International Society of Explosives Engineers
Western Canada Chapter

Best Practices Guide for Close Proximity Blasting Operations

3rd Edition

Dedicated to:

Ron Elliott

The Best Practices Guide for Close Proximity Blasting Operations is dedicated to one of our founding members, Mr. Ron Elliott.

Ron Elliott became a member of the International Society of Explosives Engineers (ISEE) in 1980 and served as founding President of the ISEE Ontario Trillium Chapter. He went on to have the honor of being elected as the first non-US President of the International Society of Explosives Engineers in 2010.

In 2011, Ron was awarded the Professional Achievement Award for recognition of Outstanding Performance in Technology by the Applied Science Technologist and Technicians of British Columbia (ASTTBC) for outstanding contributions to the blasting industry.

Ron was passionate about blasting safety, training, and furthering professionalism in our industry. Through his involvement with the ISEE and the ISEE Western Canada Chapter, he authored and co-authored many blasting-related papers that were presented at conferences held word-wide by the International Society of Explosives Engineers, European Federation of Explosives Engineers (EFEE) and the World Congress on Explosive & Blasting Techniques.

In 2014, Ron became one of the founding members of the ISEE Western Canada Chapter Urban Blasting Committee (now known as the Close Proximity Blasting Committee).

Ron's guidance, leadership, and dedication to safe and professional blasting practices was instrumental in the production of this document. Without his efforts, this publication would not exist.

Disclaimer

Every effort has been made to ensure that this *Best Practices Guide for Close Proximity Blasting Operations* serves to promote safe and productive operations within Close Proximity drilling and blasting environments.

All information, statements and recommendations offered in this document are provided in good faith and in the interest of promoting the safety and health of workers, the public, and the interests of Close Proximity blasting stakeholders.

This document cannot describe and/or be comprehensive for all Close Proximity blasting situations and circumstances.

This document should not be viewed, construed, or assumed as being completely comprehensive in identifying and addressing all Close Proximity blasting situations. It is intended to serve as a general guideline for industry best practices.

The Western Canada Chapter of the International Society of Explosives Engineers accepts no responsibility for the application of this best practices guide or recommendations contained within this document.

It is incumbent on the Blaster to evaluate these best practices and determine if they are applicable for the field conditions encountered in their specific Close Proximity blasting situation. Ultimately, the safety of Close Proximity blasting activities rests with Close Proximity Blasters and their employers.

The Western Canada Chapter of the International Society of Explosives Engineers does not guarantee the quality, accuracy, or completeness of the information provided, and is not responsible for any direct, indirect, special, incidental, or consequential damage or any other damages whatsoever and howsoever caused, arising out of or in connection with the reliance upon the information provided in these materials. Blasters undertaking Close Proximity blasting operations utilizing these best practice guidelines do so at their own risk.

For more detailed blasting related information, please consult the 18th Edition of the ISEE Blasters' Handbook or other useful reference documents detailed in Appendix D.

Document Information

This 3rd Edition *Best Practices Guide for Close Proximity Blasting Operations* is produced by the Western Canada Chapter of the International Society of Explosives Engineers.

This document has been developed by identifying Close Proximity drilling and blasting best practices through the knowledge, experience, and contributions of a wide variety of drilling, blasting and related industry professionals from throughout North America.

This document is the resultant work of our Close Proximity Blasting Committee and is intended to promote safe and productive operations within Close Proximity drilling and blasting environments. The authors, contributors and members have undertaken their best efforts in preparing this document and make no warranty of any kind, express or implied, regarding its content.

Please see our website at www.iseewest.org for the latest document update or for information on how to participate in our organization.

Document Updates

This document was revised on May 01, 2023, and supersedes all previous editions of *Best Practices Guide for Close Proximity Blasting Operations*.

The *Best Practices Guide for Close Proximity Blasting Operations* 3rd Edition was approved for release by the Close Proximity Blasting Committee on May 23, 2023.

The Close Proximity Blasting Committee of the Western Canada Chapter of the ISEE has primary responsibility for amendments to this *Best Practices Guide for Close Proximity Blasting Operations* and will update this document on an as and when required basis.

Intent and Application

This *Best Practices Guide for Close Proximity Blasting Operations* is intended to outline the guidelines for best practices to be utilized in the performance of Close Proximity drilling and blasting operations for rock excavation and act as a source document for the development of a *Control Blasting Plan*. It is designed to minimize risks from the blasting operation. This document can also serve as a training resource for Close Proximity blasters.

Other operations where explosives are utilized in Close Proximity environments such as quarries, open pit mines, demolition, fireworks, special effects, etc. are outside the scope, intent, and application of this document.

These guidelines are intended to be supplemental to any and all local, municipal, state, provincial and/or federal regulations and represent best practices for Close Proximity drilling and blasting operations.

Terminology

This *Best Practices Guide for Close Proximity Blasting Operations* utilizes industry standard terminology.

Numerical Units

This *Best Practices Guide for Close Proximity Blasting Operations* has been developed and is intended for use with metric units.

Throughout the document where metric units are cited, *approximate* imperial units are provided in parenthesis. e.g.: 500m (1600').

Please note that imperial units in this document are provided in generalisation and are not exact conversions. Readers of this document may be required to make the necessary conversions to obtain accurate imperial values to meet their specific needs.

Close Proximity Blasting Committee

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Purpose

This *Best Practices Guide for Close Proximity Blasting Operations* has been developed utilizing the knowledge and experience of a wide variety of blasting and industry related professionals throughout North America.

It is the intention of this document to identify Best Practices and to promote safe and productive operations within close proximity blasting operations. It is to be utilized where deemed useful by stakeholders.

The purpose of the *Best Practices Guide for Close Proximity Blasting Operations* is to:

1. Provide guidelines to protect the safety and health of the public, workers, and close proximity structures within the area of influence to mitigate the following environmental effects of close proximity drilling and blasting operations:

   a) Noise/Nuisance,
   b) Dust,
   c) Blast Vibration,
   d) Air Overpressure,
   e) Flyrock.

2. Advance the science and art of close proximity blasting activities.

3. Instill stakeholder confidence in our industry while undertaking close proximity blasting activities in a safe and productive manner.

4. Identify best practices for drilling and blasting operators to implement while undertaking close proximity blasting operations.

5. Act as a supplement to applicable local, provincial, state, and federal by-laws and/or regulations pertaining to aspects of drilling and blasting activities.

6. Identify best practices to assist drilling and blasting contractors in maintaining high quality and productive operations.

Scope

A close proximity blasting operation is defined within this document as any drilling & blasting operation for rock excavation undertaken within 500m (1600') of any building, structure, and/or utility (close proximity structure).

This *Best Practices Guide for Close Proximity Blasting Operations* outlines guidelines and best practices for consideration in close proximity drilling and blasting activities.

These guidelines are not intended to supersede any federal, state, provincial, or local regulations pertaining to drilling, blasting and/or the use of explosive materials or other activities.

Ultimately, the safety of close proximity blasting activities rests with the Close Proximity Blasters and their employer.

Table of Contents

Definitions

"A point of safety"
A location that is secure from fly rock.

"Air overpressure"
A pressure wave in the air between 2 and 500Hz (mostly below 20 Hz) resulting from a blast, usually expressed in decibels (dB(L)) or Pascals (pa). Note: see "Noise".

"Area of influence"
The area that could be actually, potentially or perceived to be affected by Close Proximity blasting operations as determined by the blaster in charge.

"Backline"
The final intended excavated rock face.

"Best Practices"
Procedures that are generally accepted as being correct or most effective based on industry professional experience.

"Blaster"
A person who is the holder of a valid, applicable Blaster's Certificate issued by a municipal, provincial, state, federal or recognized regulatory agency.

"Blaster in charge"
The blaster who is designated to be in control of all blasting operations. Is in control of a specific blast event.

"Blasting Consultant"
A blasting professional with a minimum of 5 cumulative years of experience working in a consulting role in the blasting field in a Close Proximity blasting environment, a Close Proximity Blasting Manager with specific knowledge and expertise in blast design to meet specific objectives as well as the control of vibration and air overpressure, and who's experience is acceptable to the appropriate regulatory authority.

"Blast hole"
A drilled hole into which a blasting charge is inserted for the purposes of rock breaking.

"Blasting incident"
An accident, near miss, close call and/or unintended occurrence caused by or as a result of the use of explosives, and also includes an unexpected result or problem with explosive products.

"Blasting limit"
The boundary to which rock is to be blasted and excavated. Includes overbreak.

"Blasting log"
A written record of the "as loaded" condition of a blast, including details of the blasting pattern, explosive loading, and hole timing in sufficient detail that the conditions of the blast could be recreated from the log. It should also contain a record of the blaster's post-blast examination, a sketch of the blast layout, seismograph identification and their locations.

"Blasting operation"
Includes preparing, placing, and firing a charge, handling a misfire, and destroying or disposing of explosive materials.

"Bench"
A near-horizontal or shallow slope surface at the top of a near-vertical rock face where blast holes are collared.

"Bench width"
The horizontal distance on the bench between the excavation backslope and the crest of the existing rock face. Generally, this dimension defines the width of the rock to be removed.

"Bootleg"
The remnant of a blast hole which did not properly break when the blast was initiated; also called socket, butt, or button.

"Buffer holes"
Buffer holes are a line or lines of holes, adjacent to and generally parallel to the final wall, with a reduced burden and/or spacing and/or diameter and/or explosive load, designed to help limit the potential for damage behind the final face.

"Burden"
The distance between the blasthole and the nearest free face. Also refers to the perpendicular distance between rows of blast holes.

"Close Proximity Blaster"
A person who is the holder of a valid Close Proximity Blaster certification issued by a municipal, provincial, state, federal or recognized regulatory agency.

"Close Proximity blasting"
Drilling & blasting operations undertaken within 500m of any "Close Proximity structure". See definition for Close Proximity Structure.

"Close Proximity Blasting Manager"
A person who is the holder of a valid Close Proximity Blaster certification issued by a municipal, provincial, state, federal or recognized regulatory agency. They have been responsible for the administration, oversight and development of blast design and control blasting plans for Close Proximity blasting operations for a minimum of 5 years. *See Blasting Consultant.*

"Close Proximity structure"
Any inhabited or non-inhabited structure, power line, power pole, gas and/or electric utility, roadway or any other identified object that may be subject to effects of drilling and blasting operations in a Close Proximity environment. Possible exemptions can be made for structures owned by the same owner for whom the blasting is being carried out or for structures where a signed waiver has been obtained.

"Control blasting"
The highly planned and controlled use of explosives and accessories in carefully spaced, aligned, loaded, and delayed drill holes to achieve specified environmental and physical blast requirements.

"Control Blasting Plan"
The blasting plan developed for a site that specifies in what manner blasting operations are to be undertaken.

"Control Blast Report"
The report that documents specified criteria of each blast performed under a Control Blasting Plan.

"Charge"
Explosive materials which may or may not contain a primer, and which are placed for the purpose of detonation.

"Cushion Blasting"
A single row of holes drilled along the neat excavation line, loaded with light, well-distributed charges and initiated after the main excavation is removed.

