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**EXPLOSIVES AND DEMOLITIONS**

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**July 2007**

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## Explosives and Demolitions

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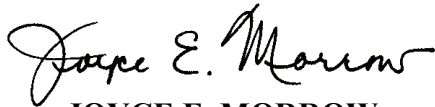
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# EXPLOSIVES AND DEMOLITIONS

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## Preface

The doctrine of explosives and demolitions focuses on the procedures that support the combat operations provided by engineer capabilities to the combined arms team. This doctrine reduces the effectiveness of barriers, obstacles, infrastructure, and minefields to maintain mobility and momentum in the operating area.

Field Manual (FM) 3-34.214 is the reference manual for explosives and demolitions procedures that support combat operations, as well as, peacetime training missions requiring *demolition* (the destruction of structures, facilities, or material by use of fire, water, explosives, mechanical, or other means) (FM 1-02) applications. FM 3-34.214 provides the theory of explosives, explosive characteristics and their common uses, formulas for calculating various types of charges, and the standard methods of priming and placing charges.

FM 3-34.214 provides doctrine on constructing charges for various applications and its uses to maintain mobility and momentum in the contemporary operational environment (COE). It focuses on the demolition systems and material required to accomplish the mission. The doctrine in this manual recognizes the need to address the urban and complex environment. This manual describes in detail the procedures required to assemble and emplace explosive charges for impartial or complete destruction.

The primary audience for FM 3-34.214 is Soldiers at the unit level and below. This doctrine will assist Army branch schools in teaching the integration of engineer explosive capabilities into Army operations. Engineer involvement is a given for nearly every military operation. The degree of involvement will include one or more of the roles associated with engineers performing demolition missions in support of the maneuver commander. Given the magnitude of the changes in demolition material and the techniques used in recent years, becoming familiar with the information in this document is essential to use explosives effectively to achieve the desired end state.

Appendix A complies with current Army directives that state that the metric system will be incorporated into all new publications.

Terms that have joint or Army definitions are identified in both the glossary and the text. Glossary references: The glossary lists most terms used in FM 3-34.214 that have joint or Army definitions. Terms for which FM 3-34.214 is the proponent FM (the authority) are indicated with an asterisk in the glossary. Text references: Definitions for which FM 3-34.214 is the proponent FM are printed in boldface in the text. These terms and their definitions will be incorporated into the next revision of FM 1-02. For other definitions in the text, the term is italicized and the number of the proponent FM follows the definition.

This publication applies to the Active Army, the Army National Guard (ARNG)/Army National Guard of the United States (ARNGUS), and the United States Army Reserve (USAR) unless otherwise stated. This publication also applies to U.S. Military Academy, United States Army National Guard, United States Army Reserve, and DA civilian employees and contractors (contracts for work on Army ranges will include a provision requiring compliance with applicable provisions of Army Regulation (AR) 385-63); (2) Reserve Officer Training Corps participating students while training on an Army controlled range; (3) Active commands (local SOPs and range policies will reinforce this order); (4) any person or organization using an Army controlled real estate or range; (5) range training and target practice activities; (6) military real estate areas that are being or have been used as bombing ranges, artillery impact areas, or target areas; and (7) all areas designated for live-fire weapons firing, including laser ranges, recreational ranges, and rod and gun club ranges located on Army property or property controlled by the Army. During mobilization, chapters and policies contained in this FM may be modified by the proponent. This FM is advisory for deployed units engaged in combat operations. This FM also applies to personnel training outside the United States. Army commanders will apply the provisions of this FM and host national agreements as appropriate.

The proponent for this publication is the United States Army Training and Doctrine Command (TRADOC). Send comments and recommendations on Department of the Army (DA) Form 2028 (Recommended Changes to Publications and Blank Forms) directly to Commandant, United States Army Engineer School, ATTN: ATSE-DD, 320 MANSCEN Loop, Suite 336, Fort Leonard Wood, Missouri 64573-8929. Submit an

## **Preface**

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electronic DA Form 2028 or comments and recommendations in the DA Form 2028 format by e-mail to <doctrine.engineer@wood.army.mil>.

Unless this publication states otherwise, masculine nouns and pronouns do not refer exclusively to men.



## Chapter 1

# Military Explosives

This chapter describes the types of demolition materials used. It also describes the demolition charges currently in the military system, special demolition charges and assemblies, and the demolition accessories used to prepare the demolitions for firing.

### SECTION I – DEMOLITION MATERIALS

#### EXPLOSIVE SELECTION

1-1. Explosives selected should fit the particular purpose, based on their relative power. Consider all characteristics when selecting an explosive for a particular demolition project. For detailed information on military explosives, see Technical Manual (TM) 9-1300-214. Table 1-1, pages 1-2 and 1-3, contains significant information regarding many United States (U.S.) explosives. See Appendix B for equivalent metric weights of standard explosives.

Table 1-1. Characteristics of U.S. Explosives

Name	Applications	Detonation Velocity		RE Factor*	Fume Toxicity	Water Resistance
		M/Sec	Ft/Sec			
Ammonium nitrate	Earthmoving	2,700	8,900	0.42	Dangerous	Poor
PETN	Detonating cord Blasting caps Demolition charges	8,300	27,200	1.66	Slight	Excellent
RDX	Blasting caps Composition explosive	8,350	27,400	1.60	Dangerous	Excellent
TNT	Demolition charge Composition explosive	6,900	22,600	1.00	Dangerous	Excellent
Tetryl	Booster charge Composition explosive	7,100	23,300	1.25	Dangerous	Excellent
Nitroglycerin	Commercial dynamite	7,700	25,200	1.50	Dangerous	Good
Black powder	Time fuse	400	1,300	0.55	Dangerous	Poor
Amatol 80/20	Bursting charge	4,900	16,000	1.17	Dangerous	Poor
Composition A3	Booster charge Bursting charge	8,100	26,500	—	Dangerous	Good
Composition B	Bursting charge	7,800	25,600	1.35	Dangerous	Excellent
Composition C4 (M112)	Cutting charge Breaching charge	8,040	26,400	1.34	Slight	Excellent
Composition H6	Cratering charge	7,190	23,600	1.33	Dangerous	Excellent
Ammonium nitrate	Cratering charge	2,700	8,900	0.42	Dangerous	Poor
Tetrytol 75/25	Demolition charge	7,000	23,000	1.20	Dangerous	Excellent
Pentolite 50/50	Booster charge Bursting charge	7,450	24,400	—	Dangerous	Excellent
M1 dynamite	Demolition charge	6,100	20,000	0.92	Dangerous	Fair
Detonating cord	Priming Demolition charge	6,100 to 7,300	20,000 to 24,000	1.66	Slight	Excellent
Sheet explosive (M186)	Cutting charge	7,300	24,000	1.14	Dangerous	Excellent
Bangalore torpedo, M1A2	Demolition charge	7,800	25,600	1.17	Dangerous	Excellent
Shaped charges M2A3, M2A4, and M3A1	Cutting charge	7,800	25,600	1.17	Dangerous	Excellent

**Table 1-1. Characteristics of U.S. Explosives**

Name	Applications	Detonation Velocity		RE Factor*	Fume Toxicity	Water Resistance
		M/Sec	Ft/Sec			
Binary mix, Sodium perchlorate, and Aluminum powder	FPE main charges	4,000	13,100	1.60	Slight	Good
*TNT equals 1.00 RE.						

## DOMESTIC EXPLOSIVES

1-2. The paragraphs below discuss the different types of domestic explosives. Domestic explosives include ammonium nitrate, trinitrotoluene (TNT) , composition C4, and dynamite.

### AMMONIUM NITRATE

1-3. Ammonium nitrate is the least sensitive of military explosives. For successful detonation, it requires a booster charge. Because of its low sensitivity, ammonium nitrate is a component of many composite explosives (combined with a more sensitive explosive). Ammonium nitrate is not suitable for cutting or breaching charges because it has a low detonating velocity. Commercial quarrying operations use ammonium nitrate demolitions extensively. Ammonium nitrate should be packed in an airtight container because it is extremely hygroscopic (absorbs humidity). Ammonium nitrate or composite explosives containing ammonium nitrate are not suitable for underwater use unless packed in waterproof containers or detonated immediately after placement.

### TRINITROTOLUENE

1-4. TNT may be in a composite (such as booster, bursting, or demolition charges) or a noncomposite form. Since TNT is a standard explosive, it is used to rate other military explosives.

### COMPOSITION C4

1-5. Composition C4 is a composite explosive containing 91 percent cyclotrimethylenetrinitramine (RDX) and 9 percent nonexplosive plasticizers. Booster charges are composed of composition C4. Composition C4 is effective in temperatures between 70°F-170°F; however, composition C4 loses its plasticity in colder temperatures.

### DYNAMITE

1-6. The paragraphs below discuss the different dynamite types. Dynamite types include standard, military, and binary explosives (fighting position excavator [FPE]).

#### Standard

1-7. Most dynamites, with the notable exception of military dynamite, contain ammonium nitrate plus varying combinations of absorbents, oxidizers, antacids, and freezing point depressants. Dynamites vary in strength and sensitivity depending on, among other factors, the percentage of ammonium nitrate. Some nitroglycerin-based dynamites are still available for general blasting and demolitions, including land clearing, cratering and ditching, and quarrying.

## Military

1-8. Military dynamite is a composite explosive that contains 75 percent cyclotrimethylenetrinitramine (RDX) (also known as cyclonite), 15 percent TNT, and 10 percent desensitizers and plasticizers. Military dynamite is not as powerful as commercial dynamite. The equivalent strength of military dynamite is 60 percent of commercial dynamite. Because military dynamite contains no nitroglycerin, it is stabler and safer to store and handle than commercial dynamite.

## Binary Explosives (Fighting Position Excavator)

1-9. Binary explosives are two inert, nonexplosive components that are mixed together to form an explosive charge. The inert components may be handled and transported safely as nonhazardous, nonexplosive items until they are mixed just before they are used. Binary explosives can be primed and initiated like any other military explosive item. The main charges of the FPE are a binary explosive formed by mixing sodium perchlorate with aluminum powder.

## FOREIGN EXPLOSIVES

1-10. Foreign countries use a variety of explosives, including TNT, picric acid, amatol, and guncotton. Picric acid is similar to TNT, but it also corrodes metals, forming extremely sensitive compounds.

### WARNING

**Do not handle picric acid. Notify *explosive ordnance disposal (EOD)* (the detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of unexploded ordnance. It may also include explosive ordnance which has become hazardous by damage or deterioration) (Joint Publication [JP] 1-02) personnel for disposition. Failure to comply could result in immediate personal injury or damage to equipment.**

1-11. Explosives of allied nations and those captured from the enemy can be used to supplement standard supplies. Use these explosives according to the instructions and directives of theater commanders. Captured bombs, propellants, and other devices may be used with U.S. military explosives for larger demolition projects, such as pier, bridge, tunnel, and airfield destruction. Most foreign explosive blocks have cap wells large enough to receive U.S. military blasting caps. Since foreign explosives may differ from U.S. explosives in sensitivity and force, make test shots to determine their adequacy before extensive use or mixing with U.S.-type explosives. Additional information on the use of demolition charges is in Appendix C.

## EXPEDIENT DEMOLITION CHARGES

1-12. Expedient techniques are intended for use only by personnel experienced in demolitions and demolition safety. Expedient techniques should not be used to replace standard demolition methods. Availability of trained Soldiers, time, and material are the factors to consider when evaluating the use of expedient techniques. For additional information on the expedient use of demolitions, see Appendix D.

## SECTION II – SERVICE DEMOLITION CHARGES

### BLOCK DEMOLITION CHARGE

1-13. Block demolition charges are prepackaged, high-explosive (HE) charges for general demolition operations, such as cutting, breaching, and cratering. They are composed of HE TNT, tetrytol, composition C-series, and ammonium nitrate. Block charges are rectangular in form except for the 40-pound, composition H6 cratering charge, military dynamite, and the 1/4-pound TNT block demolition charge,

which are all cylindrical in form. The various block charges available are described below, as well as in Table 1-2. See TM 43-0001-38 for detailed information about demolition charges and accessories.

**Table 1-2. Characteristics of Block Demolition Charges**

Explosive	Unit (lb)	Size (in)	Detonation Velocity		RE Factor	Packaging and Weight <sup>1</sup>
			M/Sec	Ft/Sec		
TNT <sup>2</sup>	0.25	1 1/2 x 3 1/2	6,900	22,600	1.00	192 per box/55 lb
	0.50	1 3/4 x 1 3/4 x 3 3/4	6,900	22,600	1.00	96 per box/53 lb
	1.00	1 3/4 x 1 3/4 x 7	6,900	22,600	1.00	48 per box/53 lb
M112 block	1.25	1 x 2 x 10	8,040	26,400	1.34	30 per box/40 lb
M186 roll	25.00	1/4 x 3 x 600	7,300	24,000	1.14	3 per box/80 lb
Composition H6 <sup>2</sup>	43.00	7 x 20	7,190	23,600	1.33	1 per box/52 lb
M1 dynamite <sup>2</sup>	0.50	1 1/4 x 8	6,100	20,000	0.92	100 per box/62 lb

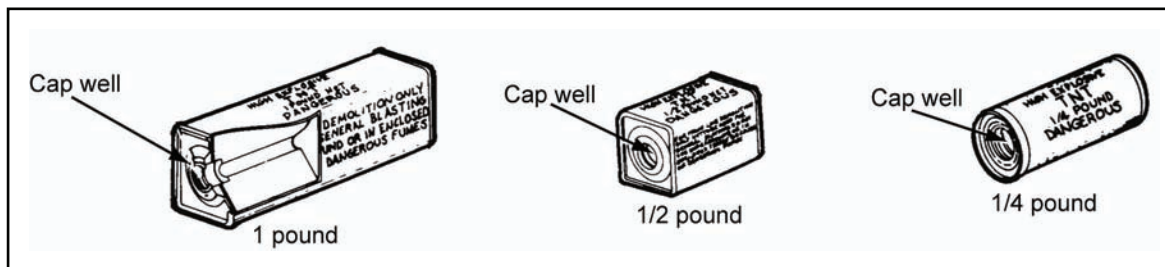
<sup>1</sup>Packaging weights include the packaging material and the weight of the container.  
<sup>2</sup>The 1/4-pound block of TNT, the composition H6 cratering charge, and the M1 dynamite are cylindrical in shape and described in terms of diameter and length.

## TRINITROTOLUENE BLOCK DEMOLITION CHARGE

1-14. TNT charges are discussed below. Discussed are the characteristics, uses, advantages, and limitations of TNT charges.

### CHARACTERISTICS

1-15. The TNT charges shown in Figure 1-1 are available in three sizes (Table 1-2). The 1/4-pound block is issued in a cylindrical, waterproof, olive drab cardboard container. The 1/2-pound and 1-pound blocks are available in similar rectangular containers. All of the three charges have metal ends with a threaded cap well in one end.



**Figure 1-1. TNT Block Demolition Charges**

### USES

1-16. TNT charges are effective for all types of demolition work, except for special steel-cutting charges. However, the 1/4-pound charge is primarily for training purposes.

### ADVANTAGES

1-17. TNT charges have a high detonating velocity. They are stable, relatively insensitive to shock or friction, and are water resistant. They are conveniently sized, shaped, and packaged.

## LIMITATIONS

1-18. TNT charges cannot be molded and are difficult to use on irregularly shaped targets. TNT is not recommended for use in closed spaces because one of the products of explosion is poisonous gases.

## M112 BLOCK DEMOLITION CHARGE

1-19. M112 block demolition charges are discussed in the paragraph below. Discussed are the characteristics, uses, advantages, and limitations of a M112 block demolition charge.

## CHARACTERISTICS

1-20. An M112 charge consists of 1 1/4 pounds of composition C4 packed in an olive drab film container with a pressure-sensitive adhesive tape on one surface (Figure 1-2). A peelable paper cover protects the tape. Table 1-2 lists additional characteristics of the M112 block.

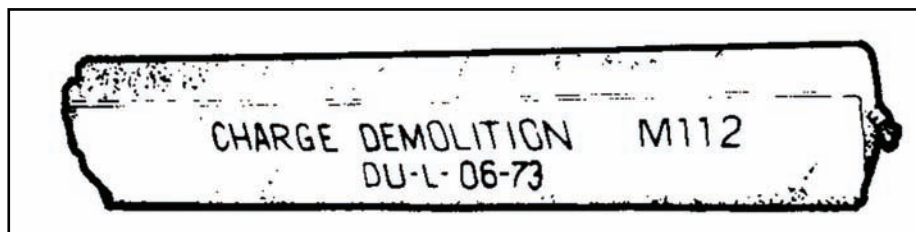


Figure 1-2. M112 Block Demolition Charge

## USES

1-21. The M112 charge is used primarily for cutting and breaching. Because of its high cutting effect and its ability to be cut and shaped, the M112 charge is ideally suited for cutting irregularly shaped targets, such as steel. The adhesive backing allows the charge to be placed on any relatively flat, clean, dry surface with a temperature that is above the freezing point. The M112 charge is the primary block demolition charge presently in use.

### WARNING

**Composition C4 explosive is poisonous and dangerous if chewed or ingested; its detonation or burning produces poisonous fumes. Cut all plastic explosives with a sharp, nonsparking steel knife on a nonsparking surface. Shears should not be used. Failure to comply could result in immediate personal injury or damage to equipment.**

## ADVANTAGES

1-22. The M112 block demolition charge can be cut or molded to fit irregularly shaped targets. The color of the wrapper helps camouflage the charge.

## LIMITATIONS

1-23. The adhesive tape will not adhere to wet, dirty, rusty, or frozen surfaces. Molding the charge can decrease its cutting effect.

## M186 ROLL DEMOLITION CHARGE

1-24. A M186 charge (Figure 1-3) is in roll form on a 50-foot plastic spool. Each foot of the roll provides about 1/2 pound of explosive. Included with each roll are 15 M8 blasting cap holders and one canvas bag with a carrying strap. Table 1-2, page 1-5, lists additional characteristics for the M186 charge. The M186 charge is adaptable for demolishing targets that require using flexible explosives in lengths longer than 12 inches. The M186 charge can be cut to the exact lengths desired. One limitation of the M186 charge is that the adhesive backing will not adhere to wet, dirty, rusty, or frozen surfaces.

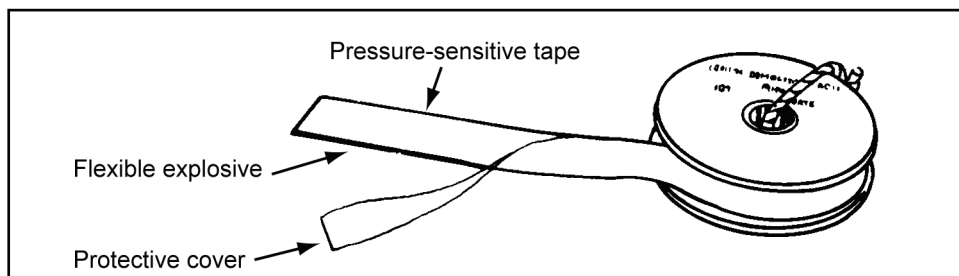


Figure 1-3. M186 Roll Demolition Charge

## 40-POUND, COMPOSITION H6 CRATERING CHARGE

1-25. Figure 1-4, page 1-8, shows a composition H6 cratering charge. It is a watertight, cylindrical metal container with 40 pounds of composition H6 explosive and has 0.43 pound of composition A5 explosive booster positioned at the top. Priming instructions are printed on the side of the canister. There is a metal ring (lifting handle) on the top of the container for lowering the charge into its hole. Table 1-2 lists additional characteristics for the composition H6 charge. This charge is suitable for cratering and ditching operations. Its primary use is as a cratering charge, but it is also effective for destroying buildings, fortifications, and bridge abutments. The advantage of this charge is its size and shape, making it ideal for cratering operations. It is inexpensive to produce compared to other explosives.

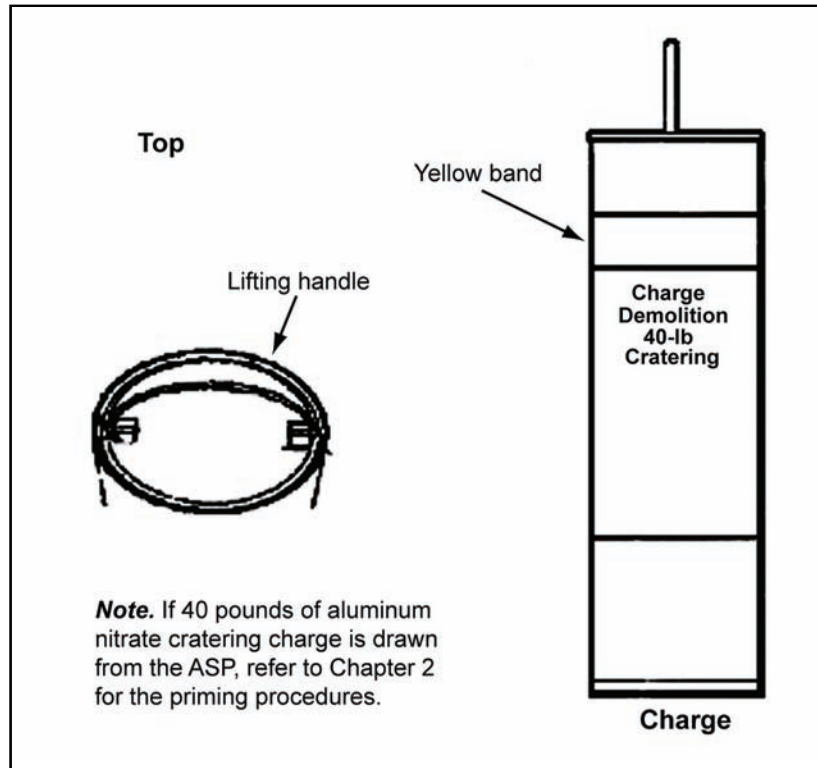


Figure 1-4. 40-Pound, Composition H6 Cratering Charge

## M1 MILITARY DYNAMITE

1-26. M1 military dynamite is discussed below. Discussed are the characteristics, uses, advantages, and limitations of M1 military dynamite.

### CHARACTERISTICS

1-27. M1 military dynamite is an RDX-based composite explosive containing no nitroglycerin (Figure 1-5). M1 dynamite is packaged in 1/2-pound, paraffin-coated, cylindrical paper cartridges, which have a nominal diameter of 1 1/4 inches and a nominal length of 8 inches. Table 1-2, page 1-4, lists additional characteristics for M1 military dynamite.

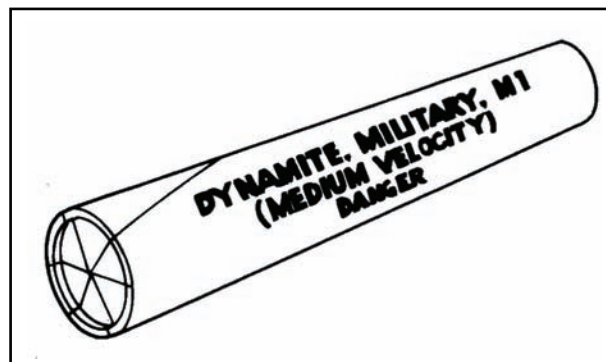


Figure 1-5. M1 Military Dynamite



**USES**

1-28. The primary use of M1 dynamite is for stump removal, military construction, quarrying, ditching, and service demolition work. M1 is suitable for underwater demolitions.

**ADVANTAGES**

1-29. M1 dynamite will not freeze or perspire in storage. Its composition is not hygroscopic. Unlike civilian dynamite containers, military shipping containers do not require turning during storage. M1 dynamite is safer to store, handle, and transport than 60 percent of commercial dynamite. Unless essential, do not use civilian dynamite in combat areas.

**LIMITATIONS**

1-30. M1 dynamite is reliable underwater for only 24 hours. Because of its low sensitivity, sticks of military dynamite should be packed well to ensure complete detonation of the charge. M1 dynamite is not efficient as a cutting or breaching charge.

**SHAPED DEMOLITION CHARGE**

1-31. The shaped demolition charge used in military operations is a cylindrical block of HE. It has a conical cavity in one end that directs the lining material of the cone into a narrow jet to penetrate materials (Figure 1-6). This charge is not effective underwater, since any water in the conical cavity will prevent the high-velocity jet from forming. To obtain maximum effectiveness, place the cavity at the specified standoff distance from the target, and detonate the charge from the exact rear center using only the priming well that is provided. Never dual-prime a *shaped charge* (a charge shaped so as to concentrate its explosive force in a particular direction) (JP 1-02).

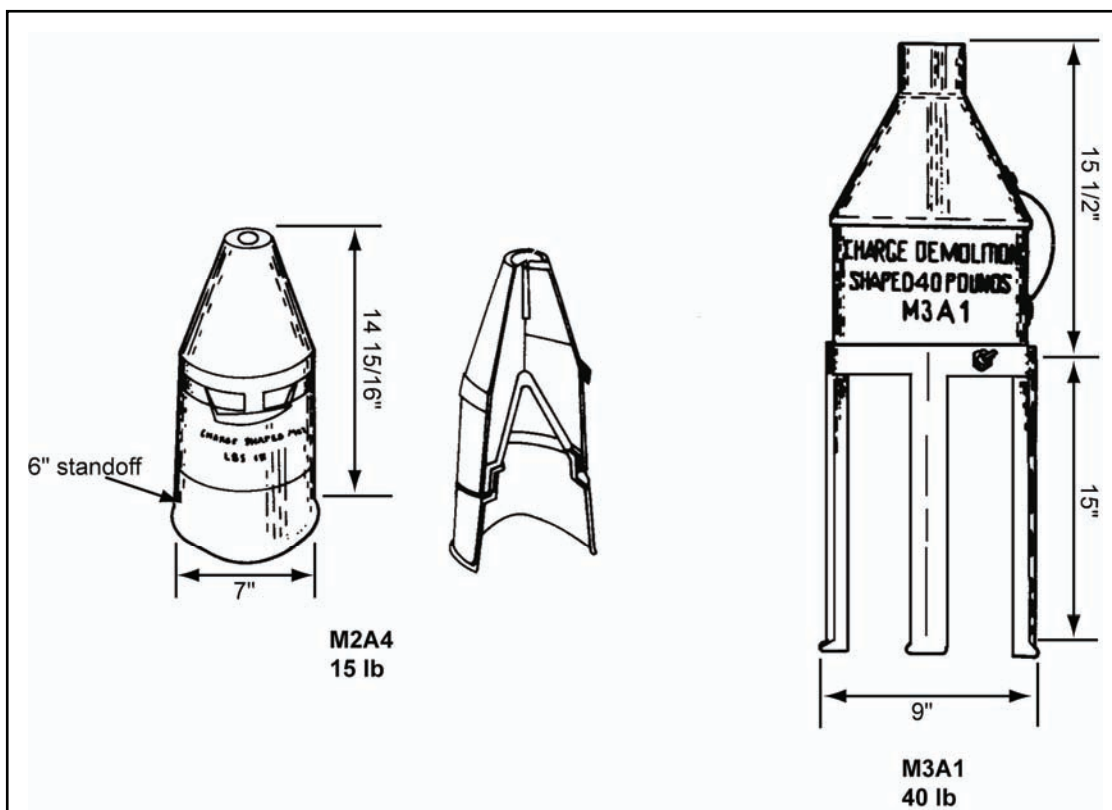


Figure 1-6. Shaped Demolition Charges

## CHARACTERISTICS

1-32. Following are the characteristics of the 15-pound M2A4 shaped demolition charge. Also discussed are the characteristics of the 40-pound M3A1 shaped demolition charge.

### 15-Pound M2A4 Shaped Demolition Charge

1-33. An M2A4 charge contains a 0.11-pound booster of composition A3 and an 11.5 1/2-pound main charge of composition B. It is packaged with three charges per wooden box (total weight is 65 pounds). This charge has a moisture-resisting, molded-fiber container. A cylindrical fiber base slips onto the end of the charge to provide a 6-inch standoff distance. The cavity liner is a cone of glass. The charge is 14 15/16 inches high and 7 inches in diameter, including the standoff. Table 1-3 lists the penetrating capabilities of the M2A4 in various types of materials.

### 40-Pound M3A1 Shaped Demolition Charge

1-34. An M3A1 charge contains a 0.11-pound booster of composition A3 and a 29.5-pound main charge of composition B. It is packaged with one charge per box (total weight is 65 pounds). The charge is in a metal container, and the cone liner is made of metal. A metal tripod provides a 15-inch standoff distance. The charge is 15 1/2 inches high and 9 inches in diameter, not including the standoff.

## USES

1-35. The primary use of a shaped demolition charge is for boring holes in the earth, metal, masonry, concrete, and paved and unpaved roads. Its effectiveness depends largely on its shape, composition, and placement. Table 1-3, pages 1-11 and 1-12, lists the penetrating capabilities of various materials and the proper standoff distances for these charges.

**Table 1-3. Characteristics of Boreholes Made By Shaped Charges**

<i>Material</i>	<i>Specifications</i>	<i>M2A4, Shaped Charge* (15 lb)</i>	<i>M3A1, Shaped Charge** (40 lb)</i>
Armor plate	Penetration	12.00 in	At least 20.00 in
	Average hole diameter	01.50 in	02.50 in
Reinforced concrete	Maximum wall thickness	36.00 in	60.00 in
	Penetration depth in thick walls	30.00 in	60.00 in
	Average hole diameter	02.75 in	03.50 in
	Minimum hole diameter	02.00 in	02.00 in
Concrete pavement (10 in with a 21-in rock base course)	Optimum standoff	42.00 in	60.00 in
	Minimum penetration depth	44.00 in	71.00 in
	Maximum penetration depth	91.00 in	109.00 in
	Minimum hole diameter	01.75 in	06.75 in
Concrete pavement (3 in with a 24-in rock base course)	Optimum standoff	42.00 in	—
	Minimum penetration depth	38.00 in	—
	Maximum penetration depth	90.00 in	—
	Minimum hole diameter	03.75 in	—
Permafrost	Hole depth (30-in standoff)	72.00 in	—
	Hole depth (42-in standoff)	60.00 in	—
	Hole depth (50-in standoff)	—	72.00 in
	Hole diameter (42-in standoff)	1.50 to 6.00 in	—
	Hole diameter (50-in standoff)	—	05.00 to 08.00 in
	Hole diameter (normal standoff)	04.00 to 30.00 in	07.00 to 30.00 in
Ice	Hole depth (42-in standoff)	07.00 ft	12.00 ft
	Hole diameter (42-in standoff)	03.50 in	06.00 in
Soil	Hole depth (30-in standoff)	07.00 ft	—
	Hole depth (48-in standoff)	—	07.00 ft
	Hole diameter (30-in standoff)	07.00 in	—
	Hole diameter (48-in standoff)	—	14.50 in
Graveled roads	Hole depth (30-inch standoff)	07.00 ft	—
	Hole depth (48-in standoff)	—	09.00 ft

**Table 1-3. Characteristics of Boreholes Made By Shaped Charges**

<i>Material</i>	<i>Specifications</i>	<i>M2A4, Shaped Charge* (15 lb)</i>	<i>M3A1, Shaped Charge** (40 lb)</i>
	Hole diameter (30-in standoff)	07.00 in	—
	Hole diameter (48-in standoff)	—	07.00 in
*A dash in the column indicates that an M3A1, shaped charged is required. **A dash in the column indicates that an M2A4, shaped charge is enough.			

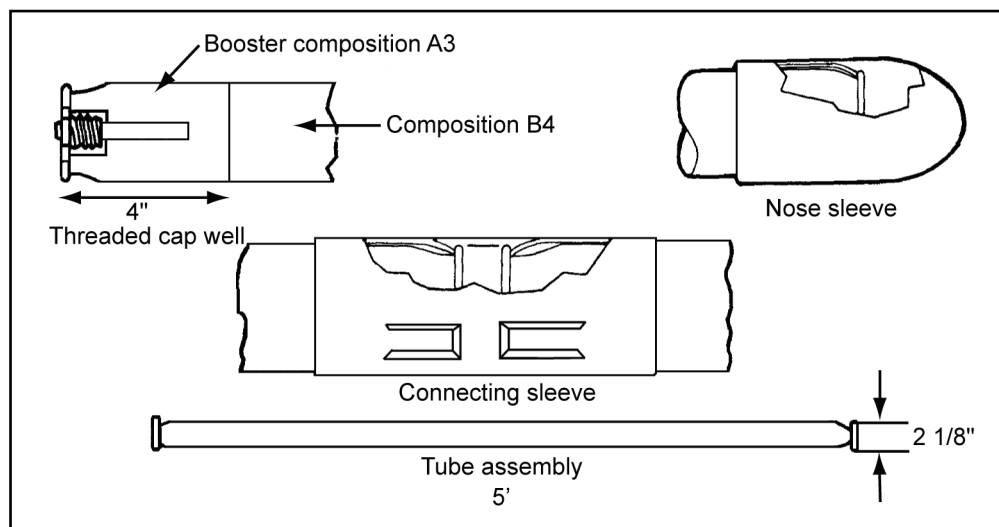
**SPECIAL PRECAUTIONS**

1-36. To achieve the maximum effectiveness of shaped charges—

- Center the charge over the target point.
- Align the axis of the charge with the direction of the desired hole.
- Use the pedestal to obtain the proper standoff distance.
- Suspend the charge at the proper height on pickets or tripods if the pedestal does not provide the proper standoff distance.
- Remove any obstruction in the cavity liner or between the charge and the target.

**M1A2 BANGALORE TORPEDO DEMOLITION KIT**

1-37. Each *demolition kit* (the demolition tool kit complete with explosives) (JP 1-02) consists of 10 tube assemblies, 10 connecting sleeves, and 1 nose sleeve. The tube assemblies or torpedoes are steel tubes 5 feet long and 2 1/8 inches in diameter, grooved and capped at each end (Figure 1-7). The torpedoes have a 4-inch composition A3 booster (1/2 pound each) at both ends of each 5-foot section. The main explosive charge is 10 1/2 pounds of composition B4. The kit is packaged in a 60 3/4- by 13 3/4- by 4 9/16-inch wooden box and weighs 211 pounds.

**Figure 1-7. M1A2 or M1A3 Bangalore Torpedo****M1A3 BANGALORE TORPEDO DEMOLITION KIT**

1-38. The M1A3 bangalore torpedo demolition kit is discussed below. Discussed are the characteristics, uses, advantages, and limitations of the demolition kit.

## CHARACTERISTICS

1-39. Each kit consists of 10 tube assemblies, connecting sleeves, and two nose sleeves. The tube assemblies, or torpedoes, are steel tubes 2 1/2 feet long and 2 1/8 inches in diameter, grooved and capped at each end (Figure 1-7). The torpedoes have a 4-inch composition A3 booster (1/2 pound each) at both ends of each 2 1/2 foot section. The main explosive charge is 5 pounds of composition B4.

## USES

1-40. The primary use of the torpedo is for clearing paths through wire obstacles and heavy undergrowth. It will clear a 3- to 4-yard-wide path through wire obstacles.

### DANGER

**The bangalore torpedo may detonate a live mine when being placed. To aid in preventing this, attach the nose sleeve to a fabricated dummy section (about the same dimensions as a single bangalore section), and place the dummy section onto the front end of the torpedo. Failure to comply may cause death or permanent injury.**

## ASSEMBLY

1-41. All sections of the torpedo have threaded cap wells at each end. To assemble two or more sections, press a nose sleeve onto one end of one tube, and then connect successive tubes (using the connecting sleeves provided) until you have the desired length. The connecting sleeves make rigid joints. The nose sleeve allows the user to push the torpedo through entanglements and across the ground.

### DANGER

**Do not modify the bangalore torpedo. Cutting the bangalore or making any other modification could cause the device to explode. Failure to comply may cause death or permanent injury.**

## M4 SELECTABLE, LIGHTWEIGHT ATTACK MUNITION

1-42. The M4 selectable, lightweight attack munition (SLAM) is discussed below. Discussed are the characteristics, uses, advantages, and limitations of the M4 SLAM.

## CHARACTERISTICS

1-43. The M4 SLAM (Figure 1-8, page 1-14) (Table 1-4, page 1-14) is olive green in color with a black liner and no labels, bands, or other distinguishing marks. When the M4 SLAM is employed, the operator selects the operating mode and length of time that it will function to defeat selected targets using an explosively formed penetrator (EFP) warhead. During bottom- and side-attack modes, the M4 SLAM will self-destruct if the selected time expires before a vehicle detonates it. With the time demolition mode, the M4 SLAM will detonate after the selected time delay has expired. Other versions of this munition are the M2 and M3 special operations forces (SOF) SLAM. The M2 version will self-disarm and will go into dud status (cannot be rearmed). The M3 version can only be initiated by command detonating the unit. The packaging protects the M4 SLAM so it will function with no degradation attributable to packaging after up to 2 years with outside, unprotected, uncontrolled storage, and 20 years protected controlled storage. No new or unique storage facilities are anticipated for the M4 SLAM munition. Individual M4 SLAMs are contained in their own reusable environmental protective packs (REPPs) that consist of two-piece plastic containers consisting of a top and bottom half held together with four clips. There are eight REPPs, eight

carrying straps, and eight leg straps in each PA19 container. The packaged ammunition is palletized on a wooden pallet. The pallet consists of 2 PA19 containers per wire-bound box and 27 wire-bound boxes for a total of 54 PA19 containers.

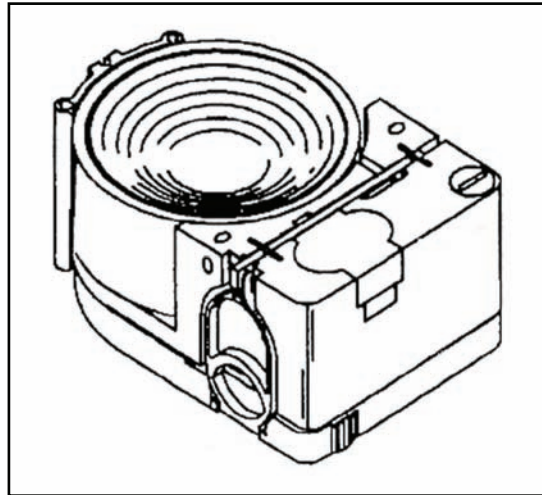


Figure 1-8. M4 SLAM

Table 1-4. M4 SLAM Characteristics

<i>Pallet Dimensions</i>	
Length	45 1/2 in
Width	35 13/16 in
Height	43 15/16 in
Weight (loaded)	2,016 lb
<i>M4 SLAM Weights and Dimensions</i>	
Weight	2.2 lb
Length	5.15 in
Width	3.5 in
Depth	2.15 in

## USES

1-44. The M4 SLAM is a small antidisturbance and tamper resistant, multipurpose munition designed to be portable, hand emplaced, and used against lightly armored infantry vehicles, parked aircraft, wheeled or tracked support vehicles, and ammunition or petroleum, oils, and lubricants (POL) storage sites.

### **DANGER**

**Never approach the M4 SLAM for any reason. Once armed, the M4 SLAM will detonate. Failure to comply may cause death or permanent injury.**

**DANGER**

During live-fire training, an initiating system (such as wire, detonating cord, or shock tube) must be laid out to a safe location away from the SLAM before arming the SLAM so that the SLAM can be safely initiated in case of an electronic shutdown or a *dud* (an explosive munition which has not been armed as intended or which has failed to explode after being armed) (JP 1-02). Failure to comply may cause death or permanent injury.

**ADVANTAGES**

1-45. The M4 SLAM can be used day or night and during all weather conditions. The four operating modes include—

- **Bottom-attack mode.** See Figure 1-9. The M4 SLAM has a built-in magnetic sensor that allows it to be used as a magnetic-influenced munition against trucks or lightly armored vehicles. The magnetic sensor is designed to trigger detonation when it senses a vehicle overpass. It can be concealed along trails and roads where target vehicles operate and can be camouflaged using light overburden, dry leaves, and grass without affecting EFP performance as long as debris does not extend beyond the depth of the EFP cup level. The M4 SLAM self-destructs if the selected time expires before a passing vehicle detonates the munition.



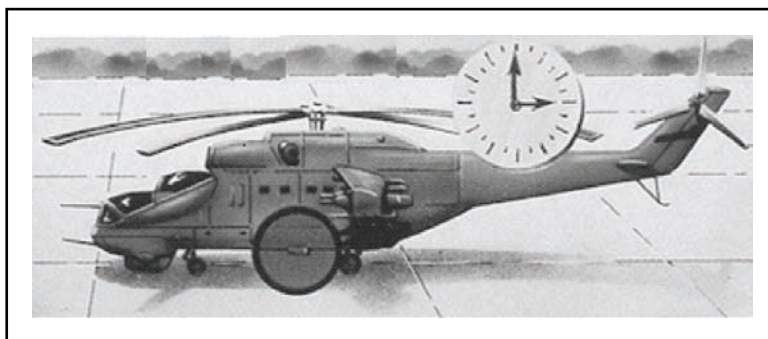
**Figure 1-9. Bottom-Attack Mode**

- **Side-attack mode.** See Figure 1-10, page 1-16. The M4 SLAM is equipped with a passive infrared (PIR) sensor specifically developed for the side-attack mode. The sensor detects trucks and lightly armored vehicles by sensing a change in background temperatures when the vehicles cross in front of the sensor port. The sensor is directional and aligned with the EFP. The M4 SLAM self-destructs if the selected time expires before being detonated by a passing vehicle.



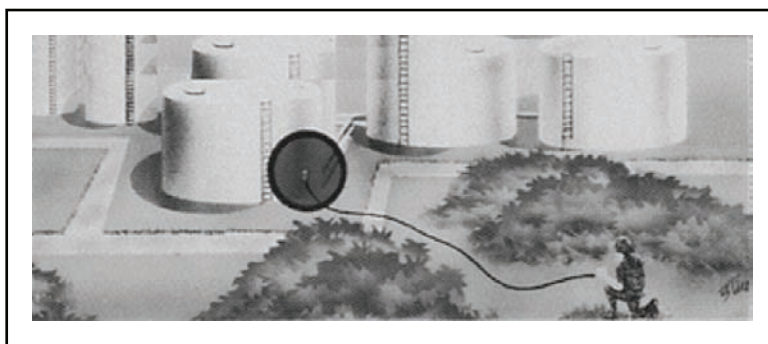
**Figure 1-10. Side-Attack Mode**

- **Timed-detonation mode.** See Figure 1-11. The M4 SLAM will detonate at the end of a selected time delay. In this mode, the magnetic sensor and PIR sensor are not operable.



**Figure 1-11. Timed-Demolition Mode**

- **Command-detonation mode.** The command-detonation mode (Figure 1-12) provides manual warhead initiation using M6, M7, or MDI blasting caps and boosters with a M1A4 priming adapter. This capability bypasses the M4 SLAM *fuze* (a device which initiates an explosive train) (FM 1-02) and safe-and-arm (S&A) assembly.



**Figure 1-12. Command-Detonation Mode**

1-46. The M4 SLAM has the following two secondary operating features:

- **Antidisturbance.** The M4 SLAM will detonate if it is moved or handled after arming. Antidisturbance is active for the bottom- and side-attack modes only.
- **Antitamper.** The M4 SLAM will detonate if any attempt is made to change the selector switch after arming. This mode is active for the bottom- and side-attack modes only.



## LIMITATIONS

1-47. The M4 SLAM warhead performance may be affected by heavy overburden. If the M4 SLAM needs to be hidden from view, a light layer of grass or leaves can be used to cover it. To defeat the target, the EFP needs a minimum of 5 inches from the point of emplacement to the target to form properly.

## M300 FIGHTING POSITION EXCAVATOR AND M301 FIGHTING POSITION EXCAVATOR RELOAD KIT

1-48. The M300 FPE and M301 FPE reload kit are discussed below. Discussed are the characteristics, uses, and emplacement of the M300 FPE and M301 FPE reload kit.

## CHARACTERISTICS

1-49. Each M300 FPE kit (Figure 1-13) comes in a canvas carrying bag and contains a four-piece bucket auger, an empty sandbag, two binary explosive containers (each with a booster assembly permanently installed), a blasting cap assembly with an M9 holder attached, and an M81 fuse igniter. The binary charges consist of two nonexplosive components that must be mixed together to form an explosive compound. The booster assemblies that prime the charges consist of a booster (containing only secondary explosive), crimped to a length of low-strength *detonating cord* (a waterproof, flexible fabric tube containing a HE designed to transmit the detonation wave) (JP 1-02) to allow charge emplacement belowground. The blasting cap assembly consists of a military-type blasting cap crimped to a 25-meter length of shock tube. The auger is used to dig holes for emplacing the charges and for measuring hole depth and separation. The M301 FPE reload kit provides additional explosives and sandbags for creating two additional two-man fighting positions. It is packaged in the same FPE canvas carrying bag. The operator must use the auger from an FPE kit to dig holes for emplacing the explosive charges of the reload kit.



Figure 1-13. M300 FPE Kit

**USES**

1-50. The FPE system is used to loosen the soil. The time it takes to dig a two-man fighting position is reduced by the FPE system.

**EMPLACEMENT**

1-51. The dimensions of a two-man fighting position (6 feet by 2 feet) are laid out on the ground. A bucket auger should be used to dig a hole one foot in from the end of the outline. The length of the bucket auger is used as a measuring device. When the handle of the auger is 1 to 2 inches above the ground hole, the depth is about 40 inches. The length of the bucket auger is used to measure the distance to a second hole location. A second hole is dug to the same depth as the first.

1-52. The protective cap is then unscrewed and removed from the end of the liquid tube. The liquid tube should be unscrewed and separated from the powder tube. The liquid tube should be held in one hand with the seal facing up to prevent spillage of the liquid component during assembly. The sealed end of the powder tube should be aligned over the liquid tube, then the two tubes should be screwed together. The tubes should be securely seated and the explosive container shook vigorously for one minute to ensure thorough mixing. After unwinding the length of the low-strength detonating cord from the spool on the powder containers, one container is lowered into each hole while the low-strength detonating cord is held out of the hole. The charges should be tamped with loose dirt.

1-53. Low-strength detonating cord is connected to the blasting cap assembly using the M9 holder attached to the blasting cap. The low-strength detonating cord is spread between the primed charge and the M9 holder of the transmission line. Avoid conditions where cords are running alongside or twisted with other cord to minimize crossover of any low-strength detonating cord.

1-54. The shock tube is run to a sheltered position about 25 meters from the buried charges. A square cut is made at the end of the shock tube assembly and an M81 fuse igniter is attached. The safety pin is removed from the M81 and the pull ring is pulled sharply to initiate the explosive train.

**SECTION III – DEMOLITION ACCESSORIES****M700 TIME-BLASTING FUSE**

1-55. A time-blasting fuse transmits a delayed spit of flame to a nonelectric blasting cap. The delay allows a Soldier to initiate a charge and get to a safe distance before the explosion. The two types of fuses are the M700 time fuse and the safety fuse. Except for SOF, the M14 and M18 modernized demolition initiator (MDI) will replace the M700 time fuse. The M700 time fuse is a dark green cord, 0.2 inch in diameter, with a plastic cover (Figure 1-14). It burns at a rate of 40 seconds per foot. However, test the burning rate as outlined in Chapter 2. Depending on the date of manufacture, the cover may be smooth or have single yellow bands around the outside at 12- or 18-inch intervals and double yellow bands at 60- or 90-inch intervals. These bands accommodate hasty measuring. The outside covering becomes brittle and cracks easily in arctic temperatures. The M700 time fuse is packaged in 50-foot coils, two coils per package, five packages per sealed container, and eight containers (4,000 feet) per wooden box (30 1/8 by 15 1/8 by 14 7/8 inches). The total package weighs 94 pounds.

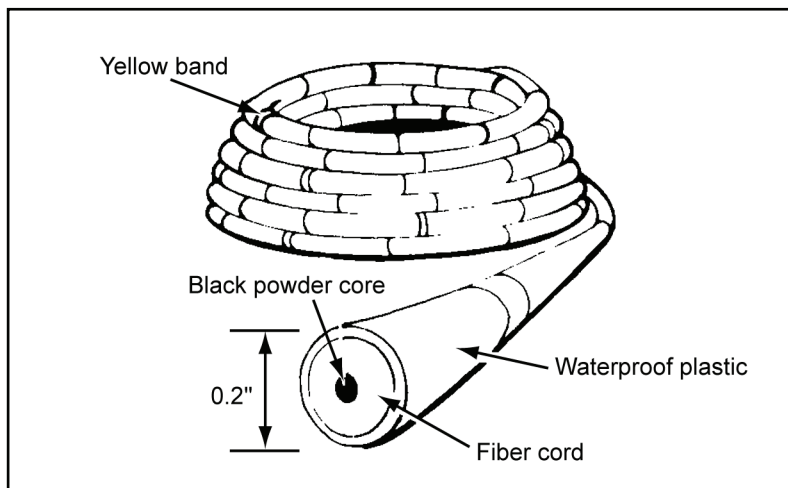


Figure 1-14. M700 Time Fuse

## DETONATING CORD

1-56. The American, British, Canadian, and Australian (ABCA) standardization program recognizes Type 1 detonating cord as the standard detonating cord. The paragraphs below discuss the characteristics, uses, and precautions of detonating cord.

### CHARACTERISTICS

1-57. Detonating cord (Figure 1-15) consists of a core of HE (6.4 pounds of pentaerythrite tetranitrate [PETN] per 1,000 feet) wrapped in a reinforced and waterproof, olive drab plastic coating. This detonating cord is about 0.2 inch in diameter, weighs about 18 pounds per 1,000 feet, and has a breaking strength of 175 pounds. Detonating cord is functional in the same temperature range as plastic explosive, although the cover becomes brittle at lower temperatures. Moisture can penetrate the explosive filling to a maximum distance of 6 inches from any cut or break in the coating. Water-soaked detonating cord will detonate if there is a dry end to allow initiation. A 6-inch tail should be left when making connections or when priming charges.

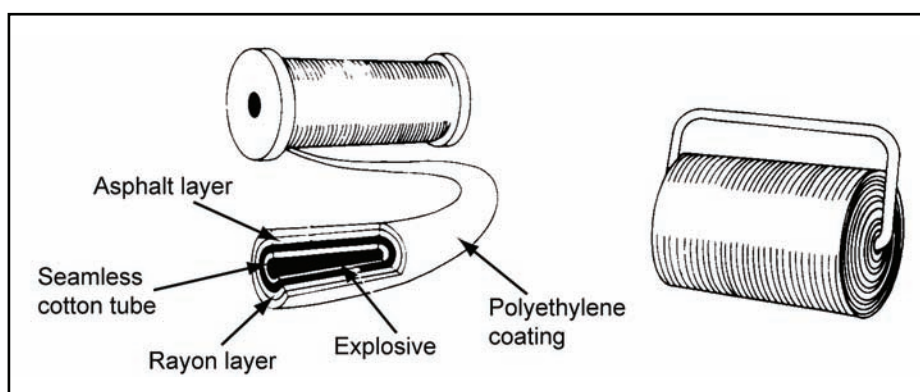


Figure 1-15. Detonating Cord

### USES

1-58. Detonating cord can be used to prime and detonate single or multiple explosive charges simultaneously. Chapter 2 explains the use of detonating cord for these purposes.

## PRECAUTIONS

1-59. The end of the detonating cord is sealed with a waterproof sealant when used to *fire* (1. The command given to discharge a weapon(s). 2. To detonate the main explosive charge by means of a firing system) (JP 1-02) (FM 1-02) underwater charges or when charges are left in place several hours before firing. If left for no longer than 24 hours, a 6-inch overlap will protect the remainder of the line from moisture. Kinks, sharp bends in priming, or unintended crossovers should be avoided because they may interrupt or change the direction of detonation and cause misfires.

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*Note.* To avoid internal cracking, do not step on the detonating cord.

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## BLASTING CAPS

1-60. Blasting caps are for detonating HEs. The two types of blasting caps are electric and nonelectric. They are designed for insertion into the cap wells and are the detonating element in certain firing systems and devices. Blasting caps are rated in power according to the size of their main charge. Number 6 and 8 commercial blasting caps are for detonating sensitive explosives, such as commercial dynamite and tetryl. Special military blasting caps (M6 electric and M7 nonelectric) ensure positive detonation of less sensitive military explosives. Their main charge is about double that of commercial Number 8 blasting caps. Never carry blasting caps loose or in uniform pockets where they are subject to shock. Properly separate the blasting caps. Blasting caps should never be stored with other explosives. Blasting caps and other explosives should not be carried in the same vehicle except in an emergency (see Chapter 6). See TM 43-0001-38 for additional information on blasting caps.

### **WARNING**

**Handle military and commercial blasting caps carefully; both are extremely sensitive and may explode if handled improperly. Do not tamper with blasting caps. Protect them from shock and extreme heat. Failure to comply could result in immediate personal injury or damage to equipment.**

## ELECTRIC

1-61. Electric blasting caps are used for command detonation or when a source of electricity (such as a blasting machine or a battery) is available. Both military and commercial caps may be used. Military caps (Figure 1-16) operate instantaneously. Commercial caps may operate instantaneously or have a delay feature. The delay time of commercial caps for military applications ranges from 1 to 1.53 seconds. Electric caps have lead wires of various lengths. The most common lead length is 12 feet. Electric caps require 1.5 amperes of power to initiate. The standard-issue cap is the M6 special electric blasting cap.

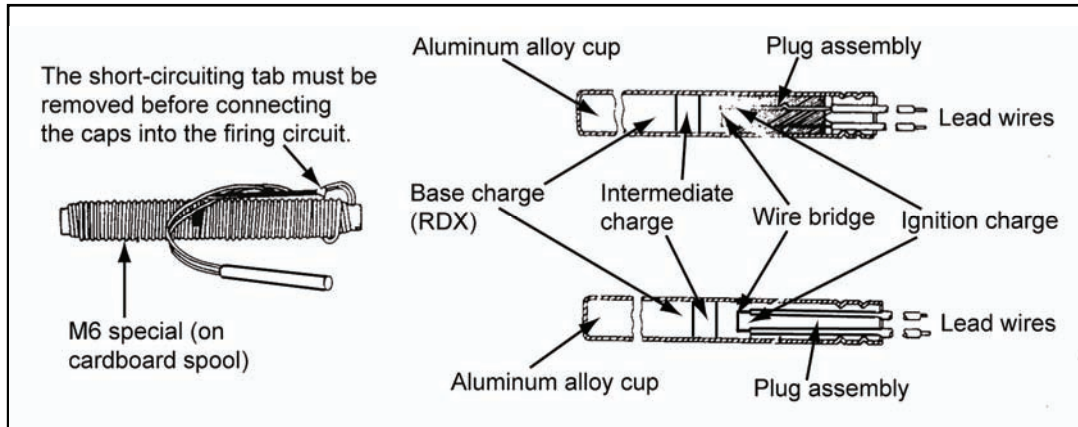


Figure 1-16. Electric Blasting Caps

**NONELECTRIC**

1-62. Nonelectric blasting caps are initiated with a time-blasting fuse, a firing device, or detonating cords (Figure 1-17). Use of nonelectric blasting caps to prime underwater charges should be avoided because the caps are hard to waterproof. If necessary, waterproof nonelectric blasting caps with a sealing compound. The M7 nonelectric blasting cap is the standard issue. The open end of the M7 nonelectric blasting cap is flared to allow easy insertion of detonating cord or a time fuse. TM 43-0001-38 gives additional information on blasting caps.

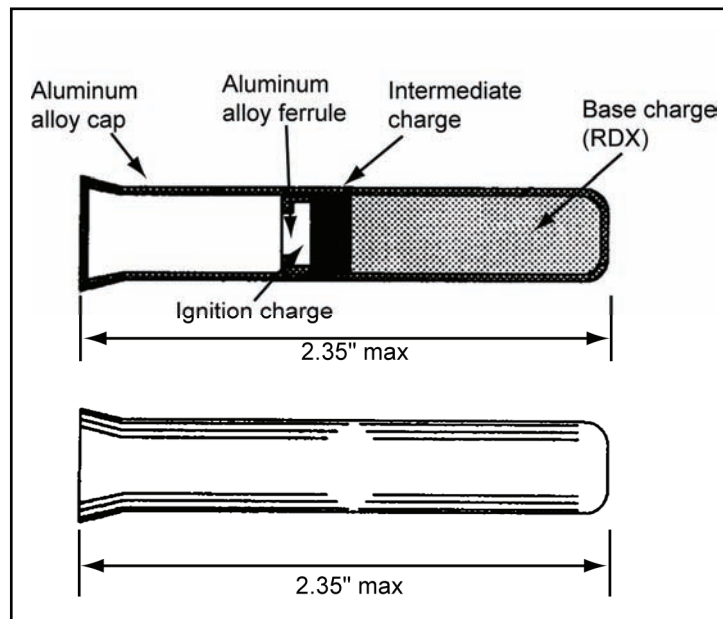


Figure 1-17. Nonelectric Blasting Caps

**BOOSTERS**

1-63. A booster is similar in appearance to a blasting cap but contains no primary explosive. The secondary explosive in the booster contains enough energy to initiate military explosives. Boosters are precrimped to low-strength detonating cord on the M151- and the M152-MDI components (Figure 1-18, page 1-22). The boosters provide a means to prime buried charges by following priming methods for standard military explosives.



**Figure 1-18. Booster**

## **NONELECTRIC BLASTING CAPS PRECRIMPED TO MODERNIZED DEMOLITION INITIATOR COMPONENTS**

1-64. The MDI system introduces precrimped blasting caps onto premature lengths of shock tube and time fuse with an environmental seal at the other end. The MDI provides the following enhancements to conducting demolition operations:

- Provides a nonelectric means of command initiation that is not sensitive to effects of overhead power transmission lines, static electricity, radio transmissions, or effects of electromagnetic pulse (EMP).
- Provides packaging configurations that permit transportation of precrimped MDI blasting caps on one vehicle at a less stringent hazard classification than individual blasting caps.
- Provides the user with a preset burn time in 1-minute increments, but allows the Soldier to conduct a more accurate burn rate.
- Eliminates blasting cap crimping operations.
- Provides detonating cord clips or holders on shock tube items for making connections to either branchlines or ring mains.
- Provides splicing tubes on spooled shock tube items for making repairs.
- Introduces low-strength detonating cord (5 to 7.5 grams of explosive per foot) with precrimped boosters to provide a capability to preprime charges for emplacement aboveground or belowground.
- Eliminates electrical initiation devices and supporting equipment requirements from demolition kits.

## **BLASTING CAP PROTECTORS**

1-65. Foam cylinders should be installed onto the high-strength blasting cap or booster of an MDI component after removal from original packaging. The protector cushions the blasting cap or booster if inadvertently struck by a hard object during handling. Soon foam cylinders will be included as part of the standard packaging for MDI high-strength blasting caps and boosters.

## **M1A4 PRIMING ADAPTER**

1-66. An M1A4 is a plastic, hexagonal-shaped device, threaded to fit threaded cap wells. The shoulder inside the threaded end will allow a time-blasting fuse and detonating cord to pass, but the shoulder is too small to pass a military blasting cap. To accommodate electric blasting caps, the adapter has a lengthwise slot that permits blasting cap lead wires to be installed into the adapter quickly and easily (Figure 1-19).

## **M1A5 PRIMING ADAPTER**

1-67. An M1A5 is a plastic, hexagonal-shaped device, threaded to fit threaded cap wells. The shoulder inside the threaded end will allow a time-blasting fuse, detonating cord, or shock tube to pass, but the shoulder is too small to pass a military blasting cap. To accommodate electric blasting caps or shock tube, the adapter has a lengthwise slot that permits blasting cap lead wires or a shock tube to be installed in the adapter quickly and easily (Figure 1-19).



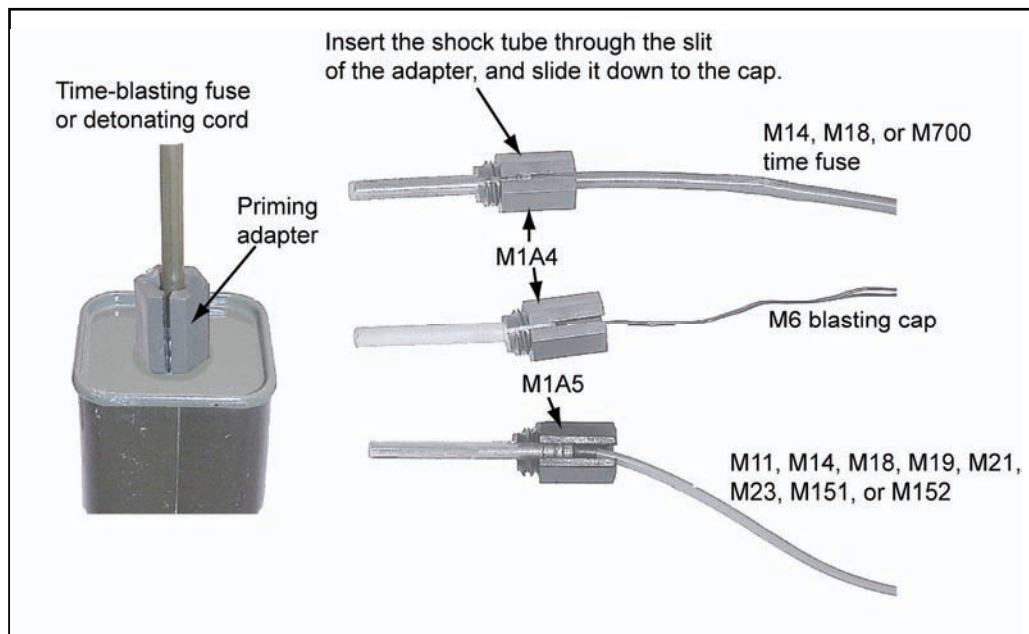


Figure 1-19. M1A4 and M1A5 Priming Adapters

## M8 BLASTING CAP HOLDER

1-68. An M8 is a metal clip designed to attach a blasting cap to a sheet explosive (Figure 1-20). These clips are supplied with M186 charges. The M8 is available as a separate-issue item in quantities of 4,000.

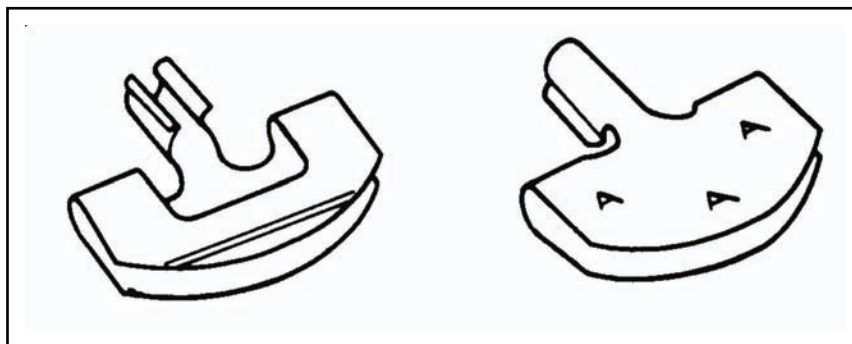


Figure 1-20. M8 Blasting Cap Holder

## M1 DETONATING CORD CLIP

1-69. An M1 clip is a device for holding two strands of detonating cord together, either parallel or at right angles (Figure 1-21, Diagram 1 [page 1-24]). Using these clips is faster and more efficient than using knots. Knots, if left for extended periods, may loosen and fail to function properly.

### BRANCHLINES

1-70. Detonating cord branchlines are connected by passing them through the trough of the M1 clip and through the hole in the tongue of the clip. Next, the ring or line main should be placed into the tongue of the clip so that it crosses over the branchline at a 90° angle, and the crossover is held secure by the tongue. It may be necessary to bend or form the tongue while doing this (Figure 1-21, Diagram 2).

## SPLICES

1-71. The ends of the detonating cords are spliced by first overlapping them about 12 inches. Each loose end is secured to the other cord by using a clip. The tongues of the clips are bent firmly over both strands. The connection is made stronger by bending the trough end of the clip back over the tongue (Figure 1-21, Diagram 3).

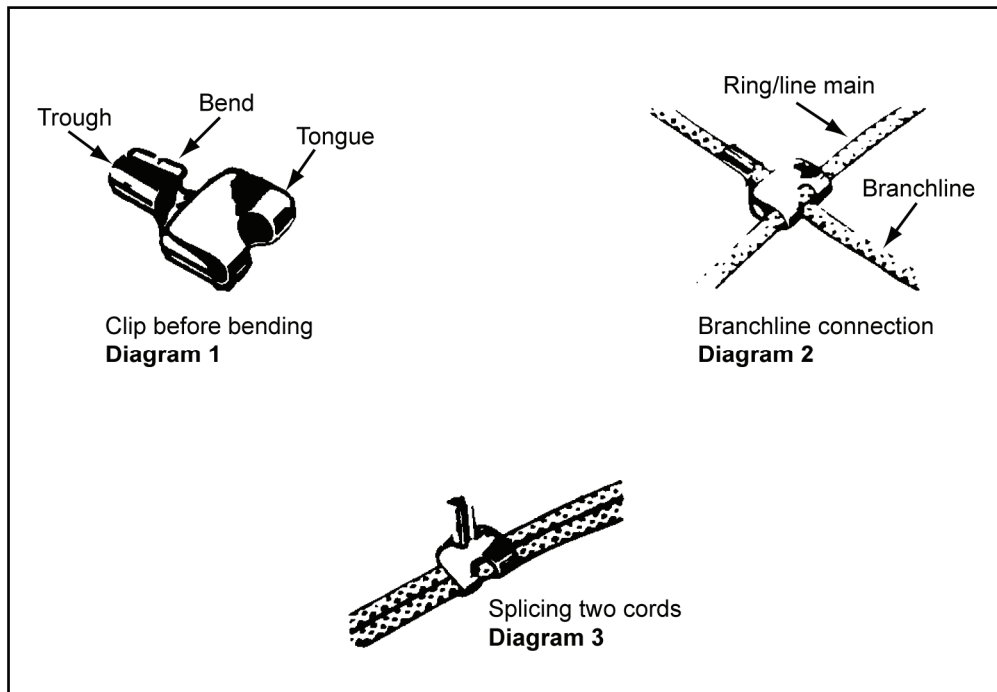


Figure 1-21. M1 Detonating Cord Clip

## M1 ADHESIVE PASTE

1-72. M1 adhesive paste is a sticky, putty-like substance that is used to attach charges to flat, overhead, or vertical surfaces. Adhesive paste is useful for holding charges while tying them in place or, under some conditions, for holding the explosive to a target without ties. This paste does not adhere satisfactorily to dirty, dusty, wet, or oily surfaces. M1 adhesive paste becomes useless when softened by water.

## PRESSURE-SENSITIVE ADHESIVE TAPE

1-73. This tape is replacing the M1 adhesive paste. The tape has better holding properties and it is easily and quickly applied. This tape is coated on both sides with pressure-sensitive adhesive and no solvent or heat is required to apply. It is available in 2-inch-wide rolls, 72 yards long. This tape should be used to hold charges effectively to dry, clean wood, steel, or concrete. This tape does not adhere to dirty, wet, oily, or frozen surfaces.

## WATERPROOF SEALING COMPOUND

1-74. This sealant is for waterproofing connections between time-blasting fuses or detonating cords and nonelectric blasting caps. The sealing compound will not make a permanent waterproof seal. Since this sealant is not permanent, underwater demolitions should be fired as soon as possible after placing them.



## M2 CAP CRIMPER

1-75. An M2 cap crimper (Figure 1-22) is used for squeezing the shell of a nonelectric blasting cap around a time-blasting fuse, standard coupling base, or detonating cord. Crimp the shell securely to keep the fuse, base, or cord from being pulled off but not so tightly that it interferes with the operation of the initiating device. A stop on the handle helps to limit the amount of crimp applied. The M2 crimper forms a water-resistant groove completely around the blasting cap. A sealing compound is applied to the crimped end of the blasting cap to waterproof it. The cutting jaw, located on the leg, is shaped and sharpened for cutting fuses and detonating cords. One leg of the handle is pointed for punching cap wells in explosive materials. The other leg has a screwdriver end. Cap crimpers are made of a soft, nonsparking metal that conducts electricity. Do not use cap crimpers as pliers because such use damages the crimping surface. The crimp hole should be round (not elongated), and the cutting jaws should not be jagged. The cutting jaws should be kept clean, and they should be used only for cutting fuses and detonating cords.

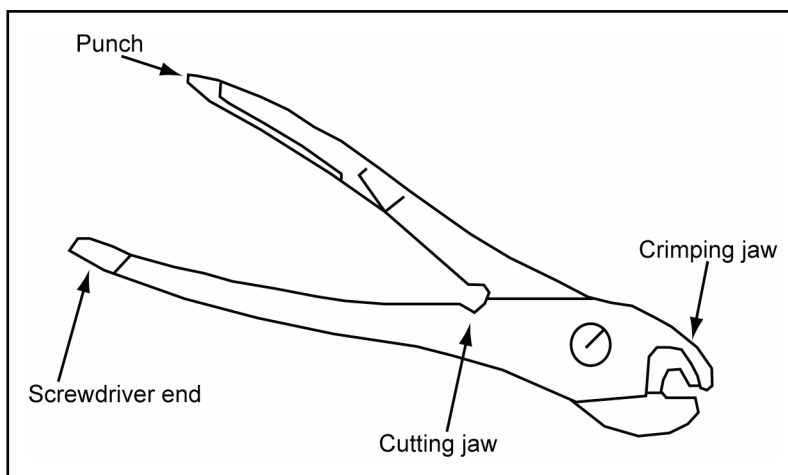


Figure 1-22. M2 Cap Crimper

## M51 BLASTING CAP TEST SET

1-76. The paragraphs below discuss the M51 blasting cap test set. Discussed are the characteristics, uses, and maintenance of the test set.

### CHARACTERISTICS

1-77. The M51 is a self-contained unit with a magneto-type impulse generator, an indicator lamp, a handle to activate the generator, and two binding posts for attaching firing leads. The test set is waterproof and capable of operating at temperatures as low as 40°F (Figure 1-23, page 1-26).

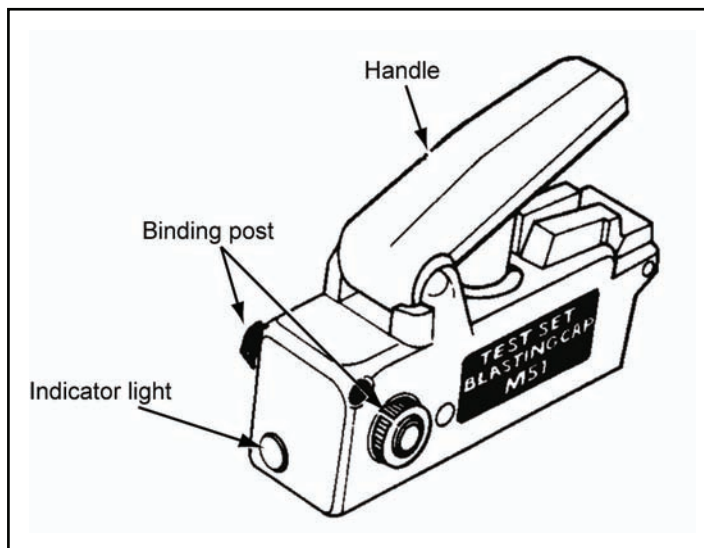


Figure 1-23. M51 Blasting Cap Test Set

## USES

1-78. The continuity of the firing wire, blasting cap, and *firing circuit* (in land operations, an electrical circuit and/or pyrotechnic loop designed to detonate connected charges from a firing point [the definition was shortened, and the complete definition is printed in the glossary]) (JP 1-02) should be checked by connecting the leads to the test set binding posts and then by depressing the handle sharply. If there is a continuous (intact) circuit, even one created by a short circuit, the indicator lamp will flash. When the circuit is open, the indicator lamp will not flash.

## MAINTENANCE

1-79. The test set should be handled carefully and kept dry to ensure optimum use. Before using, ensure that the test set is operating properly by using the following steps:

- **Step 1.** Hold a piece of bare wire or the legs of the M2 crimpers across the binding posts.
- **Step 2.** Depress the handle sharply while watching the indicator lamp (lamp should flash).
- **Step 3.** Remove the bare wire or crimper legs from the binding posts.
- **Step 4.** Depress the handle sharply while watching the indicator lamp (lamp should not flash).

Both tests should be performed to ensure that the test set is operating properly.

## BLASTING MACHINES

1-80. Blasting machines provide the electric impulse needed to initiate electric blasting cap operations. When operated, the M32, M34, and CD450-4J models use an alternator and a capacitor to energize the circuit.

### M34, 50-CAP BLASTING MACHINE

1-81. This small, lightweight machine produces adequate current to initiate 50 electrical caps that are connected in a series (Figure 1-24). It has a black band around the base and a reinforced-steel actuating handle. The M34 can be tested and operated using the following steps:

- **Step 1.** Check the machine for proper operation. This is done by releasing the blasting machine handle by rotating the retaining ring downward while pushing in on the handle (handle should automatically spring outward from the body of the machine).

- **Step 2.** Activate the machine by depressing the handle rapidly three or four times until the neon indicator lamp flashes.

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*Note.* The lamp is located between the wire terminal posts and cannot be seen until it flashes, since it is covered by green plastic.

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- **Step 3.** Insert the firing wire leads into the terminals by pushing down on each terminal post and inserting the leads into the metal jaws.
- **Step 4.** Hold the machine upright (terminals up) in either hand so that the plunger end of the handle rests in the base of the palm and the fingers grasp the body of the machine. Make sure to hold the machine correctly since the handles are easily broken.
- **Step 5.** Squeeze the handle sharply several times until the charge fires (normally, no more than three or four squeezes are required).



Figure 1-24. M34 Blasting Machine

### CD450-4J BLASTING MACHINE

1-82. The CD450-4J blasting machine is discussed below. Discussed are the operational test and general operating procedures for the machine.

#### Operational Test

1-83. An operational test should be conducted on the CD450-4J (Figure 1-25, page 1-28). This test should be conducted as follows:

- **Step 1.** Depress the charge switch and hold it down. The READY-TO-FIRE indicator should light after 1 to 5 seconds and remain lit as long as the charge switch is held down.
- **Step 2.** Continue holding the charge switch down until the READY-TO-FIRE indicator lights, then wait at least 2 seconds and then depress the FIRE switch. Continue holding both switches down for 3 seconds. Verify that the—
  - READY-TO-FIRE indicator remains lit for about 1/4 second after the FIRE switch is depressed.
  - READY-TO-FIRE indicator is unlit after performing the step above.
- Release both switches after observing the steps above. The blasting machine should be secured.

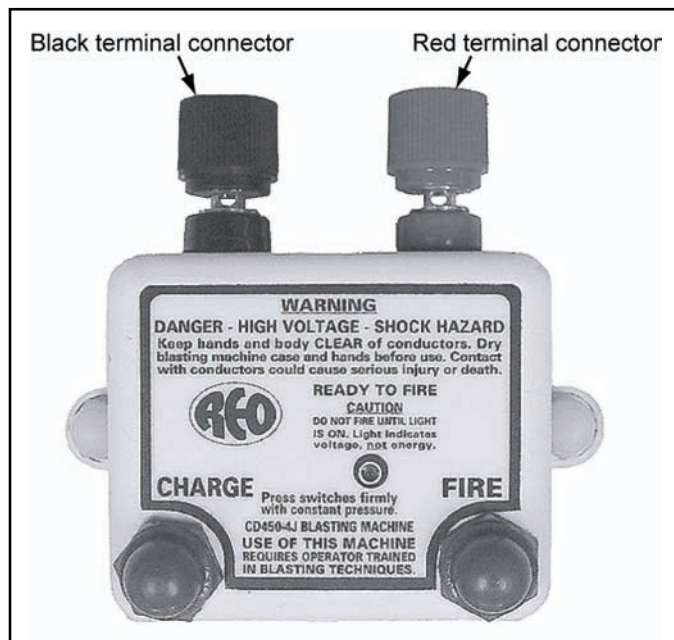


Figure 1-25. CD450-4J Blasting Machine

## General Operating Procedures

**Note.** In temperatures below 32°F, keep the CD450-4J warm until it is ready to use. During cold temperatures, fresh batteries should be used with each use. The CD450-4J is not waterproof and when wet will fail to operate.

1-84. General operating procedures should be conducted on the CD450-4J as follows:

- **Step 1.** Perform the operational test before bringing the blasting machine into the blast area.
- **Step 2.** Obtain the electric *detonator* (a device containing a sensitive explosive intended to produce a detonation wave) (JP 1-02) firing recommendations from the detonator manufacturer. Check the blasting circuit calculations before connecting to the blasting machine.
- **Step 3.** Connect the detonator wires to the lead lines using a series or other circuits that are recommended by the detonator manufacturer.
- **Step 4.** Ensure that all personnel have moved to a safe location.

### CAUTION

Keep the lead lines shunted during wiring of the electric detonators. Personal injury or damage to equipment may result from long-term failure to follow correct procedures.

- **Step 5.** Check the electric detonator circuit continuity and resistance (including the lead lines) using an approved ohmmeter.
- **Step 6.** Shunt the lead lines after checking the circuits until the blast is ready to be initiated.
- **Step 7.** Remove the shunted lead lines connection, and connect the wires to the terminals on the blasting machine.

**DANGER**

**Keep your hands and body clear of the conductors. Contact with electrical conductors could cause serious injury or death. Failure to comply may cause death or permanent injury.**

- **Step 8.** Depress the CHARGE switch and hold it down. The READY-TO-FIRE indicator lights up when the capacitor reaches 450 volts. Releasing the CHARGE switch will discharge the capacitor within 3 seconds.
- **Step 9.** Continue holding the CHARGE switch down until the READY-TO-FIRE indicator lights up. Wait at least 2 seconds, and then firmly depress the FIRE switch. Continue holding both switches down until the firing operation is complete.

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*Note.* If the blasting machine should fail to fire, release both switches, disconnect and shunt the lead lines, and notify personnel of the blast delay.

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- **Step 10.** Wait 3 seconds after the firing operation is complete, and then release both switches.
- **Step 11.** Disconnect and shunt the lead lines.
- **Step 12.** Secure the blasting machine.

## FIRING WIRE AND REEL

1-85. The paragraphs below discuss the firing wire and reel. Discussed are the lengths and types of firing wire and the use of the firing wire reel.

### FIRING WIRE

1-86. Wire for firing electric charges is available in 200- and 500-foot coils. The two-conductor American wire gauge (AWG) number 18 is a plastic- or rubber-covered wire available in 500-foot rolls. This wire is wound on an RL39A reel unit. The single-conductor, AWG number 20 annunciator wire is available in 200-foot coils and is used to make connections between blasting caps and firing wire. The WD1/telegraphic transfer (TT) communication wire will also work, but it requires a greater power source if more than 500 feet is used. Blasting machines will not initiate the full-rated number of caps connected with more than 500 feet of WD1/TT wire. As a rule of thumb, 10 less caps than the rating of the machine should be used for each additional 1,000 feet of WD1/TT wire employed.

### FIRING WIRE REEL

1-87. The RL39A reel, with spool, accommodates 500 feet of wire. The reel has a handle assembly, a crank, an axle, and two carrying straps (Figure 1-26, page 1-30). The fixed end of the wire extends from the spool through a hole in the side of the drum and fastens to two brass thumb-out terminals. The carrying handles are two U-shaped steel rods. A loop at each end encircles a bearing assembly to accommodate the axle. The crank is riveted to one end of the axle, and a cotter pin holds the axle in place on the opposite end.

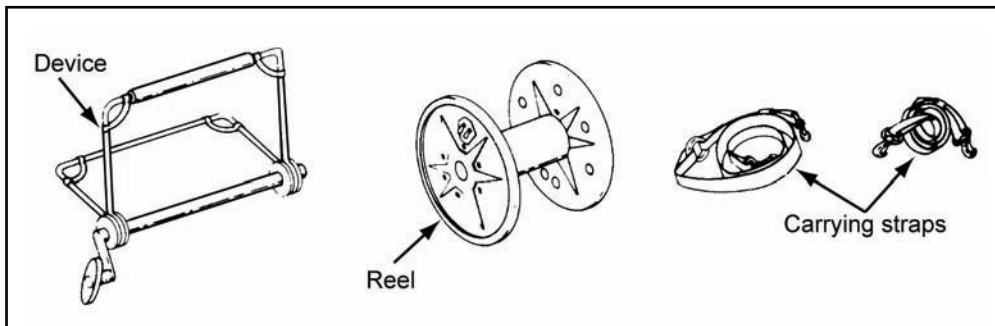


Figure 1-26. RL39A Firing Wire Reel

## NONELECTRIC FIRING DEVICES

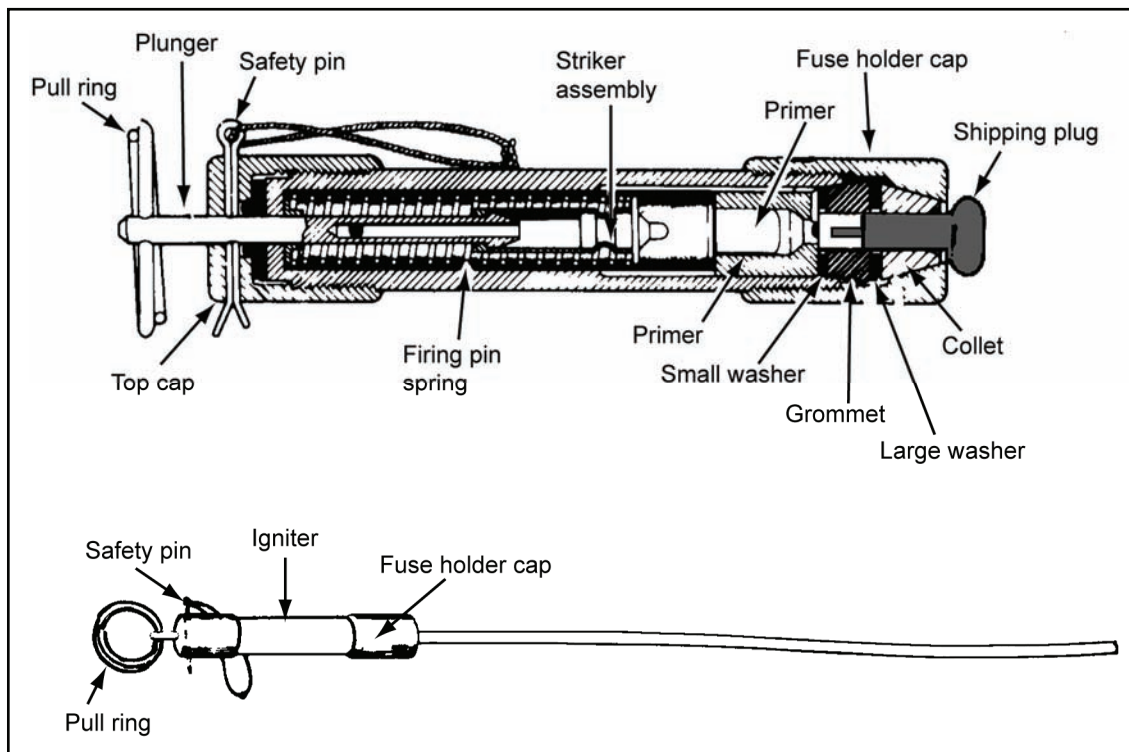
1-88. The paragraphs below discuss nonelectric firing devices. Discussed are the uses and functions of M60 and M81 fuse igniters.

### M60 FUSE IGNITER

1-89. This device is used for igniting a timed blasting fuse in all weather conditions, even underwater, if properly waterproofed. The fuse is inserted through a rubber sealing grommet and into a split collet. This procedure secures the fuse when the end cap on the igniter is tightened (Figure 1-27). With the safety pin removed, pull the pull ring to release the striker assembly, and allow the firing pin to initiate the primer and ignite the fuse. Chapter 2 gives detailed operating instructions for the M60 igniter.

#### WARNING

**Never attach an M60 igniter to the M151, M152, or detonating cord. Failure to comply could result in immediate personal injury or damage to equipment.**



**Figure 1-27. M60 Fuse Igniter**

*Note.* The M60 fuse igniter will neither physically secure the shock tube nor reliably initiate it.

### M81 FUSE IGNITER

1-90. The design and function of the M81 fuse igniter is similar to the M60 fuse igniter. The M81 has a more energetic primer and has two protective plugs in the fuse holder cap (Figure 1-28, page 1-32). A hard-plastic shipping plug keeps foreign material out of the primer and it should be removed before inserting the shock tube into the igniter. The shock tube reducer helps secure the shock tube into the M81 igniter. Both plugs should be removed before using the M81 with the M700 time fuse, M14, or M18 MDI components. See Chapter 2 for the use of the M81 with MDI components.

#### **WARNING**

**Never attach an M81 igniter to the M151, M152, or detonating cord. Failure to comply could result in immediate personal injury or damage to equipment.**

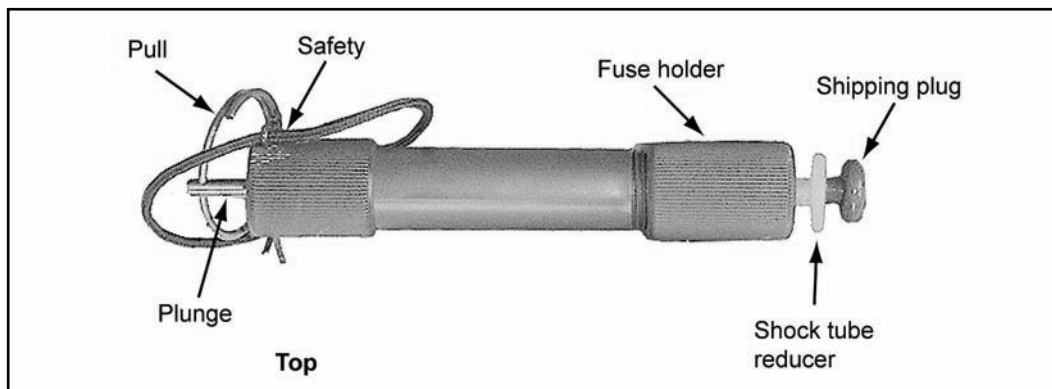


Figure 1-28. M81 Fuse Igniter

## SECTION IV – EXPLOSIVES IDENTIFICATION

### PURPOSE

1-91. Tables 1-5 through 1-7, pages 1-33 through 1-41, provide a quick reference for demolition materials common to combat engineering. This is not a comprehensive list and is subject to change.

### MATERIALS

1-92. Table 1-5 and Table 1-6, page 1-36, list materials by type, item, status, national stock number (NSN), and Department of Defense identification code (DODIC). To avoid problems when requesting materials, use current supply publications.

1-93. Table 1-7, pages 1-37 through 1-41, is used to cross-reference demolition materials by DODIC. Materials are listed by DODIC in ascending order and by nomenclature.



Table 1-5. Demolition Materials

<i>Type</i>	<i>Item</i>	<i>Status</i>	<i>NSN</i>	<i>DODIC</i>
Electric blasting caps	M6, special	Live	1375-00-028-5224	M130
	Electric cap	Inert	1375-00-621-8370	M098
Nonelectric blasting caps	J1	Live	1375-00-028-5226	M131
	M7	Live	1375-01-057-6439	M131
	Nonelectric cap	Inert	1375-00-621-8362	M097
Electric squibs	M1, flash-vented	Live	1377-00-219-8567	M842
	M1A1, flash-vented	Live	1377-00-691-1075	M851
	M1, commercial	Live	1377-00-028-5205	M851
	Squib, closed end	Live	1377-00-837-3337	M900
Detonator	M1, concussion	Live	1375-00-028-5173	M540
Firing devices, coupling bases, and bodies	M1, pull	Live	Replaced by M142	ML03
	M1A1, pressure	Live	Replaced by M142	ML03
	M3, tension	Live	Replaced by M142	ML03
	M5, pressure-release	Live	1375-00-028-5190	M627
	M142, multipurpose	Live	1375-01-040-1526	ML03
	M122, device	Live	1375-01-021-0606	ML02
	M1, delay	Live	1375-00-028-5175	M616
	Coupling base	Live	1375-00-699-5236	M327
Destructor	M10, universal	Live	1375-00-028-5171	M241
Nonelectric blasting caps	M11	Live	1375-01-415-1232	ML47
	M11, practice	Inert	1375-01-412-0160	MN36
	M16	Live	1375-01-449-9601	MN39
	M12	Live	1375-01-415-1230	MN02
	M12, practice	Inert	1375-01-412-8813	MN35
	M13	Live	1375-01-415-1231	MN03
	M14	Live	1375-01-415-1233	MN06
	M14, practice	Inert	1375-01-411-6346	MN37
	M15	Live	1375-01-415-1234	MN07
	M15, practice	Inert	1375-01-411-6345	MN38
	M18	Live	1375-01-449-9602	MN41
	M19	Live	1375-01-494-6939	MN86
	M20, practice	Inert	1375-01-494-6929	MN87
	M21	Live	1375-01-494-6945	MN88
	M22, practice	Inert	1375-01-494-6934	MN89
	M23	Live	1375-01-494-6941	MN90
Boosters	M151	Live	1375-01-467-8646	MN68
	M152	Live	1375-01-467-8685	MN69

Table 1-5. Demolition Materials

<i>Type</i>	<i>Item</i>	<i>Status</i>	<i>NSN</i>	<i>DODIC</i>
	M152, practice	Inert	1375-01-470-2399	MN75
Blasting cap and shock tube holder	M9	Live	1375-01-415-1229	ML45
Igniter	M81	Live	1375-01-415-1235	MN08
TNT	1/4 lb	Live	1375-00-926-9394	M030
	1/2 lb	Live	1375-00-028-5140	M031
	1 lb	Live	1375-00-028-5142	M032
Composition C4	M5A1	Live	1375-00-028-5148	M038
	M112	Live	1375-00-724-7040	M023
Sheet explosives	M186	Live	1375-00-728-4108	M060
Dynamite	M1	Live	1375-00-724-9613	M591
Cratering charge	40 lb	Live	1375-00-028-5145	M039
Shaped charges	M2A4, 15 lb	Live	1375-00-028-5237	M420
	M3, 40 lb	Live	1375-00-088-6691	M421
	40 lb	Live	1375-00-630-3074	M992
Demolition assemblies	M183	Live	1375-00-926-3985	M757
	M37	Live	1375-00-028-5245	M756
Bangalore torpedos	M1A2	Live	1375-00-926-1948	M028
	M1A3	Live	1375-01-528-7226	MP03
Projected charges demolition kits	M157	Live	1375-00-729-4632	M444
	M173	Live	1375-00-812-3972	M443
	M58A2/4/5	Live	1375-01-133-4189	M913
	M68A2	Inert	1375-01-125-6521	M914
	MICLIC, rocket	Live	1340-01-118-2838	J143
Booby trap simulators	M117, flash	Live	1370-00-028-5256	L598
	M118, illuminating	Live	1370-00-028-5257	L599
	M119, whistling	Live	1370-00-028-5255	L600
	Hand grenade	Live	1370-00-752-8124	L601
Smoke grenades	M18, green	Live	1330-00-289-6851	G940
	M18, yellow	Live	1370-00-289-6854	G945
	M18, red	Live	1330-00-289-6852	G950
	M18, violet	Live	1330-00-289-6853	G955
Demolition accessories	M4, fuel thickener	Live	1365-00-926-4076	K917
	M700, time fuse	Live	1375-00-028-5149	M670
	Time fuse	Inert	1375-00-628-9033	M671
	M60, fuse igniter	Live	1375-00-691-1671	M766
	Detonating cord	Live	1375-00-965-0800	M456

Table 1-5. Demolition Materials

<i>Type</i>	<i>Item</i>	<i>Status</i>	<i>NSN</i>	<i>DODIC</i>
	Detonating cord	Inert	1375-00-621-8373	M458
	Priming adapter	NA	1375-00-565-4141	M002
	M8, cap holder	NA	1375-00-926-4105	M166
	M2, crimpers	NA	5120-00-029-0683	NA
	Galvanometer	NA	6625-00-539-8444	NA
	BA245/U battery	Live	6135-00-128-1632	NA
	BA2245/U battery	Live	6135-00-833-9909	NA
	M51, test set	NA	6625-00-999-3454	NA
	Blasting machine, 10 cap	Live	1375-00-782-5541	NA
	Blasting machine, 10 cap	Live	1375-00-935-9173	NA
	Blasting machine, M34	Live	1375-00-567-0223	NA
	DR8, reel	NA	8130-00-407-7859	NA
	RL39A, reel cable	NA	3895-00-498-8343	NA
	18 AWG, firing wire	NA	6145-00-299-6172	NA
	Electric wire	NA	6145-00-542-3968	NA
	Electric wire	NA	6145-00-284-0394	NA
	Detonating cord clip	NA	1375-00-212-4602	NA

Table 1-6. U.S. Mines

<i>Type</i>	<i>Item</i>	<i>Status</i>	<i>NSN</i>	<i>DODIC</i>
AP	M14	Live	1345-00-028-5108	K121
	M17T34, practice	Live	1345-00-348-2576	K122
	M16	Live	1345-00-173-2714	K092
	M16A1	Live	1345-00-529-7303	K092
	M16A2	Live	1345-00-965-0742	K092
	M16	Inert	1345-00-799-7391	K150
	M26	Live	1345-00-678-9822	K146
	M18A1	Live	1345-00-710-6946	K143
	M1, chemical	Live	1345-00-289-6938	K260
AT	M15	Live	1345-00-028-5118	K180
	M12	Practice	1345-00-028-5117	K230
	M20	Practice	1345-00-344-2368	K231
	M21	Live	1345-00-729-4263	K181
	M69	Practice	1345-00-182-3148	K233
	M23, chemical	Live	1345-00-542-1580	K257
GEMSS	M128, dispenser	NA	1095-00-397-3456	NA
	M75, AT mine	Live	1345-01-078-4104	K184
	M74, AP mine	Live	1345-01-076-3497	K151
	M79	Practice	1345-01-074-9370	K234

Table 1-7. DODIC Index for Demolition Materials

<i><b>DODIC</b></i>	<i><b>Nomenclature</b></i>	<i><b>DODIC</b></i>	<i><b>Nomenclature</b></i>
K001	Activator, AT mine, M1	K090	Mine, AP, M2
K002	Activator, AT mine, practice, M1	K091	Mine, AP, inert, M2
K003	Activator, AT mine, M2	K092	Mine, AP, M16
K004	Trip wire assembly, F/M16A2	K105	Mine, AP, practice, M8
K005	Intervalometer, 38/A	K120	Mine, AP, M3
K008	Firing device, AP mine, M57	K121	Mine, AP, M14
K009	Firing device, AP mine, XM123	K122	Mine, AP, practice, M17T34
K010	Burster, incendiary, M4	K139	Mine, AP, practice, M68
K013	Spool, AP mine	K140	Mine, AP, empty, M3
K015	Dispense and mine, aircraft, practice, M132	K141	Mine, AP, M18
K016	Dispense and mine, aircraft, training, M133	K143	Mine, AP, M18
K018	Can, crew-trained, M133	K144	Mine, AP, inert, M18
K020	Dispense and mine, aircraft, M56	K145	Mine, AP, M18A1
K021	Intervalometer, system, F/M47	K146	Mine, AP, M26
K027	Chg, mine ejection	K150	Mine, AP, inert, M16
K028	Chg, mine ejection	K151	GEMSS, AP, M74
K030	Primer igniter, AP mine, fuse, M10A1	K170	Mine, AT, M7
K031	Primer igniter, AP mine, fuse, M10A2	K250	Mine, AT, M19
K040	Chg, spotting, AP mine, M8	K917	Thickener, fuel
K041	Chg, spotting, AP mine, M8A1	M001	Adapter, priming, plastic, M1A3 (round)
K050	Fuse, AT mine, M603	M002	Adapter, priming, plastic, M1A4 (hex)
K051	Fuse, AT mine, M604	M020	Chg, shaped, RDX, 0.062 lb
K054	Fuse, AP mine, combination, M7A1	M022	Chg, shaped, PETN, 827 lb
K055	Fuse, AP mine, combination, M10A1	M023	Chg, block, composition C4, 1.25 lb
K056	Fuse, AP mine, combination, M10A2	M024	Chg, block, PETN or RDX, 2 lb
K058	Fuse, AP mine, combination, M605	M025	Chg, composition C4, HE, M58 or M58A1, 2,000 lb
K060	Fuse, AT mine, M619	M026	Kit, demolition, bangalore torpedo, M1A1
K061	Fuse, AT mine, XM608	M027	Chg, block, practice, MK37-0
K062	Fuse, mine FMU-30/B	M028	Kit, demolition, lin, PETN, 0.75 lb
K063	Fuse, mine, inert, FMU-30/B	M029	Chg, flex, lin, PETN, 0.75 lb
K064	Fuse, AT mine, M616	M030	Chg, block, TNT, 0.25 lb
K065	Fuse, AT mine, M606	M031	Chg, block, TNT, 0.5 lb
K066	Fuse, AT mine, dispense, M56	M032	Chg, block, TNT, 1 lb
K067	Fuse, F/M 21	M034	Chg, block, TNT, 8 lb

Table 1-7. DODIC Index for Demolition Materials

<i>DODIC</i>	<i>Nomenclature</i>	<i>DODIC</i>	<i>Nomenclature</i>
M035	Chg, chain, TNT, 20 lb	M107	Cap, SP electric, 3.7-sec delay
M036	Chg, chain, TNT, 2.5 lb	M108	Cap, SP electric, 4.5-sec delay
M037	Chg, block, C2, 2.25 lb	M109	Cap, SP electric, instantaneous
M038	Chg, block, composition C4, 2.25 lb	M110	Cap, electric, high-strength
M039	Chg, block, cratering, 40 lb	M112	Cap, electric, nonsubmersible, practice, M10
M040	Chg, block, TNT, 55 lb	M118	Cap, SP electric, 6.4-sec delay
M041	Chg, block, C2, 0.5 lb	M120	Cap, electric, No. 8
M043	Chg, block, TNT, 49 lb	M125	Cap, electric, No. 8, 2d delay
M044	Chg, block or shaped, HDX 1, 12 lb	M126	Cap, electric, No. 8, 3d delay
M046	Chg, flex, lin, composition A, MK8-3, 50 lb	M127	Cap, electric, No. 8, 4th delay
M048	Chg, block, C2, 2.5 lb	M128	Cap, SP electric, 7.6-sec delay
M051	Chg, lin, practice, M68 or M68A1, 2,000 lb	M129	Cap, electric, SP strength
M060	Chg, roll, PETN, M186, 25 lb	M130	Cap, SP electric, submersible, J2/M6
M065	Chg, block, H6, 4 lb	M131	Cap, nonelectric, nonsubmersible, M7
M078	Cap, electric, nonsubmersible, M4	M138	Cap, electric, nonsubmersible
M080	Chg, flex, lin, practice, PETN, 0.007 lb	M153	Cap, electric, nonsubmersible
M081	Chg, flex, lin, PETN, 14 oz	M236	Destructor, explosive, PETN
M082	Chg, flex, lin, PETN, 22 oz	M240	Destructor, explosive, PETN
M083	Chg, flex, lin, PETN, 28 oz	M241	Destructor, explosive, universal, M10
M084	Chg, flex, lin, PETN, 36 oz	M327	Base, coupling, with primer
M085	Chg, flex, lin, PETN, 43 oz	M328	Base, coupling, without primer
M086	Chg, flex, lin, PETN, 50 oz	M405	Chg, propelling, earth rod, M112
M087	Chg, flex, lin, PETN, 57 oz	M418	Chg, shaped, RDX, MK47-0, 1.5 lb
M091	Cap, SP electric, 10-sec delay	M420	Chg, shaped, composition B, M2A4/M2A3E1, 15 lb
M092	Cap, SP electric, 11.2-sec delay	M421	Chg, shaped, composition B, M3A2, 40 lb
M093	Cap, SP electric, 12.5-sec delay	M431	Chg, rigid, lin, Amatol, 35 lb
M094	Cap, SP electric, 14-sec delay	M442	Kit, demolition, practice, M174
M095	Cap, SP electric, 15.6-sec delay	M443	Kit, demolition, projected chg, M173
M097	Cap, nonelectric, practice	M444	Kit, demolition, projected chg, M157
M098	Cap, electric, inert	M446	Kit, demolition, projected chg, M1
M101	Cap, SP electric, 0.8-sec delay	M455	Cord, detonating, Primacord®, PETN
M102	Cap, SP electric, 1.4-sec delay	M456	Cord, detonating, reinforced, waterproof
M103	Cap, SP electric, 2.2-sec delay	M457	Cord, detonating, PETN
M104	Cap, SP electric, 2.9-sec delay	M458	Cord, detonating, inert

Table 1-7. DODIC Index for Demolition Materials

<i>DODIC</i>	<i>Nomenclature</i>	<i>DODIC</i>	<i>Nomenclature</i>
M466	Detonating, percussion, MK2	M627	Device, firing, steel
M482	Chg, steel	M630	Device, firing, pull-type, M1
M483	Chg, controlled, steel	M631	Device, firing, pressure-release, M1
M485	Cutter, HE, 1-in jaw	M632	Device, firing, zinc
M486	Cutter, HE, 2-in jaw	M635	Device, firing, pull-type, M1
M540	Kit, detonator, percussion, M1	M637	Device, firing, zinc
M559	Kit, demolition, M175	M639	Device, firing, pressure-release, M5
M587	Dynamite, nitroglycerin	M641	Device, firing, tension-release
M591	Dynamite, military, M1	M643	Device, firing, tension-release
M598	Destroyer, crypto equip, M1A2	M644	Device, firing, aluminum
M600	Destroyer, crypto equip, incendiary, M2A1	M650	Device, firing, aluminum
M601	Destroyer, crypto equip, incendiary, M1A2, TH1	M670	Fuse, timed, M700
M605	Destroyer, document, emergency, incendiary, M1A2, TH4	M671	Fuze, timed, inert
M606	Destroyer, crypto equip, M1A2, TH4	M680	Cylinder, ignition, flame thrower, M1
M607	Destroyer, crypto equip, M2A1	M745	Kit, conversion, depth chg
M608	Destroyer, crypto equip, TH4	M756	Assembly, chg, M37, 20 lb
M609	Destroyer, crypto equip, M2A1, TH4	M757	Assembly, chg, composition C4, M183
M610	Destroyer, file, incendiary, ABC-M4	M767	Igniter, fuse, timed, practice, XM77
M611	Destroyer, file, incendiary, ABC-M4	M784	Chg, shaped, practice, inert, MK37-1, 7 lb
M612	Destroyer, incendiary, TH3	M790	Assembly, composition C2 or C3, MK127-0, 20 lb
M615	Igniter, document destroyer, M25	M791	Assembly, tetrytol, MK133-0, 20 lb
M616	Device, firing, M1, 6- to 14-min delay	M792	Assembly, block, composition C4, MK138-0, 20 lb
M617	Set, device, firing, M1	M810	Primer, percussion, improved, No. 3
M619	Device, firing, M1, 12- to 32-min delay	M814	Destroyer, document, 55 gal, M4
M620	Device, firing, M1, 45- to 115-min delay	M820	Kit, explosive, earth rod, No. 1
M622	Device, firing, M1, 210- to 570-min delay	M821	Kit, explosive, foxhole digger
M623	Device, firing, M1, 610- to 1,130-min delay	M832	Chg, shaped, composition H6, MK741, 1.5 lb
M624	Device, firing, brass	M833	Chg, shaped, practice, inert, MK74-0, 1.3 lb
M625	Device, firing, zinc	M836	Cap, electric, dry, instantaneous
M626	Device, firing, zinc	M855	Cap, electric, dry, 0.5-sec delay
M910	Igniter, primer and base, XM110	ML 10	Chg, shaped, flex, lin, 30 gr/ft

Table 1-7. DODIC Index for Demolition Materials

<i>DODIC</i>	<i>Nomenclature</i>	<i>DODIC</i>	<i>Nomenclature</i>
M913	Chg, flex, lin, composition C4, M58A1, 2,000 lb	ML11	Chg, shaped, flex, lin, 40 gr/ft
M914	Chg, lin, practice, M68A1, 2,000 lb	ML12	Chg, shaped, flex, lin, 60 gr/ft
M916	Chg, shaped, practice, inert, MK47-0, 1.5 lb	ML13	Chg, shaped, flex, lin, 75 gr/ft
M936	Chg, block, inert, 0.25 lb	ML14	Chg, shaped, flex, lin, 125 gr/ft
M957	Chg, shaped, composition H6, MK470, 1.13 lb	ML15	Chg, shaped, flex, lin, 225 gr/ft
M974	Cap, electric, submersible	ML16	Chg, shaped, flex, lin, 300 gr/ft
M975	Fuze, crypto equip, M210, 0.7-sec delay	ML17	Chg, shaped, flex, lin, 400 gr/ft
M976	Chg, block, composition H6, 4 lb	ML18	Chg, shaped, flex, lin, 500 gr/ft
M977	Cord, detonating, PETN	ML19	Chg, shaped, flex, lin, 600 gr/ft
M980	Chg, roll, PETN, 20 lb	ML23	Cap, bridge wire, X175E
M981	Chg, roll, PETN, 20 lb	ML25	Chg, flex, lin, M59
M982	Chg, roll, PETN, 20 lb	ML26	Chg, lin, practice, M69
M983	Chg, roll, PETN, 20 lb	ML27	Detonator, percussion, MK53
M984	Chg, roll, PETN, 20 lb, M766	ML32	Primer, percussion, M27
M986	Chg, roll, PETN, 20 lb	ML36	Kit, fuse, inert, M1147
M987	Chg, block, composition C4, 2 lb	ML37	Kit, fuse, live, M1133
M988	Chg, block, composition C4, 0.5 lb	ML45	Blasting cap and shock tube holder, M9
M989	Initiator, explosive	ML47	Cap, nonelectric, M11
M990	Detonator, flash	ML78	Chg, shaped, practice, MK47-0
M992	Chg, shaped, practice, inert, M3, 40 lb	ML82	Kit, fuse, live, M1134
M993	Chg, roll, PETN, 20 lb	MN02	Cap, blasting, nonelectric, M12
M994	Chg, roll, PETN, 20 lb	MN03	Cap, blasting, nonelectric, M13
M995	Chg, lin, composition H6, MK86-0, 0.002 kg	MN06	Cap, blasting, nonelectric, M14
M996	Chg, lin, composition H6, MK87-0, 0.013 kg	MN07	Cap, blasting, nonelectric, M15
M997	Chg, lin, composition H6, MK88-0, 1 kg	MN08	Igniter, M81
M998	Chg, rigid, lin, composition C3, MK89-0, 4 kg	MN39	Cap, nonelectric, M16
ML03	Device, firing, plastic, M142	MN41	Cap, blasting, nonelectric, M18
ML04	Cutter, HE	MN68	Booster, demolition chg, M151
ML05	Cutter, HE	MN69	Booster, demolition chg, M152
ML07	Cap, electric, nonsubmersible	MN75	Booster, demolition chg, inert, M152
ML08	Kit demolition, XM268	MN86	Cap, nonelectric, dual mini, M19
ML09	Chg, shaped, flex, lin, 20 gr/ft	MN87	Cap, nonelectric, dual mini, inert, M20
MN88	Cap, nonelectric, mini, M21	MW84	Kit, demo, tubular SWS, MK75-0



Table 1-7. DODIC Index for Demolition Materials

<i>DODIC</i>	<i>Nomenclature</i>	<i>DODIC</i>	<i>Nomenclature</i>
MN89	Cap, nonelectric, mini, inert, M22	MW85	Kit, accessory, demolition, MK29-0
MN90	Cap, nonelectric, mini, M23	MW86	Kit, firing device, MK48-0
MW02	Valve, explosive, electrically initiated	MW87	Kit, firing device, training, MK122-0
MW26	Cell, arming, MK1-8, 80-min delay	MX14	Kit, centering, cavity chg
MW27	Clip, detonating cord, M1	MY01	Clip, detonating cord, M1
MW28	Connector, plastic	MZ21	Cap, nonelectric, inert, 500 ft
MW29	Element, delay, MK19/0	MZ22	Cap, nonelectric, inert, 30 ft
MW30	Kit, demo, bangalore torpedo, M1 or M1A1	MZ23	Cap, delay, nonelectric, inert
MW31	Holder, detonator, MK2-0	MZ24	Cap, delay, nonelectric, inert, 70 ft
MW37	Driver, power-actuated, MK22-0	SS89	Chg, shock test, R/U725
MW38	Float, rigid, polyurethane	XW60	Kit, firing device, MK138-0
MW49	Connector, detonating cord, plastic	XW65	Chg, shock tube, R/U1260
MW52	Chg, sheet, MK57-0	XW66	Chg, shock test, R/U1259
MW53	Chg, sheet, MK56-0	XW67	Chg, shock test
MW56	Device, safety and arming, MK39-0	YW05	Kit, chg, training, MK75-0

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## Chapter 2

# Initiating Sets, Priming Methods, Firing Systems, and Modernized Demolition Initiators

Explained in this chapter are the different types of initiating sets and how to prepare them. Also discussed are the different methods for priming each explosive type and how to set up demolition firing systems.

## SECTION I – INITIATING SETS

### CAUTION

See the safety procedures in Chapter 6 before undertaking any demolition mission. Personal injury or damage to equipment may result from long-term failure to follow correct procedures.

## NONELECTRIC INITIATING SETS

2-1. A nonelectric system uses a nonelectric blasting cap as the initiator. The paragraphs below describe a nonelectric system.

### COMPONENTS ASSEMBLY

2-2. The initiating set consists of a fuse igniter (that produces the flame that lights the time-blasting fuse), a time-blasting fuse (that transmits the flame that fires the blasting cap), and a nonelectric blasting cap (that provides adequate shock to detonate the explosive) (Figure 2-1). For MDI components and the preparation sequence, see Section IV of this chapter. When combined with detonating cord, a single-initiating set can fire multiple charges.

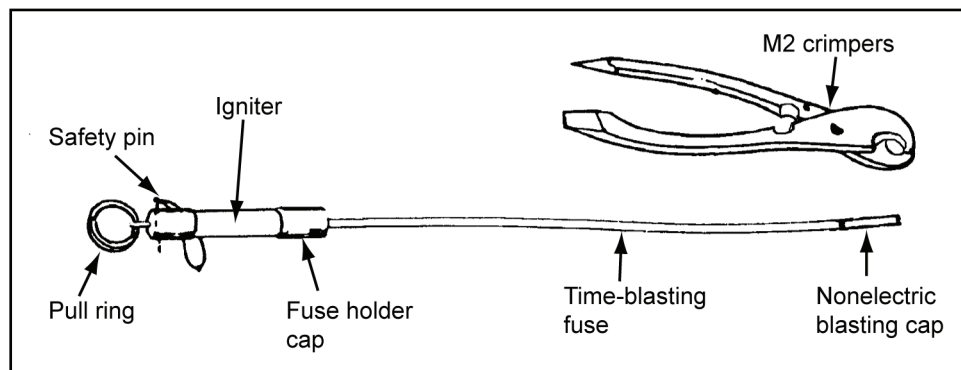


Figure 2-1. Nonelectric Initiating Set

### PREPARATION SEQUENCE

2-3. Preparing demolitions for nonelectric initiation follows specified processes. These processes are discussed below.

### Check the Time Fuse

2-4. Every coil of fuse, or remnant of a coil, is tested using the burning rate test before use. One test per day per coil is enough. The first and last 6 inches of a coil is never used because moisture may have penetrated the coil to this length. An M2 crimper is used to cut and discard a 6-inch length from the working end of the fuse (Figure 2-2). A 3-foot length of fuse is cut to check the burning rate. The fuse is ignited and the time it takes for the fuse to burn is noted. The burning rate per foot is computed by dividing the burn time (in seconds) by the length (in feet). Another test is performed to verify the results if the test burn does not fall within 5 seconds of a 40-second-per-foot burn rate. The coil is placed in the foil packet and marked with its corresponding burn rate once the burn rate is calculated.

#### **DANGER**

**Test-burn a 3-foot length of time-blasting fuse to determine the exact burn rate before use. Failure to comply may cause death or permanent injury.**

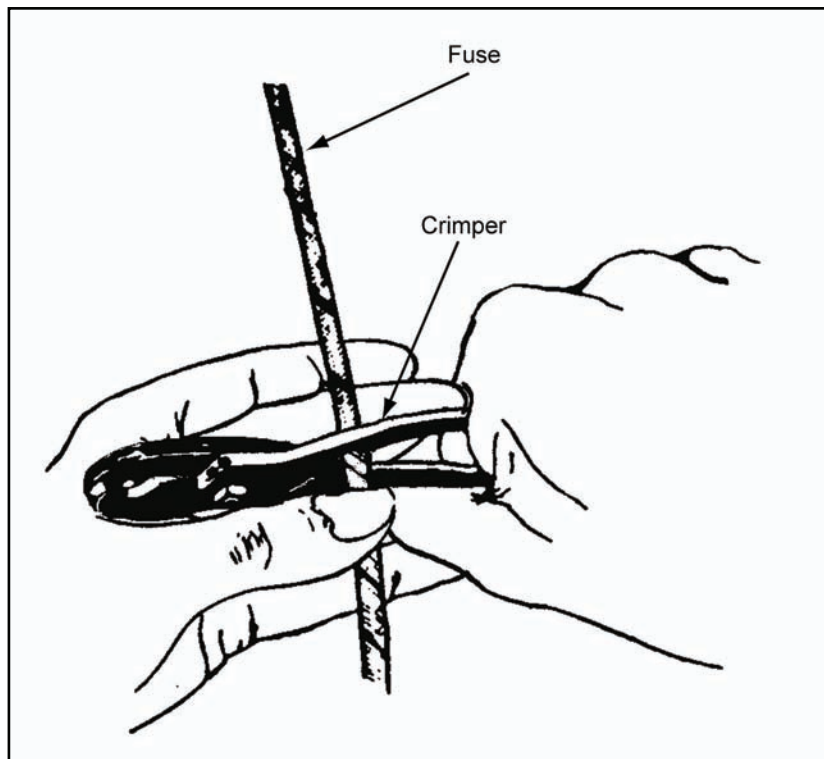


Figure 2-2. Cutting a Time Fuse

### Prepare the Time Fuse

2-5. The fuse is cut long enough to allow the person detonating the charge to reach safety (walking at a normal pace) before the explosion. This distance is walked and timed before cutting the fuse to length. The formula for determining the length of time fuse required is—

$$\frac{\text{Time required (min)} \times 60 \text{ (sec/min)}}{\text{Burning rate (sec/ft)}} = \text{Fuse length (ft)}$$

### Make the Cut Squarely Across the Fuse

2-6. The fuse should not be cut too far in advance since the fuse may absorb moisture into the open ends. The time fuse should not be allowed to bend sharply because the black powder core may crack, resulting in a misfire.

### Attach the Fuse Igniter

2-7. Attach an M60 or M81 weatherproof fuse igniter by unscrewing the fuse holder cap two or three turns, but do not remove the cap. The shipping plug is pressed into the igniter to release the split collar (Figure 1-27, page 1-29). The plug and plastic shock tube holder is rotated and removed from the igniter. The free end of the time fuse is inserted as far as possible into the space left by the removed shipping plug. The holder cap is tightened to hold the fuse and weatherproofs the joint.

### Install the Priming Adapter

2-8. The time fuse is placed through the adapter before installing (crimping) the blasting cap onto the fuse when using a priming adapter to hold a nonelectric blasting cap. The adapter threads should be pointed to the end of the time fuse that will receive the blasting cap.

### Prepare the Blasting Cap

2-9. The blasting cap should be prepared by—

- **Inspecting.** Hold the cap between your thumb and ring finger of one hand with the forefinger of the same hand on the closed end of the blasting cap. Inspect the blasting cap by looking into the open end (a yellow-colored ignition charge should be seen). Do the following if dirt or any foreign matter is present:
  - Aim the open end of the cap at the palm of your second hand.
  - Gently bump the wrist of your hand holding the cap against the wrist of the other hand.
  - Do not use the cap if the foreign matter does not dislodge.
- **Placing and crimping.** Use the following procedures to attach a nonelectric blasting cap to the time fuse or the detonating cord:
  - Hold the time-blasting fuse vertically with the square-cut end up. Slip the blasting cap gently down over the fuse so the flash charge in the cap touches the fuse.

### CAUTION

If the charge in the cap is not in contact with the fuse, the fuse may not ignite the cap (misfire). Never force a time fuse into a blasting cap (for example, by twisting). If the fuse end is flat or too large to enter the blasting cap freely, roll the fuse between your thumb and fingers until it will freely enter the cap. A rough, jagged-cut fuse inserted in a blasting cap can cause a misfire. If the cutting jaws of the M2 crimper are unserviceable, use a sharp, nonsparking knife to cut the fuse. When using a knife to cut the fuse squarely, cut the fuse against a solid, nonsparking surface such as wood. Personal injury or damage to equipment may result from long-term failure to follow correct procedures.

- Grasp the fuse with your thumb and ring finger while applying slight pressure with your forefinger on the closed end of the cap.
- Use the opposite hand to grasp the crimpers. Place the crimping jaws around the cap at a point 1/8 to 1/4 inch from the open end. Ensure that your thumb and ring finger that hold the fuse is below the crimpers. Rest the second finger of your hand holding the fuse on top of the crimpers to prevent the crimpers from sliding up the cap (Figure 2-3, page 2-4).
- Extend both arms straight out while rotating the hands so that the closed end of the blasting cap is pointing away from your body and away from other personnel.
- Tilt your head downward and crimp the blasting cap by firmly squeezing the M2 crimper handles together. Inspect the crimp when finished.

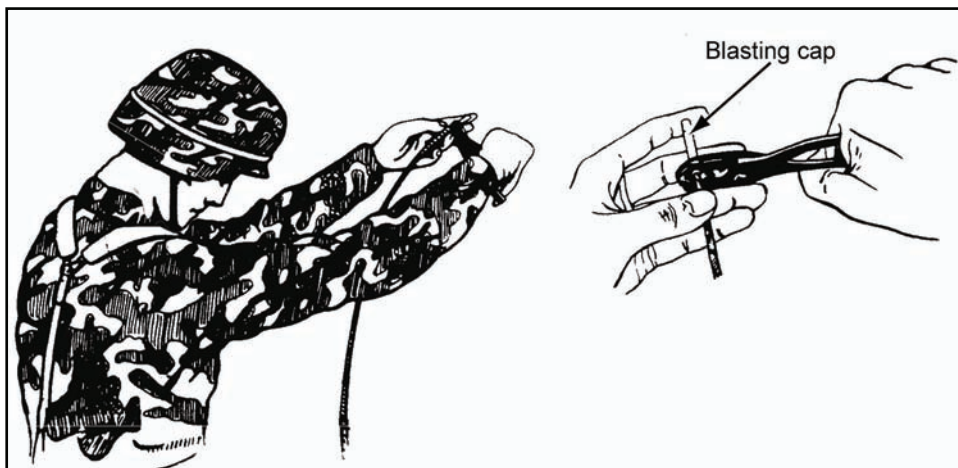


Figure 2-3. Crimping a Blasting Cap Onto a Fuse

*Note.* Attach the M60 or M81 fuse igniter to the time fuse before crimping a blasting cap to the opposite end. Do not remove the safety pin until the charge is ready to be detonated.

### WARNING

To avoid cap detonation, crimp blasting caps 1/8 to 1/4 inch from the open end of the cap. Failure to comply could result in immediate personal injury or damage to equipment.

*Note.* Protect the joint between the cap and the time-blasting fuse with a coat of sealing compound or a similar substance if the blasting cap is to remain in place several days before firing. This sealing compound does not make a waterproof seal; therefore, fire submerged charges immediately. See Chapter 6, Section II, for procedures on handling nonelectric misfires.

## FUSE INITIATION

2-10. To fire the assembly, hold the M60 or M81 igniter in one hand and then remove the safety pin with the other. While grasping the pull ring, give it a quick, hard pull. In the event of a misfire, reset the M60 or M81 by pushing the plunger all the way in (for the M60 only, rotate it left or right 180°), and attempt to fire as before.

### CAUTION

Never initiate a fuse igniter underwater. Personal injury or damage to equipment may result from long-term failure to follow the correct procedures.

2-11. If a fuse igniter is not available, light the time-blasting fuse with a match. The fuse is split at the end (Figure 2-4) and the head of an unlit match is placed in the powder train. The inserted match head is lighted with a flaming match or rubbed against the abrasive on the matchbox. It may be necessary to use two match heads during windy conditions.

