

SAFETY REGULATION no. 23



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Governing **THE USE OF EXPLOSIVES**

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STATE OF NEW JERSEY
N.J. DEPARTMENT OF LABOR & INDUSTRY, *Division of Labor*
BUREAU OF ENGINEERING & SAFETY
Trenton, N.J.

REGULATION SHELF

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FOREWORD

This Regulation is promulgated to establish reasonable minimum requirements for the safe use of explosives.

In the writing of this Regulation, the Commissioner was guided by the recommendations of the Institute of Makers of Explosives; the United States Bureau of Mines; the Bureau of Explosives, Association of American Railroads; and the National Fire Protection Association.

This Regulation is promulgated by the Commissioner of Labor and Industry of the State of New Jersey, under authority vested in him by law:

N.J.S.A. 21:1A-131. The Commissioner may make and promulgate rules and regulations necessary to further the purposes of this act. The rules and regulations may include requirements that are not mentioned specifically in this act, but which are reasonably necessary for the safety of the workers and the public and the protection of property.

The term explosives as used in this Regulation is defined in the Law itself as follows:

"Explosives" means any chemical compound or mixture that is commonly used or intended for the purpose of producing an explosion, that contains any oxidizing and combustible materials or other ingredients, in such proportions, quantities or packing than an ignition by fire, by friction, by concussion or by detonation of any part of the compound or mixture may cause such a sudden generation of highly heated gases that the resultant gaseous pressures are capable of producing destructive effects on contiguous objects. The term "explosives" shall include, but is not limited to, commercial explosives, propellants and nitro-carbo-nitrates. The term "explosives" except as specifically stated in this act, shall not include small arms ammunition, explosives in the form prescribed by the official United States Pharmacopoeia, or fireworks regulated under Revised Statutes sections 21:2-1 through 21:2-7.

Prior to promulgation this Regulation was reviewed by the New Jersey State Industrial Safety Committee, and written notice of the proposed promulgation was given all holders of explosives permits in accordance with the Explosives Act. A public hearing was held on this Regulation on June 25, 1965.

SECTION 1 — PURPOSE AND SCOPE

- 1.1 PURPOSE. This Regulation is promulgated to establish reasonable minimum requirements and standards for the use of explosives in the interest of the life, health and safety of employees, and the public, as well as the protection of property.
- 1.2 SCOPE. This Regulation is applicable to every person who uses explosives in this State.
- 1.3 EXCEPTIONS. In cases of practical difficulty or unnecessary hardship, the Commissioner may grant exceptions from this Regulation providing that a request for such exception has been made in writing. Exceptions can only be granted when it is clearly evident that a satisfactory and safe condition is attained, but cannot be granted in any case where conflict would be created with mandatory requirements of the law.

SECTION 2 — DEFINITIONS

2.1 GENERAL DEFINITIONS

- 2.1.1 Approved - approved by the Commissioner.
- 2.1.2 Commissioner - the Commissioner of Labor and Industry, or his authorized representative.
- 2.1.3 Department - the Department of Labor and Industry.

2.2 SPECIAL DEFINITIONS

- 2.2.1 Blaster - the person in possession of a valid state permit of appropriate grade to use explosives for blasting purposes.
- 2.2.2 Accelerograph - an instrument of the Crandall type, or equivalent, for recording acceleration of ground.
- 2.2.3 Seismograph - an instrument of the Leet portable displacement seismograph type, or equivalent, for recording ground displacement and frequency, or particle velocity.
- 2.2.4 Air loader - pneumatic or air-pressure equipment for injecting explosives into a drill hole or other cavity.
- 2.2.5 Loading line - the pipe or hose through which powder is introduced into the drill hole or other cavity.
- 2.2.6 Primary Blasting - the blasting operation by which the original rock formation is dislodged from its natural location, including toe and seam shooting.
- 2.2.7 Secondary Blasting - the reduction of oversize material by the use of explosives to the dimension required for handling, and shall include mud-capping and block-holding.

- 2.2.8 Toe Shooting - the removing, through the use of moderate quantities of explosives loaded into small diameter holes of ledge or high bottom that remains after a main primary shot.
- 2.2.9 Seam Shooting - removing loosened or overhanging material from the rock face by the use of explosives.
- 2.2.10 Stemming - a suitable inert incombustible, free-flowing material used to confine or separate explosives in a drill hole, or to cover explosives in mud-capping.
- 2.2.11 Mud Capping - (sometimes known as bulldozing, adobe blasting, doying) - the blasting of boulders by placing a quantity of explosives with a detonator on or against a rock, boulder or other object without confining the explosives in a drill hole.
- 2.2.12 Block holing - the breaking of boulders by firing a small charge of explosives that has been loaded in a small diameter drill hole.
- 2.2.13 Springing - the creation of a pocket in the bottom of a drill hole by the use of a moderate quantity of explosives in order that larger quantities of explosives may be inserted therein.
- 2.2.14 Blast Area - shall mean that area considered hazardous by the blaster, taking into consideration the material to be blasted, the type of the blast, the location of the blast, the number, depth and spacing of holes to be blasted, and the quantity and type of explosives used.
- 2.2.15 Energy Ratio - mathematical relation between either (1) the ground displacement and frequency of vibration or (2) acceleration of ground and frequency of vibration.
- 2.2.16 Explosive Powder Actuated Tool - shall mean a machine which propels or discharges an object by application of energy created by the detonation of an explosive for the purpose of impinging upon, affixing to or penetrating another object or material. This term shall not include jet tappers or perforators.
- 2.2.17 Permissible Explosives - those which have been tested and approved by the U.S. Bureau of Mines for blasting in explosive gaseous and explosive dust hazard atmospheres, provided they are used in the prescribed manner.
- 2.2.18 Safety Fuse - an internal burning medium through which fire is conveyed at a continuous and uniform rate for the purpose of firing explosives.

- 2.2.19 Detonating Fuse - a fuse containing a core of high explosives of sufficient strength to detonate other cap sensitive or detonating fuse sensitive explosives lying alongside and to explode the entire charge.
- 2.2.20 Detonator - any device used for the purpose of initiating an explosives charge and shall include, but is not limited to, blasting caps, electric blasting caps, or delay electric blasting caps.
- 2.2.21 Blasting Cap - a shell closed at one end, and containing a detonating charge which is ignited by flame or spark from safety fuse.
- 2.2.22 Electric Blasting Cap - a shell containing a charge of detonating compound designed to be ignited by an electric current passed through the two insulated leg wires that project through the seal of the shell.
- 2.2.23 Delay Electric Blasting Cap - an electric blasting cap with a delay timing element interposed between the ignition element and the detonating charge.
- 2.2.24 Delay Firing - the detonation of charges of explosives in predetermined sequence, which may be accomplished by using regular or short period delay electric blasting caps or some means of equivalent in effectiveness.
- 2.2.25 Primer - an explosive cartridge with a detonator or igniting agent inserted therein.
- 2.2.26 Fuse Lighters and Fuse Igniters - special devices for the purpose of igniting safety fuse.
- 2.2.27 Squibs - electric - similar in appearance to a blasting cap, which upon firing by an electric current provides an intense flame instead of a detonation.
- 2.2.28 Missed Hole - a drill hole containing an explosive charge which failed to explode.
- 2.2.29 Leading Wires - the wires extending from the end of the permanent blasting wires to the leg wires.
- 2.2.30 Permanent Blasting Wires - those wires between the blasting switch and the power switch including sections between safety switches for use in blasting where the power source is an electric circuit.
- 2.2.31 Ammonium Nitrate - a chemical compound represented by the formula $\text{NH}_4 \text{NO}_3$.

- 2.2.32 Nitro-Carbo-Nitrate - means a mixture intended for blasting consisting substantially of inorganic nitrates and carbonaceous combustibles in which none of the ingredients is a commercial explosive.
- 2.2.33 Construction Type of Excavations.
- a. Open Pit - the pit type of removal operation in which the final subgrade is 10 feet or more below the level of the surrounding area.
 - b. Side Hill - the type of rock cut with a wall on one side in which the subgrade is 10 feet or more below the level of the surrounding area.
 - c. Through Cut - the type of material removing operation with a wall on both sides in which the subgrade is 10 feet or more below the level of the surrounding area.
 - d. Trenching - material removal when the depth is less than 10 feet from the surrounding area to subgrade and including, but not limited to, pipe lines, foundations, pole lines and similar types of construction and demolition.
 - e. Tunnels and Shafts - the type of construction operation in its normal connotation.
- 2.2.34 Small Arms Ammunition - Any cartridge or shell for use in a pistol, rifle or shotgun, and shall include ball, shot or blank cartridges or shells.

SECTION 3 — GENERAL PROVISIONS

3.1 COMPLIANCE

- 3.1.1 All persons using explosives shall comply with the provisions of this Regulation.
- 3.1.2 It is prohibited for any person to:
- a. use explosives unless in possession of a valid permit, or the explosives are being used under the direct supervision of a person in possession of a valid permit to use explosives.
 - b. Use explosives except in compliance with the limitations expressed on the permit.

3.2 EXCLUDED EXPLOSIVES - excluded explosives, as listed in Section 8.1 of Safety Regulation No. 20 shall not be used.

3.3 EXEMPTIONS

3.3.1 This Regulation shall not be construed as applying to the following when used for the purpose for which they are intended:

- a. Small arms ammunition
- b. Explosive power-packs in the form of explosive cartridges.
- c. Explosive-charged construction devices such as:
 - (1) explosive rivets.
 - (2) explosive bolts.
 - (3) explosive charges for driving pins or studs.
 - (4) cartridges for explosive-actuated power tools.

3.3.2 Persons holding, or employed by a person holding, a permit to manufacture explosives, and who are engaged in the testing of explosives incident to the manufacture or development thereof, shall not be required to obtain a permit to use explosives.

3.3.3 Persons employed by a person holding a permit to use explosives in processing, and who are engaged in the testing of explosives incident to the processing of explosives shall not be required to obtain a permit to use explosives.

3.3.4 Persons who are engaged in:

- a. the hand loading of small arms ammunition which is not for resale. or
- b. hold a permit to engage in model or amateur rocketing.

3.4 ACCIDENTS, FIRES, EXPLOSIONS, THEFT OR PROPERTY DAMAGE — All accidents, fires, accidental explosions, theft or property damage occurring in connection with the use of explosives shall be reported at once to the Bureau of Engineering and Safety by telephone, and be supplemented by a detailed written report.

3.5 PERMITS

3.5.1 Requirements concerning permits are set forth in Safety Regulation No. 20 - Explosives Permits and Fees.

3.5.2 The permit to use explosives shall be in the possession of the permittee at all times when he is using explosives.

- 3.5.3 Permits shall at all times be readily available to inspection by the Commissioner, State Police or local police and fire departments, and shall be posted as directed by the Commissioner.

3.6 RESPONSIBILITY FOR COMPLIANCE

- 3.6.1 Every contractor, mine and quarry operator and other persons employing the services of a licensed blaster shall use every reasonable precaution to provide for the safety of all employees on the job and of such other persons who may be legally entitled to be on such job, as well as the safety of the public, and it shall be the duty of such contractor, mine and quarry operator and other employer to comply with the requirements of this Regulation.
- 3.6.2 Every contractor, mine and quarry operator and other persons employing the services of a licensed blaster shall be held jointly responsible with the blaster for compliance with the requirements of this Regulation.
- 3.6.3 Where work involves the use of explosives for blasting purposes, both a contractor and a sub-contractor shall comply with the requirements of this regulation.
- 3.6.4 The employer shall be made responsible for making the contents of this Regulation known to his employees.
- 3.6.5 Every employee shall observe all the requirements of this Regulation which directly concerns or affects his conduct.
- 3.6.6 The blaster shall not use and detonate explosives unless the requirements of this Regulation have been observed, and every reasonable precaution, not specifically set forth in this Regulation, is taken to prevent accidents or damage to property.

- 3.7 SMOKING AND OPEN LIGHTS - Smoking, open lights, or fire of any kind is prohibited within one hundred (100) feet where explosives are being handled, used, or temporarily placed. No source of ignition, except means necessary to light fuses or fire electric detonators is permitted in an area containing loaded holes.

3.8 INTOXICATING LIQUORS

- 3.8.1 No person while under the influence of intoxicating liquors, beverages or drugs shall handle or use explosives or be in the vicinity of loading operations.
- 3.8.2 No intoxicating liquors, beverages or drugs shall be permitted in the area where explosives are being handled, used or temporarily placed.

3.9 OPERATIONS DURING ELECTRICAL STORMS

- 3.9.1 All use of explosives, and any handling thereof, shall be stopped immediately upon the approach of a thunderstorm, and all persons in the area shall immediately seek a place of safety.
- 3.9.2 Persons working underground or in shafts or tunnels where explosives are being handled shall be warned of the storm's approach, and shall be required to seek a place of safety until informed that the storm has passed.
- 3.9.3 Explosives at the top of any shaft leading to where men are working shall be moved away from such location a distance equal to that required for inhabited buildings in the Quantity and Distance Table, upon the approach of an electrical storm, unless a greater hazard would be created thereby.

3.10 PROXIMITY TO UTILITIES - OTHER THAN GAS TRANSMISSION PIPE LINES

- 3.10.1 It shall be the responsibility of the blaster or his employer to make every reasonable effort to ascertain the location of utilities prior to conducting blasting operations.
- 3.10.2 Whenever blasting is being conducted within 50 feet of electric, water, fire alarm, telephone, telegraph and steam or other utilities, and liquid material transmission lines and within 200 feet of railroads, the blaster or his employer shall notify the appropriate representatives of such utilities at least 24 hours in advance of blasting, specifying the location and intended time of such blasting. Verbal notice shall be confirmed with written notice.
- 3.10.3 In the event of an emergency involving immediate and substantial danger to life, health or property, the 24-hour prior notice will be waived if notice, in writing, or otherwise, is given at any time before blasting is undertaken.
- 3.10.4 Service of a single notice of intention shall constitute compliance with this section when blasting takes place on more than one day, provided it is a part of a single continuing project.
- 3.10.5 In the event that damage does occur to any water, fire alarm, telephone, telegraph or steam utility, or railroad the appropriate representative of such utility or railroad shall be notified.
- 3.10.6 The maximum quantity of explosives per delay which can be detonated within 50 feet of any utility described

in Section 3.10.1 shall conform to the quantity-distance table in Section 10.4.3 of this Regulation.

3.11 PROXIMITY TO UTILITIES - GAS TRANSMISSION PIPE LINES (P. L. 1964 Chapter 53)

- 3.11.1 Whenever blasting is being conducted within 200 feet of any pipe distributing manufactured, mixed or natural gas, the blaster or his employer shall serve a written notice of intention at least 3 full working days (excluding Saturdays, Sundays, or holidays) prior to the discharge of the explosives on the person engaged in the distribution or transmission of manufactured, mixed or natural gas within the area.
- 3.11.2 The written notice of intention shall be served personally, or by registered mail or by certified mail, return receipt requested, on the person so engaged in the transmission or distribution of the aforesaid gases and shall contain the name of the person responsible, the date, place and type of discharge to be conducted.
- 3.11.3 Service of a single notice of intention shall constitute compliance with this section when the discharge of explosives take place on more than one day provided it is a part of a single continuing project.
- 3.11.4 Within three days after receipt of the notice of intention, the person engaged in the distribution or transmission of the aforesaid gases shall advise in writing or otherwise the person named in the said notice of intention.
- 3.11.5 In the event of an emergency involving an immediate and substantial danger of death or serious personal injury, it shall be lawful to discharge explosives in the ground if such notice and advice, in writing or otherwise, are given at any time before any such discharge is undertaken.
- 3.11.6 In the event that damage does occur, the person distributing or transmitting manufactured, mixed or natural gas in the area shall be notified immediately.

3.12 DETERIORATED EXPLOSIVES

- 3.12.1 No deteriorated explosives or explosives which have been damaged so they are unfit for use shall be used for blasting operations. Explosives which are deviated from normal color or condition (texture, size, etc.) shall be considered deteriorated until their exact condition is determined by expert opinion.

- 3.12.2 Explosives which have deteriorated, or have been damaged so that they are unfit for use, shall be destroyed by burning in a safe place, by a qualified person, in accordance with the safety provisions set forth by the United States Bureau of Mines and the Institute of Makers of Explosives. EXPLOSIVES SHALL NEVER BE BURIED OR COVERED BY ANY MATERIALS AS A MEANS OF DISPOSAL.

3.13 RADIO FREQUENCY TRANSMITTERS

- 3.13.1 Mobile radio transmitters which are less than 100 feet away from electric blasting caps in other than original containers shall be de-energized and be effectively locked.
- 3.13.2 All electric blasting operations shall be conducted at no less distance from any fixed or mobile AM transmitters than indicated in the following table.

Transmitter Power (Watts)	Minimum Distance (Feet)
5 - 25	100
25 - 50	150
50 - 100	220
100 - 250	350
250 - 500	450
500 - 1,000	650
1,000 - 2,500	1,000
2,500 - 5,000	1,500
5,000 - 10,000	2,200
10,000 - 25,000	3,500
25,000 - 50,000	5,000
50,000 - 100,000	7,000

- 3.13.3 Where VHF TV, FM broadcasting and FM mobile transmitters are used, electric blasting operations shall not be conducted closer to such operating transmitters than indicated in the following tables.

a. VHF Television and FM Broadcasting

Transmitter Power (Watts)	Minimum Distance (Feet)
1 - 10	5
10 - 100	20
100 - 1,000	60
1,000 - 10,000	200
10,000 - 100,000	600
100,000 - 1,000,000	2,000

b. **FM Mobile Transmitters**

Transmitter Power (Watts)	Minimum Distance (Feet)
1 - 10	5
10 - 30	10
30 - 60	15
60 - 250	30
250 - 600	45

- 3.13.5 Where UHF television transmitters are used, electric blasting operations shall not be conducted closer to such operating transmitters than indicated in the following table:

**Table of Distances
For UHF Television Transmitters**

Transmitter Power (Watts)	Minimum Distance (Feet)
1 - 10	2.5
10 - 100	8
100 - 1,000	25
1,000 - 10,000	80
10,000 - 100,000	250
100,000 - 1,000,000	800
1,000,000 - 5,000,000	2,000

- 3.13.6 When electric blasting is to be used near a transmitter where the conditions are not covered by the tables, or a field survey of hazards is warranted, the Commissioner may order such tests made as are deemed necessary. All such tests shall be made by the manufacturers of the blasting cap or by a recognized test laboratory or engineering company.

3.14 NOTIFICATION TO MUNICIPALITIES

- 3.14.1 Whenever blasting is to be conducted in a municipality, other than by a quarrying or underground mining operation, the person conducting the blasting operation shall notify the police department specifying the location and intended time of such blasting.
- 3.14.2 Service of a single notice of intention shall constitute compliance with this section when blasting takes place on more than one day, provided it is a part of a single continuing project.

3.15 TIME OF BLASTS

- 3.15.1 No person shall fire a blast in any surface blasting or tunnel blasting operation between 6:00 p.m. of any day

and 8:00 a.m. of the following day unless authorized by the Commissioner. No explosives in surface blasting shall be loaded in drill holes in the dark.

- 3.15.2 No person shall blast on Sunday without special permission from the Commissioner.

3.16 INSURANCE

- 3.16.1 Any self employed person in possession of a valid permit to use explosives for blasting purposes shall have a valid insurance policy covering blasting damage in the minimum amounts of \$50,000 for property damage including explosion, collapse and underground utility and \$100,000-\$300,000 personal injury. This requirement shall not apply to any person who possesses a Grade G (agricultural) permit.
- 3.16.2 Any person in possession of a valid permit to use explosives for blasting purposes who is working for any person, partnership, firm, association, company or corporation shall not use explosives for such person, partnership, firm, association, company or corporation unless the employer has a valid insurance policy covering blasting damage including explosion collapse and underground utility in the minimum amounts of \$50,000 for property damage and \$100,000-\$300,000 for personal injury.
- 3.16.3 Proof of the possession of a valid insurance policy covering blasting damage shall be readily available to inspection by the Commissioner, State Police or local police and fire departments.
- 3.16.4 Nothing in Sections 3.16.1 and 3.16.2 shall be construed as preventing greater insurance policies covering blasting damage when requested by any person, partnership, firm, association, company or corporation for whom blasting is being done.

SECTION 4 – HANDLING AND USE OF EXPLOSIVES IN SURFACE BLASTING

4.1 GENERAL

- 4.1.1 Only persons duly authorized by the blaster shall in any way handle or use explosives.
- 4.1.2 Blasting operations shall in every instance be restricted to as few men as is practicable, and only authorized personnel shall be allowed in the blast area.
- 4.1.3 Explosives shall be kept in original or equivalent containers until they are to be used.

- 4.1.4 Explosives shall not be left lying around.
- 4.1.5 All explosives left over after loading operations are completed shall be promptly returned to their proper magazines.
- 4.1.6 All explosives cases, wooden and fibreboard, sawdust and other rubbish from explosives containers, shall be removed to a safe place for disposal, and shall not be used again for any purpose.
- 4.1.7 In removing supplies of explosives from any magazine, those that have been longest in the magazine shall be taken out first.
- 4.1.8 No tools, except wooden wedges, and non-metallic slitters may be used for opening containers of explosives, except that metallic slitters may be used for opening fibreboard containers providing such slitters cannot come in contact with the metallic case fasteners or the explosives.
- 4.1.9 No employee or other person not in possession of the required permits shall remove any explosives from any mine, quarry, tunnel or construction site.

4.2 RESTRICTIONS

- 4.2.1 Loosening of Caked Ammonium Nitrate - Under no circumstances shall caked ammonium nitrate in bags or in bulk, be loosened by blasting with explosives.
- 4.2.2 Frozen Explosives - Frozen explosives shall not be placed or used in drill holes. No attempt shall be made to thaw frozen explosives, but rather the manufacturer shall be consulted.

4.3 DRILLING

- 4.3.1 All drill holes shall be of sufficient bore so that the cartridges of explosives can be easily inserted to the bottom of the hole without forcing or ramming.
- 4.3.2 No person shall drill in or deepen any hole that contains, or has previously contained explosives.
- 4.3.3 Drilling shall not be resumed after blasts have been fired until a thorough examination has been made to make sure that there are no unexploded charges remaining.
- 4.3.4 When drilling and loading are being performed simultaneously in the same area, the two operations shall be separated as widely as practicable, and in no case shall drilling be done closer to a loaded hole, or a hole that is being loaded, than a distance equal to the deepest blast

hole in the area, but in no case less than 25 feet.

- 4.3.5 When holes within ten (10) feet of any structure are to be loaded with explosives, line holes shall be drilled on a line parallel to the structure and as close as possible to same for protection.

4.4 ELECTRIC BLASTING

- 4.4.1 Electric blasting with batteries, blasting machines, light circuits or power circuits is permissible.
- 4.4.2 Only U.S. Bureau of Mines approved type dry cell batteries may be used as a power source and shall be used in accordance with the U.S. Bureau of Mines approval.
- 4.4.3 When firing with blasting machines, the connection, or connections shall be made as recommended by the manufacturer.
- 4.4.4 When firing with light or power current the connections shall be made in series, parallel, in a combination of series and parallel, or in a combination connection recommended by the manufacturer.
- 4.4.5 When firing with light or power current, ample power shall always be used to fire all detonators which have been connected, but under no condition shall the voltage exceed 550 volts.
- 4.4.6 Blasting machines shall be in good condition and the efficiency of the machine shall be tested periodically to make certain that it can deliver power at its rated capacity.
- 4.4.7 The number of electric detonators to be connected to the blasting machine shall not exceed the rated capacity of the machine.
- 4.4.8 All blasting machines shall be in charge of the blaster, and no other person shall connect the leading wires to the machine.
- 4.4.9 When firing with a blasting machine, it shall be located at a safe distance to be determined by the blaster, but not less than 150 feet from the blast area unless other adequate protection is afforded.
- 4.4.10 The following sequence shall be followed in making electric blasting connections, and at no time nor under any condition or circumstances shall the manner of hookup be revised or otherwise changed:

- a. Connect detonator wires.
 - b. Connect detonator wires to leading wires.
 - c. Connect leading wires to blasting machine or to safety switch.
 - d. Fire holes from blasting machine or blasting switch.
- 4.4.11 When firing by means of a blasting machine, the leading wires shall:
- a. be kept short-circuited until the shot is ready for firing, when connected to a circuit of electric detonators.
 - b. not be connected to the blasting machine until immediately before the time of firing.
 - c. be disconnected from the blasting machine and short-circuited immediately after firing.
- 4.4.12 The insulation on leading wires shall be in good condition and kept from contact with any electrical conductor, pipe lines, tracks or pools of water or oil.
- 4.4.13 Blasting circuits shall not be grounded at any point, and any bare spots in the circuit, such as wire connections, shall not be allowed to touch the ground.
- 4.4.14 All electric blasting caps shall have the leg wires twisted together or shunted until the holes have been charged to avoid a premature explosion.
- 4.4.15 Electric blasting caps and blasting circuits shall be tested by a silver chloride cell blasting galvanometer especially designed for that purpose.
- 4.4.16 Electric blasting caps should be tested individually with a blasting galvanometer before any stemming is placed in the hole.
- 4.4.17 The blasting circuit shall be tested with a blasting galvanometer before the shot is fired.
- 4.4.18 No electric blasting shall be done under overhead electric lines, or within range of them where it is possible that lead wires might be blown into contact with the electric lines, unless special precautions are taken to hold down the lead wires.
- 4.4.19 Areas to be blasted under high voltage electric lines shall be tested for extraneous electric currents by a competent person using instruments designed for this purpose. Where extraneous electrical currents exceeding 0.06 amps are detected, the use of electrical blasting is prohibited.

- 4.4.20 In any single series in the same blast, electric blasting caps shall be the same brand.
- 4.4.21 At any surface operation where a power circuit is used for blasting, all the applicable provisions of Sections 6.6, 6.8 and 6.9 of this Regulation shall be complied with.

4.5 DETONATING FUSE

- 4.5.1 All detonating fuse shall be covered with stemming of sand, dirt, or fine rock screenings where physically possible, to a depth of at least one foot.
- 4.5.2 When priming blast holes with detonating fuse, it shall be attached to the first primer cartridge to be inserted in the hole, or, it shall be inserted to the bottom of the hole, weighted by some other means.
- 4.5.3 After the primer is in position, and before loading operations continue, the detonating fuse downline shall be cut from the spool.
- 4.5.4 The detonating fuse shall extend at least two to three feet above the collar of the hole, drawn sufficiently taut to remove the slack, and secured where it will not interfere with loading operations or contact nearby explosives.
- 4.5.5 Two detonating fuse downlines shall be used in deep large diameter holes loaded with multiple primers, which are in turn separated by blasting agents, prill-oil mixtures, or cap sensitive explosives and when large primary holes are deck loaded.
- 4.5.6 When two detonating fuse downlines are used they shall be kept separated by placing them on the opposite sides of the hole so they will function independently. If such separation cannot be assured, the two lines shall be twisted together to provide a simultaneous detonation. In either case, the two downlines shall be attached to the trunk-line so that both will be initiated at the same instant.
- 4.5.7 Detonating fuse shall be inspected before stemming is placed, and at intervals during stemming to be certain that it is intact at all time.
- 4.5.8 Main or trunk line splices shall be factory splices or tight square knots. No splices shall be used in the drill hole.
- 4.5.9 All branch line connections and all connections in the trunk line, other than splices, shall be tight and at right angles. The section of the branch line that is to be connected to the trunk line must be kept dry.

- 4.5.10 Main or trunk lines shall be laid out free of kinks or coils, and all connections shall be inspected before firing the blast.
- 4.5.11 When short interval delay firing of detonating fuse is used, the practice shall conform strictly to the manufacturers recommendations.
- 4.5.12 When connecting a blasting cap or an electric blasting cap to detonating fuse, the cap shall be taped or otherwise attached securely along the side or the end of the detonating fuse, with the end of the cap containing the explosive charge pointed in the direction in which the detonation is to proceed. It is recommended that two (2) detonators be used for this purpose.
- 4.5.13 Detonators for firing the trunk line shall not be brought to the loading area nor attached to the detonating fuse until everything else is in readiness for the blast.
- 4.5.14 Care shall be taken to select a detonating fuse consistent with the type and physical condition of the drill hole, and the type of explosives used.
- 4.6 **LOADING EXPLOSIVES – GENERAL**
 - 4.6.1 Machines and all tools not used for loading explosives into bore holes shall be removed from the immediate location of holes before explosives are delivered.
 - 4.6.2 No activity of any nature other than that which is required for loading holes with explosives shall be permitted within 25 feet of holes loaded with explosives.
 - 4.6.3 Power lines and portable electric cables for equipment being used shall be kept a safe distance from explosives being loaded into drill holes. Cables within 25 feet of any hole which is loaded, or being loaded, shall be de-energized and locked out by the blaster. This shall apply only to electric blasting.
 - 4.6.4 Under no circumstances shall the amount of explosives taken into a blast area exceed the amount estimated by the blaster as necessary for the blast.
 - 4.6.5 The loading of explosives charges for any blast which is not to be detonated upon completion of the loading is prohibited unless a guard is stationed at the blast site.
 - 4.6.6 No explosives charges shall be permitted to remain in the ground overnight unless permission is first obtained from the Commissioner.

- 4.6.7 When a charge of explosives has been loaded there shall be a constant guard over same until the blast has been fired, and the blaster is satisfied that there has been no misfire.
- 4.6.8 Explosives shall not be removed from the original wrapper before being loaded into bore holes, except when irregularities of the hole make it impossible to load whole cartridges with safety, or in block-holing and pre-splitting, where small charges are desirable. This rule shall not apply to free running or slurry explosives.
- 4.6.9 When loading free running or bulk explosives, a bronze, wooden or heavy paper funnel, or a pneumatic loader shall be used unless the explosives can be poured directly from the container into the hole in such a manner as to prevent scattering of loose explosives around the collar of the hole.
- 4.6.10 The use of pneumatic loaders is prohibited unless application is first made to the Commissioner and written permission is obtained for each particular location.
- 4.6.11 When holes are loaded with a pneumatic loader, the applicable provisions of Section 7 shall be complied with.
- 4.6.12 Explosives shall be stacked in piles not less than twenty-five (25) feet from the nearest holes being loaded, and any two or more piles shall be so spaced, as provided in Section 4.6.14, as to prevent propagation of an explosion of these piles in the event of a premature explosion in any portion of the blast area.
- 4.6.13 The explosive containers, if any, shall be opened at the pile and carried up to the hole one case or unit at a time for immediate loading, or placed at the loading station not less than six (6) feet from the hole except that not more than 100 pounds of explosives shall be allowed at the loading station at any one time.
- 4.6.14 Explosives shall be distributed in such a manner that the distances from storage piles to the allowable maximum quantity of 100 pounds of explosives at the loading station, or between such 100 pound station piles, shall not be less than the quantities shown in the following quantity-distance table.

	Pounds of Explosives	Distance Between Piles of Explosives, in Feet
Up to	50	21
	100	25
	200	32
	300	37
	400	41
	500	44
	750	50
	1000	55
	1500	64
	2000	70
	2500	75
	3000	80
	5000	96
	10000	123

- 4.6.15 When explosives are delivered to the blast area by truck, the delivery shall be so arranged that loading can be started immediately or within an hour. Any truck containing explosives standing at a blast site longer than an hour before loading of drill holes commences, shall comply with the quantity-distance table for the storage of explosives in Safety Regulation No. 22. This section shall not be construed as applying to explosives trucks in which explosives are stored in a portable magazine.
- 4.6.16 Explosives shall not be placed or left within twenty-five (25) feet of an electric light circuit or electric power circuit, except during transportation.
- 4.6.17 No explosives at a blast site shall be left unattended.
- 4.6.18 All tamping poles and dollies shall be constructed of wood or suitable flexible plastic pipe with no exposed metal parts, except that non-sparking metal spikes may be used where necessary to load rough holes, and that non-sparking metal connectors may be used for extending the length of a tamping pole.
- 4.6.19 The end of the wooden tamping pole shall be kept square and of such minimum diameter that the tamping pole will not by-pass the cartridge in the hole. When using plastic pipe a wooden plug shall be placed at the end of the pipe.
- 4.6.20 The exposed parts of tamping dollies shall be constructed of hard wood and may be weighted to sink in water.

- 4.6.21 When a dolly is weighted, no metal parts shall come within one-half inch ($\frac{1}{2}$ "") of the outside dolly; and the weighting material shall be sealed inside the dolly with wooden plugs driven into and glued in place, to close the holes.
- 4.6.22 The dolly shall not be dropped more than two (2) feet upon explosives and shall not be used to force explosives down a hole, or to attempt to free a cartridge or loose explosives stuck in the hole during loading operations.
- 4.6.23 Explosives in well drill holes may be tamped with a dolly when tamping is required, but the use of a dolly shall be kept at a minimum.
- 4.6.24 Tamping sticks and dollies shall not be used when they are badly worn, or when pieces of ore, rock, dirt, or similar material is adhered to, or imbedded in, the end of the tamping stick or dolly.
- 4.6.25 Mechanical tamping devices shall be so constructed that no metal parts will enter the bore hole unless such parts are so effectively insulated that no metal can come in contact with the explosives being tamped.
- 4.6.26 Sufficient suitable stemming, or tamping material, shall be placed at the drill holes before delivery of explosives to the drill holes is started.
- 4.6.27 Stemming or tamping material shall be screened or free from excessively coarse pieces and should preferably consist of clean fine clay, sand or crushed rock screenings. The use of leaves, trash or combustible material is prohibited.
- 4.6.28 All blast holes shall be stemmed to the collar or to a point which will confine the charge and minimize the danger of flying material.
- 4.6.29 For toe-holes the collar stemming shall in no case be less than one-third the depth of the hole.
- 4.6.30 Block holes shall contain at least 85% stemming material.
- 4.6.31 Before the firing of a blast at any location where the firing of such blast is liable to cause injury to persons or property, the material to be blasted shall be properly covered or protected to safeguard against such injury.
- 4.6.32 All matting for covering blasts shall be a heavy woven matting of rope, steel wire or chain or heavy logs, securely tied together by chains or cables, and shall be of sufficient weight to prevent the scattering of the loosened

material. Displacement of such matting due to detonation shall be kept to a minimum.

4.7 FIRING CHARGES — WARNING SIGNALS

- 4.7.1 It shall be the duty of the blaster to fix the time of blasting.
- 4.7.2 Before firing any blast all means of access to the blast area shall be effectively guarded to keep out all unauthorized persons.
- 4.7.3 The blaster shall make certain all persons are out of the blast area before firing the charge. No blast shall be fired while any person is in the blast area.
- 4.7.4 A code of blasting signals shall be posted at one or more conspicuous places where blasting is being done. All lettering shall be not less than four (4) inches in height on a contrasting background.
- 4.7.5 The blaster shall sound a warning distinctly audible to all persons within the danger zone at least five (5) minutes before the charge is to be detonated, and all persons within the danger zone shall retire to a safe distance or to a safe shelter.
- 4.7.6 The last audible signal shall be of at least one minute's duration, at the end of which time the charge will be detonated.
- 4.7.7 No person shall return to the blast area until permitted to do so by the blaster, and a distinctly audible all clear signal has been given.
- 4.7.8 Where highways or buildings are located within the danger zone, employees shall be sent in each direction to warn the public when the shots are to be fired.

4.8 FIRING CHARGES — PROXIMITY TO HIGHWAYS

- 4.8.1 Primary blasting at any quarry shall be prohibited when the blast area is within fifty (50) feet of the right of way of any roadway, horizontally measured.
- 4.8.2 When the floor of a rock cut, is more than five feet below the average grade of a highway at any point within one hundred (100) feet of a highway right of way, an effective and approved barrier shall be erected by the quarry operator or contractor along the property line nearest the highway right of way for an approved distance, to provide protection against the drop or fall of vehicles or persons.

4.8.3 It shall be the duty of the quarry operator and contractor to safeguard pedestrians and other highway users and their vehicles from injury or damage due to blasting operations.

4.8.4 When the blast area is within three hundred (300) feet of a highway right of way, the blaster shall just prior to the blast, designate a sufficient number of employees of the operator, each carrying a red flag no smaller than two (2) feet in length and one (1) foot six (6) inches in width fastened to a short staff, to stop all vehicular and pedestrian traffic at predetermined points on each possible route of travel in the vicinity of the blast area until the blast has been fired. A check shall be made of the highways in the danger zone to insure that there are no parked vehicles or pedestrians who would be endangered by the blast.

4.8.5 When the all clear signal has been given all vehicular and pedestrian traffic shall promptly be allowed to proceed.

4.9 LOADING EXPLOSIVES — WARNING SIGNS

4.9.1 Standard type warning signs requesting that no radio transmitting be carried on while passing through the blast area shall be maintained on the right hand shoulder of all public and private roads. The warning signs closest to the blast area shall be approximately 350 feet from the blast area. All lettering shall be not less than four (4) inches in height on a contrasting background.

4.9.2 Standard type warning signs indicating a blast area shall be maintained at all approaches to the blast area. The warning signs closest to the blast area shall be approximately 350 feet from the blast area. All lettering shall be not less than four (4) inches in height on a contrasting background.

4.10 INSPECTION AFTER BLASTING

4.10.1 Immediately after a blast has been fired, the firing line shall be disconnected from the blasting machine, or where power switches are used they shall be locked open. All blasting lines shall be shunted.

4.10.2 Immediately following the blast a thorough inspection shall be made by the blaster to determine if all charges have been exploded before employees are allowed to return to the operation.

4.10.3 If a misfire is found, the blaster shall provide proper

safeguards for excluding all personnel from the danger zone.

- 4.10.4 All wires shall be carefully traced and search made for unexploded cartridges.
- 4.10.5 A careful lookout shall be maintained for unexploded cartridges in the muck piles. Any found shall be carefully gathered and disposed of in the same manner as required for deteriorated explosives.

4.11 MISFIRES

- 4.11.1 All misfires shall be reported at once to the quarry operator or contractor.
- 4.11.2 If broken wires, faulty connections or short circuits are determined as the cause of misfire, the proper repairs shall be made, the firing line reconnected, and the charge fired, providing the burden has not been dangerously weakened by other shots.
- 4.11.3 If an additional hole and charges are necessary for the blasting of the misfired charge, the blaster shall be responsible for directing the angle of the hole and the depth to which it shall be drilled, but no drilling shall be done within a distance of two (2) feet from a misfired charge.
- 4.11.4 In cases where a misfire is not discovered until the shovel digs into the bank and uncovers the unexploded explosives, the shovel and all other equipment which might throw sparks or be damaged by an explosion, and all workmen shall be withdrawn to a safe distance.
- 4.11.5 The blaster shall then carefully remove rock broken by the blasts of adjacent holes, maintaining a sharp lookout for loose explosives, until the bore hole containing the charge that failed is exposed.
- 4.11.6 If there is any doubt regarding the safety precautions and method to be used in refiring a misfire, the blaster or his employer shall contact the Department of Labor and Industry, and the Explosives Manufacturer's Representative. The blast area shall be blocked off and guarded until such time as the charge can be refired.
- 4.11.7 When there has been a misfire, the blaster or his employer shall immediately notify the Commissioner.
- 4.11.8 A complete record shall be kept at the quarry office or the contractor's field office showing all misfires, the method of disposal, and the name of the person who refired, or otherwise disposed of such misfired charges.