"Danger area"
An area in which there may be danger to persons or property from flying material, vibrations, air overpressure, dust or other hazardous environmental conditions resulting from drilling and blasting activities.

"Day box"
An unlicensed explosives storage facility that is not used for overnight storage.

"Delay"
Delay time period before detonation.

"Detonator"
Explosive device used to detonate commercial explosives.

"Drill log"
A written record detailing any anomalous conditions identified during the drilling of blast hole. A record of any identified or perceived changes in geology, including the presence of subsurface water, mud seams, slips, voids and/or any other details that may be useful to the Blaster.

"Explosive"
A substance that is made, manufactured, or used to produce an explosion or detonation, including but not limited to blasting explosives, pyrotechnic devices and accessories containing explosives.

"Flyrock"
The unintended throw and ejection of rock, mats and/or other material from a blast.

"Free face"
The rock face that provides relief for a blast.

"Lift"
The vertical distance between the top and bottom of an area to be blasted.

"Hole Depth"
The total drilled depth of the blast hole.

"Hole deviation"
Any misalignment of a borehole from its intended position or depth.

"Inhabited Structure"
Any building, structure or any other identified inhabited structure that may be subject to the effects of drilling and blasting operations in a close proximity environment.

"Length-to-Burden Ratio"
The face height in meters divided by the burden in meters. See Stiffness Ratio. A value of greater or equal to 3 promotes good horizontal rock mass movement.

"Line Drilling"
A single row of closely spaced, unloaded holes drilled on the neat excavation line. Used to provide a plane of weakness which the primary blast may break to.

"Magazine"
A structure used for the unattended storage of detonators and explosives. Meets the regulations and/or guidelines of municipal, provincial, state and/or federal regulations in which the blasting operation is undertaken.

"Misfire"
A charge or part of a charge which, on initiation, failed to completely detonate or function. Considered to be a dangerous condition.

"Noise"
A pressure wave in the air within the audible range (20 to 20,000 Hz) produced by activities conducted as part of a blasting operation, such as drilling, operation of equipment and blasting usually expressed in dB(A). Note: see "Air Overpressure".

"Overbreak"
Rock that is unintentionally damaged outside of the specified excavation limits.

"Overburden"
This is any material that is overlying solid rock that is to be removed.

"Peak Particle Velocity (PPV)"
PPV is the maximum speed that a particle of soil or rock moves in each of three mutually perpendicular directions (Longitudinal, Transverse and Vertical), measured in millimetres per second. The maximum PPV is the peak measurement from all of the channels.

"Pre-blast survey"
A detailed record in written form, accompanied by photos/video, of the condition of private or public property, prior to the commencement of blasting operations.

"Presplit"
A blasting method whereby shearline holes drilled on the neat excavation line are detonated prior to production holes.

"Production holes"
All holes within the specified excavation limits that are not buffer and/or shearline holes.

"Propellant Cartridges"
A deflagrating rock breaking apparatus. Propellant based, low explosive cartridges that are non-detonating and produce a high volume of gas when ignited in a blast hole.

"Primer"
An explosive to which a detonator or other initiating device has been attached.

"Qualified Blasting Surveyor"
An engineer, technologist, licenced home inspector or qualified insurance adjuster.

"Qualified monitor"
A vibration consultant or person working under the supervision of a blasting consultant trained and/or certified on the use of vibration and air overpressure monitoring equipment.

"Relief holes"
Holes drilled that are not loaded with explosives. Intended to provide relief to blast holes.

"Rock excavation"
Includes drilling holes, loading holes with explosives, detonation by controlled blasting, mucking to grade and ditch level, and removal of material to a designated area. Rock excavation also includes secondary breakage of oversize rock.

"Safety fuse assembly"
A manufactured blasting accessory consisting of a precut length of safety fuse, an igniter cord connector and a detonator.

"Shearline"
A line of holes detonated or intermittently detonated along the specified excavation backslope/neat line.

"Smooth wall"
This is a free surface or shear plane in rock produced by blasting shearline holes.

"Spacing"
The distance between blastholes perpendicular to the burden.

"Stemming"
An inert material used to confine energy within a blast hole at the top of an explosive charge.

"Stiffness Ratio"
The numeric value expressed as the bench height to burden ratio. An indicator of the relative ease at which a bench face breaks and moves along its height profile.

"Sub-drill"
The distance that a borehole is drilled below grade level.

Close Proximity Blasting Levels

It is generally accepted that the prevalence of risk involved in blasting activities increases exponentially with a reduction in distance to close proximity structures.

Based on this relationship, the establishment of distance related guidelines can mitigate the negative risks associated with vibration, air overpressure, flyrock and other related close proximity blasting issues. Therefore, it is considered necessary to classify close proximity drilling and blasting guidelines according to their location relative to close proximity structures.

For the purpose of this guide, close proximity blasting activities are classified, by distance, into five separate categories called Close Proximity Blasting Levels (CP).

Close Proximity Blasting Levels are categorized as follows:

Close Proximity (CP) Blasting Levels	
Close Proximity Blasting Level 0 (CP 0)	0m to 3m (0 to 10') distance from any Close Proximity structure.
Close Proximity Blasting Level 1 (CP 1)	Greater than 3m to 10m (>10'to 33') distance from any Close proximity structure.
Close Proximity Blasting Level 2 (CP 2)	Greater than 10m to 30m (>33' to 100') distance from any Close proximity structure.
Close Proximity Blasting Level 3 (CP 3)	Greater than 30m to 100m (>100' to 330') distance from any Close proximity structure.
Close Proximity Blasting Level 4 (CP 4)	Greater than 100m to 500m (>330' to 1600') distance from any Close proximity structure.

Control Blasting Plan

The purpose of the Control Blasting Plan is to document the hazards and risks associated with a Close Proximity Blasting Project and to document project specifics to ensure that risks and hazards are mitigated. Blast designs should never compromise safety, and safety goals must have the highest design priority.

For each Close Proximity Blasting Level, the following best practice items are outlined as part of the Control Blasting Plan:

1. Blast Design
2. Peak Particle Velocity
3. Air Overpressure
4. Maximum Blast Hole Diameter
5. Maximum Blast Hole Length
6. Explosives
7. Detonators
8. Fly Rock Control
9. Pre-Blast Survey
10. Community Notification
11. Blast Monitoring
12. Blast Documentation

Control Blasting Plan Development

When developing a project Control Blasting Plan, two primary goals should be considered: safety goals and operational goals. It is to be acknowledged under this *Best Practices Guide for Close Proximity Blasting Operations* that whenever safety goals conflict with operational goals, safety must have the highest priority.

The Control Blasting Plan should be developed, documented, and communicated to the Blaster in Charge prior to the commencement of all close proximity blasting operations. The Control Blasting Plan should include the following information:

1. Project name, location, purpose and anticipated volume/quantities, Prime Contractor, and number of workers.

2. The name of the blasting firm and of the person responsible for the blast design, including a record of experience and statement of qualifications.

3. The name of the applicable Close Proximity Blasting Manager and/or Close Proximity Blaster including a record of experience and training.

4. Suggested certifications, permits, authorizations and/or regulatory approvals for the project. First Aid Assessment and Emergency Response Plan.

5. Distance to Close proximity structures, roads/highways, property line, other site works, access conditions, ramps, prevailing wind conditions.

6. Results of the Risk/Hazard Assessment and details on how risks/hazards will be mitigated. i.e.: PPE, traffic control, blast guarding, etc.

7. Nature of the material which includes type of rock, relative hardness, joint orientation and direction, adverse jointing, and the potential for back break.

8. Fragmentation requirements of the owner.

9. Seismic modeling for nearest close proximity structure, including distance, anticipated peak particle velocity and suggested monitoring locations.

10. Blast design considerations, number of holes to be blasted, maximum number of holes per blast and anticipated number of blasts for the project. Blast sizes should be limited to shorten the duration of the blast vibration pulse as much as possible.

11. Drill hole diameter. Minimum and maximum hole depth, burden and spacing, stiffness ratio, explosive type, load, powder factor and collar, type and length of stemming material, detonator type, blast hole timing.

12. Flyrock control. Matting instructions.

13. Pre-Blast survey requirements and structures identified to be surveyed.

14. Stakeholder identification and community notification requirements.

Blast Documentation

It is best practices for the Close Proximity Blaster to document fulfillment of the Control Blasting Plan in sufficient detail in which to recreate a written record of the “as loaded” condition of a blast. The individual blast report should include:

1. A blast sketch with north arrow, typical section view, number of holes and hole depth.

2. Explosive loading details, hole timing, powder factor.

3. Fly rock control measures.

4. Monitoring results, PPV, frequency and air overpressure for each monitoring location.

5. Documentation of the blast results and details of the post-blast examination.

All blast documentation should be reviewed by the Close Proximity Blasting Manger. Detail any amendments made to the Control Blasting Plan to ensure that safety and project objectives are met. Blasting Logs should be kept on file for a minimum of 5 (five) years.

