FM 5-250

EXPLOSIVES AND DEMOLITIONS

HEADQUARTERS, DEPARTMENT OF THE ARMY

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Change 1

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EXPLOSIVES AND DEMOLITIONS

1. Change FM 5-250, 30 July 1998, as follows:

Page i. After DISTRIBUTION RESTRICTION paragraph, add the following:

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Page 4-17. Change Figure 4-105 to Figure 4-22.

Page 6-6. Table 6-2 caption, change "bear" to "bare."

Page D-3. Paragraph D-9, line 2, delete "glass."

Page D-3. After paragraph D-9 add the following:

NOTE: The United Nations Convention of Certain Conventional Weapons (CCW) mandates that all fragment munitions produce fragments that are visible by x-ray (such as metal or rock).

2. Post these changes according to DA Pamphlet 310-13.

3. File this transmittal sheet in the front of the publication.

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Washington, DC, 30 July 1998

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*This publication supersedes FM 5-250, 15 June 1992, TC 5-250, 30 September 1993, and TC 5-6-14, 18 June 1980.

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Preface

Field Manual (FM) 5-250 is the technical compilation of the explosives and explosive techniques used by United States (US) military forces. It is designed to serve as the reference manual to support combat operations as well as peacetime training missions requiring demolition applications. The manual provides a basic theory of explosives, their characteristics and common uses, formulas for calculating various types of charges, and standard methods of priming and placing these charges. It also serves as a guide to familiarize leaders and soldiers with the demolition-effects-simulators (DESs) program. Included in this discussion is the assembly, priming, and firing of all currently approved simulators. The manual provides field soldiers with the ability to conduct demolition operations using the conventional detonating-cord initiation systems as well as the recently approved modernized demolition initiators (MDIs). This manual is a stand-alone manual designed to offer a baseline knowledge of demolition techniques. Extreme caution must be used when encountering situations that require several demolition applications concurrently. The officer in charge (OIC) must maintain ultimate responsibility for the demolition-system design, ensuring the safe and efficient application of explosives.

Appendix A contains an English to metric measurement conversion chart.

The proponent of this publication is Headquarters (HQ), United States Army Engineer School (USAES). Submit changes for improving this publication on Department of the Army (DA) Form 2028 (Recommended Changes to Publications and Blank Forms) and forward to Commandant, USAES, ATTN: ATSE-TD-D, Fort Leonard Wood, MO 65473-6550.

The provisions of this publication are the subject of the following international agreements: Standardization Agreement (STANAG) 2017 (Engineer [ENGR]), Edition 3, *Orders to the Demolition Guard Commander and Firing Party Commander (Non-Nuclear)*; STANAG 2123 (ENGR), Edition 2, *Obstacle Folder*; STANAG 2036, (ENGR), Edition 4, *Land Mine Laying, Marking, Recording, and Reporting Procedures;* STANAG 2077 (INT), Edition 5, *Orders of Battle;* Quadripartite Standardization Agreement (QSTAG) 508, *Orders to the Demolition Guard Commander and Demolition Firing Party Commander*; and QSTAG 743, *Obstacle Target Folder*.

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

Chapter 1

Military Explosives

1-1. The types of demolition materials used are described in this chapter. Also described are 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

CHARACTERISTICS

1-2. To be suitable for use in military operations, explosives must have certain properties. Military explosives—

- Should be inexpensive to manufacture and capable of being produced from readily available raw materials.
- Must be relatively insensitive to shock or friction, yet be able to positively detonate by easily prepared initiators.
- Must be capable of shattering and must have the potential energy (high energy output per unit volume) adequate for the purpose of demolitions.
- Must be stable enough to retain usefulness for a reasonable time when stored in temperatures between -80 and +165 degrees Fahrenheit (°F).
- Should be composed of high-density materials (weight per unit volume).
- Should be suitable for underwater use or in damp climates.
- Should be minimally toxic when stored, handled, and detonated.

SELECTION OF EXPLOSIVES

1-3. Select explosives that fit the particular purpose, based on their relative power. Consider all characteristics when selecting an explosive for a particular demolition project. See Technical Manual (TM) 9-1300-214 for detailed information on military explosives. *Table 1-1* contains significant information regarding many of the explosives described below. See Appendix B for equivalent metric weights for standard explosives.

Table 1-1. Characteristics of US demolitions explosives

Name	Applications	Detonation Velocity		RE Factor*	Fume Toxicity	Water Resistance
		Min/Sec	Ft/Sec			
Ammonium nitrate	Cratering charge	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
Trinitrotoluene (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
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	---	Slight	Excellent
Sheet explosive M118 and 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

*TNT equals 1.00 relative effectiveness (RE).

DOMESTIC EXPLOSIVES

AMMONIUM NITRATE

1-4. Ammonium nitrate is the least sensitive of the military explosives. It requires a booster charge to initiate detonation successfully. 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.

CYCLOTRIMETHLENETRINITRAMINE (RDX)

1-5. RDX is also a highly sensitive and very powerful military explosive. It forms the base charge in the M6 electric and M7 nonelectric blasting caps. When RDX is desensitized, it serves as a subbooster, booster, bursting charge, or demolition charge. RDX is primarily used in composite explosives, such as composition A, B, and C explosives. RDX is available commercially under the name cyclonite.

PENTAERYTHRITE TETRANITRATE (PETN)

1-6. PETN is a highly sensitive and very powerful military explosive. Its explosive potential is comparable to RDX and nitroglycerin. Boosters, detonating cord, and some blasting caps contain PETN. It is also used in composite explosives with trinitrotoluene (TNT) or with nitrocellulose. A PETN-nitrocellulose composite (M118 sheet explosive) is a demolition charge. The PETN explosive is a good underwater demolition because it is almost insoluble in water.

TRINITROTOLUENE

1-7. TNT is the most common military explosive. It may be in composite form (such as a booster, a bursting or demolition charge) or in a noncomposite form. Since TNT is a standard explosive, it is used to rate other military explosives.

TETRYL

1-8. Tetryl is an effective booster charge in its noncomposite form and a bursting or a demolition charge in composite forms. Tetryl is more sensitive and powerful than TNT. However, RDX- and PETN-based explosives, which have increased power and shattering effects, are replacing tetryl and composite explosives containing tetryl.

NITROGLYCERIN

1-9. Nitroglycerin is one of the most powerful high explosives (HEs). Its explosive potential is comparable to RDX and PETN. Nitroglycerin is the explosive base for commercial dynamites. Nitroglycerin is highly sensitive to shock and is affected by extreme temperatures. Military explosives do not use nitroglycerin because of its sensitivity. Do not use commercial dynamites in combat areas.

BLACK POWDER

1-10. Black powder is the oldest-known explosive and propellant. It is a composite of potassium or sodium nitrate, charcoal, and sulfur. Time fuses, some igniters, and some detonators contain black powder.

AMATOL

1-11. Amatol is a mixture of ammonium nitrate and TNT. It is a substitute for TNT in bursting charges. Some older bangalore torpedoes use 80-20 amatol (80 percent ammonium nitrate and 20 percent TNT). Because amatol contains ammonium nitrate, it is a hygroscopic compound. Keep any explosives containing amatol in airtight containers. If properly packaged, amatol remains viable for long periods of time, with no change in sensitivity, power, or stability.

COMPOSITION A3

1-12. Composition A3 is a composite explosive containing 91 percent RDX and 9 percent wax. The purpose of the wax is to coat, desensitize, and bind the RDX particles. Composition A3 is the booster charge in some newer shaped charges and bangalore torpedoes. High-explosive plastic (HEP) projectiles may also contain composition A3 as a main charge.

COMPOSITION B

1-13. Composition B is a composite explosive containing about 60 percent RDX, 39 percent TNT, and 1 percent wax. It is more sensitive than TNT. Because of its shattering power and high detonation rate, composition B is the main charge in shaped charges.

COMPOSITION B4

1-14. Composition B4 contains 60 percent RDX, 39.5 percent TNT, and 0.5 percent calcium silicate. Composition B4 is the main charge in newer models of bangalore torpedoes and shaped charges.

COMPOSITION C4 (C4)

1-15. C4 is a composite explosive containing 91 percent RDX and 9 percent nonexplosive plasticizers. Burster charges are composed of C4. It is effective in temperatures between -70 to +170°F; however, C4 loses its plasticity in colder temperatures.

COMPOSITION H6

1-16. H6 is composite explosive containing 47 percent RDX, 30 percent aluminum and oxygen, and 22 percent wax and lecithin. It is used in modern cratering charges and in shape charges used by other military services. H6 is less volatile than ammonium nitrite (previous explosive used in cratering charges) and the H6 cratering charge allows for better development of a crater.

TETRYTOL

1-17. Tetrytol is a composite explosive containing 75 percent tetryl and 25 percent TNT. It is the explosive component in demolition charges. Different mixtures of tetryl and TNT are required for booster charges. Tetrytol is more powerful than its individual components, is better at shattering than TNT, and is less sensitive than tetryl.

PENTOLITE

1-18. Pentolite is a mixture of PETN and TNT. Because of its high power and detonating rate, a mixture of 50-50 pentolite (50 percent PETN and 50 percent TNT) makes an effective booster charge in certain models of shaped charges.

DYNAMITES

Standard Dynamite

1-19. Most dynamites, with the notable exception of military dynamite, contain nitroglycerin plus varying combinations of absorbents, oxidizers, antacids, and freezing-point depressants. Dynamites vary greatly in strength and sensitivity depending on, among other factors, the percentage of nitroglycerin they contain. Dynamites are for general blasting and demolitions, including land clearing, cratering and ditching, and quarrying.

Military Dynamite

1-20. Military dynamite is a composite explosive that contains 75 percent RDX, 15 percent TNT, and 10 percent desensitizers and plasticizers. Military dynamite is not as powerful as commercial dynamite. Military dynamite's equivalent strength is 60 percent of commercial dynamite. Because military dynamite contains no nitroglycerin, it is more stable and safer to store and handle than commercial dynamite.

FOREIGN EXPLOSIVES

COMPOSITION

1-21. 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) personnel for disposition.

USE

1-22. You may use the explosives of allied nations and those captured from the enemy to supplement standard supplies. Only expert demolitionists should use such explosives and then only according to instructions and directives of theater commanders. Captured bombs, propellants, and other devices may be used with US 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 US military blasting caps. Since foreign explosives may differ from US explosives in sensitivity and force, test shots should be made to determine their adequacy before extensive use or mixing with US-type explosives. Additional information on the use of demolition charges can be found in *Appendix C*.

EXPEDIENT DEMOLITION CHARGES

1-23. Expedient techniques are intended for use only by personnel experienced in demolitions and demolition 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. For additional information on the expedient use of demolitions, see *Appendix D*.

SECTION II. SERVICE DEMOLITION CHARGES

BLOCK DEMOLITION CHARGE

1-24. Block demolition charges are prepackaged, HE charges for general demolition operations, such as cutting, breaching, and cratering. They are composed of the HE TNT, tetrytol, composition C-series, and ammonium nitrate. Block charges are rectangular in form except for the 40-pound (lb) 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/ Weight[3]
			Min/Sec	Ft/Sec		
TNT[1]	0.25	$1\frac{1}{2} \times 1\frac{1}{2}$	6,900	22,600	1.00	192 per box/55 lb
	0.50	$1\frac{3}{4} \times 1\frac{3}{4} \times 3\frac{3}{4}$	6,900	22,600	1.00	96 per box/53 lb
	1.00	$1\frac{3}{4} \times 1\frac{3}{4} \times 7$	6,900	22,600	1.00	48 per box/53 lb
M112 block[2]	1.25	$1 \times 2 \times 7$	8,040	26,400	1.34	30 per box/40 lb
M118 block	2.00	$1 \times 3 \times 12$	7,300	24,000	1.14	2-lb block; 20 per box/42 lb; 4 sheets per package
M118 sheet[2]	0.50	$\frac{1}{4} \times 3 \times 12$	7,300	24,000	1.14	
M186 roll	25.00	$\frac{1}{4} \times 3 \times 600$	7,300	24,000	1.14	3 per box/80 lb
Composition H6[1]	43.00	7×20	7,190	23,600	1.33	1 per box/52 lb

Table 1-2. Characteristics of block demolition charges

Explosive	Unit (lb)	Size (in)	Detonation Velocity		RE Factor	Packaging/ Weight[3]
			Min/Sec	Ft/Sec		
M1 dynamite[1]	0.50	$1\frac{1}{4} \times 8$	6,100	20,000	0.92	100 per box/62 lb

[1]The 1/4 block of TNT, composition H6 cratering charge, and M1 dynamite are cylindrical in shape and described in terms of diameter and length.

[2]The volume of M112 is 20 cubic inches (in). The volume of one sheet of M118 is 9 cubic inches.

[3]Packaging weights include packaging material and weight of container.

TNT BLOCK DEMOLITION CHARGE

CHARACTERISTICS

1-25. 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.

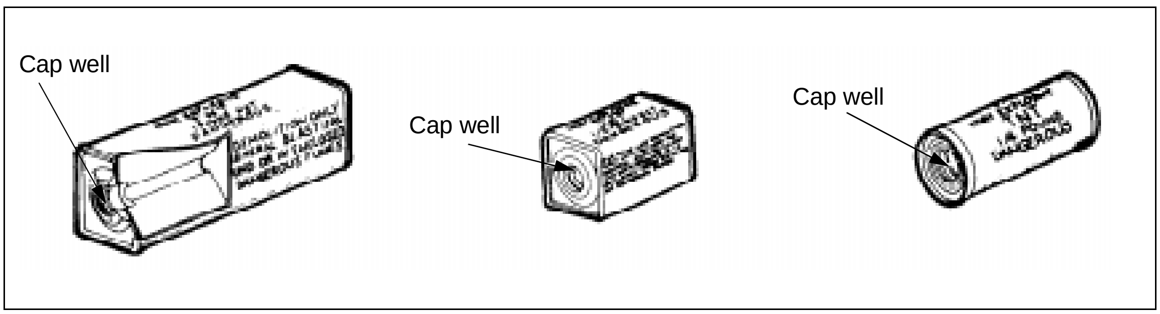


Figure 1-1. TNT block demolition charges

USE

1-26. TNT charges are effective for all types of demolition work except special steel-cutting charges. However, the 1/4-pound charge is primarily for training purposes.

ADVANTAGES

1-27. TNT charges have a high detonating velocity. They are stable, relatively insensitive to shock or friction, and water resistant. They also are conveniently sized, shaped, and packaged.

LIMITATIONS

1-28. 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

CHARACTERISTICS

1-29. An M112 charge consists of 1.25 pounds of C4 packed in an olive-drab, Mylar-film container with a pressure-sensitive adhesive tape on one surface (*Figure 1-2*). The tape is protected by a peelable paper cover. *Table 1-2* lists additional characteristics of the M112 block.

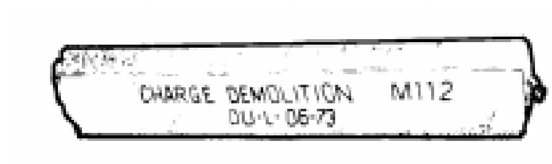


Figure 1-2. M112 block demolition charge

USE

1-30. 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 you to place the charge 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

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. Do not use shears.

ADVANTAGES

1-31. You can cut the M112 block demolition charge to fit irregularly shaped targets. The color of the wrapper helps camouflage the charge. Molding the charge can decrease its cutting effect.

LIMITATIONS

1-32. The adhesive tape will not adhere to wet, dirty, rusty, or frozen surfaces.

M118 BLOCK DEMOLITION CHARGE

CHARACTERISTICS

1-33. An M118 charge or sheet explosive is a block of four 1/2-pound sheets of flexible explosive packed in a plastic envelope (*Figure 1-3*). Twenty M118 charges and one package of 80 M8 blasting-cap holders are packed in a wooden box. Each sheet of the explosive has a pressure-sensitive adhesive tape attached to one surface. *Table 1-2* lists additional characteristics for the M118 charge.

Figure 1-3. M118 block demolition charge

USE

1-34. The M118 charge is designed for cutting, especially against steel targets. The sheets of explosive are easily and quickly applied to irregular and curved surfaces and are easily cut to any desired dimension. The M118 charge is effective as a small breaching charge but, because of its high cost, it is not recommended as a bulk explosive charge.

ADVANTAGES

1-35. The flexibility and adhesive backing of the sheets allow application to a large variety of targets. You can cut the 1/2-pound sheets to any desired dimension and apply them in layers to achieve the desired thickness. The M118 charge is not affected by water, making it acceptable for underwater demolitions.

LIMITATIONS

1-36. The adhesive tape will not adhere to wet, dirty, rusty, or frozen surfaces.

M186 ROLL DEMOLITION CHARGE

1-37. An M186 charge, shown in *Figure 1-4*, is identical to the M118 charge except that the sheet explosive is in roll form on a 50-foot plastic spool. Each foot of the roll provides about a half pound of explosive. Included with each roll are 15 M8 blasting cap holders and one canvas bag with carrying strap. *Table 1-2* lists additional characteristics for the M186 charge. Use the M186 the same as the M118. The M186 charge is adaptable for demolishing targets that require using flexible explosives in lengths longer than 12 inches. The M186 charge has all the advantages of the M118 sheet demolition charge. You can cut the M186 charge 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.

FORTY-POUND COMPOSITION H6 CRATERING CHARGE

1-38. *Figure 1-5* shows the composition H6 cratering charge. It is a watertight, cylindrical metal container with 40 pounds of composition H6 explosive and 0.43 pound of a composition A5 explosive booster positioned at the top. Priming instructions are printed on the side of the canister. There is a metal ring on the top of the container for lowering the charge into its hole. *Table 1-2*

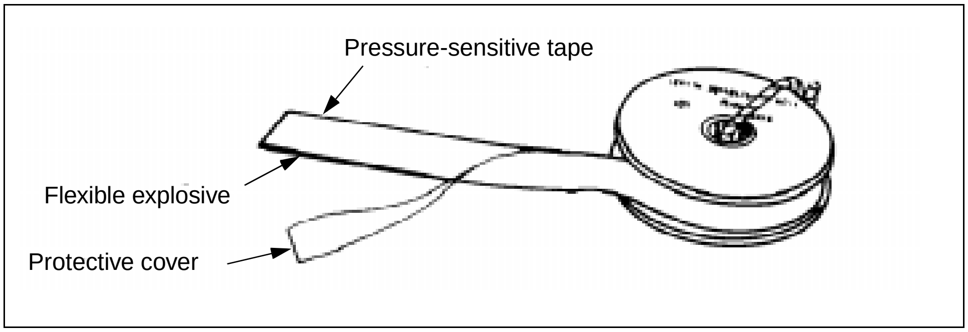


Figure 1-4. M186 roll demolition charge

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.

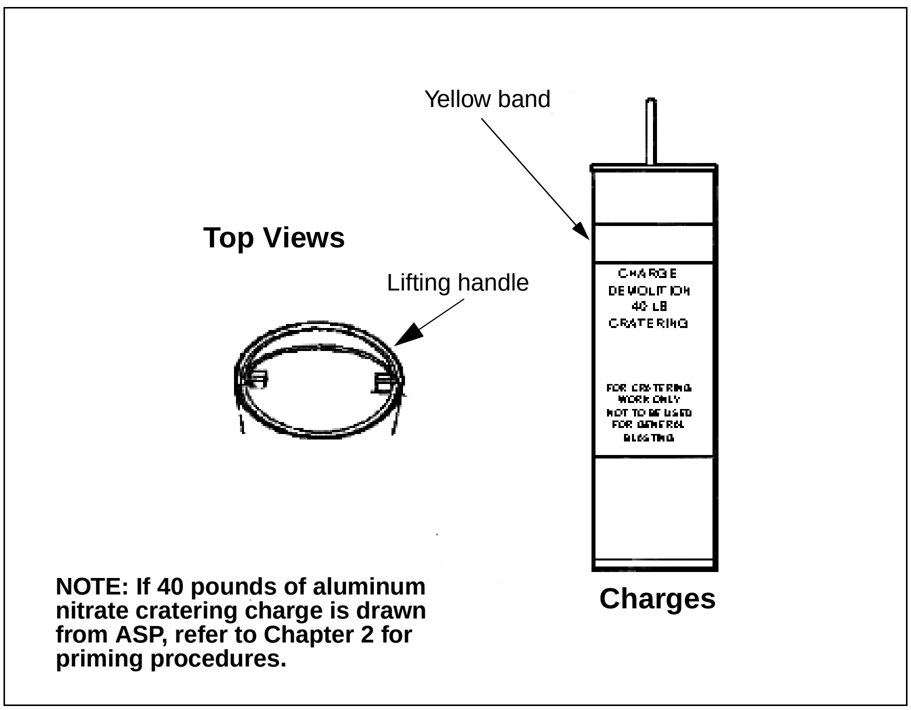


Figure 1-5. Forty-pound, composition H6 cratering charge

M1 MILITARY DYNAMITE

CHARACTERISTICS

1-39. M1 military dynamite is an RDX-based composite explosive containing no nitroglycerin (*Figure 1-6*). M1 dynamite is packaged in 1/2-pound, paraffin-coated, cylindrical paper cartridges, which have a nominal diameter of 1.25 inches and a nominal length of 8 inches. *Table 1-2* lists additional characteristics for M1 military dynamite.

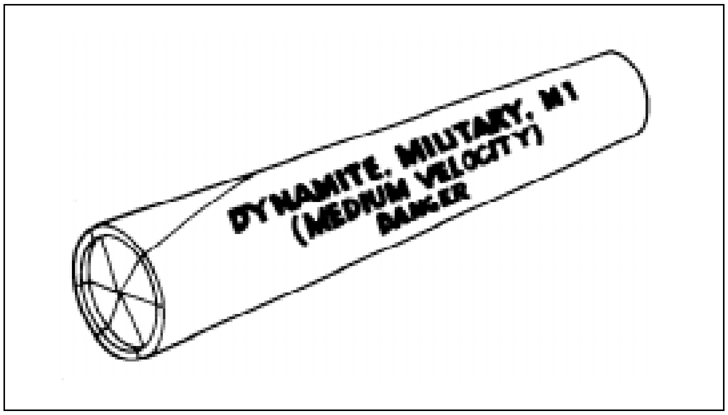


Figure 1-6. M1 military dynamite

USE

1-40. M1 dynamite's primary uses are stump removal, military construction, quarrying, ditching, and service demolition work. It is suitable for underwater demolitions.

ADVANTAGES

1-41. 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 commercial dynamite. Unless essential, do not use civilian dynamite in combat areas.

LIMITATIONS

1-42. M1 dynamite is reliable underwater only for 24 hours. Because of its low sensitivity, pack sticks of military dynamite well to ensure complete detonation of the charge. M1 dynamite is not efficient as a cutting or breaching charge.

SHAPED DEMOLITION CHARGE

1-43. 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 cone's lining material into a narrow jet to penetrate materials (*Figure 1-7*). 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.