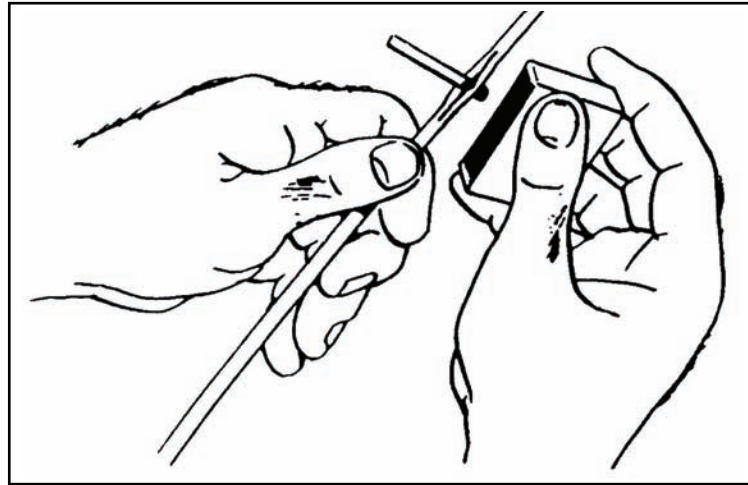


Figure 2-4. Lighting a Time Fuse With a Match

## COMPONENTS ASSEMBLY

2-12. An electric system uses an electric blasting cap as the explosion initiator. The initiating set consists of an electric blasting cap, the firing wire, and a blasting machine (Figure 2-5, page 2-6). An electric impulse (usually provided by a blasting machine) travels through the firing wire and blasting cap leads, detonating the blasting cap, which initiates the explosion. Radio waves can also detonate electric blasting caps. Therefore, observe the minimum safe distances listed in the tables in Chapter 6 at all times. A single-initiating set can be used to initiate the detonating cord or multiple charges. TM 9-1375-213-34&P provides detailed information about electric blasting equipment.

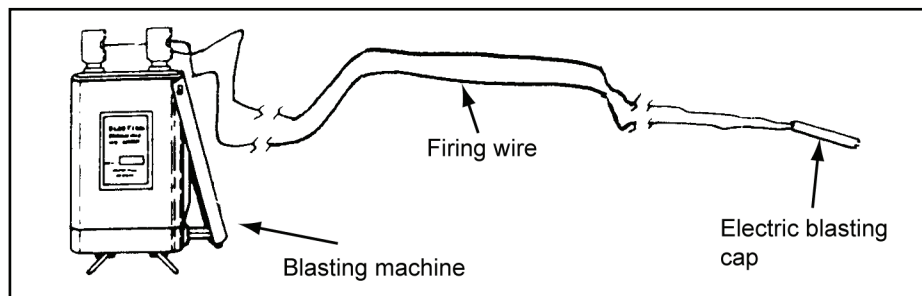


Figure 2-5. Electric Initiating Set

### CIRCUIT INITIATION

2-13. At this point, the initiating set is complete. The blasting machine should not be connected until all personnel are accounted for and clearance is received to fire the demolition. When all personnel are clear, "fire in the hole" is called three times, then the blasting machine is installed and demolition is initiated. Chapter 6 covers the procedures for electric misfires.

### ELECTRIC WIRE SPLICING

2-14. The paragraphs below discuss electric wire splicing. Explained is the preparation, method, and precautions for electric wire splicing.

#### Preparation

2-15. Before splicing, strip the insulating material from the end of the insulated wires. About 1 1/2 inches of insulation should be removed from the end of each wire (Figure 2-6, step 1). Any coating on the wire should be removed (such as enamel) by carefully scraping the wire with the back of a knife blade or other suitable tool. The bare wire should not be nicked, cut, or weakened. After scraping, lightly twist multiple-strand wires.

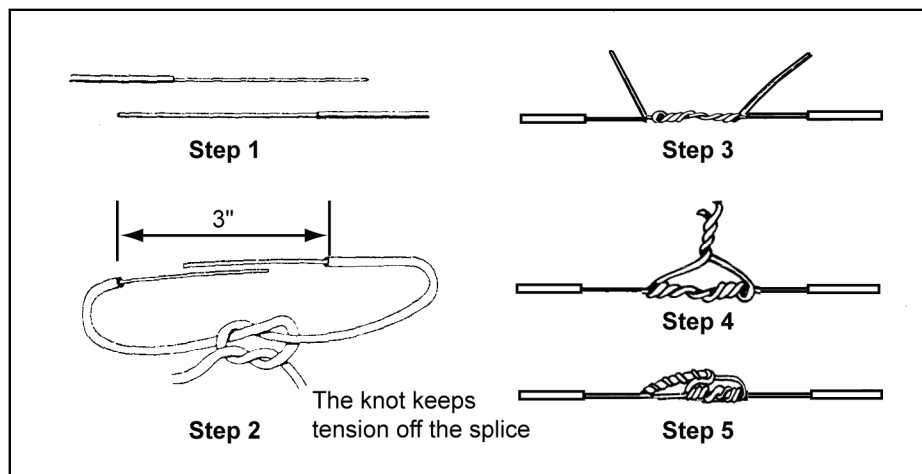


Figure 2-6. Western Union Pigtail Splice and Tension Knot

#### Method

2-16. Use the Western union pigtail splice (Figure 2-6) to splice two wires. The two pairs of wires are spliced in the same way as the 2-wire splice (Figure 2-7). When splicing, use the following steps:

- **Step 1.** Protect the splices from tension damage by tying the ends in an overhand or square knot (tension knot), allowing enough length for each splice (Figure 2-6, step 2).



- **Step 2.** Make three twists with each wire (Figure 2-6, step 3).
- **Step 3.** Twist the ends together with an additional three turns (Figure 2-6, step 4).
- **Step 4.** Flatten the splice, but not so far that the wire crimps itself and breaks (Figure 2-6, step 5).

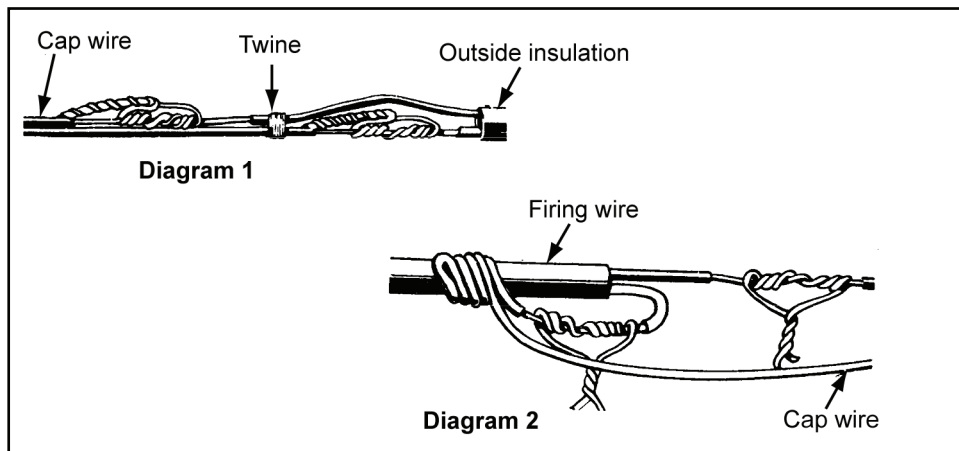


Figure 2-7. Two-Wire Splice

### Precautions

2-17. A short circuit may occur at a splice if caution is not used. For example, when splicing pairs of wires, stagger the splices and place a tie between them (Figure 2-7, Diagram 1). Another method of preventing a short circuit in a splice is using the alternate method (Figure 2-7, Diagram 2). In the alternate method, the splices are separated rather than stagger them. Splices are insulated from the ground or other conductors by wrapping them with friction tape or electric insulating tape.

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*Note.* Always insulate the splices.

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### SERIES CIRCUITS

2-18. The two types of series circuits include the common series circuit and the leapfrog series circuit (Figure 2-8, page 2-8). A common series circuit is used to connect two or more electric blasting caps to a single-firing wire. The leapfrog series method of connecting caps in a series is useful for firing any long line of charges.

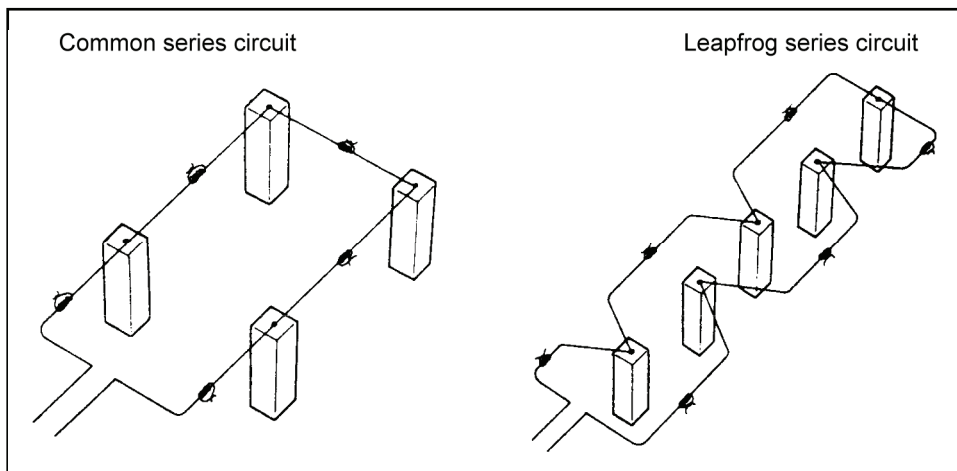


Figure 2-8. Series Circuit

### Common Series Circuit

2-19. The series circuit is prepared by connecting one blasting cap to another until only two lead wires are free. Shunt the two lead wires until you are ready to proceed with the next step. The free ends of the cap lead wires are connected to the ends of the firing wire. Connecting wires (usually an annunciator wire) are used when the distance between the blasting caps is greater than the length of the usual cap lead wires.

### Leapfrog Series Circuit

2-20. The leapfrog series method is performed by starting at one end of a row of charges and priming alternate charges to the opposite end, and then priming the remaining charges on the return leg of the series. This method eliminates the necessity for a long-return lead from the far end of the line of charges. See Appendix E for additional information on series circuits. This circuit type is rarely needed since detonating cord, when combined with a single blasting cap, will fire multiple charges.

## ELECTRIC INITIATING SETS

2-21. See Appendix E for the power requirements for series firing circuits. The following steps are used to make an electric initiating set:

- **Step 1.** Test and maintain control of the blasting machine.
  - Test the blasting machine to ensure that it is operating properly (Chapter 1).
  - Control access to all blasting machines (responsibility of the supervisor).
- **Step 2.** Test the M51 test set.
  - Check the M51 test set to ensure that it is operating properly (Chapter 1).
  - Perform both the open- and short-circuit tests.
- **Step 3.** Test the firing wire on the reel (shunted and unshunted) (Figure 2-9).
  - Separate the firing wire leads at both ends, and connect the leads at one end to the posts of the M51 test set. Squeeze the test set handle.

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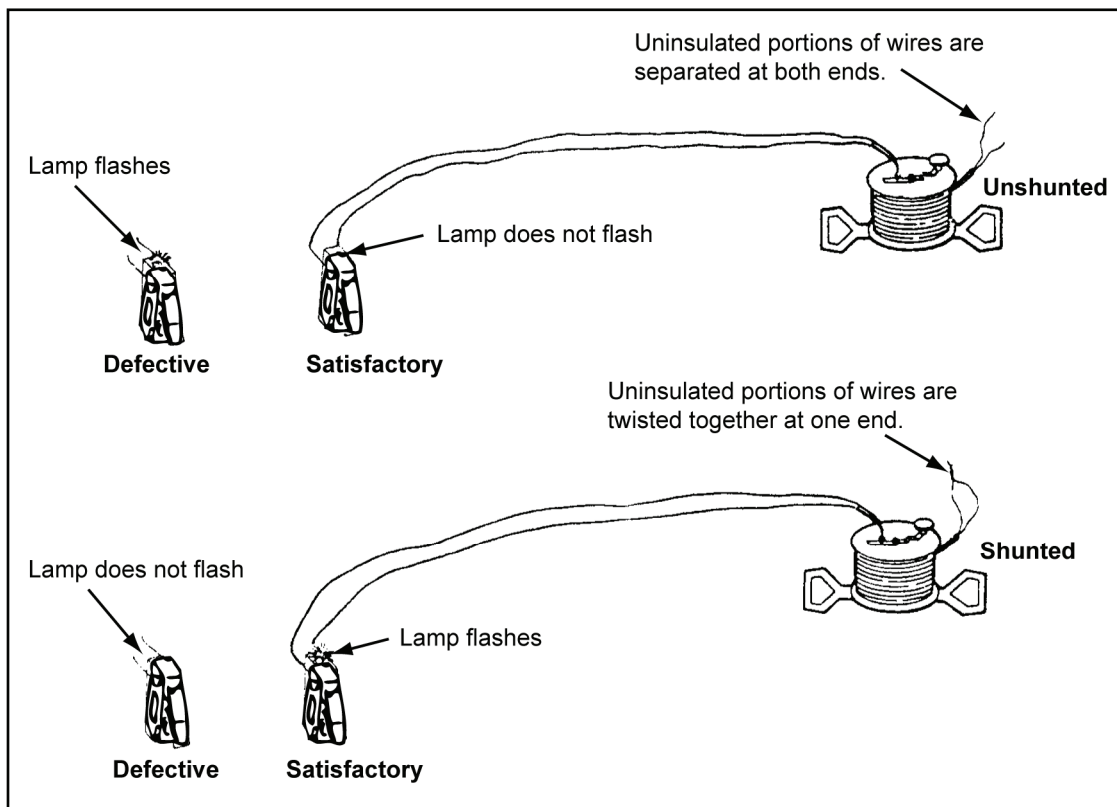
**Note.** The indicator lamp should not flash. If it does, the flash of the lamp indicates a short circuit in the firing wire.

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- Shunt the wires at one end, and connect the leads from the other end to the posts of the M51 test set. Squeeze the test set handle.

*Note.* The indicator lamp should flash. If it does not, the failure of the lamp to light indicates a break in the firing wire. At least three 180° twists should be used to shunt the wires.

- Shunt both ends of the firing wire after testing.



**Figure 2-9. Testing a Firing Wire on a Reel**

- **Step 4.** Lay out the firing wire.
  - Lay out the firing wire from the charges to the firing point after locating a firing point. Ensure that this firing point is located a safe distance away from the charges (Chapter 6).
  - Bury the firing wire or lay it flat on the ground. Do not allow vehicles to drive over the firing wire or personnel to walk on the firing wire.
  - Keep the firing wire as short as possible. Avoid creating any loops in the wire (lay it in as straight a line as possible). Cut the firing wire to length, and ensure that it is shunted.
- **Step 5.** Retest the firing wire (shunted and unshunted).
  - Perform the open- and close-circuit tests again. Ensure that the process of unreeling the wire did not separate broken wires not found when the wire was tested on the reel.
  - Guard the firing position continually from this point on. Ensure that no one tampers with the wires or fires the charges prematurely.
  - Use hand signals to indicate the test results.

---

**Note.** Hand signals are necessary because of the distance involved between the charges and the firing position. The Soldier testing the wire can give these signals directly to the Soldier at the opposite end of the wire or, if they cannot see each other, through intermediate positions or over the radio. The tester indicates to the assistant that he wants the far end of the firing wire unshunted by extending both arms straight out at shoulder height. After unshunting the firing wire, the assistant at the far end of the wire repeats the signal, indicating to the tester that his end is unshunted. When the tester wants the far end of the firing wire shunted, he signals to the assistant by clasping his hands together and extending his arms over his head, elbows bent, forming a diamond shape. After shunting the firing wire, the assistant repeats the signal, indicating to the tester that the wire is shunted.

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- Shunt both ends of the firing wire after completing the tests.
- **Step 6.** Test the electric blasting caps.
  - Remove the cap from its spool. Place the cap in the palm of your hand with the lead wires passing between your index and middle fingers.
  - Wrap the wire around the palm of your hand twice to prevent tension on the wires in the cap and the cap from being dropped.
  - Grasp the wire spool with your free hand, and unreel the wire letting the wire pass between your fingers while turning the spool. Unreel the cap wires completely from the cardboard spool. Avoid allowing the wires to slip off the ends of the cardboard spool, since this will cause excessive twists and kinks in the wires and prevent the wires from separating properly.
  - Place the blasting cap under a sandbag or helmet while extending the wires to their full length.
  - Test the blasting caps away from all other personnel. Keep your back to the blasting cap when testing it.
  - Remove the short-circuit shunt from the lead wires.
  - Hold or attach one lead wire to one of the binding posts of the M51. Hold or attach the second lead wire to the other binding post.
  - Squeeze the test set handle.

---

**Note.** The blasting cap is good if the indicator lamp flashes. If the lamp does not flash, the cap is defective; do not use it.

---

- Ensure that the cap wires are kept shunted when not testing them.
- **Step 7.** Connect the series circuit (if used) using one of the series circuits shown in Figure 2-8, page 2-8. Use the following procedures:
  - Test all blasting caps (step 6) separately, before connecting them in a circuit.
  - Join blasting-cap wires together using the Western union pigtail splice and tension knot (Figure 2-6, page 2-6). Protect all joints in the circuit with electrical insulation tape. Do not use the cardboard spool that comes with the blasting cap to insulate these connections.
  - Test the entire electrical cap circuit. Connect the two free blasting cap wires to the M51 test set after the series is completed.

---

**Note.** The indicator lamp should flash to indicate a good circuit. If the lamp does not flash, check the connections and blasting caps again.

---

- Test the cap circuit, and then shunt the two free blasting cap wires until you are ready to connect them to the firing wire.
- **Step 8.** Connect the firing wire to the cap wire.
  - Connect the free leads of the blasting caps to the firing wire before priming the charges or taping a blasting cap to a detonating cord ring main.

- Use a Western union pigtail splice to connect the firing wire to the blasting cap wires.
- Insulate the connections with tape. Never use the cardboard spool that comes with the blasting cap to insulate this connection.

---

*Note.* The firing wire is likely to break when bent to fit into the spool.

---

- **Step 9.** Test the entire firing circuit. Test the circuit from the firing point before priming the charges with electric caps or connecting the blasting caps to the firing circuit. Use the following procedures:
  - Ensure that the blasting caps are under protective sandbags while performing this test.
  - Connect the ends of the firing wire to the M51 test set.
  - Squeeze the test handle. The indicator lamp should flash, indicating a proper circuit.
  - Shunt the ends of the firing wire.

**WARNING**

**Do not prime the charges with electric blasting caps or connect electric blasting caps to the detonating cord until all other steps of the preparation sequence are complete. Failure to comply could result in immediate personal injury or damage to equipment.**

- **Step 10.** Prime the charges. Prime the charges and return to the firing point. Perform this as the last step before returning to the firing point and firing the circuit.

**WARNING**

**Prime the charges with the minimum number of personnel on-site. Failure to comply could result in immediate personal injury or damage to equipment.**

**SECTION II – PRIMING SYSTEMS**

**PRIMING CHARGES**

2-22. The four methods of priming charges are MDI, nonelectric, electric, and detonating cord. MDI, nonelectric, and electric priming involves directly inserting blasting caps into the charges and MDI M151 and MDI M152 boosters into the charges. MDI M151, MDI M152, or detonating cord priming are the preferred methods for priming all charges since it involves fewer blasting caps, makes priming and misfire investigation safer, and allows charges to be primed at state of readiness—state 1 (safe) when in place on a reserved *demolition target* (a target of known military interest identified for possible future demolition) (JP 1-02) or mission.

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*Note.* When priming with MDI, refer to Section IV of this chapter.

---

**PRIMING TRINITROTOLUENE DEMOLITION BLOCKS**

2-23. Nonelectric blasting caps, electric blasting caps, and detonating cord are used to prime TNT demolition blocks. Each of these is discussed in the paragraphs below.

## NONELECTRIC BLASTING CAP

2-24. TNT blocks have threaded cap wells. If available, use priming adapters to secure nonelectric blasting caps and timed blasting fuses to TNT blocks with threaded cap wells (Figure 2-10). When priming adapters are not available, prime TNT blocks with threaded cap wells using the following steps:

- **Step 1.** Wrap a string tightly around the block of TNT. Tie it securely, leaving about 6 inches of loose string on each end (Figure 2-11).
- **Step 2.** Insert a blasting cap with the fuse attached into the cap well.
- **Step 3.** Tie the loose ends of the string around the fuse to prevent the blasting cap from being separated from the block. Adhesive tape can also effectively secure blasting caps in charges (Figure 2-11).

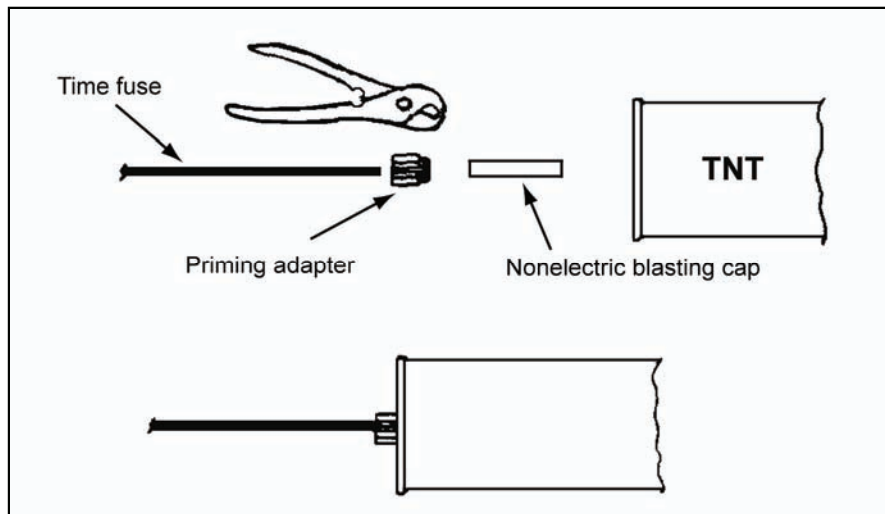


Figure 2-10. Nonelectric Priming With an Adapter

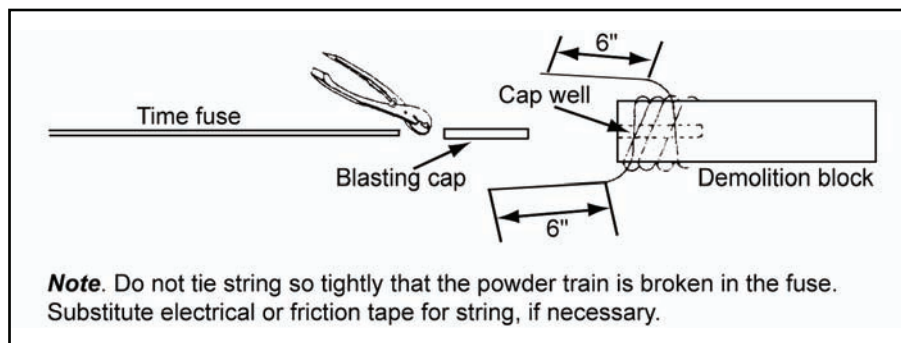


Figure 2-11. Nonelectric Priming Without an Adaptor

## ELECTRIC BLASTING CAP

2-25. Electric blasting caps can be used with priming adapters or without priming adapters. The use of these adapters is discussed in the paragraphs below.

### With a Priming Adapter

2-26. The following steps is used for priming a TNT block when using the priming adapter:

- **Step 1.** Prepare the electric initiating set before priming.

- **Step 2.** Pass the lead wires through the slot of the adapter, and pull the cap into place in the adapter (Figure 2-12). Ensure that the blasting cap protrudes from the threaded end of the adapter.
- **Step 3.** Insert the blasting cap into the threaded cap well of the TNT block, and screw the adapter into place.

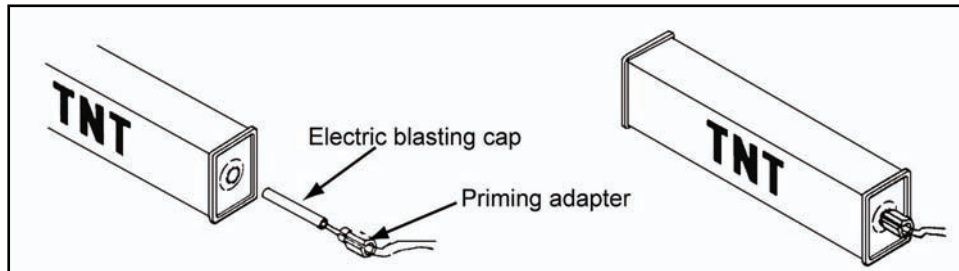


Figure 2-12. Electric Priming With an Adapter

### Without a Priming Adapter

2-27. The following steps are used if a priming adapter is not available:

- **Step 1.** Prepare the electric initiating set before priming.
- **Step 2.** Insert the electric blasting cap into the cap well. Tie the lead wires around the block, using two half hitches (Figure 2-13). Allow some slack in the wires between the blasting cap and the tie to prevent any tension on the blasting cap lead wires.

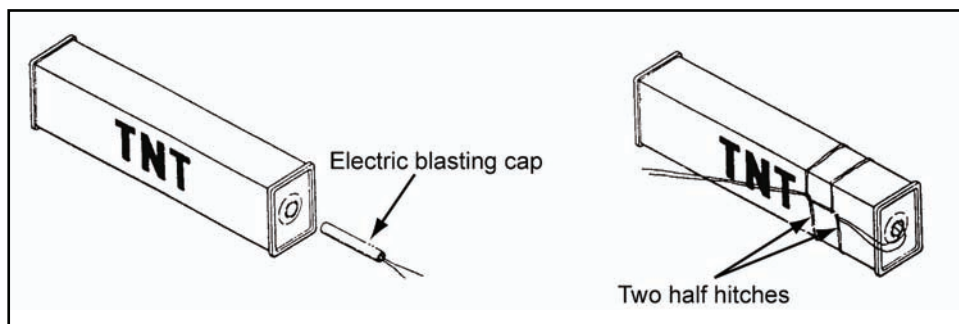


Figure 2-13. Electric Priming Without an Adapter

### DETONATING CORD

2-28. The following methods are used to prime TNT blocks with detonating cord (Figure 2-14, page 2-14):

- **Common method.** Lay one end (1-foot length) of detonating cord at an angle across the explosive. Wrap the running end around the block three turns, laying the wraps over the standing end. On the fourth wrap, slip the running end under all wraps, parallel to the standing end, and draw the wraps tight. Ensure that this forms a clove hitch with two extra turns.
- **Alternate method.** Place a loop of detonating cord on the explosive, leaving enough length on the end to make four turns around the block, and loop with the remaining end of the detonating cord. Start the first wrap, and ensure that you immediately cross over the standing end of the loop. Work your way to the closed end of the loop. Pass the free end of the detonating cord through the loop, and pull it tight to form a knot around the outside of the block.

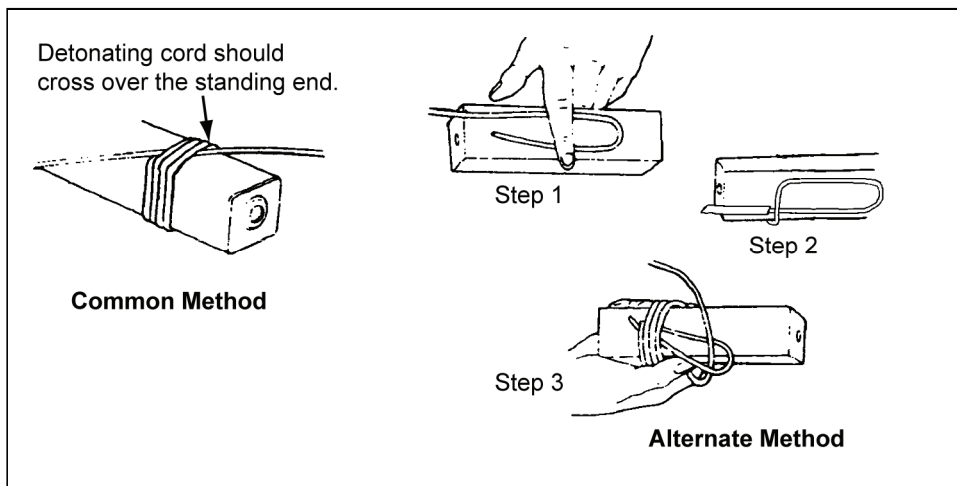


Figure 2-14. Priming TNT With Detonating Cord

## PRIMING M112 (COMPOSITION C4) DEMOLITION BLOCKS

2-29. When priming M112 (composition C4) demolition blocks, nonelectric and electric blasting caps and detonating cord are used. Each of these is discussed in the paragraphs below.

### NONELECTRIC AND ELECTRIC BLASTING CAPS

2-30. Composition C4 blocks do not have a cap well; therefore, one will have to be made. The following steps are used to make a cap well:

- **Step 1.** Use M2 crimpers or other nonsparking tools to make a hole in the end or on the side of the block (at the midpoint) large enough to hold the blasting cap.
- **Step 2.** Insert the blasting cap into the hole. Do not force the cap if the blasting cap does not fit the hole or cut; make the hole larger.
- **Step 3.** Anchor the blasting cap in the block by gently squeezing the plastic explosive around the blasting cap.

### DETONATING CORD

2-31. To prime plastic explosives with detonating cord, use the following steps:

- **Step 1.** Form either an Uli knot, a double overhand knot, or a triple-roll knot as shown in Figure 2-15.
- **Step 2.** Cut an L-shaped portion of explosive, leaving it connected to the explosive. Ensure that the space is large enough to insert the formed knot (Figure 2-16).

#### CAUTION

Use a sharp, nonsparking knife on a nonsparking surface to cut explosives. Personal injury or damage to equipment may result from long-term failure to follow correct procedures.

- **Step 3.** Place the knot in the L-shaped cut.
- **Step 4.** Push the explosive from the L-shaped cut over the knot. Ensure that there is at least 1/2 inch of explosive on all sides of the knot.
- **Step 5.** Strengthen the primed area by wrapping it with tape.



*Note.* It is not recommended that plastic explosives be primed by wrapping them with detonating cord, since wraps will not properly detonate the explosive charge.

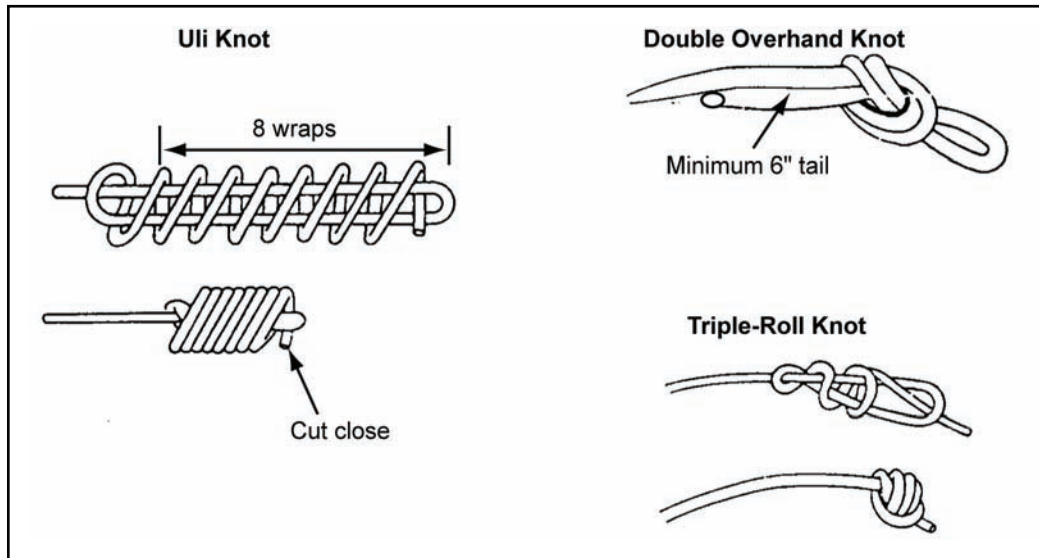


Figure 2-15. Priming Plastic Explosives With Detonating Cord

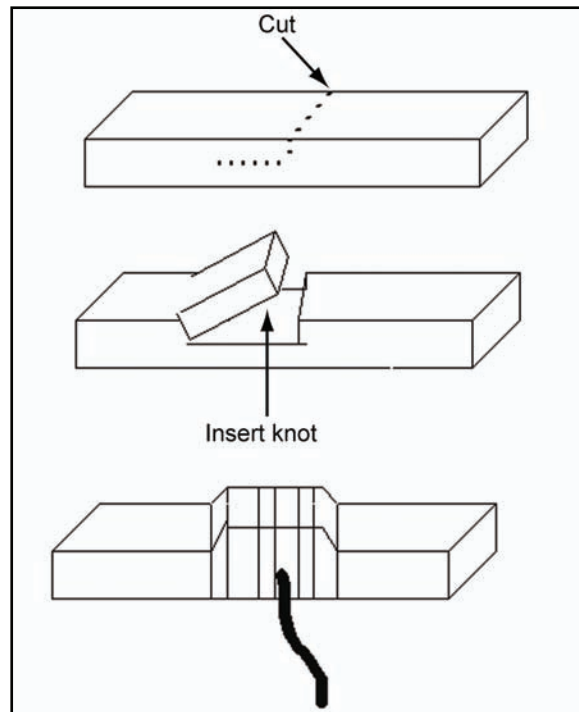


Figure 2-16. Priming Composition C4 With an L-Shaped Charge

## PRIMING M186 DEMOLITION CHARGES

2-32. M186 demolition charges can be primed by using nonelectric and electric blasting caps or detonating cord. The use of nonelectric and electric blasting caps and detonating cord is discussed below.

## NONELECTRIC AND ELECTRIC BLASTING CAPS

2-33. One of the following methods can be used to prime M186 demolition charges (Figure 2-17):

- **Method 1.** Attach an M8 blasting cap holder to the end or side of the sheet explosive. Insert an electric or a nonelectric blasting cap into the holder until the end of the cap presses against the sheet explosive.

*Note.* The M8 blasting cap holder has three slanted, protruding teeth, which prevent the clip from withdrawing from the explosive. Two dimpled spring arms firmly hold the blasting cap in the M8 holder.

- **Method 2.** Cut a notch in the sheet explosive (about 1 1/2 inches long and 1/4 inch wide). Insert the blasting cap to the limit of the notch. Secure the blasting cap with a strip of sheet explosive.
- **Method 3.** Place 1 1/2 inches of the blasting cap on top of the sheet explosive, and secure it with a strip of sheet explosive (at least 3 inches by 3 inches).

*Note.* When using sheet explosives to cut steel, Method 3 is the preferred method.

- **Method 4.** Insert 1 1/2 inches of the blasting cap between two sheets of explosive.

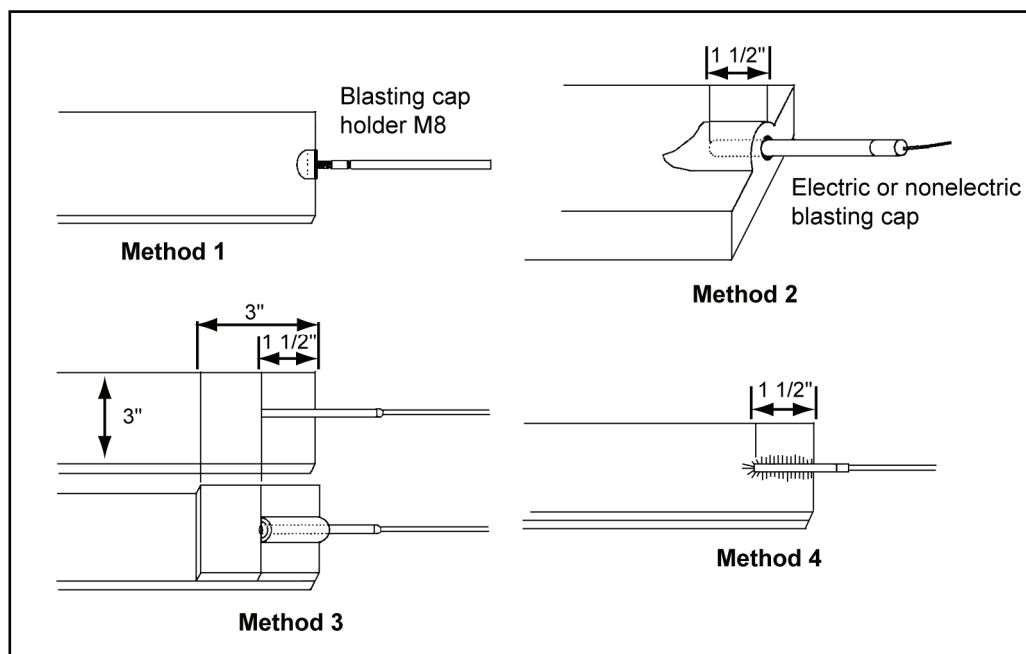


Figure 2-17. Priming Sheet Explosives

## DETONATING CORD

2-34. Sheet explosives can be primed with detonating cord using an Uli knot, double overhand knot, or triple-roll knot. Insert the knot between two sheets of explosive, or place the knot on top of the sheet explosive and secure it with a small strip of sheet explosive. The knot must be covered on all sides with at least 1/2 inch of explosive.

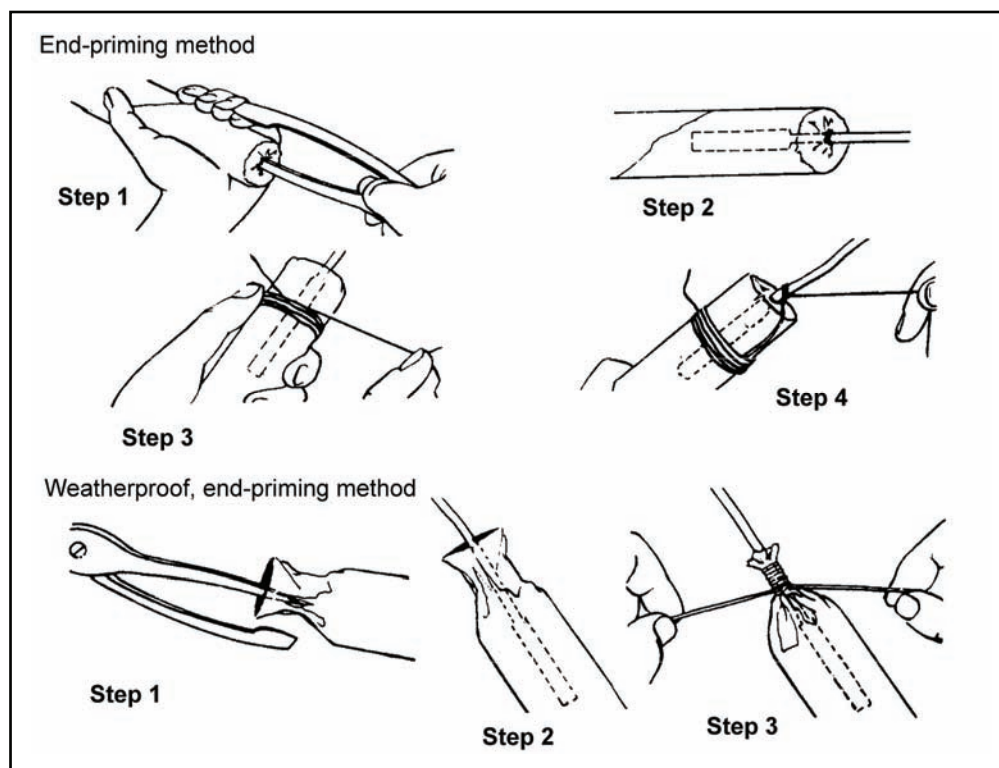
## PRIMING DYNAMITE

2-35. Dynamite can be primed at either end or side using either the nonelectric, electric, or detonating cord priming method. These methods are discussed in the paragraphs below.

## NONELECTRIC AND ELECTRIC PRIMING

2-36. There are three methods for priming dynamite nonelectrically and electrically. They are the—

- **End-priming method (Figure 2-18).** Perform the end-priming as follows:
  - **Step 1.** Making a cap well in the end of the dynamite cartridge using M2 crimpers.
  - **Step 2.** Inserting a fused blasting cap into the cap well.
  - **Steps 3 and 4.** Tying the cap and fuse securely in the cartridge with a string.
- **Weatherproof, end-priming method (Figure 2-18).** Perform the weatherproof, end-priming method as follows:
  - **Step 1.** Unfolding the wrapping at the folded end of the dynamite cartridge and making a cap well in the exposed dynamite using M2 crimpers.
  - **Step 2.** Inserting a fused blasting cap into the cap well.
  - **Step 3.** Closing the wrapping around the fuse and fastening the wrapping securely with string or tape and applying a weatherproof sealing compound to the tie.



**Figure 2-18. Nonelectric and Electric End-Priming of Dynamite**

- **Side-priming method (Figure 2-19, page 2-18).** Perform the side-priming method as follows:
  - **Step 1.** Making a cap well (about 1 1/2 inches long) into the side of the cartridge at one end using M2 crimpers. Slightly slant the cap well so the blasting cap, when inserted, will be nearly parallel to the side of the cartridge and the explosive end of the cap will be at a point nearest the middle of the cartridge.
  - **Step 2.** Inserting a fused blasting cap into the cap well.
  - **Step 3.** Tying a string securely around the fuse, and then wrapping the string tightly around the cartridge, making two or three turns before tying it.
  - **Step 4.** Weatherproofing the primed cartridge by wrapping a string closely around the cartridge, extending it an inch or so on each side of the hole to cover it completely and covering the string with a weatherproof sealing compound.

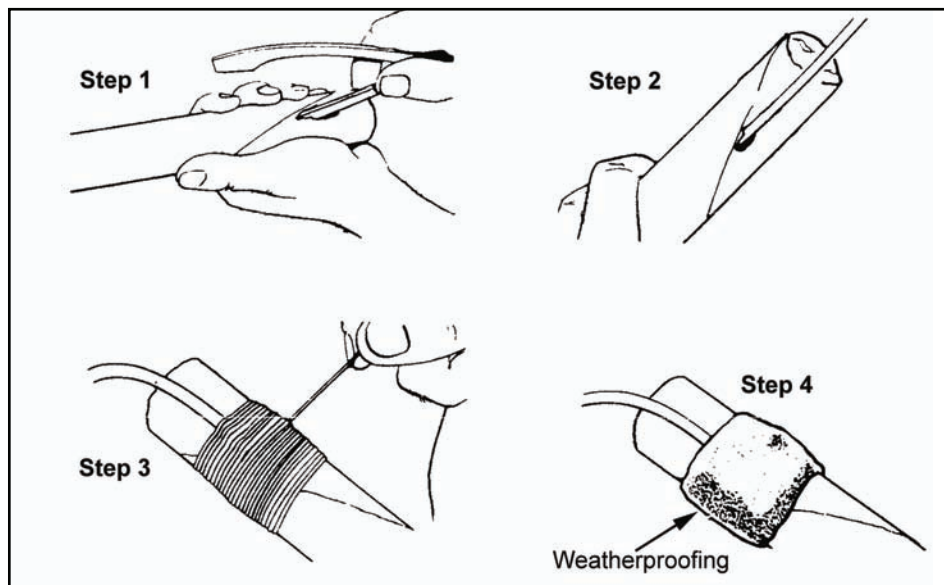


Figure 2-19. Nonelectric and Electric Side-Priming of Dynamite

### DETONATING CORD PRIMING

Detonating cord can be used to prime dynamite. Using the M2 crimpers (about 1 inch from either end of the dynamite charge), four equally spaced holes should be punched through the dynamite cartridge (Figure 2-20). The cartridge must be rotated 180° after punching each hole to keep the holes parallel. Detonating cord should be laced through the holes in the same direction that the holes are punched. The dynamite will break if the loops of the detonating cord are pulled too tightly. To secure the detonating cord tail, pass it between the detonating cord lace and the dynamite charge.

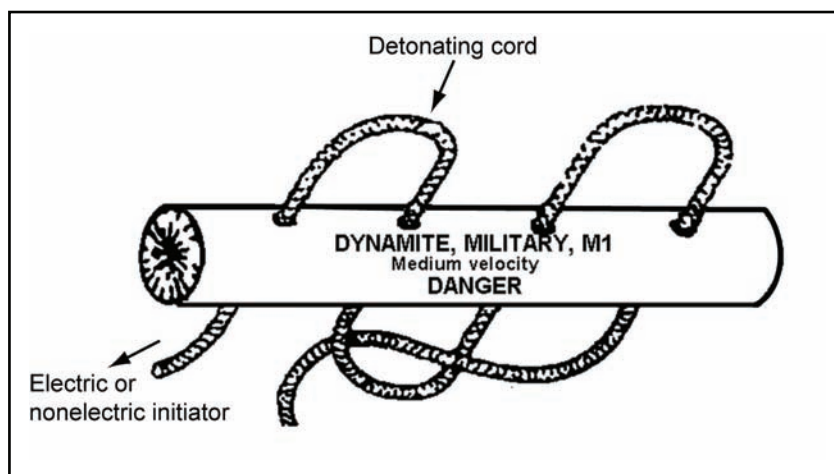


Figure 2-20. Priming Dynamite With Detonating Cord

### PRIMING 40-POUND, COMPOSITION H6 CRATERING CHARGES

2-37. The 40-pound, composition H6 cratering charge is primarily an underground charge; therefore, prime it only with composition C4 primed with detonating cord. Use dual-priming to protect against misfires as follows:

- **Step 1.** Prime two packages of composition C4 (Figure 2-21, Diagram 4, page 2-20).

- **Step 2.** Dual-prime a single cratering charge by placing the primed composition C4 packages parallel to the cratering charge and on opposite sides of it and flush with the top. Firmly hold them in place with duct tape. Instructions and markings on the canister indicate the exact placement of the composition C4 (Figure 2-21, Diagram 2, page 2-20).
- **Step 3.** Dual-prime two cratering charges by priming them in the same borehole. This requires one primed composition C4 block on each of the cratering charges, parallel to the charges and flush with the top. When placed in the borehole, the composition C4 blocks are placed on opposite sides of the 40-pound charges (Figure 2-21, Diagram 4).
- **Step 4.** Ensure that the detonation-cord branchlines (from the composition C4 block) are long enough to reach the detonating-cord ring mains after the cratering charge is in the ground. To aid in clearing possible misfires, place tape on the detonating cord from the cratering charge, 1 foot up.

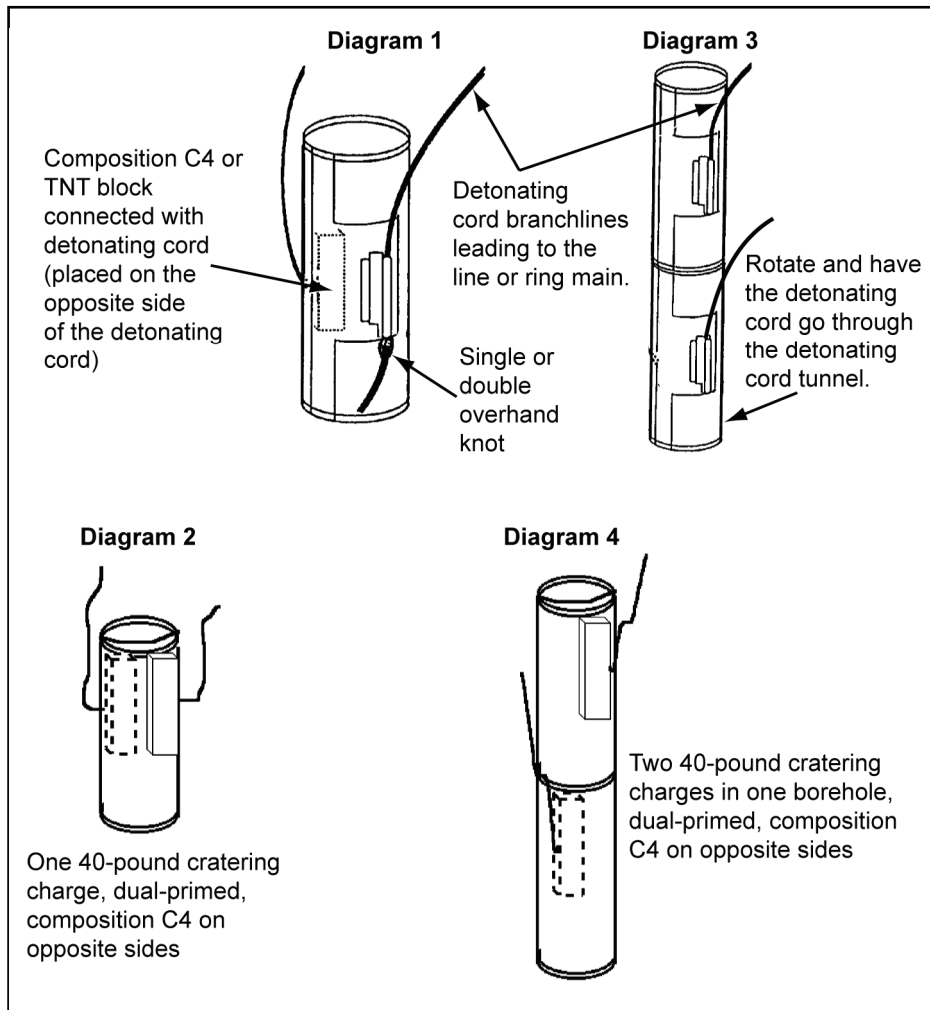
2-38. The composition H6 cratering charge replaced the 40-pound ammonium-nitrate cratering charge. If an ammonium-nitrate cratering charge is drawn from an ammonium supply point (ASP), use the following steps to prime it:

- **Step 1.** Dual-prime a single cratering charge by placing the detonating cord into the detonating cord tunnel. Tie an overhand knot with a 6-inch tail at either lower end of the length of the detonating cord. Use a minimum of 1 pound of explosive when dual-priming a single cratering charge. Prime the explosives with detonating cord and tape the charge to the center of the cratering charge (Figure 2-21, Diagram 1).
- **Step 2.** Dual-prime two cratering charges by priming only the detonating cord tunnels of each charge when placing two charges in the same borehole. The borehole is dual-primed and extra explosives as shown in Figure 2-21, Diagram 3.

---

*Note.* The borehole is dual-primed and extra explosives are not required.

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**Figure 2-21. Priming Composition H6 and Ammonium Nitrate Cratering Charges**

- **Step 3.** Ensure that the detonating cord branchlines from the 1-pound charge are long enough to reach the detonating cord ring main after the cratering charge is in the ground. Place tape on the detonating cord 1 foot up from the cratering charge to aid in clearing possible misfires.

**WARNING**

**Do not prime cratering charges with blasting caps when buried. Failure to comply could result in immediate personal injury or damage to equipment.**

**CAUTION**

Ammonium nitrate is hygroscopic and ineffective when wet. Therefore, inspect the metal container for damage or rust. Do not use damaged or rusty charges. Personal injury or damage to equipment may result from long-term failure to follow correct procedures.

**PRIMING M2A4 AND M3A1 SHAPED CHARGES**

2-39. The M2A4 and M3A1 are primed with nonelectric or electric blasting caps. These charges have a threaded cap well at the top of the cone and are primed with a blasting cap as shown in Figure 2-22, page 2-22. If a priming adapter is not available, use a piece of string, cloth, or tape to hold the cap. Simultaneously, detonate multiple shaped charges to create a line of boreholes for cratering charges by connecting each charge into a detonating cord ring or a line main. The detonating cord branchlines must be of equal length for priming shaped charges when simultaneous detonation is required. The procedures for priming shaped charges are listed below.

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*Note.* Use the crimp, tie, prime (CTP) method for shaped charges.

---

**WARNING**

**Do not dual-prime shaped charges. Prime them only with a blasting cap in the threaded cap well. Failure to comply could result in immediate personal injury or damage to equipment.**

**NONELECTRIC SHAPED CHARGE**

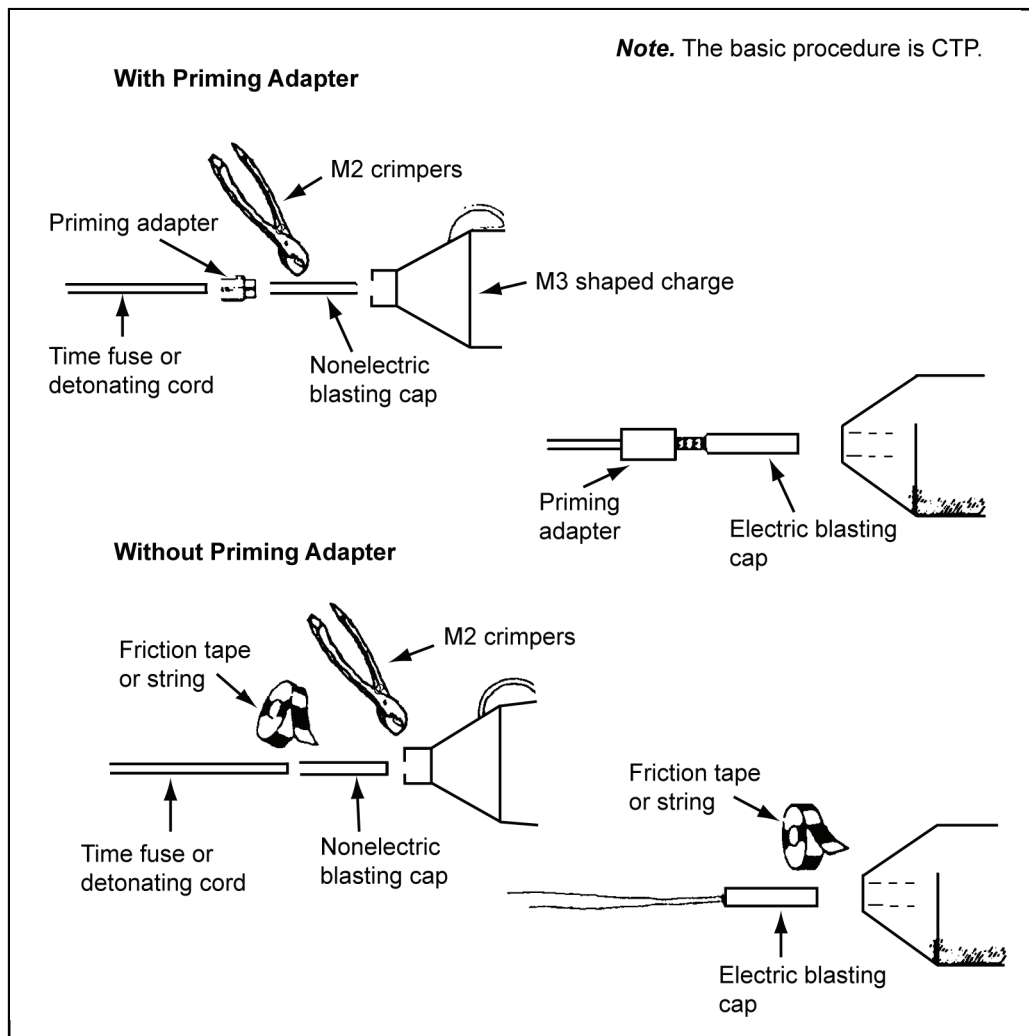
2-40. Prime nonelectric shaped charges (Figure 2-22, page 2-22) as follows:

- **Step 1.** Place a priming adapter (if using one) on the detonating cord, then crimp a nonelectric blasting cap to a branchline.
- **Step 2.** Connect the branchline to the ring main.
- **Step 3.** Insert and secure the blasting cap into the threaded cap well of the shaped charge.
- **Step 4.** Make all branchline connections before priming any shaped charges when detonating multiple shaped charges.

**ELECTRIC SHAPED CHARGES**

2-41. Electric shaped charges are primed as follows:

- Completing the initiating set and firing circuit as described in paragraph 2-21, page 2-8.
- Priming the charge.



**Figure 2-22. Priming Shaped Charges**

## PRIMING M1A2 AND M1A3 BANGALORE TORPEDOES

2-42. Nonelectric and electric initiating sets are used when priming the M1A2 and M1A3 bangalore torpedo. The paragraphs below describe the nonelectric and electric initiating sets, detonating cord, and dual priming.

### NONELECTRIC INITIATING SET

2-43. The blasting cap of a nonelectric initiating set is inserted directly into the cap well of a torpedo section (Figure 2-23, Diagram 1). If a priming adapter is not available, use tape or string to hold the blasting cap in place. When priming the bangalore with a nonelectric cap, use the CTP method.

### ELECTRIC INITIATING SET

2-44. The blasting cap of an electric initiating set is inserted into the cap well of a torpedo section. If a priming adapter is not available, hold the cap in place by taping or tying (with two half hitches) the lead wires to the end of the torpedo. Allow some slack in the wires between the blasting cap and the tie to prevent tension on the blasting cap leads, and a tension knot is used to join the firing wire to the cap wire (Figure 2-23, Diagram 2).



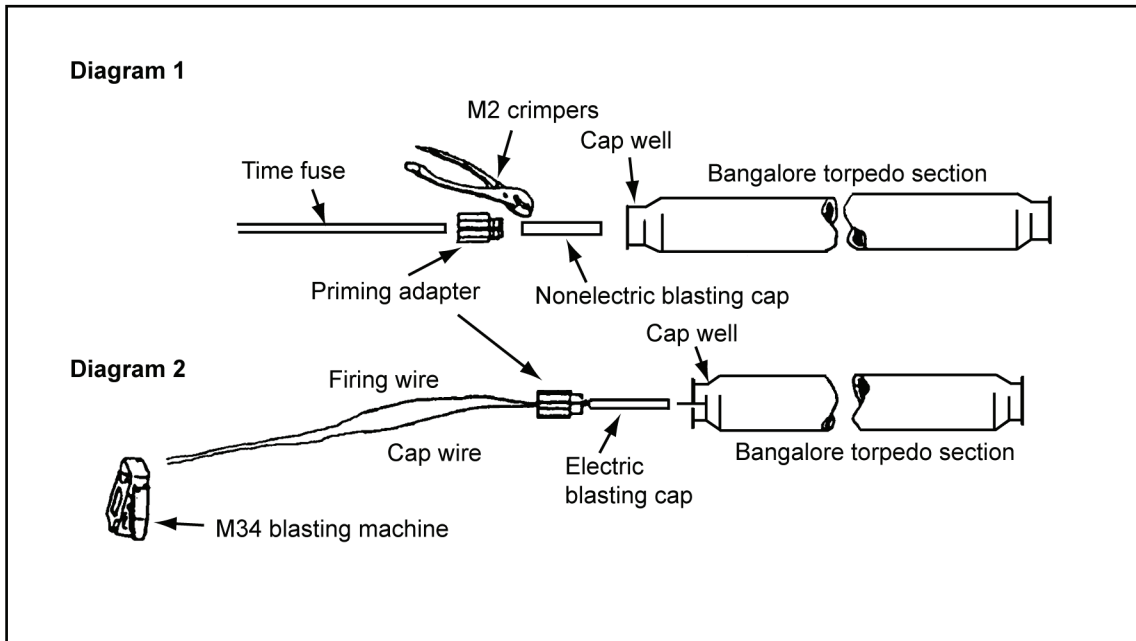


Figure 2-23. Priming a Bangalore Torpedo With a Blasting Cap

### DETONATING CORD

2-45. The torpedo is single-primed by wrapping the detonating cord eight times around the end of the section, just below the bevel (Figure 2-24). After pulling the knot tight, insert the short end of the detonating cord into the cap well, and secure it with tape, if needed. Never use the short end (tail) of the detonating cord to initiate the torpedo. Initiation must come from the running end of the detonating cord.

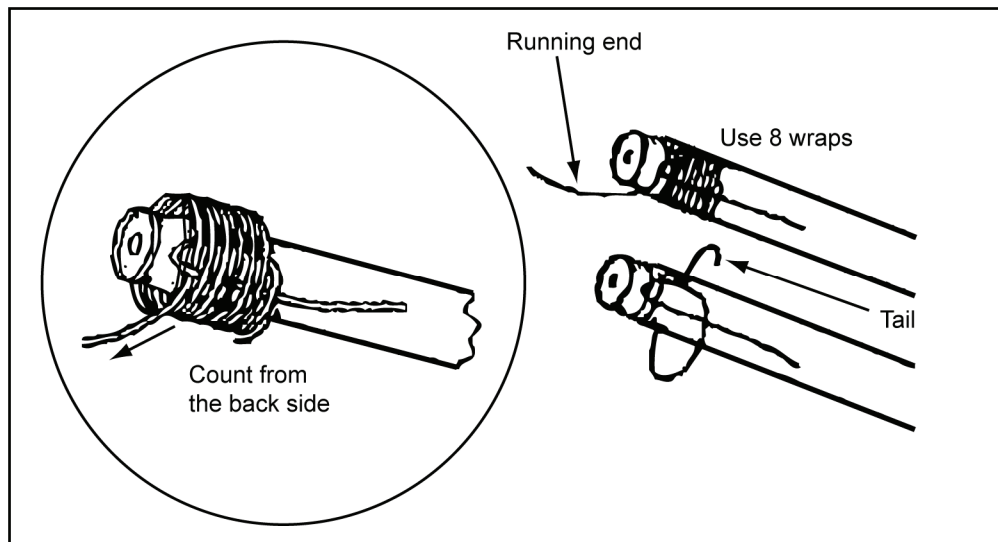


Figure 2-24. Single Priming a Bangalore Torpedo With a Detonating Cord

### DUAL PRIMING

2-46. When dual priming the torpedo, use eight wraps with one branchline as before. Then, prime it with a blasting cap or booster into the cap well.

**CAUTION**

Exactly eight wraps should be used to prime the bangalore torpedo. Too many wraps will extend the detonating cord past the booster charge housing, possibly causing the bangalore torpedo to be cut without detonating. Too few wraps may cause the bangalore torpedo to crease without detonating. Personal injury or damage to equipment may result from long-term failure to follow correct procedures.

**SECTION III – DETONATING CORD FIRING SYSTEMS**

**USE DETONATING CORD FIRING SYSTEMS**

2-47. A firing system uses detonating cord to transmit a shock wave from the initiating set to the explosive charge. Detonating cord is versatile and easy to install. It is useful for underwater, underground, and aboveground blasting because the blasting cap of the initiating set may remain above water or aboveground and does not have to be inserted directly into the charge. Detonating cord firing systems combined with detonating cord priming are the safest and most efficient ways to conduct military demolition missions. Nonelectric or electric initiating sets should be used to initiate detonating cord. The two types of detonating cord firing systems are the single-firing system and the dual-firing system. These systems are discussed in the paragraphs below.

**WARNING**

**Never attach an M60 or M81 igniter to the M151, M152, or detonating cord. Failure to comply could result in immediate personal injury or damage to equipment.**

**SINGLE-PRIMED SYSTEM**

2-48. Figure 2-25 shows a single-primed system. Each charge is single-primed with a branchline. The branchline is tied to the line main or ring main. Tying to the ring main is preferred, but construction of a ring main may not be possible because of the amount of detonating cord. The ring main decreases the chances of a misfire if a break or cut occurs anywhere within the ring main. The electric, nonelectric, or combination initiating sets are taped onto the firing system. When using a combination initiating set, the electric initiation system is always the primary means of initiation. When using dual, nonelectric initiating sets, the shorter time fuse is the primary initiating set.

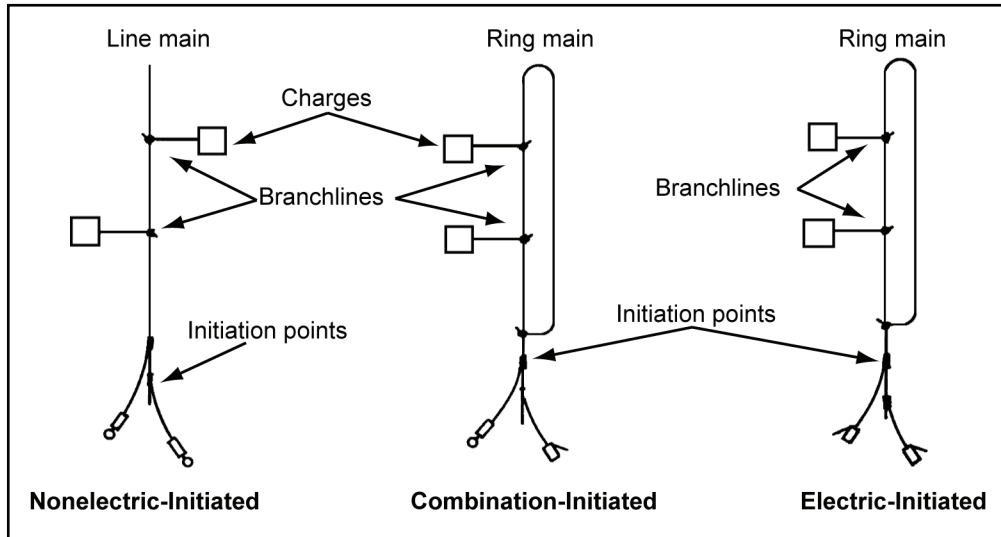


Figure 2-25. Single-Primed System (Dual-Initiated, Single-Fired, Single-Primed)

**DUAL-PRIMED SYSTEM**

2-49. Figure 2-26 shows a dual-primed system. Each charge is dual-primed with two branchlines (Figure 2-27, page 2-26). One branchline is tied to one firing system, and the other branchline is tied to an independent firing system. Line mains or ring mains may be used; however, they should not be mixed. Detonating cord will be used as crossovers. Crossovers are used to tie both firing systems together at the ends. The initiating sets are taped in with the primary initiating set going to one firing system and the secondary going to the other.

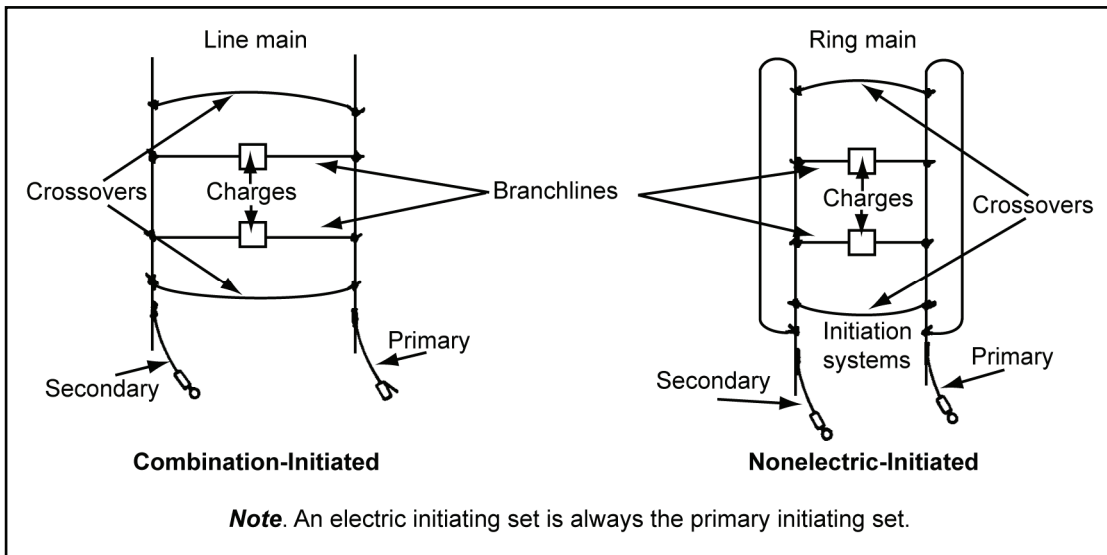
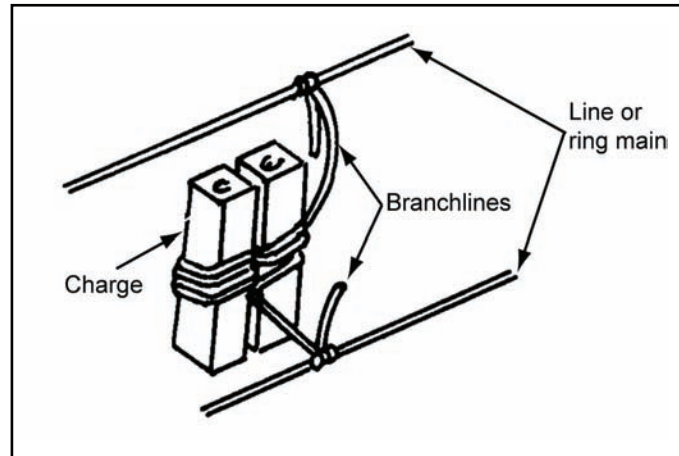
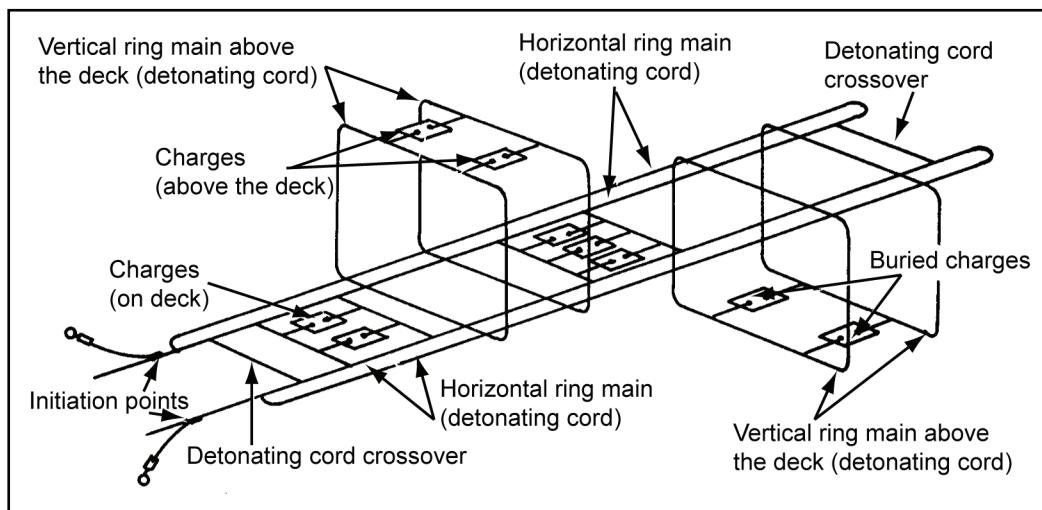


Figure 2-26. Dual-Primed System (Dual-Initiated, Dual-Fired, Dual-Primed)



**Figure 2-27. Dual-Primed Charge**

2-50. Figure 2-28 shows a dual-firing system using horizontal and vertical ring mains. The complexity of a target or obstacle may necessitate using multiple line mains or ring mains for simultaneous detonation. These are referred to as horizontal and vertical lines or ring mains.



**Figure 2-28. Dual-Firing System (Using a Bridge as a Possible Target)**

## ATTACH THE BLASTING CAP

2-51. With tape, attach the electric or nonelectric blasting cap to the detonating cord. String, cloth, or fine wire can be used if tape is not available. To overcome moisture contamination, tape the cap securely to a point 6 inches from the end of the detonating cord. The tape must not conceal either end of the cap. Taping in this way allows you to inspect the cap in case it misfires. No more than 1/8 inch of the cap needs to be left exposed for inspection (Figure 2-29).

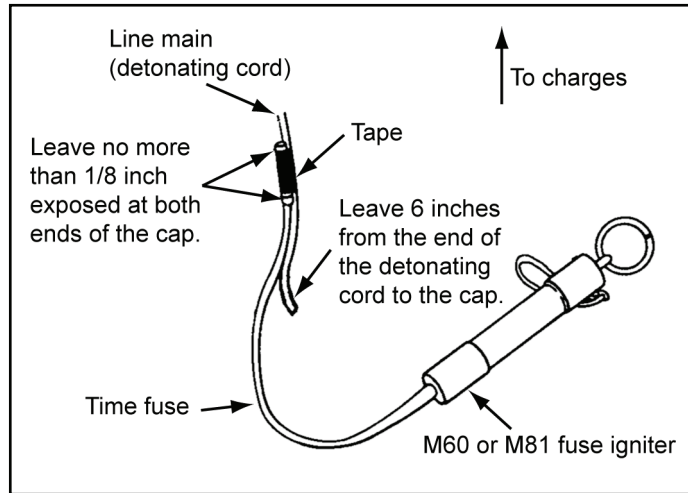


Figure 2-29. Attach a Blasting Cap to the Detonating Cord

## CONNECT THE DETONATING CORD

2-52. Square knots or detonating cord clips are used to splice the ends of the detonating cord (Figure 2-30). Always reinforce the splice with tape. Do not splice detonating cord on branchlines. Square knots may be placed underwater or underground, but the cord must be detonated from a dry end or aboveground. To prevent misfires from moisture contamination, allow 6-inch tails on square knots. Chapter 1, Section III, describes the process for connecting detonating cord with detonating cord clips.

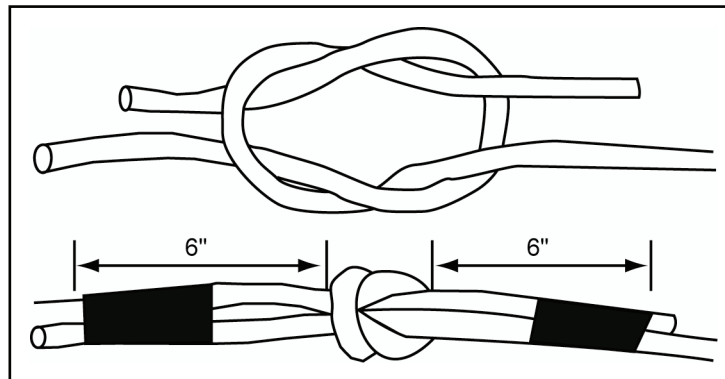
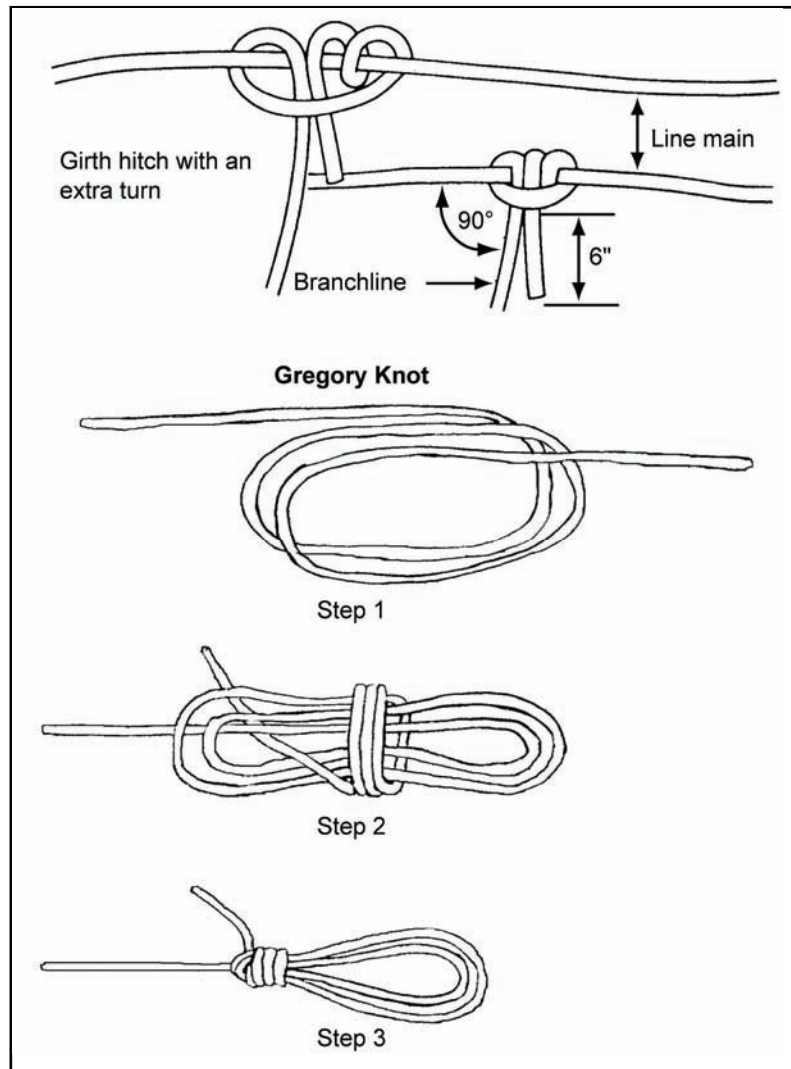


Figure 2-30. Square-Knot Connections for Detonating Cord

## BRANCHLINE

2-53. A branchline is a length of detonating cord between the charge and the firing system. Branchlines should be attached to a detonating cord ring or line main to fire multiple charges. Combining the branchline with an initiating set allows a single branchline to be fired. A branchline should be fastened to a main line with a detonating cord clip (Figure 1-16, page 1-21) or a girth hitch with an extra turn or a Gregory knot (also known as a cherry knot) (Figure 2-31, page 2-28). The connections of branchlines and line or ring mains should intersect at right angles. If these connections are not at right angles, the branchline may be blown off the line main without complete detonation. To prevent moisture contamination and to ensure positive detonation, leave at least 6 inches of the running end of the branchline beyond the tie. It does not matter which side of the knot the 6-inch tail is on at the connection of the line or ring main.



**Figure 2-31. Branchline Connections for Detonating Cord**

*Note.* Nonelectric blasting caps can be crimped to detonating cord as well as time fuses. This capability permits simultaneous firing of multiple charges primed with blasting caps.

## LINE MAIN

2-54. A line main can fire a single charge or multiple charges (Figure 2-32), but if a break in the line occurs, the detonating wave will stop at the break. When the risk of having a line main cut is unacceptable, use a ring main. Line mains are used only when speed is essential. Any number of branchlines can be connected to a line main. However, you connect only one branchline at any one point unless using a British junction (Figure 2-33).

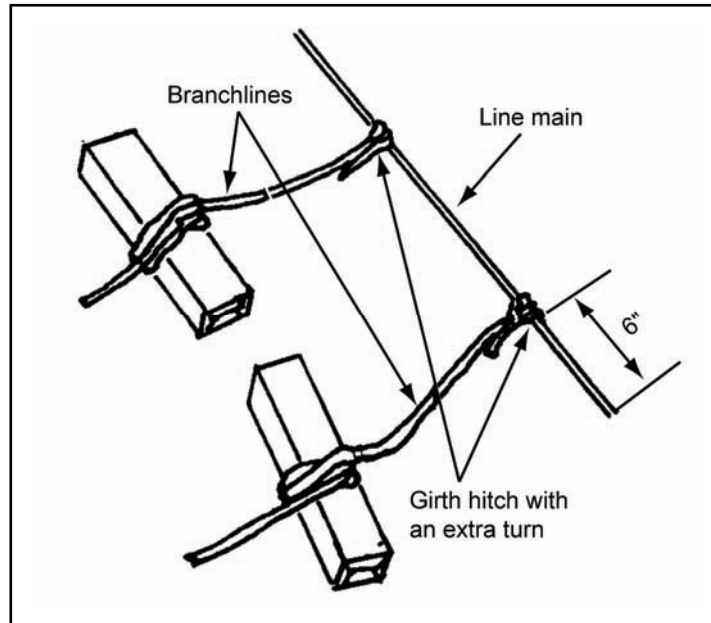


Figure 2-32. Line Main With Branchlines

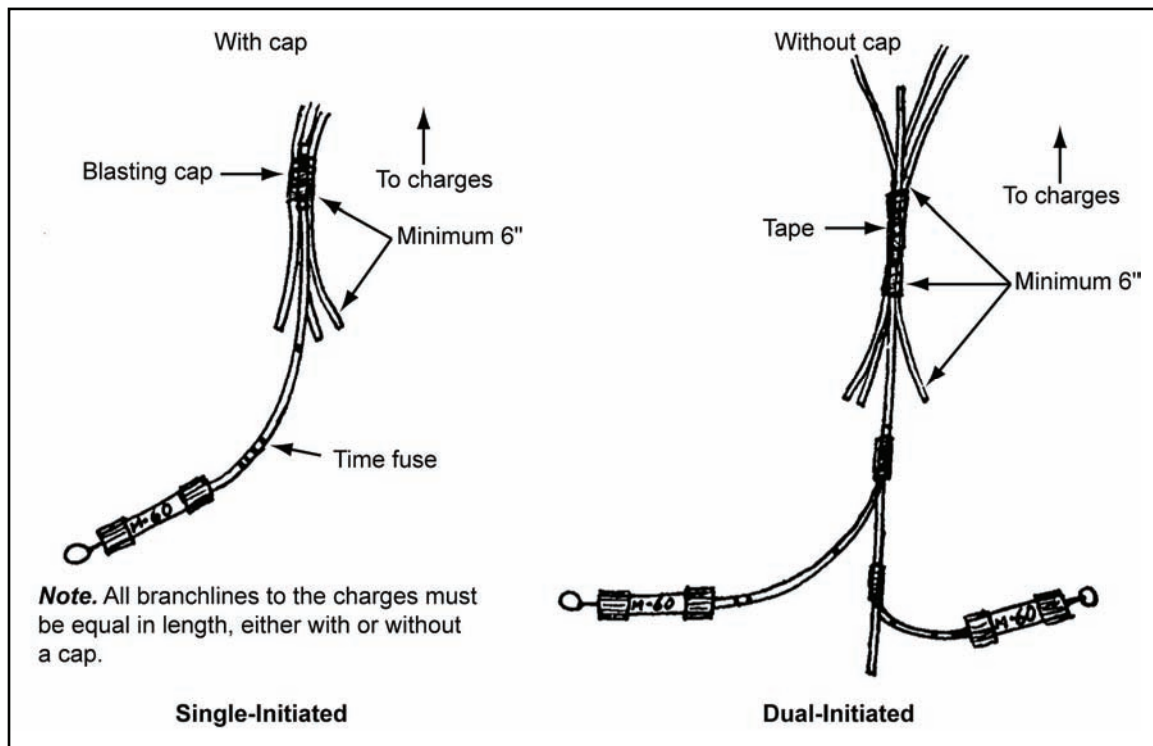


Figure 2-33. Connecting With a British Junction

## RING MAIN

2-55. Ring mains are preferred over line mains because the detonating wave approaches the branchlines from two directions. The charges will detonate even when there is a break in the ring main. A ring main will detonate an unlimited number of charges. Branchline connections to the ring main should be at right

angles. Kinks in the lines should not be sharp. Any number of branchlines can be connected to the ring main; however, never connect a branchline (at the point) where the ring main is spliced. When making branchline connections, avoid crossing lines. If a line crossing is necessary, provide at least 1 foot of clearance between the detonating cords. Otherwise, the cords may cut each other and may destroy the firing system. The methods below describe how to make a ring main (Figure 2-34).

- **Method 1.** Make a ring main by bringing the detonating cord back in the form of a loop and attach it to itself with a girth hitch with an extra turn.
- **Method 2.** Make a ring main by making a U shape with the detonating cord, and then attach a detonating cord crossover at the open end of the U. Use girth hitches with extra turns when attach the crossover.

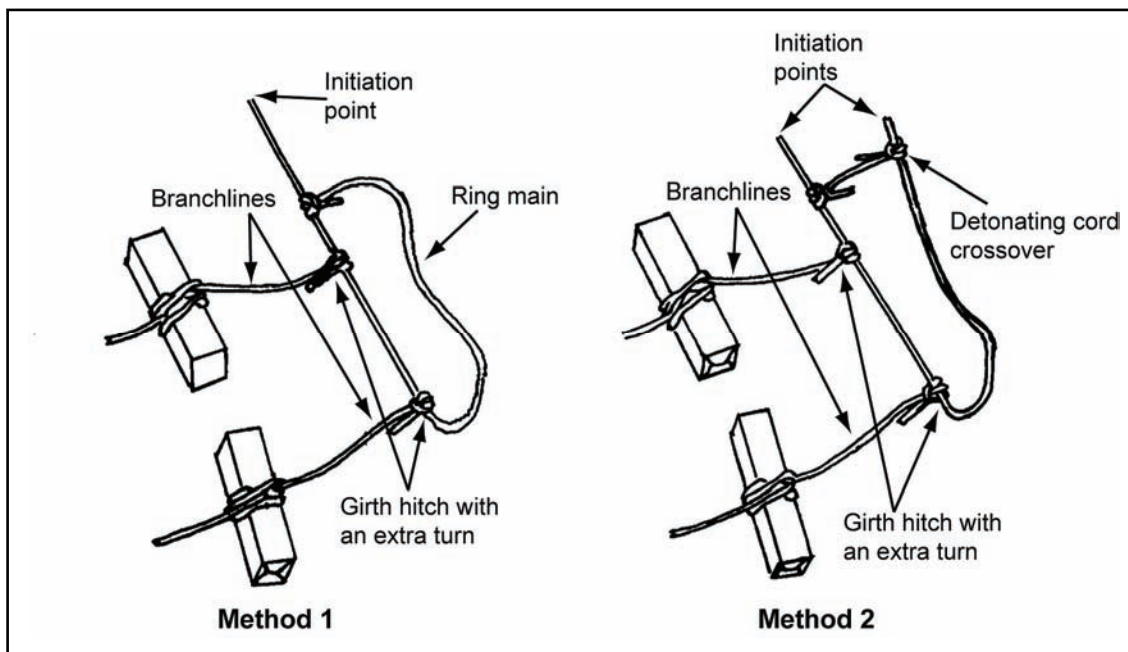


Figure 2-34. Ring Mains

## INITIATE A FIRING SYSTEM

2-56. The two types of firing systems are the single-primed and dual-primed. Initiation of these is described below.

### SINGLE-PRIMED SYSTEM

2-57. A single line or ring main should be dual-initiated as shown in Figure 2-35. The blasting cap that will detonate first should be placed closest to the end of the detonating cord (for example, the electric cap of a combination of initiating sets). Doing this ensures the integrity of the backup system if the first cap detonates and fails to initiate the line main.



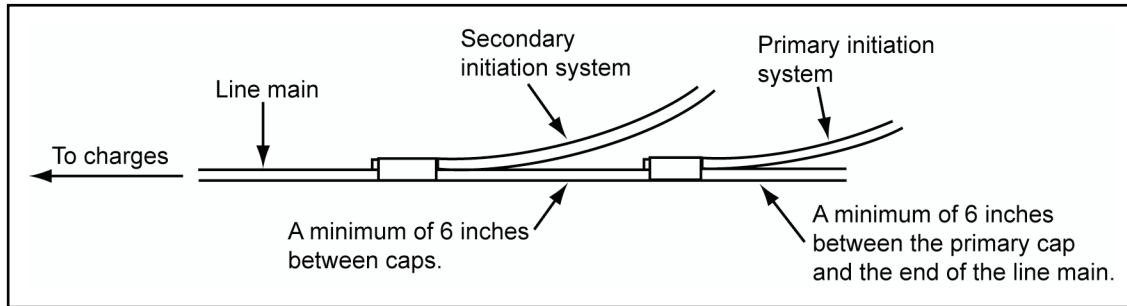


Figure 2-35. Attaching Blasting Caps to a Line Main

### DUAL-PRIMED SYSTEM

2-58. A dual-primed system is initiated as shown in Figure 2-26, page 2-25. However, the blasting caps are still connected as shown in Figure 2-29, page 2-27.

### DANGER

When using a time or safety fuse, uncoil it and lay it out in a straight line. The time fuse should be placed so that the fuse will not curl up and prematurely detonate the blasting cap crimped to it. Failure to comply may cause death or permanent injury.

## SECTION IV – MODERNIZED DEMOLITION INITIATORS

### CHARACTERISTICS

2-59. The MDI is the project name given to a new family of nonelectric blasting caps, nonelectric boosters, and associated items. MDIs supplement and partially replace the M7 nonelectric blasting cap, the M6 electric blasting cap, and the M700 time fuse. The snap-together MDI components simplify initiation systems and some types of explosive priming. In some cases, emplacement times can be decreased by up to 50 percent. MDIs also improve reliability and safety. One reason for this reliability is the fact that all of the components are sealed and, unlike standard nonelectric-priming components, cannot be easily degraded by moisture. However, once the system has been spliced, reliability is significantly degraded due to moisture. The sealed MDI components can be emplaced 70 feet underwater.

### SHOCK TUBE

2-60. The shock tube is a thin, plastic tube of extruded polymer with a dusting of cyclotetramethylene tetramine (HMX) and aluminum powder deposited on its interior surface. This special explosive dust propagates a detonation wave. The wave moves along the shock tube to a factory crimped and sealed blasting cap (which is moisture resistant). The detonation is normally contained within the plastic tubing, and if strands of tubing touch or cross over each other there is no concern that an inadvertent ignition would occur. Fragments from blasting caps or other explosive charges travel at speeds three to five times faster than the detonating wave in the shock tube. These fragments could cause damage to other shock tube assemblies. Any puncture in the shock tube in front of the dust explosion provides a path for the explosive wave to vent. The shock tube offers the instantaneous action of electric initiation without the risk of accidental initiation of the blasting cap (and the charge) by radio transmitters in the area or by static electricity discharge. The shock tube medium is extremely reliable.

**WARNING**

**Although the detonation along the shock tube is normally contained within the blasting tubing, burns may occur if the shock tube is held. Failure to comply could result in immediate personal injury or damage to equipment.**

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*Note.* To prevent misfire, MDIs used at high altitude must be precut and a temporary moisture seal applied to the ends before moving from low altitude to high altitude. This action prevents the HMX from escaping the shock tube when cut at high altitudes due to the air pressure difference between the inside of the shock tube and the surrounding atmosphere.

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**WARNING**

**Never attach an M81 until ready to attach the system. Failure to comply could result in immediate personal injury or damage to equipment.**

2-61. Shock tube functioning is usually evident by a bright flash within the tube. The flash is well contained by the olive drab coating but can be seen in the clear coating of military shock tubes. The flash can produce a burn if a piece of shock tube is held when it is functioning, even through the coating of the shock tube. Therefore, never hold a shock tube while detonating an explosive system. The free end of the shock tube blasting cap is always sealed. Cutting the shock tube exposes the open ends to moisture and should only be done if absolutely necessary. Dampening the explosive dust on the inside of the shock tube will stop a detonation from going beyond such a damp spot. Care should be used when cutting shock tubes. When cutting a shock tube, a sharp knife or other single blade should be used to produce a square cut. Never use pliers, crimpers, or scissors when cutting shock tube because they will cause narrowing of the small diameter hole in the shock tube. Any narrowing or overlapping of the hole could block the explosive path and result in a failure to ignite the explosive dust in the shock tube.

## BLASTING CAPS

2-62. Military explosives require a substantial shock to be initiated. This shock is provided by a high-strength blasting cap (nonelectric M7 or the electric M6). To replace the M6 and M7, there are high-strength and low-strength MDI blasting caps. Each blasting cap is factory crimped and sealed, making them extremely reliable.

### High-Strength Caps

2-63. High-strength caps include the M11, M14, M15, M18, M19, M21, and M23. All are nonelectric and come with a length of shock tube attached. The function of the shock tube is to transfer a small initiating impulse to the explosive end of the cap (an explosive-filled aluminum tube or detonator), which produces a detonation shock strong enough to initiate military explosives. Cap characteristics are as follows:

- The M11 cap comes with a 30-foot length of shock tube factory-attached to a military-sized aluminum blasting cap tube. The M11 is essentially instantaneous in its action. The M11 has a plastic connector on the free end of its shock tube called a detonating cord clip. The detonating cord clip facilitates quick and easy attachment onto the detonating cord.
- The M14 consists of a military strength and size nonelectric blasting cap, factory-crimped to a factory-calibrated, nominal 5-minute length of M700 time-blasting fuse.
- The M15 has *pyrotechnic* (used to introduce a delay into an explosive train because of its known burning time [the definition was shortened, and the complete definition is printed in the glossary]) (FM 1-02) (JP 1-02) devices installed to provide a small time delay between its

initiation and the firing of its detonators. The M15 has two detonators. One detonator is low strength with a 25-millisecond delay, and the other is high strength with a 200-millisecond delay.

- The M18 consists of a military strength and size nonelectric blasting cap, factory-crimped to a factory-calibrated, nominal 20-minute length of M700 time-blasting fuse.
- The M19 consists of a 200-foot length of dual minitube with an in-line initiator built into one end of each of the two minitubes and a nonelectric, nondelay high-strength blasting cap attached to the other end of each minitube. The minitube is smaller in diameter and possesses all the same characteristics of shock tube. The M81E1 igniter is attached to each in-line initiator.
- The M21 consists of a high-strength blasting cap precrimped to a 500-foot length of minitube. The M21 is about one-third the size and weight of the existing M12. The M81E1 igniter is attached to the in-line initiator.
- The M23 consists of a high-strength blasting cap precrimped to a 1,000-foot length of minitube. The M23 is about one-third the size and weight of the existing M13. The M81E1 igniter is attached to the in-line initiator.

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*Note.* All high-strength caps will be in the original packaging or a protective foam cylinder when carried by Soldiers.

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### **Low-Strength Caps**

2-64. The M12 and M13 are the two low-strength MDI blasting caps. These relay-type blasting caps come with factory-attached lengths of shock tube (500 feet for the M12 and 1,000 feet for the M13). The detonators of the relay-type caps are purposely made larger than standard military blasting caps (and the high-strength MDI blasting caps) so they will not fit in standard cap wells. It is important to remember that the low-strength, relay-type caps (such as the M12 and M13) cannot reliably set off standard military explosives. However, low-strength caps of the MDI M12 and M13 will reliably initiate detonating cord.

### **Boosters**

2-65. The M151 is a nonelectric, insensitive initiation system that is factory-assembled. It is assembled by crimping a secondary explosive booster onto a 10-foot length of low-strength detonating cord to allow the user to preprime explosives for military operations and bury explosives primed with M151. The M151 has a detonating cord clip like other MDI components for easy attachment to a line or ring main detonating cord. A pentagonal-shaped tag affixed to the low-strength detonating cord identifies it as an M151 to preclude incorrect connection within a firing system.

2-66. The M152 is a nonelectric, insensitive initiation system that is factory-assembled. It is assembled by crimping a secondary explosive booster onto a 30-foot length of low-strength detonating cord to allow the user to preprime explosives for military operations and bury explosives primed with M152. The M152 has a detonating cord clip like other MDI components for easy attachment to a line or ring main detonating cord. A pentagonal-shaped tag affixed to the low-strength detonating cord identifies it as an M152 to preclude incorrect connection within a firing system.

### **M9 BLASTING-CAP HOLDER**

2-67. Plastic holders allow the connection of several shock tubes to high-strength blasting caps and boosters. The M9 holder helps secure the connection of up to five shock tubes or low-strength detonating cord to high-strength caps or boosters. The M9 holder can also be used to connect high-strength blasting caps and boosters to detonating cord. When using the M9 holder, tape it closed.

**WARNING**

**Do not connect the shock tube, low-strength detonating cord, or detonating cord in the same holder. Detonating cord functions at a higher velocity than the HMX and aluminum in the shock tube and may cause a break in the shock tube. Failure to comply could result in immediate personal injury or damage to equipment.**

**M81 TIME-BLASTING FUSE IGNITER**

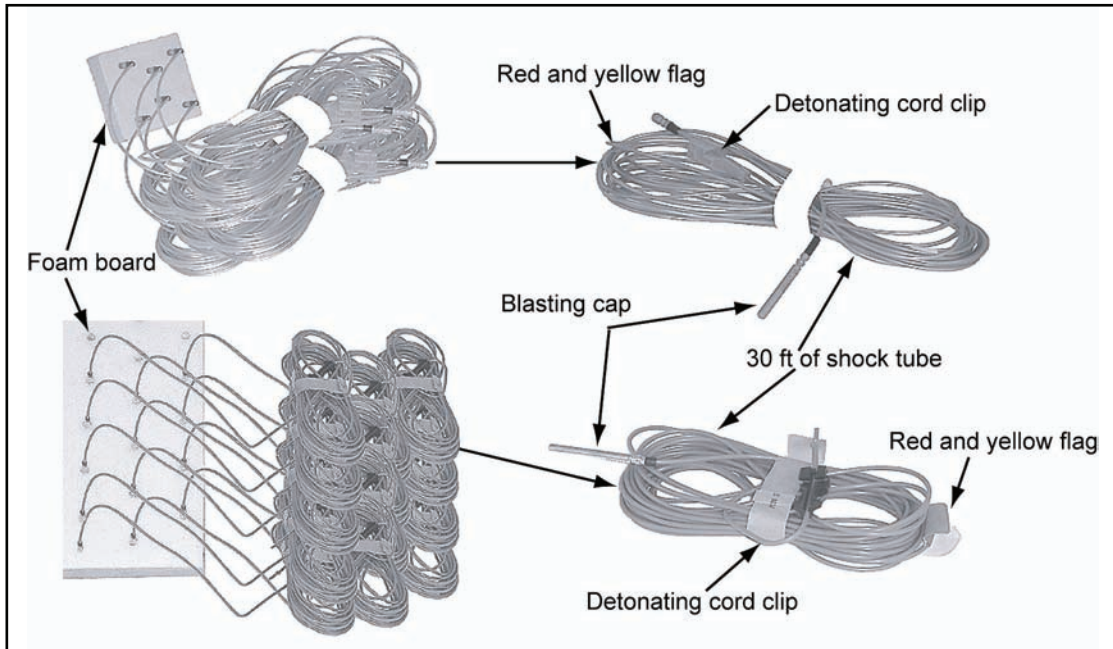
2-68. The igniter will initiate the time fuse and shock tube end of MDI components. The M81 is almost identical to the older M60 igniter, except the M81 has a screw-end cap with a green shipping plug and a silicon shock tube reducer. The cap allows the M81 to accommodate either a standard shock tube or a standard diameter time-blasting fuse (M700). Extra care is required when connecting a shock tube to an M81 igniter to ensure proper initiation of an explosive system.

**WARNING**

**Never attach detonating cord, an M151, or an M152 to the M81 igniter. Failure to comply could result in immediate personal injury or damage to equipment.**

**M11 NONELECTRIC BLASTING CAP WITH A 30-FOOT SHOCK TUBE**

2-69. The M11 is a high-strength blasting cap, factory-crimped to a 30-foot length of shock tube. A movable plastic connector (a detonating cord clip) is attached to the free end of the shock tube. The hook allows for a quick and easy attachment to a detonating cord. Two brightly colored plastic flags are attached to the shock tube near the blasting cap. A red flag is attached 1 meter from the blasting cap, and a yellow flag is attached 2 meters from the blasting cap. M11s are packaged with an issue of six M11s per subpackage as shown in Figure 2-36. Subpackages maintain the same hazard classification as the wooden crate.



**Figure 2-36. M11 Blasting Cap Component (Various Vendors)**

**USE**

2-70. The M11 can be used to prime standard military explosives. The M11 can also be used to initiate detonating cord or shock tube.

**FUNCTIONS**

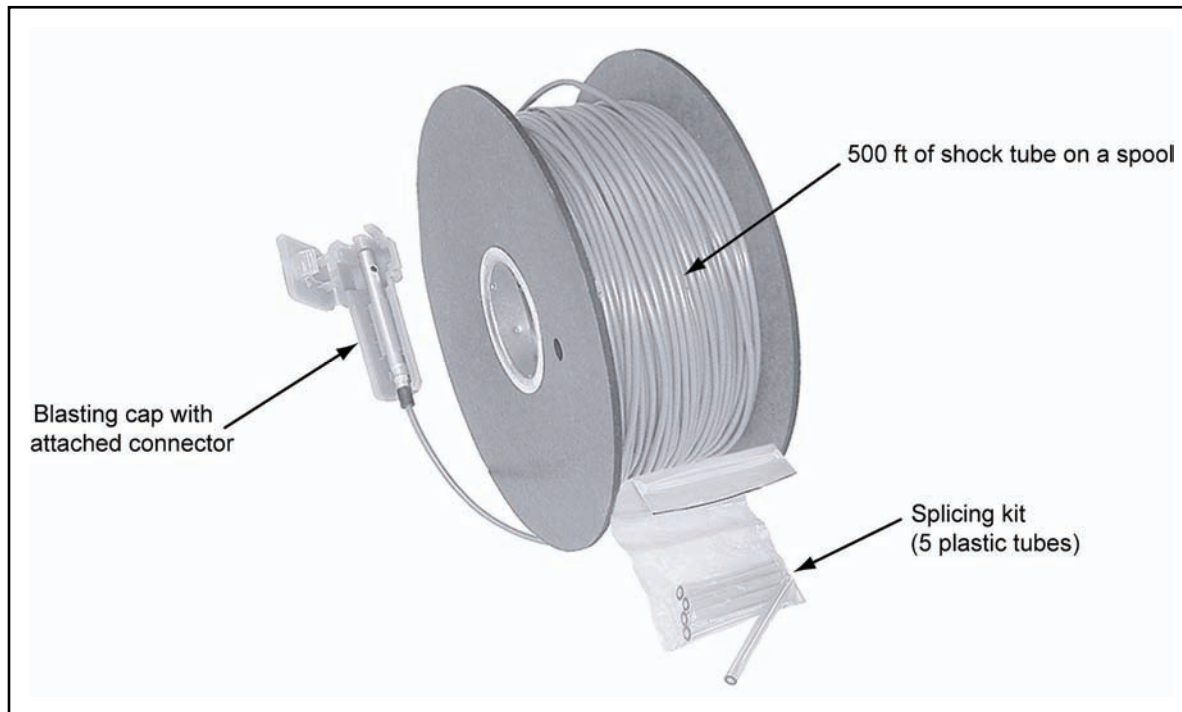
2-71. The M11 functions by sending an initiating shock or small detonation through the shock tube to the blasting cap. The shock tube itself must be initiated by a relay-type blasting cap, booster, or igniter (M81). The M11's detonation is instantaneous. See Table 2-1, page 2-36, for the M11 characteristics.

Table 2-1. M11 Characteristics

<i>Tabulated Data</i>		
Aluminum-tube detonator	Length	2.25 to 2.35 in
	Diameter	0.241 in
Shock tube	Material	Various plastics
	Length	30 ft
	Diameter	0.118 in
Filler	Detonator	Lead azide, molybdenum chromate, RDX, or PETN
	Shock tube	HMX and aluminum
	Actuation method	Shock from the detonation of a blasting cap or detonating cord
<i>Shipping and Storage Data</i>		
DOD hazard class QD/DIV/SCG	1.4S	
DOT hazard class	1.4S	
DOT label	Explosive	1.4S
DOT container marking	Proper shipping name	Detonator assemblies, nonelectric for blasting
	UN serial number	0500
	NSN	1375-01-415-1232
	DODAC	Live: ML47      Inert: MN36
	NEW (per cap)	19 gr
	Specification	QAA-1423
	Packaging	60 units per wood box; 16 boxes per pallet
Packing box	Dimensions	20.5 by 13 by 25.75 in
	Cube	2.8 cu ft
	NEW	0.16 lb
	Gross weight of package	49 lb
<i>References</i>		
TM 9-1375-213-34&P DOD Consolidated Ammunition Supply Catalog		

## M12 NONELECTRIC BLASTING CAP WITH A 500-FOOT SHOCK TUBE

2-72. The M12 is a low-strength blasting cap, factory-crimped to a 500-foot length of shock tube. A special plastic connector is attached to the detonator to facilitate a quick and easy attachment to the shock tube of up to five shock tubes or five low-strength detonating cords or one strand of standard detonating cords. The M12 is provided on a spool as shown in Figure 2-37.



**Figure 2-37. M12 Shock Tube Component and Blasting Cap With a Splicing Kit**

### USE

2-73. The M12 is used as a transmission line in a firing system. It does not have enough output to initiate military explosives reliably.

### FUNCTIONS

2-74. The M12 functions by sending an initiating shock or small detonation through the shock tube to the blasting cap. This blasting cap then actuates five shock tubes, five low-strength detonating cords, or one strand of high-strength detonating cord held by the plastic connector. The M12's shock tube must be initiated by another blasting cap or by the M81 fuse igniter. Table 2-2, page 2-38, shows the M12 characteristics.

Table 2-2. M12 Characteristics

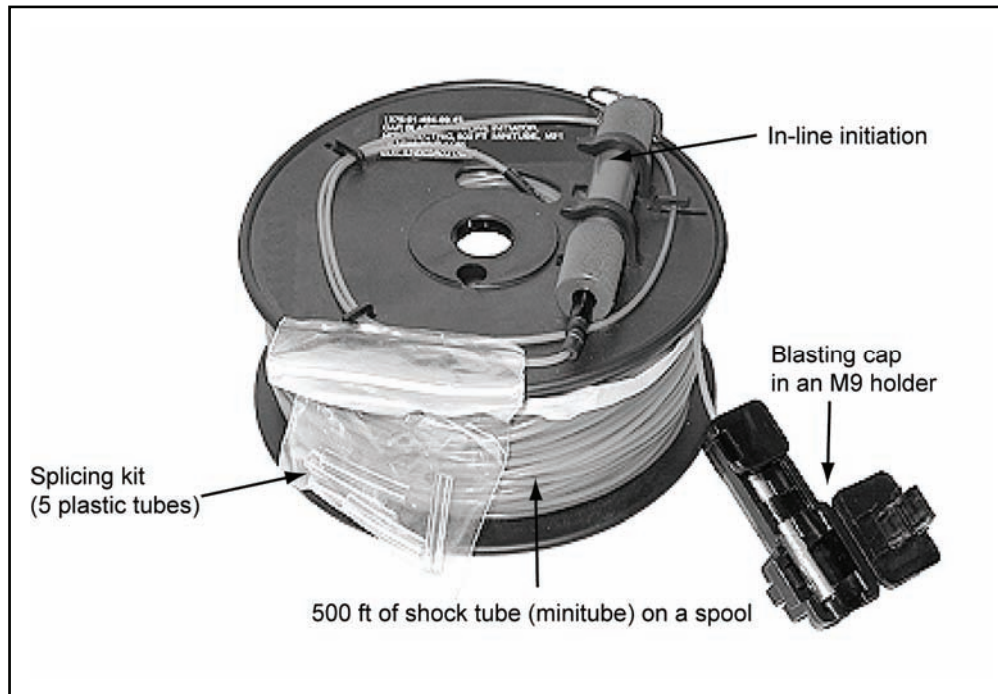
<i>Tabulated Data</i>		
Aluminum-tube detonator	Length	2.7 in
	Diameter	0.296 in
Shock tube	Material	Various plastics
	Length	500 ft
	Diameter	0.118 in
Filler	Detonator	Lead azide, PETN
	Shock tube	HMX and aluminum
	Actuation method	Shock from detonation of a blasting cap or the primer in an M81
<i>Shipping and Storage Data</i>		
DOD hazard class QD/DIV/SCG	1.4S	
DOT hazard class	1.4S	
DOT label	Explosive	1.4S
DOT container marking	Proper shipping name	Detonators, nonelectric
	UN serial number	0500
	NSN	1375-01-415-1230
	DODAC	Live: MN02      Inert: MN35
	NEW (per cap)	13 gr
	Drawing	12972628
	Specification	QAA-1459
Packing box	Dimensions	Pre-1999: 46 by 21 by 21 in Post-1999: 48.75 by 19.8 by 20.75 in
	Cube	Pre-1999: 11.74 cu ft Post-1999: 11.6 cu ft
	NEW	Pre-1999: 0.286 lb Post-1999: 0.239 lb
	Gross weight of package	Pre-1999: 169 lb Post-1999: 176 lb
<i>References</i>		
TM 9-1375-213-34&P DOD Consolidated Ammunition Supply Catalog		

## M21 NONELECTRIC BLASTING CAP WITH A 500-FOOT MINISHOCK TUBE

2-75. The M21 consists of a high-strength blasting cap precrimped to a 500-foot length of minitube. The M21 is about one-third the size and weight of the M12. The M21 has a modified M81E1 igniter moisture



cap with a protected ignition primer that is factory-installed to an in-line initiator on the minitube. The M21 has an M9 holder already connected to the high-strength cap (Figure 2-38).



**Figure 2-38. M21 MDI With a 500-Foot Shock Tube Component With a Splicing Kit**

## USE

2-76. The M21 is used to transmit a shock tube detonation impulse from an initiator (or another relay cap). Unlike the M12, a high-strength blasting cap or booster will not have to be added as part of the transmission line. The M21 high-strength cap can be secured into an M9 holder to provide the capability to initiate up to five additional shock tubes or five low-strength detonating cords or one strand of detonating cord. The M21 high-strength cap can also be used to prime military explosives.

## FUNCTIONS

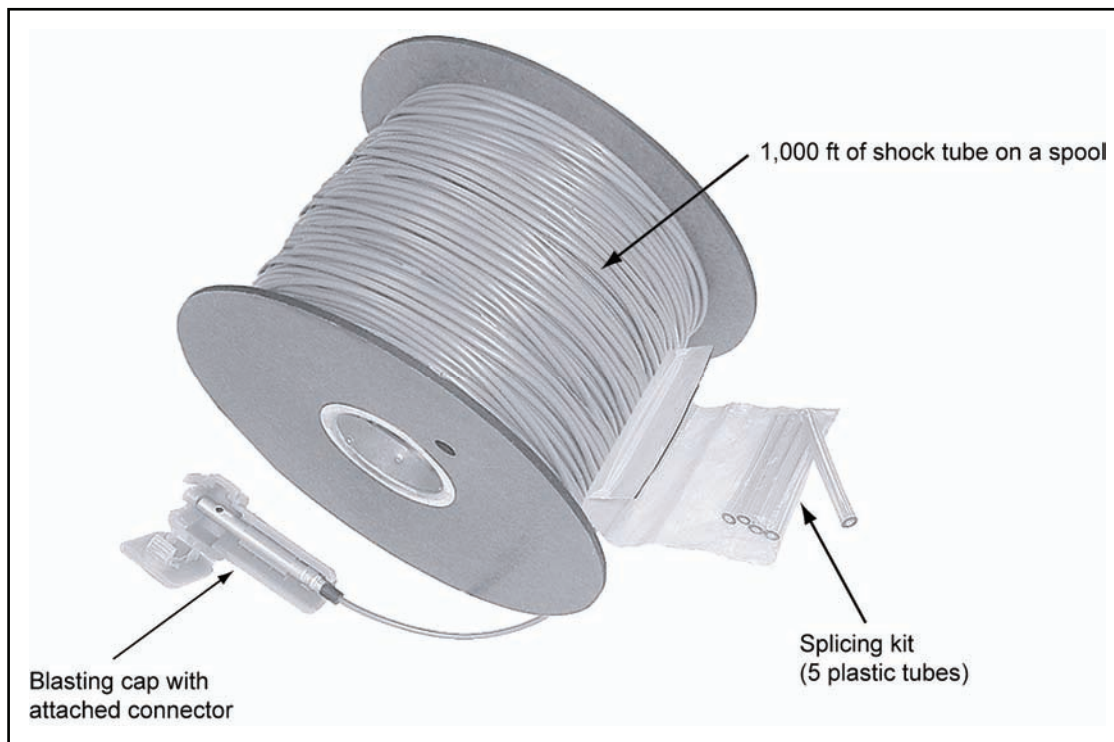
2-77. The M21 functions by sending an initiating shock or small detonation through the shock tube to the blasting cap. This blasting cap then actuates five shock tubes, five low-strength detonating cords, or one strand of high-strength detonating cord held by the plastic connector. The M21's shock tube must be initiated by another blasting cap or by the M81E1 in-line initiators. Table 2-3, page 2-40, shows the M21 characteristics.

Table 2-3. M21 Characteristics

<i>Tabulated Data</i>		
Aluminum-tube detonator	Length	2.25 to 2.35 in
	Diameter	0.230 to 0.241 in
Shock tube	Material	Various plastics
	Length	500 ft
	Diameter	0.09 in
Filler	Detonator	Lead azide, PETN
	Shock tube	HMX and aluminum
	Actuation method	Impulse from attached minitube
<i>Shipping and Storage Data</i>		
DOD hazard class QD/DIV/SCG	1.4S	
DOT hazard class	1.4S	
DOT label	Explosive	1.4S
DOT container marking	Proper shipping name	Detonating, assemblies, nonelectric
	UN serial number	0500
	NSN	1375-01-494-6945
	DODAC	Live: MN88      Inert: MN89
	NEW (per cap)	19 gr
	Drawing	12999559
	Specification	QAA-1430
Packing box	Packaging	8 units per fiberboard box; 5 boxes per wooden box (40)
	Dimensions	44 by 16.38 by 17.38 in
	Cube	5.25 cu ft
	NEW	0.28 lb
	Gross weight of package	20 lb
<i>References</i>		
TM 9-1375-213-34&P TM 9-1375-213-12 DOD Consolidated Ammunition Supply Catalog		

## M13 NONELECTRIC BLASTING CAP WITH A 1,000-FOOT SHOCK TUBE

2-78. The M13 is a low-strength blasting cap, factory-crimped to a 1,000-foot length of shock tube. A special plastic connector is attached to the detonator to facilitate quick and easy attachment to the shock tube of up to five shock tubes or five low-strength detonating cords or one strand of standard detonating cord. The M13 is provided on a spool as shown in Figure 2-39.



**Figure 2-39. M13 Shock Tube Component and Blasting Cap With a Splicing Kit**

## USE

2-79. The M13 is used as a transmission line in a firing system. It does not have enough output to initiate military explosives reliably.

## FUNCTIONS

2-80. The M13 functions by sending an initiating shock or a small detonation through the shock tube to the blasting cap. This blasting cap then actuates five shock tubes, five low-strength detonating cords, or one strand of high-strength detonating cord held by the plastic connector. The M13's shock tube must be initiated by another blasting cap or by the M81 fuse igniter. Table 2-4, page 2-42, shows the M13 characteristics.

Table 2-4. M13 Characteristics

<i>Tabulated Data</i>		
Aluminum-tube detonator	Length	2.7 in
	Diameter	0.296 in
Shock tube	Material	Various plastics
	Length	1,000 ft
	Diameter	0.118 in
Filler	Detonator	Lead azide, PETN
	Shock tube	HMX and aluminum
	Actuation method	Shock from the detonation of a blasting cap or the primer of the M81 igniter
<i>Shipping and Storage Data</i>		
DOD hazard class QD/DIV/SCG	1.4S	
DOT hazard class	1.4S	
DOT label	Explosive	1.4S
DOT container marking	Proper shipping name	Detonator assemblies, nonelectric
	UN serial number	0500
	NSN	1375-01-415-1231
	DODAC	Live: MN03      Inert: none
	NEW (per cap)	13 gr
	Drawing	12972629
	Specification	QQA-1459
Packing box	Dimensions	Pre-1999 production: 46 by 21 by 21 in Post-1999 production: 48.75 by 19.8 by 20.75 in
	Cube	Pre-1999 production: 11.74 cu ft Post-1999 production: 11.41 cu ft
	NEW	Pre-1999 production: 0.298 lb Post-1999 production: 0.2486 lb
	Gross weight of package	Pre-1999 production: 169 lb Post-1999 production: 176 lb
<i>References</i>		
TM 9-1375-213-34&P DOD Consolidated Ammunition Supply Catalog		

## M23 NONELECTRIC BLASTING CAP WITH A 1,000-FOOT MINISHOCK TUBE

2-81. The M23 consists of a high-strength blasting cap precrimped to a 1,000-foot length of minitube. The M23 is about one-third the size and weight of the M13. The M23 has a modified M81E1 igniter moisture cap with a protected ignition primer factory-crimped that is installed to an in-line initiator on the minitube. The M23 has a M9 holder already connected to the high-strength cap (Figure 2-40).

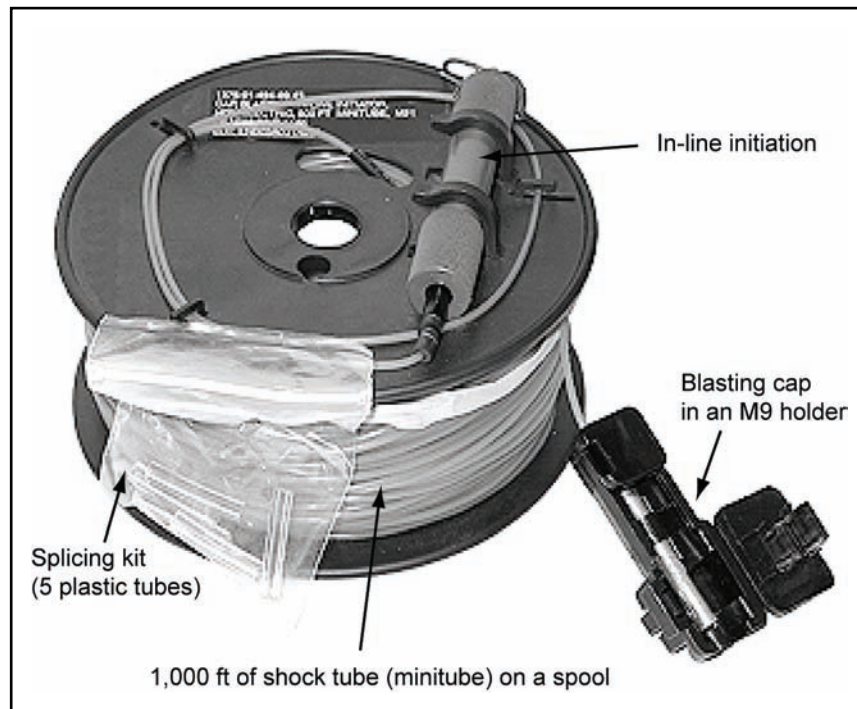


Figure 2-40. M23 MDI 1,000-Foot Shock Tube Component

### USE

2-82. The M23 is used to transmit a shock tube detonation impulse from an initiator (or another relay cap). Unlike the M13, a high-strength blasting cap or booster will not have to be added as part of the transmission line. The M23 high-strength cap can be secured into an M9 holder to provide the capability to initiate up to five additional shock tubes or five low-strength detonating cords or one strand of detonating cord. The M23 high-strength cap can also be used to prime military explosives.

### FUNCTIONS

2-83. The M23 functions by sending an initiating shock or small detonation through the shock tube to the blasting cap. This blasting cap then actuates five shock tubes, five low-strength detonating cords, or one strand of high-strength detonating cord held by the plastic connector. The M23's shock tube must be initiated by another blasting cap or by the M81E1 in-line initiators. Table 2-5, page 2-44, shows the M23 characteristics.

Table 2-5. M23 Characteristics

<i>Tabulated Data</i>		
Aluminum-tube detonator	Length	2.25 to 2.35 in
	Diameter	0.230 to 0.241 in
Shock tube	Material	Various plastics
	Length	1,000 ft
	Diameter	0.09 in
Filler	Detonator	Lead azide, PETN
	Shock tube	HMX and aluminum
	Actuation method	Impulse from attached minitube
<i>Shipping and Storage Data</i>		
DOD hazard class QD/DIV/SCG	1.4S	
DOT hazard class	1.4S	
DOT label	Explosive	1.4S
DOT container marking	Proper shipping name	Detonating, assemblies, nonelectric
	UN serial number	0500
	NSN	1375-01-494-6941
	DODAC	Live: MN90      Inert: none
	NEW (per cap)	19 gr
	Drawing	12999561
	Specification	QAA-1430
	Packaging	4 units per fiberboard box; 5 boxes per wooden box (20); 4 wooden boxes per pallet (80)
Packing box	Dimensions	44 by 16.38 by 17.38 in
	Cube	5.25 cu ft
	NEW	0.22 lb
	Gross weight of package	17 lb
<i>References</i>		
TM 9-1375-213-12 TM 9-1375-213-34&P DOD Consolidated Ammunition Supply Catalog		

## M14 NONELECTRIC BLASTING CAP WITH A DELAY

2-84. The M14 is a high-strength blasting cap, factory-crimped to about 7 ½-foot length of time fuse. The M14 is marked with yellow or black bands that represent a nominal 1 minute of burn time instead of having a yellow band every 18 inches as on the M700 time fuse. The free end of the fuse is moisture-sealed and must be cut off to the selected time band when being prepared for ignition (Figure 2-41).



**Figure 2-41. M14 Time Fuse Component (Various Vendors)**

## **USE**

2-85. The M14 is used to detonate military explosives and initiate shock tube, low-strength detonating cord, and detonating cord after being ignited. In dual initiation, an M14 can be connected to a line main or transmission line and be used as the primary or secondary initiation system.

## **FUNCTIONS**

2-86. The M14 functions by sending an initiating flame (from a time-blasting fuse igniter or a match) slowly through the length of the time-blasting fuse to the blasting cap. The 1-minute bands on the time fuse have been factory-calibrated. The burn time will increase with altitude and colder temperatures. The M14 has been designed to allow a nominal 5-minute delay, under all weather and altitude conditions, to allow personnel to move to the minimum safe distance (MSD) from the explosive charges being detonated. If greater time accuracy is required under specific altitude and weather conditions, an M14 from the same lot should be tested. The M14 being tested should be timed to the detonation of the cap to provide an actual burn time. This will allow the operator to adjust the time for the detonation of the explosive system or main charge. Table 2-6, page 2-46, shows the M14 characteristics.