Close Proximity Blasting **Summary Matrix**	Close Proximity Blasting **CP Level 0** 0m to 3m (0 to 10')	Close Proximity Blasting **CP Level 1** >3m to 10m (>10' to 33')	Close Proximity Blasting **CP Level 2** >10m to 30m (>33' to 100')	Close Proximity Blasting **CP Level 3** >30m to 100m (>100' to 330')	Close Proximity Blasting **CP Level 4** >100m to 500m (>330' to 1600')
Blast Design & Control Blasting Plan	• Close Proximity Blasting Manager with 10 or more years' experience. • Suggested oversight from an independent Blasting Consultant.	• Close Proximity Blasting Manager with 7 or more years of experience. • Suggested oversight from an independent Blasting Consultant.	• Close Proximity Blasting Manager with 5 or more years of experience suggested to design, develop, and accept Control Blasting Plan.	• Certified Close Proximity Blaster suggested to design, develop Control Blasting Plan.	• Certified Close Proximity Blaster suggested to design, develop Control Blasting Plan if blasting activities are within 500m (1600') of school, hospital, or clinic.
Peak Particle Velocity & Frequency Response	• Blast designed to 50 mm/sec (2 inches/sec) at CP Level 1 distance. • Blast designed to maximize Frequency.	• Blast designed to 50 mm/sec (2 inches/sec) or in accordance with the USBM table in Appendix A.	• Blast designed to 35 mm/sec (1.4 inches/sec) or in accordance with the USBM table in Appendix A.	• Blast designed to 25 mm/sec (1 inch/sec) or in accordance with the USBM table in Appendix A.	• Blast designed in accordance with the USBM table in Appendix A.
Air Overpressure	• Maximum 134dBL.	• Maximum 134dBL.	• Maximum 134dBL.	• Maximum 134dBL.	• Maximum 134dBL.
Blast Hole Diameter	• Suggested 45mm (1 ¾") blast hole diameter maximum. • Max 70mm (2 ¾") blast hole diameter where explosive decking/decoupling is utilized.	• Suggested 45mm (1 ¾") blast hole diameter maximum. • Max 70mm (2 ¾") blast hole diameter where explosive decking/decoupling is utilized.	• 70mm (2 ¾") blast hole diameter suggested maximum.	• 75mm (3") blast hole diameter suggested maximum.	• At the discretion of the Blaster.
Blast Hole Length	• Governed by charge weight per delay to meet suggested PPV and frequency limit.	• Governed by charge weight per delay to meet suggested PPV limit.	• Governed by charge weight per delay to meet suggested PPV limit.	• Governed by charge weight per delay to meet suggested PPV limit.	• Governed by charge weight per delay to meet suggested PPV limit.
Explosives	• Directed by the Close Proximity Blasting Manager based on blast design and structure type. • ANFO/bulk products not recommended.	• Packaged explosive to a max 38mm ($1^{1/2}$") diameter • ANFO/bulk products not recommended below critical hole diameter for product.	• Packaged explosive to a max 50mm (2") diameter • ANFO/bulk products to be utilized in accordance with manufacturers specifications.	• At the discretion of the Blaster • ANFO/bulk products to be utilized in accordance with manufacturers specifications.	• At the discretion of the Baster • ANFO/bulk products to be utilized in accordance with manufacturers specifications.
Detonators	• Electronic detonators suggested.	• Electronic detonators suggested.	• Electronic detonators suggested. • Type of detonator utilized at the discretion of the Blaster.	• Type of detonator utilized at the discretion of the Blaster.	• Type of detonator utilized at the discretion of the Blaster.
Fly Rock Control	• Adequate Blast Design. • Use of a confinement device or clear crushed rock stemming. • Adequate blast matting or earth fill.	• Adequate Blast Design. • Use of a confinement device and/or clear crushed rock stemming. • Adequate blast matting or earth fill.	• Adequate Blast Design. • Use of a confinement device and/or clear crushed rock stemming. • Adequate blast matting or earth fill.	• Adequate Blast Design. • Use of a confinement device and/or clear crushed rock stemming. • Adequate blast matting or earth fill.	• Adequate Blast Design. • Use of a confinement device and/or clear crushed rock stemming. • Blasting mats suggested within 300m (1000') • Adequate mating or earth fill.
Pre-Blast Survey	• Suggested for all Close Proximity structures within 30m (100') of the blasting limits.	• Suggested for all Close Proximity structures within 30m (100') of the blasting limits.	• Suggested for all inhabited structures within 75m (250') of the blasting limits.	• Suggested for all inhabited structures within 75m (250') of the blasting limits.	• At the discretion of the Blaster.
Community Notification	• 48 hours notification for all inhabited structures within 30m (100') of the blasting limits. • Blasting schedule to be coordinated with schools, hospitals, and clinics within 150m (500') of blasting limits.	• 48 hours notification for all inhabited structures within 30m (100') of the blasting limits. • Blasting schedule to be coordinated with schools, hospitals, and clinics within 150m (500') of blasting limits	• 48 hours notification for all inhabited structures within 75m (250') of the blasting limits. • Blasting schedule to be coordinated with schools, hospitals, and clinics within 150m (500') of blasting limits	• 48 hours for all inhabited structures within 100m (330') and/or School/Hospitals within 300m (1000') of the blasting limits. • Blasting schedule to be coordinated with schools, hospitals, and clinics within 300m (1000') of blasting limits	• 48 hours for School/Hospitals within 500m (1600') of the blasting limits. • Blasting schedule to be coordinated with schools, hospitals, and clinics within 500m (1600') of blasting limits.
Monitoring	• Monitor as per CP1 distance. • Suggested use of a high frequency geophone.	• Follow ISEE Field Practice Guidelines for Seismographs. • Monitoring at the 2 nearest Close Proximity structures.	• Follow ISEE Field Practice Guidelines for Seismographs. • Monitoring at the 2 nearest Close Proximity structures.	• Follow ISEE Field Practice Guidelines for Seismographs. • Monitoring at the 2 nearest Close Proximity structures.	• Follow ISEE Field Practice Guidelines for Seismographs. • Monitoring at the nearest Close Proximity structure. Additional monitoring as suggested.

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Close Proximity Blasting Level 0 0 to 3m (0 to 10')

Close Proximity Blasting Level 0 (CP 0) is defined as drilling and blasting activities occurring from 0 meters to 3 meters distance from any Close Proximity structure.

Close Proximity blasting operations classified CP 0 are highly specialized and involve a significant risk of property damage that may be beyond the control of the Close Proximity Blaster.

Blasting operations undertaken at Close Proximity Blasting Level 0 represent the highest potential for damage to a Close Proximity structure. This work must only be attempted by highly trained blasters who are skilled in close-in blasting work and are capable of carrying out the work safely. Other methods of rock removal such as hydraulic splitting, the use of expanding grouts, or other methods should be considered as an alternative.

Blasting operations conducted at CP 0 should be conducted in close consultation with civil, structural and/or geotechnical engineers.

CP 0 operations may require an assessment of building structures and a review of geological conditions, as suggested, to ensure that blasting operations can be carried out safely near Close Proximity structures.

The risks associated with blasting at CP 0 need to be communicated to the project owner and/or general contractor and a determination made as to who will assume these risks. It may be in the best interest of the blaster to obtain a damage release or waiver signed by the owner prior to proceeding with blasting.

CP 0 Control Blasting Plan

The purpose of the Control Blasting Plan is to document the hazards and risks associated with a Close Proximity Blasting Project and to document project specifics to ensure that risks and hazards are mitigated. Blast designs should never compromise safety, and safety goals must have the highest design priority.

The Close Proximity Blasting Manager is responsible for designing and documenting the Control Blast Plan for CP 0 operations. The Close Proximity Blasting Manager should be a blasting professional having a minimum of ten (10) years direct experience in the design, implementation, administration, and oversight of Close Proximity blasting activities.

It is suggested to have the Control Blasting Plan reviewed by an independent Blasting Consultant for CP 0 blasting operations.

The Control Blasting Plan should include the following:

Blast Design Guidelines

Blast designs should satisfy safety objectives and be appropriate for the application taking into account the geology and area control requirements when selecting hole size, explosive diameter, stemming height, type of detonators, timing and other applicable design details.

The initial blast on site should be a test blast that is limited in size and designed to evaluate the proposed blast design,

Peak Particle Velocity & Frequency

CP 0 blasts are suggested to be designed by the Close Proximity Blasting Manager to limit maximum peak particle velocities at Close Proximity Level 1 limits measured at CP 1 distances.

Blasts should be designed to maximize the Frequency of the blast vibration waves at the nearest structure.

Air Overpressure

Blasting operations performed at Close Proximity Blasting Level 0 are recommended to be designed and undertaken to an impulsive overpressure no greater than 134dBL.

Blast Hole Diameter and Depth

The Control Blasting Plan should document the blast hole diameter. The suggested maximum blast hole diameter for CP 0 operations is 45mm (1 ¾").

Where deeper holes are required such as: when drilling full depth, backfilling holes with sand, and blasting partial depth blast holes, or for perimeter control applications such as line drilling or for explosives multi-decking operations, blast hole size recommended not to exceed 70mm (2 3/4").

The depth of cut for each blast will be determined by the charge weight per delay required to meet suggested peak particle velocity limit(s) and respect adequate stiffness ratio.

Explosives

Packaged explosives to a maximum 38mm (1 ½") diameter are recommended at CP 0.

Extreme close proximity blasting operations may require the use of packaged explosives to a maximum 50mm (2") diameter. See Extreme Close Proximity Blasting Considerations on page 31 for more detailed information.

The use of ammonium nitrate/fuel oil (ANFO), bulk emulsion or other bulk type products is not recommended.

Detonators

Use of electronic detonators is suggested for operations conducted at Close Proximity Blasting Level 0.

It is recommended to pre-test all electronic detonators, prior to use, to ensure communication with the programmer.

Flyrock Controls

The Control Blast Plan should document how flyrock is to be controlled. See *Controlling Flyrock Page 24.*

Pre-Blast Surveys

Pre-Blast surveys should be conducted in accordance with the *Pre-Blast Survey of Close Proximity Structures, see Page 26*.

A pre-blast survey of all Close Proximity structures within 30m (100') of the blasting limit should be undertaken by a qualified blasting surveyor prior to the commencement of CP 0 drilling and blasting operations.

Community Notification

Best practices for notification of the community is detailed in the *Community Notification of Blasting Operations see Page 28.*

All residents or owners of Close Proximity structures, schools, and hospitals within 30m (100') of the area of influence should be notified in person, at least 48 hours prior to the commencement of drilling and blasting activities at CP 0.

Blasting schedules are to be coordinated with schools and medical treatment facilities within 150m (500') of CP 0 drilling and blasting operations.

Blast Monitoring

Blast Monitoring is to be conducted in accordance with the *Blast Monitoring, see page 29*.

The two (2) nearest Close Proximity structures within 30m (100') should be monitored with seismographs at CP 0.

For CP 0 operations, consideration should be given to the utilization of seismographs that are capable of accurately measuring high frequencies.

Documentation

The Close Proximity Blaster is to document fulfillment of the Control Blasting Plan objectives as well as regulatory blast report requirements. Blast documentation should be reviewed by the Close Proximity Blasting Manager and amendments undertaken to ensure the meeting of plan objectives.

Extreme Close Proximity Blasting Considerations

Extreme Close Proximity is generally identified as blasting operations undertaken where the horizontal distance to the structure of concern is often less than 600mm (2 feet) and the vertical depth of the cut in rock to be removed is at least twice that of the horizontal distance.

Extreme Close Proximity operations undertaken represent the highest potential for damage to a structure. It should only be undertaken by highly trained and experienced blasters who are skilled in Close Proximity blasting work and are capable of carrying out the work safely.

Extreme Close Proximity can utilize line drilling, where site conditions allow, to create a blast vibration break for additional mitigation measures. This combined with advanced, specialized blasting techniques allows for the removal of rock in close proximity to structures. The overall concept/theory is based on driving blasting wave frequencies to high levels. The resulting increase in frequencies prevents the structure from responding to high peak particle velocities that would normally cause damage.

The Close Proximity Blasting Committee recommends that other methods of rock removal such as hydraulic splitting, the use of expanding grouts, or other methods should be considered as an alternative to Extreme Close Proximity Blasting.

Please see Appendix B, Extreme Close Proximity Blasting Considerations on page 32 for more detailed information on this technique.

Close Proximity Blasting Level 1 >3m to 10m (10' to 33')

Close Proximity Blasting Level 1 (CP 1) is defined as drilling and blasting activities occurring from greater than 3 meters to 10 meters distance from any Close Proximity structure.

CP 1 Control Blasting Plan

The purpose of the Control Blasting Plan is to document the hazards and risks associated with a Close Proximity Blasting Project and to document project specifics to ensure that risks and hazards are mitigated. Blast designs should never compromise safety, and safety goals must have the highest design priority.

The Close Proximity Blasting Manager is responsible for designing and documenting the Control Blast Plan for CP 1 operations. The Close Proximity Blasting Manager should be a blasting professional having a minimum of seven (7) years direct experience in the design, implementation, administration and oversight of Close Proximity blasting activities. It is suggested to have the Control Blasting Plan reviewed by an independent Blasting Consultant for CP 1 blasting operations.