CHARACTERISTICS

Fifteen-Pound M2A4 Shaped Demolition Charge

1-44. An M2A4 charge contains a 0.11-pound booster of composition A3 and a 11.5-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

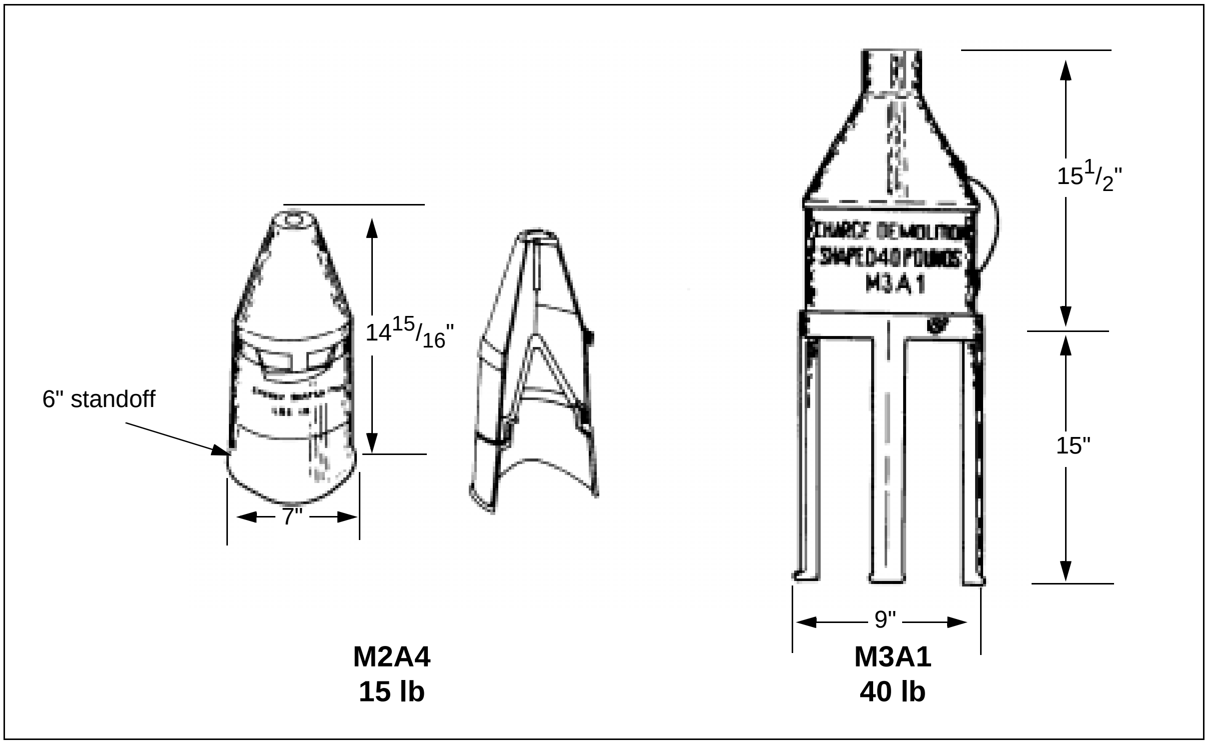


Figure 1-7. Shaped charges

a cone of glass. The charge is 14 15/16 inches high and 7 inches in diameter, including the standoff.

Forty-Pound M3A1 Shaped Demolition Charge

1-45. 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 also 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.

USE

1-46. A shaped demolition charge's primary use is for boring holes in earth, metal, masonry, concrete, and paved and unpaved roads. Its effectiveness depends largely on its shape, composition, and placement. *Table 1-3,* 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

Material	Specifications	M2A4 Shaped Charge* (15 lb)	M3A1 Shaped Charge** (40 lb)
Armor plate	Penetration	12.00 in	At least 20.00 in
	Average hole diameter	1.50 in	2.50 in

Table 1-3. Characteristics of boreholes made by shaped charges

Material	Specifications	M2A4 Shaped Charge* (15 lb)	M3A1 Shaped Charge** (40 lb)
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	2.75 in	3.50 in
	Minimum hole diameter	2.00 in	2.00 in
Concrete pavement	Optimum standoff	42.00 in	60.00 in
(10 in with 21-in	Minimum penetration depth	44.00 in	71.00 in
rock-base course)	Maximum penetration depth	91.00 in	109.00 in
	Minimum hole diameter	1.75 in	6.75 in
Concrete pavement	Optimum standoff	42.00 in	---
(3 in with 24-in	Minimum penetration depth	38.00 in	---
rock-base course)	Maximum penetration depth	90.00 in	---
	Minimum hole diameter	3.75 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)	---	5.00 to 8.00 in
	Hole diameter (normal standoff)	4.00 to 30.00 in	7.00 to 30.00 in
Ice	Hole depth (42-in standoff)	7.00 ft	12.00 ft
	Hole diameter (42-in standoff)	3.50 in	6.00 in
Soil	Hole depth (30-in standoff)	7.00 ft	---
	Hole depth (48-in standoff)	---	7.00 ft
	Hole diameter (30-in standoff)	7.00 in	---
	Hole diameter (48-in standoff)	---	14.50 in
Graveled roads	Hole depth (30-inch standoff)	7.00 ft	---
	Hole depth (48-in standoff)	---	9.00 ft
	Hole diameter (30-in standoff)	7.00 in	---
	Hole diameter (48-in standoff)	---	7.00 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 sufficient.

SPECIAL PRECAUTIONS

1-47. 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.

M183 DEMOLITION CHARGE ASSEMBLY

CHARACTERISTICS

1-48. An M183 charge or satchel charge consists of 16 M112 (C4) demolition blocks and 4 priming assemblies. It has a total explosive weight of 20 pounds. The demolition blocks come in two bags, eight blocks per bag. The two bags come in an M85 canvas carrying case. Two M85 cases come in a wooden box 17 1/8 by 11 1/2 by 12 1/2 inches. Each priming assembly consists of a 5-foot length of detonating cord with an RDX booster crimped to each end and a pair of M1 detonating-cord clips for attaching the priming assembly to a detonating cord ring or line main (*Figure 1-8*).

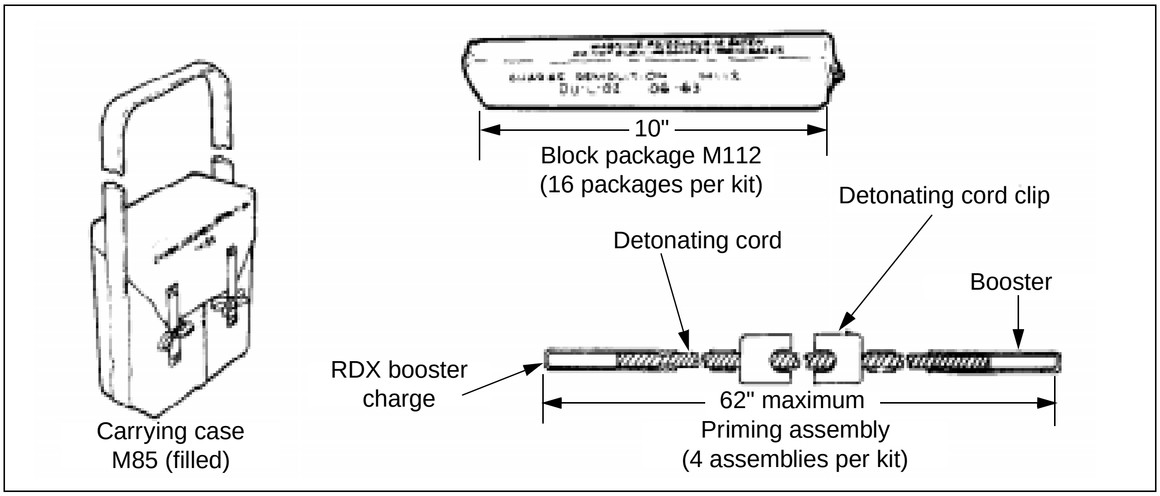


Figure 1-8. M183 demolition charge assembly

USE

1-49. The M183 assembly is used primarily for breaching obstacles or demolishing structures when large demolition charges are required. The M183 charge also is effective against smaller obstacles, such as small dragon's teeth.

M1A2 BANGALORE-TORPEDO DEMOLITION KIT

CHARACTERISTICS

1-50. Each kit consists of 10 tube assemblies, 10 connecting sleeves, and 1 nose sleeve. The tube assemblies, or torpedoes, are steel tubes 5 feet (ft) long and 2 1/8 inches in diameter, grooved, and capped at each end (*Figure 1-9*). 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.

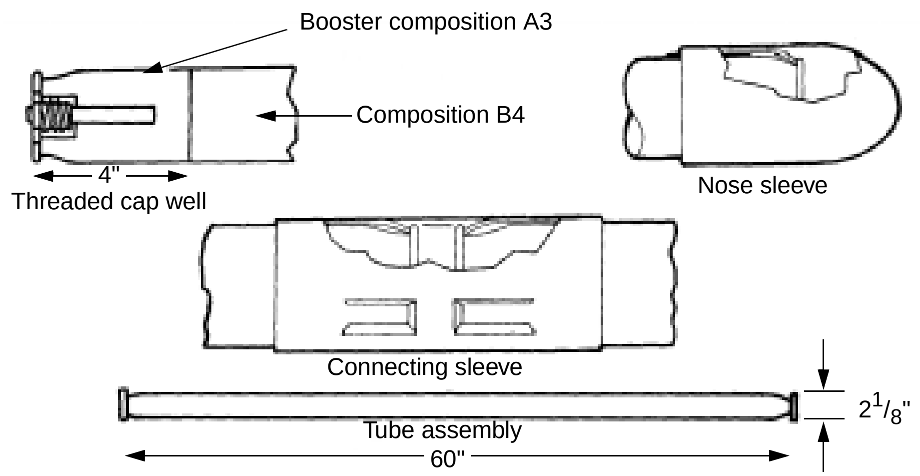


Figure 1-9. M1A2 bangalore torpedo

USE

1-51. 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 line 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

ASSEMBLY

1-52. 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 any other modification could cause the device to explode.

SECTION III. DEMOLITION ACCESSORIES

TIME BLASTING FUSE

1-53. 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 safety fuse. Except for special operations forces, the M14 (MDI) will replace the M700 time fuse soon. The M700 time fuse is a dark green cord, 0.2 inch in diameter, with a plastic cover (*Figure 1-10*). It burns at a rate of about 40 seconds (sec) 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.

DETONATING CORD

CHARACTERISTICS

1-54. The American, British, Canadian, and Australian (ABCA) Standardization Program recognizes Type 1 detonating cord as the standard detonating cord. Detonating cord (*Figure 1-11*) consists of a core of HE (6.4 pounds of 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. Leave a 6-inch tail when making connections or when priming charges.

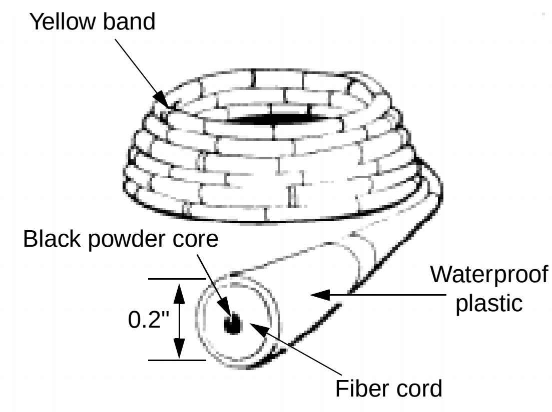


Figure 1-10. M700 time fuse

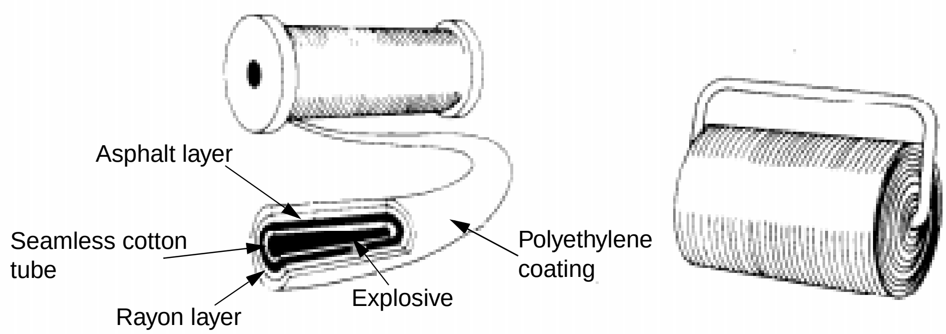


Figure 1-11. Detonating cord

USE

1-55. 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

1-56. Seal the ends of detonating cord with a waterproof sealant when used to fire 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 a line from moisture. Avoid kinks, sharp bends in priming, or unintended crossovers as they may interrupt or change the direction of detonation and cause misfires. To avoid internal cracking, do not step on the detonating cord.

BLASTING CAPS

1-57. Blasting caps are for detonating HE. The two types of blasting caps are electric and nonelectric. They are designed for insertion into cap wells and are also the detonating element in certain firing systems and devices. Blasting caps are rated in power, according to the size of their main charge. Commercial blasting caps are normally Number 6 or 8 and are for detonating the more sensitive explosives, such as commercial dynamite and tetryl. Special military blasting caps (M6 electric and M7 nonelectric) ensure positive detonation of the generally 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. Separate blasting caps properly. Never store blasting caps with other explosives. Do not carry blasting caps and other explosives in the same truck except in an emergency. (See *Chapter 6*.)

WARNING

Handle military and commercial blasting caps carefully, as both are extremely sensitive and may explode if handled improperly. Do not tamper with blasting caps. Protect them from shock and extreme heat.

Electric Blasting Caps

1-58. Use electric blasting caps 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 1-12*) 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. TM 43-0001-38 gives additional information on blasting caps. Limited quantities will be available for special purposes once MDI is fully fielded.

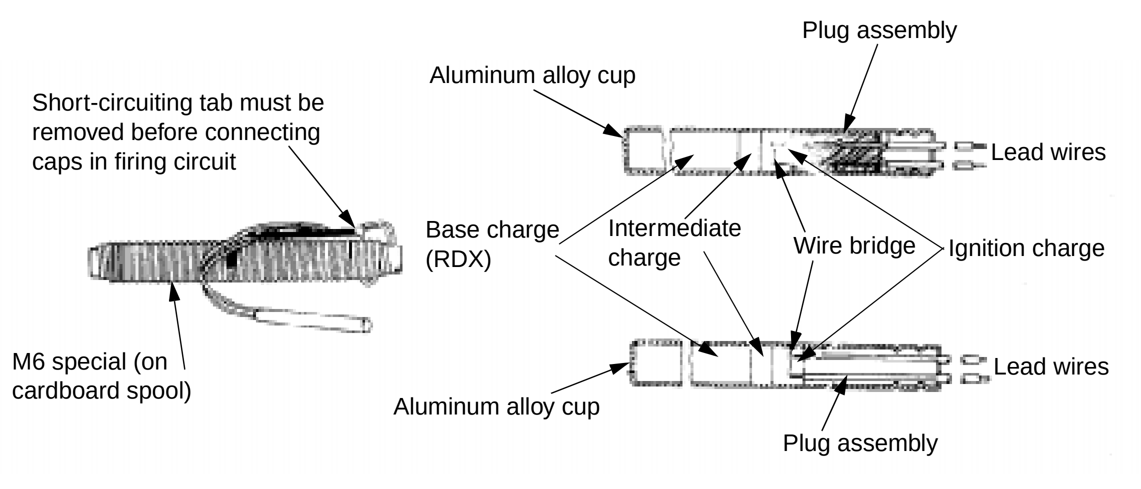


Figure 1-12. Electric blasting caps

NONELECTRIC BLASTING CAPS

1-59. Initiate these caps with time blasting fuse, a firing device, or detonating cord (*Figure 1-13*). Avoid using nonelectric blasting caps to prime underwater charges 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 time fuse. TM 43-0001-38 gives additional information on blasting caps.

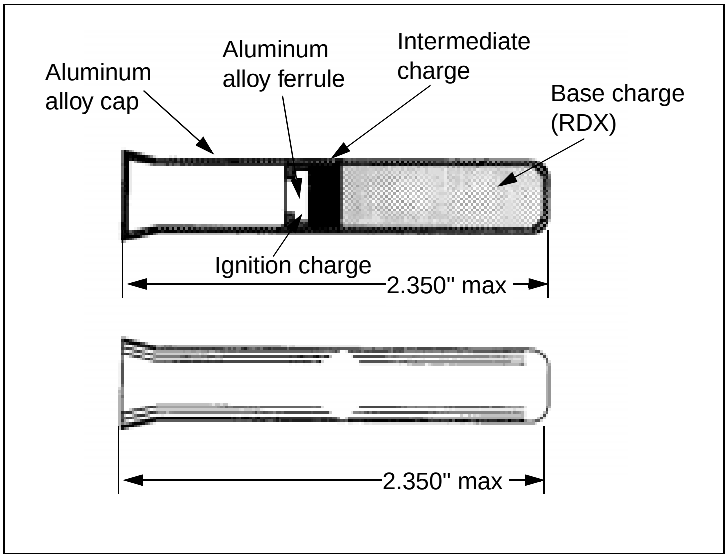


Figure 1-13. Nonelectric blasting caps

M1A4 PRIMING ADAPTER

1-60. 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 in the adapter quickly and easily (*Figure 1-14*).

M8 BLASTING-CAP HOLDER

1-61. An M8 is a metal clip designed to attach a blasting cap to a sheet explosive (*Figure 1-15*). These clips are supplied with the M118 and M186 charges. The M8 is also available as a separate-issue item in quantities of 4,000.

M1 DETONATING-CORD CLIP

1-62. An M1 clip is a device for holding two strands of detonating cord together, either parallel or at right angles (*Figure 1-16, diagram 1*). Using

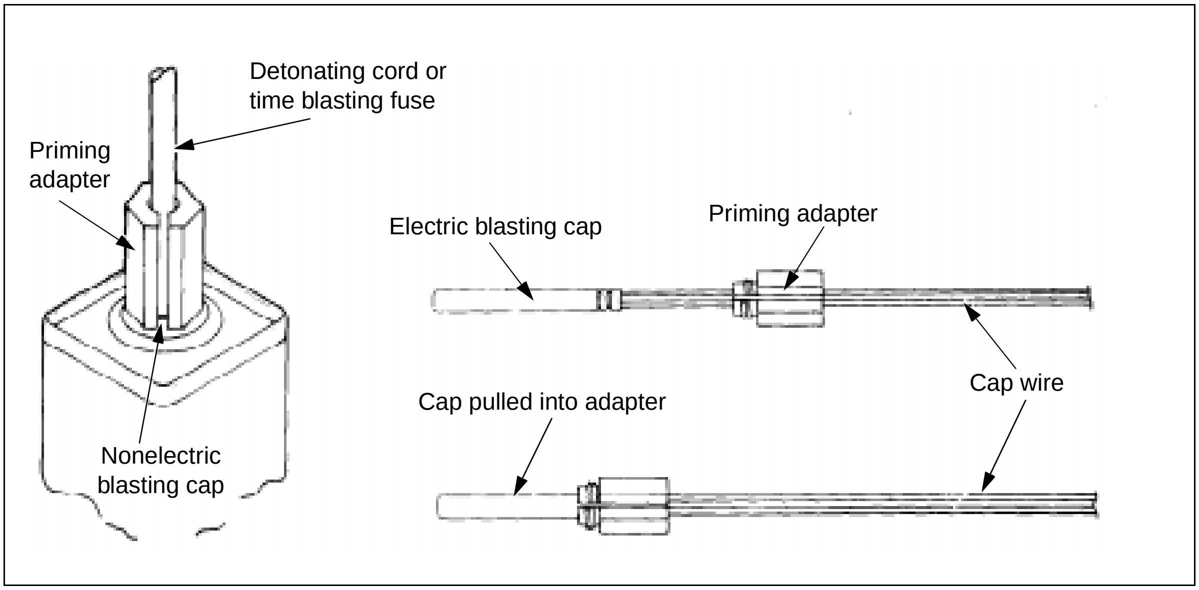


Figure 1-14. M1A4 priming adapter

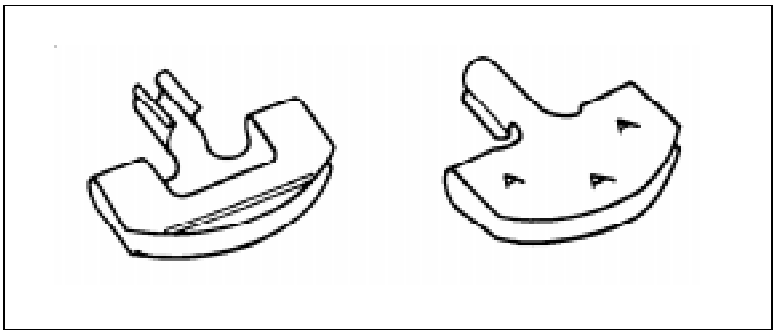


Figure 1-15. M8 blasting-cap holder

these clips is faster and more efficient than using knots. Knots, if left for extended periods, may loosen and fail to function properly.

BRANCH LINES

1-63. Connect a detonating-cord branch line by passing it through the trough of the M1 clip and through the hole in the tongue of the clip. Next, place the line/ring main into the tongue of the clip so that it crosses over the branch line at a 90-degree angle, and ensure that the crossover is held secure by the tongue; it may be necessary to bend or form the tongue while doing this. (*Figure 1-16, diagram 2*).

SPLICES

1-64. Splice the ends of detonating cords by first overlapping them approximately 12 inches. Then secure each loose end to the other cord by using a clip. Finally, bend the tongues of the clips firmly over both strands. Make the connection stronger by bending the trough end of the clip back over the tongue (*Figure 1-16, diagram 3*).

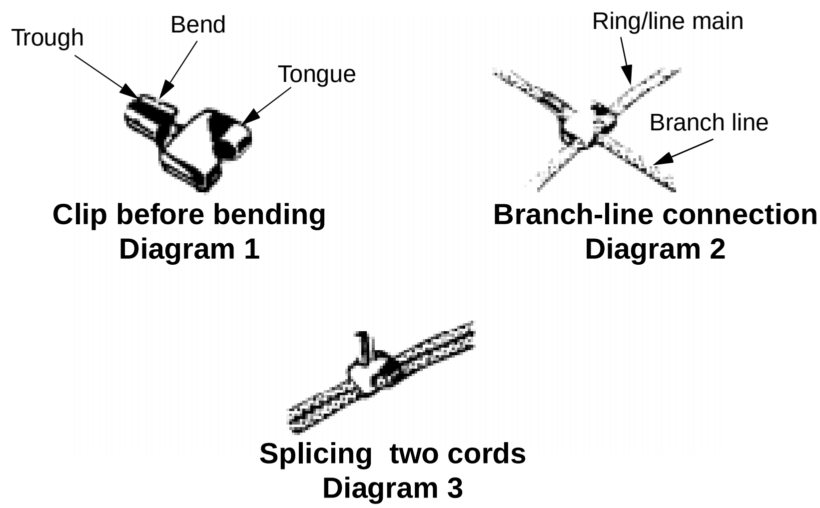


Figure 1-16. M1 detonating-cord clip

M1 ADHESIVE PASTE

1-65. 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 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

1-66. This tape is replacing M1 adhesive paste. The tape has better holding properties and is more easily and quickly applied. This tape is coated on both sides with pressure-sensitive adhesive and requires no solvent or heat to apply. It is available in 2-inch-wide rolls, 72 yards long. Use this tape to effectively hold charges to dry, clean wood, steel, or concrete. This tape does not adhere to dirty, wet, oily, or frozen surfaces.