- 4.11.9 In case a charge fires, but does not bring down the burden, it is permissible to reload the bore hole, if in suitable condition, but only after the temperature of the hole has been reduced by water or otherwise to not more than 150 degrees F.

SECTION 5 – SURFACE BLASTING METHODS

5.1 PRIMARY BLASTING

- 5.1.1 A primary blast shall be planned before the loading is started, and the planned charge for each hole shall be recorded.
- 5.1.2 The condition of each hole to be loaded and the amount, height and position of the explosives charge or charges placed in the hole shall be recorded on the loading chart.
- 5.1.3 Holes shall be checked prior to loading to determine depth and condition. Large diameter drill holes may be checked with a dolly, tamping block, measuring tape or by visual inspection with the aid of mirrors.
- 5.1.4 After any explosives have been loaded all measuring shall be done with a cloth tape or non-ferrous measuring device and a lead plumb bob, or a wooden tamping pole or wooden dolly free of exposed metal parts.
- 5.1.5 Rough or ragged holes, and holes partly closed by an obstruction that don't permit loading full cartridges, shall be cased, loaded with explosives that flow freely or have been cut in small pieces.
- 5.1.6 Water shall be removed from wet holes or such holes shall be loaded with explosives suitable for use in wet work.
- 5.1.7 Explosives cartridges shall not be dropped in a drill hole unless the hole is free from obstructions throughout its entire length.
- 5.1.8 Large diameter cartridges that have been wedged in a drill hole shall not be tamped with a dolly. After pouring water in the hole, attempts to dislodge or pierce them shall be made with a spear-shaped wooden tamping block or a small diameter wooden pole, such as recommended by the explosives manufacturer.
- 5.1.9 When loading a long line of holes with more than one loading crew, the crews shall be separated by the greatest practical distance which can be maintained as the loading progresses, and which is consistent with efficient operation and supervision of crews. Every effort shall be made

to keep the loading crews a minimum of 25 feet apart and to prevent the simultaneous loading of adjacent holes.

- 5.1.10 No hole shall be loaded until ready to be fired. All loaded holes shall be included in the same blast unless they are one hundred (100) feet or more from the nearest hole being fired.
- 5.1.11 Quantities of explosives that may be used in primary blasting shall be governed by the allowable limits as set forth in this Regulation.

5.2 SECONDARY BLASTING

- 5.2.1 No tools or equipment or activity of any kind shall be permitted on a muck pile directly above a blaster while he is loading explosives into block holes.
- 5.2.2 When explosives are not confined in a drill hole, not more than ten (10) pounds of explosives shall be detonated at any one time in a secondary shot.
- 5.2.3 No person except the blaster and any others directly engaged in loading block holes, shall be permitted within the immediate area while loading is being performed.
- 5.2.4 Loading of any block hole shall be completed in one continuous operation, including insertion of the primer and stemming.
- 5.2.5 Drill holes for secondary blasting shall be drilled deep enough to accommodate the charge of explosives, as well as sufficient stemming to confine the charge.

5.3 SPRINGING DRILL HOLES

- 5.3.1 Drill holes shall not be sprung within one hundred (100) feet of any holes containing explosives.
- 5.3.2 A hole that has been sprung shall not be loaded until a sufficient time has elapsed for the hole to cool. Artificial means may be used to cool the hole.

SECTION 6 – HANDLING AND USE OF EXPLOSIVES IN MINES AND TUNNELS

6.1 GENERAL

- 6.1.1 All provisions of Sections 4 and 5 of this Regulation which are applicable to the handling and use of explosives in mines and tunnels shall be complied with.

6.2 RESTRICTIONS

- 6.2.1 Field Mixing of Ammonium Nitrate – Fuel Oil

The compounding or mixing of ammonium nitrate and sensitizing materials in a mine or tunnel is prohibited.

6.2.2 Safety Fuse and Caps

The use of safety fuse and caps in tunnels is prohibited unless written permission is first obtained from the Commissioner.

6.2.3 Frozen Explosives

Frozen explosives shall not be placed or used in drill holes. No attempt shall be made to thaw frozen explosives, but rather the manufacturer shall be consulted.

6.3 CONTROL OF TOXIC GASES — FUME CLASS

6.3.1 The fume classification of an explosive shall be determined from the standard procedures as used by the United States Bureau of Mines for establishing the fume classification of permissible explosives.

6.3.2 The total volume of carbon monoxide and hydrogen sulphide produced by a 1-1/4 x 8" cartridge of explosive, and except as provided in Section 6.3.6, shall be as given in the following table:

Fume Class 1 — Less than 0.16 cubic feet
Fume Class 2 — From 0.16 to 0.33 cubic feet
Fume Class 3 — From 0.33 to 0.67 cubic feet

6.3.3 No explosive shall be used underground in the presence of combustible gases and/or combustible dusts unless conditions of use have been described to the Commissioner by the employer or his representative, and accepted by the Commissioner as safe.

6.3.4 Explosives for underground work must not generate hazardous fumes in greater quantities than those generated by high explosives classified Fume Class 1.

6.3.5 All containers of explosives for underground use shall be clearly marked in 1/4 inch or larger letters with the appropriate fume classification.

6.3.6 No explosives other than those in Fume Class 1 shall be used provided however that

a. Explosives complying with the requirements of Fume Class 2 and Fume Class 3 may be used if the operator has made specific application to and has shown to the satisfaction of the Commissioner that adequate ventilation has been provided.

b. When the Commissioner or the operator has reason

to believe that use of Fume Class 1 explosives may endanger employees by ignition of combustible dusts or gases, permissible explosives may be used and the ventilation increased to compensate for the resulting increase of poisonous gases.

- 6.3.7 All explosives packed in cartridges must be loaded in the original cartridge without alteration of the quantity of the wrapping.

6.4 CONTROL OF TOXIC GASES — VENTILATION AND TESTS

- 6.4.1 Efficient and adequate ventilation shall be provided so that the atmosphere where men are working contains at least 19.5 percent oxygen, not more than 0.5 percent carbon dioxide, and no harmful or dangerous quantities of dust, noxious gases, or flammable gases.
- 6.4.2 Muck piles shall be sprinkled with water before any attempt is made to remove the broken rock.
- 6.4.3 When the air in any part of a mine or tunnel is known to contain, or is suspected of containing a dangerous accumulation of gas, it shall be tested before anyone is allowed to work therein.
- 6.4.4 No one shall be permitted to work or be in a dangerous accumulation of gas unless he is wearing permissible respiratory equipment adequate for his protection.
- 6.4.5 If the main return in a mine or tunnel contains, flammable gases or vapors, any work conducted therein shall be conducted with extreme care.
- 6.4.6 If the main return of a mine or tunnel contains more than 25 percent of the lower explosive limit of any flammable gas or vapor, the employees shall be withdrawn until the condition is corrected.
- 6.4.7 When a poisonous or suffocating gas in harmful concentrations is encountered, normal operations shall cease in those places, except that under competent direction, necessary steps may be taken to make the place safe.
- 6.4.8 The accumulation of any gas shall not exceed the limits set forth in Safety Regulation No. 3 Establishing Threshold Limit Values for Dusts, Vapors, Fumes, Gases and Mists.
- 6.4.9 A dangerous accumulation of methane is any mixture of methane and air in which the proportion of methane is one (1) percent or more by volume.

- 6.4.10 Tests for flammable gases shall be made with a permissible detector, or by chemical analysis.
- 6.4.11 Tests for any gas other than flammable gas shall be made by chemical analysis or by the use of a standard testing device designed to detect the particular gas for which the test is being made, and to measure its concentration.
- 6.4.12 Tests for gases shall be made by a person familiar with the hazards of both flammable and noxious gases and who is proficient in the use of the respective testing devices. The employee so designated shall keep a dated record of all tests which shall be available to the Commissioner upon request.
- 6.4.13 Tests for Flammable and noxious gases shall be made:
 - a. Before explosives are brought to the blast site.
 - b. After the charge has been detonated.

6.5 USE OF SAFETY FUSE

- 6.5.1 Blasting with safety fuse employing hand lighting methods shall not be permitted in shaft sinking, winzes and raises more than fifty (50) feet in height, and in cutting shaft stations, in drifts, crosscuts or other places where blasting is hazardous to blasters, or where there is not sufficient protection from flying rock or concussion.
- 6.5.2 The average burning rate of safety fuse shall be determined by burning not less than three (3) three-foot (3') lengths in open air. The burning rate shall be redetermined with each new shipment, and at least every sixty (60) days. Any fuse which has a burning rate varying more than 10% from one (1) foot in 40 seconds shall not be used.
- 6.5.3 The average burning rate shall be posted on bulletin boards, or other conspicuous places where it can be seen by all employees.
- 6.5.4 It is forbidden to use fuse that has been hammered or injured in any way.
- 6.5.5 The hanging of fuse on nails or other projections which will cause a sharp bend to be formed in the fuse is prohibited.
- 6.5.6 In capping safety fuse, at least one (1) inch shall be cut from the end of each coil of fuse to be used.

- 6.5.7 Only a cap crimper of standard design shall be used for attaching blasting caps to safety fuse. The practice of crimping with teeth, knife, or any tool other than a crimper, is forbidden. The employer shall keep in accessible places, ready for use, crimpers in good repair.
- 6.5.8 Blasting caps shall not be removed from original containers, except as they are used for capping fuses.
- 6.5.9 The use of oil or grease to waterproof joints between the cap and fuse may injure the fuse and cause misfires. Therefore, waterproofing shall be done by using an approved ring-type crimp device or compound especially prepared for waterproofing.
- 6.5.10 No blasting cap used shall be of less strength than No. 6.
- 6.5.11 No unused cap or short capped fuse shall be placed in any hole to be blasted; such unused detonators shall be removed from the working place and destroyed.
- 6.5.12 No fuse shall be capped, or primers made up in any magazine, nor near any running belt or open light, or near any source of ignition or electrical current. Special benches for this purpose shall be provided at least twenty-five (25) feet distant from such places.
- 6.5.13 No employer or other person shall be permitted to carry loose caps of any kind in his clothing.
- 6.5.14 At least two (2) men shall be present at each location where cap and fuse blasting is done by hand lighting methods provided, however, that where no more than five (5) fuses are to be ignited at one time, the presence of a second man is not required.
- 6.5.15 The so-called "drop fuse" method of dropping or pushing a primer or any explosive with a lighted fuse attached to it is positively forbidden.
- 6.5.16 The use of cap and fuse for firing mud cap charges is prohibited unless charges are separated sufficiently to prevent one charge from dislodging other shots in the vicinity.
- 6.5.17 Unless fuse of a type incorporating an inner plastic jacket is used it is forbidden to use methods of attaching the capped fuse to the primer cartridge which involve half hitching the fuse around the cartridge, or reversing or otherwise causing short bends in the fuse. It is recommended that the fuse be laced through the cartridge or that the string-tied method or other equally effective means be used.

- 6.5.18 When blasting with safety fuses, consideration shall be given to the length and burning rate of the fuse, condition of the blaster's traveling way and the distance to a place of safety.
- 6.5.19 All safety fuses must be sufficiently long to extend beyond the collar of the hole, and in no case shall be less than three (3) feet in length.
- 6.5.20 Only single shots shall be fired when using three (3) foot fuses.
- 6.5.21 When lighting safety fuses, the fuses shall be so timed that no charge will explode until at least two (2) minutes after the last fuse in the blast area has been ignited.
- 6.5.22 When two (2) or more safety fuses in a group are lighted as one (1) by means of igniter cord or other similar fuse-lighting device, they may be considered as one (1) fuse for the purpose of this section.
- 6.5.23 Unless igniter cord or other similar fuse lighting device is employed, fuse used in any round which consists of two or more holes shall be cut at least six (6) feet long.
- 6.5.24 After any blast no person shall return to the blast area within thirty (30) minutes. If there is any doubt that all shots have been fired, no person shall return to the blast area within one (1) hour.

6.6 ELECTRIC BLASTING — LIGHT OR POWER CIRCUITS

- 6.6.1 Electrical current from light or power circuits shall not be used for firing shots, except where the electrical connections to such light or power circuits are made within an enclosed switchbox.
- 6.6.2 All blasting wires and circuits shall be kept well in the clear from power lines, pipe lines, tracks and other sources of possible electric currents.
- 6.6.3 Blasting lines shall run on the side of the workings opposite all power and lighting circuits and shall be properly hung on insulators.
- 6.6.4 No electric firing shall be done with a power line voltage of less than 110 volts or more than 550 volts.
- 6.6.5 Electric Circuits from the blasting switch to the blast area shall be insulated, isolated and no ground shall be permitted.
- 6.6.6 Permanent blasting lines, firing switches and auxiliary switches shall be maintained in proper condition at all times.

- 6.6.7 All power lines of any type within one hundred (100) feet of a blast area where electric blasting operations are being carried on, shall be de-energized during the loading and blasting.
- 6.6.8 The blasting circuit shall be tested before firing the shots and only a galvanometer especially designed for blasting circuits shall be used for such testing.
- 6.6.9 Before adopting any system of electrical firing, the blaster shall conduct a thorough survey for extraneous currents and if 0.06 amperes or more are detected, such extraneous currents shall be eliminated before any holes are loaded. It is recommended that the test be made with an instrument designed for this purpose.
- 6.6.10 All metal pipes and rails shall be electrically bonded together and grounded at or near the portal or shaft.
- 6.6.11 Where electric haulage is used, and the rails are used as the return circuit, the rails shall be bonded at each joint and cross-bonded at intervals not to exceed two hundred (200) feet. In addition, all pipe lines shall be cross-bonded to the rails and grounded at intervals not to exceed one thousand (1,000) feet.
- 6.6.12 Whether or not especially designed for blasting, the firing switch shall conform to the following minimum standards:
1. It shall be an externally operable switch enclosed in a tight case provided with a lock.
 2. It shall be a double pole, double throw switch with the handle arranged to be locked in the "off" position only.
 3. It shall be provided with a bar for short-circuiting leading wires when the switch is in the "off" position.
 4. The switch shall be fused and should be of sixty (60) ampere capacity.
 5. The switch shall be mounted so that the handle is down when the switch is in the "off" position. The leading wires shall be attached to the blade terminals and the power lines to the upthrow terminals.
- 6.6.13 When firing by means of a light or power circuit, such circuit shall at all times be broken in at least one place by a lightning gap of at least five (5) feet between the blasting switch and power switch, except during the actual firing operation.

- 6.6.14 The connection at such gap shall be made by means of a cable and a two-pole, sixty (60) ampere capacity plug and receptacle. The plug shall be provided with a device, preferably of the automatic type, for short-circuiting the wires when the plug is removed from the receptacle.
- 6.6.15 One of more safety switches shall be placed in the firing line in addition to the blasting switch used for firing the blast. Such switches shall be as described in Section 6.6.12 except that they need not be fused.
- 6.6.16 Safety switches shall be installed at the beginning of any branch or sections and in the firing line approximately every 500 feet. Such switches shall be as described in Section 6.6.12 except that they need not be fused.
- 6.6.17 Permanent and temporary leading wires, except for the lightning gap, shall be Type "S" cable or equivalent, or shall consist of two (2) rubber-covered aluminum or copper wires.
- 6.6.18 Rubber-covered wires used for permanent leading wires shall be installed in conduit or shall be strung on insulators and kept at least five (5) inches apart.
- 6.6.19 All leading wires shall have sufficient capacity to carry the firing current and shall in no case have a capacity of less than copper wire of No. 14 American Wire Gage.
- 6.6.20 The current carrying capacities of aluminum conductors shall be taken as eighty-four (84) percent of the same sizes of copper conductors with the same kind of insulation.
- 6.6.21 All splices shall be well made, and shall be so joined as to be electrically and mechanically secure. Splices shall be taped or otherwise effectively insulated.
- 6.6.22 Connecting wires shall be insulated single solid wires with a current-carrying capacity not less than that of copper wire of No. 20 American Wire Gage.
- 6.6.23 Bus wires shall not be smaller than No. 16 American Wire Gage solid bare copper wire.
- 6.6.24 Bus wires and connecting wires shall be short-circuited up to the time they are connected to the leading wires.
- 6.6.25 Leading wires shall be short-circuited by twisting the bare ends together up to the time these wires are connected to the permanent blasting line.
- 6.6.26 The firing switch should be at a safe location outside of

the portal of the tunnel, or not less than one thousand five hundred (1,500) feet from the face of the tunnel if the tunnel length exceeds one thousand five hundred (1,500) feet.

6.7 LOADING EXPLOSIVES — GENERAL

- 6.7.1 Machines and tools not used for loading explosives into bore holes shall be removed from the immediate location of holes before explosives are delivered to the blast area.
- 6.7.2 Loading operations shall be carried on with the smallest practical number of persons present, and no one but authorized personnel shall be allowed in the blast area.
- 6.7.3 The amount of explosives taken into a blast area shall not exceed the amount estimated by the blaster as necessary for the blast.
- 6.7.4 The loading of holes shall take place just before blasting time, and no holes shall be loaded and left standing.
- 6.7.5 All explosives packed in cartridges must be loaded in the original cartridge without alteration of the quantity of the wrapper.
- 6.7.6 Floodlights or permissible electric cap lamps, or permissible flashlights shall be used as illumination for loading operations. If current for flood lights is supplied by batteries of an electric locomotive, these lights shall be placed no closer than fifty (50) feet from the loading operation. No metal case flashlights shall be used.
- 6.7.7 Loading shall not commence until all drilling operations are completed and the drill holes are cleaned or blown out.
- 6.7.8 The use of pneumatic loaders is prohibited unless application is first made to the Commissioner and written permission is obtained for each particular location.
- 6.7.9 When holes are loaded with a pneumatic loader, the provisions of Section 7 shall be complied with.
- 6.7.10 Under no circumstances shall a workman be permitted to climb a "hung up" chute to blast it loose. A blasting stick, with the explosives securely fastened thereon, shall be used for this purpose.
- 6.7.11 There shall be no activity of any kind that would create a definite hazard to explosives that have been placed, or are being placed, for secondary blasting.

6.8 BLASTING

- 6.8.1 It shall be the duty of the employer or the blaster to fix the time of blasting.
- 6.8.2 When practicable, blasting shall be done at the end of the working shift.
- 6.8.3 Before firing a blast, warning shall be given, and all possible entries into the blasting area and any entrance to any working place where a drift, raise or other opening is about to hole through shall be carefully guarded.
- 6.8.4 The blaster shall make sure that all persons are out of the blast area before firing a blast.
- 6.8.5 Not more than one (1) chute or grizzly in the same area shall be blasted at a time and every precaution shall be used in guarding all approaches leading to the chute or grizzly about to be blasted.
- 6.8.6 When shots in secondary blasting are to be fired in such close proximity that one shot may displace another, the firing shall be done by use of detonating fuse or instantaneous electric blasting caps.
- 6.8.7 Keys to the shot firing and safety switches must be kept in the possession of the blaster.
- 6.8.8 When necessary to make repairs, extensions or tests on the blasting or shot firing line, the blaster shall unlock the padlocks and remain at the switch until he can relock it or designate that responsibility to someone who reports back to him with the keys when work is completed. No preparations for loading or blasting will be done until switches are relocked and the keys back in the possession of the blaster.
- 6.8.9 Before connecting the leading wires to the leg wires, the blaster shall make sure that the safety switch or switches are locked in the "off" position, that the lightning gap is open and the short-circuiting device is in place, and that the firing switch is locked in the "off" position.
- 6.8.10 The following procedure shall be used when firing a shot.
 - a. Before the leg wires have been connected to the leading wires, the blaster shall cause all persons to leave the blast area and proceed to a safe location. Leading wires shall be connected to the leg wires, unreeled by the blaster as he leaves the face and connected to the terminals of the permanent firing line.