The Control Blasting Plan should include the following:

Blast Design Guidelines

Blast designs should satisfy safety objectives and be appropriate for the application taking into account the geology and area control requirements when selecting hole size, explosive diameter, stemming height, type of detonators, timing and other applicable design details.

The initial blast on site should be a test blast that is limited in size and designed to evaluate the proposed blast design.

Peak Particle Velocity

Where a lack of project specific requirements exist, it is recommended that blasts at CP 1 be designed to less than 50mm/sec (2 inches/sec) peak particle velocity calculated for the nearest Close Proximity structure or in accordance with the *USBM Peak Particle Velocity versus Frequency Graph in Appendix A*.

Determine and document the anticipated Peak Particle Velocity expected at nearby Close Proximity structures based on the blast design.

Production blast sizes should be limited to shorten the duration of the blast vibration pulse as much as possible.

Air Overpressure

Blasting operations performed at Close Proximity Blasting Level 1 are recommended to be designed and undertaken to an impulsive overpressure no greater than 134dBL.

Blast Hole Diameter and Depth

The Control Blasting Plan should document the blast hole diameter. The suggested maximum blast hole diameter for CP 1 operations is 45mm (1 ¾").

Where deeper holes are required such as: when drilling full depth, backfilling holes with sand, and blasting partial depth blast holes, or for perimeter control applications such as line drilling, blast hole size recommended not to exceed 70mm (2 3/4"). The depth of cut for each blast will be determined by the charge weight per delay required to meet suggested peak particle velocity limit(s) and respect adequate stiffness ratio.

Explosives

Packaged explosives to a maximum 38mm (1 ½") diameter are recommended at CP 1.

Any use of ammonium nitrate/fuel oil (ANFO), bulk emulsion or other bulk type products must be utilized in accordance with manufacturer's recommendations.

Detonators

Use of electronic detonators is suggested for operations conducted at Close Proximity Blasting Level 1.

It is recommended to pre-test all electronic detonators, prior to use, to ensure communication with the programmer.

Flyrock Controls

The Control Blast Plan should document how flyrock is to be controlled. *See Controlling Flyrock Page 24.*

Pre-Blast Surveys

Pre-Blast surveys should be conducted in accordance with the *Pre-Blast Survey of Close Proximity Structures, see Page 26*.

A pre-blast survey of all Close Proximity structures within 30m (100') of the blasting limit should be undertaken by a qualified blasting surveyor prior to the commencement of CP 1 drilling and blasting operations.

Community Notification

Best practices for notification of the community is detailed in the *Community Notification of Blasting Operations, see Page 28*.

All residents or owners of Close Proximity structures within 30m (100') of the area of influence should be notified in person, at least 48 hours prior to the commencement of drilling and blasting activities at CP 1.

Blasting schedules are to be coordinated with schools and medical treatment facilities within 150m (500') of CP 1 drilling and blasting operations.

Blast Monitoring

Blast Monitoring is to be conducted in accordance with the *Blast Monitoring, see page 29*.

The two (2) nearest Close Proximity structures within 30m (100') should be monitored with seismographs at CP 1.

Documentation

The Close Proximity Blaster is to document fulfillment of the Control Blasting Plan objectives as well as regulatory blast report requirements. Blast documentation should be reviewed by the Close Proximity Blasting Manager and amendments undertaken to ensure the meeting of plan objectives.

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Close Proximity Blasting Level 2 >10m to 30m (>33' to 100')

Close Proximity Blasting Level 2 (CP 2) is defined as drilling and blasting activities occurring from greater than 10 meters to 30 meters distance from any Close Proximity structure.

CP 2 Control Blasting Plan

The purpose of the Control Blasting Plan is to document the hazards and risks associated with a Close Proximity Blasting Project and to document project specifics to ensure that risks and hazards are mitigated. Blast designs should never compromise safety, and safety goals must have the highest design priority.

The Close Proximity Blasting Manager is responsible for designing and documenting the Control Blast Plan for CP 2 operations. The Close Proximity Blasting Manager is recommended to be a blasting professional having a minimum of five (5) years direct experience in the design, implementation, administration, and oversight of Close Proximity blasting activities.

The Control Blasting Plan should include the following:

Blast Design Guidelines

Blast designs should satisfy safety objectives and be appropriate for the application considering the geology and area control requirements when selecting hole size, explosive diameter, stemming height, and type of detonators.

Peak Particle Velocity

Where a lack of project specific requirements exist, it is suggested that blasts at CP 2 be designed to less than 35mm/sec (1.4 inches/sec) peak particle velocity calculated for the nearest Close Proximity structure or in accordance with the *USBM Peak Particle Velocity versus Frequency Graph in Appendix A.*

Determine and document the anticipated Peak Particle Velocity expected at nearby Close Proximity structures based on the blast design.

Air Overpressure

Blasting operations performed at Close Proximity Blasting Level 2 should be designed and undertaken to an impulsive overpressure no greater than 134dBL.

Blast Hole Diameter and Depth

The Control Blasting Plan should document the blast hole diameter. It is suggested that CP 2 drilling and blasting operations blast hole size not exceed 70mm (2 ¾").

The depth of cut for each blast should be determined by the charge weight per delay required to meet suggested peak particle velocity limit(s) and respect adequate stiffness ratio.

Explosives

Packaged explosives to a maximum 50mm (2") diameter are recommended at Close Proximity Blasting Level 2.

Any use of ammonium nitrate/fuel oil (ANFO), bulk emulsion or other bulk products must be utilized in accordance with manufacturer's recommendations. There is a risk of overloading with the use of poured or pumped bulk explosives due to the filling of voids or cracks in the rock.

Detonators

The use of electronic detonators is suggested for operations conducted at Close Proximity Blasting Level 2.

It is recommended to pre-test all electronic detonators, prior to use, to ensure communication with the programmer.

Flyrock Controls

The Control Blast Plan should document how flyrock is to be controlled. *See Controlling Flyrock, page 24.*

Pre-Blast Surveys

A pre-blast survey of all Close Proximity structures within 75m (250') of the blasting limit should be undertaken by a qualified blasting surveyor prior to the commencement of drilling and blasting operations designated CP 2.

Pre-Blast surveys should be conducted in accordance with best practices - see *Pre-Blast Survey of Close Proximity Structures page 26.*

Community Notification

Best practices for notification of the community for CP 2 is documented in *Community Notification of Blasting Operations, see Page 28.*

All residents or owners of Close Proximity structures, schools, and hospitals within 75m (250') of the area of influence should be notified in person, at least 48 hours prior to the commencement of drilling and blasting activities at CP 2.

Blasting schedules are to be coordinated with schools and medical treatment centers within 150m (500') of CP 2 drilling and blasting operations.

Blast Monitoring

Blast Monitoring is to be conducted in accordance with best practices outlined in *Blast Monitoring, see page 29.*

The two (2) nearest Close Proximity structures within 75m (250') should be monitored with seismographs at CP 2.

Documentation

The Close Proximity Blaster is to document fulfillment of the Control Blasting Plan objectives as well as regulatory blast report requirements. Blast documentation should be reviewed by the Close Proximity Blasting Manager and amendments undertaken to ensure the meeting of plan objectives.

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Close Proximity Blasting Level 3 >30m to 100m (>100' to 330')

Close Proximity Blasting Level 3 (CP 3) is defined as drilling and blasting activities occurring from greater than 30 meters to 100 meters distance from any Close Proximity structure.

CP 3 Control Blasting Plan

The purpose of the Control Blasting Plan is to document the hazards and risks associated with a Close Proximity Blasting Project and to document project specifics to ensure that risks and hazards are mitigated. Blast designs should never compromise safety, and safety goals must have the highest design priority.

The Close Proximity Blasting Manager responsible for designing and documenting the Control Blast Plan for CP 3 operations is recommended to be a jurisdictionally certified Close Proximity Blaster with a minimum of 3 years' experience in directing Close Proximity blasting operations.

The Control Blasting Plan should include the following:

Blast Design Guidelines

Blast designs should satisfy safety objectives and be appropriate for the application. Consider the geology and area control requirements when selecting hole size, explosive diameter, stemming height, type of detonators, timing, and other applicable design details.

Peak Particle Velocity

Where a lack of project specific requirements exist, it is suggested that CP 3 blasts be designed to less than 25mm/sec (1 inch/sec) peak particle velocity calculated for the nearest Close Proximity structure or in accordance with the *USBM Peak Particle Velocity versus Frequency Graph in Appendix A.*

Determine and document the anticipated Peak Particle Velocity expected at nearby Close Proximity structures based on the blast design.

Air Overpressure

Blasting operations performed at Close Proximity Blasting Level 3 should be designed and undertaken to an impulsive overpressure no greater than 134dBL.

Blast Hole Diameter and Depth

The Control Blasting Plan should document the blast hole diameter. It is suggested that CP 3 drilling and blasting operations blast hole size not exceed 75 millimeters (3")

The depth of cut for each blast should be determined by the charge weight per delay required to meet suggested peak particle velocity limit(s) and respect adequate stiffness ratio.

Explosives and Detonators

Explosives and detonator selection are at the discretion of the Close Proximity Blaster.

Flyrock Controls

The Control Blast Plan should document how flyrock is to be controlled. *See Controlling Flyrock, Page 24.*

Pre-Blast Surveys

A pre-blast survey of all Close Proximity structures within 75m (250') of the blasting limit should be undertaken by a qualified blasting surveyor prior to the commencement of drilling and blasting operations designated CP 3.

Best practices for conducting pre-blast surveys are detailed in *Pre-Blast Survey of Close Proximity Structures, see page 26*.

Community Notification

Best practices for the notification of the community is documented in the *Community Notification of Blasting Operations, see page 28.*

All residents or owners of Close Proximity structures, schools, and hospitals within 100m (330') of the area of influence should be notified in person, at least 48 hours prior to the commencement of drilling and blasting activities at CP 3.

Blasting schedules are to be coordinated with schools and medical treatment centers within 300m (1000') of CP 3 drilling and blasting operations.

Blast Monitoring

Blast Monitoring is to be conducted in accordance with best practices. *See Blast Monitoring, page 29.*

The two (2) nearest Close Proximity structures within 75m (250') should be monitored with seismographs at CP 3.

Documentation

The Close Proximity Blaster is to document fulfillment of the Control Blasting Plan objectives as well as regulatory blast report requirements. Blast documentation should be reviewed by the Close Proximity Blasting Manager and amendments undertaken to ensure the meeting of plan objectives.

Close Proximity Blasting Level 4 >100m to 500m (>330' to 1600')

Close Proximity Blasting Level 4 (CP 4) is defined as drilling and blasting activities occurring greater than 100 meters to 500 meters distance from any Close Proximity structure.

CP 4 Control Blasting Plan

The purpose of the Control Blasting Plan is to document the hazards and risks associated with a Close Proximity Blasting Project and to document project specifics to ensure that risks and hazards are mitigated. Blast designs should never compromise safety, and safety goals must have the highest design priority.