WATERPROOF SEALING COMPOUND

1-67. 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, fire underwater demolitions as soon as possible after placing them.

M2 CAP CRIMPER

1-68. Use an M2 cap crimper (*Figure 1-17*) for squeezing the shell of a nonelectric blasting cap around a time blasting fuse, standard coupling base, or detonating cord. Crimp the shell securely enough 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. Apply a sealing compound 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 them as pliers because such use damages the crimping surface. Ensure that the crimp hole is round (not elongated) and the cutting jaws are not jagged. Keep the cutting jaws clean, and use them only for cutting fuses and detonating cords.

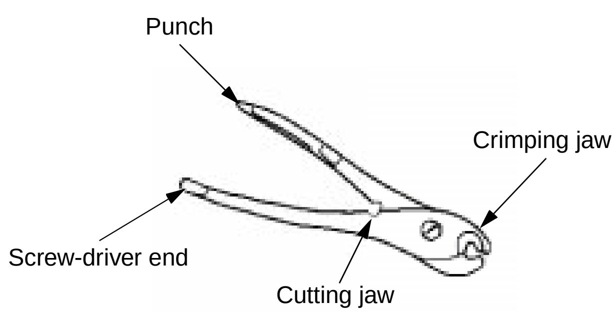


Figure 1-17. M2 cap crimper

M51 TEST SET

CHARACTERISTICS

1-69. 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 1-18*).

USE

1-70. Check the continuity of firing wire, blasting caps, and firing circuits by connecting the leads to the test-set binding posts and then 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

1-71. Handle the test set carefully, and keep it dry to ensure optimum use. Before using, ensure that the test set is operating properly by using the following procedures:

- Hold a piece of bare wire or the legs of the M2 crimpers across the binding posts.

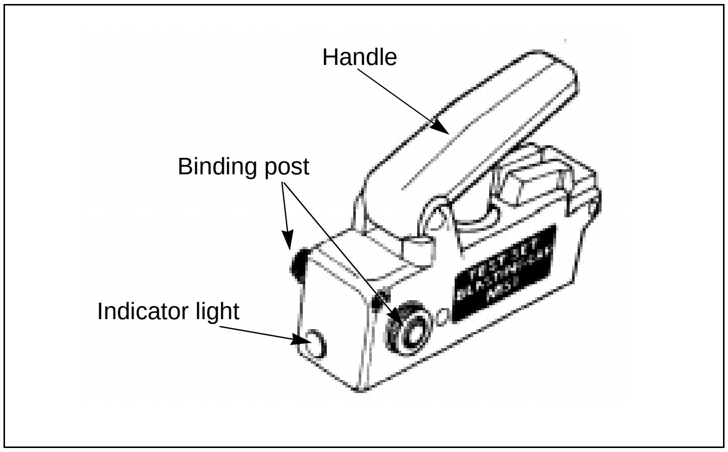


Figure 1-18. M51 blasting-cap test set

- Depress the handle sharply while watching the indicator lamp. The indicator lamp should flash.
- Remove the bare wire or crimper legs from the binding posts.
- Depress the handle sharply while watching the indicator lamp. This time the indicator lamp should not flash.
- Perform both tests to ensure that the test set is operating properly.

BLASTING MACHINES

1-72. 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.

M-32 10-CAP BLASTING MACHINE

1-73. This small, lightweight blasting machine (*Figure 1-19*) produces adequate current to initiate 10 electrical caps connected in a series using 500 feet of wire diameter (WD)-1 cable. To operate the machine, use the procedure for the M-34 50-cap blasting machine.

M-34 50-CAP BLASTING MACHINE

1-74. This small, lightweight machine produces adequate current to initiate 50 electrical caps connected in a series. It looks like the M32 blasting machine (Figure 1-19) except for a black band around the base and a reinforced-steel actuating handle. Test and operate the M34, the same as the M32, by—

- Checking the machine for proper operation. Release the blasting-machine handle by rotating the retaining ring downward while pushing in on the handle. The handle should automatically spring outward from the body of the machine.
- Activating the machine by depressing the handle rapidly three or four times until the neon indicator lamp flashes. The lamp is located between the wire terminal posts and cannot be seen until it flashes, since it is covered by green plastic.

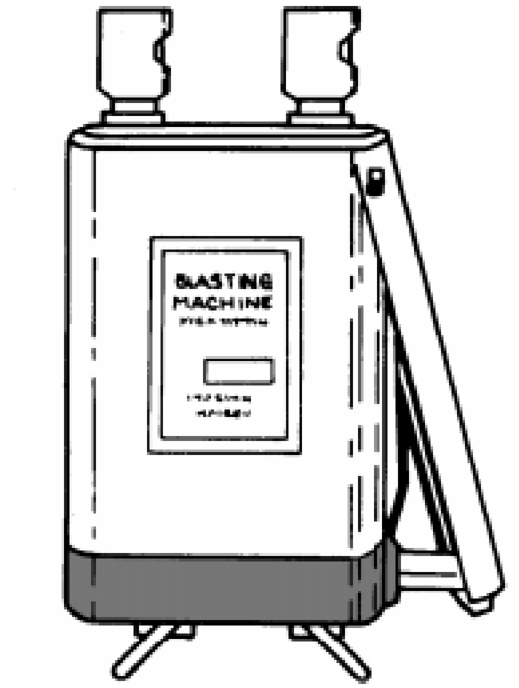


Figure 1-19. M32 blasting machine

- Inserting the firing wire leads into the terminals by pushing down on each terminal post and inserting the leads into the metal jaws.
- Holding 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 machine's body. Be sure to hold the machine correctly, as the handles are easily broken.
- Squeezing the handle sharply several times until the charge fires. Normally, no more than three or four strokes are required.

CD450-4J BLASTING MACHINE

Operational Test

1-75. Conduct an operational test on the CD450-4J as follows:

- 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.
- Continue holding the charge switch down, after the READY-TO-FIRE indicator lights, 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 above step.

Release both switches after observing the above and then secure the blasting machine.

General Operating Procedures

1-76. Conduct general operating procedures on the CD450-45 as follows:

- Perform the operational test before bringing the blasting machine into the blast area.
- Obtain electric detonator firing recommendations from the detonator manufacturer. Check the blasting circuit calculations before connecting to the
- Connect the detonator wires to the lead lines using series or other circuits recommended by the detonator manufacturer.
- Ensure that all personnel have moved to a safe location.

CAUTION
Keep the lead lines shunted during wiring of the electric detonators.

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

DANGER
Keep hands and body clear of conductors. Contact with electrical conductors could cause serious injury or death.

- Depress the CHARGE switch and hold it down. The READY-TO-FIRE indicator lights when the capacitor reaches 450 volts. Releasing the CHARGE switch will discharge the capacitor within 3 seconds.
- Continue holding the CHARGE switch down when the READY-TO-FIRE indicator lights, wait at least 2 seconds, then firmly depress the FIRE

switch. Continue holding both switches down until the firing operation is complete.

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

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

FIRING WIRE AND REEL

TYPES OF FIRING WIRE

1-77. 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-covered 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 WD-1/telegraphic transfer (TT) communication wire will also work, but it requires a greater power source if more than 500 feet are used. Blasting machines will not initiate the full-rated number of caps connected with more than 500 feet of WD-1/TT wire. As a rule of thumb, use 10 less caps than the machine's rating for each additional 1,000 feet of WD-1/TT wire employed.

REEL

1-78. 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 1-20*). 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.

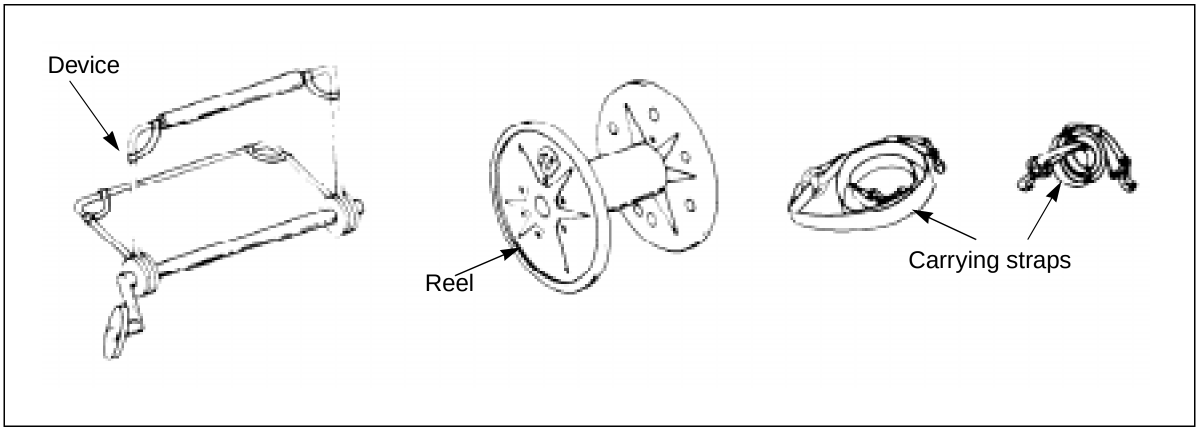


Figure 1-20. Firing-wire reel

FIRING DEVICES AND OTHER ACCESSORY EQUIPMENT

M60 WEATHERPROOF FUSE IGNITER

1-79. This device is used for igniting timed blasting fuse in all weather conditions, even underwater, if properly waterproofed. Insert the fuse 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 1-21*). With the safety pin removed, pulling the pull ring releases the striker assembly, allowing the firing pin to initiate the primer, igniting the fuse. *Chapter 2* gives detailed operating instructions for the M60 igniter.

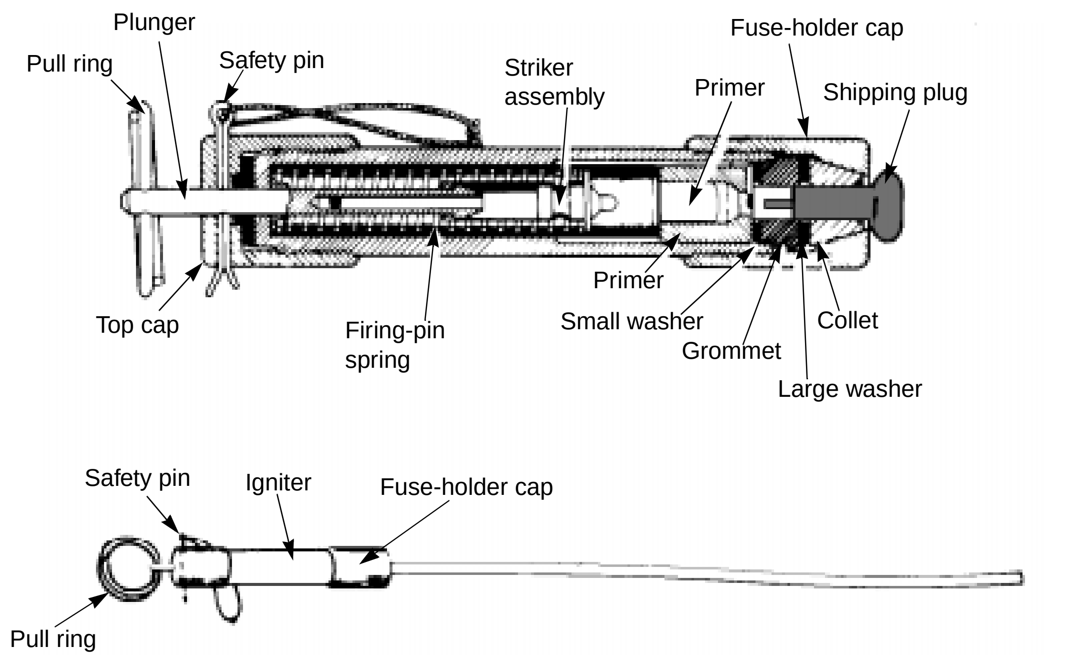


Figure 1-21. M60 fuse igniter

DEMOLITION EQUIPMENT SET

1-80. This set (electric and nonelectric explosive initiating demolition equipment set) is an assembly of tools necessary for performing demolition operations (*Table 1-4*).

Table 1-4. Demolition equipment set

Quantity	Nomenclature	Quantity	Nomenclature
3	Bag, demolition equipment	1	Machine, blasting, M34
5	Box, blasting cap, plastic, 10-cap	2	Pliers, lineman's, with side cutter, 8-inch
1	Chest, demo, engr plt, M1931	1	Pliers, diagonal-cutting, 6-in

Table 1-4. Demolition equipment set

Quantity	Nomenclature	Quantity	Nomenclature
4	Crimper, blasting cap, M2	4	Reel, cable
2	Knife, pocket, with can opener and punch	1	Machine, cable-reeling, manual
2	Knife, pocket, with screwdriver and wire scraper	2	Tape, measuring, steel, millimeters and inches
1	Shears, metal-cutting, manual, 8-inch	1	Set, blasting-cap test, M51
1	Tape, measuring, plastic-coated, 100-foot		
NOTE: The items listed in this set are available separately.			

NOTE: To cross reference demolition materials by the Department of Defense ammunition code (DODAC), see .

Chapter 2

Initiating Sets, Methods of Priming, and Firing Systems

2-1. The different types of initiating sets and how to prepare them are explained in this chapter. Also discussed are the different methods for priming each type of explosive and how to set up demolition firing systems.

SECTION I. INITIATING SETS

CAUTION
Refer to the safety procedures in Chapter 6 before undertaking any demolitions missions.

NONELECTRIC INITIATION SETS

COMPONENTS ASSEMBLY

2-2. A nonelectric system uses a nonelectric blasting cap as the initiator. The initiation set consists of a fuse igniter (produces flame that lights the time fuse), a time blasting fuse (transmits the flame that fires the blasting cap), and a nonelectric blasting cap (provides shock adequate to detonate the explosive) (Figure 2-1). See Chapter 7 for MDI components and the preparation sequence. When combined with detonating cord, a single initiation set can fire multiple charges.

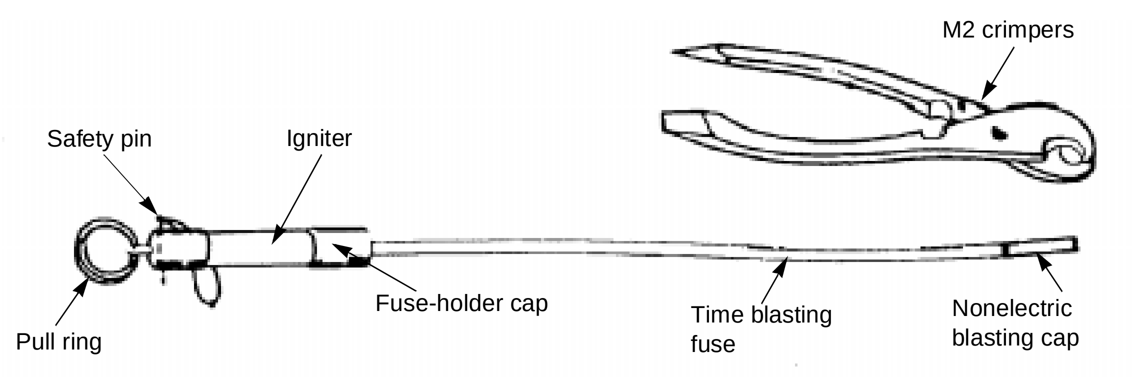


Figure 2-22. Nonelectric initiation set

PREPARATION SEQUENCE

2-3. Preparing demolitions for nonelectric initiation follows a specified process. This process includes the steps listed below.

S*tep 1.* Check the time fuse. Test every coil of fuse, or remnant of a coil, using the burning-rate test before use. One test per day per coil is sufficient. Never use the first and last 6 inches of a coil because moisture may have penetrated the coil to this length. Using an M2 crimper, cut and discard a 6-inch length from the working end of the fuse (Figure 2-2). Cut a 3-foot length of the fuse to check the burning rate. Ignite the fuse and note the time it takes for the fuse to burn. Compute the burning rate per foot by dividing the burn time (in seconds) by the length (in feet). If the test burn does not fall within 5 seconds of a 40-second-per-foot burn rate, perform another test to verify your results. Once the burn rate is calculated, it is recommended that the coil be placed in the foil packet and marked with its corresponding burn rate.

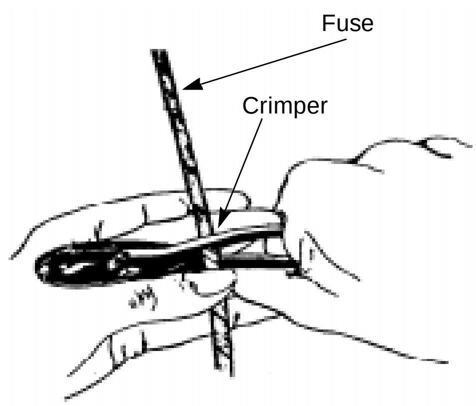


Figure 2-23. Cutting time fuse

DANGER
Test burn a 3-foot length of time blasting fuse to determine the exact rate before use.

Step 2. Prepare the time fuse. Cut the fuse long enough to allow the person detonating the charge to reach safety (walking at a normal pace) before the explosion. Walk and time this distance before cutting the fuse to length. The formula for determining the length of time fuse required is—

$$\frac{\text{time required (min) x 60 (sec/min)}}{\text{burning rate (sec/ft)}} = \text{fuse length (ft)}$$

Make your cut squarely across the fuse. Do not cut the fuse too far in advance, since the fuse may absorb moisture into the open ends. Do not allow the time fuse to bend sharply, as you may crack the black powder core, resulting in a misfire.

Step 3. Attach the fuse igniter. To attach an M81 weatherproof fuse igniter, unscrew the fuse holder cap two or three turns, but do not remove the cap. Press the shipping plug into the igniter to release the split collet (Figure 1-21, page 1-26). Rotate and remove the plug and plastic shock tube holder from the igniter. Insert the free end of the time fuse as far as possible into the space left by the removed shipping plug. Sufficiently tighten the holder cap to hold the fuse and weatherproof the joint.

Step 4. Install the priming adapter. If you use a priming adapter to hold a nonelectric blasting cap, place the time fuse through the adapter before installing (crimping) the blasting cap onto the fuse. Ensure that the adapter threads are pointing to the end of the time fuse that will receive the blasting cap.

Step 5. Prepare the blasting cap by—

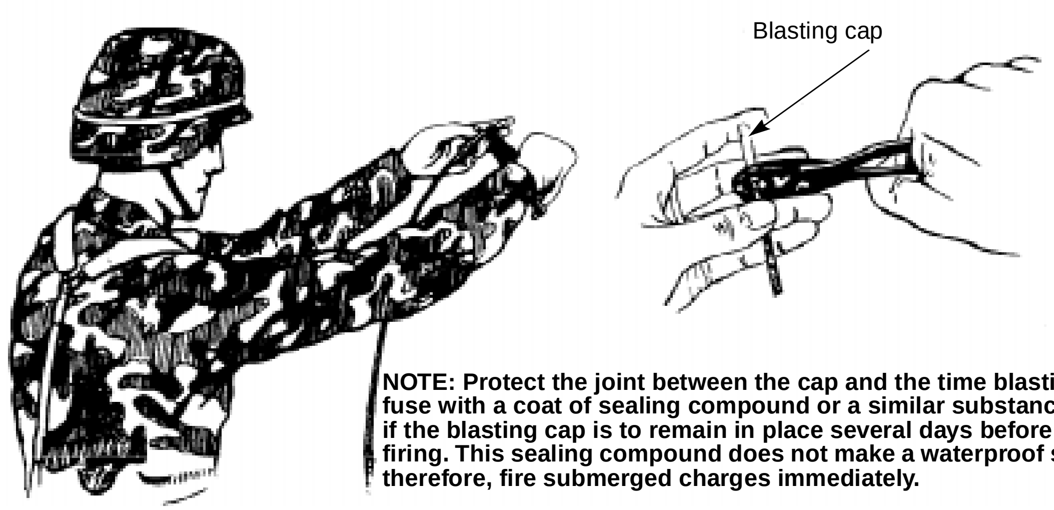
- Inspecting. Hold the cap between the thumb and ring finger of one hand, with the forefinger of the same hand on the closed end of the blasting cap. Inspect the blasting cap by looking into the open end. You should see a yellow-colored ignition charge. If dirt or any foreign matter is present, do the following:
  - — Aim the open end of the cap at the palm of the second hand.
  - — Gently bump the wrist of the cap-holding hand 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, and 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 the 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 fuse squarely, cut the fuse against a solid, nonsparking surface such as wood.

  - — Grasp the fuse with the thumb and ring finger while applying slight pressure with the 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.

The thumb and ring finger that hold the fuse will be below the crimpers. Rest the second finger of the hand holding the fuse on top of the crimpers to prevent the crimpers from sliding up the cap (Figure 2-3).



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.

Figure 2-24. Crimping a blasting cap onto fuse

— Extend both arms straight out while rotating the hands so that the closed end of the blasting cap is pointing away from the body and away from other personnel.

— Crimp the blasting cap by firmly squeezing the M2 crimper handles together, maintaining eye contact with the blasting cap. Inspect the crimp after you have finished.

NOTE: Attach the M60 fuse igniter to the time fuse before crimping a blasting cap to the opposite end. Do not remove the safety pin until you are ready to detonate the charge.

WARNING

To avoid cap detonation, crimp blasting caps $^1/_8$ to $^1/_4$ inch from the open end of the cap.

NOTE: If the cap is to remain in place several days before firing, protect the joint between the cap and the timed blasting fuse with a coat of sealing compound or similar substance.

NOTE: See paragraphs 6-16 through 6-18, pages 6-9 through 6-10, for procedures on handling nonelectric misfires.

FUSE INITIATION

2-4. To fire the assembly, hold the M60 igniter in one hand, and remove the safety pin with the other. Grasp the pull ring and give it a quick, hard pull. In the event of a misfire, reset the M60 by pushing the plunger all the way in, rotate it left or right 180°, and attempt to fire as before.

CAUTION
Water can enter through the vent hole in the pull rod when attempting to reset the igniter under water. This will prevent the fuse igniter from working after resetting.

NOTE: If a fuse igniter is not available, light the time blasting fuse with a match. Split the fuse at the end (Figure 2-4), and place the head of an unlit match in the powder train. Light the inserted match head with a flaming match, or rub the abrasive on the match box against it. It may be necessary to use two match heads during windy conditions.

