

STANDARD SPECIFICATION
SECTION 02228 BLASTING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section includes procedures for blasting for excavation. The use of explosives during construction shall be as specified herein. However, no blasting will be permitted which, in the blasting supervisor's judgment or the judgment of the District's Representative, may be detrimental to existing facilities or pipelines.
- B. The Contractor shall be liable for all injuries to, or death of, persons, or damage to property caused by a blast or explosive, and he agrees by submission of a bid to indemnify and hold the District, its officers, agents, employees, volunteers and project consultants harmless from any and all liability claims, costs, expenses including expenses of investigation and defending against the same in regard thereto.
- C. Blasting may be proposed by the Contractor as a means of excavating rock, but may not be allowed by the District. At least 28 calendar days in advance of any proposed blasting, Contractor shall submit to the District a request for permission to blast that includes a general description of the proposed blasting activities, and the approximate location(s) and volume(s) of rock to be removed by blasting. The request shall be submitted in accordance with Standard Specification Section 01300 for approval by the District. If the request for blasting is not approved by the District, then rock must be removed by means other than blasting. If the request for blasting is approved by the District, then the procedures for blasting shall conform to the requirements described herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Record Drawings and Submittals: STD SPEC 01300.
- B. Earthwork: STD SPEC 02200.
- C. Trenching, Backfilling, and Compacting: STD SPEC 02223.

1.03 REFERENCES

Comply with the applicable rules, regulations and standards established by the Regulatory Agencies, codes and professional societies listed herein, including rules and regulations for storage, transportation, and use of explosives.

- A. Whenever blasting operations are in progress, explosives shall be stored, handled and used as provided in: the Federal Occupational Safety and Health Act of 1970 and the Construction Safety Act of 1969, as amended; Safe Explosives Act, Title XI, Subtitle C of Public Law 107-296, Interim Final Rule; and Organized Crime Control Act of 1970, Title XI, Public Law 91-452, Approved October 15, 1970, as amended; and California Occupational Safety and Health Administration (Cal OSHA) – Division of Mining and Tunneling rules.

- B. Ensure that all explosive deliveries to work sites are done in compliance with recent rules and regulations issued by the Department of Transportation (DOT) and the Transportation Security Administration (TSA) on commercial transportation of explosives pursuant to the mandates of the USA PATRIOT ACT of 2001. Under TSA rules, commercial drivers with hazardous materials endorsement shall undergo a personal background records check, training and testing.
- C. Comply with all the applicable provisions of OSHA of 1970, 29 U.S.C., Section 651 et seq., including safety and health regulations for construction.
- D. U.S. Code of Federal Regulations (CFR)
 - 1. CFR 27, U.S. Department of Justice, Alcohol, Tobacco, Firearms and Explosives Division (ATF). 27 CFR Part 555, Implementation of the Safe Explosives Act, Title XI, Subtitle C of Public Law 107-296; Interim Final Rule.
 - 2. Organized Crime Control Act of 1970, Title XI, Public Law 91-452, Approved October 15, 1970, as amended.
 - 3. CFR 49, Parts 100-177 (DOT RSPA); 301-399 (DOT FHA).
 - 4. Federal Occupational Safety and Health Act of 1970, as amended.
 - 5. Construction Safety Act of 1969, as amended.
- E. State Agencies:
 - 1. California Code of Regulations (CCR)
 - a. Title 8, Chapter 4, Subchapter 20, Tunnel Safety Orders.
 - b. Title 8, General Industry Safety Orders, Subchapter 7, Group 18. Explosives and Pyrotechnics.
- F. Non-regulating Industry Support Organizations:
 - 1. Vibration Subcommittee of the International Society of Explosive Engineers (ISEE), blast monitoring equipment operation standards (1999).
 - 2. IME (Institute of Makers of Explosives) Safety Library Publications (SLPs).

1.04 DEFINITIONS

- A. Peak Particle Velocity (PPV): The maximum of the three ground vibration velocities measured in the vertical, longitudinal and transverse directions. Velocity units are expressed in inches per second (ips).
- B. Air-Overpressure: Temporary changes in ambient air pressure caused by blasting. Air-overpressure is expressed in units of psi or dB or dBL (linear decibel scale). Measurements for blasting are made with microphones having a flat frequency response for over-pressure in the 2 to 200 Hz range. A-weight or C-weight microphones shall not be used for these measurements.