The Close Proximity Blaster responsible for designing and documenting the Control Blast Plan for CP 4 operations is recommended to be a jurisdictionally certified Close Proximity blaster with a minimum of 2 years' experience in Close Proximity blasting operations.

The Control Blasting Plan should include the following:

Blast Design Guidelines

Blast designs should satisfy safety objectives and be appropriate for the application. Consider geology and area control requirements when selecting hole size, explosive diameter, stemming height, type of detonators, timing, and other applicable design details.

Peak Particle Velocity

Where a lack of project specific requirements exist, blasting operations performed at CP 4 are suggested to be designed in accordance with the *USBM Peak Particle Velocity versus Frequency Graph in Appendix A.*

Determine and document the anticipated Peak Particle Velocity expected at nearby Close Proximity structures based on the blast design.

Air Overpressure

Blasting operations performed at Close Proximity Blasting Level 4 should be designed and undertaken to an impulsive overpressure no greater than 134dBL.

Blast Hole Diameter and Depth

The Control Blasting Plan should document the blast hole diameter and blast hole length. For CP 4 Close Proximity Blasting Operations, the depth of cut for each blast should be determined by the charge weight per delay required to meet suggested peak particle velocity limit(s) and respect adequate stiffness ratio.

Explosives and Detonators

At the discretion of the Blaster.

Flyrock Controls

The Control Blast Plan should document how flyrock is to be controlled. See best practices for *Controlling Flyrock, page 24.*

Pre-Blast Surveys

Pre-blast surveys at CP 4 are to be conducted at the discretion of the Blaster. Pre-Blast surveys should be conducted in accordance with best practices – see Pre-Blast Survey of Close Proximity Structures, page 26.

Community Notification

Best practices for the notification of the community is documented in the *Community Notification of Blasting Operations, see Page 28.*

Schools, Clinics and Hospitals within 500m (1600') of the area of influence should be notified in person, at least 48 hours prior to the commencement of drilling and blasting activities at CP 4.

Blasting schedules are to be coordinated with schools and medical treatment facilities within 500m (1600') of CP 4 drilling and blasting operations.

Blast Monitoring

It is suggested that the nearest Close Proximity structure be monitored with seismographs at CP 4.

Blast Monitoring should be conducted in accordance with best practices. See *Blast Monitoring, page 29.*

Documentation

The Blaster is to document fulfillment of the Control Blasting Plan objectives as well as regulatory blast report requirements.

Blast documentation should be reviewed by the Close Proximity Blasting Manager and amendments undertaken to ensure the meeting of plan objectives.

Best Practices for Close Proximity Blasting Activities

These best practices are intended to be supplemental to local, municipal, state, provincial and/or federal regulations and represent best practices for Close Proximity drilling and blasting operations. They are not intended to supersede any federal, state, provincial, or local regulations pertaining to drilling, blasting and/or the use of explosive materials or other activities.

Planned Operations

When undertaking Close Proximity blasting activities, it is suggested that the Close Proximity Blasting Manager and/or Blaster in Charge adopt a planned, logical, and systematic sequence of operations to ensure drilling and blasting operations are conducted in a safe, effective, and productive manner. Namely:

1. Know and understand all local, municipal, provincial, state and/or federal safety rules and regulations with regard to drilling, blasting, explosive storage, and transport activities.

2. Know and understand the environmental and physical requirements/limitations for the project and drilling and blasting activities.

3. Know and understand the *Best Practices Guide for Close Proximity Blasting Operations*.

4. Determine the Close Proximity Blast Level of the drilling and blasting operations to be undertaken.

5. Develop, document, implement and review the Control Blasting Plan.

Close Proximity Blasting Project Management Program

Under this Guide, it is suggested that a Close Proximity blasting project management program be undertaken by blasting contractors to ensure that Close Proximity blasting operations are conducted in an organized and systematic manner whereby safety and blasting related risks and hazards are managed and mitigated. The Close Proximity blast project management system should be implemented to ensure:

1. Guidelines for Close Proximity blasting activities are defined.

2. Risks and hazards to the public, workers and Close Proximity structures are identified prior to the commencement of drilling and blasting operations.

3. Control Blasting Plans are designed and undertaken in accordance with best practices.

4. Owners of Close Proximity structures, residents, schools, and hospitals are notified of Close Proximity blasting activities conducted in their area.

5. Close Proximity blasting activities are evaluated for effective operations through inspection and monitoring.

Risk Assessment Process

It is suggested that companies carrying out Close Proximity blasting operations should have a Standard Operating Procedure. This should stipulate that before starting work on a new project, the Blaster-in-Charge should perform a site hazard analysis to identify risks and develop effective controls wherever possible.

The following are some potential risks that should be evaluated:

1. What impact could weather conditions have on the project? Is there a risk of lightning occurring?

2. Can high winds cause trees or other objects to fall into the job site?

3. Have all potential access routes been identified for blast guarding? Is public access to the site controlled?

4. Are cut banks stable and properly shored for excavations that are deeper than 1.2 meters (4 ft.)?

5. Has the location of all buried utilities or other sensitive structures been identified?

6. Are there any potential sources of stray electrical currents?

7. Are there any overhead hydro, telephone, or fibre optic lines present? Is there any chance that the drill mast or the excavating equipment could come within the “limits of approach”? You may need to check government electrical safety regulations to identify the proper safety allowance. You may need to have a “safety watcher” scrutinize operations close to powerlines to warn operators if they get close to the “limits of approach”.

8. What impact could the geology have on the blasting operation? Are there any weak zones such as clay seams, open joints, solution cavities, shear zones or fault zones within the rock mass?

9. Is there a risk of flyrock? Are blasting mats available and have they been brought to site?

10. Are your proposed clearing distances adequate to protect the workers and the public?

11. Are the blast holes going to be wet? Do you have the proper explosives on site to reliably deal with water conditions?

12. Are there any paths for potential after-blast fume migration through the ground and into neighbouring homes? Look for open seams in the rock, or any underground conduits such as drain fields or rock pits connecting foundation drains, basement floor drains, or sumps, and look for loose fill around conduits, etc.

13. Has there been any previous blasting carried out on site? If so, have you checked for the presence of bootlegs or un-exploded charges?

14. Have there been any previous un-resolved damage complaints from previous blasting in the area? Any prior complaints? Any known litigation?

15. Is there anyone working above you? Do not work directly below other operations. You will need to have proper job site coordination to avoid this.

16. Is there any chance of falling over the face? If the face height is greater than 3 meters (10 ft.), you will need to be wearing a fall arrest harness with lifeline secured to a suitable anchor point. Ensure that the proper equipment is available.

17. Has your examination of the work area identified the presence of slipping and tripping hazards? Develop hazard controls where possible.

18. Are proper procedures in place for the control of dust? Are drills fitted with working dust collectors or water spray systems?

19. Is proper personal protective equipment available for all workers on site?

20. Are any workers required to work alone? If so, an effective communication system may be required.

Outline all of the hazards identified and develop hazard controls or safe work procedures to address each one.

Close Proximity Blaster in Charge

The designated Close Proximity blaster-in-charge will have complete authority over all personnel within the area of influence and is ultimately responsible for all blasting activities.

The blaster-in-charge should possess appropriate training, experience, and hold all blasting licenses and certifications required by the regulatory jurisdiction of the Close Proximity blasting operations. The blaster in charge should:

- Know and comply with any federal, state, provincial, or local laws/regulations pertaining to drilling, blasting and/or the storage, transport and use of explosive materials or related activities.
- Know and understand industry best practices.
- Implement and adhere to the Control Blasting Plan approved for the project.
- Conduct a risk and hazard assessment prior to commencement of operations.
- Directly supervise all drilling and blasting activities ensuring they are undertaken in accordance with the Control Blasting Plan and in a safe and productive manner.
- Review drill logs prior to loading blast holes.
- Continuously monitor the work habits of blasting personnel and provide corrective actions when necessary.

Ensure that all appropriate documentation is retained as suggested by the project documents and all regulatory agencies. Blasting Logs should be kept on file for a minimum of 5 (five) years.

Controlling Flyrock

Fly rock is a constant concern to all stakeholders in Close Proximity Blasting operations. Flyrock can be controlled through proper blast design, stemming, matting and/or containment.

Blast Design

Proper blast design is the primary influence on controlling flyrock. An adequate blast design works to ensure the control of flyrock and efficient blast performance through proper:

- Energy Distribution
- Energy Confinement
- Energy Level
- Burden Relief
- Powder Factor
- Length to Burden Ratio

While satisfying all primary design objectives, blast designs should be as simple as possible while appropriate for the application. Close Proximity blast designs should never compromise safety, and safety goals should have the highest design priority.

The blast designer must have thorough knowledge and understanding of the project requirements and constraints prior to developing the blast design.

The geology of the blast site and area control requirements must be considered when selecting hole size, explosive diameter, stemming height, type of detonators, timing and other design details.

The Control Blasting Plan should contain full details of the blast design including: the design peak particle velocity, peak air overpressure level, number of holes per blast, pattern, orientation and size of drill holes, depth of drilling, collar and toe load, powder factor, stiffness ratio, mass, and type of charge per delay, number of delays and hole timing.

The depth of cut for each blast will be determined by the charge weight per delay required to meet suggested peak particle velocity limit(s) and respect adequate stiffness ratio. To ensure proper burden relief, it recommended that the blast designer should strive to achieve a minimum bench height to burden ratio of approximately 2 (two).

It is the responsibility of the Close Proximity Blaster to ensure that the blast is loaded according to the approved design.

Stemming

Insufficient or inadequate stemming material can contribute to flyrock and poor blast performance. Stemming lengths should be evaluated by the site conditions including:

- Quality of stemming material
- Strength of rock at top or decking area
- Hole diameter
- Powder Factor
- Burden/Relief
- Presence of water

Type of Stemming

It is suggested to utilize clear crushed rock chips and/or a commercially available energy confinement device for blast hole stemming during Close Proximity blasting operations.

Stemming Length

A suggested stemming length of 20 to 30 borehole diameters should be used assuming good quality stemming material and adequate blast design. An adjusted stemming length may be required based on site conditions.

Blasting Mats

Close Proximity drilling and blasting operations should utilize blasting mats to act as a safety measure in the control of flyrock. Blasting mats should be utilized in accordance with the following guidelines:

1. Blast matting is to be carried out under the direct supervision of the Blaster in Charge.

2. Blasting mats, rigging, and hoisting equipment are to be inspected by the Blaster in Charge immediately prior to each blast matting operation. The inspection should be documented on the Control Blast Report. Any defective blasting mats should be removed from service at the earliest opportunity.

3. Blasting mats are to be secured to the hoisting equipment by adequate rigging and should not be suspended from bucket teeth.

4. Place mats. Do not drag them over the blast. Mats should be laid in such a manner as to ensure the tie-in is not compromised.

5. Systematically place the mats, commencing from the point of initiation.

6. When utilizing electric detonators, continuity should be monitored at all times during blasting mat placement.

7. It is recommended that electronic detonator continuity be monitored at all times during blast mat placement.

8. Non-electric detonators, shock tubes and connections should be adequately protected from damage during blasting mat placement.