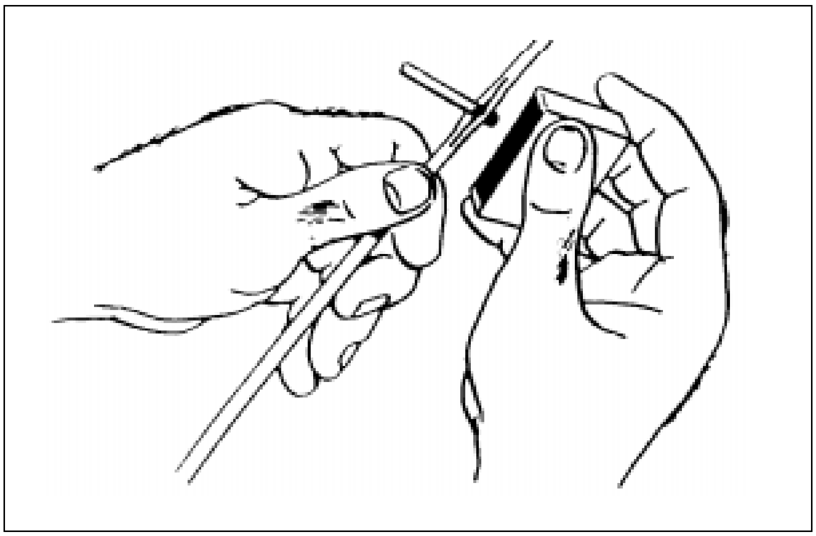


Figure 2-25. Lighting time fuse with a match

ELECTRIC INITIATION SETS

2-5. See Appendix F for the power requirements for series firing circuits. Use the following process to make an electric initiation set:

Step 1. Testing and maintaining control of the blasting machine.

- Test the blasting machine to ensure that it is operating properly (paragraph 1-75, page 1-23).
- Control access to all blasting machines. The supervisor is responsible for this.

Step 2. Testing the M51 test set.

- Check the M51 test set to ensure that it is operating properly (paragraphs 1-69 through 1-71, pages 1-21 and 1-22).
- Perform both the open- and short-circuit tests.

Step 3. Testing the firing wire on the reel (shunted and unshunted).

- 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. The indicator lamp should NOT flash. If it does, the lamp's flash indicates a short circuit in the firing wire (Figure 2-5).

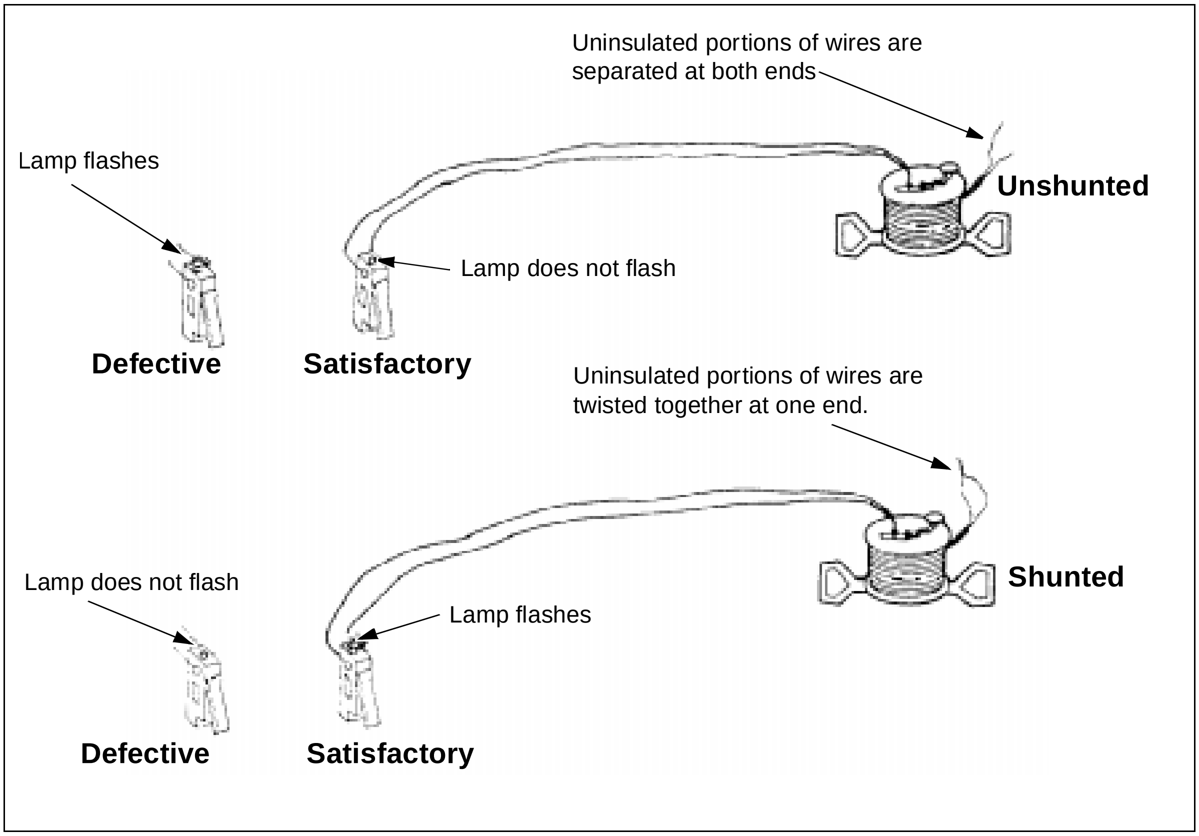


Figure 2-26. Testing firing wire on the reel

- 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. The indicator lamp should flash. If it does not, the lamp's failure to light indicates a break in the firing wire (Figure 2-5).

NOTE: Use at least three 180-degree twists to shunt the wires.

- Shunt both ends of the firing wire after testing.

Step 4. Laying out the firing wire (completely off the reel).

- Lay out the firing wire from the charges and the firing point, after locating a firing point. Ensure that this firing point is located a safe distance away from the charges (paragraphs 6-14 and 6-15, pages 6-7 through 6-9).

- Do not allow vehicles to drive over or personnel to walk on the firing wire. Always bury firing wire or lay it flat on the ground.
- 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 wire to length. Do not connect it to a blasting machine through the unused portion of wire on the reel.

Step 5. Retesting the firing wire (shunted and unshunted).

- Perform the open- and close-circuit tests again. The process of unreeling the wire may have separated broken wires not found when the wire was tested on the reel.
- Guard the firing position continually from this point on. Do this to ensure that no one tampers with the wires or fires the charges prematurely.
- Use hand signals to indicate the test results. Hand signals are necessary because of the distance involved between the charges and the firing position. The soldier testing the wire also 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 his 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 his 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 his wire is shunted.
- Shunt both ends of the firing wire after the tests are complete.

Step 6. Testing the electric blasting caps.

- Remove the cap from its spool. Place the cap in the palm of your hand, lead wires passing between your index and middle fingers.
- Wrap the wire around the palm of your hand twice. Doing this prevents tension on the wires in the cap and prevents the cap from being dropped.
- Grasp the wire spool with your free hand and unreel the wire, letting the wire pass between your fingers as you turn the spool. Completely unreel the cap wires 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 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 M51's binding posts. Hold or attach the second lead wire to the other binding post, and squeeze the test-set handle. 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. Connecting the series circuit (if used). For a series circuit, you may use one of the series circuits illustrated in Figure 2-6. Use the following procedure:

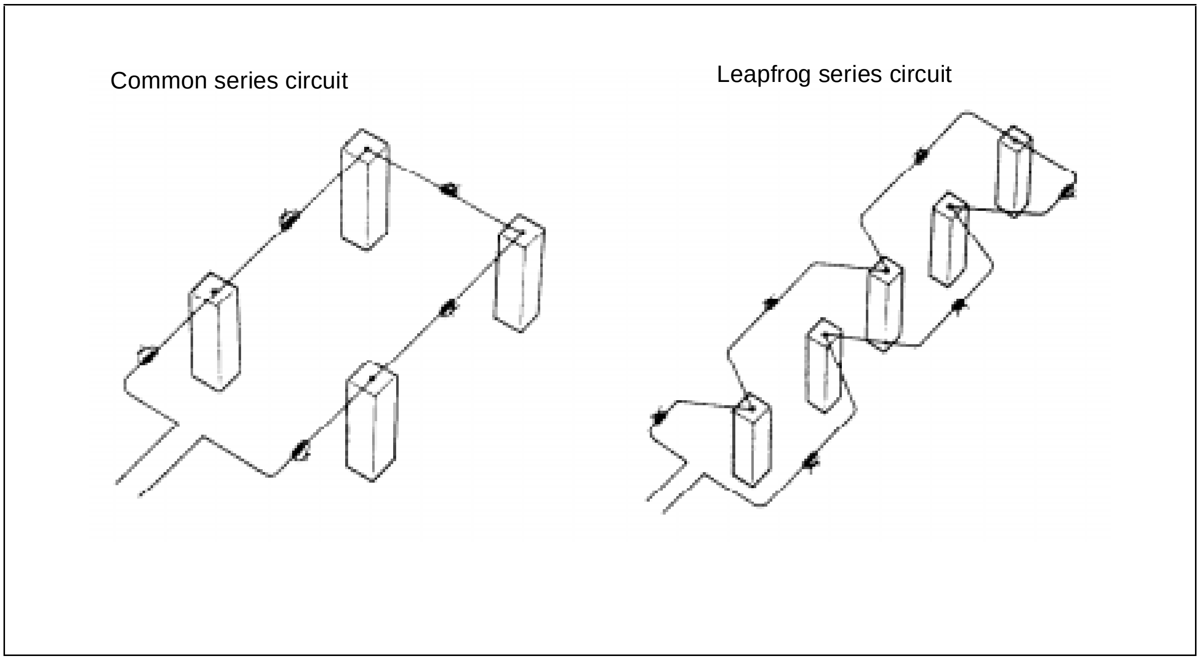


Figure 2-27. Series circuit

- Test all blasting caps (step 6, page 2-7) separately before connecting them in a circuit.
- Join blasting-cap wires together using the Western Union pigtail splice and tension knit (Figure 2-7). 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. After the series is completed, connect the two free blasting-cap wires to the M51 test set. 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. Connecting the firing wire to the cap wire.

- Connect the free leads of blasting caps to the firing wire before priming the charges or taping a blasting cap to a detonating-cord ring main.

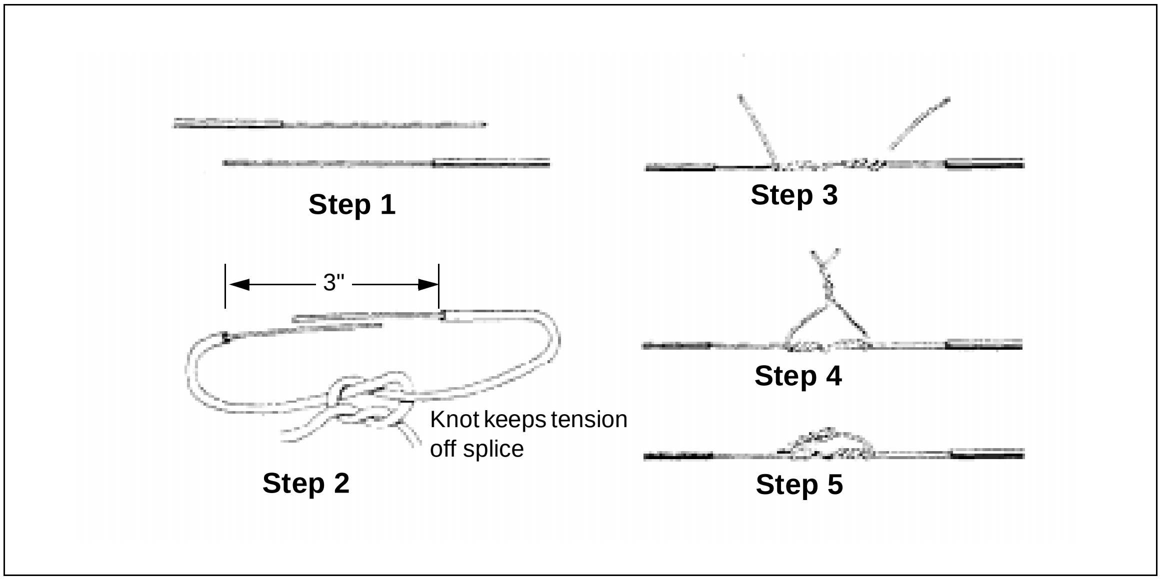


Figure 2-28. Western Union pigtail splice and tension knot

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

Step 9. Testing the entire firing circuit. Before priming the charges with electric caps or connecting the blasting caps to the firing circuit, test the circuit from the firing point. Use the following procedure:

- 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 charges with electric blasting caps or connect electric blasting caps to the detonating cord until all other steps of the preparation sequence have been completed.

Step 10. Priming the charges. Prime the charges and return to the firing point. This is the last step before actually returning to the firing point and firing the circuit.

WARNING
Prime charges with the minimum number of personnel on site.

COMPONENTS ASSEMBLY

2-6. An electric system uses an electric blasting cap as the explosion initiator. The initiation set consists of an electric blasting cap, the firing wire, and a blasting machine (Figure 2-8). 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 initiation 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.

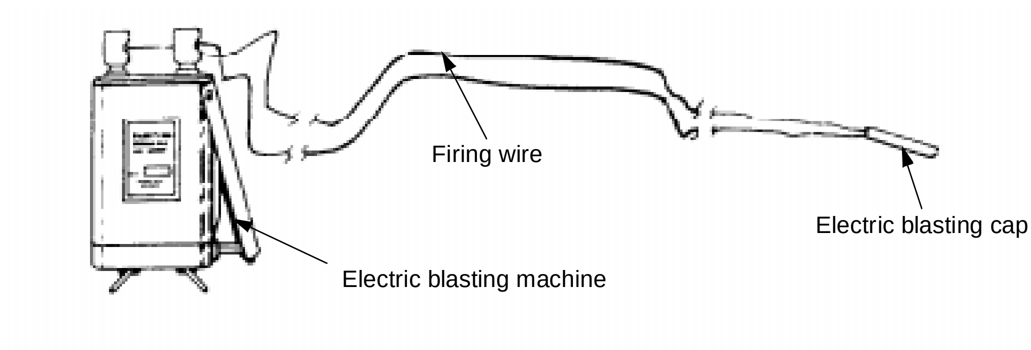


Figure 2-29. Electric initiation set

CIRCUIT INITIATION

2-7. At this point, the initiation set is complete. Do not connect the blasting machine until all personnel are accounted for and you have clearance to fire the demolition. When all personnel are clear, call "*fire in the hole*" three times, then install the blasting machine and initiate the demolition. Chapter 6 covers procedures for electric misfires.

SPLICING ELECTRIC WIRES

Preparation

2-8. Strip the insulating material from the end of insulated wires before splicing. Remove about $1^1/_2$ inches of insulation from the end of each wire (Figure 2-7, step 1, page 2-9). Also remove any coating on the wire, such as enamel, by carefully scraping the wire with the back of a knife blade or other suitable tool. Do not nick, cut, or weaken the bare wire. Twist multiple-strand wires lightly after scraping.

Method

2-9. Use the Western Union pigtail splice (Figure 2-7, page 2-9) to splice two wires. Splice two pairs of wires in the same way as the two-wire splice (Figure 2-9). Use the following procedure:

- Protect the splices from tension damage by tying the ends in an overhand or square knot (tension knot), allowing sufficient length for each splice (Figure 2-7, step 2).
- Make three twists with each wire (Figure 2-7, step 3).
- Twist the ends together with an additional three turns (Figure 2-7, step 4).
- Flatten the splice, but not so far that the wire crimps itself and breaks (Figure 2-7, step 5).

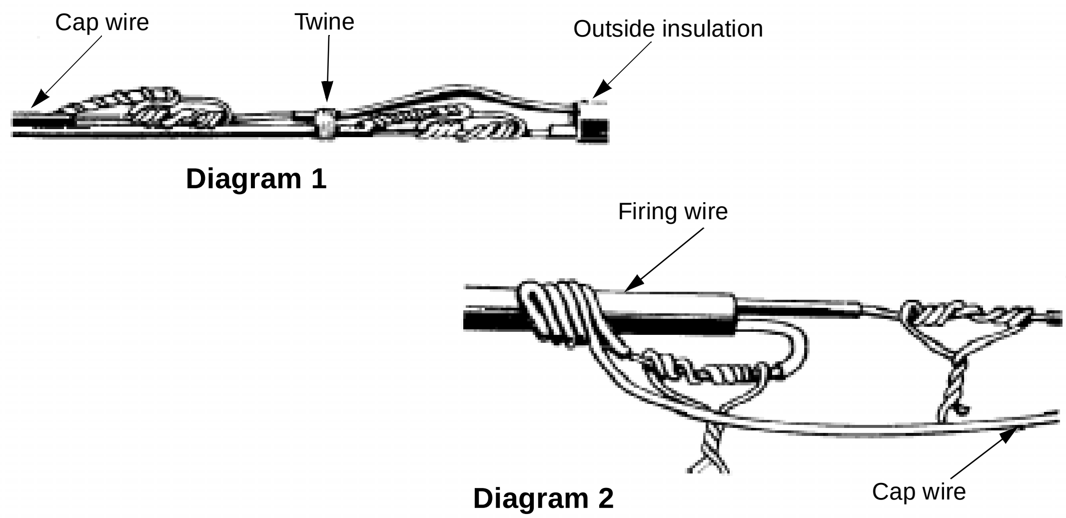


Figure 2-30. Two-wire splice

Precautions

2-10. A short circuit may occur at a splice if you do not use caution. For example, when you splice pairs of wires, stagger the splices and place a tie between them (Figure 2-9, diagram 1). Another method of preventing a short circuit in a splice is using the alternate method (Figure 2-9, diagram 2). In the alternate method, separate the splices rather than stagger them. Insulate the splices from the ground or other conductors by wrapping them with friction tape or electric insulating tape. Always insulate splices.

SERIES CIRCUITS

Common

2-11. Use a common series circuit to connect two or more electric blasting caps to a single firing wire (Figure 2-6, page 2-8). Prepare the circuit 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. Connect the free ends of the cap's lead wires to the ends of the firing wire. Use connecting wires (usually annunciator wire) when the distance between blasting caps is greater than the length of the usual cap's lead wires.

Leapfrog

2-12. The leapfrog method of connecting caps in a series is useful for firing any long line of charges (Figure 2-6, page 2-8). This 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 F for additional information on series circuits. This type of circuit is rarely needed, since detonating cord, when combined with a single blasting cap, will fire multiple charges.

SECTION II. PRIMING SYSTEMS

PRIMING METHODS

2-13. The three methods of priming charges are nonelectric, electric, and detonating cord. Nonelectric and electric priming involves directly inserting blasting caps into the charges. Use the direct-insertion method only when employing shaped charges. Detonating-cord priming is the preferred method for priming all other 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 or mission.

NOTE: You can crimp nonelectric blasting caps to detonating cord as well as time fuse. This capability permits simultaneous firing of multiple charges primed with a blasting cap.

PRIMING TNT DEMOLITION BLOCKS

NONELECTRIC

2-14. TNT blocks have threaded cap wells. Use priming adapters, if available, 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 as follows:

- Wrap a string tightly around the block of TNT, and tie it securely, leaving about 6 inches of loose string on each end (Figure 2-11).
- Insert a blasting cap with the fuse attached into the cap well.
- 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. Refer to Figure 2-11.

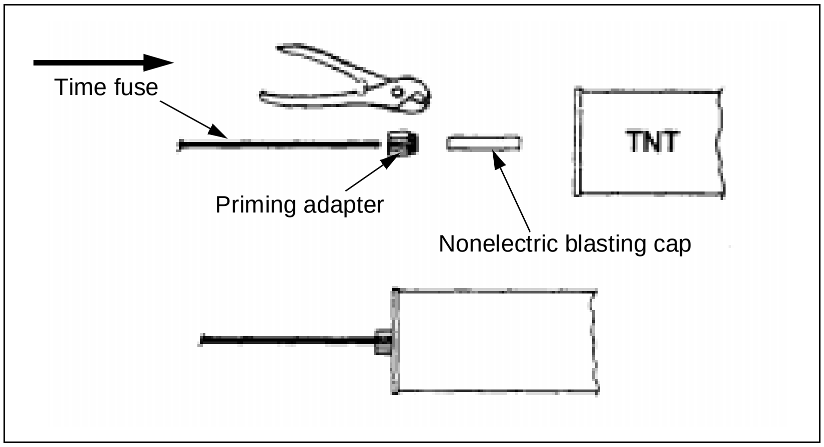


Figure 2-31. Nonelectric priming with adapter

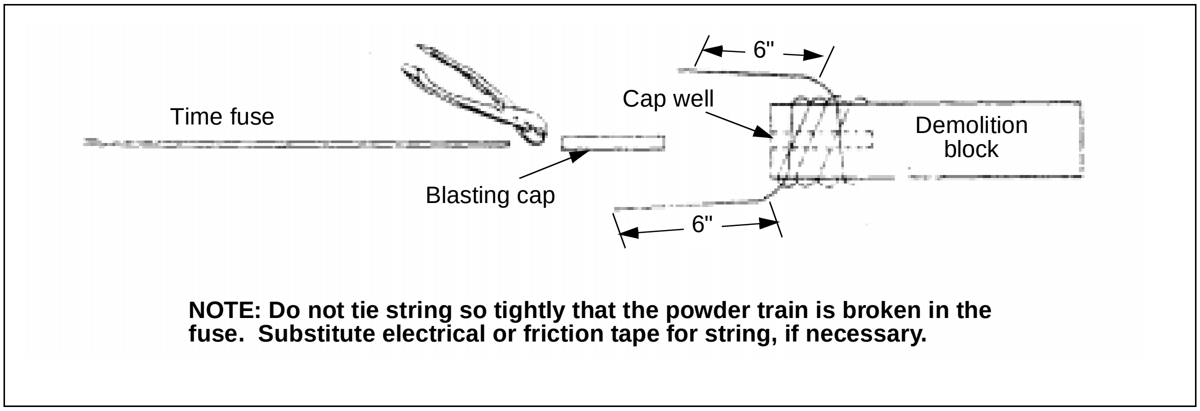


Figure 2-32. Nonelectric priming without adaptor

ELECTRIC

With Priming Adapter

2-15. Use the following procedure for priming TNT block, using the priming adapter:

- Prepare the electric initiation set before priming.
- Pass the lead wires through the slot of the adapter, and pull the cap into place in the adapter (Figure 2-12, page 2-14). Ensure that the blasting cap protrudes from the threaded end of the adapter.
- Insert the blasting cap into the threaded cap well of the TNT block and screw the adapter into place.

Without Priming Adapter

2-16. If a priming adapter is not available, use the following procedure:

- Prepare the electric initiation set before priming.
- Insert the electric blasting cap into the cap well. Tie the lead wires around the block, using two half hitches or a girth hitch (Figure 2-13, page 2-14). Allow some slack in the wires between the blasting cap and the tie to prevent any tension on the blasting-cap lead wires.

