

## PROCEDURES FOR BLASTING



**GEOTECHNICAL ENGINEERING MANUAL**

**GEM-22**

Revision #4

AUGUST 2015



GEOTECHNICAL ENGINEERING MANUAL:  
PROCEDURE FOR BLASTING

GEM-22  
Revision #4

STATE OF NEW YORK  
DEPARTMENT OF TRANSPORTATION  
GEOTECHNICAL ENGINEERING BUREAU

AUGUST 2015

## TABLE OF CONTENTS

1. INTRODUCTION.....	3
A. Purpose.....	3
B. General .....	3
C. Definitions.....	6
2. PROCEDURES FOR BLASTING WITHIN NYSDOT ROW .....	14
A. Submittal of Written Blast Plan .....	14
B. Scheduling Preblast Meetings .....	15
C. Conducting Preblast Meetings .....	15
D. Inspection and Documentation.....	16
E. Test Blasts .....	16
F. Blasting Progress Meetings .....	16
G. Blasting Review .....	16
APPENDICES .....	17
A. Preblast Meeting Itinerary .....	A-1
B. General Guidelines for Project Inspectors.....	B-1
C. Blasting Report Form SM 469 (US Customary Units) .....	C-1
Blasting Report Form SM 469 (International System of Units) .....	C-2
D. Instructions for Filling out the Blasting Report Form.....	D-1
E. Highlights from State and Federal Safety Regulations.....	E-1
F. Geologic Evaluation of Test Section .....	F-1

# 1. INTRODUCTION

## A. Purpose

This document specifies the procedure that shall be followed when a Contractor or Permittee is proposing to blast. By following this procedure, the Engineer-In-Charge or the Permit Engineer can help ensure that the Contractor accomplishes the work in a safe and effective manner. Engineering Geologists from the Geotechnical Engineering Bureau are trained and experienced in blasting safety and blasting techniques, and are available to provide assistance during all phases of the blasting operations. Prior to blasting the Contractor shall submit a written blast plan to the Engineer for conditional approval. The Engineer will forward the blast plan to the Engineering Geology Section, Geotechnical Engineering Bureau for review and written comment. After approval of the blast plan, a preblast meeting will be held which shall be attended by the Engineer, the Contractor, the Project Blaster(s), an Engineering Geologist from the Geotechnical Engineering Bureau, and representatives of all interested Agencies to discuss the proposed blasting operations. Final approval to blast will be granted based upon the results of the meeting. Test blasts may be required and may result in modifications to the blast plan. All blasts on Department contracts will be documented by the Engineer using the *Blasting Report Form SM 469 US Customary Units (GE 469 International System of Units)* (See Appendix C).

## B. General

Presplit blasting is required on State ROW when the design rock slope is one vertical on one horizontal or steeper and the vertical height of the exposed rock slope exceeds 5 ft. (1.5 m). The contract documents may also specify blasting. The Contractor may choose to use production blasting in conjunction with required presplit blasting or for general rock excavation. The Contractor may also elect to use blasting for trenching operations, structure excavations, and structure demolitions. Permit jobs that involve blasting on State ROW are subject to the same requirements as Department-let contracts. If the Permit Engineer is concerned or uncertain about the effects of blasting adjacent to State ROW, the Engineering Geology Section should be contacted for advice.

Blasters in New York State are required to possess a valid New York State Department of Labor (NYSDOL) issued Blaster Certificate of Competence. The Blaster Certificate of Competence permits the use of explosives specific to the following blasting operations. These are classified as follows: A Class A (Above/Below Ground) Certificate or Class B (Aboveground) Certificate is required for rock blasting. A Class D (Demolition) Certificate is required for demolition of bridge superstructures or substructures. A Class E (Seismic) Certificate is required for seismic surveys. In conjunction with a Blaster Certificate of Competence an Explosives License is also needed for the licensee to purchase, own, possess or transport explosives.

The blaster will conduct all blasting operations in a skillful manner so as not to cause injury, damage property, adversely affect traffic, or cause the migration/accumulation of noxious gases. Blasting activities can have negative consequences which include the following:

### 1. Flyrock

Flyrock can cause serious injury or damage when it travels outside the blast zone. Flyrock can be caused by: improper blast design; improper or insufficient stemming;

unanticipated geologic features such as voids, soft seams, and other planes of weaknesses; borehole deviation; insufficient burden; and poorly distributed explosives.

The Blaster should inspect any free rock faces for irregularities and geologic conditions that may affect the blast and adjust the drill hole locations accordingly. Profiling the rock face using simple measuring tapes, conventional surveying techniques, or more advanced laser profiling may be warranted. Driller's notes and logs should be kept and used by the Blaster to make adjustments to explosives loading to account for geologic conditions and borehole deviation. The use of Borehole Deviation Surveys may be feasible to determine boreholes that have wandered too close to each other or too close to the rock face. Monitoring of drilling operations will also provide feedback to the drillers so that they may make adjustments to their methods.

Flyrock can also be controlled by using blasting mats or soil cover to retain the exploded rock. It's important that the Blaster make sure that all personnel are outside the blasting area where fly rock can be expected.

## 2. Vibrations

Blasting generated vibrations can damage underground and aboveground structures. When the Contractor is using a seismograph to monitor vibrations on State ROW, the Standard Specifications (§203-3.02.A.3.) provides the maximum particle velocity unless directed otherwise by the Engineer or the Contract Documents. In the absence of seismic monitoring equipment, the explosives loading limits shall be based upon the scaled distance formula in the Standard Specifications. In certain circumstances, NYSDOT contract documents may also require monitoring of adjacent structures that are off the State ROW. NYSDOL regulations (12 NYCRR 61) restrict vibration levels at buildings in the vicinity of blasting operations based upon distance or vibration frequency. Even when vibrations are not at a level sufficient to cause damage, they can disturb individuals and result in complaints. Proper placement and operation of the seismograph is critical for obtaining accurate readings. Vibrations can be controlled by modifying the weight of explosives per delay, the loading density, and the delay pattern. A preblast condition survey of a structure may be required prior to blasting.

## 3. Displacement of Bedrock

Blasting, primarily trench and ditch blasting, can displace rock and damage adjacent pavement and underground utilities.

## 4. Noxious Fumes

Blasting generates carbon monoxide and other noxious fumes. The fumes generated during blasting operations, especially during trenching operations, can migrate and collect in excavations, manholes and D.I.'s, and nearby buildings. The build up of significant concentrations of gases can occur 12 hours or more after the blast. All blasting shall be conducted so that the noxious gases generated by the blast do not affect the health and safety of individuals.

