

Western Canada Chapter of the International Society of Explosives Engineers

Best Practices Guide for Urban Blasting Operations

1st Edition



Document Information

This 1st Edition *Best Practices Guide for Urban Blasting Operations* is produced by the Western Canada Chapter of the International Society of Explosives Engineers. Best practices and guidelines detailed in this publication have been developed by utilizing 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 Urban Blasting Committee and is intended to promote safe and productive operations within urban drilling and blasting environments. The authors, contributors and publishers have undertaken their best efforts in preparing this document and make no warranty of any kind, express or implied, with regard to 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 05, 2016 and supersedes all previous editions. The *Best Practices Guide for Urban Blasting Operations* 1st Edition was approved for release by the Urban Blasting Committee on May 17, 2016.

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

Disclaimer

Every effort has been made to ensure that this *Best Practices Guide for Urban Blasting Operations* serves to promote safe and productive operations within urban 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 urban blasting stakeholders.

This document cannot describe and/or be comprehensive for all urban blasting situations and circumstances. It should not be viewed, construed or assumed as being completely comprehensive in identifying and addressing all urban blasting situations. It is intended to serve as a general guideline for 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 urban blasting situation. Ultimately, the safety of urban blasting activities rests with the Urban Blaster and the 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 urban 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 C.

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This list represents the membership at the time the Urban Blasting Committee was balloted on the final text of this first edition. Since that time, changes in the membership may have occurred.

Contact Information

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Intent and Application

This *Best Practices Guide for Urban Blasting Operations* is intended to outline the guidelines for best practices to be utilized in the performance of urban drilling and blasting operations for rock excavation and act as a source document for the development of a Control Blasting Plan.

Other operations where explosives are utilized in urban 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 urban drilling and blasting operations.

Antitrust Statement

It is the policy of the Western Canada Chapter of the ISEE Board of Directors to fully comply and encourage its chapters, sections, committees, and members to comply with the antitrust laws of any recognized jurisdiction.

No employee or agent of the Western Canada Chapter of the ISEE or any officer, director or member acting on its behalf, has the authority to engage in any conduct inconsistent with the antitrust laws of any recognized jurisdiction or the guidelines established by the Western Canada Chapter of the ISEE Board of Directors.

Terminology

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

Numerical Units

This *Best Practices Guide for Urban 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.

Purpose

This *Best Practices Guide for Urban 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 promote safe and productive operations within urban drilling and blasting environments and to be utilized where deemed useful by stakeholders.

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

1. Provide guidelines to protect the safety and health of the public, workers and urban structures within the area of influence by minimizing the following environmental effects of urban drilling and blasting operations:
 - a) Noise/Nuisance,
 - b) Dust,
 - c) Blast Vibration,
 - d) Air Overpressure,
 - e) Flyrock,
 - f) Surface Water Contamination.
2. Advance the science and art of Urban Blasting activities.
3. Identify best practices for drilling and blasting operators to implement while undertaking urban blasting operations.
4. Act as a supplement to applicable local, provincial, state, and federal by-laws and/or regulations pertaining to aspects of drilling and blasting activities.
5. Identify best practices to assist drilling and blasting contractors in maintaining high quality and productive operations.
6. Instill stakeholder confidence in our industry while undertaking urban blasting activities in a safe and productive manner.