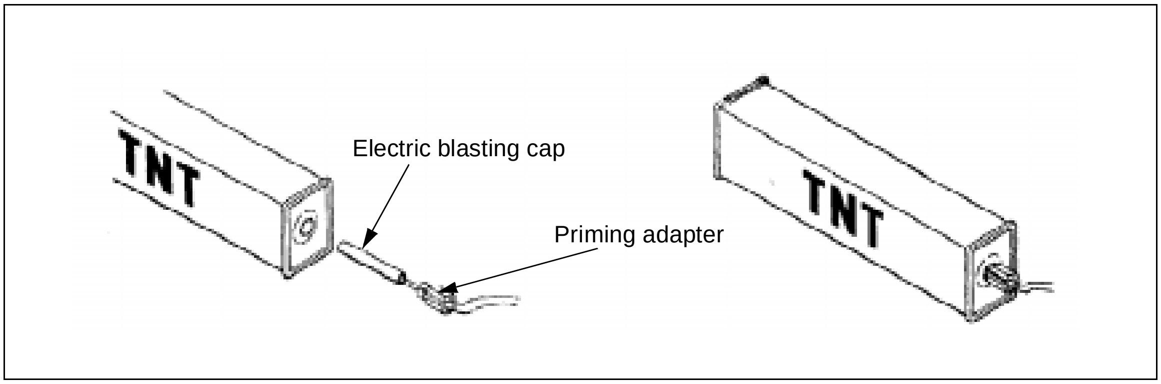


Figure 2-33. Electric priming with adapter

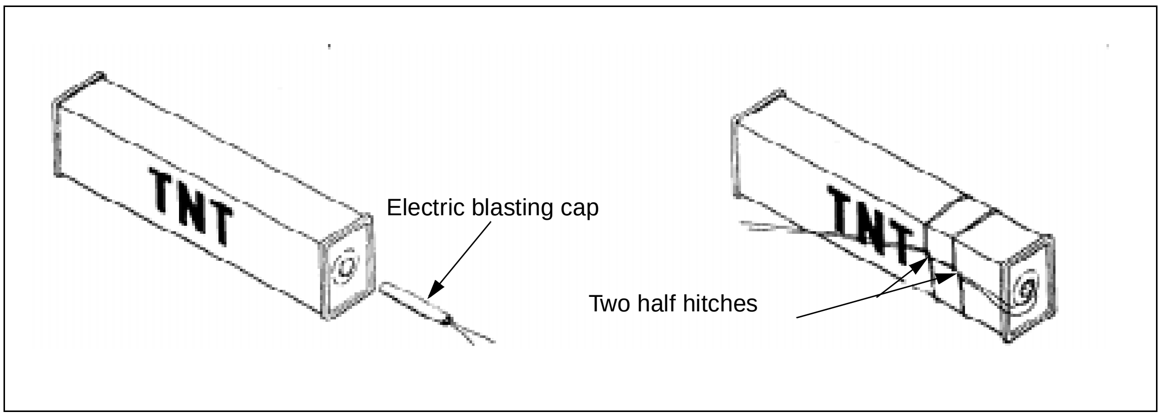


Figure 2-34. Electric priming without adapter

DETONATING CORD

2-17. Use the following methods to prime TNT blocks with detonating cord:

- Common method (Figure 2-14). Lay one end (1-foot length) of detonating cord at an angle across the explosive. Then, 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. This forms a clove hitch with two extra turns.
- Alternate method (Figure 2-14). Place a loop of detonating cord on the explosive, leaving sufficient length on the end to make four turns around the block and loop with the remaining end of the detonating cord. When starting the first wrap, 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. This forms a knot around the outside of the block.

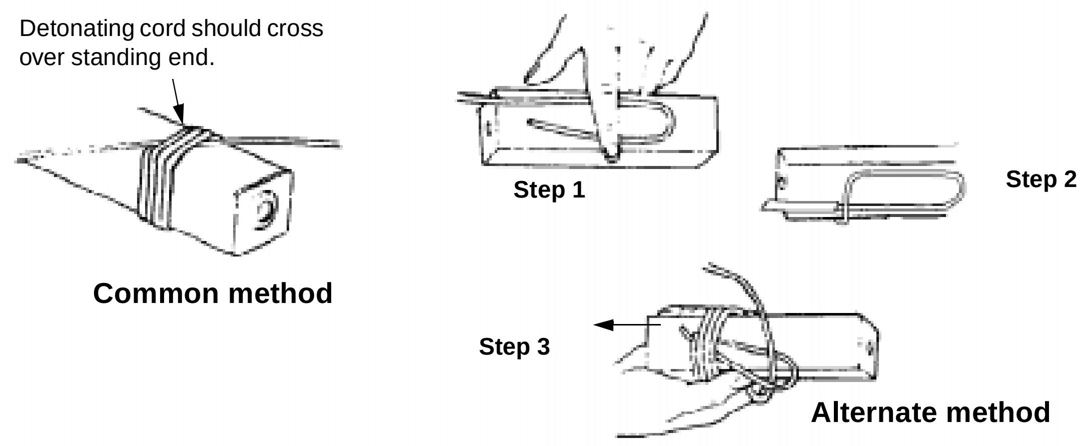


Figure 2-35. Priming TNT with detonating cord

PRIMING M112 (C4) DEMOLITION BLOCKS

NONELECTRIC AND ELECTRIC

2-18. C4 blocks do not have a cap well; therefore, you will have to make one. Use the following procedure:

- Use the M2 crimpers or other nonsparking tool to make a hole in the end or on the side of the block (at the midpoint) large enough to hold the blasting cap.
- Insert the blasting cap into the hole. If the blasting cap does not fit the hole or cut, do not force the cap; make the hole larger.
- Anchor the blasting cap in the block by gently squeezing the plastic explosive around the blasting cap.

DETONATING CORD

2-19. To prime plastic explosives with detonating cord, use the following procedure:

Form either a Uli knot, a double overhand knot, or a triple roll knot as shown in Figure 2-15, page 2-16.

- Cut an L-shaped portion of the explosive, still leaving it connected to the explosive. Ensure the space is large enough to insert the knot you formed (Figure 2-16, page 2-16).

CAUTION
Use a sharp, nonsparking knife on a nonsparking surface to cut explosives.

- Place the knot in the L-shaped cut.
- 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.

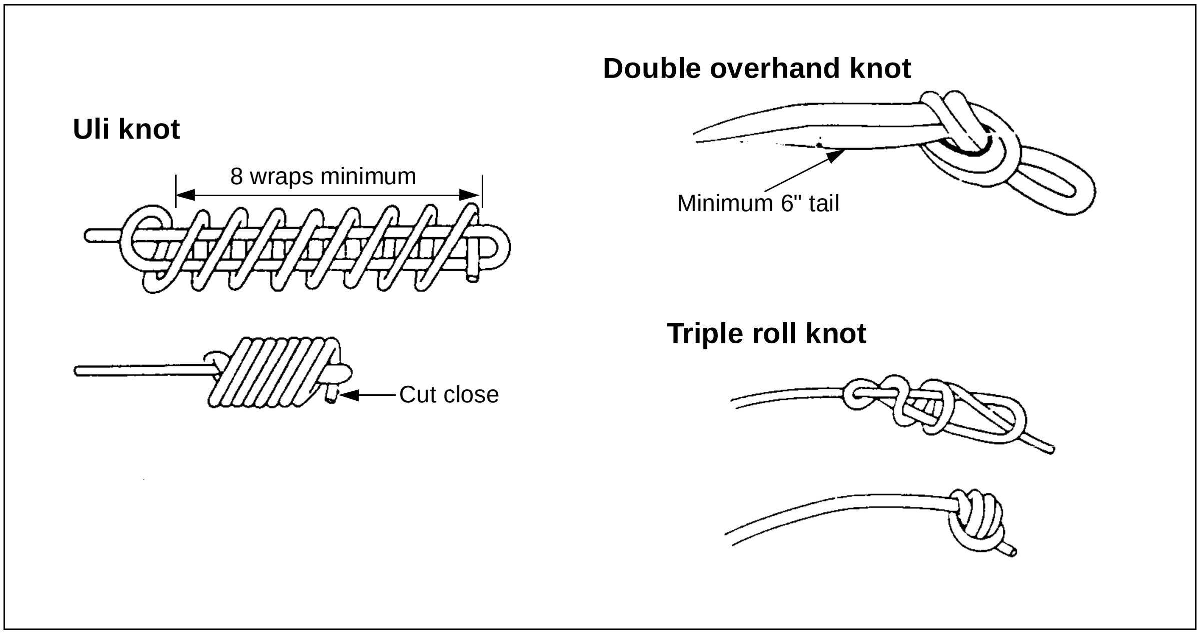


Figure 2-36. Priming plastic explosives with detonating cord

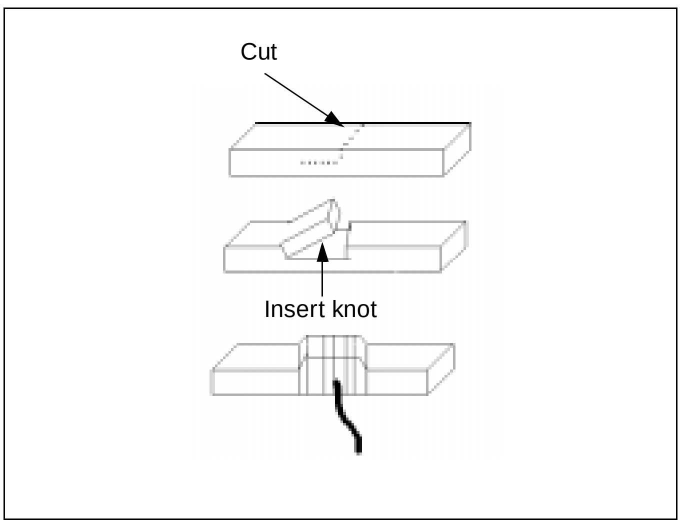


Figure 2-37. Priming C4 with L-shaped charge

- 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.

PRIMING M118 AND M186 DEMOLITION CHARGES

NONELECTRIC AND ELECTRIC

2-20. Use one of the following methods to prime M118 and M186 demolition charges:

- Method 1 (Figure 2-17). 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. 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.

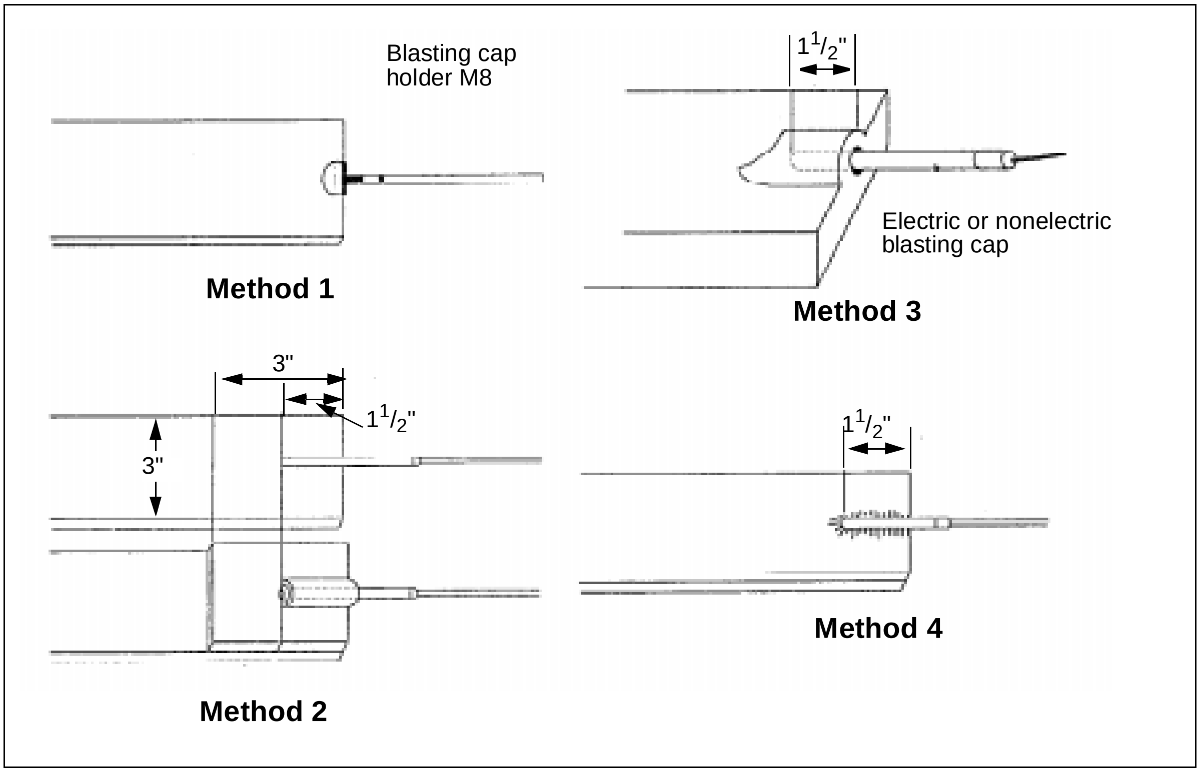


Figure 2-38. Priming sheet explosives

- Method 2 (Figure 2-17). 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 (Figure 2-17). 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 by 3 inches).
- Method 4 (Figure 2-17). Insert $1^1/_2$ inches of the blasting cap between two sheets of explosive.

DETONATING CORD

2-21. Sheet explosives also can be primed with detonating cord using a 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

2-22. Prime dynamite at either end or side using one of the following methods:

- Nonelectric
- Electric
- Detonating cord

NONELECTRIC

2-23. There are three methods for priming dynamite nonelectrically:

- End-priming method (Figure 2-18).
  - — Make a cap well in the end of the dynamite cartridge using the M2 crimpers (step 1).
  - — Insert a fused blasting cap into the cap well (step 2).
  - — Tie the cap and fuse securely in the cartridge with a string (steps 3 and 4).
- Weatherproof, end-priming method (Figure 2-18).
  - — Unfold the wrapping at the folded end of the dynamite cartridge (step 1).
  - — Make a cap well in the exposed dynamite using the M2 crimpers (step 1).
  - — Insert a fused blasting cap into the cap well (step 2).
  - — Close the wrapping around the fuse and fasten the wrapping securely with a string or tape (step 3).
  - — Apply a weatherproof sealing compound to the tie (step 3).
- Side-priming method (Figure 2-19).
  - — Make a cap well (about $1^{1}/_{2}$ inches long) into the side of the cartridge at one end using the 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 1).
  - — Insert a fused blasting cap into the cap well (step 2).
  - — Tie a string securely around the fuse. Then, wrap the string tightly around the cartridge, making two or three turns before tying it (step 3).
  - — 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 it completely. Cover the string with a weatherproof sealing compound (step 4).

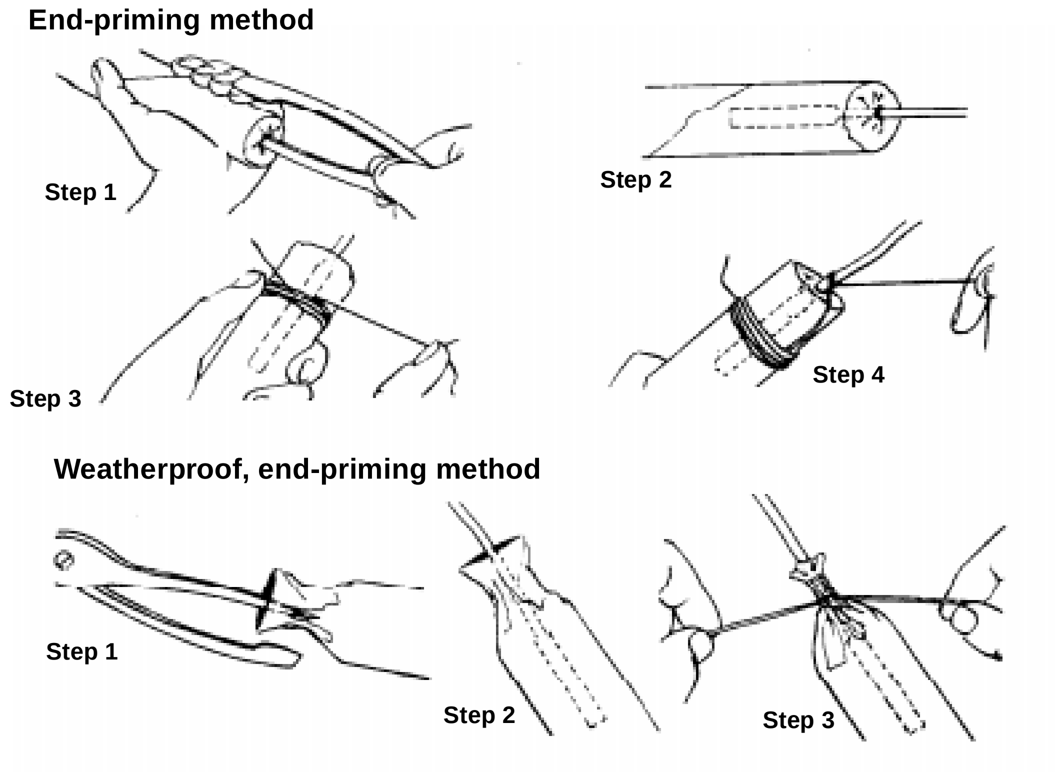


Figure 2-39. Nonelectric end priming of dynamite

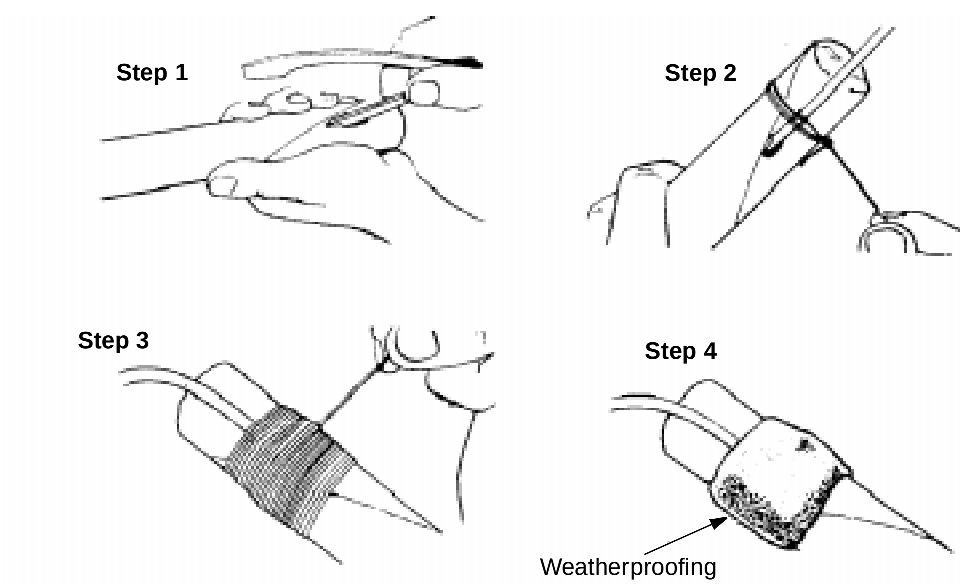


Figure 2-40. Nonelectric side priming of dynamite

DETONATING CORD

2-24. You also can use detonating cord to prime dynamite. Using the M2 crimpers, start about 1 inch from either end of the dynamite charge, and punch four equally spaced holes through the dynamite cartridge (Figure 2-20). Make sure to rotate the cartridge 180° after punching each hole to keep the holes parallel. Lace detonating cord through the holes in the same direction that you punched the holes. Take care not to pull the loops of the detonating cord too tightly or the dynamite will break. Secure the detonating cord tail by passing it between the detonating cord lace and the dynamite charge.

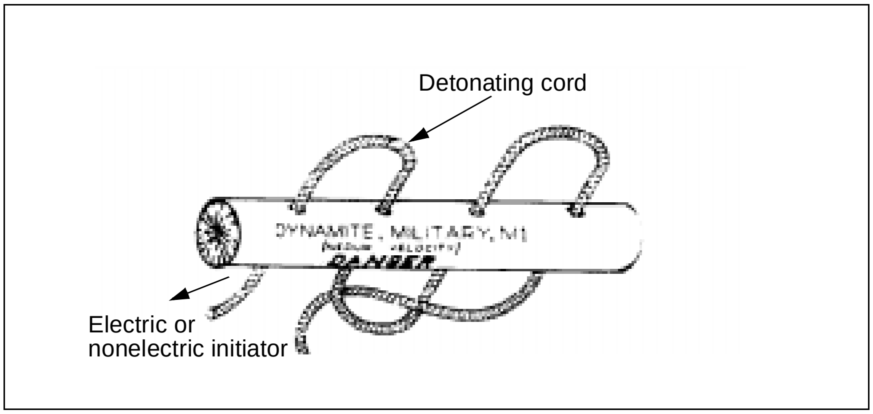


Figure 2-41. Priming dynamite with detonating cord

PRIMING FORTY-POUND, COMPOSITION H6 CRATERING CHARGES

2-25. The cratering charge is primarily an underground charge; therefore, prime it only with C4 primed with detonating cord. Use dual priming to protect against misfires. Use the following procedure:

- Prime two packages of C4 (Figure 2-16, page 2-16).
- Dual prime a single cratering charge by placing the primed C4 packages parallel to the cratering charge and on opposite sides of it and flush with the top. Firmly hold them in place with 100-miles-per-hour tape. Instructions and markings on the canister indicate the exact placement of the C4 (Figure 2-21, diagram 3).
- Dual prime two cratering charges by placing them in the same borehole. This requires one primed C4 block on each of the cratering charges, parallel to the charges and flush with the top. When placed in the borehole, the C4 blocks are placed on opposite sides of the 40-pound charges (Figure 2-21, diagram 4).
- Ensure that the detonating-cord branch lines (from the 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, you should place tape on the detonating cord from the cratering charge, one foot up.