Use of Blasting Mats

It is suggested that blasting mats be utilized for flyrock protection when blasting within 300m (1000') of any inhabited structure.

Blast Coverage

The amount of overlap of blasting mats can significantly reduce the risk of flyrock during Close Proximity blasting activities. The Close Proximity Blaster must ensure that blasts are adequately covered to ensure that flyrock is confined.

Rigging of Blasting Mats

Pre-Inspection

It is suggested that immediately prior to placing blasting mats, the Close Proximity Blaster inspect and verify the condition of all rigging to ensure safety.

Chain Systems

Chain systems used for rigging, hoisting and placement of blasting mats are recommended to have a rated working load of 4 (four) times the weight of the heaviest blasting mat utilized on site.

Wire Rope Systems

Wire rope systems used for rigging, hoisting and placement of blasting mats are recommended to have a rated working load of 5 (five) times the weight of the heaviest blasting mat utilized on site.

Blasting Mat Construction

Blasting mats should be commercially available mats that are manufactured specifically for blasting operations.

Use of Earth Material

Earth fill is commonly utilized in close proximity blasting operations to assist in controlling flyrock in conjunction with the use of blast mats or when blast matting is not practical or feasible.

When utilizing earth fill, the Close Proximity Blaster is to ensure that good clean material is carefully placed on the blast in order to prevent damage to the detonation system. In addition, enough material should be placed on the blast to ensure the containment of flyrock.

Blasting Fumes

The detonation of commercial explosives and blasting agents produces mainly carbon dioxide, nitrogen, and water vapour (steam), however, noxious gasses such as carbon monoxide and nitrogen oxides can also be present. These fumes can be dangerous if workers or the public are exposed to them. The white smoke that you see from most blasting operations is mainly steam. Carbon monoxide is colourless and odourless and in rare circumstances could seep without warning into a basement or other confined space such as a manhole.

The following can contribute to the risk of trapping fumes in the ground: blasting through overburden cover, blasting trench rock through asphalt cover or the presence of a frozen overburden cap.

Some actions that blasters can follow to mitigate risks with fumes are:

1. Identify if the conditions are present for the migration of post-blast fumes through the ground. This could involve looking for open seams such as horizontally laminated limestone, shale, or slate.

2. When carrying out blasting for new foundation excavations, ask all homeowners within 30 meters (100 ft.) of the blast site if they have working CO detectors with alarms in their homes. If not, provide them with one.

3. When carrying out close proximity trench blasting for utilities, the blaster may want to increase the notification distance.

4. Excavate shots immediately to release any post-blast fumes. If there are concerns with leaving an open excavation overnight, loose rock may be backfilled.

5. Ensure that workers who must access manholes or other confined spaces are equipped with gas monitors.

6. In instances where CO migration through the ground has been identified, success has been achieved by drilling vent holes, lining them with PVC pipe, and hooking this up to the dust collector on the drill to apply negative pressure to the ground, thus venting the CO to the atmosphere.

Pre-Blast Surveys

The primary purpose of the pre-blast survey is to document the current physical state and general condition of a Close Proximity structure at the time of the survey.

The survey can assist in determining if pre-existing damage is a result of previous blasting in the area or due to environmental or other causes.

Survey Guidelines

The pre-blast survey should consist of high-definition photos or videos of the interior and exterior of the Close Proximity structure. The purpose of these images is to provide visual documentation of the current state of the structure. The pre-blast survey is intended to document:

1. Pre-existing damage/deficiencies,
2. Structural problems, cosmetic issues,
3. Exterior grading and/or backfilled areas that are sloped incorrectly,
4. Areas that may be prone to possible damage from drilling and blasting operations,
5. Other identified concerns of the surveyor regarding the Close Proximity structure,
6. Any previous damage claims in the area as a result of previous blasting or other operations,
7. Existing or un-resolved damage complaints.

Pre-Blast Survey Area

The pre-blast survey area is determined by the Close Proximity Blasting Level according to the following table:

Pre-Blast Survey Area Matrix	
CP Level 0 **0 to 3m**	Suggested for all Close Proximity Structures within ***30m*** (100') of the blasting limits.
CP Level 1 **>3m to 10m**	Suggested for all Close Proximity structures within ***30m*** (100') of the blasting limits.
CP Level 2 **>10m to 30m**	Suggested for all Close Proximity structures within ***75m*** (250') of the blasting limits.
CP Level 3 **>30m to 100m**	Suggested for all Close Proximity structures within ***75m*** (250') of the blasting limits.
CP Level 4 **>100m to 500m**	Surveys conducted at the discretion of the Blaster.

Notification and Offer to Conduct a Pre-Blast Survey

The resident or owner of the Close Proximity structure should be contacted in person. If the resident or owner cannot be contacted, a notification should be delivered advising them of the specific contact information and an intent to schedule the pre-blast survey.

Appointments are to be made and the survey carried out at the time of the resident/owners choosing.

Refusal of a Pre-Blast Survey

Should a resident or owner of a Close Proximity structure within the blasting limits refuse entry for a pre-blast survey, or the resident/owner cannot be contacted after a minimum of three daily visits to the property, blasting may proceed without a pre-blast survey.

The lack of a pre-blast survey of a Close Proximity structure should be addressed and documented in the Control Blasting Plan.

It is suggested that a letter be sent to the owner of the Close Proximity structure documenting visits and the advantages of allowing the pre-blast survey.

It is best practices for the Blaster to monitor the location for vibration and air overpressure.

Post-Blast Survey of Close Proximity Structures

In general, post-blast surveys of Close Proximity structures are not routinely conducted unless damage to a structure is suspected.

Post-blast surveys are recommended to be carried out under the following conditions:

Damage Claim

Should a claim of blasting damage be received, a post-blast survey should key in on the general area where damage is specifically claimed with the intent of determining if there has been a change (additional cracking etc.) and if that extra "distress" is consistent with blasting. (Additional cracking in a structure is normal after a period of time or even seasonally, but if related to blasting then specific damage patterns would be evident). In most cases, the Close Proximity blaster is mandated by their insurance company to promptly report any damage claims.

Historic or Significant Structure

If the building or structure is of historic interest, or whose construction has been identified as "poor" or "suspect", it is recommended that the owners be offered a post-blast survey to confirm that no damage has taken place.

Other Construction or Blasting Operations

Should other significant construction or non-related blasting or rock removal operations take place in close proximity to the Close Proximity structure, the owner should be offered the opportunity for a post-blast survey promptly as soon as blasting work is completed.

Refusal of a Post-Blast Survey

Should a post-blast survey be declined, it should be assumed that no damage has occurred. It is recommended to document the offer of the post-blast survey and keep it on file for a period of 5 (five) years.

This section intentionally left blank.

Community Notification of Blasting Operations

Commencement of Blasting Notifications

Notification of residents or owners should involve delivering a brochure or letter in person that contains the following information:

1. Project description, location, and purpose.
2. Anticipated start and completion dates.
3. Anticipated blasting times and number of daily blasts.
4. How or if they will be notified for each blast.
5. Blasting Contractor's name and contact information.
6. Name of the person conducting the Pre-Blast survey (if suggested).

Inhabited Structures & Close Proximity Structures

It is best practice that residents or owners of all Close Proximity structures be notified in person at least 48 hours prior to the commencement of drilling and blasting activities in accordance with the following matrix:

Notification of Residents or Owners	
CP Level 0 **0 to 3m**	48-hour notice for all residents and owners of Close Proximity structures within ***30m*** (100') of the blasting limits.
CP Level 1 **>3m to 10m**	48-hour notice for all residents and owners of Close Proximity structures within ***30m*** (100') of the blasting limits.
CP Level 2 **>10m to 30m**	48-hour notice for all residents and owners of Close Proximity structures within ***75m*** (250') of the blasting limits.
CP Level 3 **>30m to 100m**	Suggested for all inhabited structures within ***100m*** (330') of the blasting limits.
CP Level 4 **>100m to 500m**	Notifications conducted at the discretion of the Blaster.

Notification of Schools and Medical Treatment Facilities

Schools, clinics & hospitals, and other such medical treatment facilities may be especially sensitive to blasting activities. It is best practice to ensure that these facilities are notified in person at least 48 hours prior to the commencement of drilling and blasting activities in accordance with the following matrix:

Notification of Schools & Medical Treatment Facilities	
CP Level 0 **0 to 3m**	48-hour notice for all schools, clinics & hospitals within ***150m*** (500') of the blasting limits.
CP Level 1 **>3m to 10m**	48-hour notice for all schools, clinics & hospitals within ***150m*** (500') of the blasting limits.
CP Level 2 **>10m to 30m**	48-hour notice for all schools, clinics & hospitals within ***150m*** (500') of the blasting limits.
CP Level 3 **>30m to 100m**	48-hour notice for all schools, clinics & hospitals within ***300m*** (1000') of the blasting limits.
CP Level 4 **>100m to 500m**	48-hour notice for all schools, clinics & hospitals within ***500m*** (1600') of the blasting limits.

Blast Notification

Some schools, medical treatment facilities and other stakeholders may be sensitive to blasting operations and may require specified notification of all daily blasting activities.

It is best practice for the Close Proximity Blasting Manager to coordinate the blasting schedule accordingly to accommodate these types of facilities to ensure blasting does not interfere with sensitive procedures, processes, and school children.

Blast Monitoring

Vibration and Air Overpressure

It is best practice to utilize blasting seismographs in close proximity blasting operations to measure and document levels of ground vibration and air overpressure produced by close proximity blasting activities. Close proximity blasting operations should ensure that:

1. All blast monitoring is to be undertaken by a qualified monitor, in accordance with the most recent version of the" ISEE Field Practices Guidelines for Blasting Seismographs".

2. Monitoring is undertaken at the nearest Close Proximity structure of each blast or as otherwise specified by the Close Proximity Blasting Manager.

3. A monitoring report is kept for each blast that documents:
   a) Close Proximity structure name.
   b) Exact location and distance from the blasting limit in meters or feet.
   c) Date and time of the blast.
   d) Peak Particle Velocity (PPV) in mm/sec or in/sec, and frequency in Hertz (Hz).
   e) Air Overpressure Level in Decibels (dBL) & frequency in Hertz (Hz).
   f) Seismograph records should be filed with the Blasting Log and kept on file for a minimum of 5 (five) years.

4. The location and identification of each seismograph should be documented on the Blasting Log.

5. Include a photo of the seismograph location and equipment setup.

Seismograph Setup

The accuracy of seismic and air overpressure measurements is essential to ensure that Close Proximity blasting operations have been undertaken in accordance with criteria set by the owners, regulators, and/or Blasting Consultant. Seismographs used to monitor blasting operations should:

1. Meet the requirements of the International Society of Explosives Engineers "Field Performance Guidelines for Blasting Seismographs".

2. Have a documented calibration report showing that the unit was calibrated within 1 (one) year of its use in Close Proximity blasting operations.

Visual Recording

It is suggested that video recording of blasting operations is undertaken to document close proximity blasting activities and serve as a blast archive.