Table of Contents

DOCUMENT INFORMATION	2	URBAN BLASTING LEVEL 2 >10M TO 30M (>33' TO 100').....	13
DOCUMENT UPDATES	2	UBL 2 CONTROL BLASTING PLAN.....	13
DISCLAIMER	2	1. Blast Design Guidelines.....	13
URBAN BLASTING COMMITTEE.....	2	2. Peak Particle Velocity.....	13
CONTACT INFORMATION	2	3. Air Overpressure	13
INTENT AND APPLICATION	3	4. Blast Hole Diameter.....	13
ANTITRUST STATEMENT	3	5. Explosives.....	13
TERMINOLOGY	3	6. Detonators	13
NUMERICAL UNITS	3	7. Flyrock Controls.....	13
PURPOSE	3	8. Pre-Blast Surveys.....	13
DEFINITIONS.....	6	9. Community Notification.....	13
SCOPE.....	8	10. Blast Monitoring	13
URBAN BLASTING LEVELS	8	11. Documentation	13
CONTROL BLASTING PLAN	9	URBAN BLASTING LEVEL 3 >30M TO 100M (>100' TO 330').....	14
CONTROL BLASTING PLAN DEVELOPMENT.....	9	UBL 3 CONTROL BLASTING PLAN.....	14
BLAST DOCUMENTATION	9	1. Blast Design Guidelines.....	14
URBAN BLASTING LEVEL 0	11	2. Peak Particle Velocity.....	14
0 TO 3M (0 TO 10').....	11	3. Air Overpressure	14
Definition.....	11	4. Blast Hole Diameter and Depth	14
URBAN BLASTING LEVEL 1 >3M TO 10M (10' TO 33')	12	5. Explosives and Detonators.....	14
UBL 1 CONTROL BLASTING PLAN.....	12	6. Flyrock Controls.....	14
1. Blast Design Guidelines.....	12	7. Pre-Blast Surveys.....	14
2. Peak Particle Velocity.....	12	8. Community Notification.....	14
3. Air Overpressure.....	12	9. Blast Monitoring	14
4. Blast Hole Diameter	12	10. Documentation	14
5. Explosives.....	12	URBAN BLASTING LEVEL 4 >100M TO 500M (>330' TO 1600')	15
6. Detonators	12	UBL 4 CONTROL BLASTING PLAN.....	15
7. Flyrock Controls.....	12	1. Blast Design Guidelines.....	15
8. Pre-Blast Surveys.....	12	2. Peak Particle Velocity.....	15
9. Community Notification.....	12	3. Air Overpressure	15
10. Blast Monitoring	12	4. Blast Hole Diameter and Depth	15
11. Documentation	12	5. Explosives and Detonators.....	15
		6. Flyrock Controls.....	15
		7. Pre-Blast Surveys.....	15
		8. Community Notification.....	15
		9. Blast Monitoring	15
		10. Documentation	15
		BEST PRACTICES FOR URBAN BLASTING ACTIVITIES	16
		PLANNED OPERATIONS	16
		URBAN BLASTING PROJECT MANAGEMENT PROGRAM	16
		URBAN BLASTER IN CHARGE.....	16
		CONTROLLING FLYROCK	17
		BLAST DESIGN	17
		STEMMING	17
		BLASTING MATS	17
		Use of Blasting Mats.....	18
		Blast Coverage	18
		Rigging of Blasting Mats.....	18
		Blasting Mat Construction	18
		USE OF EARTH MATERIAL.....	18

PRE-BLAST SURVEY OF URBAN STRUCTURES19
SURVEY GUIDELINES19
PRE-BLAST SURVEY AREA19
NOTIFICATION AND OFFER TO CONDUCT A PRE-BLAST SURVEY19
REFUSAL OF A PRE-BLAST SURVEY19

POST-BLAST SURVEY OF URBAN STRUCTURES20
DAMAGE CLAIM.....20
HISTORIC OR SIGNIFICANT STRUCTURE20
OTHER CONSTRUCTION OR BLASTING OPERATIONS.....20
REFUSAL OF A POST-BLAST SURVEY20

COMMUNITY NOTIFICATION OF BLASTING OPERATIONS.....21
COMMENCEMENT OF BLASTING NOTIFICATIONS21
INHABITED STRUCTURES & URBAN STRUCTURES21
NOTIFICATION OF SCHOOLS AND MEDICAL TREATMENT FACILITIES ..21
BLAST NOTIFICATION21

BLAST MONITORING.....22
VIBRATION AND AIR OVERPRESSURE22
SEISMOGRAPH SETUP.....22
VISUAL RECORDING22
BLAST MONITORING MATRIX22

**APPENDIX A: USBM – FREQUENCY VERSUS PARTICLE
VELOCITY23**

APPENDIX B – REFERENCE MATERIALS.....24

APPENDIX C – GENERIC FORM TEMPLATES25
SAMPLE CONTROL BLASTING PLAN26

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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 Pascal (pa). Note: see "Noise".

"Area of influence"

The area that could be actually, potentially or perceived to be affected by urban blasting operations. Determined by the blaster in charge and measured in meters from the blasting limit.

"Best Practices"

Procedures that are generally accepted as being correct or most effective.

"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 an urban environment, an Urban Blasting Manager with specific knowledge and expertise in blast design to meet specific objectives as well as the control of vibration and air blast, and who's experience is acceptable to the appropriate regulatory authority.

"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.

"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.

"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.

"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.

"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 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 an urban environment.

“Magazine”

A structure used for the unattended storage of detonators and explosives, and 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 are detonated prior to production holes.