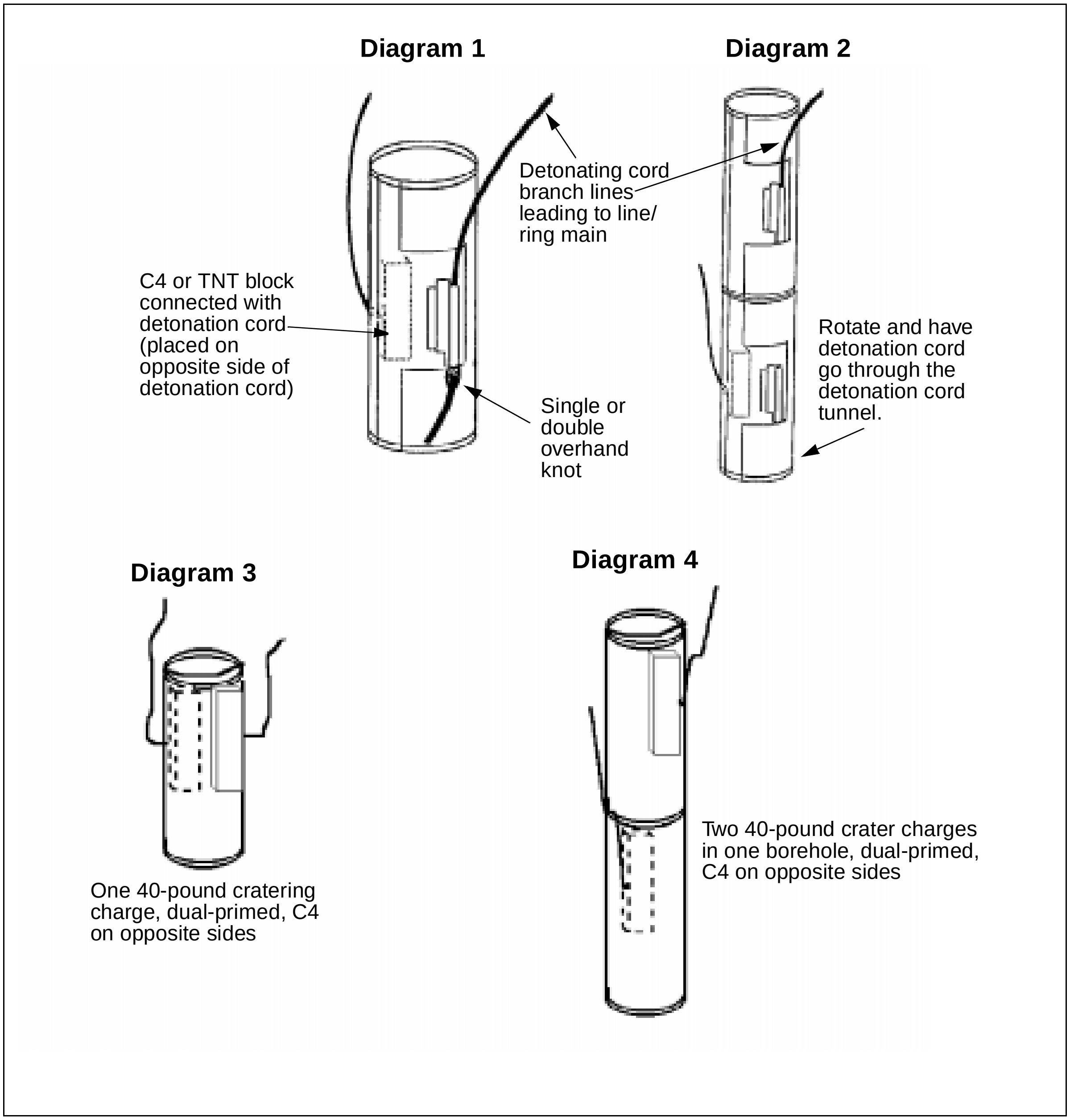


Figure 2-42. Priming composition H6 and ammonium nitrate cratering charge

2-26. The composition H6 cratering charge replaced the 40-pound ammonium-nitrate cratering charge. If an ammonium-nitrate cratering charge is drawn from an ammunition supply point (ASP), use the following procedure to prime it:

- 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 the 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 explosive with detonating cord and tape the charge to the center of the cratering charge (Figure 2-21, diagram 1, page 2-21).

- 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 are not required as shown in Figure 2-21, diagram 2.

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.

PRIMING M2A4 AND M3A1 SHAPED CHARGES

2-27. The M2A4 and M3A1 are primed only with electric or nonelectric blasting caps. These charges have a threaded cap well at the top of the cone. Prime them with a blasting cap as shown in Figure 2-22. Use a piece of string, cloth, or tape to hold the cap if a priming adapter is not available. Simultaneously detonate multiple shaped charges to create a line of boreholes for cratering charges by connecting each charge into a detonating-cord ring or line main. The procedure for priming shaped charges are listed below.

WARNING

Do not dual prime shaped charges. Prime them only with a blasting cap in the threaded cap well.

NONELECTRIC

2-28. Prime nonelectric shaped charges as follows:

- Crimp a nonelectric blasting cap to a branch line.
- Connect the branch line to the ring main.
- Insert and secure the blasting cap into the threaded cap well of the shaped charge.
- Make all branch-line connections, before priming any shaped charges, when detonating multiple shaped charges.

ELECTRIC

2-29. Prime electric shaped charges as follows:

- Complete the initiation set and firing circuit as described in paragraph 2-5, page 2-5.
- Prime the charge.

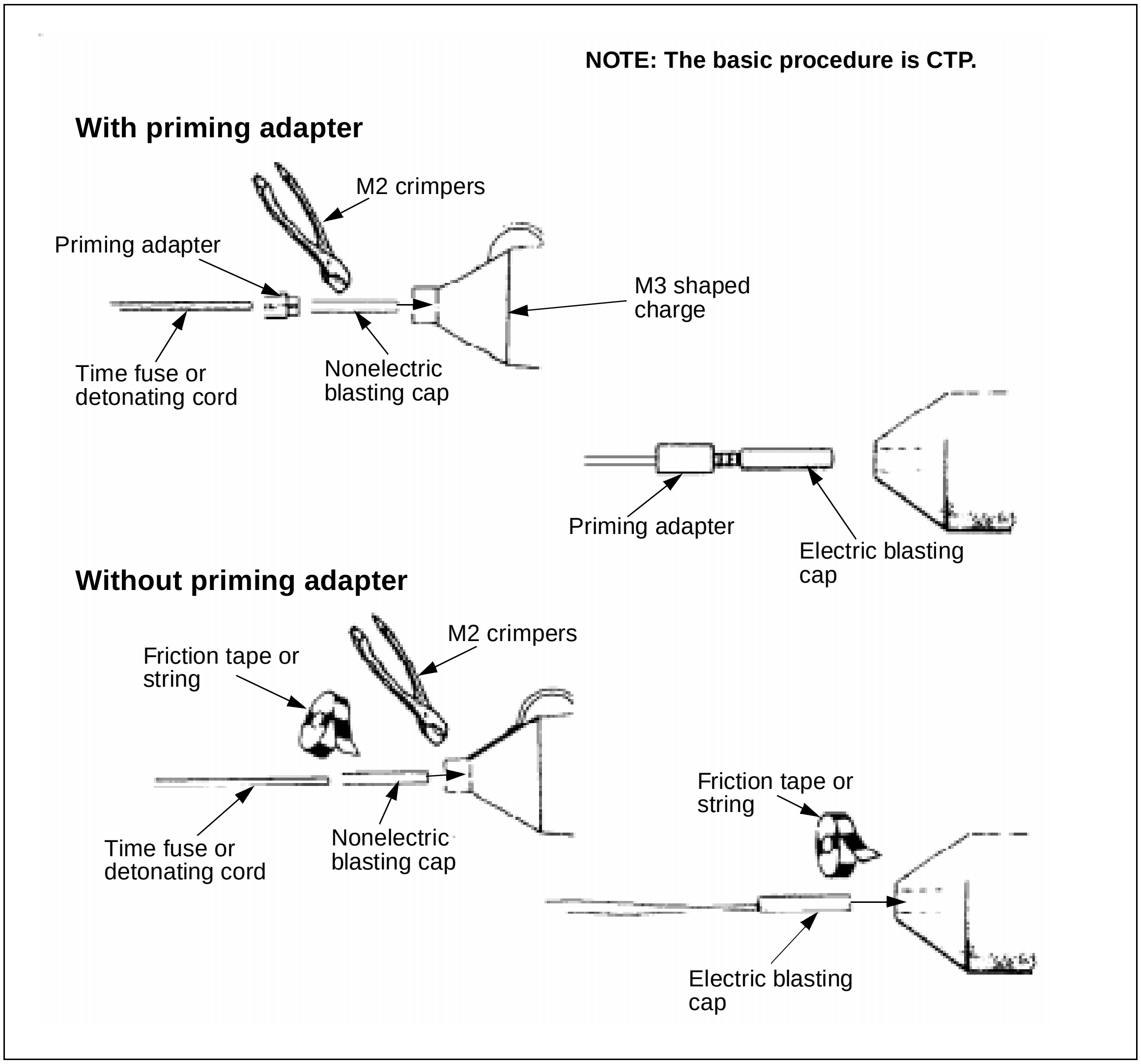


Figure 2-43. Priming shaped charges

PRIMING THE BANGALORE TORPEDO

NONELECTRIC

2-30. Insert a blasting cap of a nonelectric initiation set directly into the cap well of a torpedo section (Figure 2-23, diagram 1, page 2-24). 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 crimp, tie, prime (CTP) method.

ELECTRIC

2-31. Insert the blasting cap of an electric initiation set 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 use a tension knot to join the firing wire to the cap wire.

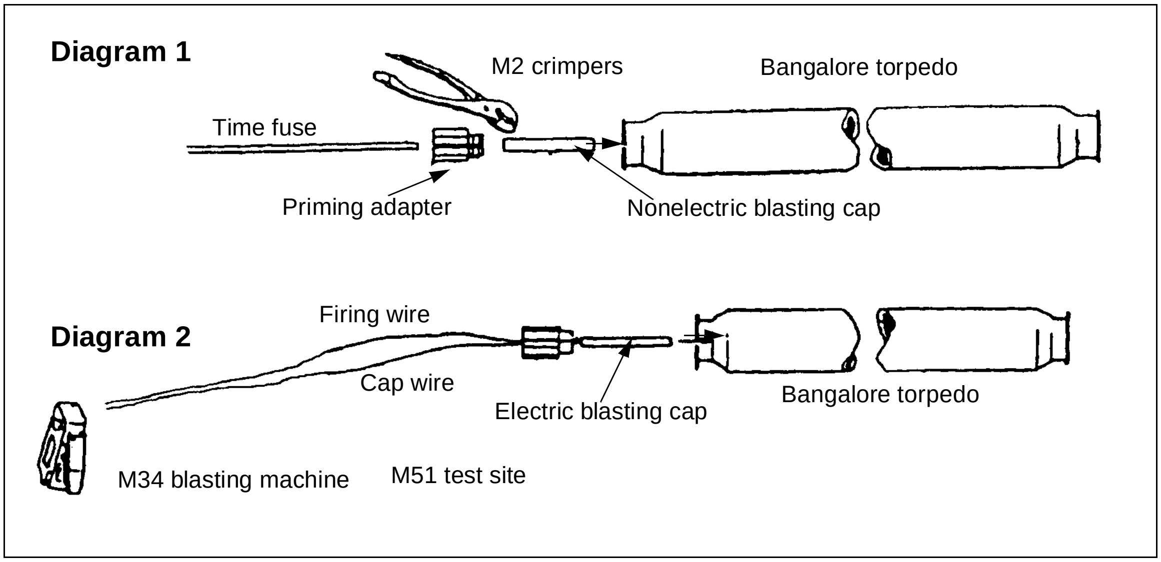


Figure 2-44. Priming a bangalore torpedo with a blasting cap

DETONATING CORD

2-32. Prime the torpedo 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.

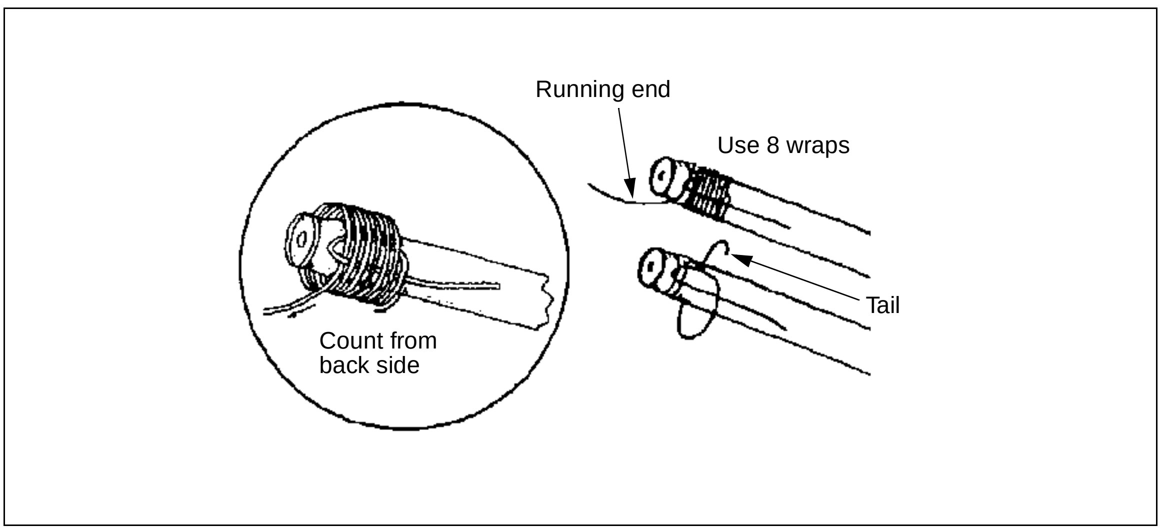


Figure 2-45. Single priming a bangalore torpedo with a detonating cord

DUAL PRIMING

2-33. When dual priming the torpedo with two branch lines, wrap detonating cord four times around the end of the section with one branch line, and repeat the procedure for the remaining branch line. Make sure that the wraps are positioned and tied the same as the single branch line with eight wraps. Another method that you can use to dual prime the bangalore torpedo, but only as a last resort, is to tie eight wraps with one branch line as before. Then, prime it with a nonelectric cap attached to the other detonating cord branch line. When priming the bangalore with a nonelectric cap, use the CTP method.

CAUTION

Use exactly eight wraps to prime the torpedo. Too many wraps will extend the detonating cord past the booster charge housing, possibly causing the torpedo to be cut without detonating. Too few wraps may cause the torpedo to only be creased, without detonating.

SECTION III. DETONATING-CORD FIRING SYSTEMS

TYPES OF DETONATING-CORD FIRING SYSTEMS

SINGLE

2-34. Figure 2-25, page 2-26, shows a single-firing system. Each charge is single-primed with a branch line. The branch line 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 initiation sets are then taped onto the firing system. When using a combination initiation set, the electric initiation system is always the primary means of initiation. When using dual, nonelectric initiation sets, the shorter time fuse is the primary initiation set (Figure 2-26, page 2-26).

DUAL

2-35. Figure 2-27, page 2-27, shows a dual-firing system. Each charge is dual-primed with two branch lines (Figure 2-28, page 2-27). One branch line is tied to one firing system, and the other branch line is tied to an independent firing system. Line mains or ring mains may be used; however, they should not be mixed. To help prevent misfires, use detonating-cord crossovers. Crossovers are used to tie both firing systems together at the ends. The initiation sets are taped in with the primary initiation set going to one firing system and the secondary going to the other.

2-36. Figure 2-29, page 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 will be referred to as horizontal and vertical lines or ring mains.

DETONATING CORD

2-37. A firing system uses detonating cord to transmit a shock wave from the initiation set to the explosive charge. Detonating cord is versatile and easy to

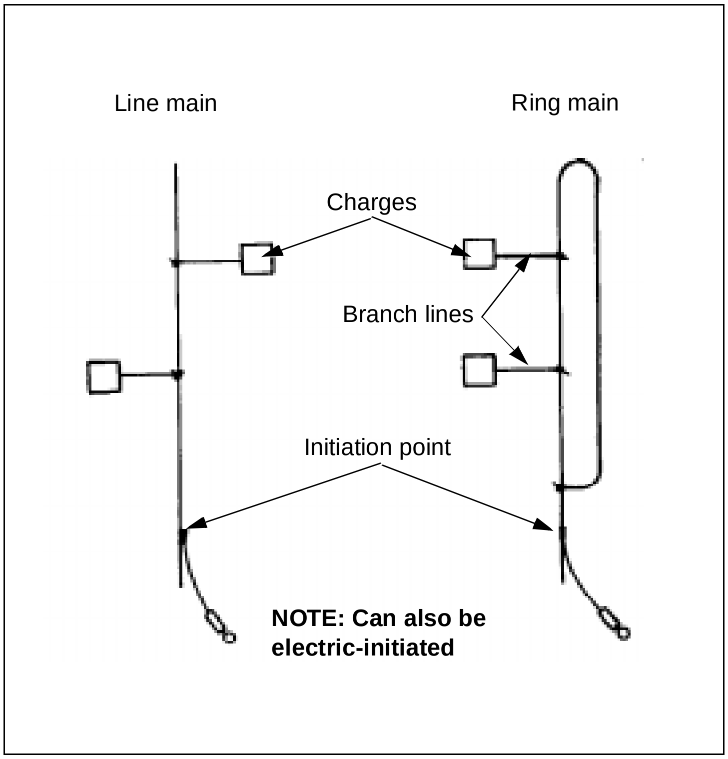


Figure 2-46. Single-firing system (single-initiated, single-fired, single-primed)

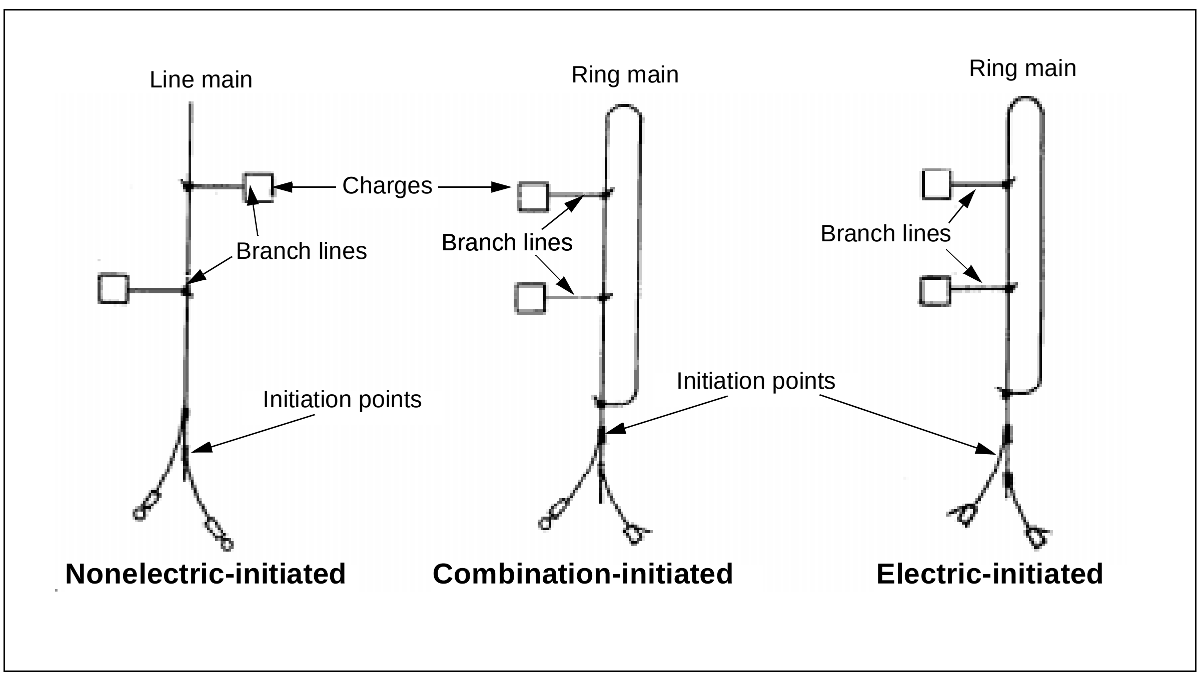


Figure 2-47. Single-firing system (dual-initiated, single-fired, single-primed)

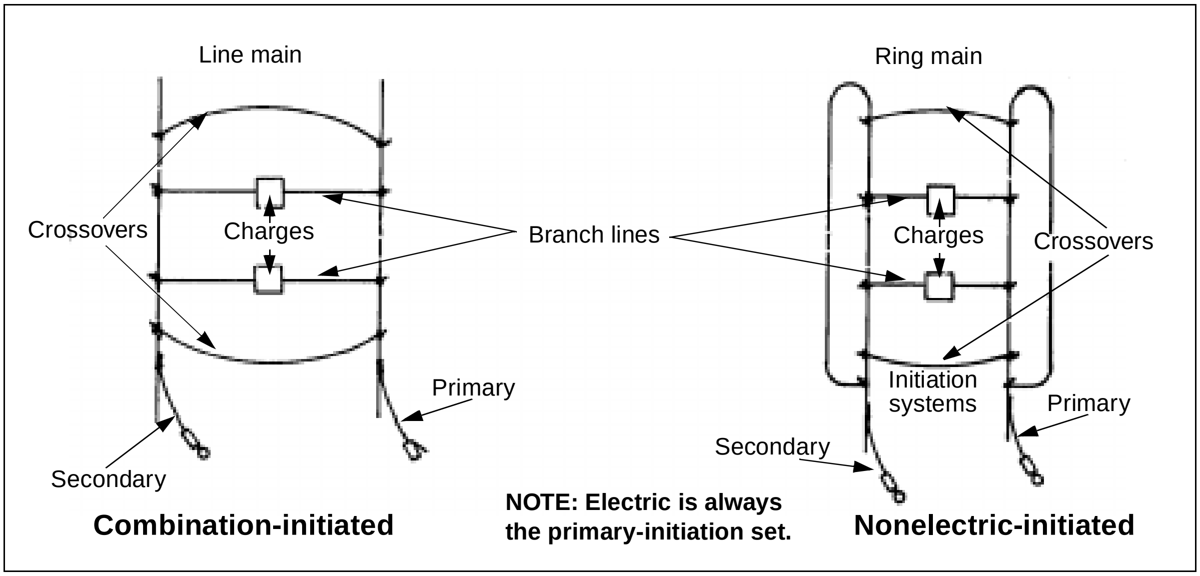


Figure 2-48. Dual-firing system (dual-installed, dual-fired, dual-primed)

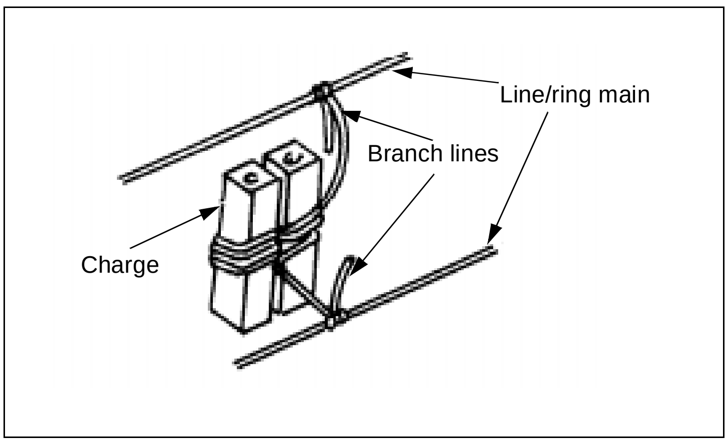


Figure 2-49. Dual-primed charge

install. It is useful for underwater, underground, and above-ground blasting because the blasting cap of the initiation set may remain above water or above ground 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. Initiate detonating cord with nonelectric or electric initiation sets.

