28-10. Checklists and Forms.
Not Applicable.

Chapter 29
Blasting

This chapter applies to blasting activities performed by DoD civilians or by contractors under direction of USACE for work involving commercial explosives on Civil and Military construction projects.

29-1. References.

a. Alcohol Tobacco and Firearms (ATF) P 5400.7, Publication of Federal Explosives Laws and Regulations (https://www.atf.gov/explosives/docs/report/publication-federal-explosives-laws-and-regulations-atf-p-54007) (29-1.a)

b. ANSI/ASSP A10.7, Safety and Health Requirements for Construction and Demolition Use, Storage, Handling and Site Movement of Commercial Explosives and Blasting Agents (https://webstore.ansi.org/) (29-1.b)

c. DA Pam 385-64, Ammunition and Explosives Safety Standards (https://armypubs.army.mil/ProductMaps/PubForm/PAM.aspx) (29-1.c)

d. Defense Explosives Safety Regulation 6055.09 (https://denix.osd.mil/) (29-1.d)

e. Institute of Makers of Explosives (IME) SLP-14, Handbook for the Transportation and Distribution of Explosive Materials (https://www.ime.org/products/category/safety_library_publications_slps) (29-1.e)

f. IME SLP-3, Suggested Code of Regulations for the Manufacture, Transportation, Storage, Sale, Possession and Use of Explosive Materials (https://www.ime.org/products/category/safety_library_publications_slps) (29-1.f)

g. IME SLP-20, Safety Guide for the Prevention of Radio Frequency Radiation Hazards in the Use of Commercial Electric Detonators (Blasting Caps) (https://www.ime.org/products/category/safety_library_publications_slps) (29-1.g)

h. NFPA 495, Explosive Materials Code (https://www.nfpa.org/Codes-and-Standards) (29-1.h)

i. UFGS 31 23 00.00, Tunnel Excavation – Blasting (https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-31-23-00-00) (29-1.i)

j. 27 CFR 555, Commerce in Explosives (https://www.govinfo.gov/content/pkg/CFR-2020-title27-vol3/pdf/CFR-2020-title27-vol3-part555.pdf) (29-1.j)

k. 29 CFR 1910.109, Explosives and Blasting Agents (https://www.govinfo.gov/content/pkg/CFR-2020-title29-vol5/pdf/CFR-2020-title29-vol5-sec1910-109.pdf) (29-1.k)

l. 29 CFR 1926 Subpart U, Blasting and the Use of Explosives (https://www.govinfo.gov/content/pkg/CFR-2020-title29-vol8/pdf/CFR-2020-title29-vol8-part1926-subpartU.pdf) (29-1.l)

m. 49 CFR 177.835, Class 1 Materials (https://www.govinfo.gov/content/pkg/CFR-2020-title49-vol2/pdf/CFR-2020-title49-vol2-sec177-835.pdf) (29-1.m)

29-2. Definitions.

a. Attendant. An authorized individual who has the explosives or the use of explosives within their field of vision and with the ability to respond appropriately. (29-2.a)

b. Blast Area. The area of a blast within the influence of flying rock and ejecta, gases, and concussion that may cause injury to persons or property. (29-2.b)

c. Blast Site. The area where explosive material is handled during the loading of blastholes, including 50 feet (15.2m) in all directions from the perimeter formed by loaded holes. A minimum of 30 feet (9.1 m) may replace the 50 feet (15.2m) requirement if the perimeter of loaded holes is marked and separated from non-blast site areas by a barrier. The 50 feet (15.2 m) or 30 feet (9.1 m) distance requirements, as applicable, apply in all directions along the full depth of the blasthole. In underground mines, at least 15 feet (4.6 m) of a solid rib, pillar, or broken rock can be substituted for the 50 feet (15.2 m) distance. (29-2.c)

d. Blaster. A qualified individual who assists with the design, loading, and firing of explosives. (29-2.d)

e. Blaster-in-Charge. The blaster who is in charge of and responsible for the design, loading, and firing of explosives at a specific jobsite. (29-2.e)

f. Bootlegs. The part of a drilled blasthole that remains when the force of the explosion does not break the rock completely to the bottom of the hole. (29-2.f)

g. Electric Detonator. A detonator designed for, and capable of, initiation by means of an electric current. (29-2.g)

h. Electronic Detonator. A detonator that utilizes stored electrical energy as a means of powering an electronic timing delay element/module and that provides initiation energy for firing the base charge. (29-2.h)

i. Flyrock. Material propelled from the blast area by the force of an explosion. (29-2.i)

j. Qualified Person (QP). See paragraphs 1-2 or 2-2, as applicable. (29-2.j)

k. Underground Blasting. The controlled use of explosives and other methods in underground construction, shafts, and caissons. (29-2.k)

29-3. Personnel Required Qualification/Training.

a. General. (29-3.a)

(1) The personnel that are involved in blasting operations must be trained in the following:

(a) The requirements for handling, transportation, and storage of explosives.