“Production holes”

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

“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 a length of a bore hole 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.

“Urban Blaster”

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

“Urban blasting”

Drilling & blasting operations undertaken within 500m of any urban structure.

“Urban Blasting Manager”

A person who is the holder of a valid Urban Blaster certification issued by a municipal, provincial, state, federal or recognized regulatory agency. He/she has been responsible for the administration, oversight and development of blast design and control blasting plans for urban blasting operations for a minimum of 5 years. See *Blasting Consultant*.

“Urban structure”

Any inhabited structure or non-inhabited structure, power line, power pole, gas and/or electric utility, or any other identified object that may be subject to effects of drilling and blasting operations in an urban environment.

Scope

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

This *Best Practices Guide for Urban Blasting Operations* outlines guidelines and best practices for consideration in urban 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 urban blasting activities rests with the Urban Blaster and their employer.

Urban Blasting Levels

It is generally accepted that the prevalence of risk involved in blasting activities increases proportionally to the reduction in distance to urban 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 urban blasting issues. Therefore, it is considered necessary to classify urban drilling and blasting guidelines according to their location relative to urban structures.

For the purpose of this guide, urban blasting activities are classified, by distance, into five separate categories called Urban Blasting Levels (UBL).

Urban blasting levels are categorized as follows:

Urban Blasting Level 0

UBL 0 - 0m to 3m (0 to 10') distance from any urban structure.

Urban Blasting Level 1

UBL 1 – greater than 3m to 10m (>10' to 33') distance from any urban structure.

Urban Blasting Level 2

UBL 2 – greater than 10m to 30m (>33' to 100') distance from any urban structure.

Urban Blasting Level 3

UBL 3 – greater than 30m to 100m (>100' to 330') distance from any urban structure.

Urban Blasting Level 4

UBL 4 – greater than 100m to 500m (>330' to 1600') distance from any urban structure

Control Blasting Plan

The purpose of the Control Blasting Plan is to document the hazards and risks associated with an Urban 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 urban 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 Urban 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 urban 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 Urban Blasting Manager and/or Urban 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 urban 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 urban 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.
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 Urban 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 Urban Blasting Manager. Detail any amendments made to the Control Blasting Plan to ensure safety and project objectives are met.