ATTACHING THE BLASTING CAP

2-38. Attach the blasting cap, electric or nonelectric, to the detonating cord with tape. You can use string, cloth, or fine wire if tape is not available. Tape the cap securely to a point 6 inches from the end of the detonating cord to overcome moisture contamination. The tape must not conceal either end of the cap. Taping in this way allows you to inspect the cap in case it misfires.

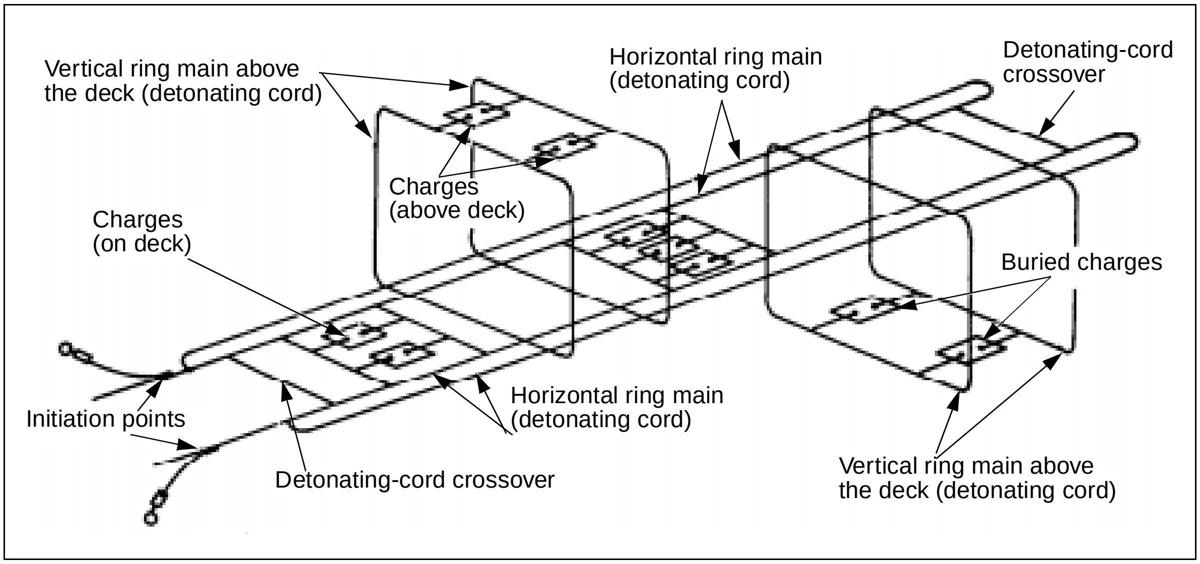


Figure 2-50. Dual-firing system (using a bridge as a possible target)

No more than $^1/_8$ inch of the cap needs to be left exposed for inspection (Figure 2-30).

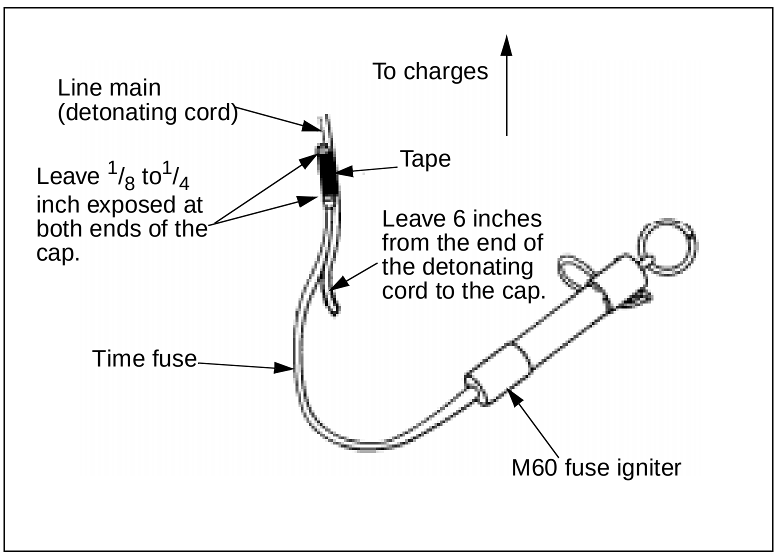


Figure 2-51. Attaching blasting cap to detonating cord

CONNECTING THE DETONATING CORD

2-39. Use square knots or detonating-cord clips to splice the ends of detonating cord (Figure 2-31). Always reinforce the splice with tape. Do not splice detonating cord on branch lines. Square knots may be placed in water or in the ground, but the cord must be detonated from a dry end or above ground. Allow 6-inch tails on square knots to prevent misfires from moisture contamination. Paragraph 1-64, page 1-20, describes the process for connecting detonating cord with detonating-cord clips.

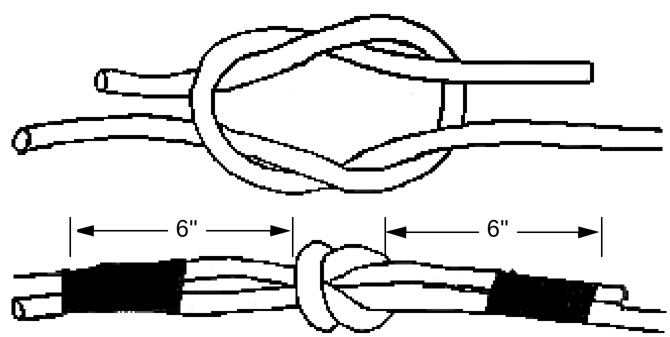


Figure 2-52. Square-knot connections for detonating cord

BRANCH LINE

2-40. A branch line is a length of detonating cord between the charge and the firing system. Attach branch lines to a detonating-cord ring or line main to fire multiple charges. Combining the branch line with an initiation set allows you to fire a single branch line. Fasten a branch line to a main line with a detonating-cord clip (Figure 1-16, page 1-20), a girth hitch with an extra turn (Figure 2-32, page 2-30), a cherry knot, or a Gregory knot. The connections of branch lines and ring or line mains should intersect at right angles. If these connections are not at right angles, the branch line may be blown off the line main without complete detonation. To prevent moisture contamination and ensure positive detonation, leave at least 6 inches of the running end of the branch line beyond the tie. It does not matter which side of the knot the 6-inch tail is on at the connection of the ring or line main.

LINE MAIN

2-41. A line main can fire a single charge or multiple charges (Figure 2-33, page 2-31), 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. Use line mains only when speed is essential. You can connect any number of branch lines to a line main. However, you connect only one branch line at any one point unless you use a British junction (Figure 2-34, page 2-31).

RING MAIN

2-42. Ring mains are preferred over line mains because the detonating wave approaches the branch lines 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. Branch-line connections to the ring main should be at right angles. Kinks in the lines should not be sharp. You can connect any number of branch lines to the ring main; however, never connect a branch line (at the point) where the ring main is spliced. When making branch-line 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.

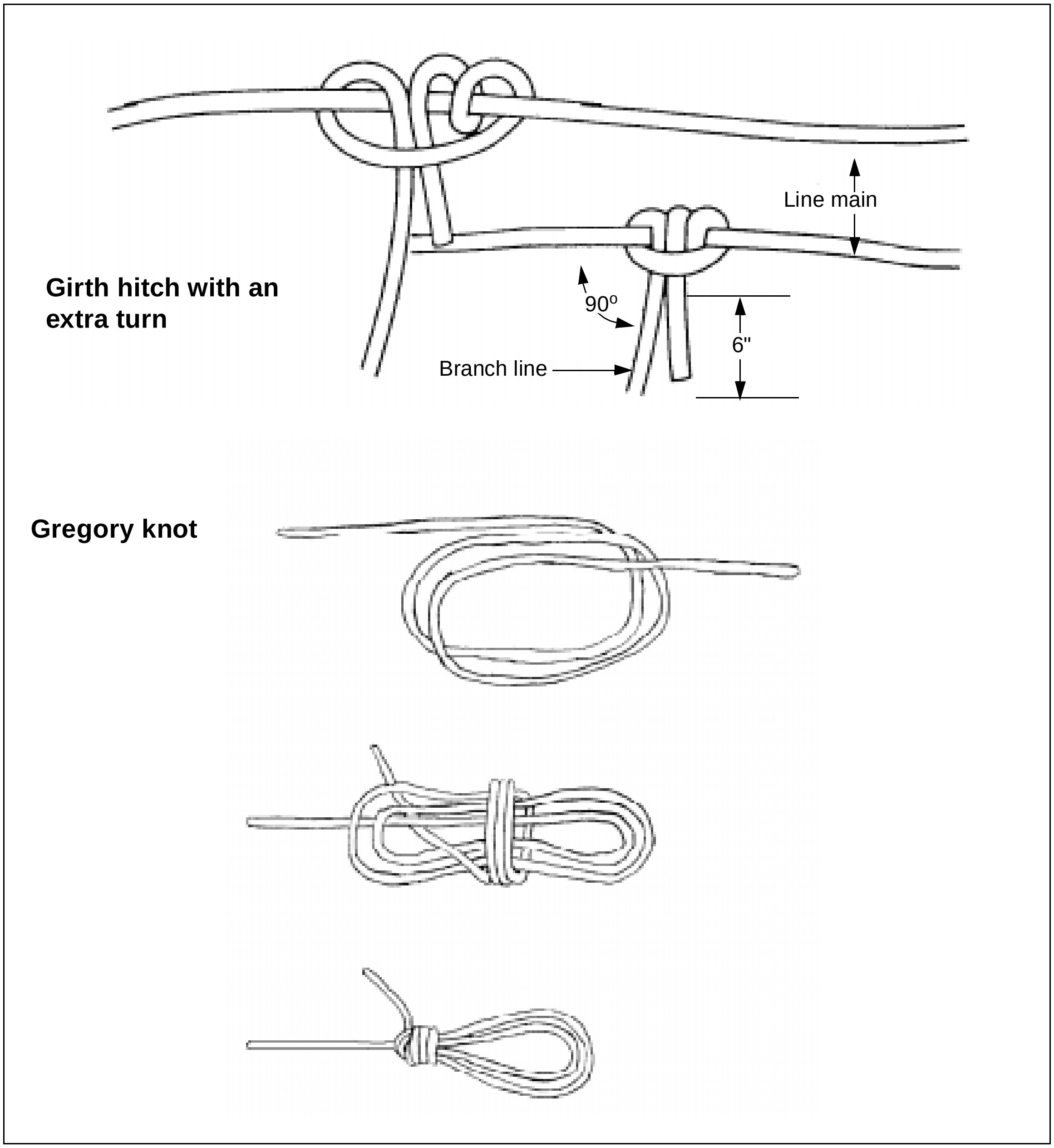


Figure 2-53. Branch-line connections for detonation cord

Method 1

2-43. Make a ring main by bringing the detonating cord back in the form of a loop and attaching it to itself with a girth hitch with an extra turn (Figure 2-35, page 2-32, diagram 1).

Method 2

2-44. Make a ring main by making a U-shape with the detonating cord, then attaching a detonating-cord crossover at the open end of the U. Use girth hitches with extra turns when attaching the crossover (Figure 2-35, diagram 2).

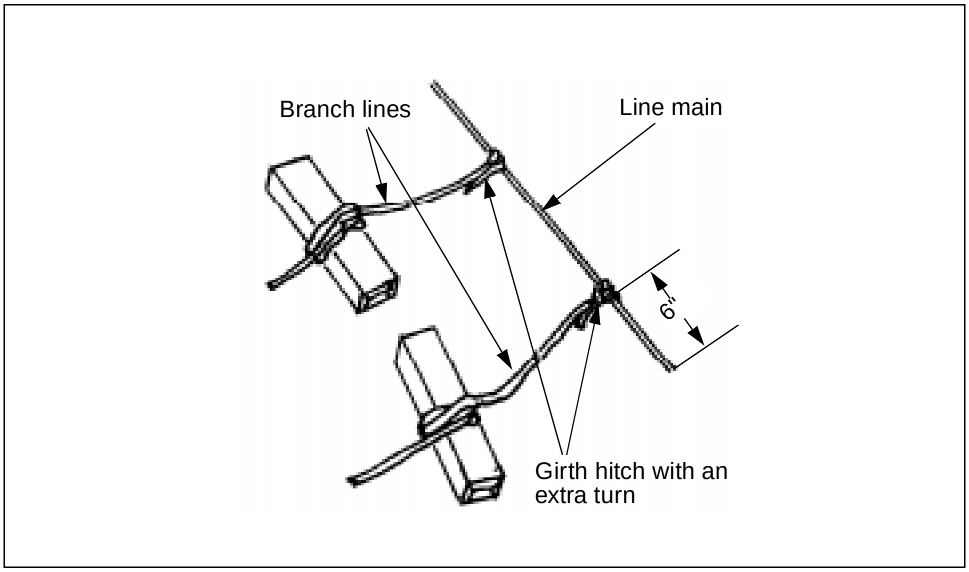


Figure 2-54. Line main with and without branch lines

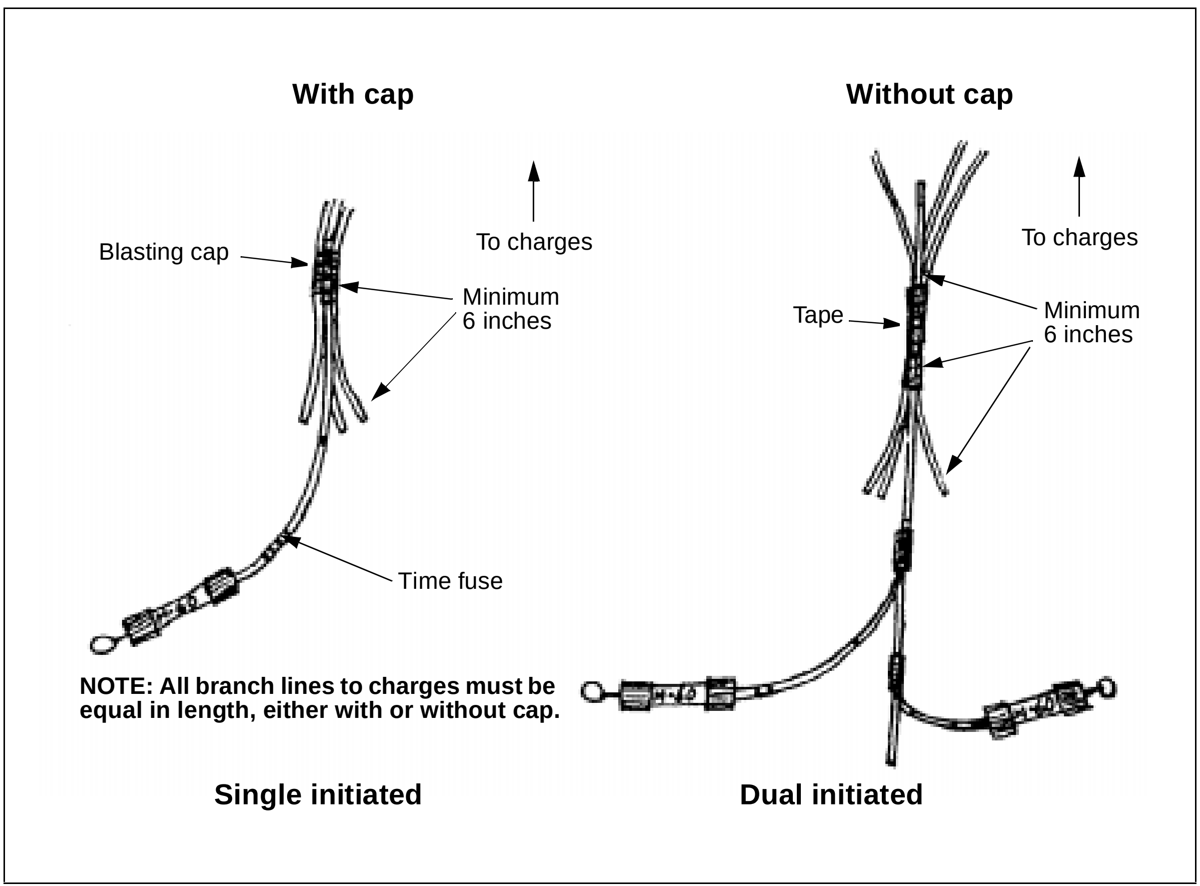


Figure 2-55. British junction

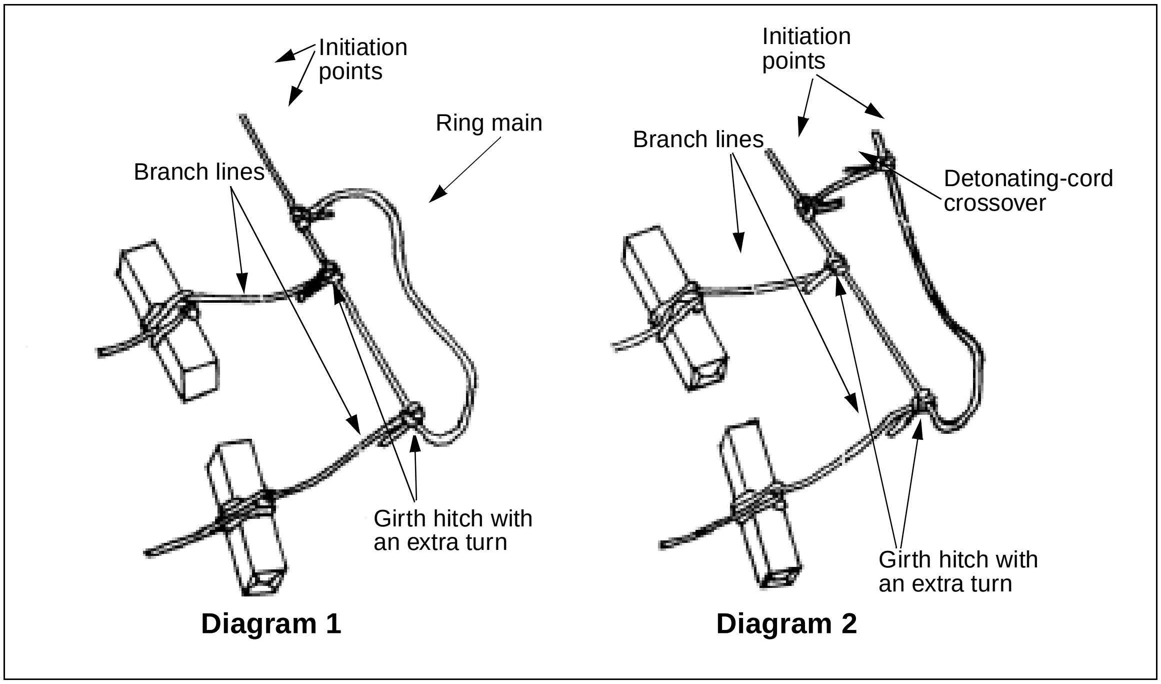


Figure 2-56. Ring mains

An advantage of the U-shaped ring main is that it provides two points of attachment for initiation sets.

Method 3

2-45. Make a ring main by making a U-shape with the detonating cord. Bring the two ends of the U-shape together. The primary/secondary caps should be taped between the two ends.

INITIATING A FIRING SYSTEM

SINGLE-FIRING SYSTEM

2-46. Whenever possible, dual initiate a single line or ring main as shown in Figure 2-36. Place the blasting cap that will detonate first closest to the end of the detonating cord (for example, the electric cap of a combination of initiation sets). Doing this will ensure the integrity of the backup system if the first cap detonates and fails to initiate the line main.

DUAL-FIRING SYSTEM

2-47. Initiate a dual-firing system as shown in Figure 2-27, page 2-27. However, the blasting caps are still connected as shown in Figure 2-30, page 2-28.

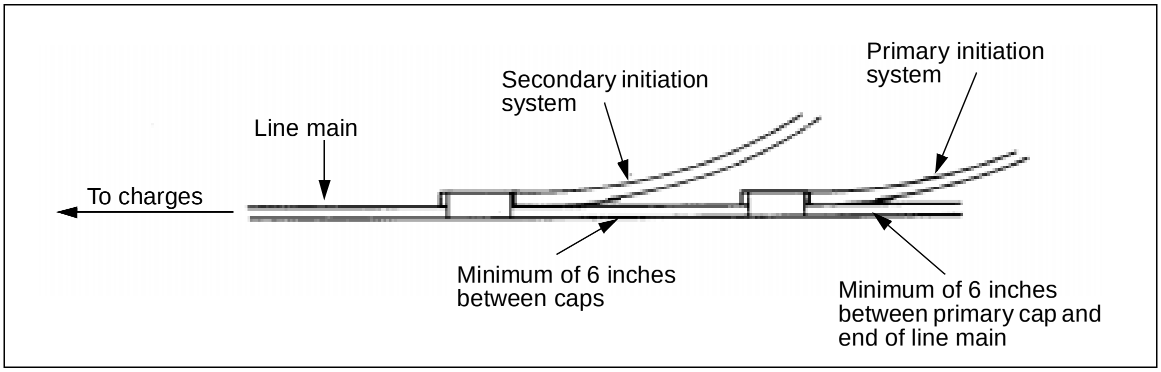


Figure 2-57. Attaching blasting caps to a line main

> **WARNING**
> **When using time or safety fuse, uncoil it and lay it out in a straight line. Place the time fuse so that the fuse will not curl up and prematurely detonate the blasting cap crimped to it.**

Chapter 3

Calculating and Placing Charges

3-1. Charge calculations are discussed in this chapter. Included in this chapter are the six-step problem-solving formats for all types of calculations and the different methods for placing charges.

SECTION I. DEMOLITION

DEMOLITION PRINCIPLES

3-2. 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 also 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

3-3. 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 three detectable destructive effects:

- Deformation. The charge's shock wave 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's contact area.

- Spalling. The charge's shock wave 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 charge's compressive shock wave 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 therefore displace the 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

3-4. 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 contact area and thickness to 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 thinly or wrong strength), the shock wave tends to travel in a parallel rather than a perpendicular direction to the surface. As a result, the target's volume 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

3-5. The destructive effect of an explosive charge also depends on the location of the charge in relation to the target's size, shape, and configuration. 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 shock wave's force. 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.

TYPES OF CHARGES

INTERNAL CHARGES

3-6. Internal charges are charges which are placed in boreholes in the target. Confine the charges 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. Fill and tamp stemming material against the explosive to fill the borehole to the surface. In drilled holes, tamp the explosive as it is loaded into the hole. Tamp stemming material only with a nonsparking tool.

EXTERNAL CHARGES

3-7. External charges are charges which are placed on the target's surface. Cover and tamp the charges 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. Tamp small breaching charges on horizontal surfaces with several inches of wet clay or mud.