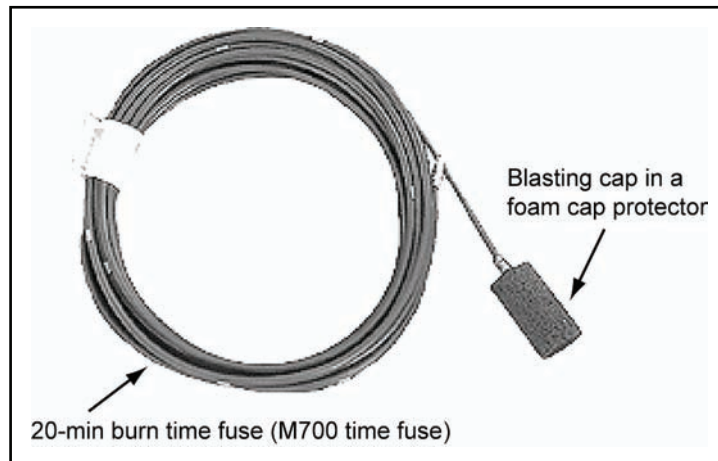
Table 2-6. M14 Characteristics

<i>Tabulated Data</i>		
Aluminum-tube detonator	Length	2.25 to 2.35 in
	Diameter	0.230 to 0.241 in
Time-blasting fuse	Material	Plastic-covered fiber
	Length	About 7.5 ft
	Diameter	0.25 in
Filler	Detonator	Lead styphnate, lead azide, PETN
	Time fuse	Black powder
	Actuation method	M81 fuse igniter or flame from a match
<i>Shipping and Storage Data</i>		
DOD hazard class QD/DIV/SCG	1.4S	
DOT hazard class	1.4S	
DOT label	Explosive	1.4S
DOT container marking	Proper shipping name	Detonators, nonelectric
	UN serial number	Pre-1999: 0455 Post-1999: 0500
	NSN	Pre-1999 production: 1375-01-415-1233 Post-1999 production: 1375-01-482-7380
	DODAC	Live: MN06      Inert: MN37
	NEW (per cap)	Pre-1999 production: 16 gr Post-1999 production: 16 gr
	Drawing	12982929
	Specification	QAA-1424B
	Packaging	Pre-1999 production: 10 units per fiberboard box; 6 boxes per wooden box (60) Post-1999 production: 10 units per fiberboard box; 4 boxes per wooden box (40)
Packing box	Dimensions	26 by 18 by 11 in
	Cube	2.8 cu ft
	NEW	Pre-1999 production: 1.554 lb Post-1999 production: 1.6 lb
	Gross weight of package	Pre-1999 production: 57 lb Post-1999 production: 86 lb
<i>References</i>		
TM 9-1375-213-34&P DOD Consolidated Ammunition Supply Catalog		

## M18 NONELECTRIC BLASTING CAP WITH A DELAY

2-87. The M18 is a high-strength blasting cap, factory-crimped to about 30-foot length of time-blasting fuse. The black bands represent 1 minute of burn time. The free end of the fuse is moisture-sealed and must be cut off to the selected time band when being prepared for ignition (Figure 2-42).





**Figure 2-42. 20-Minute Burn Time M18 Component**

### **USE**

2-88. The M18 is used to detonate all standard military explosives. It is also used to initiate shock tube blasting caps and detonating cord up to 20 minutes after being ignited.

### **FUNCTIONS**

2-89. The M18 functions by sending an initiating flame (from a fuse igniter or a match) slowly through the length of the time-blasting fuse to the factory-crimped blasting cap. The 1-minute bands on the time fuse have been calibrated at sea level at a temperature of 125°F. The burn time will increase with altitude and colder temperatures. The M18 has been designed to allow a nominal 20-minute delay under all weather and altitude conditions. This allows personnel to move to the MSD from the emplaced explosive charges being detonated. Table 2-7, page 2-48, shows the M18 characteristics.

Table 2-7. M18 Characteristics

<i>Tabulated Data</i>		
Aluminum-tube detonator	Length	2.25 to 2.35 in
	Diameter	0.230 to 0.241 in
Time-blasting fuse	Material	Plastic-covered fiber
	Length	30-ft approximate length
	Diameter	0.25 in
Filler	Detonator	Lead styphnate, lead azide, PETN
	Time fuse	Black powder
	Actuation method	M81 fuse igniter or flame from a match
<i>Shipping and Storage Data</i>		
DOD hazard class QD/DIV/SCG	1.4S	
DOT hazard class	1.4S	
DOT label	Explosive	1.4S
DOT container marking	Proper shipping name	Detonators, nonelectric for blasting
	UN serial number	0345
	NSN	1375-01-449-9602
	DODAC	Live: MN41      Inert: none
	NEW (per cap)	16 gr
	Drawing	12982929
	Specification	QAA-1424B
	Packaging	2 per barrier bag; 5 barrier bags inside box; 4 boxes in overpack (40)
Packing box	Dimensions	26 by 18 by 11 in
	Cube	2.8 cu ft
	NEW	0.104 lb (for 60 caps NEW = 1.57 lb)
	Gross weight of package	57 lb
<i>References</i>		
TM 9-1375-213-34&P DOD Consolidated Ammunition Supply Catalog		

## M15 NONELECTRIC BLASTING CAP WITH A DELAY

2-90. The M15 consists of two blasting caps, factory-crimped at each end of a 70-foot length of shock tube. The blasting caps are slightly different in size and contain different delay elements. The shorter, low-strength blasting cap is designed to initiate another piece of shock tube in the firing system, while the longer high-strength blasting cap is designed to prime explosives. Since the M15 high-strength blasting cap is commercially used in boreholes, two brightly colored plastic flags are attached to the shock tube near the detonator. A red flag is attached 1 meter from the longer high-strength blasting cap, and a yellow flag is attached 2 meters from the low-strength blasting cap (Figure 2-43).



Figure 2-43. M15 Delay Blasting Cap

**DANGER**

The M15 can only be used belowground in quarry operations according to FM 3-34.465. Failure to comply may cause death or permanent injury.

**USE**

2-91. The M15 is used to provide a delay element in a combination firing system to obtain staged detonations. Delayed and staged detonations are essential in quarrying operations but are also used in relieved-face cratering.

**FUNCTIONS**

2-92. The M15 sends an initiating shock (or small detonation) through the shock tube to both of the blasting caps. These contain pyrotechnic-delay elements. The delay times in the two detonators are different; one is 25 milliseconds (low-strength, smaller cap with a shock tube connector), and the other is 200 milliseconds (higher-strength, larger cap with a shock tube connector). The high-strength blasting cap is slightly larger in diameter than a standard blasting cap and will not fit in a standard cap well. The M15 shock tube must be initiated by another MDI component. Table 2-8, page 2-50, shows the M15 characteristics.

Table 2-8. M15 Characteristics

<i>Tabulated Data</i>		
Aluminum-tube detonator	Length (low strength)	2.5 in
	Length (high strength)	3.5 in
	Diameter (low strength)	0.296 in
	Diameter (high strength)	0.296 in
	NEW (per cap)	Low strength: 3 gr High strength: 15 gr
Shock tube	Material	Various plastics
	Length	70 ft
	Diameter	0.118 in
Filler	Detonator	Lead azide, PETN
	Shock tube	HMX and aluminum
	Actuation method	Shock from the detonation of a blasting cap or detonating cord
<i>Shipping and Storage Data</i>		
DOD hazard class QD/DIV/SCG	1.4S	
DOT hazard class	1.4S	
DOT label	Explosive	1.4S
DOT container marking	Proper shipping name	Detonator assemblies, nonelectric
	UN serial number	0500
	NSN	1375-01-447-2049
	DODAC	Live: MN07      Inert: MN38
	NEW (per cap)	1.36 gr
	Drawing	12972631
	Specification	QAA-1425
	Packaging	60 units per wood box; 4 boxes (240) per pallet
Packing box	Dimensions	46 by 21 by 21 in
	Cube	11.74 cu ft
	NEW	0.18 lb
	Gross weight of package	118 lb
<i>References</i>		
TM 9-1375-213-34&P DOD Consolidated Ammunition Supply Catalog		

## M151 BOOSTER DEMOLITION CHARGE

2-93. The M151 is a nonelectric, insensitive initiation system that is factory-assembled by crimping a secondary explosive booster onto a 10-foot length of low-strength detonating cord to allow the user to

preprime explosives for military operations and bury explosives primed with M151. The M151 has a detonating cord clip like other MDI components for easy attachment to a line or ring main detonating cord. A pentagonal-shaped tag affixed to the low-strength detonating cord identifies it as an M151 to preclude incorrect connection within a firing system.

**CAUTION**

Do not use M151 low-strength detonating cord as a line or ring main. The M151 is only used as a branchline and cannot be substituted for standard detonating cord. Personal injury or damage to equipment may result from long-term failure to follow correct procedures.

**USE**

2-94. The M151 is used to prime charges in situations where simultaneous initiation and detonation are desired. Prepriming of charges allows a Soldier to transport the preprimed charge in the vehicle or on his person. This also allows for the burial of an explosive charge.

**WARNING**

**Never attach an M60 or M81 igniter to the M151. Failure to comply could result in immediate personal injury or damage to equipment.**

**FUNCTIONS**

2-95. The M151 functions upon receiving an initiating shock from a blasting cap or other booster. When the booster functions, it detonates the primed explosive charge. The M151 booster can be secured in the M9 holder by using the small flap. Table 2-9, page 2-52, shows the M151 characteristics.

Table 2-9. M151 Characteristics

<i>Tabulated Data</i>		
Aluminum-tube booster cap	Material	PETN
	Length	2.25 to 2.35 in
	Diameter	0.230 to 0.241 in
Low-strength detonating cord	Material	Black fiber, with an environmental seal on one end, 5 to 7.5 gr per ft
	Marking	Green pentagonal-shaped identification tag on both ends of the assembly, marked M151 to distinguish a low-strength detonating cord from other MDI components
	Length	10 ft
	Diameter	0.150 in
	Actuation method	Shock from the detonation of a blasting cap or detonating cord when an M151 is used as a branchline
<i>Shipping and Storage Data</i>		
DOD hazard class QD/DIV/SCG	1.4S	
DOT hazard class	1.4S	
DOT label	Explosive	1.4S
DOT container marking	Proper shipping name	Detonator, assemblies, nonelectric
	UN serial number	0410
	NSN	1375-01-467-8646
	DODAC	Live: MN68      Inert: none
	NEW	87 gr
	Drawing	D10451-1 Ensign-Bickford drawing
	Specification	None
	Packaging	20 per cardboard box; 6 boxes per overpack (120)
Packing box	Dimensions	None
	Cube	None
	NEW	1.13 lb
	Gross weight of package	46 lb
<i>References</i>		
TM 9-1375-213-34&P DOD Consolidated Ammunition Supply Catalog		

## M152 BOOSTER DEMOLITION CHARGE

2-96. The M152 is a nonelectric insensitive initiation system that is factory-assembled by crimping a secondary explosive booster onto a 30-foot length of low-strength detonating cord. This allows the user to preprime explosives for military operations and bury explosives primed with M152. The M152 has a detonating cord clip like other MDI components for easy attachment to a line or ring main detonating cord.

A pentagonal-shaped tag affixed to the low-strength detonating cord identifies it as an M152 to preclude incorrect connection within a firing system (Figure 2-44).

**CAUTION**

Do not use M152 low-strength detonating cord as a line or ring main. The M152 is only used as a branchline and cannot be substituted for standard detonating cord. Personal injury or damage to equipment may result from long-term failure to follow correct procedures.

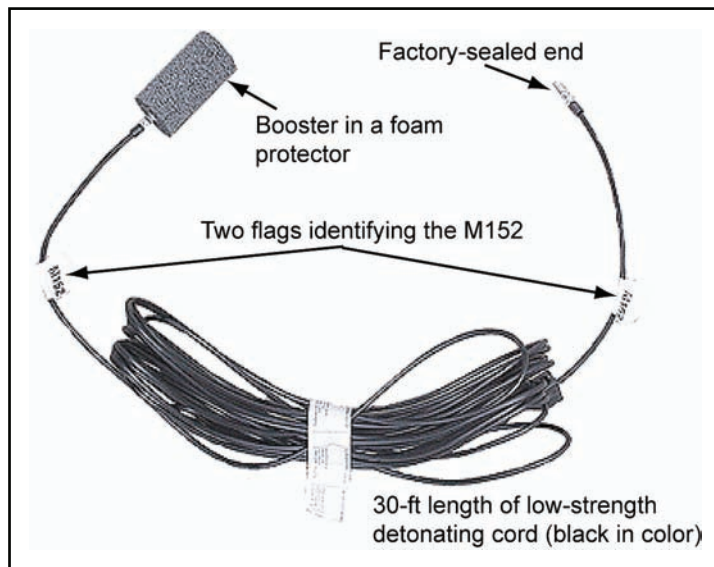


Figure 2-44. M152 Low-Strength Detonating Cord Component

**USE**

2-97. The M152 is used to prime charges in situations where simultaneous initiation and detonation are desired. Prepriming of charges allows a Soldier to transport the preprimed charge in the vehicle or on his person. This also allows for the burial of an explosive charge.

**WARNING**

Never attach an M60 or M81 igniter to the M152. Failure to comply could result in immediate personal injury or damage to equipment.

**FUNCTIONS**

2-98. The M152 functions upon receiving an initiating shock from a blasting cap or other booster. When the booster functions, it detonates the primed explosive charge. The M152 booster can be secured in the M9 holder by using the small flap. Table 2-10, page 2-54, shows the M152 characteristics.

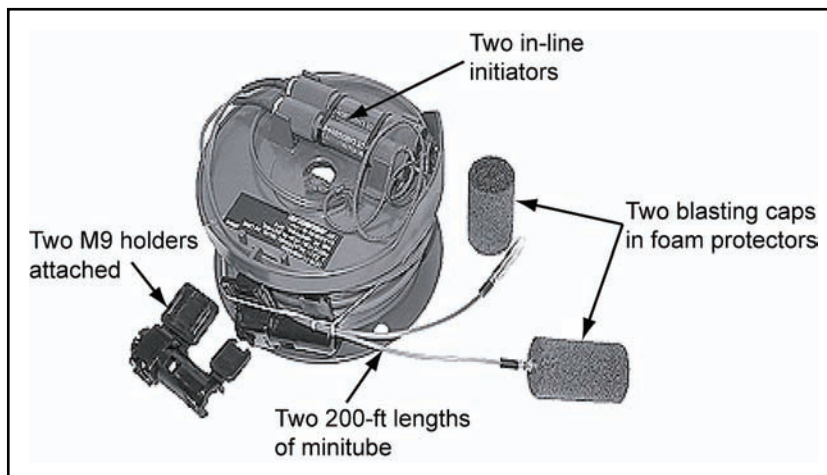
Table 2-10. M152 Characteristics

<i>Tabulated Data</i>		
Aluminum-tube booster cap	Material	PETN
	Length	2.25 to 2.35 in
	Diameter	0.230 to 0.241 in
Low-strength detonating cord	Material	Black fiber, with an environmental seal on one end, 5 to 7.5 gr per ft
	Marking	Green pentagonal-shaped identification tag on both ends of the assembly, marked as M152
	Length	30 ft
	Diameter	0.150 in
	Actuation method	Shock from the detonation of a blasting cap or detonating cord when an M152 is used as a branchline
<i>Shipping and Storage Data</i>		
DOD hazard class QD/DIV/SCG	1.4S	
DOT hazard class	1.4S	
DOT label	Explosive	1.4S
DOT container marking	Proper shipping name	Detonator, assemblies, nonelectric
	UN serial number	0410
	NSN	Live: 1375-01-470-2399 Inert: 1375-01-467-8645
	DODAC	Live: MN69 Inert: MN75
	NEW	197 gr
	Drawing	D10451-2 Ensign-Bickford drawing
	Specification	None
	Packaging	20 per cardboard box; 3 boxes per overpack (60)
Packing box	Dimensions	None
	Cube	None
	NEW	1.44 lb
	Gross weight of package	46 lb
<i>References</i>		
TM 9-1375-213-34&P DOD Consolidated Ammunition Supply Catalog		

## M19 NONELECTRIC BLASTING CAP WITH A DUAL MINISHOCK TUBE

2-99. The M19 consists of a 200-foot length of dual minitube with an in-line initiator built into one end of each of the two minitubes and a nonelectric, nondelay high-strength blasting cap attached to the other end of each minitube. The minitube is smaller in diameter and possesses all the same characteristics of a shock tube. The M81E1 igniter is attached to each in-line initiator. M9 plastic holders are provided in the packaging for each M19 to facilitate quick and easy attachment to the minitube of additional blasting cap components (Figure 2-45).





**Figure 2-45. M19 Dual-Minitube and Blasting Cap Component**

### USE

2-100. The M19 is used to initiate standard military explosives and demolition charges by inserting the blasting caps directly into an explosive or the cap well of demolition charges. The M19 is particularly suited for urban terrain missions when very high reliability is required.

### FUNCTIONS

2-101. The M19s minitube must be initiated by a blasting cap or by activating the firing assembly of the M81E1 igniter. To actuate the M81E1, remove the cotter pin, and then pull the pull ring to the limit of its travel. The pull ring rod then releases the firing pin. The firing assembly of the M81E1 igniter strikes the M42C1 primer. The small detonation impulse (shock wave) from the primer is transmitted through the minitube into a less sensitive explosive contained within its blasting cap. The blasting cap can actuate an additional number of components held by the M9 plastic holder or can directly initiate explosive charges or demolition devices. Table 2-11, page 2-56, shows the M19 characteristics.

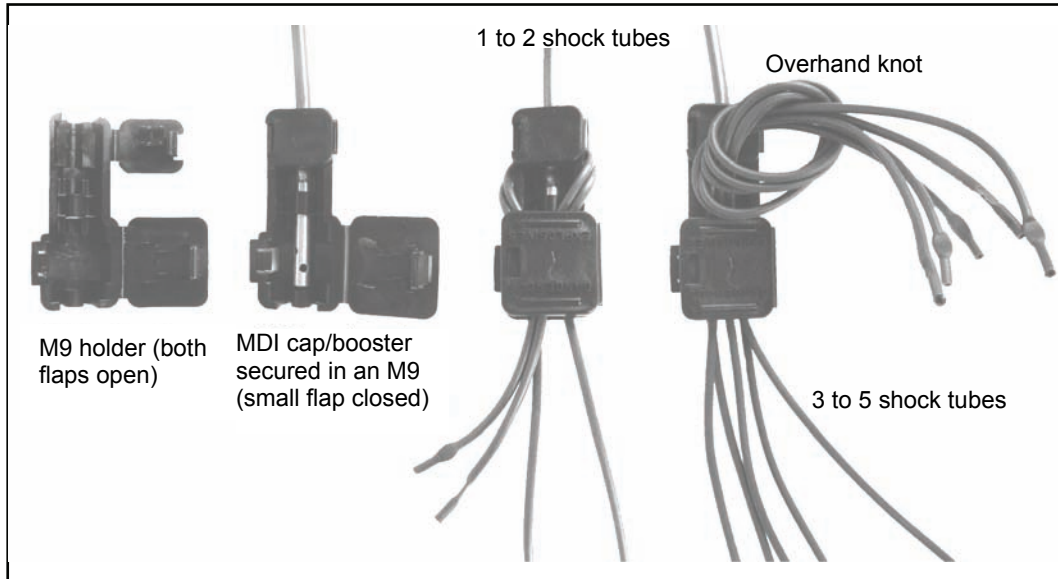
Table 2-11. M19 Characteristics

<i>Tabulated Data</i>		
Aluminum-tube detonator	Length	2.25 to 2.35 in
	Diameter	0.230 to 0.241 in
Shock tube	Material	Various plastics
	Length	200 ft (dual)
	Diameter	0.09 in
Filler	Detonator	Lead azide, RDX
	Shock tube	HMX and aluminum
	Actuation method	Impulse from attached minitube
<i>Shipping and Storage Data</i>		
DOD hazard class QD/DIV/SCG	1.4S	
DOT hazard class	1.4S	
DOT label	Explosive	1.4S
DOT container marking	Proper shipping name	Detonating assemblies, nonelectric
	UN serial number	500
	NSN	1375-01-494-6939
	DODAC	Live: MN86      Inert: MN87
	NEW (per cap)	18 gr
	Drawing	12999557
	Specification	QAA-1431
	Packaging	8 per fiberboard box; 5 boxes per wooden box (40)
Packing box	Dimensions	44 by 16 by 21.5 in
	Cube	8.76 cu ft
	NEW	0.31 lb
	Gross weight of package	20 lb
<i>References</i>		
TM 9-1375-213-12 TM 9-1375-213-34&P DOD Consolidated Ammunition Supply Catalog		

## M9 BLASTING CAP AND SHOCK TUBE HOLDER

2-102. Plastic holders allow the connection of several shock tubes to high-strength blasting caps and boosters (Figure 2-46). The M9 holder helps secure the connection of up to five shock tubes or low-strength detonating cords to high-strength caps or boosters. The M9 holder can also be used to connect high-strength blasting caps and boosters to detonating cord. When using the M9 holder, tape it closed.

*Note.* Do not connect the shock tube, low-strength detonating cord, or detonating cord in the same holder. Detonating cord functions at a higher velocity than the HMX and aluminum in the shock tube and may cause a break in the shock tube.



**Figure 2-46. M9 Blasting Cap and Shock Tube Holder**

## USE

2-103. The M9 can accommodate and ensure proper proximity for initiating up to five shock tubes, five low-strength detonating cords, or one strand of detonating cord from the blasting cap or booster. The M9 can also be used to connect the MDI blasting cap or booster to a detonating cord line or a ring main.

## FUNCTIONS

2-104. Shock tubes must be positioned straight through the holder with an overhand knot when using one or more (Figure 2-46). The blasting cap or booster is inserted and secured by closing the smaller hinged flap. Insert the ends of the shock tubes through the channels in the holder. Close the large flap to secure the overhand knot. Use tape to secure the large flap in place. See Table 2-12, page 2-58, for the M9 characteristics. In the event an M9 holder becomes unserviceable or is not available, use tape to make MDI connections. To attach a blasting cap to MDI components using tape, ensure that all strands of shock tube or low-strength detonating cord being connected are in contact with the blasting cap or booster and is secured with tape.

Table 2-12. M9 Characteristics

<i>Tabulated data</i>		
Dimensions (closed)	Length	3.0 in
	Diameter	1.3 in
	Thickness	0.7 in
	Accommodation	One cap or booster per five shock tubes on low-strength detonating cords
	Material	Polyethylene
	Color	Black
	NSN	1375-01-415-1229
	DODAC	1375-ML45
	Drawing	12972626
	Specification	QAA-1423
	Gross weight of item	1 oz
	Packaging	500 units per box
	Gross weight of package	49 lb
Limitations	Because this item is designed for one-time use, continued use in training will wear out the hinges very quickly.	

## M81 TIME-BLASTING FUSE IGNITER WITH SHOCK TUBE CAPABILITY

2-105. The M81 igniter will initiate the time fuse and shock tube end of MDI components (Figure 2-47). The M81 is almost identical to the older M60 igniter, except the M81 has a screw-end cap with a green shipping plug and a silicon shock tube reducer. The cap allows the M81 to accommodate the standard shock tube or the standard-diameter, time-blasting fuse (M700). Extra care is required when connecting the shock tube to an M81 igniter to ensure proper initiation of an explosive system.

### WARNING

**Never attach an M151, M152, or detonating cord to the M81 igniter. Failure to comply could result in immediate personal injury or damage to equipment.**

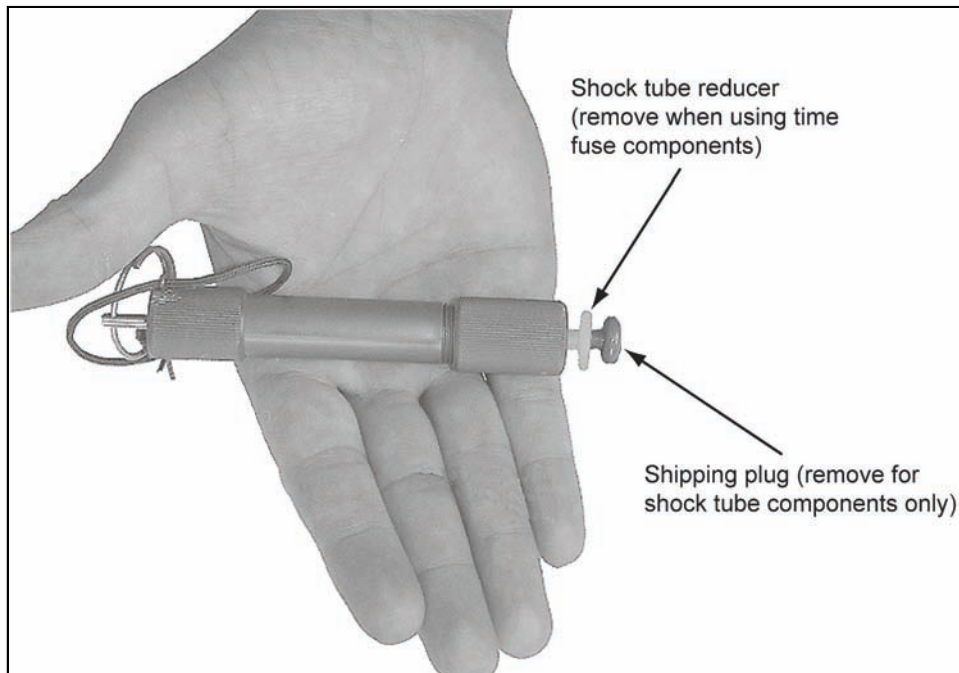


Figure 2-47. M81 Fuse Igniter

## USE

2-106. The M81 igniter is used to ignite a time-blasting fuse or to initiate a shock tube.

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**Note.** The standard M60 igniter (which has an almost identical appearance to the M81) will not secure or reliably initiate the shock tube.

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## FUNCTIONS

2-107. The M81 is actuated as follows:

- Loosen the screw cap and remove the shipping plug when using shock tube. Remove both the shipping plug and shock tube reducer when using a time fuse (Figure 2-47).
- Insert the freshly cut end of the time-blasting fuse or shock tube in the hole from which the plugs were removed.
- Tighten the screw cap to secure the fuse or shock tube.
- Remove the safety (cotter) pin by squeezing the safety pin ends together then pulling on the cord.
- Pull the pull ring to the limit of its travel.

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**Note.** When the M81 reaches its limit of travel, the pull ring rod releases the firing pin. The spring forces the pin into the primer. The primer fires with a flame, and an explosive shock ignites the fuse or initiates the shock tube.

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2-108. Table 2-13, page 2-60, shows the M81 characteristics.

Table 2-13. M81 Characteristics

<i>Tabulated Data</i>		
Body	Length	4.0 in
	Diameter	Pull ring: 1.2 in Body: 0.75 in
	Material	Plastic
Filler	M42 primer	Primer mix
	NEW (per igniter)	0.00005 lb (0.000023 gr)
	Actuation method	Impact of the spring-loaded firing pin on the primer is affected by the operator pulling the pull ring.
<i>Shipping and Storage Data</i>		
DOD hazard class QD/DIV/SCG	1.4S	
DOT hazard class	1.4S	
DOT label	Explosive	1.4S
DOT container marking	Proper shipping name	Lighters, fuse
	UN serial number	0131
	NSN	1375-01-415-1235
	DODAC	Live: MN08      Inert: none
	Drawing	12972638
	Specification	QAA-1442
	Drawing	12972628
	Specification	QAA-1423
Packing box	Dimensions	21.5 by 12 by 14.5 in
	Cube	2.16 cu ft
	NEW	0.03 lb
	Gross weight (with contents)	65 lb
<i>References</i>		
TM 9-1375-213-34&P DOD Consolidated Ammunition Supply Catalog		

## SECTION V – EXPLOSIVE CHARGES PRIMED WITH MODERNIZED DEMOLITION INITIATORS

2-109. There are three methods of priming explosive charges—nonelectric (MDI), boosters (MDI), and detonating cord. Only nonelectric (MDI) and boosters are discussed in this section. Priming charges with MDI M151 or MDI M152 components or detonating cord are the preferred methods for reserve demolition targets, which allow charges to be primed at state of readiness—state 1 (safe).

### NONELECTRIC PRIMING

2-110. Use high-strength MDI blasting caps or boosters for priming explosive charges that are emplaced aboveground. For priming explosive charges belowground, use the M151 or M152 booster. Use the M12 and M13 only as transmission lines in firing systems (refer to Section VI of this chapter).

#### WARNING

**Do not insert blasting caps in explosive charges until ordered to do so. Failure to comply could result in immediate personal injury or damage to equipment.**

2-111. MDI priming is safer and more reliable than the current nonelectric cap priming methods. MDI blasting caps and boosters are already factory-crimped to precut lengths of shock tube or time-blasting fuse. Because the caps are sealed units, they are resistant to moisture and will not misfire in damp conditions. However, once the system has been spliced, reliability will be significantly degraded due to moisture. Also, the human factor of incorrect crimping is removed, making MDI blasting caps and boosters extremely reliable. MDI blasting caps and boosters can be used with priming adapters or can be inserted directly into the explosive charge and secured with tape. If using priming adapters, place them on high-strength blasting caps and boosters as outlined in the note below.

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*Note.* Older M1A4 priming adapters must be slid down the full length of the shock tube or low-strength detonating cord to the high-strength blasting cap or booster. To slide the priming adapter on the free end of the shock tube, it will be necessary to cut off the end of the shock tube to remove the sealed end cap, and then slide the detonating cord clip off. The preferred priming adapter is the M1A5 priming adapter, which has wider slots and can be placed over the shock tube at a point near the blasting cap or booster.

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### TRINITROTOLUENE BLOCK DEMOLITION CHARGE

2-112. TNT blocks have threaded cap wells. A priming adapter is used to secure a high-strength blasting cap or booster in the cap well of the TNT block as shown in Figure 2-48, page 2-62. When priming adapters are not available, prime TNT blocks by inserting a high-strength blasting cap or a booster into the cap well of the charge and secure it with tape.

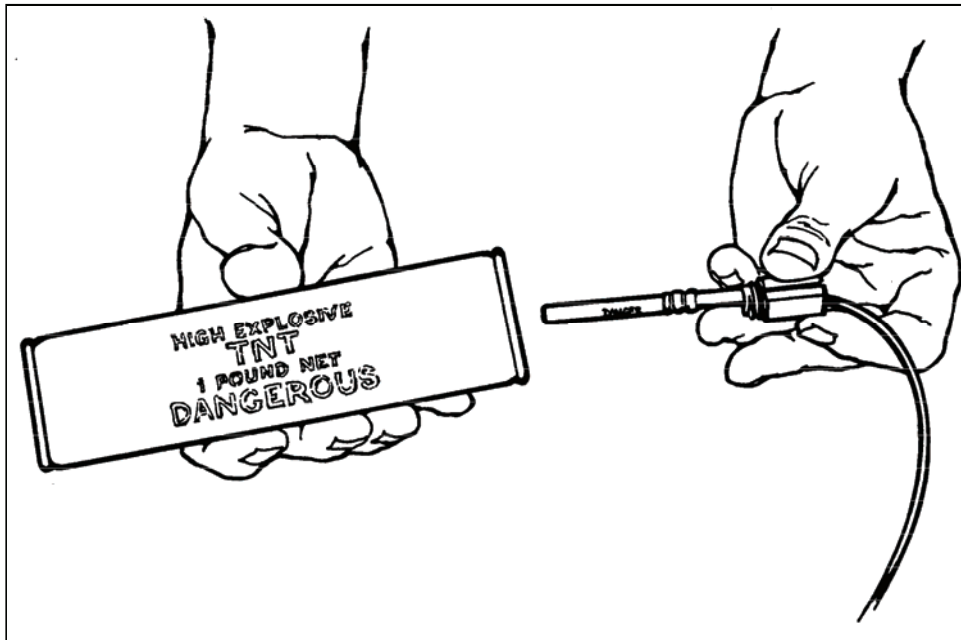


Figure 2-48. Priming a TNT Block With an MDI

## MILITARY DYNAMITE

2-113. Military dynamite can be primed with MDI blasting caps or boosters using either the end- or side-priming method. M2 crimpers or other nonsparking tools are used to make a cap well in one end of the dynamite cartridge. If using the side-priming method, make the cap well in the side of the cartridge at one end. The blasting cap or booster is inserted nearly parallel to the side of the cartridge. The explosive tip of the cap should be near the middle of the cartridge. A blasting cap or booster is inserted into the cap well. The shock tube, time fuse, or low-strength detonating cord is secured to the cartridge with tape to hold the blasting cap or booster firmly in place (Figure 2-49). For quarry operations, see FM 3-34.465.

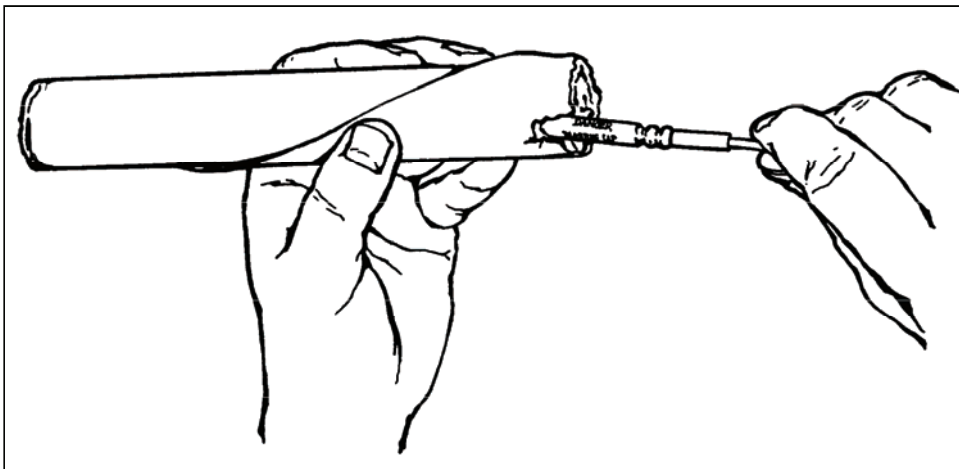


Figure 2-49. Priming M1 Dynamite With an MDI

## M112 (COMPOSITION C4) DEMOLITION BLOCK

2-114. Use M2 crimpers or other nonsparking tools to make a hole in one end or on the side (at the midpoint) of the demolition block. The hole should be large enough to hold a blasting cap or booster. Insert



a blasting cap or booster into the hole produced by the M2 crimpers. Do not force the blasting cap or booster if it does not fit; make the hole larger. The blasting cap or booster is anchored in the demolition block by gently squeezing the composition C4 plastic explosive around the blasting cap or booster. The blasting cap or booster is secured by tape in the charge (Figure 2-50).

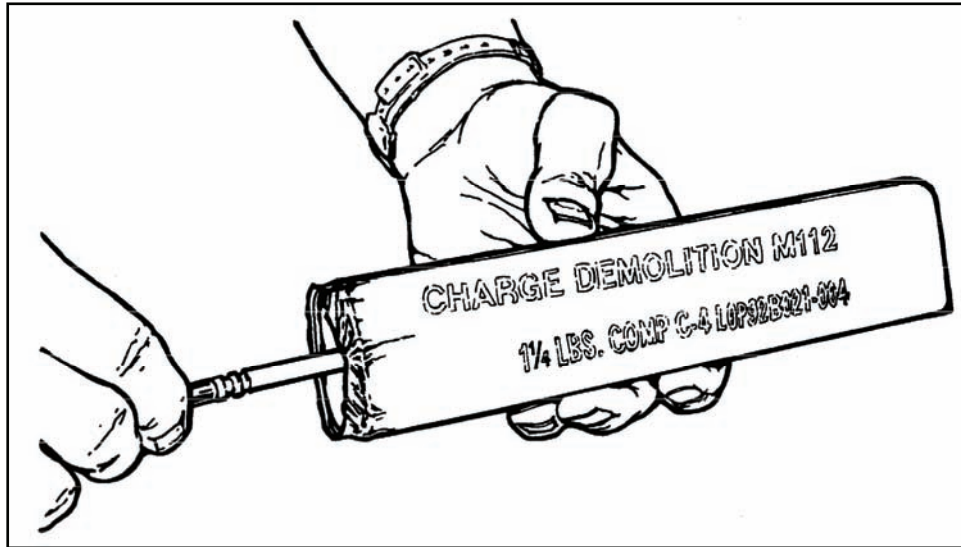


Figure 2-50. Priming a Composition C4 Demolition Block With an MDI

## 40-POUND CRATERING CHARGE

2-115. The 40-pound cratering charge is primed using one M151 or M152 booster and one M112 composition C4 or two M112 composition C4 as boosters attached to the side of the charge. Forty-pound cratering charges should not be primed with blasting caps.

### WARNING

Do not use the low-strength detonating cord of the M151 or M152 to lower 40-pound cratering charges into the holes. Failure to comply could result in immediate personal injury or damage to equipment.

## M2A4 AND M3A1 SHAPED CHARGES

2-116. The M2A4 and M3A1 shaped charges have a threaded cap well at the top of the cone. A priming adapter is used, if available, to secure a blasting cap or booster in the threaded cap well. If a priming adapter is not available, use tape to secure the blasting cap or booster in the cap well (Figure 2-51, page 2-64).



**Figure 2-51. Priming Shaped Charges With an MDI**

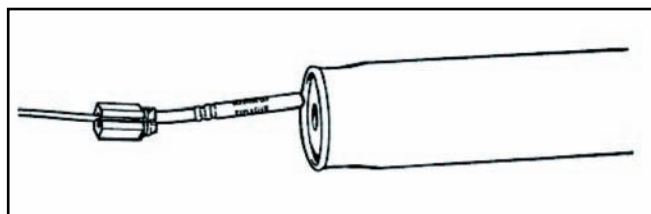
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*Note.* Charges will not be primed with blasting caps until the charges are placed on the target.

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## BANGALORE TORPEDO

2-117. The bangalore torpedo is primed using a blasting cap or a booster. Insert the blasting cap or booster into the cap well in the end section of the charge, and secure it with a priming adapter. If a priming adapter is not available, use tape to hold the blasting cap or booster firmly in place (Figure 2-52).



**Figure 2-52. Priming the Bangalore Torpedo With an MDI**

## SECTION VI – INITIATING SETS AND FIRING SYSTEMS

### INITIATING SETS

2-118. All MDI blasting caps and boosters can be used to initiate shock tube. Only use blasting caps or boosters to initiate detonating cord or to prime and initiate explosive charges directly. MDI initiating sets are used to initiate instantly. An M12, M13, M19, M21, and M23 or an M14 or M18 can be used to create a delay. When using a combination (command and delayed) initiation system on the MDI, the command initiation will be the primary initiation system, and the delay initiation will be the secondary initiation system.

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*Note.* Cover the secondary-initiation system blasting cap to reduce fragmentation hazards of the cap.

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2-119. If the primary initiating system fails, the secondary initiating system will function and initiate the system when the time fuse burns down to the blasting cap. If the primary initiates the system, the secondary blasting cap will detonate along with the other components of the firing system if it was connected to the detonating cord. If the secondary blasting cap was connected to the shock tube or the low-strength detonating cord, it will detonate when the time fuse burns down to the blasting cap. When using dual-delay initiation systems, the shorter delay is the primary initiation system. When placing multiple charges, the transmission line blasting caps and charges should be a sufficient distance apart to prevent fragments from cutting other shock tube or low-strength detonating cord components before their planned ignition.

**WARNING**

**Always observe the safe distances given in Chapter 6. Failure to comply could result in immediate personal injury or damage to equipment.**

## INSTANTANEOUS OR COMMAND INITIATION

2-120. To achieve the necessary safe distance from the explosive charges being emplaced, lay out one or more M12s, M13s, M21s, or M23s. The blasting cap furthest from the initiation point is connected to the MDI firing system or to the detonating cord ring main. When returning to the initiation point, visually inspect the initiation system for possible misfire problems. This is the only test procedure for the MDI initiation system. At the initiation point, the M81 igniter is secured to the M12 or M13 shock tube as follows:

- Loosen the M81 end cap three to four turns counterclockwise, and remove the hard, plastic shipping plug. Pull the shipping plug out of the igniter ensuring not to remove the shock tube reducer.
- Cut off the crimped end of the shock tube at the desired length of the relay cap shock tube using a sharp knife.

**WARNING**

**Crimpers will not make a smooth enough cut to ensure that the M81 will function the shock tube. Failure to comply could result in immediate personal injury or damage to equipment.**

- Push the shock tube into the hole in the M81 end cap as far as it will go. Turn the igniter end cap clockwise and finger tight to secure it in the device once the shock tube has seated (Figure 2-53, page 2-66).
- Ensure that all friendly personnel are at a safe distance from the explosive charge and that they take appropriate cover.
- Squeeze together the spread legs of the safety (cotter) pin. Use the safety pin cord to remove the safety pin from the body of the igniter. Wear a leather glove, and grasp the igniter body firmly with one hand, with the pull ring fully accessible to the other hand.
- Actuate the igniter by sharply pulling its pull ring. Ensure that the pop of the igniter primer is heard.

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*Note.* The mechanism of the M81 is identical to that of the old M60 igniter. If the primer does not fire, the M81 can be recocked and reactivated immediately. The igniter should be held firmly and then the pull rod should be pushed back into the igniter until a click is heard or felt, and then the pull ring should be pulled again sharply to actuate it. If the igniter primer fires, but the charge does not, refer to Section VII, Misfires, in this chapter.

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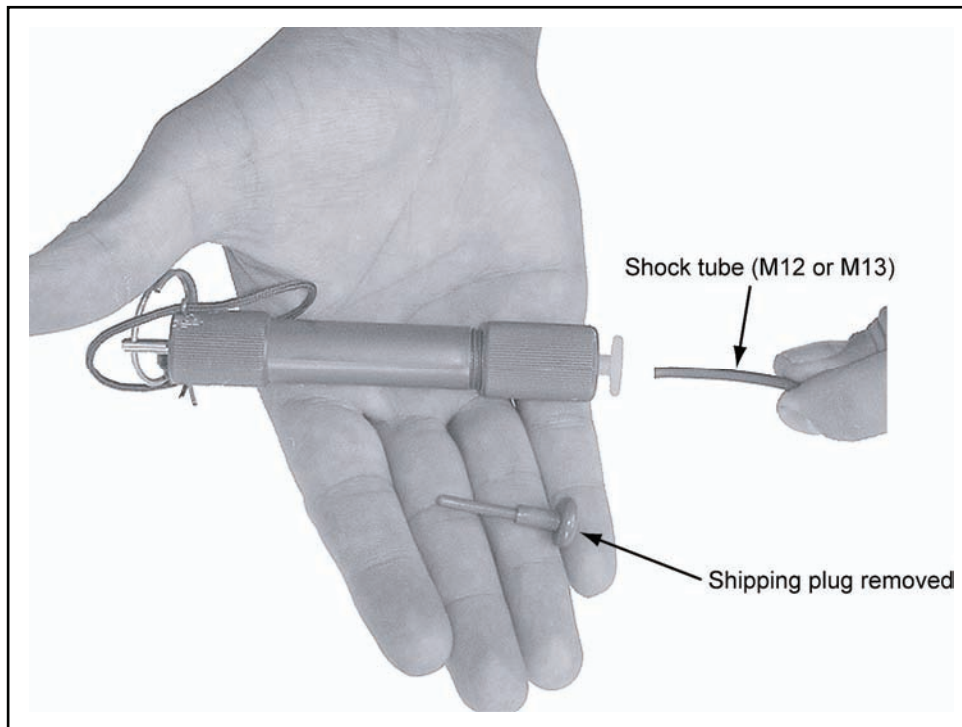
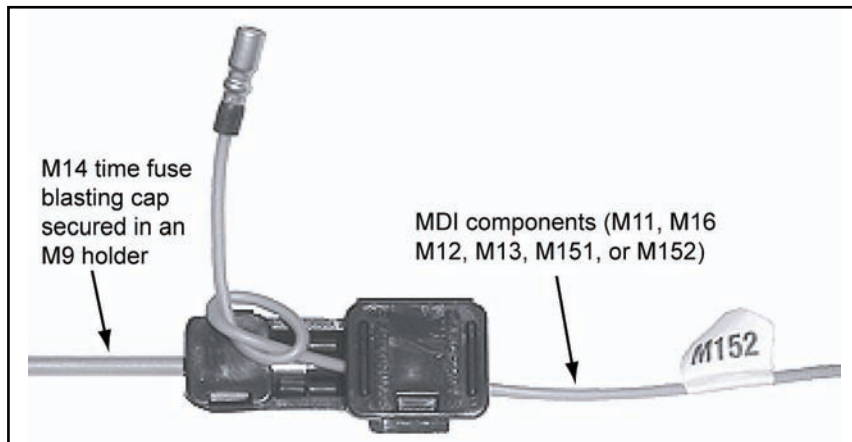


Figure 2-53. M81 Fuse Igniter With a Shock Tube

## DELAY INITIATION

2-121. The M14 delay blasting cap assembly has a 7 1/2-foot length of time fuse marked in nominal 1-minute increments giving a total delay of a nominal 5 minutes. Before attaching the M14 to the initiation system, visually inspect the initiating sets for possible misfire problems. This is the only test procedure for the MDI initiating set. The M14 is initiated by—

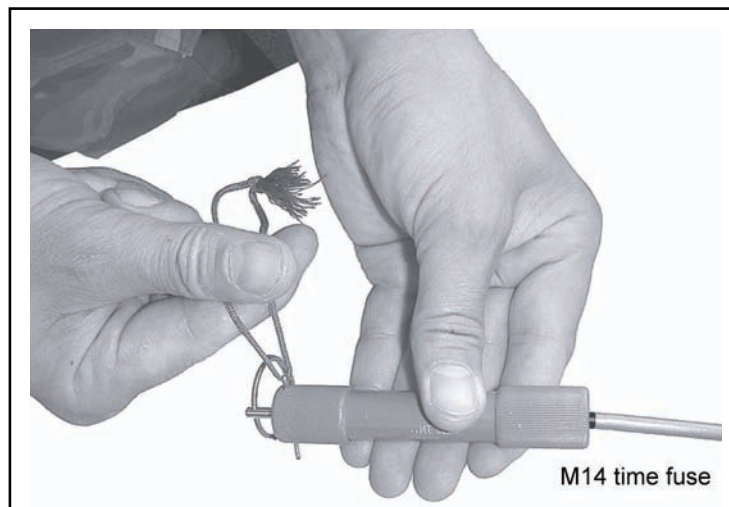
- **Step 1.** Opening an M9 blasting cap holder.
- **Step 2.** Inserting the M14 blasting cap.
- **Step 3.** Snapping shut the smaller hinged flap to secure the M14.
- **Step 4.** Placing up to five shock tubes, five low-strength detonating cords, or one strand of detonating cord in the M9 holder if they are run straight through the M9 and are not looped.
- **Step 5.** Tying the shock tube, low-strength detonating cord, or detonating cord ends into an overhand knot.
- **Step 6.** Placing the shock tube, low-strength detonating cord, or detonating cord in the M9 holder alongside the blasting cap and securing the M9 larger hinged holder flap.
- **Step 7.** Securing the large flap with tape (Figure 2-54).



**Figure 2-54. M9 Blasting Cap Holder in a Delay Initiation**

2-122. A M14 time fuse is installed as follows:

- **Step 1.** Use a sharp knife to cut 1/4 inch of the time fuse and the metal seal from the free end of the M14 time fuse (if the maximum 5-minute delay is required). Cut at the marked bands to reduce the delay, if so desired. Ensure that the delay on the time fuse allows for withdrawal to a safe distance or allows time to take appropriate cover.
- **Step 2.** Loosen the M81 end cap three to four turns counterclockwise so the hard, plastic shipping plug can be easily removed. Pull the shipping plug and shock tube reducer out of the igniter.
- **Step 3.** Secure an M81 fuse igniter to the freshly cut end of the M14 time fuse (Figure 2-55).
- **Step 4.** Squeeze the spread legs of the safety (cotter) pin together. Use the safety pin cord to remove the safety pin from the body of the igniter. Wear a leather glove and grasp the igniter body firmly with one hand, with the pull ring fully accessible to the other hand. Pull the igniter pull ring sharply to actuate.
- **Step 5.** Ensure that smoke is coming from the fuse or out of the vent hole in the igniter.
- **Step 6.** Remove the igniter, and withdraw to a safe distance or to appropriate cover.



**Figure 2-55. M81 Fuse Igniter With an M14 Time Fuse Installed**

## SPECIAL CONDITIONS

2-123. The ambient temperature and the altitude of the site have an impact on the operation of the MDI. Cold weather and high altitudes will extend the delay times on the M14 and M18. Precautions can be taken when using MDI in extreme cold temperatures and/or high altitudes by dual-priming and dual-initiating the charges to ensure proper initiation. When using MDI for ice demolitions, the same precautions must be taken with one addition; if the charges are to be placed in the ice or under water in extreme cold conditions, the same rules apply as if the target were stemmed or tamped. For these types of missions, use detonating cord for priming and branchline construction.

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*Note.* The M14 and M18 time-blasting fuses gives about a 5-minute delay and 20-minutes, respectively, between lighting the fuse and initiating the detonator. Like the standard M700 fuse, the burning time will vary with temperature and altitude. For example, operating at an altitude of 12,000 feet in cold weather will extend the delay time significantly. When exact detonation times are required, command-detonation methods should be considered.

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### WARNING

**When using an MDI in extreme cold temperatures and/or high altitudes, dual-prime and dual-initiate the charges. Failure to comply could result in immediate personal injury or damage to equipment.**

## MODERNIZED DEMOLITION INITIATOR FIRING SYSTEMS

2-124. With the introduction of MDI components, there are two types of firing systems: a stand-alone and a combination firing system. Both systems can be emplaced as single- or dual-firing systems. The choice of which system to use for a particular demolition mission is left to the experience of the engineer commander. However, the combination firing system is the preferred method for reserved demolition targets. Whenever handling MDI components with blasting caps or boosters outside of their original packaging, ensure that they are inserted into a foam protective cap or an M9 holder to prevent damage.

## DISPOSAL

2-125. After the charges have been successfully fired, the unit commander is responsible for ensuring the proper disposal of the residue. The used shock tube is nonrecyclable plastic and may be sent directly to an approved landfill. However, the blasting cap residual is considered hazardous waste and must be removed from the shock tube and disposed of according to local policy. Commanders must coordinate with the local Directorate of Engineering (Department of Public Works) and/or the local Defense Reutilization and Marketing Office (DRMO) for local disposal guidance and landfill information.

### WARNING

**Do not dispose of used shock tubes by burning them because of the potentially toxic fumes given off from the burning plastic. Failure to comply could result in immediate personal injury or damage to equipment.**

## STAND-ALONE SYSTEM

2-126. The stand-alone firing system is one in which the initiating sets and transmission and branchlines are constructed using only MDI components and the explosive charges are primed with MDI blasting caps

or boosters. It is important to ensure that the firing system is balanced. All charges must have the same distance in the shock tube length and the low-strength detonating cord from the firing point to the charge. Figure 2-56 shows the MDI single-firing system and Figure 2-57, page 2-70, shows the MDI dual-firing system.

2-127. The disadvantages of a single-firing system are that if the transmission line is cut, charges down line from the cut will not detonate. If there is a possibility of the transmission lines being cut (for example, through artillery fires), a second firing system should be added as shown in Figure 2-57.

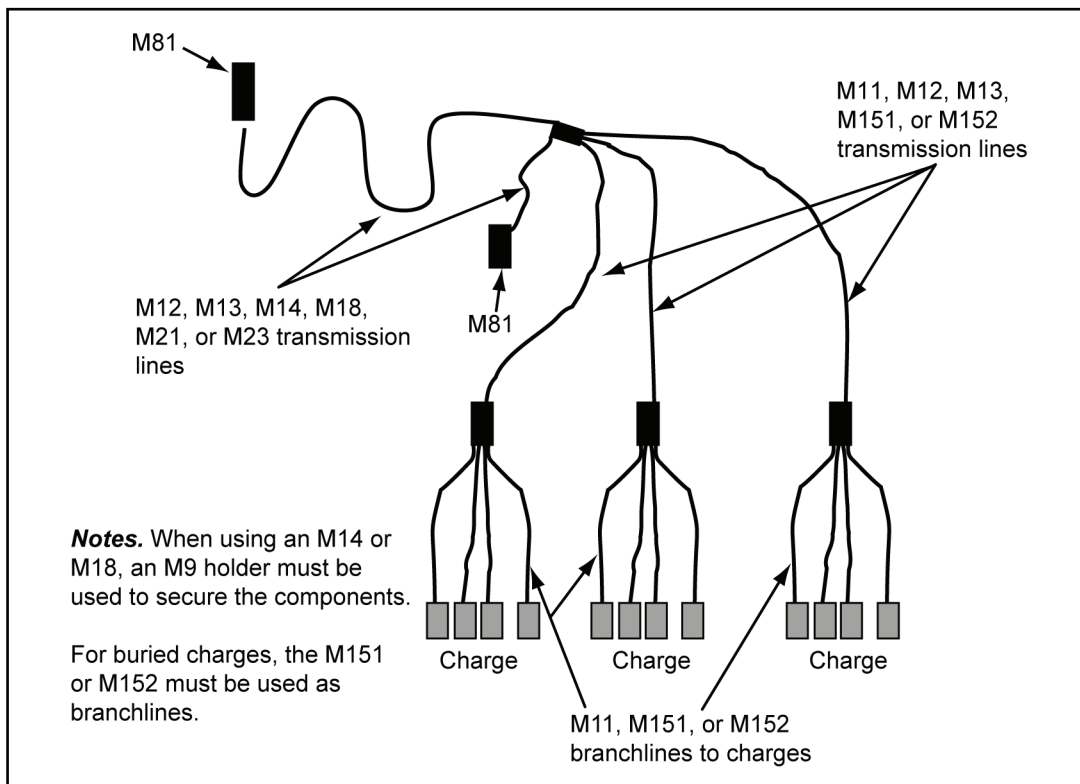
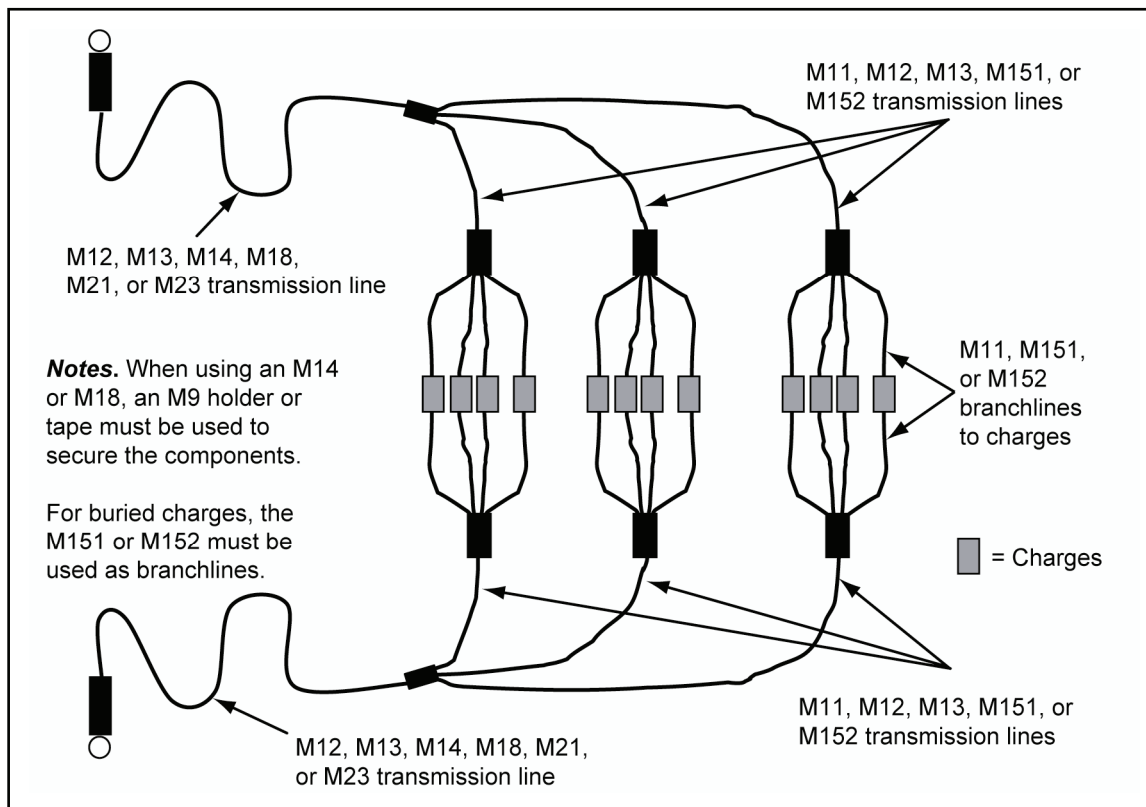


Figure 2-56. MDI Single-Firing System (Single-Primed and Dual-Initiated)

**WARNING**

**When making multishock tube installations, ensure that the shock tubes are protected from the effects of the nearby relay caps and charges. The shrapnel produced by a cap or charge could easily cause a misfire (partial or complete). When there are many shock tubes involved in a shot, they should be carefully placed away from the junction. Failure to comply could result in immediate personal injury or damage to equipment.**

2-128. The stand-alone MDI firing system is used for all types of demolition missions, including bridge demolitions. The MDI firing system can be used to initiate reserved demolition targets. However, only the M151 or M152 may be used to prime charges. Under current internationally agreed upon doctrine, charges cannot be primed with blasting caps until a change of readiness from state 1 (safe) to state 2 (armed) is ordered. Priming every charge with MDI blasting caps at this critical moment would take a considerable amount of time and be unacceptable to the maneuver commander. Priming charges with MDI M151 or MDI M152 components or detonating cord are the required methods for reserve demolition targets. The charges in this case are now dual-primed, the transmission line is laid in the opposite direction of the first transmission line, and the system is a balanced system.



**Figure 2-57. MDI Dual-Firing System (Dual-Primed and Dual-Initiated)**

## CONSTRUCTION SEQUENCE OF A MODERNIZED DEMOLITION INITIATOR USING A SHOCK TUBE

2-129. The demolition site should be thoroughly reconnoitered before emplacing explosive charges on the firing system. The following steps should be used:

- **Step 1.** Identify the firing point, and observe the safe distances as given in Chapter 6.
- **Step 2.** Emplace and secure primed explosive charges on the target.
- **Step 3.** Begin with the set of explosive charges furthest from the firing point, and place a sandbag or other easily identifiable marker over the transmission line blasting cap. Use an M11 or M152 if the distance between the sets of charges is less than 30 feet. Use an M151 if the distance is less than 10 feet.
- **Step 4.** Attach branchlines from the primed explosive charges to the transmission line using the attaching method as shown in Figure 2-46, page 2-57. Secure the transmission and branchlines by taping all the holders closed.
- **Step 5.** Unreel the transmission line to the firing point. Achieve the necessary safe distance by using several M12s, M13s, M21s, or M23s if needed. Use an M14 or M18 as an ignition element of a transmission line to provide time to reach a safe distance without the need to lay and connect multiple M12s, M13s, M21s, and M23s spooled components as transmission lines.



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*Note.* To effectively prevent a misfire, the shock wave in the shock tube must travel the same distance to all charges. No more than five M11, M151, or M152 branchlines can be connected to the transmission line blasting cap holder. If there are more than five charges, group the branchlines from the charges, and connect them to the M9s blasting cap holder of another M11, M151, or to an M152 branchline. The branchline is connected to the transmission line blasting-cap holder as shown in Figure 2-46, page 2-57. The transmission and branchlines are secured by a large, hinged flap and the flap is secured with tape.

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- **Step 6.** Perform a visual inspection of the firing system for possible misfire indicators while en route to the firing point.
- **Step 7.** Initiate the system at the firing point using the procedures in paragraph 2-121.

### CONSTRUCTION SEQUENCE OF A MODERNIZED DEMOLITION INITIATOR USING AN M151 OR AN M152

2-130. The boosters are factory-crimped onto low-strength detonating cord. The booster is used to prime charges that are either buried or aboveground by substituting, not eliminating, the present use of standard detonating cord as a branchline or to prime charges. When an M151 or M152 is removed from an original shipping container, a foam protector should be installed on the booster. As low-strength detonating cord is used, additional procedures are involved in the use of an M151 and M152. These procedures include—

- Removing any tape used to bundle an M151 or M152.
- Spreading the low-strength detonating cord between the primed charge and the M9 holder of the transmission line when charges are in the same general area.
- Avoiding conditions where one or more cords are running alongside or twisted with other cords or crossovers any low-strength detonating cord.
- Ensuring that the cords are in contact with a blasting cap or booster.

2-131. Thoroughly reconnoiter the demolition site before emplacing explosive charges on the firing system. Use the following steps:

- **Step 1.** Identify the firing point, and observe the safe distances as given in Chapter 6.
- **Step 2.** Emplace and secure primed explosive charges on the target.
- **Step 3.** Begin with the set of explosive charges farthest from the firing point, and place a sandbag or other easily identifiable marker over the transmission line blasting cap. Use an M11 or M152 if the distance between the sets of charges is less than 30 feet. Use an M151 if the distance is less than 10 feet.
- **Step 4.** Attach branchlines from the primed explosive charges to the transmission line. See Figure 2-58, page 2-72. The attaching method is shown in Figure 2-46. Secure the transmission and branchlines by taping all the holders closed.
- **Step 5.** Unreel the transmission line to the firing point. Use several M12s, M13s, M21s, or M23s to achieve the necessary safe distance needed. Use an M14 or M18 as an ignition element of a transmission line to provide time to reach a safe distance without laying and connecting multiple M12s, M13s, M21s, and M23s spooled components as transmission lines.
- **Step 6.** Perform a visual inspection of the firing system for possible misfire indicators while en route to the firing point.
- **Step 7.** Initiate the system at the firing point using the procedures in paragraph 2-121.

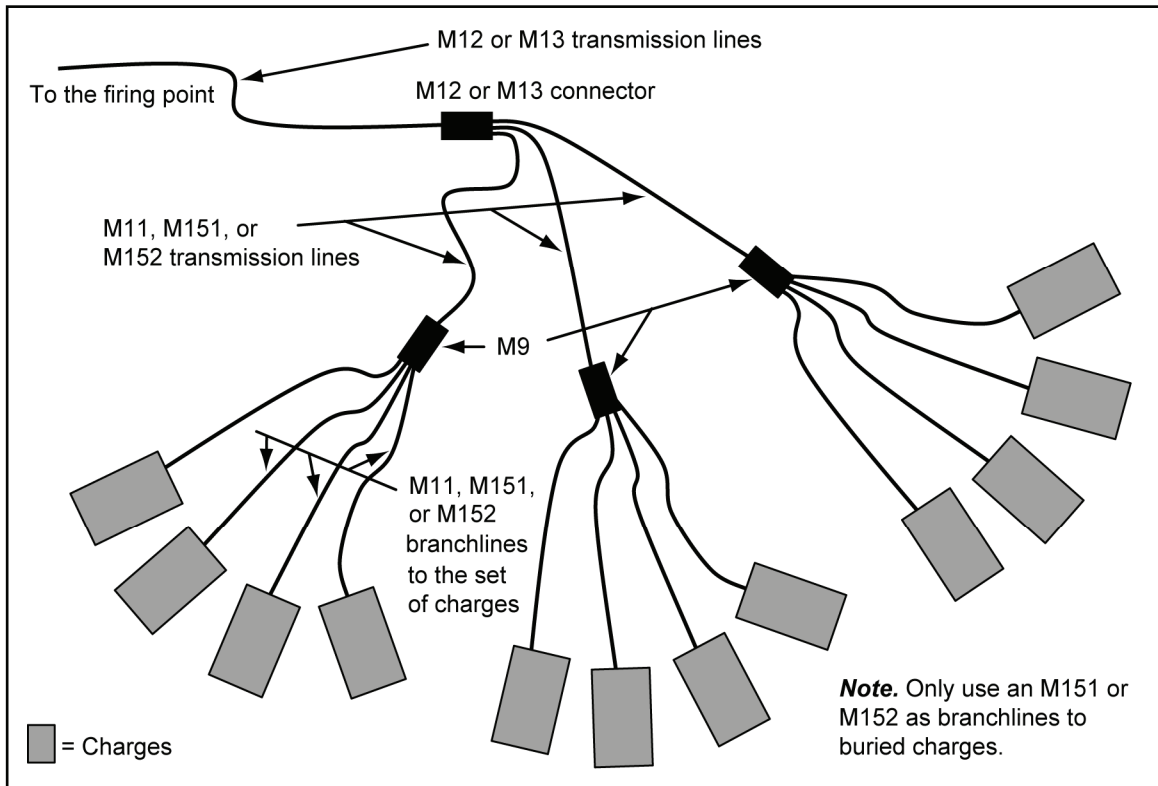
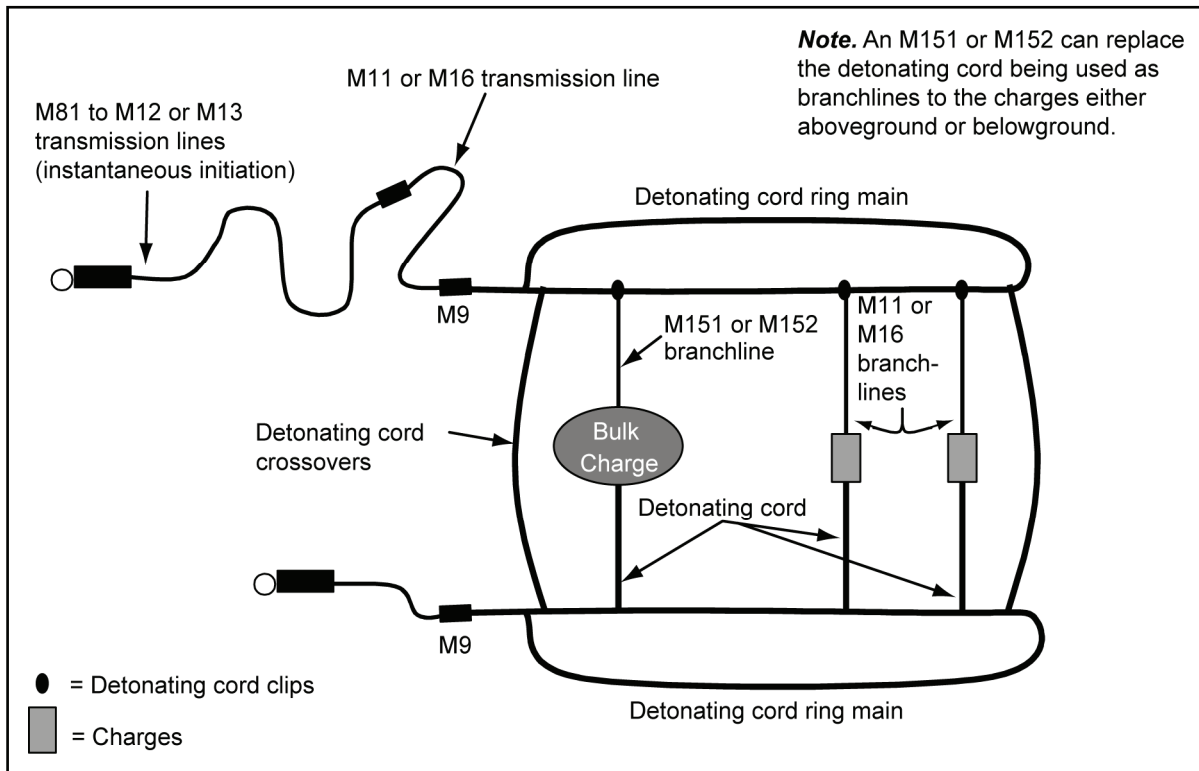


Figure 2-58. MDI Branchline Array

**COMBINATION FIRING SYSTEM**

2-132. A combination firing system is one which consists of the MDI initiating set, either a detonating cord line used as a line or ring main and branchlines that can be either MDI shock tube components or booster components used as branchlines (Figure 2-59).



**Figure 2-59. Combination (MDI and Detonating Cord) Firing System (Dual)**

2-133. Use the combination (MDI and detonating cord) firing system for all types of demolition missions. It combines the advantages of MDI components with the simplicity and flexibility of detonating cord. The combination firing system is the preferred method for reserved demolition targets, underwater operations, and operations where subsurface-laid charges are used.

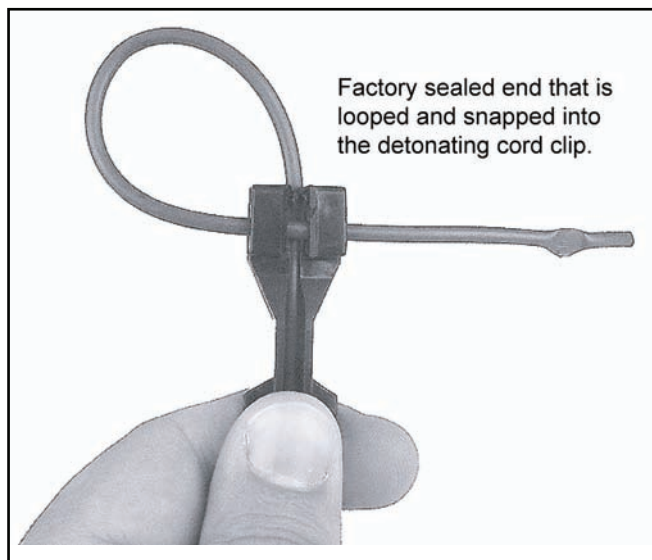
### CONSTRUCTION SEQUENCE FOR MODERNIZED DEMOLITION INITIATOR SHOCK TUBE COMPONENTS AND DETONATING CORD

2-134. Thoroughly reconnoiter the site before emplacing explosive charges on the firing system. Use the following steps:

*Note.* M151s or M152s can be used to replace detonating cord when used as branchlines to charges placed either aboveground or belowground.

- **Step 1.** Identify the firing point, and observe the safe distances as given in Chapter 6.
- **Step 2.** Emplace and secure the primed explosive charges on the target.
- **Step 3.** Construct detonating cord line or ring mains according to the procedures in Section III, of this chapter.
- **Step 4.** Cover the blasting cap of the transmission line with a sandbag or another easily identifiable marker at the connection between the detonating cord line and ring main to the MDI initiating set.

- **Step 5.** Tie in any detonating cord branchlines to the line or ring main. Clip the branchlines to the detonating cord line or ring main using the attached detonating cord clip if priming with MDI. Do this by—
  - Looping the shock tube around and into the detonating cord clip (Figure 2-60).
  - Pulling the shock tube tight to prevent the detonating cord clip from slipping.
  - Clipping the detonating cord line or ring main into the detonating cord clip.
  - Laying the branchlines toward the charges if an M11 is used.



**Figure 2-60. MDI Detonating Cord Clip**

- **Step 6.** Lay out an M11, M151, or M152 with an M9 installed as a transmission line from the detonating cord ring main to the transmission line.
- **Step 7.** Attach the M11, M151, or M152 to the holder on the transmission line blasting cap holder, and secure with tape.
- **Step 8.** Tie an overhand knot in the detonating cord of the ring main, and place it into the M9 blasting cap holder. Secure the large flap with tape.
- **Step 9.** Perform a visual inspection of the entire firing system for any flaws, which might cause a misfire.
- **Step 10.** Initiate the system at the firing point using the procedures in paragraph 2-121.

## SHOCK TUBE SPLICING

2-135. The MDI shock tube components are extremely reliable because all the components are sealed. Unlike standard, nonelectric priming components, they cannot be easily degraded by moisture. Cut shock tubes make the open ends vulnerable to moisture. Dampened explosive film on the inside of the shock tube will stop a detonation from going beyond such a damp spot. Care should be taken when cutting and splicing the shock tube. When cutting the shock tube, make a temporary moisture seal by bending it 2 inches onto itself from the cut and taping it together along the open end with electrical tape. Splicing tubes are used to repair a break in the shock tube of a transmission or branchline (for example, caused by shrapnel from artillery fire). Every splice in the shock tube reduces the reliability of the firing system. The number of splices in a shock tube line should be kept to as few as practicable.

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*Note.* A fully sealed MDI component should be used to replace the broken shock tube. If a fully sealed MDI component is not available, splicing is used as a last resort. When conducting water or diving demolition missions, do not splice the shock tube.

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2-136. The following procedures are the proper way to splice the shock tube:

- **Step 1.** Use a sharp knife to make a square cut about 3 feet from the previously cutoff end of the shock tube, whether or not it was knotted according to the guidance above. Immediately seal off the shock tube remaining on the spool by bending 2 inches of the shock tube end over on itself and taping it in place to provide a temporary moisture seal. Tie a knot if no tape is available.
- **Step 2.** Tie loosely the two shock tube ends to be spliced together in an overhand knot. Leave at least 2 inches free at the end of each shock tube beyond the knot.
- **Step 3.** Pull the shock tube lightly to tighten the knot, but not so tight as to significantly deform the shock tube in the knot.
- **Step 4.** Push one of the free shock tube ends to be spliced firmly into one of the precut splicing tubes at least 1/4 inch.
- **Step 5.** Push the other shock tube end firmly into the other end of the splicing tube at least 1/4 inch (Figure 2-61).

*Note.* It is not necessary for the two ends of the shock tube to meet; the detonation wave in the shock tube will still generate over a small gap.

### CAUTION

Taping two cut ends of the shock tube together does not make a reliable splice. Personal injury or damage to equipment may result from long-term failure to follow correct procedures.

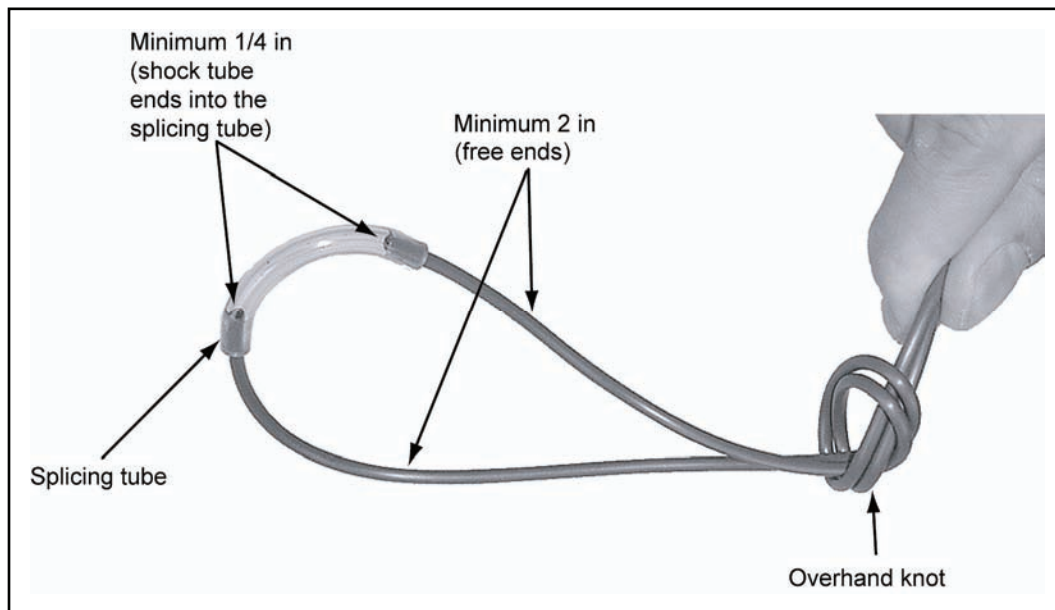


Figure 2-61. Splicing a Shock Tube

## SECTION VII – SAFETY PROCEDURES

### MODERNIZED DEMOLITION INITIATOR CONSIDERATIONS

2-137. When conducting training and missions with the MDI, follow the general safety considerations for demolitions as given in Chapter 6 and DA Pamphlet 385-63. When MDI components are removed from their original packaging, install a foam protector onto the blasting cap or booster. Misfires occur when—

- The shock tube is cut using crimpers.
- The M81 fuse igniter is not properly connected to the shock tube before initiation or the shock tube is pulled after being secured in the M81.
- The shock tube is cut by shrapnel during the initiation process.
- The shock tube is incorrectly inserted into the holders on the M12 or M13 blasting caps or into the M9 holder.
- An overhand knot is not used to secure the spliced area. A splice without a knot can separate by a small accidental tug on the shock tube.

2-138. MDI components, with factory-crimped blasting caps attached to a shock tube, in their original packaging and subpackaging are marked according to Department of Transportation hazard class explosives requirements. These items can be transported with other explosives provided they are compatible. See DA Pamphlet 385-64 to identify the classes of explosives that can be transported in the same vehicle.

## MODERNIZED DEMOLITION INITIATOR MISFIRES

2-139. Working on or near a misfire is the most hazardous of all blasting operations. A misfire in the MDI system is extremely rare if the following procedures are used:

- Prepare and emplace all components of the firing systems. Use dual-firing systems where appropriate. Ensure that the detonating cord, shock tube, or low-strength detonating cord in the blasting cap holder is in contact with the blasting cap. Do not mix the detonating cord, shock tube, or low-strength detonating cord in the same M9 holder.
- Mark or cover MDI blasting caps with sandbags or other clearly identifiable markers to prevent personnel from damaging the caps during setup.
- Emplace and prime all charges safely.
- Prime all buried charges with an M151, M152, or detonating cord.
- Perform any tamping operation with care to avoid damage to the charges and the priming system. Always tamp with a nonsparking tool.
- Initiate charges according to the correct technique.
- Inspect visually the firing system before initiation.

### **DANGER**

**Do not handle misfires down range until the required 30-minute waiting period for both primary and secondary initiation systems has elapsed and other safety precautions have been taken. Failure to comply may cause death or permanent injury.**

2-140. The most common cause of a misfire in a shock tube firing system is the initiating element, usually an M81 igniter. The following misfire procedures are for both command-initiated and delay-initiated systems(Figure 2-62):

- A failure with the M81 will occur if the primer does not fire. If, after two retries, the M81 does not result in it firing, cut the shock tube, replace the igniter with a new one, and repeat the firing procedure.
- Another misfire mode for the M81 is that the primer fires but blows the shock tube out of its securing mechanism without it firing. This is usually due to the shock tube not having been properly inserted and secured in the igniter. To correct this problem, cut a minimum of 3 feet from the end of the shock tube. It is recommended that the shock tube be checked for the presence of fine explosive powder following step 1 in the next paragraph. If powder is present, replace the igniter and repeat the firing procedure.

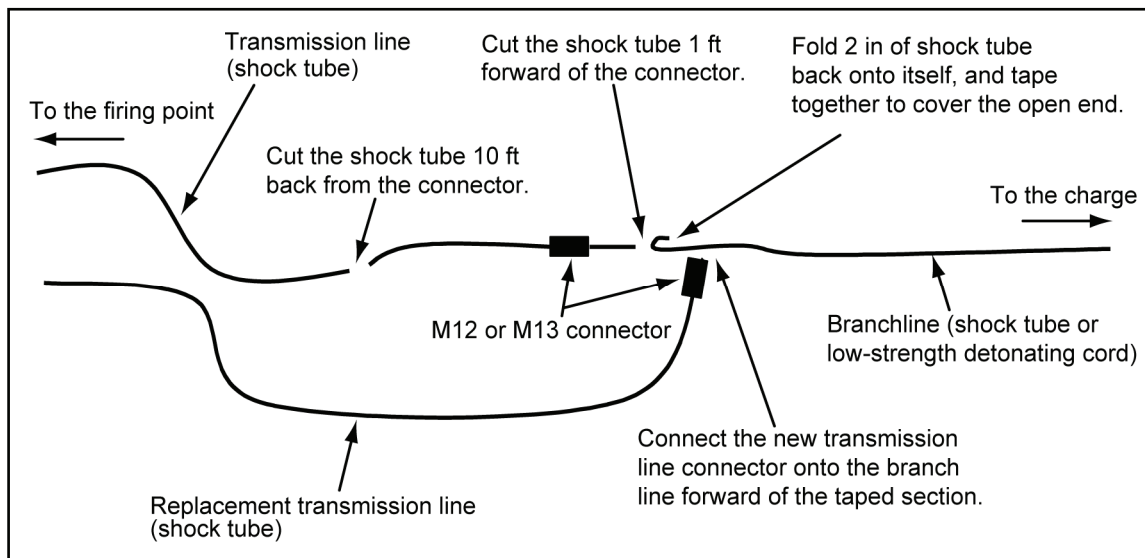


Figure 2-62. MDI Misfire Procedures

2-141. The following steps are used to correct misfire problems:

- **Step 1.** If the igniter appears to have functioned properly (the primer pops or smokes), but the charge did not fire, cut off the first 6 inches of shock tube and discard. Then cut a 1-foot section from the shock tube. Hold the 1-foot piece of shock tube so that one end is over the palm of your hand, then blow through the other end. If no powder is present, proceed to step 2. If a gray or silver powder is blown from the shock tube, it has not fired. In this case, install a new igniter on the freshly cut end of the shock tube, and repeat the firing procedure. If detonation does not occur, proceed to step 3.
- **Step 2.** If the igniter or initiating element functioned properly and no powder was blown from the shock tube in the previous step or its flash was seen, observe the burn time plus 30 minutes before going downrange.
- **Step 3.** After waiting the burn time plus 30 minutes, proceed downrange and check all the components in the firing system. The most likely cause of a misfire is the incorrect placement of the shock tube in the blasting cap holders (for example, the blasting cap detonated but failed to initiate the shock tube of the next down-line MDI component). If a blasting cap has not fired, it is likely that the shock tube was not initiated by the up-line blasting cap. To determine if the shock tube has fired at a particular point, perform step 1 with a 1-foot section of shock tube cut from the suspect area.
- **Step 4.** If the shock tube still contains the explosive dust, attach a new component by cutting the shock tube down line from the defective shock tube 1 foot past the blasting cap holder. Seal the shock tube by bending it 2 inches from the cut and taping it. On the defective tube, move down and cut it 10 feet from the blasting cap. Remove and dispose of the defective shock tube and cap according to local misfire policies. Then, lay out the shock tube of the replacement component back to the firing point, and repeat the firing sequence when it is safe to do so.
- **Step 5.** If the shock tube contains no explosive dust because it has been fired, the problem is probably with the blasting cap. The shock tube is cut down line from the defective blasting cap 1 foot past the blasting cap holder. Then, seal the shock tube by bending it 2 inches from the cut and taping it. On the shock tube of the defective blasting cap, move down and cut it 10 feet from the blasting cap. Remove and dispose of the defective shock tube and cap according to local misfire policies. Then, lay out the shock tube of the replacement component back to the firing point, and repeat the firing sequence when it is safe to do so.

## DANGER

**Never yank or pull hard on the shock tube. This may actuate the blasting cap. Failure to comply may cause death or permanent injury.**

- **Step 6.** If the first component of the firing train was not the one that failed, check out each succeeding component until the failed one is found. Then, replace the failed or fired relay components back to the initiating site as in steps 4 and 5.
- **Step 7.** If the failed component appears to be the final high-strength blasting cap or booster, replace if it is easily accessible. If it is used to prime an explosive charge, do not disturb it. Then, place a new, primed 1-pound explosive charge next to the misfired charge and detonate it when it is safe to do so.
- **Step 8.** If the charges were primed with MDI M151 or MDI M152 components and buried, follow the above misfire procedures to the low-strength detonating cord of an MDI M151 or MDI M152. If the transmission line blasting cap has failed to function, use a nonsparking tool to cut the low-strength detonating cord 1 foot past the failed transmission line blasting cap. Then, walk back 10 feet from the defective blasting cap, and cut the transmission line shock tube. Remove the defective shock tube, failed cap, and the length of low-strength detonating cord is and dispose of them according to local misfire procedures. Lay out a replacement transmission line to the firing point and then connect the remaining low-strength detonating cord to the transmission line holder. Repeat the firing sequence to detonate the charge. If the buried charge has failed to detonate, but the booster cord has functioned to the surface of the buried charge, follow the procedures in Chapter 6, Section III.

## SECTION VIII – MODERNIZED DEMOLITION INITIATOR USE WITHIN COMMON DEMOLITION MISSIONS

### FIRING SYSTEMS PLANNING

2-142. The MDI system has many components that make up a firing system. Because of this, it is critical during the planning and resourcing phase of the operation that the firing system be planned in detail. The process of planning the firing system from the charge to the firing point is critical to the success of the mission. Demolition site reconnaissance is required and precise numbers of shock tube, holders, and other devices must be determined before executing the demolition mission. All residue must be collected and disposed of whenever possible. This is both an environmental and a tactical necessity.

2-143. A number of missions require charges to detonate simultaneously. To assure this, branchlines of equal length must be attached to the initiating cap or booster or detonating cord ring main if used. Making branchlines as short as is practical will further improve the simultaneous detonation of the charges. For example, if the farthest distance for one of three branchlines is 15 feet, measure the three lines, tie an overhand knot at this point, and connect the transmission line between the knot and the charge or move all three J hooks to that point and connect.

### STEEL-CUTTING CHARGES

2-144. Steel-cutting charges should be emplaced according to the procedures outlined in Chapter 3. See Figure 2-63 for an example of steel I beam cutting charges.



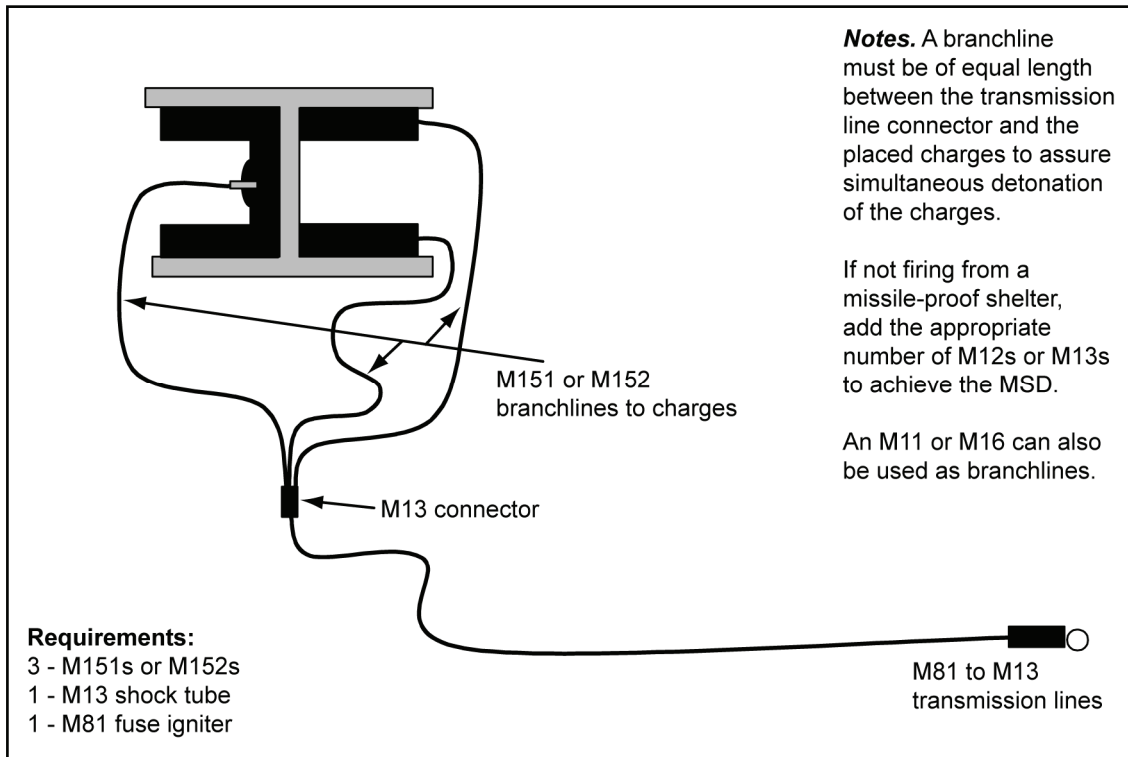


Figure 2-63. Steel I Beam Cutting Charges

## BRIDGE DEMOLITION CHARGES

2-145. When a demolition team has a bridge target assigned, planning should include a review of the MDI characteristics in simultaneous detonation of charges, branchlines, or equal distant branchlines placement in holders. See Figure 2-64, page 2-80, and Figure 2-65, page 2-80, for examples of bridge demolition charges.

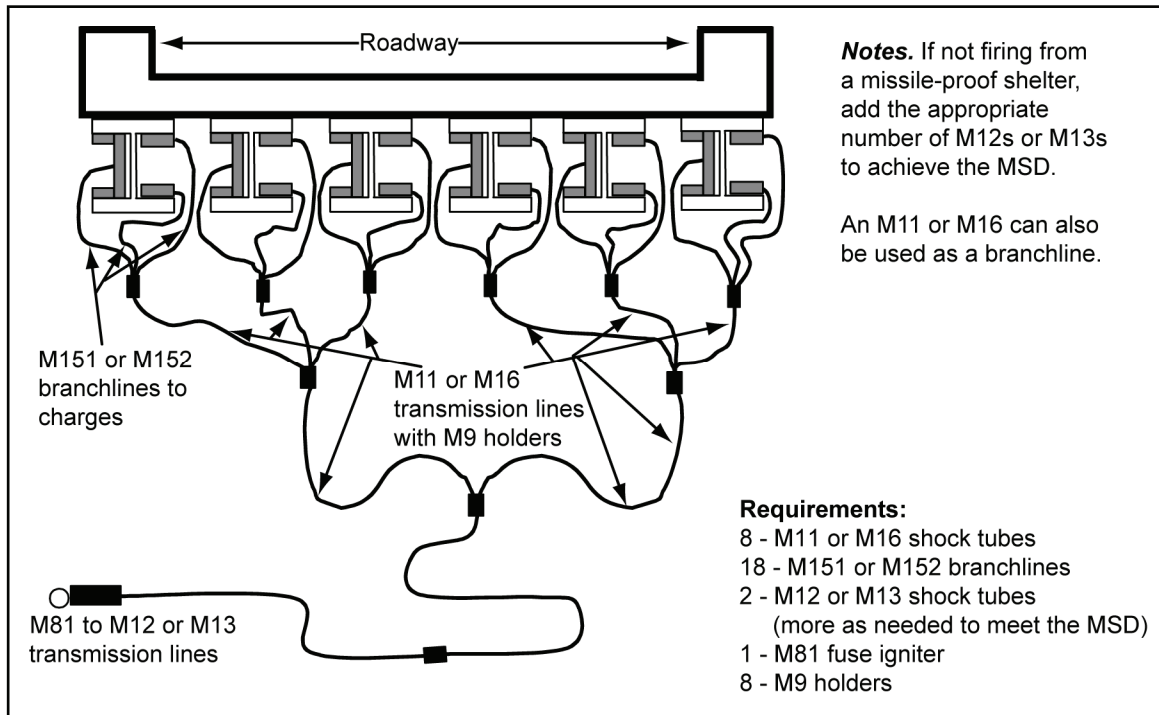


Figure 2-64. Bridge Demolition Charges (MDI-Balanced Firing System)

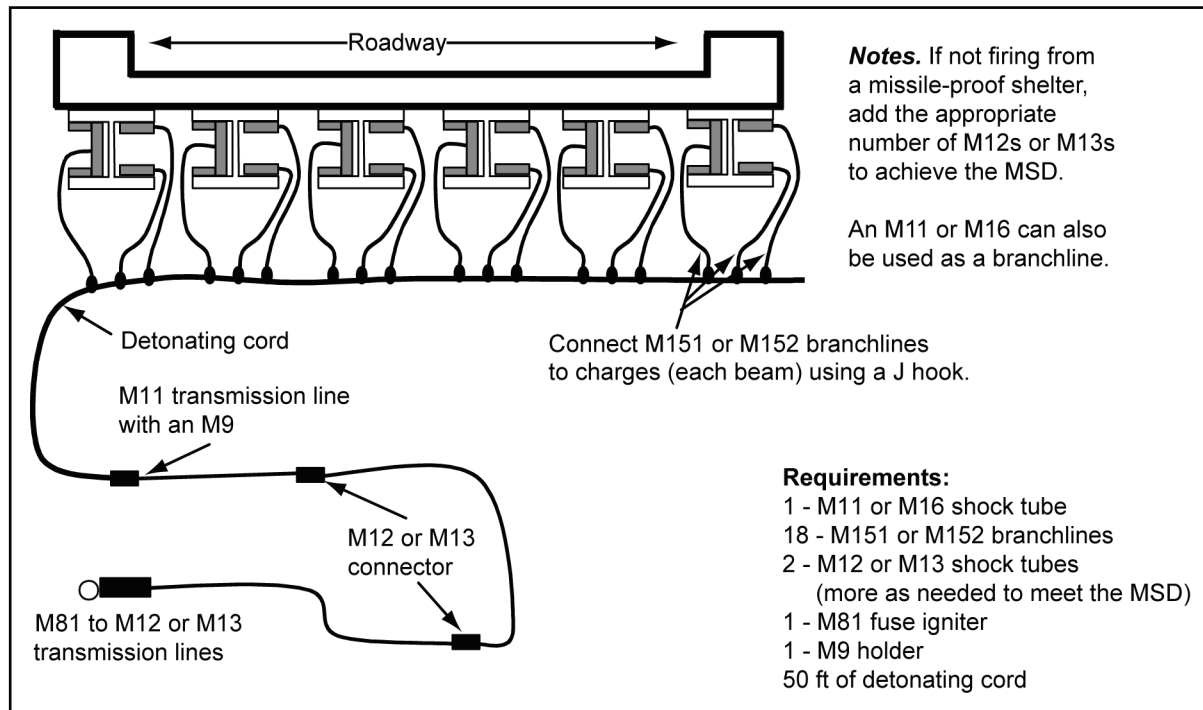


Figure 2-65. Bridge Demolition Charges (MDI or Detonating Cord Combination)

## BRIDGE DEMOLITION CHARGES AND CONSTRUCTION SEQUENCE USING SHOCK TUBE COMPONENTS

2-146. Bridge demolition charges should be emplaced according to the procedures outlined in Chapter 4.

## TIMBER-CUTTING CHARGES

2-147. Timber-cutting charges should be emplaced and primed according to the procedures outlined in Chapter 3.

### EXTERNAL TIMBER CHARGE

2-148. Figure 2-66 shows external timber charges using dual initiation. The following steps are used when placing external timber charges:

- **Step 1.** Place explosives according to the procedures outlined in Chapter 3.
- **Step 2.** Lay out transmission lines from the charge to the firing point.
- **Step 3.** Lay out branchlines from the charges to the holder on the M12 transmission line. Insert the branchlines into the holder, snap the hinged flap shut, and tape it closed.
- **Step 4.** Prime the charges according to the procedures outlined in Chapter 3, using minimal personnel on the site.
- **Step 5.** Inspect the firing system while moving to the firing point once all charges have been properly placed and primed. At the firing point, attach the M81 fuse igniter to the end of the M12 or M13 transmission line and initiate the firing system.

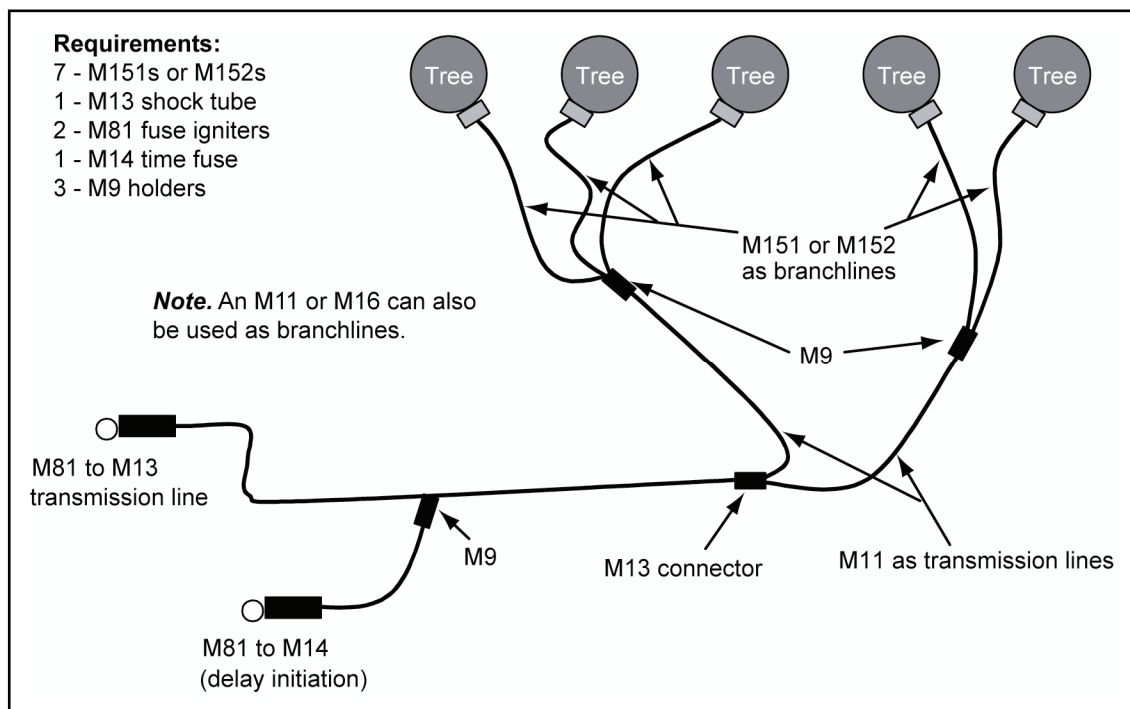


Figure 2-66. External Timber Charges Using Dual Initiation

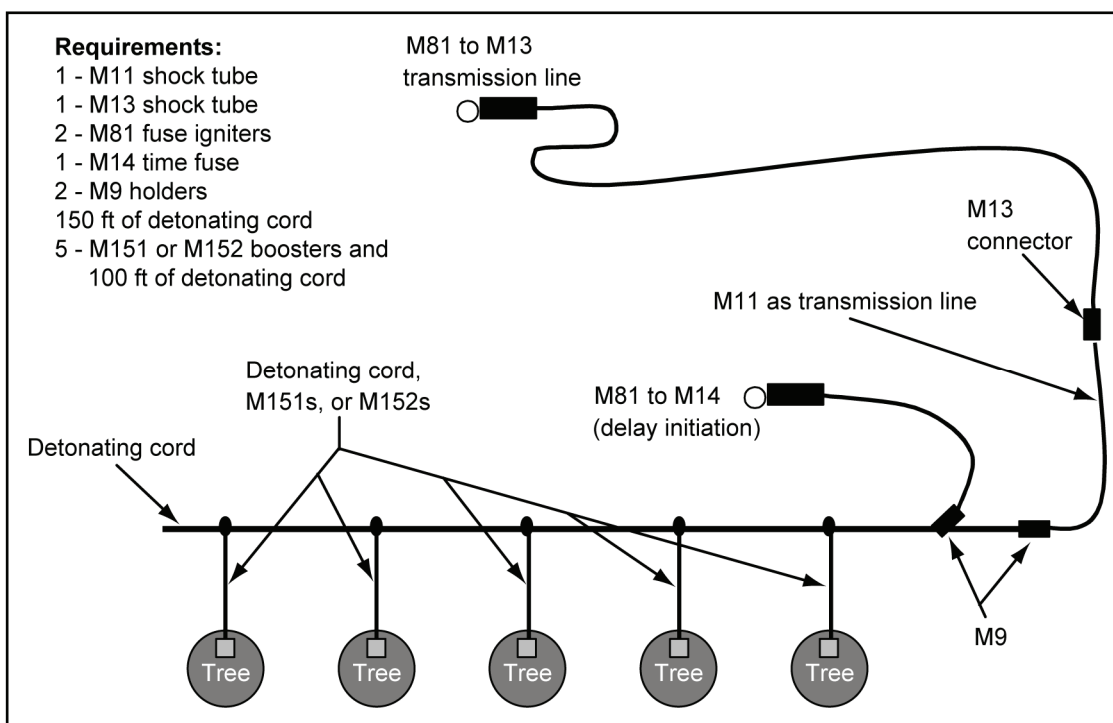
## INTERNAL TIMBER CHARGE

**WARNING**

**Do not use MDI shock tube components for priming internal charges. Use the M151 or M152. Failure to comply could result in immediate personal injury or damage to equipment.**

2-149. Figure 2-67 shows internal timber charges with dual initiation. The following steps are used when placing internal timber charges:

- **Step 1.** Place primed explosives according to the procedures outlined in Chapter 3.
- **Step 2.** Lay out transmission lines from the charge to the firing point.
- **Step 3.** Lay out branchlines.
- **Step 4.** Tie the branchlines into the line main.
- **Step 5.** Construct the line main according to the procedures outlined in Chapter 2.
- **Step 6.** Connect the transmission line to the line main using an M9 holder, and tape it closed.



**Figure 2-67. Internal Timber Charges With Dual Initiation**

## BREACHING CHARGES

2-150. Breaching charges are emplaced according to the procedures outlined in Chapter 3. See Figure 2-68.

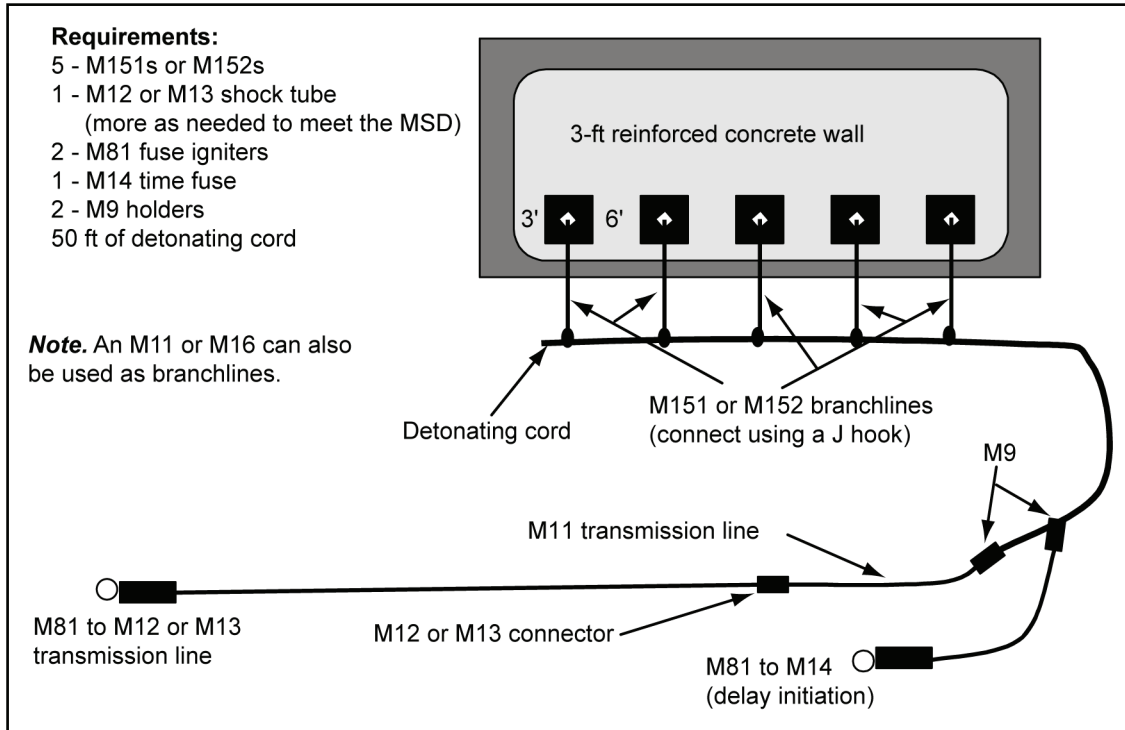


Figure 2-68. Breaching Using Detonating Cord and Dual Initiation

## MINEFIELD BREACHING CHARGES

2-151. Emplace (mine or countermine) breaching charges according to the procedures outlined in FM 3-34.210. Using blasting cap components is not very efficient due to the time constraints and direct-fire exposure. Use of M151 or M152 boosters or detonating cord are the preferred methods for minefield-breaching charges during tactical or protective-minefield breaches.

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## Chapter 3

# Charge Calculations and Placement

This chapter discusses charge calculations. Included are the six-step, problem-solving formats for all types of calculations and the different methods for placing charges.

### SECTION I – DEMOLITIONS

#### DEMOLITION PRINCIPLES

3-1. The amount and placement of explosives are key factors in military demolition projects. Formulas are available to help an engineer calculate the required amount of explosives. Demolition principles and critical-factor analysis guide a Soldier in working with explosive charges. The available formulas for demolition calculations are based on the detonation effects, the charge dimension significance, and the charge-placement significance.

#### DETONATION EFFECTS

3-2. When an explosive detonates, it violently changes into highly compressed gas. The explosive type, density, confinement, and dimensions determine the rate at which the charge changes to a gaseous state. The resulting pressure then forms a compressive shock wave that shatters and displaces objects in its path. A HE charge detonated in direct contact with a solid object produces the following three detectable, destructive effects:

- **Deformation.** The shock wave charge deforms the surface of the object directly under the charge. When the charge is placed on a concrete surface, it causes a compressive shock wave that crumbles the concrete in the immediate vicinity of the charge, forming a crater. When placed on a steel surface, the charge causes an indentation or depression about the size of the charge contact area.
- **Spalling.** The shock wave of the charge chips away at the surface of the object directly under the charge. This action is known as spalling. If the charge is large enough, it will spall the opposite side of the object. Because of the difference in density between the target and the air, the compressive shock wave of the charge reflects as a tensile shock wave from the free surface if the target has a free surface on the side opposite the charge. This action causes spalling of the target-free surface. The crater and spalls may meet to form a hole through the wall in concrete demolitions. On a steel plate, the charge may create one spall in the shape of the explosive charge, throwing the spall from the plate.
- **Radial cracking.** If the charge is large enough, the expanding gases can create a pressure load on the object that will cause cracking and displacing of material. This effect is known as radial cracking. When placed on concrete walls, the charge may crack the surface into a large number of chunks and project them away from the center of the explosion. When placed on steel plates, the charge may bend the steel away from the center of the explosion.

#### CHARGE DIMENSION SIGNIFICANCE

3-3. The force of an explosion depends on the quantity and power of the explosive. The destructive effect depends on the direction of the explosive force. To transmit the greatest shock, a charge must have the optimal relationship of the contact area and the thickness to the target volume and density. If a calculated charge is spread too thinly, not enough space will be provided for the shock wave to reach full velocity before striking the target. In improperly configured explosives (too thin or wrong strength), the shock wave tends to travel in a parallel rather than a perpendicular direction to the surface. As a result, the volume of

the target will be too much for the resulting shock wave. Additionally, a thick charge with too small a contact area will transmit a shock wave over too small a target area with much lateral loss of energy.

### CHARGE PLACEMENT SIGNIFICANCE

3-4. The destructive effect of an explosive charge depends on the location of the charge in relation to the size, shape, and configuration of the target. For the most destructive effect, detonate an explosive of the proper size and shape for the size, shape, and configuration of the target. Any significant air or water gap between the target and explosive will lessen the force of the shock wave. Cut explosives (such as sheet or plastic explosives) to fit odd-shaped targets. Whenever possible, place explosive charges to detonate through the smallest part of the target. Use internal charges to achieve maximum destruction with minimum explosives expense. Tamping external charges increases their destructive effect.

### CHARGE TYPES

3-5. Internal and external charges are the two charge types. Internal charges are charges that are placed in boreholes in the target. External charges are charges that are placed on the surface of the target.

#### INTERNAL CHARGES

3-6. Internal charges are confined with tightly packed sand, wet clay, or other material (stemming). Stemming is the process of packing material on top of an internal borehole or crater charge. Stemming material is filled and tamped against the explosive to fill the borehole to the surface. In drilled holes, tamp the explosive as it is loaded into the hole. Stemming material should be tamped only with a nonsparking tool.

#### EXTERNAL CHARGES

3-7. External charges are covered and tamped with tightly packed sand, clay, or other dense material. Stemming material may be loose or in sandbags. To be most effective, make the thickness of the tamping material at least equal to the breaching radius. Small breaching charges are tamped on horizontal surfaces with several inches of wet clay or mud.

### CHARGE CALCULATION FACTORS

3-8. The amount of explosives required is calculated for any demolition project. Charge calculations are based on the following critical factors:

- **Type and strength of target materials.** A target may be timber, steel, or other material. Concrete may be reinforced with steel to increase the strength of the concrete.
- **Target size, shape, and configuration.** These characteristics all influence the required type and amount of explosives. For example, large or odd-shaped targets, such as concrete piers and steel beams, are more economically demolished with multiple charges than with a single charge.
- **Desired demolition effect.** The extent of the demolition project and the other desired effects should be considered, such as the direction that trees will fall when constructing an abatis.
- **Explosive type.** The characteristics of each explosive type determine its application for demolition purposes. Table 1-1, pages 1-2 and 1-3, lists these characteristics.
  - **Charge size and placement (Table 3-1).** When using external charges without considering placement techniques, use a flat, square charge with a thickness-to-width ratio of 1:3. Charges should be fastened to the target using wire, adhesive compound, tape, or string. Charges should be propped against targets with wooden or metal frames made of scrap or other available materials or placed in boreholes.
- **Tamping method.** If you do not completely seal or confine the charge or if you do not ensure the material surrounding the explosive is balanced on all sides, the force of the explosive will escape through the weakest spot. To keep as much explosive force as possible on the target, pack material around the charge to fill any empty space. This material is called tamping material, and



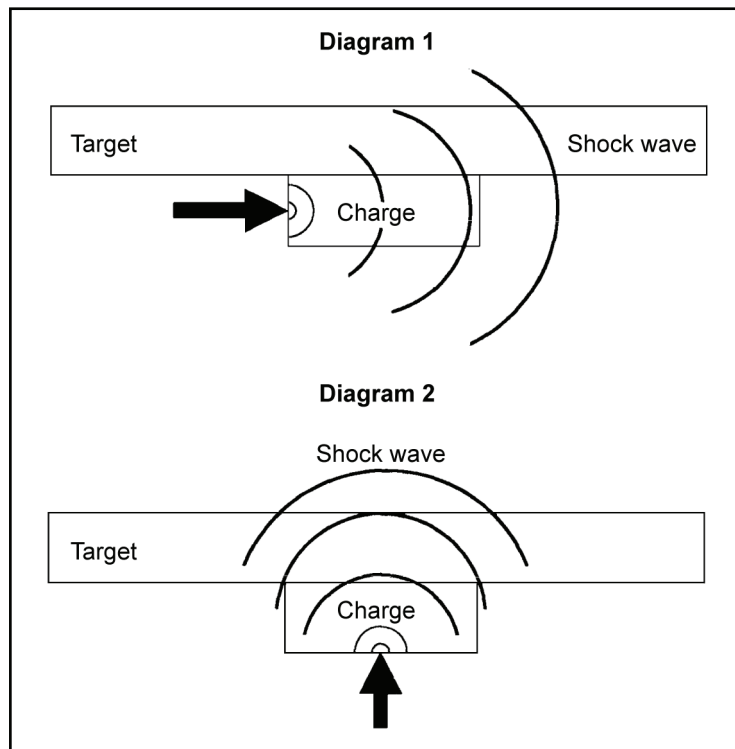
the process is called tamping. Sandbags and earth are examples of common tamping materials. Always tamp charges with a nonsparking tool.

- Priming direction.** The direction in which the shock wave travels through the explosive charge will affect the rate of energy transmitted to the target. If the shock wave travels parallel to the surface of the target (Figure 3-1, Diagram 1), the shock wave will transmit less energy over a period of time than if the direction of detonation is perpendicular to the target (Figure 3-1, Diagram 2). For best results, prime the charge in the center of the face farthest from the target.

**Table 3-1. Breaching Charge Thickness**

<i>Charge Weight (lb)</i>	<i>Charge Thickness (in)</i>
Less than 5	1
5 to less than 40	2
40 to less than 300	4
300 or more	8

**Note.** If using TNT, use the approximate thickness.



**Figure 3-1. Direction of Initiation**

## EXPLOSIVE SELECTIONS

3-9. Explosive selection for successful demolition operations is a balance between the factors listed in paragraph 3-8 and the practical aspects; target type; the amount and types of explosives, materials (such as sandbags), equipment, and personnel available; and the amount of time available to accomplish the mission.

## CHARGE CALCULATIONS

3-10. Use the six-step, problem-solving format below for all charge calculations. This format is used to determine the weight (P) of the explosives required for a demolition task in pounds of TNT. If using an explosive other than TNT, adjust P accordingly by dividing P for TNT by the relative effectiveness (RE) factor of the explosive you plan to use (Table 1-1, pages 1-2 and 1-3).

- **Step 1.** Determine the critical dimensions of the target.
- **Step 2.** Calculate the weight of a single charge of TNT by using the appropriate demolition formula.
- **Step 3.** Divide the quantity of explosive by the RE factor. Skip this step if using TNT.
- **Step 4.** Determine the number of packages of explosive for a single charge by dividing the individual charge weight by the standard package weight of the chosen explosive. Round this result to the next higher, whole package. Use volumes instead of weights for special-purpose charges (ribbon, diamond, saddle, and similar charges).
- **Step 5.** Determine the number of charges based on the targets.
- **Step 6.** Determine the total quantity of explosives required to destroy the target by multiplying the number of charges (step 5) by the number of packages required per charge (step 4).

## SECTION II – NORMAL CUTTING CHARGES

### TIMBER-CUTTING CHARGES

3-11. Plastic explosives are the best timber-cutting charges for both internal and external placement. These explosives make excellent internal charges because they are easily tamped into boreholes. They make excellent external charges, because they are easy to tie, tape, or fasten to the target. Timber will vary widely in its physical properties from location to location, requiring careful calculation. Therefore, make test shots on the specific timber type to determine the optimal size of the timber-cutting charge.

#### INTERNAL CHARGES

3-12. The following formula is used to calculate internal cutting charges:

$$P = \frac{D^2}{250} \text{ or } P = 0.004D^2$$

where—

*P* = TNT required per tree (in pounds)

*D* = diameter or the least dimension of dressed timber (in inches)

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**Note.** Diameter = circumference divided by 3.14

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For trees that are up to 18 inches in diameter, use one hole to place the explosive. For larger trees, use two holes drilled at right angles to each other without intersecting but as close together as possible. Two-inch-diameter holes should be drilled to a depth equal to two-thirds of the diameter of the tree. Evenly split the required charge between the holes. This will allow enough room to place the explosive in the holes and leave enough room to cap them with mud or clay (Figure 3-2). For dimensioned timber requiring two boreholes, place the boreholes side by side. When placing the charges, form the plastic explosive to the approximate diameter of the hole. To not reduce the density of the explosive, try to minimize the amount of molding. The charge is primed with detonating cord (see Chapter 2, Section II) and placed in the hole. A nonsparking tool is used to finish filling the holes by packing them with mud or clay. When using two boreholes, connect the branchlines in a British junction (Figure 2-33, page 2-29). For an example calculation, see Appendix F (Figure F-1, page F-1).

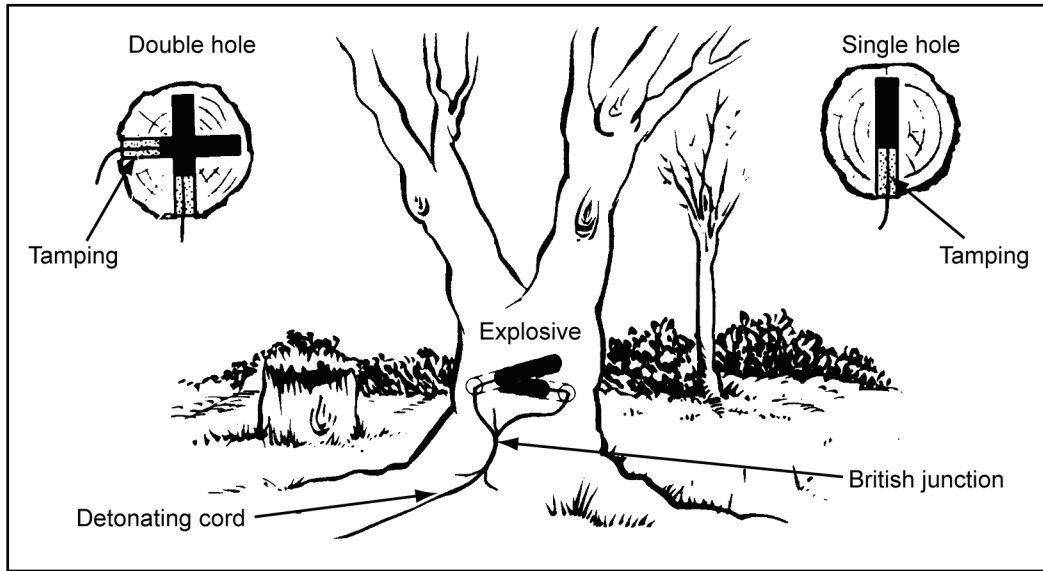


Figure 3-2. Timber-Cutting Charge (Internal)

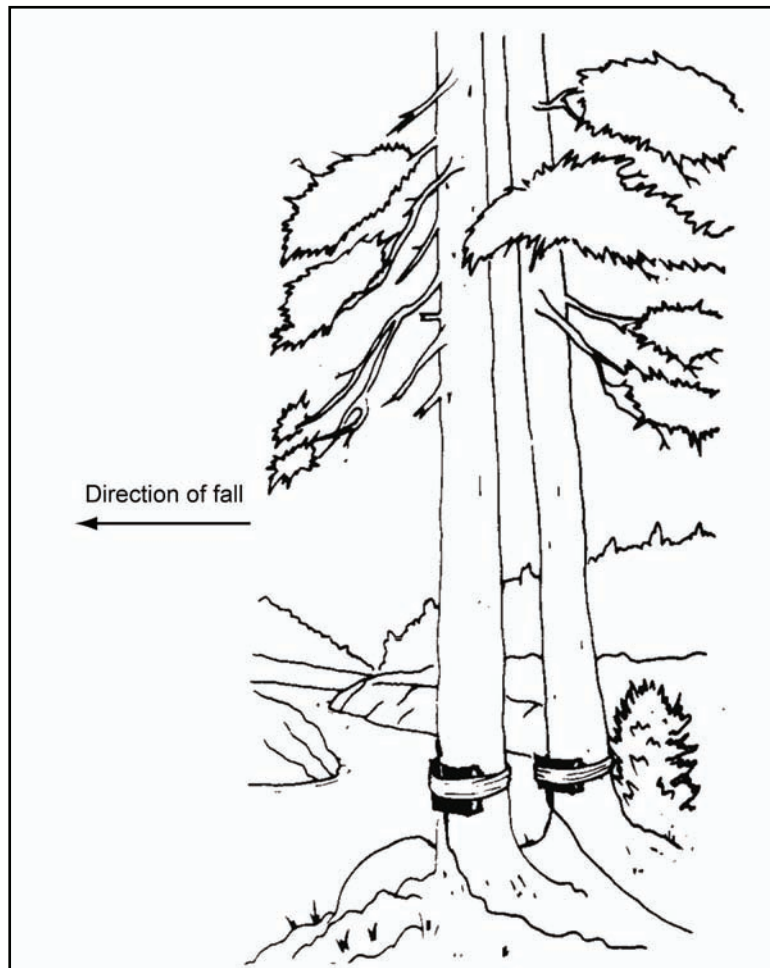
**EXTERNAL CHARGES**

3-13. To be most effective, external charges should be rectangular, 1 to 2 inches thick, and twice as wide as they are high. Remove the bark to place the explosive in direct contact with solid wood and to reduce air gaps between the charge and the wood. If the timber is not round or if the direction of fall is not important, place the explosive on the widest face. This will concentrate the force of the blast through the least dimension of the timber. Trees will fall toward the side on which the explosive is placed, unless influenced by the wind or the lean of the tree (Figure 3-3, page 3-6). If the tree is leaning the wrong way or a strong wind is blowing, place a 1-pound kicker charge on the side opposite the main charge, about two-thirds of the way up the tree. The kicker charge is fired at the same time as the main charge. For the best results when using composition C4, orient the longest dimension of the charge horizontally. Orienting the charges vertically tends to allow gaps to develop between the charges. Use the following formula to determine the amount of explosive needed for cutting trees, posts, beams, or other timber using untamped external charges. For an example calculation, see Figure F-2, page F-2.

$$P = \frac{D^2}{40} \text{ or } P = 0.025D^2$$

where—

- P = TNT required per target (in pounds)
- D = diameter or least dimension of dimensioned timber (in inches)



**Figure 3-3. Timber-Cutting Charge (External)**

### **RING CHARGE**

3-14. The ring charge is a band of explosives that completely encircles the tree (Figure 3-4). The explosive band should be as wide as possible and at least 1/2 inch thick for small-diameter trees (up to 15 inches in diameter) and 1 inch thick for medium- and large-diameter trees (up to 30 inches in diameter). Remove the bark to place the explosive in direct contact with solid wood and to reduce air gaps between the charge and the wood. Determine the amount of explosive necessary by using the external-charge formula. Prime the ring charge in two opposing places with branchlines. Connect the branchlines in a British junction (Figure 2-33, page 2-29).