	Urban Blasting Level 0 0m to 3m (0 to 10')	Urban Blasting Level 1 >3m to 10m (>10' to 33')	Urban Blasting Level 2 >10m to 30m (>33' to 100')	Urban Blasting Level 3 >30m to 100m (>100' to 330')	Urban Blasting Level 4 >100m to 500m (>330' to 1600')
Best Practices					
Blast Design & Control Blasting Plan	Please see Urban Blasting Level 0 section of this document on Page 11.	<ul style="list-style-type: none"> Urban Blasting Manager with 7 or more years of experience suggested to review Control Blasting Plan Suggested oversight from an independent Blasting Consultant 	<ul style="list-style-type: none"> Urban Blasting Manager with 5 or more years of experience suggested to design, develop and accept site Control Blasting Plan 	<ul style="list-style-type: none"> Certified Urban Blaster suggested to design, develop site Control Blasting Plan 	<ul style="list-style-type: none"> Certified Urban Blaster suggested to design, develop site Control Blasting Plan if blasting activities are within 500m (1600') of school, hospital or clinic
Peak Particle Velocity & Frequency Response		<ul style="list-style-type: none"> Blast designed to 50 mm/sec (2 inches/sec) or in accordance with the USBM table in Appendix A 	<ul style="list-style-type: none"> Blast designed to 35 mm/sec (1.4 inches/sec) or in accordance with the USBM table in Appendix A 	<ul style="list-style-type: none"> Blast designed to 25 mm/sec (1 inch/sec) or in accordance with the USBM table in Appendix A 	<ul style="list-style-type: none"> Blast designed in accordance with the USBM table in Appendix A
Air Overpressure		<ul style="list-style-type: none"> Maximum 134dBL 	<ul style="list-style-type: none"> Maximum 134dBL 	<ul style="list-style-type: none"> Maximum 134dBL 	<ul style="list-style-type: none"> Maximum 134dBL
Blast Hole Diameter		<ul style="list-style-type: none"> Suggested 45mm (1 3/4") blast hole diameter maximum 	<ul style="list-style-type: none"> 70mm (2 3/4") blast hole diameter suggested maximum 	<ul style="list-style-type: none"> 75mm (3") blast hole diameter suggested maximum 	<ul style="list-style-type: none"> At the discretion of the Urban Blaster
Blast Hole Length		<ul style="list-style-type: none"> Governed by charge weight per delay to meet suggested PPV limit 	<ul style="list-style-type: none"> Governed by charge weight per delay to meet suggested PPV limit 	<ul style="list-style-type: none"> Governed by charge weight per delay to meet suggested PPV limit 	<ul style="list-style-type: none"> Governed by charge weight per delay to meet suggested PPV limit
Explosives		<ul style="list-style-type: none"> Packaged explosive to a max 38mm (1 1/2") diameter ANFO/bulk products not recommended below critical hole diameter for product. 	<ul style="list-style-type: none"> Packaged explosive to a max 50mm (2") diameter ANFO/bulk products to be utilized in accordance with manufacturers specifications 	<ul style="list-style-type: none"> At the discretion of the Urban Blaster ANFO/bulk products to be utilized in accordance with manufacturers specifications 	<ul style="list-style-type: none"> At the discretion of the Urban Blaster ANFO/bulk products to be utilized in accordance with manufacturers specifications
Detonators		<ul style="list-style-type: none"> Electronic detonators suggested 	<ul style="list-style-type: none"> Electronic detonators suggested 	<ul style="list-style-type: none"> Type of detonator utilized at the discretion of the Urban Blaster 	<ul style="list-style-type: none"> Type of detonator utilized at the discretion of the Urban Blaster
Fly Rock Control		<ul style="list-style-type: none"> Adequate Blast Design Use of a confinement device and/or clear crushed rock stemming Adequate blast matting or earth fill 	<ul style="list-style-type: none"> Adequate Blast Design Use of a confinement device and/or clear crushed rock stemming Adequate blast matting or earth fill 	<ul style="list-style-type: none"> Adequate Blast Design Use of a confinement device and/or clear crushed rock stemming Adequate blast matting or earth fill 	<ul style="list-style-type: none"> Adequate Blast Design Use of a confinement device and/or clear crushed rock stemming Blasting mats suggested within 300m (1000') Adequate blast matting or earth fill
Pre-Blast Survey		<ul style="list-style-type: none"> Suggested for all urban structures within 30m (100') of the blasting limits 	<ul style="list-style-type: none"> Suggested for all inhabited structures within 75m (250') of the blasting limits 	<ul style="list-style-type: none"> Suggested for all inhabited structures within 75m (250') of the blasting limits 	<ul style="list-style-type: none"> At the discretion of the Urban Blaster
Community Notification		<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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		<ul style="list-style-type: none"> Follow ISEE Field Practice Guidelines for Seismographs. Monitoring at the 2 nearest urban structures. 	<ul style="list-style-type: none"> Follow ISEE Field Practice Guidelines for Seismographs. Monitoring at the 2 nearest urban structures. 	<ul style="list-style-type: none"> Follow ISEE Field Practice Guidelines for Seismographs. Monitoring at the 2 nearest urban structures. 	<ul style="list-style-type: none"> Follow ISEE Field Practice Guidelines for Seismographs. Monitoring at the nearest urban structure. Additional monitoring as suggested

Urban Blasting Level 0

0 to 3m (0 to 10')

Definition

Urban Blasting Level 0 (UBL 0) is defined as drilling and blasting activities occurring from 0 meters to 3 meters distance from any urban structure.

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

Blasting operations undertaken at Urban Blasting Level 0 represent the highest potential for damage to an urban 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, or use of expanding grouts should be considered as an alternative.

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

UBL 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 in close proximity to urban structures.

This section intentionally left blank.

The risks associated with blasting at UBL 0 need to be communicated to the project owner and/or general contractor and a determination made as to who will assume these risks.

Urban Blasting Level 1

>3m to 10m (10' to 33')

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

UBL 1 Control Blasting Plan

The purpose of the Control Blasting Plan is to document the hazards and risks associated with an Urban 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 Urban Blasting Manager is responsible for designing and documenting the Control Blast Plan for UBL 1 operations. The Urban Blasting Manager should be a blasting professional having a minimum of seven (7) years direct experience in the design, implementation, administration and oversight of urban blasting activities.

The Control Blasting Plan should include the following:

1. 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.

2. Peak Particle Velocity

Where a lack of project specific requirements exist, it is recommended that blasts at UBL 1 be designed to less than 50mm/sec (2inches/sec) peak particle velocity calculated for the nearest urban 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 urban structures based on blast design.