(b) Employee training programs and certifications as required by state or company.

(c) Types of explosives.

(d) Schedule of activities and loading procedures.

(e) Detailed blasting schedule.

(f) Explosives transportation route.

(g) Safety signals, methods, and locations.

(h) Blast area clearance.

(i) Methods for securing the site.

(2) All personnel working with explosives must be in good physical condition to perform the necessary tasks. Personnel must be able to understand and give written and verbal orders.

(3) All persons involved in the transportation, storage, handling, or use of explosives or blasting agents must be at least 21 years old. If allowed by applicable national, state, or local regulations, workers at least 18 years old only handling explosive materials must be supervised by a licensed blaster.

(4) All persons involved in the transportation, storage, handling, or use of explosives or blasting agents must be trained and able to read and understand instructions in English.

(5) All individuals handling explosive materials must be trained in the following areas:

(a) The physical and health hazards of the explosive materials.

(b) The operational activities involved in use of the explosives.

(c) Plans for emergency procedures in case of a fire or explosion.

b. Transporting Explosive Materials. (29-3.b)

(1) Operators of vehicles transporting explosive materials must be physically fit, careful, reliable, able to read and understand safety instructions (see para 18-3).

(2) Only the authorized driver and helper are permitted to ride on any conveyance transporting explosive materials or detonators.

(3) The driver must be trained in the use of a portable extinguisher (see chapter 9).

(4) Drivers must be trained in the DOT or DoD applicable standards.

c. Blasters. Blasters must be trained and certified for the type of blasting performed onsite. (29-3.c)

(1) Blasters must be qualified, by reason of training, knowledge, or experience, in the field of transporting, storing, handling, and use of explosives. The must have a working knowledge of state and local laws and regulations which pertain to explosives.

(2) Blasters must be licensed, as applicable, according to state and local regulations.

(3) Blasters must furnish satisfactory evidence of competency in handling explosives and performing in a safe manner the type of blasting that will be required.

(4) Blasters must be knowledgeable about the use of each type of explosive material and blasting circuit that is being employed.

d. Blaster-in-Charge. The Blaster-in-Charge must be licensed by the AHJ. When working in a jurisdiction without an applicable licensing program managed by the AHJ, the Blaster-in-Charge must be a CP. See paragraphs 1-2 or 2-2, as applicable, for the definition of a CP. (29-3.d)

e. Attendants. Attendants must be: (29-3.e)

(1) Aware of the class of explosive material in the motor vehicle and of its inherent dangers.

(2) Familiar with the measures and procedures to be followed to protect the public from inherent dangers.

(3) Familiar with the vehicle they are assigned to attend.

(4) Trained, authorized, and enabled to move the vehicle when required.

(5) Awake and alert and not engaged in other duties or activities such as phone conversations, texting, listening to music, or engaged in other electronic or internet activities that divert the Attendant's attention from the vehicle and explosives.

29-4. Roles and Responsibilities.

a. Blaster. (29-4.a)

(1) For electric and electronic detonators, Blasters must test all blasting circuits using only blasting galvanometers or other instruments that have been specifically designed for this purpose.

(2) Keep an accurate, up-to-date record of explosives, blasting agents, and blasting supplies used in each blast.

b. Blaster-in-Charge. The Blaster-in-Charge is responsible for conducting the following: (29-4.b)

(1) Removing electric circuits.

(2) Ensuring safe illumination of the blast site.

(3) Loading shot holes.

(4) Connecting up blasting circuits.

(5) Vacating the blast site.

(6) Safe disposition of personnel during blasting.

(7) Detonating the round.

(8) Conduct a thorough inspection of the blast components after the blast connection hookup of the detonators according to the Master Blasting Plan.

(9) Ensure that proper shunting and/or connection practices are followed and that the blasting leads are not connected to the power source, blasting machine or other initiating device until the blast is ready to be fired.

(10) Inspecting the blast site post detonation to verify that all changes have detonated, determine it is safe, and give the all-clear signal.

(11) Develop a procedure for resolving the misfire and communicate that plan to essential personnel before work begins. The procedure will be detailed in the Master Blasting Plan.