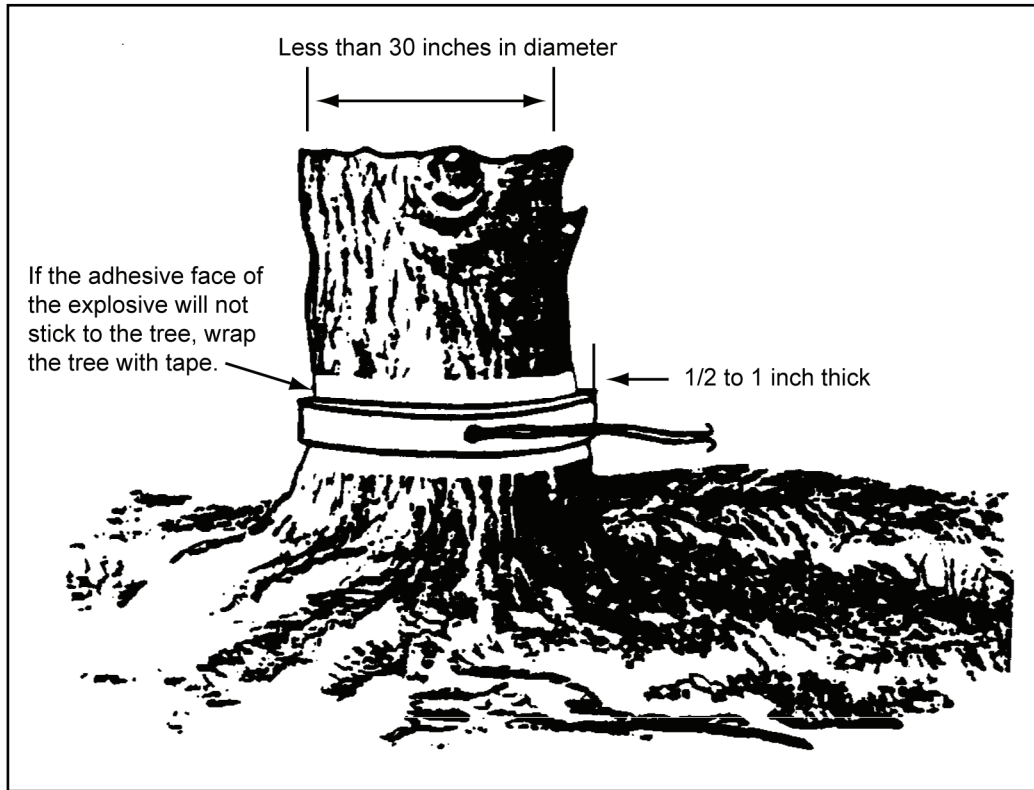


Figure 3-4. Timber-Cutting Ring Charge

## UNDERWATER CHARGES

3-15. To cut a timber pile underwater, a method similar to the one shown in Figure 3-5 should be used. The charge size is determined using the breaching formula. On the upstream side of the pile, the charge should be placed as deep as possible. The stream flow on this part of the pile will maximize the tamping effect on the explosive. If timber underwater is to be cut below mud or sand, engineer diver assets can be used to water jet the soil away before charges are placed.

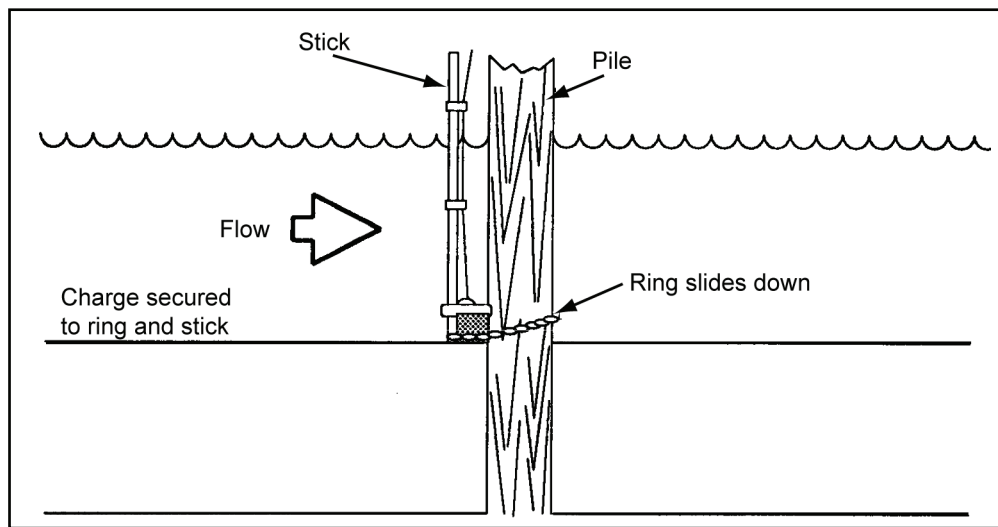


Figure 3-5. Cutting a Timber Pile Underwater

**ABATIS**

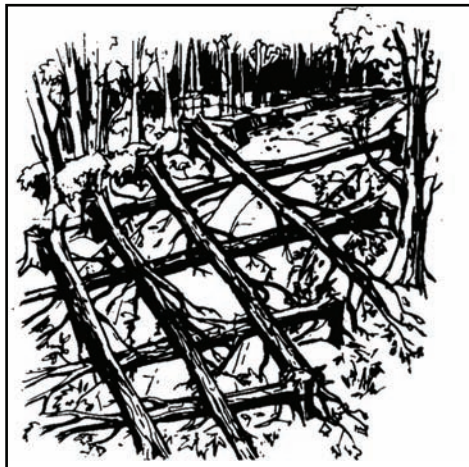
3-16. Fallen tree obstacles (Figure 3-6) are made by cutting trees that remain attached to their stumps. Since trees vary in their physical properties, a test shot should be conducted if time and explosives are available. The following formula is used to compute the amount of TNT required for the test shot:

$$P = \frac{D^2}{50} \text{ or } P = 0.02D^2$$

where—

*P* = TNT required per tree (in pounds)

*D* = diameter or least dimension of dimensioned timber (in inches)



**Figure 3-6. Abatis**

**Placement**

3-17. External placement should be used with the charge 5-feet aboveground level. The tree will fall toward the side where the explosive is attached unless influenced by the lean of the tree or wind.

**Special Considerations**

3-18. The following should be considered when creating an abatis:

- Place a 1-pound kicker charge on the side opposite the main charge, about two-thirds of the way up the tree, if the tree is leaning the wrong way or a strong wind is blowing. Fire the kicker charge at the same time as the main charge.
- Ensure that the obstacle will cover at least 75 meters in depth.
- Ensure that the individual trees are at least 2 feet in diameter. Smaller trees are not effective obstacles against tracked vehicles.
- Fell trees 3 to 5 meters apart to create a condition to prevent tracked vehicles from driving over the top of the obstacle.
- Fell the trees at a 45° angle toward the enemy.
- Simultaneously detonate the charges on one side of the road at a time and then fell the trees on the other side of the road.
- Enhance the obstacle with the use of wire, mines, and booby traps.

**HASTY TIMBER CALCULATIONS**

3-19. The situation sometimes require the use of hasty timber calculations. Table 3-2 lists the required number of composition C4 packages for cutting timber with internal, external, and abatis charges.

**Table 3-2. Timber-Cutting Charge Size**

Charge Type	Packages of Composition C4 (1.25-lb packages) Required by Timber Diameter (in)											
	6	8	10	12	15	18	21	24	27	30	33	36
Internal	1	1	1	1	1	1	2	2	2	3	3	4
External	1	1	2	3	4	5	7	9	11	14	17	20
Abatis	—	—	—	—	—	—	—	7	9	11	14	16

**Note.** The packages required are rounded up to the next whole package.

## STEEL-CUTTING CHARGES

**WARNING**

**Steel-cutting charges produce metal fragments. Proper precautions should be taken to protect personnel. Failure to comply could result in immediate personal injury or damage to equipment.**

3-20. In order to prepare steel-cutting charges, the target factors and the explosive factors must be known. The paragraphs below discuss the target and explosive factors.

### TARGET FACTORS

3-21. Target configuration and target materials are critical in steel-structure demolitions, more so than with other materials.

#### Target Configuration

3-22. The configuration of the steel in the structure determines the type and amount of charge necessary for successful demolition. Examples of structured steel are I beams, wide-flange beams, channels, angle sections, structural Ts, and steel plates used in building or bridge construction.

#### Target Materials

3-23. In addition to its configuration, steel also has a varied composition. It includes—

- **High-carbon steel.** Metalworking dies and rolls are composed of high-carbon steel and are very dense.
- **Alloy steel.** Gears, shafts, tools, and plowshares are usually composed of alloy steel. Chains and cables are often made from alloy steel; however, some chains and cables are composed of high-carbon steel. Alloy steel is not as dense as high-carbon steel.
- **Cast iron.** Some steel components (such as railroad rails and pipes) are composed of cast iron. Cast iron is very brittle and easily broken.
- **Nickel-molybdenum steel.** Nickel-molybdenum steel cannot be cut easily by conventional steel-cutting charges. The jet from a shaped charge will penetrate it, but cutting requires multiple charges or linear-shaped charges. Nickel-molybdenum steel shafts can be cut with a diamond charge, but not with the saddle charge. Therefore, use some method other than explosives to cut nickel-molybdenum steel, such as thermite, acetylene, or electrical cutting tools.

## EXPLOSIVE FACTORS

3-24. In steel-cutting charges, the type, placement, and size of the explosive are important. Confining or tamping the charge is rarely practical or possible. The type, placement, and size are factors that are important when selecting steel-cutting charges.

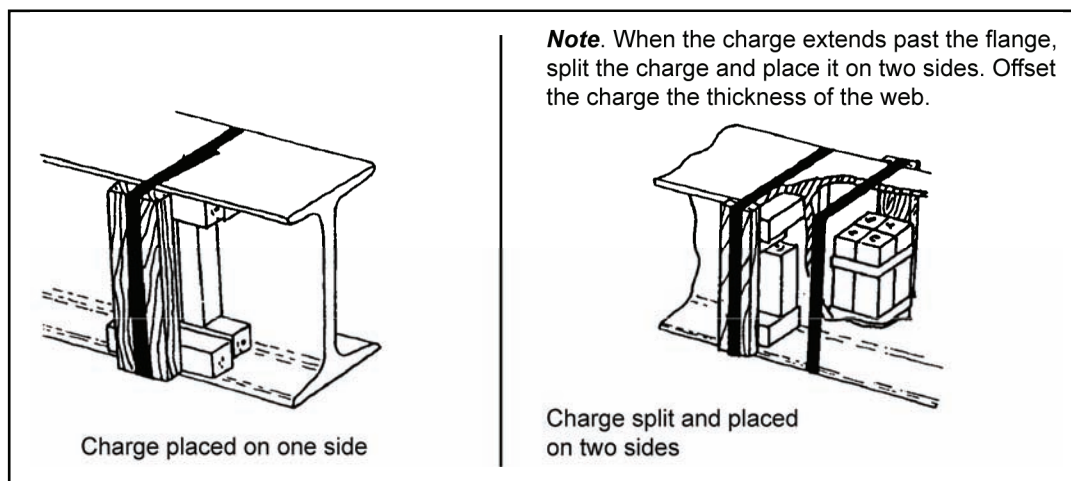
### Type

3-25. Plastic explosive (composition C4) and sheet explosive are the best explosives for steel cutting. These explosives have very effective cutting power and are easily cut and shaped to fit tightly into the grooves and angles of the target. These explosives are particularly effective when demolishing structural steel, chains, and steel cables.

### Placement

3-26. See Figure 3-7. To achieve the most effective initiation and results, ensure that—

- The charge is continuous over the complete line of the proposed cut.
- There is close contact between the charge and the target.
- The width of the cross section charge is between one and three times its thickness. Do not use charges more than 6 inches thick, because better results can be achieved by increasing the width rather than the thickness.
- The long charges are primed every 4 to 5 feet. If butting composition C4 packages end-to-end along the line of the cut, prime every fourth package.
- The direction of initiation is perpendicular to the target (Figure 3-1, page 3-3).



**Figure 3-7. Placing Charges on Steel Members**

### Size

3-27. The size of the charge is dictated by the type and size of the steel I beam and the charge type selected. Either composition C4 or TNT block explosives can be used for the cutting steel; composition C4 works the best. Each steel configuration requires a unique charge size.

### Block Charge

3-28. The following formula will give you the charge size necessary for cutting I beams, built-up girders, steel plates, columns, and other structural steel sections. When calculating cutting charges for steel beams, the area for the top flange, web, and the bottom flange should be calculated. Built-up beams have rivet heads and angles or welds joining the flanges to the web. The thickness of one rivet head and the angle iron must be added to the flange thickness when determining the thickness of a built-up beam flange. The thinnest point of the web is used as the web thickness (the rivet head and angle iron thickness should be



ignored). The lattice of lattice girder webs are cut diagonally by placing a charge on each lattice along the line of the cut. Use Table 3-3 and Table 3-4, page 3-12, to determine the correct amount of explosive necessary for cutting steel sections. The following formula is used to determine the required charge size (Table 3-3 is based on this formula) (see sample calculations in Appendix F, Figures F-3 and F-4, pages F-3 and F-4):

$$P = \left(\frac{3}{8}\right) A \text{ or } P = 0.375A$$

where—

*P* = TNT required (in pounds)

*A* = cross-sectional area of the steel member (in square inches) cross-sectional area for a circular target ( $A = \pi r^2$  [ $\pi = 3.14$ ])

**Table 3-3. Hasty, Steel-Cutting Chart for TNT**

Average Thickness of Section (in)	Pounds of Explosive (TNT) for Rectangular Steel Sections of Given Dimensions																
	Height of Section (in)																
	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24
1/4	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.5	1.7	1.9	2.1	2.3
3/8	0.3	0.5	0.6	0.7	0.9	1.1	1.2	1.3	1.4	1.6	1.7	2.0	2.3	2.6	2.8	3.1	3.4
1/2	0.4	0.6	0.8	1.0	1.2	1.4	1.5	1.7	1.9	2.1	2.3	2.7	3.0	3.4	3.8	4.2	4.5
5/8	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.2	2.4	2.7	2.9	3.3	3.8	4.3	4.7	5.2	5.7
3/4	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.8	3.1	3.4	4.0	4.5	5.1	5.7	6.3	6.8
7/8	0.7	1.0	1.4	1.7	2.0	2.4	2.7	3.0	3.3	3.7	4.0	4.6	5.3	6.0	6.6	7.3	7.9
1	0.8	1.2	1.5	1.9	2.3	2.7	3.0	3.4	3.8	4.2	4.5	5.3	6.0	6.8	7.5	8.3	9.0

Table 3-4. Hasty, Steel-Cutting Chart for Composition C4

Follow these steps to use this table: 1. Measure each rectangular section of the total member separately. 2. Find the appropriate charge size for the rectangular section from the table. Use the next larger dimension if the section dimension is not listed in the table. 3. Add the individual charges for each section to obtain the total charge weight.														
Section Thickness (in)	Weight of Composition C4 Required for Rectangular Steel Sections (height or width, in inches)													
	2	3	4	5	6	8	10	12	14	16	18	20	22	24
1/4	0.2	0.3	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.2	1.3	1.5	1.6	1.8
3/8	0.3	0.4	0.5	0.6	0.7	0.9	1.1	1.3	1.5	1.8	2.0	2.1	2.4	2.6
1/2	0.3	0.5	0.6	0.8	0.9	1.2	1.5	1.8	2.1	2.3	2.6	2.9	3.2	3.4
5/8	0.4	0.6	0.8	0.9	1.1	1.5	1.8	2.2	2.5	2.9	3.2	3.5	3.9	4.3
3/4	0.5	0.7	0.9	1.1	1.3	1.8	2.1	2.6	3.0	3.4	3.8	4.3	4.7	5.1
7/8	0.6	0.8	1.1	1.3	1.5	2.1	2.5	3.0	3.5	4.0	4.5	5.0	5.5	5.9
1	0.6	0.9	1.2	1.5	1.8	2.3	2.9	3.4	4.0	4.5	5.1	5.6	6.2	6.8
<b>Note.</b> Round up to the nearest 1/10 pound when calculating charge size.														

**High-Carbon or Alloy Steel**

3-29. The following formula should be used to determine the required charge for cutting high-carbon or alloy steel:

$$P = D^2$$

where—

$P$  = TNT required (in pounds)

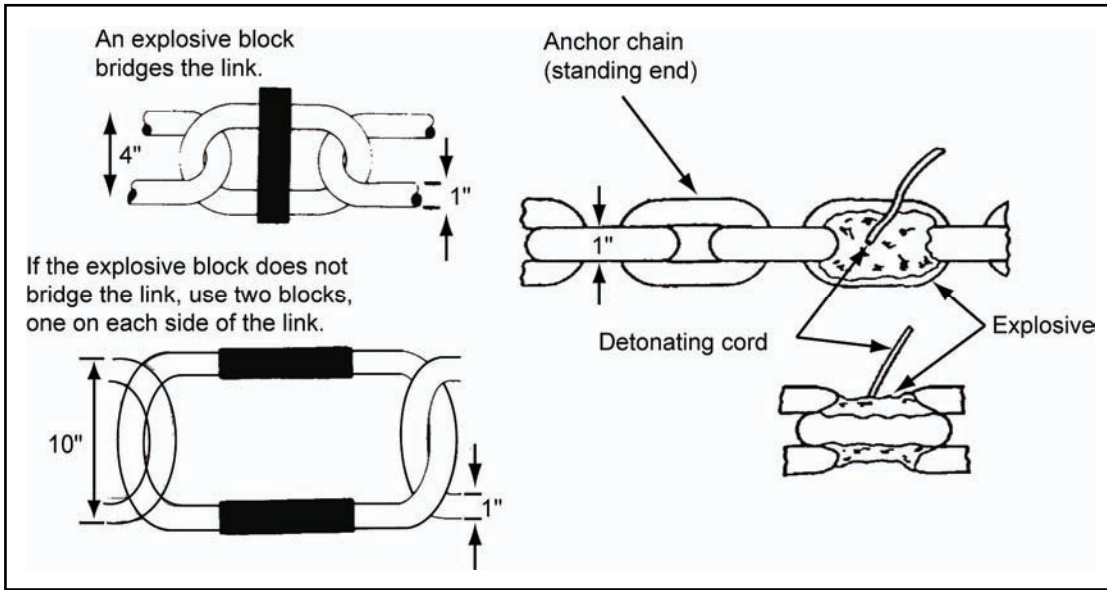
$D$  = diameter or thickness of section to be cut (in inches)

**Steel Bars, Rods, Chains, and Cables (Up to 2 Inches)**

3-30. The size of these materials make proper charge placement difficult. For example, Figure 3-8 shows a charge placement on a chain. If the explosive is long enough to bridge both sides of the link or is large enough to fit snugly between the two links, use one block. If the explosive is not large enough to bridge both sides, two blocks should be used. The following amount of explosive should be used:

- One pound of explosive for materials up to and including 1 inch in diameter or thickness.
- Two pounds of explosive for materials between 1 and 2 inches in diameter or thickness. Prime both charges so they will detonate simultaneously.

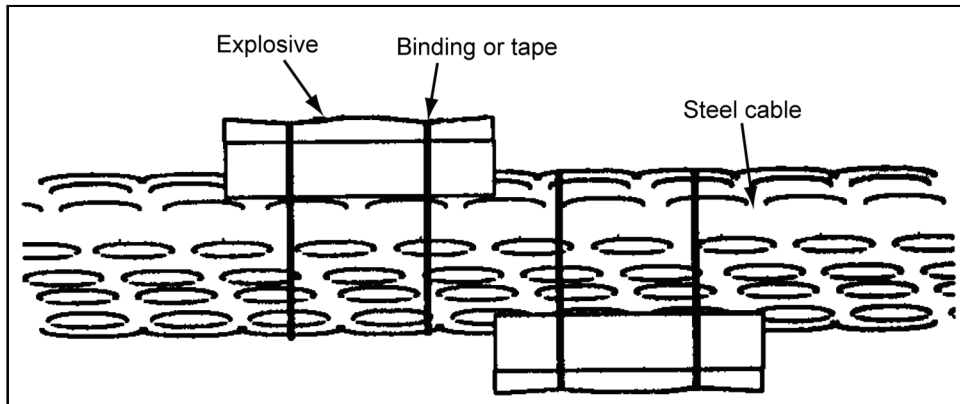
**Note.** Experience has shown that a link filled with explosive will be severed by detonation. See Appendix G for the underwater method.



**Figure 3-8. Charge Placement on Chains**

***Steel Bars, Rods, Chains, and Cables (Over 2 Inches)***

3-31. When the target diameter or thickness is 2 inches or greater, the equation for high-carbon or alloy steel should be used. When the thickness or diameter is 3 inches or greater, half of the charge should be placed on each side of the target, and the placement should be staggered to produce the maximum-shearing effect (Figure 3-9).



**Figure 3-9. Charge Placement on a Steel Cable (3 Inches or Larger)**

***Railroad Rails***

3-32. The height of the railroad rail is the critical dimension for determining the amount of explosives required. For rails 5 inches or more in height, such as rail crossovers or switches, 1 pound of explosives should be used. For rails less than 5 inches high, use 1/2 pound of explosives (Figure 3-10, page 3-14). Railroad frogs require 2 pounds of explosives. If possible, charges should be placed at vulnerable points, such as frogs, switches, and crossovers. Charges should be placed at alternate rail splices for a distance of 500 feet and on the inside of the rails.

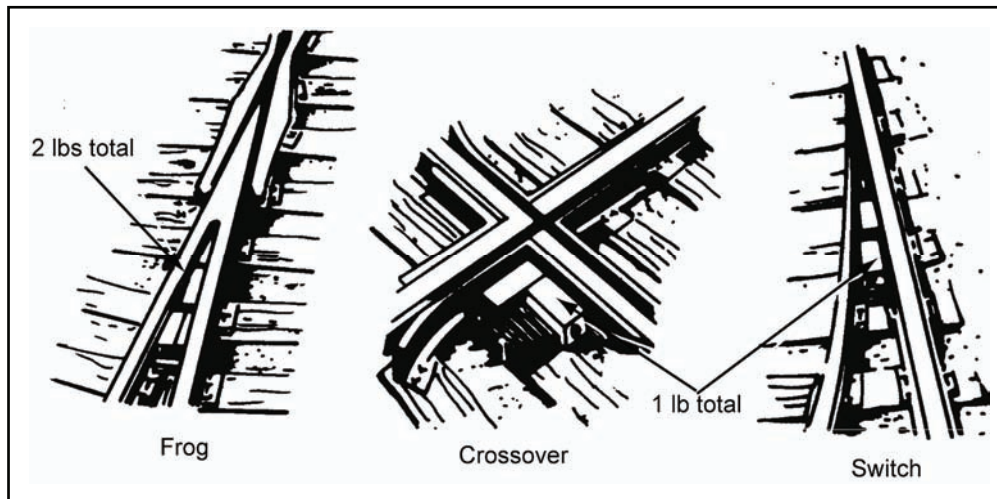


Figure 3-10. Charge Placement on Railroad Rails

## SECTION III – SPECIAL CUTTING CHARGES

### PURPOSE

3-33. When time and circumstances permit, special cutting charges (ribbon, saddle, and diamond charges) should be used instead of conventional cutting charges. These charges may require extra time to prepare, since they require exact and careful target measurement to achieve optimal effect. With practice, an engineer can become proficient at calculating, preparing, and placing these charges in less time than required for traditional charges. Special cutting charges use considerably less explosive than conventional charges. Plastic-explosive (M112) or sheet explosive (M186) charges should be used as special charges. Composition C4 requires considerable cutting, shaping, and molding that may reduce its density and, therefore, its effectiveness. Using special cutting charges requires considerable training and practice.

### RIBBON CHARGE

3-34. Ribbon charges are used to cut flat, steel targets up to 3 inches thick (Figure 3-11). The charge thickness is made one-half the target thickness, but never less than 1/2 inch. The charge width is made three times the charge thickness and the length of the charge is equal to the length of the desired cut. Ribbon charges are detonated from the center of the C-shaped charge and the center of the top and bottom flange charges when placing on I beams or wide-flange beams. When using the ribbon charge to cut structural steel sections, the charge should be placed as shown in Figure 3-12. The detonating cord branchlines must be the same length and must connect in a British junction (Figure 2-33, page 2-29). Figure F-5, page F-5, shows how to calculate steel-cutting charges for steel plates. The charge thickness, width, and length is determined as follows:

- **Charge thickness.** The charge thickness equals one-half the thickness of the target; however, it will never be less than 1/2 inch. The thickest part of the target is used to calculate the charge thickness.
- **Charge width.** The charge width equals three times the charge thickness.
- **Charge length.** The charge length equals the length of the desired cut.

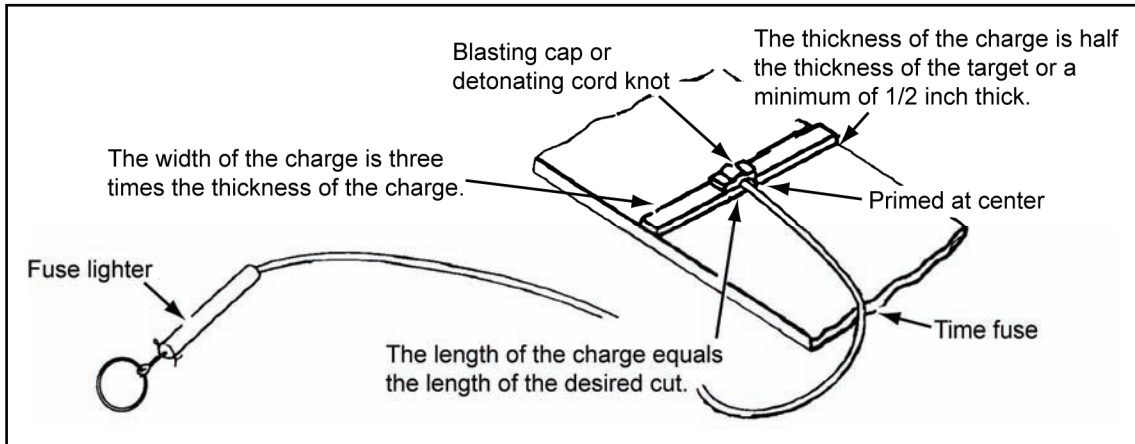


Figure 3-11. Using a Ribbon Charge

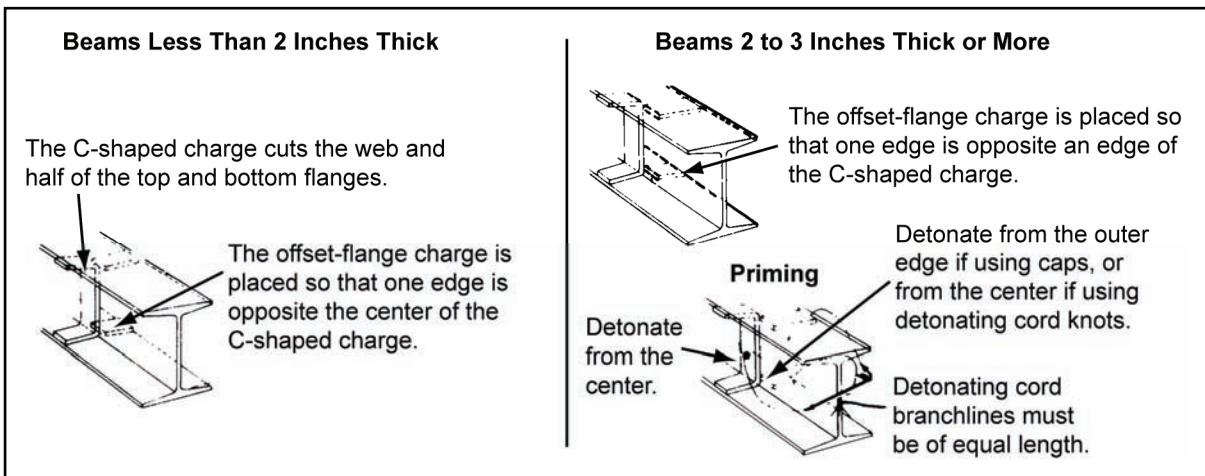


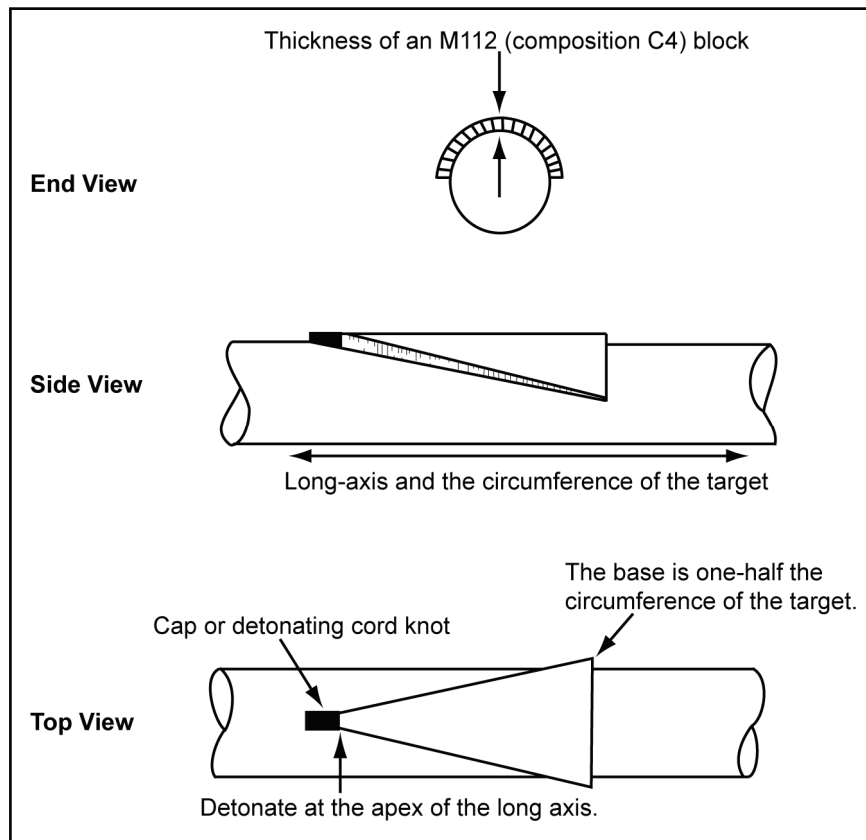
Figure 3-12. Placing a Ribbon Charge on Structural Steel

## SADDLE CHARGE

3-35. This steel cutting method uses the destructive effect of the cross fracture formed in the steel by the base of the saddle charge (the end opposite the point of initiation). This charge is used on mild steel bars, whether round, square, or rectangular shaped, up to 8 inches in diameter (Figure 3-13, page 3-16). The charge is made 1 inch thick. The dimensions, detonation, and the placement of the saddle charge is determined as follows (see Figure F-7, page F-7, for an example calculation on steel cutting charges for steel bars):

- **Dimensions.**
  - **Thickness.** The charge should be made 1 inch thick (the standard thickness of M112 block explosive).
  - **Base width.** The base width should be made equal to one-half the target circumference or perimeter.
  - **Long-axis length.** The long-axis length should be made equal to the target circumference or perimeter.
  - **Volume (cubic inches).** The volume is computed as:  $Long\ axis \times base \times 0.5 = volume$ .
- **Detonation.** Detonate the saddle charge by placing a blasting cap or detonating cord knot at the apex of the long axis.

- **Placement.** Ensure that the long axis of the saddle charge is parallel with the long axis of the target. Cut the charge to the correct shape and dimensions, and then place it around the target. Ensure that the charge maintains close contact with the target by taping the charge to the target.



**Figure 3-13. Using a Saddle Charge**

## DIAMOND CHARGE

3-36. This stress-wave method employs the destructive effect of two colliding shock waves. The simultaneous detonation of the charge from opposite ends (Figure 3-14) produces the shock waves. The diamond charge is used on high-carbon or alloy steel bars that are up to 8 inches in diameter. The dimensions, placement, and priming are determined as follows (for an example calculation on steel-cutting charges for high-carbon steel, see Figure F-8, page F-7):

- **Dimensions.**
  - **Thickness.** The charge should be made 1 inch thick (the standard thickness of an M112 block explosive).
  - **Long-axis length.** The long-axis length should be made equal to the target circumference.
  - **Short-axis length.** The short-axis length should be made equal to one-half the long axis.
  - **Volume (cubic inches).** The volume is computed as:  $Long\ axis \times short\ axis \times 0.5 = volume.$
- **Placement.** Place the explosive completely around the target so that the ends of the long axes touch. Slightly increase the charge dimensions to do this, if necessary. Tape the charge to the target to ensure adequate contact with the target.
- **Priming.** Prime the diamond charge (Figure 3-14) with two detonating cord branchlines using one of the following methods:
  - Detonating cord knots (Figure 2-15, page 2-15).
  - Two caps.

*Note.* When using a British junction, ensure that the branchlines are the same length.

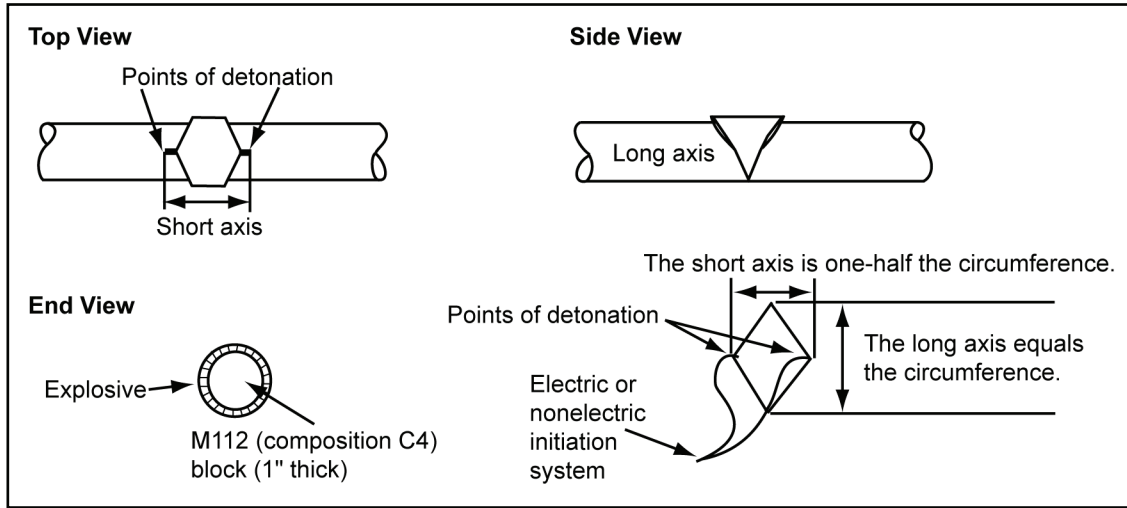


Figure 3-14. Using a Diamond Charge

## SECTION IV – BREACHING CHARGES

### CRITICAL FACTORS

3-37. Breaching charges are used to destroy bridge piers, bridge abutments, and permanent field fortifications. The size, shape, placement, and tamping or confinement of breaching charges is critical to success. The size and confinement of the explosive are the most critical factors, because the targets are usually very strong and bulky. The intent of breaching charges is to produce and transmit enough energy to the target to make a crater and create spalling. Breaching charges placed against reinforced concrete will not cut metal reinforcing bars. After the concrete is breached, remove or cut the reinforcement with a steel-cutting charge.

### COMPUTATION

3-38. When performing a computation for breaching charges, the formula to determine the size of the charge must be known. The breaching radius, the material factor, and the tamping factor must also be known.

### FORMULA

3-39. The following formula is used to determine the size of the charge required to breach concrete, masonry, rock, or similar material:

$$P = R^3KC$$

where—

$P$  = TNT required (in pounds)

$R$  = breaching radius (in feet)

$K$  = material factor, which reflects the strength, hardness, and mass of the material to be demolished (Table 3-5, page 3-18)

$C$  = tamping factor, which depends on the location and tamping of the charge (Figure 3-15, page 3-18).

Table 3-5. Material Factor (K) for Breaching Charges

<i>Material</i>	<i>R</i>	<i>K</i>
Earth	All values	0.07
Poor masonry Shale Hardpan Good timber Earth construction	Less than 1.5 m (5 ft) 1.5 m (5 ft) or more	0.32 0.29
Good masonry, Concrete block Rock	0.3 m (1 ft) or less Over 0.3 m (1 ft) to less than 0.9 m (3 ft) 0.9 m (3 ft) to less than 1.5 m (5 ft) 1.5 m (5 ft) to less than 2.1 m (7 ft) 2.1 m (7 ft) or more	0.88 0.48 0.40 0.32 0.27
Dense concrete First-class masonry	0.3 m (1 ft) or less Over 0.3 m (1 ft) to less than 0.9 m (3 ft) 0.9 m (3 ft) to less than 1.5 m (5 ft) 1.5 m (5 ft) to less than 2.1 m (7 ft) 2.1 m (7 ft) or more	1.14 0.62 0.52 0.41 0.35
Reinforced concrete (factor does not consider cutting steel)	0.3 m (1 ft) or less Over 0.3 m (1 ft) to less than 0.9 m (3 ft) 0.9 m (3 ft) to less than 1.5 m (5 ft) 1.5 m (5 ft) to less than 2.1 m (7 ft) 2.1 m (7 ft) or more	1.76 0.96 0.80 0.63 0.54

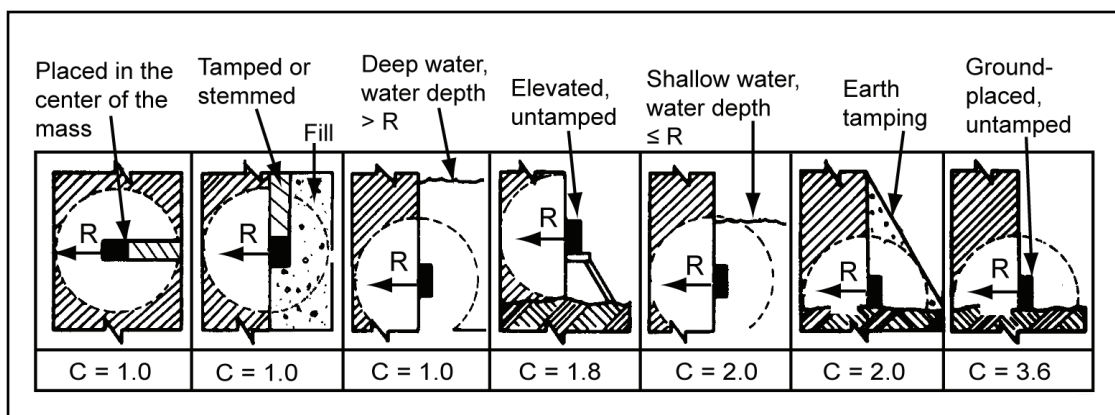


Figure 3-15. Tamping Factor (C) for Breaching Charges

### BREACHING RADIUS

3-40. The breaching radius for external charges is equal to the thickness of the target being breached. For internal charges placed in the center of the target mass, the breaching radius is one-half the thickness of the target. If the charge is placed at less than one-half the mass thickness, the breaching radius is the longer of the distances from the center of the charge to the outside surfaces of the target. For example, when breaching a 4-foot wall with an internal charge placed 1 foot into the wall, the breaching radius is 3 feet (the longest distance from the center of the explosive to an outside target surface). If placed at the center of the wall mass, the breaching radius of the explosive is 2 feet (one-half the thickness of the target). The



breaching radius is 4 feet for an external charge on this wall. Values of R are rounded to the next higher 1/4-foot distance for internal charges and to the next higher 1/2-foot distance for external charges.

### MATERIAL FACTOR

3-41. The material factor represents the strength and hardness of the target material. Table 3-5 gives values for K for various types and thicknesses of material. When the target material cannot be positively identified, assume that the target consists of the strongest material type in the general group. Always assume that concrete is reinforced and masonry is first-class unless the exact condition and construction of the target materials is known.

### TAMPING FACTOR

3-42. The tamping factor depends on the charge location and the tamping materials used. Figure 3-15 shows the methods for placing charges and gives the values of C for both tamped and untamped charges. When selecting a value for C from Figure 3-15, do not consider a charge tamped with a solid material (such as sand or earth) as fully tamped unless the charge is covered to a depth equal to or greater than the breaching radius. The water depth must be greater than the radius to use 1 as C.

### REINFORCED CONCRETE BREACHING

3-43. Table 3-6, page 3-20, gives the number of composition C4 packages required for breaching reinforced concrete targets. The breaching-charge formula does not factor in cutting the steel. The remaining steel is cut using steel-cutting charges. The amounts of composition C4 in the table are based on the formula in paragraph 3-39, page 3-17. To use the table, do the following:

- Measure the concrete thickness.
- Decide how the charge will be placed against the target. Compare the method of placement with the diagrams at the top of Table 3-6. Use the column that lists the greatest amount of explosive if in doubt about which column to use.
- Select the amount of explosive required based on the target thickness, using the column directly under the chosen placement method. For example, 200 packages of composition C4 are required to breach a 7-foot, reinforced concrete wall with an untamped charge placed 7-feet aboveground.

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*Note.* See Figure F-9, page F-8, for an example calculation on breaching charges for a reinforced-concrete pier.

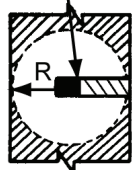

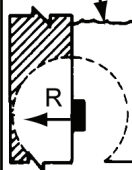
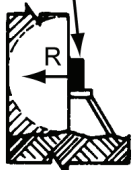
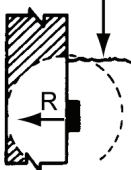
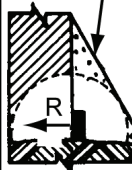

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### MATERIALS BREACHING

3-44. Table 3-6 can be used to determine the amount of composition C4 required for other materials by multiplying the value from the table by the proper conversion factor from Table 3-7, page 3-21. The following procedure can be used:

- Determine the material type in the target. Assume that the material is the strongest type from the same category if in doubt.
- Determine from Table 3-6 the amount of explosive required if the object is made of reinforced concrete.
- Find the appropriate conversion factor from Table 3-7.
- Multiply the number of packages of explosive required (Table 3-6) by the conversion factor (Table 3-7).

**Table 3-6. Breaching Charges for Reinforced Concrete**

	<i>Placement Methods</i>						
	Placed in the center of the mass	Tamped or stemmed	Deep water, water depth > R	Elevated, untamped	Shallow water, water depth ≤ R	Earth tamping	Ground-placed, untamped
							
	C = 1.0	C = 1.0	C = 1.0	C = 1.8	C = 2.0	C = 2.0	C = 3.6
<i>Reinforced Concrete Thickness (ft)</i>	<i>Packages of M112 (Composition C4)</i>						
2.0	1	5	5	9	10	10	17
2.5	2	9	9	17	18	18	33
3.0	2	13	13	24	26	26	47
3.5	4	21	21	37	41	41	74
4.0	5	31	31	56	62	62	111
4.5	7	44	44	79	88	88	157
5.0	9	48	48	85	95	95	170
5.5	12	63	63	113	126	126	226
6.0	13	82	82	147	163	163	293
6.5	17	104	104	186	207	207	372
7.0	21	111	111	200	222	222	399
7.5	26	137	137	245	273	273	490
8.0	31	166	166	298	331	331	595
<b>Note.</b> The results of all calculations for this table have been rounded up to the next whole package.							

**Table 3-7. Conversion Factors for Material Other Than Reinforced Concrete**

<i>Material</i>	<i>Conversion Factor</i>
Earth	0.1
Ordinary masonry Hardpan Shale Ordinary concrete Rock Good timber Earth construction	0.5
Dense concrete First-class masonry	0.7

## NUMBER AND PLACEMENT OF CHARGES

3-45. When preparing breaching charges, the number and placement of the charges must be known. The paragraphs below discuss how to determine the necessary information needed.

### NUMBER OF CHARGES

3-46. The following formula is used for determining the number of charges required for demolishing piers, slabs, or walls:

$$N = \frac{W}{2R}$$

where—

*N* = number of charges (If *N* is less than 1.25, use one charge; if *N* is 1.25 but less than 2.5, use two charges; if *N* is equal to or greater than 2.5, round to the nearest whole number and use that many charges.)

*W* = pier, slab, or wall width (in feet)

*R* = breaching radius (in feet)

### PLACEMENT OF CHARGE

3-47. Before a charge is placed, the limitations and configuration of the charge must be known. The paragraphs below describe the limitations and configuration of the charge placement.

#### Limitations

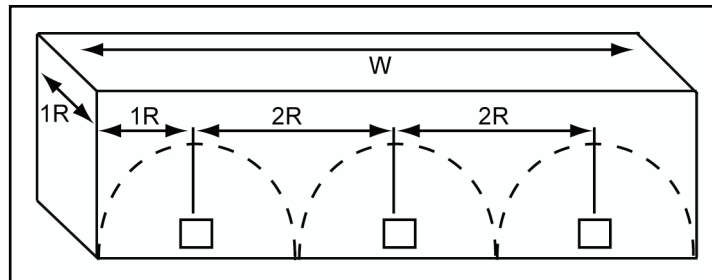
3-48. Piers and walls offer limited locations for placing explosives. Unless a *demolition chamber* (space intentionally provided in a structure for the emplacement of explosive charges) (JP 1-02) is available, place the charges against one face of the target. Placing a charge aboveground level is more effective than placing one directly on the ground. When the demolition requires several charges to destroy a pier, slab, or wall and elevated charges are to be used, the charges should be distributed equally no less than one breaching radius high from the base of the target. This takes maximum advantage of the shock wave. If possible, place breaching charges so that there is a free reflection surface on the opposite side of the target. This free reflection surface allows spalling to occur. If time permits, tamp all charges thoroughly with soil or filled sandbags. The tamped area must be equal to or greater than the breaching radius. For piers, slabs, or walls partially submerged in water, charges should be placed at a distance equal to the breaching radius and below the waterline (Figure 3-15, page 3-18).

**Configuration**

3-49. For maximum effectiveness, place the explosive charge in the shape of a flat square. The thickness of the charge depends on the amount of explosive required (Table 3-1, page 3-3).

**Placement**

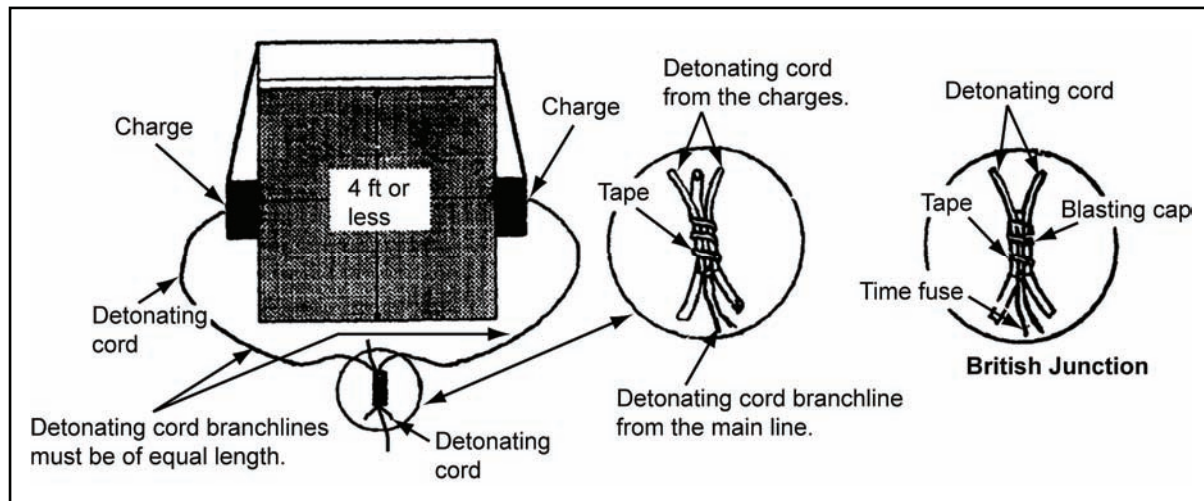
3-50. The first charge is placed R distance in from one side of the target. The remaining charges are spaced at a distance of 2R apart, center to center (Figure 3-16).



**Figure 3-16. Charge Placement**

**COUNTERFORCE CHARGES**

3-51. This special breaching technique is effective against rectangular masonry or concrete columns 4 feet thick or less. It is not effective against walls, piers, or long obstacles. The obstacle must have at least three free faces or be freestanding. If constructed of plastic explosives (composition C4), properly placed and detonated, counterforce charges produce excellent results with a relatively small amount of explosive. Their effectiveness results from the simultaneous detonation of two charges placed directly opposite each other and as near the center of the target as possible (Figure 3-17).



**Figure 3-17. Counterforce Charge**

**CALCULATION**

3-52. The thickness or diameter of the target determines the amount of plastic explosive required. The amount of plastic explosive equals 1 1/2 times the thickness of the target in feet (1 1/2 pounds of explosive per foot). Round fractional measurements to the next higher half foot before multiplying. For example, a concrete target measuring 3 feet 9 inches thick requires 6 pounds of plastic explosive (1 1/2 pounds per foot times 4 feet). For an example calculation on counterforce charges, see Figure F-10, page F-8.

**PLACEMENT**

3-53. When placing a counterforce charge, split the charge in half. The two halves are placed directly opposite each other on the target. This method requires accessibility to both sides of the target so that the charges will fit flush against their respective target sides.

**PRIMING**

3-54. On the face farthest from the target, prime a counterforce charge. The ends of the detonating cord branchlines are joined in a British junction (Figure 3-17, page 3-23). The length of the branchlines must be equal to ensure simultaneous detonation.

**SECTION V – CRATERING AND DITCHING CHARGES****FACTORS**

3-55. To be effective obstacles, craters must be too wide for track vehicles to span and too deep and steep-sided for any vehicle to pass through. Blasted craters will not stop modern tanks indefinitely. A tank, making repeated attempts to traverse a crater, will pull soil loose from the slopes of the crater, filling the bottom, and reducing both the depth and slope angle of the crater.

**SIZES**

3-56. Craters are effective antitank (AT) obstacles if a tank requires four or more passes to traverse the crater, thereby providing enough time for AT weapons to stop the tank. Craters should be large enough to tie into natural or constructed obstacles at each end. The effectiveness of blasted craters can be improved by placing log hurdles on either side, digging the face of the hurdle vertically on the friendly side, mining the site with AT and antipersonnel (AP) mines, filling the crater with water, or using other means to further delay enemy armor. Craters should be cut across the desired gap at a 45° angle from the direction of approach. To obtain this 45° angle, the following formula should be used:

$$\text{width} \times 1.414 = \text{length of crater}$$

3-57. To achieve enough obstacle depth, place craters in multiple rows. To enhance some other obstacle, such as a bridge demolition, single or multiple rows should be used. When creating more than one row of craters, they should be spaced far enough apart so that a single armored-vehicle-launched bridge (AVLB) will not span them.

**EXPLOSIVES**

3-58. All military explosives can create AT craters. When available, use a 40-pound, composition H6, cratering charge (Figure 1-4, page 1-8) for blasting craters.

**CHARGE CONFINEMENT**

3-59. Cratering charges or explosives should be placed in boreholes. Then, tamp them.

**HARD-SURFACED PAVEMENT BREACHING**

3-60. Hard-surfaced pavements are breached so that holes can be dug for the cratering charges. This can be done by exploding tamped charges on the pavement surface. A 1-pound charge of explosive is used for each 2 inches of pavement thickness. Charges are tamped twice as thick as the pavement thickness. Shaped charges are effective for breaching hard-surfaced pavements. A shaped charge will readily blast a small-diameter borehole through the pavement and into the subgrade. Blasting the boreholes with shaped charges will speed up the cratering task by eliminating the need to breach the pavement with explosive charges. After blasting, a hole should be dug for the cratering charge. Do not breach concrete at an expansion joint because the concrete will shatter irregularly. Table 1-3, pages 1-11 and 1-12, lists hole depths and the optimum standoff distances when using 15- or 40-pound shaped charges against various types of material.

Shaped charges do not always produce open boreholes capable of accepting a 7-inch diameter cratering charge. To accommodate the cratering charge, some earth may need to be removed or narrow areas widened. Widen deep, narrow boreholes by knocking material from the constricted areas with a pole or rod or by breaking off the shattered concrete on the surface with a pick or crowbar and posthole diggers.

## HASTY CRATER METHOD

3-61. The hasty crater method takes the least amount of time to construct, based on the number and depth of the boreholes. However, it produces the least effective barrier because of its depth and shape (Figure 3-18). The hasty crater method forms a V-shaped crater about 6 to 7 feet deep and 20 to 25 feet wide, extending about 8 feet beyond each end borehole. The sides of the crater slope should be 25° to 35°. Modern U.S. tanks require an average of four attempts to breach a hasty crater. To form a crater that is effective against tanks, boreholes must be at least 5 feet deep with at least 50 pounds of explosive in each hole.

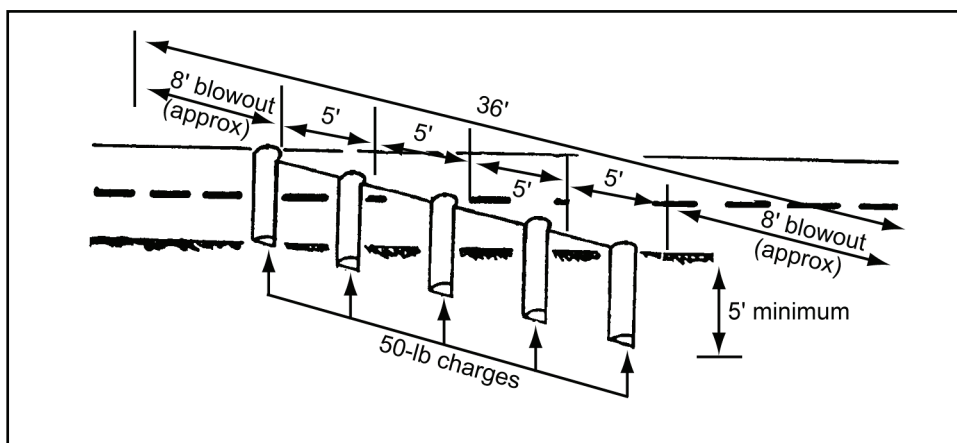


Figure 3-18. Hasty Crater Charge Placement

## BOREHOLES

3-62. All boreholes are to be dug the same depth (5 feet or deeper is recommended). The boreholes are spaced at 5-foot intervals, center to center, across the area to be cratered. The following formula is used in the six-step, problem-solving format (Section I), to compute the number of boreholes:

$$N = \frac{L - 16}{5} + 1$$

where—

- $N$  = number of boreholes (Round fractional numbers to the next higher, whole number.)
- $L$  = length of the crater (in feet) (Measure across the area to be cut. Round fractional measurements to the next higher foot.)
- 16 = combined blowout of 8 feet on each side
- 5 = 5-foot spacing
- 1 = factor to convert from spaces to holes

## CHARGE SIZE

3-63. Boreholes are loaded with 10 pounds of explosive per foot of borehole depth. When using standard cratering charges, supplement each charge with additional explosives to obtain the required amount. For example, a 6-foot hole would require one 40-pound cratering charge and 20 pounds of TNT or 16 packages of composition C4.

**FIRING SYSTEM**

3-64. Dual-firing systems should be used (Figure 2-26, page 2-25). They are initiated with an M12, M13, or M14. The 40-pound cratering charge is dual-primed as shown in Figure 2-21, page 2-20.

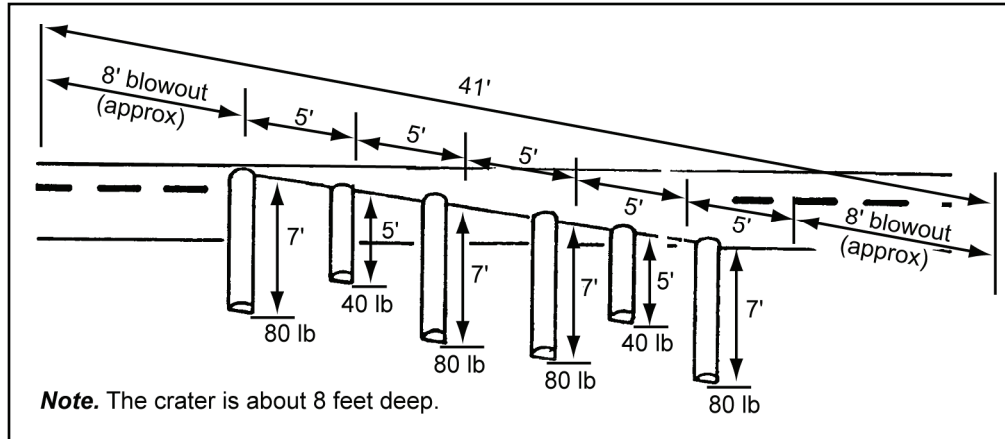
**BOREHOLE TAMPING**

3-65. All boreholes should be tamped with suitable materials.

**DELIBERATE CRATER METHOD**

3-66. Figure 3-19 shows the deliberate crater method. This method produces a more effective crater than the hasty method. Modern U.S. tanks require an average of eight attempts to breach a deliberate crater. Placing charges deliberately produces a V-shaped crater about 7 to 8 feet deep and 25 to 30 feet wide with side slopes of 30° to 37°. The crater extends about 8 feet beyond the end boreholes. The following steps are used to create a deliberate crater:

- **Step 1.** Determine the number of boreholes required, using the same formula as for a hasty crater. Place two adjacent 7-foot boreholes in the middle when there is an even number of holes (Figure 3-19).
- **Step 2.** Dig or blast the boreholes 5 feet apart, center to center, in a line across the area to be cut. Make the end boreholes 7 feet deep and the other boreholes alternately 5 and 7 feet deep. Never place two 5-foot holes next to each other.
- **Step 3.** Place 80 pounds of explosives in the 7-foot holes and 40 pounds of explosives in the 5-foot holes.
- **Step 4.** Use dual-firing systems (Figure 2-26). Dual-prime the 40-pound cratering charge as shown in Figure 2-21.
- **Step 5.** Tamp all charges with suitable materials.



**Figure 3-19. Deliberate Crater Charge Placement**

*Note.* For an example calculation on cratering charges, see Figure F-11, page F-9.

**RELIEVED-FACE CRATER METHOD**

3-67. The method shown in Figure 3-20, page 3-26, produces a crater that is a more effective obstacle to modern tanks than the hasty crater. This technique produces a trapezoidal-shaped crater about 7 to 8 feet deep and 25 to 30 feet wide with unequal side slopes. In compact soil, such as clay, the relieved-face cratering method will create an obstacle such as the one shown in Figure 3-20. The side nearest the enemy slopes about 25° from the surface to the crater bottom. The opposite (friendly) side slopes about 30° to 40°

from the surface to the crater bottom. However, the exact shape of the crater depends on the soil type. The following procedures are used to create a relieved-face crater:

- Drill two lines of boreholes 8 feet apart, spacing them at 7-foot centers on dirt- or gravel-surfaced roads. Drill the two lines of boreholes 12 feet apart on hard-surfaced roads. Use the following formula to compute the number of boreholes for the friendly-side row:

$$N = \frac{L - 10}{7} + 1$$

where—

- $N$  = number of boreholes (Round fractional numbers to the next higher, whole number.)
- $L$  = crater length (in feet) (Measure across the area to be cut. Round fractional measurements to the next higher foot.)
- 10 = combined blowout of 5 feet on each side
- 7 = spacing of holes
- 1 = factor to convert spaces to holes

- Stagger the boreholes in the row on the enemy side in relation to the holes in the row on the friendly side (Figure 3-20).

**Note.** The line closest to the enemy will always contain one less borehole than the friendly line.

- Make the boreholes on the friendly side 5 feet deep, and load them with 40 pounds of explosive.
- Make the boreholes on the enemy side 4 feet deep, and load them with 30 pounds of explosive.
- Use a dual-firing system for each line of boreholes. Prime 40-pound cratering charges as shown in Figure 2-21, page 2-20.
- Tamp all holes with suitable material.

3-68. There must be a 0.5- to 1.5-second delay in detonation between the two rows of boreholes. An M15 may be used as the delay detonation system. On the enemy side first, detonate the row. Then fire the friendly-side row while the earth from the enemy-side detonation is still in the air.

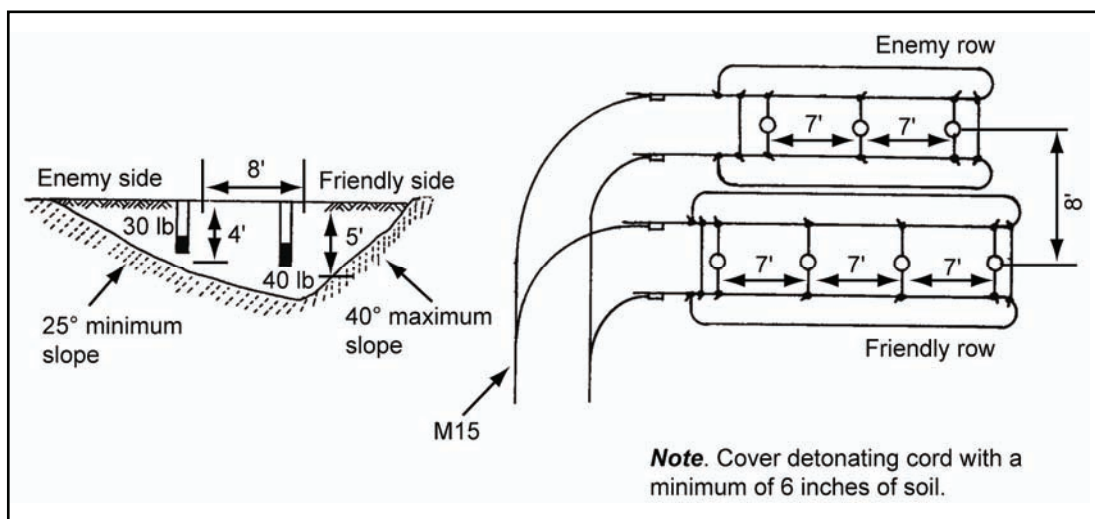


Figure 3-20. Relieved-Face Crater on Dirt- or Gravel-Surfaced Roads



## MISFIRE PREVENTION

3-69. The shock and blast of the first row of charges may affect the delayed detonation of the friendly-side charges. To aid in preventing misfires of the friendly-side charges, protect the detonating cord lines by covering them with about 6 inches of earth.

## CRATERS CREATED IN PERMAFROST AND ICE

3-70. Permafrost and ice can be as hard as solid rock. Therefore, procedures must be adapted for blasting or cratering to accommodate permafrost and ice conditions.

### BLASTING IN PERMAFROST

3-71. In permafrost, blasting requires about twice as many boreholes and larger charges than for cratering operations in moderate climates. Blasted frozen soil breaks into clods 12 to 18 inches thick and 6 to 8 inches in diameter. Because normal charges have insufficient force to blow these clods clear of the boreholes, the spall falls back into the crater when the blast subsides.

#### Boreholes

3-72. Before conducting extensive blasting, the soil should be tested in the area to determine the number of boreholes needed. Boreholes are dug with standard drilling equipment, steam-point drilling equipment, or shaped charges. Standard drilling equipment has one serious defect—the air holes in the drill bit freezes. There is no known method to prevent this freezing. Steam-point drilling is effective for drilling boreholes in sand, silt, or clay but not in gravel. Immediately after withdrawing the steam point, the charges should be placed. If you do not, the area around the borehole thaws and collapses. Shaped charges are also effective for producing boreholes, especially when forming craters. Table 1-3, pages 1-11 and 1-12, lists borehole sizes made by shaped charges in permafrost and ice.

#### Explosives

3-73. If available, low-velocity explosives should be used for blasting holes in arctic climates. The displacing quality of low-velocity explosives will more effectively clear large boulders from the crater. If only high-velocity explosives are available, tamp the charges with water and let them freeze before detonating. Unless thoroughly tamped, high-velocity explosives tend to blow out of the boreholes.

### BLASTING IN ICE

3-74. Access holes in ice are required for obtaining water and determining the capacity of the ice for bearing aircraft and vehicles and integrating obstacles. To accommodate rapid forward movements, ice capacities must be determined quickly. Blasting operations provide this ability.

#### Boreholes

3-75. Small-diameter access holes should be made using shaped charges. An M2A4 charge will penetrate ice as thick as 7 feet, an M3A1 charge will penetrate over 12 feet of ice (Table 1-3), and an M3A1 can penetrate deeper. This has only been tested on ice that is about 12 feet thick. If placed at the normal standoff distance, the charges form a large crater at the surface and require considerable probing to find an actual borehole. A standoff distance of 42 inches or more should be used with an M2A4 shaped charge to avoid excessive crater formation. An M2A4 creates a borehole with an average diameter of 3 1/2 inches. An M3A1 borehole has an average diameter of 6 inches. In late winter, ice grows weaker and changes color from blue to white. Although the structure and strength of ice vary, the crater effect is similar, regardless of the standoff distance.

#### Craters

3-76. Surface craters are made with composition H6 cratering charges. For the best results, the charges should be placed on the surface of cleared ice and tamp them with snow. When determining charge size,

keep in mind that ice has a tendency to shatter more readily than soil, and this tendency will decrease the size of the charge.

### MAKING VEHICLE OBSTACLES

3-77. A vehicle obstacle can be created in ice by first making two or more rows of boreholes. The boreholes are spaced 9 feet apart and staggered in relation to the holes in the other rows. M112 charges are suspended about 2 feet below the bottom surface of the ice with cords tied to sticks, bridging the sticks over the top of the holes. The size of the charge depends on the thickness and condition of the ice. Test shots are used to find the optimum amount. This obstacle type can retard or halt enemy vehicles for about 24 hours at temperatures near  $-4^{\circ}\text{F}$ .

### CRATERS CREATED FROM CULVERTS

3-78. Destroying a culvert less than 15 feet deep may also produce an effective crater. The charges are primed for simultaneous detonation, and sandbags are used to tamp all charges thoroughly. Culverts that are no deeper than 5 feet are destroyed by placing explosive charges the same as for hasty road craters. Boreholes are spaced at 5-foot intervals in the fill above and alongside the culvert. Ten pounds of explosives per foot of depth is placed in each hole.

### CRATERS CREATED FROM ANTITANK DITCHES

3-79. AT ditches are excavated by either the hasty or deliberate cratering method. Refer to the information on hasty and deliberate cratering in this section.

### DITCHING METHODS

3-80. Explosives can create ditches rapidly. Ditches are sloped at a rate of 2 to 4 feet of depth per 100 feet of run. Ditches are placed in areas where natural erosion will aid in producing the correct grade. If a ditch cannot be placed in an area aided by erosion, the ditch should be made deeper, increasing the depth as the length increases. The single-line and cross-section methods are used for creating ditches.

#### SINGLE-LINE METHOD

3-81. The single-line method (Figure 3-21) is the most common ditching method. A single row of charges are detonated along the centerline of the proposed ditch, leaving any further widening for subsequent lines of charges. Table 3-8 gives charge configurations for the single-line method.

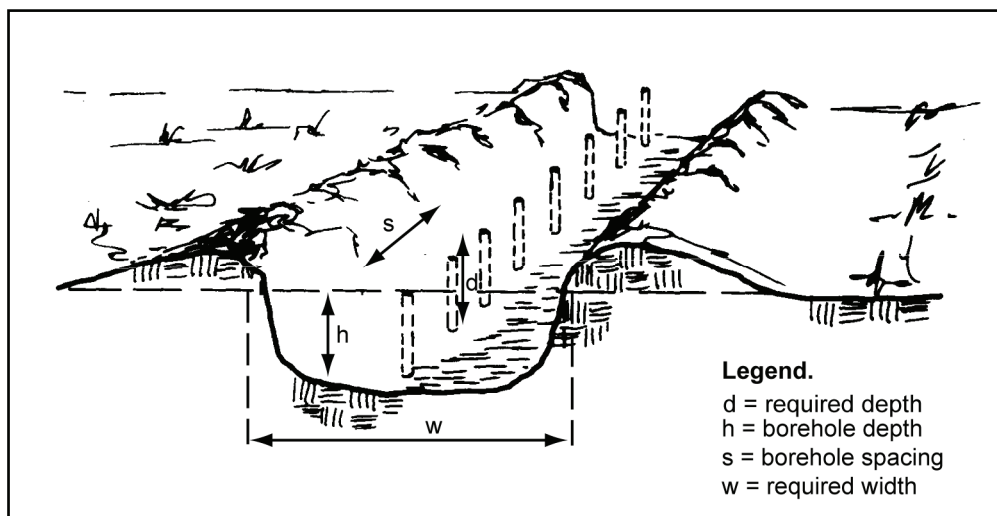


Figure 3-21. Single-Line Ditching Method

Table 3-8. Single-Line Ditching Explosives Data

Serial	Required Ditch Depth (d)	Required Width Top of Ditch (w) (in ft)	Charges per Hole (in lb)	Borehole Depth (h) (in ft)	Borehole Spacing (s) (in ft)
1	2.5	5.0	0.5	1.5	1.5
2	3.0	7.0	1.0	2.0	2.0
3	4.0	9.0	2.0	3.0	3.0
4	6.0	12.0	5.0	5.0	4.0
5	10.0	16.0	10.0	8.0	5.0

**CROSS-SECTION METHOD**

3-82. When the full width of the ditch in one operation must be blasted, the cross-section method should be used (Figure 3-22). Table 3-9, page 3-30, gives charge configurations for the cross-section method. An extra charge is placed midway between the lines of charges.

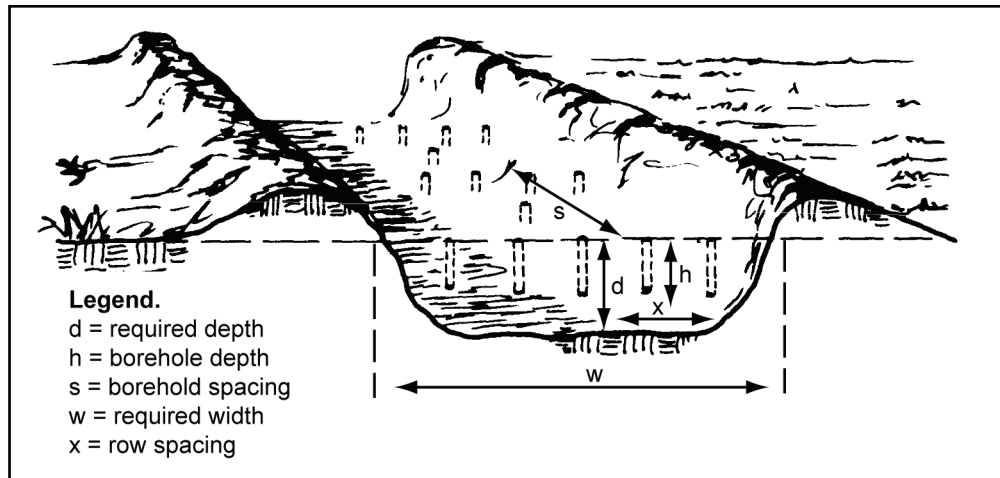


Figure 3-22. Cross-Section Ditching Method

Table 3-9. Cross-Section Ditching Explosives Data

Serial	Required Depth (d)	Required Width (w) (ft)					Charge per Hole (in lb)	Borehole Depth (h) (in ft)	Borehole Spacing (s) (in ft)	Row Spacing (x) (in ft)
		Number of Boreholes in Each Cross Section								
		3	5	7	9	11				
1	2.5	7.5	11	13	16	18	0.5	1.5	1.3	2.5
2	3.0	10.0	13	16	19	22	1.0	2.0	1.5	3.0
3	4.0	14.0	19	24	29	34	2.0	3.0	2.5	4.5
4	6.0	20.0	28	36	44	52	5.0	5.0	4.0	6.0
5	10.0	26.0	33	46	56	65	10.0	7.0	5.0	8.0

## SECTION VI – LAND-CLEARING CHARGES

### STUMP REMOVAL

3-83. Stumps have two general root types—taproot and lateral root (Figure 3-23). The stump diameter is measured 12- to 18-inches aboveground level. Then the diameter is rounded to the next higher 1/2 foot. One pound of explosive is used per foot of diameter for dead stumps and 2 pounds of explosive per foot of diameter for live stumps. If the complete tree is being removed, 3 pounds of explosives per foot of diameter should be used. If the root type cannot be identified, it is assumed that the tree has a lateral-root structure and removal proceeds accordingly.

#### TAPROOTED STUMPS

3-84. Two methods are common for removing taprooted stumps. One method is to drill a hole in the taproot and place the charge in the hole. Another method is to place charges on both sides of the taproot, creating a shearing effect (Figure 3-23). If possible, the charges should be placed in contact with the root and at a depth about equal to the diameter of the stump.

#### LATERAL-ROOTED STUMPS

3-85. When blasting lateral-rooted stumps, drill sloping holes between the roots (Figure 3-23). At a depth equal to the radius of the stump base, drill the holes. Place the charges as close to the center of the stump as possible. Trees with large lateral roots may require additional charges. Additional charges are placed directly underneath the large lateral roots.

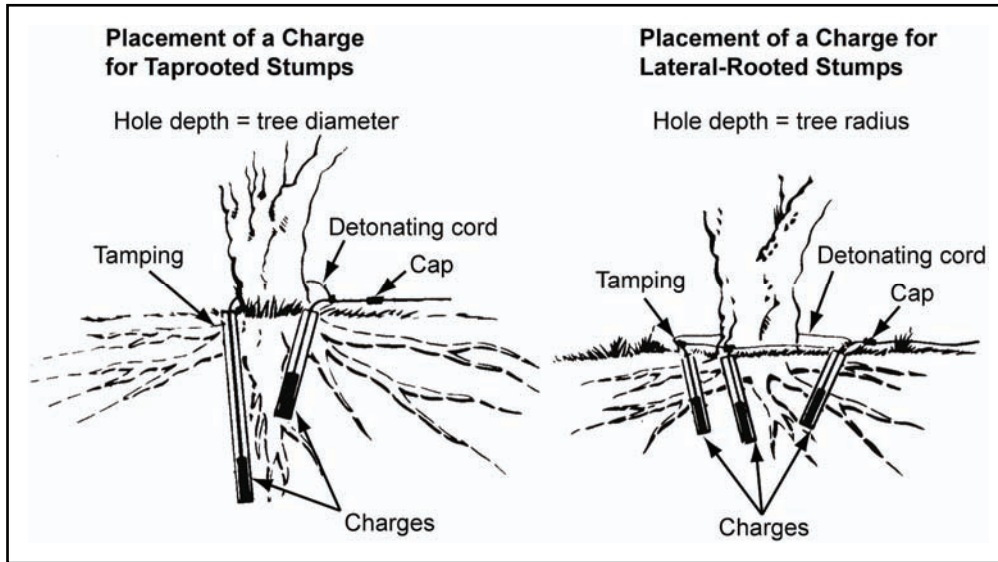


Figure 3-23. Stump Blasting

## BOULDER REMOVAL

3-86. Blasting is an effective way to remove boulders. The most practical methods are snake hole, mudcap, and blockhole.

### SNAKE HOLE METHOD

3-87. This method involves digging a hole beneath the boulder large enough to hold the charge. The charge is packed under and against the boulder as shown in Figure 3-24. Table 3-10, page 3-32, lists the required charge sizes.

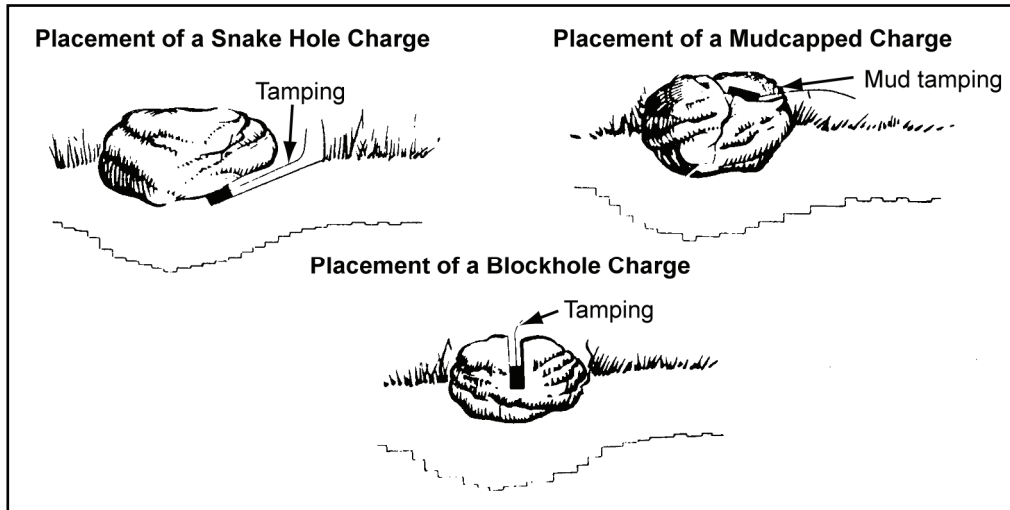


Figure 3-24. Boulder Blasting

Table 3-10. Boulder-Blasting Charges

<b>Boulder Diameter (ft)</b>	<b>Charge Size (lb)</b>		
	<b>Snake Hole Method</b>	<b>Mudcap Method</b>	<b>Blockhole Method</b>
<b>3</b>	0.75	2.0	0.250
<b>4</b>	2.00	3.5	0.375
<b>5</b>	3.00	6.0	0.500

### MUDCAP METHOD

3-88. With the mudcap method, the charge is placed in a crack or seam in the boulder (Figure 3-24, page 3-31). Then the charge is covered with 10 to 12 inches of mud or clay. Table 3-10 lists the required charge sizes.

### BLOCKHOLE METHOD

3-89. The blockhole method involves drilling a hole in the top of the boulder deep enough and wide enough to hold the amount of explosive required (Table 3-10). The charge is primed with detonating cord and is tamped firmly (Figure 3-24).

### DETONATING CORD WICK OR SPRINGING CHARGE

3-90. A detonating cord wick or springing charge is a comparatively small charge for enlarging a borehole to accommodate a larger charge. At times, two or more springing charges may have to be detonated in succession to make the chamber large enough for the final charge. Wait at least 30 minutes between firing successive charges to allow the borehole to cool, unless the hole is cooled with water or compressed air. For soils, several strands of detonating cord should be used, 5 to 6 feet long, taped together to form a multicord wick. For best results, the wick should be extended to the full length of the borehole. As a general rule, one strand of detonating cord (single-cord wick) will widen the diameter of the borehole by about 1 inch. For example, a 10-cord wick will create a 10-inch diameter borehole. The initial borehole is made by driving a steel rod about 2 inches in diameter into the ground to the required depth. The wick is placed into the initial borehole with an inserting rod or some other field-expedient device. The detonating cord wick works best in hard soils (see Appendix D). If placing successive charges in the same borehole, use water or compressed air, or wait 30 minutes for the borehole to cool before placing the next charge.

### QUARRYING

3-91. Military quarries are generally open-faced and mined by the single- or multiple-bench method. FM 3-34.465 gives detailed information on military quarries.

## SECTION VII – SPECIAL APPLICATIONS

### SURVIVABILITY POSITIONS

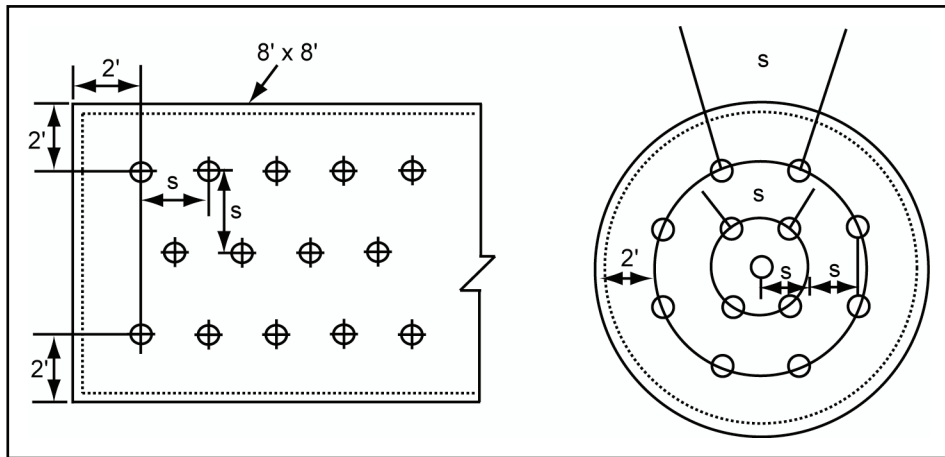
3-92. In many circumstances, using explosives can reduce digging time and effort. Explosives should only be used in soil that would be excavated by a pick and shovel. Explosives are not recommended for excavations less than 2 feet deep. To limit the dispersion of soil to as small an area as possible, use small charges buried and spaced just enough to loosen the soil. Attempting to form a crater spreads soil over a large area, affecting concealment and weakening the sides of the finished position. Explosives can create individual-fighting positions and larger crew-served gun or vehicle positions. Explosives used in this manner require some advance preparation. In the case of an individual-fighting position, the preparation time may exceed the time required to prepare the position by traditional methods.

**DEPTH**

3-93. Charges are placed 1 foot shallower than the required depth to a maximum of 4 feet. If the required depth is greater than 5 feet, dig the position in two stages, dividing the required depth in half for each stage. Boreholes are made with an earth auger, wrecking bar, picket driver, or other expedient device.

**SPACING**

3-94. For rectangular excavations, the boreholes are dug in staggered lines. For circular excavations, the boreholes are dug in staggered, concentric rings. The spacing (denoted as *s*) (Figure 3-25) between boreholes in each line or ring and between lines or rings should be between 1 and 1 1/2 times the depth of the borehole. All charges should be at least 2 feet inside the proposed perimeter of the excavation. Also, an 8- by 8-inch channel should be dug around the outer perimeter of the proposed excavation with the outer edge of the channel forming the outer edge of the finished excavation. Figure 3-25 shows layouts for rectangular and circular excavations.



**Figure 3-25. Borehole Layouts**

**CHARGE SIZE**

3-95. To dig foxholes, use 1/4-pound charges of plastic explosive. For large excavations, use charges between 1/2 and 1 1/2 pounds, depending on spacing and soil characteristics. A test shot is usually necessary to determine the correct charge size.

**CONCEALMENT**

3-96. Reduce explosion noise and spoil scatter by leaving any sod in place and covering the site with a blasting mat. Blasting mats can be improvised by tying tires together with natural or synthetic rope (steel wire rope is unacceptable) or by using a heavy tarpaulin.

**EQUIPMENT DESTRUCTION**

3-97. The following paragraphs discuss how to destroy equipment, such as guns and vehicles.

**WARNING**

**Steel-cutting charges produce metal fragments. Proper precautions should be taken to protect personnel. Failure to comply may cause death or permanent injury.**

**WARNING**

**Beware of potential radiological hazards associated with ordnance (depleted uranium [DU] and some weapon system sights [foreign-tritium]). Take proper protective measures before and after equipment destruction. Failure to comply could result in immediate personal injury or damage to equipment.**

**GUNS**

3-98. Gun barrels are destroyed with explosives or their own ammunition. Small components should be removed or destroyed (such as sights and other mechanisms). The following procedures should be performed when preparing a gun for demolition:

- Block the barrel just above the breach. Solidly tamp the first meter of the bore with earth for small-caliber guns that use combined projectile-propellant munitions. Load a projectile and aim the tube to minimize damage if the round is ejected. For heavier guns that use projectiles, separate from the propellants.
- Refer to Table 3-11 for the charge size required for standard barrel sizes. Determine the required charge size using the following formula (if necessary):

$$P = \frac{D^2}{636}$$

where—

*P* = quantity of explosive (any HE) (in pounds)

*D* = bore size of the barrel (in millimeters)

636 = constant used to compute *P*

- Pack the explosive, preferably composition C4, into the breach immediately behind the tamping. Place the plastic explosive in close contact with the chamber. Close the breach block as far as possible, leaving only enough space for the detonating cord to pass without being bent or broken. Place 15-pound charges on the drive wheels of tracked guns and on the wheels and axles of towed guns, if time permits. Connect the branchlines in a junction box, or use a ring main. Simultaneously detonate all charges.

**Table 3-11. Gun-Destruction Charge Sizes**

<b>Serial</b>	<b>Barrel Size (mm)</b>	<b>Charge Size (lb)</b>
<b>1</b>	76	10
<b>2</b>	105	18
<b>3</b>	120	23
<b>4</b>	155	38
<b>5</b>	203	66

**Note.** Determine the appropriate charge sizes for barrel sizes not listed by comparing them to known barrel sizes. For example, use the explosive weight in Serial 3 for a 112-millimeter barrel (23 pounds) and Serial 4 for a 152-millimeter barrel (38 pounds).



## VEHICLES

3-99. To destroy friendly vehicles, refer to the applicable TM. When destroying vehicle components, use the following priorities:

- **Priority 1.** Carburetor, distributor, fuel pump or injectors, and fuel tanks and lines.
- **Priority 2.** Engine block and cooling system.
- **Priority 3.** Tires, tracks, and suspension system.
- **Priority 4.** Mechanical or hydraulic systems (where applicable).
- **Priority 5.** Differential and transfer case.
- **Priority 6.** Frame.

### Armored Fighting Vehicles

3-100. Armored fighting vehicles (AFVs) can be destroyed beyond repair by detonating a 25-pound charge inside the hull. The charge may be a bulk 25-pound charge or a number of smaller charges placed on the driving, turret, and gun controls. To increase the amount of damage to the AFV, ensure that the ammunition within the AFV detonates simultaneously with the other charges and that all hatches, weapons slits, and other openings are sealed. If it is not possible to enter the AFV, place the two charges under the gun mantle, against the turret ring, and on the final drive (Figure 3-26). If explosives are not available, destroy the AFV by using AT weapons or fire or destroy the main gun with its own ammunition.

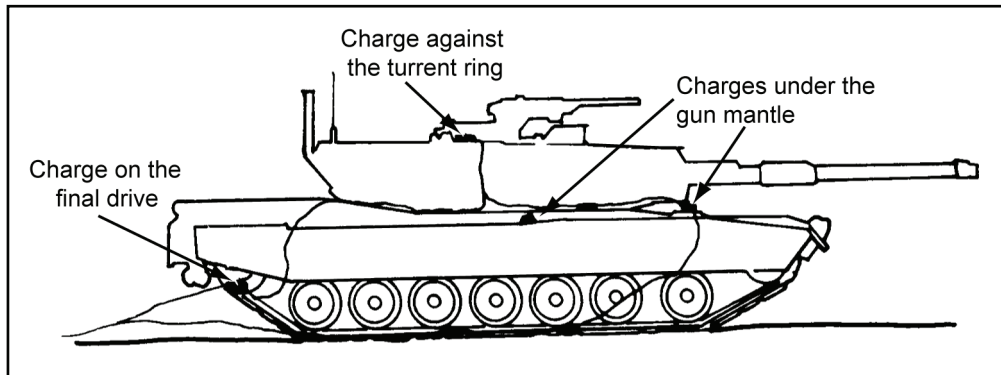


Figure 3-26. AFV Charge Placement

### Wheeled Vehicles

3-101. When using the explosive method, wheeled vehicles can be destroyed beyond repair by wrecking the vital parts with a sledgehammer or explosives. If HEs are available, 2-pound charges should be used to destroy the cylinder head, axles, and frame.

3-102. When using the improvised method, the engine oil and coolant should be drained and the engine ran at full throttle until it seizes. To finish the destruction, burn the vehicle (ignite the fuel in the tank).

## UNDERWATER DEMOLITIONS

3-103. See Appendix G for use and placement of underwater demolitions. Appendix G outlines the techniques, tactics, and procedures for underwater clearance.

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## Chapter 4

# Bridge Demolition

The purpose of bridge demolition is to create gaps in bridges by attacking key bridge components. This makes gaps large enough to make repairs uneconomical and to force the enemy to construct other bridges on other sites. The minimum gap required must exceed the assault bridging capability of the enemy by 5 meters. For planning purposes, use 25 meters as the minimum gap size, but 35 meters is preferred. The complete demolition of a bridge usually involves destroying all the components (spans, piers, and abutments). Complete demolition may be justified when the terrain forces the enemy to reconstruct a bridge on the same site. However, complete destruction is not required to meet the tactical objective. The attack method that achieves the tactical goal should be selected with a minimum expenditure of resources.

### BRIDGE DEBRIS

4-1. Debris may cause enemy forces serious delays, if it obstructs the gap (Figure 4-1). Debris also provides excellent concealment for mines and booby traps. Whenever possible, demolish bridges in such a way that the resulting debris hinders reconstruction.

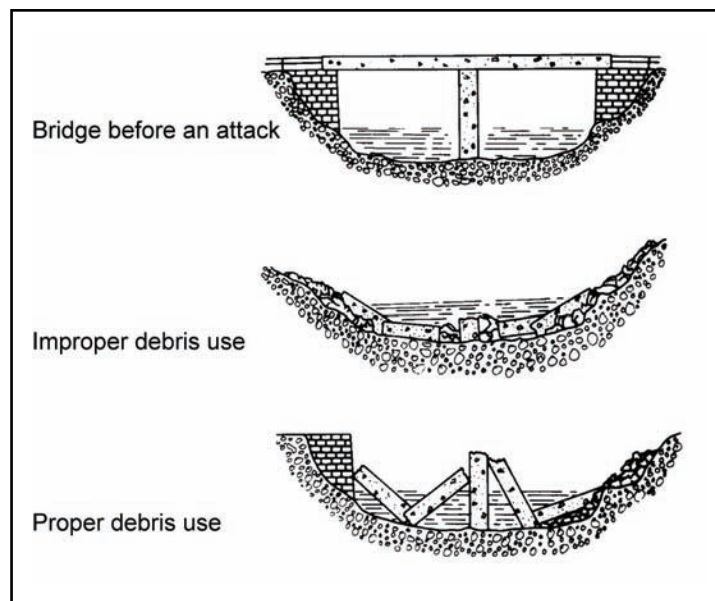


Figure 4-1. Debris Use

### BRIDGE CATEGORIES

4-2. The first step in any efficient bridge demolition is to categorize the bridge correctly. The term categorization has been adopted to avoid confusion with classification, which is concerned with the load-carrying capacity of bridges. The correct categorization of bridges, coupled with an elementary knowledge of bridge design, allows you to select a suitable attack method. All bridges fit into one of the following three categories: simply supported, miscellaneous, and continuous.

## SIMPLY SUPPORTED

4-3. In simply supported bridges, the ends of each span rest on the supports, and there are no intermediate supports. The free bearing conditions shown in Figure 4-2 represent any bearing that allows some horizontal movement (for example, roller bearings, sliding bearings, and rubber bearing pads).

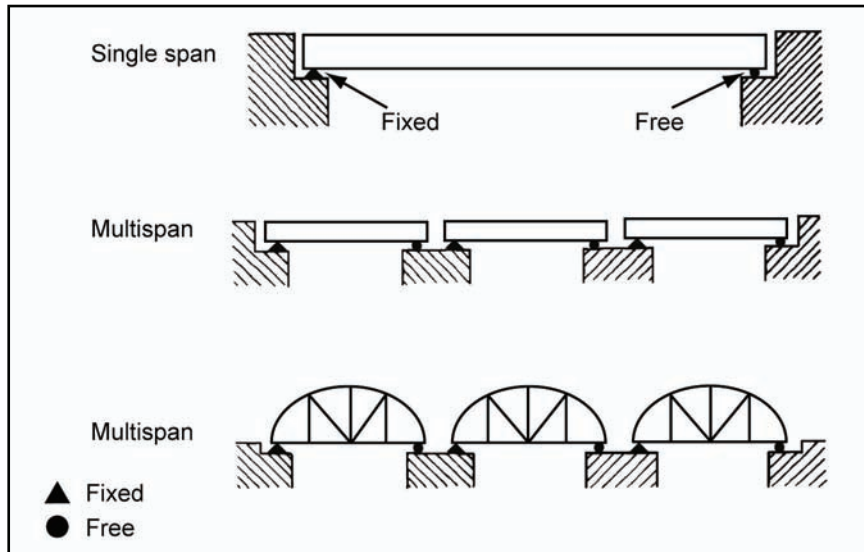


Figure 4-2. Simply Supported Bridges

## MISCELLANEOUS

4-4. Miscellaneous bridges form a small portion of bridge structures. The theoretical principles governing these bridges determine the appropriate attack methods. Examples of bridges in this category are suspension, lift, and cable-stayed bridges.

## CONTINUOUS

4-5. If a continuous bridge does not fit the miscellaneous category and is not simply supported, categorize it as a continuous bridge. Hence, continuous has a wider meaning than multispan, or continuous-beam bridges, as is normally implied.

## ATTACK TYPES

4-6. When designing a bridge demolition, the first priority is to create a gap. This may require one or two attacks to accomplish. Further actions to improve the obstacle may follow if the situation permits.

## BOTTOM ATTACK

4-7. In a bottom attack, a hinge forms at the top. As the span falls, the cut ends at the bottom move outward. The span may form a three-pin arch and fail to fall completely if the distance the cut ends must move is greater than the total end clearance (denoted as  $E$ ) between the span ends and the pier or abutment faces (Figure 4-3). If a three-pin arch situation is likely, do not attempt a bottom attack.

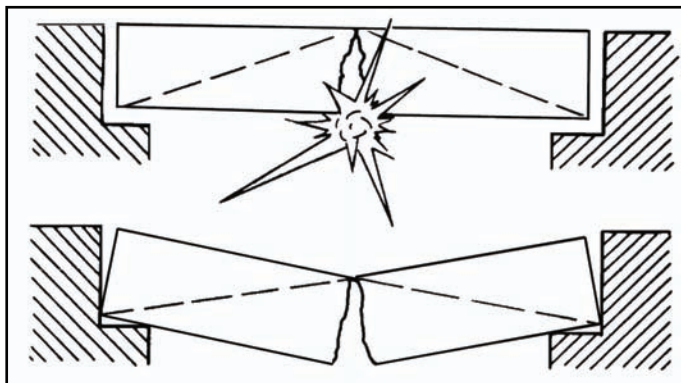


Figure 4-3. Three-Pin Arch Effect

### TOP ATTACK

4-8. In a top attack, a hinge forms at the bottom. As the span falls, the cut ends at the top move inward. Some bridges may jam along the faces of the cut before the ends of the span fall off the abutments, forming a cranked beam (Figure 4-4). The length of span (denoted as  $L_c$ ) removed at the top should be enough to prevent the formation of a cranked beam.

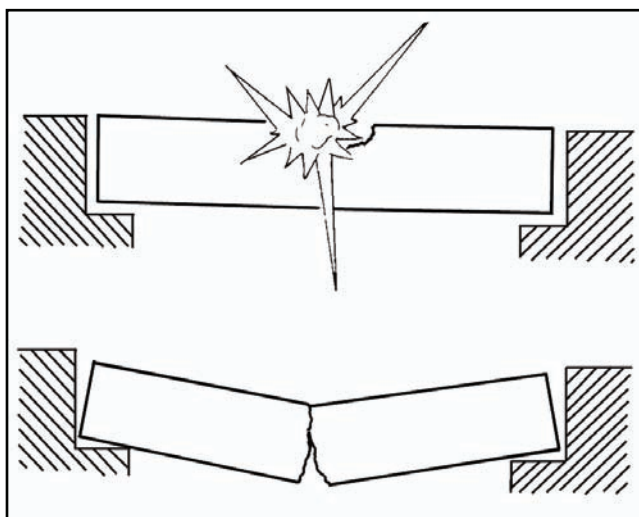


Figure 4-4. Cranked-Beam Effect

### SUCCESSFUL BRIDGE DEMOLITIONS

4-9. There are two minimum conditions for successful bridge demolition. They are—

- **Condition 1 (a proper collapse mechanism design).** Under normal conditions, a bridge is a stable structure. In bridge demolitions, the goal is to destroy the appropriate parts of a bridge so that it becomes unstable and collapses under its own weight. In other words, a collapse mechanism is formed. This may involve either cutting completely through all structural members or creating points of weakness in certain parts of the bridge. Figure 4-5, page 4-4, shows an improper collapse mechanism and the hinges that have not been formed. At times, making bridges unstable by attacking their piers rather than their superstructures is easier, but it is still possible for bridges not to collapse, even though they lose the support provided by one or more of their piers. To avoid this type of demolition failure, place the charges on the structural members of the superstructure immediately above the piers being attacked.

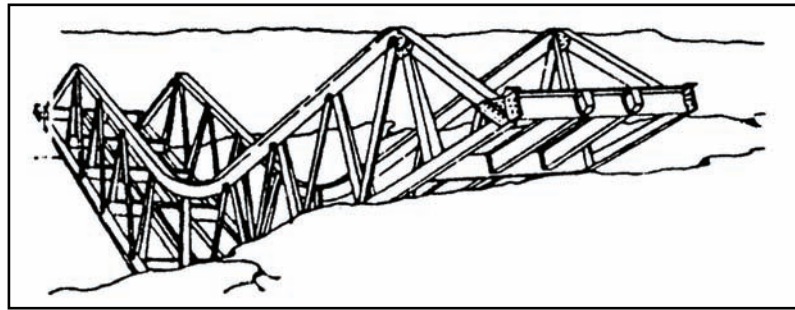


Figure 4-5. Improper Collapse Mechanism and Hinges

- **Condition 2 (an attacked span that moves freely and far enough under its weight and creates the desired obstacle).** Figure 4-6 shows a bridge demolition where the collapse mechanism has formed but where it has failed to form the desired obstacle because the bridge span has jammed before moving far enough. To complete the demolition in this example, remove only a small portion of the abutment to allow the span to swing down freely.

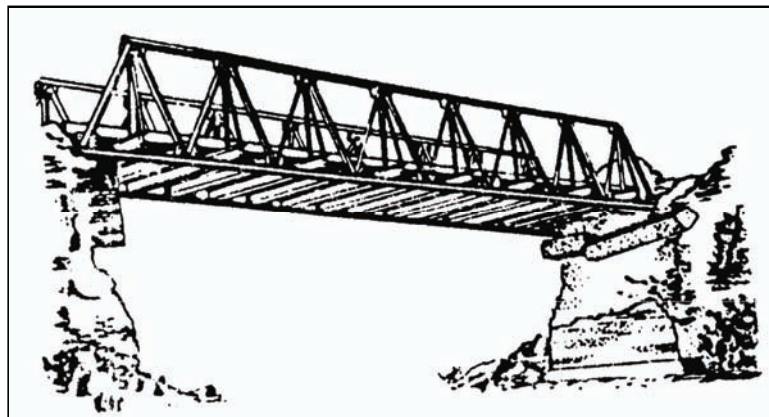


Figure 4-6. Jammed Bridge Span

### COLLAPSE MECHANISM TYPES

4-10. Figures 4-7 through 4-9 show the three basic collapse mechanisms. The three collapse mechanisms are the seesaw, beam, and member without support.

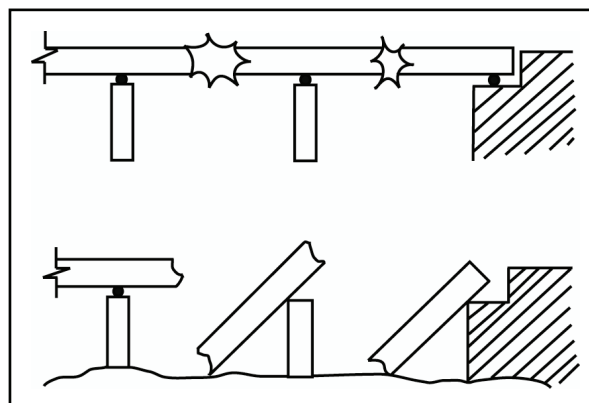


Figure 4-7. Seesaw Collapse Mechanism

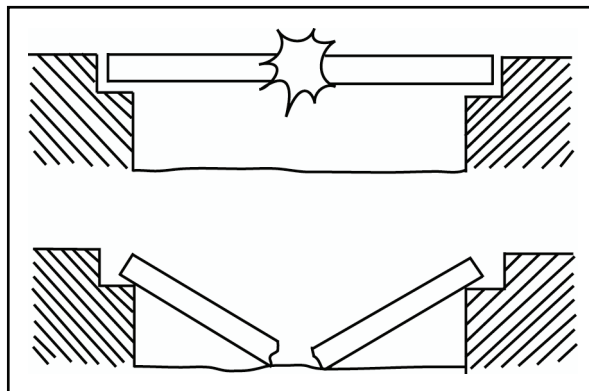


Figure 4-8. Beam Collapse Mechanism

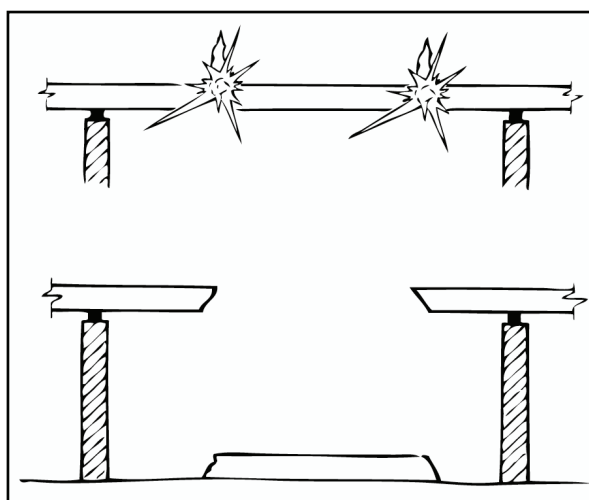


Figure 4-9. Member Without a Support Collapse Mechanism

## EFFICIENT DEMOLITION METHODS

4-11. To ensure that a demolition achieves collapse with reasonable economy, consider the factors required to achieve an efficient demolition. The best balance between these factors will depend on the particular demolition under consideration. An efficient demolition should—

- Achieve the desired effect.
- Use the minimum amount of resources (time, manpower, and explosives).
- Observe the proper priorities. The demolition reconnaissance report clearly states the priorities and separately lists the requirements for priority 1 actions and priority 2 improvements (the priorities are explained below). If enough gap will result by attacking bridge spans, do not perform the priority 2 improvements unless the report specifies complete destruction or an excessively long gap. If the total gap spanned by a bridge is too small to defeat enemy assault bridging, consider the site as an unsuitable obstacle unless the gap can be increased. Engineer efforts may be better applied elsewhere. To improve an obstacle, increase the gap by demolishing the abutments and building craters on the immediate approaches. In this case, attack nearby bypass sites (by placing mines and craters).
  - **Priority 1.** The desired obstacle should be created. The minimum gap required is 5 meters greater than the assault bridging capability of the enemy. Ideally, demolition should be accomplished with the first attempt. However, many reinforced- or prestressed-concrete

bridges may require two-stage attacks. Attacking the friendly side of spans will permit economical reconstruction of the bridge at a later date, if necessary.

- **Priority 2.** Improvements to the gap should be made. This activity is performed only when it is specified on the demolition reconnaissance report. When no reconnaissance report has been issued and time permits, perform improvements in the sequence specified below. Deviation from this sequence should only be made under exceptional circumstances or when directed to do so by the responsible commander. The standard sequence of demolition is to destroy and mine the blown abutment, to lay mines in likely bypasses, to blast craters and lay mines in likely approaches, and to destroy the piers.

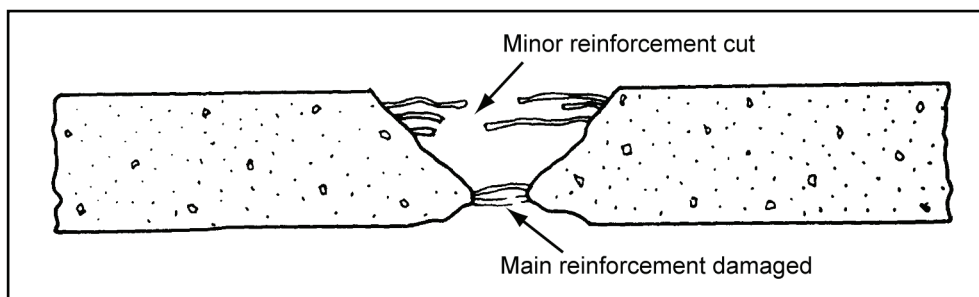
## CONCRETE-STRIPPING CHARGES

4-12. Concrete-stripping charges are bulk, surface-placed charges designed for removing concrete from reinforced-concrete beams or slabs and exposing the steel reinforcement. Although these charges cause some damage to the reinforcing steel, the extent of this damage cannot be predicted. These charges are effective against reinforced-concrete beams or slabs up to 2 meters thick.

### Charge Effects

4-13. Figure 4-10 shows the effect of the concrete-stripping charge. Using the proper charge size for the thickness of the target will—

- Remove all concrete from above the main reinforcing steel.
- Remove all concrete from below the main reinforcing steel (spalling).
- Damage the main reinforcing steel to some extent.
- Destroy the minor reinforcing steel near the surface under the charge.



**Figure 4-10. Effect of a Concrete Stripping Charge**

### Charge Calculations

4-14. For all simply supported concrete bridges, removing all concrete over the required length of the span removed will cause collapse. For beam or slab bridge spans (T beam and I beam bridges), determine the charge sizes for the beams or slabs separately. The following procedure is used for determining charge sizes for simply supported spans (see Figure F-12, page F-10, for an example calculation):

- Calculate the mass of the charge required.

$$P = (3.3h + 0.5)^3(3.3)$$

where—

$P$  = required charge size in pounds of TNT per meter of bridge width

3.3 = constant to determine  $P$

$h$  = beam or slab plus roadway depth in meters (minimum is 0.3 meters and maximum is 2 meters)

0.5 = constant to determine  $P$



- Calculate the width of the required ditch. (The charge will produce a ditch across the width of the bridge.) Determine the width of this ditch using the following formula:

$$W_d = 2h + 0.3$$

where—

$W_d$  = ditch width (in meters)

$h$  = overall roadway or beam or slab depth (in meters)

- Compare the required  $W_d$  with the required  $L_C$ , and take the appropriate action.
  - If  $L_C$  is equal to or less than  $W_d$ , use one row of charges as specified by P.
  - If  $L_C$  is greater than  $W_d$  but less than twice  $W_d$ , increase the size of the charge by 10 percent.
  - If  $L_C$  is twice the  $W_d$ , double the charge and place them in two lines side by side.
- Place charges in a continuous line across the full width of the bridge at the point of attack. Ensure that the shape of the end cross section of the charge is such that the width is between one and three times the height of the charge.
- Tamp the charges, if required.

---

**Note.** No tamping is required for the concrete-stripping charge as calculated. If tamping with two filled sandbags per pound of explosive, the calculated mass of charge should be reduced by one third.

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## UNSUCCESSFUL BRIDGE DEMOLITIONS

4-15. A no-collapse mechanism and jamming are two possible reasons for unsuccessful bridge demolitions. The formation of cantilevers (Figure 4-11) is a typical example of a no-collapse mechanism being formed. The likelihood of this occurring is high when attacking continuous bridges. The span, once moved by the collapse mechanism, jams before moving far enough to create the desired obstacle. The most likely causes of jamming are the formation of a three-pin arch or a cranked beam (Figure 4-12, page 4-8). When attacking bridge spans, always consider the possibility of jamming during bottom and top attacks.

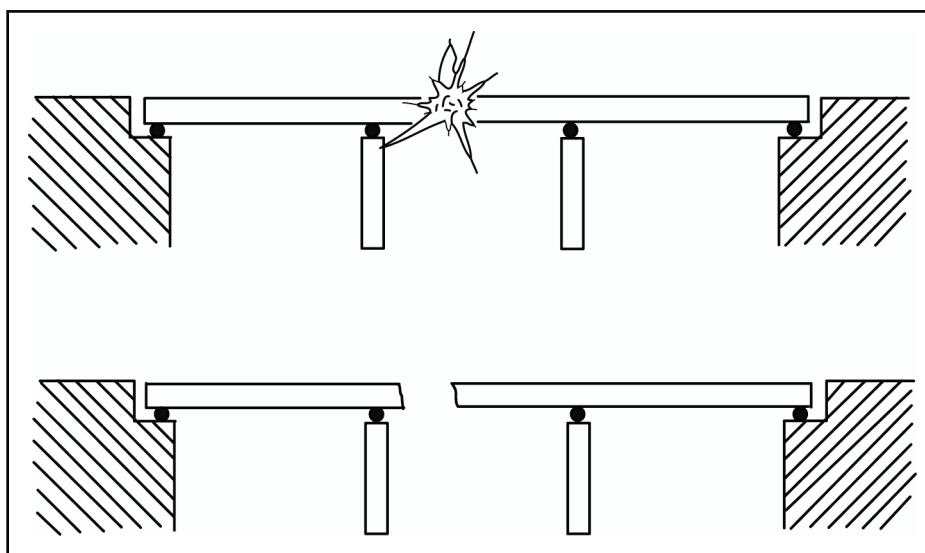


Figure 4-11. Cantilever Effect

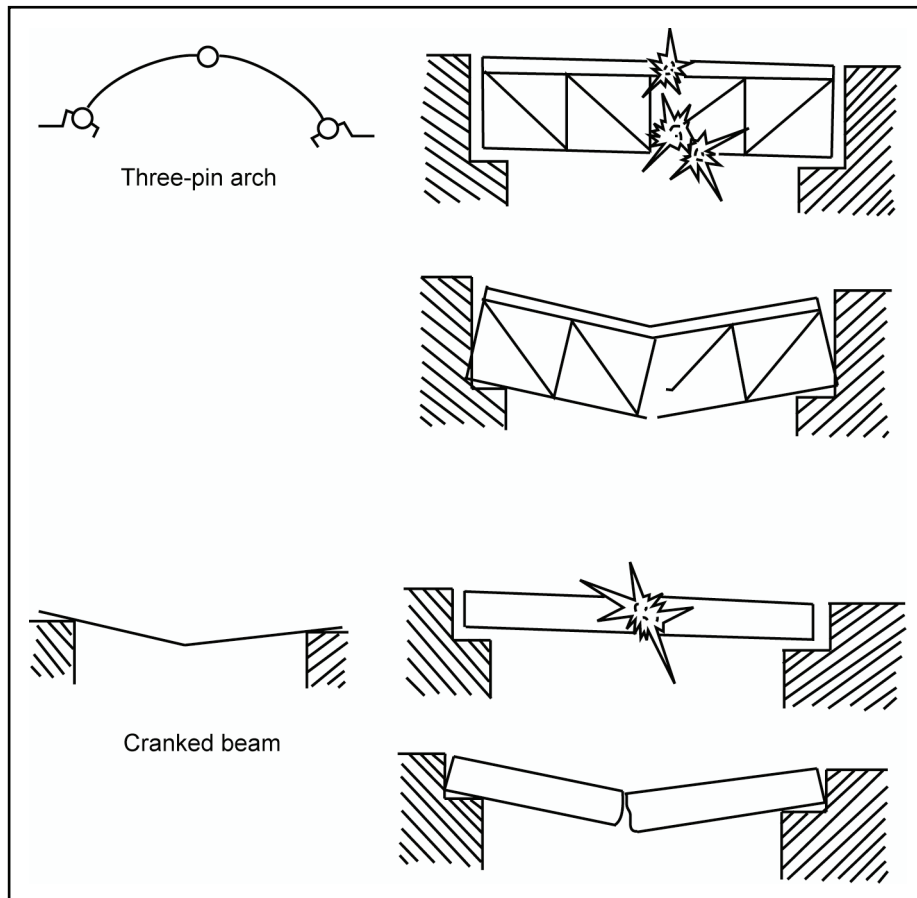
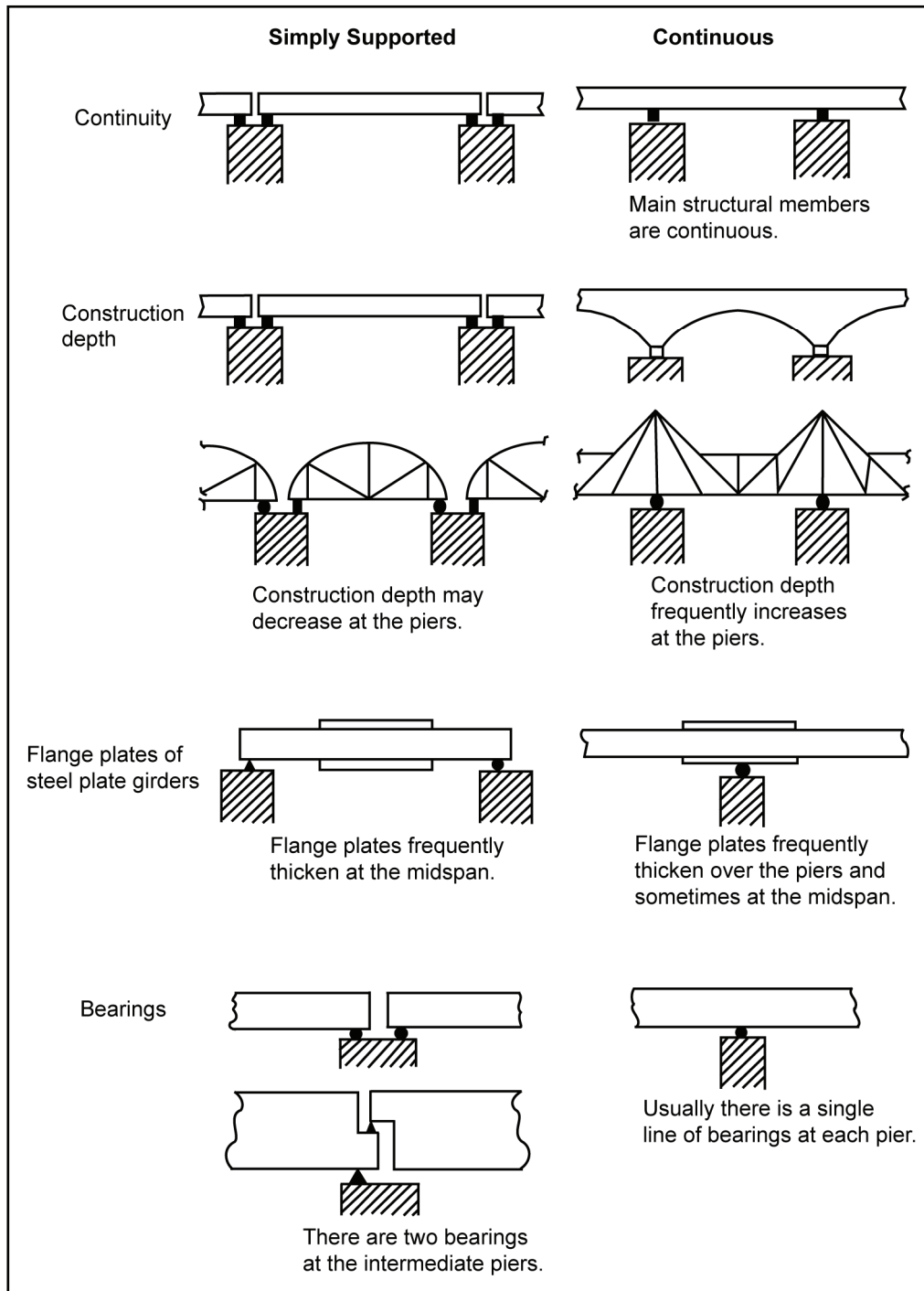


Figure 4-12. Causes of Jamming

## SIMPLY SUPPORTED BRIDGES AND CONTINUOUS BRIDGES

4-16. The external appearance of a bridge can sometimes be deceptive. Whenever possible, consult construction drawings to determine the correct bridge category. If drawings are not available and there is any uncertainty about the category to which the bridge belongs, assume the bridge is of continuous construction. Since more explosive is necessary to demolish a continuous bridge, assume that a continuous construction will provide more than enough explosive to demolish a bridge of unknown construction. The following describes some differences between simply supported and continuous bridges (Figure 4-13):

- **Continuity.** In simply supported bridges, the entire superstructure is composed of a span or multiple spans supported at each end. The main structural members (individual spans) meet end-to-end, and each intermediate pair of ends is supported by a pier. The single ends are supported by the abutments. In continuous bridges, the main structural members are formed into one piece and do not have breaks over the piers, if any are present.
- **Construction depth.** In multispan, simply supported bridges, the construction depth of the span may decrease at the piers. In continuous bridges, construction depth frequently increases at the piers.
- **Flange thickness.** In simply supported, steel-girder bridges, the thickness of the flange frequently increases at the midspan. In continuous bridges, the flange size frequently increases over the piers.
- **Bearing.** In multispan, simply supported bridges, two lines of bearing is needed at the piers. In continuous bridges, only one is needed.



**Figure 4-13. Span Differences**

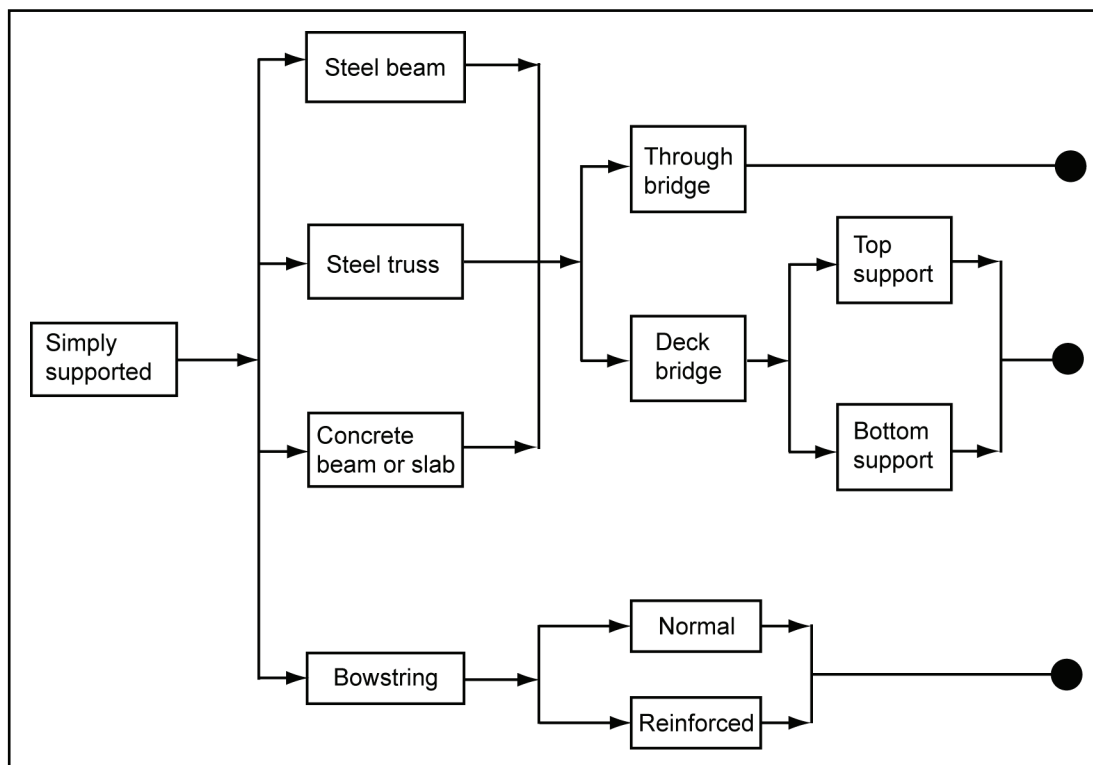
4-17. More explosive is necessary to demolish a continuous bridge, assuming that a continuous construction will provide more than enough explosive to demolish a bridge of unknown construction. To use the tables in Appendix H correctly, decide whether the bridge is in the simply supported, continuous, or miscellaneous category and follow the procedures as outlined in the appropriate paragraph.

## SIMPLY SUPPORTED BRIDGES

4-18. Figure 4-14 is a categorization chart for simply supported bridges. This chart is entered from the left, and the lines and arrows are followed across to the right. The path selected must include all categorization terms applicable to the simply supported bridge that is planned to be demolished. There are four main subcategories:

- Steel beam.
- Steel truss.
- Concrete beam or slab.
- Bowstring.

4-19. The first three are further subdivided into deck bridges, which carry their loads on top of the main structural members and through bridges. When dealing with deck bridges, note the locations of the bearing (supporting the top or bottom chord or flange); this will influence the possibility of jamming.



**Figure 4-14. Categorization Chart for Simply Supported Bridges**

### Steel-Beam Bridges

4-20. Steel-beam bridges may be constructed of normal steel-beam, plate-girder, or box-girder spans. Figure 4-15 shows typical cross sections of these spans. For an example calculation, see Figure F-13, page F-11.

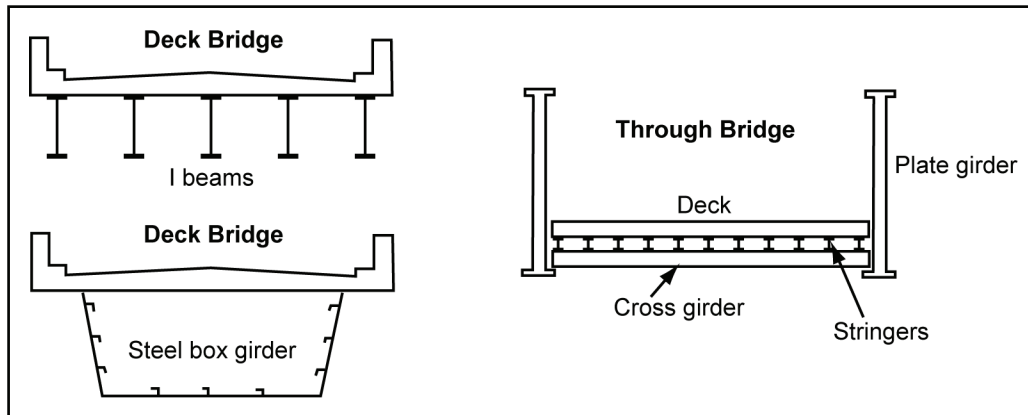


Figure 4-15. Typical Cross Sections of Steel-Beam Bridges

### Steel-Truss Bridges

4-21. Figure 4-16 shows the side elevations for three normal steel-truss spans. Note that all truss bridges have diagonal members in the trusses.

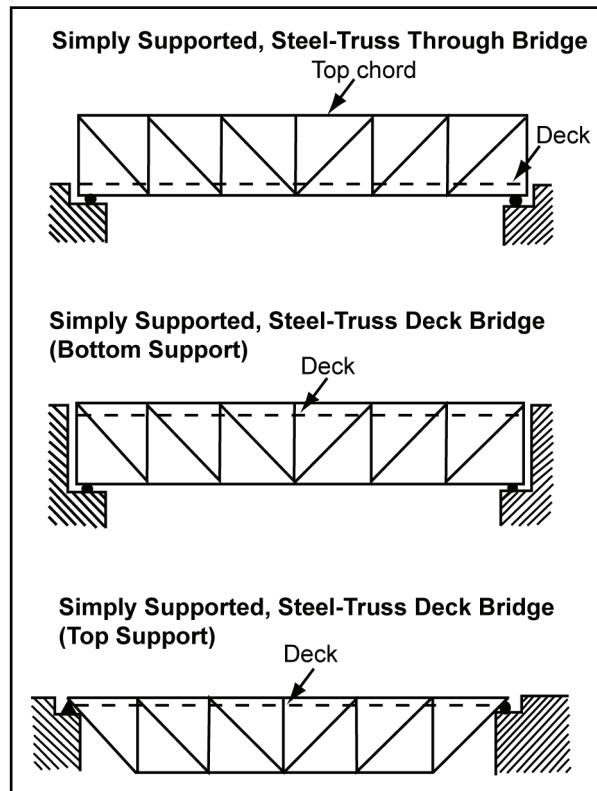


Figure 4-16. Side Elevation of Steel-Truss Bridges

### Concrete-Beam or Slab Bridges

4-22. For categorization purposes, distinguish between reinforced- and prestressed-concrete bridges, because the methods of attack are the same for both. Figure 4-17, page 4-12, shows midspan, cross-sectional views of these bridge types. At midspan, the majority of steel reinforcing rods or tendons are located in the bottom portion of the superstructure. The attack methods detailed in Appendix H take this reinforcing condition into account.

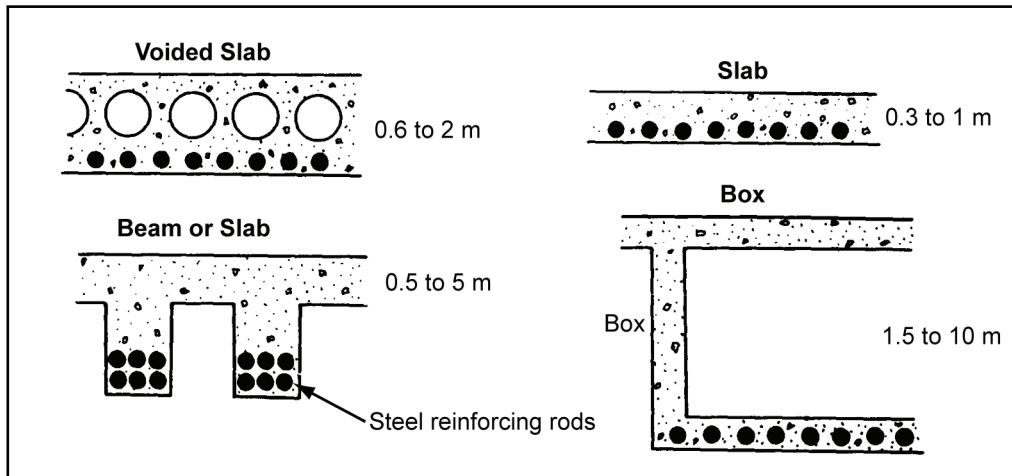


Figure 4-17. Midspan, Cross-Sectional Views of Typical Concrete Bridges

### Bowstring Bridges

4-23. Figure 4-18 shows the features of a normal bowstring bridge. The features of this bridge include the following:

- The bow is in compression.
- The bow may be a steel beam, box girder, concrete beam, or steel truss. The depth (thickness) of the bow is larger than or equal to the depth of the support members of the deck.
- The deck acts as a tie and resists the outward force applied by the bow.
- The deck is designed as a weak beam supported by the hangers.

*Note.* There is no diagonal bracing between the hangers.

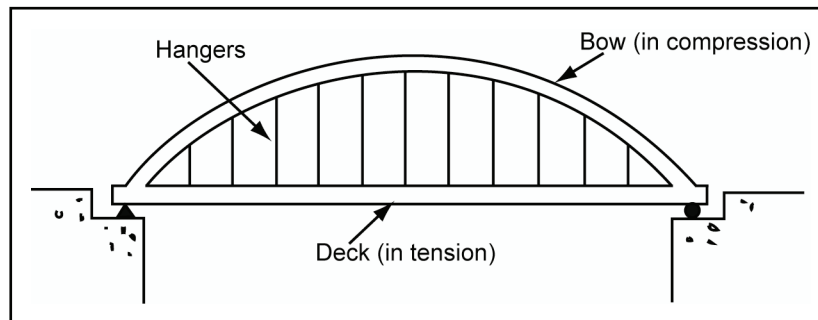


Figure 4-18. Normal Bowstring Bridge

4-24. Occasionally, the bow and hangers are used to reinforce a steel-beam or -truss bridge. This bridge type is categorized as a bowstring reinforced-beam or reinforced-truss bridge (Figure 4-19). In this type of bridge, the depth of the bow will always be less than the depth of the support members of the deck.

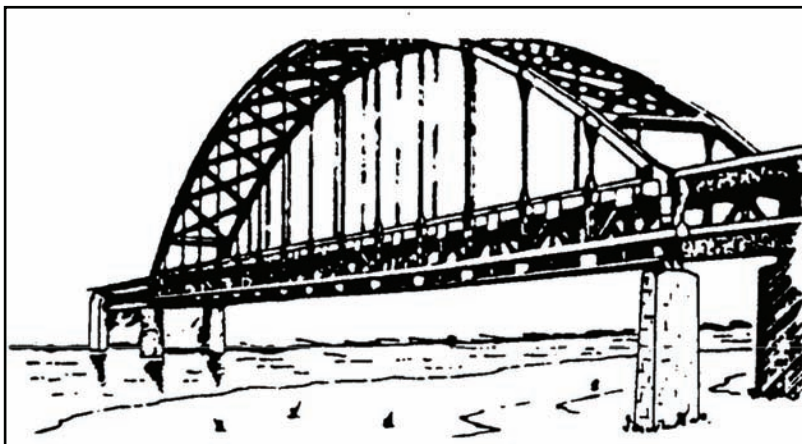


Figure 4-19. Bowstring-Reinforced Truss Bridge

**Reconnaissance**

4-25. For simply supported bridges, use the following reconnaissance procedures:

- Categorize the bridge.
- Measure the bridge using the following measurements with Figure 4-20 as an example:
  - **Length (L).** Measure the length of the span to be attacked in meters.

---

*Note.* This distance is not the clear gap, but the length of the longitudinal members that support the deck from end to end.

---

- **Depth (H).** Measure the depth of the beam, truss, or bow in meters (include the deck with the beam or truss measurement).
- **Total end clearance (E).** Total the amount of end clearance at both ends of the span in meters.
- **Average length of the bearing supports (L<sub>s</sub>).** Measure the average length of the bearing supports from the ends of the spans to the faces of the abutments or piers in meters.
- Determine the attack method (see Appendix H).
- Determine the critical dimensions of the span required for charge calculations.

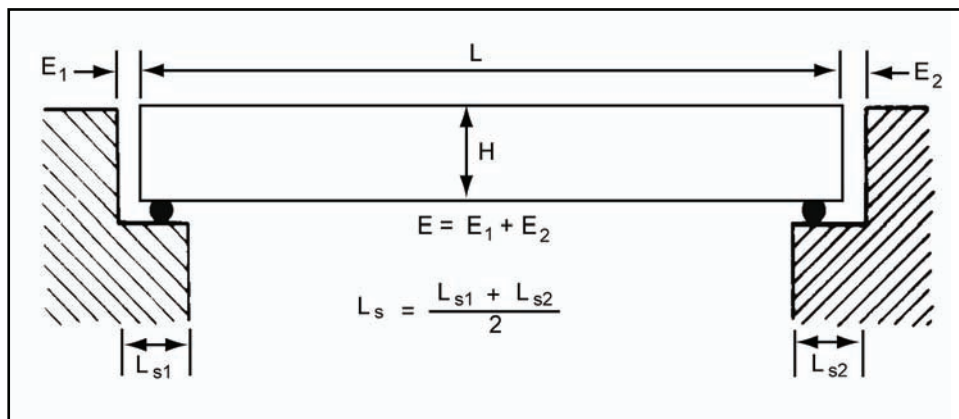


Figure 4-20. Measurements of Simply Supported Spans

## Attack Considerations

4-26. Two considerations apply when attacking a simply supported span. They are the point of attack and the line of attack.

### Point of Attack

4-27. Simply supported bridges should be attacked at or near the midspan. This is done because—

- Bending movements are maximum at the midspan.
- The likelihood of jamming during collapse is reduced if the bridge is attacked at the midspan.

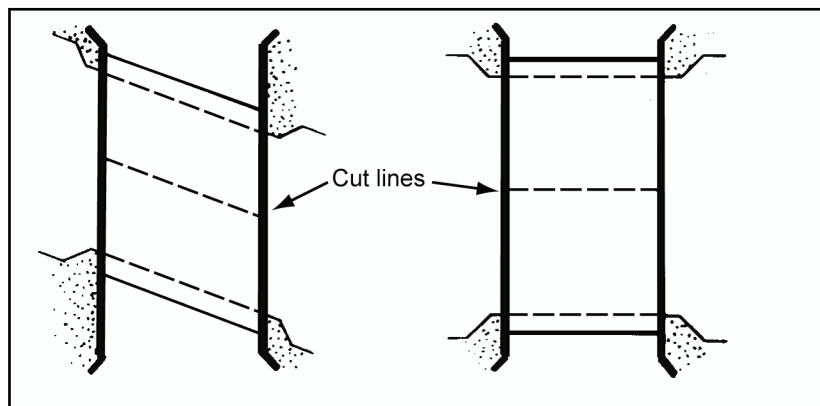
### Line of Attack

4-28. The line of attack should be parallel to the lines of the abutments (Figure 4-21). This reduces the risk that the two parts of the span will slew in opposite directions and jam. Do not employ any technique that induces a twist in the bridge. If the line of attack involves cutting across transverse beams, reposition the line of attack to cut between the transverse beams.

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*Note.* For a sample calculation, see Figure F-14, page F-12.

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**Figure 4-21. Line of Attack**

## Attack Methods

4-29. See Appendix H, Table H-4, pages H-4 through H-8. Table H-4 lists in recommended order, by bridge category, the attack methods likely to produce the most economical demolition. Within each category are variations to accommodate the differences in construction materials, span configurations, load capacities (road, rail, or both), and gap and abutment conditions. The three recommended ways of attacking simply supported spans are bottom, top, and angled attacks. In all cases, ensure that jamming cannot occur during collapse. Use Table H-4 to determine the charge location.

### Bottom Attack Method

4-30. Use the bottom attack method whenever possible; it leaves the roadway open and enables you to use the bridge, even when demolitions are at a ready-to-fire state (state 2). Reinforced and prestressed (tension) beams are very vulnerable to a bottom attack, because the steel cables and reinforcing bars run along the bottom portion of the beam and are covered by less concrete. The major disadvantages of the bottom attack are the increased amount of time and effort necessary for placing and inspecting the charges. Because it is generally impracticable to place enough explosive below a reinforced or prestressed slab to guarantee a cut deeper than 0.15 meter, use the top or angled attacks listed in Table H-4 for these types of bridges. When Table H-4 lists a bottom attack, determine the required end clearance ( $E_R$ ) from Table H-1, page H-1, to prevent jamming. If  $E$  is greater than  $E_R$ , jamming will not occur. If  $E$  is less than  $E_R$ , use a top or angled



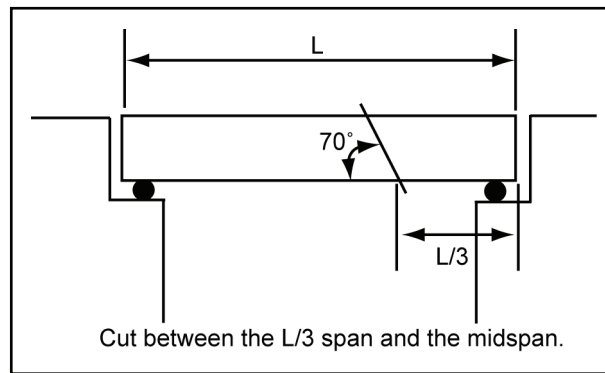
attack or destroy one abutment at the places where jamming would occur. Figure F-13, page F-11, explains the method for bottom attack calculations.

**Top Attack Method**

4-31. See Appendix H. When Table H-4, page H-4, lists a top attack,  $L_C$  must be removed from the top of the bridge to prevent jamming. From Table H-2, page H-2, determine  $L_C$ . In a V-shaped section, remove  $L_C$  along the full depth of the target. For reinforced-concrete bridges, use a concrete-stripping charge (discussed earlier in this chapter) to remove  $L_C$  from the top of the bridge. This action, by itself, should cause collapse. There is no requirement to cut steel reinforcing rods. Figure F-14 shows the method for top attack calculations.

**Angled Attack Method**

4-32. For angled attacks, cut all members (span, handrails, service pipes, and so forth) of the bridge. The angle of attack should be made about  $70^\circ$  to the horizontal to prevent jamming. The location of the charge should be between the midspan point and a point  $L/3$  from the end (Figure 4-22). Although an angled attack is effective on any bridge type, it is essential when the bridge must be kept open to traffic or when there is ample time to prepare demolitions.



**Figure 4-22. Location of an Angled Charge**

**CONTINUOUS BRIDGES**

4-33. Figure 4-23, page 4-16, is a categorization chart for continuous bridges. This chart is used like the chart for simply supported bridges. There are six main subcategories: cantilever, cantilever and suspended span, beam or truss, portal, arch, and masonry arch. The first five categories differentiate between steel and concrete construction, because each material has a different attack method. If a continuous bridge is of composite construction (for example, steel beams supporting a reinforced-concrete deck), the material that comprises the main, longitudinal, load-bearing members will determine the attack method.

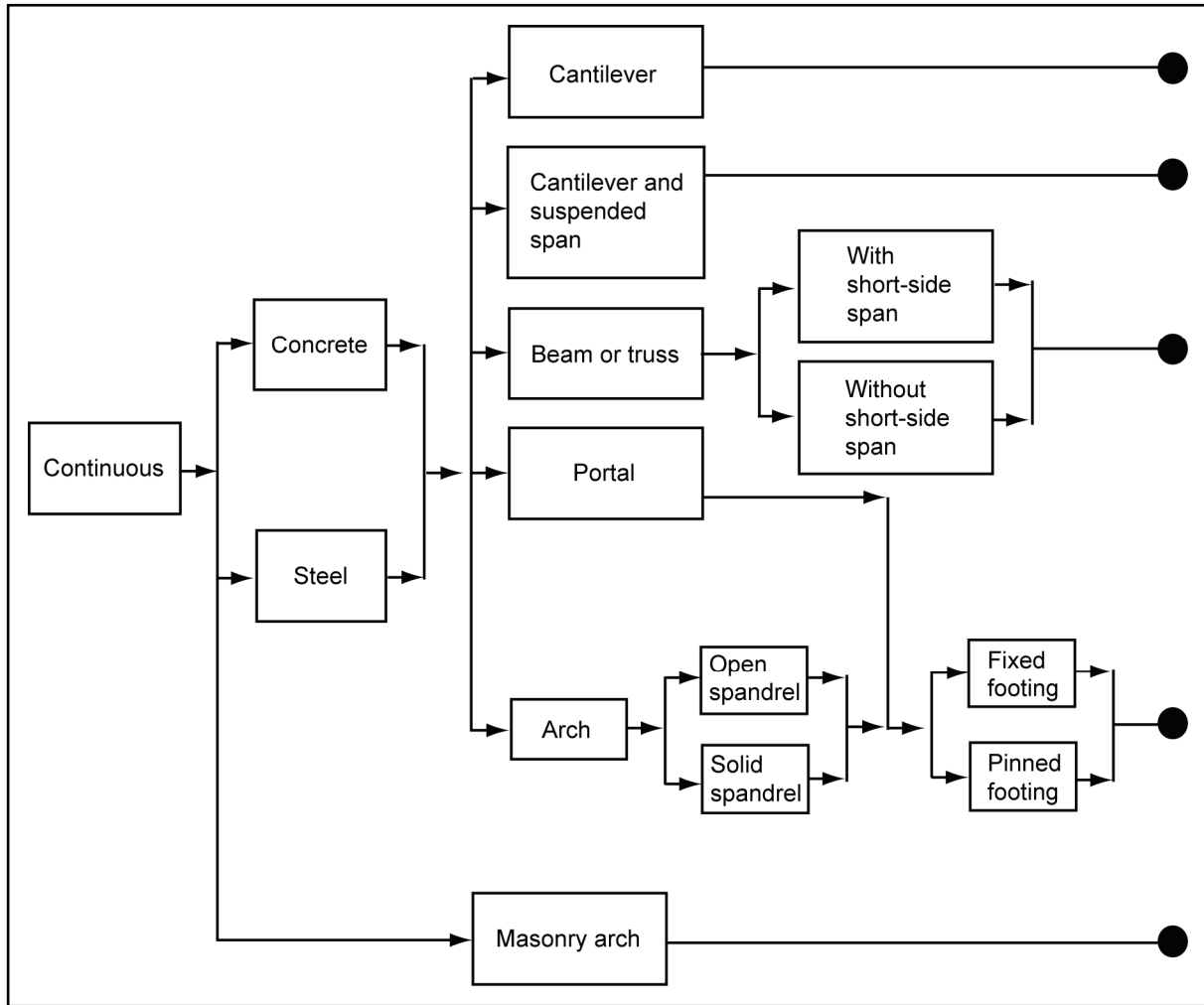


Figure 4-23. Continuous Bridges Categorization Chart

**Cantilever Bridges**

4-34. A cantilever bridge (Figure 4-24) has a midspan shear joint. The full lengths of the anchor spans may be built into the abutments, making the cantilever difficult to identify.

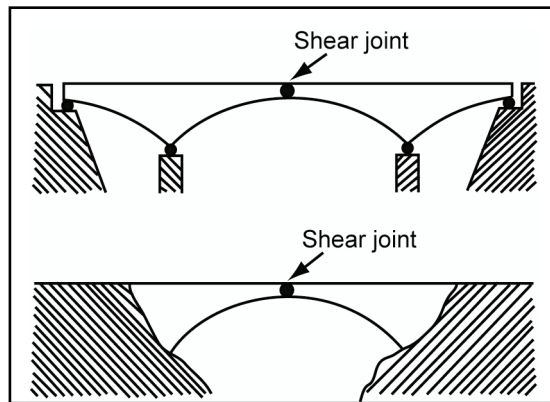


Figure 4-24. Cantilever Bridges

### Cantilever and Suspended-Span Bridges

4-35. If a cantilever bridge incorporates a suspended span (Figure 4-25) that is at least 5 meters longer than the enemy assault bridging capability, this section of the bridge should be attacked. This requires less preparation. Because suspended spans are simply supported, the attack method described for simply supported bridges should be used (Table H-4, pages H-4 through H-8).

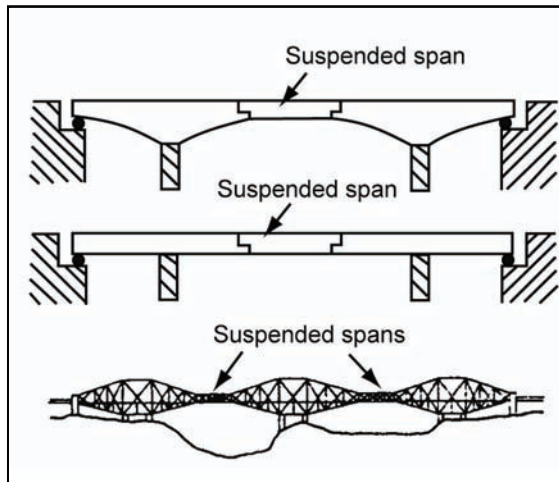


Figure 4-25. Cantilever and Suspended Span Bridges

### Beam or Truss Bridges

4-36. For beam or truss bridges (Figure 4-26, Figure 4-27, page 4-18, and Figure 4-28, page 4-18), differentiate between those bridges with spans of similar lengths and those with short-side spans because this affects the attack method. A short-side span is one that is less than three quarters of the length of the next adjacent span.

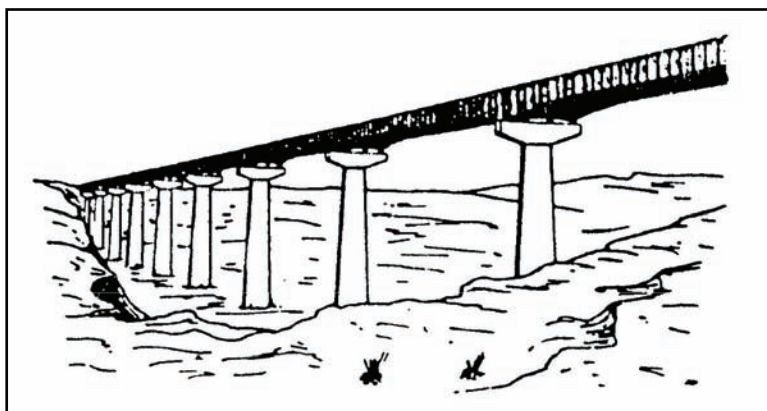


Figure 4-26. Steel-Beam Bridge Without a Short-Side Span

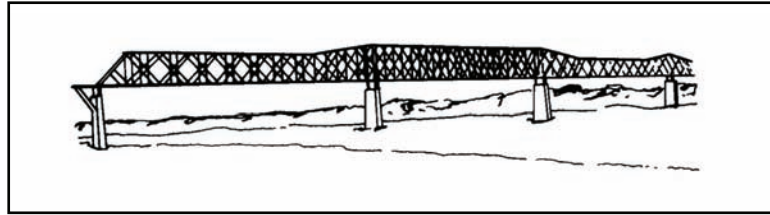


Figure 4-27. Steel-Truss Bridge With a Short-Side Span

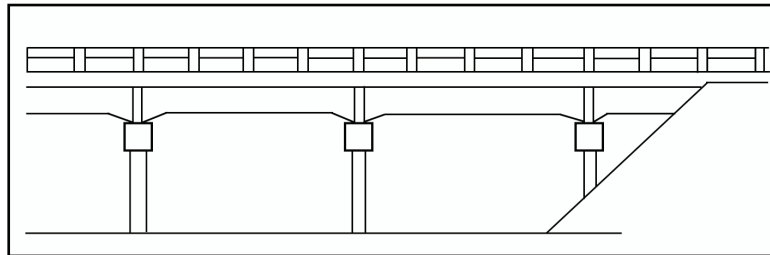


Figure 4-28. Steel-Beam Bridge With a Short-Side Span

**Portal Bridges**

4-37. For portal bridges (Figure 4-29), differentiate between those with fixed footings and those with pinned footings because this affects the attack method. If the footing type cannot be determined, assume that it has fixed footings. Portal bridges, as opposed to arch bridges, lack a smooth curve between the bearing point of the span and the span itself.

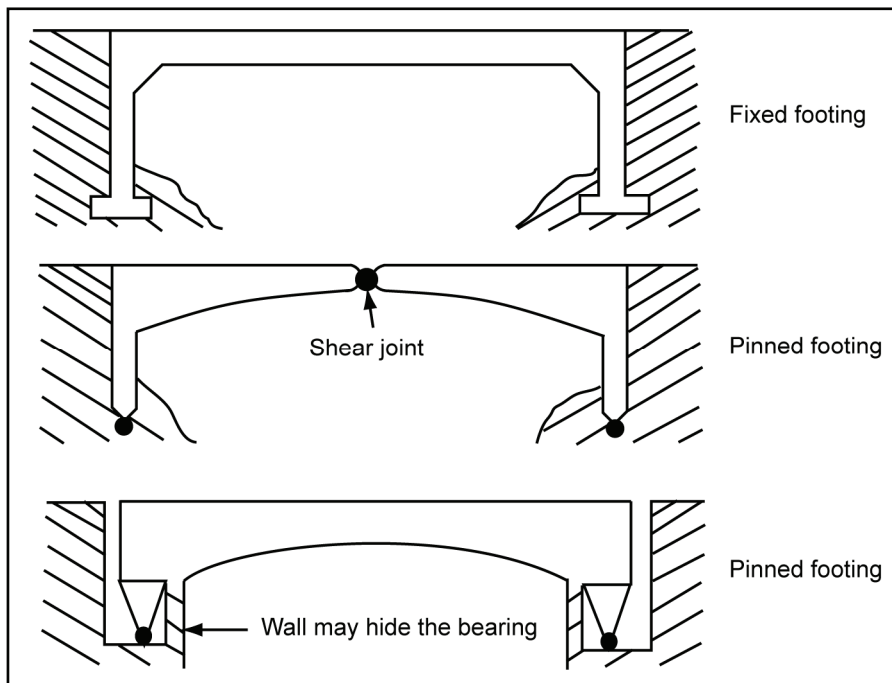


Figure 4-29. Typical Portal Bridges

### Arch Bridges

4-38. In arch bridges (Figure 4-30), determine whether the bridge has an open or solid spandrel and fixed or pinned footings. Again, when in doubt, assume that it has fixed footings.

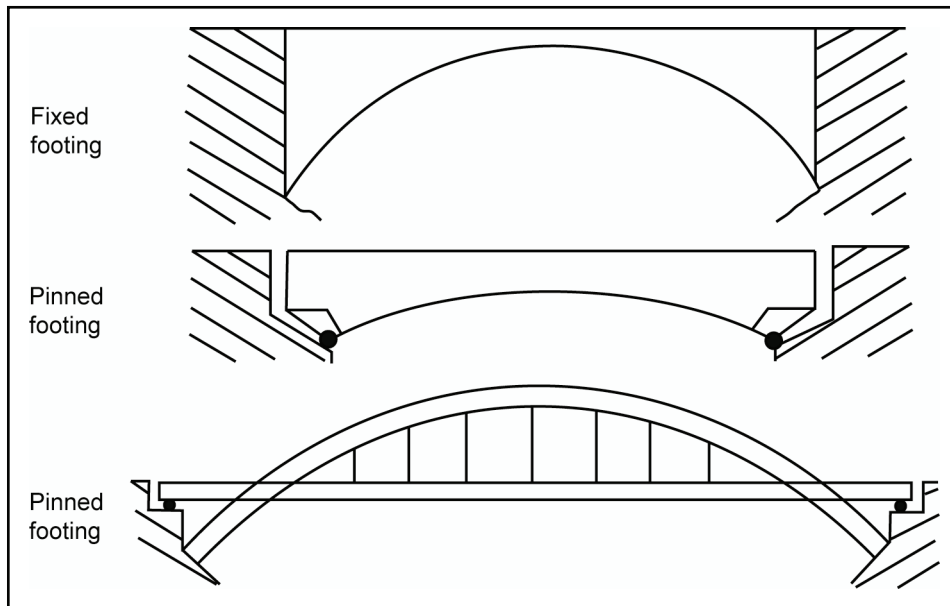


Figure 4-30. Arch Bridges

### Masonry-Arch Bridges

4-39. Masonry-arch bridges (Figure 4-31) should be identified by their segmental arch ring. It is easy to mistake a reinforced-concrete bridge for a masonry arch bridge because many reinforced-concrete bridges have masonry faces. The underside of the arch should always be checked. The underside is rarely faced on reinforced-concrete bridges.

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*Note.* For an example calculation, see Figure F-15, page F-13.

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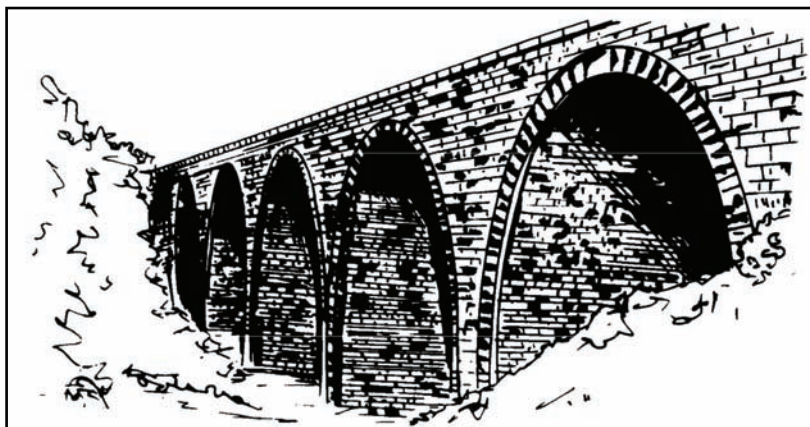


Figure 4-31. Masonry-Arch Bridge

## Reconnaissance

4-40. Reconnaissance for continuous bridges is discussed below. The following reconnaissance procedure is used:

- Categorize the bridge.
- Measure the bridge using the following measurements, with Figure 4-32 as an example:
  - **Length (L).** Measure the span that is planned for attack (in meters) (between the centerlines of the bearings).
  - **Rise (H).** For arch and portal bridges, measure the rise (in meters) (from the springing or bottom of the support leg to the deck or top of the arch, whichever is greater).
- Determine the attack method from Appendix H.
- Determine the critical dimensions necessary for charge calculations.

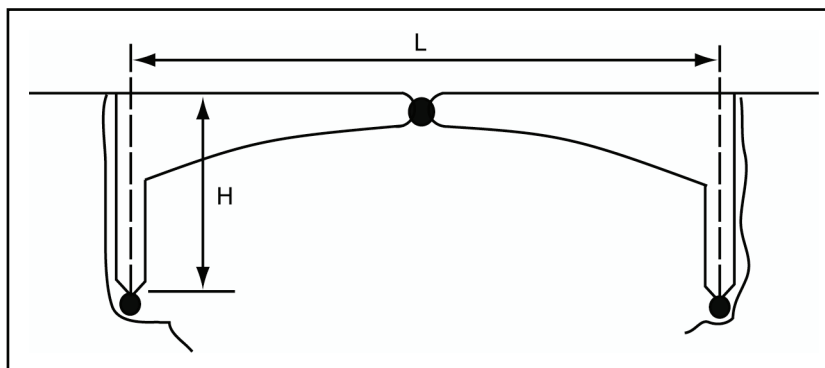


Figure 4-32. Measurements of Continuous Bridges

## Bridge Attacks

4-41. As with simply supported spans, two considerations apply when attacking continuous spans: the point of attack and the line of attack. No common point-of-attack rule exists for all categories of continuous bridges, but the line-of-attack rule applies to all continuous bridges. That is, the line of attack must be parallel to the lines of the abutments, and twisting must not occur during the demolition. If the recommended line of attack involves cutting across transverse beams, the line to cut between adjacent transverse beams should be repositioned. Table H-5, pages H-9 through H-15, lists attack methods for continuous spans.

### Steel Bridges

4-42. When attacking continuous-span steel bridges, the seesaw or unsupported-member collapse mechanism should be used. Both mechanisms produce complete cuts through the span. If charges can be properly placed, these bridges might be demolished with a single-stage attack. However, on particularly deep superstructures (concrete decks on steel beams), charges designed to sever the deck may not cut through all of the reinforcing steel. Therefore, during reconnaissance, the possibility of a two-stage attack on deep, composite superstructures should be planned for. Angle cuts should be made at about 70° to the horizontal to prevent jamming during collapse.

### Concrete Bridges

4-43. Continuous concrete bridges are the most difficult to demolish and are poor choices for reserved demolitions. Even when construction drawings are available and there is ample time for preparation, single-stage attacks are rarely successful.

### *Arch and Portal Bridges*

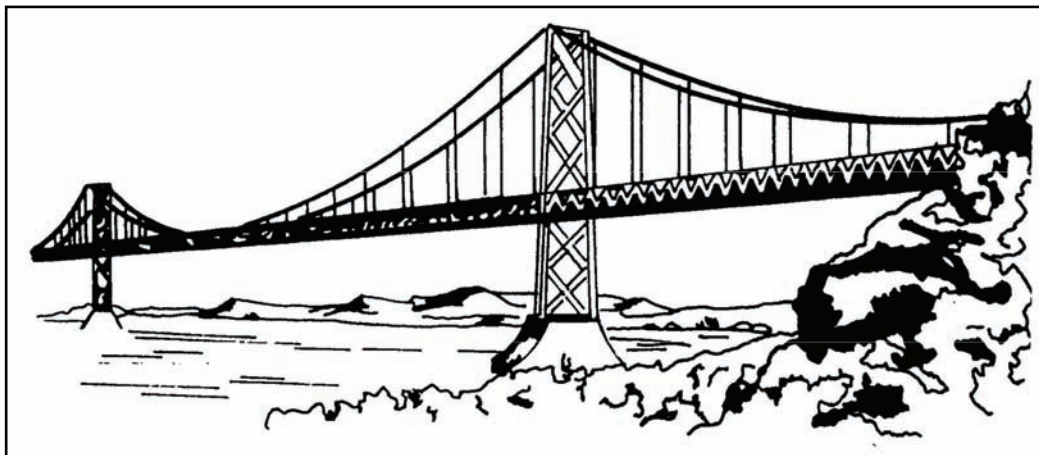
4-44. For arch bridges and portal bridges with pinned footings, collapse can be guaranteed only by removing a specified minimum span length. This minimum length is determined by using Table H-3, page H-3, and the length of the span (denoted as  $L$ ) and the rise for arch (denoted as  $H$ ) values determined by reconnaissance.

## MISCELLANEOUS BRIDGES

4-45. There are two types of miscellaneous bridges. They are suspension span bridges and moveable bridges. The characteristics of these bridges are described in the paragraphs below.

### SUSPENSION SPAN BRIDGES

4-46. Suspension-span bridges usually span very large gaps. These bridges have two distinguishing characteristics: roadways carried by flexible members (usually wire cable) and long spans (Figure 4-33).



**Figure 4-33. Suspension Span Bridge**

### Components

4-47. The components of suspension span bridges are cables, towers, trusses or girders, and anchors. Suspension bridge cables are usually multiwire-steel members that pass over the tower tops and terminate at anchors on each bank. The cables are the load-carrying members. (The Golden Gate Bridge has 127,000 miles of wire cable of this type.) The towers support the cables. Towers may be steel, concrete, masonry, or a combination of these materials. The trusses or girders do not support the load directly; they only provide stiffening. Anchors hold the ends of the cables in place and may be as large as 10,000 cubic feet.

### Demolishing Methods

4-48. The following paragraphs describe how to destroy major and minor bridges:

- **Major bridges.** Anchors for major suspension bridges are usually too massive to be demolished. The cables are usually too thick to be cut effectively with explosives. The most economical demolition method is to drop the approach span or a roadway section by cutting the suspenders of the main or load-bearing cables. The repair and tactical bridging capabilities of the enemy determine the length of the target section. When reinforced-concrete towers are present, it may be feasible to breach the concrete and cut the steel of the towers.
- **Minor bridges.** The two vulnerable points on minor suspension bridges are towers and cables. The following destruction methods are used:



- **Towers.** Destroy towers by placing tower charges slightly above the level of the roadway. Cut a section out of each side of each tower. Place the charges so that they force the ends of the cut sections to move in opposite directions, twisting the tower.

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*Note.* This prevents the end of a single cut from remaining intact. Demolition chambers in some of the newer bridges make blasting easier, quicker, and more effective.

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- **Cables.** Destroy cables by placing charges as close as possible to anchor points, such as the top of the towers. (Cables are difficult to cut because of the airspace between the individual wires in the cable.) Ensure that the charge extends no more than one-half the circumference of the cable.

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*Note.* These charges are usually bulky, exposed, and difficult to place. Shaped charges are very effective for cutting cable.

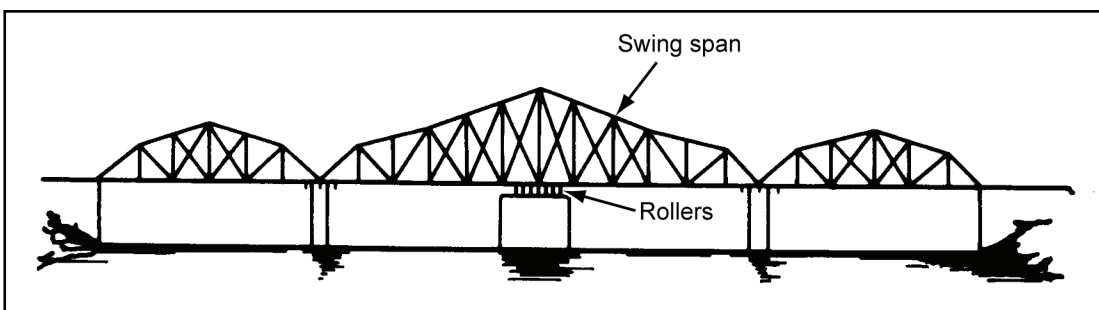
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## MOVABLE BRIDGES

4-49. Movable bridges have one or more spans that open to provide increased clearance for waterway traffic. The three basic types of movable bridges are swing span, bascule, and vertical lift. The characteristics of these bridges are described in the paragraphs below.

### Swing Span Truss Bridges

4-50. A swing span bridge is a continuous span capable of rotating on a central pier. The arms of a swing span truss bridge may not be of equal length. In that case, weights must be added to balance the arms. Rollers that run on a circular track on top of the central pier carry the weight of the span. The swing span is independent from any other span in the bridge. A swing span truss bridge is identified by its wide central pier. This central pier is much wider than the one under a continuous-span bridge that accommodates the rollers and turning mechanism (Figure 4-34).



**Figure 4-34. Swing Span Truss Bridge**

4-51. Because swing span truss bridges are continuous bridges, an attack method from the continuous-bridge section in Appendix H should be used. For partial demolition, open the swing span and damage the turning mechanism.

### Bascule Bridges

4-52. Bascule bridges are more commonly known as drawbridges. These bridges usually have two leaves that fold upward (Figure 4-35), but some bascule bridges may have only one leaf (Figure 4-36). The movable leaves in bascule bridges appear in following three general forms:

- Counterweights below the road level (most modern).
- Counterweights above the road level (older type).
- No counterweights (the oldest type, usually timber, lifted by cable or rope).



4-53. To destroy this bridge, demolish the cantilever arms with an attack method appropriate for simply supported bridges. For partial demolition, the bridge and jam should be opened or the lifting mechanism destroyed.

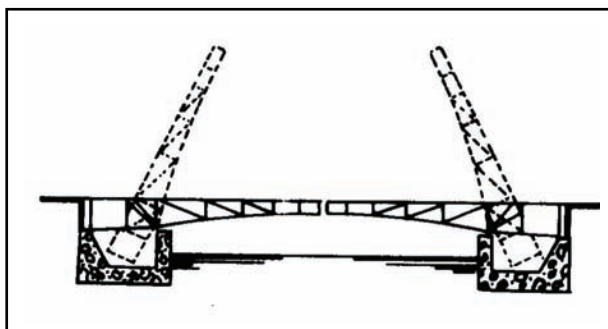


Figure 4-35. Double-Leaf Bascule Bridge

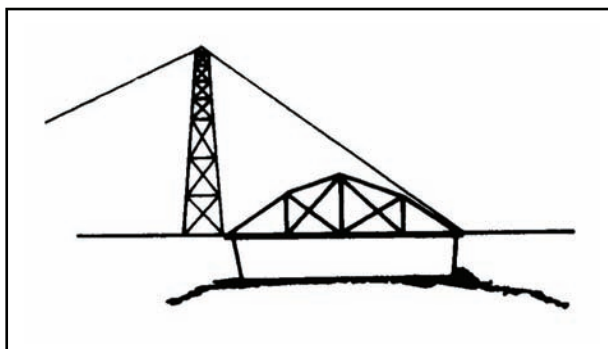


Figure 4-36. Single-Leaf Bascule Bridge

### Vertical Lift Bridges

4-54. These bridges have simply supported, movable spans that can be raised vertically in a horizontal position. The span is supported on cables that pass over rollers and connect to large, movable counterweights (Figure 4-37).

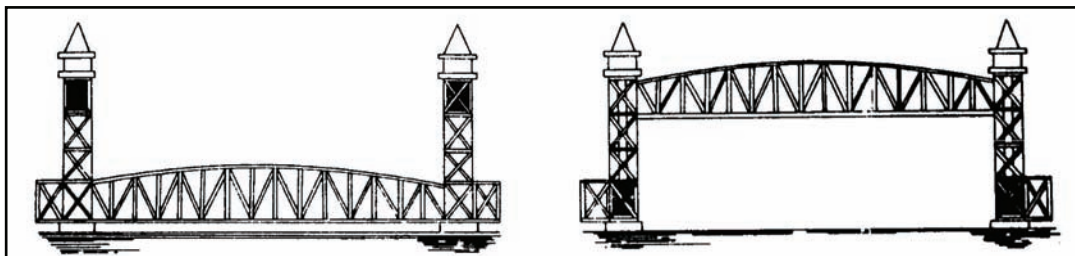
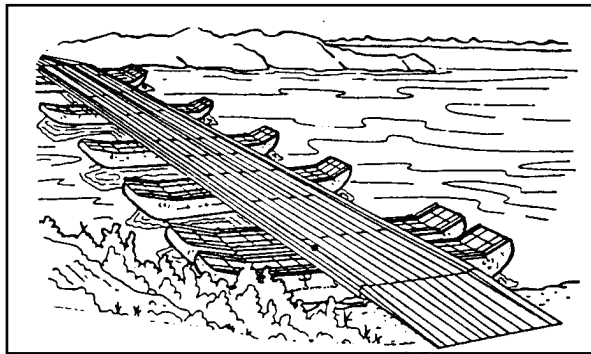


Figure 4-37. Vertical Lift Bridge

4-55. To destroy this bridge, the movable span should be demolished with an attack method appropriate for simply supported bridges. Another method is to raise the bridge, and cut the lift cables on one end of the movable span. The movable span will either wedge between the supporting towers or fall free and severely damage the other tower.

### Floating Bridges

4-56. Floating bridges consist of a continuous metal or wood roadway. These bridges are supported by floats or pontoons (Figure 4-38, page 4-24).



**Figure 4-38. Floating Bridge**

### ***Pneumatic Floats***

4-57. Pneumatic floats are airtight compartments of rubberized fabric inflated with air. For a hasty attack of these bridges, the anchor cables and the bridle lines are cut with axes and the steel cables with explosives. Also, the floats are punctured with small arms or machine-gun fire. Using weapons to destroy the floats requires a considerable volume of fire because each float has a large number of watertight compartments. Another method is to make a clean cut through the float, using detonating cord stretched snugly across the surface of the pontoon compartments. One strand of cord is enough to cut most fabrics, but two strands may be necessary for heavier materials. Also, one turn of a branchline cord is placed around each inflation valve. This prevents the raft from being reinflated if it is repaired. Do not use mainline cords to cut valves because the blast wave may fail to continue past any sharp turn in the cord.

### ***Rigid pontoons***

4-58. Rigid pontoons are made of wood, plastic, or metal. To destroy these bridges, a 1/2-pound charge is placed on the upstream end of each pontoon at water level. A charge is detonated simultaneously. If the current is rapid, the anchor cables are cut so that the bridge will be carried downstream. Another method is to cut the bridge into rafts. One-half pound charges are placed at each end of each pontoon, and detonate them simultaneously. To destroy metal tread ways on floating bridges, the steel-cutting formula is used (see Chapter 3). The placement and size of the charges depend on the bridge type. Placing cutting charges at every other joint in the tread way will damage the bridge beyond use.

### **Bailey Bridges**

4-59. To destroy Bailey bridges, 1-pound charges are placed between the channels of the upper and lower chords. One-half pound charges for cutting diagonals and 1-pound charges are used for cutting sway bracing (Figure 4-39).

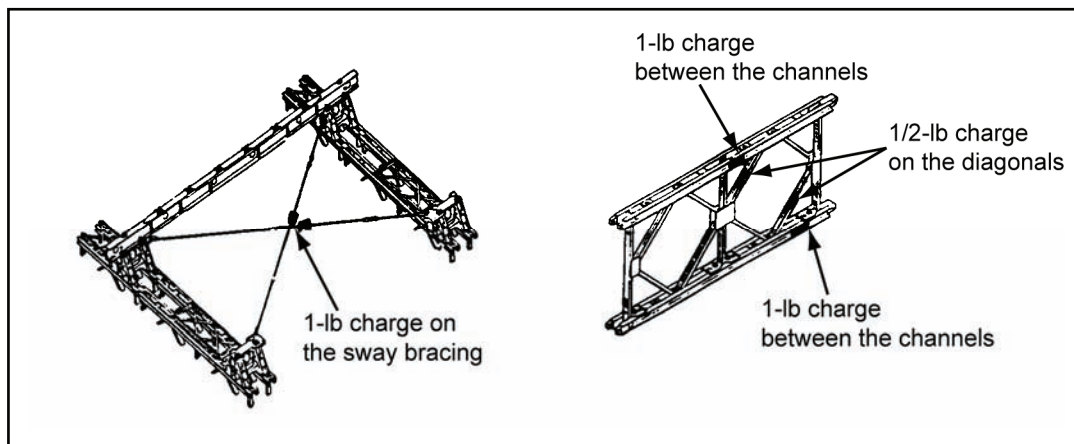


Figure 4-39. Bailey Bridge Demolition

***In-Place Demolitions***

4-60. The bridge should be cut in several sections by attacking the panels on each side, including the sway bracing. The attack angle should be 10° to the horizontal to prevent jamming. In double-story or triple-story bridges, increase the charges on the chords at the story-junction line. For further destruction, charges are placed on the transoms and stringers.

***In-Storage or In-Stockpile Demolition***

4-61. When abandoning bridges in storage, no component is left that the enemy can use as a unit or for improvised construction. The essential components should be destroyed so that the enemy cannot easily replace or manufacture them. Panel sections are considered essential components. To render the panels useless, the female lug in the lower tension chord removed or distorted. All panels should be destroyed before destroying other components.

**ABUTMENTS**

4-62. To demolish abutments, charges are placed in the fill behind the abutment. This method uses less explosive than external breaching charges and also conceals the charges from the enemy. The disadvantage is the difficulty in placing the charges. When speed is required, do not place charges behind abutments if it is known that the fill contains large rocks.

**ABUTMENTS 5 FEET THICK OR LESS**

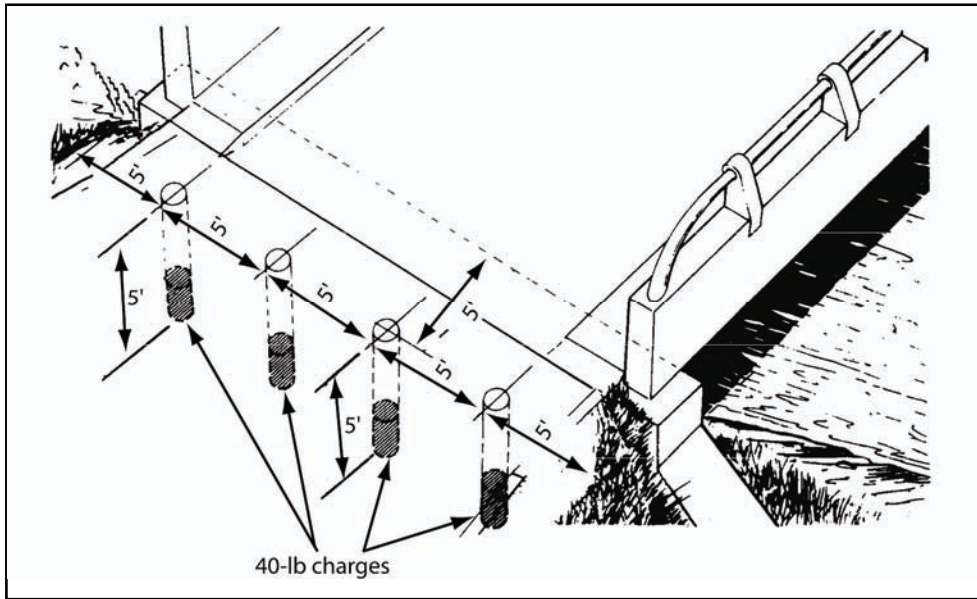
4-63. Abutments 5 feet thick or less are demolished by placing a line of 40-pound cratering charges on 5-foot centers, in boreholes 5 feet deep, and located 5 feet behind the face of the abutment (using the triple-nickel-forty method). The first hole is placed 5 feet from either end of the abutment, then this spacing continues until a distance of 5 feet or less remains between the last borehole and the other end of the abutment (Figure 4-40, page 4-26). If the bridge approach is steep, the breaching charges are placed against the rear of the abutment. The number of 40-pound cratering charges is determined as follows:

$$N = \frac{W}{5} + 17 (-1)$$

where—

- N* = number of charges; round UP to next higher whole number
- W* = abutment width (in feet)
- 5 = center mass distance between boreholes
- 17 = constant to find the number of charges

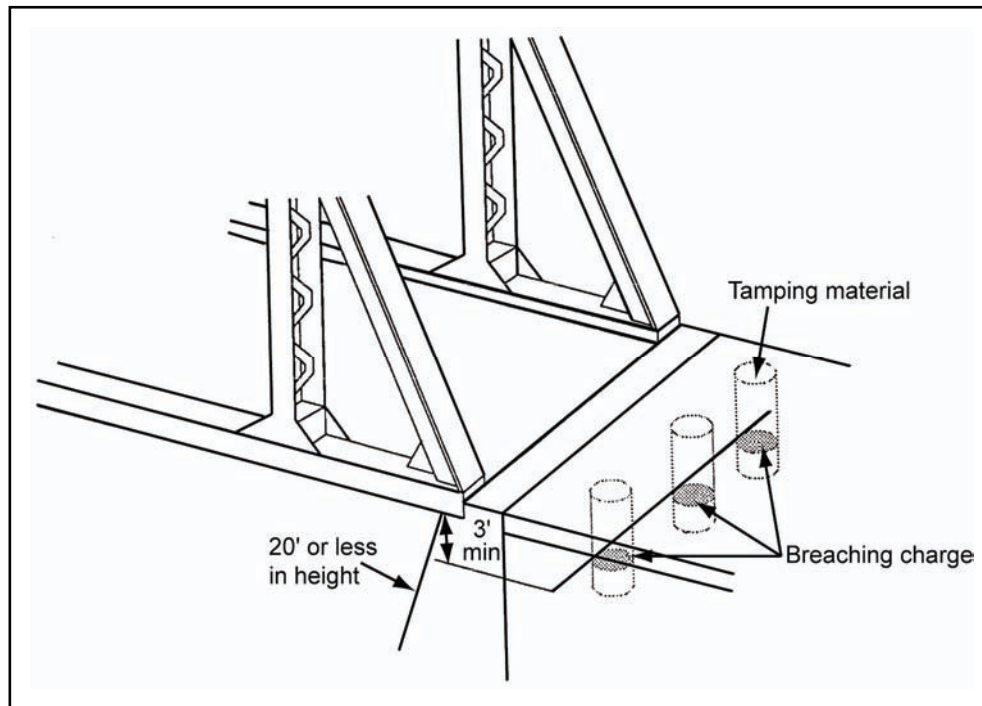
1 = convert spaces to holes



**Figure 4-40. Abutment Destruction (5 Feet Thick or Less)**

**ABUTMENTS OVER 5 FEET THICK**

4-64. These abutments are destroyed with breaching charges in contact with the back of the abutment. The amount of each charge is calculated using the breaching formula in the equation in paragraph 3-39. The abutment thickness is used as the breaching radius. The number of charges and their spacing is determined using the equation in paragraph 3-46. Charges are placed at least 3 feet below the bridge seat (where the bridge superstructure sits on the abutment) (Figure 4-41).



**Figure 4-41. Abutment Destruction (Over 5 Feet Thick)**

### **ABUTMENTS OVER 20 FEET HIGH**

4-65. These abutments are demolished by placing a row of breaching charges at the base of the abutment, on the gap side, in addition to the charges specified the following on intermediate supports. All charges are fired simultaneously. This method tends to overturn and completely destroy the abutment.

### **WING WALLS**

4-66. If the wing walls can support a rebuilt or temporary bridge, destroy the wing walls by placing charges behind them the same as for abutments. See Figure 4-40 and Figure 4-41.

## **INTERMEDIATE SUPPORTS**

4-67. Intermediate supports include external and internal charges. Each of these are discussed in the paragraphs below.

### **EXTERNAL CHARGES**

4-68. External charges are placed at the base of the pier or higher and are spaced by more than twice the breaching radius (Figure 4-42, page 4-28). Charges are staggered to leave a jagged surface to hinder future use. All external charges are thoroughly tamped with earth and sandbags if time, size, shape, and location of the target permits.

### **INTERNAL CHARGES**

4-69. Internal charges on intermediate supports require less explosive than external charges. (For charge placement, see Figure 4-42.) However, unless the support has built-in demolition chambers, this method requires an excessive amount of equipment and preparation time. The equation in paragraph 3-39 should be used to determine the amount of each charge. M112 (composition C4) is ideal for internal charges. All charges of this type should be thoroughly tamped with nonsparking tools (such as blunt, wooden tamping

sticks or similar tools). If the support has demolition chambers, the charges are placed in boreholes created with shaped charges or drilled with pneumatic or hand tools. A 2-inch-diameter borehole holds about 2 pounds of explosive per foot of depth. The steel reinforcing bars, however, make drilling in heavily reinforced concrete impractical.

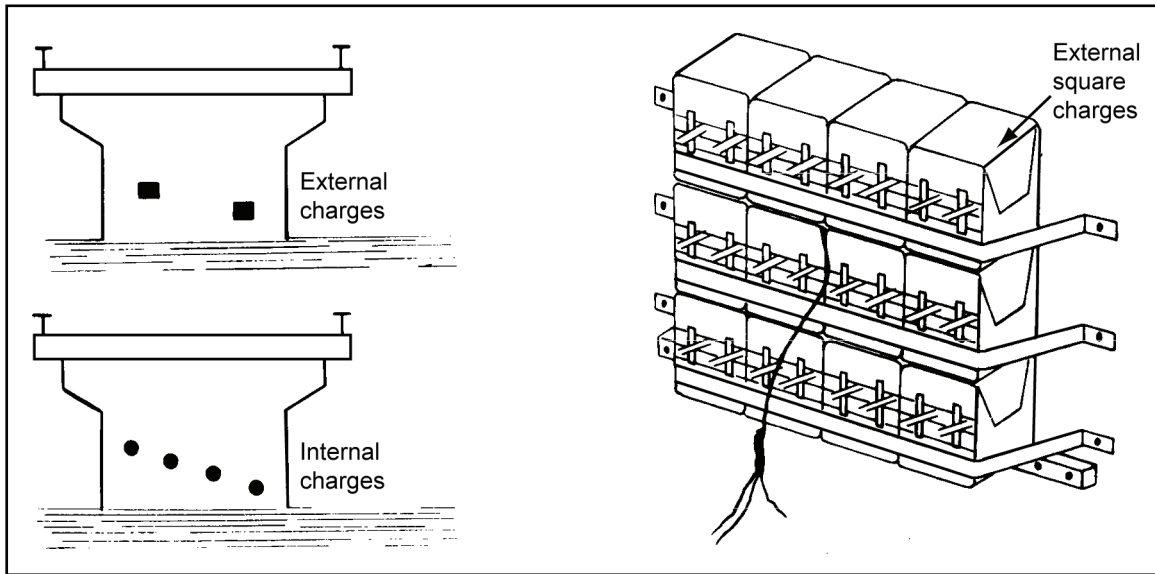


Figure 4-42. Intermediate-Support Placement Charges

This chapter implements Standardization Agreement (STANAG) 2017, STANAG 2077, STANAG 2123, Quadripartite Standardization Agreement (QSTAG) 508, and QSTAG 743.

## Chapter 5

# Demolition Operations and Training

Planning for demolitions and preliminary and reserved demolitions are described in this chapter, including Orders for Demolition which is outlined in STANAG 2077. The chapter also provides information on how to prepare DA Form 2203 (Demolition Reconnaissance Record) and how to complete an obstacle folder as outlined in STANAG 2123. This chapter also provides details for each simulated demolition type, the priming methods for each type, the initiating set preparation, and the setup of firing systems.

### SECTION I – DEMOLITION OPERATIONS

5-1. This section provides information about the use of obstacles, the types of operations, demolition planning, demolition orders, preliminary and reserved demolitions, reconnaissance orders and records, and obstacle folders.

#### DEMOLITION OBSTACLES

5-2. A *demolition obstacle* is an obstacle created by using explosives. Although engineers use explosives for quarrying, land-clearing, and other projects, their most important use is creating demolition obstacles. Engineers use demolition obstacles in conjunction with many other types of obstacles, including mines. They also use explosives to destroy materiel and facilities that must be abandoned (denial operations).

#### BARRIERS AND DENIAL OPERATIONS

5-3. Division or higher-echelon commanders direct the use of extensive barriers and denial operations. Commanders must carefully prepare and closely coordinate these operations with all tactical plans. Engineer units provide technical advice and supervision, estimate the resources necessary for obstacle construction, construct barriers or obstacles, and recommend allocation of engineer resources. They usually construct demolition obstacles because they have the special skills and equipment to accomplish these tasks.

#### DEMOLITION PLANNING

5-4. A *demolition plan* is the documentation with data required for the preparation of a single demolition. Any demolition project is based on careful planning and reconnaissance. The following factors are used as a basis for selecting and planning demolition projects:

- The mission.
- The limitations and instructions from a higher authority.
- The current tactical and strategic situation and future plans (conditions that indicate the length of time the enemy must be delayed, the time available for demolition, and the extent of denial objectives).

- The capabilities and limitations of the enemy, as well as the effect that denial operations have on enemy forces, strategically and tactically.
- The likelihood that friendly forces may reoccupy the area, requiring obstacle neutralization.
- The economy of effort.
- The time, material, labor, and equipment available.
- The effect on the local population.
- The target protection required.

## DEMOLITION ORDERS

5-5. Authorized commanders use orders for the demolition to pass their orders to the *demolition guard* (a local force positioned to ensure that a target is not captured by an enemy before orders are given for its demolition and before the demolition has been successfully fired [the definition was shortened, and the complete definition is printed in the glossary]) (FM 1-02) (JP 1-02) and the *demolition firing party* (the party at the site that is technically responsible for the demolition and that actually initiates detonation or fires the demolitions) (FM 1-02) (JP 1-02). The orders for the demolition, as outlined in STANAG 2017 and QSTAG 508, is a standard four-page form used by the North Atlantic Treaty Organization (NATO) and ABCA countries. This form is used for preparing all reserved and preliminary demolitions. Page one of the form contains the instructions, duties, and responsibilities of demolition personnel.

## PRELIMINARY DEMOLITIONS

5-6. With prior authority, a preliminary demolition is detonated immediately after preparation. Preliminary demolitions present fewer difficulties to both commanders and engineers than do reserved demolitions. Commanders may restrict preliminary demolitions for tactical, political, or geographical reasons.

### ADVANTAGES

- 5-7. Preliminary demolitions have some advantages. They are as follows:
- Engineers normally complete each task and move to the next without having to leave demolition guards or firing parties at the site.
  - Preparation efforts are less subject to interference by enemy or friendly troops.
  - Elaborate precautions against failure are not required; preliminary demolitions require only single-firing systems.
  - Engineers can perform demolition operations for a particular target in stages rather than all at once.

### PROGRESSIVE PREPARATION

5-8. When preparation time is limited, engineers prepare the demolition in progressive stages. This gives the engineers the ability to create effective obstacles even if preparations must stop at any stage.

## RESERVED DEMOLITIONS

5-9. The responsible commander must carefully control a reserved demolition target. The target may be a vital part of the tactical or strategic plan or the demolition will be performed in close contact with the enemy.



## CONSIDERATIONS

5-10. Occasionally, errors in orders, control, or timing cause serious consequences during demolition operations. In addition, engineers may encounter the following special problems when dealing with reserved demolition targets:

- Traffic lanes must be kept open until the last moment. This means they cannot use the simplest and quickest demolition techniques to accomplish the mission.
- Demolitions must be weatherproofed and protected from traffic vibrations and enemy fire over long periods. Dual-firing systems must be used and demolitions must be carefully placed and protected from passing vehicles or pedestrians.
- Demolition sites must be guarded until the demolitions are fired.

## STATE OF READINESS—STATE 1 (SAFE)

5-11. In state 1, the demolition charges are in place and secure. Vertical and horizontal ring mains are installed (Figure 2-28, page 2-26) and not connected. Charges are primed with detonating cord knots, M151, M152, or wraps to minimize the time necessary to convert the system from state of readiness—state 1 (SAFE) to state of readiness—state 2 (ARMED). Charges that require blasting caps for priming cannot be primed at state of readiness—state 1, and branchlines with caps crimped to them cannot be connected to ring mains. Blasting caps and initiating sets are not attached to charges or firing systems. M151 and M152 boosters are the preferred priming method.

## STATE OF READINESS—STATE 2 (ARMED)

5-12. In state 2, blasting caps are in appropriate charges, and initiating sets are connected to ring mains. All charges and firing systems are complete and ready for detonation. The demolition is ready for immediate firing.

## RESPONSIBILITIES

5-13. The paragraphs below describe the responsibilities of authorized commanders, demolition guard commanders, and demolition-firing party commanders.

### Authorized Commanders

5-14. These commanders have overall responsibility for the operational plan. At any stage of the operation, they may delegate responsibilities. For example, when authorized commanders withdraw through other units' intermediate positions, they pass control to the commanders holding the intermediate positions. The commanders holding the intermediate positions then become the authorized commanders. Authorized commanders—

- Designate demolition targets as reserved targets.
- Order the demolition guard, and detail the strength and composition of the guard party.
- Specify the state of readiness and order changes to the state of readiness, if necessary.
- Give the orders to fire demolitions.
- Give the demolition guard commander or the demolition-firing party commander the authority, in case of imminent capture, to fire the demolition on his own initiative.
- Destroy captured or abandoned explosives and demolition materials to prevent them from falling into enemy hands.

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*Note.* Commanders should carefully select the demolition site and consider all safety precautions necessary when destroying abandoned demolitions. Chapter 6, Section IV, covers the procedures and methods for destroying explosives.

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- Issue written instructions (demolition orders) to the unit providing the demolition guard and demolition-firing party.

- Notify all headquarters of any delegation of authority or reclassification of any demolition from a reserved to a preliminary status.
- Establish effective channels for communicating firing orders and readiness states to demolition guard commanders or demolition-firing party commanders.

### **Demolition Guard Commanders**

5-15. These commanders are normally the infantry or armor task force commanders who control the target area. The demolition guard commanders—

- Command all troops and firing parties at reserved demolitions.
- Provide protection for reserved demolitions, firing parties, and targets.
- Control all traffic over or through targets.
- Pass written state-of-readiness orders to demolition-firing party commanders, including changes to these orders.
- Keep authorized commanders informed of the status of preparations, targets, and operational situations at sites.
- Pass written firing orders to demolition-firing party commanders to fire demolitions.
- Report demolition results to authorized commanders.
- Maintain succession (chain of command) lists for appointment to demolition guard and demolition-firing party commanders.

### **Demolition-Firing Party Commanders**

5-16. These commanders are normally officers or noncommissioned officers (NCOs) from the engineer unit that prepared the demolitions. They supervise the preparing, charging, and firing of the demolition. Demolition-firing party commanders—

- Maintain the state of readiness that is specified by authorized commanders and advise demolition guard commanders of the time requirements for changing states of readiness and completing obstacles.
- Fire demolitions when ordered by the authorized commander and ensure that demolitions are successful and complete.
- Report the results of demolitions to demolition guard commanders or, if none, to the authorized commanders.
- Report the results of demolitions up the chain of command and complete of the obstacle folder, if required.
- Maintain succession (chain of command) lists for appointment as demolition-firing party commander, if the initial commander should become injured.

## **COMMAND AND CONTROL OF RESERVED DEMOLITIONS**

5-17. The paragraphs below discuss the command and control of reserved demolitions. Discussed is the command post, the firing point, alternate positions, the checkpoint, and refugee-control points.

### **Command Post**

5-18. The demolition guard commander should place his command post where he can best control the defense of the demolition target from the friendly side. However, this location may conflict with the requirements of the demolition firing point, which should be close to or collocated with the command post. Usually, some compromise is necessary.

### **Firing Point**

5-19. The firing point should be as close to the target as safety allows. The firing point must protect the firing party from the effects of blast and falling debris and be positioned so that the demolition-firing party commander is—

- Easily accessible to the demolition guard commander for receiving orders.
- In close contact with the firing party.
- Able to see the entire target.

### **Alternate Positions**

5-20. The demolition guard commander should designate an alternate command post and firing point, if possible. The firing party should be able to fire the demolitions from either the primary or alternate firing points.

### **Checkpoint**

5-21. When units are withdrawing from an enemy advance, identification can be a problem. Withdrawing troops are responsible for identifying themselves to the demolition guard. The demolition guard must always establish and operate a checkpoint. The demolition guard commander may use military police to perform this duty. Good communication is essential between the checkpoint and the demolition guard commander. Each unit withdrawing through the demolition target should send a liaison officer to the checkpoint, well in advance of the arrival of the withdrawing unit.

### **Refugee-Control Points**

5-22. The demolition guard commander may need to establish and operate a refugee-control point for civilian traffic. He should place a checkpoint on the enemy bank and a release point on the friendly bank to control refugees. The commander may use military or local police to operate the control points. Personnel operating the checkpoints should halt refugees off the route and then escort them, in groups, across the target to the release point. Refugees must not interfere with the movement of withdrawing forces or demolition preparations.

## **RECONNAISSANCE ORDERS**

5-23. Thorough reconnaissance is necessary before planning a demolition operation. Reconnaissance provides detailed information in all areas related to the project. Before conducting any reconnaissance, the reconnaissance party commander must receive clear objectives. The reconnaissance order specifies these objectives. This information helps the reconnaissance party to determine the best method of destroying the target and to estimate the preparation time required. For example, if the reconnaissance party knows that manpower and time are limited but explosives are plentiful, they may design demolitions requiring few men and little time but large quantities of explosives. These orders should detail the reconnaissance party to determine the following:

- The location and nature of the target.
- The purpose of the demolition operation (to delay an enemy infantry battalion for 3 hours).
- The proposed classification of the demolition (reserved or preliminary).
- The firing system type desired (dual or single).
- The economy of effort (whether the demolition must be completed in one stage or multiple stages).
- The utility of the target during demolition operations (whether the target must remain open to traffic during demolition preparations).
- The amount of time allowed or expected between preparation and execution of the demolition operation.
- The amount of time allowed for changing the state of readiness (safe to armed).
- The labor and equipment available for preparing the demolitions.
- The types and quantities of explosives available.

## RECONNAISSANCE RECORD

5-24. A reconnaissance party reports the results of its reconnaissance on DA Form 2203. The form is used with the appropriate sketches to record and report the reconnaissance of military demolition projects. Figure I-1, page I-4, contains a sample of DA Form 2203 and instructions to complete it. Available paper is used and attached to the completed DA Form 2203.

5-25. When time and conditions permit, the reconnaissance report is used as the source document for preparing the obstacle folder. If the obstacle folder is not available, this report is used in its place. In certain instances, the report may require a security classification. For the required information and instructions, see DA Form 2203.

## OBSTACLE FOLDER

5-26. The obstacle folder, as outlined in STANAG 2123 and QSTAG 743, provides all the information necessary to complete a specific demolition operation. NATO and ABCA personnel use this booklet to collect information and to conduct demolition operations. The responsible commander should prepare an obstacle folder during peacetime for all preplanned targets to allow for efficient demolition operations. Obstacle folders are prepared for reserved and preliminary demolitions. The obstacle folder is not used in tactical situations because the detailed information in the obstacle folder, including multiple languages, is not easily completed under field or tactical conditions.

## LANGUAGE

5-27. Since not all NATO and ABCA personnel speak the same language, obstacle folders must be multilingual. The preparing unit may speak a different language than the unit actually conducting the demolition operation. Therefore, it is essential to prepare the obstacle folder in more than one language. However, prepare map notes, plans, sketches, and so forth in one language, and provide translations for the other languages in the available space. The languages necessary in an obstacle folder is determined based on the following:

- The languages of the units involved in the demolitions.
- The language of the host nation.
- One of the two official NATO languages (English or French).

## CONTENTS

5-28. The obstacle folder contains six sections for recording information. Additional information may be noted in the appropriate place within the obstacle folder and then inserted as an additional page immediately following the notation (for example, "location and type, see page 4a"). The following are the six parts of the obstacle folder:

- Location of the target.
- Supply of explosives and equipment.
- Orders for preparing and firing.
- Handover and takeover instructions.
- Demolition report.
- Official signature.

## SPECIAL INSTRUCTIONS

5-29. The list of explosives, stores, and mines required does not cover every possible situation. However, it does indicate a logical order for recording or determining the required materials. Only the materials required for the particular target are marked. The transport team leader uses the first list. For major operations, note the size, composition, and mission of the various participating work parties. The demolition-firing party commander may detach the first copy of the demolition report and forward it to a higher-echelon headquarters.

## SECTION II – DEMOLITION EFFECTS SIMULATOR DEVICES

5-30. To meet the field requirement, all demolition effects simulator (DES) training devices must be the same weight, size, and shape as the real item to produce realistic loads on both the individual Soldier and the logistics system, and they should produce enough visual and sound effects to enhance battlefield realism. All safety precautions should be followed for live explosives and demolitions when using DESs. All Soldiers will observe the standard operational and safety procedures in this manual when using DESs. All MSDs should be observed, even though, realistically, these safety distances are less for DESs.

### OVERVIEW

5-31. Currently, 10 DESs are available for field training exercises. These devices simulate the—

- Sheet explosive.
- M112 (composition C4) block.
- 1-pound TNT block.
- M5A1 demolition block.
- M183 demolition (satchel) charge.
- M2A3 15-pound shaped charge.
- M3 40-pound shaped charge.
- 40-pound cratering charge.
- Bangalore torpedo.
- M1 military dynamite.

5-32. DES devices can simulate blowing mines in place, destroying timber trestle bridges, destroying captured equipment and supplies, cratering, and gaining access to a building during training for urban operations. All of these missions can be executed safely with little or no damage to facility infrastructures.

5-33. All charges except the M112 (composition C4) block and the sheet explosive are chalk charges. Chalk charges are various containers filled with a chalk powder, sand mixture, and detonating cord. The detonating cord is the explosive propellant that discharges the chalk powder. The M112 DES block is a nonexplosive clay compound that replicates composition C4. The sheet explosive is made of nonexplosive rubber matting. The explosive signatures come strictly from the detonating cord blast.

### PREREQUISITES

5-34. Soldiers who assemble DES devices must be familiar with all detonating cord priming methods (see Chapter 2). The 8-wrap Uli knot is the primary priming method. It gives the DES the explosive power to create the desired sound signatures and expel the chalk that creates the visual signature. Other priming methods are the girth hitch with an extra turn, the triple-roll knot, the double-overhand knot, and the common and alternate methods.

## SECTION III – CHARACTERISTICS AND ASSEMBLY INSTRUCTIONS

5-35. This section gives guidance in the assembly and use of DES devices. The materials, assembly instructions, and uses are only recommendations pertinent to each product. However, as a standard marking system, all DESs and DES containers are labeled with red lettering. (See Appendix J for a list of DES materials.)

### SHEET EXPLOSIVE DEMOLITION EFFECTS SIMULATOR

5-36. The sheet explosive demolition charge DES is eight pieces of rubber matting cut into sheets identical to plastic-sheet explosive. The sheets are glued together (making four 1/4-inch sheets) and then packed into clear plastic bags, marked with DES labels.

## PRIMARY USES

5-37. This charge is primarily used for the following charges:

- Ribbon.
- Saddle.
- Diamond.
- Steel-cutting.

## ASSEMBLY INSTRUCTIONS

5-38. The following steps should be used to assemble sheet explosive DESs:

- **Step 1.** Cut out eight pieces of rubber matting (1/8 by 3 by 11 inches).
- **Step 2.** Place two pieces of matting side by side.
- **Step 3.** Put glue on the rough side of one sheet (Figure 5-1), leaving enough space for inserting the MDI cap. Do not put glue where the MDI cap will be inserted for priming.
- **Step 4.** Place the rough sides of the sheets together (Figure 5-1), and weight with a heavy object until the glue dries.
- **Step 5.** Ensure that the glue is completely dry, and package four 1/4-inch-thick sheets (Figure 5-1) into a plastic bag.
- **Step 6.** Seal the plastic bag with clear tape.
- **Step 7.** Place a DES label on the package.
- **Step 8.** Place 20 DES charges into each shipping container.
- **Step 9.** Label each container.

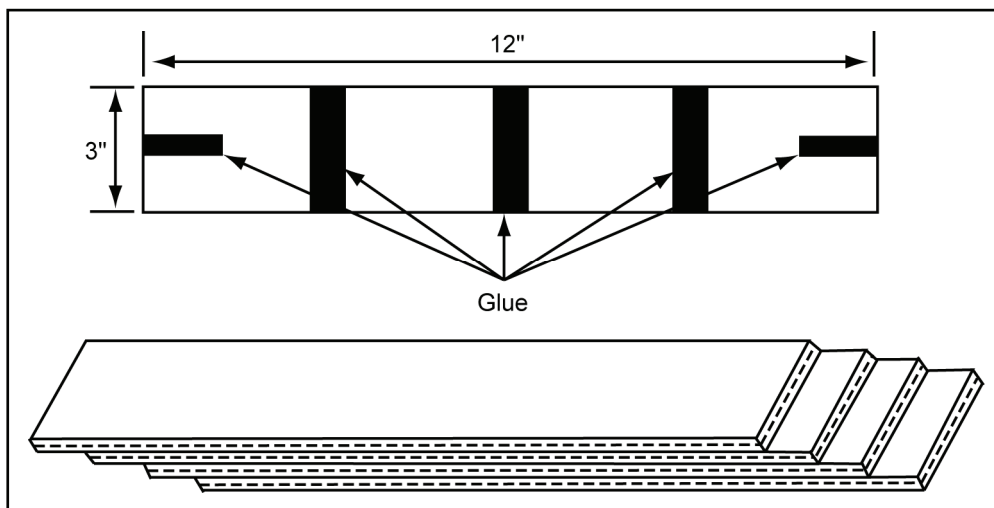


Figure 5-1. Sheet Explosive DES Assembly

## SPECIFICATIONS

5-39. The sheet explosive DES specifications are as follows:

- Weight: 2 pounds.
- Dimensions: 12 by 3 by 1/4 inches.
- Packaging: 20 per container.
- Container: 13 3/8 by 15 1/2 by 7 5/8 inches.

## BILL OF MATERIALS

5-40. The bill of materials (BOM) for a sheet explosive is shown in Table 5-1.

**Table 5-1. BOM for a Sheet Explosive DES**

<i>Material</i>	<i>Quantity</i>
Rubber matting, 18 inch	8 ea
Glue	6 oz
Clear plastic bag	1 ea
Clear tape	2 ft
Two-sided adhesive tape	2 ft
DES label	1 ea

## **M112 (COMPOSITION C4) BLOCK DEMOLITION EFFECTS SIMULATOR**

5-41. The M112 (composition C4) block DES is made from 1 1/4 pounds of moist pottery clay (nonexplosive), formed and packaged like composition C4. It is then packed in clear plastic wrap with DES markings and pressure-sensitive adhesive tape on the back. The tape is protected by a peel-away paper cover.

### **PRIMARY USES**

5-42. The M112 charge is used primarily for steel-cutting charges, forced entry of buildings, breaching, cutting timber, demolishing bridges, and neutralizing mines.

### **ASSEMBLY INSTRUCTIONS**

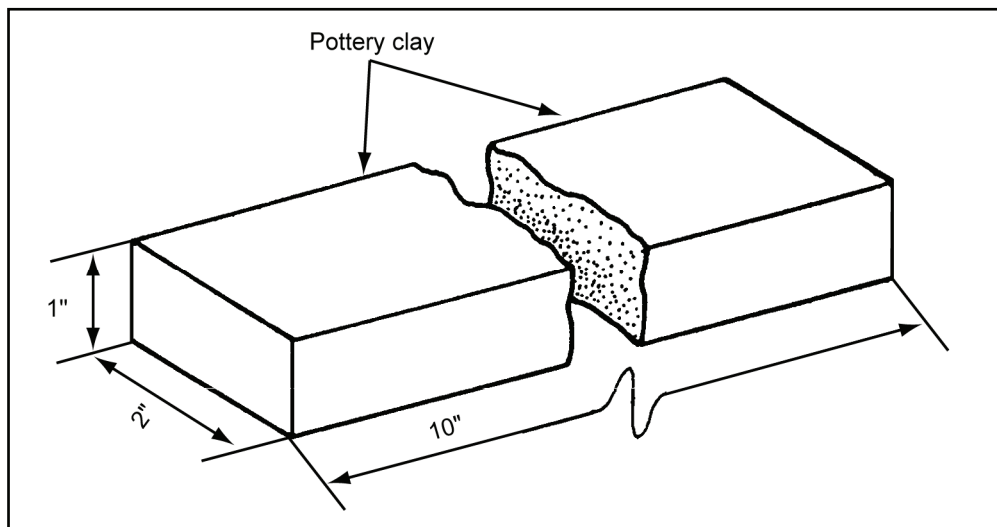
5-43. The following steps should be used to assemble M112 (composition C4) block DESs:

- **Step 1.** Remove the moist pottery clay from the shipping container.
- **Step 2.** Mold the clay into a 1 1/4-pound block. Use a mold to form the clay correctly (1 by 2 by 10 inches) (Figure 5-2, page 5-10).
- **Step 3.** Cover the block with a thin covering of mineral oil.
- **Step 4.** Place the block into a clear plastic bag, and seal the bag tightly with clear tape.
- **Step 5.** Place two-sided adhesive tape on the backside of the packaged clay block.
- **Step 6.** Label the front with a DES label.
- **Step 7.** Box 30 DES blocks per shipping container.
- **Step 8.** Label each container.

### **SPECIFICATIONS**

5-44. The M112 block DES specifications are as follows:

- Weight: 1 1/4 pounds.
- Dimensions: 1 by 2 by 10 inches.
- Packaging: 30 blocks per container.
- Container: 13 3/8 by 15 1/2 by 7 5/8 inches.



**Figure 5-2. M112 (Composition C4) Block DES**

### BILL OF MATERIALS

5-45. The BOM for an M112 (composition C4) block DES is shown in Table 5-2.

**Table 5-2. BOM for an M112 (Composition C4) Block DES**

<i>Material</i>	<i>Quantity</i>
Moist pottery clay	1 1/4 lb
Mineral oil	1 oz
Clear plastic bag	1 ea
Clear tape	10 in
Two-sided adhesive tape	9 in
DES label	1 ea

## 1-POUND, TRINITROTOLUENE-BLOCK DEMOLITION EFFECTS SIMULATOR

5-46. The TNT-block DES is made of 1 pound of chalk powder and sand mixture placed into a cardboard box that has the same measurements as an actual TNT box. The device can be made with or without an internal detonating cord booster charge.

### PRIMARY USES

5-47. This charge is used primarily for the following:

- Neutralizing mines.
- Reducing fortifications.
- Urban operations.
- Breaching.
- Cutting timber.

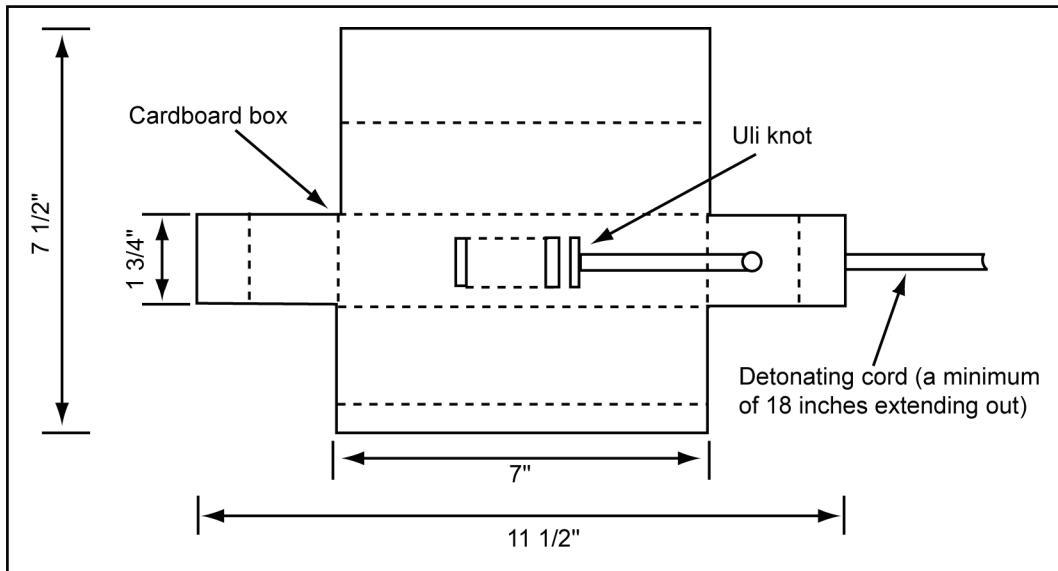


## ASSEMBLY INSTRUCTIONS

5-48. The following steps should be used to assemble 1-pound, TNT-block DESs:

- **Step 1.** Assemble the box by folding along the creases (Figure 5-3).
- **Step 2.** Tape the box to prevent it from unfolding.
- **Step 3.** Fill half of the box with a 50:50 mixture of chalk powder and sand mixture.
- **Step 4.** Tie an Uli knot, and place it in the box.
- **Step 5.** Finish filling the box with the chalk powder and sand mixture.
- **Step 6.** Make a small hole in the top flap.
- **Step 7.** Thread the free end of the detonating cord through the hole at least 18 inches.
- **Step 8.** Close the top flap, and completely tape the outside with olive drab fabric tape.
- **Step 9.** Label each block with a DES label.
- **Step 10.** Place 48 TNT DES devices in each shipping crate.
- **Step 11.** Label each crate.

*Note.* Omit steps 3 and 5 if using detonating cord as an external primer or if priming with a nonelectric or electric blasting cap inserted in a cap well.



**Figure 5-3. 1-Pound, TNT-Block DES**

## SPECIFICATIONS

5-49. The 1-pound, TNT-block DES specifications are as follows:

- Weight: 1 pound.
- Dimensions: 7 by 1 3/4 by 1 3/4 inches.
- Packing: 48 blocks per box.
- Packing Box: 7 5/8 by 16 1/2 by 12 3/8 inches.

## BILL OF MATERIALS

5-50. The BOM for a 1-pound, TNT-block DES is shown in Table 5-3, page 5-12.

**Table 5-3. BOM for a 1-Pound TNT-Block DES**

<i>Material</i>	<i>Quantity</i>
Cardboard box	1 ea
Detonating cord	4 ft
50:50 mixture of chalk powder and sand	1 lb
Olive drab fabric tape	4 ft
DES label	1 ea

## M5A1 (DEMOLITION) BLOCK CHARGE EFFECTS SIMULATOR

5-51. The M5A1 (demolition) block charge DES is a rectangular cardboard box filled with 2 1/2 pounds of chalk powder and sand mixture. This device can be made with or without an internal detonating cord booster.

### PRIMARY USES

5-52. The M5A1 charge is used primarily for the following:

- Demolishing bridges.
- Breaching.
- Neutralizing mines.
- Reducing fortifications.
- Cutting timber.

### ASSEMBLY INSTRUCTIONS

5-53. The following steps should be used to assemble M5A1 demolition-block DESs:

- **Step 1.** Assemble the box by folding along the creases (Figure 5-4).
- **Step 2.** Tape the box to prevent it from folding.
- **Step 3.** Fill half of the box with a 50:50 mixture of chalk powder and sand mixture.
- **Step 4.** Tie an Uli knot, and place it in the box.
- **Step 5.** Finish filling the box with the chalk powder and sand mixture.
- **Step 6.** Make a small hole in the top flap.
- **Step 7.** Thread the free end of the detonating cord through the hole at least 18 inches.
- **Step 8.** Close the top flap, and completely tape the outside with olive drab fabric tape.
- **Step 9.** Label each block with a DES label.
- **Step 10.** Place 24 demolition blocks in each container.
- **Step 11.** Label each container.

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*Note.* Omit steps 4 and 5 if using detonating cord as an external primer or when priming with a nonelectric or electric blasting cap inserted in a cap well.

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### SPECIFICATIONS

5-54. The M5A1 demolition-block DES specifications are as follows:

- Weight: 2 1/2 pounds.

- Dimensions: 11 3/4 by 2 1/4 by 2 1/4 inches.
- Packaging: 24 blocks per container.
- Container: 12 1/2 by 14 1/4 by 9 1/2 inches.

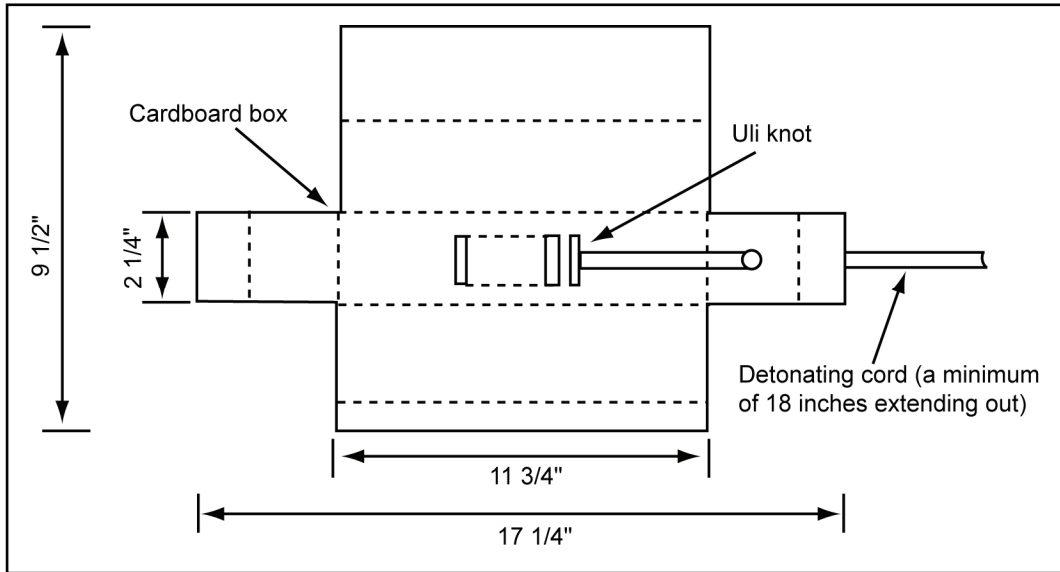


Figure 5-4. M5A1 (Demolition) Block DES

**BILL OF MATERIALS**

5-55. The BOM for an M5A1 demolition block DES is shown in Table 5-4.

**Table 5-4. BOM for an M5A1 Demolition Block DES**

<i>Material</i>	<i>Quantity</i>
Cardboard box	1 ea
Detonating cord	4 ft
50:50 mixture of chalk powder and sand	2 1/2 lb
Olive drab fabric tape	5 ft
DES label	1 ea

**M183 DEMOLITION-SATCHEL CHARGE DEMOLITION EFFECTS SIMULATOR**

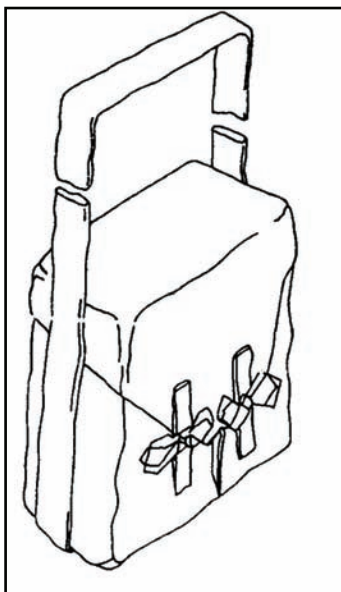
5-56. The M183 demolition-satchel charge assembly DES, or satchel charge, consists of eight M5A1 DES blocks. The blocks come in two sandbags, four blocks per bag. The two bags come in an M85 canvas carrying case (Figure 5-5, page 5-14). Two M85 cases come in a wooden box.

**PRIMARY USES**

5-57. This charge is used primarily for—

- Breaching.
- Demolishing bridges.

- Reducing fortifications.
- Destroying cache sites.



**Figure 5-5. Filled M85 Carrying Case**

### ASSEMBLY INSTRUCTIONS

5-58. The following steps should be used to assemble M183 satchel-charge assembly DESs:

- **Step 1.** Construct four M5A1 DES demolition blocks using the assembly instructions for the M5A1 in paragraph 5-38, page 5-8, except for having an 8-inch tail of detonating cord coming out the bottom. Ensure that only one of the blocks has the 18-inch length of cord extending out of the top; trim all others evenly with the top of the box and tape shut.
- **Step 2.** Tape the four M5A1 demolition blocks DES together.
- **Step 3.** Cut and place 12 inches of detonating cord along the bottom end of the M5A1 blocks (Figure 5-6).
- **Step 4.** Tape or tie the 8-inch tails of the M5A1 blocks to the 12-inch detonating cord along the bottom.
- **Step 5.** Trim off and tape all detonating cord ends.
- **Step 6.** Place the four demolition blocks in a sandbag that has been cut or rolled back, exposing the top edge of the four blocks (Figure 5-6).
- **Step 7.** Repeat steps 1 through 6 for the second half of the M183.
- **Step 8.** Place the two complete sandbags into the canvas satchel charge bag, and tie it shut.
- **Step 9.** Place a DES label on the satchel charge.
- **Step 10.** Place two satchel charges in each shipping container.
- **Step 11.** Label each container.

### SPECIFICATIONS

5-59. The M183 demolition-satchel charge DES specifications are as follows:

- Weight: 20 pounds.
- Dimensions: 12 3/4 by 10 1/4 by 4 7/8 inches.
- Packaging: Two satchel charges per container.
- Container: 13 1/4 by 10 3/4 by 11 1/4 inches.

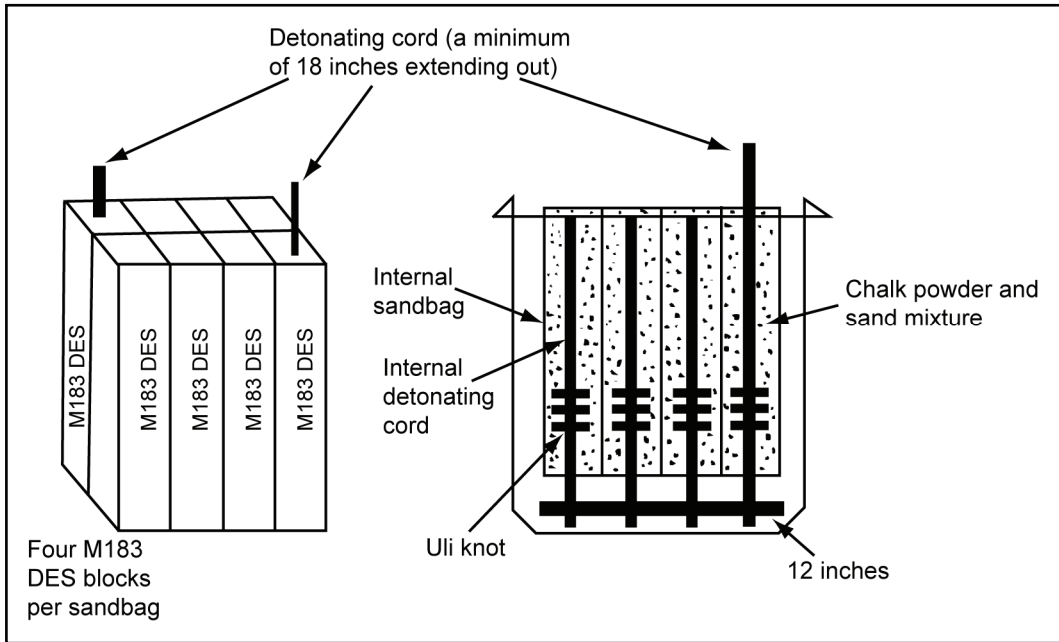


Figure 5-6. M183 Satchel Charge DES

**BILL OF MATERIALS**

5-60. The BOM for an M183 demolition-satchel charge DES is shown in Table 5-5.

**Table 5-5. BOM for an M183 Demolition-Satchel Charge DES**

<i>Material</i>	<i>Quantity</i>
M112 demolition blocks	16 ea
M85 canvas bag	1 ea
Detonating cord	4 ft
Fabric tape	48 in
Sandbag	2 ea
DES label	1 ea

**M2A3 15-POUND, SHAPED CHARGE DEMOLITION EFFECTS SIMULATOR**

5-61. This charge is made of one steel, shaped charge training aid filled with 1 1/2 pounds of chalk powder and sand mixture. The mixture is placed in a 10-inch-long by 2 1/8-inch (outside) diameter cardboard tube. Detonating cord is used as the propellant. The cardboard tube is inserted in the middle of the training device with 18 inches of detonating cord extending out through the top of the device.

**PRIMARY USES**

5-62. This charge is primarily used for the following:

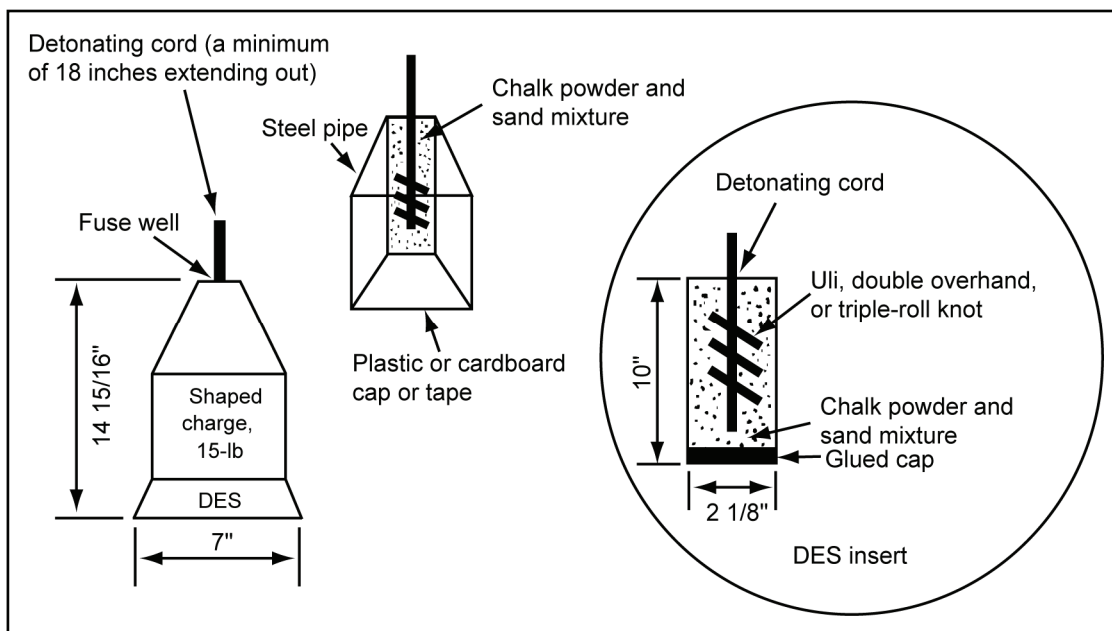
- Cratering.

- Destroying abutments.

### ASSEMBLY INSTRUCTIONS

5-63. The following steps should be used to assemble M2A3 15-pound, shaped charge DESs:

- **Step 1.** Cut the cardboard tube insert (10 inches), and glue a plastic cap on one end (Figure 5-7). Allow it to dry.
- **Step 2.** Fill half of the tube with a 50:50 mixture of chalk powder and sand mixture.
- **Step 3.** Tie an Uli knot or double-overhand knot in 36 inches of detonating cord. Place the knot inside the tube (Figure 5-7). Finish filling the tube with the chalk powder and sand mixture.
- **Step 4.** Cut a 1/8-inch hole in the center of a second plastic cap.
- **Step 5.** Thread the detonating cord through the hole in the cap with a minimum of 18 inches extending out.
- **Step 6.** Glue the cap on the open end of the tube, and allow it to dry.
- **Step 7.** Place tape over the free-running end of the detonating cord.
- **Step 8.** Place the cardboard tube into the steel, shaped charge training device, threading the detonating cord up through the fuse well at least 18 inches (Figure 5-7).
- **Step 9.** Tape the end of the detonating cord to the charge.
- **Step 10.** Label each charge with a DES label.
- **Step 11.** Place three DES shaped charges into an old shipping container, or place four charges if using a new container.
- **Step 12.** Label the container.



**Figure 5-7. 15-Pound, Shaped Charge DES**

### SPECIFICATIONS

5-64. The M2A3 15-pound, shaped charge DES specifications are as follows:

- Weight: 15 pounds.
- Dimensions: 14 15/16 by 7 inches.
- Packing: Old container, three charges; new container, four charges.

**BILL OF MATERIALS**

5-65. The BOM for an M2A3 15-pound, shaped charges is shown in Table 5-6.

**Table 5-6. BOM for an M2A3 15-Pound, Shaped Charge DES**

<i>Material</i>	<i>Quantity</i>
M2A3 steel, shaped charge DES	1 ea
Cardboard tube	1 ea
Detonating cord	4 ft
50:50 mixture of chalk powder and sand	1.5 lb
Plastic cap	2 ea
Glue	1 container
Fabric tape	4 ft or 2 ea
DES label	1 ea

**M3 40-POUND, SHAPED CHARGE DEMOLITION EFFECTS SIMULATOR**

5-66. This charge is made of one steel, shaped charge training aid filled with 1 1/2 pounds of chalk. The chalk is placed into an 11- by 2 1/8-inch (outside) diameter cardboard tube. A detonating cord is used as the propellant. The cardboard tube is inserted into the middle of the training device with 18 inches of detonating cord extending out through the top of the device.

**PRIMARY USES**

5-67. This charge is used primarily for the following:

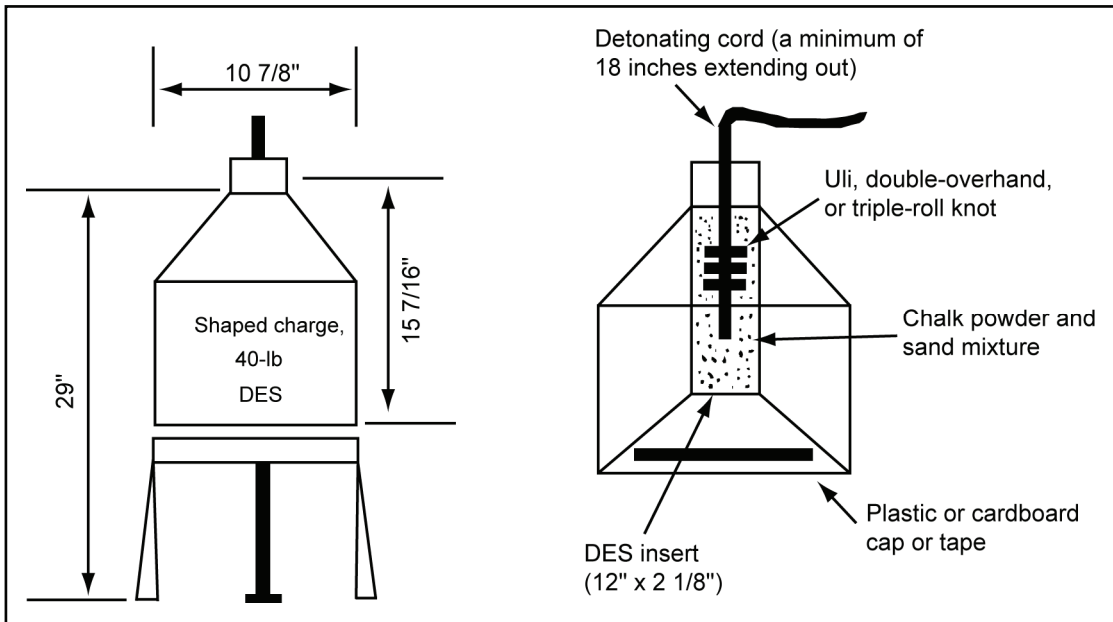
- Cratering.
- Destroying abutments.

**ASSEMBLY INSTRUCTIONS**

5-68. The following steps should be used to assemble M3 40-pound, shaped charge DESs:

- **Step 1.** Cut a cardboard tube insert (12 inches), and glue a plastic cap on one end (Figure 5-8, page 5-18). Allow it to dry.
- **Step 2.** Fill half of the tube with a 50:50 mixture of chalk powder and sand mixture.
- **Step 3.** Tie an Uli knot or a double-overhand knot in 36 inches of detonating cord, and place the knot inside the tube.
- **Step 4.** Finish filling the tube with the chalk powder and sand mixture (Figure 5-8).
- **Step 5.** Cut a 1/8-inch hole in the center of a second plastic cap.
- **Step 6.** Thread the detonating cord through the hole in the cap with a minimum of 18 inches extending out.
- **Step 7.** Glue the cap on, and allow it to dry.
- **Step 8.** Place tape over the free-running end of the detonating cord.
- **Step 9.** Place the cardboard tube into the steel, shaped charge training device, threading the detonating cord up through the fuse well at least 18 inches (Figure 5-8).

- **Step 10.** Tape the bottom end of the detonating cord to the charge.
- **Step 11.** Label each charge with a DES label.
- **Step 12.** Place one DES shaped charge in each shipping container.
- **Step 13.** Label each container.



**Figure 5-8. 40-Pound, Shaped Charge DES**

**SPECIFICATIONS**

5-69. The M3 40-pound, shaped charge DES specifications are as follows:

- Weight: 40 pounds.
- Dimensions: 15 7/16 by 10 7/8 inches.
- Packing: One per container.

**BILL OF MATERIALS**

5-70. The BOM for a M3 40-pound, shaped charge DES is shown in Table 5-7.



**Table 5-7. BOM for a 40-Pound, Shaped Charge DES**

<i>Material</i>	<i>Quantity</i>
M3 steel, shaped charge, DES	1 ea
Cardboard tube	1 ea
Detonating cord	4 ft
50:50 mixture of chalk powder and sand	10 lb
Glue	1 container
Fabric tape or plastic cap	4 ft or 2 ea
DES label	1 ea

## 40-POUND, CRATERING CHARGE DEMOLITION EFFECTS SIMULATOR

5-71. This charge is made of a cardboard tube, 24 inches long by 7 inches in diameter, filled with about 40 pounds of chalk powder and sand mixture. Detonating cord is used internally as the basic propellant charge.

### PRIMARY USES

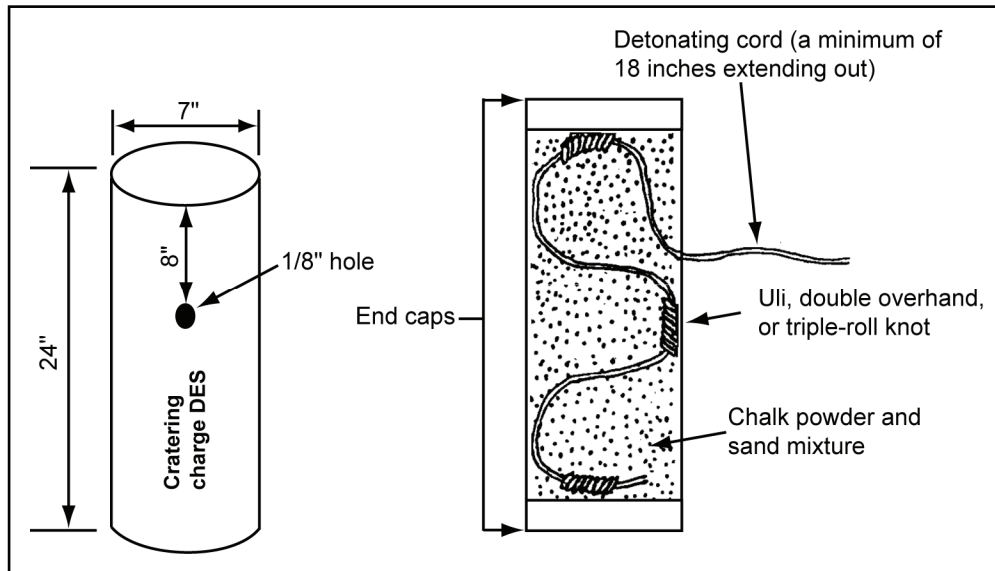
5-72. This charge is used primarily for the following:

- Cratering.
- Destroying abutments.

### ASSEMBLY INSTRUCTIONS

5-73. The following steps should be used to assemble 40-pound, cratering charge DESs:

- **Step 1.** Glue a plastic cap in the bottom of the cardboard tube, and allow it to dry.
- **Step 2.** Cut a 1/8-inch hole about 8 inches from the top of the tube (Figure 5-9, page 5-20).
- **Step 3.** Tie three Uli knots or a double-overhand knot about 10 inches apart in a length of detonating cord, leaving about 18 inches after the last knot (Figure 5-9).
- **Step 4.** Place the first knot along the bottom of the tube.
- **Step 5.** Tape the remaining knots to the inside of the tube, ensuring that the detonating cord does not cross over itself.
- **Step 6.** Fill the tube halfway with the chalk powder and sand mixture.
- **Step 7.** Thread the running end of the detonating cord through the 1/8-inch hole (Figure 5-9). Ensure that at least 18 inches of detonating cord extends out of the hole.
- **Step 8.** Finish filling the tube with the chalk powder and sand mixture. Use a scale to ensure the proper weight.
- **Step 9.** Glue a plastic end cap in the top of the tube.
- **Step 10.** Place a DES label on the tube.
- **Step 11.** Place one DES 40-pound cratering charge in each shipping container.
- **Step 12.** Label each container.



**Figure 5-9. 40-Pound, Cratering Charge DES**

### SPECIFICATIONS

5-74. The 40-pound, cratering charge DES specifications are as follows:

- Weight: 40 pounds.
- Dimensions: 24 by 7 inches.
- Packing: One charge per box.

### BILL OF MATERIALS

5-75. The BOM for a 40 pound, cratering charge DES is shown in Table 5-8.

**Table 5-8. BOM for a 40-Pound, Cratering Charge DES**

<i>Material</i>	<i>Quantity</i>
Cardboard tube	1 ea
Detonating cord	8 ft
50:50 mixture of chalk powder and sand	40 lb
Plastic bag	1 ea
Plastic end cap	2 ea
Glue	1 container
DES label	1 ea

### BANGALORE TORPEDO DEMOLITION EFFECTS SIMULATOR

5-76. The bangalore torpedo DES is made of a 5-foot-long by 2 1/8-inch-diameter cardboard tube filled with about 15 pounds of chalk powder and sand mixture. Detonating cord is used for the internal booster charge.

**PRIMARY USES**

5-77. The bangalore torpedo DES is used primarily clearing the following:

- Wire obstacles.
- AP minefields.

**ASSEMBLY INSTRUCTIONS**

5-78. The following steps should be used to assemble bangalore torpedo DESs:

- **Step 1.** Tie at least three Uli knots, equally spaced, in an 18-foot length of detonating cord (Figure 5-10, page 5-22).
- **Step 2.** Thread the detonating cord through the 5-foot cardboard tube, leaving equal amounts extending out of each end.
- **Step 3.** Take a 2-inch-long by 1-inch-diameter plastic plumber's coupling, and drill two 1/8-inch holes completely through the coupling at half an inch from each end.
- **Step 4.** Thread the running end of the detonating cord through the two holes at the top. Wrap the cord around the coupling five times, and tape it in place.
- **Step 5.** Thread the detonating cord through one of the holes at the bottom of the coupling.
- **Step 6.** Pass the detonating cord through both holes of the 3/4-inch plastic coupling, and tape it down.
- **Step 7.** Insert the 3/4-inch coupling into the 1-inch coupling (Figure 5-10).
- **Step 8.** Insert the coupling assembly into the cardboard tube, keeping it flush with the end of the tube.
- **Step 9.** Wrap the assembly with fabric tape to keep a tight fit in the main tube.
- **Step 10.** Cut an eyelet in the plastic end cap, and glue it into the end of the tube.
- **Step 11.** Gently pull any of the slack out of the detonating cord through the opposite end of the cardboard tube.
- **Step 12.** Fill the tube with 15 pounds of 50:50 mixture of chalk powder and sand.
- **Step 13.** Repeat steps 3 through 8 at the other end.
- **Step 14.** Cut an eyelet in the plastic end cap, and glue it into the end of the tube.
- **Step 15.** Label all DES tubes.
- **Step 16.** Box 10 tubes per shipping container. Label each container.

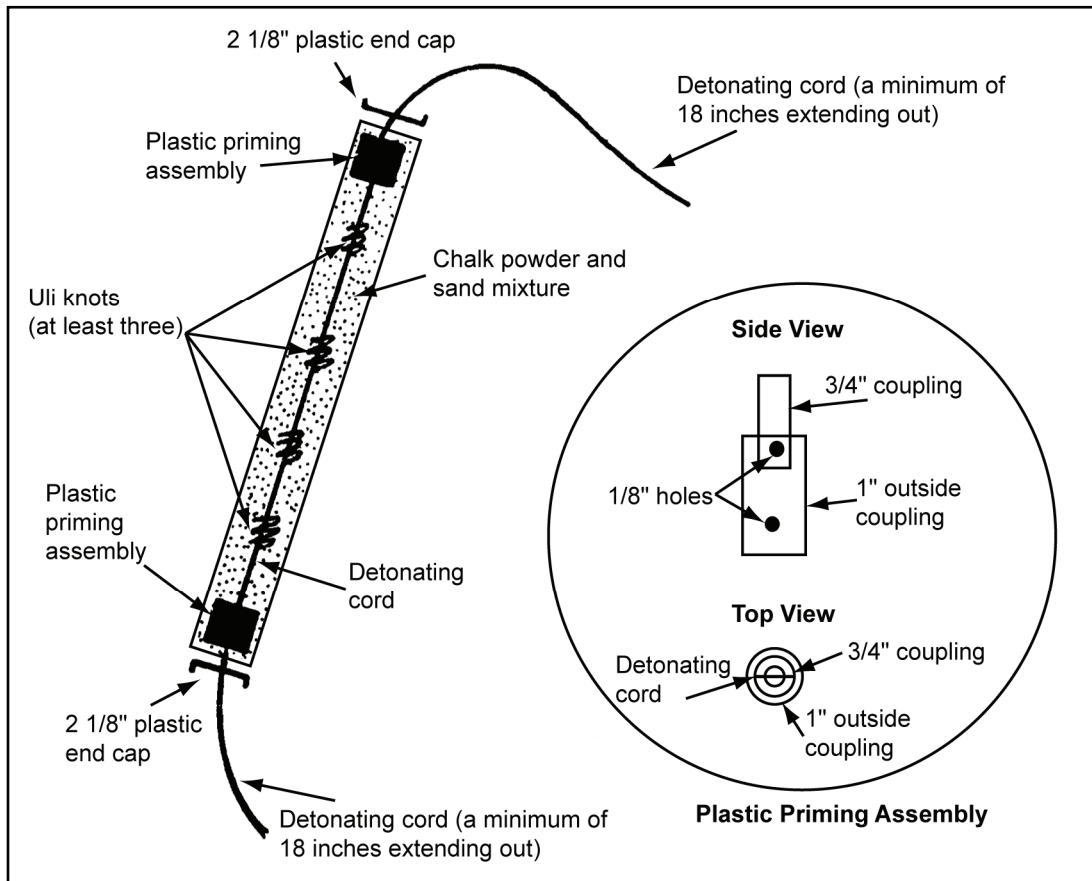


Figure 5-10. Bangalore Torpedo DES

**SPECIFICATIONS**

5-79. The bangalore torpedo DES specifications are as follows:

- Weight: 15 pounds.
- Dimensions: 5 feet by 2 1/8 inches in diameter.
- Packing: 10 tubes per shipping container.

**BILL OF MATERIALS**

5-80. See Table 5-9. The BOM for a bangalore torpedo DES is shown in Table 5-9.

**Table 5-9. BOM for a Bangalore Torpedo DES**

<i>Material</i>	<i>Quantity</i>
Cardboard tube, 5-ft by 2 1/8-in diameter	1 ea
Detonating cord	18 ft
Plastic coupling (1 in)	2 ea
Plastic coupling (3/4 in)	2 ea
Plastic end cap	2 ea
50:50 mixture of chalk powder and sand	15 lb
Glue	6 oz
Fabric tape	2 ft
DES label	1 ea

**M1 MILITARY DYNAMITE DEMOLITION EFFECTS SIMULATOR**

5-81. The M1 military dynamite DES is an 8- by 1 1/4-inch cardboard tube filled with 1/2 pound of chalk powder and sand mixture. The device has no internal detonating cord.

**PRIMARY USES**

5-82. The military dynamite DES is used primarily for the following:

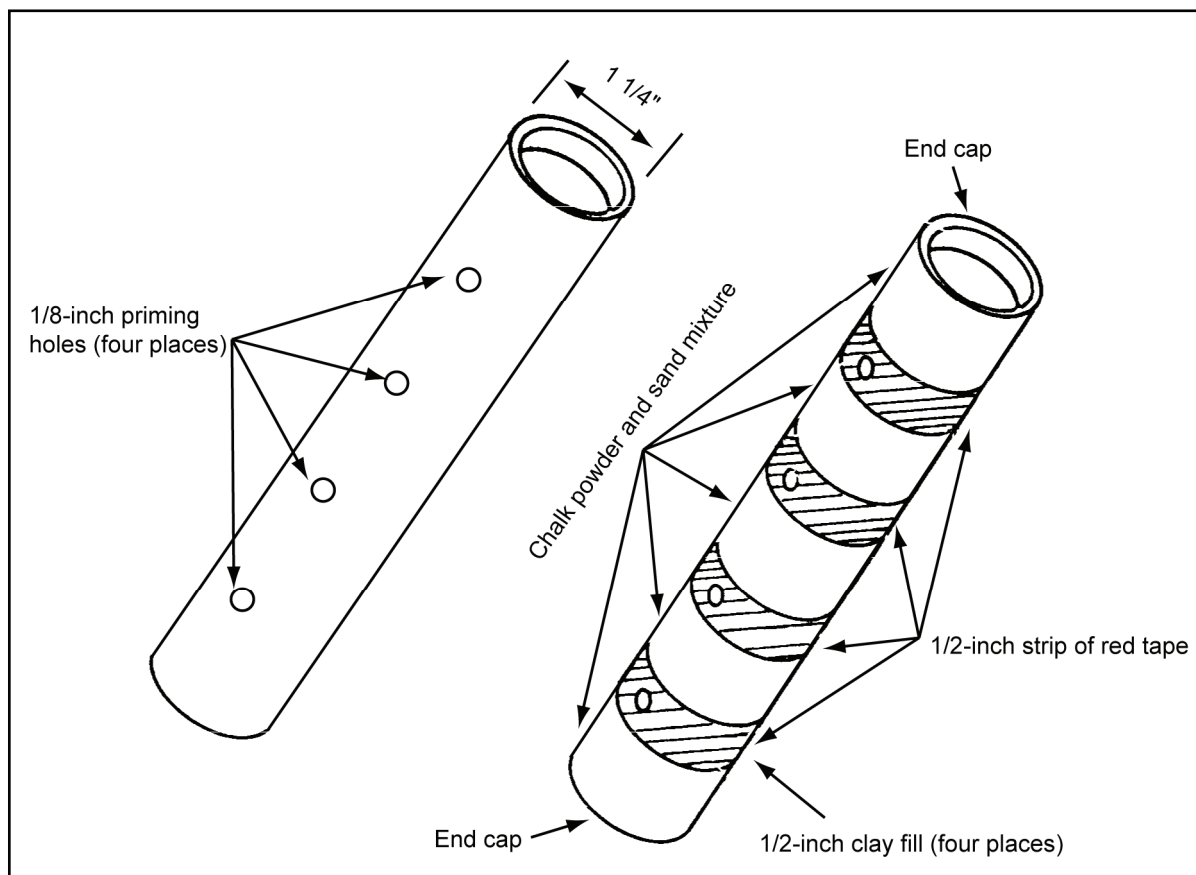
- Cratering.
- Removing stumps.
- Breaching.

**ASSEMBLY INSTRUCTIONS**

5-83. The following steps should be used to prime with an MDI:

- **Step 1.** Glue an end cap into one end of the tube, and allow it to dry.
- **Step 2.** Punch four 1/8-inch priming holes through both sides of the tube at designated locations (Figure 5-11, page 5-24).
- **Step 3.** Fill the tube up almost to the first hole with the chalk powder and sand mixture.
- **Step 4.** Tamp a 1/2-inch piece of clay fill on top of the chalk powder and sand mixture past the first hole.
- **Step 5.** Fill the tube with the chalk powder and sand mixture almost up to the next hole.
- **Step 6.** Tamp a 1/2-inch piece of pottery clay into the tube past the second hole.
- **Step 7.** Repeat the process for the third and fourth holes.
- **Step 8.** Glue the second end cap in place, and allow it dry.
- **Step 9.** Tape the tube with olive drab fabric tape.
- **Step 10.** Tape the holes with a 1/2-inch strip of red tape.
- **Step 11.** Label with a DES label.
- **Step 12.** Package 100 per shipping container.

- **Step 13.** Label each container.



**Figure 5-11. M1 Military Dynamite DES**

5-84. The following assembly instructions should be used for priming with a blasting cap instead of detonating cord:

- **Step 1.** Glue an end cap into one end of the tube, and allow it to dry.
- **Step 2.** Fill the tube with the chalk powder and sand mixture.
- **Step 3.** Glue the second end cap in place, and allow it dry.
- **Step 4.** Tape the tube with olive drab fabric tape.
- **Step 5.** Label with a DES label.
- **Step 6.** Package 100 per shipping container.
- **Step 7.** Label each container.

### SPECIFICATIONS

5-85. The M1 military dynamite DES specifications are as follows:

- Weight: 1/2 pound.
- Dimensions: 8 by 1 1/4 inches.
- Packing: 100 per box.

### BILL OF MATERIALS

5-86. The BOM for an M1 military dynamite DES is shown in Table 5-10.

**Table 5-10. BOM for an M1 Military Dynamite DES**

<i>Material</i>	<i>Quantity</i>
Cardboard tube, 8-in by 1 1/4-in diameter	1 ea
50:50 mixture of chalk powder and sand	8 oz
Clay fill, pottery	6 oz
End cap	2 ea
Glue	3 oz
Olive drab fabric tape	2 ft
Red fabric tape	6 in
DES label	1 ea

## SECTION IV – PRIMING METHODS

5-87. This section covers priming methods for each DES device. Using detonating cord as the propellant charge in the DES system requires modifications to the normal priming sequence. Efforts are being made to correct these minor deficiencies. (See Chapter 2 for assembly instructions for initiating sets.) DES devices are primed with detonating cord, a nonelectric blasting cap, or an electric blasting cap. Detonating cord priming is the preferred method for priming DES charges since it involves fewer blasting caps, makes priming and misfire investigation safer, and allows charges to be primed at state of readiness—state 1 (safe) when in place on a reserved demolition. DESs can be primed with or without internal detonating cord boosters.

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*Note.* A 6-inch length of detonating cord equals the power output of a blasting cap. However, detonating cord will not detonate explosives as reliably as a blasting cap because its power is not as concentrated. Therefore, always use several turns or a knot of detonating cord for priming charges.

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## DEMOLITION EFFECTS SIMULATORS WITHOUT INTERNAL DETONATING CORD BOOSTERS

5-88. These DESs are primarily chalk powder and sand mixture filled devices, except for the sheet explosive and M112 DESs, which are made from rubber matting and moist clay fill. They have priming procedures identical to real explosive devices, which are primed with the detonating cord. The paragraphs below contain priming instructions for the following DESs:

- Sheet explosive.
- M112 (composition C4) block.
- 1-pound TNT block or one M5A1 demolition block.
- M1 military dynamite.

### SHEET EXPLOSIVE DEMOLITION EFFECTS SIMULATOR

5-89. Priming instructions for the sheet explosive DES are discussed in the paragraphs below. Discussed is the use of detonating cord and MDIs.

**Detonating Cord**

5-90. Either an Uli knot, a double-overhand knot, or a triple-roll knot (Figure 5-12) and one of the following methods is used to prime sheet explosives:

- **Method 1.** Insert the knot between two sheets of explosive.
- **Method 2.** Place the knot on top of the sheet explosive, and secure it with a small strip of sheet explosive (Figure 5-13). Strengthen the primed area by wrapping it with green duct tape or electrical tape.

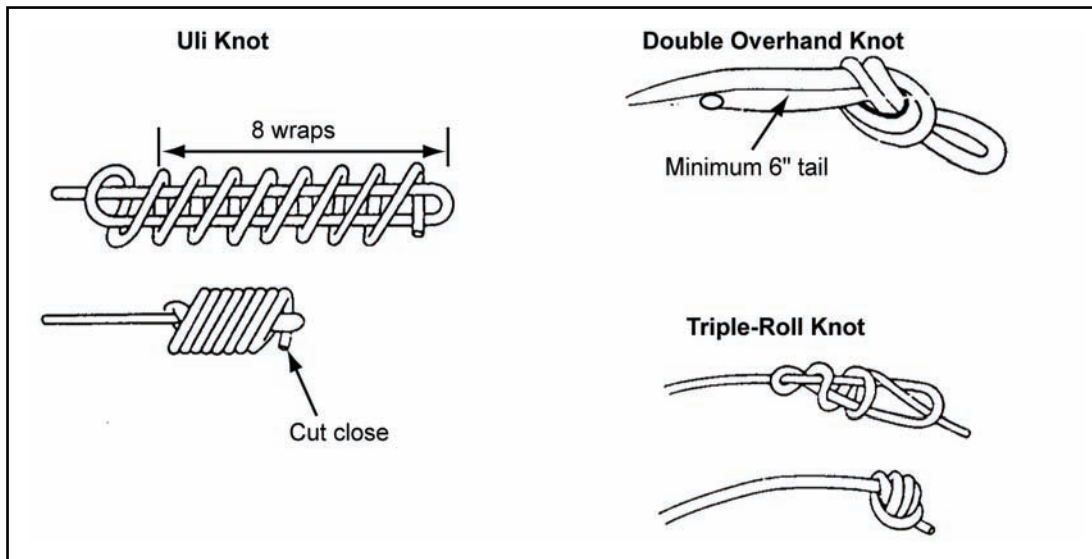


Figure 5-12. Knots

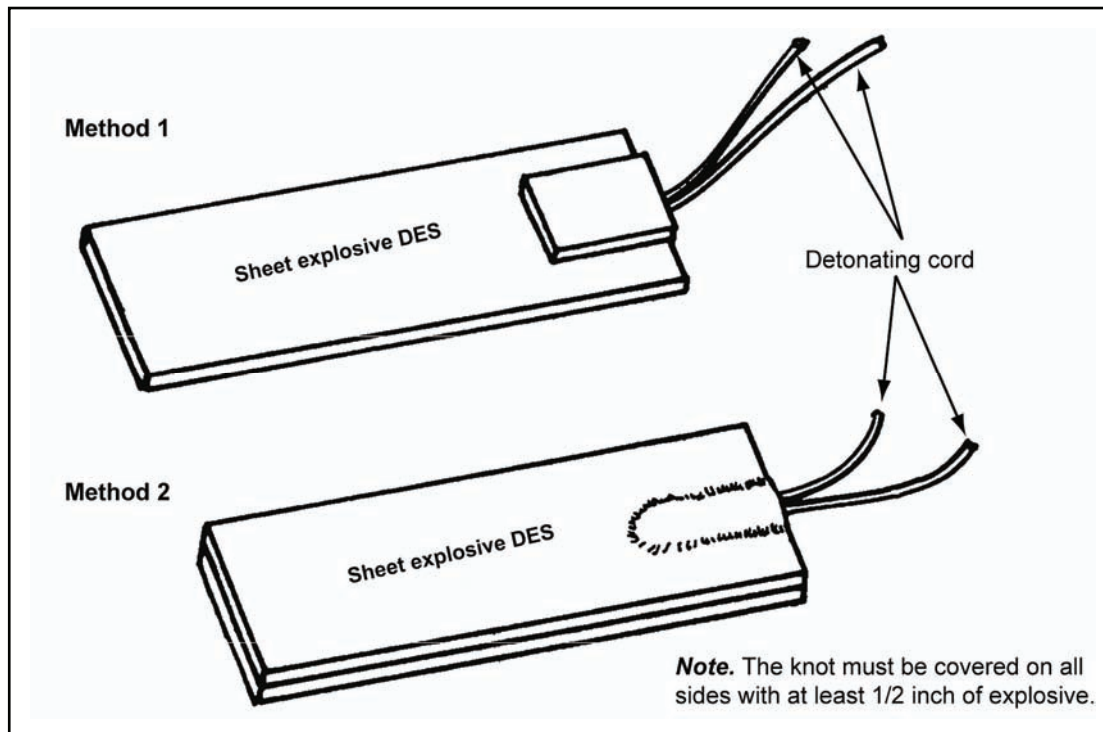


Figure 5-13. Priming a Sheet Explosive DES With Detonating Cord



### Modernized Demolition Initiator

5-91. To prime sheet explosive DES charges, use Figure 5-14 and one of the following methods:

- **Method 1.** Attach an M8 blasting-cap holder to the end or side of the sheet explosive DES. Insert an M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster into the holder until the end of the blasting cap presses against the sheet explosive DES.

*Note.* The M8 blasting-cap holder has three teeth that prevents the clip from withdrawing from the explosive; two spring arms firmly hold the M11 cap in the M8 holder.

- **Method 2.** Cut a notch in the sheet explosive DES (about 1 1/2 inches long and 1/4 inch wide). Insert the M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster to the limit of the notch. Secure the blasting cap with a strip of sheet explosive and adhesive tape.
- **Method 3.** Place 1 1/2 inches of the M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster on top of the sheet explosive DES. Secure it with a strip of sheet explosive DES (at least 3 by 3 inches) and adhesive tape.
- **Method 4.** Insert the end of the blasting cap 1 1/2 inches between two sheets of DES sheet explosive. Wrap the sheets with tape to secure the M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster.

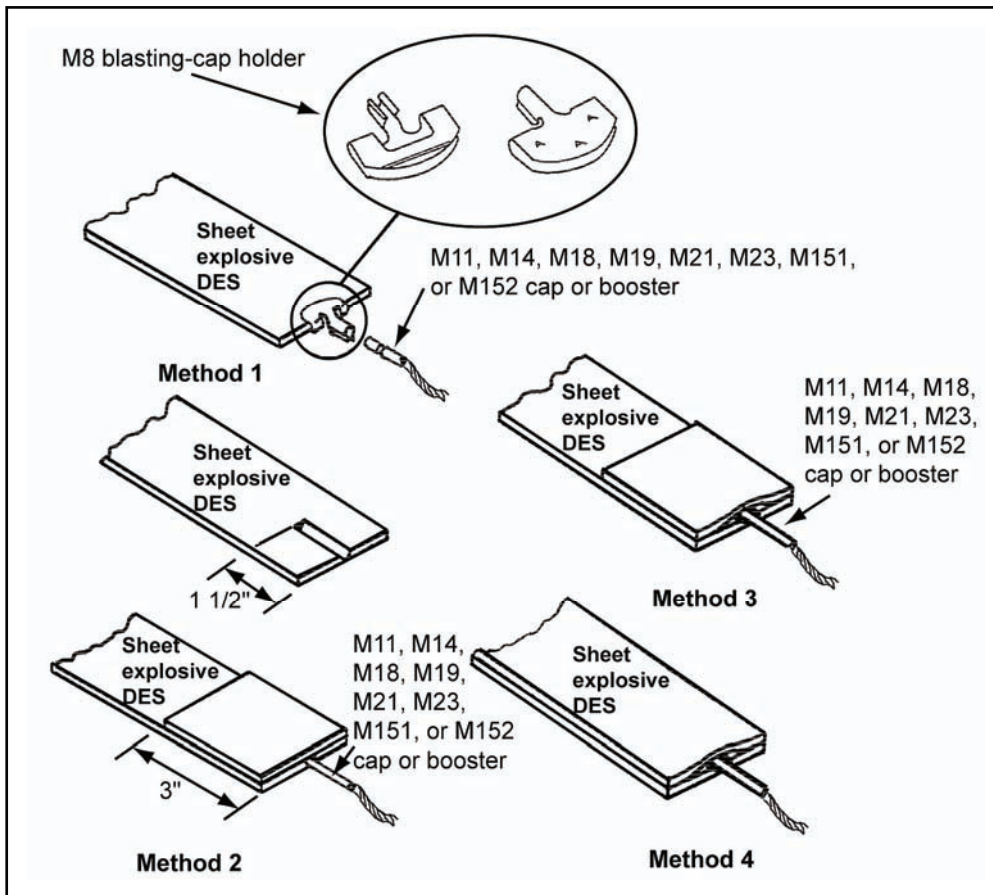


Figure 5-14. Priming a Sheet Explosive DES With MDI

## M112 (COMPOSITION C4) BLOCK DEMOLITION EFFECTS SIMULATOR

5-92. Priming instructions for the M112 (composition C4) block DES are discussed in the paragraphs below. Discussed is the use of detonating cord and MDIs.

### Detonating Cord

5-93. To prime M112 (composition C4) block DES with detonating cord, use Figure 5-15 and the following steps:

- **Step 1.** Form either an Uli knot or a triple-roll knot (Figure 5-12, page 5-26).
- **Step 2.** Cut a notch out of the DES large enough to insert the knot that was formed.

#### WARNING

**Use a sharp, nonsparking knife on a nonsparking surface to cut the explosive. Failure to comply could result in immediate personal injury or damage to equipment.**

- **Step 3.** Place the knot in the cut.
- **Step 4.** Use the clay that was removed from the notch to cover the knot. Ensure that there is at least 1/2 inch of clay on all sides of the knot.
- **Step 5.** Strengthen the primed area by wrapping it with tape.

*Note.* It is not recommended that an M112 (composition C4) block DES be primed by wrapping it with detonating cord, since wraps will not properly detonate the actual explosive charge.

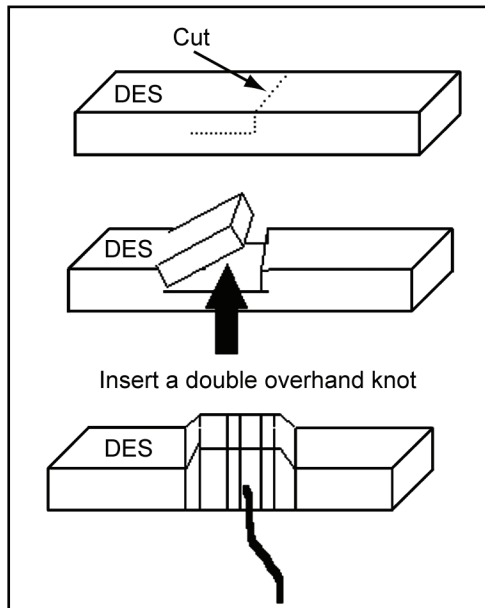


Figure 5-15. Priming an M112 DES With Detonating Cord

### Modernized Demolition Initiator

5-94. M112 (composition C4) block DES does not have a cap well. The following steps are used to make a cap well and to prime the DES with an M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster:

- **Step 1.** Make a hole in the end or on the side (at the midpoint) with an M2 crimper or other nonsparking tool that is large enough to hold the blasting cap.
- **Step 2.** Insert the M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster into the hole or cut. Do not force the cap if the M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster does not fit the hole or cut—make the hole larger.
- **Step 3.** Anchor the M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster in the DES block by gently squeezing the clay around the blasting cap.
- **Step 4.** Strengthen the primed area by wrapping it with tape.

### 1-POUND TRINITROTOLUENE-BLOCK DEMOLITION EFFECTS SIMULATOR AND M5A1 DEMOLITION-BLOCK DEMOLITION EFFECTS SIMULATOR

5-95. The same methods are used to prime both the 1-pound, TNT block DES (only the TNT is shown in Figure 5-16) and the M5A1 demolition block DES.

### Detonating Cord

5-96. DES blocks without internal detonating cord boosters can be primed with detonating cord using several methods (Figure 5-16, page 5-30). The two standard methods are the—

- **Common method (method 1).** Lay one end (2-foot length) of detonating cord at an angle across the DES block. Wrap the running end around the block three turns, laying the wraps over the standing end. Slip the running end (on the fourth wrap) under all wraps, parallel to the standing end, and draw the wraps tight.
- **Alternate method (method 2).** Place a loop of detonating cord on the DES block, leaving enough length on the end to make four turns around the block and loop. Start the first wrap, and ensure that you immediately cross over the standing end of the loop, working your way to the closed end of the loop. Pass the free end of the detonating cord through the loop, and pull it tight to form a knot around the outside of the block.

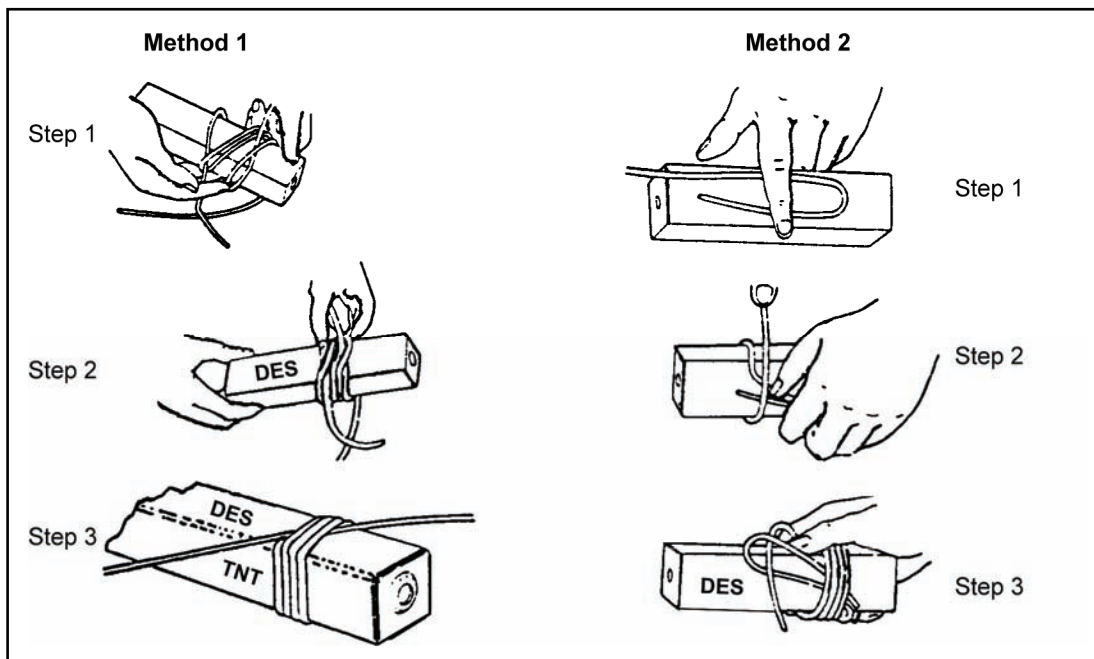


Figure 5-16. Priming a TNT Block DES Using Detonating Cord

### Modernized Demolition Initiator

5-97. Some TNT or M5A1 DES blocks may have threaded cap wells. If so, use a priming adapter (if available) to secure the M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster to the DES block (Figure 5-17). If a priming adapter is not available or the DES block does not have a threaded cap well, prime without an adapter. If there is no cap well, make one using the following steps:

- **Step 1.** Use M2 crimpers or other nonsparking tools to make a hole in the end. Do not force the cap if the M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster does not fit the hole or cut, make the hole larger.

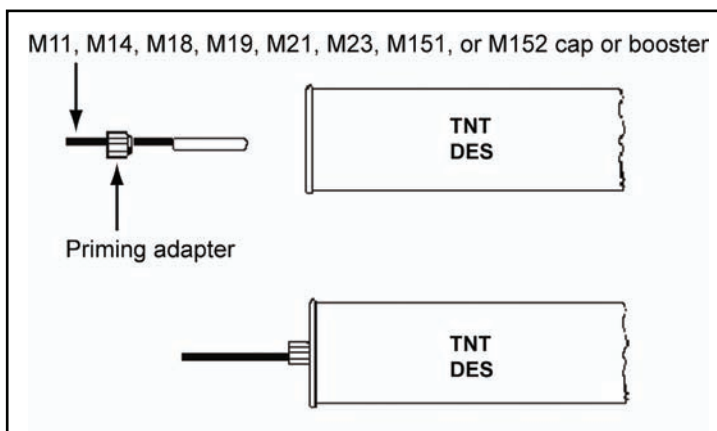
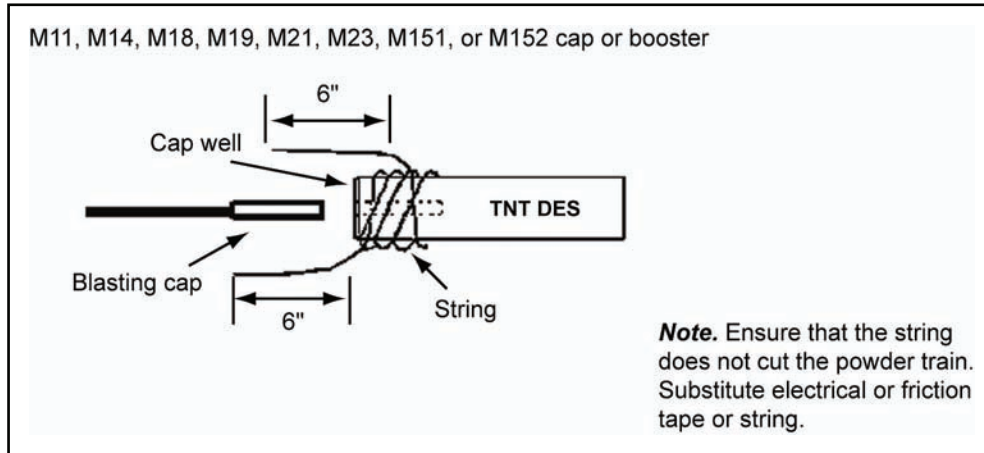


Figure 5-17. Priming a TNT Block DES (With Adapter) Using an MDI

*Note.* Prepare the initiating set before priming. Cap control must be according to the information in this manual.

- **Step 2.** Wrap a string tightly around the DES block and tie it securely, leaving about 6 inches of loose string at each end.
- **Step 3.** Insert the M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster into the cap well. Make a cap well if there is not one.
- **Step 4.** Tie the loose string around the fuse to prevent the M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster from separating from the block (Figure 5-18).

*Note.* Electrical or friction tape can also effectively secure an M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster in the DES.



**Figure 5-18. Priming a TNT DES (Without Adapter) Using an MDI**

## M1 MILITARY DYNAMITE DEMOLITION EFFECTS SIMULATOR

5-98. Priming instructions for the M1 military dynamite DES is discussed in the paragraphs below. Discussed is the use of detonating cord and MDIs.

### Detonating Cord

5-99. See Figure 5-19. The following steps and Figure 5-19, page 5-32, are used to prime with detonating cord:

- **Step 1.** Use M2 crimpers to punch four holes through the DES dynamite cartridge in areas covered by red tape. Ensure that the DES cartridge is rotated 180° after punching each hole to keep the holes parallel.
- **Step 2.** Lace the detonating cord through the holes in the same direction the holes were punched.
- **Step 3.** Secure the detonating cord tail by passing it between the detonating cord lace and the DES dynamite charge.

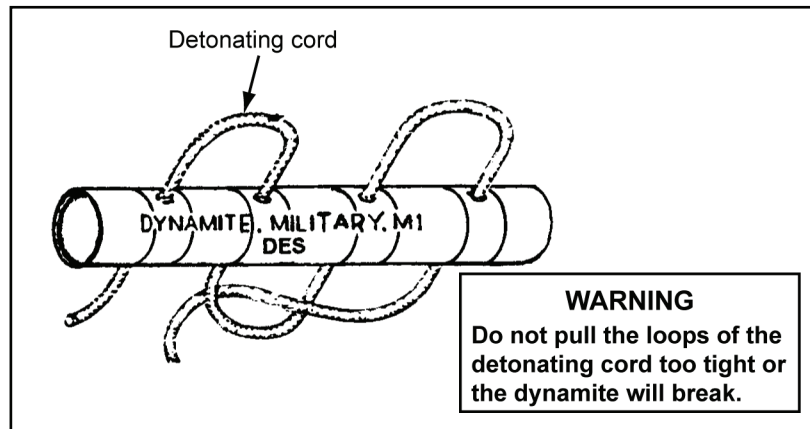


Figure 5-19. Priming an M1 Dynamite DES Using Detonating Cord

### Modernized Demolition Initiator

5-100. Primed MDIs should be at the end or side. Choose the method (end- or side-priming) that will prevent damage to the primed block of explosive during placement.

#### End-Priming Method

5-101. See Figure 5-20. The following steps and Figure 5-20 are used to perform end priming:

- **Step 1.** Use M2 crimpers to make a cap well in the end of the dynamite cartridge.
- **Step 2.** Insert the M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster into the cap well.
- **Step 3.** Tie the M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster and fuse securely in the cartridge with a string.

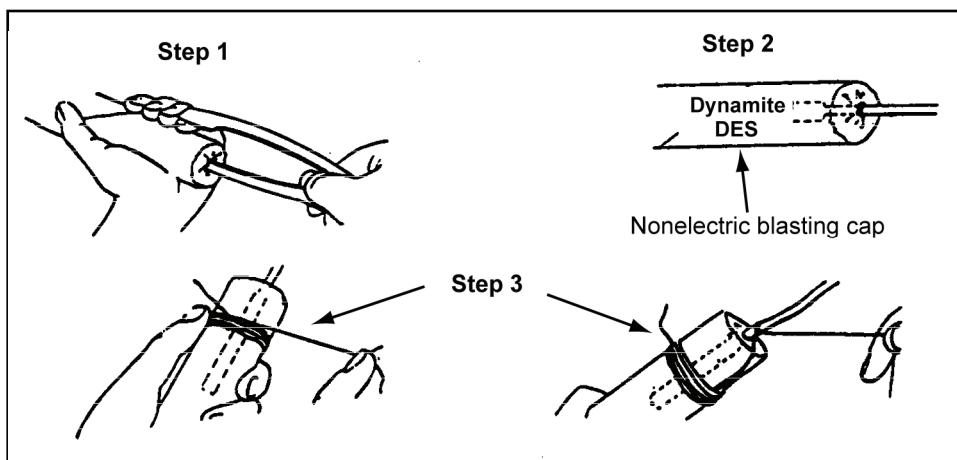
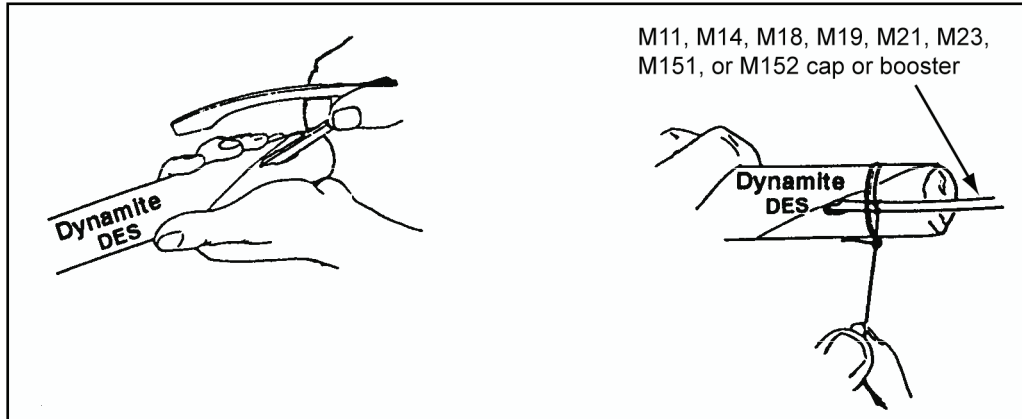


Figure 5-20. End-Priming M1 Military Dynamite Using a DES

**Side-Priming Method**

5-102. See Figure 5-21. The following steps and Figure 5-21 are used to perform side priming:

- **Step 1.** Use M2 crimpers and make a cap well (about 1 1/2 inches long) in the side of the DES cartridge at one end. Slightly slant the cap well so the M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster, when inserted, will be nearly parallel to the side of the DES cartridge and the explosive end of the cap will be at a point nearest the middle of the cartridge.
- **Step 2.** Insert a M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster into the cap well.
- **Step 3.** Tie a string securely around the fuse. Wrap the string tightly around the cartridge, making two or three turns before tying it.



**Figure 5-21. Side-Priming M1 Military Dynamite DES**

*Note.* Weatherproof the primed cartridge by wrapping a string closely around the cartridge, extending it an inch or so on each side of the hole to cover the hole completely. Cover the string with a weatherproof sealing compound.

## DEMOLITION EFFECTS SIMULATORS WITH INTERNAL DETONATING CORD BOOSTERS

5-103. These explosive DESs have an internal Uli or double-overhand knot with 18 inches of detonating cord extending out (running end). This running end is used to prime the DES using detonating cord or an M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster. The two methods used are the—

- **Detonating cord method.** Tape the detonating cord to the running end of the internal detonating cord.
- **Nonelectric or electric method.** Tape an M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster to the running end of the internal detonating cord.

*Note.* This device also has an internal propellant (detonating cord) to expel the chalk powder and sand mixture.

5-104. The paragraphs below contain priming instructions for the following:

- A 1-pound, TNT block DES.
- An M5A1 demolition block DES.
- An M183 demolition satchel charge DES.
- An M2A3 15-pound, shaped charge DES.
- An M3 40-pound, shaped charge DES.
- A 40-pound, cratering-charge DES.

- A bangalore torpedo DES.

### 1-POUND, TRINITROTOLUENE BLOCK DEMOLITION EFFECTS SIMULATOR

5-105. The paragraphs below contain priming instructions for the 1-pound TNT block DES. Discussed is the use of detonating cord and MDIs.

#### Detonating Cord

5-106. The method shown in Figure 5-22 is used for 1-pound TNT DES. Also, one of the three methods for TNT without an internal detonating cord booster can be used, except the 18-inch tail is placed under the wraps of the detonating cord.

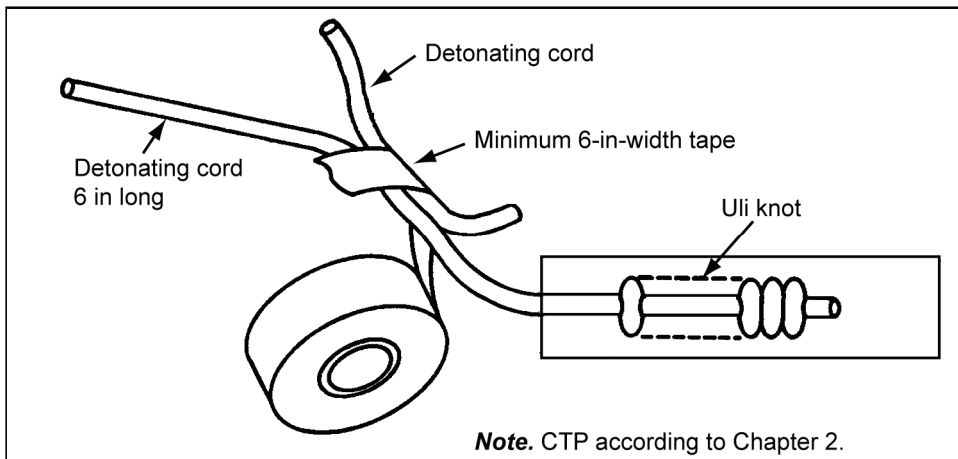


Figure 5-22. Priming a TNT DES (With Booster) Using Detonating Cord

#### Modernized Demolition Initiator

5-107. As shown in Figure 5-23, tape an M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster to the detonating cord.

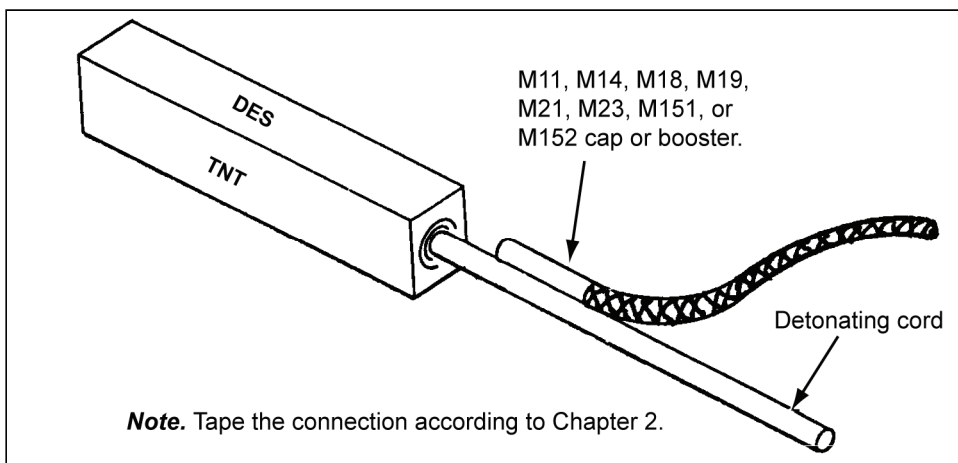


Figure 5-23. Priming a TNT DES (With Booster) With an MDI

### M5A1 DEMOLITION BLOCK DEMOLITION EFFECTS SIMULATOR

5-108. The paragraphs below contain priming instructions for the M5A1 demolition block DES. Discussed is the use of detonating cord and MDIs.

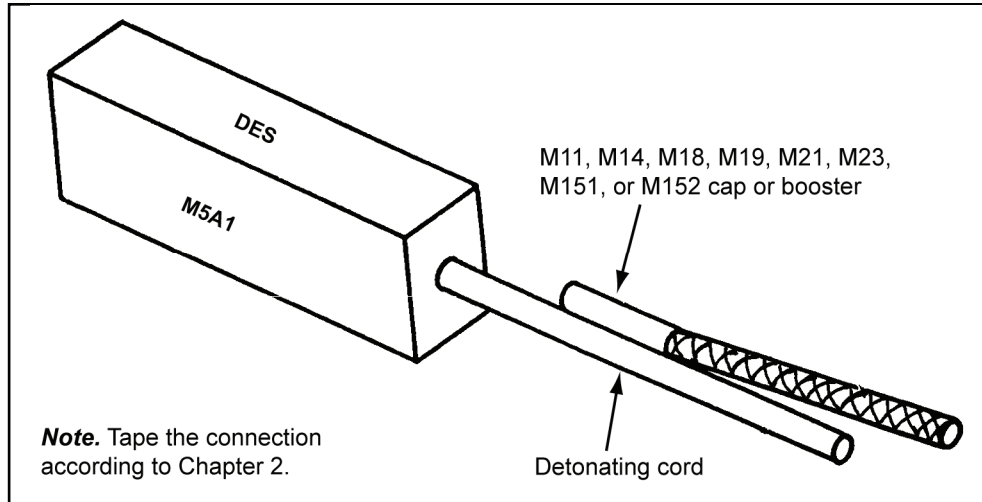


### Detonating Cord

5-109. See Figure 5-24 for priming the block. This is the same as TNT priming (paragraphs 2-23 through 2-28).

### Modernized Demolition Initiator

5-110. See Figure 5-24. As shown in Figure 5-24, tape an M11, M14, M18, M19, M21, M23, M151, or M152 cap or booster to the detonating cord.



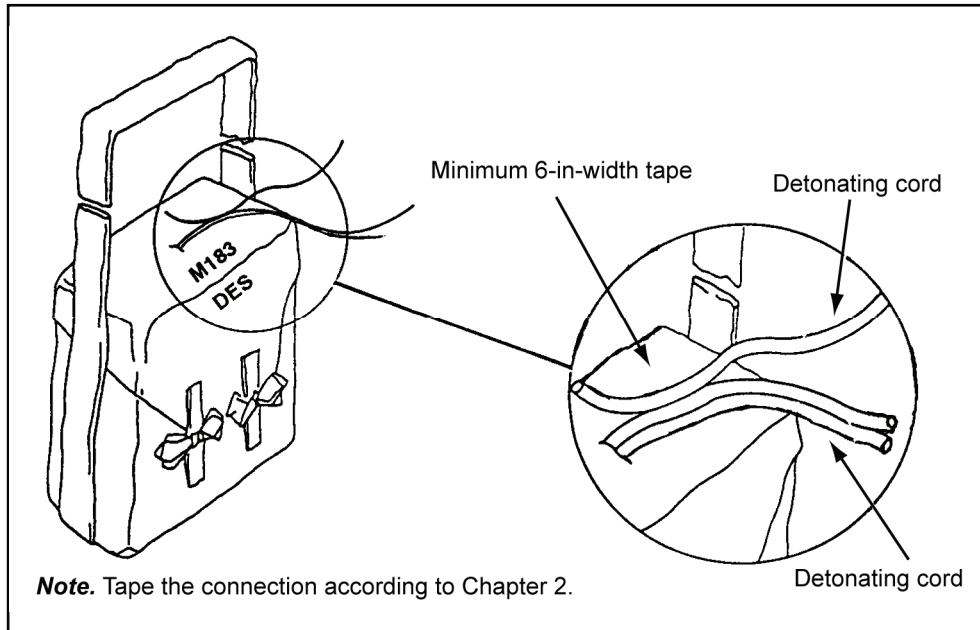
**Figure 5-24. Priming an M5A1 DES Using an MDI**

### M183 DEMOLITION SATCHEL CHARGE DEMOLITION EFFECTS SIMULATOR

5-111. The paragraphs below contain priming instructions for the M183 demolition satchel charge DES. Discussed is the use of detonating cord and MDIs.

### Detonating Cord

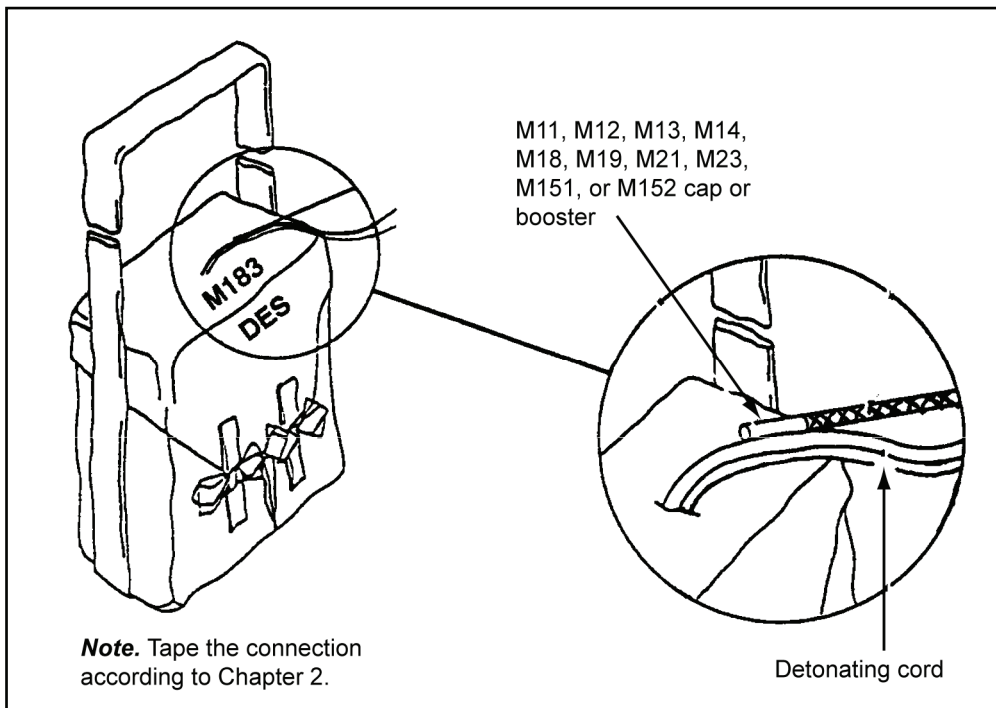
5-112. See Figure 5-25, page 5-36. Figure 5-25 shows how to prime the M183 demolition (or satchel charge) assembly with detonating cord.



**Figure 5-25. Priming an M183 DES Using Detonating Cord**

**Modernized Demolition Initiator**

5-113. See Figure 5-26. As shown in Figure 5-26, tape an M11, M12, M13, M14, M18, M19, M21, M23, M151, or M152 cap or booster to the detonating cord.



**Figure 5-26. Priming an M183 DES Using an MDI**

## M2A3 15-POUND, SHAPED CHARGE DEMOLITION EFFECTS SIMULATOR

5-114. The paragraphs below contain priming instructions for the M2A3 15-pound, shaped charge DES. Discussed is the use of detonating cord and MDIs.

### Detonating Cord

5-115. See Figure 5-27. Figure 5-27 shows how to prime an M2A3 15-pound, shaped charge DES using detonating cord.

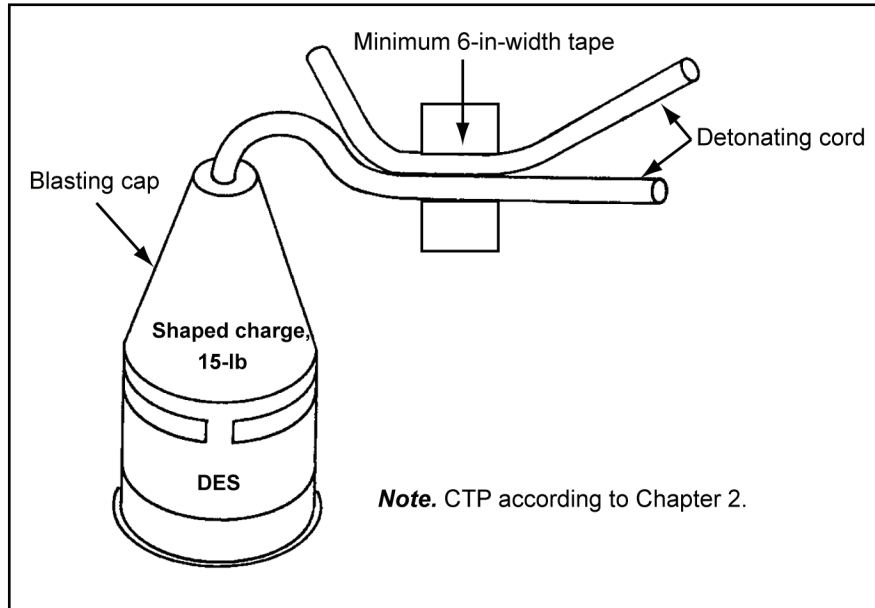


Figure 5-27. Priming a 15-Pound, Shaped Charge DES Using Detonating Cord

### Modernized Demolition Initiator

5-116. See Figure 5-28. Figure 5-28 shows an M11, M12, M13, M14, M18, M19, M21, M23, M151, or M152 cap or booster.

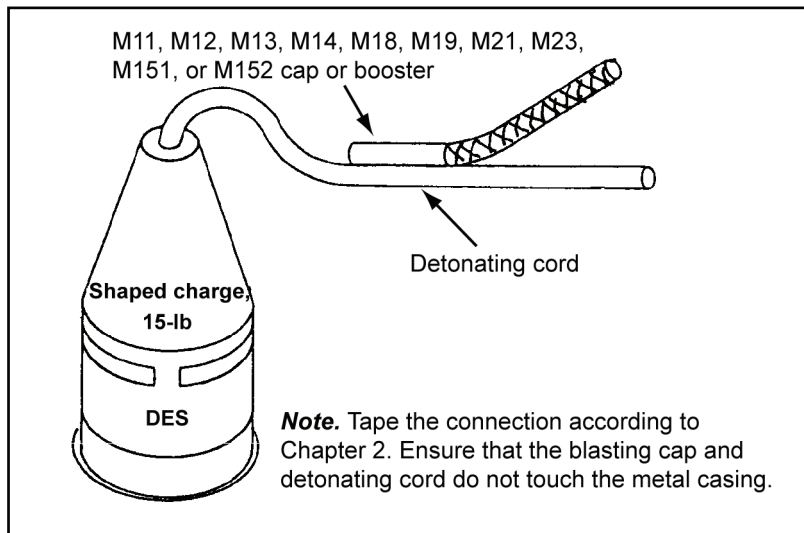


Figure 5-28. Priming a 15-Pound, Shaped Charge DES Using an MDI

### M3 40-POUND, SHAPED CHARGE DEMOLITION EFFECTS SIMULATOR

5-117. The paragraphs below contain priming instructions for the M3 40-pound, shaped charge DES. Discussed is the use of detonating cord and MDIs.

#### Detonating Cord

5-118. See Figure 5-29. Figure 5-29 shows how to prime a 40-pound, shaped charge DES using detonating cord.

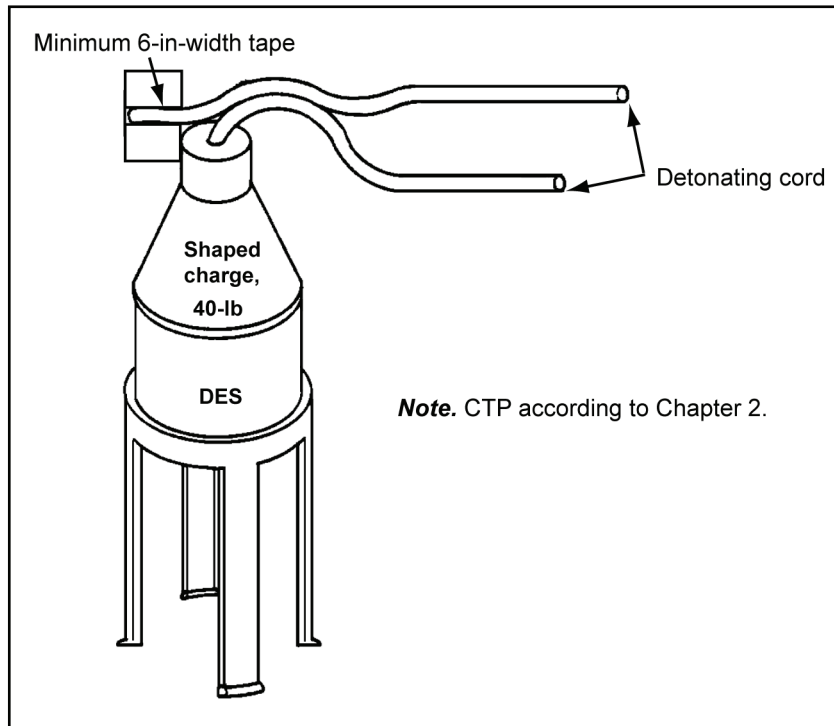


Figure 5-29. Priming a 40-Pound, Shaped Charge DES Using Detonating Cord

#### Modernized Demolition Initiator

5-119. See Figure 5-30. As shown in Figure 5-30, tape an M11, M12, M13, M14, M18, M19, M21, M23, M151, or M152 cap or booster to the detonating cord.

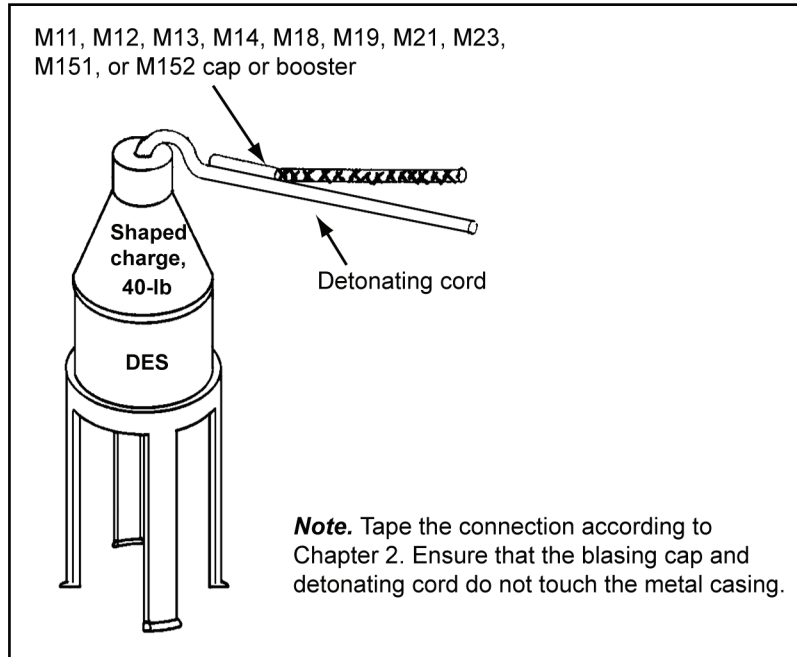


Figure 5-30. Priming a 40-Pound, Shaped Charge DES Using an MDI

**40-POUND, CRATERING-CHARGE DEMOLITION EFFECTS SIMULATOR**

5-120. Aboveground, tape detonating cord or an M11, M12, M13, M14, M18, M19, M21, M23, M151, or M152 cap or booster directly to the internal detonating cord booster that is sticking out of the DES charge. Belowground, tape the detonating cord to the internally charged detonating cord branchline with a minimum of 6-inch-width tape. Discussed is the use of detonating cord and MDIs.

*Note.* Do not use caps belowground. All belowground charges must be dual-primed with a minimum of 1 pound of explosive.

**Detonating Cord**

5-121. See Figure 5-31. Figure 5-31 shows how to prime a 40-pound, cratering charge DES using detonating cord.

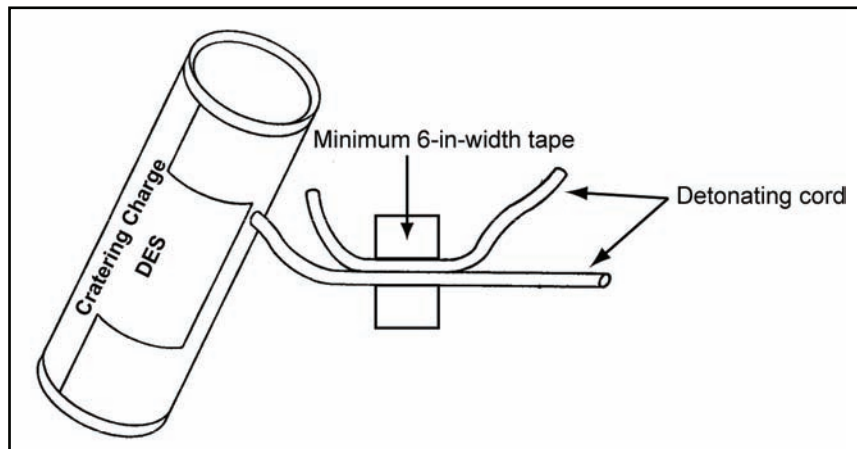


Figure 5-31. Priming a 40-Pound, Cratering Charge DES Using Detonating Cord

### Modernized Demolition Initiators

5-122. See Figure 5-32. As shown in Figure 5-32, tape an M151 or M152 cap to the detonating cord.

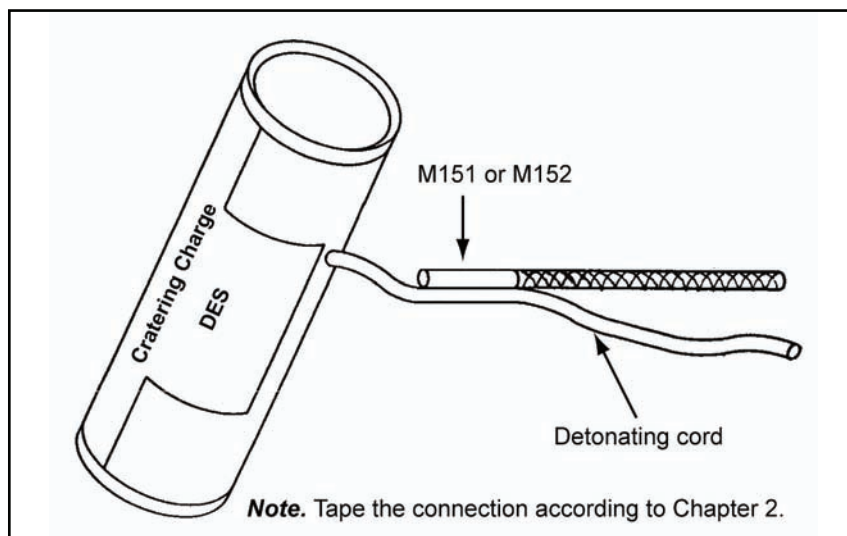


Figure 5-32. Priming a 40-Pound, Cratering Charge DES Using an MDI

### BANGALORE TORPEDO DEMOLITION EFFECTS SIMULATOR

5-123. Priming instructions for the bangalore torpedo DES are discussed below. Discussed is the use of detonating cord and MDIs.

#### Detonating Cord

5-124. A bangalore torpedo is primed using detonating cord as shown in Figure 5-33, page 5-40, or by tying a square knot in place of the tape. When using a square knot, allow 6-inch tails to prevent misfires from moisture contamination. Never use the short end (tail) of the detonating cord to initiate the torpedo. Initiation must come from the running end of the detonating cord. Square knots may be placed in water or in the ground, but the cord must be detonated from a dry end or aboveground.

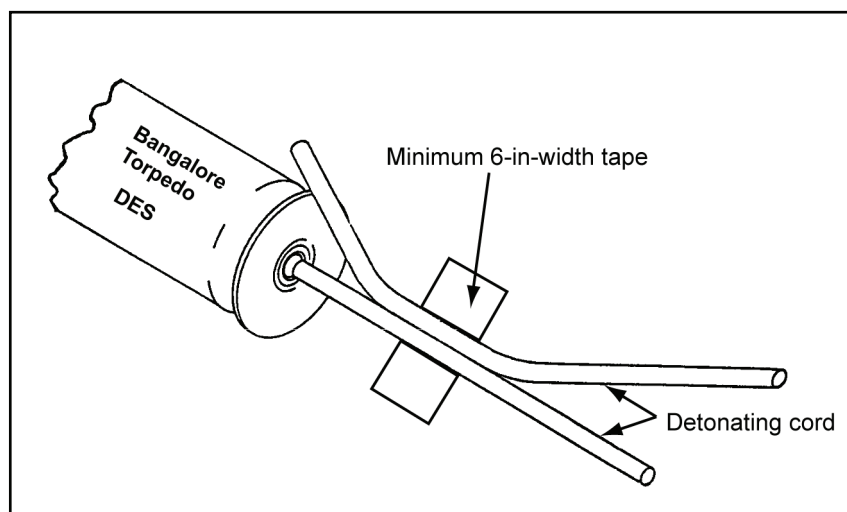


Figure 5-33. Priming a Bangalore Torpedo DES Using Detonating Cord

### Modernized Demolition Initiator

5-125. A blasting cap or booster is taped to the detonating cord booster. See Figure 5-34.

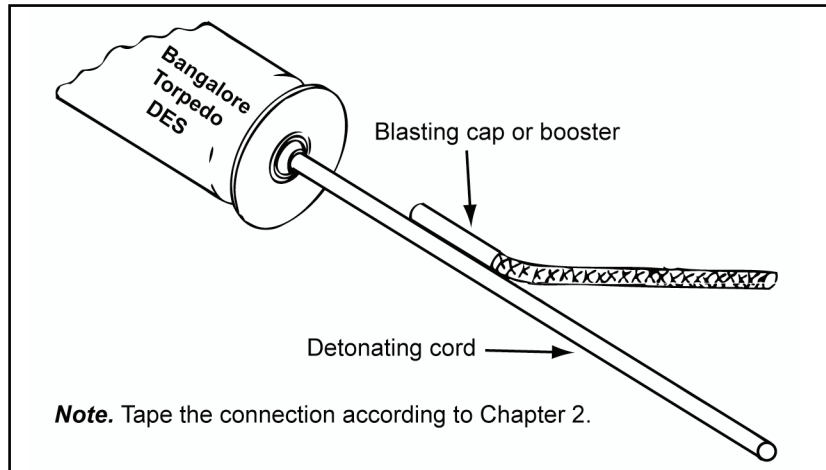


Figure 5-34. Priming a Bangalore Torpedo DES Using an MDI

## SECTION V – SAFETY PROCEDURES AND RISK ASSESSMENT

5-126. Safety is not just a peacetime requirement. It is an integral part of the planning, preparation, and execution phases of every mission, both for training and during combat. In war, as in peace, unsafe acts are unacceptable. This section outlines and reviews safety procedures already in existence for the use of demolitions and explosives. (See the safety procedures in Chapter 6 for additional information.)

### SAFETY GUIDELINES

5-127. Unit leaders should continually make safety a primary emphasis during all phases of mission planning and training whether inert, DES, or live explosives are in use. Leaders must continually review safety references and teach safety procedures to each Soldier. Before using DESs, units must perform a risk assessment. (See Appendix K for the safety risk assessment.)

### LEADER RESPONSIBILITIES

5-128. Leaders must be aware of the need to address safety during all phases of an operation. Unit leaders must constantly remind junior leaders and Soldiers about safety, and note deficiencies throughout the planning, preparation, and execution phases of a demolition mission. Leaders need to consider the following points during planning, preparation, and execution phases of all demolition operations:

- Do not divide responsibilities for preparing, placing, or firing charges. Ensure that one individual is responsible for supervising all phases of the operation.
- Prime and use explosive materials according to their intended purpose.
- Ensure that MSDs are enforced and tactically or administratively cleared.

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**Note.** At a minimum, leaders and Soldiers must maintain the MSD as prescribed in AR 385-63 and Table 6-2, page 6-7, of this FM.

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- Ensure that Soldiers handle and inspect all DESs and live munitions according to this FM.
- Ensure that transportation and storage are according to the local demolitions standing operating procedure (SOP). Ensure that units establish appropriate ammunition handling areas.
- Ensure that no blasting caps or firing systems are attached to any detonating cord or other charge (DES or live) unless a demolitions NCO is notified he and approves of it.

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## Chapter 6

# Demolition Safety

This chapter deals with the safety surrounding demolitions. The main safety points for the different types of demolitions and demolition devices are discussed. Also outlined in this chapter are the misfire procedures, transportation and storage safety, military explosives destruction, and environmental protection.

### SECTION I – GENERAL SAFETY

#### CONSIDERATIONS

6-1. When dealing with demolitions, general safety should be observed. The following should be considered when dealing with the general safety of demolitions:

- Do not attempt to conduct a demolitions mission if you are unsure of the demolition procedures; review references or obtain assistance.
- Prevent inexperienced personnel from handling explosives.
- Avoid dividing responsibility for demolition operations.
- Use the minimum number of personnel necessary to accomplish the demolition mission.
- Take your time when working with explosives; make your actions deliberate.
- Post guards at all times to prevent access inside the danger radius.
- Maintain control of the blasting machine or initiation source at all times.
- Use the minimum amount of explosives necessary to accomplish the mission while keeping enough explosives in reserve to handle any possible misfires.
- Maintain accurate accountability of all explosives and accessories.
- Store blasting caps separately and at a safe distance from other explosives.
- Ensure that all personnel and equipment are accounted for before detonating a charge.
- Ensure that warnings are given before initiating demolitions; give the warning “Fire in the hole!” three times.
- Guard the firing points at all times.
- Assign a competent safety officer for every demolition mission.
- Dual initiate all demolitions, regardless of whether they are single- or dual-primed.
- Avoid using deteriorated or damaged explosives.
- Do not dismantle or alter the contents of any explosive material.
- Do not mix live and inert (dummy) explosives.
- Do not use blasting caps underground. Use detonating cord or M151 or M152 boosters to prime underground charges. See FM 3-34.465 for quarry operations.

#### EXPLOSIVE MATERIALS

6-2. Explosive materials consist of blasting caps, time fuse, shock tubes, detonating cord, low-strength detonating cord, plastic and sheet explosives, FPE binary explosive charges, and commercial explosives. Boosters consists of M151s and M152s (see Chapter 2). The paragraphs below describe how each of these materials are used.

## BLASTING CAPS

6-3. Both military and commercial blasting caps are extremely sensitive and can explode unless handled carefully. Blasting caps can detonate if exposed to extreme heat (cook off). Military blasting caps are more powerful and often more sensitive than their commercial counterparts. When using commercial blasting caps to detonate military explosives, ensure that they are powerful enough to detonate the explosives, thus avoiding misfires.

### WARNING

**Power requirements for electric caps from different manufacturers vary, so never mix caps from different manufacturers or lots because this could result in misfires. Failure to comply could result in immediate personal injury or damage to equipment.**

6-4. When installing caps in explosives, never force them into an explosive or a cap well; the appropriate tool for making or enlarging the cap well should be used. When taping the blasting cap onto the detonating cord, ensure that 1/8 to 1/4 inch of the cap is clearly visible at both ends. When nonessential personnel are on site, do not connect blasting cap initiating sets to ring or line mains or charges. Blasting caps should never be left unattended before or after attaching them to the charges or firing system.

## Nonelectric Blasting Caps

- 6-5. When using nonelectric blasting caps as an explosive material, the following procedures are used:
- Use only authorized equipment and procedures when crimping nonelectric blasting caps to the time fuse or detonating cord.
  - Maintain blasting caps in the appropriate cap box until needed. Never store blasting caps with explosives.
  - Do not carry loose blasting caps in pockets or place them in containers. Ensure that they are secured.
  - Do not blow into a nonelectric cap or attempt to remove any obstructions from the blasting cap well. Remove obstructions that will dislodge by using the wrist-to-wrist tap method.
  - Do not insert anything but time fuse or detonating cord into a nonelectric blasting cap. Do not twist the time fuse or detonating cord while attempting to insert it into a blasting cap.
  - Do not attempt to crimp a blasting cap that is installed in an explosive. Remove the blasting cap from the charge if the blasting cap has come loose from the time fuse or detonating cord, recrimp the cap, and then reinstall the cap in the charge.
  - Avoid striking, pinching, and mashing nonelectric blasting caps during crimping activities. Use only M2 crimpers for all crimping operations.
  - Cut the fuse to allow an interval of not less than 10 seconds between firings when using nonelectric blasting caps to dual-prime demolitions.

## Electric Blasting Caps

- 6-6. When using electric blasting caps as an explosive material, the following procedures are applied:
- Do not remove the short-circuiting shunt unless the cap is being tested or connected. (The shunt prevents accidental initiation by static electricity.) Twist the bare ends of the lead wires together at least three times (180° turns) to provide a proper shunt, if the blasting cap has no shunt.
  - Use proper grounding procedures when static electricity is present (see paragraph 6-19).
  - Protect the blasting caps by placing them in a metal can with a snug-fitting cover (1/2 inch or more of cover overlap) when transporting electric blasting caps near vehicles (including aircraft) equipped with a transmitter. Do not remove blasting caps from their containers near an operating transmitter unless the hazard has been judged acceptable.

- Keep electric blasting caps at least 155 meters from energized power lines. Temporarily cut the power to the lines during blasting operations if using electric blasting caps near power lines.
- Use at least the minimum current required to fire electric blasting caps.
- Check circuit continuity of electric blasting caps before use.
- Cover connections between blasting cap leads and firing wires with insulating tape, not the cardboard spool.
- Remove firing wire loops and, if practical, bury blasting wires.

### **WARNING**

**Never mix caps from different manufacturers because power requirements for electric caps from different manufacturers vary and could result in misfires. Failure to comply could result in immediate personal injury or damage to equipment.**

## **TIME FUSE**

6-7. When using time fuse, the following procedures are used:

- Conduct a test burn of at least 3 feet for each roll of time fuse. Perform another test burn before using the fuse if the fuse has not been used within 24 hours of the test burn.
- Use M2 crimpers to cut the time fuse. Use a sharp knife to cut the fuse if serviceable M2 crimpers are not available. Ensure that the fuse end is cut squarely. Make the cut on a nonsparking surface, such as wood.

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*Note.* A rough or jagged-cut fuse can cause a misfire.

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- Avoid cutting the fuse until it is ready to be inserted into the igniter and blasting cap.
- Do not use the first or last 6 inches of the time fuse from a new or partial roll (this helps to avoid problems from moisture infiltration).
- Avoid sharp bends, loops, and kinks in the time fuse.
- Avoid stepping on the fuse.

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*Note.* Any of these conditions or actions can break the powder train and result in a misfire.)

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## **SHOCK TUBES**

6-8. The detonation is contained within the plastic tubing and if strands of tubing touch or cross over each other there is no concern that an inadvertent ignition would occur. Fragments from blasting caps or other explosive charges travel at speeds three to five times faster than the detonating wave in the shock tube. These fragments could cause damage to other shock tube assemblies. The following procedures are applied:

- Never use crimpers when cutting shock tubes.
- Splice shock tubes only when the MDI components cannot be replaced.

6-9. The flash of the shock tube can produce a burn if a piece of shock tube is held when it is functioning, even through the olive drab coating. Therefore, never hold a shock tube while detonating an explosive system. If an unsealed shock tube is left unused for extended periods, it may not be reliable and should not be used.

## **DETONATING CORD**

6-10. Detonating cord should not be carried or held around your neck. The additional 6-inch tail should not be cut off when cutting detonating cord because 6-inch tails are standard on the knots to avoid moisture infiltration. Sharp bends, loops, and kinks should be avoided, and the cord should not be stepped on. Any of

these conditions or actions can change the path of detonation or cause the cord to cut itself. When using detonating cord, the following procedures are used:

- Use M2 crimpers to cut the time fuse. Use a sharp knife to cut the fuse if serviceable M2 crimpers are not available. Ensure that the fuse end is cut squarely. Make the cut on a nonsparking surface, such as wood.

---

*Note.* A rough or jagged-cut fuse can cause a misfire.

---

- Avoid cutting the fuse until it is ready to be inserted into the blasting cap.
- Do not use the first or last 6 inches of the time fuse from a new or partial roll (this helps to avoid problems from moisture infiltration).

### LOW-STRENGTH DETONATING CORD

6-11. Low-strength detonating cord is precrimped to a booster in all military applications and should be handled carefully. When installing boosters in explosive, never force them into an explosive or a cap well; the appropriate tool should be used for making or enlarging the cap well. The following procedures are used:

- Never leave boosters unattended before or after attaching them to explosive charges.
- Do not carry or hold low-strength detonating cord around your neck.
- Do not cut an additional 6-inch tail off when cutting low-strength detonating cord, because 6-inch tails are standard for taping and on knots to avoid moisture infiltration.
- Avoid sharp bends, loops, crossovers, and kinks in the detonating cord.
- Avoid stepping on it the cord.

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*Note.* Any of these conditions or actions can change the path of detonation or cause the cord to cut itself.

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### PLASTIC AND SHEET EXPLOSIVES

6-12. Plastic and sheet explosives should be cut with a sharp knife on a nonsparking surface; never use shears. Handling of explosives with your bare skin should be avoided as much as possible.

### FIGHTING POSITION EXCAVATOR BINARY EXPLOSIVE CHARGES

6-13. The following procedures are used when dealing with FPE binary explosive charges:

- Do not mix the nonexplosive binary components together until you are ready to emplace the charges. Do not attempt to separate the containers after mixing.

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*Note.* Once the contents of the binary components are mixed, they form an explosive, and the process cannot be undone.

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- Hold the liquid container with the seal facing up, and screw the powder container onto the liquid container to avoid spilling the contents when screwing the two nonexplosive containers together.
- Ensure that the binary charges are preprimed with a booster attached to low-strength detonating cord.
- Avoid sharp bends, loops, crossovers, and kinks in the branchlines.
- Avoid stepping on the cord.

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*Note.* Any of these conditions or actions can change the path of low-strength detonating cord or cause the cord to cut itself.

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- Do not twist or pinch the cord when using the branchline to lower the explosive charges into bore holes.
- Do not use excessive force to pull out the charges if the charges need to be readjusted in the borehole.

## COMMERCIAL EXPLOSIVES

6-14. Commercial dynamite is sensitive to heat, shock, and friction and is not recommended for use in combat areas. Old commercial dynamite should not be used, because it is extremely sensitive and very unstable. The procedures in DA Pamphlet 385-64, the Army publications used, or the manufacturer's recommendations should be followed to destroy aged commercial dynamite. When commercial dynamite freezes, it becomes covered with crystals and is very unstable (do not use frozen dynamite).

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*Note.* Commercial dynamite containing nitroglycerin requires special handling and storage. When in storage, commercial dynamite should be rotated to prevent the nitroglycerin from settling to the bottom of the explosive.

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## BOREHOLES

6-15. No void spaces should be left in boreholes, especially in quarrying operations. A secondary explosion can result from a borehole with voids between loaded explosives. After the first blast, it may take up to 15 minutes for such an explosion to occur. All voids should be tamped with the appropriate material. When using detonating cord wick to dig boreholes, allow at least 30 minutes for boreholes to cool between placing and firing successive detonating cord wick, or cool the boreholes with water or compressed air to save time.

## TOXICITY

6-16. Enough time should be allowed for blast fumes, dust, and mist to clear before inspecting or occupying a blasting area. Most military explosives are poisonous if ingested and will produce lethal gases if detonated in confined areas (such as tunnels, caves, bunkers, and buildings). TNT is extremely poisonous and it should be avoided when blasting in enclosed areas.

### WARNING

**When working with explosives, avoid touching sensitive areas of your body, such as around the face and groin. After working with explosives, wash your hands, especially before consuming food. Failure to comply could result in immediate personal injury or damage to equipment.**

## NATURAL PHYSICAL PROPERTIES

6-17. Natural physical properties include lightning, static electricity, induced currents, blast effects, and missile hazards. Each of these are discussed in the paragraphs below.

### LIGHTNING

6-18. Lightning is a hazard to both electric and nonelectric blasting charges. A lightning strike or a nearby miss is almost certain to initiate either system type. If lightning strikes occur, even far away from the blasting site, electrical firing circuits could be initiated by high, local earth currents and shock waves resulting from the strikes. These effects are increased when lightning strikes occur near conducting elements, such as fences, railroads, bridges, streams, and underground cables or conduits and in or near

buildings. The only safe procedure is to suspend all blasting activities during electrical storms or when an electrical storm is imminent.

## STATIC ELECTRICITY

6-19. Though rare, electric blasting caps can possibly be initiated by static electricity. If possible, avoid using electric blasting caps if static electricity is a problem. Exercise extreme caution when working with explosives in cold, dry climates or when wearing clothing and equipment that produce static electricity, such as clothing made of nylon or wool. Before handling an electric blasting cap, always remove the static electricity from your body by touching the earth or a grounded object. It may be necessary to perform this grounding procedure often in an area where static electricity is a constant problem.

## INDUCED CURRENTS

6-20. Radio signals can induce a current in electric blasting caps and prematurely detonate them. Table 6-1 lists the MSDs from transmitters for safe electrical blasting. This table applies to operating radio, radar, microwave, cellular telephone, and television transmitting equipment near electric caps. Keep mobile transmitters and portable transmitters at least 50 meters from any electric blasting cap or electrical firing system. Electric blasting caps should not be used within 155 meters of energized power transmission lines.

**Table 6-1. MSD for Blasting Near Radio Frequency Energy**

<i>Average or Peak Transmitter Power* (in watts)</i>	<i>MSD (in meters)</i>
0 to 29	30
30 to 49	50
50 to 99	110
100 to 249	160
250 to 499	230
500 to 999	305
1,000 to 2,999	480
3,000 to 4,999	610
5,000 to 19,999	915
20,000 to 49,999	1,530
50,000 to 100,000	3,050

\*When the transmission is a pulsed- or continuous-wave type and its pulse widths are less than 10 microseconds, the left-hand column indicates the average power. For all other transmitters, including those with pulse widths greater than 10 microseconds, the left-hand column indicates peak power.

## BLAST EFFECTS

6-21. A *blast effect* is the destruction of or damage to structures and personnel by the force of an explosion on or above the surface of the ground. Blast effect may be contrasted with the cratering and ground-shock effects of a projectile or charge that goes off beneath the surface. (JP 1-02) (FM 1-02)

6-22. Personnel close to explosions may experience permanent hearing loss or other injury from the pressure wave caused by an explosion. Hearing protection should be worn during all blasting operations. Personnel observing MSDs for bare charges (Table 6-2 and AR 385-63) generally will not be affected by blast effects. See AR 385-63 and DA Pamphlet 385-63 for additional information on blast effects.

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*Note.* See Chapter 7 for explosive urban entry techniques.

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Table 6-2. MSD for Personnel in the Open (Near Bare Charges)

Explosive Weight (lb)	MSD		Explosive Weight (lb)	MSD	
	Feet	Meters		Feet	Meters
27 or less	985	300	175	1,838	560
30	1,021	311	200	1,920	585
35	1,073	327	225	1,999	609
40	1,123	342	250	2,067	630
45	1,168	356	275	2,136	651
50	1,211	369	300	2,199	670
60	1,287	392	325	2,258	688
70	1,355	413	350	2,313	705
80	1,415	431	375	2,369	722
90	1,474	449	400	2,418	737
100	1,526	465	425	2,461	750
125	1,641	500	500	2,625	800
150	1,752	534	—	—	—

### MISSILE HAZARDS

6-23. Explosives can propel lethal missiles great distances. The distances these missiles will travel in the air depends primarily on the relationship between the missiles weight, shape, density, initial projection angle, and initial speed. Under normal conditions, the missile-hazard area of steel-cutting charges is greater than that of cratering, quarrying, and surface charges.

### UNDERWATER OPERATIONS

6-24. Underwater operations include the use of explosives, nonelectric caps, time fuse, detonating cord, MDI components, and M60 or M81 fuse igniters. Each of these is discussed in detail in the paragraphs that follow.

### EXPLOSIVES

6-25. Explosives are subject to erosion by water. Unprotected explosives will deteriorate rapidly, reducing their effectiveness. All exposed explosives should be adequately protected when used in water, especially running water.

### NONELECTRIC CAPS

6-26. Nonelectric caps depend on combustion to work properly. Any moisture inside a nonelectric cap may cause a misfire. Because nonelectric blasting caps are difficult to waterproof, explosives should be primed with detonating cord. The M151 or M152 boosters and detonating cord can be used to prime demolition charges underwater.

### TIME FUSE

6-27. Time fuse depends on combustion to burn properly. Time fuse burns significantly faster underwater due to water pressure. The fuse is placed underwater at the last possible moment before firing.

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*Note.* If the mission requires using time fuse underwater, then do the testburn underwater.

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## DETONATING CORD

6-28. The ends of detonating cord are sealed with a waterproof sealing compound when using detonating cord for initiating underwater charges or charges that will remain in place several hours before firing. Leaving a 6-inch overhang in the detonating cord will protect the remaining line from moisture.

## MODERNIZED DEMOLITION INITIATOR COMPONENTS

6-29. All MDI components (except for the M81) are factory-crimped to a blasting cap or booster and sealed for waterproofing to 70 feet (5 feet for the M14 and M18). MDI components should be inspected to ensure that there are no punctures in the shock tube, low-strength detonating cord, and time fuse and that all crimps and seals are intact before emplacing them underwater. The M151 or M152 boosters and detonating cord can be used to prime demolition charges underwater. When cutting shock tube or time fuse to attach an M81 igniter, do not allow moisture to enter the open end.

## M60 OR M81 FUSE IGNITERS

6-30. The M60 or M81 should not be used underwater. Water can penetrate the fuse igniter through the vent hole located in the pull rod.

## SAFE DISTANCES

6-31. The following general rules apply when determining the distances at which personnel in the open are relatively safe from missiles created by bare charges placed on the ground, regardless of the type or condition of the soil (AR 385-63). Table 6-2, page 6-7, lists the MSDs for selected charge weights.

- **Charges of less than 27 pounds.** The minimum missile-hazard distance is 300 meters.
- **Charges of more than 27 pounds, but less than 425 pounds.** The distances in Table 6-2 should be used.
- **Charges of more than 425 pounds.** The MSD is 750 meters.
- **Charges of more than 2,000 pounds.** The following formulas should be used:

$$MSD \text{ (meters)} = 100 \sqrt[3]{\text{pounds of explosive}}$$

$$MSD \text{ (feet)} = 300 \sqrt[3]{\text{pounds of explosive}}$$

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*Note.* See Chapter 7 for explosive urban entry techniques.

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6-32. Missile-proof shelters can be as close as 100 meters from the detonation site, provided they are strong enough to withstand the heaviest possible missile resulting from the demolition. All personnel will wear approved protective helmets and single hearing protection.

## SECTION II – MISFIRE PROCEDURES

### CHARGES FIXED TO TARGETS

6-33. When charges are fixed to targets and not simply placed on the ground, the following MSDs are used:

- **Charges placed on steel.**
  - The preferred method of employing steel-cutting charges is in a bunker designed for that purpose. Steel-cutting charges (amount of explosives and placement) will be calculated based on the appropriate formulas and the tables in this FM.



- If a steel-cutting bunker is not available, charges will be fired in an excavated pit that is at least 1 meter deep, and a mat made of a hemp-type material must cover the charge. Steel-cutting charges fired outside a steel-cutting bunker will not exceed 0.9 kilogram.
- Personnel must be a minimum of 100 meters from the charge at detonation and must be in a missile proof shelter, 300 meters in defilade, or 1,000 meters if in the open.
- **Charges placed on concrete.**
  - Charges placed on concrete will not exceed 18 kilograms and should be placed on the side nearest the observers.
  - Observers must be at least 100 meters away in a missile-proof shelter, 300 meters away in defilade, or 900 meters away in the open. An unoccupied distance of 900 meters will be provided on the opposite side of the charge where most missile hazards will be thrown.

## BANGALORE TORPEDO

6-34. Personnel must be a minimum of 100 meters from the charge at detonation. Personnel must be in a missile-proof shelter, 300 meters if in a defilade, or 1,000 meters if in the open.

## SLAM M4

6-35. Personnel must be a minimum of 100 meters from the charge at detonation. Personnel must be in a missile-proof shelter, 300 meters if in a defilade, or 1,000 meters if in the open.

## NONELECTRIC

6-36. Nonelectric misfires may be caused by—

- Moisture in the time fuse, detonating cord, or explosives.
- Failure to seat the time fuse completely in the blasting cap or the fuse igniter.
- Failure to seat the shock tube or time fuse completely in the fuse igniter.
- Breaks in the time fuse, shock tube, or detonating cord.
- Time fuse having jagged or uneven ends.
- Failure to seat the blasting caps securely in the cap well or explosive.
- Loosely or improperly installed detonating cord.
- Debris in the blasting cap.
- Blasting caps from commercial sources that are not strong enough to detonate military explosives.

## PREVENTION

6-37. Nonelectric misfires are minimized by taking the following precautions:

- Prepare and place all primers properly.
- Load all charges carefully.
- Detonate charges with the proper techniques.
- Use dual-initiation systems and, if possible, dual-firing systems.
- Use detonating cord or M151 or M152 for underground demolitions. Do not bury the blasting caps.
- Perform tamping operations carefully to avoid damaging prepared charges.
- Avoid crimping blasting caps onto time fuse in the rain; seek a covered area out of the rain.
- Ensure that the time fuse or shock tube is completely seated when installing it into a blasting cap or fuse igniter.

## CLEARING PROCEDURE

6-38. The Soldier who placed the charges should investigate any misfires, and correct any problems with the demolition using the following procedures:

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*Note.* During training, the range safety officer (RSO) or officer in charge (OIC) should investigate any misfires and correct any problems with the demolitions.

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- After attempting to fire the demolition, delay investigating any detonation problem for at least 30 minutes, plus the time remaining on the secondary initiating system. Sometimes, tactical conditions may require an investigation before the 30-minute limit.
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*Note.* For Navy and Marine Corps, wait 60 minutes plus the time remaining on the secondary initiating system (see NAVSEA SW060-AA-MMA-010).

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- For aboveground misfires of charges primed with blasting caps, place a primed, 1-pound charge next to the misfired charge, and detonate the new charge. Each misfired charge or charge separated from the firing circuit that contains a blasting cap requires a 1-pound charge for detonation. Scattered charges that contain blasting caps should not be touched; they must be destroyed in place. For charges primed with detonating cord, follow the procedures in paragraphs 6-42 through 6-45.
- For a nonelectric cap that has detonated but failed to initiate a detonating cord branchline, line main, or ring main, attach a new cap to the detonating cord, and then move to a safe place.
- For buried charges, remove the tamping to within 1 foot of the misfired charge and constantly check the depth while digging to avoid striking the charge. When you are within 1 foot of the misfired charge, place a primed, 2-pound charge on top of the original charge, and detonate the new charge. If digging over the original charge is impractical, dig a new borehole of the same depth beside the original hole, 1 foot away, and then place a primed, 2-pound charge in the new hole and detonate the new charge.

## ELECTRIC

6-39. Electric misfires may be caused by—

- An inoperable or weak blasting machine or power source.
- Improper operation of the blasting machine or power source.
- Defective or damaged connections (such as short circuits, breaks in the circuit, or too much resistance in the electrical wiring) are common conditions resulting in misfires.
- Faulty blasting caps.
- Different manufacturers' blasting caps being used in the same circuit.
- An inadequate power source for the number of blasting caps in the circuit (such as too many caps or too small a blasting machine).

## PREVENTION

6-40. One Soldier should be assigned the responsibility for all the electrical wiring in a demolition circuit. This Soldier should—

- Perform all splicing.
- Install all blasting caps in the firing circuit, and not bury the blasting caps.
- Make all of the connections between blasting cap wires, connecting wires, and firing wires.
- Inspect the system for short circuits.
- Avoid grounding out the system.
- Ensure that the number of blasting caps in any circuit does not exceed the rated capacity of the power source.

## CLEARING PROCEDURE

6-41. The following procedures are used to clear electric misfires:

- Make another attempt to fire.
- Use the secondary firing system, when present.
- Check the wire connections, blasting machine, or power-source terminals.
- Disconnect the blasting machine or power source, and test the blasting circuit. Check the continuity of the firing wire with a circuit tester.
- Use another blasting machine or power source and attempt to fire the demolition again, or change operators.
- Disconnect the blasting machine, shunt the wires, and investigate immediately when employing only one electrical-initiation system. When employing more than one electrical-initiation system, wait 30 minutes before inspecting. (Tactical conditions may require an investigation before the 30-minute limit.)

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*Note.* For Navy and Marine Corps, wait 60 minutes (see NAVSEA SW060-AA-MMA-010).

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- Inspect the entire circuit for wire breaks or short circuits.
- Do not attempt to remove or handle an electric blasting cap if a problem is suspected. Place a primed, 1-pound charge next to the misfired charge, and detonate the new charge.

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*Note.* When using a combination-initiated system, refer to paragraph 6-36 through 6-38 for the procedures for a nonelectric misfire.

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## DETONATING CORD

6-42. The paragraphs below should be used when dealing with detonating cord misfires. Discussed is how to handle detonating cord, detonating cord priming, and M151 and M152 booster low-strength detonating cord misfires.

### DETONATING CORD

6-43. If the detonating cord fails to function properly, a new blasting cap should be attached to the remaining detonating cord, taking care to fasten it properly, and detonate the new blasting cap. Branchlines should be treated the same.

### DETONATING CORD PRIMING

6-44. If the detonating cord leading to the charge detonates but fails to explode the charge, the following action should be taken:

- Do not investigate until the charges have stopped burning. Wait 30 minutes if the charge is underground.
- Reprime and attempt to detonate the charge. Collect scattered charges that do not contain blasting caps, and detonate them together.
- Dig near underground charges to within 1 foot of the charge. Place a primed, 2-pound charge on top or to the side of the charge, and detonate the new charge.

### M151 OR M152 BOOSTER LOW-STRENGTH DETONATING CORD

6-45. If the low-strength detonating cord leading to the charge functioned but failed to explode the charge, take the following action:

- Wait 30 minutes.
- Follow the procedures for buried charges in paragraph 6-38.

## SECTION III – TRANSPORTATION AND STORAGE SAFETY

### TRANSPORTATION

6-46. When transporting explosives, Soldiers should observe both military and commercial transportation regulations and safety procedures. The paragraphs below discuss these regulations and procedures.

#### REGULATIONS

6-47. Both military and commercial carriers are subject to regulations when transporting military explosives and other dangerous military materials within the United States. AR 385-64 and DA Pamphlet 385-64 contain the minimum safety requirements for handling and transporting military explosives and ammunition. When transporting explosives outside the United States, follow the regulations from the host countries as well. All explosives transport personnel must learn the local procedures and safety procedures.

#### SAFETY PROCEDURES

6-48. The commander should assign a primary and assistant operator to each vehicle transporting explosives on public highways, roads, or streets. Whenever transporting explosives locally, operators must observe safety rules.

#### Vehicles

- 6-49. When using vehicles to transport explosives, these precautions are followed:
- Ensure that vehicles are in good condition. Inspect all vehicles intended for hauling explosives before loading them. Protect against any short circuits in the electrical system.
  - Install fire-resistant and nonsparking cushioning to separate the explosives from any metal truck components if using vehicles with steel or partial-steel bodies.
  - Do not load vehicles beyond their rated capacities when transporting explosives.
  - Cover open-bodied vehicles hauling explosives with a fire-resistant tarpaulin.
  - Mark all vehicles transporting explosives with reflective placards indicating the explosive types carried (see AR 385-64 and DA Pamphlet 385-64).
  - Use demolition transports for explosives only. Do not carry metal tools, carbides, oils, matches, firearms, electric storage batteries, flammable substances, acids, or oxidizing or corrosive compounds in the bed or body of any vehicle transporting explosives.
  - Equip vehicles transporting explosives with not less than two Class 10 BC fire extinguishers for on-post shipments. Place the extinguishers at strategic points so they are ready for immediate use. Keep vehicles away from congested areas. Consider the parking congestion.
  - Operate vehicles transporting explosives with extreme care. Do not drive at a speed greater than 35 miles per hour. Make full stops at approaches to all railroad crossings and main highways.

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*Note.* This does not apply to convoys or crossings protected by guards or highway workers (flaggers).

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- Keep flames at least 50 feet from vehicles or storage points containing explosives.

#### Cargo (Explosives)

- 6-50. When transporting explosives, these precautions are followed:
- Do not leave explosives unattended.
  - Do not mix live and inert (dummy) explosives.
  - Secure the load of explosives in the transport to prevent shifting during transport.

- Do not transport blasting caps or other initiators in the same vehicles carrying explosives unless absolutely necessary. Separate the blasting caps from other explosives if both blasting caps and explosives must be carried in the same vehicle.

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*Note.* Carry the caps in a closed metal container in the cab of the transport.

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- Do not allow anyone other than the primary and assistant operators to ride on or in a truck transporting explosives. Do not refuel a vehicle while carrying explosives except in an emergency.

## Fire

6-51. If fire breaks out in a vehicle transporting explosives, these actions are followed:

- Try to stop the vehicle away from any populated areas.
- Stop traffic from both directions. Warn the vehicle drivers and passengers and occupants of nearby buildings to keep at least 2,000 feet away from the fire.
- Inform police, firefighters, and other emergency response personnel that the cargo is explosives.
- Attempt to extinguish the fire with fire extinguishers, sand, dirt, or water if the fire involves only the engine, cab, chassis, or tires. Stop fighting the fire and evacuate to a distance of at least 2,000 feet if the fire spreads to the body of the transport or the cargo.
- Do not attempt to extinguish burning explosives without expert advice and assistance.

## STORAGE SAFETY

6-52. Proper storage safety should be observed at all times. The paragraphs below discuss the storage safety of permanent and temporary magazines and the use of temporary storage.

### MAGAZINES

6-53. The two types of magazines are permanent and temporary. Although permanent magazines are preferred, temporary or emergency magazines are frequently required when permanent construction is not possible. FM 4-30.1 gives details on storage of explosives in magazines. The paragraphs below should be considered when constructing magazines.

#### Permanent

6-54. The acceptability of magazine locations should be considered based on the safety requirements, accessibility, dryness, and drainage. Safety and accessibility are the most important factors. An ideal location is a hilly area where the height of the ground above the magazine provides a natural wall or barrier to buildings, centers of communication, and other magazines in the area. Hillside bunkers are not desirable because adequate ventilation and drainage are often difficult to achieve. To lessen the danger of fire, clear brush and tall grass is cleared from the site.

6-55. All magazines should have a grounded, overhead lightning rod system. All metal parts (doors, ventilators, window sashes, reinforcing steel, and so forth) are connected to buried conduits of copperplate or graphite rods in several places. Guards are placed at all magazines to prevent unauthorized personnel from gaining access to the magazine facilities.

6-56. Barricades are installed around the magazines to ensure that there is a substantial obstacle between the magazines and the inhabited buildings. For certain explosives, effective natural or artificial barricades reduce the required MSDs between magazines and railways and highways by one-half. The use of barricades permit the storage of larger quantities of explosives in any given area. Although barricades help protect magazines against explosives and bomb or shell fragments, they do not safeguard against pressure damage. AR 385-64 and DA Pamphlet 385-64 give more specific guidance on barricades.

## Temporary

6-57. When permanent-magazine construction is not possible, temporary magazines are created by placing explosives on pallets to accommodate ventilation. The pallets are stored in a well-drained bunker. The bunker is excavated in a dry area and is reverted with timber to prevent collapse. Alternatives are an isolated building or a light, wooden-frame house with a wedge-type roof covered with corrugated iron or tent canvas. Field-expedient storage facilities are marked on all four sides with signs (see AR 385-64 and DA Pamphlet 385-64).

## TEMPORARY STORAGE

6-58. When necessary, store limited supplies of explosives in covered ammunition shelters. To prevent fire or explosion from being transmitted between shelters, ensure that the temporary facilities are separated adequately. Piles of temporarily stored explosives should not contain more than 500 pounds each and are spaced no closer than 140 feet. Explosive components are piled separately. Explosives, caps, and other demolition material stored in training areas are kept in covered ammunition shelters and are under guard at all times. The local safety SOPs, AR 385-64, and DA Pamphlet 385-64 are used as guides for temporary storage operations.

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*Note.* Any deviation from the requirement for separate storage of blasting caps and explosives should be approved through the Director, United States Army Defense Ammunition Center, McAlester, Oklahoma 74501.

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## SECTION IV – MILITARY EXPLOSIVES DESTRUCTION

### CONCEPT

6-59. Destroying demolition materials is a unit commander's decision. The purpose of this intentional destruction is to prevent an enemy from capturing stockpiles of explosives. Whenever a commander orders destruction, two primary considerations are site selection and safety precautions. EOD units are responsible for destroying damaged or unserviceable explosives and demolition materials (see AR 75-14, FM 4-30.51, and TM 43-0001-38). Explosive and nonexplosive demolition materials should be completely destroyed in a combat zone. Essential components of sets and kits should be damaged to prevent complete assembly by removal of undamaged components. Such destruction is a command decision based on the tactical situation, the security classification of the demolition materials, their quantity and location, the facilities for accomplishing destruction, and the time available. In general, burning and detonating or a combination of both are the most effective means of destruction.

### SITE SELECTION

6-60. The demolition materials' destruction site is selected for its ability to provide the greatest obstruction to enemy movement, but prevent hazards to friendly troops. Even in the fastest-paced operations, safety is important and the appropriate safety precautions should be adhered to, if possible.

### METHODS

6-61. Burning or detonating, in that order, are considered the most satisfactory methods for destroying demolition materials to prevent enemy use. DA Pamphlet 385-64 and TM 9-1300-214 cover procedures for explosives and ammunition destruction in greater detail.

### BURNING

6-62. Packed and unpacked HE items are destroyed by burning. These explosives include linear, shape, and block demolition charges; stick dynamite; detonating cord; firing devices; and timed blasting fuse. Destroying blasting caps by burning them should not be attempted since they will detonate from extreme heat. They should be separated from other explosives and destroyed by detonation. Personnel should not

attempt to extinguish burning explosives without expert advice and assistance. The following procedures should be used for burning explosives:

- Place blasting caps in piles separate from explosives, and destroy them by detonation. Ensure that blasting caps are stored far enough away from the other explosives being burned to prevent the burning explosives from detonating the blasting caps or vice versa.
- Stack explosives in a pile over a layer of combustible material. Ensure that the piles do not exceed 2,000 pounds or are no more than 3 inches thick.
- Ignite the pile with a combustible train (excelsior or slow-burning propellant) of suitable length, and take cover immediately. Calculate the MSD from the pile using Table 6-2, page 6-7. This distance is never less than 300 meters.
- Do not try to extinguish burning explosives without expert advice and assistance.

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*Note.* Burning explosives cannot be extinguished by smothering them or drenching them. In fact, smothering will probably cause an explosion.

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## DETONATION

6-63. The tactical situation, the commander's intent, the lack of time, the explosive type, or safety considerations may require an explosive to be detonated instead of burned. The following procedures should be used for detonating explosives:

- Establish a safety zone for missile and blast effect by computing the MSD required for the amount of explosives to be detonated (Table 6-1, page 6-6).
- Do not exceed the limitations of the disposal site. Make several smaller piles of explosives, and stagger their detonating times instead of detonating one large pile of explosives.
- Use a minimum of two initiation systems to detonate a pile of explosives.
- Prime explosives every 4 to 5 feet when placing explosives in long rows or lines.
- Ensure positive contact between primed charges and other explosives in the pile or row.

## SECTION V – ENVIRONMENTAL PROTECTION

### MILITARY MUNITIONS RULE

6-64. Section 107, Federal Facilities Compliance Act of 1992, requires the Environmental Protection Agency (EPA), in consultation with the Department of Defense (DOD) and the individual states, to issue a rule identifying when conventional and chemical or military munitions become hazardous waste under the Resource Conservation and Recovery Act (RCRA), and to provide for protective storage and transportation of that waste. The objective of the Army is to minimize health hazards and environmental damage caused by the use or misuse of hazardous material. Military munitions must be stored, transported, used, and maintained to ensure their effective, efficient, and safe employment to protect human health and the environment.

### DEFINITION OF MILITARY MUNITIONS

6-65. The military is required under Section 107 of the Federal Facilities Compliance Act to comply with EPA standards to control and dispose of military munitions, such as—

- Confined gases.
- Liquid and solid propellants.
- Explosives.
- Pyrotechnics and chemical- and riot-control agents.
- Smokes and incendiaries, including bulk explosives and chemical warfare agents.
- Chemical munitions.
- Rockets and guided and ballistic missiles.

- Bombs, warheads, and mortar rounds.
- Artillery ammunition.
- Small arms ammunition.
- Grenades and mines.
- Torpedoes and depth charges.
- Cluster munitions and dispensers.
- Demolition charges.
- Devices and components thereof.

While the EPA strongly encourages individual states to adopt the terms of the Military Munitions Rule, it acknowledges that individual states may adopt requirements that are more stringent or broader in scope than federal requirements.

### DEFINITION OF SOLID WASTE

6-66. The Military Munitions Rule clarifies when conventional and chemical or military munitions become a hazardous waste under the RCRA. The regulatory definition of solid waste, as it applies to three specific categories of military munitions, are munitions that—

- Are unused.
- Are being used for their intended purpose.
- Have been used or fired.

6-67. The Military Munitions Rule conditionally exempts from the RCRA the—

- Manifest requirements and container marking requirements (such as waste, nonchemical, and military munitions) that are shipped from one military-owned or -operated treatment, storage, or disposal facility to another according to DOD military munitions shipping controls.
- Subtitle C of the storage regulations (waste, nonchemical, and/or military munitions) that are subject to the jurisdiction of the DOD Defense Environmental Safety Board's storage standards.

6-68. The Military Munitions Rule identifies four specific circumstances under which unused munitions are considered to be a solid waste for regulatory purposes. Unused munitions are a solid waste when they are—

- Abandoned by being disposed of, burned, incinerated, or treated before disposal.
- Removed from storage for being disposed of, burned, incinerated, or treated before disposal.
- Deteriorated, leaking, or damaged to the point that they cannot be put into serviceable condition or cannot reasonably be recycled or used for other purposes.
- Determined by an authorized military official to be a solid waste.

6-69. The Military Munitions Rule identifies that military munitions are not a solid waste for regulatory purposes when they—

- Are used for their intended purpose (training military personnel, research, development, testing, and evaluation) and are destroyed during range-clearance operations at active and inactive ranges.
- Have not been used or discharged (including their components) and are repaired, reused, recycled, reclaimed, disassembled, reconfigured, or otherwise subjected to materials recovery activities.

6-70. The rule specifies that used or fired munitions are still solid waste when they are removed from their landing spot and one of the following conditions exists:

- They are managed off the range (for example, transporting them off the range and storing, reclaiming, treating, or disposing of them).
- They are disposed of on the range (such as being buried or becoming landfill).

6-71. Additional information relating to the Military Munitions Rule can be found in Part 266, Subpart M, Title 40, Code of Federal Regulations (CFR). This CFR only applies to the continental United States and its territories and possessions. However, if the military is operating in a foreign country, it must comply with



the host nations environmental standards. U.S. federal regulations are used only if the host nation's standards are less stringent.

## **ENVIRONMENTAL RISK MANAGEMENT**

6-72. The environment must be considered when using explosives during operations and training. Environmental hazards can be eliminated or reduced by modifying an operation through proper training and environmental risk assessments. Through this process, battle-focused training and operations can still lead to mission completion. Refer to FM 5-19 for further guidance and procedures for conducting environmental risk assessments.

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## Chapter 7

# Explosive Urban Entry

This chapter provides safety standards and procedures for gaining entry into buildings by using explosive entry techniques. Urban situations may require a precise application of firepower. This is especially true of an urban environment where the enemy is mixed with civilians. The presence of civilians can restrict the use of explosives and reduce the combat power available. Rules of engagement (ROE) can prohibit the use of certain weapons until a specific hostile action takes place. All Soldiers must be aware of the ROE. Leaders must include the precise use of weapons and explosives in their planning for missions on urban terrain.

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*Note.* High-rise building demolition missions under combat conditions require significant demolition planning, coordination, and expertise. A combat engineer has basic expertise to understand many of the principles involved in demolishing such complex buildings but requires a building demolition expert to assist in building a detailed plan. Each building requires case-by-case study and planning before detonation procedures. When such situations arise, the United States Army Corps of Engineers explosive effects team should be contacted via the TeleEngineering Operations Center (TEOC). The commander should not accept risk without expert reachback assistance to accomplish the task. TeleEngineering is capable of addressing a complex task that is encountered in the field. Soldiers can quickly send information through the TeleEngineering kit via advanced communication links to the TEOC. The TEOC can tap the required technical expertise through the Corps's research laboratories, districts and divisions, private industry, and academia to provide a quick answer to the task. In this task, the explosive effects team would assist in assessing the design of the demolition plan, providing there is telephonic, computer, or video teleconference reachback capabilities at the location. The TEOC can be contacted by e-mail at <teoc@usace.army.mil>, on the Web at <<http://teleengineering.usace.army.mil/>>, or by telephone at (601) 634-2735; and DSN 312-446-2735.

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## BREACHING EFFECTS AND HAZARDS

7-1. The paragraphs below will provide a general understanding of the effects and hazards associated with explosive breaching. They will also identify the precautions and measures that can negate or at least reduce the effects of explosives, blast pressure, fragmentation, and thermal effects.

### EXPLOSIVE EFFECT

7-2. When the explosive is detonated, the explosive material is instantaneously converted into a rapidly expanded mass of gases. The explosive detonation will result in four fundamental effects that may affect the breacher team and/or the surrounding areas—blast pressure, fragmentation, thermal effect, and chemical poisoning.

## Blast Pressure

7-3. Once the detonation occurs, a mass of expanding gas rolls outward in a circular pattern from the point of detonation like a giant tidal wave, smashing and shattering any object in its path. The farther the pressure wave travels from the point of detonation, the less power it possesses until it dwindles to nothing. Blast pressure has two pressure phases—positive and negative.

- **Positive pressure phase.** When the blast pressure wave is formed at the instant of detonation, the pressure actually compresses the surrounding atmosphere. The layer of compressed air, known as the shock front, is the leading edge of the positive pressure. The shock front is only a fraction of an inch thick and is that part of the atmosphere that is compressed before it is set in motion. As the shock front, followed by the positive pressure wave moves outward, it applies a sudden shattering, hammering blow to any object in its path.
- **Negative pressure phase.** As the shock front moves outward, it pushes the surrounding air away from the point of detonation. This outward compressing and pushing of air forms a partial vacuum at the point of detonation. When the shock front and positive pressure has dissipated, the broad partial vacuum causes the compressed and displaced atmosphere to reverse its movement and rush inward to fill the void. This reverse movement of air is known as the negative pressure phase. The displaced air rushing back toward the point of detonation has mass, power, and great velocity.

7-4. In addition to having two pressure phases, the blast effect creates other effects that may cause major problems for the breacher team. This is known as blast pressure phenomenon. Preparation would include being equipped with suitable protection. Blast pressure phenomenon also includes—

- **Dynamic pressure.** Dynamic pressure is the transitional pressure exerted on an object by the blast. This is the pressure felt and the damage caused by the impact of the shock front with the object. A person standing in the open, in the line of travel of a blast wave, would be exposed to dynamic pressure.
- **Incidental pressure.** Incident pressure is the pressure measured at 90° to the blast front direction of travel. A person standing behind a barrier, wall, building, or so forth, which is in the line of travel of the blast shock front, would be exposed to incident pressure.
- **Reflective pressure.** Reflective pressure is a rapid buildup of pressure that occurs when a shock front strikes any surface in the line of travel and bounces off. There is a rapid amplification of pressure as a result of the piling up and reflection of the wave off the surface. This reflection results even though the exposed surface may fail or collapse. The pressure wave impacting the surface will reflect at 90° angles and at twice the strength regardless of the surface material. Additionally, if the wave is reflected in a corner, the pressure can quadruple.
- **Residual pressure.** Residual pressure is the amount of overpressure built-up in a confined space from the result of a detonation. A detonation results in the production of a huge quantity of gas, which creates pressure within a confined space.

## Fragmentation

7-5. When an explosive charge is detonated, shattering fragments of the casing and any item located in close proximity to the charge will be hurled outward at high speeds. Fragmentation may be a major hazard that Soldiers should be aware of and protect against.

7-6. Items that may cause fragmentation hazards include blasting caps, charge construction materials, prop sticks, doorknobs, doorjambes, and so forth. These fragments may not only be harmful to immediate personnel, but also to the surroundings.

## Thermal Effect

7-7. The thermal effect produced by the detonation of an urban charge is usually seen as a bright flash or fireball. This is normally not a significant hazard unless highly combustible materials engulf the breacher team.

## **Chemical Poisoning**

7-8. The chemicals used in explosives, the detonation itself, and/or the toxic gases from building materials may be poisonous. When explosives are used in enclosed areas, appropriate respiratory protection must be worn.

## **IMPACT**

7-9. Impact injuries can cause serious injury and can be fatal. The two types of impact injuries are acceleration and deceleration.

- **Acceleration.** Acceleration injuries can be produced in two ways. First, the body or a body part is impacted by a projectile or fragment. This is called blunt trauma. Second, the victim is hit with the blast pressure wave and is accelerated through the air.
- **Deceleration.** Deceleration injuries occur when an accelerated victim impacts a surface. Injuries can range from lacerations to massive brain injury.

## **DEBRIS**

7-10. Debris is anything that impedes movement through the entry point. For example, doors lying inside or outside of the entry point or portions of the door frame or other parts of the opening that has been created by the explosions.

## **SAFETY**

7-11. There are several measures that must be taken into consideration when dealing with explosive urban entry charges. These measures include calculating the MSD, the fragmentation distance, the charge placement, and proper positioning.

## **SAFE BLAST DISTANCE CALCULATION**

7-12. By calculating the net-explosive weight (NEW) and applying the standoff formula, breachers can determine the MSD. By knowing the necessary safe distance, the breachers can avoid injury from blast overpressure and fragmentation from the explosion.

## **FRAGMENTATION DISTANCE**

7-13. Fragmentation and missile hazards near the detonation of HEs must be reduced to an acceptable level. The safe fragmentation distance far exceeds the safe overpressure distance. Using just the safe fragmentation distance will not allow an expedient entry. It is the breachers responsibility to recommend measures to protect the team from fragmentation and missile hazards.

## **CHARGE PLACEMENT**

7-14. Breachers should place the charge so that the fragmentation and missile hazards will be thrown away from the team and/or structures that should not be damaged (if possible).

## **PROPER POSITIONING**

7-15. Proper positioning is the most important factor in reducing hazards to personnel. The number of personnel should be limited to the absolute minimum in the immediate vicinity of the detonation. Any available cover should be taken advantage of during the detonation or when a breacher blanket is not available.

## NET-EXPLOSIVE WEIGHT AND MINIMUM SAFE DISTANCES

7-16. Each breaching charge is designed and constructed to defeat a specific target. Calculating the NEW of the charge will allow the breacher to determine the safe distance for the assault team during detonation. Without this information, the breacher could place the assault team in a dangerous location.

### FORMULA

7-17. NEW equals the total pounds of explosives expressed in TNT equivalent. The formula is—

$$qty \times wt \times RE \text{ factor} = NEW$$

where—

*qty* – quantity

*wt* = weight

*RE* = relative effectiveness

*New* = net explosive weight (or TNT equivalent)

This formula must be worked for each explosive type used and all of the products added together for the total NEW of a charge. See Table 7-1.

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**Note.** Some explosives are listed in grain per foot or in grams. These must be converted to pounds, multiplied by the RE factor for TNT, then added together to determine the NEW equivalent to TNT.

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To convert grams to grains:  $grams \times 15.4 = grains$

To convert grains to pounds:  $grains \div 7,000 = pounds$

To convert grains per foot to pounds:  $(feet \times grains/ft) \div 7,000 = pounds$

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**Note.** If in pounds, leave in pounds, multiply (if necessary) by the package weight, and then multiply by the RE factor. If not in pounds, convert to pounds using the formulas above, multiply by the package weight (if necessary), multiply by the RE factor, and then add all explosives together; this will be the NEW (equivalent to TNT).

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### DANGER

The standoff formula in this chapter references overpressure safe distances. The formula does not account for fragmentation, decibels, or heat. The breacher needs to take other precautions to mitigate hazards. Failure to comply may cause death or personal injury.

Table 7-1. NEW Formulas

<b>RE Factors</b>		
<b>Item</b>	<b>Explosive</b>	<b>RE Factor</b>
FLSC	CH-6	1.50
Sheet explosive (composition C2)	PETN based	1.66
Detonating cord	PETN	1.66
M6 and M7 blasting caps	RDX	1.60
Composition C4 M112	RDX based	1.34
Dynamite	RDX	0.92
Booster	PETN based	1.66
Composition C4 M186	PETN/RDX	1.14
<b>NEW Formula</b>		
<b>Explosives</b>	<b>Formula</b>	
Composition C4 (M112) 1.25 lbs per block	lb x 1.34 =	
Composition C4 (M186)	lb x 1.14 =	
Dynamite	lb x 0.92 =	
TNT	Needs no conversion	
FLSC 4-ft sections	ft x gr x 1.50 =	
Detonating cord	ft x gr x 1.66 =	
M6 and M7 blasting caps	N x 13.5 x 1.6 = 21.6	
Sheet explosive	(L x W) T x 15.4 x 1.66 =	
Booster, 20 g	20 x 15.4 x 1.66 =	
<b>MDI Cap Weigh (this table takes in account for all conversions)*</b>		
<b>MDI Cap</b>	<b>Converted Grain Weight</b>	
M11	19	
M12	13	
M13	13	
M14 delay	16	
M15 delay	15 and 3	
M16	19	
M18 delay	16	
M19 dual (two caps)	35	
M21	19	
M23	19	
MDI booster (includes detonating cord)	Converted grain weight	
M151	87	
M152	197	
Where—g = gram gr = grain L = length N = number T = thickness W = width		

**STANDOFF FORMULA FOR OVERPRESSURE**

7-18. The following formula is used to calculate the MSD without shielding. The result is rounded up to the nearest whole number. For urban breaching, calculate for overpressure and protect your team from fragmentation.

*Note.* The MSD with shielding is half the distance without shielding and is rounded up to the next whole foot. It takes 3.4 pounds per square inch to rupture an eardrum. With proper hearing protection, use 4 pounds per square inch as the maximum when calculating for blast overpressure. Four pounds per square inch has a K factor of 18 as shown in Table 7-2. Pounds per square inch less than 4 may be used. For example, 2 will have a K factor of 30 and you will receive less overpressure.

<i>Explosion Effect</i>	<i>Pounds per Square Inch</i>	<i>K Factor</i>
Hazardous Fragmentation		300
Blast Overpressure (pounds per square inch)	0.07	300.02
	0.10	250
	0.50	75
	1	45
	2	30
	3	20
	4	18
	5	15
	6	14
	7	13
	8	12
	9	11
	10	10
	15	8
	20	7
	30	6
	40	5
	60	4
100	3.5	
200	3	

Formula (also see the note in Table 7-3):

$$MSD = \sqrt[3]{NEW} * K \text{ factor}$$

where—

*K* = is a constant taken from the *K* factor chart (Table 7-2), normally *K* = 18 for 4 pounds per square inch (see the warning below)

**WARNING**

This standoff is only assumed safe when proper hearing protection is used. Failure to comply could result in immediate personal injury or damage to equipment. It takes 3.4 pounds per square inch to rupture an eardrum, 40 pounds per square inch to collapse a lung, and 220 pounds per square inch to loose a limb.



Table 7-3. MSD for K Factor of 18 Representing 4.5 Pounds Per Square Inch

<i>NEW TNT Equivalent</i>	<i>Cube Root</i>	<i>Safe Distance (ft)</i>	<i>MSD Without Shielding (ft)</i>	<i>MSD With Shielding (ft)</i>
0.01	0.215443469	03.877982448	4	2
0.02	0.271441762	04.885951716	5	3
0.03	0.310723251	05.593018517	6	3
0.05	0.368403150	06.631256704	7	4
0.08	0.430886938	07.755964891	8	4
0.12	0.493242415	08.878363474	9	5
0.17	0.553965826	09.971384868	10	5
0.22	0.603681074	10.866259330	11	6
0.29	0.661910595	11.914390710	12	6
0.37	0.717905435	12.922297840	13	7
0.47	0.777498010	13.994964180	14	7
0.57	0.829134434	14.924419820	15	8
0.70	0.887904002	15.982272030	16	8
0.84	0.943538796	16.983698330	17	9
1.00	1.000000000	18.000000000	18	9
1.17	1.053728243	18.967108370	19	10
1.37	1.110640541	19.991529740	20	10
1.58	1.164713284	20.964839120	21	11
1.82	1.220929150	21.976724690	22	11
2.08	1.276500859	22.977015470	23	12
2.37	1.333263885	23.998749930	24	12
2.67	1.387300109	24.971401960	25	13
3.01	1.443850292	25.989305260	26	13
3.37	1.499258893	26.986660070	27	14
3.76	1.554996019	27.989928340	28	14
4.18	1.610863572	28.995544290	29	15
4.62	1.665510308	29.979185550	30	15
5.00	1.709975946	30.779567020	31	16
MSD = MSD with shielding (round up to the nearest whole number)				
<b>Note.</b> When using this table, if the NEW (carry out two places past the decimal) falls between the two numbers depicted in column 1, use the next higher number in column 1 for determining the safe blast distance with or without shielding in columns 4 and 5.				

7-19. Use the following example problems and Table 7-3, page 7-7, (with formula) to obtain the NEW and the standoff for overpressure:

---

**Example 1.** Calculate the standoff. You are given one 5-foot piece of 50-grain-per-foot detonating cord, one 12-inch piece of 50-grain-per-foot detonating cord, and one M11 blasting cap. What is the NEW and the standoff?

---

$$\{(Length\ in\ feet\ [F] \times gr\ per\ ft) \times RE\} \div 7,000 = NEW$$

$$5\ ft \times 50 \times 1.66 = 415\ gr\ of\ TNT$$

$$1\ ft \times 50 \times 1.66 = 83\ gr\ of\ TNT$$

$$1 \times 19 \times 1.60 = 30.4\ gr\ of\ TNT$$

$$415 + 83 + 30.4 = 528.4\ gr\ of\ TNT$$

$$528.4 \div 7,000 = 0.0754\ NEW = .08\ NEW\ TNT\ equivalent$$

$$MSD = \sqrt[3]{NEW} * K\ factor$$

$$.43 \times 18 = 7.74\ (round\ up\ to\ 8\ ft)$$

$$Standoff = 8\ feet\ without\ shielding; 4\ feet\ with\ shielding$$


---

**Example 2.** Calculate the standoff. You are given a 42-inch piece of 50-grain-per-foot detonating cord and one M11 blasting cap. What is the NEW and the standoff?

---

$$3.5 \times 50 \times 1.66 = 290.5\ gr\ of\ TNT \quad (42\ in \div 12\ ft = 3.5\ ft)$$

$$1 \times 19 \times 1.60 = 30.4\ gr\ of\ TNT$$

$$290.5 + 30.4 = 320.9\ gr\ of\ TNT$$

$$320.9 \div 7,000 = 0.0458\ NEW = .05\ NEW\ TNT\ equivalent$$

$$MSD = \sqrt[3]{NEW} * K\ factor$$

$$.37 \times 18 = 6.66\ (round\ up\ to\ 7\ ft)$$

$$Standoff = 7\ feet\ without\ shielding; 4\ feet\ with\ shielding$$


---

**Example 3.** Calculate the standoff. You are given a 14-foot piece of 50-grain-per-foot detonating cord, two M112 composition C4 blocks, and one M11 blasting cap. What is the NEW and the standoff?

---

$$14\ ft \times 50 \times 1.66 = 1,162\ gr\ of\ TNT$$

$$2 \times 1.25 \times 1.34 = 3.35\ lbs\ of\ TNT\ (already\ in\ pounds)$$

$$1 \times 19 \times 1.60 = 30.4\ gr\ of\ TNT$$

$$1,162 + 30.4 = 1,192.4\ gr\ of\ TNT$$

$$1,192.4 \div 7,000 = 0.17\ NEW\ gr\ of\ TNT$$

$$0.17 + 3.35 = 3.53\ NEW\ TNT\ equivalent$$

$$MSD = \sqrt[3]{NEW} * K\ factor$$

$$1.50 \times 18 = 27\ ft$$

$$Standoff = 27\ feet\ without\ shielding; 14\ feet\ with\ shielding$$


---

**Example 4.** Calculate the standoff. You are given a 32-foot piece of 50-grain-per-foot detonating cord, six M112 composition C4 blocks, one 12-inch piece of 50-grain-per-foot detonating cord, and one M11 blasting cap. What is the NEW and the standoff?

---

*Answer:*

$$6 \times 1.25 \times 1.34 = 10.05\ lbs\ of\ TNT\ (already\ in\ pounds)$$

$$32\ ft \times 50 \times 1.66 = 2,656\ gr\ of\ TNT$$

$$1\ ft \times 50 \times 1.66 = 83\ gr\ of\ TNT$$

$$1 \times 19 \times 1.60 = 30.4 \text{ gr of TNT}$$

$$2,656 + 83 + 30.4 \text{ gr of TNT} = 2,769.4 \text{ gr of TNT}$$

$$2,769.4 \div 7,000 = 0.395 \text{ lbs of TNT} = 0.4 \text{ NEW}$$

$$0.4 + 10.05 = 10.45 \text{ NEW}$$

$$MSD = \sqrt[3]{NEW} * K \text{ factor}$$

$$2.19 \times 18 = 39.42 \text{ (round up to 40 ft)}$$

Standoff = 40 feet without shielding; 20 feet with shielding

## DETONATING CORD LINEAR CHARGE

7-20. The detonating cord linear charge (Figure 7-1) is an exterior charge which is effective against wooden and metal doors that open inward and outward. The charge uses the blast principle to cut the door along the length of the charge, thereby, defeating the attachment mechanisms and the security of the door.

*Note.* It is recommended that both ends of all lengths of detonating cord be taped.

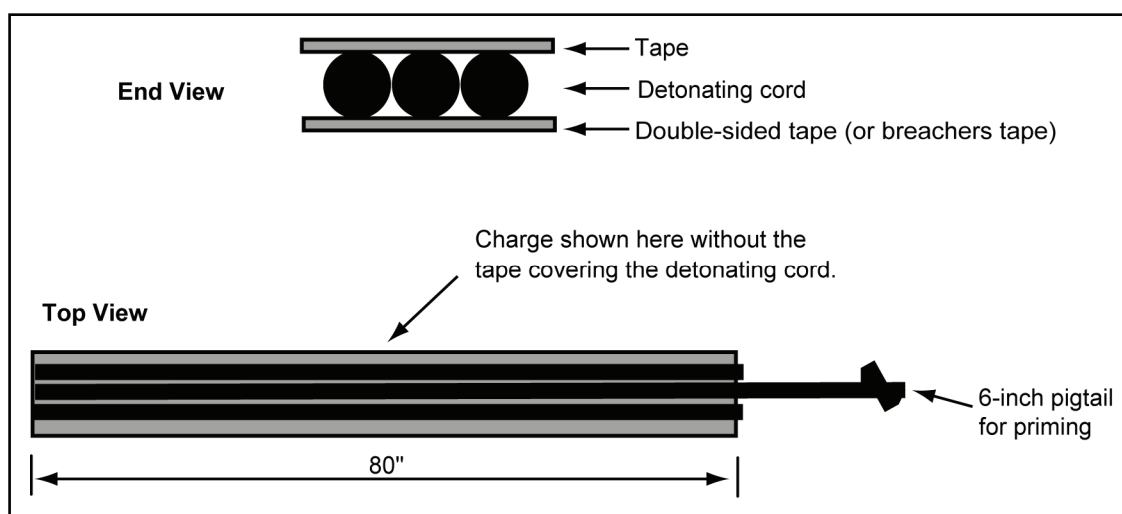


Figure 7-1. Detonating Cord Linear Charge

## MATERIALS REQUIRED

7-21. Explosive materials required include 21 feet of 50-grain-per-foot detonating cord (this number may vary depending on the door type; one 80-inch piece of detonating cord should be added for security doors).

7-22. Nonexplosive materials required include 2-inch pressure-sensitive tape (duct tape) and double-sided tape.

*Note.* Use three strips of detonating cord for all doors except extremely rugged security doors. Use four strips when a very secure structure is encountered using security-type doors of solid wood, such as an oak blank or ribbed metal.

## CHARGE CONSTRUCTION

7-23. The following steps are used to construct a detonating cord linear charge:

- **Step 1.** Cut a piece of double-sided tape 80 inches long. Peel one side, and lay the tape flat on a table with the sticky side up.

- **Step 2.** Cut and place a 92-inch piece of 50-grain-per-foot detonating cord strip down the center of the double-sided tape, keeping the detonating cord as straight as possible. Ensure that one end of the detonating cord is even with the end of the tape.
- **Step 3.** Cut two 80-inch lengths of detonating cord (three for heavier metal doors) and place one on each side of the 92-inch piece of 50-grain-per-foot detonating cord. Ensure that the detonating cord is tight against each other for the entire length.
- **Step 4.** Use duct tape, and cover the detonating cord and tape.
- **Step 5.** Form a pigtail to aid in priming using the end of the 92-inch length of detonating cord.
- **Step 6.** Use duct tape to make a buddy tab (folded tape) at the top of the charge, and continue to run the duct tape down the length of the paper covering. This ensures easier separation of the end of the tape and its adhesive backing.
- **Step 7.** Roll the charge, starting at the bottom with the paper side inward. This ensures the ease of charge placement and keeps the tape covering from cracking or coming off.

### CHARGE PLACEMENT

7-24. The charge can be placed on the hinge side, doorknob side, or in the center of the door. If placed toward the door edge, do not place it closer than 4 inches from the edge. Exact placements will determine the result of the cut. The following steps are used to place a charge:

- **Step 1.** Peel off the double-sided tape backing when placing the charge on the target, and attach the charge to the target from the top to the bottom.
- **Step 2.** Pull the buddy tab down slightly from the top of the charge, and begin attaching the tape to the door.
- **Step 3.** Place the charge straight up and down (Figure 7-2) on the door. Place the charge as close to the mechanism as possible to cut the door and allow entry.

---

*Note.* When placing the charge on the door locking mechanism side, not enough space may be available to place the charge directly over the locking mechanism running parallel to the doorframe.

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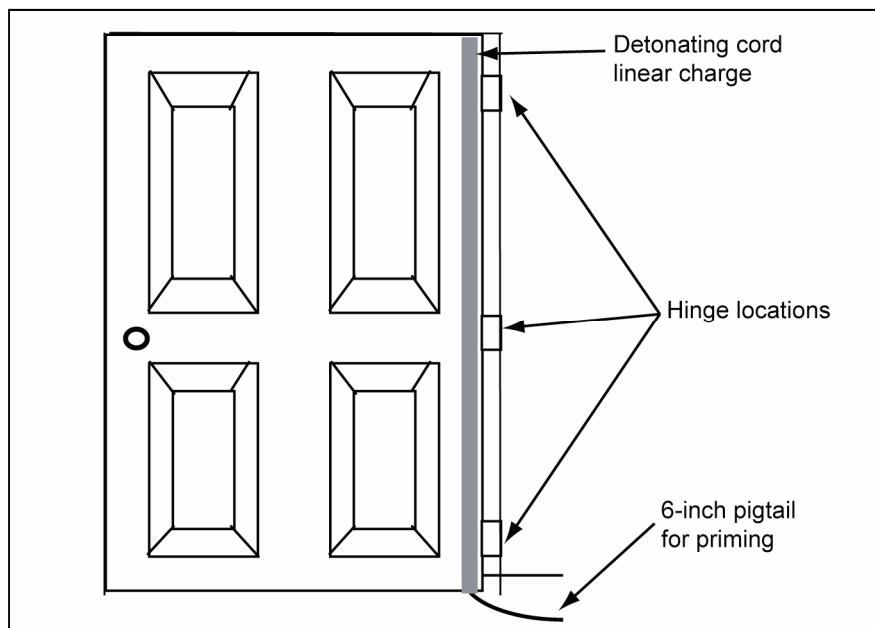
- **Step 4.** Prime the charge after it is attached to the door. This makes it much easier to unroll the charge during emplacement without the shock tube becoming twisted.

---

*Note.* Placing the charge during wet conditions may cause the adhesive tape to be ineffective. A secondary mounting method must be available if the tape backing does not stick. Staples may be used for wooden doors and prop sticks may be used for any door type.

---

If time is available and the situation allows, cut any additional length off the charge to fit the desired cut.



**Figure 7-2. Up-and-Down Charge**

7-25. Hinge-side placement of the detonating cord linear charge is the preferred method for breaching the door. Allowing the remaining portion of the door to fall inside the target structure may be considered a hindrance to the entry.

7-26. Knob-side placement cuts the door and allows the door to swing open. This leaves most of the door in the frame, but may allow the door to swing and hit the assault team.

7-27. When placing the charge vertically (centered on the door), the door is cut in half, removed from the frame, and propelled within the structure. This could create fragmentation within the structure and could also be a hazard to movement for the assault team.

### **ADVANTAGES AND DISADVANTAGES**

7-28. Detonating cord linear charges have advantages and disadvantages.

- **Advantages.**
  - It is compact when rolled, allowing for easy carrying.
  - One person can carry multiple charges.
  - It is designed to defeat a variety of doors and defeat barriers.
  - The charge is forgiving as to exact placement while still achieving desired results.
- **Disadvantages.**
  - Some doorframes may prevent a complete cut.
  - Tape will not adhere well to wet or dirty surfaces.
  - Tape backing has a tendency to rip while being removed during charge placement.

### **OVAL (SILHOUETTE) CHARGE**

7-29. The oval charge (Figure 7-3 and Table 7-4, page 7-12) is used against all wooden doors and selected walls, such as those constructed of plywood, sheetrock, unfilled concrete block, and other lightly constructed materials.

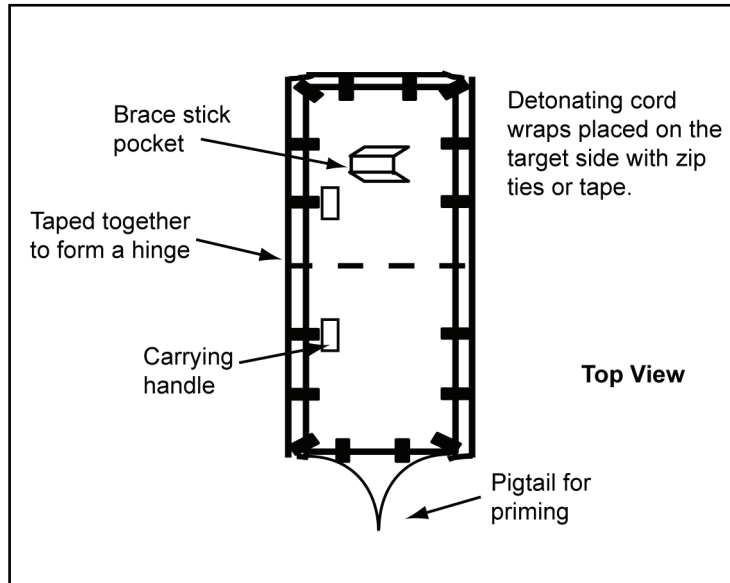


Figure 7-3. Oval (Silhouette) Charge

Table 7-4. Target Thickness

<i>Target</i>	<i>Explosive (50-grain-per-foot detonating cord)</i>
Wall, exterior lap siding, stud, or sheetrock	5 wraps
Wall, cinder block	8 wraps
Roof, shingle or plywood	6 wraps

**MATERIALS REQUIRED**

7-30. The following explosive and nonexplosive materials are required:

- **Explosive materials.**
  - 12-foot wraps of 50-grain-per-foot detonating cord.
  - Five wraps for an exterior wall (exterior lap siding, studs, or sheetrock) (four 12-foot pieces of detonating and one 13-foot piece of detonating cord).
  - Six wraps for a roof (shingle or plywood) (five 12-foot pieces of detonating cord and one 13-foot piece of detonating cord).
  - Eight wraps for an unfilled cinder block wall.
  - Appropriate priming system.
- **Nonexplosive materials.**
  - Duct tape.
  - Two E-type silhouettes.
  - One prop stick, if required.
  - Zip ties.

**CHARGE CONSTRUCTION**

7-31. The following steps are used to construct the charge:

- **Step 1.** Secure two E-silhouette targets. Cut one head off at the shoulders. Leave one head on at what will be the charge bottom.
- **Step 2.** Position the targets back-to-back with the green sides facing each other. Tape, with duct tape, the targets together along the bottom edge of the two targets.
- **Step 3.** Punch three holes, evenly spaced along the bottom of the targets, 1/4 to 1/2 inch up from the bottom. Thread a zip tie through each hole, and tighten enough so as to leave a 1/2-inch gap. This creates a hinge that allows the charge to fold easily.
- **Step 4.** Cut a 2- by 5-inch rectangular hole 1 to 2 inches from the side and center through both target pieces to create a carrying handle for the charge while it is folded.
- **Step 5.** Open the hinge that was created, ensuring that the E silhouette with the head attached is at the bottom.
- **Step 6.** Create a prop stick holder by cutting a U shape 3 inches long by 4 inches wide about 4 to 6 inches in from the headless end. Ensure that the opening of the U faces the bottom of the charge.
- **Step 7.** Punch three evenly spaced holes about 1/4 inch from the edge along the side of each E silhouette. Thread the zip ties through the holes of the E silhouette. Fasten the zip ties just tight enough to stay closed. Ensure that the fastening head of the zip ties is over the edge of the E silhouette so they will not interfere with the adhesion of the charge to the breaching target.
- **Step 8.** Punch two holes in the top and bottom of the E silhouette in the same manner as the holes punched in the sides. Ensure that these holes align where the shoulders of the target turn to form a straight edge.
- **Step 9.** Punch a pair of holes in the center of the head on the bottom of the E silhouette about 1/2-inch apart.
- **Step 10.** Thread one zip tie down and back through the two holes in the head of the E silhouette. Fasten the zip ties just tight enough to stay closed.

---

*Note.* Zip ties must be loose enough to thread multiple loops of detonating cord through them. If zip ties are not available, a 3- to 4-inch piece of double-sided tape can be used. Tape over the detonating cord with duct tape.

---

7-32. The following steps are used to attach the explosive:

- **Step 1.** Start at the bottom, right-hand E-silhouette shoulder, and feed the running end of the detonating cord through the zip ties to form a loop.

---

*Note.* Work each wrap of the loop from the center of the E silhouette towards the outside. Do not feed through the zip tie on the head at this time. The type of obstacle construction material determines the number of wraps. Five wraps of detonating cord for interior walls, studs, and sheetrock; six wraps of detonating cord for roof shingles and plywood; and eight wraps of detonating cord for block walls.

---

- **Step 2.** When the determined number of wraps has been completed, feed the running end through the zip tie in the head at the bottom of the E silhouette leaving a 1-foot tail.
- **Step 3.** Pull enough detonating cord from the standing end (spool) to match the length of the running end. Cut the standing end from the spool.
- **Step 4.** Feed the cut end through the zip tie in the head in the same manner as before.
- **Step 5.** Tighten the zip ties around the E silhouette working from the same point where the feed started. Pull the slack towards the loose zip ties.
- **Step 6.** Tighten the zip tie in the head.
- **Step 7.** Cut off the ends of all the zip ties as close to the fastening head as possible.

---

*Note.* Tape the exposed ends of the zip ties to cover any sharp ends created by cutting them off.

---

7-33. The following steps are used to construct a charge attachment system:

- **Step 1.** Cut two pieces of double-sided tape 6 to 8 inches long.
- **Step 2.** Remove the cover from one side of the tape. Attach one piece to the top of the charge just below the prop stick U on the backside of the charge.
- **Step 3.** Cover the protective cover of the remaining side with waterproof tape leaving a 1-inch overhang folded against it to create a pull tab.
- **Step 4.** Attach the second piece on the bottom of the charge in the center of the shoulder area on the backside of the charge. Create a pull tab for this strip in the same manner as above.
- **Step 5.** Cut a nonmetallic prop stick (such as a broom handle that is 2 by 4 inches) or a tree branch to the proper size to hold the charge against the target.

**WARNING**

**A prop stick may produce secondary fragmentation up to 100 meters to the rear. The doorknob and locking mechanism are missile hazards. Failure to comply could result in immediate personal injury or damage to equipment.**

**CHARGE PLACEMENT**

7-34. The charge on the target with the E-silhouette head is placed as a standoff from the ground. The charge is attached to the target with the head side down.

- Remove the protective cover from the double-sided tape using the pull tab created during the charge construction.
- Push the charge backing material, adhesive side down, against the target ensuring that the double-sided tape is adhered to the target.
- Place the charge centered on the doors unless the doors are over 8 feet tall, then place the charge about 1 foot above the floor.

**WARNING**

**Placing the charge higher than 1 foot above the floor will create a tripping hazard as a result of the blast. Failure to comply could result in immediate personal injury or damage to equipment.**

---

*Note.* Use a nonmetallic prop stick for heavier charges. Place one end of the stick against the charge under the flap created during construction. Place the other end on the ground, and push it towards the target to prop the charge against the target.

---

- Place the charge on walls about 1 foot above the floor. Locate the wall studs before placement of the charge.
- 

*Note.* The charge is 19 inches wide when constructed from an E silhouette. The center of the charge should be centered between the studs regardless of the stud spacing. Wall studs are normally spaced at 16 to 24 inches on center.

---



**WARNING**

**A prop stick may produce secondary fragmentation up to 100 meters. Failure to follow proper procedures could result in immediate personal injury or damage to equipment.**

**ADVANTAGES AND DISADVANTAGES**

7-35. The following are the advantages and disadvantages of an oval charge:

- **Advantages.**
  - It will provide an opening where one does not normally exist.
  - It is easy to make and employ.
- **Disadvantages.**
  - It is difficult to move through rough terrain.
  - Transportability becomes a problem if the charge is constructed far away from the target.
  - It throws a considerable amount of debris and fragmentation into the target site.

**CONCRETE CHARGE**

7-36. The concrete charge uses the blast principle to breach concrete up to 19 inches thick. The information in the paragraphs below should be applied.

**MATERIALS REQUIRED**

7-37. Concrete charge material required include 50-grains-per-foot detonating cord (Table 7-4, page 7-12). Each wrap of the 50-grain-per-foot detonating cord should be 12 feet long. Material requirements include—

- **Explosive materials.**
  - Six blocks of composition C4.
  - Thirty-two feet of 50-grain-per-foot detonating cord.
  - A dual-firing system.
- **Nonexplosive materials.**
  - Backing material.
  - Tape.
  - A prop stick.

**CHARGE CONSTRUCTION**

7-38. The following steps are used to construct a concrete charge:

- **Step 1.** Cut a 12-foot length of detonating cord (this will be the main line). Cut and tie the remaining detonating cord to this line.
- **Step 2.** Cut 12 pieces of detonating cord, each piece 18 to 20 inches long. Tie Uli knots on the main line.
- **Step 3.** Tape a block of composition C4 to the knots once the Uli knots are tied (one knot on each end of the block). Ensure that the Uli knots slide if adjustments need to be made at the target.
- **Step 4.** Space the blocks evenly, but no more than 12 inches apart.

**CHARGE PLACEMENT**

7-39. The following steps are used to place a concrete charge:

- **Step 1.** Place the charge flat against the target.

- **Step 2.** Pull the buddy tab, and attach the charge.
- **Step 3.** Fire the charge.

### ADVANTAGES AND DISADVANTAGES

7-40. The following are the advantages and disadvantages of a concrete charge:

- **Advantages.**
  - It is relatively easy to employ.
  - The charge is versatile.
  - Anyone on the other side of the charge will be nonfunctional.
- **Disadvantages.**
  - The charge has a high NEW.
  - The charge will not cut rebar or other reinforcement.

### RUBBER-STRIP CHARGE (WINDOW CHARGE)

7-41. The rubber-strip charge can defeat the locking mechanism of wooden or metal doors (Figure 7-4) and windows. When used on a door, the charge dislodges the locking mechanism from the frame and/or door. When used on a window, the rubber-strip charge uses the power of explosives to push the window sash or glass from the frame, thus creating a hole of entry without creating a large amount of fragmentation. The design of the charge causes the explosives to detonate and in turn pushes a nonexplosive medium (rubber) through the target. It is this pushing effect which limits the collateral damage created within the structure.

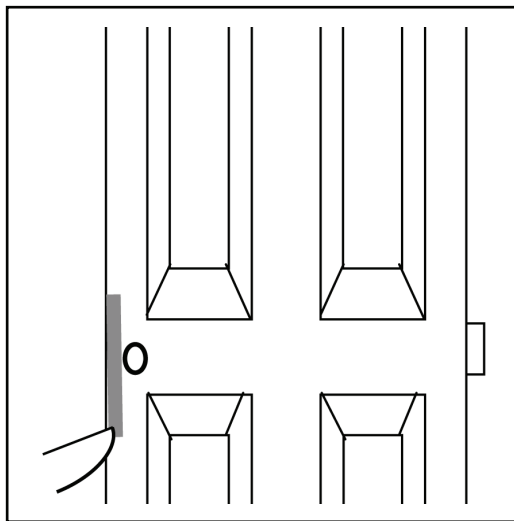


Figure 7-4. Placement of a Rubber-Strip Charge (Doors)

### MATERIALS REQUIRED

7-42. Explosive materials required include 5 feet of 50-grain-per-foot detonating cord. For priming, add 1 foot of 50-grain-per-foot detonating cord.

7-43. Nonexplosive materials required include—

- A medium 1- by 18-inch strip of Goodyear™ 330B rubber, belted, conveyer belt rubber.

---

*Note.* If these items are not available, the medium must be a material that will not disintegrate when the detonation occurs, such as a truck mud flap or polystyrene cutting board.

---

- Duct tape or electrical tape.

- Double-sided tape.

## CHARGE CONSTRUCTION

7-44. The following steps are used to construct a rubber-strip charge (Figure 7-5):

- **Step 1.** Cut a strip of rubber, or whatever is being used as a medium, 18 inches long by 1 inch wide.
- **Step 2.** Cut the detonating cord into two 18-inch strips and one 30-inch strip.
- **Step 3.** Place the 30-inch piece of detonating cord in the center running lengthwise down the rubber allowing 6 inches to hang over the 1-inch edge.
- **Step 4.** Place an 18-inch strip on each side of the 30-inch piece of detonating cord to cover the rubber.
- **Step 5.** Tape both ends and the center with one to two wraps of electrical tape or equivalent-sized strips of duct tape.
- **Step 6.** Fold 6 inches of the detonating cord upon itself, and tape to make a 3-inch priming pigtail.
- **Step 7.** Place strips of double-sided tape on the rubber side of the charge. Use duct tape to make a buddy tab (folded tape) at the top of the charge, and continue to run the duct tape down the length of the paper covering to prevent the double-sided tape from tearing when the paper backing is removed.

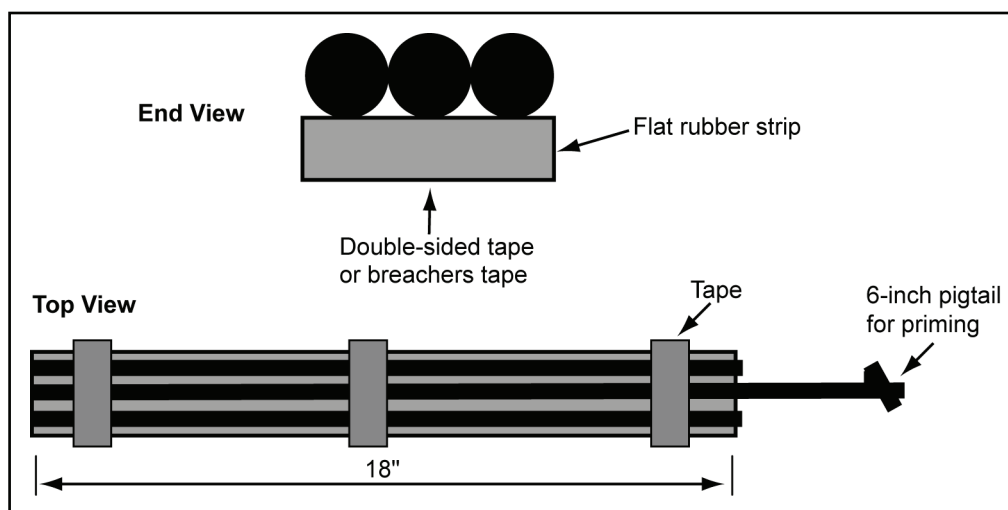


Figure 7-5. Rubber-Strip Charge Construction

## DOOR CHARGE PLACEMENT

7-45. The following steps are used to employ the charge on a door:

- **Step 1.** Attach the charge to the target by—
  - Removing the protective cover from the double-sided tape by pulling the buddy tab created during charge construction.
  - Placing the charge on the door with the rubber side of the charge facing the target, between the doorknob or any other locking mechanism and the doorjamb.
  - Adding additional tape, if necessary, to secure the charge to the door.
- **Step 2.** Attach the initiation system by—
  - Turning the couplings of the two fuse igniters counterclockwise and removing the shipping plugs from the igniters.
  - Cutting off the sealed end of the blasting cap assemblies and attaching the end to the fuse igniters with the safety pins facing the same direction.

- Using the bight to attach the initiating system using an M9 or taping the blasting caps directly to the bight formed with the detonating cord.
- **Step 3.** Prepare to detonate the charge by—
  - Standing at a safe distance from the charge as determined by the breach team leader.
  - Firing the charge upon command from the breach team leader.

### WARNING

**The doorjamb will be the protective shielding when the charge is fired. There is a chance that, if the charge can be seen, injuries could occur by blasting fragmentation. Failure to follow proper procedures could result in immediate personal injury or damage to equipment.**

## WINDOW CHARGE PLACEMENT

7-46. To employ the charge on light residential windows, the buddy tab is removed exposing the double-sided tape, and the charge is placed on the window (Figure 7-6). The following steps are used:

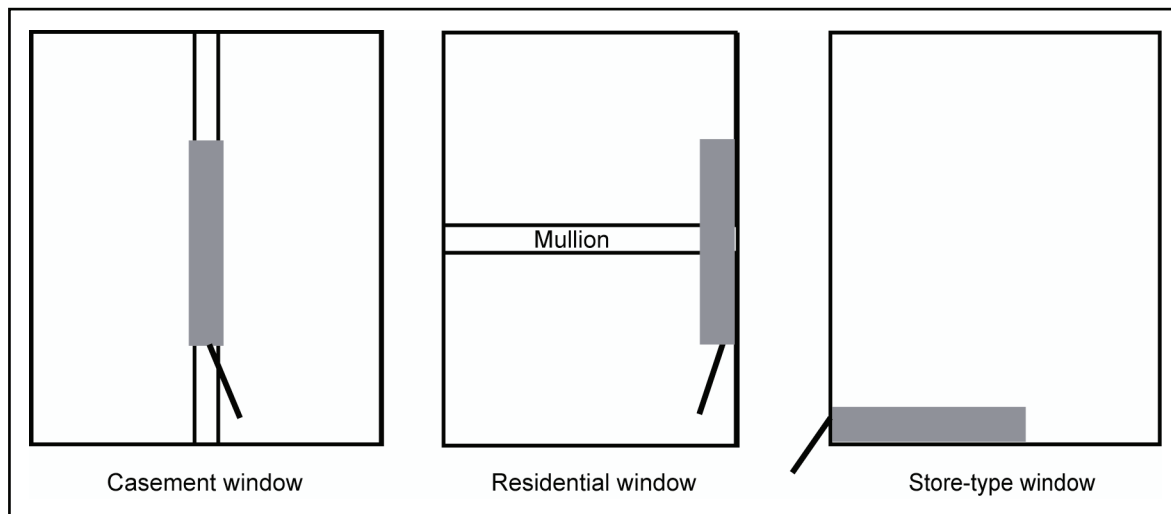
- **Step 1.** Place the charge on the side stiles with the rubber side of the charge facing the target. Ensure that the charge overlaps the meeting rails and both sashes. (Charges placed horizontally on the meeting rails may result in the rails being blown out and most of the glass and sashes remaining in place.) Place the charge along the side stiles and across the meeting rails to push the stiles out of the window frame, thus removing the sashes from the window.

---

*Note.* It is not necessary for the entire length of the charge to be touching the window stile. If the charge is placed on a double-hung window, the bottom portion can be pushed in to touch the inner window stile or it can be left hanging. The results will be the same.

---

- **Step 2.** Add additional tape, if necessary, to secure the charge to the window.
- **Step 3.** Back off to a safe distance, and initiate the charge.
- **Step 4.** Be prepared to break and rake any glass left in the window frame after detonating.



**Figure 7-6. Placement of a Rubber-Strip Charge (Windows)**

7-47. For a casement window, place the charge is placed vertically on the mullion (Figure 7-6). This placement will remove the mullion and break the glass. You should—

- Add additional tape, if necessary, to hold the charge in place.
- Back off to a safe distance, and initiate the charge.
- Ensure that employment of the charge is followed up with a break and rake of the remaining glass.

7-48. On heavier store-type windows (Figure 7-6), the charge should be placed on the bottom of the window in the corner (with the rubber side of the charge facing the target). You should—

- Add additional tape, if necessary.
- Back off a safe distance, and initiate the priming system.

---

*Note.* The explosive will push the medium through the target, removing the glass from the bottom of the window. The window will fall down under its own weight.

---

- Be prepared to break and rake any glass left in the frame after the charge detonates, since the commercial window is large.

---

*Note.* If attacking a larger window, two charges placed end to end in the corner may be needed.

---

## ADVANTAGES AND DISADVANTAGES

7-49. Advantages and disadvantages of a rubber-strip charge includes the following:

- **Advantages.**
  - They are a small compact charge.
  - They are easy to make.
  - They are easy to employ.
  - The charge can be placed quickly.
  - They have a very low NEW, producing minimal lethal fragmentation.
- **Disadvantages.**
  - Fragmentation created from a commercial window.
  - Break and rake may be required if the charge does not completely remove the glass from the window frame.

## WATER CHARGE

7-50. This charge (Figure 7-7, page 7-20) is primarily used on metal or steel doors. The charge should be centered on the door to buckle it, causing the locking mechanism to slide out of the strike plate. The fluids in the intravenous (IV) bags act as force and tamp devices. When placed on solid wooden doors, it must be placed over the locking mechanism.

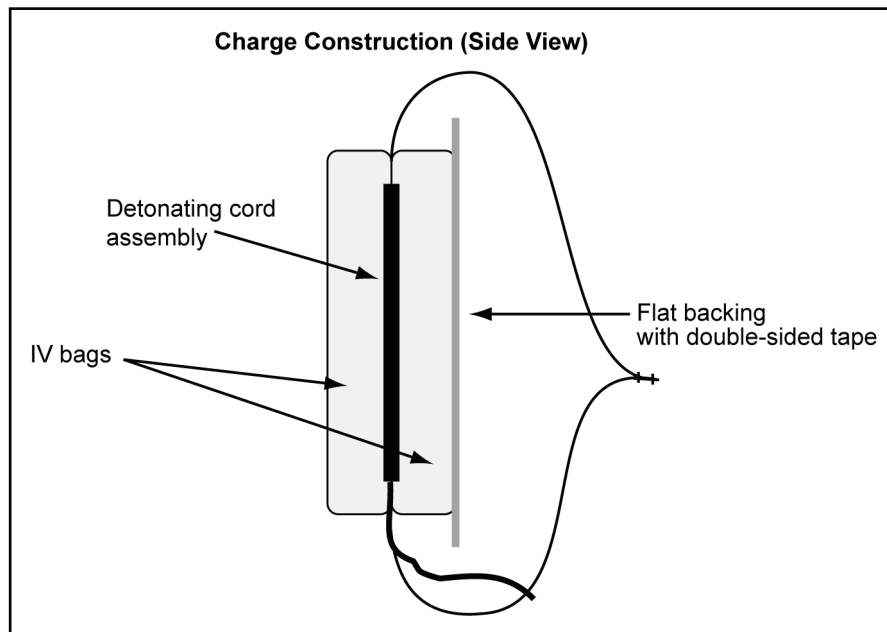


Figure 7-7. Water Charge

## MATERIALS REQUIRED

7-51. The following explosive and nonexplosive materials are required:

- **Explosive materials.**
  - 11 feet of 50-grain-per-foot detonating cord or 12 feet with a priming system.
  - A priming system of your choice.
- **Nonexplosive materials.**
  - 550 cord.
  - Double-sided tape or breachers tape.
  - Suitable backing material (cardboard).
  - Duct tape and electrical tape.
  - Prop stick.
  - Two each, 500- or 1,000-milliliter IV bags.

## CHARGE CONSTRUCTION

7-52. The following steps are used to construct a water impulse charge:

- **Step 1.** Prepare the material for charge construction.
  - Do not remove the outer lining from two IV bags. This provides added protection to the IV bags to prevent leaking and will not affect the result of the charge.
  - Cut a piece of backing material 4 by 8 inches or equal to the size of the IV bag.

---

*Note.* Backing material should be the size of the IV bag. Any heavy cardboard will work. The backing material provides a flat surface area to attach the charge to the target.

---

- Cut a 3-foot and an 8-foot piece of detonating cord.
- Fold the 8 foot piece in half four times for 500-milliliter bags and three times for 1,000-milliliter bags.
- Center the 3-foot section of detonating cord lengthwise in the center of the 8-foot folded section.

- Tape the folded detonating cord tightly around the 3-foot section with electrical tape, and then cover it with waterproof tape.
- Tape the backing material to one of the two IV bags.

---

*Note.* Ensure that the backing material maintains a flat face and is not curved from taping. If curved, it will reduce the charge-to-target contact area.

---

- **Step 2.** Attach the explosive.
  - Center the detonating cord onto one IV bag, and tape it in place with 2 or more wraps of electrical tape.

---

*Note.* Taping the detonating cord in place will keep it from pulling out as the charge is constructed.

---

- Place the second IV bag facing the same direction on top of the first, and tape it tightly to the first bag. Ensure that the detonating cord is sandwiched between the two IV bags. Protect the IV bags by taping them entirely with duct tape.

---

*Note.* Ensure that the backing material remains flat so that the breachers tape or double-sided tape can be placed on the charge to secure the charge to the target.

---

- **Step 3.** Construct the charge attachment system.
  - Construct a bridle for the water charge by cutting 3 foot of 550 cord and tying an overhand knot about 3 inches from each end. This assists in holding up the charge.

---

*Note.* This bridle will allow the charge to hang from a prop stick.

---

- Place one end of the cord along one side of the charge. Secure it to the charge with duct tape just above the knot.
- Run the tape halfway around the charge. Form a loop with the 550 cord, and place the opposite end along the other side of the charge. Secure it to the charge by running the tape the rest of the way around the charge and over the 550 cord just below the knot.
- Fold the ends of the cord below the knots back over the tape, and cover the cord ends with more tape.

---

*Note.* The reversing of the cord will ensure that it does not pull out from under the tape.

---

- Cover the entire face of the backing material with double-sided tape.
- Peel back the protective cover, and run a strip of duct tape across the top and bottom one-half inch of the double-sided tape. Run this strip of tape onto the charge.

---

*Note.* This strip ensures that the duct tape does not come off in adverse weather.

---

- Tape the two free ends of the detonating cord together to allow for the priming system hook-up. Use electrical tape at the ends and about 3 inches up on the detonating cord.
- Cut a prop stick to an appropriate length, and notch it to hold the 550 cord.

## CHARGE PLACEMENT

7-53. The following steps should be used to attach the charge to the target:

- **Step 1.** Cut a prop stick to an appropriate length, and notch it in the middle to hold the 550 cord.
- **Step 2.** Attach the charge to the target using one of the following methods:

- **Inward-opening wooden doors.** Place the charge by setting it on top of the doorknob and prop it up with a stick.

---

*Note.* This allows for more support of the charge with the capability to defeat the door even if it has a dead bolt.

---

- **Metal doors.** Place the charge centered both horizontally and vertically on the door (Figure 7-8).

---

*Note.* The normal tendency is to place the charge too high. It takes practice to ensure the proper placement of the charge. When fired, the hydraulic pressure buckles the center of the door causing the locking and closing mechanism to slide out of the strike plate and opening the door. In most cases, it will rip the entire door from the frame.

---

- **Metal security doors.** Place the charge next to the locking.

---

*Note.* A metal security door is constructed of 14- or 16-gauge steel and contains steel ribs running vertically between the door panels. A centered charge will not defeat this door because the ribs strengthen the door and keep it from buckling. Placing the charge next to the locking mechanism defeats the locking mechanism and allows the door to open.

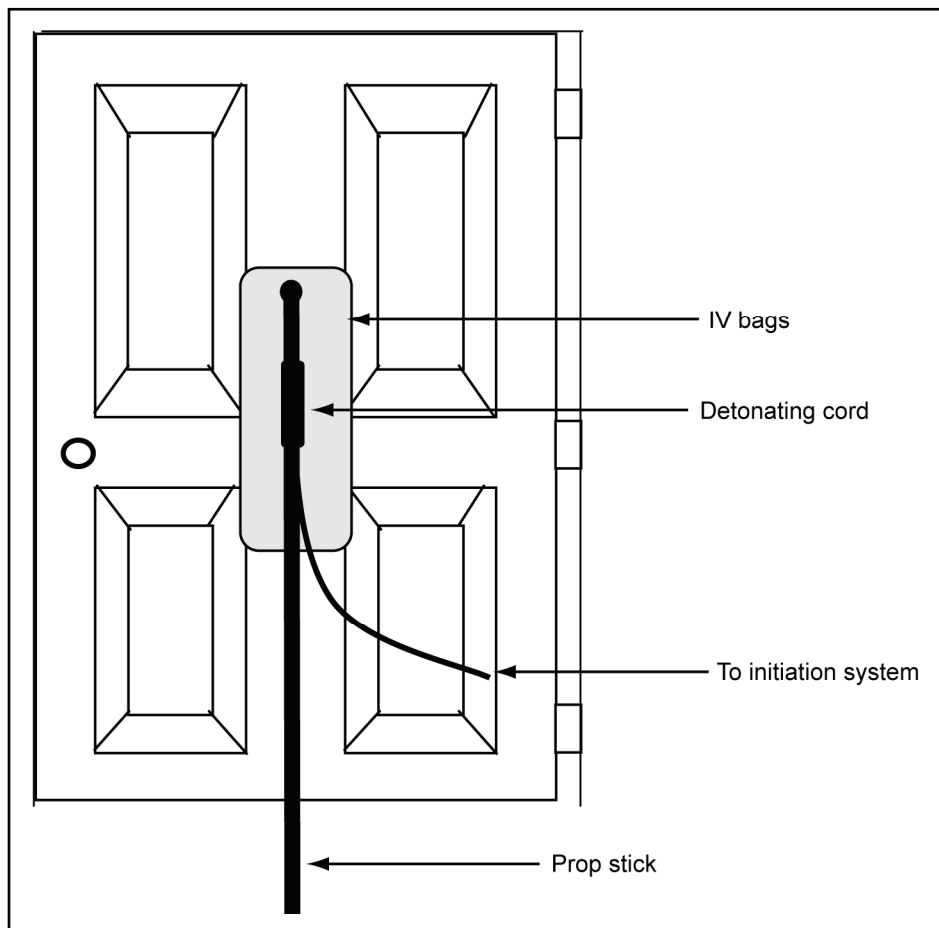
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- **Outward-opening doors.** Place the charge centered horizontally and vertically on the door. (As with the inward opening door, the door will buckle. In this case the door will bounce off the door jam and open.)
- **Screen doors.** Place the charge directly on the screen door in the position it would be placed for the door type located being the screen door.

**DANGER**

**A prop stick may produce secondary fragmentation up to 100 meters to the rear. The doorknob and locking mechanism are missile hazards. Failure to follow proper procedures may cause death or permanent injury.**





**Figure 7-8. Placement of a Water Impulse Charge (Metal Door)**

### ADVANTAGES AND DISADVANTAGES

7-54. The advantages and disadvantages of a water impulse charge include the following:

- **Advantages.**
  - It is a small or compact charge.
  - It is easy to construct.
  - It has a low NEW.
  - It has some fragmentation.
- **Disadvantages.**
  - There is a chance of bags leaking between the assembly area and the target site.
  - The weight could become a factor if carrying it for a long distance.

### C-CHARGE

7-55. The C-charge can be used to open a solid wood door or a metal door. The charge cuts the lock out of the door.

### MATERIALS REQUIRED

7-56. Explosive materials required include 6.5 feet of 50-grain-per-foot detonating cord. Nonexplosive materials required include duct tape, cardboard, and double-sided tape.

## CHARGE CONSTRUCTION

7-57. The following steps are used to construct a C-charge (Figure 7-9):

- **Step 1.** Prepare the material for charge construction.
  - Cut the backing material in about an 8-inch square.

---

*Note.* Backing material should be a relatively heavy cardboard.

---

- Apply double-sided tape along three edges of the backing material forming a C shape. Ensure that the closed end of the C is in line with one edge of the backing material.

---

*Note.* Leave the protective cover on the outside of the tape until ready to apply the detonating cord.

---

- Cut the required amount of detonating cord long enough to form a C on the outer edge of the C created with the double-sided tape.

---

*Note.* To help with the measurement for the correct length of detonating cord, lay the first piece of cord along the outer edge of the C created by the double-sided tape. Follow the outer edge of the C starting at the top of the opening. Travel along the outer edge of the backing material and return to the bottom of the opening. Cut off the first piece.

---

- Use the length of the first piece of detonating cord, and cut a template. Cut the remaining number of pieces of detonating cord for the charge.
- Cut a 30-inch length of detonating cord, and set it aside. Use this piece to prime the charge.
- **Step 2.** Attach the explosive.
  - Remove the protective cover from the double-sided tape, and press the first piece of detonating cord in place along the outside edge of the double-sided tape. Form a C shape, ensuring that the closed end of the C is in line with the back edge of the backing material by pressing them one piece at a time inside the previous piece working towards the center.
  - Place the correct number of detonating cord pieces (4 to 10).
  - Tape the detonating cord to the double-sided tape with electrical tape every 2 to 4 inches, starting about 2 inches in from the opened end of the C.
  - Trim the ends of the detonating cord evenly on both sides.
- **Step 3.** Prime the charge.
  - Form a bight in the 30-inch piece of detonating cord previously cut by bending it in half.
  - Connect the two lengths of detonating cord by wrapping a piece of electrical tape around both lengths about 4 inches from the end of the bight.
  - Line the ends of the two lengths of detonating cord up with the ends of the detonating cord that make up the charge. Prime the charge by laying the lengths of detonating cord on top of the charge and holding it in place with duct tape.
  - Cover all the detonating cord with waterproof tape. Ensure that the detonating cord is completely covered with the tape.
- **Step 4.** Construct a charge attachment system.
  - Ensure that the charge is facing up, and mark a spot on the backing material in the center of the C about 2 1/5 inches from the edge of the backing material with the opened side of the C.
  - Make cuts 2 to 3 inches long forming a star at the spot marked on the backing material. (This will form an area to press the charge over the doorknob.)

**CAUTION**

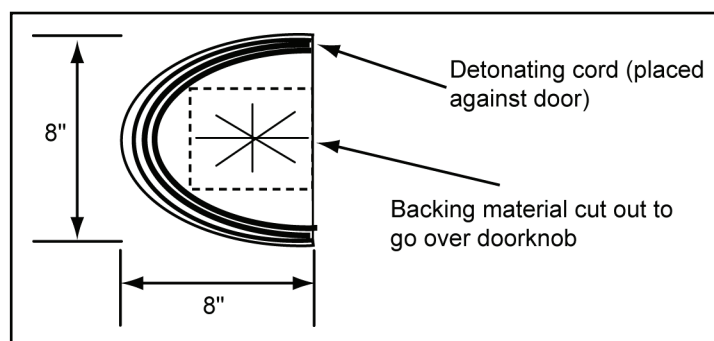
Do not cut closer than 1 inch from the straight edge of the charge. Personal injury or damage to equipment may result from long-term failure to follow correct procedures.

- Apply double-sided tape to the back of the charge on three sides of the backing material forming a C in the same manner as the front side.

*Note.* Leave the protective cover on the outside of the tape.

- Apply waterproof tape to the protective cover of the double-sided tape. Cut the waterproof tape the same width as the double-sided tape so it does not overlap and stick to the backing material. Extend the waterproof tape about 1 inch past the edge on the top side of the C opening, and fold it back against itself forming a pull tab.

*Note.* This will allow quick removal of the protective cover from the double-sided tape so the charge can be stuck to its target.

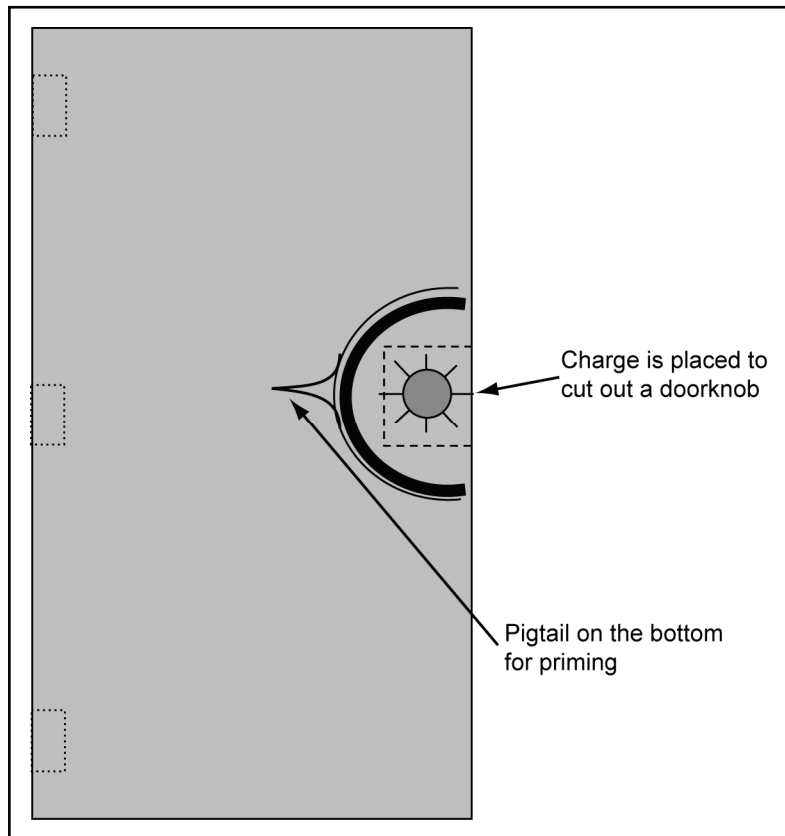


**Figure 7-9. C-Charge Construction**

## CHARGE PLACEMENT

7-58. The charge is placed on the doorknob or locking mechanism (Figure 7-10, page 7-26). The charge is secured in place with double-sided tape. The detonating cord must be held firmly against the surface of the door. The charge should be attached to the target by—

- Removing the protective cover from the double-sided tape just before placing the charge.
- Pushing the star previously cut in the backing material, adhesive side down, over the doorknob. Ensure that the open side of the C faces the door edge.
- Pressing the charge tightly against the door ensuring that the double-sided tape is adhered to the door.



**Figure 7-10. Placement of a C-Charge (Door)**

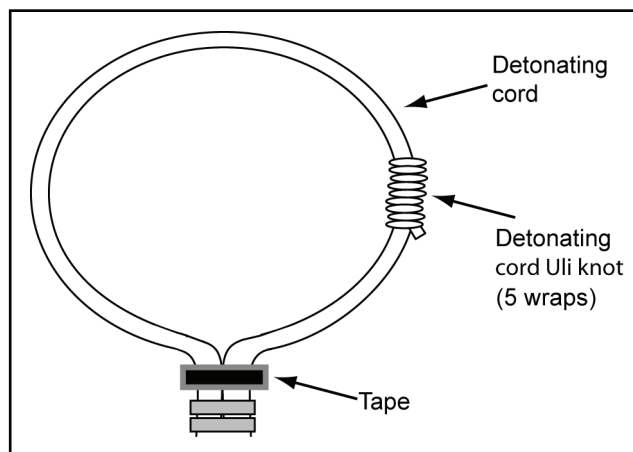
### **ADVANTAGES AND DISADVANTAGES**

7-59. The following are the advantages and disadvantages of a C-charge:

- **Advantages.**
  - It is a small or compact charge.
  - It is easy to construct.
  - It has a low NEW.
  - There is very little fragmentation
- **Disadvantages.** Incorrect placement can cause a breach to fail.

### **DOUGHNUT CHARGE**

7-60. The doughnut charge (Figure 7-11) can open a solid wood door or a metal door. The charge cuts the lock out of the door and is the only interior breaching charge.



**Figure 7-11. Doughnut Charge**

## MATERIALS REQUIRED

7-61. Explosive materials required include 42 inches of 50-grain-per-foot detonating cord. Nonexplosive materials required include duct tape.

## CHARGE CONSTRUCTION

7-62. The following steps are used to construct a doughnut charge:

- **Step 1.** Cut one 18-inch piece of 50-grain-per-foot detonating cord.
- **Step 2.** Cut one 24-inch piece of 50-grain-per-foot detonating cord.
- **Step 3.** Use a 24-inch piece of detonating cord to tie an Uli knot (5 wrap) onto the 18-inch piece of detonating cord. Fold that same 18-inch piece of detonating cord to form a loop. Use electrical tape to tape the ends of the detonating cord together.
- **Step 4.** Use a piece of duct tape, and make a sliding tape knot on the detonating cord loop. To do this, take a 6-inch strip of tape, fold a 2-inch section over upon itself to create a nonstick surface, and wrap the tape around the detonating cord. Continue wrapping until the tape is finished. Ensure that the tape knot slides easily on the detonating cord loop. Finally, slide the tape toward the ends of the loop to provide enough room to slide the loop over a doorknob.
- **Step 5.** Ensure that both the Uli knot and tape slide freely.
- **Step 6.** Construct and attach a priming system at the running ends of the loop.

## CHARGE PLACEMENT

7-63. The following steps are used to place the doughnut charge on the target:

- **Step 1.** Loop the charge over the doorknob.
- **Step 2.** Slide the large Uli knot to one side of the detonating cord loop.
- **Step 3.** Slide the knot to the side if the detonating cord loop has a natural bend, which will allow the natural bend to curve toward the door.
- **Step 4.** Place the detonating cord loop over the doorknob so that the Uli knot is between the doorknob and the doorjamb.
- **Step 5.** Position the Uli knot over the throw of the knob.
- **Step 6.** Slide the tape knot toward the loop so that the loop is tightened onto the doorknob.
- **Step 7.** Place the natural bend of the detonating cord toward the door to ensure that the blasting cap is pushed into the door, providing the protection of the doorjamb between the breacher and the charge.
- **Step 8.** Take cover, and initiate the priming system.

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**Note.** This is the only breaching charge that is direct-primed (no detonating cord loop). To reduce the NEW (this is an internal charge), this charge is single-primed.

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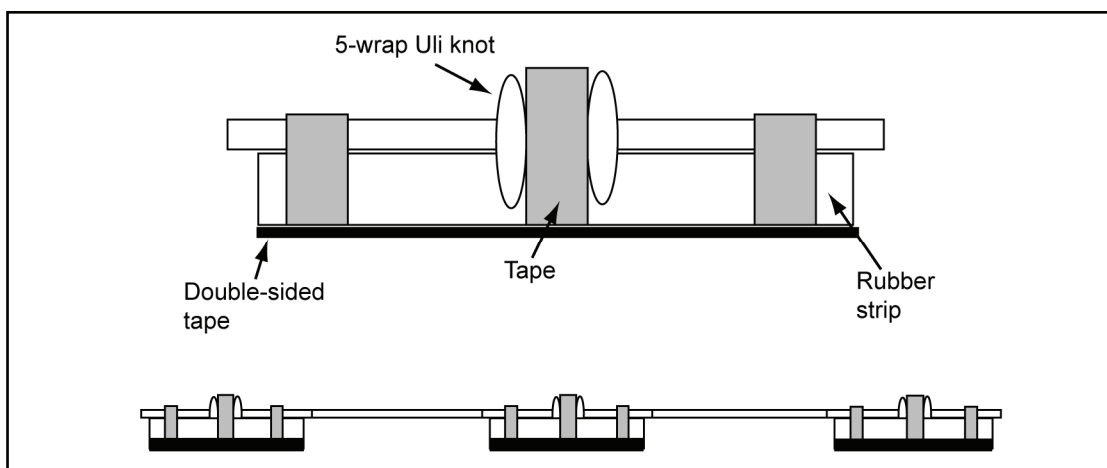
### ADVANTAGES AND DISADVANTAGES

7-64. The advantage of the doughnut charge is that it is easily constructed and carried, and one individual can easily carry multiple charges.

7-65. The disadvantage of a doughnut charge is that incorrect placement can cause a breach to fail.

### ULI KNOT SLIDER CHARGE

7-66. The Uli knot slider charge (Figure 7-12) may be used against inward- and outward-opening doors made of either wood or metal. This charge is very effective, and at the same time, produces minimal collateral damage. The Uli knot (5-wrap) must slide freely.



**Figure 7-12. Uli Knot Slider Charge**

### MATERIALS REQUIRED

7-67. Explosive materials required include 18 feet of 50-grain-per-foot detonating cord. For a detonating cord loop, add 1 foot of 50-grain-per-foot detonating cord.

7-68. Nonexplosive materials required include—

- Duct tape.
- Electrical tape.
- Three 1- by 5-inch pieces of flat rubber (or suitable material, such as a material that is able to convert the blast dynamic pressure into impulse pressure without disintegrating). For example, a truck mud flap, a plastic cutting board, or a truck tire.

### CHARGE CONSTRUCTION

7-69. The following steps are used to construct a Uli knot slider charge:

- **Step 1.** Use a sharp knife to cut three 1- by 5-inch strips of rubber.
- **Step 2.** Cut one 8-foot piece of 50-grain-per-foot detonating cord.

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**Note.** Testing has found that 96 inches will cover most standard and nonstandard doors.

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- **Step 3.** Cut twelve 5-inch pieces of 50-grain-per-foot detonating cord.

- **Step 4.** Cut the remaining 50-grain-per-foot detonating cord into three equal length pieces. Ensure that each piece is 24 inches long.
- **Step 5.** Use electrical tape or duct tape to secure four 5-inch pieces of detonating cord onto one side of a 1- by 5-foot strip of rubber. Ensure that an untaped area is left on the top center of the detonating cord (where the Uli knot will lay). Repeat this step for the other two pieces of rubber.
- **Step 6.** Use the 24-inch pieces of detonating cord to tie three Uli knots onto the 8-foot piece of detonating cord. Ensure that the Uli knots slide freely on the 8-foot section of detonating cord.
- **Step 7.** Secure the Uli knots to the rubber pieces with tape.
- **Step 8.** Cut three 1- by 5-inch pieces of double-sided tape, and attach them to the bottom of the three charge bodies. Ensure that the buddy tabs are made for ease of removal of the tape backing.
- **Step 9.** Tie an overhand knot in one end of the 8-foot piece of detonating cord to prevent the charge bodies from sliding off.
- **Step 10.** Fold 6 inches of the other end of the 8-foot length of detonating cord upon itself, and tape it to make a 3-inch priming pigtail.

## CHARGE PLACEMENT

7-70. Depending on the situation, remove the protective backing either in the safe area or en route to the target. Place the Uli knot slider charge on the target in the following manner:

- Place the charge bodies on the door parallel to the hinges on an outward-opening door (hinges exposed).
- Place the charge bodies on the door as close to the suspected hinge positions as possible on an inward opening door (hinges not exposed). Typical hinge placement on doors is as follows:
  - Top hinge—about 7 to 9 inches or one hand length down from the top.
  - Center hinge—centered between the top and bottom hinge, about one hand height above the doorknob.
  - Bottom hinge—about 10 inches up from the bottom.

---

*Note.* When encountering entrances that have screen or storm doors in front of the main door, place the charge bodies on the screen or storm door so that the medium will impact the main door next to the main door hinges. The intent is not to defeat the screen or storm door. It is irrelevant as to which side the hinges are on. The attack is on the main door. The only real difference is that there is now a standoff created by the screen or storm door, and greater care will have to be used in the placement of the charge bodies in order to hit the target points.

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## ADVANTAGES AND DISADVANTAGES

7-71. The advantages and disadvantages of a Uli knot slider charge include the following:

- Advantages.
  - It is easily adjusted at the target to be able to compensate for different hinge placement.
  - It can be effectively used against targets with screen or storm doors.
  - It can effectively be used against targets with multiple dead men (braces or barriers) on the inside of the door.
- Disadvantages.
  - The Uli knot slider charge is extremely violent on the target.
  - When incorrectly placed on wood doors, the medium becomes a hazard to personnel within range of the target.
  - Incorrect placement, especially on inward-opening wooden doors, can cause a breach to fail.

## FENCE CHARGE

7-72. The fence charge (Figure 7-13) is used against heavy-gauge-metal fence material, such as chain link. This charge will work on other fence materials to create a hole for an assault element.

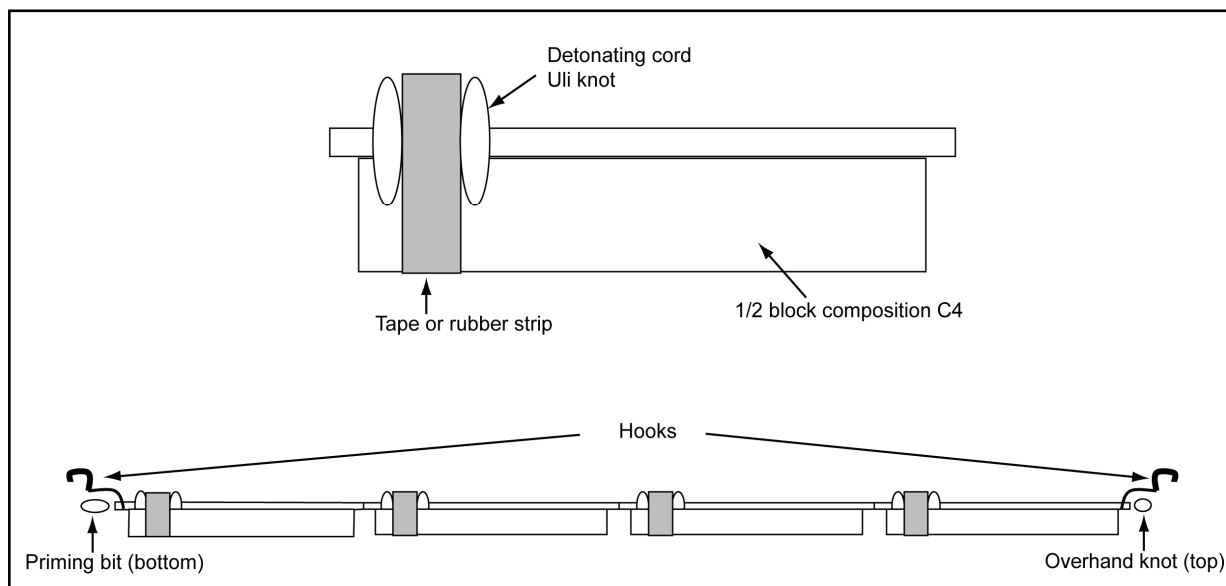


Figure 7-13. Fence Charge

### MATERIALS REQUIRED

7-73. Explosive and nonexplosive material required includes—

- **Explosive material.**
  - 14 feet of 50-grain-per-foot detonating cord.
  - 4 M112 composition C4 blocks.
- **Nonexplosive material.**
  - 2 treble hooks or nails.
  - 4 inches of surgical tubing or a thick rubber band.
  - Electrical tape.
  - Duct tape.

### CHARGE CONSTRUCTION

7-74. The following steps are used to construct a fence charge:

- **Step 1.** Cut four 21-inch pieces of detonating cord (this should leave one remaining 7-foot piece of detonating cord).
- **Step 2.** Cut off 1 foot of detonating cord to use as a priming bite, leaving one 6-foot piece.
- **Step 3.** Use the four pieces of detonating cord, and tie four separate Uli knots onto the 6-foot piece of detonating cord.
- **Step 4.** Tie an overhand knot at one end of the 6-foot strand of detonating cord, ensuring that there is an additional 2 to 3 inches of detonating cord from the knot to the end of the detonating cord.

---

*Note.* This provides an explosive area to secure a treble hook or nail. The knot prevents any explosives from sliding off of the main line. This end is called the top end.

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- **Step 5.** Take the end of the detonating cord without the knot, and fold it over to form a priming bite. Secure it firmly with electrical tape (called the bottom end).
- **Step 6.** Cut each M112 block lengthwise, making two 1- by 1- by 11-inch pieces out of each block (four half blocks total). Cover the cut piece with duct tape to keep the composition C4 from falling apart. Leave one end of each piece uncovered. (This is where the 5-wrap Uli knot will be attached.)
- **Step 7.** Place the first composition C4 block onto the detonating cord touching the overhand knot. Position the Uli knot on the composition C4 at the bottom edge. Cut out a notch for the Uli knot. Place the excess composition C4 around the Uli knot before taping to the main line. Ensure that it is deep enough so that the main line of detonating cord is at least flush with the composition C4. Firmly tape the entire composition C4 block to the Uli knot and detonating cord. Ensure that the Uli knot slides freely.
- **Step 8.** Position the Uli knot as the previous one, and tape the entire block in place no more than 5 inches below the first composition C4 block position and the second composition C4 block. Continue this procedure with the remaining composition C4 blocks and Uli knots.
- **Step 9.** Use tape to attach a treble hook to the top end of the detonating cord on the composition C4 side. Ensure that this is secure enough to hold the entire charge with tension placed on it. If using a nail, bend the nail to a 45° angle, and secure it in place. Ensure that the hook points toward the bottom end of the charge.
- **Step 10.** Secure one end of the surgical tubing or rubber band to the detonating cord just below the bottom-composition C4 block.
- **Step 11.** Attach a second hook or nail to the surgical tubing or rubber band. Use the nails or hooks to secure the charge to the fence.

## ADVANTAGES AND DISADVANTAGES

7-75. The following are the advantages and disadvantages of a fence charge:

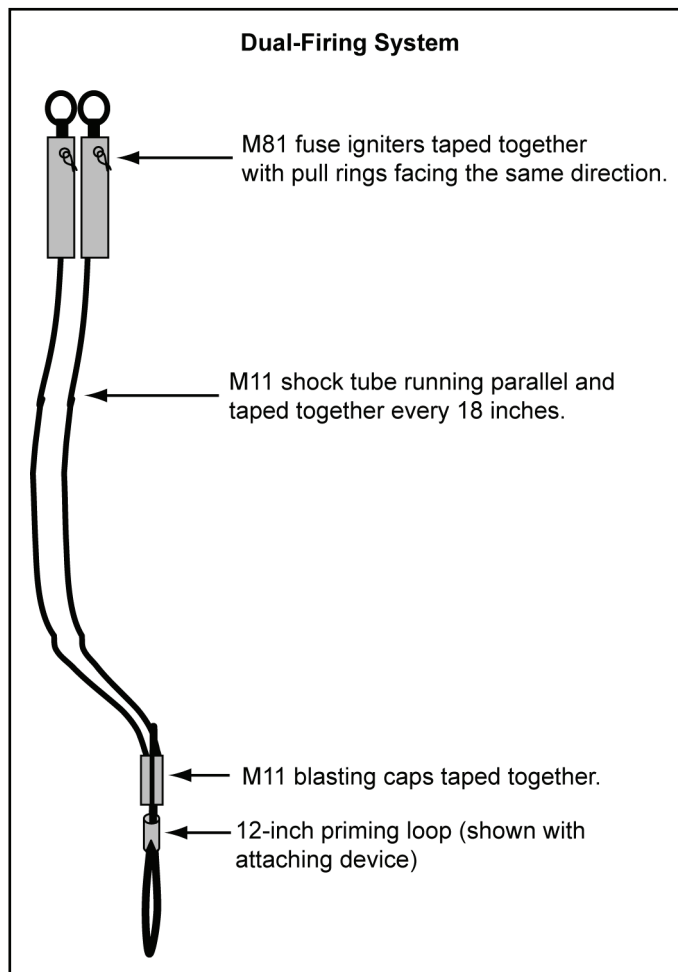
- **Advantages.**
  - It provides quick access through the fence.
  - It is easy and quick to construct.
  - It has rapid placement.
- **Disadvantages.**
  - It is a high-net explosive charge.
  - It has a high amount of fragmentation.
  - It may need mechanical backup.

## RAPID WALL-BREACHING KIT

7-76. The rapid wall-breaching kit (RWBK) provides a capability that is preformed, prepackaged, easily and rapidly employed, lightweight, and safe. The RWBK consists of commercial explosive cutting tape (ECT) initiated by an MDI. The kit provides an explosive means to create man-sized holes rapidly in buildings and in walls for dismounted mobility in urban and complex terrain environment, to rapidly cut steel and other materials to breach obstacles, and to create obstacles to deny or impede enemy mobility.

## INITIATION SYSTEM USING A MODERNIZED DEMOLITION INITIATOR

7-77. The initiation devices used are an important part of urban breaching. The charges used should be command detonated, and all charges should be dual-initiated with the exception of the doughnut charge. See Figure 7-14, page 7-32.



**Figure 7-14. Initiation System Using MDIs**

## MATERIALS REQUIRED

7-78. The following are the materials required for an MDI:

- Explosive materials (such as M19, M81, M11, M12, M13, M21, or M23).
- Nonexplosive materials (such as electrical tape, string, or rubber bands).

---

*Note.* Use the M19 for the initiation system. When the M19 is not available, construct an initiation system.

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## CONSTRUCTION

7-79. Use the following steps when constructing an MDI initiation system:

- **Step 1.** Turn the screw cap of the M81 fuse igniters several turns counterclockwise, and remove the shipping plugs from the igniters.
- **Step 2.** Cut off the sealed end of the M11, M12, M13, M21, or M23 branchlines, and attach to the M81 igniters with M81 safety pins facing the same direction.
- **Step 3.** Tape an M11, M12, M13, M21, or M23 every 18 inches to improve efficiency.
- **Step 4.** Tape an 18- to 24-inch length of detonating cord to the M11, M12, M13, M21, or M23 blast caps so they overlap and the detonating cord forms a loop.

## BREACHERS BRIEF

7-80. All elements of the brief should be covered. The following format should be used:

- **Primary target.** Give a full description of the primary target or targets if a multiple breaches are planned. Discuss the target type (such as the door or window) and where the target is located in relation to the position and the surrounding area.
- **Alternate target.** Determine if there is an alternate target. Determine what will be the alternate target if the primary target cannot be accessed. Be sure to describe this target in detail, by type, the location, and surrounding hazards. Explain where it is located in relation to the primary target, distance, direction, and method of approach.
- **Charges, tools, or techniques for each target.** Tell what charges will be used (primary charge, alternate charge, and all interior charges). Explain what mechanical tools will be used in attacking the target and how to use them, and explain how to backup the explosive charge. Go into the specifics of how the charges will be employed and how the mechanical tools will be employed as a back up. Explain the detonation system. Explain what initiation type will be used with each charge (shock tube, time fuse, electric, and so forth). Describe what signal or notice will be used to let everyone know the charge is to be fired. Tell if the shot will go on the signal or if there will be a delay and whether they will hear the delay (pop or bang).
- **Net explosive weight.** Give the NEW and the MSD for each charge to be used. At a minimum, ensure that the MSD standoff is given.

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*Note.* Certain situations in an urban environment may warrant the assault team to position themselves closer to the breach. In this situation, tell the assault unit the MSD they can be from the breach and why.

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- **Location of equipment within the team.** Tell who is to carry what equipment and where that individual is in the element. Describe the primary and alternate charges and any other equipment that will or may be used in the breaching operations.
- **Location of the breacher and assistants.** Tell the unit where you will be during the different phases of the assault. (They may have to assist you or pick up the breach if you become injured.) Tell them where you will be in the formation during—
  - **The movement to the target.** Ensure that everyone knows where in the formation the breacher will be if movement to the target is necessary.
  - **The charge placement.** Explain where the breacher and assistant will be when placing the charge and how the charge will be placed.
  - **Firing.** Determine where the breacher and the assistant will be when the charge is fired.
  - **The assault.** Determine where the breacher and the assistant will be when the actual assault is being conducted.
- **Charge placement and attack point.** Discuss where and how the charge will be placed on the target. (This area complements the information given, such as where the personnel will be during charge placement in case someone has to assist you.) Ensure that the specifics are discussed of who will do what during the placement (such as who holds the shock tube, who places the charge, who controls the firing device, and who pays out and secures the firing system).
- **Conditions expected during the breach.** Explain exactly what will happen when the breach charge is fired. Ensure that the noise, fire, smoke, and any other effects that will result during the firing of the breach are explained. Explain the firing sequence and if there will only be one noise or multiple noises.

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*Note.* The more the team knows what to expect, the better prepared they are to react.

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- **Post blast conditions.** Explain the conditions in the area of the breach that the team members can expect to encounter when they reach the breach site (such as dense smoke, fiberglass dust, or grease). Emphasize the fragmentation hazards and how long to wait before they expose

themselves to the breach point. Determine what the breach point will look like, where it will be, where the plug will be, and what should the team members look out for (such as the plug or a swinging door). Explain what type of damage will have occurred to the structure and will any other attack method be required before entering the building (such as a rake or break).

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*Note.* The more they know, the better they can react.

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- **Abort or alternate the breach signal.** Explain the communications plan and the signals needed to put an abort or a move to the alternate breach into effect. Discuss who will signal the abort or alternate and what the criteria will be to put a call for these plans into effect.
- **Misfire procedures.** Discuss what needs to be done if the charge dies and does not detonate. Explain to the team the procedures for reattaching an initiation system, if necessary. Explain who in the team will carry a backup system.
- **Compromise procedures.** Discuss what the team should do to secure the charges in case the team is compromised. Explain that the assault leader will make the final decision on the compromise reaction; however, as the breacher you must suggest what actions are to be taken in reference to the breach team.
- **Breacher casualty procedures.** Designate who will take over in the event that you are a casualty. Be sure to cover where each team member carrying a charge is to carry it. (Should a member go down, the designated replacement must be able to recover the charge without a search.) Ensure that each replacement knows what to do in the event he becomes the breacher (determine who will take over, determine who will take over if the assistant is a casualty, and determine the necessary security measures).
- **Actions upon encountering booby traps and improvised explosive devices.** Brief the team on these actions. Ensure that each member of the team understands that he **MUST** be on the lookout for booby traps and improvised explosive devices (IEDs). Review the unit SOP of the assault team in case there are major differences in how they are handled.

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*Note.* As the breacher, you will likely be the first one to encounter booby traps.

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- **Any other pertinent information.** Brief anything that is important for the team to know and that could not logically be fit anywhere else in the sequence.

## HASTY BREACHERS BRIEF

7-81. War may not permit the breacher to give a full, deliberate brief. Under tactical conditions, the brief will have to be shortened and be delivered fast with all the necessary information. This will ensure that the breach team can carry out the mission even if one member is wounded. All members should have the vital information, such as where equipment is located and who has it. The following format is used when time does not permit for a deliberate brief:

- **Primary target.** Give a full description of the primary target and/or the alternate target, type of target (such as door by type or window), and where the target is located in relation to your position and the surrounding area.
- **Charges.** Determine what type of charges will be used. If time or the situation allows, show the charge and give a brief description of how it works.
- **NEW/standoff.** Ensure that everyone knows where they should position themselves before execution of placing the charge on the target.
- **Security.** Explain to the breacher team the security requirements during movement, placing the charge, and during detonation and what role they will play.
- **Charge placement and attack points.** Ensure that everyone in the breach team knows where the charge will be placed in case they have to assist the breacher. Discuss how and where the charge will be placed.
- **Post-blast conditions.** Explain the conditions at the breach point that the breach team may encounter, such as noise, fire, flying debris, smoke, and any other effects that may result during

detonation of the charge at the breach site. Emphasize on the firing sequence and if there will be one blast or multiple blasts. The more the team knows of what to expect, the better prepared the team will be and will be able to react quickly.

- **Failed breach.** Discuss the method of entry should the charge fail to provide the opening planned for at this point of the brief. This gives the mechanical breacher time to react with the tools that may be needed to create the entry point and continue the mission.
- **Breachers casualty procedures.** Determine who will take over in the event that the breacher becomes a casualty. Be sure to cover whom is carrying the charges where they will carry them.

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*Note.* Should a team member go down, a designated replacement must be able to recover the charge and complete the mission. This ensures that all team members are able to conduct the other person's job.

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7-82. Regardless of the breaching method used to lead the assault, the breacher sets the pace for the entire element. The breacher team should be given as much information as possible about the breach, even if it is only a hasty brief. The information will give the entire team the confidence and will enhance the chances of a successful breach.

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## Appendix A

# Metric Conversion Chart

This appendix complies with current Army directives, which state that the metric system will be incorporated into all new publications. Table A-1 is a metric measurement conversion chart.

**Table A-1. Metric Conversion Chart**

<i>U.S. Units</i>	<i>Multiplied By</i>	<i>Equals Metric Units</i>
Cubic feet	0.02832	Cubic meters
Cubic inches	16.38720	Cubic centimeters
Cubic yards	0.76460	Cubic meters
Degrees Fahrenheit	Subtract 32 degrees, and multiply by 0.55556	Degrees Celsius
Feet	0.30480	Meters
Feet per second	18.28800	Meters per minute
Gallons	3.78540	Liters
Grams	0.001	Kilograms
Inches	25.40010	Millimeters
Long tons	1.01600	Metric tons
Miles per hour	1.60930	Kilometers per hour
Miles per hour	0.04470	Meters per second
Miles (statute)	1.60930	Kilometers
Miles (nautical)	1.85320	Kilometers
Ounces	29.6	Milliliters
Pounds	0.45359	Kilograms
Short tons*	0.90700	Metric tons
Square inches	6.45160	Square centimeters

Table A-1. Metric Conversion Chart

<i>Metric Units</i>	<i>Multiplied By</i>	<i>Equals U.S. Units</i>
Cubic centimeters	0.06100	Cubic inches
Cubic meters	35.31440	Cubic feet
Cubic meters	1.30790	Cubic yards
Degrees Celsius	Add 17.8 degrees, and multiply by 1.80000	Degrees Fahrenheit
<i>Metric Units</i>	<i>Multiplied By</i>	<i>Equals U.S. Units</i>
Kilograms	1,000	Grams
Kilograms	2.20460	Pounds
Kilometers	0.62137	Miles (statute)
Kilometers	0.53960	Miles (nautical)
Kilometers per hour	0.62100	Miles per hour
Liters	0.26420	Gallons
Meters	3.28080	Feet
Meters per minute	0.05470	Feet per second
Meters per second	2.23700	Miles per hour
Metric tons	1.10200	Short tons
Metric tons	0.98400	Long tons
Milliliters	0.0338	Ounces
Millimeters	0.03937	Inches
Square centimeters	0.15500	Square inches



## Appendix B

# Metric Charge Calculations

NATO requirements make metric conversions necessary. The following formulas are metric equivalents for charge calculations.

### EQUIVALENT METRIC WEIGHTS FOR STANDARD EXPLOSIVES

B-1. See Table B-1. Table B-1 lists the metric equivalents for standard U.S. Army demolition charges.

**Table B-1. Standard U.S. Army Demolition Charges (Metric Equivalents)**

<i>Explosive</i>	<i>Unit (lb)</i>	<i>Detonation Velocity</i>		<i>RE Factor</i>	<i>Weight (Metric) (kg)</i>
		<i>M/Sec</i>	<i>Ft/Sec</i>		
TNT	00.25	6,900	22,600	1.00	00.113
	00.50	6,900	22,600	1.00	00.227
	01.00	6,900	22,600	1.00	00.454
M2 tetrytol	02.50	7,000	22,900	1.20	01.134
M3 composition C2 or C3	02.25	7,625	25,000	1.34	01.021
M5A1 composition C4	02.50	8,040	26,400	1.34	01.134
M112 block (composition C4)	01.25	8,040	26,400	1.34	00.567
M186 roll (PETN)	25.00	7,040	23,600	1.14	11.340
Composition H6	43.00	7,190	23,600	1.33	18.140
M1 dynamite	00.50	6,100	20,000	0.92	00.227
M2A4 shaped charge	15.00	7,800	25,600	1.17	06.800
M3A1 shaped charge	40.00	7,800	25,600	1.17	18.140
M183 assembly	20.00	8,040	26,400	1.34	09.070

### TIMBER-CUTTING FORMULAS

B-2. The following formulas are examples of charge calculations converted to their metric equivalents.

- **Tamped internal charges.**

$$K = \frac{D^2}{3,500}$$

where—

- K* = TNT required (in kilograms)  
*D* = timber diameter (in centimeters)

- **Untamped external charges.**

$$K = \frac{D^2}{560}$$

where—

$K$  = TNT required (in kilograms)  
 $D$  = timber diameter (in centimeters)

- **Abatis charges.**

$$K = \frac{D^2}{700}$$

where—

$K$  = TNT required (in kilograms)  
 $D$  = timber diameter (in centimeters)

## STEEL-CUTTING FORMULAS

B-3. Table B-2 gives the correct metric weight of TNT necessary to cut structural-steel sections of various dimensions. To find the correct metric weight, use the following formulas or Table B-2:

- **Structural steel.**

$$K = \frac{A}{38}$$

where—

$K$  = TNT required (in kilograms)  
 $A$  = cross-sectional area of the steel (in square centimeters)

- **Other steel.**

$$K = \frac{D^2}{14}$$

where—

$K$  = TNT required (in kilograms)  
 $D$  = section diameter (in centimeters)

Table B-2. TNT Steel-Cutting Charges

Average Section Thickness (cm)	Section Width (cm)											
	4	6	8	10	15	20	25	30	35	40	50	60
0.5	0.06	0.08	0.11	0.13	0.20	0.27	0.33	0.40	0.46	0.53	0.66	0.79
1.0	0.11	0.16	0.21	0.27	0.40	0.53	0.66	0.79	0.93	1.06	1.32	1.58
1.5	0.16	0.24	0.32	0.40	0.60	0.79	0.99	1.19	1.39	1.58	1.98	2.37
2.0	0.21	0.32	0.42	0.53	0.79	1.06	1.32	1.58	1.85	2.11	2.64	3.16
2.5	0.27	0.40	0.53	0.66	0.99	1.32	1.65	1.98	2.31	2.64	3.29	3.95
3.0	0.32	0.48	0.64	0.79	1.19	1.58	1.98	2.37	2.77	3.16	3.95	4.74
3.5	0.37	0.56	0.74	0.93	1.39	1.85	2.31	2.77	3.23	3.69	4.61	5.53

## PRESSURE CHARGES FOR T BEAMS

B-4. The following formula is used to determine the metric size of T beam pressure charges:

$$K = 48^2 T$$

where—

$K$  = TNT required (in kilograms)

$H$  = T beam height (in meters)

$T$  = beam thickness (in meters)

---

**Note.** Measure H and T to the nearest 0.1 meter, but no less than 0.3 meter. Minimum tamping required is 30 centimeters. Increase K by one-third for untamped charges.

---

## BREACHING CHARGES

B-5. See Table B-3, page B-4. The following formula is used to determine the metric size of breaching charges:

$$K = R^3 MC$$

where—

$K$  = TNT required (in kilograms)

$R$  = breaching radius (in meters) (Chapter 3)

$M$  = material factor (Table B-3)

$C$  = tamping factor (Figure 3-15, page 3-19)

**Table B-3. Material Factors for Breaching Charges**

<i>Material</i>	<i>Breaching Radius (R)</i>	<i>Material Factor (M)</i>
Earth	All values	1.12
Poor masonry Shale Hardpan Good timber Earth construction	Less than 1.5 m 1.5 m or more	5.13 4.64
Good masonry Concrete block Rock	0.3 m or less Over 0.3 m to less than 1 m 1 m to less than 1.5 m 1.5 m to less than 2 m 2 m or more	14.09 07.69 06.41 05.13 04.32
Dense concrete First-class masonry	0.3 m or less Over 0.3 m to less than 1 m 1 m to less than 1.5 m 1.5 m to less than 2 m 2 m or more	18.26 09.93 08.33 06.57 05.61
Reinforced concrete (The material factor does not consider the cutting of steel.)	0.3 m or less Over 0.3 m to less than 1 m 1 m to less than 1.5 m 1.5 m to less than 2 m 2 m or more	28.19 15.38 12.81 10.09 08.65

**BREACHING RADIUS**

B-6. The breaching radius is the distance a charge must penetrate to displace or destroy the target. For example, to determine the breaching radius for a 2.9-meter concrete wall with a charge placed on its side, use 3.0 as the breaching radius in the formula above. Always round the depth of the target to the next higher quarter meter (2.9 becomes 3.0, 2.54 becomes 2.75, and so forth).

**MATERIAL FACTOR**

B-7. See Table B-3. Table B-3 lists the material factors for breaching charges.

**TAMPING FACTOR**

B-8. The value of the tamping factor depends on the location and tamping of the charge. A charge is not adequately tamped unless the depth of the tamping material equals or exceeds the breaching radius. Figure 3-15, page 3-19, gives values for the tamping factors.

## **Appendix C**

# **Demolition Charge Use**

When using landmines, aerial bombs, shells, and foreign explosives as demolition charges, take the appropriate precautions outlined in the paragraphs that follow. Using such explosives is usually uneconomical, but may occasionally become necessary or desirable.

### **SOURCES**

C-1. Primary and supplementary charges are the two types of charges used. The paragraphs below describe their use.

#### **PRIMARY CHARGES**

C-2. Primary charges are obtained from captured or friendly supply stocks or, in the case of landmines, recovered from enemy or friendly minefields. Unexploded duds (shells or bombs) should never be used for demolition purposes.

#### **SUPPLEMENTARY CHARGES**

C-3. When necessary, allied nation or captured explosives to supplement or replace standard explosive charges can be used

### **LANDMINES**

C-4. The paragraphs below describe the safety precautions that need to be used when dealing with landmines. Also described are charge calculations and landmine priming.

#### **SAFETY PRECAUTIONS**

C-5. Only use defused mines as demolition charges. Recovered mines may be sensitive because of near misses and may detonate during normal handling. The theater commander prescribes the policy for using salvaged or captured threat mines.

### **CHARGES**

C-6. When calculating charges using mines, only the explosive weight is considered. Generally, use normal explosive quantities for cratering or pressure charges. The mine case does not allow proper contact of the explosives against irregularly shaped objects; therefore, it may be necessary to increase the size of the cutting charges considerably when using mines for this purpose. Test shots are the best way to determine the proper charge under given conditions. Table C-1, page C-2, lists the explosives content of various AT mines by country of origin. U.S. mines are current; foreign mines may be current or obsolete.

Table C-1. AT Mine Explosives Content (By Nation)

<i>Country</i>	<i>Mine Type</i>	<i>Weight/Explosive</i>
United States	M15 AT (metallic)	22 lb of composition B
	M19 AT (nonmetallic)	21 lb of TNT composition B
	M21 AT (metallic)	10.5 lb of composition H6
Belgium	PRB-4 AT	20 lb of hexogen
China	Dual-purpose number 4 (metallic)	4.5 lb of TNT
Czech Republic or Slovakia	PT-Mi-K AT (metallic)	11 lb of TNT
	PT-Mi-Ba AT (plastic)	12 lb of TNT
	Na-Mi-Ba AT (plastic)	5.3 lb of Tritol
	TQ-Mi-AT (cardboard)	11.5 lb of TNT
Finland	M36 AT (metallic)	8 lb of TNT
	M39 AT (metallic)	8.8 lb of TNT
France	M1948 AT (metallic)	11.5 lb of TNT or military dynamite
	M1948 plate-charge AT (metallic)	15.2 lb of TNT or picric acid*
	M1951 shaped-charge AT (metallic)	4 to 5 lb of kexolite
	M1951 AT (caseless)	14.3 lb of TNT (cast)
	M1951 AT (plastic "grille")	11 to 16 lb of PETN
Japan	Model 63 heavy AT	24.2 lb of composition B
Netherlands	Type II AT (metallic)	9 lb of TNT
South Korea	Heavy AT (metallic)	22 lb of TNT
	Type I dual purpose (metallic)	5.7 lb of TNT
	Type II dual purpose (metallic)	4.5 lb of TNT
Former Soviet Union	TMD-B AT (wooden)	11 to 15 lb of amatrol, TNT, or picric acid*
	TMN-46 AT (metallic)	12.6 lb of TNT
	YaM-5 AT	8 to 11 lb of TNT or amatol
United Kingdom	Mark 4 GS AT (metallic)	8.25 lb of TNT
	Mark 5 GS AT (metallic)	4.5 lb of TNT
	Mark 5 HC AT (metallic)	8.3 lb of TNT
	Mark 7 AT (metallic)	19.6 lb of TNT

\*Picric acid corrodes metals by forming extremely sensitive compounds that are easily detonated. DO NOT handle mines loaded with this explosive except to move them to a safe disposal area for destruction.

## PRIMING

C-7. A landmine can be detonated by placing a 1-pound charge as close to the mine as possible without touching the mine. If firing large quantities of mines simultaneously, prime several mines to ensure complete detonation. Detonating a single mine normally detonates any other mine in direct contact with the primed mine.

## GENERAL PURPOSE AERIAL BOMBS

C-8. General-purpose (GP) aerial bombs make satisfactory demolition charges. However, they are more effective as cratering charges.

### SAFETY PRECAUTIONS

C-9. The shape of an aerial bomb makes it inefficient for demolitions requiring close contact between the explosive and the target. Precautions should be taken against fragmentation, because the steel fragments from bomb cases may fly great distances. Before using any bomb, it should be positively identified it as a GP bomb.

### CHARGES

C-10. The explosive content of an aerial bomb is about half its total weight. Table C-2 lists the explosives content for various GP bombs. About 20 percent of the explosive potential of an aerial bomb is expended in shattering the casing.

**Table C-2. GP Aerial Bombs (Explosives Content)**

<i>Bomb</i>	<i>Explosive Weight (lb)</i>	<i>Total Weight (lb)</i>
<b><i>Old Series</i></b>		
AN-30A1, 100-lb GP	57	120
AN-M57A1, 250-lb GP	125	261
AN-M64A1, 500-lb GP	266	549
AN-M65A1, 1,000-lb GP	555	1,064
AN-M66A2, 2,000-lb GP	1,098	2,113
<b><i>New Series</i></b>		
M117, 750-lb GP	386	823
M118, 3,000-lb GP	1,975	3,049
<b><i>Low-drag</i></b>		
MK81, mod 1, 250-lb GP	100	260
MK82, mod 1, 500-lb GP	192	531
MK83, mod 3, 1,000-lb GP	445	985
MK84, mod 1, 2,000-lb GP	945	1,970
<b><i>Low-Drag, Snakeye I</i></b>		
MK81, mod 1, 250-lb GP	100	300
MK82, mod 2, 500-lb GP	192	560

### PRIMING

C-11. Bombs less than 500 pounds are detonated by placing a 5-pound explosive charge on the middle of the casing; bombs exceeding 500 pounds require a 10-pound charge. Fuses should not be placed on the nose or tail of the bomb. To ensure detonation, prime large bombs separately.

## ARTILLERY SHELLS (NONNUCLEAR)

C-12. Artillery shells are used for demolition when only fragmentation is desired. The guidance in the following paragraphs should be applied.

## SAFETY PRECAUTIONS

C-13. Artillery shells have a low-explosive content. They are generally not adequate for other demolition purposes.

## CHARGES

C-14. Shells smaller than 100 millimeters should be avoided. The 105-millimeter, howitzer, HE shell that weighs 33 pounds, and contains only 5 pounds of explosive. The 155-millimeter howitzer shell contains only 15 pounds of explosive.

## ARTILLERY SHELL PRIMING

C-15. Shells up to 240 millimeters are detonated by placing 2-pound charges on the case, just forward of the rotating band. To ensure complete detonation of multiple shells simultaneously, place a charge on each shell. The M10 universal destruction device is used to detonate shells that have threaded fuse wells of 1.7- or 2-inch diameters. Completely fill the booster cavities of bombs and large projectiles by adding booster cups to the M10 destruction device, as required.

## FOREIGN EXPLOSIVES

### **DANGER**

**Ensure that positive identification of the ordnance item filler is made before use in demolition operations or disposal of munitions. Munitions can contain a variety of hazardous fillers other than HE. Failure to comply may cause death or permanent injury.**

C-16. Foreign explosives are used to supplement standard U.S. charges. In certain cases, they are used instead of U.S. charges.

## SAFETY PRECAUTIONS

C-17. Only experienced demolition personnel should work with foreign explosives and then only according to instructions and directives issued by the theater commander. TM 9-1300-214 lists the most common foreign explosives.

## PRIMING

C-18. Most foreign-explosive blocks have cap wells large enough to receive U.S. military blasting caps. However, test fire these charges with U.S. military blasting caps to ensure positive detonation. In certain instances, you may have to initiate the explosives by using a standard U.S. demolition block primed with a blasting cap.



## Appendix D

# Expedient Demolitions

Expedient techniques are intended for use only by personnel experienced in demolitions and demolitions safety. Do not use expedient techniques to replace standard demolition methods. Availability of trained Soldiers, time, and material are the factors to consider when evaluating the use of expedient techniques.

## SHAPED CHARGE

D-1. Shaped charges concentrate the energy of the explosion released on a small area, making a tubular or linear fracture in the target. The versatility and simplicity of shaped charges make them effective against many targets, especially those made of concrete or with armor plating.

### DESCRIPTION

D-2. A shaped charge (Figure D-1) can be improvised. Because of the many variables (configuration, explosive density, linear cavity density, and so forth), consistent results are impossible to obtain. Therefore, experiment to determine the optimum standoff distances. Plastic explosive is best suited for this charge type. However, dynamite and molten TNT can be effective expedients.

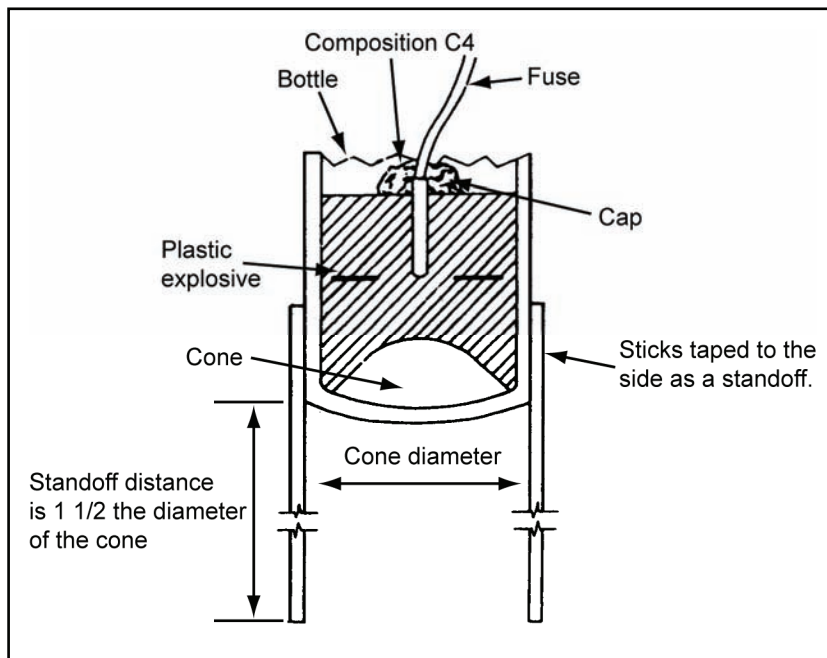


Figure D-1. Improvised Shaped Charge

### FABRICATION

D-3. For a shaped charge, a container should be obtained. Both ends of the container should be removed. Almost any kind of container will work (cans, jars, bottles, or drinking glasses). Some containers come equipped with built-in cavity liners, such as champagne or cognac bottles with the stems removed. With the ends removed, the container is ready for a cavity liner and explosive. Optimum shaped-charge characteristics include the following:

- **Cavity liner.** A cone-shaped cavity liner should be made for the container from copper, tin, zinc, or glass. Funnels or bottles with a cone in the bottom (champagne or cognac bottles) are excellent. However, if material is not available for a cavity liner, make a workable, but less effective shaped charge by cutting a cone-shaped cavity in a block of explosive.
- **Cavity angle.** For most high-explosive antitank (HEAT) ammunition, the cavity angle is 42° to 45°. Expedient charges will work with cavity angles between 30° and 60°.
- **Explosive height (in the container).** The explosive height is two times the cone height, measured from the base of the cone to the top of the explosive. Being careful not to alter the cavity angle of the cone, press the explosive into the container. The explosive should be tightly packed and free of any air pockets.
- **Standoff distance.** The normal standoff distance is 1 1/2 the diameter of the cone. Standoff sticks are used to achieve this.
- **Detonation point.** The exact top center of the charge is the detonation point. If any part of the blasting cap is exposed or extends above the charge, cover the blasting cap with a small quantity of composition C4.

---

*Note.* Remove the narrow neck of a bottle or the stem of a glass by wrapping it with a piece of soft, absorbent twine or by soaking the string in gasoline and lighting it. Place two bands of adhesive tape, one on each side of the twine, to hold the twine firmly in place. Turn the bottle or stem continuously with the neck up to heat the glass uniformly. Submerge the neck of the bottle in water, and tap it against some object to break it off after the twine or plastic has burned. Tape the sharp edge of the bottle to prevent cutting your hands while tamping the explosive in place. A narrow band of plastic explosive placed around the neck of the bottle and burned, gives the same results as string or twine. Do not immerse the bottle in water before the plastic explosive has completely burned, or it may detonate.

---

## PLATTER CHARGE

D-4. The platter charge uses the Miznay-Shardin effect. It turns a metal plate into a powerful, blunt-nosed projectile (Figure D-2). The platter charge can be used in situations requiring shaped charges or as a penetrator for demolition missions. If available, use a round, steel platter. However, a square platter will also work.

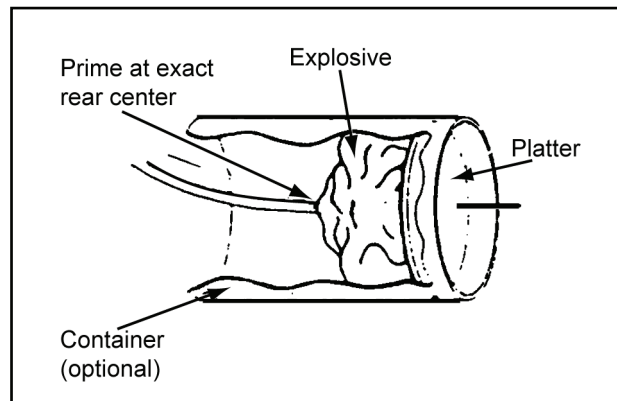


Figure D-2. Platter Charge

## CHARGE SIZE

D-5. A quantity of explosive equal to the weight of the platter should be used. The platter should weigh 2 to 6 pounds.

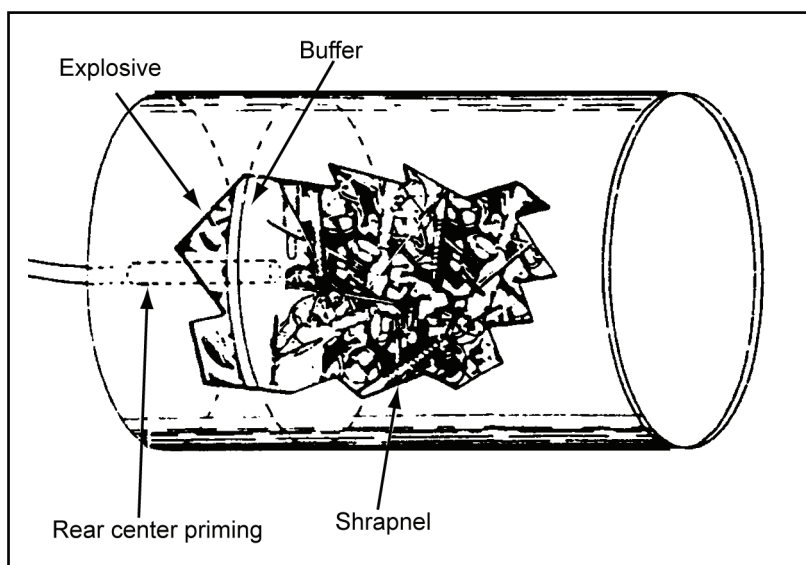
## FABRICATION

D-6. The explosive should be uniformly packed behind the platter. A container is not necessary if the explosive will remain firmly against the platter without a container. Tape is an acceptable anchoring material. At the rear center, prime the charge. If any part of the blasting cap is exposed, cover the blasting cap with a small quantity of composition C4.

D-7. If available, use a gutted M60 fuse igniter as an expedient aiming device, and aim the charge at the direct center of a target. The explosive should be on the side of the platter opposite the target. With practice, a 55-gallon drum or a relatively small target can be hit at 25 yards about 90 percent of the time with a platter charge.

## GRAPESHOT CHARGE

D-8. The grapeshot charge consists of a container (an ammunition can or a number 10 can), projectiles (nails, bolts, small pieces of scrap metal, or rocks), buffer material (soil, leaves, felt, cloth, cardboard, or wood), a charge (plastic explosive like composition C4), and a blasting cap or detonating cord. This charge should be used when conventional claymore-type firing devices are not available. Assemble these components as shown in Figure D-3. A quantity of explosive equal to 1/4 the projectile weight should be used.



**Figure D-3. Grapeshot Charge**

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*Note.* The United Nations Convention on Certain Conventional Weapons (CCW) mandates that all fragment munitions produce fragments that are visible by an X ray (such as metal or rock).

---

D-9. In the center of the bottom of the container, make a hole large enough to accept a blasting cap or a detonating cord knot. The components are placed in the container as follows:

- **Step 1. Explosive.** Place the plastic explosive uniformly in the bottom of the container. Remove all voids or air spaces by pressing the composition C4 into the container using a nonsparking instrument.
- **Step 2. Buffer.** Place 2 inches of buffer material directly on top of the explosive.
- **Step 3. Projectiles.** Place the projectiles on top of the buffer material. Place a covering over the projectiles to prevent them from spilling out when handling the charge.

D-10. In the plastic explosive charge, make a cap well through the hole in the bottom of the container, and insert the blasting cap of the initiating set. If any part of the blasting cap is exposed, cover it with a small quantity of composition C4. From about 100 feet, aim the charge at the center of the target.

## DUST-INITIATOR CHARGE

D-11. Dust-initiator charges use small quantities of explosives with larger amounts of powdered materials (dust or cover) to destroy thin-walled, wooden buildings or railroad boxcars. These charges work best in an enclosed area with few windows. At detonation, the dust or cover is distributed in the air within the target and ignited by an explosive-incendiary charge. The dust-initiator charge consists of an explosive (mixed with equal parts of incendiary mix) and a cover of finely divided organic material. The charge can be detonated by attaching initiating sets to the detonating cord.

## CHARGE COMPUTATIONS

D-12. The charges and cover size for the charge computations are as follows:

- **Charge size.** One pound of explosive-incendiary mixture will effectively detonate up to 40 pounds of cover. To make a 1-pound explosive-incendiary mixture, combine 1/2 pound of crushed TNT or composition C3 and 1/2 pound of incendiary mix (two parts of aluminum powder or magnesium powder and three parts of ferric oxide). Do not use composition C4, because the explosive component in composition C4 will not combine properly with the incendiary mixture.
- **Cover (dust) size.** Use 3 to 5 pounds of cover for each 1,000 cubic feet of target (3 pounds for enclosed buildings, and 5 pounds for partially enclosed buildings). The cover can consist of coal dust, cocoa, powdered coffee, confectioners' sugar, tapioca, wheat flour, cornstarch, hard rubber dust, aluminum powder, magnesium powder, powdered soap, or a volatile fuel, such as gasoline.

## FABRICATION

D-13. The TNT explosive is placed in a canvas bag and crushed into a powder with a wooden mallet. In the same bag that contains the crushed explosive, an equal amount of incendiary mixture is added and mixed thoroughly. This explosive incendiary charge is primed with a detonating cord knot. The primed charge is placed in the center of the target. The cover is then poured or placed on top of the primed charge to form a pyramid. When using gasoline as the cover, no more than 3 gallons should be used, since greater quantities will not evenly disperse in the air and will give poor results.

## IMPROVISED CRATERING CHARGE

D-14. This charge is used to supplement the 40-pound cratering charge or as an improvised cratering charge when 40-pound cratering charges are not available. It consists of a mixture of ammonium-nitrate fertilizer, (at least 33.33 percent nitrogen) and diesel fuel, motor oil, or gasoline. The ratio of fertilizer and fuel is 25 pounds to 1 quart. The fertilizer must not be damp. From the mixture, almost any size of improvised charge can be fabricated. Proceed as shown in the following steps:

- **Step 1.** Measure the fertilizer and fuel for the size of charge required.
- **Step 2.** Add the fuel to the fertilizer and mix thoroughly.
- **Step 3.** Allow the fuel to soak into the fertilizer for 1 hour.
- **Step 4.** Place half of the ammonium-nitrate charge in the borehole. Then, place two 1-pound primed blocks of explosives in the borehole, and add the remainder of the ammonium-nitrate charge. Never leave the charge in the borehole for a long period, since the charge will accumulate moisture, reducing its effectiveness.

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*Note.* Boreholes should receive 10 pounds of explosives for every foot of depth and must be dual-primed.

---

- Detonate the charge.

## IMPROVISED BOREHOLE METHOD (DETONATING CORD WICK)

D-15. The detonating cord wick (Figure D-4) is used to enlarge boreholes in the soil. The best results are obtained in hard soil. The following procedures should be used:

- Tape together several strands of detonating cord 5 to 6 feet long (generally, one strand enlarges the diameter of the hole by about 1 inch). Tape or tie the strands together into a wick for optimum results.
- Make a hole by driving a steel rod about 2 inches in diameter into the ground to the depth required.

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*Note.* According to the rule of thumb, a hole 10 inches in diameter holds 10 strands of detonating cord.

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- Place the detonating cord wick into the hole using an inserting rod or some other field expedient. Ensure that the strands are extended the full length of the hole.
- Fire the cord either electrically or nonelectrically. Fire an unlimited number of wicks at one time by connecting them with the detonating cord ring main or line main. Blow out excess gases and inspect the hole for excessive heat if placing successive charges in the holes.

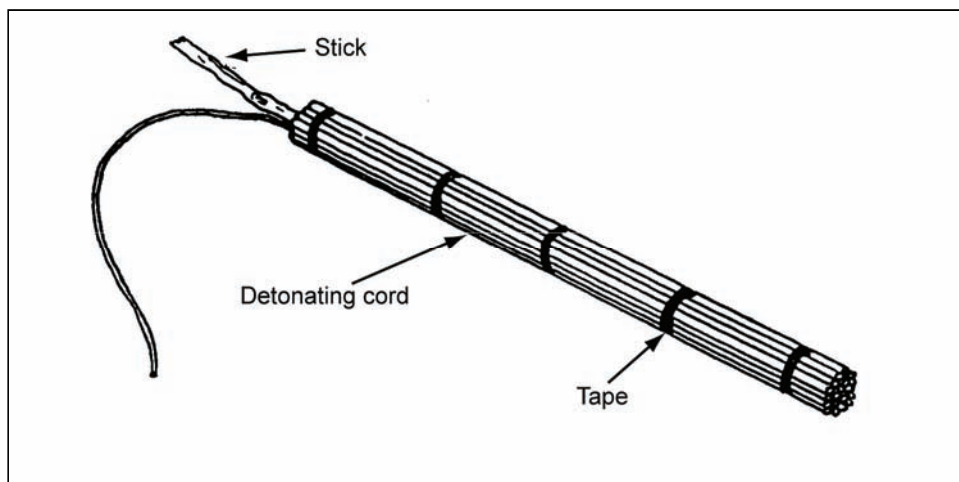


Figure D-4. Detonating Cord Wick

## AMMONIUM-NITRATE SACHEL CHARGE

D-16. Although a satchel charge is excellent, it is most suitable for cratering. A more manageable charge may be used by mixing ammonium-nitrate fertilizer with melted wax instead of oil. The mixing ratio is 4 pounds of fertilizer to 1 pound of wax. The primer should be set in place before the mixture hardens.

### PREPARATION

D-17. The following steps are used to prepare a ammonium-nitrate satchel charge:

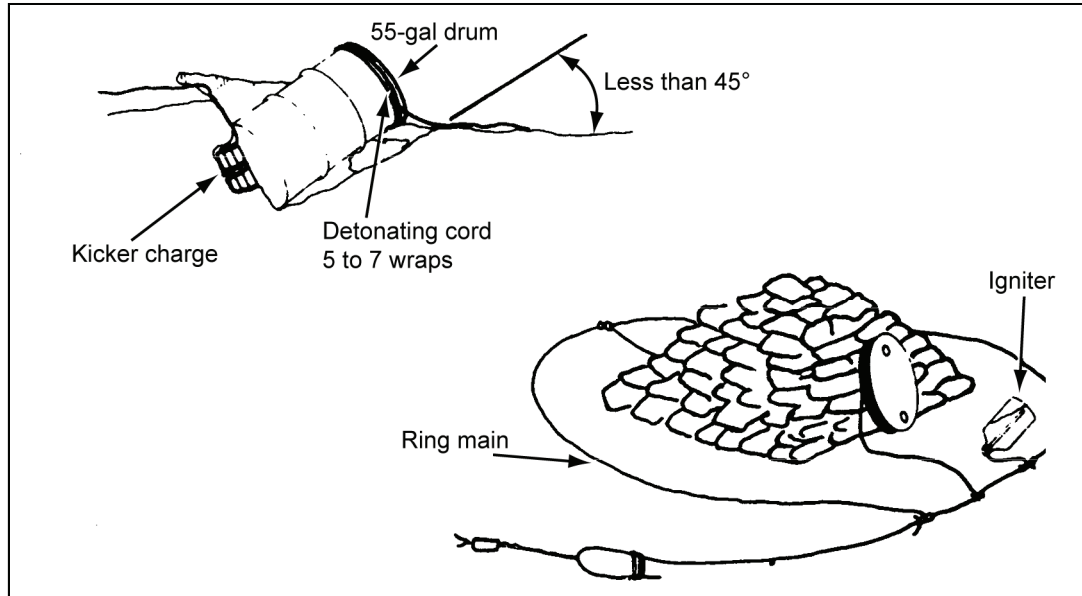
- **Step 1.** Melt the wax in a container.
- **Step 2.** Stir in the ammonium-nitrate pellets, ensuring that the wax is hot while mixing. Before the mixture hardens, add a 1/2-pound block of explosive primed with detonating cord.
- **Step 3.** Ensure that the primed charge is in the center of the mixture and that there is enough detonating cord available to attach the initiating sets.
- **Step 4.** Pour the mixture into a container. Add shrapnel material to the mixture, if desired, or attach on the outside of the container to give a shrapnel effect.
- **Step 5.** Detonate the charge by attaching initiating sets to the detonating cord coming from the satchel charge.

USE

D-18. Because the wax and fertilizer may be molded into almost any size or shape, it may be applied to a large number of demolition projects with satisfactory results.

**EXPEDIENT FLAME FOUGASSE**

D-19. The expedient flame fougasse is used in defensive or offensive operations for its incendiary, illuminating, and signaling effects. The charge consists of a 55-gallon drum of thickened fuel, a kicker charge, and detonating cord (Figure D-5). A 55-gallon drum containing a fougasse mixture is effective for a controlled-direction burst.



**Figure D-5. Expedient Flame Fougasse**

**PREPARATION**

D-20. The following steps are used to prepare a flame fougasse:

- **Step 1.** Make the fougasse mixture by mixing 3 ounces of M4 thickening compound per gallon of gasoline or jet petroleum 8 fuel.

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*Note.* Depending on the temperature, the mixture may take from 15 minutes to several hours to thicken to the desired viscosity (resembling applesauce or runny gelatin). For a 55-gallon drum, vigorously mix 150 ounces of M4 thickening compound with 50 gallons of gasoline or JP 8 fuel.

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- **Step 2.** Dig an angled trench for the 55-gallon drum that will allow the best coverage and dispersion of the flame fougasse. Do not build the trench steeper than 45°. Make a small cutout area in the back of the trench for the kicker charge (2 pounds of TNT or 1 block of composition C4).
- **Step 3.** Prime the kicker charge with detonating cord, leaving 6 to 10 feet of detonating cord free to tie into a ring main.
- **Step 4.** Wrap the top end of the 55-gallon drum with 5 to 7 wraps of detonating cord, leaving 6 to 10 feet of the detonating cord free to tie into a ring main.
- **Step 5.** Lay the drum in the trench, and place the kicker charge in the small cutout. Push the drum against the back of the trench so that the kicker charge seats firmly against the bottom of the drum. (It may be necessary to tamp the soil around the charge to center the kicker charge properly against the bottom of the drum.) Ensure that the running ends of detonating cord for the

kicker charge and drum top extend from the trench. Avoid kinks or sharp bends in the detonating cord.

- **Step 6.** Lay out a ring main of detonating cord around the 55-gallon drum, and tie the detonating cord from the kicker charge and wraps to the ring main.
- **Step 7.** Cover the entire 55-gallon drum with a minimum of 3 feet of tamped soil, leaving the front of the drum exposed or uncovered.
- **Step 8.** Use a length of detonating cord and tape one end under the spoon handle of an igniter trip flare (M49). Tape the spoon handle down securely, attach the trip flare to a stake, and position the stake 3 to 4 feet in front of the drum. Attach the free end of the detonating cord that is secured to the trip flare to the ring main. During combat, a white phosphorous (WP) grenade (M34) will work in place of the trip flare. Do the following if trip flares are not available:
  - Take a 2-liter plastic bottle, and fill it half full with raw gasoline or JP 8 (unthickened).
  - Punch a hole in the cap of the bottle. Thread one end of a detonating cord through the hole.
  - Tie a single overhand knot in the detonating cord to prevent it from being pulled back out of the cap.
  - Place the detonating cord with the single overhand knot inside the bottle. Secure the cap onto the bottle.
  - Take the opposite end of the detonating cord, and attach it to the ring main.
- **Step 9.** Attach initiating sets to the ring main or junction box.

## FUNCTION

D-21. When initiated, the ring main initiates the detonating cord to the trip flare, the drum top, and the kicker charge. The wraps cut the top of the drum off, the kicker charge propels the thickened fuel outward, and the trip flare ignites the thickened fuel as it travels downrange. The result is a flash of flame that spreads downrange for about 100 meters.

## ALTERNATE EXPEDIENT FLAME FOU GASSE (USING STEEL WOOL)

D-22. Steel wool can be used to ignite the thickened fuel if fuel igniters or trip flares are not available. The same amount of explosives is used for a kicker charge (2 pounds of TNT or 1 block of composition C4). The explosives are primed with detonating cord. A buffer material is attached (such as cardboard around the kicker charge) and secured with tape. Steel wool is attached to the buffer material so that it covers the entire width of the kicker charge. The steel wool will ignite the fuel in the drum once the kicker charge is propelled through the back section. The steel wool must be in contact with the back section of the drum. The result will be the same as with the fuel igniter or trip flare.

## IMPROVISED BANGALORE TORPEDO

D-23. The improvised bangalore torpedo is used to defeat wire obstacles. The following steps are used to prepare an improvised bangalore:

- **Step 1.** Separate the packaging material from the composition C4 (M112). Place it in the concave portion of two U-shaped pickets that are not bent or damaged.
- **Step 2.** Mold the composition C4 explosive, using a nonsparking tool, into the concave position that runs the entire length of the U-shaped pickets.
- **Step 3.** Place a line of detonating cord (after tamping the composition C4) on top of the composition C4 of one of the pickets, and make a single overhand knot every 6 to 8 inches. Ensure that the detonating cord runs several feet past the U-shaped picket length so that it can be tied into a firing system.
- **Step 4.** Place the other U-shaped picket (tamped with composition C4) onto the picket with the detonating cord. Ensure that the composition C4 explosive from each picket is touching and that the detonating cord is in the middle.
- **Step 5.** Secure the two U-shaped pickets together with tape or wire.

## EXPEDIENT BRANCHLINE CONNECTIONS

### GREGORY KNOT

D-24. The Gregory knot (Figure D-6) is a detonating cord knot tied at the end of a branchline to connect the branchline to a firing system. The Gregory knot saves time on a target when tied before arriving at the mission site. This knot does not take the place of the girth hitch with an extra turn or detonating cord clips.

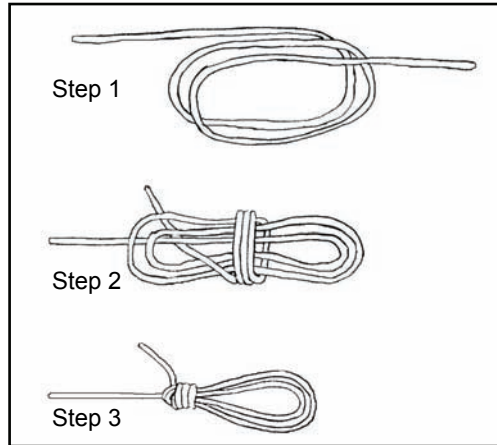


Figure D-6. Gregory Knot

### SCANMAN KNOT

D-25. The scanman knot (Figure D-7) is a detonating cord knot tied at the end of a branchline to connect the branchline to a firing system. The scanman knot saves time on a target when tied before arriving at the mission site. This knot does not take the place of the girth hitch with an extra turn or detonating cord clips.

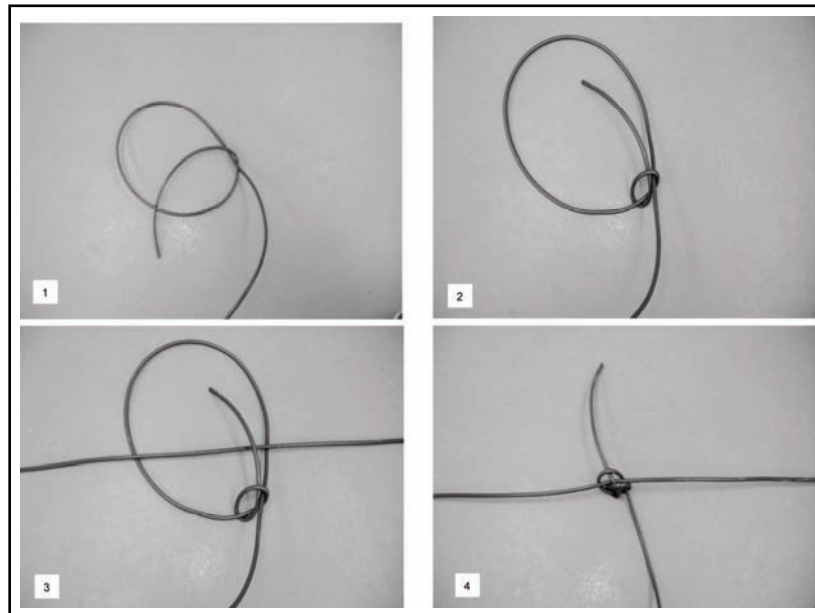


Figure D-7. Scanman Knot



## Appendix E

### Power Requirements for Series Firing Circuits

Electric blasting caps are connected in a series and fired with an electric power source (blasting machine). A series circuit provides a single path for the electrical current that flows from one firing wire through each blasting cap to the next blasting cap and back to the other firing wire. A series circuit should not contain more than 50 blasting caps. Connecting more than 50 blasting caps in a series circuit increases the chances of breaks in the firing line or cap leads.

#### OHM'S LAW

E-1. Ohm's law defines the amount of voltage necessary to detonate the blasting caps. The required voltage for a firing circuit is determined as follows:

$$E = IR$$

where—

$E$  = electric potential or voltage (in volts)

$I$  = current (in amperes)

$R$  = resistance (in ohms)

#### ELECTRIC-POWER FORMULA

E-2. The amount of electric power (watts) necessary to detonate blasting caps is determined as follows:

$$W = I^2R$$

where—

$W$  = electrical power (in watts)

$I$  = current (in amperes)

$R$  = resistance (in ohms)

#### ELECTRIC BLASTING CAPS

E-3. Military electric blasting caps connected in a series require at least 1.5 amperes to fire, regardless of the number of caps in the series. The resistance of a military electric blasting cap is 2 ohms.

#### CIRCUIT RESISTANCE

E-4. The power source should be adequate to fire all charges connected to the circuit. Firing wire and blasting caps contribute to the total resistance in the circuit. The amount of resistance is determined by combining the individual resistances of the blasting caps and wires. The resistance of the wire depends on the size and length of the wire. Table E-1, page E-2, gives the resistance per 1,000 foot of various sizes of copper wire.

Table E-1. Resistance of Copper Wire

<i>Wire Characteristics</i>			
<i>AWG (B&amp;S) Gauge Number</i>	<i>Diameter (in)</i>	<i>Weight (lb/ft)</i>	<i>Resistance per 1,000 ft (ohms)</i>
2	3/10	5.0	0.2
4	1/4	7.9	0.3
6	1/6	12.6	0.4
8	1/8	20.0	0.6
10	1/10	31.8	1.0
12	1/12	50.0	1.6
14	1/16	80.0	2.5
16	1/20	128.0	4.0
18	1/25	203.0	6.4
20	1/30	323.0	10.2

**Note.** For resistance, the ratings are for single-strand wire. Since blasting wire usually comes in double strands, use half its length to compute total resistance.

## SERIES CIRCUIT CALCULATIONS

E-5. Calculations are completed for any series circuit involved in determining the amount of current (amperes), voltage (volts), and power (watts) needed to fire the circuit. The following procedures are applied:

- **Current.** Ensure that the current required for a series circuit of electric blasting caps is 1.5 amperes, regardless of the number of blasting caps in the circuit.
- **Resistance.** Determine the resistance in the circuit as explained in paragraph E-4.
- **Voltage.** Determine the required voltage for the circuit using the formula in paragraph E-1.
- **Power.** Determine the required power for the circuit using the formula in paragraph E-2.

E-6. The current, voltage, and power required to detonate a 20-cap series circuit consisting of special electric blasting caps and 500 feet of standard, 2-conductor, 18-gauge firing wire is determined by using the following procedure:

- **Current.** Ensure that the amount of current required to detonate this circuit is 1.5 amperes.
- **Resistance.** Use the information below to obtain the resistance.
  - **Caps.** 2.0 ohms (20 caps) = 40.0 ohms.
  - **Wire.** 500 feet (2 strands) = 1,000 feet = 6.4 ohms (Table E-1).
  - **Total resistance.** 46.4 ohms.

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**Note.** Number 18 wire consists of two strands. The example specifies a 500-foot piece of wire, so use 1,000 feet as the total wire length for determining resistance (500 x 2 = 1,000).

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- **Voltage.** Use the formula below to obtain the voltage.

$$E = IR = 1.5(46.4) = 69.6 \text{ volts}$$

- **Power.** Use the formula below to obtain the power.

$$W = I^2(R) = 1.5^2(46.4) = 104.4 \text{ watts}$$

## VOLTAGE DROP

E-7. Ohm’s law allows you to determine the amount of voltage required (voltage drop) for a blasting circuit. In practice, the voltage drop should never exceed 90 percent of the available voltage. If it does, decrease the resistance or increase the voltage in the circuit to ensure that proper detonation occurs.

## BLASTING MACHINES

E-8. The nameplate on power sources normally states the amperage and the voltage ratings. Before using any power source, determine whether it is suitable for the firing circuit. Generally, determine the adequacy of a power source by consulting Table E-2. This table lists the sizes of circuits that power sources can support. The capabilities of the power source must be determined from the nameplate. The following steps are followed:

- **Step 1.** Multiply the voltage rating of the power source by 90 percent to get an adjusted voltage rating.
- **Step 2.** Divide the adjusted voltage rating by the amperage rating (1.5 amperes) of the circuit.

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*Note.* At this point, you have the maximum allowable resistance in the circuit in ohms.

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- **Step 3.** Determine the total resistance of the firing wire (Table E-1).
- **Step 4.** Subtract the resistance of the wire from the maximum allowable circuit resistance (step 2) to determine the maximum allowable resistance of the blasting caps in the circuit.
- **Step 5.** Determine the maximum number of blasting caps the circuit will support by dividing the allowable resistance for caps (step 4) by the resistance in one cap (2 ohms).

**Table E-2. Power Source Capabilities**

Power Source	Circuit Size (Series)		
	10-cap	30-cap	50-cap
Blasting machine, 10 cap	X	—	—
Blasting machine, 30 cap	X	X	—
Blasting machine, 50 cap	X	X	X
Generator, 1.5 kw, portable (115 volts, 13.5 amperes)	X	X	—
Generator, 3 kw, portable (115 volts, 26 amperes)	X	X	—
Generator, 5 kw, portable (115 volts, 43.5 amperes)	X	X	—
Generator, 3 kw, portable (220 volts, 13.5 amperes)	X	X	X
Generator, 5 kw, portable (220 volts, 22.5 amperes)	X	X	X

E-9. The maximum number of electric blasting caps allowed in a series circuit fired by a 220-volt, 13.5-ampere generator and 250 feet of double-strand, 20-gauge wire (a total of 500 feet of wire) is determined as follows:

- **Maximum allowable resistance (paragraph E-8, steps 1 and 2).**

$$\frac{0.90 (200 \text{ volts})}{1.5 \text{ amperes}} = 120 \text{ ohms}$$

- **Total resistance of the firing wire (Table E-1, page E-2).**

$$\frac{10.2 \text{ ohms (500 feet)}}{1,000} = 5.1 \text{ ohms}$$

- **Maximum allowable resistance of the blasting caps (paragraph E-8).**

$$120 \text{ ohms} - 5.1 \text{ ohms} = 126.9 \text{ ohms}$$

- **Maximum number of blasting caps.**

$$\frac{126.9 \text{ ohms}}{2 \text{ ohms}} = 63.45 \text{ caps (round down to 63 caps)}$$

## **BATTERIES AND DRY CELLS**

E-10. See paragraph E-9. The procedure in paragraph E-9 is used to determine the size of a circuit supported by a battery or dry cell.

## Appendix F

### Example Calculations

This appendix contains examples of charge, demolition, and attack calculations that are discussed in Chapters 3 and 4. Use TNT in the 1-pound package and use 20 cubic inches for the volume of composition C4 when calculating the problems that follow. For examples of charge calculations, refer to Figures F-1 through F-11, pages F-1 through F-9. For examples of demolition calculations, see Figure F-12, page F-10. For examples of attack calculations, see Figures F-13 through F-15, pages F-11 through F-13.

#### CHARGE CALCULATIONS

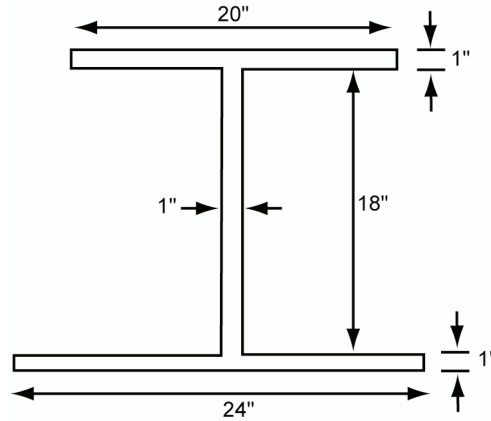
<b>Problem.</b> Using the internal timber cutting charge, determine the quantity of composition C4 required to cut a 30-inch diameter tree.	
Step 1	Obtain the critical dimensions.  <i>D = 30 inches</i>
Step 2	Calculate the TNT or use the rule of thumb.  $P = \frac{D^2}{250} = \frac{30^2}{250} = \frac{900}{250} = 3.6 \text{ pounds of TNT}$  <b>Note.</b> $P = .004D^2$
Step 3	Divide by the RE factor, if required.  $\frac{P}{RE} = \frac{3.6}{1.34} = 2.68 \text{ pounds of composition C4}$
Step 4	Divide by the package weight or volume, and round UP to the next whole package.  $\frac{P}{\text{Package weight}} = \frac{2.68}{1.25} = 2.14, \text{ round up to 3 packages of composition C4}$
Step 5	Calculate the number of charges.  <i>One tree = One charge</i>
<b>Note.</b> You must split the charge between the two boreholes because the tree is larger than 18 inches in diameter. See Chapter 3, Section II.	
Step 6	Calculate the total amount of explosives.  <i>Step 4 x Step 5 = Total packages = 3 x 1 = 3 packages of composition C4</i>
<b>Solution.</b> To cut a 30-inch diameter tree using an internal timber-cutting charge, three packages of composition C4 is needed and is placed in two boreholes. See Figure 3-2, page 3-5, for charge placement.	

**Figure F-1. Timber-Cutting Charge Calculation (Internal)**

<p><b>Problem.</b> Using the external timber cutting charge formula, determine the quantity of TNT required to cut a 30-inch diameter tree.</p>	
Step 1	<p>Obtain the critical dimensions.</p> <p><math>D = 30 \text{ inches}</math></p>
Step 2	<p>Calculate the TNT or use the rule of thumb.</p> <p><math>P = \frac{D^2}{40} = \frac{30^2}{40} = \frac{900}{40} = 22.5 \text{ pounds of TNT}</math></p> <p><b>Note.</b> <math>P = .025D^2</math></p>
Step 3	<p>Divide by the RE factor, if required.</p> <p><math>\frac{P}{RE} = \frac{22.5}{1} = 22.5 \text{ pounds of TNT}</math></p>
Step 4	<p>Divide by package weight or volume, and round UP to the next whole package.</p> <p><math>\frac{P}{\text{Package weight}} = \frac{22.5}{1} = 22.5 \text{ packages of TNT; round up to 23 packages of TNT}</math></p>
Step 5	<p>Calculate the number of charges.</p> <p><i>One tree = One charge</i></p>
Step 6	<p>Calculate the total amount of explosives.</p> <p><math>\text{Step 4} \times \text{Step 5} = \text{Total packages} = 23 \times 1 = 23 \text{ packages of TNT}</math></p>
<p><b>Solution.</b> To cut a 30-inch diameter tree using an external timber charge, 23 packages of TNT is needed. See Figure 3-3, page 3-6, for charge placement.</p>	

**Figure F-2. Timber-Cutting Charge Calculation (External)**

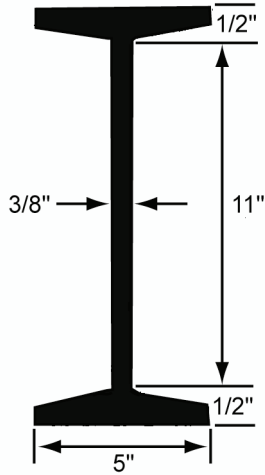
**Problem.** Using the steel-cutting charge formula,  $P = \frac{3}{8} A$ , determine the quantity of composition C4 required to cut the two steel beams shown below.



Step 1	<p>Obtain the critical dimensions.</p> <ul style="list-style-type: none"> <li>a. Top flange: 20 x 1 = 20 square inches</li> <li>b. Web: 18 x 1 = 18 square inches</li> <li>c. Bottom flange: 24 x 1 = 24 square inches</li> </ul>
Step 2	<p>Calculate the TNT or use the rule of thumb.</p> <ul style="list-style-type: none"> <li>a. Top flange: 20 x 1 = 20 square inches</li> <li>b. Web: 18 x 1 = 18 square inches</li> <li>c. Bottom flange: 24 x 1 = 24 square inches</li> <li>d. Total square inches = 62 square inches (a + b + c)</li> </ul> $P = \frac{3}{8} A = \frac{3}{8} \times 62 = 23.25 \text{ pounds of TNT}$ <p><b>Note.</b> <math>P = 0.375A</math></p>
Step 3	<p>Divide by the RE factor, if required.</p> $\frac{23.25}{1.34} = 17.35 \text{ pounds of composition C4}$
Step 4	<p>Divide by the package weight or volume, and round UP to the next whole package.</p> $\frac{17.35}{1.25} = 13.8; \text{ round up to 14 packages of composition C4}$
Step 5	<p>Calculate the number of charges.</p> <p><i>Two beams = Two charges</i></p>
Step 6	<p>Calculate the total amount of explosives.</p> <p><i>Step 4 x Step 5 = Total packages = 14 x 2 = 28 packages of composition C4</i></p>
<p><b>Solution.</b> To cut the two beams, 28 packages of composition C4 is needed. See Figure 3-7, page 3-10, for charge placement.</p>	

Figure F-3. Steel-Cutting Charge Calculation

**Problem.** Using the hasty, steel-cutting formula and Table 3-4, page 3-12, determine the quantity of composition C4 required to cut the steel beam shown below.

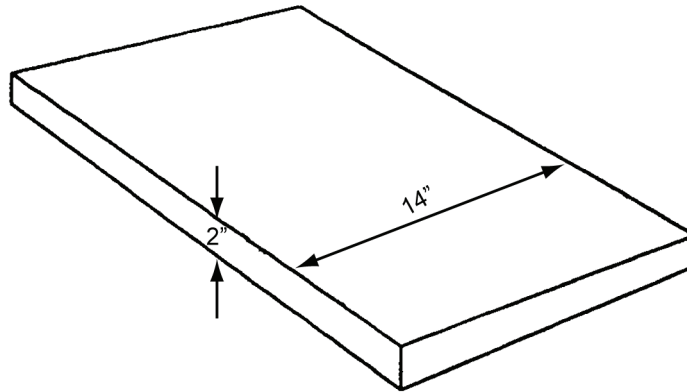


Step 1	<p>Obtain the critical dimensions.</p> <ul style="list-style-type: none"> <li>a. Top flange: 5 x 1/2 inches</li> <li>b. Web: 11 x 3/8 inches</li> <li>c. Bottom flange: 5 x 1/2 inches</li> </ul>
Step 2	<p>Calculate the TNT or use the rule of thumb.</p> <ul style="list-style-type: none"> <li>a. Top flange: 5 x 1/2 = 0.8 pounds from Table 3-4</li> <li>b. Web: 11 x 3/8 pounds = 1.3 pounds from Table 3-4</li> <li>c. Bottom flange: 5 x 1/2 = 0.8 pounds from Table 3-4</li> <li>d. Total = 2.9 pounds of composition C4 (a + b + c)</li> </ul>
Step 3	<p>Divide by the RE factor, if required.</p> <p>Not required.</p>
Step 4	<p>Divide by the package weight or volume, and round UP to the next whole package.</p> $\frac{P}{\text{Package weight}} = \frac{2.9 \text{ lbs of composition C4}}{1.25 \text{ package weight}} = 2.32; \text{ round up to 3 packages of composition C4}$
Step 5	<p>Calculate the number of charges.</p> <p><i>One beam = One charge</i></p>
Step 6	<p>Calculate the total amount of explosives.</p> <p><i>Step 4 x Step 5 = Total packages = 3 x 1 = 3 packages of composition C4</i></p>
<p><b>Solution.</b> Three packages of composition C4 is needed. See Figure 3-7, page 3-10, for charge placement.</p>	

**Figure F-4. Hasty, Steel-Cutting Charge Calculation**



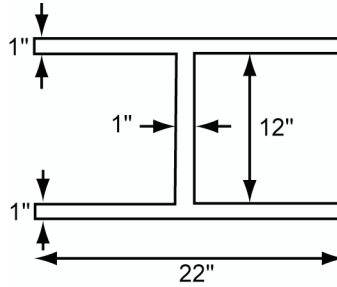
**Problem.** Using the steel-cutting charge calculation (steel plate), determine the quantity of composition C4 required to cut the steel plate shown below using a ribbon charge.



Step 1	Obtain the critical dimensions. a. Cut length: 14 inches b. Target thickness: 2 inches
Step 2	Calculate the TNT or use the rule of thumb. a. Thickness: 1/2 (target thickness) = 1 inch b. Width: 3 (charge thickness) = 3 inches c. Length: cut length = 14 inches $Volume = T \times W \times L = 1 \times 3 \times 14 = 42 \text{ cubic inches}$
Step 3	Divide by the RE factor, if required. Not required because only composition C4 or sheet explosives are used.
Step 4	Divide by the package volume, and round UP to the next whole package. M112 volume = 20 cubic inches $\frac{42}{20} = 2.1$ (round up to 3)
Step 5	Calculate the total amount of charges. <i>One plate = One charge</i>
Step 6	Calculate the total amount of explosives. <i>Step 4 x Step 5 = Total packages = 3 x 1 = 3 packages of composition C4</i>
<b>Solution.</b> To cut the steel plate, three packages of composition C4 is needed. See Figure 3-11, page 3-15, for charge placement.	

**Figure F-5. Steel-Cutting Charge Calculation (Steel Plate)**

**Problem.** Using the steel-cutting charge calculation (I beam), determine the quantity of composition C4 required to cut the I beam shown below using a ribbon charge.



<p>Step 1</p>	<p>Obtain the critical dimensions.</p> <p>a. Top flange: <math>22 \times 1 = 22</math> inches              b. Web: <math>12 \times 1 = 12</math> inches              c. Bottom flange: <math>22 \times 1 = 22</math> inches</p>
<p>Step 2</p>	<p>Calculate the TNT or use the rule of thumb.</p> <p>a. Thickness = <math>1/2</math> (target thickness) = <math>1/2</math> inches              b. Width = 3 (charge thickness) = <math>1\ 1/2</math> inches              c. Length = Cut length = <math>21 + 21 + 11 = 53</math> inches</p> <p><math>Volume = T \times W \times L = 1/2 \times 1\ 1/2 \times 53 = 39.75</math> cubic inches of composition C4</p> <p>The diagram shows the I-beam with charge placement. The top flange width is labeled as <math>22 - 1 = 21</math> inches, the web height is labeled as <math>12 - 1 = 11</math> inches, and the web thickness is 1 inch.</p>
<p>Step 3</p>	<p>Divide by the RE factor, if required.</p> <p>Not required because only composition C4 or sheet explosives are used.</p>
<p>Step 4</p>	<p>Divide by the package weight or volume, and round UP to the next whole package.</p> <p><math>N = \frac{Charge\ volume}{Package\ volume} = \frac{39.75}{20} = 1.98</math>; round up to 2 packages of composition C4</p>
<p>Step 5</p>	<p>Calculate the number of charges.</p> <p>One I beam = One charge</p>
<p>Step 6</p>	<p>Calculate the total amount of explosives.</p> <p>Step 4 x Step 5 = Total packages = <math>2 \times 1 = 2</math> packages of composition C4</p>
<p><b>Solution.</b> To cut the I beam, two packages of composition C4 as needed. See Figure 3-12, page 3-15, for charge placement.</p>	

**Figure F-6. Steel-Cutting Charge Calculation (I Beam)**

<b>Problem.</b> Using the steel-cutting charge calculation (steel bar), determine the quantity of composition C4 required to cut a 7-inch steel bar using a saddle charge.	
Step 1	Obtain the critical dimensions. a. Target diameter = 7 inches b. Target circumference = $3.14 \times 7 = 21.98$ inches
Step 2	Calculate the TNT or use the rule of thumb. a. Thickness = 1.00 inch b. Base width = $1/2$ (target circumference) = 10.99 inches c. Long axis = target circumference = 21.98 inches d. Total volume = $1/2$ (base width) (long axis) = 120.78 cubic inches of explosive
Step 3	Divide by RE factor, if required. Not required because only composition C4 or sheet explosives are used.
Step 4	Divide by the package weight or volume, and round UP to the next whole package. $N = \frac{\text{Charge volume}}{\text{Package volume}} = \frac{153.75}{20} = 7.68; \text{ round up to 8 packages of composition C4}$
Step 5	Calculate the number of charges. <i>One bar = One charge</i>
Step 6	Calculate the total amount of explosives. <i>Step 4 x Step 5 = Total packages = <math>8 \times 1 = 8</math> packages of composition C4</i>
<b>Solution.</b> To cut the steel bar using a saddle charge, eight packages of composition C4 is needed. See Figure 3-13, page 3-16, for charge placement.	

**Figure F-7. Steel-Cutting Charge Calculation (Steel Bar)**

<b>Problem.</b> Using the steel-cutting charge calculation (high-carbon steel), determine the quantity of composition C4 required to cut an 8-inch, high-carbon, steel bar using a diamond charge.	
Step 1	Obtain the critical dimensions. a. Target diameter: 8 inches b. Target circumference: $3.14 \times 8 = 25.12$ inches
Step 2	Determine the required charge dimensions. a. Thickness: 1.00 inch b. Short axis: $1/2$ (target circumference) = 12.56 inches c. Long axis: target circumference = 25.12 inches d. Total volume: $1/2$ (thickness x long axis x short axis) = 157.7536 cubic inches
Step 3	It is not necessary to determine the equivalent amount of composition C4 because this charge uses and is computed for plastic explosive (composition C4) or sheet explosive, not TNT.
Step 4	Determine the number of required packages of composition C4. $N = \frac{\text{Charge volume}}{\text{Package volume}} = \frac{157.7536}{20} = 7.88768; \text{ round up to 8 packages of composition C4}$
Step 5	Calculate the number of charges. <i>One bar = One charge</i>
Step 6	Calculate the total amount of explosives required. <i>Step 4 x Step 5 = Total packages <math>8 \times 1 = 8</math> packages of composition C4 is required</i>
<b>Solution.</b> To cut one high-carbon steel bar, eight packages of composition C4 is needed. See Figure 3-14, page 3-17, for charge placement.	

**Figure F-8. Steel-Cutting Charge Calculation (High-Carbon Steel)**

<b>Problem.</b> Using the formula $R^3KC$ , determine the number of composition C4 packages required to breach a reinforced-concrete pier, 5 feet thick and 30 feet wide. The charges will be elevated 5 feet and untamped.	
Step 1	Obtain the critical dimensions. a. Breaching radius (R): 5 feet b. Pier width (W): 30 feet
Step 2	Calculate the TNT or use the rule of thumb. $P = R^3KC = 5^3(0.63)1.8 = 141.75$ pounds of TNT
Step 3	Divide by the RE factor, if required. $\frac{141.75}{1.34} = 105.78$ pounds of composition C4
Step 4	Divide by the package weight or volume, and round UP to the next whole package. $N = \frac{\text{Charge weight}}{\text{Package weight}} = \frac{105.78}{1.25} = 84.62$ ; round up to 85 packages of composition C4
Step 5	Calculate the number of charges. $N = \frac{W}{2R} = \frac{30}{2(5)} = 3$ charges
Step 6	Calculate the total amount of explosives. $\text{Step 4} \times \text{Step 5} = \text{Total packages} = 85 \times 3 = 255$ packages of composition C4
<b>Solution.</b> To breach the pier, 255 packages of composition C4 are needed. See Figure 3-16, page 3-22, for charge placement.	

**Figure F-9. Breaching Charge Calculation (Reinforced Concrete Pier)**

<b>Problem.</b> Using the counterforce charge calculation, determine the required amount of composition C4 needed to counterforce four concrete cubes 3 feet thick.	
Step 1	Obtain the critical dimensions. <i>Target thickness = 3 feet</i>
Step 2	Calculate the TNT or use the rule of thumb. $P = 1 \frac{1}{2}$ pounds of composition C4 per foot of diameter $P = 1 \frac{1}{2} \times 3 = 4.5$ pounds of composition C4
Step 3	Divide by the RE factor, if required. Not required because only composition C4 or sheet explosives are used.
Step 4	Divide by the package weight or volume, and round UP to the next whole package. $N = \frac{\text{Charge weight}}{\text{Package weight}} = \frac{4.5}{1.25} = 3.6$ ; round up to 4 packages of composition C4
Step 5	Calculate the number of charges. <i>Four cubes = Four charges</i>
Step 6	Calculate the total amount of explosives. $\text{Step 4} \times \text{Step 5} = \text{Total packages} = 4 \times 4 = 16$ packages of composition C4
<b>Solution.</b> To counterforce four cubes, 16 packages of composition C4 as needed. See Figure 3-17, page 3-22, for charge placement.	

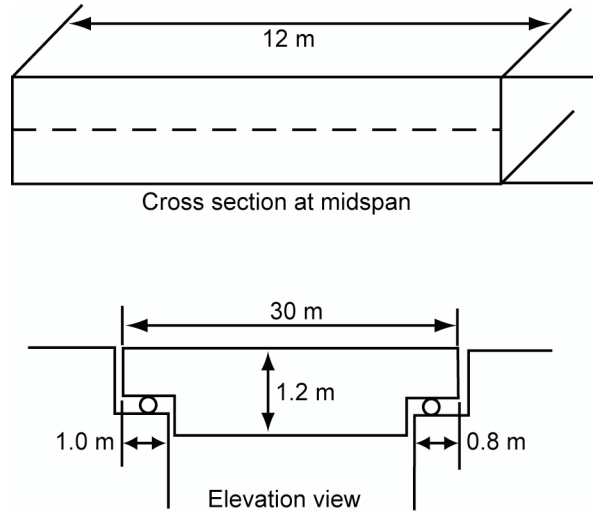
**Figure F-10. Counterforce Charge Calculation**

<b>Problem.</b> Using the cratering charge calculation, determine the quantity of cratering charges and composition C4 required to create a deliberate crater 146 feet long.	
Step 1	Obtain the critical dimensions. <i>Crater length (L) = 146 feet</i>
Step 2	Calculate the TNT or use the rule of thumb. a. 7-foot borehole = 80 pounds of explosive b. 5-foot borehole = 40 pounds of explosive
Step 3	Divide by the RE factor, if required. Not required.
Step 4	Divide by the package weight or volume, and round UP to the next whole package. a. 7-foot borehole = 2 cratering charges and 2 packages of composition C4 b. 5-foot borehole = 1 cratering charge and 2 packages of composition C4
Step 5	Calculate the number of charges. $N = \frac{L - 16}{5} + 1 = \frac{146 - 16}{5} + 1 = 27 \text{ holes}$ 27/2 = 13.5; round up to 14 for 7-foot holes and round down to 13 for 5-foot holes
Step 6	Calculate the total amount of explosives. a. 7-foot boreholes: 14 holes (2 cratering charges + 2 packages of composition C4) = 28 cratering charges + 28 packages of composition C4 b. 5-foot boreholes: 13 holes (1 cratering charges + 2 packages of composition C4) = 13 cratering charges + 26 packages of composition C4  <i>Total = 41 cratering charges and 54 packages of composition C4</i>
<b>Solution.</b> To create a deliberate crater 146 feet long, 41 cratering charges and 54 packages of composition C4 are needed. See Figure 3-19, page 3-25, for charge placement.	

**Figure F-11. Cratering Charge Calculation**

## DEMOLITION CALCULATIONS

**Problem.** Using a concrete-stripping charge to destroy a simply supported, concrete-deck, top-support bridge span. The diagram below shows the span dimensions (determine the quantity of composition C4 required).



### Beam Calculations

Step 1	Determine the amount of TNT required per meter. $P = (3.3h + 0.5)^3 3.3 = [3.3(1.2) + 0.5]^3 3.33 = 295.42606488$ pounds of TNT per meter
Step 2	Determine the amount of explosive (TNT) per beam. $P = (\text{pounds TNT/meter}) (\text{bridge width, in meters})$ $P = 295.42606488 = 3545.11277856$ pounds of TNT
Step 3	Determine the equivalent amount of composition C4. $\frac{P}{RE} = \frac{3545.11277856}{1.34} = 2645.606551$ pounds of composition C4
Step 4	Determine the required packages of composition C4 per beam. $P = \frac{\text{Charge weight}}{\text{Package weight}} = \frac{2645.606551}{1.25} = 2116.532408$ ; round up to 2117 of composition C4
Step 5	Calculate the number of charges. <i>One bridge = One charge</i>
Step 6	Calculate the total amount of explosives. <i>Step 4 x Step 5 = Total packages = 2117 x 1 = 2117 packages of composition C4</i>

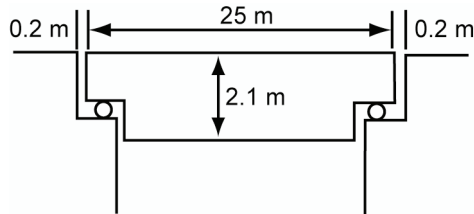
**Solution.** To destroy this simply-supported concrete deck, top support bridge span, 2,098 packages of composition C4 is needed.

**Figure F-12. Concrete Stripping Charge Calculation**

## ATTACK DEMOLITIONS

**Problem.** Using a bottom-attack bridge calculation, determine the attack method for demolishing a simply supported, steel-beam deck bridge with bottom supports and the following measurements:

- a. Length (L): 25 meters
- b. Height (H): 2.1 meters
- c. End clearance (E): 0.4 meters

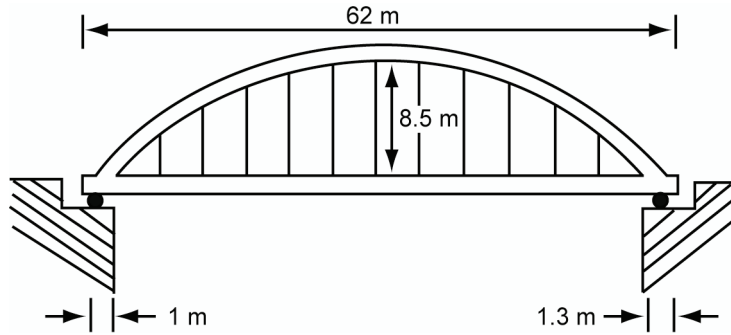


Step 1	Refer to Appendix H. Table H-1, page H-1, lists the bottom attack method for this bridge, provided that the actual end clearance (E) is greater than $E_R$ .
Step 2	<p>Perform the calculation to determine whether E is greater than <math>E_R</math>.</p> <ul style="list-style-type: none"> <li>a. Determine the height-to-length ratio (H/L).</li> </ul> $\frac{H}{L} = \frac{2.1}{25} = 0.084$ <ul style="list-style-type: none"> <li>b. Find the corresponding E/L value (Table H-1). Since 0.084 is not found on the table, go to the next higher value, 0.09.</li> <li>c. From the higher value, 0.09, move directly below, and find value 0.0160.</li> <li>d. Determine the required end clearance. Find <math>E_R</math> as follows:</li> </ul> $E_R = \text{Value found (0.0160)} \times \text{length (25)} = 0.4 \text{ meters}$
<p><b>Solution.</b> Compare the actual and required end clearances. Since the actual end clearance (0.4 meter) is equal to the required end clearance (0.4 meter), a bottom attack is possible without any likelihood of the span jamming.</p>	

**Figure F-13. Bottom-Attack Bridge Calculation**

**Problem.** Using the top-attack bridge calculation, determine the attack method for demolishing a simply supported, bowstring bridge with the following measurements.

- a. Length (L): 62 meters
- b. Height (H): 8.5 meters
- c. Average length of bearing supports ( $L_S$ ): 1.15 meters



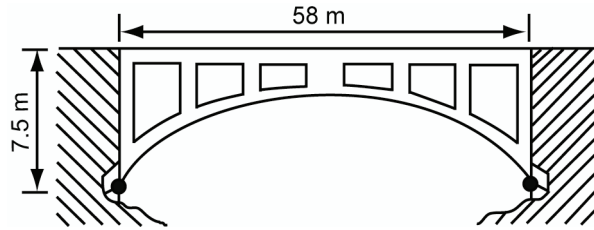
Step 1	Refer to Appendix H. Table H-2, page H-2, lists the top-attack method for this bridge.
Step 2	Determine the height-to-length ratio (H/L). $\frac{H}{L} = \frac{8.5}{62} = 0.137$ Since 0.137 is not found on the table, round UP to 0.14.
Step 3	Determine the required-gap ratio ( $L_S/L$ ). $\frac{L_S}{L} = \frac{1.15}{62} = 0.0185$
Step 4	Find the corresponding $L_S/L$ value (Table H-2). Since 0.0185 is not found on the table, round UP to 0.020.
Step 5	a. Intersect the $L_S/L$ and H/L values on the table to get the value of $L_C/L$ . $L_C/L = 0.082$ b. Multiply the $L_C/L$ value by the length to get $L_C$ . $L_C = 0.082 \times 62 = 5.08 \text{ meters}$
Step 6	Determine where place the charges by dividing $L_C$ in half ( $5.08 \div 2 = 2.54$ meters).
<b>Solution.</b> The proposed cut must be 2.54 meters from either side of the midspan. Mark the bridge in this location. This location is the centerline for the proposed cut.	

**Figure F-14. Top-Attack Bridge Calculation**



**Problem.** Using the arch-bridge attack calculation, determine the attack method for a continuous, concrete-arch bridge with open spandrels and pinned footings, having the following measurements:

- a. Length (L): 58 meters
- b. Rise (H): 7.5 meters



Step 1	Refer to Appendix H. Table H-4, pages H-4 through H-8, lists the bridge-attack method for this bridge.
Step 2	Determine the height-to-length ratio (H/L): $\frac{H}{L} = \frac{7.5}{58} = 0.129$
Step 3	Find the corresponding $L_C/L$ value (Table H-3, page H-3). Since 0.129 is not found on the table, round UP to 0.14. The value found below 0.14 is 0.04.
Step 4	Determine the required length of the cut. $L_C = \frac{L_C}{L} (L) = (0.04) 58 = 2.32 \text{ meters}$
Step 5	Determine where to place the charges. Place the charges at the midspan.
<b>Solution.</b> The proposed cut must be at the midspan. Mark the bridge in this location. This location is the centerline for the proposed cut.	

Figure F-15. Arch-Bridge Attack Calculation

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## Appendix G

# Underwater Demolitions

This appendix outlines the techniques, tactics, and procedures used by military divers to perform harbor clearance, impalement blasting, trenching, tunneling, channel alteration, and sandbar removal. The primary use of explosives in underwater salvage is harbor clearance. Explosives are used to clear ship passages and for cutting wreckage. When using demolitions with manual, underwater-cutting techniques, explosive cutting has extensive application in “cut-and-lift” harbor clearance operations, and increase the use of certain “patch-and-pump” situations when portions of a wreck are refloated individually. Other underwater salvage operations requiring the use of explosives include rock and coral blasting, channel or harbor bottom altering, concrete and masonry blasting, steel breaking and cutting, ship cutting, and removal of ship propellers. These operations may be used alone or with harbor clearance.

## HARBOR CLEARANCE

G-1. A harbor may be blocked deliberately to deny its use to an enemy or as a result of bombardment. In one case, ships and other objects will be positioned and sunk in locations to make harbor clearance difficult. In another case, obstruction will be haphazard. When harbors are blocked intentionally, it is possible that explosives have been placed as hazards for harbor clearance personnel. When harbors are obstructed as a result of bombardment, there may be explosives in sunken ships or scattered on the harbor bottom.

### **DANGER**

**The rendering safe of underwater explosive ordnance is outside the scope of salvage operations. Whenever the presence of explosives is known or suspected, Navy EOD personnel should clear the area before salvage operations begin. Failure to comply may cause death or permanent injury.**

## SHIP SALVAGE

G-2. Before salvage operations begin, determine whether sunken ships are to be dispersed by explosives, converted to mooring or docking facilities, or salvaged for reuse or scrap. The condition of a sunken ship and the need for it may dictate that the ship be salvaged for reuse. The need for scrap steel and the availability of outgoing supply channels may make salvage for scrap the prime consideration. On the other hand, the immediate tactical need for the harbor may make it imperative that all sunken ships be dispersed or flattened so the harbor will be cleared in the minimum time.

G-3. Unsalvageable vessels and other equipment can be marked and left in place, sectioned and removed, flattened, dispersed, or settled with explosives. Whether a particular ship is dispersed completely in one continuous operation is determined by the overall situation at the site. If a well-blocked harbor is made usable first for shallow-draft vessels and then for deeper-draft ships, the upper portions of several obstacles are dispersed and followed by progressive demolition of the lower portions of the same obstacles. If a single sunken ship blocks a channel, the entire ship may be dispersed in a single operation. Depending on the particular situation, sectioning, flattening, dispersal, and settlement methods can be used.

## SECTIONING

G-4. Sectioning involves cutting the vessel into manageable pieces. It also involves removing the pieces to designated locations.

## FLATTENING

G-5. Flattening uses explosives to first remove the superstructure and then crushes the hull to the bottom. The stages in which a ship is flattened will depend on the position of the ship with respect to the bottom. A ship resting on its side presents a different problem from one that is sitting upright on the bottom. In most cases, the masts and rigging are removed first, then the superstructure is removed or dispersed, and finally the hull itself is flattened. In all hull-flattening operations, charges are placed to take advantage of the weight of and existing stresses in structural members. The greater the stress on the member, the less explosive needed to cut or break it.

## DISPERSAL

G-6. The time limitation in the emergency clearing of a harbor or channel usually does not permit the salvage of a sunken ship, either by raising or by cutting it up for scrap. When time is essential, dispersal of the sunken ship by demolition is the most effective way of clearing the harbor or channel. The hull is dispersed by placing heavy demolition charges inside each end of the hull and one heavy charge in the center. Detonation of the charges is simultaneous. Usually the heavy planking or frames take most of the ribs and frames with it, forcing the hull outward by the explosion. Ribs or frames left standing must be cut individually.

## SETTLEMENT

G-7. Explosives can be used to prevent the ship from settling on the bottom. Explosives can also be used to make the ship settle farther on the bottom.

- **Prevention.** When a ship is to be salvaged, the bottom can be compacted beneath it to prevent further settling. This is done by driving detonating powder points into the bottom around the hull. For this purpose, the powder points should be loaded with an explosive with a low rate of detonation, such as ammonium nitrate. Charges must be light enough so the hull of the ship is not damaged.
- **Future settlement.** When a ship resting on a sandy or muddy bottom is to be dispersed or flattened, it should be settled as deeply as possible. Settle it by blowing holes in the hull along the bottom to reduce the bearing surface. This allows the bottom material to ooze into the hull. Added settling will result from increasing the weight of the ship by filling the voids with sand, mud, or gravel through an airlift.

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*Note.* Removing large sections of steel may require a surface crane or winch from the supported unit.

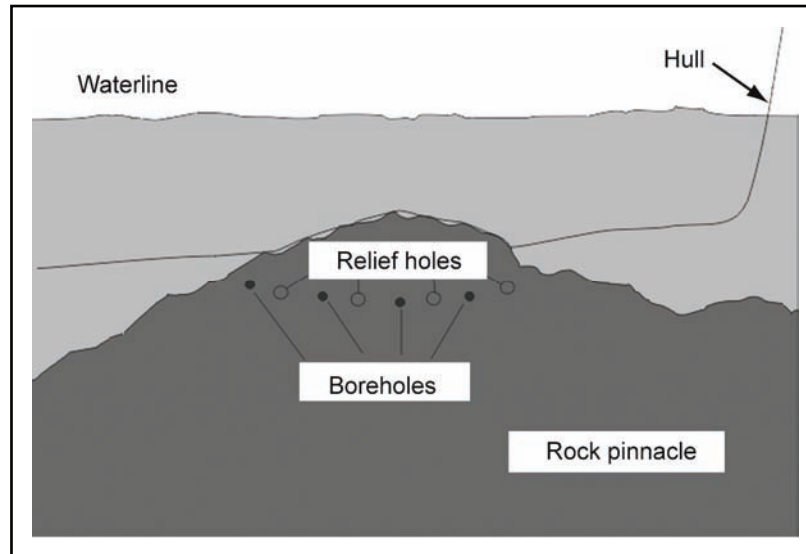
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## IMPALEMENT BLASTING

G-8. Using explosives to remove an impaling point is a slow process. Extra caution should be used when blasting rock or coral that is in contact with the hull of a watercraft. This will avoid driving the rock further into the hull or inflicting shock wave damage on the ship. The only procedure feasible under such circumstances is to begin with very small charges per shot. After each blast, the results are checked and either the charge size is increased or the step is repeated by using the same size charge. Efforts to speed the process are likely to cause additional damage. Engineer divers are trained to use special procedures and techniques and are equipped to perform impalement-blasting operations.

## IMPALEMENT BLASTING OUTSIDE THE HULL

G-9. A hydraulic sinker drill is used to drill a pattern of small boreholes along the planned cut line, leaving some holes uncharged. Relief holes will vent explosive pressure and increase the shattering effect by decreasing the lateral burden about the charge (Figure G-1).



**Figure G-1. Impalement Blasting Outside the Hull**

G-10. A large internal patch of concrete is poured, if available, into a form inside the hull around the point of impalement. This establishes a medium that transmits the explosive shock wave from the water through the hull plate. Because the shock is absorbed and not reflected, larger charges per blast are possible without causing damage.

### WARNING

**As always, even when concrete is being used, treat initial shots as tests rather than one-shot solutions. Failure to comply could result in immediate personal injury or damage to equipment.**

G-11. Small charges (about 1/8 to 1/4 pound of explosives) are used initially. To avoid creating a large shock wave, small charges are used in a delay sequence. This process is continued until the impaling point is removed.

## IMPALEMENT BLASTING WITHIN THE HULL

G-12. The pinnacle is attacked from within the ship when external access to the impaling point is dangerous or impossible (Figure G-2, page G-4) The pinnacle is attacked by—

- Cementing the rock to the hull so that it plugs the hole (Figure G-3, page G-4).

---

*Note.* The ship can then be freed by shattering small portions of the impaling point and breaking the rock free, about 2 feet outside the hull, with each round of explosives.

---

- Using a hydraulic sinker drill to drill a pattern of small boreholes along the planned cut line, leaving some of the holes uncharged.

*Note.* Relief holes will vent explosive pressure and increase the shattering effect by decreasing the lateral burden about the charge.

- Repeating the procedure until the obstacle is removed.

**WARNING**

Open doors and cargo hatches to prevent an internal overpressurization of the hull. A flood control plan is required. Failure to comply could result in immediate personal injury or damage to equipment.

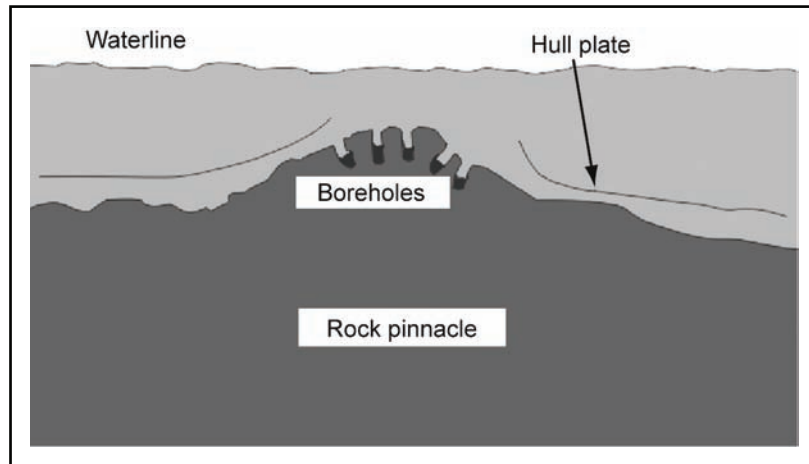


Figure G-2. Impalement Blasting Within the Hull

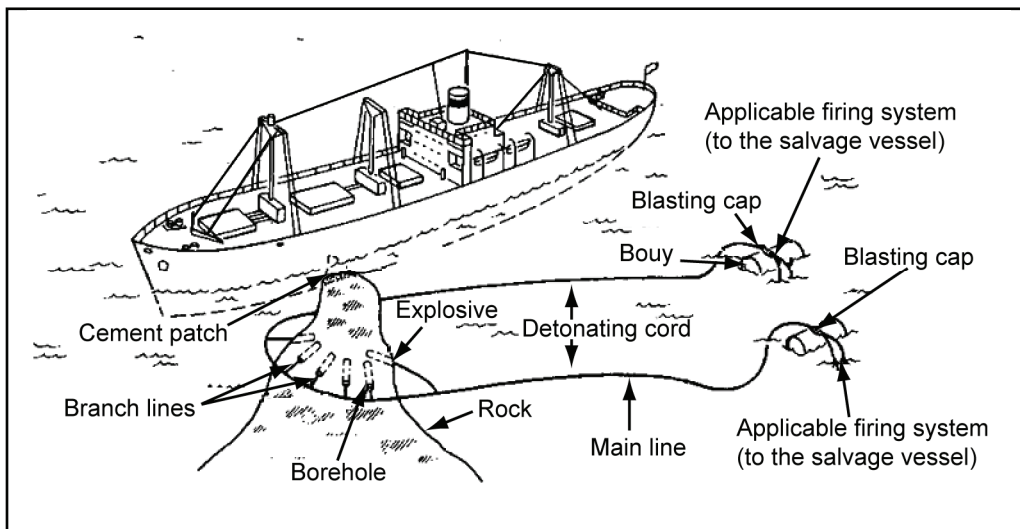


Figure G-3. Freeing a Ship From a Rock Pinnacle

## TRENCHING AND TUNNELING

G-13. Trenching and tunneling in a hard rock bottom requires the use of explosives. Such operations, adjacent to a ship that is to be salvaged, must be done with charges light enough so that the ship itself will not be damaged. After blasting in rock, an airlift may be needed to remove material (Figure G-4).

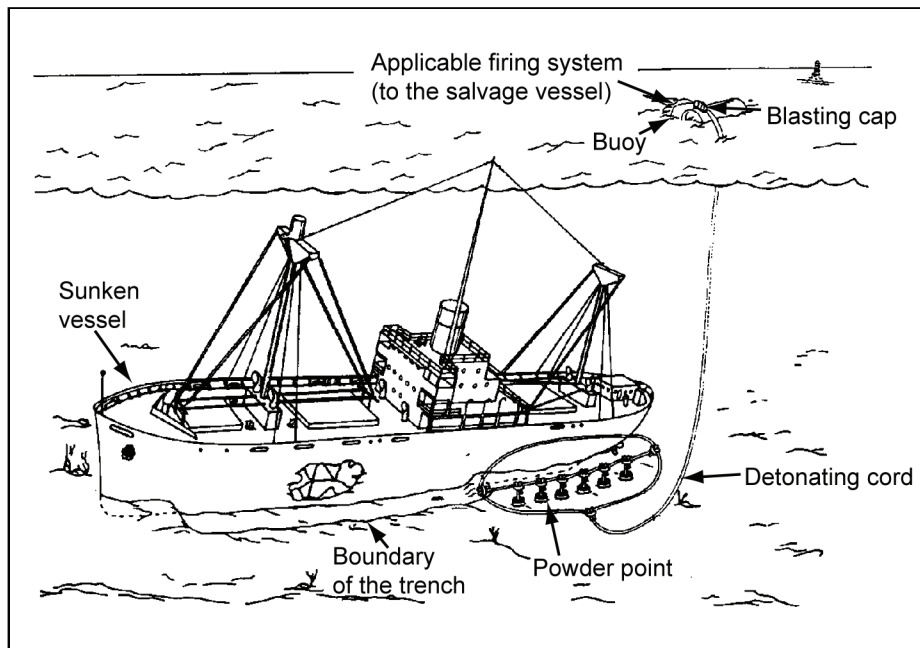


Figure G-4. Trenching and Tunneling With Explosives Alongside a Ship

### POWDER POINTS

G-14. Powder points are constructed by driving or jetting pipes into the bottom of a harbor or channel and then placing charges of composition C4 in the pipes. Charges are made above-water, then the diver places them into the pipes. To construct powder points, use the following procedures:

- **Above-water.**
  - Prepare the plastic explosive charges.
  - Tie a double overhand knot in detonating cord of sufficient length to lower the charge to the bottom of the pipe.
- **Underwater.**
  - Place the powder point perpendicular to the material to be moved.
  - Drive the powder point to a depth equal to that of the desired grade line, plus the distance between the points.
  - Mold the knotted detonating cord into the top half of the prepared, plastic-explosive charge, and place the charge into each pipe. Ensure that alternate points contain different charges so that the detonation effects will not cancel each other.
  - Join individual charges together by a branchline, and connect them to the ring main. Attach the ring main to the surface initiating system by using a double main line of detonating cord.

### BOREHOLES

G-15. When powder points cannot be used, place charges in boreholes spaced and staggered the same way as powder points. Boreholes for powder charges are constructed by digging or by using a hydraulic sinker drill. When a sinker drill is unavailable or time is limited, use small-shaped charges to blast small-diameter holes into the rock or hard bottom. Boreholes are enlarged by using additional explosives.

## CHANNEL ALTERATION

G-16. Channel alteration is an expanded trenching operation. The convenience of straight channels and free, open anchorages for ship handling must be sacrificed to speed and the most expedient means of making the harbor usable. Where a deep channel is necessary, a large amount of blasted bottom material must be removed with the aid of dredging equipment for ultimate disposal (Figure G-5).

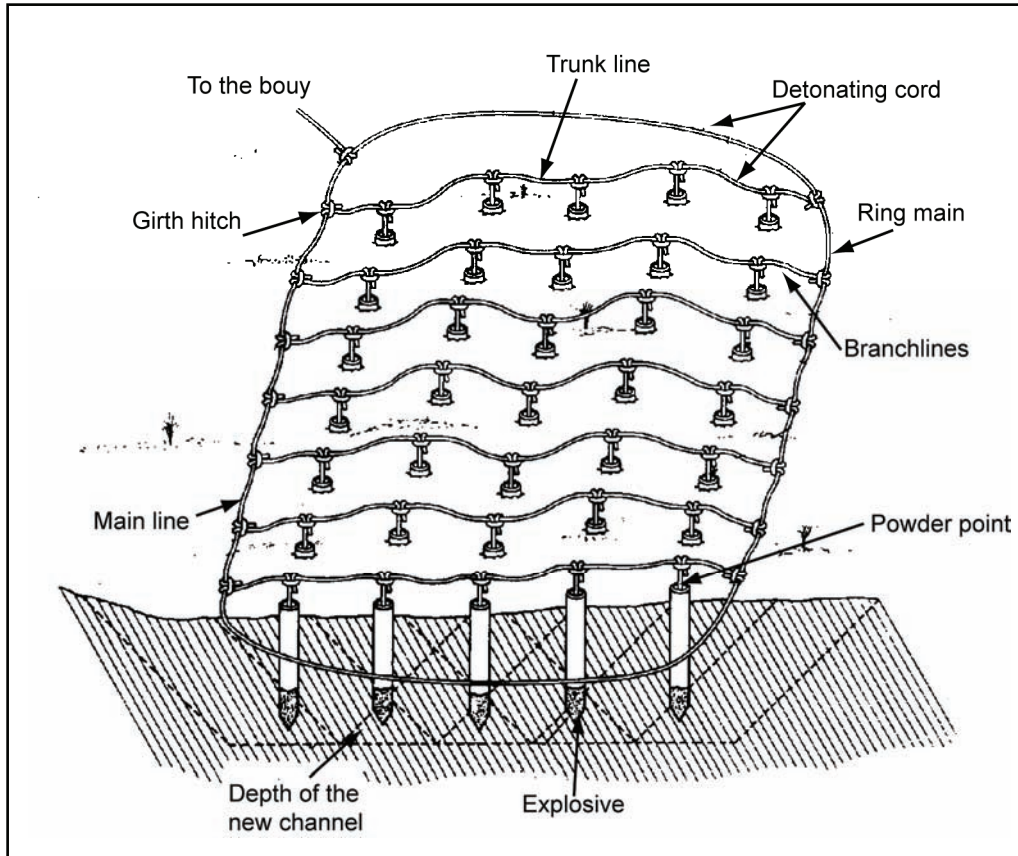


Figure G-5. Channel Alteration

### POWDER POINTS

G-17. For constructing powder points, refer to paragraph G-14. The procedure described here is used as the last procedure for completing underwater procedures (use this procedure for channel alteration only).

G-18. Widen or straighten a channel by placing a light charge along the bottom of the existing channel to be detonated at the same time as the charges in the side being blasted. This prevents the material blasted from the side from settling in the existing channel.

### BOREHOLES

G-19. Where powder points cannot be used, place charges in boreholes that are spaced and staggered the same way as powder points. The boreholes for powder charges are constructed by digging or by using a hydraulic sinker drill. When a sinker drill is unavailable or time is limited, use small-shaped charges to blast small-diameter holes into the rock or hard bottom. Boreholes are enlarged by using more explosives.



## SANDBAR REMOVAL

G-20. When sandbars cover a large area or the depth of the cut makes the use of a water jet to scour away sand impractical, use demolitions powder points (Figure G-6). Refer to the previous paragraphs for the use of powder points to trench, tunnel, and alter.

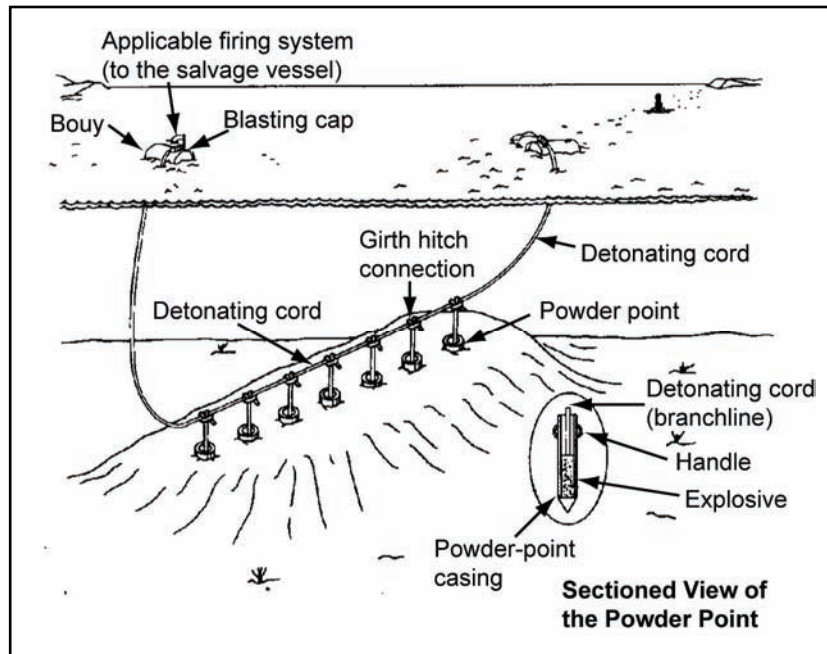


Figure G-6. Sandbar Removal

## DOUBLE-WATERPROOF FIRING ASSEMBLY

G-21. The double-waterproof firing assembly (DWFA) is used in water as an inexpensive and time-saving method of ensuring positive detonation of the main charge that has a detonating cord as the priming agent. The DWFA can be constructed from floatable materials other than wood, such as bubble wrap cushioning material or a steel drum (Figure G-7, page G-8).

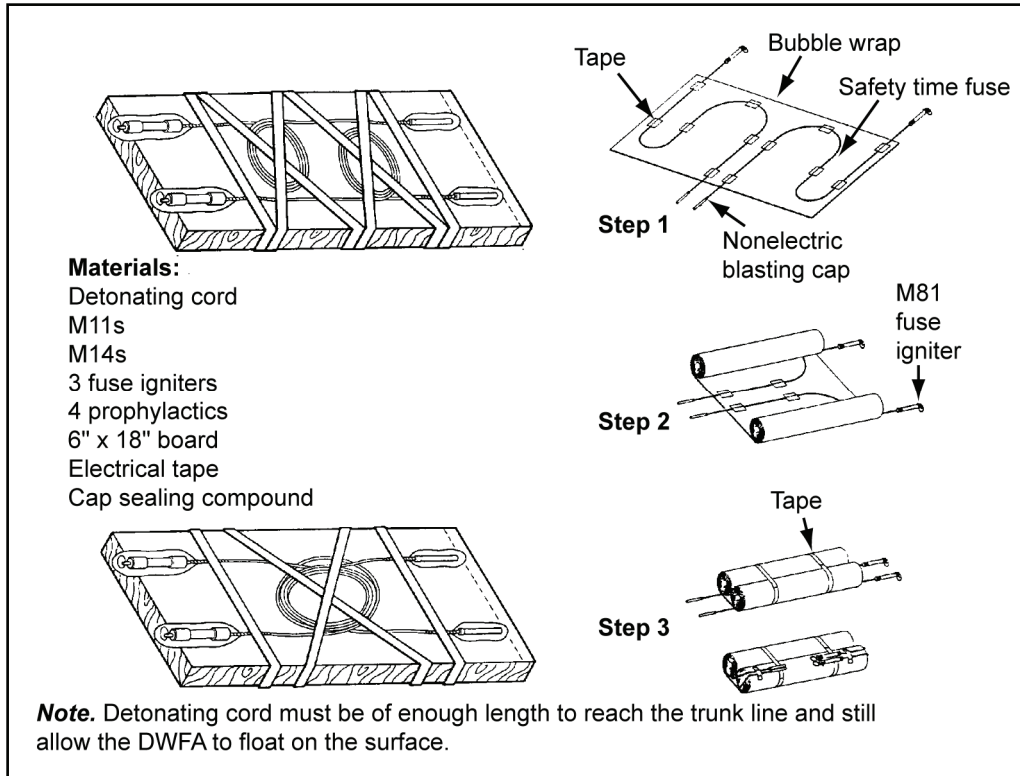


Figure G-7. DWFA Board

### DOUBLE-WATERPROOF FIRING ASSEMBLY BOARD OR BUBBLE WRAP PREFIRING PROCEDURES

G-22. When performing prefiring procedures using DWFA board or bubble wrap, the following precautions should be used:

- Observe standard explosive and nonelectric firing-safety precautions.
- Ensure that the DWFA remains on the surface of the water with the fuse igniter end securely taped to board or bubble wrap.

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**Note.** This prevents the rapid burning of the time fuse due to water pressure, which could cause premature detonation.

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- Attach the DWFA to the support line or the strain relief buoy, then attach the detonating cord to the blasting caps.
  - Untape the coils of the time fuse, and place them face down into the water to prevent them from burning through.
- 

**Note.** This could result in premature detonation.

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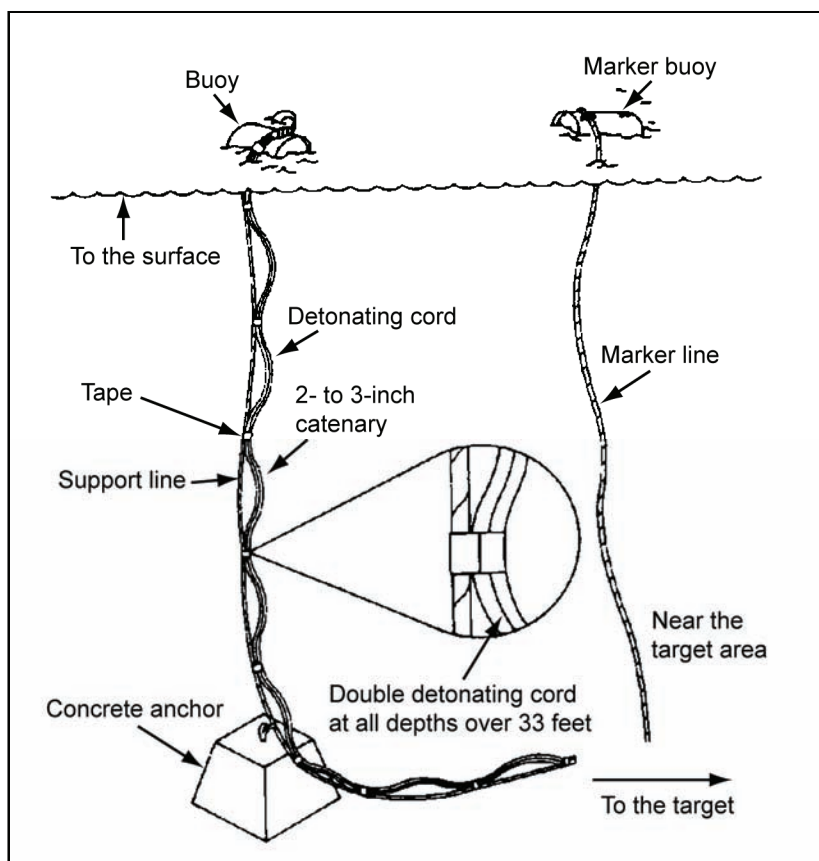
- Use multiple DWFAs on larger targets if necessary.

### DETONATING CORD PREPARATION

G-23. The paragraphs below describe how to prepare detonating cord. Discussed is how to prepare a support- or strain-relief line, an anchor, a detonating cord (doubling), and a marker buoy.

## SUPPORT- OR STRAIN-RELIEF LINE

G-24. The support- or strain-relief line is a strength member used to reinforce the firing train. It is attached to the DWFA and runs down to either the target or an anchor on the bottom (Figure G-8).



**Figure G-8. Typical Detonating Cord Preparation**

G-25. To reduce the possibility of breaking the firing train due to tension on the detonating cord, a support- or strain-relief line is connected to the detonating cord. The detonating cord is attached to the support or strain-relief line with plastic tie straps (zip ties). The tie straps are attached about every 3 feet with a 2- to 3-inch catenary (slack) between connecting points. One of the following should be used to attach the detonating cord to the trunk line:

- Gregory knot.
- Girth hitch with an extra turn connection.
- Detonating cord connector with a right-angle connection.

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*Note.* Several unconventional knots can be used, such as the Gregory knot and right-angle knot connection, to attach the detonating cord to the trunk line.

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## ANCHOR

G-26. The support or strain-relief line is attached with detonating cord to the target or to an anchor as close to the main charge as possible. This will avoid cap-and-charge separation due to wave action, current, and so forth.

**DETONATING CORD (DOUBLING)**

G-27. Detonating cord leads should be doubled at all depths over 33 feet. The double-strand detonating cord will be tie-strapped together to the support- or strain-relief line about every 3 feet.

**MARKER BUOY**

G-28. An additional marker buoy is attached to the target areas. This bouy is used for relocation when returning for shot investigation.

## Appendix H

# Attacking Bridges With Demolitions

The attack methods in this appendix are for the most common bridge types; however, they are not all inclusive. When faced with unusual construction methods or materials (for example, hayricks that are linear shaped charges used by host NATO countries), the responsible engineer should adapt one of the recommended methods or recategorize the bridge as a miscellaneous bridge and design the demolition using the principles discussed in Chapter 4. Use Tables H-1 through H-3, pages H-1 through H-3, to determine the required clearance to prevent jamming. Use Table H-4, pages H-4 through H-8, and Table H-5, pages H-9 through H-15, for the attack methods.

**Table H-1. Minimum  $E_R$  Values For Bottom Attack (Percent)**

<b>H/L</b>	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10
<b><math>E_R/L</math></b>	0.0002	0.0008	0.0020	0.0030	0.0050	0.0070	0.0100	0.0130	0.0160	0.0200
<b>H/L</b>	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20
<b><math>E_R/L</math></b>	0.0240	0.0290	0.0340	0.0390	0.0440	0.0500	0.0570	0.0630	0.0700	0.0770

where—

H = beam, truss, and bow depth in meters (includes the deck)

L = length of span for attack measured from end to end of the longitudinal members which support the deck in meters

$E_R$  = required end clearance in meters

**Notes.**

1. Go UP to the next higher value if the result of H/L is not on the chart exactly as calculated. For example, H/L = 0.076, use the column headed 0.08. Read down that column to determine  $E_R/L$ . In this case,  $E_R/L$  = 0.0130.
2. Multiply the  $E_R/L$  value determined from the chart by L to get  $E_R$ .

Table H-2. Minimum  $L_c$  Values For Top Attack (Midspan)

$\frac{L_s}{L}$	$(\frac{L_c}{L})$ Ratio of Section Removed to Span Length														
	$\frac{H}{L}$	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018	0.020	0.030	0.040	0.050	0.060	0.080
0.01	0.003	0.003	0.004	0.004	0.005	0.005	0.005	0.006	0.006	0.007	0.009	0.010	0.011	0.013	0.015
0.02	0.005	0.006	0.007	0.008	0.009	0.010	0.011	0.011	0.012	0.015	0.017	0.019	0.022	0.026	0.030
0.03	0.008	0.009	0.011	0.012	0.014	0.015	0.016	0.017	0.018	0.022	0.026	0.029	0.033	0.039	0.045
0.04	0.011	0.013	0.015	0.016	0.018	0.019	0.021	0.022	0.023	0.029	0.034	0.039	0.043	0.052	0.060
0.05	0.013	0.016	0.018	0.020	0.022	0.024	0.026	0.028	0.029	0.036	0.043	0.049	0.054	0.065	0.075
0.06	0.015	0.019	0.022	0.025	0.027	0.029	0.031	0.033	0.035	0.044	0.051	0.058	0.065	0.078	0.090
0.07	0.018	0.022	0.026	0.029	0.031	0.034	0.036	0.039	0.041	0.051	0.060	0.068	0.076	0.091	0.105
0.08	0.021	0.025	0.029	0.033	0.036	0.039	0.042	0.044	0.047	0.058	0.068	0.078	0.087	0.104	0.120
0.09	0.023	0.028	0.033	0.037	0.040	0.044	0.047	0.050	0.053	0.065	0.077	0.087	0.097	0.116	0.135
0.10	0.026	0.032	0.036	0.041	0.045	0.049	0.052	0.055	0.058	0.073	0.085	0.097	0.108	0.129	0.150
0.11	0.028	0.035	0.040	0.045	0.049	0.053	0.057	0.061	0.064	0.080	0.094	0.107	0.119	0.142	0.165
0.12	0.031	0.038	0.044	0.049	0.054	0.058	0.062	0.066	0.070	0.087	0.102	0.116	0.130	0.155	0.180
0.13	0.033	0.041	0.047	0.053	0.058	0.063	0.067	0.072	0.076	0.095	0.111	0.126	0.140	0.168	0.195
0.14	0.036	0.044	0.051	0.057	0.063	0.068	0.073	0.077	0.082	0.102	0.119	0.136	0.151	0.181	0.210
0.15	0.038	0.047	0.054	0.061	0.067	0.073	0.078	0.083	0.088	0.109	0.128	0.145	0.162	0.194	0.225
0.16	0.041	0.050	0.058	0.065	0.072	0.078	0.083	0.088	0.093	0.116	0.136	0.155	0.173	0.207	0.240
0.17	0.043	0.053	0.062	0.069	0.076	0.082	0.088	0.094	0.099	0.124	0.145	0.165	0.184	0.220	0.255
0.18	0.046	0.056	0.065	0.073	0.080	0.087	0.093	0.099	0.105	0.131	0.154	0.175	0.194	0.233	0.270
0.19	0.049	0.060	0.069	0.077	0.085	0.092	0.099	0.105	0.111	0.138	0.162	0.184	0.205	0.246	0.285
0.20	0.051	0.063	0.073	0.081	0.089	0.097	0.104	0.110	0.117	0.145	0.171	0.194	0.216	0.259	0.300

**Note.** If the results of  $L_s/L$  or  $H/L$  are not on the chart exactly as calculated, go UP to the next higher value on the chart. For example, if  $H/L = 0.021$ , use 0.03; if  $L_s/L = 0.0142$ , use 0.016. Intersect the  $L_s/L$  and  $H/L$  values on the chart to get the value of  $L_c/L$ . Multiply the  $L_c/L$  value by  $L$  to get  $L_c$ .

**Table H-3. Minimum  $L_c$  Values For Arch and Pinned-Footing Bridge Attacks**

<b>H/L</b>	0.040	0.060	0.080	0.100	0.120	0.140	0.160	0.180	0.200
<b><math>L_c/L</math></b>	0.003	0.007	0.013	0.020	0.030	0.040	0.053	0.067	0.083
<b>H/L</b>	0.220	0.240	0.260	0.280	0.300	0.320	0.340	0.360	—
<b><math>L_c/L</math></b>	0.100	0.130	0.150	0.170	0.200	0.230	0.270	0.300	—

where—

H = rise for arch or portal bridges (measure the rise) [in meters] from the springing or bottom of the support leg to the deck or top of the arch, whichever is greater)

L = length of span for attack between the centerlines of the bearings (in meters)

$L_c$  = required length of the span removed (in meters)

**Note.** If the result of H/L is not on the chart exactly as calculated, go UP to the next higher value on the chart. For example, if H/L = 0.089, use 0.100 to determine  $L_c/L$ . In this case,  $L_c/L = 0.02$ . Multiply the  $L_c/L$  value by L to get  $L_c$ . For example,  $0.02 \times L = L_c$ .

Table H-4. Attack Methods on Simply Supported Bridges

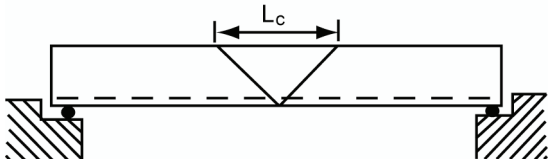
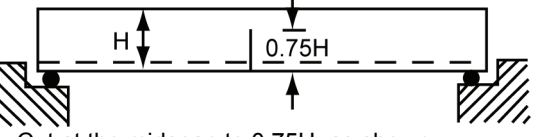
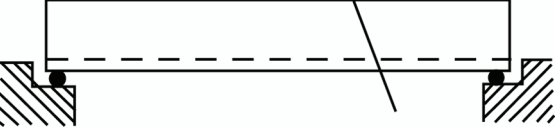
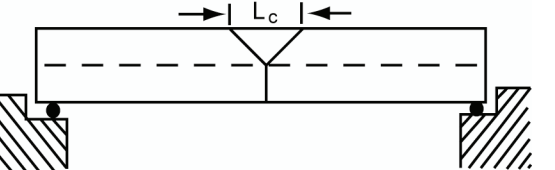
Serial <i>a</i>	Sub-category <i>b</i>	Type <i>c</i>	Attack Method <i>d</i>	Remarks <i>e</i>
1	Steel beam	Through bridge, Method I	<p>Top attack:</p>  <ol style="list-style-type: none"> <li>1. Cut at the midspan.</li> <li>2. Cut the beams, including the bottom flange in a "V."</li> <li>3. Do not consider cutting the deck.</li> </ol>	None
2	Steel beam	Through bridge, Method II	<p>Bottom attack: <math>E</math> is greater than <math>E_R</math></p>  <ol style="list-style-type: none"> <li>1. Cut at the midspan to <math>0.75H</math>, as shown.</li> <li>2. Cut the deck across the full bridge width.</li> </ol>	None
3	Steel beam	Through bridge, Method III	<p>Angled attack:</p>  <ol style="list-style-type: none"> <li>1. Cut between the <math>1/3</math> span and the midspan.</li> <li>2. Cut the deck across the full bridge width.</li> </ol>	End clearance is not a consideration.
4	Steel beam	Through bridge, Method IV	<p>Bottom attack: <math>E</math> is less than <math>E_R</math></p> <ol style="list-style-type: none"> <li>1. Cut at the midspan to <math>0.75H</math>.</li> <li>2. Cut the deck across the full bridge width.</li> <li>3. Attack one abutment or pier to create sufficient end clearance.</li> </ol>	None
5	Steel beam	Through bridge, Method V	<p>Top attack:</p>  <ol style="list-style-type: none"> <li>1. Cut at the midspan.</li> <li>2. Cut the bridge as shown where the deck is located well above the beam bottom.</li> <li>3. Do not consider cutting the deck.</li> </ol>	None



Table H-4. Attack Methods on Simply Supported Bridges

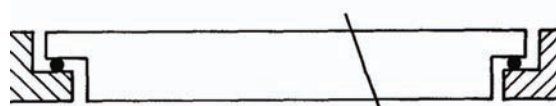
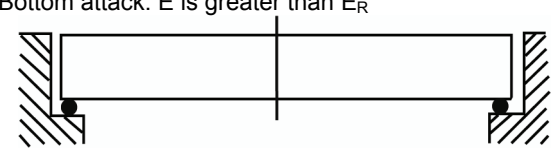
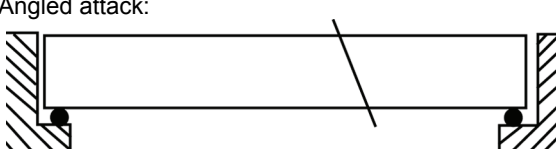
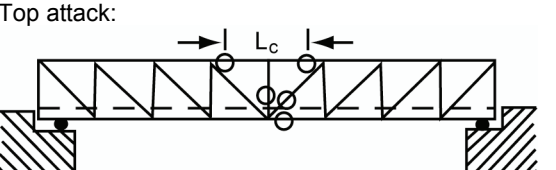
Serial	Sub-category	Type	Attack Method	Remarks
a	b	c	d	e
6	Steel beam	Deck bridge, top support	<p>Angled attack:</p>  <ol style="list-style-type: none"> <li>Cut between the 1/3 span and the midspan.</li> <li>Cut the deck across the full bridge width.</li> </ol>	<ol style="list-style-type: none"> <li>Configuration found in cantilever and suspended-span bridges.</li> <li>End clearance is not a consideration.</li> </ol>
7	Steel beam	Deck bridge, bottom support, Method I	<p>Bottom attack: <math>E</math> is greater than <math>E_R</math></p>  <ol style="list-style-type: none"> <li>Cut at the midspan.</li> <li>Do not consider cutting the deck.</li> </ol>	None
8	Steel beam	Deck bridge, bottom support, Method II	<p>Bottom attack: <math>E</math> is less than <math>E_R</math></p> <ol style="list-style-type: none"> <li>Cut at the midspan.</li> <li>Do not consider cutting the deck.</li> <li>Attack one abutment or pier to create sufficient end clearance.</li> </ol>	None
9	Steel beam	Deck bridge, bottom support, Method III	<p>Angled attack:</p>  <ol style="list-style-type: none"> <li>Cut between the 1/3 span and the midspan.</li> <li>Cut the deck across the full bridge width.</li> </ol>	End clearance is not a consideration.
10	Steel truss	Through bridge, Method I	<p>Top attack:</p>  <ol style="list-style-type: none"> <li>Cut at the midspan.</li> <li>Cut the top chord twice, vertically (if necessary), diagonals, and bottom chord.</li> <li>Remove the wind bracing over the midspan.</li> <li>Do not consider cutting the deck.</li> </ol>	None

Table H-4. Attack Methods on Simply Supported Bridges

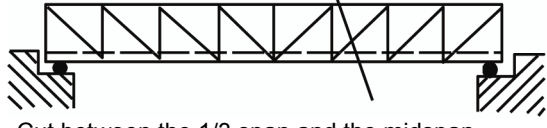
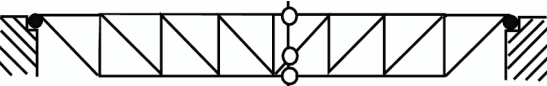
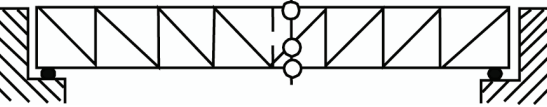
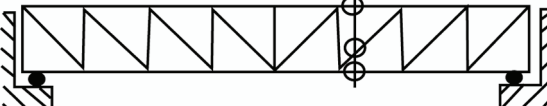
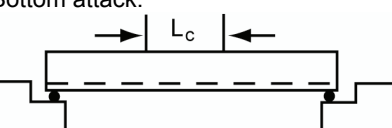
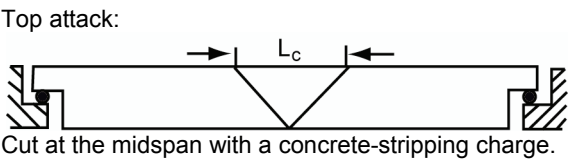
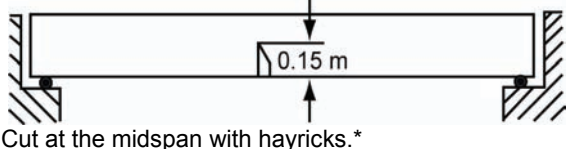
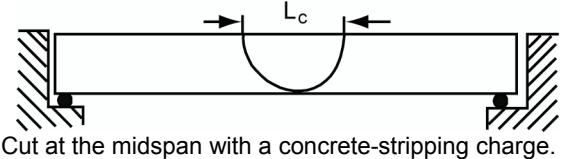
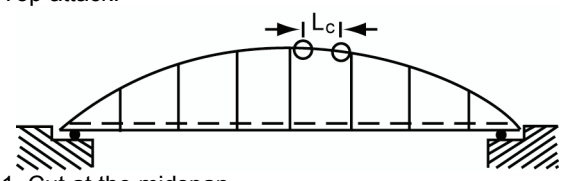
Serial	Sub-category	Type	Attack Method	Remarks
a	b	c	d	e
11	Steel truss	Through bridge, Method II	<p>Angled attack:</p>  <ol style="list-style-type: none"> <li>Cut between the 1/3 span and the midspan.</li> <li>Cut the top chord, diagonals, and bottom chord in one bay only.</li> <li>Cut the deck across the full bridge width.</li> </ol>	None
12	Steel truss	Deck bridge, top support	<p>Bottom attack:</p>  <ol style="list-style-type: none"> <li>Cut between the 1/3 span and the midspan.</li> <li>Cut the top chord, diagonals, and bottom chord in one bay only.</li> <li>Do not consider cutting the deck.</li> </ol>	<ol style="list-style-type: none"> <li>Configuration found in cantilever and suspended-span bridges.</li> <li>End clearance is not a consideration.</li> </ol>
13	Steel truss	Deck bridge, bottom support, Method I	<p>Bottom attack: <math>E</math> is greater than <math>E_R</math></p>  <ol style="list-style-type: none"> <li>Cut at the midspan.</li> <li>Cut the top chord, diagonals, and bottom chord in one bay only.</li> <li>Do not consider cutting the deck.</li> </ol>	None
14	Steel truss	Deck bridge, bottom support, Method II	<p>Bottom attack: <math>E</math> is less than <math>E_R</math></p> <ol style="list-style-type: none"> <li>Cut at the midspan.</li> <li>Cut the top chord, diagonals, and bottom chord in one bay only.</li> <li>Do not consider cutting the deck.</li> <li>Attack one abutment or pier to create sufficient end clearance.</li> </ol>	None
15	Steel truss	Deck bridge, bottom support, Method III	<p>Angled attack:</p>  <ol style="list-style-type: none"> <li>Cut between the 1/3 span and midspan.</li> <li>Cut the deck across the full bridge width.</li> </ol>	End clearance is not a consideration.
16	Concrete	Through bridge	<p>Bottom attack:</p>  <ol style="list-style-type: none"> <li>Cut at the midspan.</li> <li>Cut the deck across the full bridge width.</li> </ol>	This method applies to slab bridges only.

Table H-4. Attack Methods on Simply Supported Bridges

Serial	Sub-category	Type	Attack Method	Remarks
a	b	c	d	e
17	Concrete	Deck bridge, top support	<p>Top attack:</p>  <p>Cut at the midspan with a concrete-stripping charge.</p>	<ol style="list-style-type: none"> <li>1. Configuration found in cantilever and suspended-span bridges.</li> <li>2. Remove concrete for <math>L_c</math> distance to the full width and depth of beams.</li> </ol>
18	Concrete	Deck bridge, bottom support, Method I	<p>Bottom attack: E is greater than <math>E_R</math></p>  <p>Cut at the midspan with hayricks.*</p>	<ol style="list-style-type: none"> <li>1. This method applies to slab bridges only.</li> <li>2. Sufficient reinforcing bars are cut to cause bridge collapse.</li> </ol>
19	Concrete	Deck bridge, bottom support, Method II	<p>Bottom attack: E is less than <math>E_R</math></p> <ol style="list-style-type: none"> <li>1. Cut at the midspan with hayricks.*</li> <li>2. Attack one abutment or pier to create a sufficient end clearance.</li> </ol>	<p>This method applies to slab bridges only.</p>
20	Concrete	Deck bridge, bottom support, Method III	<p>Top attack: E is less than <math>E_R</math></p>  <p>Cut at the midspan with a concrete-stripping charge.</p>	<p>Remove concrete for <math>L_c</math> distance to full width and depth of beams.</p>
21	Bowstring	Normal	<p>Top attack:</p>  <ol style="list-style-type: none"> <li>1. Cut at the midspan.</li> <li>2. Cut the bow in two places.</li> <li>3. Cut all hangers between the bow cuts.</li> <li>4. Do not consider cutting the deck.</li> </ol>	<p>None</p>

**Table H-4. Attack Methods on Simply Supported Bridges**

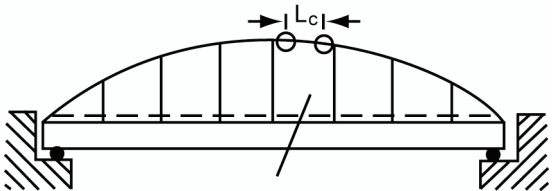
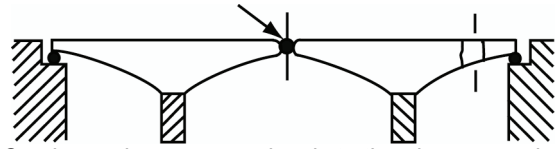
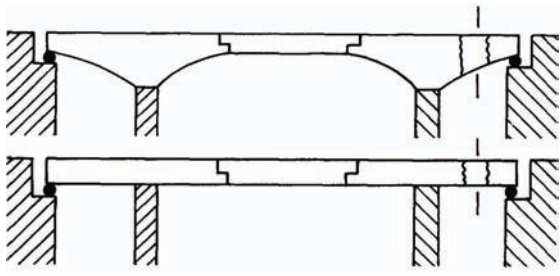
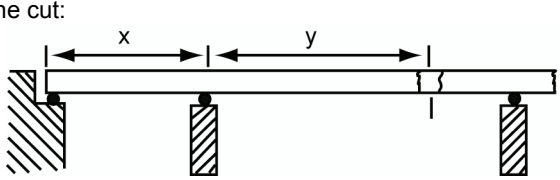
<i>Serial</i>	<i>Sub-category</i>	<i>Type</i>	<i>Attack Method</i>	<i>Remarks</i>
<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>
22	Bowstring	Reinforced beam or truss	<p>Top attack, plus girders:</p>  <p>1. Cut the truss or beam with the appropriate method (Serials 1 through 15). 2. Cut the bow in two places, including the hangers.</p>	None
*Hayricks are not in the U.S. Army supply system.				

Table H-5. Attack Methods on Continuous Bridges

Serial	Sub-category	Type	Attack Method	Remarks
a	b	c	d	e
1	Concrete	Cantilever	<p>Two cuts:</p>  <p>1. Cut the anchor span as closely to the pier as practical. 2. Cut the midspan shear joint.</p>	<p>1. Cutting the anchor span may require a two-stage attack. 2. Use a concrete-stripping charge for the first stage.</p>
2	Concrete	Cantilever and suspended span	<p>One cut:</p>  <p>Cut the anchor as closely to the pier as practical.</p>	<p>1. Cutting the anchor span may require a two-stage attack. 2. Use a concrete-stripping charge for the first stage. 3. If demolition of the suspended span will create the desired obstacle, regard the span as simply supported and attack accordingly.</p>
3	Concrete	Beam or truss with short side span	<p>One cut:</p>  <p>1. Cut interior span so <math>y</math> is greater than <math>1.25x</math>. 2. If necessary, cut other interior spans as in Serial 4.</p>	<p>1. Cutting longer spans may require a two-stage attack. 2. Use a concrete-stripping charge for the first stage.</p>

**Table H-5. Attack Methods on Continuous Bridges**

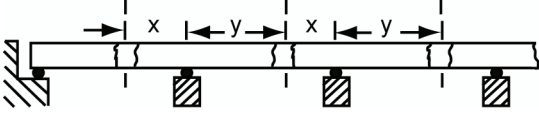
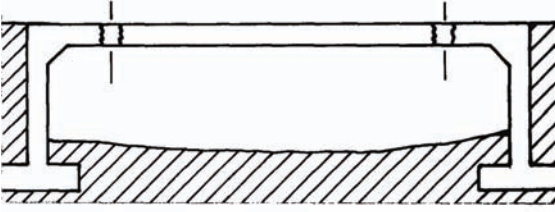
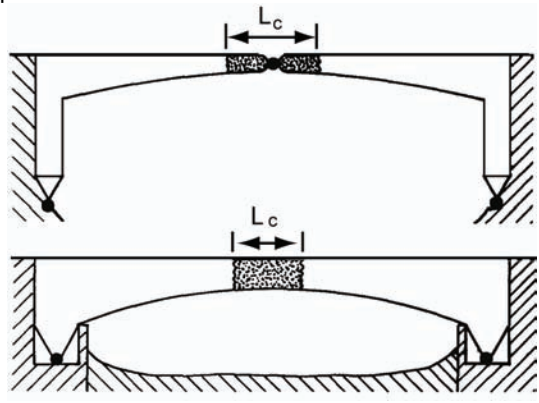
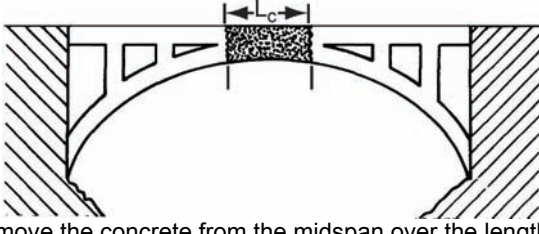
Serial	Sub-category	Type	Attack Method	Remarks
a	b	c	d	e
4	Concrete	Beam or truss without short side span	<p>Two or more cuts:</p>  <p>Cut the interior span so <math>y</math> is greater than <math>1.25x</math>.</p>	<ol style="list-style-type: none"> <li>1. Cutting these spans may require a two-stage attack.</li> <li>2. Use a concrete-stripping charge for the first stage.</li> </ol>
5	Concrete	Portal, fixed footing	<p>Two cuts:</p>  <p>Cut the span twice, close to the pier.</p>	<ol style="list-style-type: none"> <li>1. Cutting these spans may require a two-stage attack.</li> <li>2. Use a concrete-stripping charge for the first stage.</li> </ol>
6	Concrete	Portal, pinned footing	<p>Strip concrete:</p>  <p>Remove concrete from the midspan over length <math>L_c</math> with a concrete-stripping charge.</p>	<ol style="list-style-type: none"> <li>1. Remove all concrete for <math>L_c</math>.</li> <li>2. A one-stage attack should be adequate.</li> <li>3. When footing conditions are unknown, use Serial 5.</li> <li>4. For <math>L_c</math> use Table H-3, page H-3.</li> </ol>
7	Concrete	Arch, open spandrel, fixed footing, Method I	<p>Strip concrete:</p>  <p>Remove the concrete from the midspan over the length of <math>L_c</math> with a concrete-stripping charge.</p>	<ol style="list-style-type: none"> <li>1. Applies to arches greater than 35 meters.</li> <li>2. A one-stage attack should be adequate.</li> <li>3. For <math>L_c</math> use Table H-3.</li> </ol>

Table H-5. Attack Methods on Continuous Bridges

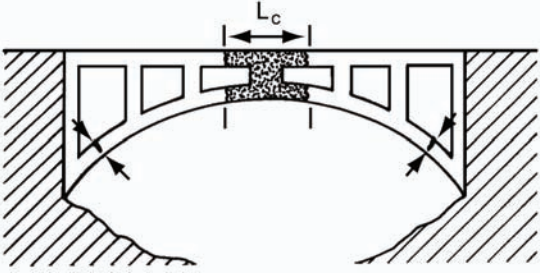
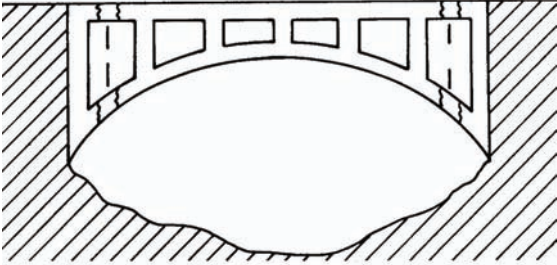
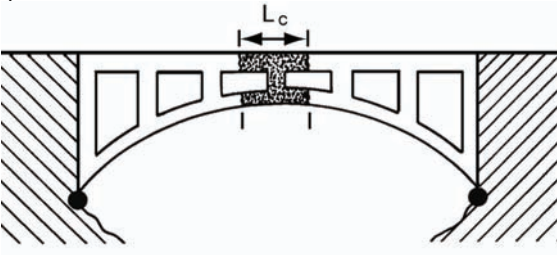
Serial	Sub-category	Type	Attack Method	Remarks
a	b	c	d	e
8	Concrete	Arch, open spandrel, fixed footing, Method II	<p>Strip concrete:</p>  <p>1. Remove the concrete from the midspan over the length of <math>L_c</math> with a concrete-stripping charge. 2. Attack springing with hayricks* at the top face of the arch ring.</p>	<p>1. Applies to arches less than 35 meters. 2. A one-stage attack should be adequate. 3. For <math>L_c</math> use Table H-3, page H-3.</p>
9	Concrete	Arch, open spandrel, fixed footing, Method III	<p>Four cuts:</p> 	<p>1. This is an alternative to Method II, applies to arches less than 35 meters. 2. Two-stage attack will probably be required. 3. Use a concrete-stripping charge for the first stage. 4. For <math>L_c</math> use Table H-3.</p>
10	Concrete	Arch, open spandrel, pinned footing	<p>Strip concrete:</p>  <p>Remove concrete from the midspan over the length of <math>L_c</math> with a concrete-stripping charge.</p>	<p>1. A one-stage attack should be adequate. 2. For <math>L_c</math> use Table H-3.</p>

Table H-5. Attack Methods on Continuous Bridges

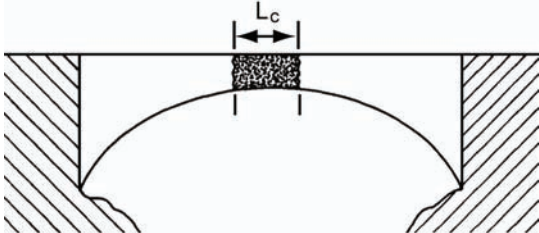
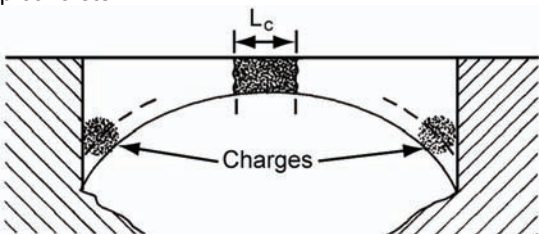
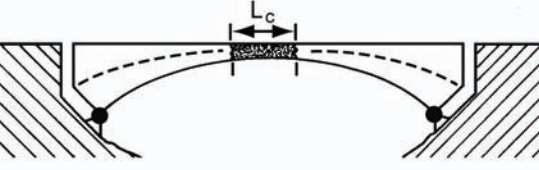
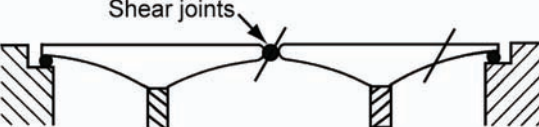
Serial	Sub-category	Type	Attack Method	Remarks
a	b	c	d	e
11	Concrete	Arch, solid spandrel, fixed footing, Method I	<p>Strip concrete:</p>  <p>Remove the concrete from the midspan over the length of <math>L_c</math> with a concrete-stripping charge.</p>	<p>1. This applies to arches of span greater than 35 meters only.                  2. A one-stage attack should be adequate.                  3. For <math>L_c</math> use Table H-3, page H-3.</p>
12	Concrete	Arch, solid spandrel, fixed footing, Method II	<p>Strip concrete:</p>  <p>1. Remove concrete from the midspan over the length of <math>L_c</math> with a concrete-stripping charge.                  2. Attack both springing points with concrete-stripping charges.</p> <ul style="list-style-type: none"> <li>• Against the bottom face of the arch ring.</li> <li>• Against the top face (must remove the fill beneath the roadway to access the arch ring).</li> </ul>	<p>1. Applies to arches less than 35 meters.                  2. A one-stage attack should be adequate.                  3. For <math>L_c</math> use Table H-3.</p>
13	Concrete	Arch, solid spandrel, pinned footing	<p>Strip concrete:</p>  <p>Remove concrete from the midspan over the length of <math>L_c</math> with a concrete-stripping charge.</p>	<p>1. A one-stage attack should be adequate.                  2. For <math>L_c</math> use Table H-3.</p>
14	Steel	Cantilever	<p>Two cuts:</p>  <p>1. Cut the anchor span as closely to the pier as practical.                  2. Cut the midspan shear joints.</p>	None



Table H-5. Attack Methods on Continuous Bridges

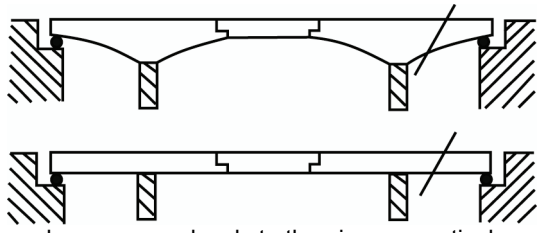
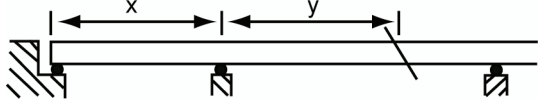
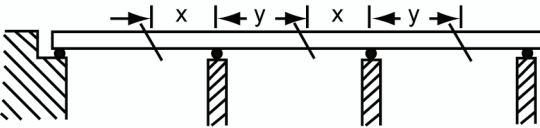
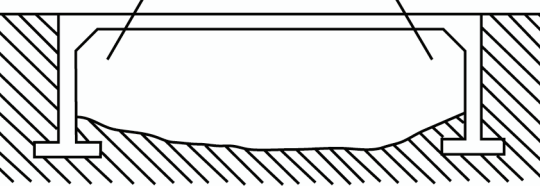
Serial	Sub-category	Type	Attack Method	Remarks
a	b	c	d	e
15	Steel	Cantilever and suspended span	<p>One cut:</p>  <p>Cut anchor span as closely to the pier as practical.</p>	<p>If demolition of the suspended span will create the desired obstacle, regard the span as simply supported, and attack accordingly.</p>
16	Steel	Beam or truss with short side span	<p>One cut:</p>  <p>1. Cut the interior span so y is greater than 1.25x. 2. If necessary, cut other interior spans as in Serial 17.</p>	None
17	Steel	Beam or truss without short side span	<p>Two or more cuts:</p>  <p>Cut spans so y is greater than 1.25x.</p>	None
18	Steel	Portal, fixed footing	<p>Two cuts:</p>  <p>Cut the span twice and close to the piers.</p>	None

Table H-5. Attack Methods on Continuous Bridges

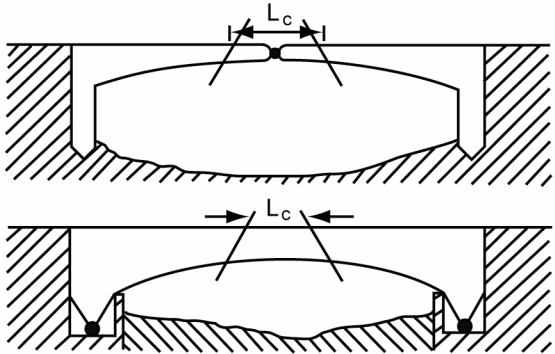
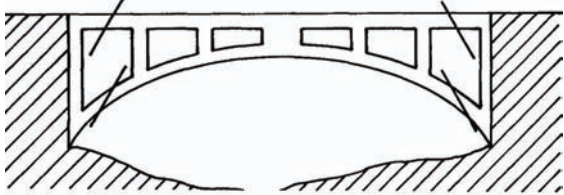
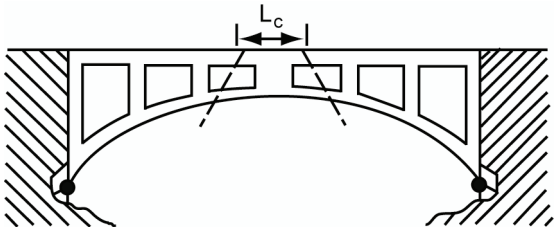
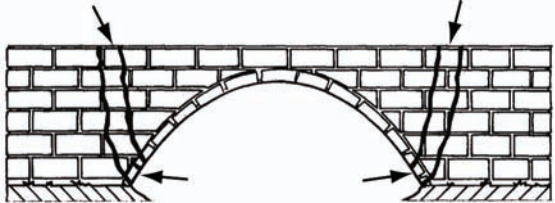
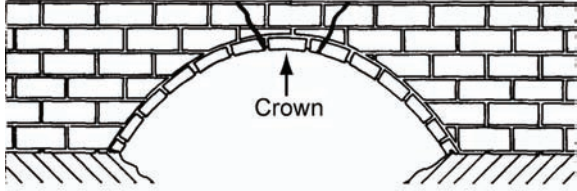
Serial	Sub-category	Type	Attack Method	Remarks
a	b	c	d	e
19	Steel	Portal, pinned footing	<p>Two cuts:</p>  <p>Remove the section from the midspan over the length of <math>L_c</math>.</p>	Use Table H-3, page H-3, for $L_c$ .
20	Steel	Arch, open spandrel, fixed footing	<p>Four cuts:</p> 	<ol style="list-style-type: none"> <li>1. Angle cuts about <math>70^\circ</math>.</li> <li>2. For <math>L_c</math>, use Table H-3.</li> </ol>
21	Steel	Arch, open spandrel, pinned footing	<p>Two cuts:</p>  <p>Remove the section from the midspan over the length of <math>L_c</math>.</p>	For $L_c$ , use Table H-3.
22	Masonry	Arch, Method I	<p>Two cuts:</p>  <ol style="list-style-type: none"> <li>1. Cut at the haunches.</li> <li>2. Attack the arch ring, spandrel walls, and parapet.</li> </ol>	None

Table H-5. Attack Methods on Continuous Bridges

Serial	Sub-category	Type	Attack Method	Remarks
a	b	c	d	e
23	Masonry	Arch, Method II	<p>One cut:</p>  <p>Breach the arch ring at the crown.</p>	<p>1. Use this method as an alternate to Method I only when time is insufficient to allow attack at the haunches.                  2. For L<sub>c</sub>, use Table H-3, page H-3.</p>
*Hayricks are not in the U.S. Army supply system.				

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## **Appendix I**

# **Instructions For Completing Demolitions-Related Reports**

A completed target folder contains demolition orders and an obstacle folder. Chapter 5 discusses demolition orders and the obstacle folder. The sample form shown in Figure I-1, pages I-4 through I-8, is used to complete DA Form 2203. Page 4 of DA Form 2203 provides detailed instructions on how to complete the form.



<b>DEMOLITION RECONNAISSANCE RECORD (Continued)</b>	
Place additional comments in the appropriate blocks.	
<b>15. EQUIPMENT AND TRANSPORT REQUIRED (Continued)</b>	<i>HMMMW (1 - transport of caps) 2 1/2 ton cargo (1 - transport of demo) Rope 3/4 in (200 ft) Squad vehicle (1 - transport of troops)</i>
<b>17. TIME, LABOR, AND EQUIPMENT REQUIRED FOR BYPASS (Continued)</b>	<i>To bridge at site: 1 dozer, 1 bucket loader, 3.5 hours to clear and improve approach. Ribbon bridge assembly - 10 interior bays, 2 ramp bays, 30 minutes MGB - 1 company, 3 hours</i>
<b>18. REMARKS (Continued)</b>	
<b>19. ADDITIONAL COMMENTS (Specify block)</b>	<i>Block 8 cont'd. Bridge is over Big Piney River, near town of Devil's Elbow. Block 13 cont'd. Antivehicle ditch (wheel only) on southeast side of bridge.</i>

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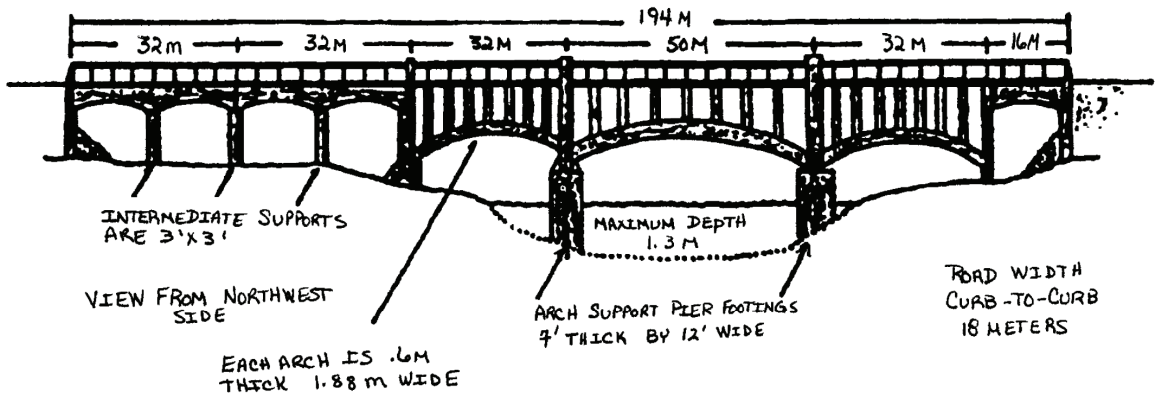
Figure I-1. Sample DA Form 2203 (Continued)

<b>DEMOLITION RECONNAISSANCE RECORD (Continued)</b>	
Place additional comments in the appropriate blocks.	
20. GENERAL DESCRIPTION SKETCH (Attach additional sketches if required)	
21. PURPOSE OF PROPOSED DEMOLITION SKETCH (Attach additional sketches if required)	
<p style="text-align: center;">CHARGE PLACEMENT</p>	<p style="text-align: center;">FIRING SYSTEM</p>
<div style="display: flex; justify-content: space-between;"> <span>DA FORM 2203, MAY 2007</span> <span>Page 3 of 4 APD V1.00</span> </div>	

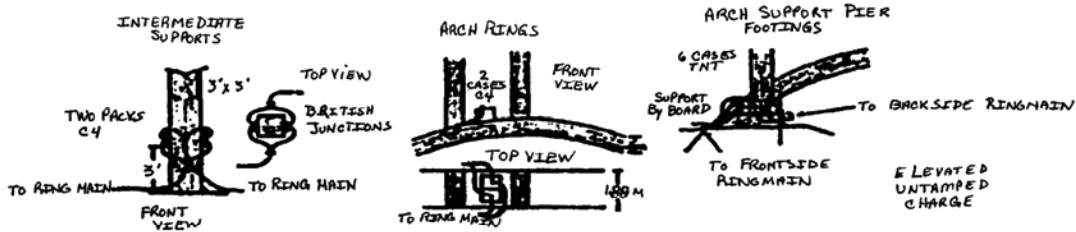
Figure I-1. Sample DA Form 2203 (Continued)



Block 20. GENERAL DESCRIPTION (CONTINUED)



Block 21. NATURE OF PROPOSED DEMOLITION SKETCH (CONTINUED)  
METHOD OF PRIMING AND CHARGE CALCULATIONS



INTERMEDIATE SUPPORT  
(USE COUNTERFORCE CHARGE)

1. CRITICAL DIMENSIONS: SUPPORT IS 3' x 3'
2. SOLVE FOR TNT: (1 1/2 lbs per Foot)  
 $1\frac{1}{2} \times 3 = 4.5$  lbs of C4 (C4 REQUIRED)
3. DIVIDE BY RE: (USING C4, RE: 1.34)  
NO CONVERSION REQUIRED; COUNTERFORCE IS CALCULATED IN C4.
4. SOLVE FOR SINGLE CHARGE PACKAGE:  
 $4.5 \div 1.25$  (PKG WT C4) = 3.6 @ 4 PACKAGES
5. NUMBER OF CHARGES: 8 SUPPORTS
6. TOTAL REQUIRED: (STEP 4 x STEPS)  
4 PACKAGES x 8 SUPPORTS = 32 PACKAGES

ARCH RINGS (USE CONCRETE STRIPPING CHARGE)

1. CRITICAL DIMENSIONS: 1.88 M WIDE BY .6 M DEEP
2. SOLVE FOR TNT:  $P = (3.3 \times .6 + .5)^3 \div 1.5$   
 $P = (2.48)^3 \div 1.5$   
 $P = 16.25$   
 $16.25 \times 1.5 = 22.875$  Kg/m  
 $22.875 \times 1.88 = 43.005$  Kg/m  
 $43.005 \times 2.2046 = 94.81$  LBS TNT
3. DIVIDE BY RE (RE FOR C4 = 1.34)  
 $94.81 \div 1.34 = 70.75$  LBS C4
4. SOLVE FOR SINGLE CHARGE:  
 $70.75 \div 1.25 = 56.67$  @ 57 PKGS
5. NUMBER OF TARGETS = 8

ARCH RINGS (CONTD)

6. TOTAL REQUIRED: (STEP 4 x STEPS)  
 $57 \times 8 = 456$  PKGS  
600 PKGS PER BOX = 15.2 @ 16 CASES

PIER FOOTINGS

- (USE BREACHING FORMULA:  $P = R^3 KC$ )
1. CRITICAL DIMENSIONS: PIER IS 2 1/2' x 7' x 9'
  2. SOLVE FOR TNT:  $R = 7' \cdot 7^3 = 343$   
K FOR REINFORCED CONCRETE OR  $\geq .54$   
C FOR ELEVATED UNTAMPED = 1.8  
 $343 \times .34 \times 1.8 = 333.39$
  3. DIVIDE BY RE: (RE FOR TNT = 1)  
 $333.39 \div 1 = 333.39$
  4. SOLVE FOR SINGLE CHARGE PACKAGE:  
 $333.39 \div 1$  (1 LB PKG OF TNT): 333.39  
 $333.39 @ = 334$  PACKAGES
  5. NUMBER OF CHARGES = 4 PIER
  6. TOTAL REQUIRED: (STEP 4 x STEPS)  
 $334 \times 4 = 1336$  PACKAGES  
(36 PKG PER BOX = 23.8 CASES)  
 $23.8 @ 24$  CASES

Figure I-1. Sample DA Form 2203 (Continued)

<b>DEMOLITION RECONNAISSANCE RECORD (Continued)</b>
Instructions for completing the DA Form 2203
<p><b>Use the following instructions to complete DA Form 2203.</b></p> <p><i>Block 1 (FILE NO.).</i> Leave blank unless a higher headquarters provides this number. Higher headquarters provides this number or enters it after the form has been submitted.</p> <p><i>Block 2 (DEMOLITION RECON REPORT NO.).</i> Leave blank unless a higher headquarters provides this number. Higher headquarters provides this number or enters it after the form has been submitted. The company SOP may specify the procedures for determining this number.</p> <p><i>Block 3 (DATE).</i> Enter the date the reconnaissance was performed.</p> <p><i>Block 4 (TIME).</i> Enter the time the reconnaissance party arrived at the target site (local or Zulu time).</p> <p><i>Block 5 (RECON ORDERED BY).</i> Enter the name, rank, and organization of the command authority authorizing the reconnaissance action.</p> <p><i>Block 6 (PARTY LEADER).</i> Enter the name, rank, and organization of the NCOIC or OIC of the reconnaissance party who was physically at the site when the reconnaissance was performed.</p> <p><i>Block 7 (MAP INFORMATION).</i> Obtain this information from a map of the reconnaissance area. Enter the information in this block.</p> <p><i>Block 8 (TARGET AND LOCATION).</i> Enter a brief description of the target and the distance and direction from an identifiable landmark (railroad bridge, crossroads, hilltop, and so forth). For example, "Target is 275°, 300 meters from the railroad bridge, 2 miles east of Hanesville, on Route 2." Continue the information in block 19 if needed.</p> <p><i>Block 9 (TIME OBSERVED).</i> Enter the time you last saw the target as you departed the site.</p> <p><i>Block 10 (COORDINATES).</i> Enter the complete 8-digit map coordinates of the target.</p> <p><i>Block 11 (GENERAL DESCRIPTION).</i> When applicable, include the type of construction, width of the roadway, number of lanes or tracks, type of pavement, number of spans, condition of spans or entire bridge, and bridge categorization and classification. For example, "Prestressed-concrete T beam bridge, four simple spans supported by six concrete columns, two lanes; total bridge length is 140 feet; roadway width is 30 feet; overall bridge width is 36 feet; height is 16 feet; Class 80; very good condition."</p> <p><i>Block 12 (NATURE OF PROPOSED DEMOLITION).</i> State the expected amount of destruction and the priority for placing charges, if feasible. Provide a sketch showing the number and type of charges to use (tamped or untamped), where the charges should be placed, and the type of firing system required.</p> <p><i>Block 13 (UNUSUAL FEATURES OF SITE).</i> Include any special features of the target or site that might affect the method of demolition (high-tension lines, radar installation, underwater blasting, and so forth). Give any details that may affect the security of the target and the demolition work party.</p> <p><i>Block 14 (MATERIAL REQUIRED).</i> Indicate the mission types, quantities, caps, detonators, and so forth proposed for the demolition.</p> <p><i>Block 15 (EQUIPMENT AND TRANSPORT REQUIRED).</i> Specify the amount and type of transportation required (for example, two 5-ton dump trucks, one ram set with 50 cartridges, two post-hole diggers, two demolition sets, 10 pounds of 16d nails, twelve 8-foot 2 by 4s). Continue comments in block 15 on page 2 of the form.</p> <p><i>Block 16 (PERSONNEL AND TIME REQUIRED FOR).</i> Complete subsections a and b, indicating the number of personnel and amount of time necessary for placing the demolitions. The distance between the firing points and firing systems will be a consideration for determining the amount of time necessary to arm and fire the explosives.</p> <p><i>Block 17 (TIME, LABOR, AND EQUIPMENT REQUIRED FOR BYPASS (Enter the location and method)).</i> Enter the equipment necessary to clear the site after demolition and the available bypasses that allow units to bypass the site. Continue comments in block 17 on page 2 of the form.</p> <p><i>Block 18 (REMARKS).</i> Include any appropriate remarks that are not covered in blocks 1 through 17. Continue remarks in block 18 on page 2 of the form.</p> <p><i>Block 19 (ADDITIONAL COMMENTS).</i> Use this block as a continuation for all other blocks. Identify the block being continued.</p> <p><i>Block 20 (GENERAL DESCRIPTION SKETCH).</i> Include on this sketch--</p> <ul style="list-style-type: none"> <li>The avenues of approach to the target and possible bypasses in the vicinity of the target. Indicate route numbers and the direction to cities.</li> <li>The rivers or streams including name, direction of flow, and velocity in meters per second.</li> <li>The terrain features, including observation points, cover and concealment, swampy areas, deep valleys, and so forth.</li> <li>A compass arrow indicating north (indicate grid or magnetic).</li> <li>The dimensions of the proposed target.</li> <li>The number and length of bridge spans.</li> <li>The height of the bridge from the ground or water.</li> </ul> <p><i>Block 21 (PURPOSE OF PROPOSED DEMOLITION SKETCH).</i> Include on this sketch the--</p> <ul style="list-style-type: none"> <li>Dimensions of members to be cut.</li> <li>Placement of charges.</li> <li>Charge calculations. Use either the formula or table method, but show the work.</li> <li>Priming of charges.</li> <li>Branch lines.</li> <li>Ring mains.</li> <li>Firing systems.</li> <li>Firing points.</li> </ul>
<p>DA FORM 2203, MAY 2007 <span style="float: right;">Page 4 of 4 APD V1.00</span></p>

Figure I-1. Sample DA Form 2203 (Continued)

## **Appendix J**

### **Demolition Effects Simulator Materials**

This appendix contains information needed to order materials (for BOM) when constructing DES devices. Table J-1, pages J-2 and J-3, shows the materials available when constructing DES devices and where the materials can be obtained.

Table J-1. DES Materials

	<i>Materials</i>	<i>Sources</i>
1	Adapter, priming	1375-00-565-4141
2	Bag, carrying M85	NSN/local purchase
3	Bag, plastic, 12 by 12 in	8105-00-837-7757
4	Box, cardboard, 7 by 1 3/4 by 1 3/4 in	Local purchase
5	Box, cardboard, 11 3/4 by 2 1/4 by 2 1/4 in	Local purchase
6	Box, wooden, bangalore torpedo	TSC/DRMO
7	Box, wooden, cratering charge	TSC/DRMO
8	Box, wooden, dynamite	TSC/DRMO
9	Box, wooden, M112	TSC/DRMO
10	Box, wooden, M118 (sheet explosive)	TSC/DRMO
11	Box, wooden, M183	TSC/DRMO
12	Box, wooden, M3	TSC/DRMO
13	Box, wooden, M2A3	TSC/DRMO
14	Box, wooden, M5A1	TSC/DRMO
15	Box, wooden, TNT	TSC/DRMO
16	Cap, blasting, electric	1375-00-756-1865
17	Cap, blasting, nonelectric	1375-00-756-1864
18	Cap, plastic end, 1 1/4 in	Local purchase
19	Cap, plastic end, 2 1/8 in	Local purchase
20	Cap, plastic end, 7 in	Local purchase
21	Chalk, field marking	Local purchase
22	Charge, shaped, metal, M2A3	Local fabrication
23	Charge, shaped, metal, M3	Local fabrication
24	Clay, pottery, moist	Local purchase
25	Cord, detonating	1375-00-965-0800
26	Coupling, plastic, 3/4 in	4730-00-472-5056
27	Coupling, plastic, 1 in	4730-00-472-5058
28	Fuse, time	1375-00-628-9033
29	Glue, super	8040-00-142-9193
30	Holder, blasting cap, M8	1375-00-926-4105
31	Label, bangalore torpedo DES, 3/8 in and 1 1/4 in	TSC
32	Label, cratering charges DES, 3/8 in and 1 1/4 in	TSC
33	Label, dynamite DES, 3/8 in and 1 1/4 in	TSC
34	Label, M112 DES, 3/8 in and 1 1/4 in	TSC
35	Label, M118 DES, 3/8 in and 1 1/4 in (sheet explosive)	TSC
36	Label, M183 DES, 3/8 in and 1 1/4 in	TSC

Table J-1. DES Materials

	<i>Materials</i>	<i>Sources</i>
<b>37</b>	Label, M5A1 DES, 3/8 in and 1 1/4 in	TSC
<b>38</b>	Label, TNT DES, 3/8 in and 1 1/4 in	TSC
<b>39</b>	Label, shaped charge, 15 lb, DES, 3/8 in and 1 1/4 in	TSC
<b>40</b>	Label, shaped charge, 40 lb, DES, 3/8 in and 1 1/4 in	TSC
<b>41</b>	M2 crimpers	5120-00-029-0683
<b>42</b>	Matting, floor, 1/8 in	7220-01-025-1695
<b>43</b>	Oil, mineral	Local purchase
<b>44</b>	Sand	Local purchase
<b>45</b>	Sandbag	Local purchase
<b>46</b>	String	NSN
<b>47</b>	Tape, clear	7510-00-995-0455
<b>48</b>	Tape, duct, green	7510-00-074-5124
<b>49</b>	Tape, electrical, black	5970-00-419-4291
<b>50</b>	Tape, fabric, olive drab green	7510-00-266-5016
<b>51</b>	Tape, fabric, red	7510-00-074-4969
<b>52</b>	Tape, PSA	7510-01-057-0096
<b>53</b>	Tube, cardboard, 10 by 2 1/8 in	Local purchase
<b>54</b>	Tube, cardboard, 12 by 2 1/8 in	Local purchase
<b>55</b>	Tube, cardboard, 24 by 7 in	Local purchase

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## **Appendix K**

# **Risk-Assessment Checklist**

This appendix contains a sample risk assessment for conducting live demolitions training. This is only a general assessment. Each commander must evaluate his own risks for demolition training and develop countermeasures to minimize them. See Table K-1, pages K-2 and K-4, for the risk assessment for live demolitions. Table K-2, page K-5, shows the risk-assessment factors used in this assessment. Table K-3, page K-5, couples the probability with the severity of the training and provides a level of risk involved for the training.

**Table K-1. Commander's Risk Assessment for Live Demolitions**

<i>Hazards</i>	<i>Probability</i>	<i>Severity</i>	<i>Overall</i>	<i>Countermeasures</i>
<b>1. Charging the preparation area.</b>				
a. Issue demolitions. The demolition is dropped, mishandled, or accidentally discharged.	D	2	M	Demolition instructors supervise closely. Charges are primed with detonating cord knots only. Demolition instructors control the caps.
b. Construct the charges.				
(1) The explosives are stored improperly.	E	1	L	The OIC ensures proper storage; for example, the MDI is stored in a separate bunker from explosives.
(2) The charge has too much demolition.	E	2	L	The training and PE are conducted in the classroom. Charges are issued to the Soldiers in correct size by the NCOIC of the range.
(3) The charge detonates during construction.	E	2	L	The demolition instructors control the caps; one-to-one supervision when using caps and placement.
(4) The charge is not primed correctly.	D	2	M	The training and PE are conducted in the classroom. Demolition instructors supervise and check each charge.
(5) An accident occurs due to the improper construction of the field-expedient demolition.	E	1	M	The instructions in this FM and FM 5-34 should be followed. Excess use of blasting caps should be eliminated.
<b>2. Moving to a detonation area.</b>				
a. A Soldier trips.	C	4	L	The Soldier attends a safety briefing on watching where to step and range walk only; no running. Troops should not be overloaded.
b. A Soldier drops or mishandles the demolition.	D	2	M	The movement on the range should be slowed down. The demolition instructor has control of the caps. Caps should be carried separately from the demolitions.
<b>3. Preparing the final demolition charges.</b>				
a. A low-strength cap is used instead of a high-strength cap.	D	2	M	The training and the PE are conducted in the classroom. Demolition instructors issue the caps and supervise the crimping.
b. The cap received a shock during preparation or movement.	D	2	M	Slow down movement on the range. Carry caps in a protective case.
<b>4. Detonating the charges.</b>				
a. A Soldier is not accounted for.	E	1	M	Leaders conduct a headcount, and the range NCOIC verifies it. A safety briefing is given to everyone on the range.



**Table K-1. Commander's Risk Assessment for Live Demolitions**

<i>Hazards</i>	<i>Probability</i>	<i>Severity</i>	<i>Overall</i>	<i>Countermeasures</i>
b. A Soldier does not have enough time to reach safety.	D	2	M	Demolition instructors check the time fuse system during construction. The MSD is identified in the safety brief (bunkers). The Soldier initiates charges only by taking commands from the safety officer. Using MDI, command detonation ensures that the transmission lines run to the firing point.
c. The fuse igniter fails to operate.	D	3	L	The training and the PE are conducted in the classroom. The safety officer supervises the pulling of the fuse igniters and ensures that they are burning. If the igniters are not burning, the safety officer talks the Soldier through the correct misfire procedures.
d. Soldiers are hit by shrapnel or debris.	D	3	L	Ensure that all Soldiers are in the bunkers or at the MSD before the blast. Place guards with radios at the four corners of the heavy range (road intersections) when firing a mine or bangalore.
e. The firing system detonates prematurely.	D	2	M	Minimum personnel should be downrange. The demolition instructor supervises the construction of the firing system.
f. The charge misfires.	D	2	M	Cease-fire and use the proper clearing procedures according to this FM (wait 30 minutes). Clearing charges are available at the assembly area. The safety officer will clear the misfire or call EOD, as appropriate.
g. The misfire is not identified or not cleared.	D	2	M	The safety officer clears and ensures that there are no misfires before letting the Soldiers on the detonating portion of the range.
h. A Soldier improperly constructs the initiation system.	D	2	M	One-to-one supervision is given when the Soldier constructs initiating sets. Demolition instructors and the safety officer will check all the work.
i. A Soldier does not wait for sufficient time after the blast.	1	E	M	Before going downrange, wait 10 minutes after the blast. The RSO does all inspecting and clearing.
<b>5. Controlling the range.</b>				
a. A stranger wanders onto the range.	E	1	M	Establish roadblocks and post guards according to the installation regulations.
b. The blast limits are exceeded.	E	2	L	The NCOIC only issues the demolition needed for each serial. The safety officer calls in the blast amount to range control when requesting a blast window. All Soldiers are briefed on the blast limits.

Table K-1. Commander's Risk Assessment for Live Demolitions

<i>Hazards</i>	<i>Probability</i>	<i>Severity</i>	<i>Overall</i>	<i>Countermeasures</i>
c. The RSO or the demolition instructors fail to follow procedures.	E	1	M	The safety officer will be an E7 or above and certified by range control. The safety officer will be solely dedicated to observing safety. All demolition instructors are thoroughly briefed and rehearsed on their duties.
d. Demolitions stored improperly cause an accident due to detonation.	E	1	M	Store demolition in earth-covered culverts. No smoking or open flames permitted within 50 feet of the culverts. Do not leave demolitions in the bunkers overnight. Evacuate the area if the demolitions ignite. Store caps in a separate bunker from the demolitions. (See AR 385-63.)
e. An accident occurs due to inexperienced range personnel.	E	1	M	All demolition instructors and the safety officer will have a current range safety card with a demolitions certification stamp.
f. A Soldier gets poison ivy or oak, has an allergic reaction to an insect sting or bite, or is bitten by a snake.	C	4	L	Conduct a safety briefing. Identify Soldiers allergic to these items or insects and ensure that they have the proper medication with them (such as bee-sting kits). Avoid poisonous plants and animals.
g. A Soldier receives a cold- or hot-weather injury.	E	4	L	Ensure that leaders and Soldiers monitor each other for signs or symptoms. Ensure that water is on the site. Warm up the tent, if needed. Dress according to the weather. Follow guidance according to heat and wind-chill categories. Conduct a safety briefing.
h. A Soldier receives an injury requiring first aid.	E	4	L	Have a first aid bag present with the combat medic.
i. A Soldier receives a serious injury requiring medical evacuation.	D	1	H	Maintain communications with range control to call for an ambulance.

**Table K-2. Factors**

<b>Severity</b>	<b>Level</b>	<b>Results</b>
1	Catastrophic	Death or permanent total disability, system loss, or major property damage. Loss of ability to accomplish assigned mission.
2	Critical	Permanent partial disability, temporary total disability in excess of 3 months, major system damage, or significant property damage. Significantly degrades mission capability in terms of required "mission" standards.
3	Marginal	Minor injury, lost workday, accident, compensable injury or illness, minor system damage, or minor property damage. Degrades mission capabilities in terms of required "mission" standards.
4	Negligible	First aid or minor supportive medical treatment or minor system impairment. Little or no impact on "mission" accomplishment.
<b>Probability</b>	<b>Level</b>	<b>Results</b>
A	Frequent	For an individual Soldier or item, this occurs often in the Soldier's career or equipment service life. For all Soldiers exposed or item inventory, this is continuously experienced.
B	Likely	For an individual Soldier or item, this occurs several times in the Soldier's career or equipment service life. For all Soldiers exposed or item inventory, this occurs frequently.
C	Occasional	For an individual Soldier or item, this occurs sometime in the Soldier's career or equipment service life. For all Soldiers exposed or item inventory, this occurs sporadically or several times in inventory service life.
D	Remote	For an individual Soldier or item, it is possible to occur in the Soldier's career or equipment service life. For all Soldiers exposed or item inventory, there is a remote chance of occurrence; expected to occur sometime in inventory service life.
E	Unlikely	For an individual Soldier or item, one can assume it will occur in the Soldier's career or equipment service life. For all Soldiers exposed or item inventory, it is possible but improbable; occurs only very rarely.

**Table K-3. Severity of Training**

<b>Probability</b>					
<b>Severity</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>
1	E	E	H	H	M
2	E	H	H	M	L
3	H	M	M	L	L
4	M	L	L	L	L

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# Glossary

## SECTION I – ACRONYMS AND ABBREVIATIONS

<b>ABCA</b>	American, British, Canadian, and Australian
<b>AFR</b>	Air Force regulation
<b>AFV</b>	armored fighting vehicle
<b>AP</b>	antipersonnel
<b>approx</b>	approximately
<b>AR</b>	Army regulation
<b>ARNG</b>	Army National Guard
<b>ARNGUS</b>	Army National Guard of the United States
<b>ASP</b>	ammunition supply point
<b>AT</b>	antitank
<b>attn</b>	attention
<b>AVLB</b>	armored-vehicle-launched bridge
<b>AWG</b>	American wire gauge
<b>B&amp;S</b>	Brown & Sharpe
<b>bde</b>	brigade
<b>bn</b>	battalion
<b>BOM</b>	bill of materials
<b>C4</b>	composition C4
<b>CCW</b>	Convention on Certain Conventional Weapons
<b>CFR</b>	Code of Federal Regulations
<b>chg</b>	charge
<b>cm</b>	centimeter(s)
<b>co</b>	company
<b>COE</b>	contemporary operational environment
<b>COL</b>	colonel
<b>contd</b>	continued
<b>crypto</b>	cryptography
<b>CTP</b>	crimp, tie, prime
<b>cu</b>	cubic
<b>DA</b>	Department of the Army
<b>demo</b>	demolition
<b>DES</b>	demolition effects simulator
<b>div</b>	division
<b>DOD</b>	Department of Defense
<b>DODAC</b>	Department of Defense ammunition code
<b>DODIC</b>	Department of Defense identification code
<b>DRMO</b>	Defense Reutilization and Marketing Office

<b>DSN</b>	defense switching network
<b>DU</b>	depleted uranium
<b>DWFA</b>	double waterproof firing assembly
<b>E-7</b>	sergeant first class
<b>ea</b>	each
<b>ECT</b>	explosive cutting tape
<b>EFP</b>	explosively formed penetrator
<b>enl</b>	enlisted
<b>EMP</b>	electromagnetic pulse
<b>EN</b>	engineer
<b>enr</b>	engineer
<b>EOD</b>	explosive ordnance disposal
<b>EPA</b>	Environmental Protection Agency
<b>equip</b>	equipment
<b>F</b>	Fahrenheit
<b>FBE</b>	fighting position excavator
<b>flex</b>	flexible
<b>FLSC</b>	flexible linear shape charge
<b>FM</b>	field manual
<b>FMFM</b>	fleet Marine force manual
<b>FPE</b>	fighting position excavator
<b>ft</b>	feet; foot
<b>ft/sec</b>	feet per second; foot per second
<b>g</b>	gram(s)
<b>g/sq in</b>	gram(s) per square inch
<b>gal</b>	gallon(s)
<b>GEMSS</b>	ground-emplaced mine scattering system
<b>GP</b>	general purpose
<b>gm/sq in</b>	gram(s) per square inch
<b>gr</b>	grain(s)
<b>gr/ft</b>	grain(s) per foot
<b>GS</b>	general services
<b>HC</b>	high capacity
<b>HE</b>	high explosive
<b>HEAT</b>	high-explosive antitank
<b>hex</b>	hexagon
<b>HMMWV</b>	high-mobility, multipurpose wheeled vehicle
<b>HMX</b>	cyclotetramethylene tetramitramine
<b>hr</b>	hour(s)
<b>http</b>	hypertext transfer protocol
<b>IED</b>	Improved explosive device

<b>in</b>	inch(es)
<b>int</b>	intelligence
<b>IV</b>	intravenous
<b>JP</b>	joint publication
<b>kg</b>	kilogram(s)
<b>kw</b>	kilowatt(s)
<b>lin</b>	linear
<b>lb</b>	pound(s)
<b>m</b>	meter(s)
<b>MANSCEN</b>	Maneuver Support Center
<b>max</b>	maximum
<b>MCO</b>	Marine Corps order
<b>MCRP</b>	Marine Corps reference publication
<b>MDI</b>	modernized demolition initiator
<b>MGB</b>	medium girder bridge
<b>MICLIC</b>	mine-clearing line charge
<b>mil</b>	military
<b>min</b>	minute(s)
<b>mm</b>	millimeter(s)
<b>mod</b>	modification
<b>MSD</b>	minimum safe distance
<b>NA</b>	not applicable
<b>NATO</b>	North Atlantic Treaty Organization
<b>NAVSEA</b>	Navy Sea Systems Command
<b>NCO</b>	noncommissioned officer
<b>NCOIC</b>	noncommissioned officer in charge
<b>NEW</b>	net-explosive weight
<b>No.</b>	number
<b>NSN</b>	national stock number
<b>OIC</b>	officer in charge
<b>OPNAVINST</b>	Chief of Naval Operations instruction
<b>oz</b>	ounce(s)
<b>PE</b>	practice exercise
<b>PETN</b>	pentaerythrite tetranitrate
<b>PIR</b>	passive infrared
<b>pkg</b>	package
<b>POL</b>	petroleum, oils, and lubricants
<b>PSA</b>	pressure sensitive adhesive
<b>QD</b>	quality distance
<b>QSTAG</b>	Quadripartite Standardization Agreement
<b>qty</b>	quantity

<b>RCRA</b>	Resource Conservation and Recovery Act
<b>RDX</b>	cyclotrimethylenetrinitramine (commercial name, cyclonite)
<b>RE</b>	relative effectiveness
<b>REPP</b>	reusable environmental protective pack
<b>ROE</b>	rules of engagement
<b>RSO</b>	range safety officer
<b>RWBK</b>	rapid wall-breaching kit
<b>S&amp;A</b>	safe and arm
<b>SCG</b>	storage compatibility group
<b>sec</b>	second(s)
<b>SLAM</b>	selectable lightweight attack munition
<b>SOF</b>	special operations forces
<b>SOP</b>	standing operating procedure
<b>SP</b>	special purpose
<b>sq</b>	square
<b>SSG</b>	staff sergeant
<b>STANAG</b>	standardization agreement
<b>TEOC</b>	TeleEngineering Operations Center
<b>TM</b>	technical manual
<b>TNT</b>	trinitrotoluene
<b>TRADOC</b>	United States Army Training and Doctrine Command
<b>TSC</b>	Training Support Center
<b>TT</b>	telegraphic transfer
<b>UN</b>	United Nation
<b>U.S.</b>	United States
<b>USACE</b>	United States Army Corps of Engineers
<b>USAR</b>	United States Army Reserve
<b>UXO</b>	unexploded explosive ordnance
<b>wt</b>	weight
<b>WP</b>	white phosphorous

## SECTION II – TERMS

### **blast effect**

(joint) Destruction of or damage to structures and personnel by the force of an explosion on or above the surface of the ground. Blast effect may be contrasted with the cratering and ground-shock effects of a projectile or charge that goes off beneath the surface. (JP 1-02) (FM 1-02)

### **demolition**

(NATO) The destruction of structures, facilities, or material by use of fire, water, explosives, mechanical, or other means. (FM 1-02)

### **demolition chamber**



(joint, NATO) Space intentionally provided in a structure for the emplacement of explosive charges. (JP 1-02)

**demolition firing party**

(joint) The party at the site that is technically responsible for the demolition and that actually initiates detonation or fires the demolitions. See also **demolition guard**. (JP 1-02) (FM 1-02)

**demolition guard**

(joint, NATO) A local force positioned to ensure that a target is not captured by an enemy before orders are given for its demolition and before the demolition has been successfully fired. The commander of the demolition guard is responsible for the tactical control of all troops at the demolition site, including the demolition firing party. The commander of the demolition guard is responsible for transmitting the order to fire to the demolition firing party. (FM 1-02) (JP 1-02)

**demolition kit**

(joint, NATO) The demolition tool kit complete with explosives. (JP 1-02)

**\*demolition obstacle**

An obstacle created by using explosives.

**\*demolition plan**

Documentation with data required for the preparation of a single demolition.

**demolition target**

(joint, NATO) A target of known military interest identified for possible future demolition. (JP 1-02)

**detonating cord**

(joint, NATO) A waterproof, flexible fabric tube containing a high explosive designed to transmit the detonation wave. (JP 1-02)

**detonator**

(joint, NATO) A device containing a sensitive explosive intended to produce a detonation wave. (JP 1-02)

**dual-firing circuit**

(joint, NATO) An assembly comprising two independent firing systems, both electric or both non-electric, so that the firing of either system will detonate all charges. (JP 1-02)

**dud**

(joint, NATO) Explosive munition which has not been armed as intended or which has failed to explode after being armed. (JP 1-02)

**explosive ordnance disposal**

(joint, NATO) The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of unexploded explosive ordnance. It may also include explosive ordnance which has become hazardous by damage or deterioration. Also called **EOD**. (JP 1-02)

**fire**

(joint, NATO) 1. The command given to discharge a weapon(s). 2. To detonate the main explosive charge by means of a firing system. (JP 1-02) (FM 1-02)

**firing circuit**

(joint, NATO) 1. In land operations, an electrical circuit and/or pyrotechnic loop designed to detonate connected charges from a firing point. 2. In naval mine warfare, that part of a mine circuit which either completes the detonator circuit or operates a ship counter. (JP 1-02)

**fuze**

(NATO) A device which initiates an explosive train. (FM 1-02)

**main detonating line**

(joint, NATO) In demolition, a line of detonating cord used to transmit the detonation wave to two or more branches. (JP 1-02)

**pyrotechnic**

(joint) A mixture of chemicals which, when ignited, is capable of reacting exothermically to produce light, heat, smoke, sound, or gas. [Note: the Army definition adds, "...and may also be used to introduce a delay into an explosive train because of its known burning time. The term excludes propellants and explosives."]. (FM 1-02) (JP 1-02)

**shaped charge**

(joint, NATO) A charge shaped so as to concentrate its explosive force in a particular direction. (JP 1-02)

**sympathetic detonation**

(joint, NATO) Detonation of a charge by exploding another charge adjacent to it. (JP 1-02)

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### **DOCUMENTS NEEDED**

These documents must be available to the intended users of this publication.

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\*DA Form 2203, *Demolition Reconnaissance Record*

\*This source was also used to develop this publication.

### **READINGS RECOMMENDED**

These sources contain relevant supplemental information.

None.

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