3. Air Overpressure

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

4. Blast Hole Diameter

The Control Blasting Plan should document the blast hole diameter. The suggested maximum blast hole diameter for UBL 1 operations is 45mm (1 3/4").

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").

5. Explosives

Packaged explosives to a maximum 38mm (1 1/2") diameter are recommended at UBL 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.

6. Detonators

Use of electronic detonators is suggested during operations conducted at Urban Blasting Level 1.

7. Flyrock Controls

The Control Blast Plan should document how flyrock is to be controlled. See Controlling Flyrock Page 17.

8. Pre-Blast Surveys

Pre-Blast surveys should be conducted in accordance with the Pre-Blast Survey of Urban Structures, see Page 19.

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

9. Community Notification

Best practices for notification of the community is detailed in the Community Notification of Blasting Operations - see Page 21.

All inhabited structures, residents or owners of urban 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 UBL 1.

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

10. Blast Monitoring

Blast Monitoring is to be conducted in accordance with the Blast Monitoring recommendations, see page 22. The two (2) nearest urban structures within 30m (100') should be seismically monitored at UBL 1.

11. Documentation

The Urban 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 Urban Blasting Manager and amendments undertaken to ensure the meeting of plan objectives.

Urban Blasting Level 2

>10m to 30m (>33' to 100')

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

UBL 2 Control Blasting Plan

The purpose of the Control Blasting Plan is to document the hazards and risks associated with an Urban 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 Urban Blasting Manager is responsible for designing and documenting the Control Blast Plan for UBL 2 operations. The Urban 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 urban blasting activities.

The Control Blasting Plan should include the following:

1. 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.

2. Peak Particle Velocity

Where a lack of project specific requirements exist, it is suggested that blasts at UBL 2 be designed to less than 35mm/sec (1.4 inches/sec) peak particle velocity calculated for the nearest urban 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 urban structures based on blast design.

3. Air Overpressure

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

4. Blast Hole Diameter

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

5. Explosives

Packaged explosives to a maximum 50mm (2") diameter are recommended at Urban 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.

6. Detonators

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

7. Flyrock Controls

The Control Blast Plan should document how flyrock is to be controlled. See Controlling Flyrock - page 17.

8. Pre-Blast Surveys

A pre-blast survey of all urban 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 UBL 2.

Pre-Blast surveys should be conducted in accordance with best practices - see Pre-Blast Survey of Urban Structures page 19.

9. Community Notification

Best practices for notification of the community for UBL 2 is documented in Community Notification of Blasting Operations – see Page 21.

All inhabited structures, owners of urban 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 UBL 2.

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

10. Blast Monitoring

Blast Monitoring is to be conducted in accordance with best practices outlined in Blast Monitoring - see page 22.

The two (2) nearest urban structures within 75m (250') should be seismically monitored at UBL 2.

11. Documentation

The Urban 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 Urban Blasting Manager and amendments undertaken to ensure the meeting of plan objectives.

Urban Blasting Level 3

>30m to 100m (>100' to 330')

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

UBL 3 Control Blasting Plan

The purpose of the Control Blasting Plan is to document the hazards and risks associated with an Urban 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 Urban Blaster is responsible for designing and documenting the Control Blast Plan for UBL 3 operations.

The Control Blasting Plan should include the following:

1. 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.

2. Peak Particle Velocity

Where a lack of project specific requirements exist, it is suggested that UBL 3 blasts be designed to less than 25mm/sec (1 inch/sec) peak particle velocity calculated for the nearest urban 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 urban structures based on blast design.

3. Air Overpressure

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

4. Blast Hole Diameter and Depth

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

Blast hole length for operations at UBL 3 are to be determined by the Urban Blaster and governed by charge weight per delay to meet suggested Peak Particle Velocity limit.

5. Explosives and Detonators

Explosives and detonator selection are at the discretion of the Urban Blaster.

6. Flyrock Controls

The Control Blast Plan should document how flyrock is to be controlled. See Controlling Flyrock – Best Practices Page 17.

7. Pre-Blast Surveys

A pre-blast survey of all urban 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 UBL 3.

Best practices for conducting pre-blast surveys are detailed in Pre-Blast Survey of Urban Structures - see page 19.

8. Community Notification

Best practices for the notification of the community is documented in the Community Notification of Blasting Operations - see page 21.

All inhabited structures, owners of urban 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 UBL 3.

