

CALIFORNIA DEPARTMENT OF TRANSPORTATION

# Maintenance Equipment Training Academy



(Photo Courtesy of David Schroeder)

# Caltrans Maintenance Blasting Manual

NAME: \_\_\_\_\_

DATE COURSE TAKEN: \_\_\_\_\_

## TABLE OF CONTENTS

<b>PRINCIPLES OF BLASTING</b> .....	1
<b>QUALIFICATIONS OF BLASTERS</b> .....	2
<b>Suspension - Blaster's License</b> .....	3
<b>Training</b> .....	3
<b>SAFETY</b> .....	4
<b>Code of Safe Practices (COSP)</b> .....	4
<b>Clothing</b> .....	4
<b>Accident Prevention</b> .....	4
MAJOR ACCIDENT CAUSES .....	4
PREMATURE DETONATION .....	4
SHOT GUARDING.....	5
BLASTING SIGNALS .....	5
BLASTING ACCIDENT PROCEDURES.....	5
DISPOSING OF OLD OR DETERIORATED EXPLOSIVES .....	5
<b>Proper Use and Handling</b> .....	6
DRILLING .....	6
PRIMER MAKE-UP.....	6
LOADING PROCEDURES .....	7
STEMMING.....	7
STEMMING.....	7
MUD-CAPPING or CONE-BLASTING .....	7
GENERAL INFORMATION .....	8
RETREAT FROM AND RETURN TO SITE .....	9
<b>TYPES OF EXPLOSIVES</b> .....	15
<b>Descriptions and Comparisons</b> .....	15
DYNAMITE.....	15
WATER GELS, SLURRY, EMULSIONS .....	15
BLASTING AGENTS .....	15
BINARY.....	15
<b>Properties of Explosives</b> .....	16
Detonation velocity.....	16
The density, or specific gravity.....	16
The strength.....	16
Sensitivity .....	16
Water resistance .....	16
The fume class .....	16
Detonation pressure .....	16
<b>METHODS OF BLAST INITIATION</b> .....	17
<b>Electric</b> .....	17
Recommendations for Electrical Blasting.....	17
Electric Initiation Equipment.....	18
TYPES OF ELECTRIC CAPS.....	18
TYPES OF CIRCUITS (see illustration on page 23). .....	18

CIRCUIT RESISTANCE AND ITS MEASUREMENT (see illustration on page 24).....	19
EQUATIONS FOR BLASTING CIRCUITS .....	19
REQUIREMENTS FOR ELECTRIC BLASTING CAPS.....	19
INITIATION METHOD .....	20
HAZARDS .....	20
HANDLING MISFIRES.....	21
<b>Cap &amp; Fuse Initiation</b> .....	27
INITIATION.....	27
DETONATING DEVICES.....	27
DETONATING CORD .....	29
INITIATING METHODS .....	30
HANDLING MISFIRES.....	33
<b>BLAST DESIGN, AIR BLAST AND VIBRATION</b> .....	38
<b>Blast Design</b> .....	38
SHOT PLANNING.....	38
BLAST CALCULATIONS.....	38
TIMING PATTERNS.....	40
<b>Air Blast</b> .....	41
<b>Vibration</b> .....	41
<b>STORAGE</b> .....	42
<b>Types of Magazines</b> .....	42
<b>Magazine Construction</b> .....	42
<b>Magazine Placement</b> .....	42
<b>Housekeeping</b> .....	43
<b>Inventory</b> .....	43
<b>Records and Thefts</b> .....	43
<b>TRANSPORTATION</b> .....	47
<b>Vehicle</b> .....	47
<b>Placarding</b> .....	47
<b>Hazardous Materials Bill of Lading</b> .....	47
<b>Driver</b> .....	47
<b>Routes</b> .....	48
<b>Loading</b> .....	48
<b>Vehicle Fires</b> .....	48
<b>RECORD KEEPING</b> .....	54
<b>REGULATIONS</b> .....	58
<b>Federal</b> .....	58
<b>State</b> .....	58
<b>Counties and Cities</b> .....	58
<b>TERMS AND DEFINITIONS</b> .....	59

# CALTRANS BLASTING MANUAL

## INTRODUCTION

### PRINCIPLES OF BLASTING

The first principal one usually learns about blasting is that competence in this field is best gained by experience in making blasts rather than by reading a book or by listening to a lecture. The reason for this is that there are a large number of variables affecting blasting results and not all of these can be accounted for by a few rules or a few sets of equations. Even experienced blasters, when operating a new area, may have to make one or two shots just to acclimate themselves to the new conditions with which they are faced.

Although blasting is still more of an art than a science, there are some principals that are applicable to most situations and which serve as a start in the planning and execution of blasts. We can look at these as well as at some of the more obvious variables that must be considered in the planning and implementation of a blasting program.

You may not always enjoy the luxury of planning the blasting program on a particular job without some restrictions. The drilling, digging, and hauling equipment may have previously been designed and your blasting procedures and results must be compatible with these requirements. You may also be restricted by state, federal, local and job regulations, such as a maximum borehole diameter in the area of slopes, maximum explosive weight per delay period to minimize vibration in built-up areas, "Air Blast" or noise limitations, and time of day when blasting is permitted. If you consider all of these restrictions in your initial planning, you can eliminate many problems that would otherwise be encountered after the job has started.

Your blasting plan must also be flexible so that you can modify it after a job has started to account for those variables that you will have, at least, only limited knowledge of in advance. Examples of these variables are the amount of water in the boreholes, the ease or difficulty with which various types of rock can be broken and the geological formation of the rock.

The first and most important factor that must be considered in planning your blasting program is safety. Much of this is covered by state, federal and local regulations requiring licensing of magazine sites, having a licensed blaster in charge of blasting, etc. See Chapter 2, Safety.

Up to this time, no one has been able to classify all of the variables that are pertinent in blasting. This is the reason that blasting is still more of an art than a science. There is, however, considerable activity in trying to give blasting a more scientific basis. The Bureau of Mines has and is trying to develop a more accurate relationship between the theory of explosives and rock breakage and the practical aspects of blasting.

If and when you have special problems, do not hesitate to call on an expert because they are more than willing to work with you and know the various rules of thumb that have been developed to plan and implement blasting programs. Additional advice and suggestions can be obtained from your explosive supplier.

# CALTRANS BLASTING MANUAL

## I. QUALIFICATIONS OF BLASTERS

The Department shall require that the blaster (applicant) furnish satisfactory proof of proficiency in the use and handling of explosives; the equipment and protective devices necessary for blasting operations; the safety precautions necessary in conducting blasting operations or furnish proof that the blaster has had at least 3 years' experience as an assistant to a person having a valid Blaster's License in various phases of the use and handling of explosives.

The Department shall ensure that the blaster (applicant) is able to understand and give understandable orders and is in such physical and mental condition that would not interfere with the performance of the required duties to safely conduct blasting operations.

A qualified blaster is a person having a current, valid California "Blaster's License" for the work to be done. Blasting operations shall include, but not be limited to, the use, on-site transportation, and storage of commercial explosives, blasting agents, and other materials used in blasting.

A reasonable number of other persons may work under the direct supervision of a licensed blaster for the purpose of obtaining the necessary experience to qualify for a blaster's license.

No person shall be allowed to handle or use explosives while under the influence of intoxicating liquors, narcotics, or other dangerous drugs.

The Department (supervisor) shall ensure, at the time of blasting operations, that the licensed blaster is fit for duty. In addition blasters involved in avalanche control must be capable of working with explosives in adverse conditions (snow and blowing snow) and should have a basic understanding of avalanche characteristics

The Blaster's License shall be displayed for inspection when requested by a representative of the Division, Department, or proper authority.

Prior to attending blaster training and becoming a licensed and/or certified blaster, the employee shall be recommended for the training by the maintenance manager. The employee must receive a background check by Department of Justice (DOJ) prior to attending the training. Any fees associated with the background check must be paid by the source district. The licensed blaster is required to get the DOJ certificate renewed each year.

# CALTRANS BLASTING MANUAL

## A. Suspension - Blaster's License

1. The Division may suspend a blaster's license when, in the opinion of the Division:
  - a. There is a question or doubt of the competency of the licensed blaster, or
  - b. The licensed blaster has not complied with requirements, safety orders, or rules of the Division.
2. The licensed blaster shall be given notice and a hearing before suspending a blaster's license.
3. In the event of suspension or cancellation of a blaster's license, the person may not apply for a new license for a period of 6 months and the application shall be handled in the same manner as an original blaster's license.
  - a. The licensed blasters shall notify the Department immediately if their license is suspended or canceled.

## B. Training

All persons who handle or transport detonators or explosives shall be trained in the hazards of the job and safe performance of their duties. Trainees shall be under the direct supervision of a licensed blaster (GISO 5239).

### 1. TRAINING REQUIRED FOR CALTRANS BLASTERS:

- a. Blasting Safety, 32 hours.

Training in the safe use and handling of explosives and the mechanics of detonation. The first half of the course is classroom training and the second half being "hands on" training using explosives in the field.

This training is mandated pursuant to AB 965, Chapter 958 (1985), Departmental Policy and General Industrial Safety Order 5239.

All new blasters are required to attend this course prior to licensing.

- b. Blasting Safety (Annual Refresher), 24 hours.

Refresher training in the safe use and handling of explosives and the mechanics of detonation. Half of the course is in the classroom and half is "hands on" training with explosives in the field.

This training is mandated pursuant to Departmental Policy, General Industrial Safety Order 5239 and Chapter 958 (1985).

All Caltrans Licensed Blasters who have attended the Basic Blasting Safety Course shall attend this refresher course each year to maintain Caltrans Blaster Certification.

# CALTRANS BLASTING MANUAL

## II. SAFETY

### A. Code of Safe Practices (COSP)

A licensed blaster shall be in charge of all blasting operations, and will have the following responsibilities:

1. Shot Plan.
2. Review work area protection procedures and any traffic control requirements.
3. Review blasting signals with employees involved with traffic control and post at flagging stations.
4. Pre-op equipment required for the job and review safe practice rules for applicable equipment (see equipment index).
5. Assure that only the licensed blaster and the employees involved with the work are in the blasting area.
6. Assemble necessary materials, blasting equipment and storage equipment.
7. Use appropriate personal protective equipment and proper clothing (see B, Clothing).
8. Use proper explosive for the work being done.
9. Use proper detonating method for type of work being done.
10. Cease all blasting operations and clear the area if an electrical storm approaches.
11. Inspect area for possible fly rock, vibration, and shock wave problems.
12. Use proper shot guarding procedures.

### B. Clothing

1. Non-static electricity generating type (see article on pages 9-12).

### C. Accident Prevention

Of utmost importance is a continuing educational program for you and your blasting crew to keep from becoming complacent in your attitudes toward explosives and from developing unsafe handling habits. Carelessness and mishandling are the most common causes for explosive accidents and cannot be overlooked in day to day operations. The "do's" and "don'ts" pamphlets included in your Manual should be reviewed periodically as they cover nearly every handling question that might come up. However, blast layout and design is also important from a safety standpoint. Improperly designed shots can result in unexploded explosives in the muck pile, hazardous muck pile configuration and other unsafe conditions.

1. MAJOR ACCIDENT CAUSES:
  - a. Failure to clear and safeguard blast site.
  - b. Drilling into explosives.
  - c. Improper fuse lighting procedures.
  - d. Premature blasts due to extraneous current.
2. PREMATURE DETONATION

The blaster must be constantly aware of changing conditions that could bring about a hazardous situation where premature detonation of the explosives becomes possible. Modern explosives, when properly stored and used, are quite safe. **Nearly every explosives-related accident is the result of human error.** The blaster needs to guard against becoming complacent in the use and handling of explosives. Respect the energy that is at your disposal.

Never allow anyone to smoke within 50 feet of any explosives or explosives magazine.

Immediately after loading a shot, return all unused materials to the storage facility. If the blasting program involves numerous shots that day, move unused explosives to a safe

## CALTRANS BLASTING MANUAL

location prior to firing any blast. Never leave any explosives unattended until they have been properly returned to the magazine and it has been secured.

### 3. SHOT GUARDING

- a. Most injuries and fatalities occurring during blasting operations involve failure to properly clear the blast area.
- b. After the shot is loaded and ready to be fired, a complete check of the area shall be made to determine that no one remains in any area that could prove hazardous.

### 4. BLASTING SIGNALS

- a. Once the area has been cleared for the shot, the following blasting signals shall be used and posted at blasting site. (See page 13):

**Warning Signal** - 5 minutes. Prior to blast, a 1-minute series of long audible signals.

**Blasting Signal** - 1 minute prior to blast, a series of short audible signals.

**All Clear Signal** - following inspection of area, one prolonged audible signal.

- b. The blaster responsible for firing the shot should be in a location where he is protected and has a clear view of the blast area and all approaches. In situations where additional shot guards must be posted, the blaster shall not fire the shot without a positive signal from the guards that their areas of responsibility are also clear. **Make sure everyone understands the blasting signals.** Have a good system of communications.

### 5. BLASTING ACCIDENT PROCEDURES

In the event of a blasting accident, such as vandalism, lightning strike, etc., affecting the safety of workers in which explosives are involved, whether or not personal injury is sustained, licensed blasters shall immediately, within 24 hours, notify their supervisor and the Division (CAL-OSHA), and other appropriate authorities. Their supervisor shall immediately notify the Area Superintendent, who shall immediately notify the Regional Manager. The Regional Manager shall immediately notify the District Maintenance Engineer. The Regional Office shall forward a written report of the incident to the District Maintenance Engineer to include the following:

- a. The names and license numbers of all blasters involved.
- b. The names and occupations of any persons injured.
- c. The type of explosives, detonators, and method or methods of detonation of explosives.
- d. A factual account of events pertinent to the accident.

In any blasting incident in which serious personal injury is sustained, there shall be **NO** continuation of the blasting operation involved until such time as the Division has completed its investigation or authorized resumption of work.

### 6. DISPOSING OF OLD OR DETERIORATED EXPLOSIVES

Deteriorated or damaged explosives may be more hazardous than those in good condition and consequently, require special care in handling and disposal.

In the event it appears necessary to destroy commercial explosives, all handling and destruction should be deferred until a manufacturer has been consulted. The exception would be the disposal of duds in avalanche control work.

If the manufacturer of the explosives in question is known, seek their assistance. If the manufacturer is not known, contact any member company of the Institute of Makers of Explosives. Some military installations have Explosive Ordnance Demolition (EOD) teams that can be contacted.

# CALTRANS BLASTING MANUAL

## D. Proper Use and Handling

### 1. DRILLING

Make sure your drilling equipment is in good condition.

Inspect the drilling location for hazards before starting. Look specifically for remaining "bootlegs" from previous shots that could contain un-shot explosives. See "MISFIRES" for information.

NEVER collar the drill in a "bootleg" left from a previous shot nor attempt to deepen any hole that has contained explosives.

Do not drill within 50 feet of any loaded hole or any hole suspected of containing explosives.

Review COSP for drilling.

### 2. PRIMER MAKE-UP

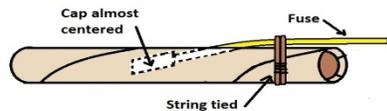
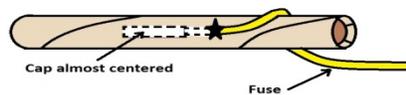
Proper primer make-up ensures that the cap is securely attached to the primer cartridge and is in the correct position to provide reliable initiation of the cartridge.

For cartridge explosives, this position is in the center of one end of the cartridge. An approved powder punch should be used to put a hole in the end of the cartridge. The hole should be deep enough to completely contain the cap.

For a two-component cartridge, the cap shall be securely fastened in the cap well provided. Be sure the end of the cap is butted against the bottom of the cap well.

For a two-component pouch, the cap shall be fully inserted in the cap well when one is provided. If cap well is not provided, the cap shall be fully inserted into the pouch and taped in place.

The cap shall always have its "business" end pointed in the direction of desired detonation. This is very important with columns of two or more cartridges.



# CALTRANS BLASTING MANUAL

## 3. LOADING PROCEDURES

Prior to loading any hole it shall be checked for condition. This is easily accomplished with a tamping pole. Make sure the hole is free of obstructions and is large enough to allow the explosives to be loaded without undue force.

If bottom detonation is desired, load the primer cartridge first. Make sure the primer cartridge goes all the way to the bottom of the hole. Load the remaining cartridges, following with the tamping pole often enough to make sure they are going to the bottom and that there are no gaps in the powder column. If a second primer cartridge is required at the top of the column, load it with the cap pointing down.

If you are loading dynamite or water-gels, you may wish to tamp the charges to improve borehole coupling and increase the loading density in the hole. When tamping, use light, firm blows only. **NEVER** tamp the primer cartridge(s).

Tamping poles shall be wood or Division approved semi-conductive plastic only. With the exception of non-sparking metal connectors, poles shall have no exposed metal parts. Never use a piece of drill steel or metal pipe as a tamping pole.

While loading, check the column height often enough to preclude overloading the hole. When loading ANFO, check the column height continuously.

The end of the tamping pole shall be kept squared and shall be of such size that the pole will not bypass the cartridges in the hole.

The Department shall ensure that wood or plastic tamping poles that are acceptable to the Division (CAL-OSHA) are used by employees.

**NOTE:** There are many kinds of "plastics", most of which cannot be used safely for tamping explosives. Some plastics are too soft to withstand physical abuse, some are too hard, and others are dangerously flammable or will absorb nitroglycerine or generate hazardous accumulations of static electricity.

## 4. STEMMING

Putting stemming material in the hole on top of the explosive charge serves to better confine the energy and provides improved fragmentation. The best stemming material consists of angular crushed stone chips. They tend to remain in place longer when the explosive detonates. Next best is damp sand. Tamping it helps considerably. The most common stemming material consists of drill cuttings, mainly because of the proximity to the hole. If drill cuttings are used, they should definitely be tamped to obtain good results. The worst stemming material would be pea gravel as it tends to exit the hole quite readily. All boreholes shall be stemmed.

## 5. FLY ROCK AND OTHER HAZARDS

## 6. MUD-CAPPING or CONE-BLASTING

When using surface charges to break rock, several precautions must be observed to obtain the desired results.

- a. If more than one charge is used, care must be taken to see that all charges detonate simultaneously. If this is not done, an early charge detonating may dislodge a later charge.
- b. Detonating cord and/or cap wires should be anchored to preclude their whipping about and pulling loose from their respective charges.
- c. Placement of the detonating cord or "business" end of the cap should take advantage of the directional effect of the initiation system.

## CALTRANS BLASTING MANUAL

- d. Cone-blasting differs from mud-capping in that no cover material is used. The charge is placed in the shape of a cone. The cap must be placed in the top of the cone, business end down.
- e. Mud-capping and cone-blasting are to be used only in case of an emergency.

### 7. GENERAL INFORMATION

- a. There shall be no smoking or open flame of any kind within 50 feet of any area where explosives are being handled. No source of ignition, except necessary means to light fuses or fire electric detonators, shall be permitted in an area containing loaded holes.
- b. Explosive containers shall only be opened with non-sparking tools, except metallic slitters may be used to open cardboard cartons containing explosives.
- c. Paper cartons, sawdust, and other rubbish from explosive containers shall be removed to a safe place and destroyed by burning.
- d. Explosive magazines shall not be placed or left within 25 feet of an electric light or power circuit or within 100 feet when in proximity to overhead lines and/or high-voltage lines.
- e. All detonators, detonating fuses, primers, and explosives left over after loading operations shall be promptly returned to their proper magazines.
- f. Provide an inventory tally sheet (or stock cards) in or on each first- and second-class magazine. This sheet shall indicate the quantity of powder or detonators placed therein or removed each time such transfer is made. The date and name of the person making the transfer shall be shown. An inspection shall be done at least every seven (7) days.

**EXCEPTION:** For magazines located on U.S. Forest Service property, inventory shall be in accordance with local U.S.F.S. regulations.

- g. Primers not made up in a make-up magazine shall be made up at a location at least 100 feet from the first-class storage magazine and at a safe distance from other workers not involved in the blasting operations.
- h. Loading shall not commence until all drilling is completed and drill holes are cleaned or blown out, unless this procedure is impracticable under conditions encountered. When conditions justify simultaneous loading and drilling in the same area, the two operations shall be separated as widely as practicable, and in no case less than 50 feet from drilling operations.

No vehicle traffic shall be permitted over loaded holes.

Holes shall not be loaded within 50 feet of vehicular traffic unless there is a written variance approved by the Division.

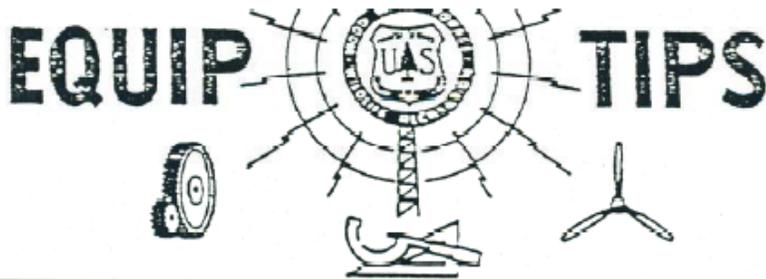
Loaded holes shall not be left unattended.

Explosives or blasting agents shall not be abandoned.

- i. No fire shall be fought where the explosives are in imminent danger of contact with fire. All employees shall be removed to a safe area and the fire area guarded against intruders.
- j. Insofar as possible, blasting operations above ground shall be conducted between sunup and sundown (GISO 5291).
- k. Black powder shall not be used under any condition except when using Safety Fuse with black powder core.
- l. Explosives or blasting agents shall not be left unattended at the blast site.

## CALTRANS BLASTING MANUAL

8. RETREAT FROM AND RETURN TO SITE
  - a. Lead wires shall not be connected to the permanent shot- firing line until all personnel have retreated to a place of safety, except the person making the connection. No unnecessary work will be done at the site during or after loading before the shots are fired.
  - b. After electric blasting, the BLASTER shall wait at least 5 minutes before returning to the point of blasting. After inspecting the blast site the BLASTER will give the all clear signal. The blasting switches shall be locked in the "off" position, the portable cord disconnected, and the blasting wires shunted by temporary bonding of the plug poles. Upon returning to the site, the lead wires shall be disconnected from the end of the permanent shot-firing line and the ends shunted. Blasting machine should remain in the BLASTER'S presence at all times. All blasting materials shall be removed from the site, including leg wires.



FOREST SERVICE EQUIPMENT DEVELOPMENT CENTER, MISSOULA, MONTANA

**Can static electricity from clothing detonate electric blasting caps?**



Almost everyone has had their clothing snap with static electricity. This often occurs as you slide out of an auto and reach for the door handle, or walk across a carpeted room and reach for a metal object. Recently, fieldmen have asked if these electrical sparks are more than annoyance. Can electrically charged clothing detonate electric blasting caps, which are known to be quite sensitive?

**What causes static electricity in clothing?**

Static electricity is generated by separating two materials that are in contact with each other. The materials do not have to be rubbed together, but friction causes closer contact, and therefore larger charges develop. Dissimilar materials tend to generate a larger electrical charge than similar materials.

The amount of static electricity stored in clothing depends on how well the material conducts electricity — which is determined by its moisture content. Fabrics with a high moisture content dissipate the electrical charge; fabrics with a low moisture content store the electrical charge. The following list shows the moisture content of some common fabrics:

Fiber	Water Content Dry Weight (percent)
wool	15
Rayon	12
cotton	9
Nylon	4
polyester (Dacron, Terylene)	0.04
acrylic	1.50

## CALTRANS BLASTING MANUAL

Natural fibers like wool and cotton, as well as Rayon, which is made from cotton or wood cellulose, retain moisture much better than true synthetics such as Nylon and Dacron. Therefore, cotton, wool, and Rayon do not build up large electrical charges as the synthetics do. However, if the relative humidity is very low, the capacity of cotton and wool to store an electrical charge will also increase. Relative humidity has a great influence on the amount of electrical energy that can be generated and stored in clothing. The lower the moisture content of the air, the greater the charge. For this reason the hazard of electrostatic

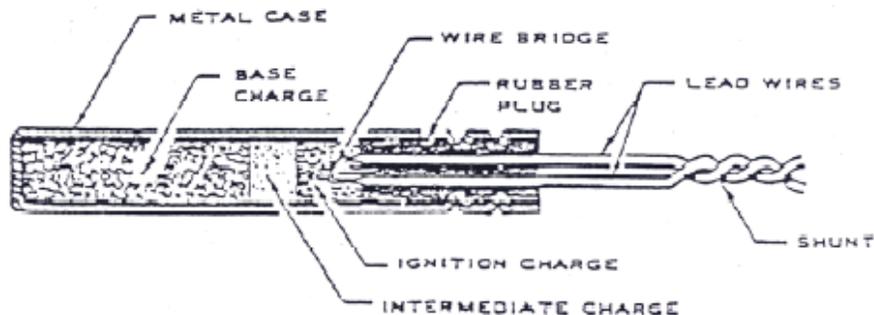
sparks is greatest in arid climates. The danger is particularly serious when it is both cold and dry, because not only is the relative humidity low, workers also tend to mix both wool and polyester garments to keep warm. Arctic research done by both the United States and Canadian armed services shows that removal of a Nylon parka after exercising at -30 degrees F. can develop a potential difference of over 7,000 volts, or nearly 4 millijoules of stored energy. The Bureau of Mines has calculated that an individual can become charged with up to 15 millijoules of electrostatic energy.

### Electric Blasting Caps

Electric Blasting caps consist of a wire bridge surrounded by a sensitive explosive. When electrical energy is delivered to the lead wires, the bridge wire heats, and at the critical temperature, detonates the explosive. The cap can absorb more energy without detonating if the energy is delivered at a low rate over a long period of time. However, a relatively small amount of electrical energy delivered in a pulse, such as a spark of the discharge from a capacitor, will detonate the cap. The caps are so designed that large blasts requiring hundreds of caps can be fired with confidence that all caps will be set off. Typically, 3-15 millijoules of electric energy are enough to insure detonation

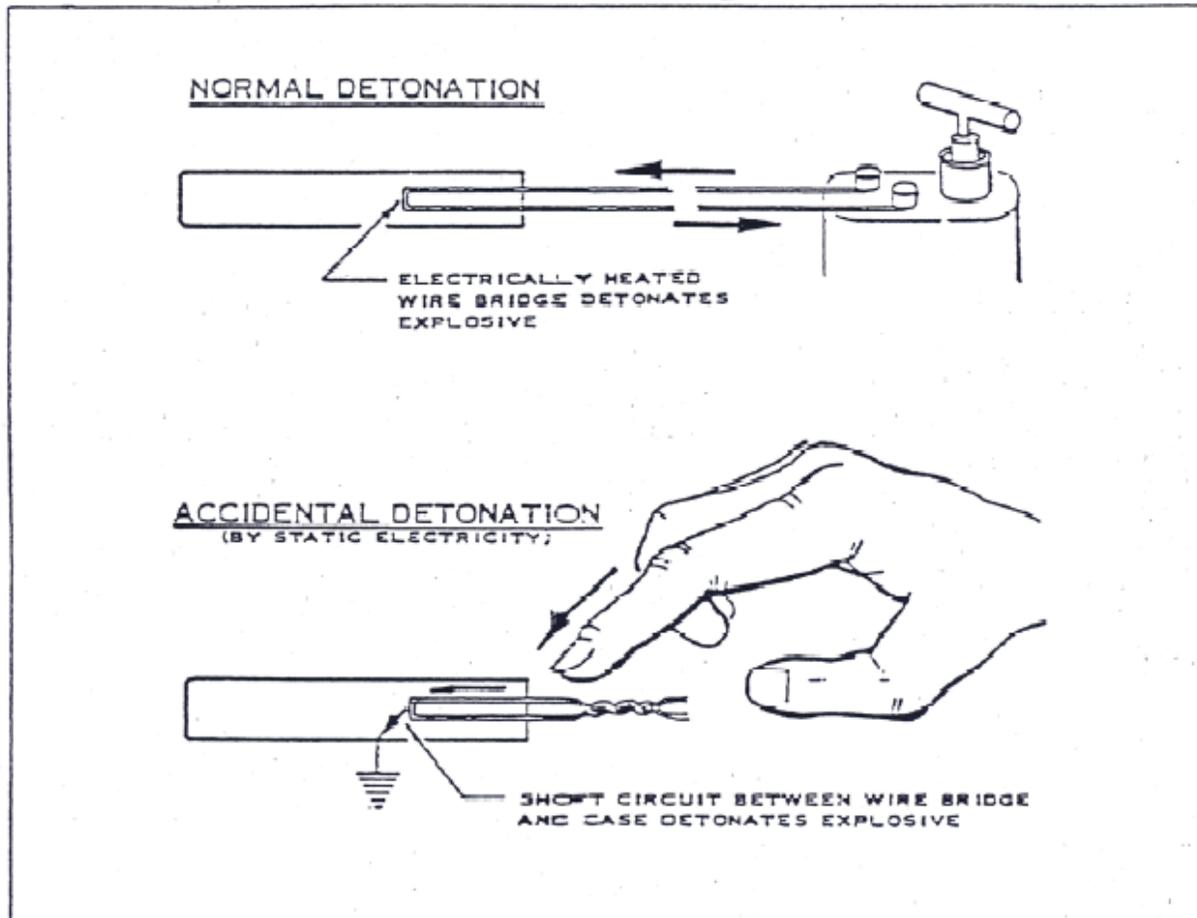
of a cap with 100 percent reliability. (Under certain circumstances, research indicates, clothing can accumulate an electrostatic charge well within this range.)

Inexperienced blasters often assume that to detonate a cap electric current must travel down the lead wires to the explosive, and until the shunt bridging the two wires is removed the cap cannot be fired. However, electric caps can also be detonated by an electric charge that "shorts" between the case of the cap and either bridge wire. (This is what makes static-charged clothing so hazardous.)



TYPICAL ELECTRIC BLASTING CAP

## CALTRANS BLASTING MANUAL



### Case Histories

Research by Federal agencies, the military, and industry has indicated that under certain conditions a worker can generate in his clothing an electrostatic charge powerful enough to detonate an electric cap. Since much of the evidence is theoretical and inconclusive to the layman, are there cases on record in which common electric caps have been detonated by an electric spark from clothing? An explosives expert in the Detonation Physics Division, Naval Weapons Center, China Lake, Calif., cited the following incidents:

**CASE 1 (1958).** A worker on a seismic test program in arid dry terrain held a cap in one hand and threw the leg wires into the air. The cap detonated, resulting in serious injury. Conditions were a strong wind and blowing dust. No other data are available.

**CASE 2 (1966).** The subject person was hand digging a well in decomposed granitic rock. He loaded three holes using No. 6 electric caps (no delay, manufacturer unknown) with the caps in parallel and on a 90-100 foot lead wire. The subject was holding one leg of the lead wire in his hand as he slid across the seat of his pickup truck. All three caps fired. The subject was wearing "blue jeans." The seat cover was probably vinyl (original for '48 Chev.). The subject heard and felt a spark in the hand with the leg wire and reported seeing "about an eighth-inch spark". The weather was clear and dry, and the time of year was Spring.

**CASE 3.** The Naval Weapons Center has often demonstrated how various electrosensitive devices can be initiated by the static collection by a person walking across a carpeted room.

# CALTRANS BLASTING MANUAL

## Precautions When Using Electric Caps

Clothing is not always the main cause of accidental explosions involving static electricity. However, the hazard is well enough documented to warrant taking the following precautions:

**1** Wear garments of wool or cotton. If possible, do not wear a mixture of garments, some wool, some cotton.



WEAR WOOL OR COTTON  
BUT DO NOT MIX!

**2** Do not wear any garment that is made from synthetic materials, such as Dacron, Nylon, Terylene, etc. Be especially careful not to wear a mixture of wool garments and synthetic garments.



DO NOT WEAR SYNTHETICS!

**3** Never remove a garment such as a jacket or sweater while working close to electric caps, especially if one of the garments is wool and it is in contact with a synthetic fabric. Removing a Nylon jacket from contact with a wool shirt can generate enough static electricity to detonate an electric cap.



NEVER  
REMOVE  
GARMENTS  
WHILE  
WORKING  
WITH  
ELECTRIC  
CAPS

**4** If you remove a garment, discharge the static charge by holding a water pipe or a tap for at least 10 seconds, or by pressing both hands against damp earth. While this will not completely discharge the clothing, it will reduce the charge considerably.



HOLD FOR AT LEAST 10 SECONDS

**5** Treat clothing with a fabric softener, which will increase moisture retention and lessen the tendency to build static charges.



ADD FABRIC SOFTENER  
TO RINSE WATER

- **WARNING SIGNAL**  
*5 MINUTES PRIOR TO BLASTING*  
A 1-MINUTE SERIES OF LONG SIGNALS
- **BLASTING SIGNAL**  
*1 MINUTE PRIOR TO BLASTING*  
A SERIES OF SHORT AUDIBLE SIGNALS
- **ALL-CLEAR SIGNAL**  
*FOLLOWING INSPECTION OF BLAST AREA*  
*1 PROLONGED SIGNAL*

# CALTRANS BLASTING MANUAL

## III. TYPES OF EXPLOSIVES

### A. Descriptions and Comparisons

1. DYNAMITE - A cap-sensitive explosive, usually sensitized with nitroglycerin. **(SHALL NOT BE USED BY CALTRANS PERSONNEL.)**

ADVANTAGES:       Reliable detonation  
                          Wide range of sizes, grades

DISADVANTAGES: Headaches (Caused by nitroglycerin)  
                          Flash-over between holes  
                          Cost  
                          Storage (shelf life) and transportation

2. WATER GELS, SLURRY, EMULSIONS - Although different from one another in many ways, they will be treated as one entity in this section. They may or may not be cap-sensitive, depending on the formulation. (When cap-sensitive they are classified as High Explosives. Some that are able to pass the necessary tests are classified as Blasting Agents.) They are mixtures of oxidizers, fuels and sensitizers and usually contain between 5% and 45% water.

ADVANTAGES:       Greater resistance to accidental detonation  
                          Better coupling with the borehole

DISADVANTAGES: Temperature affects sensitivity  
                          Dead-pressing between holes

3. BLASTING AGENTS - A blasting agent is defined as any material or mixture, consisting of a fuel and an oxidizer, in which none of the ingredients is classified as an explosive and which, when mixed and packaged for shipment, cannot be detonated with a number 8 strength cap. The most common blasting agent is ANFO, which is a mixture consisting of 94% prilled ammonium nitrate and 6% diesel fuel.

ADVANTAGES:       Low cost  
                          Resistance to accidental detonation  
                          Fast loading

DISADVANTAGES: Not water resistant  
                          Requires booster

4. BINARY [two component] EXPLOSIVES - These consist of two separately packaged materials, neither of which is an explosive. When combined, the two materials become an explosive compound.

ADVANTAGES:       No storage magazines required  
                          Easily transportable

DISADVANTAGES: Relatively high cost  
                          Labor to mix  
                          Limited range of grades, sizes

## CALTRANS BLASTING MANUAL

### B. Properties of Explosives

1. Detonation velocity is the rate (in feet per second) at which the detonation wave progresses through the explosive. This is an important property because it best describes the manner in which the explosive accomplishes its task. A high velocity would indicate a shattering effect. Conversely, a lower velocity, with a good gas build-up, should result in a heaving action.
2. The density, or specific gravity of an explosive is measured in grams per cubic centimeter. The loading density, usually expressed in pounds per foot, is calculated from the specific gravity of the explosive and the diameter of the explosive column.
3. The strength of an explosive can be measured in many ways. Strength is a function of velocity, specific gravity and the gas generated. It is important to remember that strength relates to the amount of work that an explosive does, and not to the way in which the work is accomplished.
4. Sensitivity of an explosive represents the ease with which it can be initiated. This rating is often expressed as gap sensitivity and represents the distance in inches through air at which a primed half cartridge will sympathetically detonate an unprimed half cartridge.
5. Water resistance is the ability of an explosive to withstand exposure to water and still perform satisfactorily. It is expressed in several ways. Sometimes it is rated as Poor, Fair, Good or Excellent. Occasionally it is assigned a number ranging from 1 [good] to 4 [poor]. A much better system is to rate water resistance as the amount of time that the explosive can remain under a given head of water and still perform satisfactorily. [For example: 24 hours in depths of 60 feet.]
6. The fume class of an explosive is determined by the quantity of toxic gasses produced during detonation. Fume class 1 has the least amount of noxious gas, while fume class 3 has the highest. Unless there is adequate ventilation, only explosives rated as fume class 1 can be used. Explosives used underground must always be fume class 1.
7. Detonation pressure is the pressure of the detonation wave as it progresses through the explosive. It is a function of velocity, density and the ingredients in an explosive. When selecting a booster for blasting agents, a high detonation pressure is desirable.

# CALTRANS BLASTING MANUAL

## IV. METHODS OF BLAST INITIATION

### A. Electric

1. General Recommendations for Electrical Blasting
  - a. Always get an accurate hole count. On deep holes, decide upon the number of caps per hole.
  - b. Make a drawing of the blasting pattern and decide upon the delays to be used.
  - c. On the drawing, show how the series are connected. If wiring series-in-parallel, remember to balance the series.
  - d. Know the resistance of the individual caps. Calculate in advance what each series should read on the Blaster's Multimeter.
  - e. Leave shunts on the caps until ready to start hooking up. If any cap has to be tested prior to hooking up, be sure and re-shunt it afterward.
  - f. When wiring, make clean, tight connections from hole to hole. Keep bare wires and splices out of mud and water. It is good practice to keep splices up off the ground.
  - g. Leading wires used for electric blasting caps shall be at least 25 feet away from all power and light lines and shall not contact metal pipes or similar conductors. If power conductors are within the possible range of flying wire from a blast, such wire shall be secured with anchored rope mats, or equivalent, so that contact will be avoided. If the possibility of contact cannot be avoided by these or similar steps, a non-electric method of detonation shall be used. Lead wires shall be run at right angles to nearby high-voltage lines wherever practicable so as to reduce the possibility of unexpected blasts fired by induced current.
  - h. The blasting circuit shall not make use of the ground or grounded wires to carry current.
  - i. Shot-firing switches and blasting machines shall be so located that the operator is protected from the hazard of fly rock.
  - j. Before adopting any system of electrical firing, the blaster shall conduct a thorough survey for extraneous currents, and all dangerous currents shall be eliminated before any holes are loaded.
  - k. All connecting wires and leading wires shall consist of insulated solid copper or solid aluminum wires in good condition and of sufficient current-carrying capacity.
    - l. After wiring each series, test it with a Blaster's Multimeter. If it doesn't read close to what you calculated in step d above, it is a signal that something is wrong. After you are satisfied that you have a good series, shunt it and move on to the next series. Continue this process until all series have been completed.
  - m. Once a shot has been connected, block off the area. No one shall walk over the connected series except the blaster in charge of the shot. The blaster shall then check each series.
  - n. Test the firing line (lead line) from the blast end. Know what resistance you should read. Test it open (for shorts) and closed (for breaks). The end that will be connected to the blasting machine shall be left shunted after testing.
  - o. Un-shunt and connect each individual series to the firing line. As you do, test each series with a Blaster's Multimeter.
  - p. After all series have been connected to the firing line, check the firing line at the end where the blasting machine will be connected. Again, know what resistance should be encountered. A reading that is different from what is expected is a good clue that something is wrong.

# CALTRANS BLASTING MANUAL

- q. Shot hook-up is one of the most critical phases of blasting. Haste in wiring up and getting off the shot is probably the largest single threat to successful blasting.

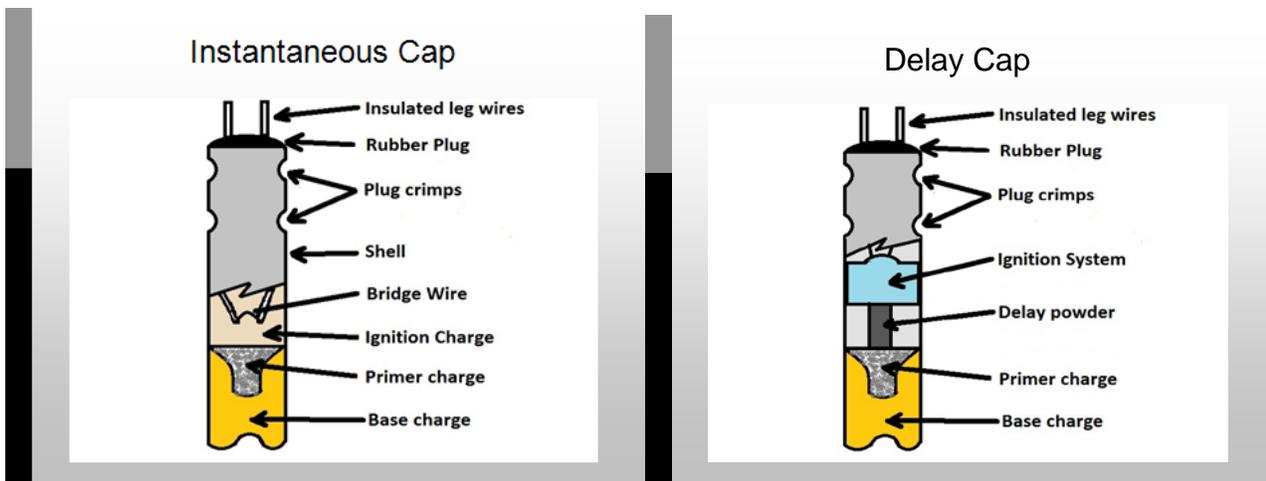
## 2. Electric Initiation Equipment

- a. Blasting Machine - Capacitor discharge
- b. Blaster's Multimeter with STRAY CURRENT capability
- c. Lead Line (Shorted lead-line reel preferred).
- d. Connecting Wire
- e. Black Plastic Tape
- f. Powder Punch (Non-sparking)
- g. Tamping Pole (Non-sparking)
- h. Blow Pipe
- i. Detonating Cord
- j. Detonating Cord Connectors
- k. Diagonal Cutter (Non-sparking)
- l. Day Box and Cap Box (with lock)
- m. Blaster's Log

## 3. TYPES OF ELECTRIC CAPS

Electric blasting caps can be divided into three types:

- a. Instant caps can be used in conjunction with delay caps to provide one additional time period.
- b. Millisecond delays, where the time between delays is measured in milliseconds (thousandths of a second), are used mainly in production shots where there is a free face. Properly used, they reduce vibration and flyrock and increase fragmentation. Millisecond delays and long period delays are seldom combined in the same blast, and then only by persons experienced in their use.
- c. Long period delay caps, where the time is measured in fractions of a second or whole seconds, are normally used in shaft sinking and tunnel rounds where the longer times allow appreciable rock movement between delays. Sometimes referred to as "tunnel delay".



## 4. TYPES OF CIRCUITS (see illustration on page 23).

When connecting electric blasting caps, two types of circuits are utilized:

- a. The Series Circuit, where there is but one path for current flow.

## CALTRANS BLASTING MANUAL

- b. The Parallel Circuit, where there are two or more parallel paths for current flow. (NOT RECOMMENDED FOR CALTRANS PERSONNEL.)

As the number of caps increases, a combination of the two types is used, resulting in what is called Series-in-Parallel. (NOT RECOMMENDED FOR CALTRANS PERSONNEL.)

5. CIRCUIT RESISTANCE AND ITS MEASUREMENT (see illustration on page 24).
- a. It is important to be able to calculate and measure the resistance in a blasting circuit. The unit of measure for electrical resistance is the OHM. The only Caltrans approved device that measures resistance is the Blaster's Multimeter, Blaster's Ohmmeter or Blaster's Galvanometer.
- b. The series circuit is the most commonly used in simple surface blasting work. As the shot size gets larger, the single series is broken down into two series, which are placed in parallel. As the shot gets larger still, additional series are placed in parallel. In these instances, it is important that the series are balanced. That is to say that the resistances of the individual series are approximately equal. This helps assure equal current flow through each of the series.
- c. The straight circuit is not normally used in surface work. It is used underground when firing with power lines and then only by personnel experienced in its use.
- d. The Blaster's Galvanometer, Blaster's Ohmmeter, or the Blaster's Multimeter are the only devices that shall be used in measuring blasting circuit resistance. The current that they put through the circuit is well below that required to detonate an electric blasting cap. Other types of ohmmeters and multi-meters can detonate caps in the blasting circuit and shall never be allowed anywhere near the blast site.

### EQUATIONS FOR BLASTING CIRCUITS

Resistance of a Series Circuit (OHMS)

$$R_T = R_1 + R_2 + R_3 \text{ etc.}$$

Series in Parallel Circuit (OHMS) [See illustrations of problems on pages 23 and 24]

Circuit Resistance =  $\frac{\text{No. Caps} \times \text{Res. one cap}}{\text{Number of Series}}$  or  $\frac{\text{Resistance of one Series}}{\text{Number of Series}}$

Ohms Law

The current (I) flowing in an electrical circuit is equal to the applied voltage (E) divided by the resistance (R).

$$I = \frac{E}{R}$$

Where: I = Current in amperes  
E = Applied voltage in volts  
R = Resistance in Ohms

6. CURRENT REQUIREMENTS FOR ELECTRIC BLASTING CAPS
- a. In order to fire an electric cap, the bridge wire (or electric match, in an Atlas cap) must be heated by the electrical current to the temperature necessary to light the ignition charge. This could be done with a relatively low current flow of 0.4 to 0.5 amps; however, the time required to ignite the cap at these low current levels may vary from a few to several hundred milliseconds. At low current levels, with more than one cap in the circuit, one cap may fire before the bridge wires in the remaining caps reach ignition temperature. When this happens, the circuit would be opened and any remaining bridge wires would cool down and misfires would result. For this

# CALTRANS BLASTING MANUAL

reason, it is necessary to provide all caps in the blasting circuit with current levels high enough to provide reliable initiation.

- b. The basic guidelines that follow apply to all electric blasting caps. NEVER MIX CAPS FROM ONE MANUFACTURER WITH THOSE OF ANOTHER IN THE SAME BLAST. They don't have the same timing intervals and the resistance values differ. Various manufacturers recommend different current levels for their caps. If you have a question pertaining to a particular manufacturer's caps, you should contact the manufacturer or their representative.

Maximum continuous current through a delay cap .....		.10 amps
Minimum firing current.....	Series circuit (DC) .....	1.5 amps
	Series circuit (AC) .....	3.0 amps
	Parallel (AC or DC) .....	1.5 amps
Series-in-parallel (AC or DC) .....		2.0 amps
		Per series
Maximum non-firing current (short time periods) .....		.25 amps
Maximum allowable stray current.....		.05 amps
		(Or 50 milliamps)

## 7. INITIATION METHOD

The only method of initiating electric blasting caps is with an approved blasting machine. There are two basic types of blasting machine; generator ("plunger" and "twist-handle") and capacitor-discharge (CD). ONLY CD TYPE SHALL BE USED BY CALTRANS. The rated capacity of a blasting machine is listed on the name plate and should be followed. Properly used and maintained, a blasting machine should consistently fire circuits for which they are rated. Capacitor-discharge machines are available that will shoot as many as 1200 30-ft electric blasting caps at one time.

## 8. HAZARDS

Extraneous electricity represents the greatest hazard when using electric blasting caps. This hazard can come from various sources, any of which could prematurely detonate the shot. Some sources of extraneous electricity:

- a. Stray Current - This can come from nearby operating electrical equipment, power plants, etc., and usually results from faulty grounding or improper insulation. It can also be caused by galvanic action from dissimilar metals in the ground. It can enter the blasting circuit through bare splices lying on the ground, skinned wires in the hole, and anywhere else that bare portions of the circuit are in contact with a conductor or the ground. Prior to blasting electrically, tests for stray current should be accomplished with a Blaster's Multimeter (with the capability of testing for stray current). Instructions for conducting tests for stray current are included with the instrument. If stray current exceeds .05 amps (or 50 milliamps) and cannot be reduced or eliminated, electrical blasting must be discontinued.
- b. Static Electricity - There are numerous sources of static electricity, i.e., low humidity and high wind, clothing worn by the blaster, and "Whipping" a firing line through dry grass.
- c. Lightning - This represents a hazard, not only when using electric initiation, but to ALL blasting. Upon the approach of an electrical storm, all blasting operations shall be discontinued and personnel withdrawn to a place of safety until the hazard has passed.

## CALTRANS BLASTING MANUAL

- d. Radio Frequency (RF) Energy - This hazard comes in the form of powerful electromagnetic fields generated by transmitters. Blasting circuits, acting as receiving antennas, can pick up sufficient electrical energy to cause one or more of the caps to detonate.

The two major sources of RF energy of particular concern to the blaster are: One, Commercial AM broadcast transmitters, because the transmitting frequency is low and the power output can be very high. Luckily, their antennas are usually quite visible. And two, Mobile radio transmitters, mainly because of the hazard they pose if brought into or near the shot area. See IME Publication 20 for further information on this potential hazard.

- e. High Voltage Power Lines - These present two different hazards. The first is from current induced into a blasting circuit that is located near the power line. The second comes from having the firing line thrown up into the power lines from the force of the blast. This latter occurrence has killed more blasters than premature blasts caused by induced current. The licensed blaster shall notify the utility company at least 24 hours in advance of the blasting operation unless it is an emergency.

### 9. HANDLING MISFIRES

- a. No two misfires are alike. The handling of misfires is the most hazardous operation that the blaster is likely to encounter. Some telltale signs of a misfire:
  - 1. Detonating cord tails or remnants.
  - 2. ANFO or other explosive residue.
  - 3. Collar of hole undisturbed.
  - 4. Shape of muck pile not as anticipated.
- b. Minimum return time to a suspected misfire:
  - 1. Cap and safety fuse - 60 minutes  
Avalanche – 60 minutes
  - 2. Other initiation - 30 minutes

Note that these are MINIMUM times. A longer time may be required depending on the situation.

- c. Disposing of a misfire:
  - 1. Determine if it is safe to shoot misfired hole(s). In some instances, there is insufficient burden and firing the hole would be more hazardous than removing the explosives.
  - 2. If using electric caps and detonating cord, hook up again and attempt to re-fire. Remember to go through blasting signals and all other procedures as though it were a regular blast.
  - 3. Remove stemming material, re-prime top of powder column, stem and re-fire.
  - 4. Remove stemming material and ALL explosives. The stemming and explosive shall be washed out with water. In a case of absolute necessity, air may be used provided a suitable nonmetallic, non-static prod or hose is used.
  - 5. Holes shall never be drilled where there is danger of intersecting a charged hole of misfired explosives.
  - 6. No other work shall be performed in the danger area except that necessary to remove the hazard of the misfire. No other employees except the licensed

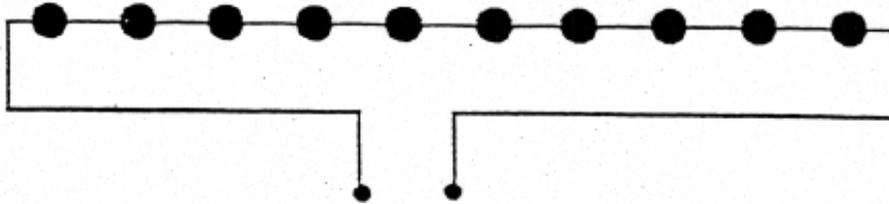
## CALTRANS BLASTING MANUAL

blaster and the necessary crew shall be in the danger area when a misfire hazard is being removed.

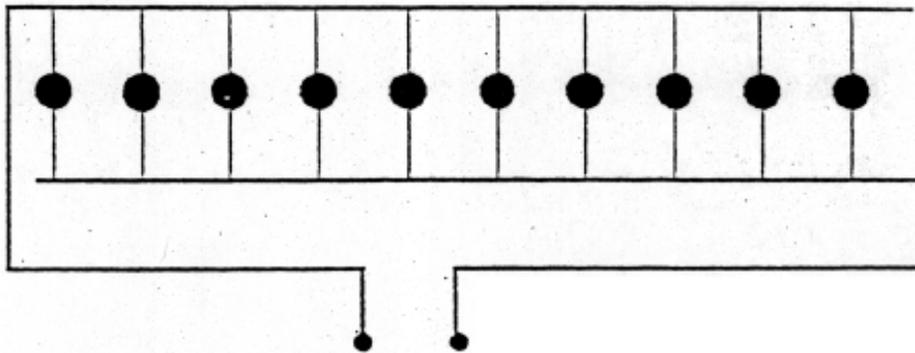
**CAUTION:** Remember that every misfire can present a different set of problems. Watch for them. Be sure of what you are doing. If in doubt, obtain experienced help.

BLASTING CIRCUITS

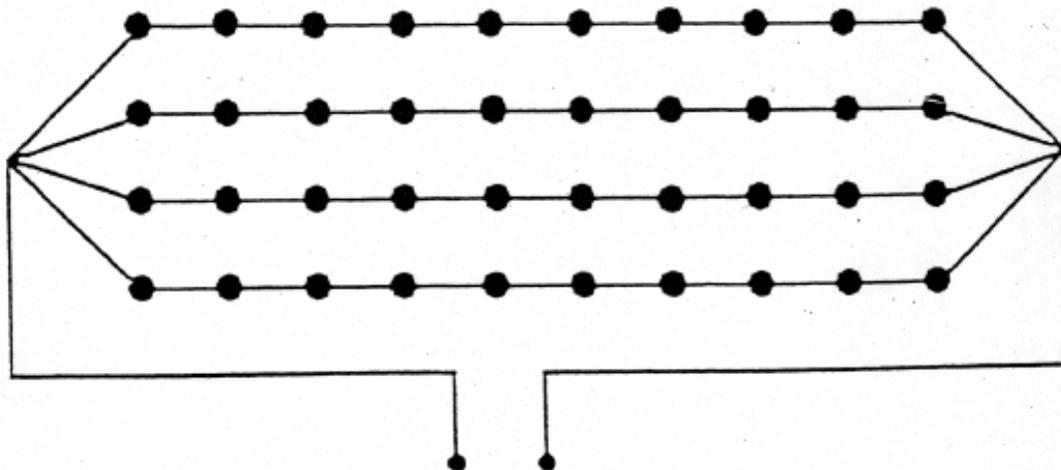
SERIES



PARALLEL



SERIES-IN-PARALLEL



# CALTRANS BLASTING MANUAL

**TABLE 11-1**  
Nominal Resistance\* of Du Pont Electric  
Blasting Caps in Ohms per Cap

Length of Wire in Feet	Copper Wire		Iron Wire		Length of Wire in Feet
	Instantaneous Caps	Delay Caps	Instantaneous Caps	Delay Caps	
4	1.26	1.16	2.10	2.00	4
6	1.34	1.24	2.59	2.49	6
7			2.84		7
8	1.42	1.32	3.09	2.99	8
9			3.34		9
10	1.50	1.40	3.59	3.49	10
12	1.58	1.48	4.09	3.99	12
14	1.67	1.57	4.58	4.48	14
16	1.75	1.65	5.08	4.98	16
20	1.91	1.81	6.08	5.98	20
24	2.07	1.97			24
30	2.31	2.21			30
40	2.15	2.06			40
50	2.42	2.32			50
60	2.69	2.59			60
80	2.71	2.61			80
100	3.11	3.01			100
120	3.51	3.41			120
150	4.11	4.01			150
200	5.12	5.02			200
250	6.12	6.02			250
300	7.13	7.03			300
400	9.13	90.3			400

\*At 68° Fahrenheit

**TABLE 11-2**  
Resistance\* of Copper Wire

AWG Gauge No.	Ohms per 1,000 Feet
6	0.395
8	0.628
10	0.999
12	1.588
14	2.525
16	4.02
18	6.39
20	10.15
22	16.14

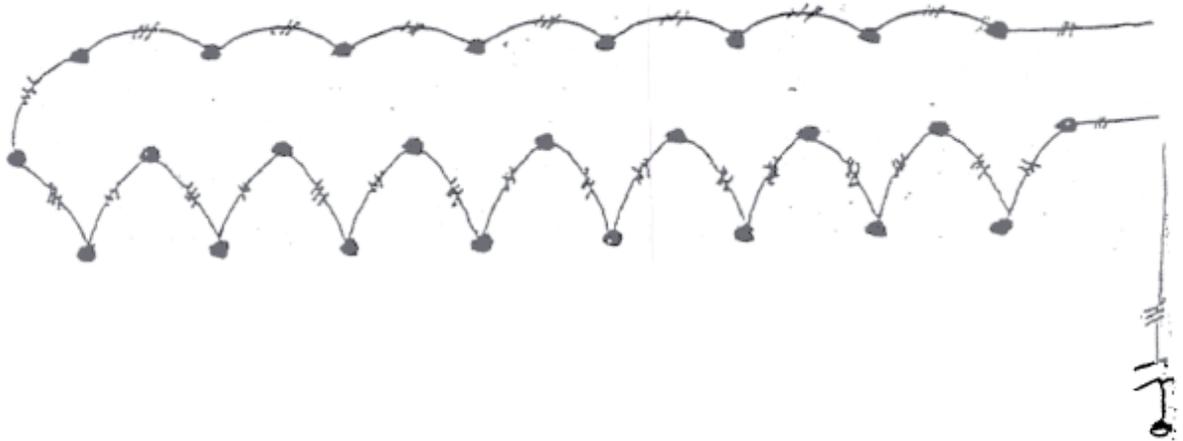
\*At 68° Fahrenheit

# CIRCUIT RESISTANCE and its MEASUREMENT

Series Circuit of 25 40-ft. Copper Wire DuPont MS  
Delay Blasting Caps with a 600-ft. 14-Gauge Copper  
Lead Line and 100-ft. 20-Gauge Connecting Line

Resistance of a Series Circuit

$$R_T = \text{No. Caps} \times \text{Res. One Cap} + R_{FL} + R_{CL}$$

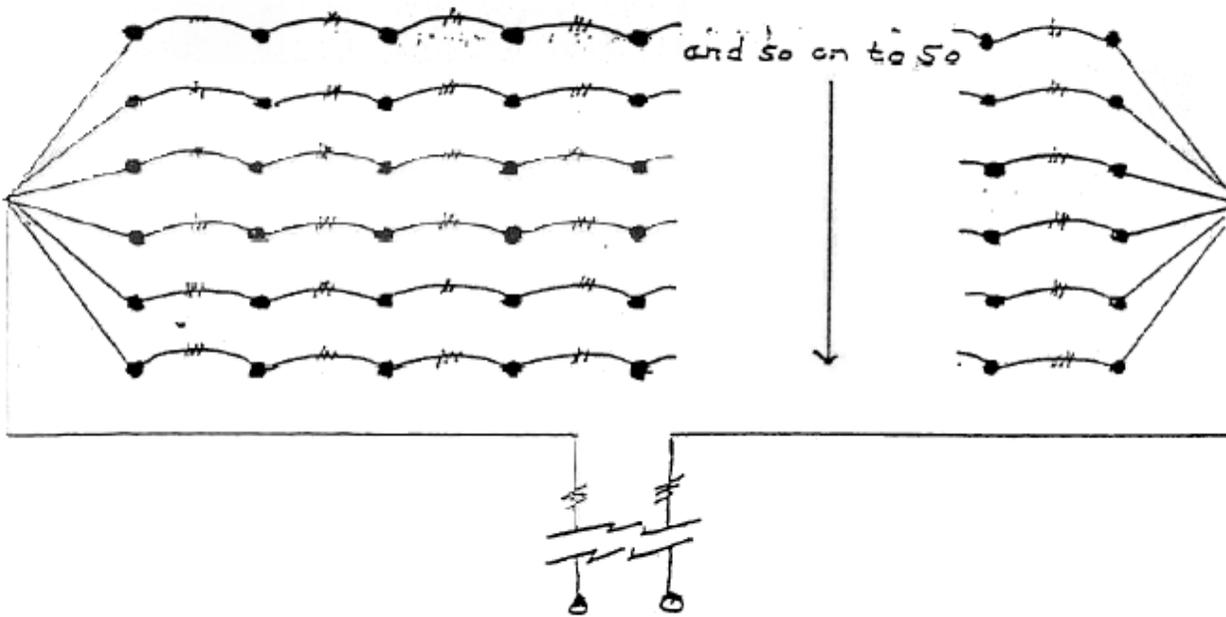


# CIRCUIT RESISTANCE and its MEASUREMENT

Series-In-Parallel Circuit of 300.50-ft. Copper Wire  
DuPont MS Delay Caps Connected In Six Series With  
Caps-Per-Series, A 700-ft. 14-Guage Copper Wire  
Lead Line, and a 200-ft 20-Guage Copper Wire  
Connecting Line.

Resistance of a Series-In-Paralle Circuit

$$R_T = \frac{\text{No. Caps (One Series)} \times \text{Res. One Cap}}{\text{No. of Series}} + R_{FL} +$$



Note - In a series-in-parallel circuit each series should be electrically balanced. Usually, an equal number of caps in each series will produce a balanced series.

# CALTRANS BLASTING MANUAL

## A. Cap & Fuse Initiation

1. INITIATION EQUIPMENT
  - a. Fuse Cutter and Crimping Tool
  - b. Powder Punch (Non-sparking)
  - c. Black Plastic Tape
  - d. Pull Wire Igniters
  - e. Tamping Pole (Non-sparking)
  - f. Blow Pipe
  - g. Detonating Cord
  - h. Detonating Cord Connectors
  - i. Safety Fuse
  - j. Day Box and Cap Box (with lock)
  - k. Blaster's Log

2. DETONATING DEVICES

For the purpose of this text, safety fuse and fuse are synonymous.

Safety fuse is expressly for the purpose of transmitting flame to a blasting cap and consists of a center core of black powder, supported and enclosed in various wrappings and waterproofing materials. When safety fuse is ignited, the flame is contained within these wrappings and emerges first at the lit end as a jet of flame called the "end spit". In addition to transmitting flame to the cap, the fuse length provides a means whereby a time delay can be provided before the cap detonates.

The burning rate of safety fuse manufactured in the United States is 40 seconds per foot at sea level, plus or minus a tolerance of 10 percent. Several things affect the burning rate, including altitude, age, and compression, among others. It has been estimated that the burning rate slows down approximately 1 second for every 1000-foot increase in altitude.

Blasters shall know the burning rate for the fuse they are using. It is important that sufficient length be used to provide safe escape time for the blaster. The standard method for determining the burning rate is to test burn and time a 3-foot length. Under normal conditions, this would result in a 2-minute fuse; however, the tolerance alone could result in times 12 seconds longer or shorter. Other factors could add or subtract further time.

### **KNOW THE BURNING RATE OF ANY FUSE YOU ATTEMPT TO USE.**

- a. CAP AND FUSE
  1. Notice shall be displayed prominently at the work location stating the burning rate of the safety fuse used (see example of required notice on page 32).
  2. A waterproof ring-type crimp or a compound especially prepared for waterproofing shall be used in wet work. Oil or grease shall not be used to waterproof joints between cap and safety fuse as they may injure the safety fuse or cause misfires.
  3. In capping a safety fuse, at least 1 inch shall be cut from the end of each coil of fuse to be used. This will prevent damp fuse ends from getting into the cap.
  4. When capping a safety fuse, the fuse ends shall be cut squarely across with a clean, sharp cutting blade, and square cut end gently seated without twisting against the detonating compound in the cap at the time of crimping. Methods of attaching the capped fuse to the primer cartridge which involve half-hitching the fuse around the cartridge or otherwise causing short bends in the fuse shall not be used.

## CALTRANS BLASTING MANUAL

**NOTE:** It is recommended that the string-tied method be used, that the fuse be laced through the cartridge (see illustration on page 33), or that some other equally effective method of attachment be followed. (Example: Taping with electrical tape)

5. Only a cap crimper designed for the purpose shall be used for attaching the blasting cap to a fuse. Knives, ordinary pliers, teeth, or other inadequate substitutes shall not be used.
6. All safety fuses shall be cut sufficiently long to extend beyond the collar of the hole, and in no case shall they be less than 3 feet in length. Exception: avalanche blasting.
7. Damaged safety fuse shall not be used. Damage of certain types, especially that resulting from a crushing blow, may affect the rate of burning.
8. Safety fuse should be cut into desired lengths and capped in a location properly equipped and suited for such work.
9. Caps shall not be removed from original containers except where they are to be used promptly in capping fuses for current use.
10. When lighting safety fuses, considerations shall be given to the length and condition of the blaster's route to a place of safety.
11. No more than 12 safety fuses shall be ignited consecutively before seeking a place of safety. Timing shall be such that no charge will detonate until at least 2 minutes after the last fuse in the blast area has been ignited. Exception: Avalanche: A blaster shall only work with one hand charge at a time.

**NOTE:** When 2 or more safety fuses in a group are lit as 1 fuse, they may be considered as 1 fuse for the purpose of this section.

12. If there is reason to believe that any charge has not exploded, no person shall approach the place where such charge was placed for a period of 60 minutes after the firing (see Misfires).
13. Regulations specify a minimum safety fuse length of 36 inches (approximately 2 minutes). Under certain conditions, this amount of time could be insufficient and a longer fuse should be selected. Plan your shot and determine the fuse lengths so that sufficient escape time remains after the last fuse is lit.
14. For avalanche, safety fuse shall be cut to allow a burn rate of no less than 90 seconds.
15. Two people must be present when lighting fuses by hand. Each person may light no more than 12 individual fuses. Don't kink or damage fuses. Don't use damaged fuse.
16. Keep safety fuse ends dry. Inspect for and guard against damp fuse ends. If you suspect fuse may have absorbed moisture, cut off and discard a short length to eliminate the moisture.
17. Cut safety fuse end square with a fuse cutting tool, sharp knife or razor blade. Make sure that none of the outer wax coating is smeared across the powder core.
18. Make sure the cap contains no foreign matter. NEVER insert anything in a cap except safety fuse. Moisture in the cap is just as detrimental as moisture in the fuse. Blasting caps that have been exposed to excessive moisture should not be used.
19. Use only an approved cap crimper that is in good condition to attach the cap to the safety fuse. Never make up a cap and safety fuse assembly in a magazine or near a source of ignition.

## CALTRANS BLASTING MANUAL

20. Before crimping a cap onto a length of safety fuse, be sure that the fuse end is seated lightly but snugly against detonating compound in the cap. DO NOT TWIST THE FUSE IN THE CAP.
21. Crimp the cap onto the fuse, being careful not to accidentally crimp into the detonating compound in the cap. Properly done, the resulting crimp needs no further waterproofing.
22. If, however, there is concern that moisture could penetrate the joint and cause a misfire, the cap and fuse assembly can be dipped in an approved waterproofing agent. Never use grease or oil. They could penetrate the fuse materials and cause further problems.
23. In lighting fuses, it is recommended that only those devices designed for the purpose be used. These consist of pull wire igniters, lead spitter and ignitacord connectors. Never use a cigarette or pipe lighter for this purpose. It is possible to ignite the fuse jacket, the results of which could be quite unpredictable. When using pull-wire lighters, it is important that the igniter is attached just prior to lighting the fuse.

### 3. DETONATING CORD

- a. Detonating cord is a strong flexible cord with a core containing an explosive. In most commercial grades, the explosive is PETN (pentaerythritol tetranitrate). When detonating cord is initiated with a blasting cap, it detonates along its entire length at a velocity of approximately 23,000 feet per second. As it detonates, it has the equivalent initiating energy of a blasting cap at all points. Recommended grades, when used as trunk lines, will initiate any number of additional lengths, extension or branches through proper knot connections.
- b. There are two primary disadvantages to the use of detonating cord:
  - (1) Air blast
  - (2) Fire hazard.

These normally limit the use of detonating cord to isolated areas and areas of low fire hazard. Air blast can be minimized if the cord can be covered with sand or dirt. Normally, it takes about 6 inches of sand to make an appreciable difference in the noise level.
- c. Detonating cord can initiate any cap-sensitive explosive that it contacts.
- d. Although detonating cord is relatively insensitive to premature or accidental detonation from heat, friction, impact, stray current and static electricity, it must still be treated with the respect due any explosive.
- e. Detonating cord is capable of detonating in both directions. For this reason, always cut the detonating cord from the spool after the appropriate amount has been unreeled.
- f. When tying-in a shot with detonating cord, it is preferable to use a closed loop system. This provides two paths of initiation to each explosive charge. If the shot is quite large, the closed loop should have additional cross-ties. If the shot consists of a series of boulders or is a long, slender pattern, the closed loop may not be practical.
- g. Detonating cord can be used as a booster for any charge by making a closed loop (mach wave generator - see illustration on page 34) and is the recommended detonating method.
- h. When tying branches or down lines to a trunk line, use a clove hitch or double-wrap clove hitch (or similar knot that will result in a 90-degree tie-in angle and that will not

## CALTRANS BLASTING MANUAL

slip - see knot tying illustration on page 35). The tie-in angle should always be maintained as close to 90 degrees as possible to prevent a cut-off.

- i. Do not use damaged or kinked detonating cord. Do not make sharp bends or acute angles with the cord. This can also result in a cut-off of the powder train.
- j. Caps for firing the detonating cord shall not be brought onto the shot until everything else is in readiness for the blast. When attaching the cap, tape or tie it tightly to the cord with the business end of the cap pointing in the direction of desired detonation. It is good practice to attach the cap to a short pig-tail of detonating cord that is then tied to the closed loop system.
- k. Detonating cord that has absorbed moisture will detonate reliably through the damp portion, but may not be capable of being initiated at the damp area. For this reason, it is best to cut off any damp ends before tying in or attaching the initiating cap.
- l. Remnants of cord left over can be destroyed by gathering them into a bunch and attaching to the cord in the shot. It is recommended that this be done in a spot where the additional energy will not affect the shot.
- m. Devices called MS connectors can be utilized to provide short time delays between holes in a detonating cord initiated blast. These are commonly available in 9, 17, and 25 millisecond delays. Longer times are also manufactured. When using these devices in closed loop systems, care must be taken in planning the shot so that a portion of the closed loop does not negate the delay desired. Follow the manufacturer's recommendations packaged in the cartons when using MS connectors.

#### 4. INITIATING METHODS

- a. Pull Wire Igniter with Safety Fuse & Cap
- b. Nonel Blasting Cap
- c. Electric Blasting Cap
- d. Igniter Cord: A small cord which burns progressively along its length, with a short, hot, external flame at the zone of burning. Igniter cord is available in three different burning speeds:  
FAST 3 to 5 seconds per foot  
MEDIUM 5 to 10 seconds per foot  
SLOW 16 to 20 seconds per foot
- e. Quarrycord: A cord-type burning igniter designed mainly for firing a large number of charges in secondary blasting. "Quarrycord" burns at the rate of approximately one second per foot.
- f. Lead Spitter Fuse Lighter: A coil of thin lead tubing filled with black powder. Burning rate: 36 seconds per foot.
- g. Pull Wire Igniter: This is a paper tube closed at one end and containing an igniting device. The unit is placed over the end of the fuse and is lighted by pulling the protruding wire. Good for wind, rain and snow conditions.

# CALTRANS BLASTING MANUAL

## Non-Electric Initiation (NONELECTRIC SHOCK TUBE SYSTEM)

### 1. NONEL EQUIPMENT

- a. Approved Nonel Blasting Machine
- b. Powder Punch ( Non Sparking )
- c. Black Plastic Tape
- d. Plastic Shock Tube Splicers ( Approved)
- e. Tamping Pole ( Non Sparking)
- f. Blow Pipe
- g. Detonating Cord
- h. Detonating Cord Connectors
- i. Day Box and Cap Box (with lock)
- j. Cutting Tool (Non sparking)
- k. Shock Tube Lead In Line
- l. Nonel Detonators
- m. Surface Connectors
- n. Blasters Log

2. The Nonel blast initiation system consists of various initiation devices attached to lengths of shock tube. The shock tube, which is small diameter plastic tube containing a thin layer of reactive material (normally HMX and powdered aluminum), is the basis of the non-electric system. When initiated the shock tube transmits a low energy signal directly into the various initiating devices attached to it. The signal can best be described as a miniature dust explosion and travels through the tubing at approximately 6,500 feet per second. While the tubing is normally left intact after the signal has passed through, it may rupture at those points where there is an accumulation of the reactive material.

In order to start a reaction within the tubing, one must provide both heat and impact simultaneously. This can be accomplished with a blasting cap, an electric detonator, a shotgun primer, detonating cord, an electrically operated initiation device (specifically designed for the purpose) or another non-electric detonator. The reaction inside the tubing is of very low strength and will only serve to initiate the devices to which it has been assembled.

### 3. Splicing Tubing

Non-electric shock tube does not have sufficient energy to initiate cap-sensitive explosives with which it may come in contact. It also does not have sufficient energy to activate another length of tubing that it is alongside of, even if it is in contact with it. Thus, you cannot splice two shock tubes by tying them together as you would detonating cord. If shock tube must be spliced, it must be done only with the proper splicing kit, which consists of a short length of tubing into which the shock tube ends are inserted. When splicing non-electric shock tubes, keep all dirt and moisture out of the ends of the tubing. Failure to do so may result in a misfire when the reaction encounters the blockage. Insert the ends to be joined into the splice tube. It is an extremely tight fit and you probably will not be able to make the ends meet. This is intentional and a gap inside the splice tube of 1/4" to 1/2" is desirable.

## CALTRANS BLASTING MANUAL

### 4. ADVANTAGES AND DISADVANTAGES (non-electric shock tube)

The main advantage of non-electric initiation system over other means of initiation is that it cannot be initiated by RF energy, static electricity or other stray current. Although the hazards of capacitive induction and stray current radiating outward from a lightning strike are eliminated through the use of non-electric the hazard of a direct lightning strike still exists, hence the following is appropriate.

IF AN ELECTRICAL STORM APPROACHES, CLEAR THE BLAST AREA AND DO NOT LET ANYONE ENTER IT UNTIL THE STORM HAS PASSED AND LIGHTNING HAS MOVED OFF TO A SAFE DISTANCE.

Another advantage over electrical initiation is the flexibility provided by the capability of using a detonator to start another series of detonators (and a detonator in that series starting yet another series of detonators, etc.). In sequential initiation, this provides the blaster with an unlimited number of circuits. The main disadvantage to the non-electric shock tube system is that the system cannot be tested (as one would check an electrical circuit with a blasters multimeter). The system must be checked visually. For this reason, it is important to keep the blast hookup and the blast area neat and orderly. An additional minor disadvantage to the system is the bulk of the material for storage purposes. Non-electrics do not bundle as tightly as electric detonators. So-called redundant systems are even bulkier because they have two parallel tubes for each detonator.

### 5. SAFETY PRECAUTIONS AND SUGGESTIONS

- a. While non-electric tubing is relatively insensitive to friction and shock, these same cannot be said for the detonators are assembled to it. They must be treated with the same respect that is due any detonator. If an object were to be dropped on a length of tubing, it probably only damage the tube. If the same object were to fall on the detonator, it could result in a detonation. This may also start a reaction in the tube. In the case of the double ended delay or MS connector, which have devices on both ends, this could result in the connected portion of the blast being initiated.
- b. When using surface delays, after inspecting for proper connections, turn the connector block face down (small plastic "door" down) and cover the entire block with a couple shovels of drill cuttings or dirt. This should be done to prevent shrapnel from flying forward and cutting of tubes ahead of the initiating signal. A secondary purpose for covering these is to reduce noise. The double ended delay and Micro-Cap surface delay plastic connectors do not normally require this precaution, because are low-strength detonators contained in a stronger block.
- c. There will almost always be some excess tubing tails on the ground in the blast area after hooking up. These tails should be coiled or other wise gathered so that they cannot inadvertently come in contact with an earlier-firing detonator or detonating cord line that might initiate them earlier in the sequence than intended. It is not a good practice to cut this excess tubing from the circuit. Water or dirt entering the cut ends could result in a misfire. Coiling the tubing and placing a small rock on it will make the shot circuit easier to check visually.
- d. With the exception of MS connectors, when connected properly, non-electric devices will not initiate backwards through the system. While this can minimize the effect of an inadvertent detonation, it also means that the blaster cannot re-initiate a misfired blast from end opposite the original initiating point.
- e. Do not put BOTH shock tube and detonating cord in the same connector block. The signal travels at only 6500 ft. per second while the detonating cord detonates at

## CALTRANS BLASTING MANUAL

approximately 23,000 ft. per second. At some point, as the two are separated, the detonating cord will destroy the tubing without initiating it, resulting in a mis-fire.

- f. When a blast must be covered with mats or dirt, care must be taken to assure that nothing damages the shock tubes. Remember that they cannot be tested after they are covered.
- g. Regardless of the type of device used to initiate the non-electric system, it should not be brought onto the blast or connected to the system until everyone has been cleared to a safe location and the blast is ready to be fired.

### 6. HANDLING MISFIRES

No two misfires are alike. The handling of misfires is the most hazardous operation that the blaster is likely to encounter.

- a. Some telltale signs of a misfire:
  - (1). Detonating cord tails or remnants.
  - (2). ANFO or other explosive residue.
  - (3). Collar of hole undisturbed.
  - (4). Shape of muck pile not as anticipated.
  - (5). Shot didn't sound as expected.
  - (6) Unexploded Surface Connectors ( Nonel )
  - (7) Powdered Reactive Material present in Shock Tube ( Nonel )
- b. Minimum return time to a suspected misfire:
  - (1). Cap and safety fuse - 60 minutes (Including Avalanche – 60 min. )
  - (2). Other initiation - 30 minutes (Nonel & Electric)

NOTE: These are MINIMUM times. A longer time may be required, depending on the situation.
- c. Disposing of a misfire:
  - (1). Determine if it is safe to shoot misfired hole(s). In some instances, there is insufficient burden and firing the hole would be more hazardous than removing the explosives.
  - (2). If using cap and safety fuse and detonating cord, re-prime and attempt to re-fire. Remember to go through blasting signals and all other procedures as though it were a regular blast.
  - (3). Remove stemming material, re-prime top of powder column, stem and re-fire.
  - (4). Remove stemming material and ALL explosives.

**CAUTION:** Remember that every misfire can present a different set of problems. Watch for them. Be sure of what you are doing. If in doubt, obtain experienced help.

**NOTICE!**

**FUSE USED HERE**

**burns at the rate of**

**ONE FOOT in      SECONDS**

---

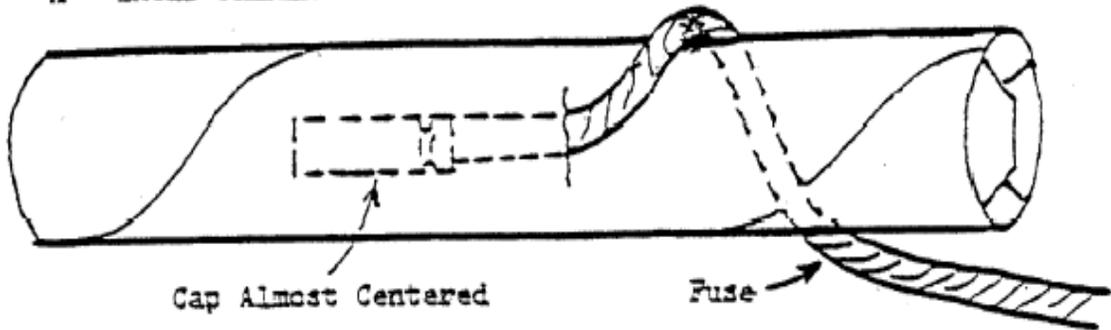
Form 6 12 Rev.

September 1962

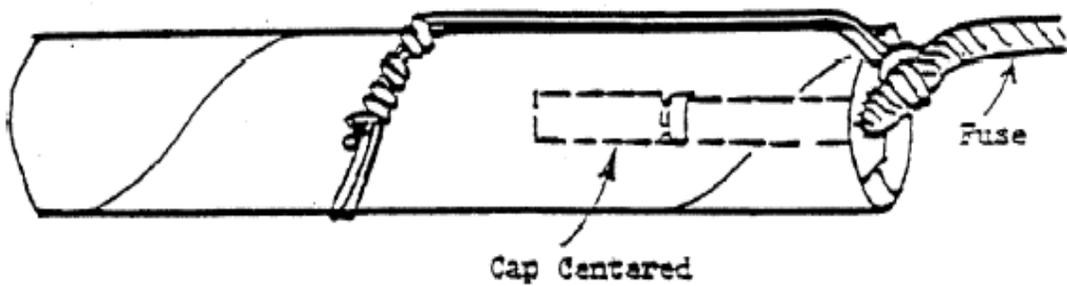
This form distributed by  
State of California  
Department of Industrial Relations  
**DIVISION OF INDUSTRIAL SAFETY**  
965 Mission St., San Francisco 3      357 So. Hill St., Los Angeles 13

# CALTRANS BLASTING MANUAL

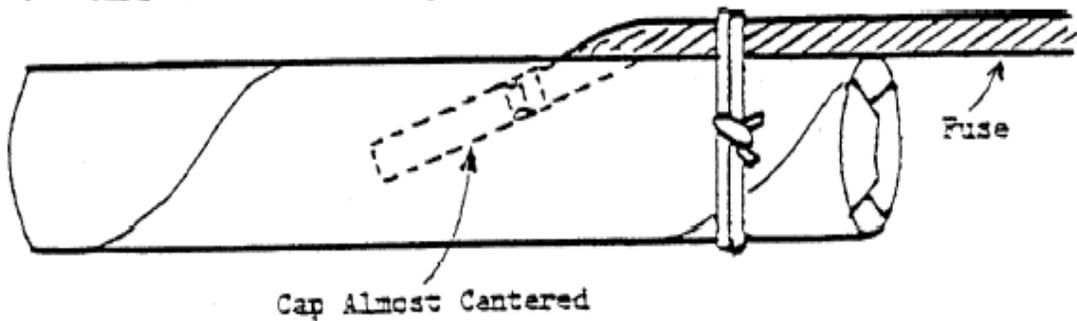
A - LACED PRIMER



B - CENTER PRIMING - String Tied

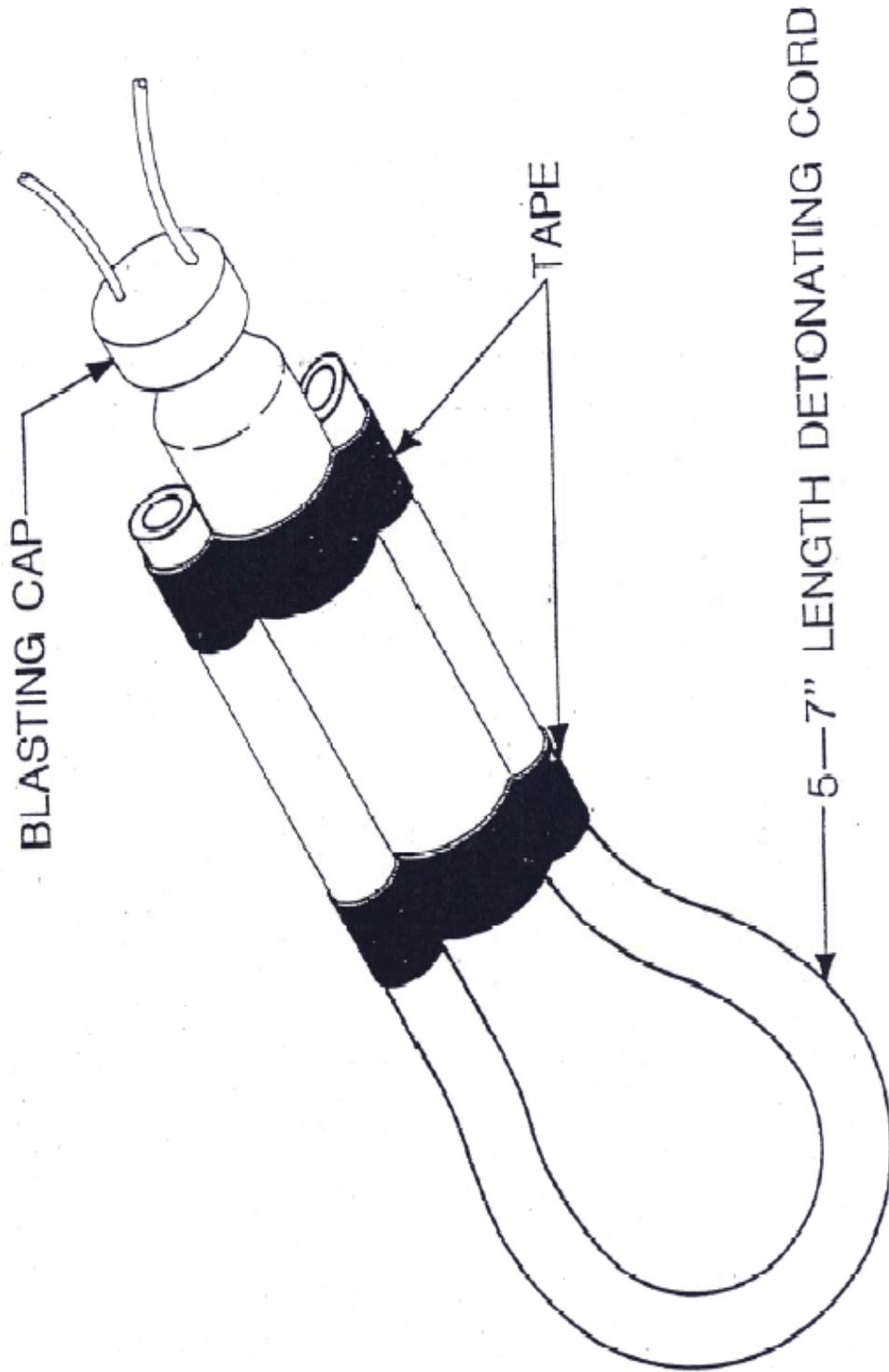


C - SIDE PRIMING - String Tied

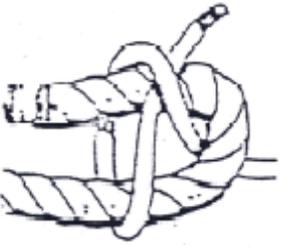
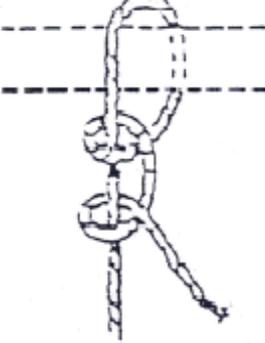
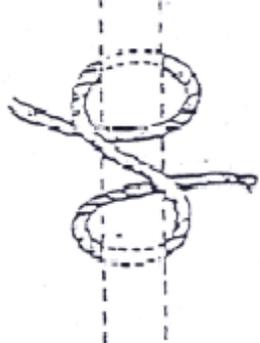
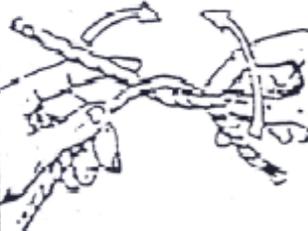
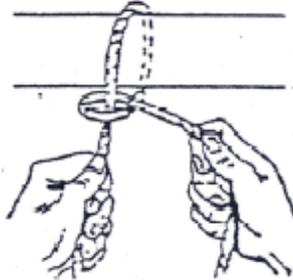
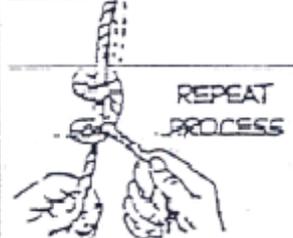
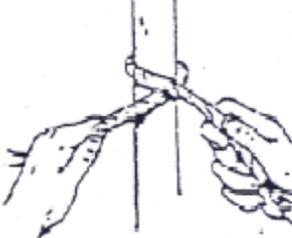


Don't use sharp bends that may cause failures.

MACH-WAVE GENERATOR



# CALTRANS BLASTING MANUAL

 <p><b>SQUARE KNOT</b> FOR TYING ROPES OF EQUAL THICKNESS. VERY USEFUL IN FIRST AID.</p>	 <p><b>SHEET BEND</b> FOR JOINING TWO ROPES TOGETHER OF DIFFERENT THICKNESS.</p>	 <p><b>TWO HALF HITCHES</b> FOR TYING A ROPE TO A POLE OR RING.</p>	 <p><b>CLOVE HITCH</b> FOR SECURING BOATS - FOR LASHINGS.</p>
<p><b>SQUARE KNOT</b></p>  <p>TWIST LEFTHAND ROPE END OVER, BEHIND, UNDER RIGHT HAND ROPE.</p>  <p>AGAIN TWIST SAME END AS BEFORE... OVER, BEHIND, UNDER. LEFT OVER RIGHT - RIGHT OVER LEFT!</p>	<p><b>SHEET BEND</b></p>  <p>FORM A BIGHT (LOOP) ON THE HEAVIER ROPE. BRING OTHER LINE END THROUGH LOOP, TWIST IT OVER AND UNDER LOOP.</p>  <p>THEN BRING SMALL LINE IN UNDER ITSELF.</p>	<p><b>TWO HALF HITCHES</b></p>  <p>PASS ROPE AROUND POLE. CARRY ROPE END OVER AND UNDER AND THROUGH LOOP THUS FORMED.</p>  <p>REPEAT PROCESS</p>	<p><b>CLOVE HITCH</b></p>  <p>BRING ROPE END AROUND POLE, LAY IT OVER THE ROPE ITSELF.</p>  <p>BRING END ONCE MORE AROUND POLE. CARRY END UNDER THE ROPE ITSELF.</p>

# CALTRANS BLASTING MANUAL

## V. BLAST DESIGN, AIR BLAST AND VIBRATION

### A. Blast Design

Blast design is not a precise science. Most successful blasters use some rule of thumb (basic fundamentals) in designing their blasts, but usually only achieve their goals after gaining experience in blasting the particular type of rock at hand. The powder factors and other guidelines listed in this section have been derived after reviewing the results of many blasting operations encompassing many variable factors. It is not intended that they be considered as recommendations for any particular blasting situation. The final responsibility for blast design must always be assumed by the blaster.

An individual tool for the blaster is a file of blast reports. Not only do these provide evidence of the manner in which the job is accomplished, but also provide a wealth of information which can be drawn upon as future blasting situations develop.

1. SHOT PLANNING - In order to properly design any blast, the blaster must first do adequate shot planning. At a minimum, this would consist of defining the following:
  - a. Breakage desired:
    - Size of digging/handling equipment
    - Size of crushing equipment (if required)
    - Rip-rap or dimensional stone
    - Other size limitations
  - b. Rock quality/character:
    - Hard?      Soft?      Porous?
    - Wet?      Dry?      Variable?
    - Joint and slip planes?      Bedding planes?
    - Voids or other incompetent zones?
  - c. Site limitations:
    - Structures/property to protect?
    - Distance to nearest structures?
    - Utilities nearby?      Traffic?
  - d. Safety limitations:
    - Adequate protection from flyrock?
    - Weather - LIGHTNING a possibility?
      - Humidity high/low?
    - Electrical hazards?      RF hazards?
    - Ventilation?      Impact hazards (rock falls)?
  - e. Equipment/materials limitations:
    - Drilling equipment - Size, condition
    - Explosives - Type, size, quantity available
    - Accessories - Blasting machine capacity
      - Firing line length
2. BLAST CALCULATIONS - In the following discussions on blast calculations, reference will occasionally be made to various powder factors. Powder factor (expressed in pounds of explosive per cubic yard of rock) is not the best tool for designing blasts; however, it presents the blaster with a useful yardstick with which to compare somewhat similar blasts.

## CALTRANS BLASTING MANUAL

- a. **BOULDER BLASTING** - This usually involves rock that has less confinement than that encountered in production blasting. As a result, the probability of flyrock occurring is much greater. Adequate means must be used to contain the flyrock in those locations where it could cause damage.
1. **BLOCK-HOLING** requires that explosives be loaded into one or more holes drilled into the rock, normally to a depth of 55 to 60 percent of the depth or thickness of the rock. The powder factor for block-holing varies depending on the quality of the rock, site safety limitations, and whether or not it is partially buried. (If the boulder is of sufficient size that a large number of holes is required, better results might be obtained if the shot is designed as a production blast as outlined later in this section.) Some typical powder factors from previous block-hole shots are as follows:

Completely buried:	.34 lb/cu.yd.
Free boulder:	.17 lb/cu.yd.
Vicinity of buildings:	.08 -.14 lb/cu.yd.
Lowest probable effective:	.05 lb/cu.yd.

If there is any chance that damage can occur from flyrock, adequate covering must be used.
  2. **MUD-CAPPING** (cone blasting), is the usual method used when it isn't possible or practical to drill the rock. It shall only be used where the resulting air-blast can be tolerated. Because the gas generation property of the explosive is lost in this method, a larger quantity of explosive will be required to adequately break the rock. A high velocity explosive with good shattering capability should be used. The amount of explosive required can be reduced by approximately 25 percent by covering the charge with a 6-inch layer of mud. The mud must be free of all stones and other materials that could become projectiles. The efficiency of the charge can also be increased by making sure that there is good contact (coupling) between the boulder and the charge. Some imagination must be used in selecting the location of the charge. Experience will show that the charge works best when placed where one would normally strike the boulder with a hammer if you were attempting to break it by hand. Care must be taken, however, as there will usually be excessive flyrock from the side of the boulder opposite the charge. Powder factors for mud-capping can range from 1.5 to 4.0 lbs/cu.yd.
  3. **SNAKE-HOLING** is a method used on boulders that are partially buried. A hole is punched under the rock and is loaded with the required explosives. In instances where a larger quantity of explosives must be loaded, the hole is usually "sprung" with a small charge and, after allowing time for the cavity to cool, loaded with the required charge. The primer is usually loaded last. Depending on the charge weight, the boulder can be broken and/or expelled from the hole. The powder factor for this type of blasting is usually larger than block-holing, but is less than mud-capping. As in all boulder blasting operations, adequate confinement of flyrock is important.

## CALTRANS BLASTING MANUAL

4. SEAM-BLASTING consists of loading explosives directly into deep seams or cracks in the rock. The seam should be well situated and at least 3/4" wide for this method to work. Confinement of the explosive through the use of stemming material or mud-capping is important. The powder factor for this type of boulder blasting will be slightly higher than block-holing. This method of blasting boulders is the least desirable due to the likelihood of flyrock and the problems of charge location and confinement.
5. PRODUCTION BLASTING, as used in this section, refers to the blasting of a rock mass where a larger number of holes must be drilled and loaded. This type of blasting would typically be found in quarrying, ditching, side-hill cuts, through-cuts, etc. (Not normally used by Caltrans personnel.)
6. TIMING PATTERNS - As noted earlier in the sections on initiation systems, there are two basic delay types, long period delays and short period (millisecond) delays. The timing patterns that we will be considering here are of the millisecond delay type.  
Millisecond delays are used between charges in a blast for several basic reasons:
  - a. To assure that one or more free faces progress through the shot, providing a consistent burden.
  - b. To enhance fragmentation between adjacent holes.
  - c. To reduce ground vibration and air-blast.
  - d. To provide a means of directing the displacement of the blasted material.

Theoretically, it is possible to "fine tune" the timing of a blast to achieve ideal results. In most instances, however, the blaster must design his blast using the standard millisecond (ms) delays provided by the manufacturer. Under normal circumstances, these will suffice. In critical situations, where strict vibration controls or other site conditions dictate their use, systems are available that provide a greater range of timing. These are not within the scope of this manual. Should the need for them arise, it is suggested that the explosive supplier or other acknowledged authority be contacted regarding their use.

Lately, with greater demands for better fragmentation and reduced vibration, considerable research has been done with timing ratios as applied to burden and spacing. Some of the basic guidelines that have been developed are:

Where air-blast is critical, the delay between holes is very important. This results in a blast progression that is approximately half the speed of sound and reduces the air blast effect generated by face movement.

From a practical standpoint, the nominal time between delay numbers is often what is used. In the case of detonating cord with ms connectors, the delay nearest meeting this criterion would work best. Where possible, corner holes should be given extra delay time.

The delay time between rows should be two to three times the delay time between holes in a row.

The last row in the shot is often delayed slightly more than preceding rows. This serves to allow rock in previously fired rows time to move out and tends to reduce back-break in the remaining face.

Non-electric shock tube blasting system has the most versatile delay capability.

# CALTRANS BLASTING MANUAL

## B. Air Blast

Air-blast is an impulsive sound generated by an explosive blast and the resulting rock fragmentation and movement.

Sources of air-blast would include the following:

1. The detonation of surface charges.
2. Detonating cord trunk-lines on the surface.
3. Rock displacement, either at the face or around the collar of the borehole.
4. Gas escaping through fractured rock.
5. Gas escaping through blown out stemming.

The following variables have an effect on the character and level of air-blast:

- a. Charge weight.
- b. Distance.
- c. Delay intervals between holes.
- d. Face orientation.
- e. Explosive confinement.
- f. Weather.

Some reduction in the air-blast from a detonating cord initiation system can be achieved through the use of covering with a minimum of 6 inches of material and the use of the lightest grade of detonating cord that is consistent with the task at hand.

It is difficult, if not impossible, to cover surface charges sufficiently to achieve a reasonable reduction in air-blast. Consequently, surface charge use shall be restricted to those areas where air-blast would not cause problems.

Good blasting practices, involving proper stemming techniques, hole patterns, powder factors and timing will help reduce excessive air-blast from the other sources.

## C. Vibration

Vibration, or seismic energy, is an undesirable side-effect of blasting. It is usually described as the displacement, acceleration or velocity of a particular point (or particle) in the ground. Peak particle velocity (PPV) has been universally accepted as the best description of vibration.

The following conditions contribute to blast-induced vibration:

1. Excessive number of holes firing on the same delay.
2. Excessive burden on a hole.
3. Incorrect timing patterns.
4. Excessive number of rows in the blast.
5. Holes that are under loaded.

# CALTRANS BLASTING MANUAL

## VI. STORAGE

All explosives must be stored in an acceptable magazine to prevent theft or premature detonation.

### A. Types of Magazines

Type	Description	Bullets	Resistant to		
			Fire	Weather	Theft
I	Permanent Building	X	X	X	X
II	Portable	X	X	X	X
III	Day Box		X	X	X
IV	Trailer, Shed		X	X	X
V	Trailer, Shed			X	X

All classes of explosives can be stored in Types I, II, III.

Type IV is used for the storage of low explosives, blasting agents or 1.4B detonators.

Type V is used for the storage of blasting agents only.

Detonators are **never** to be stored with other classes of explosives.

Detonating cord shall not be kept or stored with blasting caps, but may be stored with other explosives.

Type III magazines (day boxes) must be attended at all times and do not normally contain more explosives than are expected to be used that day. Explosives must be returned to a Type I or Type II magazine at end of shift or workday.

All trailer magazines must be immobilized. (tires removed or locking device on King pin)

### B. Magazine Construction

Magazine construction shall comply with General Industry Safety Orders (GISO) subsection 5254 and 5255 and Bureau of Alcohol, Tobacco, and Firearms subsection 55.207 thru 55.211.

Magazines must have (two) five –tumbler locks with 3/8" shackles. All locks must be protected with a ¼ " steel hood. Exceptions are Type III magazines (day boxes) that require only one lock that need not protected with a hood.

No metal may be exposed on the interior of a magazine.

All types of magazines must be ventilated. Exceptions are Type III magazines (day boxes).

All magazines should be grounded. MSHA and Cal OSHA require that metal magazines be electrically bonded and grounded.

### C. Magazine Placement

Magazine shall be located and protected so as to prevent accidental impact from vehicles and falling objects. They shall be at least 100 feet from high voltage power lines and 25 feet from low voltage power lines. Magazines shall be located in accordance with the American Table of Distances from buildings and roads (see copy of GISO 5252-5253 on pages 39-41). Signs reading "EXPLOSIVES, KEEP OFF" shall be located on all approaches to the magazine and placed so that a bullet passing through the sign would not strike the magazine.

# CALTRANS BLASTING MANUAL

## D. Housekeeping

1. Areas around magazines shall be kept free of rubbish, dry weeds and other combustible materials for at least 50 feet.
2. The interior of the magazine shall be kept clean and neat with cases stored flat, top side up. Corresponding grades and sizes should be stored together with marking exposed for easy identification.
3. Non-sparking tools only shall be allowed on the interior of the magazine.
4. No match, fire, or lighting device of any kind, except electric flashlight, electric lantern, or permissible cap light, shall be permitted in a magazine at any time.

## E. Inventory

1. Inventory is defined as all explosive materials, explosive components, ammunition, blasting caps, fuse, detonating cord, nonel materials, Locat rounds including Locat arming devices and/or Locat fuse, any type of initiation devices, igniters, etc.
2. An independent physical inventory of all explosive materials and explosive components must be performed and documented at least once every ninety calendar days. The person performing the independent physical inventory will be a licensed blaster or a trainee under the direct supervision of a licensed blaster and will verify the count of the explosive materials, explosive components, report and record any discrepancies, and sign the inventory log.
3. All explosive materials and explosive components, including explosive materials and explosive components used for training purposes are to be recorded into and charged from the Service and Supply System (SVS) and Integrated Maintenance Management System (IMMS). In the event of a discrepancy between the SVS/IMMS inventory information and the explosive magazine inventory document, the explosive magazine inventory document shall take precedence and the SVS/IMMS information shall be corrected.

## F. Records and Thefts

1. Adequate records shall be maintained at all times. In case of theft, current inventory records shall be accurate to determine what is missing (see Section XIII Record Keeping). Any person who has knowledge of the theft or loss of any explosive materials or explosive components from their stock must report the theft or loss within 24 hours of discovery to ATF and to the appropriate local authorities. Regulations at 27 CFR 55.30 implementing section 842(k), require that the report of theft or loss be made by telephone and in writing to BATF).
2. In accordance with OSHA requirements, magazines shall be checked at least every seven days to determine whether an unauthorized entry has occurred. It is recommended that a security check inspection of explosive magazines be performed on Mondays and Fridays or the next working day so that evidence of an unauthorized entry over a weekend can be identified promptly. Magazine inventory and security check shall be in duplicate. One copy remains in the magazine, the other copy secured in the supervisor's office.

## CALTRANS BLASTING MANUAL

3. If a theft or unauthorized entry is discovered report the circumstances to your supervisor immediately. Perform a complete physical inventory count of explosive materials and explosive components to determine what is missing. The supervisor or blaster shall immediately notify the nearest Bureau of Alcohol, Tobacco and Firearms (BATF) office or call the toll free number at 1-800-800-3855.
4. The supervisor shall notify local law enforcement agencies to report the theft or loss.
5. Complete the report form (ATF Form F5400.5) and attach any additional sheets or invoices necessary to provide the required information and mail or fax it to the ATF office nearest you.

# CALTRANS BLASTING MANUAL

<p>14. Method of Entry <i>(Complete if applicable)</i></p> <p>Locks Cut <input type="checkbox"/>      Inside Help <input type="checkbox"/></p> <p>Locks Picked <input type="checkbox"/>      Wall Entry <input type="checkbox"/></p> <p>Door Unlocked <input type="checkbox"/>      Key Stolen/ Used <input type="checkbox"/></p> <p>Door Blown Open <input type="checkbox"/></p>	<p>15. Hood Defeated <i>(If yes, check the applicable box below)</i>    Yes <input type="checkbox"/>    No <input type="checkbox"/></p> <p>Broken <input type="checkbox"/></p> <p>Cut <input type="checkbox"/></p> <p>Removed <input type="checkbox"/></p> <p>Inadequate for Lock Used <input type="checkbox"/></p>
---	---

16. Other Information Pertinent to the Theft or Loss

<p>17. Signature and Title of Person Making Report</p>	<p>18. Federal Explosives License or Permit Number</p>
--	--

### Reporting Instructions

Fax this completed form to the ATF address listed below or call if no fax is available:

**Bureau of Alcohol, Tobacco, Firearms and Explosives**  
**U.S. Bomb Data Center**  
**P.O. Box #50980**  
**Washington, DC 20091**  
**Toll Free Fax: 1-866-927-4570**

Questions regarding the completion of this form should be referred to the U.S. Bomb Data Center toll free at 1-800-461-8841.

### Privacy Act Information

The following information is provided pursuant to section 3 of the Privacy Act of 1974 (5 U.S.C. § 522a(e)(3))

1. **Authority.** Solicitation of this information is made pursuant to Title XI of the Organized Crime Control Act of 1970 (18 U.S.C. Chapter 40). Disclosure of a theft or loss of explosive materials is mandatory pursuant to 18 U.S.C. § 842(k) for any person who has knowledge of such theft or loss from his stock.
2. **Purpose.** The purpose for the collection of this information is to give ATF notice of the theft or loss of explosive materials, and to furnish ATF with the pertinent facts surrounding such theft or loss. In addition, the information is used to confirm and verify prior notification of this theft or loss of explosive materials.
3. **Routine Uses.** The information will be used by ATF to aid in the administration of laws within its jurisdiction concerning the regulation of explosive materials and other related areas. In addition, the information may be disclosed to other Federal, State, foreign, and local law enforcement of laws within their jurisdiction.
4. **Effects of not supplying information requested.** 18 U.S.C. § 842(k) makes it unlawful for any person, who has knowledge of the theft or loss of explosive materials from his stock, to fail to report such theft or loss within twenty-four hours of discovery thereof, to the Secretary and to appropriate local authorities. The penalty for violation of this section is a fine of not more than \$1,000 or imprisonment for not more than one year, or both. 18 U.S.C. § 844(b)

### Paperwork Reduction Act Notice

This request in accordance with the Paperwork Reduction Act of 1995. The purpose of this information collection is to report the theft or loss of explosive materials. The information is used for investigative purposes by ATF officials. This information is mandatory by statute. (18 U.S.C. § 842)

The estimated average burden associated with this collection of information is 1 hour and 48 minutes per respondent or recordkeeper, depending on individual circumstances. Comments concerning the accuracy of this burden estimate and suggestions for reducing this burden should be addressed to Reports Management Officer, Document Services Branch, Bureau of Alcohol, Tobacco, Firearms and Explosives, Washington, DC 20226.

An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

ATF E-Form 5400.5  
Revised January 2006

# CALTRANS BLASTING MANUAL

PLATE B-14  
TABLE 1

As Revised and Approved by the Institute of Makers of Explosives – June 1991

QUANTITY OF EXPLOSIVE MATERIALS		DISTANCES IN FEET							
		x 304.8 for mm							
		Inhabited Buildings		Public Highways with Traffic Volume of less than 3,000 Vehicles per Day		Passenger Railways – Public Highways with Traffic Volume of more than 3,000 Vehicles/Day		Separation of Magazines	
Pounds Over	Pounds Not Over								
x 0.454 for kg		Barricaded	Unbarricaded	Barricaded	Unbarricaded	Barricaded	Unbarricaded	Barricaded	Unbarricaded
0	5	70	140	30	60	51	102	6	12
5	10	90	480	35	70	61	128	8	16
10	20	110	220	45	90	81	162	10	20
20	30	125	250	50	100	93	186	11	22
30	40	140	280	55	110	103	206	12	24
40	50	150	300	60	120	110	220	14	28
50	75	170	340	70	140	127	254	15	30
75	100	190	380	75	150	139	278	15	32
100	125	200	400	80	160	150	300	18	36
125	150	215	430	85	170	159	318	19	38
150	200	235	470	95	190	175	350	21	42
200	250	255	510	105	210	189	378	23	46
250	300	270	540	110	220	201	402	24	48
300	400	295	590	120	240	221	442	27	54
400	500	320	640	130	260	238	476	29	58
500	600	340	680	135	270	253	506	31	62
600	700	355	710	145	290	266	522	32	64
700	800	375	750	150	300	278	556	33	66
800	900	390	780	155	310	289	578	34	70
900	1000	400	800	160	320	300	600	36	72
1000	1200	425	850	165	330	318	636	39	78
1200	1400	450	900	170	340	336	672	41	82
1400	1600	470	940	175	350	351	702	43	86
1600	1800	490	980	180	360	366	732	44	88
1800	2000	505	1010	185	370	378	756	45	90
2000	2500	545	1090	190	380	408	816	49	98
2500	3000	580	1160	195	390	432	864	52	104
3000	4000	635	1270	210	420	474	949	58	116
4000	5000	685	1370	225	450	513	1026	61	122
5000	6000	730	1460	235	470	546	1092	65	130
6000	7000	770	1540	245	490	573	1146	68	136
7000	8000	800	1600	250	500	600	1200	72	144
8000	9000	835	1670	255	510	624	1248	75	150
9000	10000	865	1730	260	520	645	1290	78	156
10000	12000	875	1750	270	520	687	1374	82	164

# CALTRANS BLASTING MANUAL

12000	14000	885	1770	275	550	723	1446	87	174
14000	16000	900	1800	280	560	756	1512	90	180
16000	18000	940	1880	285	570	786	1572	94	188
18000	20000	975	1950	290	580	813	1626	98	196
20000	25000	1055	2000	315	630	876	1752	105	210
25000	30000	1130	2000	340	680	933	1866	112	224
30000	35000	1205	2000	360	720	981	1962	119	238
35000	40000	1275	2000	380	760	1026	2000	124	248
40000	45000	1340	2000	400	800	1068	2000	129	258
45000	50000	1400	2000	420	840	1104	2000	135	270
50000	55000	1460	2000	440	880	1140	2000	140	280
55000	60000	1515	2000	455	910	1173	2000	145	290
60000	65000	1565	2000	470	940	1206	2000	150	300
65000	70000	1610	2000	485	970	1236	2000	155	310
70000	75000	1655	2000	500	1000	1263	2000	160	320
75000	80000	1695	2000	510	1020	1293	2000	165	330
80000	85000	1730	2000	520	1040	1317	2000	170	340
85000	90000	1760	2000	530	1060	1344	2000	175	350
90000	95000	1790	2000	540	1080	1368	2000	180	360
95000	100000	1815	2000	545	1090	1392	2000	185	370
100000	110000	1835	2000	550	1100	1437	2000	195	390
112000	120000	1855	2000	555	1110	1479	2000	205	410
120000	130000	1875	2000	560	1120	1521	2000	215	430
130000	140000	1890	2000	565	1130	1557	2000	225	450
140000	150000	1900	2000	570	1140	1593	2000	235	470
150000	160000	1935	2000	580	1160	1629	2000	245	490
160000	170000	1990	2000	590	1180	1662	2000	255	510
170000	180000	2010	2000	600	1200	1695	2000	265	530
180000	190000	2030	2010	605	1210	1725	2000	275	550
190000	200000	2055	2030	610	1220	1755	2000	285	570
200000	210000	2055	2055	620	1240	1762	2000	295	590
210000	230000	2100	2100	635	1270	1836	2000	315	630
230000	250000	2155	2155	650	1300	1890	2000	335	670
250000	275000	2215	2215	670	1340	1950	2000	360	720
275000	300000	2275	2275	690	1380	2000	2000	385	770

# CALTRANS BLASTING MANUAL

Table 2  
Table of Separation Distances of  
Ammonium Nitrate and Blasting Agents from Explosives  
or Blasting Agents

<i>Donor Weight</i>		<i>Minimum Separation Distance of Acceptor when Barricaded (ft.)</i>		<i>Minimum Thickness of Artificial Barricades (in.)</i>
<i>Pounds Over</i>	<i>Pounds Not Over</i>	<i>Ammonium Nitrate</i>	<i>Blasting Agent</i>	
	100	3	11	12
100	300	4	14	12
300	600	5	18	12
600	1,000	6	22	12
1,000	1,600	7	25	12
1,600	2,000	8	29	12
2,000	3,000	9	32	15
3,000	4,000	10	36	15
4,000	6,000	11	40	15
6,000	8,000	12	43	20
8,000	10,000	13	47	20
10,000	12,000	14	50	20
12,000	16,000	15	54	25
16,000	20,000	16	58	25
20,000	25,000	18	65	25
25,000	30,000	19	68	30
30,000	35,000	20	72	30
35,000	40,000	21	76	30
40,000	45,000	22	79	35
45,000	50,000	23	83	35
50,000	55,000	24	86	35
55,000	60,000	25	90	35
60,000	70,000	26	94	40
70,000	80,000	28	101	40
80,000	90,000	30	108	40
90,000	100,000	32	115	40
100,000	120,000	34	122	50
120,000	140,000	37	133	50
140,000	160,000	40	144	50
160,000	180,000	44	158	50
180,000	200,000	48	173	50
200,000	220,000	52	187	60
220,000	250,000	56	202	60
250,000	275,000	60	216	60
275,000	300,000	64	230	60

STORAGE OF EXPLOSIVES

<b>POWDER MAGAZINE</b>	<b>CAP MAGAZINE</b>
DYNAMITE	ELECTRIC BLASTING CAPS
WATER GELS/SLURRY	NONELS
BLASTING AGENTS (AN/FO)	FUSE CAPS
DETONATING CORD	IGNITACORD/QUARRYCORN
CAST BOOSTERS	IGNITACORD CONNECTORS
EXTRUDED BOOSTERS	FUSE LIGHTERS
SAFETY FUSE	SAFETY FUSE
	MS CONNECTORS

# CALTRANS BLASTING MANUAL

## VII. TRANSPORTATION

### A. Vehicle

Vehicles used for the transportation of explosives shall be strong enough to carry the load and shall be in good mechanical condition. The vehicle must be qualified and designated by CHP Biennial Inspection of Terminals (BIT) Inspector. Prior to transporting explosives, the vehicle shall be given an extensive safety inspection. Particular attention shall be given to items that present a fire hazard, such as oil leaks, worn electrical insulation, under inflated tires, fuel leaks, exhaust leaks, etc. The bed or cargo compartment shall have a tight floor and have no exposed metal that could come in contact with the explosive cargo. If the vehicle has an open body, the cargo must be covered with a flame-proof and moisture-proof tarpaulin or other effective protection against moisture and sparks. A vehicle used for the transportation of explosives shall be equipped with at least two fully charged fire extinguishers having a minimum rating of 4-A:20-B:C in good condition securely mounted separately in conspicuous locations or in clearly marked compartments and readily accessible. The driver shall be trained in the use of the extinguisher carried on the vehicle.

Emergency repairs may be made on explosive laden vehicles provided such repairs do not require the use of flame or spark producing tools. In no instance shall a loaded vehicle be taken into a shop for repairs. . (GISO Title 8, Article 115, Sub-section 5262.)

No vehicle shall be left unattended when transporting explosives. (GISO Title 8, Article 115, Sub-section 5263.)

### B. Placarding

Vehicles carrying certain hazardous cargos are required to be placarded on all four sides. The type and quantity of explosive being transported determines the type of placarding. The lists of placarding requirements are as follows (also see placarding requirements on page x):

1. Class 1.1, 1.2, 1.3 - any quantity
2. Class 1.4, 1.5, 1.6 - 1001 lbs. or more
3. Class 5.1 - 1001 lbs. or more

### C. Hazardous Materials Bill of Lading

Vehicles transporting quantities and types of explosives that require placarding must also carry a hazardous material bill of lading. This information is required so that the cargo can be properly identified by agencies responding to an emergency.

### D. Driver

Vehicles hauling explosives shall be in the charge of, and driven by, a properly licensed driver (including a Hazardous Material endorsement). The driver shall be familiar with all local, state and federal regulations governing the transportation of explosives and be familiar with the hazards of the cargo. The driver shall be trained in emergency procedures, including the use of fire extinguishers.

Personnel, other than those needed to perform the work, shall not be carried on a vehicle transporting explosives.

No person shall smoke, carry matches or any other flame producing device, nor shall firearms be carried while in or near a vehicle transporting explosives.

## CALTRANS BLASTING MANUAL

### **E. Routes**

When transporting explosives, the route shall be carefully selected to provide the least exposure to schools, hospitals or any area where large numbers of people gather. In addition, routes should avoid areas of civil disturbance, fires and other areas of potential hazards.

In some areas, explosive routes may be designated by fire and law enforcement agencies.

When transporting 1001 lbs. or more of explosives, CHP designated routes shall be used.

### **F. Loading**

Blasting caps, including electric blasting caps, shall not be transported on any vehicle hauling over 5000 pounds of explosives (GISO 5262).

Other hazardous materials shall never be transported on the same vehicles as explosives. These materials include corrosives, flammables, poisons, radioactive material, and other hazardous materials.

### **G. Vehicle Fires**

Use good judgment. Stop traffic and clear the area for at least 2000 feet. If possible, separate the fire from the cargo. If the fire is not in the cargo or cargo compartment, attempts may be made to extinguish it. No attempt should be made to extinguish a fire in the cargo compartment.

**Vehicle Placarding Requirements**

Commodity	Quantity	Placard Required
Explosives 1.1, 1.2, 1.3	Any	Explosives *
Explosives 1.4	Less than 1,001 lbs **	none
Explosives 1.4	1,001 lbs or more	Explosives 1.4
Blasting Agents 1.5	Less than 1,001 lbs	None
Blasting Agents 1.5	1,001 lbs or more	Explosives 1.5
Oxidizers 5.1	Less than 1,001 lbs **	None
Oxidizers 5.1	1,001 lbs or more	Oxidizer 5.1
Explosives 1.6	Less than 1,001 lbs **	None
Explosives 1.6	1,001 lbs or more	Explosives 1.6

\* Enter Division Number 1.1, 1.2 or 1.3 and compatibility group letter when required.

Placard any quantity.

\*\* When determining the 1,001 lbs gross weight all 1.4, 1.5, 1.6 and 5.1 must be combined.

**Class 1- Explosives**

- Division 1.1 Explosives with a mass explosive hazard
- Division 1.2 Explosives with a projection hazard
- Division 1.3 Explosives with predominantly a fire hazard
- Division 1.4 Explosives with no significant blast hazard
- Division 1.5 Very insensitive explosives; blasting agents
- Division 1.6 Extremely insensitive detonating articles

**Compatibility Group**

- A Substances which are expected to mass detonate very soon after fire reaches them.
- B Articles which are expected to mass detonate very soon after fire reaches them.
- C Substances or articles which may be readily ignited and burn violently without necessarily exploding.
- D Substances or articles which may mass detonate (with blast and/or fragment hazard) when exposed to fire.
- E&F Articles which may mass detonate in a fire.
- G Substances and articles which may mass explode and give off smoke or toxic gasses.
- H Articles which in a fire may eject hazardous projectiles and dense white smoke.
- J Articles which may mass explode.
- K Articles which in a fire may eject hazardous projectiles and toxic gasses.
- L Substances and articles which present a special risk and could be activated by exposure to air or water.
- N Articles which contain only extremely insensitive detonating substances and demonstrate a negligible probability of accidental ignition or propagation.
- S Packaged substances or articles which, if accidentally initiated, produce effects that are usually confined to the immediate vicinity.

# CALTRANS BLASTING MANUAL



# Hazardous Materials Warning Placards

Actual placard size: 273 mm (10.8 inches) on all sides

## CLASS 1 Explosives



§172.522,  
§172.523,  
§172.524,  
§172.525

\*Enter Division Number 1, 1.2, or 1.3, and compatibility group letter, when required; placard any quantity. For Divisions 1.4, 1.5, and 1.6, enter compatibility group letter, when required; placard 454 kg (1,001 lbs) or more.

## CLASS 2 Gases



§172.528,  
§172.530,  
§172.532,  
§172.540

For NON-FERMENTABLE GAS, OXYGEN (compressed gas or refrigerated liquid), and FLAMMABLE GAS, placard 454 kg (1,001 lbs) or more gross weight. For POISON GAS (Division 2.3), placard any quantity.

## CLASS 3 Flammable Liquid and Combustible Liquid



§172.542  
§172.544

For FLAMMABLE, placard 454 kg (1,001 lbs) or more. GASOLINE may be used in place of FLAMMABLE placard displayed on a cargo tank or portable tank transporting gasoline by highway. Placard combustible liquid transported in bulk. See §172.504(f)(2) for use of FLAMMABLE placard in place of COMBUSTIBLE. FUEL OIL may be used in place of COMBUSTIBLE on a cargo or portable tank transporting fuel oil not classed as a flammable liquid by highway.

## CLASS 4 Flammable Solid, Spontaneously Combustible, and Dangerous When Wet



§172.546, §172.547, §172.548

For FLAMMABLE SOLID and SPONTANEOUSLY COMBUSTIBLE, placard 454 kg (1,001 lbs) or more. For DANGEROUS WHEN WET (Division 4.3), placard any quantity.

## CLASS 5 Oxidizer & Organic Peroxide



§172.550, §172.552

For OXIDIZER and ORGANIC PEROXIDE (other than TYPE B, temperature controlled), placard 454 kg (1,001 lbs) or more. For ORGANIC PEROXIDE (Division 5.2), Type B, temperature controlled, placard any quantity.

## CLASS 6 Poison (Toxic) and Poison Inhalation Hazard



§172.504 (b)(1),  
§172.554  
§172.555

POISON-INHALATION HAZARD (Division 6.1), Zone A or B inhalation hazard only, placard any quantity. For POISON, PCI or PCI, other than Zone A or B, inhalation hazard only) and KEEP AWAY FROM FOOD (PGII), placard 454 kg (1,001 lbs) or more. For Transit on 2.003, see §171.14 b(3).

## CLASS 7 Radioactive



§172.556

Placard any quantity - packages bearing RADIOACTIVE YELLOW-III labels only. Certain low specific activity radioactive materials in "exclusive use" will not bear the label, but if the radioactive placard is required for exclusive use shipments of low specific activity material and surface contaminated objects transported in accordance with §173.427(b)(3) or (c).

## CLASS 8 Corrosive



§172.558

Placard 454 kg (1,001 lbs) or more.

## CLASS 9 Miscellaneous Dangerous



§172.560

Not required for domestic transportation. A bulk packaging containing a Class 9 material must be marked with the appropriate ID number displayed on each of the materials in placard, on average panel, or a white square-on-point display.

## CLASS 9 Miscellaneous Dangerous



§172.560

A freight container, unit load device, transport vehicle, or rail car which contains non-bulk packagings with two or more categories of hazardous materials that require different placards specified in Table 2 may be placarded with DANGEROUS placards instead of the specific placards required for each of the materials in Table 2. However, when 1,000 kg (2,205 lbs) or more of one category of material is loaded at one loading facility, the placard specified in Table 2 must be applied.

White square background required for placard for highway route controlled quantity radioactive material and for rail shipment of certain explosives and poisons, and for flammable gas in a DOT 113 tank car §172.507 and §172.510.

§172.527

PLACARDS OR ORANGE PANELS

§172.332

and

Appropriate placard must be used.

### IDENTIFICATION NUMBER DISPLAYS

MUST BE DISPLAYED ON: (1) Tank Cars, Cargo Tanks, Portable Tanks, and other Bulk Packagings; (2) Vehicles or containers containing 4000 kg (8,820 lbs) in non-bulk packages of only a single hazardous material having the same proper shipping name and identification number; and (3) 1,000 kg (2,205 lbs) of materials poisonous by inhalation in Hazard Zone A or B. See §172.301(a)(5) and §172.313(c).

# Hazardous Materials Warning Labels

Actual label size: 100 mm (3.9 inches) on all sides

CLASS 1 Explosives: Divisions 1.1, 1.2, 1.3, 1.4, 1.5, 1.6	CLASS 2 Gases: Divisions 2.1, 2.2, 2.3	CLASS 3 Flammable Liquid	CLASS 4 Flammable Solid, Spontaneously Combustible, and Dangerous When Wet: Divisions 4.1, 4.2, 4.3	CLASS 5 Oxidizer, Organic Peroxide: Divisions 5.1 and 5.2
<p>§172.411 include compatibility group letter. include division number and compatibility group letter.</p>	<p>§172.415, §172.416, §172.417, §172.405(b)</p>	<p>§172.419</p>	<p>§172.420, §172.422, §172.423</p>	<p>§172.426, §172.427</p>
<b>CLASS 6 Poison (Toxic), Poison Inhalation Hazard, Infectious Substance: Divisions 6.1 and 6.2</b>	<b>CLASS 7 Radioactive</b>	<b>CLASS 8 Corrosive</b>	<b>CLASS 9 Miscellaneous Hazardous Material</b>	<b>For Aircraft Only</b>
<p>§172.405(c), §172.422, §172.430, §172.432</p>	<p>§172.436, §172.438, §172.440, §172.450</p>	<p>§172.442</p>	<p>§172.446</p>	<p>§172.443</p>
<p>serious substance label not required on an outer packaging, if the OSHA Hazard Marking (29 CFR 1910.103(a)) is used. The CDC Etiologic Agent label must be used as prescribed in 42 CFR 72.5 and 72.6.</p>	<p>Empty Label <b>EMPTY</b></p>			
<b>INNER PACKAGES COMPLY WITH PRESCRIBED SPECIFICATIONS</b> §173.25 c)(4)	<p>§172.322</p>	<p>§172.325</p>	<p>§172.313(b)</p>	<p>§172.316(e), §172.316(f)</p>

## **CALTRANS BLASTING MANUAL**

### **VIII. RECORD KEEPING**

All licensed blasters shall keep a log of all their firings, including firings used for training purposes. The firing information shall be recorded by completing the blasting log as shown on page 54.

An accurate magazine inventory shall be kept using the type of form shown on pages 55 and 56. This shall be done each time explosives are added or removed from the magazine. If the magazine is on Federal property, you must obey Federal rules and regulations in addition to all CalOsha and Caltrans regulations.







# CALTRANS BLASTING MANUAL

## IX. REGULATIONS

### A. Federal

1. Bureau of Alcohol, Tobacco, and Firearms ATF: Explosives Law and Regulations Chapter 40
  - a. Subpart A Subsection 55.1, 55.2 - Scope of Regulations
  - b. Subpart B Subsection 55.11 - Meaning of Terms
  - c. Subpart C Subsection 55.21-55.32 - Administrative and Miscellaneous Provisions
  - d. Subpart D Subsection 55.42-55.63 - Licenses and permits
  - e. Subpart E Subsection 55.71-55.83 - License and permit proceedings
  - f. Subpart F Subsection 55.101-55.109 - Conduct of Business or operations
  - g. Subpart G Subsection 55.121-55.130 -Records and Reports
  - h. Subpart H Subsection 55.141-55.142 - Exemptions
  - i. Subpart I Subsection 55.161-55.166 - Unlawful Acts, Penalties, Seizures and Forfeitures
  - j. Subpart K Subsection 55.201-55.220 - Storage

### B. State

1. General Industry Safety Orders - Group 18 - Explosives and Pyrotechnics.
  - a. Article
    - (1) 113 - Explosives, Blasting Agents and Pyrotechnics
    - (2) 114 - Storage of Explosives
    - (3) 115 - Transportation of Explosives
    - (4) 116 - Handling and Use of Explosives--Blasting operations
    - (5) 118 - Explosives for Well Service Industry
    - (6) 119 - Manufacture of Explosives and Fireworks
    - (7) 120 - Mixing Blasting Agents
    - (8) 121 - Snow Avalanche Blasting
    - (9) 123 - Smokeless propellants

### C. Counties and Cities

1. It is the responsibility of licensed blaster to contact local agencies. (Please fill in contacts as necessary below.)
  - a.
  - b.
  - c.
  - d.
  - e.

# CALTRANS BLASTING MANUAL

## TERMS AND DEFINITIONS

**AIR BLAST** - The airborne shock wave generated by an explosion.

**AMERICAN TABLE OF DISTANCES** - A quantity-distance table, prepared and approved by the IME, for storage of explosive materials to determine safe distances from buildings, highways, railways, and other stored explosive materials.

**AMMONIUM NITRATE** - A chemical compound. Formula:  $\text{NH}_4\text{NO}_3$ .

**AMPERE** - A unit of electrical current produced by 1 volt acting through a resistance of 1 ohm.

**ANFO** - A mixture of Ammonium Nitrate and Fuel Oil. An oxygen balanced and free flowing mixture of approximately 94% ammonium nitrate and 6% diesel fuel oil.

**ANSI** - American National Standards Institute. A non-governmental organization concerned with safety and health standards for industry.

**APPROVED** - Terms which mean APPROVED, APPROVAL or AUTHORIZED by the authority having jurisdiction.

**AUTHORITY HAVING JURISDICTION** - The governmental agency (or individual) responsible for approving equipment, an installation or a procedure.

**AVAILABLE ENERGY** - The energy from the explosive that is capable of performing useful work.

**BARRICADE (ARTIFICIAL)** - An artificial mound of earth of a minimum thickness of three feet or acceptable equivalent.

**BARRICADE (NATURAL)** - Natural features of the ground, such as hills, or timber of sufficient density that the surrounding exposures which require protection cannot be seen from the magazine when the trees are bare of leaves.

**BARRICADED** - The effective screening of a building containing explosives. (A straight line from the top of any side wall of the building containing explosives to the eave line of any magazine or other building or to a point 12 feet above the center of a railway/highway shall pass through such barrier.)

**BASE CHARGE** - The main explosive charge in the base of a blasting cap.

**BINARY EXPLOSIVE** - (Two component) Two separately packaged materials, neither of which is an explosive.

**BLACK POWDER, ALL TYPES** - A low explosive compound of sulfur, charcoal, and an earth nitrate (usually potassium or sodium nitrate). (NOT TO BE USED BY CALTRANS PERSONNEL. GISO Title 8, Article 113, Section 5243.)

**BLAST AREA** - The area of a blast, including the area immediately adjacent, influenced by fly rock.

**BLASTER** - A qualified, licensed person in charge of (and responsible for) estimating, preparing, loading and firing explosive charges and the handling of any misfires.

**BLASTER'S MULTIMETER** - Used for checking extraneous sources of electricity.

**BLASTING ACCESSORIES** - Non-explosive devices and materials used in blasting (cap crimpers, tamping bags, blasting machines, blasting galvanometers, and cartridge punches, etc.).

**BLASTING AGENT** - Any mixture consisting of fuel and oxidizer, intended for blasting, not otherwise defined as an explosive, such as water gel, etc.

**BLASTING CAP** - A shell closed at one end and containing a charge of detonating compound which is ignited from a spark. Also referred to as fuse cap, regular/ordinary blasting cap.

**BLASTING CREW** - Under the direct supervision of a qualified, licensed blaster, a group of persons whose purpose is to load explosive charges in an area to be blasted.

**BLASTING GALVANOMETER** - An electrical resistance measuring device designed specifically and approved for testing of electric blasting cap circuits.

## CALTRANS BLASTING MANUAL

**BLASTING MACHINE** - An electrical device which provides electrical energy for the purpose of energizing electric blasting caps.

**BLASTING MACHINE, CD TYPE** - An electrical device which provides electrical energy for the purpose of energizing electric blasting caps by using the electrical discharge of capacitors.

**BLASTING MACHINE, GENERATOR TYPE** - An electromechanical device which provides a specified current for the purpose of energizing electric blasting caps where the generation of electrical power is the result of hand operations.

**BLASTING MAT** - A mat of woven steel wire, rope, scrap tires, or other suitable material or construction to cover blast holes for the purpose of preventing flying rock missiles.

**BLASTING VIBRATIONS** - The energy from a blast that manifests itself in earth-borne vibrations which are transmitted through the earth away from the immediate blast area.

**BLOCK-HOLING** - The secondary reduction of boulders by loading and firing light explosive charges in small-diameter drilled holes.

**BOOSTER** - An explosive charge, usually of high strength and high- detonation velocity, used to increase the efficiency of the initiation system of the main charge.

**BOOTLEG** - That part of a drilled blast hole that remains when the force of the explosion does not break the rock completely to the bottom of the hole.

**BOREHOLE (BLAST HOLE)** - A hole drilled for the purpose of accepting an explosive charge.

**BRIDGEWIRE** - A resistance wire attached to the electrical leads of an electric blasting cap and imbedded in the initiating element of the cap.

**BRISANCE** - The shattering power of an explosive material as distinguished from its total work capacity.

**BULK MIX** - A mass of explosive material prepared for use in bulk form without packaging.

**BULLDOZE** - A mud-covered or unconfined explosive charge fired in contact with a rock surface without the use of a bore hole. Also known as MUDCAPPING. (Emergency use only.)

**BULLET-RESISTANT** - Magazine walls or doors of construction resistant to penetration of a bullet of 180-grain M2 ball ammunition having a nominal muzzle velocity of 2700 feet per second fired from a .30 caliber rifle from a distance of 100 feet perpendicular to the wall or door.

When a magazine ceiling or roof is required to be BULLET-RESISTANT, the ceiling or roof shall be constructed of materials comparable to the side walls or of other materials which will withstand penetration of the bullet above described when fired at an angle of 45 degrees from the perpendicular.

Tests to determine bullet resistance shall be conducted on test panels or empty magazines which shall resist penetration of 5 out of 5 shots placed independently of each other in an area at least 3 feet by 3 feet. If hardwood or softwood is used, water content of the wood shall not exceed 15%.

**BULLET-SENSITIVE EXPLOSIVE MATERIAL** - Explosive material that can be detonated by 180-grain M2 ball ammunition having a nominal muzzle velocity of 2700 feet per second when the bullet is fired from a .30 caliber rifle at a distance of not more than 100 feet and the test material, at a temperature of 70° to 75°F., is placed against a backing material of 1/2 inch steel plate.

**BURDEN** - That dimension of a medium to be blasted measured from the borehole to the face at right angles to the spacing. It means also the total amount of material to be blasted by a given hole, usually measured in cubic yards or in tons.

**BUREAU OF ALCOHOL, TOBACCO AND FIREARMS (BATF)** - A bureau of the Department of the Treasury having responsibility for the enactment and enforcement of regulations related to commerce in explosives under PART 181 of Title 26 of the Code of Federal Regulations.

**BUREAU OF EXPLOSIVES** - A bureau of the Association of American Railroads which the U.S. Department of Transportation may consult to classify explosive material for the purposes of interstate transportation.

**CAP CRIMPER** - A mechanical device for crimping the metallic shell of a blasting cap securely to a section of inserted safety fuse.

## CALTRANS BLASTING MANUAL

**CAP SENSITIVITY** - The sensitivity of an explosive to initiation, expressed in degree to an IME NO 8 TEST DETONATOR or fraction thereof.

**CAPPED FUSE** - A length of safety fuse to which a blasting cap has been attached.

**CARTON** - A lightweight inner container for explosive materials, usually encased in a heavy shipping type of container called a case.

**CARTRIDGE** - An individual closed shell, bag or tube of circular cross section containing explosive material.

**CARTRIDGE COUNT (STICK COUNT)** - A method of expressing the specific gravity of an explosive cartridge by listing the number of cartridges per 50- pound case.

**CARTRIDGE PUNCH** - A wooden, plastic or non-sparking metal device used to punch an opening in an explosive cartridge to accept a detonator or a section of detonating cord.

**CASE** - An outer substantial shipping container for explosive materials.

**CASE INSERT** - A set of printed, precautionary instructions, including the IME Do's and Don'ts which is inserted into a case of explosive materials.

**CASE LINER** - A plastic or paper barrier used to prevent leaking or sifting explosives from getting out of the shipping case.

**CAST EXTRUDER OR PRESSED BOOSTER OR PRIMER** - A cast, extruded or pressed solid high explosive (not nitroglycerin-sensitized) used to detonate less sensitive explosives.

**CFM** - An abbreviation for cubic feet of compressed air per minute, as produced by an air compressor.

**CLASS 1.1, 1.2 EXPLOSIVES** - Explosives, possessing detonating or otherwise

maximum hazard, such as, but not limited to, dynamite, nitroglycerin, picric acid, lead azide, fulminate of mercury, black powder, RDX and PETN, more than 1000 blasting caps and detonating primers. This would include Class 7 Military Explosives. GISO, Title 8, Article 113, Section 5237.

**CLASS 1.3 EXPLOSIVES** - Explosives that in general function by rapid

combustion rather than detonation, and include such explosive devices as flash powders and propellant explosives which include some smokeless powders. This would include Class 2 Military Explosives. GISO, Title 8 Article 113, Section 5237.

**CLASS 1.4 EXPLOSIVES** - Explosives which contain Class A or Class B explosives, or both, as components but in restricted quantities. GISO, Title 8, Article 113, Section 5237.

**COLLAR** - The mouth or opening of a borehole.

**COLUMN CHARGE** - A charge of explosives in a blast hole in the form of a long continuous unbroken column.

**COMMERCIAL EXPLOSIVES** - Explosives designed, produced, and used for commercial or industrial applications other than military.

**CONE BLASTING** - A cone shaped explosive charge fired in contact with a rock surface without the use of a borehole.

**CONFINED DETONATION VELOCITY** - The detonation velocity of an explosive or blasting agent in a container such as a borehole in contrast to detonating in the open.

**CONNECTING WIRES** - The insulated wires that may be needed to complete a circuit between the leg wires of adjacent caps or to connect a circuit of caps to the lead (firing) line.

**CORE LOAD** - The explosive core of detonating cord, expressed as the number of grains of explosive per foot.

**COSP** - Code of Safe Practices.

**COYOTE SHOOTING** - A method of blasting using a number of relatively large concentrated charges of explosives placed in one or more small tunnels driven in a rock formation.

## CALTRANS BLASTING MANUAL

**CRIMP** - The folded ends of paper explosive cartridges or the depression at one end of a blasting cap which serves to secure the blasting cap to the safety fuse.

**CRIMPING** - The act of securing a blasting cap to a section of safety fuse by compressing the metal shell of the cap against the fuse by means of a cap crimper.

**CURRENT LIMITING DEVICE** - An electric or electro-mechanical device that limits (1) actual amount of current or (2) the time of current flow to an electric blasting cap circuit.

**CUSHION BLASTING** - A method of blasting in which an air space is left between the explosive charge and the stemming, or in which the blast hole is purposely drilled larger than the diameter of the explosive cartridge to be loaded. This is done to lessen vibration and fly rock.

**DEFLAGRATION** - An extremely rapid burning producing vigorous evolution of heat or flame and moving through the material at a speed less than that of sound in the material. Explosive with a velocity below 3000 feet per second are said to deflagrate rather than detonate.

**DELAY BLASTING** - The practice of initiating individual blast holes or rows of blast holes at predetermined time intervals as compared to instantaneous blasting where all holes are fired essentially simultaneously.

**DELAY ELECTRIC BLASTING CAPS** - Electric blasting caps with a built-in delay mechanism that delays the cap detonation from the application of current in predetermined time intervals from milliseconds up to about 1/2 to 1 second between successive nominal delay periods.

**DELAY ELEMENT** - The element in a delay electric blasting cap or a non-electric delay blasting cap that produces the required predetermined time delay between initiation and detonation.

**DELAY TAG** - A tag, band, or marker on a delay electric blasting cap or a non-electric delay blasting cap denoting the delay sequence and/or the actual delay firing time.

**DENSITY** - The mass of an explosive per unit of volume, usually expressed in grams per cubic centimeter or pounds per cubic foot.

**DEPARTMENT** - For the purpose of this text, Department shall be considered Caltrans, DOT, unless otherwise noted.

**DEPARTMENT OF TRANSPORTATION (DOT) FEDERAL** - A cabinet-level agency of the federal government. It has the responsibility for the comprehensive regulations of transportation safety and issues regulations governing interstate shipments of explosives and other hazardous materials.

**DEPARTMENTAL POLICY** - Policy established by Caltrans.

**DETONATING CORD** - A flexible cord containing a center core of high explosives which, when detonated, will have sufficient strength to detonate other cap-sensitive explosives with which it is in contact.

**DETONATING CORD DOWNLINE** - The section of detonating cord that extends within the blast hole from the ground surface down to the explosive charge.

**DETONATING CORD, MS CONNECTORS** – Non-electric, short interval (millisecond) delay devices for use in delaying blasts which are initiated by detonating cord.

**DETONATING CORD, TRUNKLINE** - The line of detonating cord that is used to connect and initiate other lines of detonating cord.

**DETONATING PRIMER** - A name applied for transportation purposes to a device consisting of a detonator and an additional charge of explosives assembled as a unit.

**DETONATING VELOCITY** - The speed at which detonation progresses through an explosive.

**DETONATION** - An explosive reaction, also called detonation wave, that moves through the material at a velocity greater than the speed of sound in the material.

**DETONATION PRESSURE** - The pressure, usually expressed in pounds per square inch or atmospheres, produced in the action zone of a detonating explosive.

**DETONATOR** - Any device containing a detonating charge that is used for initiating detonation in an explosive; the term includes, but is not limited to, electric blasting caps of instantaneous and delay types, and blasting caps for use with safety fuses.

## CALTRANS BLASTING MANUAL

**DITCH BLASTING** - The formation of a ditch in soft marsh earth by the detonation of a series of explosive charges.

**DITCHING DYNAMITE** - A nitroglycerin-type explosive especially designed to sympathetically propagate from charge to charge in a ditch blast. (NOT TO BE USED BY CALTRANS PERSONNEL).

**DIVISION** - (OF INDUSTRIAL RELATIONS, CAL/OSHA), State agency that has the responsibility for controlling the use, storage and transportation of explosives; and for licensing blasters. For the purpose of this text, Division shall be considered CAL/OSHA.

**DO'S AND DON'TS** - A list of precautions printed by the Institute of Makers of Explosives (IME Safety Library Publication No. 4) pertaining to the transportation, storage, handling, and use of explosives and inserted in each case of high explosives.

**DRILLING PATTERN** - A description of the location of blast holes in relationship to each other and the free face. The burden and spacing dimensions are usually expressed in feet.

**DYNAMITE** - A high explosive used for blasting, consisting essentially of a mixture of, but not limited to, nitroglycerin, nitrostarch, ammonium nitrate, sodium nitrate, and carbonaceous materials. (NOT TO BE USED BY CALTRANS PERSONNEL; see Chapter IX, Maintenance Manual, Volume 1.)

**ELECTRIC BLASTING CAP** - A blasting cap designed for, and capable of, initiation by means of an electric current.

**ELECTRIC STORM** - An atmospheric disturbance characterized by intense electrical activity producing lightning, thus presenting the hazard of accidental initiation of blasting caps.

**EMERGENCY PROCEDURE CARD** - Instructions carried on a truck transporting explosive materials and giving specific procedures in case of emergency.

**EXPLOSIVE LOADING FACTOR** - The amount of explosive used per unit of rock, usually expressed as pounds of explosives per cubic yard or rock per pound of explosives, or their reciprocals.

**EXPLOSIVE MATERIALS** - These include explosives, blasting agents and detonators. The term includes, but is not limited to, dynamite and other high explosives, slurries and water gels, blasting agents, black powder, pellet powder, initiating explosives, detonators, and detonating cord. A list of explosive materials determined to be within the coverage of "18 U.S.C. Chapter 40, Importation, Manufacture, Distribution and Storage of Explosive Materials" is issued at least annually by the Director of the Bureau of Alcohol, Tobacco and Firearms of the Department of the Treasury.

The United States Department of Transportation (DOT) classifications of explosive materials used in commercial blasting operations are not identical with the statutory definitions of the Organized Crime Control Act of 1970, Title 18 U.S.C., Section 841. To achieve uniformity in transportation, the definitions of the United States Department of Transportation in Title 49 Transportation CFR, Parts 1-999 subdivides these materials into Class 1.1, 1.2, 1.3, and 1.4 Explosives, 1.5 Blasting Agents and 5.1 Oxidizing Materials.

**EXPLOSIVE STRENGTH** - A value for the amount of energy released by an explosive on detonation and its capacity to do useful work.

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

**EXTRA (AMMONIA) DYNAMITE** - A dynamite that some of the nitroglycerin has been replaced with a sufficient amount of ammonium nitrate to retain the original explosive strength.

**FERTILIZER GRADE AMMONIUM NITRATE** - A grade of ammonium nitrate as defined by the Fertilizer Institute.

## CALTRANS BLASTING MANUAL

**FIRE EXTINGUISHER RATING** - A rating set forth in the National Fire Code which may be identified on an extinguisher by a number indicating extinguisher's relative effectiveness followed by a letter indicating the class or classes of fires for which the extinguisher has been found to be effective. For example using a fire extinguisher rated at **4-A:20-BC**. The number in front of the A rating indicates how much water the extinguisher is equal to and represents 1.25 gallons of water for every unit of one, this means that the extinguisher is equal to five (4 x 1.25) gallons of water. The number in front of the B rating represents the area in square feet of a class B fire that a non-expert should be able to extinguish. Using the example **4-A:20-BC**, a non-expert user should be able to put out a flammable fire that is as large as 20 square feet. The letter A represents **Ordinary Combustibles** (paper, cloth, wood, rubber and many plastics). The letter B represents **Flammable Liquids** (oils, gasoline, paints, lacquers, grease, solvents, etc). The letter C represents **Electrical Equipment** (fuse boxes, energized electrical equipment computers, etc). A fire extinguisher with a 4-A:20-BC rating, is a multi-purpose dry chemical and is suitable for use on Class A, B and C fires.

**FIRE-RESISTANT** - Construction methods designed to offer reasonable protection against fire.

**FIREWORKS** - Combustible or explosive compositions or manufactured articles designed and prepared for the purpose of producing audible or visible effects, and shall include such articles as fuses.

**FIRING CURRENT** - An electric current of recommended magnitude to sufficiently energize an electric blasting cap or a circuit of electric blasting caps.

**FIRING LINE** - Durable waterproof insulated wire(s) connecting the electrical power source with the electric blasting cap circuit.

**FLARE** - A pyrotechnic device designed to produce a single source of intense light. Shall not be used as an ignition device.

**FLASH OVER** - The sympathetic detonation between explosive charges or between charged blast holes.

**FLASH POINT** - The lowest temperature at which vapors above a volatile combustible substance ignite in air when exposed to flame.

**FLY ROCK** - Rocks propelled from the blast area by the force of an explosion.

**FORBIDDEN OR NOT ACCEPTABLE EXPLOSIVES** - Explosives which are forbidden or not acceptable for transportation by common, contract, or private carriers, by rail freight, rail express, highway, air or water in accordance with the regulations of the U.S. Department of Transportation.

**FUEL** - A substance which may react with the oxygen in the air or the oxygen or other oxidizing substance yielded by an oxidizer to produce combustion.

**FUME CLASSIFICATION (IME)** - A classification indicating the amount of poisonous or toxic gases produced by an explosive or blasting agent. The IME FUME CLASSIFICATION is expressed as follows:

CUBIC FEET OF POISONOUS GASES PER (1 1/4" x 8") CARTRIDGE OF EXPLOSIVES	
FUME CLASS	CUBIC FEET OF GAS
1	Less than 0.16
2	0.16 to 0.33
3	0.33 to 0.67

NOTE: The U.S. Bureau of Mines limits poisonous or toxic gases to 2.5 cubic feet per pound of permissible explosive.

**FUMES** - The products of an explosion contain poisonous or toxic gases and nonpoisonous or nontoxic gases. For the purpose of fume classification, only poisonous or toxic gases such as carbon monoxide, hydrogen sulphide and nitrogen oxides are considered.

**FUSE** - (See SAFETY FUSE)

**FUSE CUTTER** - A mechanical device for cutting safety fuse clean and at right angles of its long axis.

## CALTRANS BLASTING MANUAL

**FUSE LIGHTERS** - Pyrotechnic devices for the rapid and certain lighting of safety fuse.

**GAUGE** - A series of standard sizes used in describing the diameter of wire.

**GALVANOMETER** - (See BLASTING GALVANOMETER)

**GAP SENSITIVITY** - The maximum distance for propagation between standard charge sizes of explosive donor and acceptor. It is used for measuring the likelihood of sympathetic propagation.

**GELATIN DYNAMITE** - A type of highly water-resistant dynamite characterized by its gelatinous consistency. (NOT TO BE USED BY CALTRANS PERSONNEL.)

**GRAINS** - A system of weight measurement where 7000 grains are equivalent to one standard 16-ounce pound.

**GVW** - Gross vehicle weight.

**HANGFIRE** - The detonation of an explosive charge at some undetermined time after its normally designed firing time. This can be a dangerous phenomenon.

**HARDWOOD** - Red oak, white oak, hard maple, ash or hickory, free of loose knots, wind shakes, or similar defects, having a moisture content not exceeding 15%.

**HERTZ** - A synonym for "cycles per second."

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

**HIGHWAY** - Any public street, public alley, or public road.

**IGNITER CORD** - A small-diameter pyrotechnic cord that burns at a uniform rate with an external flame and used to ignite a series of safety fuses.

**INHABITED BUILDING** - A building regularly occupied in whole or part as a habitation for human beings, or any church, school house, railroad station, store, other structure where people are accustomed to assemble, except any building or structure occupied in connection with the manufacture, transportation, storage or use of explosive material.

**INITIATION** - The act of causing an explosive material to detonate.

**INSTANTANEOUS DETONATOR** - A detonator that has a firing time essentially of zero seconds as compared to delay detonators with firing times of from several milliseconds to several seconds.

**INSTITUTE OF MAKERS OF EXPLOSIVES (IME)** - A nonprofit trade association representing leading U.S. producers of commercial explosive materials and dedicated to safety in the manufacture, transportation, storage and use of explosive materials.

**INSTITUTE OF MAKERS OF EXPLOSIVES NO. 8 TEST DETONATOR** IME No. 8 test detonator has 0.40 to 0.45 grams PETN base charge pressed to a specific gravity of 1.4 g/cc and primed with standard weights of primer, depending on manufacturer.

**ISSUING AUTHORITY** - The governmental agency, office, or official vested with the authority to issue permits or licenses.

**LEADING LINES OR LEADING WIRES** - The wire(s) connecting the electrical power source with the electric blasting cap circuit.

**LEG WIRES** - The two single insulated wires or one duplex insulated wire extending from an electric blasting cap.

**LIQUID FUELS** - Fuels in a liquid state. They may be used with oxidizers to form blasting agents and/or explosives.

**LOADING DENSITY** - The pounds of explosive loaded per lineal foot of borehole occupied by the explosive, expressed as pounds/foot of borehole.

**LOADING POLE** - A nonmetallic pole used to assist the placing and compacting of explosive charges in boreholes.

## CALTRANS BLASTING MANUAL

**LOW EXPLOSIVES** - Explosives which are characterized by deflagration or a low rate of reaction and the development of low pressures.

**MACH WAVE GENERATOR** - A device used to increase the detonating effect of a blasting cap.

**MAGAZINE** - Any building or structure approved for the storage of explosive materials.

**MAIN EXPLOSIVE CHARGE** - The explosive material which is expected to perform the work of blasting. This is usually the explosive or blasting agent which fills the borehole.

**MANUFACTURING CODES** - Code markings stamped on explosive materials packages, indicating, among other information, the date of manufacture.

**MAXIMUM FIRING CURRENT** - The highest amperage current recommended for the safe and effective performance of an electric blasting cap.

**MILLISECOND** - One thousandth of a second.

**MINIMUM FIRING CURRENT** - The lowest electrical current that will initiate an electrical blasting cap within a specified short interval of time.

**MINIMUM SENSITIVITY** - An air gap, measured in inches, which determines whether the explosive material is within specific tolerances for gap sensitivity.

**MINE SAFETY AND HEALTH ADMINISTRATION (MSHA)** - An agency of the U.S. Department of the Interior concerned with promulgation and enforcement of health and safety regulations in the mining field.

**MISFIRE** - An explosive charge which partly or completely failed to detonate as planned.

**MOTOR VEHICLE** - Any self-propelled vehicle, truck, tractor, semi trailer, or full trailer used for the transportation of freight over public highways.

**MUCKPILE** - A pile of broken material resulting from a blast.

**MUDCAPPING** - A mud-covered explosive charge fired in contact with a rock surface without the use of a borehole. Synonymous with BULLDOZE. (Emergency use only.)

**MUNROE EFFECT** - The concentration of explosive action through the use of a shaped charge.

**NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) STANDARDS** - Standards for explosive materials and ammonium nitrate issued by the National Fire Protection Association.

**NATIONAL SAFETY COUNCIL (NSC)** - A nonprofit organization chartered by Congress to provide a regular information service on the causes of accidents and ways to prevent them.

**NITROGLYCERIN** - An explosive chemical compound used as a sensitizer in dynamite and represented by the formula  $C_3H_5(ON_2)_3$ . (NOT TO BE USED BY CALTRANS PERSONNEL.)

**NONSPARKING METAL** - A metal that will not produce a spark when struck with other tools, rock, or hard surfaces.

**OCCUPATIONAL SAFETY & HEALTH ADMINISTRATION (FED-OSHA)** - An agency of the U.S. Department of Labor active in eliminating occupational hazards and promoting employee safety. (Cal-OSHA is state agency under Division of Industrial Relations.)

**OXIDIZER OR OXIDIZING MATERIAL** - A substance, such as a nitrate, that readily yields oxygen or other oxidizing substances to stimulate the combustion of organic matter or other fuel.

**OXYGEN BALANCE** - The oxygen content of an explosive material expressed as percent excess (+) or deficient (-).

**PARALLEL CAP CIRCUIT** - A circuit in which one leg wire from each blasting cap is connected to one side of the blasting circuit and the other leg wire to the other side of the circuit.

**PASSENGER RAILWAY** - Any steam, electric, or other railroad or railway which carries passengers for hire.

**PERMISSIBLE EXPLOSIVE** - Explosives that are permitted for use in gassy and dusty atmospheres and which must be approved by the U.S. Bureau of Mines. Permissible explosives must be used and stored in accordance with certain conditions specified by the U.S. Bureau of Mines.

## CALTRANS BLASTING MANUAL

**PERSON** - Any individual, corporation, company, association, firm, partnership, society, or joint stock company.

**PETN** - A shortened form for the explosive, pentaerythritol tetranitrate.

**PLACARDS** - Signs placed on vehicles transporting explosive materials or oxidizers indicating the nature of the cargo.

**PLYWOOD** - Exterior construction-grade plywood used for explosives magazines.

**POWER SOURCE** - The source of power for energizing electric blasting cap circuits.

**PREMATURE FIRING** - The detonation of an explosive charge or the ignition of an electric blasting cap before the planned time. This can be a hazardous occurrence and is usually accidental.

**PRILLED AMMONIUM NITRATE** - Ammonium nitrate in a pelleted or prilled form.

**PRIMARY BLAST** - A blast that loosens the rock or ore from its original or natural location in the ground. It is as compared to a secondary blast which may be used to reduce the rocks from the primary blast to smaller size for ease of handling.

**PRIMARY EXPLOSIVE** - A sensitive explosive which nearly always detonates by simple ignition from such means as spark, flame, impact and other primary heat sources of appropriate magnitude.

**PRIMER** - A unit, package or cartridge of explosives used to initiate other explosives or blasting agents.

**PROPAGATION** - The detonation of explosive charges by an impulse received from adjacent or nearby explosive charges.

**PROPELLANT** - An explosive that normally functions by deflagration and used for propulsion purposes.

**PUBLIC CONVEYANCE** - Any railroad car, streetcar, ferry, cab, bus, aircraft, or other vehicle which is carrying passengers for hire.

**PYROTECHNICS** - Any combustible or explosive compositions or manufactured articles designed and prepared for the purpose of producing audible or visible effects. Pyrotechnics are commonly referred to as fireworks.

**QUANTITY-DISTANCE TABLE** - A table listing minimum recommended distances from explosive materials stores of various weights to some predetermined locations.

**RADIO FREQUENCY ENERGY (RF)** - The energy of an electromagnetic wave in the radio frequency spectrum. Under certain circumstances this energy can cause initiation of electric blasting caps. See IME Safety Library Publication No. 20 for recommended safe distances.

**RADIO FREQUENCY TRANSMITTER** - An electronic device for transmitting a radio frequency wave; i.e., a radio transmitting station - mobile or stationary.

**RECEPTOR (ACCEPTOR)** - A charge of explosive materials receiving an impulse from an exploding donor charge.

**REGULATIONS** - Regulations promulgated by federal, state or local regulatory agencies governing the manufacture, transportation, storage, handling and use of explosive material.

**SAFETY FUSE** - A flexible cord containing an internal burning medium by which fire or flame is conveyed at a continuous and uniform rate from the point of ignition to the point of use, usually a detonator.

**SAFETY STANDARD** - Suggested precautions relative to the safety practices to be employed in the manufacture, transportation, storage, handling and use of explosive materials.

**SCALED DISTANCE** - A factor relating similar blast effects from various size charges of the same explosive at various distances.

**SECONDARY BLASTING** - Blasting to reduce the size of boulders resulting from a primary blast. This may include mud-capping.

**SENSITIVITY** - A physical characteristic of an explosive, classifying its ability to detonate upon receiving an external impulse such as impact, shock, flame, or other influences which can cause explosive decomposition.

## CALTRANS BLASTING MANUAL

**SEPARATION DISTANCES** - Minimum recommended distances from explosive materials accumulations to certain specific locations.

**SERIES ELECTRIC BLASTING CAP CIRCUIT** - An electric blasting cap circuit that provides for one continuous path for the current through all caps in the circuit.

**SERIES IN PARALLEL ELECTRIC BLASTING CAP CIRCUIT** - A combination of series and parallel circuits where several series of caps are placed in parallel. (NOT RECOMMENDED FOR CALTRANS OPERATIONS.)

**SHALL AND SHOULD** - The word "shall" is to be understood as mandatory, and the word "should" as advisory.

**SHAPED CHARGE** - An explosive with a shaped cavity, specifically designed to produce a high velocity cutting or piercing jet of product reaction.

**SHELF LIFE** - The length of time of storage during which an explosive material retains adequate performance characteristics.

**SHOCK WAVE** - A transient pressure pulse that propagates at supersonic velocity.

**SHORT DELAY BLASTING** - The practice of detonating blast holes in successive intervals where the time difference between any two successive holes is measured in milliseconds.

**SHOT ANCHOR** - A device that anchors explosive materials charges in the borehole so that the charges will not be blown out by the detonation of other charges.

**SHUNT** - A short-circuiting device provided on the free ends of the leg wires of electric blasting caps to protect them from accidental initiation by extraneous electricity.

**SIGNS-EXPLOSIVE** - Signs placed on vehicles transporting explosives denoting the character of the cargo, or near storage areas as a warning to unauthorized personnel.

**SILVER CHLORIDE CELL** - A special cell of relatively low current output used in a blasting galvanometer or in other types of electrical measurement devices to check continuity and resistance of electric blasting caps.

**SINGULAR AND PLURAL** - Words used in the singular shall include the plural and in the plural shall include the singular.

**SLURRIES** - These comprise a wide variety of materials used for blasting. As manufactured, they have varying degrees of sensitivity to initiation. They usually contain substantial proportions of water and ammonium nitrate, some of which is in solution in the water. Some SLURRIES are sensitized by a material classified as an explosive. Some contain no ingredient classified as an explosive but may be sensitized with metals such as aluminum or with other fuels. Under the regulations of the U.S. Department of Transportation, SLURRIES may be classified as Explosives Class A, Explosives Class B, or Oxidizing Materials.

**SMALL ARMS AMMUNITION** - Any cartridge for shotgun, rifle, pistol, revolver, and cartridges for propellant-actuated power devices and industrial guns (.75 caliber or less). Military-type ammunition containing explosive bursting charges or any incendiary tracer, spotting, or pyrotechnic projectile is excluded from this definition.

**SMALL ARMS AMMUNITION PRIMERS** - Small percussion-sensitive explosive charges encased in a cap and used to ignite propellant powder.

**SMOKE** - The air-borne suspension of solid particles from the products of detonation or deflagration.

**SMOKELESS PROPELLANT (SMOKELESS POWDER)** - Solid propellant, commonly called smokeless powders in the trade, used in small arms ammunition, cannon, rockets, propellant-actuated power devices, etc.

**SNAKEHOLE** - A borehole drilled in a slightly downward direction from the horizontal into the floor elevation of a quarry face. Also, a hole driven under a boulder.

**SOFTWOOD** - Douglas fir or other wood equal in bullet resistance and free from loose knots, wind shakes or similar defects, having a moisture content not exceeding 15%.

## CALTRANS BLASTING MANUAL

**SPACING** - The distance between boreholes measured parallel to the free face toward which rock is expected to move.

**SPECIFIC GRAVITY** - The ratio of the weight of any volume of substance to the weight of an equal volume of pure water.

**SPRINGING** - The practice of enlarging the bottom of a blast hole by the use of a relatively small charge of explosive material. Typically used in order that a larger charge of explosive material may be inserted therein for a primary blast.

**SQUIB** - A firing device that burns with a flash and used for igniting black powder or pellet powder.

**STABILITY** - The ability of an explosive material to retain chemical and physical properties specified by the manufacturer when exposed to specified environmental conditions over a specified period of time.

**STATIC ELECTRICITY** - Stationary charges of electricity produced by the moving friction between unlike materials and which will flow to ground or to another body of different potential.

**STEMMING** - Inert noncombustible material placed in a borehole after the explosive. Used for the purpose of confining explosive materials or to separate charges of explosive material in the same borehole.

**STORAGE** - The safe keeping of explosive materials, usually in specifically designed structures called magazines.

**STRAY CURRENT** - A flow of electricity outside of the conductor which normally carries it.

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

**SYMPATHETIC PROPAGATION** - The detonation of an explosive material as the result of receiving an impulse from another detonation through air, earth or water.

**TABLE OF RECOMMENDED SEPARATION DISTANCES OF AMMONIUM NITRATE AND BLASTING AGENTS FROM EXPLOSIVES AND BLASTING AGENTS** - A quantity- distance table from National Fire Protection Association Standard No. 492.

**TAMPING** - To compact an explosive charge or the stemming in a blast hole. Frequently used synonymously with STEMMING.

**TAMPING POLE** - A wooden or Division approved semi-conductive plastic pole used to compact explosive charges or stemming.

**TEST BLASTING CAP NO. 8** - A No. 8 test blasting cap containing 2 grams of a mixture of 80% mercury fulminate and 20% potassium chlorate, or a cap of equivalent strength.

**THEFT-RESISTANT** - Construction methods designed to offer reasonable protection against theft.

**TOE** - The perpendicular distance from blast hole to the free face measured at the floor elevation of the pit or quarry.

**TRUNKLINE** - The line of detonating cord on the ground surface which connects detonating cord down lines.

**UNBARRICADED** - The absence of a natural or artificial barricade around explosive storage area or facilities.

**UNCONFINED DETONATION VELOCITY** - The detonation speed of an explosive material without confinement; for example, a charge fired in the open.

**UNDERWRITERS LABORATORY, INC. (UL)** - A nationally recognized incorporated testing laboratory qualified and equipped to conduct the necessary tests to determine compliance with appropriate standards and the satisfactory performance of materials or equipment in actual usage.

**U.S. BUREAU OF MINES (USBM)** - A bureau of the U.S. Department of the Interior active in promoting safety in coal mines and in carrying out broad programs in mining and related fields.

**VOLT** - The unit of electromotive force. It is the difference in potential required to make a current of one ampere flow through a resistance of one ohm.

## CALTRANS BLASTING MANUAL

**WARNING SIGNAL** - A visual or audible signal which is used for warning personnel in the vicinity of the blast area of the impending explosion.

**WATER GELS** - These comprise a wide variety of materials used for blasting. As manufactured, they have varying degrees of sensitivity to initiation. They usually contain substantial proportions of water and ammonium nitrate, some of which is in solution in the water. Some WATER GELS are sensitized by a material classified as an explosive. Some contain no ingredient classified as an explosive but may be sensitized with metals such as aluminum or with other fuels. Under regulations of the U.S. Department of Transportation, WATER GELS may be classified as Explosives Class A, Explosives Class B, or Oxidizing Materials. Usually used in quarry operations.

**WATER RESISTANCE** - The ability of an explosive to withstand the desensitizing effect of water penetration.

**WATER STEMMING BAGS** - Plastic bags with a self-sealing valve classified as a permissible stemming device by the U.S. Bureau of Mines.

**WEIGHT STRENGTH** - The strength of an explosive material per unit of weight expressed as a percentage of the weight of some recognized explosive standard.



# CALTRANS BLASTING MANUAL

## BLASTING EXPERIENCE

(Use additional sheets if necessary)

EMPLOYER \_\_\_\_\_ Your Position \_\_\_\_\_

Address \_\_\_\_\_ From (Mo./Yr.) \_\_\_\_\_ to (Mo./Yr.) \_\_\_\_\_

Type of blasting work done \_\_\_\_\_

Initiation systems used \_\_\_\_\_

Supervisor \_\_\_\_\_ Telephone No. \_\_\_\_\_

EMPLOYER \_\_\_\_\_ Your Position \_\_\_\_\_

Address \_\_\_\_\_ From (Mo./Yr.) \_\_\_\_\_ to (Mo./Yr.) \_\_\_\_\_

Type of blasting work done \_\_\_\_\_

Initiation systems used \_\_\_\_\_

Supervisor \_\_\_\_\_ Telephone No. \_\_\_\_\_

EMPLOYER \_\_\_\_\_ Your Position \_\_\_\_\_

Address \_\_\_\_\_ From (Mo./Yr.) \_\_\_\_\_ to (Mo./Yr.) \_\_\_\_\_

Type of blasting work done \_\_\_\_\_

Initiation systems used \_\_\_\_\_

Supervisor \_\_\_\_\_ Telephone No. \_\_\_\_\_

EMPLOYER \_\_\_\_\_ Your Position \_\_\_\_\_

Address \_\_\_\_\_ From (Mo./Yr.) \_\_\_\_\_ to (Mo./Yr.) \_\_\_\_\_

Type of blasting work done \_\_\_\_\_

Initiation systems used \_\_\_\_\_

Supervisor \_\_\_\_\_ Telephone No. \_\_\_\_\_

Special Training, Seminars, etc. \_\_\_\_\_

Other States' Blasting Licenses or Certificates, if any \_\_\_\_\_

The application fee is \$15 for the license and \$15 for renewals. Make check/money order payable to the State of California.

Applicant must appear in person to take the examination for a blaster's license. A license will be issued only to persons possessing sufficient knowledge and experience to conduct the acts specified in the application. The license will be issued after the applicant has passed the written and oral examination and a background check has been made to determine the applicant's qualifications. The undersigned applicant certifies that he/she is familiar with applicable Federal, State, and Local laws, rules, regulations, and orders relating to the use, handling, possession, transportation, and storage of explosives. If this license is issued, the blaster, and all other persons designated by the blaster, will strictly observe such laws, rules, and regulations.

hereby certify under penalty of perjury that the information on this application is true and correct.

Date \_\_\_\_\_ Applicant's signature \_\_\_\_\_

Date \_\_\_\_\_ Approved for exam by \_\_\_\_\_

CALTRANS BLASTING MANUAL

Cal/OSHA – W – 1

STATEMENT OF CITIZENSHIP, ALIENAGE, AND IMMIGRATION STATUS FOR STATE PUBLIC BENEFITS

---

Print Name of Applicant	Date
-------------------------	------

---

Print Name of Person Acting for Applicant, if any	Relationship to Applicant
---	---------------------------

---

**State Public Benefits to Citizen and Aliens**

Citizens and nationals of the United States, who meet all eligibility requirements for the benefits described in subsection 344.85 (b)(1)-(b)(6), must fill out Sections A and D.

Aliens, who meet all eligibility requirements for the benefits, as described in subsection 344.85 (b)(1)-(b)(6), must complete SECTIONS A, B, C, and D of this form.

**Section A: Citizenship/Immigration Status Declaration**

- 1. Is the applicant a citizen or national of the United States?    Yes             No

If the answer to the above question is yes, where was he/she born? \_\_\_\_\_  
(City/State)

- 2. To establish citizenship or nationality, please submit one of the documents on List A (attached hereto) which is legible and unaltered to establish proof.

***IF YOU ARE A CITIZEN OR NATIONAL OF THE UNITED STATES, GO DIRECTLY TO SECTION D.***

***IF YOU ARE AN ALIEN, PLEASE COMPLETE SECTION B, OR IF APPLICABLE, SECTION C.***

**Section B: Alien Status Declaration**

**IMPORTANT:** Please indicate the applicant's alien status below, and submit documents evidencing such status. The alien status documents listed for each category are the most commonly used documents that the United States Immigration and Naturalization Service (INS) provides to aliens in those categories. You can provide other acceptable evidence of your alien status even if not listed below.

- 1. An alien lawfully admitted for permanent resident under the Immigration and Naturalization Act (INA). Evidence includes:

## CALTRANS BLASTING MANUAL

- INS Form 1-551 (Alien Registration Receipt Card, commonly known as a “green card”); or
  - Unexpired Temporary 1-551 stamp in foreign passport or on INS Form 1-94
2. An alien who is granted asylum under section 208 of the INA. Evidence includes:
- INS Form 1-94 annotated with stamp showing grant of asylum under section 208 of the INA;
  - INS Form 1-688B (Employment Authorization Card) annotated “274a. 12(a)(5)”;
  - INS Form 1-766 (Employment Authorization Document) annotated “A5”;
  - Grant letter from the Asylum Office of INS; or
  - Order of an immigration judge granting asylum.
3. A refugee admitted to the United States under section 207 of the INA. Evidence includes:
- INS Form 1-94 annotated with the stamp showing admission under section 207 of the INA;
  - INS Form 1-688B (Employment Authorization Card) annotated “274a 12(a)(3)”;
  - INS Form 1-766 (Employment Authorization Document) annotated “A3”; or
  - INS Form 1-571 (Refugee Travel Document).
4. An alien paroled into the United States for at least one year under section 212(d)(5) of the INA. Evidence includes:
- INS Form 1-94 with stamp showing admission for at least one year under section 212(d)(5) of the INA. (Applicant cannot aggregate periods of admission for less than one year to meet the one-year requirement.)

## CALTRANS BLASTING MANUAL

5. An alien whose deportation is being withheld under section 243(h) of the INA (as in effect immediately prior to September 30, 1998) or Section 241 (b)(3) of such Act (as amended by section 305(a) of division C of Public Law 104-208). Evidence includes:
- INS Form 1-688B (Employment Authorization Card) annotated "274a.12(a)(10)";
  - INS Form 1-766 (Employment Authorization Document) annotated "A10", or
  - Order from an immigration judge showing deportation withheld under section 243(h) of the INA as in effect prior to April 1, 1997, or removal withheld under section 241(b)(3) of the INA.
5. An alien who is granted conditional entry under section 203(A)(7) of the INA as in effect prior to April 1, 1980. Evidence includes:
- INS Form 1-94 with stamp showing admission under section 203(a)(7) of the INA;
  - INS Form 1-688B (Employment Authorization Card) annotated "274a.12(a)(3)"; or
  - INS Form 1-766 (Employment Authorization Document) annotated "A3."
7. An alien who is Cuban or Haitian entrant (as defined in section 501(e) of the Refugee Education Assistance Act of 1980). Evidence includes:
- INS Form 1-551 (Alien Registration Receipt Card, commonly known as "green card") with the code CU6, CU7, or CH6;
  - Unexpired temporary 1-551 stamp in foreign passport or on INS Form) 1-94 with the code CU6 or CU7; or
  - INS Form 1-94 with stamp showing parole as "Cuban/Haitian Entrant" under section 212(d)(5) of the INA.
8. An alien paroled into the United States for less than one year under section 212(d)(5) of the INA. (Evidence includes INS Form 1-94 showing statuses.)
9. An alien not in categories 1 through 8 who has been admitted to the United States for a limited period of time ( a non-immigrant). Non-immigrants are persons who have temporary status for a specific purpose. (Evidence includes INS Form 1-94 showing this status.)

**SECTION C: Declaration for Battered Aliens**

**Important:** Complete this section if the applicant, the applicant's child or the applicant child's parent has been battered or subjected to extreme cruelty in the United States.

1. Has the INS or the EOIR granted a petition or application filed by or on behalf of the applicant, the applicant's child, or the applicant's child's parent under the INA or found that a pending petition sets forth a prima facie case? Evidence includes one of the documents on List B (attached hereto).
  
2. Has the applicant, the applicant's child, or the applicant child's parent been battered or subjected to extreme cruelty in the United States by a spouse or parent, or by a spouse's or parent's family member living in the same house (where the spouse or parent consented to, or acquiesced in the battery or cruelty)?

**SECTION D:**

**I DECLARE UNDER PENALTY OF PERJURY UNDER THE LAWS OF THE STATE OF CALIFORNIA THAT THE ANSWERS I HAVE GIVEN ARE TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE.**

\_\_\_\_\_  
Applicant's Signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Signature of Person Acting for Applicant

\_\_\_\_\_  
Date