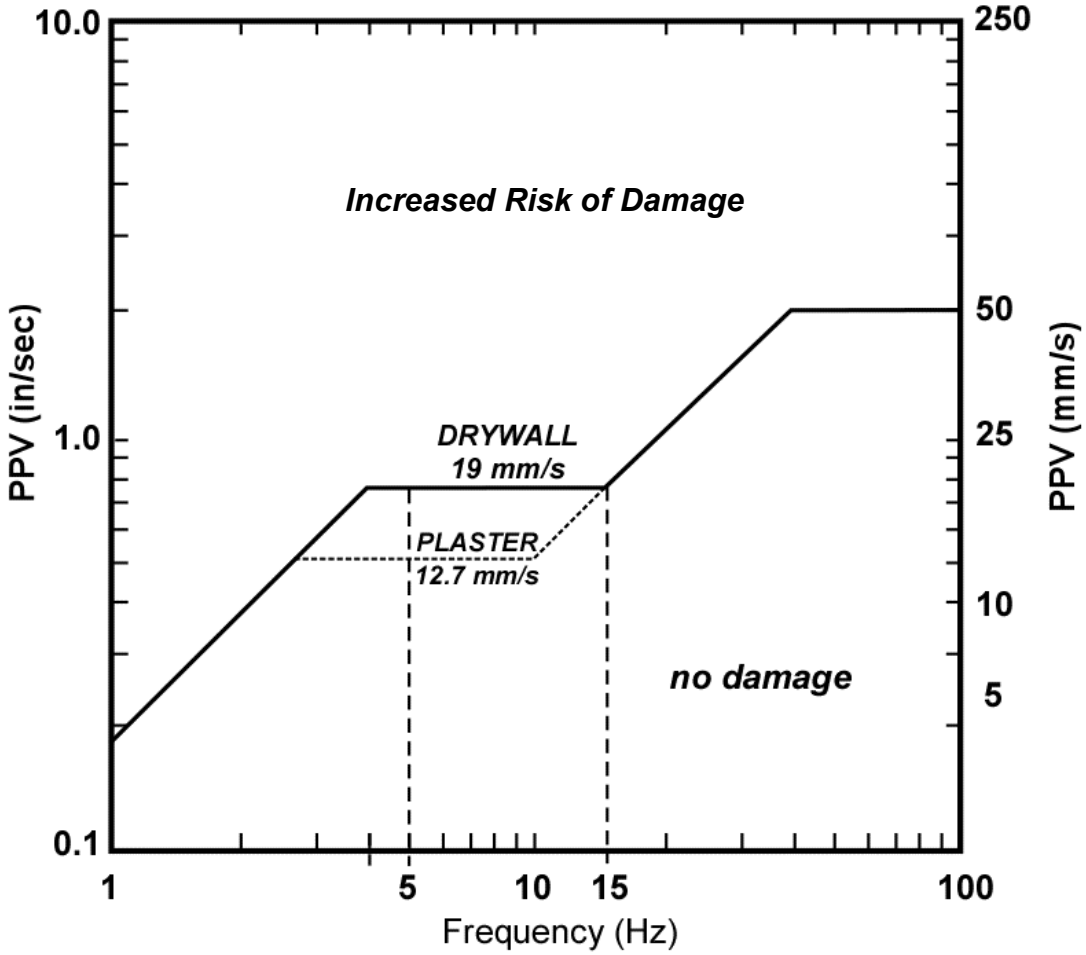
Blast Monitoring Matrix

It is recommended that monitoring of close proximity blasting operations is undertaken in accordance with the following monitoring matrix:

Blast Monitoring Matrix	
CP Level 0 **0 to 3m**	Monitoring with standard vibration monitoring equipment may not accurately reflect actual vibration levels. PPV levels required to produce damage may be higher for high frequency blast events encountered at CP 0.
CP Level 1 **>3m to 10m**	Monitoring at the two (2) nearest Close Proximity structures within ***30m*** (100').
CP Level 2 **>10m to 30m**	Monitoring at the two (2) nearest Close Proximity structures within ***75m*** (250') of the blasting limits.
CP Level 3 **>30m to 100m**	Monitoring is suggested at the two (2) nearest Close Proximity structures within ***75m*** (250') of the blasting limits.
CP Level 4 **>100m to 500m**	Monitoring is suggested at the nearest Close Proximity Structure.

Appendices

Appendix A:
USBM – Frequency versus Peak Particle Velocity



Appendix B:
Extreme Close Proximity Blasting Considerations

Disclaimer

The Western Canada Chapter of the International Society of Explosives Engineers does not guarantee the quality, accuracy, or completeness of the information provided, and is not responsible for any direct, indirect, special, incidental, or consequential damage or any other damages whatsoever and howsoever caused, arising out of or in connection with the reliance upon the information provided in these materials. Blasters undertaking Close Proximity blasting operations utilizing these best practice guidelines do so at their own risk.

For more detailed blasting related information, please consult the 18th Edition of the ISEE Blasters' Handbook or other useful reference documents detailed in Appendix D.

The Best Practices Guide for Close Proximity Blasting Operations contains numerous generally accepted industry blasting guidelines. It is acknowledged that the use of advanced blast techniques to remove rock in very close proximity may require modifications to these generally accepted principals including hole depth and diameter as well as peak particle velocity limits.

All information, statements and recommendations offered in this document are provided in good faith and in the interest of promoting the safety and health of workers, the public, and the interests of Close Proximity blasting stakeholders.

This document cannot describe and/or be comprehensive for all Close Proximity blasting situations and circumstances.

Supplemental Risk Assessments

Prior to undertaking drilling and blasting operations, additional factors to be considered are:

1. Along with utilities, have all other potential buried structures adjacent to the site been identified?
2. Has the condition and vibration sensitivity of adjacent buildings been considered?
3. Has a Geotechnical Engineer undertaken a slope stability assessment to ensure the stability of rock and soil beneath nearby properties and structures?

Qualifications

Blasting at Close Proximity Levels 0, 1 & 2, should only be performed by licensed, approved, highly experienced, and closely supervised Blasters. The blasting of improperly loaded, inadequately timed, or poorly stemmed boreholes can lead to negative results. Advanced, specialized blasting techniques are required to ensure that the structure(s) of concern is/are properly safeguarded from damage. Particular attention should be given to:

- Pre-Blast surveys.
- Neighborhood notification and advance warning protocol.
- Placement and type of blast mat cover.
- Proper guarding procedures.
- Supervision by a qualified Close Proximity Blasting Manager.

Project Oversight

A fully qualified, company employed Close Proximity Blasting Manager with demonstrated, recommended experience is crucial when blasting at Close Proximity Levels 0, 1 & 2 to provide project oversight.

Insurance Considerations

Blasting companies undertaking work at Close Proximity Blasting Levels 0, 1 & 2 must provide full proof of insurance with no clear space offset limitations. This is to ensure that there will be no insurance gap where a clear space clause may allow the insurance provider to evade liability.

Extreme Close Proximity Blasting – CP 0

The blast design principles for blasting at Close Proximity Level 0 requires the use of explosive charges in the immediate area of structures that are known to be sensitive to blast induced vibrations. This has implications for the maximum peak particle velocity limits normally recognized as an industry standard. This takes advantage of several elements often unrecognized in blast design which only become apparent at proximate distances and can be briefly summarized as follows:

1. All explosives detonated in a dense medium such as rock generate peak particle velocities of varying amplitude and frequency. Higher frequencies generally occur at the initial site of the explosion and are filtered out and decrease with time and distance. As demonstrated in the USBM chart included in Appendix 'A' of this document, higher frequencies may allow incrementally higher near field particle velocities.

2. At the very short offsets seen in very close proximity blasting, the vertical distance component must now be considered as the slope distance between the structure and the charge centre of gravity becomes more pronounced. This has a beneficial effect on the relationship between distance and charge weight per delay.

3. As in most controlled blasting applications, extreme close proximity blasting utilizes timed delays to distribute the total charge weight detonated over time. As individual charge weights are relatively small in relation to the affected rock mass, these higher particle velocities are experienced over a relatively short and localized portion of the structure of concern. The more massive portions of the affected structure are therefore not mobilized, helping to reduce the overall vibrational impact.

4. Notwithstanding the elements listed above, it is recognized that the primary contributing factor in any successfully completed extreme close proximity blasting project is the establishment and management of an accurately drilled vibration and overbreak control perimeter with minimal deviation from neat lines. When properly completed, it can effectively reflect, attenuate, and scatter blast induced particle velocities. This causes the vibration wave to become unorganized and significantly reduces negative effects on the proximate structure of concern.

Applied Blasting Techniques

Depending on the limiting distances and project rock removal requirements, various blasting techniques should be considered when at Close Proximity Levels 0, 1 & 2. In general, they can be summarized as follows:

- Multiple Charge Decking.
- Air Decking.
- Bracket charging with both toe and collar air decks.
- Multiple combined charge and air decks.
- Multiple Benching.
- Deliberate borehole decoupling.
- Line Drilling and relief hole drilling on the backline.

Important Blast Design Considerations

Several important elements should be carefully managed during the drilling and blasting process. They are listed as follows:

Bench Drilling

In Extreme Close Proximity applications where multiple benches are required, there may be a desire that boreholes first be drilled full depth and partially stemmed up in order that the rock excavation can be segmentally benched with holes subsequently flushed without the need for re-drilling. This practice should be avoided for the following reasons:

1. The original borehole sockets can be difficult to locate and identify in subsequent lifts.

2. The stemming sand may become packed or partially melted from the previous upper charge detonations making access to the new hole collars problematic.

3. Re-drilling in original sockets to restore blocked boreholes from a previous blast may be contrary to safety regulations.

4. Full depth boreholes may wander or stray from the original pattern affecting the geometry of subsequent lower benches.

5. Contemplated adjustments to pattern design on lower lifts will be difficult to implement. This consideration is especially important if lower benches are drilled at a larger hole diameter due to the increasing diagonal distance from the structure of concern.

It is therefore recommended that, with exception of the backline boreholes, each bench be re-established with a separate drill mobilization in order that the above identified issues are circumvented.

Borehole Diameters

Several different borehole diameters have been successfully employed in Close Proximity blasting. Various diameters and offsets along with their accompanying advantages are listed below:

Diameter of 32 - 52mm, (1.25”- 2”)

At CP 0, usually bench drilled as upper lift, single pass production boreholes in front of, and adjacent the back line. At this diameter and low Close Proximity (CP) offset, concentrated charges must be loaded utilizing one or more of the techniques listed in “Applied Blasting Techniques”.

Advantages: Used to reduce burden and spacing as well as charge diameter. At CP 0 offsets, often used as buffer holes between the perimeter line drill back line and other larger diameter boreholes at CP 1 and 2 distances. Allows explosive loads to be concentrated at more remote distances from the structure(s) of concern. This has a beneficial effect on the scale distance resultant.

Diameter of 70mm, (2.75”)

At CP 0, drilled as production boreholes in sequential benches/lifts. Also used as production boreholes drilled below larger diameter relief boreholes on the backline. At this diameter and at lower CP offsets, concentrated charges must be loaded utilizing one or more of the techniques listed above.