- b. Safety switches shall be closed as the blaster retreats and the lightning gap closed between the power and blasting switches.
- c. The power switch shall be unlocked and the handle moved to an "on" position. The blasting switch shall be unlocked and moved to the "on" position to fire the shot.
- d. Immediately, the blaster shall return the handle of the firing switch to "off" position and lock it, and then reopen the lightning gap.

6.9 PROCEDURE AFTER BLASTING

- 6.9.1 No one shall enter the place where the blasting has been done until the leading wires have been disconnected from the source of electrical energy, and the firing switch and auxiliary switch or switches have been locked in the "off" position.
- 6.9.2 After a blast, no workman shall return to the area until sufficient time has elapsed for the removal of all toxic gases and smoke and the air is clear enough to distinguish loose or dangerous ground.
- 6.9.3 In case the shot fails to fire, the blaster shall:
 - a. Lock the firing switch in the "off" position and open the lightning gap.
 - b. Wait at least fifteen (15) minutes before proceeding to the safety switch or switches, which he shall lock in the "off" position before entering the blast area.
- 6.9.4 The blaster shall carefully examine the work place after a blast for missed holes and unexploded caps or explosives before allowing other personnel to enter the blast area.

6.10 MISFIRES

- 6.10.1 No other work shall be done except that necessary to remove the hazard, and only those persons necessary to do the work shall remain in the danger zone.
- 6.10.2 No attempt shall be made to extract explosives from any charged or misfired hole; a new primer shall be put in and the hole reblasted, or the explosives may be removed by washing out with water or where the misfire is under water, blown out with air.
- 6.10.3 No drilling or picking shall be permitted at the face until all missed holes have been detonated.

- 6.10.4 No employee shall be permitted to drill in any part of a bootleg hole which has been left standing from a previous blast.
- 6.10.5 A complete record shall be kept at the job site showing all misfires, method of disposal, and the name of the person who refired, or otherwise disposed of such mis-fired charges.

SECTION 7 — PNEUMATIC EXPLOSIVES LOADING

7.1 GENERAL

- 7.1.1 Drill holes shall be loaded by a method acceptable to the Commissioner.
- 7.1.2 No pneumatic loading shall be allowed at any location until permission has been granted in writing by the Commissioner.

7.2 LOADING EQUIPMENT — DESIGN AND CONSTRUCTION

- 7.2.1 The air loader and all accessory equipment, other than ground connections shall be constructed of materials compatible with the ammonium nitrate composition. No copper, zinc or galvanized metal shall be used.
- 7.2.2 The air loader loading pipe, funnel, and all fittings and connections between the air loader and the discharge end of the loading pipe shall be constructed entirely of non-sparking, electrically conductive material.
- 7.2.3 The pot or hopper of the closed type of air loader shall be of sufficient strength to withstand a hydrostatic pressure test of 150 pounds per square inch.
- 7.2.4 The air loader pot or hopper shall be self-supporting in an upright position. This may be accomplished by special design or by a suitable stand to which the pot or hopper may be secured.
- 7.2.5 A screen of non-sparking material of 20 mesh size, or an air filter or a trap of equivalent filtering capacity, shall be in the air supply line adjacent to the air loader to remove solid particles from the compressed air.

7.3 AIR TEMPERATURE AND PRESSURE

- 7.3.1 The temperature of the air supplied to the air loader shall not exceed 150 degrees F.
- 7.3.2 An air pressure reducing regulator of standard manufacture shall be installed in the air supply line.

- 7.3.3 The maximum air pressure to the loading hose shall not exceed the manufacturer's recommendations and shall be tested at operating pressure prior to the start of the loading operations.
- 7.3.4 An air pressure relief valve of standard manufacture shall be installed in the air supply line between the air pressure reducing regulator and air loader. The relief valve shall be of the direct spring-loaded type, set to operate at 10% above the operating pressure.
- 7.3.5 A pressure gauge shall be installed in the air supply line between the air pressure reducing regulator and the air loader in such position as to be easily read by the operator when in his working place.

7.4 STATIC ELECTRICITY AND STRAY CURRENTS

- 7.4.1 All pneumatic and air pressure equipment used for loading blasting agents shall be adequately grounded to dissipate static electric charges that may be generated during the loading operation.
- 7.4.2 Loading equipment mounted on a car and rails must be thoroughly insulated from the car and rails and grounded by a separate static-dissipating ground.
- 7.4.3 No loading operations shall be performed during an electrical storm.
- 7.4.4 The machine or hopper, discharge hose, fittings, discharge tube, and loading tube must form a continuous electrically conductive path to a ground.
- 7.4.5 Water lines, air lines, fan lines, rails or the permanent electrical grounding systems, shall not be used to ground pneumatic loading equipment.
- 7.4.6 Loading shall not be attempted unless suitable precautions are taken to reduce static electricity and stray currents to a safe level.
- 7.4.7 A definite earth ground showing a resistance not to exceed one megohm (1,000,000 ohms) must be established. An instrument for determining ground resistance must be kept on hand, and ground resistance checked daily while the loader is being used.
- 7.4.8 Metal or low resisting loading tubes shall not be used.
- 7.4.9 The hose leading from the loader to the holes being loaded shall be of semi-conductive material having a resistance in ohms per foot of not less than 5,000 ohms or more than 30,000 ohms.

- 7.4.10 The air supply shall be connected to the air loader by means of a non-conductive hose.
- 7.4.11 When the relative humidity is less than 65 percent:
 - a. electric detonators shall not be used except for collar priming.
 - b. safety fuse or detonating fuse shall be used for bottom priming.
- 7.4.12 All detonator leg wires shall be kept shunted until ready to hook up to the firing unit.

7.5 LOADING IN BOREHOLES

- 7.5.1 The air supply line shall be thoroughly blown out before it is attached to the air loader.
- 7.5.2 Air used for pneumatic loading of blasting agents shall be free of excessive moisture and oil.
- 7.5.3 Free flowing blasting agents and water based explosives shall be poured into the air loader through a funnel and screen of electrically conductive non-sparking material. The screen shall be grounded and bonded to the machine. Openings in the screen shall not be larger than two mesh nor smaller than three mesh.
- 7.5.4 Loading tubes must be at least two (2) feet longer than the deepest hole being loaded.
- 7.5.5 Only free flowing blasting agents and water based explosives shall be used in an air loader.
- 7.5.6 Air loaders and loading lines used for loading explosives shall not be used for stemming purposes.
- 7.5.7 Before blowing stemming into a loaded hole or cavity with an air loader, sufficient stemming shall be pushed in with a tamping stick to prevent blowing the stemming directly against the explosives.
- 7.5.8 All tamping poles shall be constructed of wood or suitable flexible plastic pipe with no exposed metal parts, except that non-sparking metal spikes may be used where necessary to load rough holes, and that non-sparking metal connectors may be used for extending the length of a tamping pole.
- 7.5.9 When loading over electric blasting cap wires, contact between any metal part of the loader and cap leg wires shall be avoided.

- 7.5.10 Holes shall not be lined with non-conductive material which would prevent the charged blasting agent particles from discharging to the borehole walls.
- 7.5.11 Primers which contain a blasting cap, electric blasting cap or delay blasting cap shall not be handled by persons who have previously been operating pneumatic loading devices unless that person has grounded himself to bleed off static charges.
- 7.5.12 All loading equipment must be removed from the area before leg wire shunts are removed and the loaded holes are tied in for blasting.
- 7.5.13 The Air loader and loading line shall be cleaned thoroughly after use, not later than the end of the shift during which it was used.

SECTION 8 — AMMONIUM NITRATE — FUEL OIL

8.1 GENERAL

- 8.1.1 The storage of blasting agents shall comply with Safety Regulation No. 22 governing the storage of explosives.
- 8.1.2 Only persons duly authorized by the blaster shall in any way handle, use or compound blasting agents.

8.2 RESTRICTIONS

- 8.2.1 Except when blasting agents are compounded at the blast site for immediate use, any such mixing or compounding shall be deemed to be manufacturing of explosives and shall be subject to all applicable provisions of the Explosives Act.
- 8.2.2 Mobile equipment designed for mixing in transit is prohibited.

8.3 COMPOSITION

- 8.3.1 No liquid fuel with flash point lower than that of No. 2 Diesel Fuel Oil shall be used.
- 8.3.2 Crude oil, crankcase oil and more volatile fuels such as gasoline or kerosene shall not be used.
- 8.3.3 If solid fuels are used, they shall be chosen to minimize dust explosion hazard.
- 8.3.4 Metal dusts (aluminum powder, etc.) peroxides, chlorates and perchlorates, and explosive substances such as nitroglycerin or other high explosives, shall not be used to

sensitize ammonium nitrate unless the strict standards of normal explosive-plant operations are met.

- 8.3.5 No unusual compositions shall be attempted except under the supervision of competent personnel able to evaluate the possibility of new hazards in the operation, and equipped to determine the sensitivity of the resulting compositions.

8.4 BLAST HOLE MIXING

- 8.4.1 Smoking or open lights, matches or other flame producing devices shall not be permitted within fifty (50) feet of the mixing site.
- 8.4.2 The area surrounding the mixing site shall be kept free of rubbish, dry grass, or other combustible materials for not less than fifty (50) feet in all directions.
- 8.4.3 Fuel oil shall be poured so that it will not spill onto clothing.
- 8.4.4 Mixing shall be done using equipment, materials and methods approved by the Commissioner as adequate to provide for proper and safe admixture without frictional heating, compaction or confinement.
- 8.4.5 Such mixing shall be done in quantities and at locations which shall be appropriate to minimize requirements for storage, handling and transportation of blasting agents.
- 8.4.6 Broken bags or broken cartridges of blasting agents shall immediately be closed up and removed.

SECTION 9 — RECORDS

9.1 GENERAL

- 9.1.1 A record shall be kept of every blast and all records shall be retained at least until the end of the calendar year next following the year in which the record is made. All such records shall be open to inspection by the Commissioner.
- 9.1.2 One copy of the minimum recorded data covering every blast shall be forwarded to the Department by the blaster under whose supervision the blast was fired, if a request for such data has been demanded, in writing, by the Commissioner.
- 9.1.3 At least one copy of the records required by this Section shall be maintained at the quarry, mine office or construction blasting site at all times.

9.2 INVENTORY

- 9.2.1 A continuous inventory of explosives purchased for any given construction project, shall be kept at the site.
- 9.2.2 A continuous inventory of explosives purchased for any mine or quarry shall be kept at the plant office.
- 9.2.3 All inventory records shall conform to the requirements of Section 7.4.4 of Safety Regulation No. 20 "Establishing Standards for Explosives Permits and Fees."

9.3 MINIMUM RECORDED DATA — PRIMARY BLASTING

- 9.3.1 Plan of blast site shall include
 - a. involved portion of the quarry or construction site showing the location and spacing of holes.
 - b. typical cross-section showing overburden, burden at top and toe of face, height of face, depth of holes, kind and quantity of explosives including distribution of explosives, and length and kind of stemming material.
- 9.3.2 Additional data shall include
 - a. kind of blasting cap, distribution of instantaneous or short-period delay blasting caps or both, delay interval used and the order of firing.
 - b. maximum amount of explosives per delay.
 - c. drilling record showing unusual joint or seam conditions in the rock.
 - d. comments by blaster regarding character of breakage, height of breakage, length of throw, effectiveness of shot and unusual results or effects.
 - e. weather conditions including the direction and approximate velocity of wind, atmospheric temperature, relative humidity and cloud conditions.
 - f. date and time of firing blast.
 - g. name of person in responsible charge of loading and firing, and blasting permit number.
 - h. name and location of quarry or construction site.
 - i. signature of blaster making the report.
- 9.3.3 Any person using the services of a weather forecasting service for blasting operations shall include all data received from the weather service on the blast report.

9.4 MINIMUM RECORDED DATA — SECONDARY BLASTING

9.4.1 The recorded data shall include

- a. the number of holes.
- b. kind and quantity of explosives.
- c. kind of blasting caps and delay interval.
- d. date and time of firing.
- e. the name of person in responsible charge of loading and firing, and blasting permit number.
- f. signature of blaster making the report.
- g. name and location of quarry or construction site.

9.5 MISFIRES

9.5.1 The recorded data shall include

- a. involved portion of the quarry mine or construction site.
- b. date of misfire.
- c. number of holes involved in misfire.
- d. cause of misfire.
- e. method used to reblast misfire.
- f. name of blaster in responsible charge of handling misfire.
- g. signature and title of person making the report.

9.6 SEISMOGRAPH RECORDS

If seismograph or air pressure readings, or both, are taken upon authorization of the quarry or mine operator or contractor, a copy of the covering seismograph report shall be forwarded to the Commissioner without delay, together with a copy of the records required to be maintained by Section 9.3.2.

9.7 RECORDED SEISMOGRAPH DATA

9.7.1 The recorded data shall include

- a. identification of instrument used.
- b. name of observer.
- c. name of interpreter.
- d. distance and direction of recording station from area of detonation.

- e. type of ground at recording station or location in structure.
- f. maximum amplitudes for all components, as well as resultant for all recorded frequencies of vibrations.
- g. duration of motion in excess of one-one thousandth of an inch.
- h. frequency of ground motion in cycles per second.
- i. maximum energy ratio or particle velocity.
- j. a copy of the photographic records of seismograph readings.

SECTION 10 — SEISMIC EFFECTS

10.1 Allowable Limits

- 10.1.1 Blasting activities shall be so conducted that ground vibrations measured at the nearest structure or building do not exceed the standards established in this Regulation.
- 10.1.2 Allowable limits of ground motion, energy ratio and particle velocity contained in this section shall be considered not to produce structural damage in any structure that has been reasonably well constructed according to accepted engineering practice.

10.2 Restrictions on Quantity of Explosives — The use of explosives within the limitations of this Regulation shall only be undertaken with quantities of explosives not in excess of those permitted by Section 10.4 and except as further restricted by other requirements of this Regulation.

10.3 Special Explosives Quantity Limits — When ground characteristics for any specific blasting location have been determined by instrumentation, the allowable quantity-distance relations between the amount of explosives used and the distance from the blast site shall be determined from the accepted results of instrumentation at the given operation for the various weights of explosives. The general vibration measurements shall not exceed the standards established in this Regulation.

10.4 Allowable Quantities of Explosives

- 10.4.1 In the absence of approval methods of instrumentation to restrict vibrations to the levels specified in this Regulation, the quantity of explosives used in blasting shall not exceed the quantities in Sections 10.4.2 or 10.4.3.

10.4.2 Quarry Blasting Quantity-Distance Table

Distance from blast area to nearest structure, neither quarry owned nor leased, in feet	Maximum quantity of explosives per shot for instantaneous firing or per delay for delay firing, in pounds
100	75
200	92
300	116
400	140
500	176
600	209
700	259
800	330
900	403
1000	495
1200	770

10.4.3 Construction Blasting Quantity-Distance Table

Maximum quantity of explosives per shot for instantaneous firing or per delay for delay firing, in pounds	Distance from blast area to nearest building or structure in feet
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Trenching, Tunnels,
Shafts, Side Hill or
Through Cuts

See Note 1	Less than 5
1/4 pound	6 - 10
1/5 pound per foot of distance	15 - 50
1/4 pound per foot of distance	60 - 200
Over 50 — See note 2	

1. Total quantity of explosives shall not exceed 1/4 lb. per shot up to five feet from nearest building or structure.
2. Seismic control, to determine the ground constant, shall be required for more than 50 pounds of explosives.

10.5 Frequency — Amplitude Relations

- 10.5.1 Blasting operations shall be so conducted that ground vibrations do not exceed the maximum amplitude of ground vibrations as related to frequencies of vibration set forth in this table.

Table of Frequency — Amplitude Relations

Frequency of Ground Motion in cycles per second up to	Maximum amplitude of ground motion, in inches not more than
10	0.0305
20	0.0153
30	0.0102
40	0.0076
50	0.0061
60	0.0051
70	0.0043
80	0.0038

10.6 Energy Ratio

10.6.1 Energy ration shall be calculated by the following formula

$$E. R. = (3.29 FA)^2$$

where F = frequency in cycles per second

and A = amplitude in inches

Total E.R. is equal to the arithmetical sum of the Energy Ratios in three mutually perpendicular planes of motion in the vertical and horizontal directions at any one instant of time.

10.6.2 The Maximum Total Energy Ratio shall not exceed 1.0 and all recordings shall be taken at the most critical location.

10.6.3 Where ground frequency and displacement characteristics have been determined by approved methods of instrumentation, ground transmission constants may then be determined by the formulae

$$K = \frac{(D)^2}{(50C)}ER \text{ and } K' = \frac{(D)^2}{(50C')}ER$$

where ER is Maximum Total Energy Ratio calculated from instrument recordings.

10.6.4 Maximum allowable explosive quantities used in relation to distances may then be determined by the formulae

$$C = \frac{D}{50\sqrt{K}} \text{ and } C' = \frac{D}{50\sqrt{K'}}$$

where D = Distance from blast in feet

C = Maximum number of pounds of explosives on any one delay period after the first period

K = Ground transmission constant based on C

C' = Number of pounds of explosives on the first period

K' = Ground transmission constant based on C'.

10.7 Particle Velocity

- 10.7.1 Particle Velocity shall be calculated by the following formula

$$\text{Particle Velocity (V)} = \frac{A}{t}$$

where A = the amplitude in inches

and t = time in seconds

Total Peak Particle Velocity is equal to the vector sum of the Particle Velocities in three mutually perpendicular planes of motion in the vertical and horizontal directions at any one instant of time.

- 10.7.2 The Maximum Total Peak Particle Velocity shall not exceed 1.92 and all recordings shall be taken at the most critical location.

- 10.7.3 Where Peak Particle Velocity Characteristics have been determined by approved methods of instrumentation, ground transmission constants may then be determined by the formulae

$$K = \frac{VD}{C} \text{ and } K' = \frac{VD}{C'}$$

where V is Maximum Total Peak Velocity calculated or read directly from instrument recordings.

- 10.7.4 Maximum allowable explosives quantities used in relation to distance may then be determined by the formulae

$$C = \frac{1.92 D}{K} \text{ and } C' = \frac{1.92 D}{K'}$$

where D = Distance from blast in feet

C = Maximum number of pounds of explosives
on any one delay period after the first period.

K = Ground transmission constant based on C

C' = Number of pounds of explosives on the first
period

K' = Ground transmission constant based on C'

APPENDIX

Details of the material shown are general, and may be altered to suit the individual, provided the minimum requirements of this Regulation are met.



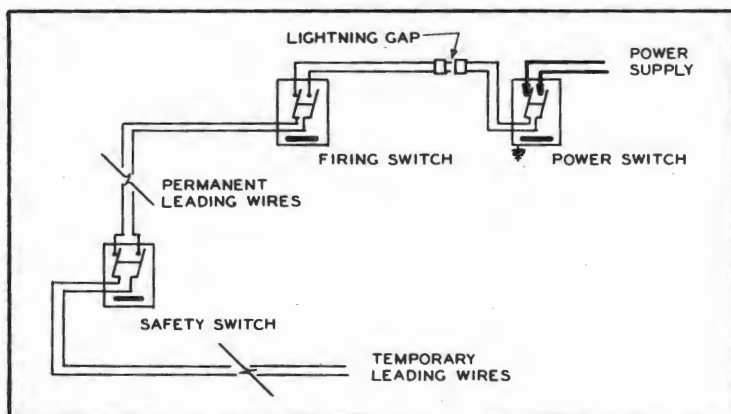


DIAGRAM FOR BLASTING WITH
LIGHT OR POWER CIRCUIT