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

9. Blast Monitoring

Blast Monitoring is to be conducted in accordance with best practices – see Blast Monitoring - page 22.

The two (2) nearest urban structures within 75m (250') should be seismically monitored at UBL 2.

10. Documentation

The Urban 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 Urban Blasting Manager and amendments undertaken to ensure the meeting of plan objectives.

Urban Blasting Level 4

>100m to 500m (>330' to 1600')

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

UBL 4 Control Blasting Plan

The purpose of the Control Blasting Plan is to document the hazards and risks associated with an Urban 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 Urban Blaster is responsible for designing and documenting the Control Blast Plan for UBL 4 operations.

The Control Blasting Plan should include the following:

1. 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.

2. Peak Particle Velocity

Where a lack of project specific requirements exist, blasting operations performed at UBL 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 urban structures based on blast design.

3. Air Overpressure

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

4. Blast Hole Diameter and Depth

The Control Blasting Plan should document the blast hole diameter and blast hole length. For UBL 4 Urban Blasting Operations, blast hole diameter and depth is to be governed by charge weight per delay to meet suggested Peak Particle Velocity limits.

5. Explosives and Detonators

At the discretion of the Urban Blaster.

6. Flyrock Controls

The Control Blast Plan should document how flyrock is to be controlled. See best practices for Controlling Flyrock - page 17.

7. Pre-Blast Surveys

Pre-blast surveys at UBL 4 are to be conducted at the discretion of the Urban Blaster. Pre-Blast surveys should be conducted in accordance with best practices – see Pre-Blast Survey of Urban Structures page 19.

8. Community Notification

Best practices for the notification of the community is documented in the Community Notification of Blasting Operations – Best Practices. See Page 21.

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 UBL 4.

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

9. Blast Monitoring

It is suggested that the nearest urban structure be seismically monitored at UBL 4.

Blast Monitoring should be conducted in accordance with best practices - see Blast Monitoring, page 22.

10. Documentation

The Urban 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 Urban Blasting Manager and amendments undertaken to ensure the meeting of plan objectives.

Best Practices for Urban Blasting Activities

These best practices are intended to be supplemental to local, municipal, state, provincial and/or federal regulations and represent best practices for urban 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 urban blasting activities, it is suggested that the Urban 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 Urban Blasting Operations*.
4. Determine the Urban Blast Level of the drilling and blasting operations to be undertaken.
5. Develop, document, implement and review the Control Blasting Plan.

Urban Blasting Project Management Program

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

1. Guidelines for urban blasting activities are defined.
2. Risks and hazards to the public, workers and urban 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 urban structures, residents, schools and hospitals are notified of urban blasting activities conducted in their area.
5. Urban blasting activities are evaluated for effective operations through inspection and monitoring.

Urban Blaster in Charge

The designated urban 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 suggested within the regulatory jurisdiction of the urban blasting operations. The blaster in charge should:

1. 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.
2. Know and understand industry best practices.
3. Implement and adhere to the Control Blasting Plan approved for the project.
4. Conduct a risk and hazard assessment prior to commencement of operations.
5. 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.
6. Continuously monitor the work habits of the blasting crew, and provide corrective actions when necessary.
7. Ensure that all appropriate documentation is kept and submitted as suggested by the project documents and all regulatory agencies.

Controlling Flyrock

Fly rock is a constant concern to all stakeholders in Urban 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
- 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. Urban 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 sound pressure level, number of holes per blast, pattern, orientation and size of drill holes, depth of drilling, collar and toe load, stiffness ratio, mass and type of charge per delay, number of delays and hole timing.

It is the responsibility of the Urban Blaster to ensure that the blast is loaded according to the 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 urban blasting operations.

Stemming Length

A suggested stemming length of 20 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

Urban drilling and blasting operations should utilize blasting mats to act as a safety measure in the control 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 Urban 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, circuit resistance should be monitored at all times during blasting mat placement.
7. 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 of any inhabited structure.

Blast Coverage

The amount of overlap of blasting mats can significantly reduce the risk of flyrock during urban blasting activities. The Urban 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 Urban 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 four (4) 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 five (5) times the weight of the heaviest blasting mat utilized on site.

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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 urban 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 urban blaster is to ensure that good clean material is carefully placed on the blast in order to prevent damaging the detonation system. In addition, enough material should be placed on the blast to ensure the containment of flyrock.