- C. Occupied Building: Structure on or off construction limits that is occupied by humans or livestock.
- D. Residential Building: Includes single and multiple family dwellings, hotels, motels and any other structure containing sleeping quarters.
- E. Scaled Distance: A factor describing relative vibration energy based on distance and charge-per-delay. For ground vibration control and prediction purposes, Scaled Distance (Ds) is obtained by dividing the distance of concern (D) by the square root of the charge-per-delay (W), $D_s = D/(W)^{0.5}$. Minimum scaled distance limits are used to establish charge weights and the units of scaled distance (Ds) are ft-lb-0.5.
- F. Charge-per-Delay: For vibration control, any charges firing within any 8-millisecond time period are considered to have a cumulative effect on vibration and air-overpressure effects. Therefore, the maximum charge-per-delay (W) is the sum of the weight of all charges firing within any 8-millisecond time period. For example, if two 10-lb. Charges fire at 100 ms and one 15-lb charge fires at 105 ms, the maximum charge per delay would be 35 lbs.
- G. Production Holes: Blast holes in the main body of the rock mass being removed by drilling and blasting.
- H. Stemming: Crushed stone, tamped clay or other inert earth material placed in the unloaded collar area of blastholes for the purpose of confining explosive charges and limiting rock movement and air-overpressure (airblast).
- I. Primary Initiation: The method whereby the blaster initiates the blast(s) from a remote and safe location. Primary initiation systems use pneumatic tubing or shock-tubes to convey firing energy from blasters to blast locations.
- J. Sub-drilling: The portion of the blasthole that is drilled below or beyond the desired excavation depth or limit. Subdrilling is generally required to prevent the occurrence of high or tight areas of unfractured rock between blastholes.
- K. Prohibited Persons: Persons prohibited from handling or possessing explosive materials as defined by the seven categories described in Section 555.11 of 27 CFR (ATF Rules).
- L. Delay: A distinct pause of pre-determined time between detonations of single charges or groups of charges.
- M. Blaster-in-Charge or Blasting Supervisor: The single designated and licensed person with complete responsibility and total authority over all decisions involving safe handling, use and site storage of explosives.

1.05 SUBMITTALS

- A. Submit submittal packages in accordance with Standard Specification Section 01300.
- B. Submit Safety Plan for the Use of Explosives that meets all requirements of paragraph 1.06, E.
- C. Submit Blasting Control Plan meeting requirements of paragraph 1.06, J.

- D. Submit after blast reports meeting all requirements of paragraph 1.06, R.
- E. Submit copies of all required blasting permits.

1.06 PERMITS, SAFETY ORDERS AND RECORDS

- A. No drilling or blasting work shall be performed until the Contractor's Safety Plan and Blasting Control Plan for such operations has been submitted and approved by the District's Representative.
- B. Prior to any blasting by the Contractor for the work, obtain the blasting permits required by San Diego County, the State of California, and any applicable agency having jurisdiction. Notify the fire district, local fire department, and utilities in the general blast area. The San Diego Sheriff's Department requires prior notification of any blasting work. The assigned USA Dig Alert construction project notification number, date and blast area location are required on the permit application from the Sheriff's Department. A copy of all permits required shall be submitted to the District's Representative prior to drilling for blasting.
- C. The transporting, handling, storage, and use of explosives shall conform to the requirements specified in the General Industry Safety Orders of the California Division of Industrial Safety; provided, that if the amount of explosives to be transported exceeds 1,000 pounds, a permit to transport shall be secured from the California Highway Patrol; and further provided, that the locations, access, and construction of all explosive storage magazines shall be in accordance with the American Table of Distances for Storage of Explosives and approved by the District's Representative.
- D. Comply with the requirements specified in the General Industry Safety Orders of the California Division of Industrial Safety.
- E. At a minimum of 14 days prior to the commencement of any work involving explosives, including drilling, submit a complete Safety Plan For The Use Of Explosives. A Blasting Safety Plan simply stating: "all regulations will be followed" will not be acceptable. Blasting Safety Plan shall include:
 - 1. A complete list of all authorities having jurisdiction over operations involving the transportation, storage, handling and use of explosives.
 - 2. A printed copy of all applicable federal, state and local regulations governing the use and storage of explosives for this work shall be attached to the Blasting Safety Plan.
 - 3. Copies of all required blasting permits regarding explosive use and storage.
 - 4. Copies of California Blasting Licenses, including proper initiation system and construction blasting endorsements, for all blasters overseeing blasting operations.
 - 5. A list of at least three previous projects of similar character, successfully completed. List shall include contact names and phone numbers of the owner's responsible project manager or engineer.

6. A complete description of the clearing and guarding procedures that will be employed to ensure personnel, staff, visitors, and all other persons are at safe locations during blasting. This information shall include details regarding visible warning signs or flags, audible warning signals, method of determining blast areas (all areas affected by any potentially harmful blast effects), access blocking methods, guard placement and guard release procedures, primary initiation method, and the system by which the blaster-in-charge will communicate with site security guards.
 7. A detailed description of how explosives will be: 1) kept in day-storage-boxes when on site, and 2) transported and used at the various project work areas. Plans shall explain how day-storage magazines and explosive transport vehicles will satisfy all applicable ATF, OSHA, federal, CalOSHA, and San Diego County regulations. This plan shall also indicate how explosives will be inventoried, secured and guarded to prevent theft or unauthorized use.
 8. Include Material Safety Data Sheets (MSDS) and specific details about hazard communication programs for employees.
 9. Equipment that will be used to monitor the approach of lightning storms and in the event of such, evacuation and site security plans.
 10. Detailed contingency plans for handling of misfires caused by cutoffs or other causes.
- F. A minimum of 14 days prior to commencement of any blasting operations, the Contractor shall be responsible for all notification required by his permits, but shall at a minimum notify all residences within 600 feet of any blast at least 24 hours prior to the blast. Contractor shall be responsible for inspection of structures as required by his permits prior to the blast.
- G. A blasting supervisor licensed by the State of California, Division of Industrial Safety, and acceptable to the District's Representative shall be on the site, and in immediate charge of the blasting operations. The license of the supervising blaster(s) shall contain endorsements for construction blasting and use of non-electric initiation systems. Such supervisor shall have no less than three years of continuous experience in controlled blasting on projects of similar character. A written description of the education and experience of this supervisor shall be submitted to the District's Representative. The description shall be specific and include references who are able to verify the details.
- H. The Contractor shall retain the services of an outside Consultant regarding the prediction and control of ground vibration and air-overpressure. Such Consultant shall not be in the employ of the Contractor and shall be subject to the approval of the District's Representative. Consultant's qualifications shall be submitted to the District's Representative in writing as part of the Blasting Control Plan.
- I. Proper criteria and blast effects limitations for any given location and any given structures, residences, utilities, and any other facilities shall be evaluated and determined by the Contractor and by the approved Blasting Consultant.
- J. Submit a Blasting Control Plan to the District's Representative. No blasting operation, including drilling, shall start until the District has reviewed and approved the Blasting Control Plan. Allow not less than two weeks for District review of the Plan. In the event that additional or revised Blasting Control Plans are required, provide at least two weeks for the

review of each additional plan. Approval of the Contractor's Blasting Control Plan or blasting procedures shall not relieve the Contractor of any of his responsibility for assuring the complete safety of his operations or for the successful completion of the work in conformity with the requirements of the Drawings and Standard Specifications. The Blasting Control Plan shall include:

1. Details of controlled blasting techniques. Include plan and vertical section drawings showing hole locations, spacing, diameter and loading details for typical blastholes charges.
 2. All blast plan drawings shall indicate explosive types, amounts, priming method, initiator types, delay periods, and locations, charge firing times, stemming type and quantities, and typical charge weights.
 3. Plans for preventing overbreak or ground shifting that could threaten adjacent buried utilities. Plan shall include calculations showing predicted levels of vibration not exceeding 5.0 in/s at the nearest buried pipe.
 4. Methods of drilling, including equipment descriptions, and hole placement and alignment techniques.
 5. Hole Charging Methods: Primer make-up, placement of charges and inert stemming and method of securing detonators until tie-in.
 6. Initiation system hook-up methods and method of primary initiation.
 7. Methods for preventing spills or losses of explosives, drilling fluids, oil, or any other pollutants to ground during all handling and hole charging operations. Include details of all containment and contingency plans for quickly and effectively cleaning up any spilled materials.
 8. Method of safe and approved disposal of all explosive packaging materials.
 9. Copies of: 1) blasting permits, 2) blasters' licenses, and 3) explosive transporters' commercial driver's licenses with Hazmat endorsements.
 10. The Blasting Control Plan shall indicate the type and method of instrumentation proposed to determine the ground motion particle velocity and air blast overpressure. The description shall include the manufacturer and model of the instrumentation, the source of the instrumentation (rented or owned and by whom). Include copies of calibration certificates issued by the equipment maker that confirm the instruments and transducers have been calibrated within the last 12 months.
- K. A minimum of two portable seismographs shall be available for use on the project at all times. The seismographs shall be capable of producing a permanent record and shall meet the following technical standards.
1. Equipment for on-site and off-site particle velocity and air overpressure monitoring shall be 4-channel (1 overpressure and 3 seismic channels) units capable of digitally storing collected data. Equipment shall be capable of printing ground motion time histories and summaries of peak motion intensities and frequencies. Printed report

records shall also include date, time of recording, operator name, instrument-number and date of last calibration.

2. Instruments shall have a flat frequency response between 2 and 250 Hz for particle velocity and from 2 to 200 Hz for air overpressure.
 3. The digitizing sampling rate for peak particle velocity and air overpressure measurements shall be least 1,024 samples per second.
 4. Seismographs used for off-site compliance monitoring shall be capable of recording overpressure from 88 to 148 dBL, and particle velocity from 0.05 to 5.0 in/sec.
 5. Systems shall be capable of providing printed event reports that include all peak measurements, frequencies and complete waveform plots.
 6. Seismographs shall have adequate memory to digitally record events of the blast-induced motion lasting up to five seconds.
 7. All seismograph software systems shall be capable of saving back-up copies of all event files on floppy or Zip disks in file formats supported by software that can open and interpret stored data. Upon request of the District's Representative the Contractor shall provide a licensed copy of the appropriate software, and all monitoring data files, to the District.
 8. Seismographs shall be provided by:
 - a. White Industrial Seismology Inc. (303) 324-4116,
 - b. Nomis Seismographs. (205) 592-2466,
 - c. GeoSonics/Vibr-Tech. (724) 934-2900, or
 - d. Instantel. (425) 888-5425.
- L. All vibration and air-overpressure measuring equipment shall be used in accordance with the standards established by the Vibration Section of The International Society of Explosives Engineers (ISEE). The following standards shall be applied when measuring blast-induced vibration and air-overpressure.
1. General Guidelines for Vibration and Air-Overpressure Measuring Equipment:
 - a. Only personnel who have successfully completed a proper training course shall operate monitoring equipment.
 - b. The recording units and sensor instruments shall be calibrated. Documenting certificates shall be kept on file and copies shall be provided to District's Representative upon request.
 - c. When employing instruments to operate in auto-trigger-mode, trigger levels shall be set low enough to record blast effects. If expected levels of blast noise or vibration do not exceed minimum trigger levels, the instrument shall be attended by an operator and turned on manually.

- d. The horizontal distance from the seismograph to the blast shall be known to at least two significant digits. For example, a blast within 1000 feet would be nearest tens of feet and a blast within 10,000 feet would be measured to the nearest hundreds of feet. Where the vertical-to-horizontal ground slope ratio exceeds 2.5 to 1, slant distances or true distance shall be used and recorded in the monitoring records.
 - e. When instruments are used in auto-trigger and continuous-recording mode to record the effects of multiple blasts, the time between successive blasts shall be at least one (1) minute and seismographs shall be set to NOT automatically print out event records. These procedures shall ensure that instruments have adequate time to save event data for each blast and reset to monitoring mode before subsequent blasts occur.
 - f. The memory or record capacity of the seismograph shall be sufficient to store the event data from the blast(s) planned during that operating day.
 - g. Instruments shall be set to save full waveform data for all monitored blast and digitally saved event files shall contain this data for use in further analyses if needed.
 - h. In order to prevent false triggering, suspended or freely moving cables shall be secured from movement by the wind or other extraneous sources.
2. Ground Vibration Monitoring:
- a. Sensor Placement
 - 1) Place the sensor on or in the ground on the side of the structure towards the blast. A structure can be a house, pipeline, telephone pole, etc. Measurements on driveways, walkways, and slabs are to be avoided where possible.
 - 2) Place the sensor within 10 feet of the structure or less than 10% of the distance from the blast, whichever is less.
 - 3) Avoid placing velocity transducers in loose or low-density soils. The density of the ground shall be greater than or equal to the sensor density.
 - 4) Place transducers so they are level or nearly level.
 - 5) Orient sensor blocks so the arrow indicating the longitudinal direction is aimed at the blast location.
 - 6) Where access to a structure is not available, place the transducers at the accessible location closest to the structure of concern and in line with the blast.
 - b. Sensor Coupling

- 1) Based on expected acceleration as determined from ISEE Standards (see Table 1 below), use the following methods to couple vibration transducers to the ground or structure to avoid decoupling errors:
 - a) Less than 0.2 g: No burial or attachment is necessary.
 - b) Between 0.2 and 1.0 g: Transducer shall be attached to the ground with a spike or covered with a sand bag.
 - c) Greater than 1.0 g: Transducer shall be buried, bonded to the ground or structure with stiff clay or putty, or some other method that shall achieve firm attachment.

Table 1: Acceleration Intensity (g's) Based on Estimated Particle Velocities and Frequencies

	Maximum Frequency (Hz or cycles-per-second)										
	4	10	15	20	25	30	40	50	100	150	200
PPV (in/s) at Acc. (g) \geq 0.2	3.08	1.23	0.82	0.62	0.49	0.41	0.31	0.25	0.12	0.08	0.06
PPV (in/s) at Acc. (g) \geq 1.0	15.38	6.15	4.10	3.08	2.46	2.05	1.54	1.23	0.62	0.41	0.31

- 2) Employ the following methods for sensor burial:
 - a) Excavate a hole that is no less than three times the height of the sensor (ANSI S2.47-1990, R1997).
 - b) If possible, spike the sensor to the bottom of the hole.
 - c) Firmly compact soil around and over the sensor.
- 3) Employ the following methods for attaching sensors to bedrock or hard structural surfaces:
 - a) Bolt, clamp or use epoxy or putty to firmly couple the sensor to the hard surface.
 - b) The sensor may be attached to the foundation of the structure if it is located within +/- 1-foot of ground level (USBM RI 8969). This method shall only be used if burial, spiking or and bagging is not practical.
- 4) If disturbance of the ground is not possible, cover transducers with sand bags loosely filled with about 10 pounds of sand. When placed over the sensor, the sandbag profile shall be as low and wide as possible with a maximum amount of firm contact with the ground. If possible also spike the sensor to the ground.

c. Programming Considerations for Ground Vibration Monitoring:

- 1) The PPV ground motion trigger-level shall be programmed low enough to trigger the unit from blast vibrations and high enough to minimize the occurrence of false events. The level shall be slightly above the expected background vibrations for the area.
- 2) If PPV is expected to exceed 10 in/s or frequency is expected to exceed 250 Hz, special sensors shall be used to measure blast effects. A digital sampling rate shall be used that provides accurate recordings. The approach shall be described in the Blasting Plan.
- 3) Set the record time for 2 seconds longer than the blast duration plus 1 second for each 1100 feet from the blast.

3. Air-Overpressure Monitoring:

a. Microphone Placement:

- 1) Place the microphone along the side of the structure nearest the blast.
- 2) Cover the microphone with a windscreen and mount it near the velocity transducers.
- 3) The preferred microphone height is 3 feet above the ground or within 1.2 inches of the ground. If other heights are to be used, describe them in the Blasting Plan. (ANSI S12.18-1994, ANSI S12.9-1992/Part2) (USBM RI 8508)
- 4) If possible, the microphone shall not be shielded from the blast by nearby buildings, vehicles or other large barriers. If such shielding cannot be avoided, the horizontal distance between the microphone and shielding object shall be greater than the height of the shielding object above the microphone.
- 5) If microphones are placed too close to a structure, the airblast may reflect from the house surface and record higher amplitudes. Structure response noise may also be recorded. Place the microphone near a corner of the structure in order to minimize reflection of over-pressure energy. (USBM RI 8508).

b. Programming Considerations for Air-Overpressure Monitoring:

- 1) When only an airblast measurement is desired, set the trigger level low enough to trigger the unit from the airblast and high enough to minimize the occurrence of false events. The level shall be slightly above the expected background noise for the area.
- 2) When only recording airblast, set the recording time for at least 2 seconds more than the blast duration. When ground vibrations and air-overpressure measurements are desired on the same record, set the record time for 2 seconds longer than the blast duration plus 1 second for each 1100 feet from the blast.

- M. Design of drilling and blasting patterns, explosive types, and quantities shall be at the Contractor's choice; provided, that non-electric initiation devices shall be used and the ground motion limitations as specified herein are met with respect to explosive detonated per delay period; and provided further, that non-nitroglycerin explosive types are used in wet ground conditions, unless the dynamite is phlegmatized (i.e. PowerDitch 1000).
- N. Approval of the Contractor's Blasting Control Plan shall not relieve the Contractor of any of his responsibility under the Contract for assuring the complete safety of his operation with respect to adjacent improvements so as to not aggravate the existing structural conditions or cause damage, or for the successful completion of the work in conformity with the requirements of the Drawings and Standard Specifications. Such approval shall not operate to waive any of the requirements of the Standard Specifications nor relieve the Contractor of any regulation or permit obligation thereunder.
- O. As production blasting operations progress, the drilling and blasting procedures shall be determined only by satisfactory results achieved. If a drilling and blasting program results in unacceptable results, devise and employ methods which will improve results. The revision may include special methods such as, but not limited to, zone blasting, shorter holes, different delay patterns, reduction in size of individual blasts, smaller diameter blast holes, closer spacing of blast holes, or reduction of explosives as necessary to improve results.
- P. Regardless of the ground motion and air-overpressure limits set forth herein, controlled blasting shall be conducted in a manner which will produce relatively smooth and sound rock faces at the final excavation lines. The type, distribution and quantity of explosive detonated per delay period shall be such that existing rock fractures will neither be opened nor new fractures created outside of the minimum excavation limits. Whenever, in the opinion of the District's Representative or independent Inspector, further blasting is liable to reduce rock stability or damage pipelines or other structures, the Contractor shall cease blasting and continue to excavate the rock by approved mechanical means. Excessive blasting or "overshooting" will not be permitted, and any material outside the authorized cross-section which may be shattered or loosened by blasting shall be removed and replaced with acceptable materials at the Contractor's expense.
- Q. Blasting shall be done only by properly trained workers under the direct supervision of a State-licensed Blasting Supervisor. Blasting shall be done only when proper precautions are taken for the protection of persons, the work, and existing structures. Any damage done to persons, private property, the work, or existing structures shall be the responsibility of the Contractor.
- R. Keep accurate records of each blast. Blasting records shall be available to the District's Representative at all times and shall contain the following data as a minimum:
1. Blast identification by numerical and chronological sequence.
 2. Location (referenced to pipeline stationing), date and time of blast.
 3. Type of material blasted.
 4. Number of holes, burden and spacing.
 5. Diameter and depth of holes.

6. Height or length of stemming.
7. Types of explosives used.
8. Types of caps and delay periods used.
9. Total amount of explosives used.
10. Maximum amount of explosives per delay period of 9 milliseconds or greater.
11. Powder factor (pounds of explosive per cubic yard of material blasted).
12. Method of firing and type of circuit.
13. Weather conditions (including wind direction).
14. Direction and distance to nearest structure or position of concern.
15. Type and method of instrumentation.
16. Location and placement of instruments by plotting numbered locations on scaled maps to within +/- 1 foot where the equipment was placed.
17. Instrumentation records and calculations for determination of ground motion particle velocity or for charge size based on scaled distance.
18. An ongoing log-log plot of both vibration and air blast data. The Contractor or his consultant shall maintain an ongoing log-log plot of both ground vibration and air blast overpressures, and shall submit an updated plot to the District's Representative after each blast, highlighting the newest data.
19. Measures taken to limit air overpressure and fly rock.
20. Any unusual circumstances or occurrences during blast.
21. Name of Contractor.
22. Name, license number and signature of responsible Blasting Supervisor.
23. Summary report of all complaints including complaints regarding blasting-related damage.
24. Method to notify other contractors, personnel on-site of a scheduled blast.
25. Provide a summary report of all complaints, including complaints regarding blast-related damage.
26. Within 24 hours after each blast, Contractor shall submit to the District's Representative a summary report addressing items 1 through 25 above for compilation in a three-ring binder and have the Contractor's current blast reports so compiled and available for immediate review by authorities having jurisdiction, including the District and the District's Representative.