When site conditions and blasting procedures indicate that there is the potential for the migration and accumulation of gases, the Contractor should specify information collection activities, modification of blasting procedures, and an action plan in the event of a high reading or alarm. Such site conditions could include but are not limited to: open jointed bedrock (i.e. karstic limestone); an impermeable soil layer overlying the bedrock (i.e. clay or saturated soil); and proximity to buildings. Blasting procedures that may increase the risk include confined (i.e. trenching), large, and frequent blasts. Information collection activities should include preblast surveys of all buildings within a minimum of 300 ft. (100 m) of the blast, which would identify potential sources of entry and potential pathways to the buildings such as buried utility trenches. Information collection activities should also include monitoring of carbon monoxide levels before, during, and after the blast. Modification of blasting procedures should include limiting the size and frequency of blasts to limit the production of noxious fumes, and stripping of the overburden prior to blasting and excavating the shot rock immediately after blasting to allow the venting of gases. The use of vent holes or vent pits may also be necessary. The action plan should cover both building occupants and monitoring personnel.

#### 5. Airblast Overpressure

Although unusual, blasting generated air waves can reach a level where they can damage buildings. NYSDOL (12 NYCRR 61) specifies limits for airblast levels at buildings in the vicinity of blasting operations. Air waves not at a level sufficient to cause damage can disturb individuals, resulting in complaints. Factors that affect air blast overpressure include topography, blast design, and atmospheric conditions. Blasts may have to be redesigned or rescheduled for more favorable atmospheric conditions to minimize air waves.

#### 6. Misfires

Misfires happen when a loaded hole, portion of a loaded hole, or several loaded holes fail to detonate during a blast. Misfires can be caused by failure of the detonation system or by explosive column cutoffs. Sometimes it is apparent immediately after a blast that a misfire has occurred. Other times it's not discovered until the blasted rock is being excavated and unexploded explosives are discovered within the shot rock pile. The Blaster-in-Charge is responsible for checking the shot immediately after the blast for misfired holes and, if discovered, re-detonating the loaded holes. If re-firing a misfired hole presents a hazard, the explosive may be removed by washing out with water or, if underwater, blown out with air. No drilling or digging shall be permitted until all missed holes have been addressed. When unexploded explosives are discovered mixed in with the shot rock, excavation will cease until a Project Blaster is notified and he is able to supervise the continued rock excavation and proper disposal of the unexploded explosives. All personnel involved with excavating shot rock should be vigilant for the presence of unexploded explosives.

Each Certified Blaster is required to report to the NYSDOL any unusual incident or event that occurs during the blasting operations. They are also required to report any instances of premature detonation, damage from air blast, damage from excessive ground vibration, or instances of fly rock. Damage must be reported even when it is alleged and/or the complaint is made after a

substantial lapse of time.

### **C. Definitions**

**Airblast** - The airborne shock wave generated by an explosion.

**ANFO** – A blasting agent composed primarily of ammonium nitrate and fuel oil.

**Authorized Blasting Assistant** – An individual who has been authorized by the certified blaster-in-charge to work on a blasting operation after such blaster-in-charge has confirmed that the individual is either a certified blaster, or otherwise meets the following qualifications:

- (1) Is at least eighteen years old;
- (2) Has been properly trained in the performance of the tasks to be assigned; and
- (3) Has been made aware of and understands the blasting hazards and risks.

**Backbreak** – Rock broken beyond the limits of the last row of holes in a blast, synonymous with overbreak.

**Base Charge** – The main explosive charge in the base of a detonator or a heavy charge at the base of a column of presplit powder.

**Battered Production Holes** – The row of production holes closest to presplit line, drilled at the same angle as the presplit holes.

**Bench** – A horizontal ledge from which holes are drilled downward into the material to be blasted.

**Binary Explosive** – A blasting explosive formed by the mixing of two phosphoric materials, for example, ammonium nitrate and nitromethane.

**Blast Pattern** – The plan view of the drill holes as laid out for blasting.

**Blast Plan** – A written procedure that details the methods and manner by which a Project blaster will comply with pertinent laws, rules, regulations, and contract documents. The plan shall include all information, as detailed in Section 2A, necessary to evaluate the effectiveness and safety of the proposed blasting operations. Individual blasts on a project are rarely identical. The plan should show the details for a typical blast with the understanding that minor modifications in the field will be allowed. Significant changes to the blasting operations will require that a new blast plan be submitted for approval. When deemed necessary by the Engineer, approved blast plans will be required for each individual shot.

**Blaster-in-Charge** – The Project Blaster in charge of a specific blast. Responsibilities include delivery of explosives, storage, loading, and detonation of the blast. *A project may have several Project Blasters, but only one blaster is in charge of each blast.*



**Blasting Agent** – An explosive material, consisting of fuel and oxidizer that can't be detonated with only a No. 8 blasting cap.

**Blast Area** – An area near any blasting operation in which concussion, flying material or debris, or gases resulting from a detonation of explosives can reasonably be expected to cause injury or property damage.

**Blasting Galvanometer** – An electrical resistance instrument designed specifically for testing electrical continuity of electric detonators and circuits containing them. Other acceptable instruments for this purpose are Blasting Ohmmeters and Blaster's Multimeters.

**Blasting Mat** – A Mat of woven steel wire, scrap tires, or other suitable material to cover blastholes for the purpose of preventing flyrock.

**Blasting Site** – The specific place defined by the Blaster-in-Charge where explosives are used in blasting operations. A blast site is part of the blast area.

**Blasting Superintendent** – The Contractor may use a Blasting Superintendent to provide general oversight for drilling and blasting operations. However, the Blaster-in-Charge is responsible for each blast.

**Blasting Vibrations** – The energy from a blast that manifests itself in the form of vibrations which are transmitted through the earth away from the immediate blast area.

**Booster** – An explosive charge, usually of high detonation velocity and detonation pressure, designed to be used in the explosive initiation sequence between an initiator or primer and the main charge.

**Bulk Strength** – The strength per unit volume of an explosive calculated from its weight strength and density.

**Burden** – The distance from the borehole to the nearest free face or the distance between boreholes measured perpendicular to the spacing.

**Certified Blaster** – An individual who has been issued a "Blaster Certificate of Competence" by the NYSDOL for using explosives.

**Collar** – The mouth or opening of a borehole.

**Column Charge** – A long, continuous, unbroken column of explosives in a blasthole.

**Continuity Check (Circuit)** – A determination that an initiation system is continuous and contains no breaks or improper connections that could cause stoppage or failure of an ignition system. For an electric initiation system, the check is performed both visually and by using a blasting galvanometer or other device. For a non-electric initiation system, the check can only be done visually.

**Deck Loading (Decking)** – A method of loading blastholes in which the explosive charges, called decks or deck charges, in the same hole are separated by stemming or an air cushion. The separate decks may or may not be fired on the same delay.

**Deflagration** – An explosive reaction such as a rapid combustion that moves through an explosive material at a velocity less than the speed of sound in the material.

**Delay Blasting** – The practice of initiating individual explosive decks, boreholes, or rows of boreholes at predetermined time intervals using delay detonators, or other delaying methods, as compared to instantaneous blasting where all holes are fired essentially at the same time.

**Delay Detonator** – An electric or nonelectric detonator used to introduce a predetermined lapse of time between the application of a firing signal and the detonation of a charge.

**Departmental Engineering Geologist** – An Engineering Geologist of the Geotechnical Engineering Bureau authorized by the Director of the Geotechnical Engineering Bureau to perform the duties required under the NYS DOT Standard Specifications. Engineering Geologists are trained and experienced in blasting safety and blasting techniques, and are available to provide assistance during all phases of the blasting operations.

**Design Rock Slope** – A cut slope in rock constructed at the angle and location specified in the contract plans. Presplit blasting is usually used to construct the slope so that the finished slope is stable and free from significant rock hazards.

**Detonating Cord** – A flexible cord containing a center core of high explosives which may be used to initiate other high explosives.

**Detonating Cord Trunkline** – The line of detonating cord that is used to connect and initiate other lines of detonating cord.

**Detonation** – An explosive reaction that moves through an explosive material at a velocity greater than the speed of sound in the material.

**Detonator** – Any device containing an initiating or primary explosive that is used for initiating detonation in another explosive material.

**Drilling Pattern** – The location of blast holes in relation to each other and the free face.

**Dynamite** – A high explosive used for blasting, consisting essentially of a mixture of, but not limited to nitroglycerin, nitrocellulose, ammonium nitrate, sodium nitrate, and carbonaceous materials.

**Electric Blasting Circuit** – An electric circuit containing electric detonators and associated wiring.

**Electric Detonators** – A detonator designed for, and capable of, initiation by means of an electric current.

**Emulsion** – An explosive material containing substantial amounts of oxidizer dissolved in water droplets, surrounded by an immiscible fuel; or droplets of an immiscible fuel surrounded by water containing substantial amounts of oxidizer.

**Explosion** – A chemical reaction involving an extremely rapid expansion of gases usually associated with the liberation of heat.

**Explosive** – Any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion.

**Explosives License – Own & Possess** – A license issued by NYS Department of Labor for the purpose of purchasing, owning, possessing, or transporting explosives.

**Explosive Loading Factor** – The amount of explosive used per unit volume of rock. Also called Powder Factor.

**Explosive Materials** – These include explosives, blasting agents, and detonators. The term includes, but is not limited to, dynamite and other high explosives; slurries, emulsions, and water gels; black powder and pellet powder; initiating explosives; detonators (blasting caps); and detonating cord.

**Extra (Ammonia) Dynamite** – A dynamite in which part of the nitroglycerin is replaced by ammonium nitrate in sufficient quantity to result in the same weight strength.

**Extraneous Electricity** – Electrical energy, other than actual firing current or the test current from a blasting galvanometer, that is present at a blast site and that could enter an electric blasting circuit. It includes stray current, static electricity, RF (electromagnetic) waves, and time-varying electric and magnetic fields.

**Flyrock** – Rocks propelled from the blast area by the force of an explosion.

**Fragmentation** – The breaking of a solid mass into pieces by blasting.

**Free Face** – A rock surface exposed to air or water which provides room for expansion upon fragmentation. Sometimes called open face.

**Fuel** – A substance which may react with oxygen to produce combustion.

**Fumes** – The gaseous products of an explosion. For the purpose of determining the fume classification of explosive material, only poisonous or toxic gases are considered.

**Gelatin Dynamite** – A type of highly water resistant dynamite characterized by its gelatinous or plastic consistency.

**Geology** – A description of the types and arrangement of rock in an area; the description usually includes the bedding dip and strike, the type and extent of pre-existing breaks in the rock, and the hardness and massiveness of the rock, as these affect blast design.

**Grains** – A weight measurement where 7000 grains are equivalent to 1 lb. (0.45 kg).

**Ground Vibration** – Shaking the ground by elastic waves emanating from a blast. Usually measured in in/s (mm/s) of particle velocity.

**High Explosives** – Explosives which are characterized by a very high rate of reaction, high pressure development, and the presence of a detonation wave in the explosive.

**Initiator** – A detonator, detonating cord or similar device used to start detonation or deflagration in an explosive material.

**Lift** – The vertical thickness of rock fragmented from a single blast.

**Loading** – Placing explosive material in a blast hole or against the material to be blasted.

**Loading Density** – The weight of explosive loaded per unit length of borehole occupied by the explosive, expressed as lbs/ft (kg/m) of borehole.

**Loading Limits** – The maximum quantity of explosives allowed per delay period as specified by the Standard Specifications.

**Loading Pole** – A nonmetallic pole used to assist in placing and compacting explosives charges in boreholes.

**Low Explosives** – Explosives which are characterized by deflagration or low rate of reaction and the development of low pressure.

**Magazine** – Any building, structure, or container approved for the storage of explosives materials.

**Mass Explosion** – An explosion which affects almost the entire load or quantity of explosives virtually instantaneously.

**Maximum Particle Velocity (Peak Particle Velocity)** – The maximum velocity at which the ground surface moves as a wave passes under it. The customary practice is to apply vibration limits to the peak particle velocity of the largest single component on the seismograph.

**Millisecond (ms)** – One thousand part of a second (.001 or 1/1000 sec.).

**Misfire** – A blast or specific borehole that failed to detonate as planned. Also the explosive materials that failed to detonate as planned.

**Muckpile** – The pile of broken material resulting from a blast.

**Nitroglycerin** – An explosive chemical compound used as a sensitizer in dynamite.

**Nonelectric Detonator** – A detonator that does not require the use of electric energy to function.

**Nonsparking Metal** – A metal that will not produce a spark when struck with other tools, rock, or hard surface.

**Overbreak** – See backbreak.

**Overburden** – Material of any nature laying on top of the rock that is to be blasted.

**Oxidizer** – A substance, such as nitrate, that readily yields oxygen or other oxidizing substances to promote the combustion of organic matter or other fuel.

**Particle Velocity** - The velocity at which the ground surface moves as a wave passes under it.

**PETN** – An abbreviation for the name of the high explosive pentaerythritol tetranitrate.

**Placards** – signs placed on vehicles transporting hazardous materials (including explosive materials) indicating the nature of the cargo.

**Phosphoric Materials** – Two or more unmixed, commercially manufactured, prepackaged chemical materials which are not classified as explosives but which, when mixed or combined, form a blasting explosive.

**Powder Factor** – The amount of explosive used per unit volume of rock. Also called Explosive Loading Factor.

**Preblast Survey** – A documentation of the preexisting condition of structures near an area where blasting is to be conducted.

**Premature Firing** – The detonation of an explosive charge before the intended time.

**Presplitting** – A blasting method in which cracks for the final contour or payline are created by firing a single row of holes containing light, well distributed charges, prior to the initiation of the remaining holes in the blast pattern.

**Prilled Ammonium Nitrate** – Ammonium nitrate in a pelleted or prilled form.

**Primer** – An explosive charge used to initiate other explosives or blasting agents. The primer is initiated by a detonator or detonating cord to which is attached a detonator.

**Production Blasting** – A blasting method whose sole purpose is to fragment the rock.

**Propagation** – The detonation of an explosive charge by an impulse received from an adjacent or nearby explosive charge.

**Project Blaster(s)** – A certified blaster who has been approved to blast on State ROW (see Blaster-in-Charge).

**Relief** – The effective distance from a blast hole to the nearest free face (synonymous with burden).

**Round** – A group of boreholes fired or intended to be fired in a continuous sequence.

**Scaled Distance** – A factor relating expected vibration levels from various weight charges of explosive materials at various distances.

**Secondary Blasting** – Blasting to reduce the size of boulders resulting from a primary blast.

**Seismograph** – An instrument which records ground vibrations generated by blasting operations. Particle velocity displacement is generally measured and recorded in three mutually perpendicular directions.

**Sensitivity** – A physical characteristic of an explosive material classifying its ability to be initiated upon receiving an external impulse such as impact, shock, flame, friction, or other influence which can cause detonation.

**Shaped Charges** – An explosive with a shaped cavity specifically designed to produce a high velocity cutting or piercing jet of product reaction; usually lined with metal to create a jet of molten liner material. They are generally used to cut steel members during superstructure demolition.

**Shock Tube** – A small diameter plastic tube used for initiating detonators. It contains only a limited amount of reactive material so that the energy that is transmitted through the tube by means of a detonation wave is guided through and confined within the walls of the tube.

**Short Delay Blasting** – The practice of detonating blastholes in successive intervals where the time distance between any two successive detonations is measured in milliseconds.

**Slurry** – An explosive material containing substantial portion of a liquid, oxidizers, and fuel, plus a thickener.

**Stemming** – Inert material placed in a borehole on top of or between separate charges. Used for the purpose of confining explosive gases or to physically separate charges of explosive material in the same borehole.

**Subdrilling** – The practice of drilling boreholes below floor level or working elevation to insure breakage of rock to working elevation.

**Sympathetic Detonation** – The detonation of an explosive material as the result of receiving an impulse from another detonation through air, earth, or water. Synonymous with sympathetic propagation.

**Tamping** – The action of compacting the explosive charge or the stemming in a blasthole. Sometimes refers to the stemming material itself.

**Warning Signal** – An audible signal which is used for warning personnel in the vicinity of the blast area of the impending explosion.

**Water Gel** – An explosive material containing substantial portions of water, oxidizers, and fuel, plus a cross-linking agent.

**Water Resistance** – The ability of an explosive to withstand the desensitizing effect of water penetration.

**Weight Strength** – The energy of an explosive material per unit of weight.

## **2. PROCEDURE FOR BLASTING WITHIN NYS DOT ROW**

### **A. Submittal of Written Blast Plan**

A written blast plan prepared by a Project Blaster shall be submitted by the Contractor to the Engineer a minimum 10 working days prior to scheduling a preblast meeting. The Engineer shall send a copy of the Blast Plan to the Regional Geotechnical Engineer who shall forward a copy to the Geotechnical Engineering Bureau, Engineering Geology Section for review. The Blast Plan may be returned to the blaster for revision or clarification prior to scheduling the preblast meeting. The blast plan shall detail the methods and manner by which the Project Blaster will comply with pertinent laws, rules, regulations, and contract documents. The plan shall include all information necessary to evaluate the effectiveness of the proposed blasting operations. The blast plan shall include all steps necessary to ensure that the proposed blasting activity does not cause injury, damage property, adversely affect traffic, or cause the migration/accumulation of noxious gases. Individual blasts on a project are rarely identical. The plan should show the details for a typical blast with the understanding that minor modifications in the field will be allowed. Significant changes to the blasting operations will require that a new blast plan be submitted for approval. When deemed necessary by the Engineer, approved blast plans will be required for each individual shot. The blast plan shall include the following items:

#### **1. Project Designations**

- Name of Project Blaster(s).
- Photocopy of the Project Blaster's Explosives License (Own & Possess) and Certificate of Competence.
- Employer of the Project Blaster (Contractor or subcontractor).
- Scheduled start date and length of blasting operations and blast monitoring operations.
- Limits of blasting work.
- Requirements for local permits.
- Location of any State owned structures in proximity to the blasting.
- Location of any utilities in proximity to the blasting.
- Location of any contaminants or flammable liquids or vapors in the area to be blasted.

#### **2. Safety and Health Requirements**

- Type of audible warning signals and signal sequence.
- Name of company that will deliver explosives to the project site.
- Location of any preblast surveys.
- Location of any vibration monitoring at State owned structures, utilities on or off State ROW, or privately owned structures off State ROW.
- Location of any air blast overpressure monitoring.
- If seismographs will be used, provide the manufacturer's name, model number, and documentation of calibration performed within the last 12 months. Also provide name(s) of seismograph operators and relevant training and experience.
- List steps that will be taken to control flyrock (i.e. blasting mats).



- Are carbon monoxide or other noxious fumes likely to migrate from the blast location or accumulate within nearby structures and, if so, what will be done to detect and prevent their migration.

### 3. Methods and Procedures

- Type of drilling equipment.
- Method of collaring and aligning presplit drill holes.
- Hole diameter.
- Drilling pattern.
- Use of sequential timer.
- Types of explosives, primers, initiators, and other blasting devices. Include manufacturer's technical data sheets and material safety data sheets for all products.
- Loading parameters:
  - A. Maximum and/or average weight of explosives per volume of rock.
  - B. Maximum weight of explosives per delay.
- Blasting cap delay patterns.

### **B. Scheduling Preblast Meetings**

After approval is granted to schedule the meeting, the Engineer should contact the Engineering Geology Section via the Regional Geotechnical Engineer, and the Contractor, to schedule the meeting. The Contractor is responsible for inviting the Blaster (all Blasters whom the Contractor wants to be designated as Project Blasters must attend the meeting) and all interested parties (including but not limited to utilities, railroads, local political jurisdictions, local law enforcement agencies, and local emergency services) a minimum of 3 work days in advance of the meeting. Representatives for all utilities located within 200 ft. (60 m) of the blasting (300 ft. (90 m) for gas transmission lines) shall be invited.

### **C. Conducting Preblast Meetings**

A preblast meeting shall be held at the site to discuss the proposed blasting operations. In attendance will be the Engineer, the Contractor, the Project Blaster(s) an Engineering Geologist from the Geotechnical Engineering Bureau, and other interested parties. Final approval to blast will be granted based upon the results of the meeting.

A preblast meeting is intended to initiate open communications with the Project Blaster(s) relating to the requirements for rock drilling and blasting, and demolition by blasting work on Departmental projects. An Engineering Geologist from the Geotechnical Engineering Bureau conducts the preblast meeting, which includes discussions on the blast plan and other pertinent information (see Appendix A).

A new preblast meeting will be required to designate new Project Blasters.

#### **D. Inspection and Documentation**

An Engineering Geologist will be available to train construction inspection staff in the proper method of inspecting blasting operations including ensuring that the blasting is carried out in a safe manner and documenting each blast using the *Blasting Report Form SM 469 US Customary Units (GE 469 International System of Units)* (see Appendix B, C, and D).

The State requires that, when seismographs are used to monitor vibrations, the Contractor will maintain seismograph records and make them available to the State if requested.

#### **E. Test Blasts**

Test sections are required for presplit slopes and test blasts may be required for other types of blasting situations. An Engineering Geologist will evaluate the test blast/section and determine if adjustments to the rock slope design and/or blasting operations are necessary (see Appendix F).

#### **F. Blasting Progress Meetings**

At the request of the Engineer, meetings may be held at any time during the project to review the progress of the blasting operations, discuss modifications to the methods and procedures of the written blast plan and/or discuss issues with upcoming blasts. In attendance will be the Engineer, the Contractor, the Project Blaster(s), an Engineering Geologist from the Geotechnical Engineering Bureau, and other interested parties.

As indicated previously, a new preblast meeting is required to designate new Project Blasters.

#### **G. Blasting Review**

If a blast causes injury, damage to property, adversely affects traffic, or causes gases to migrate and/or accumulate in a potentially harmful manner, all blasting operations shall cease by order of the Engineer for a review of the procedures. The review will be conducted by the Engineer in conjunction with an Engineering Geologist from the Geotechnical Engineering Bureau to ensure proper procedures and practices were used and to determine if the approved procedures need to be revised. Should the findings of the review indicate the injury, damage, traffic delay, or migration/accumulation of gases was attributed to improper blasting operations, the Blaster-in-Charge may be removed at the State's option.

**APPENDICES**



1. Opening Remarks
  - a. Verification of Attendance of Concerned Parties
  - b. Statement of DOT Standard Specifications
  - c. Description of Project by Engineer (Scope of Work, Stationing, etc.)
  - d. Start Date for Blasting Operations
  - e. Estimated Time to Complete Blasting
2. Project Designations
  - a. Identify Prime Contractor
  - b. Identify Project Blaster(s)
  - c. Insurance Details
3. Safety and Health Requirements
  - a. State and Federal Laws
  - b. Local Permits/Laws
  - c. Signage and Traffic Control (per MUTCD)
  - d. Audible Warning Signal System
  - e. Proper Delivery and Storage of Explosive Material
  - f. Pre-Blast Survey
  - g. Vibration and Airblast Monitoring (NYSDOL limits and qualified seismograph operators)
  - h. Flyrock Control
  - i. Control of Blast Generated Fumes
  - j. Other concerns (Utilities, Municipalities, etc.)
  - k. Duty to Report Unusual Incidents (12 NYCRR 61)
4. Blasting Specifics/Review of Blast Plan
  - a. Verification of License/Certificate of Competence
  - b. Methods/Procedures
    1. Type of Drilling Equipment
    2. Hole Size
    3. Drilling Pattern
    4. Timing of Blast/Type of System (Electric/Non-Electric)
    5. Explosives (Brand, Size, etc.)
    6. Blasting Caps (Type, Delay, etc.)
    7. Loading of Holes
5. Presplitting
  - a. General Rules/Regulations/Specifications regarding presplit rock slopes
  - b. Test Section
  - c. Rules/Regulations regarding multiple lifts
  - d. Scaling
6. Conclusion



## 1. Drilling

Establish that:

- a. Prior to blasting, no rock excavation is allowed within 10 ft. (3 m) of the presplit line.
- b. Overburden is stripped from bedrock along the top of the presplit line. Ensure that the bedrock surface is not overexcavated as in the case of weak shale.
- c. The drill steel is straight and in satisfactory condition.
- d. The plumb line for orienting the drill steel alignment is correctly located on a line parallel to the presplit line.
- e. The slope inclination template is the proper dimension and that a minimum 2 ft. (0.6 m) carpenter's level is attached to the template. (Preblast meeting agreement).
- f. The driller or the driller's assistant has achieved the proper drill steel alignment as the drill bit is collared by the bedrock surface. (The alignment can only be assured at this time since once the drill is progressed into the rock, it is very difficult to reconfigure alignment).
- g. The drill hole is of the proper depth (including sub-drilling) for each hole
- h. The pre-split drill holes are on 3 ft. (1 m) centers
- i. The driller is using carbide insert cross bits (preferable to button bits) and solid drill steel (preferable to spiral drill steel).
- j. The closest row of production (fragmentation) holes to the presplit line is drilled no closer than 4 ft. (1.2 m) to and on the same angle as the presplit holes.
- k. Driller's notes and logs should be kept.

## 2. Blasting

Check:

- a. The depth of each presplit hole and clear any obstructions immediately prior to loading any explosives.
- b. The presplit explosive weight to insure that it is not heavier than the specified maximum weight of 0.35 pound per linear foot (0.5 kg per meter). It is recommended that the inspector count the number of sticks of explosive in a new box, multiply by the standard length of each cartridge to obtain the total cartridge length of each box and divide the box weight by the total cartridge length of box.
- c. That the presplit line is loaded first, and a minimum distance of burden + 3 ft. (1 m) in advance of the closest loaded production hole in the section
- d. That the earliest sequenced delay detonator is affixed to the presplit trunk line detonating cord, ensuring that the presplit slope is blasted prior to any adjacent production hole by a minimum of 25 milliseconds.
- e. That no free flowing explosives (ANFO, prills or water gels) be used in any production holes located within 10 ft. (3 m) of the presplit slope.
- f. That the stemming material to be used for presplit holes is #1A crushed stone rather than crushed gravel. (Crushed gravel has rounded edges and shotguns out of the hole rather than locking together to keep the presplit explosive gasses in the hole to split the bedrock).
- g. Driller's notes and logs should be used by the Project Blaster to make adjustments to explosives loading to account for geologic conditions and borehole deviation.





SM 469 (5/90)

NEW YORK STATE  
DEPARTMENT OF TRANSPORTATION

**BLASTING REPORT**

Job Stamp

E.I.C.:  
Inspector:  
Blaster:

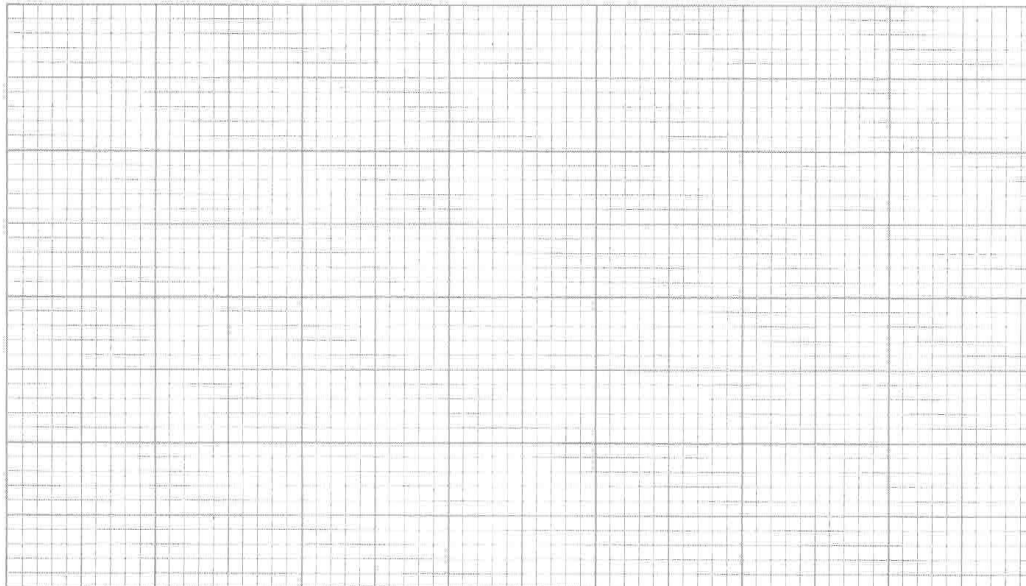
Report No.:  
Date:  
Time:

SHOT HOLE DATA	PRESPLIT			PRODUCTION		
Station Limits	Offset					
No. & Diameter	No.	Diam.		No.	Diam.	
Spacing/Pattern	Spacing			Pattern		
Depth	To Grade	Overdrilling		To Grade	Overdrilling	
Total Depth						
Stemming	Depth	Type		Depth	Type	
Explosive & Detonation Data		Base Charge	Column Charge		Explosive	Blasting Agent
	Producer			Producer		
	Type			Type		
	Dimension			Dimension		
	Weight		# / Ft.	Weight		
Total Weight						
Initiation (type)						
Delays	Number	Period(s)		Number	Period(s)	
Max. lbs/Delay						

Presplit Holes Tested for Obstruction , Burden +3 Ft. (or \_\_\_\_\_) Loaded Ahead   
 Check List Fired 25MS Ahead , Only Cartridges within 10 Feet of Slope

Remarks: \_\_\_\_\_

**IGNITION PATTERN**



GE 469 MET (2/00)

NEW YORK STATE  
DEPARTMENT OF TRANSPORTATION

**BLASTING REPORT**

Job Stamp

E.I.C.:  
Inspector:  
Blaster:

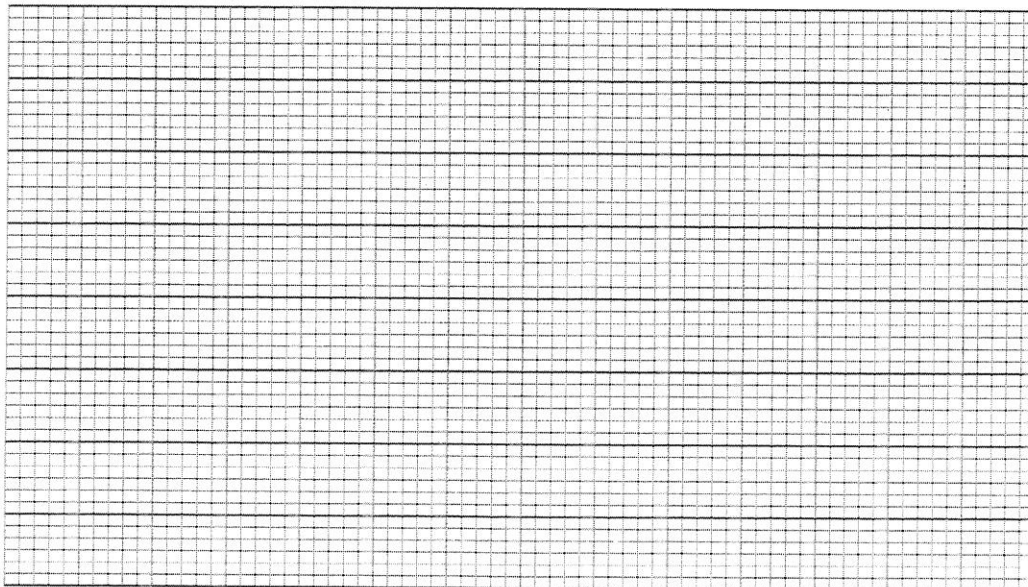
Report No.:  
Date:  
Time:

SHOT HOLE DATA	PRESPLIT			PRODUCTION		
Station Limits	Offset					
No. & Diameter	No.	Diam.		No.	Diam.	
Spacing/Pattern	Spacing			Pattern		
Depth	To Grade		Overdrilling	To Grade	Overdrilling	
Total Depth						
Stemming	Depth	Type		Depth	Type	
Explosive & Detonation Data		Base Charge	Column Charge		Explosive	Blasting Agent
	Producer			Producer		
	Type			Type		
	Dimension			Dimension		
Total Weight			kg/m	Weight		
Initiation (type)						
Delays	Number	Period(s)		Number	Period(s)	
Max. kg/Delay						

Presplit Holes Tested for Obstruction , Burden +1 m (or \_\_\_\_\_) Loaded Ahead   
 Check List Fired 25MS Ahead , Only Cartridges within 3m of Slope

Remarks: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

IGNITION PATTERN



**Heading Data**

- Job Stamp - Imprint job stamp under "Job Stamp".
- E.I.C. - Enter the name of the Engineer-in-Charge.
- Inspector - Enter the name of the state or consultant blast inspector.
- Blaster - Enter the name of the Blaster-in-Charge.
- Report No. - Sequentially number from 1, beginning with the first blast detonated.
- Date - Enter the date of the blast. If the shot is loaded one day and detonated the next, enter the date of the detonation.
- Time - Enter the actual time and date (if different from loading) the blast is detonated (Hr. & Min).

**Shot Hole Data**

- Station Limits - Enter the stations of the beginning and end of the presplit holes to be detonated if presplit is involved. Do the same for production holes, if production only is loaded.
- No. & Diameter - Enter total number of presplit holes & diameter. Do the same for production holes.
- Spacing/Pattern - Maximum 3 ft. (1 m) on center for presplit holes. For production pattern enter average distance between holes in rows and average distance between rows (Spacing X Burden) in feet (meters).
- Depth - Enter range of depth to grade next to "To Grade", enter depth of overdrilling next to 'Overdrilling' (feet) (meters).
- Total Depth - The sum of 'To Grade' & 'Overdrilling' = total depth. Because 'to grade' and 'overdrilling' are usually ranges, 'total depth' will usually be a range also.
- Stemming - Depth in feet (meters), from top of drill hole to top of explosives. For presplit holes it's required that the presplit powder be within 3 ft. (1 m) of the ground surface and the entire hole stemmed.
- Type - It's required that No. 1-A crushed stone be used for stemming presplit holes. Production holes can be stemmed with drill cuttings or soil as long as it's effective.

**Explosive and Detonation Data**

- Producer - Enter the manufacturer of each explosive (base charge, column charge, production explosive & blasting agent). Examples are Dyno Nobel and Austin.
- Type - Enter the manufacturer's product name of each in the appropriate column. Also enter the strength percentage (40%, 60%, etc.) as on the container. Examples are Dynosplit and Unimax.
- Dimension - Enter diameter and length of the individual cartridges in the appropriate columns.
- Weight - Enter weight per stick of base charge, weight/foot (weight/meter) of presplit powder, weight per stick of production charges & weight of column for blasting agent. All weight is in pounds (kilograms).
- Total weight - Enter the sum total for each type of explosive, base charge, column charge, production explosive & blasting agent.
- Initiation (Type) - Enter 'electric blasting (EB) caps' or 'non electric blast (NEB) caps' or other method as used. List cap manufacturer brand and series.
- Delays - Enter the number of different delay periods used. Period(s): enter the delay periods used. Examples are: electric – 25,75,100 ms; nonelectric – 25/350, 25/500 ms.
- Max. lbs/Delay  
Max. kg/Delay - Add the weight of explosives on each different delay per blast. The greatest weight of explosives detonated per delay is the max. pounds/delay (kilograms/delay) at 25 ms or 75 ms or 250 ms, etc.

**Presplit Check List**

Before Loading any holes with explosives

1. The blaster must designate P-S holes in the section to be loaded.
2. Back up from end and designate the production section to be loaded.
3. Check all P-S holes for obstruction and clear all P-S holes before loading any P-S or production powder.

Holes Tested for Obstructions  - check the box only after all presplit holes have been tested for clearance immediately before loading any explosives. Use either loading poles, measuring tape or some other device which can assure that the holes are clear to the full drilled length. All obstructed holes must be cleared before any explosives loading can begin.

Burden +3 ft. (or \_\_\_\_\_)

(Burden +1 m (or \_\_\_\_))

Loaded Ahead  - check the box only after it has been determined that the presplit line is loaded with explosives a length which equals the burden + 3 ft. (+ 1 m) past the closest production hole to the end of the presplit line. Usually this works out to 3 presplit holes. No production holes can be loaded past a perpendicular line to the presplit line from the third hole back.

Fired 25 MS ahead  -

Presplit holes must be detonated a minimum of 25 MS ahead of the production holes in that section.

Only Cartridges within 10 ft. of Slope  -

(Only Cartridges within 3 m of Slope )- No uncontained or poured explosives are allowed in holes within 10 ft. (3 m) of the presplit plane.

Remarks - Utilized this area to report on the results of the blast, i.e. damage/no damage, cutoffs, flyrock, road closed, traffic delay, seismograph locations and readings, carbon monoxide monitor locations and readings, etc.

- Ignition Pattern-** Utilize this area to draw an accurate plan view of drill holes, including:
- a. edge of rock
  - b. north arrow
  - c. station and offset of beginning and end of presplit line
  - d. hole numbers
  - e. spacing
  - f. burden
  - g. timing of initiation of each hole (adjusted to sequential timer if one is used. Diagram wiring connections).
  - h. important geologic features, i.e., seams, boulders, etc.
  - i. hole depths and lbs. (kg) of explosives per hole & per deck, if used
  - j. show detonation cord type & location

**Transportation of explosives** (12 NYCRR 39; 49 CFR 177; 29 CFR 1926 Subpart U)

- A vehicle carrying explosives shall not be left unattended or unguarded. Someone able to move the vehicle, familiar with the hazards of the material being transported and who knows what to do in an emergency must be awake in the vehicle or within 100 ft. (30 m) of the vehicle and have it in clear view.
- It is prohibited to park within 300 ft. (90 m) of a bridge, tunnel, building, a place where people gather, or an open fire unless absolutely necessary to perform their work.
- The vehicle shall not be parked within 5 ft. (1.5 m) of a traveled roadway.
- The vehicle shall make no unnecessary stops.
- Explosives shall be loaded/unloaded only when engine is off and parking brake is set.
- Do not travel through congested areas or heavy traffic unless it is a designated route.
- No device or material capable of producing spark, flame or heat shall be placed or carried on a vehicle containing explosives.
- Proper placards are required on both sides and the front and back of the vehicle.
- Fire extinguishers required with a rating of at least 10: ABC. If carrying 200 lbs. (90 kg) or more of explosives, two 10 to 12 lbs. (4.5 to 5.5 kg) carbon dioxide fire extinguishers or two 4 to 7 lbs. (1.8 to 3 kg) dry chemical fire extinguishers are required.
- Explosives shall not be transported on a trailer and a vehicle carrying explosives shall not have a trailer in tow.
- The sides and ends of an open-ended vehicle shall be high enough to prevent packages of explosives from falling off the vehicle and the explosives shall not be stacked higher than the sides of the vehicle.
- Up to 50 detonators may be carried on a vehicle containing explosives provided that: the detonators are in their original shipping containers, or a box constructed of 1 in. (25 mm) lumber lined with padding not less than ½ in. (13 mm) thick or wrapped in cloth with cloth separating each detonator, and the detonators must be in a place remote from the explosives that is easily accessible for quick removal.
- Exposed ferrous metal on the vehicle body that may come in contact with the explosive packages must be covered with wood or other non-ferrous material.

## **APPENDIX E      Highlights from State and Federal Safety Regulations**

### **Explosive safety and handling (29 CFR 1926 Subpart U)**

- Smoking, firearms, matches, open flames lamps, flames, heat producing devices and sparks are prohibited in or near magazines or while explosives are being handled, transported or used.
- All explosives must be accounted for at all times. Explosives not in use shall be in a locked magazine.
- Explosives or blasting agents shall not be abandoned.
- Original containers or class II magazines shall be used for the transport of detonators and explosives from storage to the blasting area.
- Blasting operations above ground shall be conducted between sunup and sundown.
- Electric detonators shall be short-circuited and shunted in holes which have been primed until wired into the blasting circuit.
- Blasting operations shall be suspended and personnel shall leave the blasting area upon the approach and progress of an electrical storm.
- Blasting zone signs and signs warning against the use of mobile radio transmitters must be posted on all roads within 1000 ft. (300 m) of the blasting area.
- Mobile radio transmitters which are less than 100 ft. (30 m) from electric blasting caps shall be deenergized and effectively locked.
- Empty boxes and paper and fiber packing materials, which have previously held explosives, shall not be used for any purpose and shall be destroyed by burning.
- Blasting operations in the vicinity of overhead power lines, communication lines, utilities, or other services and structures will not be carried out until the Utilities are notified and measures for safe control have been taken.
- Use of black powder is prohibited.
- Smoking and open flames are not permitted within 50 ft. (15 m) of explosives and detonator storage magazines.
- Tamping will be done with wood rods or plastic tamping poles without exposed metal parts. No violent tamping is allowed.
- After loading holes, all unused explosives and detonators must be returned to an authorized magazine.



## **APPENDIX E**

### **Highlights from State and Federal Safety Regulations**

- No person will be allowed to deepen drill holes which have previously contained explosives or blasting agents.
- Equipment will not be operated within 50 ft. (15 m) of loaded holes (no drilling, digging, etc.).
- Electric cables in the proximity of the blast area shall be deenergized and locked out.
- Holes will be checked prior to loading to determine depth and conditions of the hole.
- No drilling is allowed within 50 ft. (15 m) of a hole that has been loaded with explosives and has failed to detonate.
- All blast holes will be stemmed to the collar or a point that will confine the charge.
- Blasting cap leg wires will be kept short-circuited (shunted) until they are connected into the circuit for firing.
- A code of blasting warning signals (29 CFR 1926) shall be posted conspicuously at the operation and all employees shall be familiar with the signals.
- A loud signal must be given by the blaster of record prior to firing the blast.
- Flaggers must be safely positioned on roadways passing through the danger zone to stop traffic during the blasting operations.
- Following the blast, the blasting machine or other initiation devices shall be disconnected from the firing line or turned off in the case of power switches.
- The blaster shall check the surrounding rubble and blasting area to determine that all charges have been exploded.
- If a misfire occurs, only those employees necessary to do the work shall remain in the blast zone.
- No attempt will be made to extract explosives from any charged or misfired hole. A new primer shall be installed and the hole reblasted. If refiring the hole is a hazard, the explosives may be removed by washing out with water.
- No drilling, digging, or picking will be permitted until all missed holes have been detonated.

## **APPENDIX E      Highlights from State and Federal Safety Regulations**

### **Explosive licensing (12 NYCRR 39, 12 NYCRR 61)**

- To purchase, transport, own and possess explosives, an explosives license is required.
- The handling and placing of explosives in preparation of a blast shall be performed by a certified blaster or by persons under the supervision of a certified blaster.
- Only a certified blaster may detonate explosives. The Blaster must be certified in the specific Department of Labor category in order to perform the work.

### **Explosive storage (12 NYCRR 39, 29 CFR 1926 Subpart U)**

- Magazines and all enclosures used for storage of explosives shall be kept locked.
- Inventory of explosives shall be taken at the end of the day after blasting operations or whenever the magazine is opened.
- Magazines shall be inspected at least every 3 days.
- No smoking or flames are allowed within 50 ft. (15 m) of any explosive or magazine.
- No blasting equipment shall be stored in a magazine.
- Separate magazines shall be provided for explosives and detonators.
- No lights in magazine except battery activated electric flashlights or electric lanterns enclosed in rubber or other insulating cover.
- Ground around the magazine for a distance of 25 ft. (7.5 m) must be kept clean of flammable debris such as dry leaves and grass.
- No discharge of firearms at or within 500 ft. (150 m) of a magazine.
- Magazines must be located certain distances from buildings, railways, highways and other magazines based on the quantity of explosives stored in the magazine.
- The distances of separation can be decreased by 50% if the magazine or other structure containing explosives is protected by an efficient barricade.
- Explosive quantity conversion of detonators and detonating cord.
  - Cap size up to and including #8: 1000 caps are rated equivalent to 1.5 lbs. (0.7 kg) of explosives.
  - Cap size larger than #8: 1000 caps are rated equivalent to 3 lbs. (1.4 kg) of explosives.

- Detonating cord up to and including 60 grains/foot: 1000 ft. (300 m) is rated equivalent to 9 lbs. (4 kg) of explosive.
- Detonating cord above 60 grains/foot: 1000 ft. (300 m) is rated equivalent to 15 lbs. (6.8 kg) of explosives.

**Underground utilities (12 NYCRR 53)**

- Underground facilities within 15 ft. (4.5 m) of a proposed excavation or demolition must be staked, marked or otherwise designated.
- Verification shall be accomplished by exposing the underground facility or its encasement to view or by other means mutually agreed to by the excavator and operator.
- Powered equipment shall not be used within 4 in. (100 mm) of the verified location of an underground facility.



## **APPENDIX F    Geologic Evaluation of Test Section**

A test section is required on all newly constructed (or reconfigured) presplit slopes. The test section should be cleared and scaled in such a manner that its appearance and attitude be identical to that of the finished rock cut.

The test section exposes all discontinuities present in the bedrock. Since even the most advanced design exploration methods cannot reveal every feature present, the test section will enable the Engineering Geologist to determine if the slope will be stable as designed. If it is determined upon evaluation of the test section that the slope is unstable, the Engineering Geologist can change the slope design to one which will be stable.

The Engineering Geologist will inspect the test section, paying specific attention to drill butt traces. The geologist will examine:

1. Initial alignment of drill steel
2. Divergence, convergence or oversteepening of drilled holes  
Possible causes:
  - a. Drill Bits (Cross Bits are preferable to Button Bits)
  - b. Drill Steel (Solid Steel is preferable to Spiral Steel)
  - c. Geology
    1. Alternating Beds (e.g. shale/sandstone/shale)
    2. Jointing/Fractures/Voids
    3. Soft Rock (leading to gravity caused oversteepening)
  - d. Excessive down pressure
3. Final Appearance of Finished Slope
  - a. Dimensions of Finished Product
  - b. Rock Condition
  - c. Unconformities/Significant Facies Changes
4. Concerns/Issues as the slope weathers

If the Engineering Geologist is not satisfied with the final appearance of the test section, or more information is needed, an additional test section may be required to fully address all concerns.