Pre-Blast Survey of Urban Structures

The primary purpose of the pre-blast survey is to document the current physical state of an urban structure. The survey can assist in determining if blasting operations are responsible for environmental or physical damage. The survey is to be conducted to document the existing condition of the urban structure at the time of the survey.

Survey Guidelines

The pre-blast survey should consist of high-definition photos or videos of the interior and exterior of the urban 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 inspector regarding the urban structure.

Pre-Blast Survey Area

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

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

Notification and Offer to Conduct a Pre-Blast Survey

The resident or owner of the urban 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 an urban 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 an urban structure should be addressed and documented in the Control Blasting Plan.

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

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

Post-Blast Survey of Urban Structures

In general, post-blast surveys of urban 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).

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.

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Other Construction or Blasting Operations

Should other significant construction or non-related blasting or rock removal operations take place in close proximity to the urban structure, the owner should be offered the opportunity for a post-blast survey promptly 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 7 years.

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 & Urban Structures

It is best practice that residents or owners of all urban 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	
UB Level 0 0 to 3m	48 hours notice for all residents and owners of urban structures within 30m (100') of the blasting limits.
UB Level 1 >3m to 10m	48 hours notice for all residents and owners of urban structures within 30m (100') of the blasting limits.
UB Level 2 >10m to 30m	48 hours notice for all residents and owners of urban structures within 75m (250') of the blasting limits.
UB Level 3 >30m to 100m	Suggested for all inhabited structures within 100m (330') of the blasting limits.
UB Level 4 >100m to 500m	Notifications conducted at the discretion of the Urban 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	
UB Level 0 0 to 3m	48 hours notice for all schools, clinics & hospitals within 150m (500') of the blasting limits.
UB Level 1 >3m to 10m	48 hours notice for all schools, clinics & hospitals within 150m (500') of the blasting limits.
UB Level 2 >10m to 30m	48 hour notice for all schools, clinics & hospitals within 150m (500') of the blasting limits.
UB Level 3 >30m to 100m	48 hours notice for all schools, clinics & hospitals within 300m (1000') of the blasting limits.
UB Level 4 >100m to 500m	48 hours 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 Urban 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 urban blasting operations to measure and document levels of ground vibration and air overpressure produced by urban blasting activities. Urban 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 urban structure of each blast or as otherwise specified by the Urban Blasting Manager.
3. A monitoring report is kept for each blast that documents:
 - a) Urban 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).

Seismograph Setup

The accuracy of seismic and air overpressure measurements is essential to ensure that urban 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 one (1) year of its use in urban blasting operations.

Visual Recording

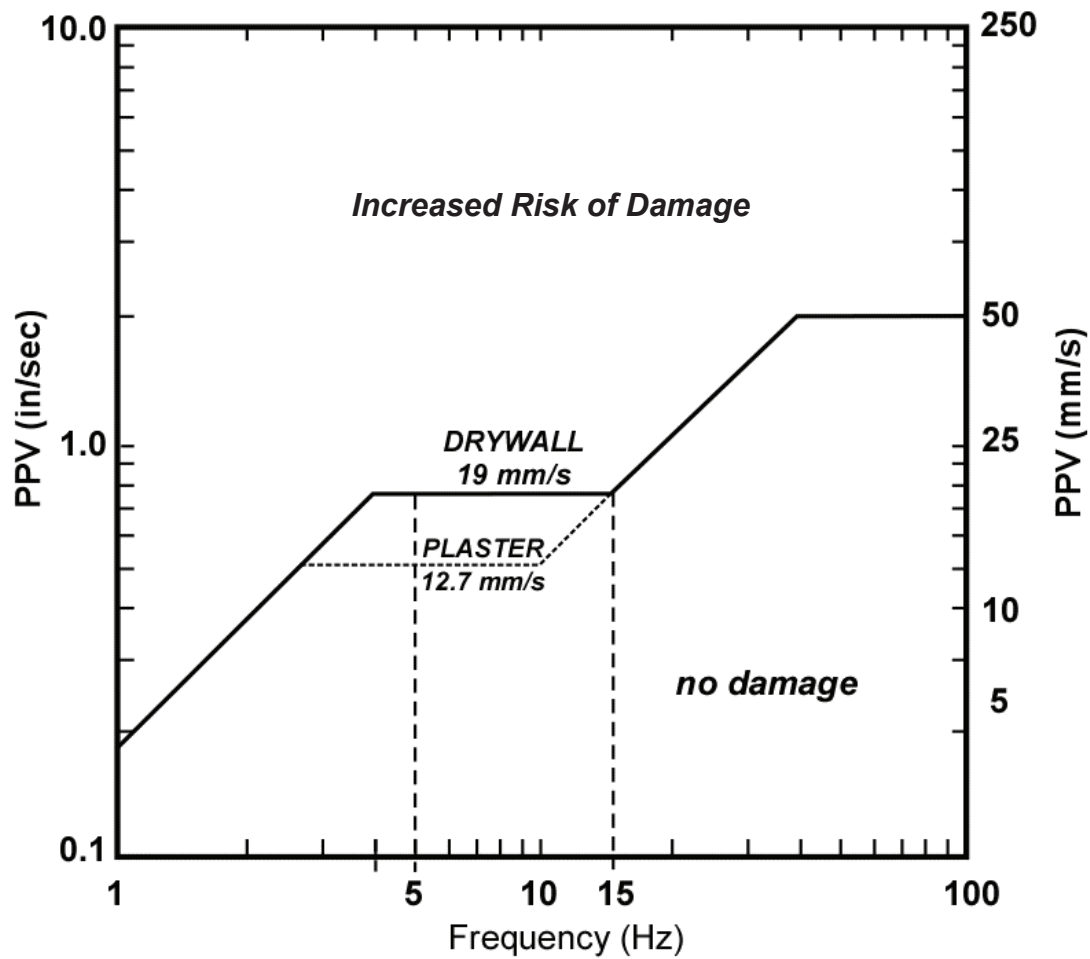
It is suggested that video recording of blasting operations is undertaken to document urban blasting activities and serve as a blast archive.