(12) Oversee transportation, handling, storage, and use of explosives, blasting agents, and blasting equipment, to include supervising Blasters, directing and supervising all loading and firing, and supervising drilling performed to neutralize misfires. Ensure all personnel are physically fit and able to perform task as necessary.

c. Explosive Workers/Handlers. All persons involved in the transportation, storage, handling, or use of explosives or blasting agents must not be under the influence of intoxicants, narcotics, or other substances that reduce their ability to function normally. (29-4.c)

29-5. Inspection Requirements.

a. Blasting Machines. Inspect blasting machines according to the manufacturer's instructions. (29-5.a)

b. All loaded holes or charges must be checked and located, and all detonating cord connections must be inspected before firing the blast. (29-5.b)

c. Blaster. Inspect the blaster to determine that all charges have been exploded. An assessment of the blast site must include identification of components that may safely be inspected and a determination of the appropriate actions according to the Master Blasting Plan. (29-5.c)

d. Motor Vehicle. Motor vehicles used for transporting explosive materials must be inspected each day before use to determine that it is in proper condition for safe transportation. The inspection must verify that: (29-5.d)

(1) Fire extinguishers are charged and ready for use.

(2) All electric wiring is protected and fastened to prevent short-circuiting.

(3) Chassis, motor, pan, and underside of body are reasonably clean and free of excess oil and grease.

(4) Fuel tanks, feed lines, and crossover lines are secure and have no leaks.

(5) Brakes, lights (including back-up lights), alarms, horns, windshield wipers, defrosters, and steering apparatus are functioning properly.

(6) Tires are properly inflated and are in serviceable condition, and free of defects and mismatching, which might cause overheating or failure.

(7) Safety signs/placards are displayed.

e. Magazine Inventory. Inspect magazine inventories to verify contents and quantities including: (29-5.e)

(1) Date of acquisition.

(2) Name/Brand of manufacturer.

(3) Manufacturers marks/identification.

(4) Quantity.

(5) Description.

(6) Name, address, and license number of the deliverer.

(7) Daily transactions with documentation available upon request.

(8) That the magazine was inspected at least every seven days with documentation available upon request.

f. Magazines. Inspect magazines to verify: (29-5.f)

(1) Magazine and locks meet the requirements of ATF P 5400.7.

(2) All access roads to explosive material storage facilities are posted with a sign stating not to fight explosive fires, that explosives are stored onsite, and a contact number.

(3) All signs are located so that a bullet passing through the sign will not strike a magazine.

(4) Magazines are only used to store explosive materials and other blasting materials.

(5) That the total net explosive weight stored does not exceed the quantity for which the magazine is suited.

(6) The magazine is properly grounded.

(7) The local fire department has been notified of the type, magazine capacity, and location of each site where explosive materials are stored.

g. Blasting Records. Inspect blasting records to verify that they contain: (29-5.g)

(1) Names of the Blaster-in-Charge and individual crew members.

(2) Names of all personnel present at the blast site during loading.

(3) The exact blast site location and weather conditions.

(4) Individual blast-specific information to include loading of holes, geologic data such as changes of rock conditions observed in drilling bore holes, and vibration compliance data.

(5) A sketch of the blast site showing the locations and number of detonators and primers and pounds of explosive.

(6) Time of the blast.

(7) The Blaster-in-Charge's signature.

29-6. Activity Hazard Analysis (AHA) Requirements.
Develop AHAs according to paragraphs 1-6 or 2-6, as applicable. The AHA must provide provisions for the blasting activities performed to include transportation and handling.

29-7. Minimum Plan Requirements.

a. Explosives Site Safety Plan (ESSP). An ESSP is required when explosives are stored onsite. The plan must be developed according to ANSI/ASSP A10.7 and applicable federal and state and regulations prior to placing explosives onsite or starting explosives-related operations. If the site is a military installation, the ESSP must be approved by DoD Explosives Safety Board. (29-7.a)

b. Master Blasting Plan. Develop a Master Blasting Plan prior to the placement of explosives onsite or the start of any explosives related operations. Submit Master Blasting Plan to the USACE supervisor for approval by the blasting subject matter expert (SME), or to the KO or COR for acceptance by the blasting SME. As a minimum, it must contain the following: (29-7.b)

(1) The names, qualifications, certifications, and responsibilities of personnel involved with explosives, see paragraph 29-3. Include at a minimum the Blaster-in-Charge.

(2) The contractor's requirements for handling, transporting, and storing explosives.

(3) Employee training programs and certifications.

(4) Types of explosives.

(5) Schedule of activities and loading procedures.

(6) Detailed blasting schedule.

(7) Explosives transportation route.

(8) Safety signals methods and locations.