PART 2 - MATERIALS

Furnish materials and equipment required for blasting operations and monitoring. Material usage, including transportation and storage, shall conform to all applicable regulatory agency and permit requirements.

PART 3 - EXECUTION

3.01 BLASTING HOURS

Blast only between the hours of 7 a.m. and 5 p.m. during any workday, Monday through Friday, unless special circumstances warrant another time or day and special approval is granted in writing by the District and the agency having jurisdiction. For any blasting within 1,200 feet of a residence or commercial structure, blast only between the hours of 9:00 a.m. and 5:00 p.m.

3.02 BLASTING PROCEDURES

- A. Control fly rock and debris to prevent damage to persons, structures, existing improvements, or vegetation. Clean the blasting site of debris associated with the blasting operation at the end of each working day. Use blasting mats in developed areas. Equipment used for drilling of holes shall have a positive means of dust control.
- B. Do not perform blasting closer than 8 feet to existing water, gas, sewer, or other buried utilities.
- C. Use controlled blasting techniques to keep the air blast overpressure, vibrations, and noise within the limits herein specified. Use controlled blasting techniques to minimize overbreak or fracturing of rock beyond the designated excavation boundaries. Excessive blasting will not be permitted. Material outside the authorized cross-section, which may be shattered or loosened because of blasting, shall be removed at the Contractor's expense and the area repaired to the satisfaction of the District's Representative. Discontinue any method of blasting which leads to overshooting, is hazardous in any way to persons, or destructive to property or habitat.
- D. Notify the District's Representative at least seven workdays before all blasting and if blasting will occur within 1200 feet of a residence or commercial structure or utility.
- E. Fifteen minutes prior to each blast, sound an audible siren or horn capable of being heard within one-half mile of the blasting site.
- F. Blasting operations may be suspended by the District's Representative for any one or more of the following:
 - 1. Safety precautions are inadequate.
 - 2. Ground motion vibration levels exceed specified limits of particle velocity or frequency.
 - 3. Existing structural conditions are aggravated or adjacent improvements are damaged as a result of blasting.

4. Blasting methods adversely impact the stability of intact rock outside the prescribed limits of excavation.
5. Skilled operators and/or licensed foreman are not present.

Blasting operations shall not resume until modifications have been made to correct the conditions that resulted in the suspension.

- G. Repair or replace any damage caused by blasting. Repair or replace any damage resulting from possession or use of explosives for the Work.

3.03 MAXIMUM PARTICLE VELOCITIES

Monitor vibrations by measuring the peak particle velocity in the vicinity of work. Peak particle velocity is defined as a maximum of the three velocity components, measured in three mutually perpendicular directions at any point by an instrument. The peak particle velocity of any individual components as measured on or at the locations as specified in the submitted vibration and frequency's monitoring plan, for all blasting, or other vibration-inducing operations, shall not exceed the following levels:

Point of Concern	Maximum Allowable Peak Particle Velocity, PPV (in/sec)	Frequency Range (Hz)
Surface Structures	0.5	2-250
Buried Pipes or Utility Cables	5.0	2-250

3.04 AIR-OVERPRESSURE

Blast induced air-overpressure at the property or right of way lines or structures within 300 feet of the blast area shall not exceed 0.03 psi (140 dBL). Air-overpressure at residential or other occupied structures shall not exceed 0.012 psi (133 dBL).

3.05 CONSEQUENCES OF BLASTING SPECIFICATION VIOLATIONS

Any violations of Section 3.03 Maximum Particle Velocities or Section 3.04 Air-Overpressure shall obligate the Contractor to pay for all costs to the District caused by the violation, including by not limited to: District staff and consultant's time and expenses that are required, as solely determined by the District's Representative, to investigate such violations. This includes, but is not limited to, reviews of resubmittals by the Contractor, analyses of subsequent Blasting Control Plans submitted by the Contractor, meetings with the Contractor and his Blasting Consultant, and investigations into the condition of existing pipeline, wells, structures, etc. These costs shall be actual cost to the District without additional mark-up, and the District's decision to charge the contractor shall be final.

END OF SECTION