Blast Monitoring Matrix

It is recommended that monitoring of Urban Blasting operations are undertaken in accordance with the following monitoring matrix:

Blast Monitoring Matrix	
UB Level 0 0 to 3m	Monitoring with standard vibration monitoring equipment may not accurately reflect actual vibration levels, and PPV damage may vary for high frequencies encountered at UBL 0.
UB Level 1 >3m to 10m	Monitoring at the two (2) nearest urban structures within 30m (100').
UB Level 2 >10m to 30m	Monitoring at the two (2) nearest urban structures within 75m (250') of the blasting limits.
UB Level 3 >30m to 100m	Monitoring is suggested at the two (2) nearest urban structures within 75m (250') of the blasting limits.
UB Level 4 >100m to 500m	Monitoring is suggested at the nearest Urban Structure.

Appendix A: USBM – Frequency versus Particle Velocity



Appendix B – Reference Materials

ISEE Blasters' Handbook 18th Edition

International Society of Explosives Engineers, 30325 Bainbridge Road, Cleveland, Ohio USA 44139-2295
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

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 web site

www.explosives.org

ISEE Field Practices Guidelines for Blasting Seismographs

International Society of Explosives Engineers, 30325 Bainbridge Road, Cleveland, Ohio USA 44139-2295

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 #	
UB 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 Urban Structures:		Blasting Manager:	
Permits Required:		Blaster in Charge:	
Rock Details: Rock type, back break potential, hardness, joint orientation, etc.		Fragmentation Requirements of the Owner:	
<p><u>Sketch Project/Attach Map</u> — include distances to urban structures, roads/highways, property lines, other site works, etc.</p>			


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.

<p><u>Typical Load</u></p> 	<p><u>Typical Timing Plan</u></p>
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Seismic Modeling			
Instructions: Complete seismic modeling for the two nearest urban structures.			
Allowable Peak Particle Velocity (PPV)		Allowable Air Overpressure	
mm/sec		dB(L)	
Structure #1 Details:		Structure #2 Details:	
Distance to Structure #1		Distance to Structure #2	
Pre-blast Survey		Pre-blast Survey	
YES NO		YES NO	
Proposed Seismograph Location #1:		Proposed Seismograph Location #2:	
Calculated PPV at Structure #1		Calculated PPV at Structure #2	
mm/sec		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.	

Sample Control Blast Report

Instructions

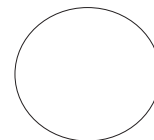
1. Review the Control Blasting Plan.
2. Complete the Control Blast Report for each blast.
3. Provide sufficient detail in which to recreate a written record of the "as loaded" of the blast.
4. Document the blast results and details of the post blast examination. Provide pictures/video if required.

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/m³) =

Max kg per Delay =

Measurements =

m³

Seismic Data

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

Total Explosive Usage

Product	Quantity

Blast Results/Notes/Comments

Blaster Signature: