

TENNESSEE FIRE MARSHAL EXPLOSIVES USERS TEST STUDY GUIDE

February 2008

NOTE: *This guide is not all inclusive and knowing its contents does not guarantee the applicant will pass the exam. Thorough knowledge of blasting and explosives methods and terminology, and state rules and regulations is required.*

ADMINISTRATIVE INFORMATION

Blasting in the state of Tennessee is principally regulated by the Department of Commerce and Insurance, Division of Fire Prevention, also known as the State Fire Marshal's Office.

The division registers firms, blasters, limited blasters, and handlers engaged in the use of explosives. Persons below the age of 21 do not qualify for a blaster's or limited blaster's registration. Persons below the age of 18 do not qualify for a handler's registration. Blaster and limited blaster applicants must pass an examination prior to registration. Access to and possession of explosive materials should be limited to registered blasters, limited blasters, and handlers. Exceptions:

68-105-120. Exceptions. — [Amended effective January 1, 2008. See the Compiler's Notes.]

Nothing contained in this chapter shall apply to:

(1) Personnel of the military or naval forces of the United States, or to the duly organized military force within the state, so long as these persons are acting within their respective official capacities and in the performance of their official duties;

[Effective January], 2008. See the Compiler's Notes]

(2) Personnel of law enforcement entities, so long as these persons are acting within their official capacities and in the performance of their official duties;

(3) The use of explosives for occasional agricultural blasting. "Agricultural blasting" means stump removal, beaver dam or lodge eradication and other similar types of personal agricultural use;

Registrants should be familiar with other agencies and regulations which govern explosives compliance. Violation of the provisions of any Tennessee explosives law or regulation can result in a suspended or revoked registration or a fine up to \$2,500 for individuals or \$5,000 for firms.

Federal agencies regulating explosives:

Bureau of Alcohol, Tobacco and Firearms, 27 Code of Federal Regulations
Occupational Safety and Health Administration, 29 Code of Federal Regulations
Mine Safety and Health Administration, 30 Code of Federal Regulations
U.S. Department of Transportation, 49 Code of Federal Regulations

Tennessee blasting law requires firms to maintain blasting and explosives liability insurance of at least \$1,000,000.

STORAGE

Storage generally falls into two categories, attended and unattended. All storage containers are classified as a magazine. Magazines are subdivided into five types:

Type I is masonry with a 3-point mortise lock.

Type II is relocatable, 1/4" steel, hardwood lining, two protected padlocks.

Type III is a "daybox". Metallic exterior, non-sparking interior, hasp, padlock. For attended workday use only.

Type IV has several standards for "low explosives" and detonators that are covered under this classification.

Type V is essentially a locked container (can be a semi-trailer with a kingpin lock and padlocked doors for blasting agents only).

Magazine locations should be in compliance with the American Table of Distances for Storage of Explosives. Brush, trash, and fuel sources should be cleared to 25 feet around the magazine. No smoking is allowed within 50 feet of the magazine.

0780-2-15-.07 BLASTING STORAGE AND DESTRUCTION OF MATERIALS.

(1) Blasting Storage

- (a) Temporary storage. Explosives may be stored in an approved Type 2 or Type 3 magazine or day box for one (1) day's usage only during daytime blasting operations and must be removed from temporary storage at the end of the work day. If the blasting firm or blaster has requested the Commissioner or his or her authorized representative to approve blasting at night, then the Commissioner or his or her authorized representative shall also consider appropriate requests to approve the extended use of the temporary storage during the nighttime blasting operations. The magazine or day box must be attended by a blaster, limited blaster or handler who has access to and knowledge of the contents. A blaster, limited blaster or handler must also be actively and directly in contact with, or within the sight of, without the aid of telescopic optical equipment or electronic devices, the temporary storage to maintain sufficient control.

ACCOUNTABILITY

According to Bureau of Alcohol, Tobacco and Firearms regulations, a firm using explosives has to account for all materials by close of the next business day. The chain of accountability includes: records of deliveries and returns from suppliers, magazine logs, inventories of materials on hand and shot reports.

Tennessee state law requires that shot reports (blast records) be maintained and available for 3 years. Information required by the BATF in accounting for material includes: Trade name, quantity, size, length, delay number.

COMMERCIAL EXPLOSIVES

Molecular.....	Cast boosters Detonators Detonating Cord Specialty Items
Gelatin Dynamite.....	Straight Gelatin Dynamite Ammonia Gelatin Dynamite (Extra Gelatin) Semi-gelatin Dynamite
Slurry-Cartridged.....	Monomethylaminenitrate Aluminized Air Sensitized

Slurry-Watergel, Emulsion

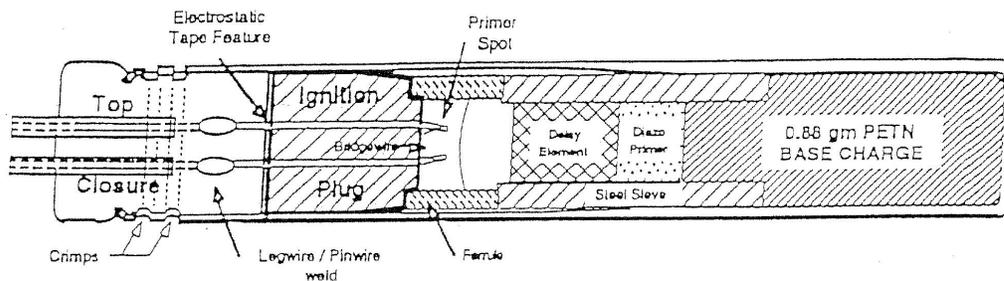
Slurry-Bulk.....Air Sensitized
Aluminized
Explosive Sensitized
Heavy ANFO

ANFO-Bulk.....Aluminized ANFO
Heavy ANFO

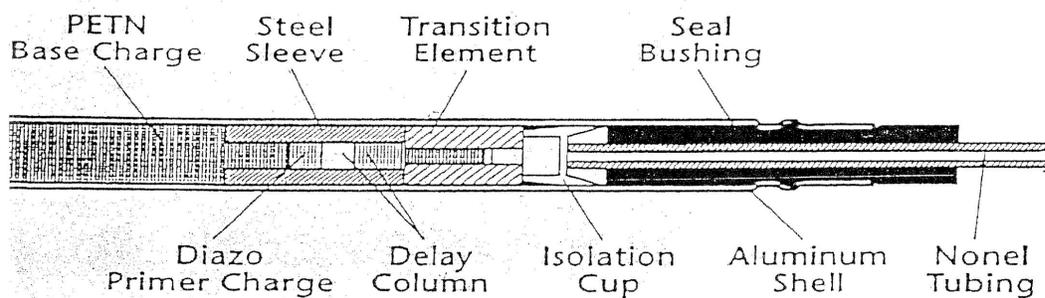
ANFO-Cartridged, Dry Blasting Agents.....ANFO
Aluminized ANFO
Densified ANFO

Binary.....Two Component

Cross section of a delayed blasting cap



Cross section of a delayed nonelectric blasting cap



EXPLOSIVE MATERIALS AND PRODUCT SELECTION

Explosives are often discussed in terms of their USDOT classification. These are:

Detonators: commonly called blasting caps, they bear a USDOT label of 1.1B or 1.4B, largely dependent on packaging.

Explosives 1.1D: These are sensitive to initiation by blasting caps. Dynamite, watergels and emulsions are included.

Blasting Agents (Explosives), 1.5D: These materials require a higher order explosive for reliable initiation. They include emulsions, watergels and ANFO.

Booster: a very high order 1.1D explosive intended to be used in priming blasting agents, particularly if over 4" in diameter.

Detonating Cord, 1.1D or 1.4D: See nonelectric initiation for details.

Dynamite: A combination of nitroglycerin or similar explosive (e.g. ethyleneglycol- dinitrate) and other fuels.

Emulsions: Explosive compounds dissolved in small water droplets surrounded by oil, forming an oil mixture with an emulsifying agent added to prevent separation.

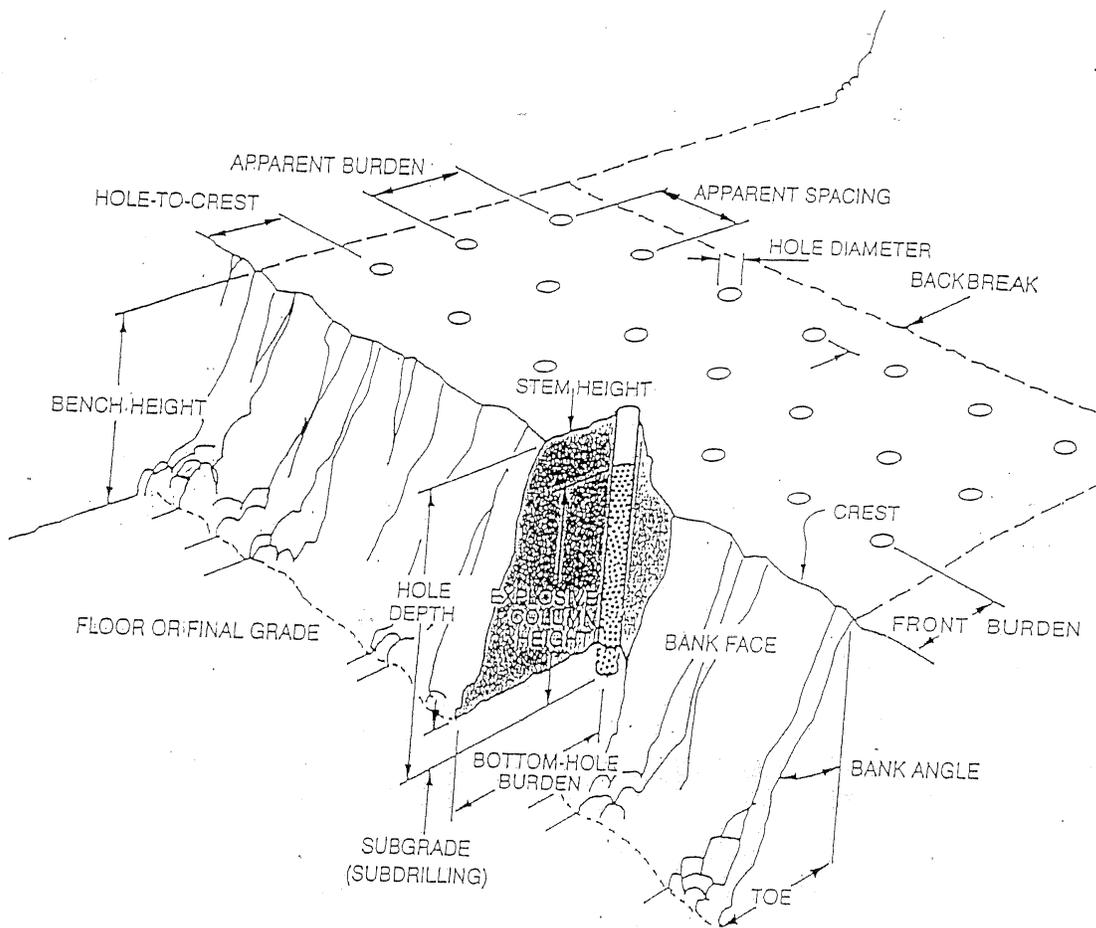
Watergel: Oxidizer, fuel, significant portion of water and a crosslinking agent form an explosive material.

ANFO: Ammoniumnitrate/fuel mixture: an inexpensive oxygen balanced mix; poor water resistance, usually bulk loaded.

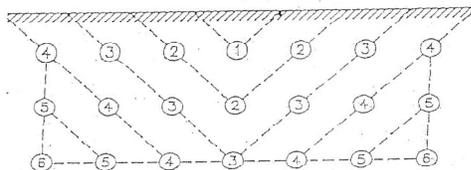
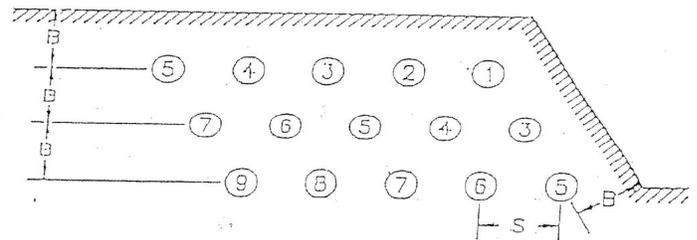
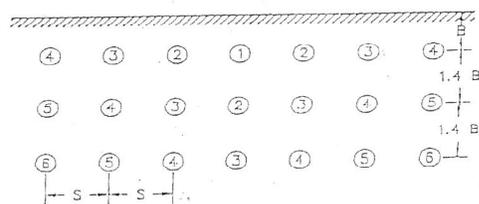
Binary: Two component: a mix-on-site cartridge product usually ammonium nitrate and nitromethane. Not USDOT rated, requires detonator or 50 grain cord for priming.

Permissibles: Explosives and allied products approved for use in underground coal mines and other gaseous environments.

Explosives Terms Illustrated

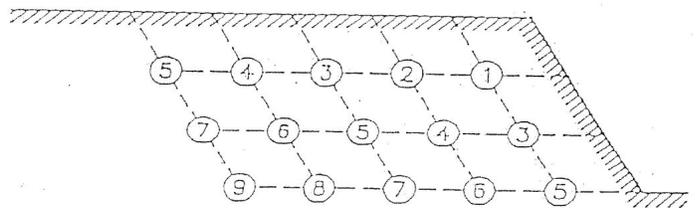


Basic Delay Patterns



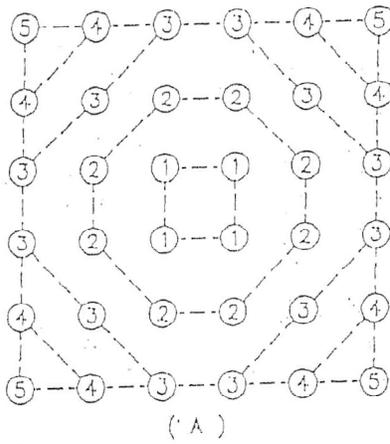
$S = 1.4 B$

V-Cut (Square Corner), Progressive Delays, $S = 1.4$

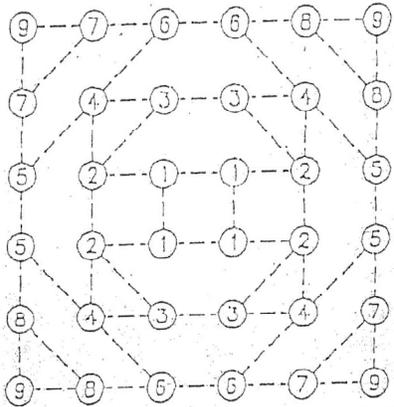


$S = 1.15 B$

Angle Corner, Progressive Delays
(Low Bench) $S = 1.15 B$



(A)



(B)

Sinking Cuts, Square Pattern

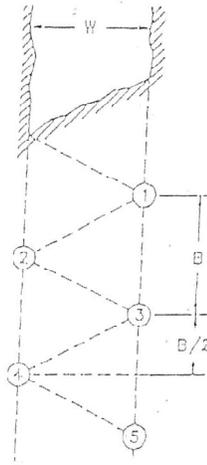
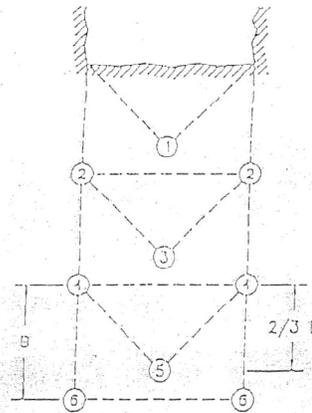


Figure 7.28 Two Row Trench Design



Three Row Trench Design

BLASTING FORMULAS

$$\text{Pounds-Per-Foot} = \text{Diameter}^2 \times .34 \times \text{Specific Gravity}$$

Used to determine pounds of explosive in a foot of powder column for a given diameter. Specific Gravity is density compared to water. For packaged products use cartridge diameter, for bulk use the hole diameter.

$$\text{Cubic Yards-Per-Hole} = (B \times S \times D) \div 27$$

Burden x Spacing x Depth (remember depth of rock)

In trench work, it may be desirable to substitute a number of linear feet (L.F.) for burden, trench width for spacing and adjust for the number of holes in that pattern.

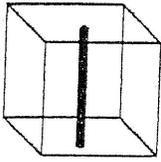
Changing Burden (and Spacing) and Bit Size

$$\text{New Burden (and spacing)} = (\text{new bit dia.} \div \text{old bit dia.}) \times \text{Old Burden}$$

Quarry Note: a cubic yard of limestone is 2.23 tons

Volume in Yards

Calculating Cubic Yards per Hole:



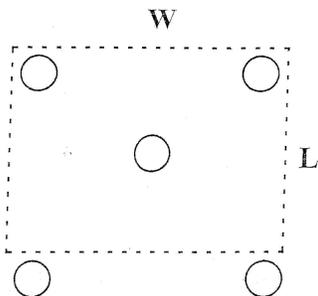
$$B \times S \times HD \div 27$$

Where: B = burden (ft), S = Spacing (ft), HD = hole depth (ft)

Example: 8' burden, 9' spacing, 12' depth

$$\begin{aligned} \text{Volume (cubic yards)} &= 8' \times 9' \times 12' \div 27 \\ &= 32 \text{ Cubic Yards per Hole (yds}^3\text{)} \end{aligned}$$

Cubic Yards Per Hole-Trench



$$\text{Length} \times \text{Width} \times \text{Depth} \div 27 = \text{yds}^3 \text{ per 3 holes}$$

Divide by 3 for yds³ per hole

BLAST LOADING

The initial group of tasks involves: giving notifications (72 hour notice to underground utilities), obtaining required permits, acquiring proper storage, determining exposure distances, examining the blast site and area, assembling the necessary equipment and materials, and planning the shot.

After a blasting plan has been made, preparing the site, then drilling the shot takes place. Care is taken to ensure: pattern, alignment and proper depth of drilling seams, voids and other irregularities are logged so the blaster can use decks where needed. All holes are checked prior to drill departure.

The blaster confirms the condition and wetness of the holes, the state of his equipment, and that he has the tools and materials needed. These tasks are completed before loading begins.

Loading begins by "laying out" the caps. While to casual observation this seems unnecessary or improper, it is a useful exercise, particularly with electric detonators. The blaster starts at the opening hole and works his way back through the shot in firing order. Two functions are served:

first, the cap requirement is confirmed; second, the blaster views the shot as he has planned its development, in delay order.

Assembling the first primer follows. Primers are assembled by placing a detonator into a cap-sensitive explosive and securing them in a manner that will allow immediate retrieval. This may be accomplished by half-hitching, threading, or taping the wire, shocktube or detonating cord through or to the cartridge. Select the method that matches the materials. Do not make up primers in advance; load them immediately after assembly, never tamp primers.

While loading ensure only water resistant explosives are used in wet holes. Monitor the rise of explosives in the holes to avoid filling voids and seams or overloading. This especially applies to bulk loaded explosives, including bagged ANFO. Tamp, guide and retrieve materials in a blasthole only using nonsparking tools. In the case of electric initiation, test detonators with a blaster's galvanometer prior to stemming the holes.

Hook-up or wire the shot according to manufacturer's recommendations and established industry practices, and within the blasting machine's rated capacity. If using electric initiation, calculate the circuit's total resistance, and then test it. Check the blasting machine's indicators. If laying mats, maintain a circuit check throughout the process.

Evacuate the blast site, confirm warning and all clear signals, and place guards where needed. Exchange signals, fire the shot, inspect the muckpile, then sound the all clear. At any time, if in doubt, **don't!** Determine the problem and correct it.

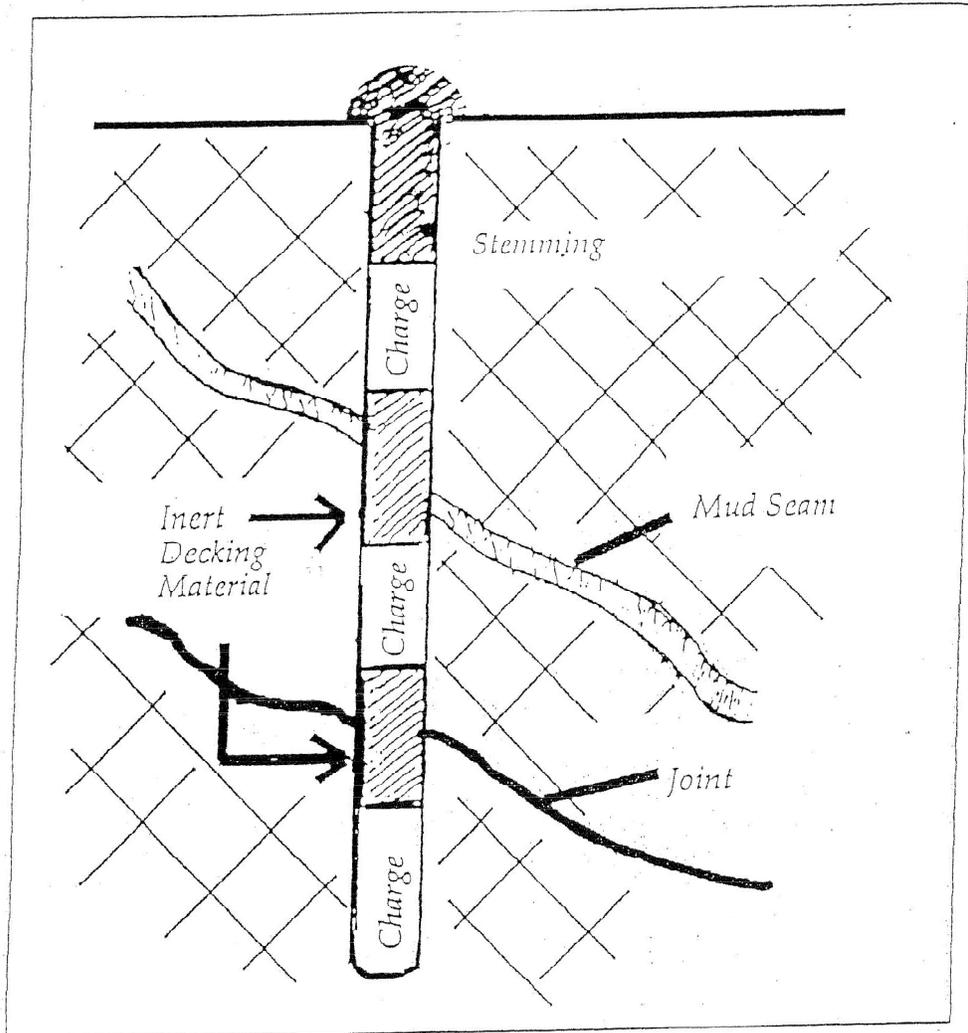
If not yet accomplished, log explosives into the magazine and secure them before you leave the blast area, complete the blast report (shot report).

THE USE OF DECKS IN A BOREHOLE

A deck is the interruption of the explosive column with stemming material. In addition to this example one may deck to: achieve better distribution without a total increase in explosive weight, to create additional delay periods in the hole or to influence the direction of movement.

Initiation may be accomplished through multiple priming or the use of detonating cord.

Thought should be given in advance to the desired firing order of the charges.



Loading Blastholes According to Hard and Weak Zones.