(9) Blast area clearance.

(10) Example wiring diagram.

(11) Methods for securing the site.

(12) Seismograph, vibration, and damage control.

(13) Test shots, post-blast inspection and misfire procedures.

(14) Provisions for disposal of explosives, blasting agents, unused and associated material.

(15) Post-blast ventilation requirements.

(16) Public relations requirements before and after blasting (for example, community communication and protection of structures and personnel).

(17) Misfire procedures.

(18) The safe setback distance for personnel during blasting and misfire remediation. The distance must be based on the distance of physical separation and/or engineered or natural barriers.

(19) Lightning and static hazard procedure for the project specifications will detail what is required for each on a project.

c. Vibration Monitoring Plan. Prepare a written plan for monitoring vibrations and air blast prior to initiation of controlled blasting operations for USACE supervisor for approval or KO or COR for acceptance. The plan, at a minimum, must include:

(1) Structures requiring a pre-blast survey.

(2) Locations for monitoring instrumentation.

(3) Types and number of instruments.

(4) Example reports for displaying monitoring results.

29-8. General Requirements.

a. General. (29-8.a)

(1) Prerequisites. Obtain written permission from the USACE supervisor/KO or COR before bringing explosive materials onto the jobsite. Periodic replenishment of previously approved supplies does not require re-approval.

(2) A Blaster-in-Charge must oversee the transporting, handling, storing, and use of explosives, blasting agents, and blasting equipment. Blasters must work under the supervision of the Blaster-in-Charge.

(3) Provide warning signs at points of access to blasting area.

(4) Discontinue operations involving the handling or use of explosive materials and move personnel to a safe area during the approach or progress of a thunderstorm or dust storm. Establish and implement controls to prevent accidental discharge of electric blasting caps from extraneous electricity.

(5) Do not perform blasting operations near overhead power lines, communications lines, utility services, or other structures until the operators and/or owners have been notified and measures for safe control have been taken.

(6) The Blaster-in-Charge will direct and supervise all loading and firing.

(7) Use a positive system to detect and measure the probability of lightning or massive static electrical discharges.

(8) Follow procedures in the Master Blasting Plan when lightning or static hazard is present or when a static detection device indicates a potential hazard.

(9) Use an electric blasting machine or a properly designed power source to initiate any blasts fired by electric detonators.

(a) Use a blasting machine or starting device according to the manufacturer's instructions to initiate any blasts fired by non-electric detonators.

(b) Use an approved non-electrical initiation system according to the manufacturer's instructions and system requirements when blasting near radar or radio transmission facilities or near electrical energy sources where testing has shown that RF energy or stray electrical current may present a hazard from electrical blasting.

(c) When electric detonators are used, short circuit (shunt) the leg wires until connected into the circuit for firing.

(10) Initiate detonating cord by non-electric detonator (cap and fuse), electric detonator, shock tube detonator or gas-initiated detonator according to the manufacturer's instructions.

(11) Use delayed electric detonators, non-electric delay detonators, detonating cord connectors, or electronic detonators for all delayed blasts according to the manufacturer's instructions.

(12) After firing the shot, immediately disconnect the cable between the switches and lock both switches in the open position.

(13) The Blaster must keep possession of the keys to the blaster at all times.

(14) Use appropriately sized insulated solid core wires in good condition for all lines.

(15) Provide sufficient firing line to permit the blaster to be located at a safe distance from the blast. Consider the following factors when determining the safe distance of the blast area:

(a) Geology or material to be blasted.

(b) Blast pattern.

(c) Burden, depth, diameter, and angle of the holes.

(d) Previous blasting experience at the site.

(e) Delay system, powder factor, and pounds per delay.

(f) Type and amount of explosive material.

(g) Type and amount of stemming.

(16) Do not operate mechanized equipment (including drills) within 50 feet (15.2 m) of a loaded hole, unless blasting mats or back covering are placed.

(17) The use of black powder is prohibited.

(18) All refuse from explosive loading, such as empty boxes, paper, and fiber packing, may not be reused for any purpose. Obliterate all explosive markings and dispose of the refuse at an approved location or make it unusable by a method approved by the USACE supervisor or accepted by the KO or COR.

b. Blasting Machines. (29-8.b)

(1) Operate, maintain, test (prior to use and periodically thereafter), and inspect blasting machines according to the manufacturer's instructions.

(2) Secure blasting machines so they are accessible only to the Blaster. Only the Blaster is permitted to connect the leading wire to the machine.

(3) Do not connect any firing line to a blasting machine or other power source until the shot is to be fired. The firing line must be checked with an approved blasting instrument before being connected to the blasting machine or other power source.

c. Blasting Power Supply. When energy for blasting is taken from power circuits, the voltage must not exceed 550 volts. (29-8.c)

(1) The blasting switch must be an ungrounded UL (or other NRTL) listed, enclosed, and externally operated double-pole double-throw switch that will shunt the firing lines when locked in the open position.

(2) Install a grounded switch between the blasting switch and the power circuit at a distance not less than 15 feet (4.6 m) from the blasting switch.

(3) Provide a lightning gap of at least 15 feet (4.6 m) between the two switches. Use cable, plug, and receptacle to make the gap connection.

d. Storage of Explosives. (29-8.d)

(1) When on a DoD installation, store explosives according to the requirements of the ESSP.

(2) When on a non-DoD installation, store explosives according to the requirements of ATF P 5400.7.

(3) Keep two copies of an accurate running inventory of all explosives and blasting agents stored at the project site. Keep one at the magazine and one in a facility which is at least 50 feet (15.2 m) from the magazine.

e. Security of Explosives. (29-8.e)

(1) Guard magazine areas to control access to the explosives and to ensure no one tampers with explosives during non-working hours.

(2) Do not abandon explosive materials.

(3) If explosives are lost or stolen, immediately (within 24 hours) report the circumstances and details of incident to the nearest ATF office, the local law enforcement authorities, and the USACE supervisor/KO or COR.

f. Transportation of Explosive Materials. (29-8.f)

(1) Comply with the following federal requirements and any applicable state requirements when transporting explosive materials by the following modes.

(a) Comply with the DOT requirements when transporting over public highways.

(b) Comply with the USCG requirements when transporting by vessel.

(c) Comply with the FAA requirements when transporting by aircraft.

(2) Do not load vehicles used for transportation of explosive materials beyond their rated capacity. Secure the explosive materials to prevent shifting of load or dislodgment from the vehicle. When explosive materials are transported by a vehicle with an open body, securely mount a magazine or closed container on the bed to contain the cargo.

(3) Display placards, lettering, and/or numbering required by DOT on all vehicles transporting explosive materials.

(4) Do not transport explosive materials and blasting supplies with other materials or cargoes. Do not transport detonators in the vehicle or conveyance with other explosives performed according to 49 CFR 177.835.

(5) Vehicles used in the transportation of explosives must be substantially constructed, in good repair, and must have tight beds to prevent explosives from falling from the vehicle. The ends and sides of vehicles must be high enough to prevent containers from falling off.

(6) Do not carry any spark-producing tools, carbides, oils, matches, firearms, electric storage batteries, flammable substances, acids, or oxidizing or corrosive compounds in the bed or body of any vehicle transporting explosive materials.

(7) Equip vehicles transporting explosive materials with two fire extinguishers having a rating of 4A-40B:C per NFPA 495 and IME SLP-3 and place them at strategic spots (see para 9-7).

(a) The extinguishers must be of a type listed by a NRTL and must be ready for use.

(b) Train the driver on how to use the fire extinguisher (see para 29-3.b).

(8) Do not drive a vehicle containing explosive materials into a garage or repair shop, park it in congested areas, or store it for any time in a public garage or similar building.

(9) Operate vehicles transporting explosive materials with extreme care. Drivers must stop at approaches to all railroad crossings and main highways, and the vehicles may not proceed until it is known that the way is clear.

(10) Refuel vehicles loaded with explosives according to DA Pam 385-64.

(11) Persons employed in the transportation, handling, or other use of explosive materials must not smoke or carry on their persons or in the vehicle any matches, firearms, ammunition, or flame-producing devices.

(12) Make provision for safe transfer of explosive materials to magazine vessels (for example, substantial ramps or walkways free of tripping hazards).

(13) Do not leave vehicles transporting explosive materials unattended.

(14) Notify the hoist operator before explosive materials are transported in a shaft conveyance.

(15) For underground work, hoist, lower, or convey explosive materials in a powder car. Do not transport any other materials, supplies, or equipment in the same conveyance at the same time.

(16) Do not permit any persons to ride in any shaft conveyance transporting explosive materials. Load and unload only when the conveyance is stationary.

(17) Do not transport explosive materials on any locomotive. At least two car lengths must separate the locomotive from the powder car.

(18) Do not transport explosive materials on a man haul trip.

(19) Pull, do not push, the car or conveyance containing explosive materials whenever possible.