Advantages: This is the smallest borehole diameter that can be efficiently drilled with guide bits utilizing T45 drill rods. This combination limits the borehole deviation that can occur with smaller and more flexible drill rods. It is an important contributor in drilling accurate boreholes to support uniform explosive distribution throughout the affected rock mass.

Diameter of 100mm, (4”)

Drilled as unloaded and stemmed vibration interceptor holes along the back line and are commonly advanced with guide bits on 200mm, (8”) centers. They are generally utilized as single pass boreholes as their alignment and efficiency is significantly reduced below depths of 3.5 m, (11.5’). At CP 0 offsets, 70mm, (2.75”) holes at 1.2m, (4’) spacing are often advanced to subgrade below these relief holes to allow subsequent loading once the upper benches have been removed.

Relief Borehole Stemming

Regardless of the stemming limitations identified above, it is recommended that all unloaded backline boreholes drilled for relief or line drilling purposes be fully and properly stemmed prior to the loading of explosives in neighboring boreholes. This is to prevent the ejection of flyrock from the venting of explosive gases through open, nearby and unloaded boreholes when firing an adjacent shot. It is very difficult to provide sufficient cover over these holes due to the interference caused by the proximity of the previously blasted vertical backline. This makes proper blast mat overlap past the backline holes virtually impossible to implement on subsequent lower lifts. This requirement can be easily overlooked and casual adherence to this important requirement has led to near misses in the past.

Supplemental Equipment & Facilities

Due to the inability of Blasters to identify any or all pre-existing subsurface anomalies existing beyond the backline, it is recommended that company owned, or controlled drilling, blasting, shoring, shotcrete, anchoring and bolting facilities be readily available to immediately repair any unplanned or inadvertent local slope failures that may occur. It is also recommended that independent geotechnical project oversight be available on a continual basis.

Structural Considerations

The existing age and condition of adjacent buildings at Close Proximity Blasting Levels 0, 1 & 2, should be carefully considered and inspected. Their general characteristics are summarized below:

1. Single family dwellings, single or double level structures, heritage buildings:
   - Usually are offset from the property line, unlike larger structures. This provides a distance component which can add to the factor of safety in blast design.
   - May have more vibration sensitive interior finishings at or near the edge of the facing/adjacent excavation.
   - Will often be founded on bedrock due to the presence of the neighboring excavation. If not, underpinning may be required to provide additional foundation support prior to blasting.

2. Multi-story units, high rise condominiums and apartments, commercial buildings:
   - These larger structures generally have more reinforced interior support than single or double level structures. Footings and foundations will be constructed with a higher bearing capacity to carry the load of the stories above.
   - Sensitive interior fittings are often located above or at a separate distance from, the new excavation.
   - Newer structures are commonly built with robust construction, providing an additional measure of blast induced vibration resistance.

3. Other “Structures of concern” factors to consider:
   - Each structure should be evaluated on its own merits with blast design adjustments to suit.
   - Some types of structures may have unique characteristics that make them more sensitive to blast induced vibrations. This would include, but are not limited to, unreinforced or unsupported concrete block walls, heritage buildings, and brick chimneys.
   - The project geotechnical engineer can be resourced for professional assistance on the condition and vibration resistance of neighboring buildings.

Detonator Selection

While successful results have been realized in the past with the use of non-electric delays in Close Proximity blasting, the use of electronic detonators are known to provide an additional factor of safety against pyrotechnic cap scatter. It is therefore suggested that electronic detonators be used when working at CP 0, 1 & 2 distances.

Boundary & Grade Control

While accurate and complete grade and line control is important in any blasting endeavor, it is critical in a Close Proximity blasting environment due to the following factors:

1. Where blind forming concrete or structural shotcrete placement is required at very close proximity to sensitive structures, every centimeter of horizontal separation is critical.

2. Excessive over-drill resulting in overloading below grade can lead to a waste of explosives, added vibration and increased costs for concrete replacement to subgrade. It is recommended that a target receiver be added to the loading pole during blasthole preparation and used together with a laser level to precisely adjust borehole depth to design subgrade. This will assist in limiting unnecessary borehole depth, excess charge weights and poor toe relief.

3. An accurately established and maintained vertical back line will allow line drill boreholes to be collared at a precise offset from the desired final wall face. This is important as there is a tendency for the rock between relief holes to form small lips or bulges which may remain after excavation.

Appendix C:
Generic Form Templates

Sample Control Blasting Plan

Instructions

1. Review the project for both Safety and Operational Goals.
2. Complete the Control Blasting Plan to accommodate the Project safety, operational and stakeholder requirements.
3. Review and update the Control Blasting Plan as required.

Date	
Project	
Area #	
CP Level	**0 1 2 3 4** Circle all that apply

Project Details			
Project Name:		**Prime Contractor:**	
Project Purpose:		**Site Manager:**	
		Primary Regulator:	
Volume/Quantity		**Blasting Firm:**	
Minimum Distance to Close Proximity Structures:		**Blasting Manager:**	
Permits Required:		**Blaster in Charge:**	
Rock Details: Rock type, back break potential, hardness, joint orientation, etc.		**Fragmentation Requirements of the Owner:**	

Sketch Project/Attach Map – include distances to Close Proximity structures, roads/highways, property lines, other site works, etc.

Typical Blast Data

Instructions: Provide data for the typical blast that will occur on site. Attach additional sheets for more than one typical as required.

Explosive Type		**Initiation Type**	
Detonator Type		**Anticipated # of Typical Blasts for Project**	
Number of Holes		**Collar Length**	
Hole Diameter		**Type of Stemming**	
Min. Hole Depth		**Number of Rows**	
Max. Hole Depth		**Burden**	
Stiffness Ratio		**Spacing**	
# of Decks/hole		**Holes/Delay**	
Deck Separation		**Hole to Hole Timing**	
Max KG per delay		**Max Powder Factor**	

Typical Load & Hole Timing Plan

Instructions: Provide a detailed hole load and timing plan for the typical blast. Indicate initiation point and individual hole timing.

Typical Load

Typical Timing Plan

Seismic Modeling

Instructions: Complete seismic modeling for the two nearest Close Proximity structures.

Allowable Peak Particle Velocity (PPV)	mm/sec	**Allowable Air Overpressure**	dB(L)
Structure #1 Details:		**Structure #2 Details:**	
Distance to Structure #1		**Distance to Structure #2**	
Pre-blast Survey	YES NO	**Pre-blast Survey**	YES NO
Proposed Seismograph Location #1:		**Proposed Seismograph Location #2:**	
Calculated PPV at Structure #1	mm/sec	**Calculated PPV at Structure #2**	mm/sec

Typical Flyrock Controls

Flyrock Controls to be utilized:	
Typical Matting Instructions:	

Stakeholder & Community Notification

Instructions: List of Stakeholders and detail notification requirements for each.

Stakeholders	Notification Requirements

Blast Firing & Guarding Plan

Blast Firing Procedures	
Blast Guarding Plan Attach map of location and show guard locations.	

First Aid Assessment

Nearest Hospital:	**Distance to Nearest Hospital**	km
	Time to Nearest Hospital	hr mins
Site Risk Level:		
Maximum number of workers for First Aid Assessment (Add the above to get a total number)		Total Workers
Types of Injuries likely to occur?		
Barriers to First Aid being provided to an injured worker?		
Assessed requirement for First Aid		
Level 1 Level 2 Level 3	Personal	Ambulance ETV Other:

Emergency Response Plan

Emergency Evacuation Location:			
Primary Injured Evacuation Method?	**Air – Contact Helicopter Daily**	**Ground – Ensure Proper Equipment**	
First Aid Location:			
Designated ETV (if applicable):			
Communication Available on Site:	**Cell #**	**Sat.#**	**Radio Freq:**
Site Access Instructions for Ambulance:			

Emergency Contacts

Police/Ambulance	**911**
Hospital	

Sample Control Blast Report

Instructions

1. Review the Control Blasting Plan.
2. Complete the Control Blast Report for each blast.
3. Provide sufficient detail in which to recreate a written record of the "as loaded" of the blast.
4. Document the blast results and details of the post blast examination. Provide pictures/video if required.

Site:	
Blast #	
Date:	
Blast Time:	
Blaster in Charge:	

Drill, Load & Timing Data

Hole or Row #	Depth	Load	Nominal Timing
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			

Blast Hole Diagram: Indicate Hole timing & mat placement.

Indicate North

Pattern _____ # Mats Used _____

Powder Factor (kg/m^3) =	**Max kg per Delay =**	**Measurements =** m^3

Seismic Data

Structure #1	Location:			
	PPV – mm/sec	V =	L =	T =
	Frequency (Hz)	V =	L =	T =
	Air Overpressure dB(L)		PPV	
Structure #2	Location:			
	PPV – mm/sec	V =	L =	T =
	Frequency (Hz)	V =	L =	T =
	Air Overpressure dB(L)		PPV	

Total Explosive Usage

Product	Quantity

Blast Results/Notes/Comments

Blaster Signature:

Sample Drill Log

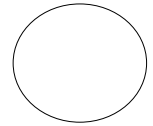
Site:	
Date:	
Driller:	

Station:	

Blast Hole Drill Log

Hole #	Diameter	Depth	Angle	Comments: voids, seams, water, etc.
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				

Blast Hole Diagram Instructions: Fully diagram the area. Indicate Burden and Spacing in feet (') or meters (m)



Indicate North

Appendix D:
Reference Materials

ISEE Blasters' Handbook 18th Edition	International Society of Explosives Engineers, 26500 Renaissance Parkway, Cleveland, Ohio USA 44128 www.isee.org
Blasting Damage and Other Structural Cracking – A Guide for Adjusters and Engineers	Property Claim Services and Engineering and Safety Service of the American Insurance Services Group (AISG), Published by the American Insurance Association, 3rd Edition, 1990
The Effects of Vibrations and Environmental Forces – A Guide for the Investigation of Structures	Lewis L. Oriard, Published by the International Society of Explosives Engineers, 1999
Tall Structure Response to Close-in Urban Blasting in New York City	Cathy Aimone-Martin and Brent Meins, Proceedings of the 40th Conference on Explosives and Blasting Technique, 2014. Published by the International Society of Explosives Engineers.
Tall Structure Response to Close-in Urban Blasting in New York City - Part 2	Cathy Aimone-Martin and Brent Meins, Proceedings of the 41st Conference on Explosives and Blasting Technique, 2015. Published by the International Society of Explosives Engineers.
Explosives Engineering, Construction Vibrations and Geotechnology	Lewis L. Oriard, Published by the International Society of Explosives Engineers, 2002
Micrometer Crack Response to Vibration and Weather	Charles H. Dowding, Published by the International Society of Explosives Engineers, 2008
USBM RI 8507 & RI 8485	David E. Siskind, Ph.D. et al., US Bureau of Mines Reports of Investigations. Report RI 8507.
Vibrations from Blasting	David E. Siskind, Ph.D., Published by the International Society of Explosives Engineers, 2000
World of Explosives website	www.explosives.org
ISEE Field Practices Guidelines for Blasting Seismographs	International Society of Explosives Engineers, 26500 Renaissance Parkway, Cleveland, Ohio USA 44128