Reported (Nearest Protected Structure)	$ft/lb^{1/2}$	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
SD_2 Calculated (Nearest Protected Structure)	$ft/lb^{1/2}$	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
SD_2 Reported (Additional Monitoring)	$ft/lb^{1/2}$	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
SD_2 vs PEAK PARTICLE VELOCITY (PPV)											
$PPV_{Best\ Fit} = 119(SD_2)^{-1.52}$ (SD_2 Reported)	in/sec	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
$PPV_{Upper\ Bound} = 438(SD_2)^{-1.52}$ (SD_2 Reported)	in/sec	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
PPV Reported > $PPV_{Upper\ Bound}$? (SD_2 Reported)		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
$PPV_{Best\ Fit} = 119(SD_2)^{-1.52}$ (SD_2 Calculated)	in/sec	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
$PPV_{Upper\ Bound} = 438(SD_2)^{-1.52}$ (SD_2 Calculated)	in/sec	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
PPV Reported > $PPV_{Upper\ Bound}$? (SD_2 Calculated)		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
CUBE ROOT SCALED DISTANCE (SD_3)											
SD_3 Reported (Nearest Protected Structure)	$ft/lb^{1/3}$	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
SD_3 Calculated (Nearest Protected Structure)	$ft/lb^{1/3}$	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
SD_3 Reported (Additional Monitoring)	$ft/lb^{1/3}$	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
SD_3 vs AIRBLAST (AB)											
$AB_{Highwall} = 0.162(SD_3)^{-0.79}$ (SD_3 Reported)	dB	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
$AB_{Parting} = 169(SD_3)^{-1.62}$ (SD_3 Reported)	dB	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
$AB_{Parting} = 169(SD_3)^{-1.62}$ (SD_3 Calculated)	dB	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
AB Reported > $AB_{Parting}$ (SD_3 Reported)?		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
AB Reported > $AB_{Parting}$ (SD_3 Calculated)?		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A