(20) Place a reflectorized sign on every powder car or conveyance. The sign must be reflectorized with a sharply contrasting background and the word "EXPLOSIVES" in letters not less than 4 inches (10.2 cm) in height on each side.

g. Handling of Explosive Materials. (29-8.g)

(1) Do not smoke or use open lights or fire of any kind within 50 feet (15.2 m) of any area where explosives are being handled. Ignition sources, except necessary means to light fuses or fire electric detonators, are not permitted in an area containing loaded holes.

(2) Use only non-sparking tools or instruments to open containers of explosive materials. Metal cutters may be used for opening fiberboard boxes, paper bags or plastic tubes.

(3) Remove explosive materials from containers only as they are needed for immediate use.

(4) Separate explosive materials and detonators or primers must and take to the blasting area in original containers, Type 3 magazines, or containers according to 49 CFR 177.835.

(5) Do not make up primers in advance or in excess of the immediate need for a hole being loaded.

(6) Do not make up primers in or near magazines or excessive quantities of explosive materials.

(7) After loading, remove all excess explosive materials and detonators to a safe location or return them at once to the storage magazines. Follow the same rules as when conveying them to the blasting area.

(8) Do not take more explosive materials to an underground loading area than the amount estimated to be necessary for the blast.

(9) Take detonators into pressure working chambers separately from the other explosive materials.

h. Underground Blasting. (29-8.h)

(1) Develop and submit a Master Blasting Plan for underground blasting (see para 29-7.b).

(2) Explosives.

(a) Only use Fume Class 1 explosives in tunnel blasting. Fume Class 2 or Fume Class 3 explosives may be used only if adequate ventilation is provided. Only a qualified/licensed Blaster will handle explosives.

(b) It is prohibited to store explosives, blasting agents, or detonators in tunnels or underground work areas.

(3) Blasting Circuits.

(a) Utilize a power blasting switch system for all underground blasts.

(b) Install sectioning switches, or equivalent, in the firing line at 500 feet (152.4 m) intervals.

(4) Loading.

(a) Disconnect all power, water, and air lines from the loading jumbo prior to loading. Relocate existing power lines, including lighting circuits, a minimum of 50 feet (15.2 m) from the loading jumbo.

(b) Illuminate the loading area to a minimum of 10 foot-candle (108 Lux), when measured 50 feet (15.2 m) from the face. If additional illumination is needed, equip the loading crew with head lamps approved by a NRTL for the environment where they will be used.

(c) Equipment used for pneumatic placement of non-cap-sensitive blasting agents must be designed for that purpose and must be grounded while in use.

(5) Blasting.

(a) A QP must inspect the underground supports in the blast area after each blast. Secure deficient supports before resuming work. Inspect the rock surfaces and scale the crown and walls to remove loosened pieces. If required, provide shoring, bracing, rock bolts, shotcrete, or chain-link fabric, before mucking. Prior to drilling the next round, test the rock bolts located within 100 feet (30.5 m) of the previous blast.

(b) Wet down the muck pile prior to mucking and keep it wet during mucking operations.

i. Electromagnetic Radiation. (29-8.i)

(1) Do not perform blasting operations or store electric detonators in the vicinity of operating RF transmitters or other RF producing devices, except where the clearances according to IME SLP-20 can be maintained.

(2) Use an approved non-electric initiation system when performing blasting operations according to the manufacturer's instructions and system requirements.

j. Vibration and Damage Control. (29-8.j)

(1) Carefully plan, with full consideration of all forces and conditions involved, blasting operations in or adjacent to cofferdams, piers, underwater structures, buildings, structures, or other facilities.

(2) Establish a written plan for monitoring the operations prior to initiating vibration-controlled blasting operations (see para 29-7.c).

(3) Notify owners, occupants, and the public of the nature of blasting operations to be undertaken and controls that will be used as required by state and local ordinance.

(4) Where vibration damage may occur, limit the energy ratios and peak particle velocities to the levels set by the states or included in the NFPA 495 requirements, whichever is more stringent. An exception may be granted when approved by the USACE supervisor or accepted by the KO or COR; if an approved engineering analysis demonstrates that the proposed vibration exceedance will not cause damage and is safe. Suspend blasting when any recording exceeds either the energy ratio or peak particle velocity limits. Immediately notify the local SOHO, Blasting SME, USACE supervisor, KO or COR, and contractor designated authority (if applicable) of the exceedance and do not resume blasting until the cause has been determined and corrective measures taken.

(5) Where required by state regulations, determine scaled distances before each shot and included in the records. Do not exceed the scaled distances limitations set by the state.

(6) Do not exceed 133 dB (0.013 psi) air blast pressure on structures unless an engineering analysis, approved by the USACE supervisor or accepted by the KO or COR, demonstrates that the proposed air blast exceedance will not cause damage and is safe.

(7) A QP must monitor, record, and interpret the vibrations. Furnish a copy of records and interpretations to the USACE supervisor/KO or COR.

(8) Use vibration and/or air blast measuring equipment specifically designed and manufactured such purpose.

(9) Use appropriate blast holes patterns, detonation systems, and stemming to prevent venting of blasts and to minimize air blast and noise levels produced by blasting operations.

k. Drilling and Loading. (29-8.k)

(1) All drill holes must be large enough to freely allow for the insertion of the explosives.

(2) Do not drill in an area already blasted until remaining "bootlegs" are examined for unexploded charges and the total area has been examined to make sure that there are no unexploded charges remain.

(a) Never insert a drill, pick, or bar into bootlegs even if examination fails to disclose explosives.

(b) Do not drill holes where there is a danger of intersecting an undetonated hole, such as in an area where misfires have occurred.

(c) The Blaster-in-Charge must supervise drilling performed to neutralize misfires. The Blaster-in-Charge must be familiar with the conditions under which the misfired holes were drilled, loaded, primed, and initiated and with the drilling equipment capabilities that will be used during the neutralization.

(3) Do not conduct drilling and loading operations in the same area. Separate drilling from loaded holes by at least the depth of the loaded hole, but in no case less than 50 feet (15.2 m).

(4) Do not deepen drill holes that have contained explosives or blasting agents.

(5) Do not drill where a loaded hole might be disturbed or intersected.

(6) See chapter 18 for earth drilling requirements.

(7) Keep the blast site free of any equipment, operations, or persons not essential to loading. Do not permit vehicle traffic over loaded holes. Guard or barricade the blast site and post with danger signs to restrict unauthorized entry.

(8) Load only those holes that will be fired in the next round of blasting. After loading, immediately return all remaining explosive materials and detonators to an authorized magazine. Do not leave explosive materials or loaded holes unattended at the blast site at any time.

(9) Do not load sprung or jet-pierced holes until it is established that the hole has cooled sufficiently to safely load.

(10) Do not load or use explosive underground in the presence of combustible gases or combustible dusts unless a CP certifies in writing that the conditions of use

have been thoroughly identified and are safe. The CP must be qualified by a thorough knowledge of the factors to be evaluated or have been given written permission by the AHJ.

(11) Do not make-up primers in advance. Prime only the cartridges that will be used in the next round of blasting.

(12) Do not insert detonators in explosive materials that do not have a cap well without first making a hole in the cartridge with a non-sparking punch of proper size, or the appropriate pointed handle of a cap crimper.

(13) Seat cartridges only by even steady pressure.

(14) Tamp with wood rods having no exposed metal parts. Non-sparking metal connectors may be used for joint poles. A plastic tamping pole, approved by the USACE supervisor or accepted by the KO or COR, may also be used.

(15) Springing (that is, enlarging the bottom of a blasthole by firing a relatively small charge of explosive material) boreholes is prohibited.

(16) Use of Detonating Cord.

(a) Handle and use detonating cord with the same respect and care given other explosives, careful not to damage or sever cord during and after loading and hooking-up.

(b) When using a detonating cord down line and after the primer is loaded in the hole, cut the detonating cord from the supply reel before loading the rest of the charge.

(c) Detonating cord must be connected according to manufacturer's recommendation. Only use knot or other cord-to-cord connections with detonating cord when the explosive core is dry.

(d) All detonating cord trunk lines and branch lines must be free of loops, sharp kinks, or angles that direct the cord back toward the oncoming line of detonation.

(e) When connecting a detonator to detonating cord, tape or otherwise secure attach the detonators along the side of the detonating cord, with the end of the detonator containing the explosive charge pointing in the direction in which the detonation is to proceed.

(f) Do not bring detonators for firing the trunk line into the loading area nor attach them to the detonating cord until everything else is ready for the blast.

(17) The Blaster must keep an accurate, up-to-date record of explosives, blasting agents, and blasting supplies used in each blast.

(18) Stem loaded holes to the collar with non-combustible material.

(19) Where blasting may cause injury or damage by flying rock or debris, cover all charges with blasting mats or back cover them before firing. Where mats are used, take care to protect blasting lines.

(a) If flyrock leaves the blast area, cease all blasting until a report is filed by a QP. The report must explain the cause of the flyrock and the methods that will be employed on all subsequent blasts to reduce the throw of flyrock.

(b) If flyrock leaves the work site, cease all blasting operations until a QP reviews the blast site and determines the cause and solution to the flyrock program. Before blasting proceeds, submit a written report to the USACE supervisor for approval or to the KO or COR for approval.

l. Wiring. Wire electric initiation systems according to the Master Blasting Plan and the manufacturer's recommendations. (29-8.l)

m. Firing. (29-8.m)

(1) Prior to firing each shot, warn all persons in the blast area of the blast and order to a safe distance from the blast site. Do not fire blasts until it is certain that every person has retreated to a safe distance and no one remains in a dangerous location.

(2) Prior to firing each shot, a flag person must be posted at all access points of the blast area to prevent access.

(3) Prior to firing each shot, drill boats and other vessels must be moved to a safe distance from the blast area.

(a) Prior to and while the drill boat or vessel is being moved from the blast area, sound off a series of short signals by horn or whistle like the usual navigation warning signals.

(b) Do not fire any blast while any vessel under way is closer than 1,500 feet (457.2 m) to the underwater blasting area. Notify those onboard vessels or craft moored or anchored within 1,500 feet (457.2 m) before each blast is fired.

(c) Do not fire any blast closer than 250 feet (76.2 m) to a boat or vessel containing an explosive magazine. Personnel engaged in drilling operations on another drill boat within 500 feet (152.4 m) must leave the drill frames for cover if any holes have been loaded.

(d) Do not fire any blast while any swimming or diving is in progress near the blasting area.

(e) Whenever a drill boat is moved from the drilling location, fire all loaded under water holes.

(4) Safety Signals.

(a) All blasting operations must use the following safety signals:

(a-1) WARNING SIGNAL. A one-minute series of long audible signals made 5 minutes prior to the shot.

(a-2) BLAST SIGNAL. A series of short audible signals made 1 minute prior to the shot.

(a-3) ALL CLEAR SIGNAL. A prolonged audible signal following the inspection of each blast site.

(b) Make the safety signals using a compressed air whistle, a horn, or equivalent means. The signals must be clearly audible at the most distant point in the blast area. Do not use the boat whistle on a drill boat as a safety signal.

(c) Post the code for safety signals and warning signs and flags at all access points.

(d) Train individuals so they are familiar with the safety signals and instructions.

(5) The Blaster-in-Charge will make the lead line connections and fire the shot. Make all connections from the borehole back to the source of firing. Do not connect the lead line to the blasting machine or other source of energy until the charge is to be fired.

(6) After firing an electric blast, immediately disconnect the leading wires from the power source and shunted.

(7) When firing a circuit of electric blasting caps, take care to ensure that an adequate quantity of delivered current is available according to the manufacturer's instructions.

n. Post-Blast Procedures. (29-8.n)

(1) Immediately after each blast has been fired, disconnect the firing line from the blasting machine or power source and lock open all power switches. Test the atmosphere in each confined space and ventilate, as necessary.

(2) Do not permit anyone other than the Blaster-in-Charge to return to the blast area until the "all clear" signal is given.

(3) Scale down loose pieces of rock and other debris from the sides of the face of the blast site and make the blast area safe before proceeding with other work.

(4) Misfires.

(a) Handle misfires under the direction of the Blaster-in-Charge according to the procedures in the established Master Blasting Plan. The Blaster-in-Charge will determine the safest method for handling the hazards of misfires (some misfires may require consultation with the supplier or manufacturer of the explosive material).

(b) Do not perform other work within the misfired area except work that is necessary to remove the misfire hazard. Only those employees necessary to do the work may remain in the misfire area.

(c) Do not drill, dig, or pick near the misfire holes until they have been detonated or the Blaster-in-Charge has approved that work can proceed.

(d) Depending on the experience and ability of the Blaster-in-Charge, a secondary/dual initiation system to prevent misfires should be considered.

(e) When a misfire is declared, the Blaster must wait 30 minutes (cap and fuse 1-hour) before inspecting the site and provide proper safeguards for excluding all employees, except those necessary to do the work, from the blast area as defined in the Master Blasting Plan. The Blaster must establish the limits of the misfired area around the misfire according to the site-specific Master Blasting Plan.

o. Underwater Blasting. (29-8.o)

(1) A Blaster must conduct all blasting operations. No shot will be fired without their approval.

(2) Do not use loading tubes and casings of dissimilar metals because of possible electric transient currents from galvanic action of the metals and water.

(3) Use only water-resistant blasting caps and detonating cords for all marine blasting. Load through a rigid non-sparking loading tube.

(4) Display blasting flags.

(5) When more than one hole is loaded, anchor and float a steel shot line over the row of loaded holes. Tie the detonation down line from each loaded hole to the steel line and tie the loose end to the detonation trunk line.