CHARGE CALCULATION DETERMINATION

3-8. Calculate the amount of explosives required for any demolition project, 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, thereby increasing the concrete's strength.
- 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. Consider the extent of the demolition project and the other desired effects, such as the direction trees will fall when constructing an abatis.
- Explosive type. The characteristics of each type of explosive determines its application for demolition purposes. *Table 1-1* lists these characteristics.
- Charge size and placement (use *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. In general, charges of less than 5 pounds should be at least 1 inch thick. Charges from 5 to 40 pounds should be 2 inches thick. Charges of 40 pounds or more should be 4 inches thick. Fasten charges to the target using wire, adhesive compound, tape, or string. Prop charges against targets with wooden or metal frames made of scrap or other available materials, or place the charges in boreholes.
- Tamping method. If you do not completely seal or confine the charge or if you do not ensure that the material surrounding the explosive is balanced on all sides, the explosive's force 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 target's surface (*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

Charge Weight (lb)	Charge Thickness (in)
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 approximate thickness.**	

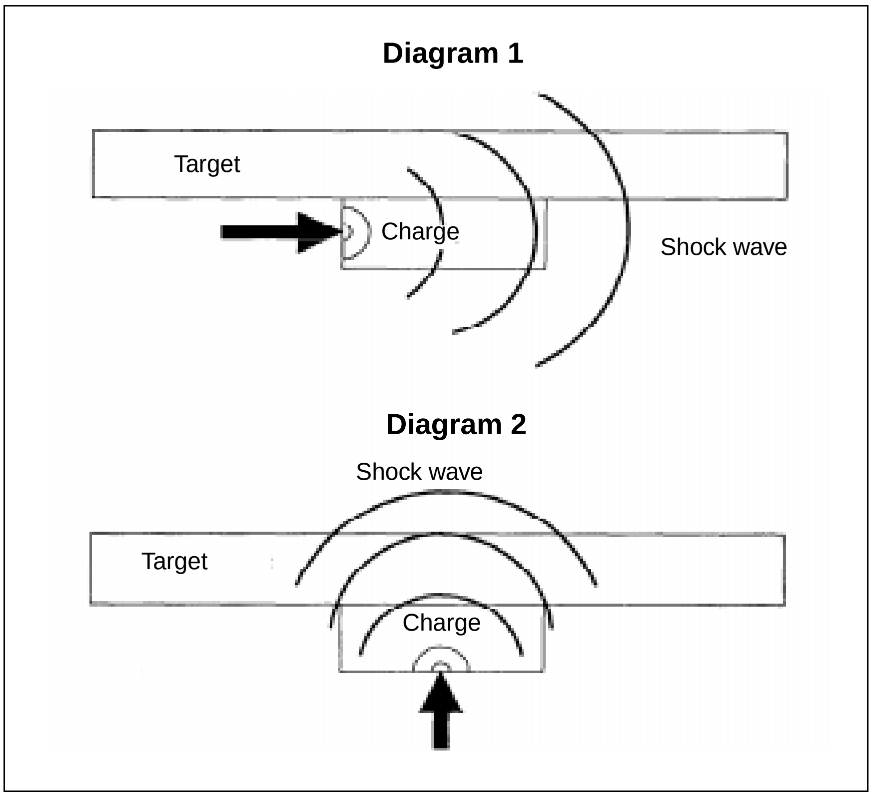


Figure 3-1. Direction of initiation

CHARGE SELECTION AND CALCULATION

SELECTION

3-9. Explosive selection for successful demolition operations is a balance between the critical 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.

CALCULATION

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

- *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. If you are using a rule of thumb, calculate the weight of the charge then skip to step 4.
- *Step 3.* Divide the quantity of explosive by the RE factor. If you are using TNT or applying a rule of thumb, skip this step.
- *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 target(s).
- *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, as 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 type of timber to determine the optimal size of the timber-cutting charge.

INTERNAL CHARGES

3-12. Use the following formula 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 least dimension of dressed timber, in inches*

NOTE: Diameter = circumference divided by 3.14.

3-13. Use one hole to place the explosive in trees that are up to 18 inches in diameter. For larger trees, use two holes, drilled at right angles to each other without intersecting, but as close together as possible. Drill 2-inch-diameter holes to a depth equal to two-thirds the diameter of the tree. Split the required charge evenly 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 approximate the hole's diameter. Try to minimize the amount of molding so as not to reduce the explosive's density. Prime the charge with detonating cord (*paragraph 2-19*) and place the charge in the hole. Finish filling the holes by packing them with mud or clay, using a nonsparking tool. When using two boreholes, connect the branch lines in a British junction (*Figure 2-34*). For an example calculation, see *Example G-1*.

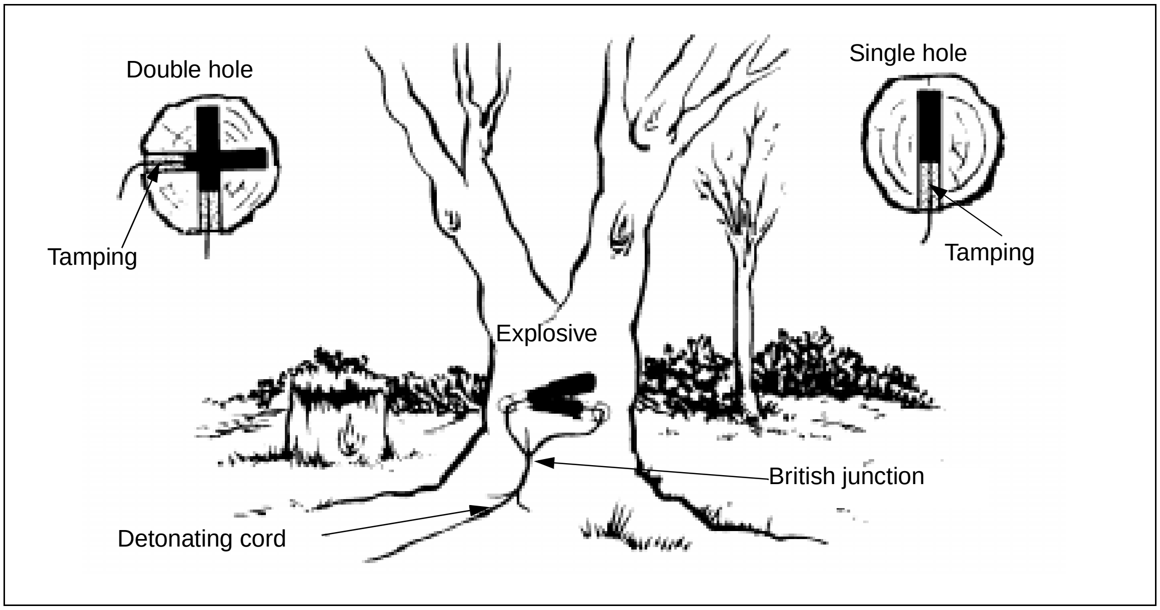


Figure 3-2. Timber-cutting charge (internal)

EXTERNAL CHARGES

3-14. 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).* 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. Fire the kicker charge at the same time as the main charge. For best results when using C4, orient the charge's longest dimension horizontally. Orienting the charges vertically tends to allow gaps to develop between the charges. Use the following formula (see sample calculation to determine the amount of explosive needed for cutting trees, posts, beams, or other timber, using untamped external charges (for an example calculation, see *Example G-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

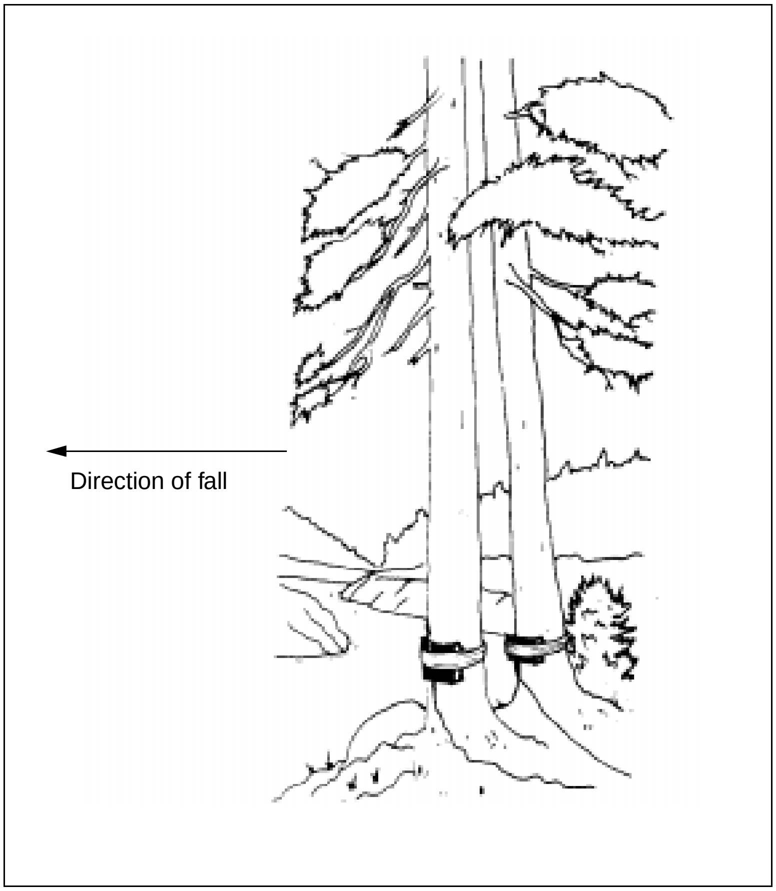


Figure 3-3. Timber-cutting charge (external)

RING CHARGE

3-15. The ring charge is a band of explosives completely encircling 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 branch lines. Connect the branch lines in a British junction (*Figure 2-34*).

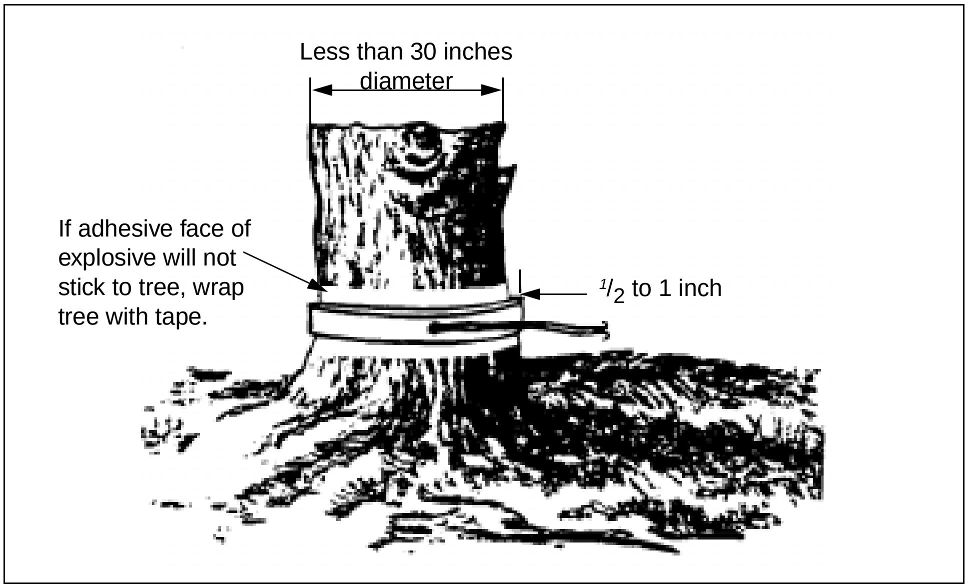


Figure 3-4. Timber-cutting ring charge

UNDERWATER CHARGE

3-16. To cut a timber pile underwater, use a method similar to the one shown in *Figure 3-5*. Determine the charge size using the breaching formula. Place the charge on the pile's upstream side and 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 the mud or sand, engineer diver assets can be used to water jet the soil away before charges are placed.

ABATIS

3-17. 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. Use the following formula to compute the amount of TNT required for the test shot:

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

where—

P = TNT required per tree, in pounds

D = diameter or least dimension of dimensioned timber, in inches

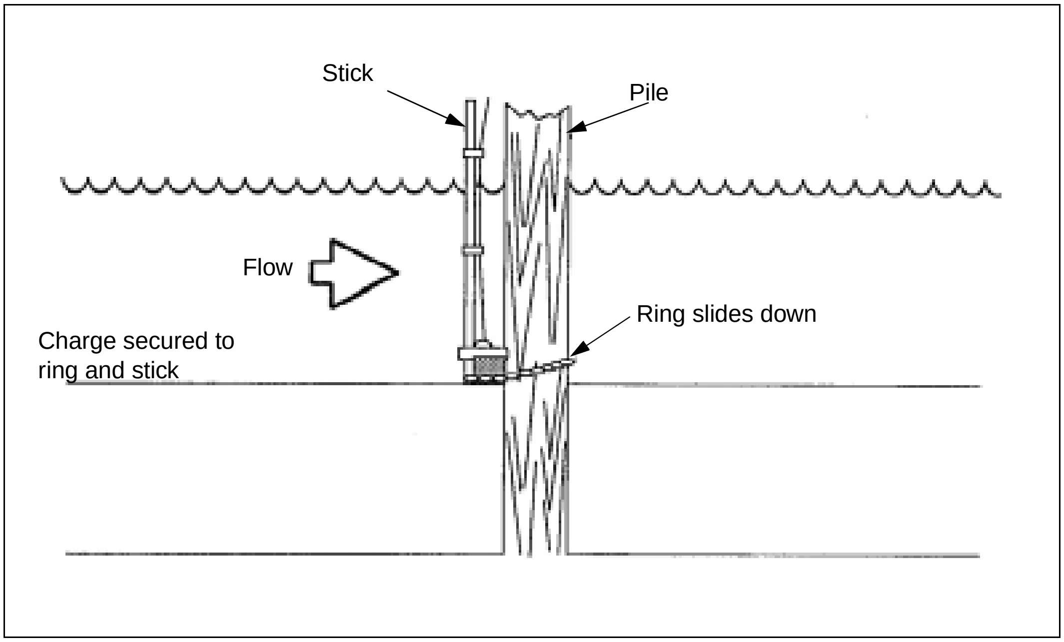


Figure 3-5. Cutting a timber pile underwater

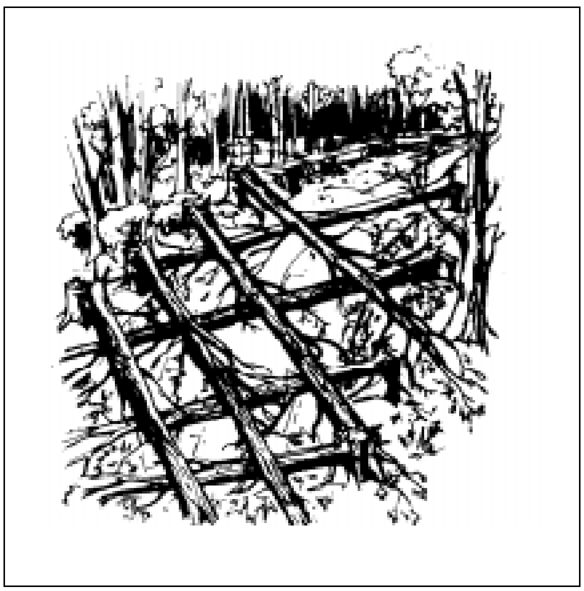


Figure 3-6. Abatis

Placement

3-18. Use external placement with the charge 5 feet above ground level. The tree will fall toward the side where the explosive is attached unless influenced by the lean of the tree or by the wind.

Special Considerations

3-19. Consider the following when creating an abatis:

- Ensure that the obstacle will cover at least 75 meters (m) in depth.

- Ensure that the individual trees are at least 24 inches in diameter. Smaller trees are not effective obstacles against tracked vehicles.
- Fell trees 3 to 5 meters apart. Doing this creates a condition that prevents 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. 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

3-20. *Table 3-2* lists the required number of C4 packages for cutting timber with internal, external, and abatis charges.

Table 3-2. Timber-cutting charge size

Charge Type	Packages of C4 Required (1.25-lb Packages) 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: **Packages required are rounded UP to the next whole package.**												

STEEL-CUTTING CHARGES

WARNING
Steel-cutting charges produce metal fragments. Take proper precautions to protect personnel.

TARGET FACTORS

3-21. The following target factors 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 varied composition:

- High-carbon steel. Metal-working dies and rolls are normally 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. This type of 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. However, the saddle charge will not cut nickel-molybdenum shafts. 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 following factors are important when selecting steel-cutting charges:

Type

3-25. Plastic explosive (C4) and sheet explosive (M118) 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 target's grooves and angles. These explosives are particularly effective when demolishing structural steel, chains, and steel cables.

Placement

3-26. Refer to *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 charge's cross section is between one and three times its thickness. Do not use charges more than 6 inches thick because you can achieve better results by increasing the width rather than the thickness.
- Long charges are primed every 4 to 5 feet. If butting 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*).

Size

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

Block Charge

3-28. Generally, the following formula will give you the charge size necessary for cutting I-beams, built-up girders, steel plates, columns, and other

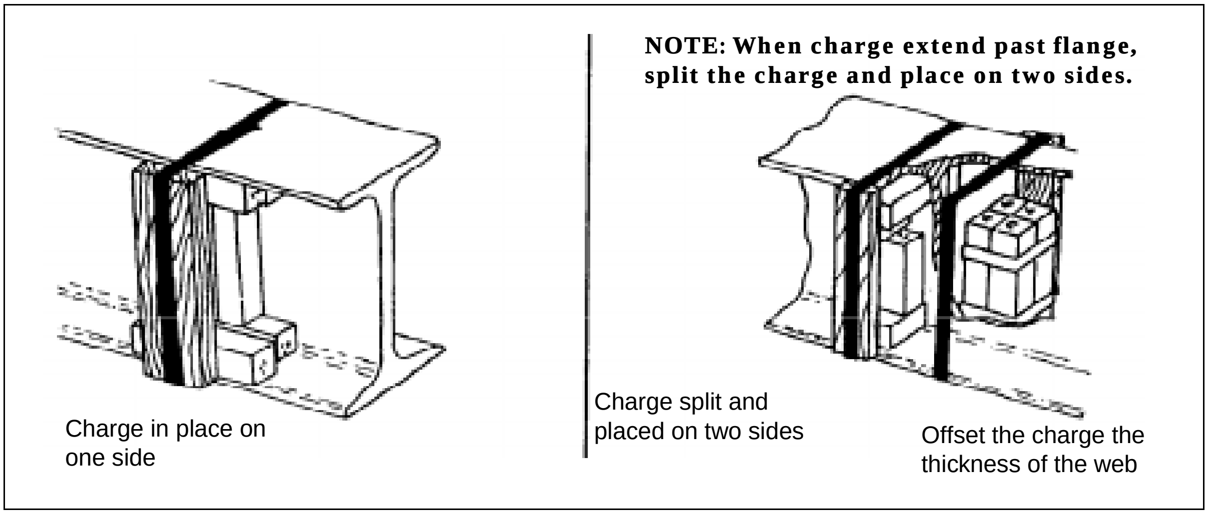


Figure 3-7. Placing charges on steel members

structural-steel sections. (When calculating cutting charges for steel beams, calculate the area for the top flange, web, and bottom flange.) Built-up beams also have rivet heads and angles or welds joining the flanges to the web. You must add the thickness of one rivet head and the angle iron to the flange thickness when determining the thickness of a built-up beam's flange. Use the thinnest point of the web as the web thickness, ignoring rivet-head and angle-iron thickness. Cut the lattice of lattice-girder webs diagonally by placing a charge on each lattice along the line of the cut. Use *Tables 3-3* and *3-4* to determine the correct amount of explosive necessary for cutting steel sections. Use the following formula to determine the required charge size (Table 3-3 is based on this formula) (see sample calculations, *G-3 through G-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

Table 3-3. Hasty steel-cutting chart for TNT

Average Thick-ness 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**
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 C4

Section Thickness (in)	Weight of 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

NOTE**: Round UP to the nearest 1/10 pound when calculating charge size.**

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. If the section dimension is not listed in the table, use the next-larger dimension.
3. Add the individual charges for each section to obtain the total charge weight.

High-Carbon or Alloy Steel

3-29. Use the following formula 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 makes 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, use two blocks. Use the following amount of explosive:

- For materials up to and including 1 inch in diameter or thickness, use 1 pound of explosive.
- For materials between 1 and 2 inches in diameter or thickness, use 2 pounds of explosive. 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 H* **for the underwater method.**

Steel Bars, Rods, Chains, and Cables (over 2 inches)

3-31. When the target diameter or thickness is 2 inches or greater, use the equation in *paragraph 3-28*. When the thickness or diameter is 3 inches or greater, place half of the charge on each side of the target and stagger the placement to produce the maximum shearing effect (*Figure 3-9*).

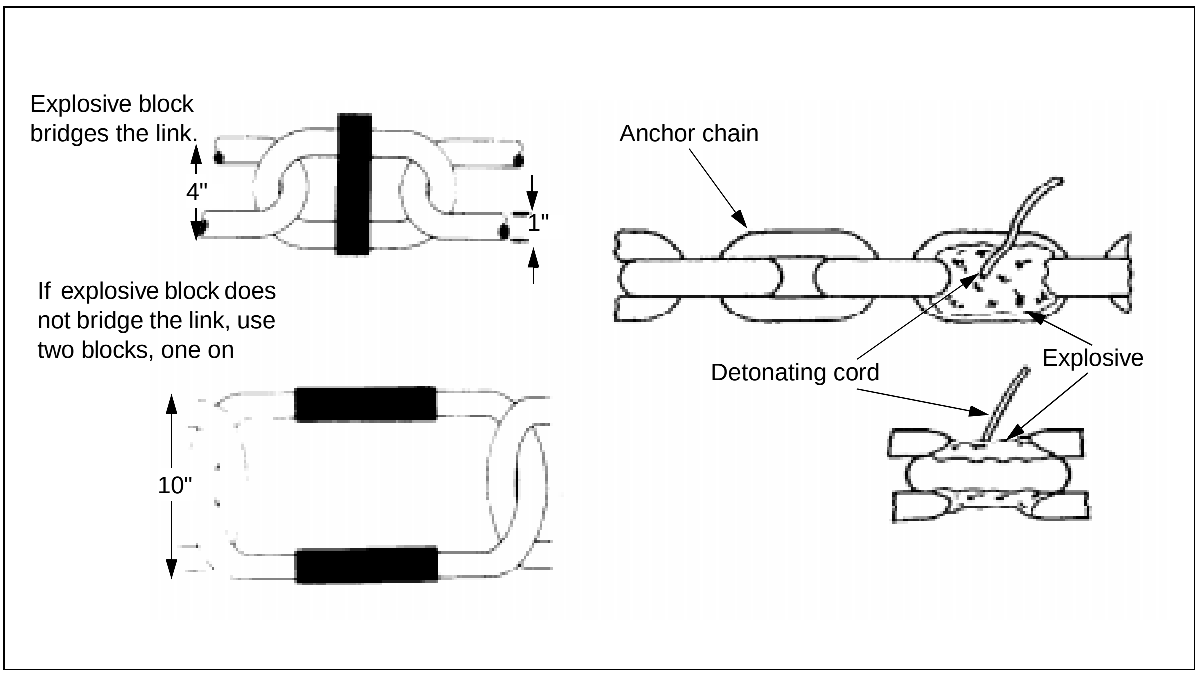


Figure 3-8. Charge placement on chains

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, rail

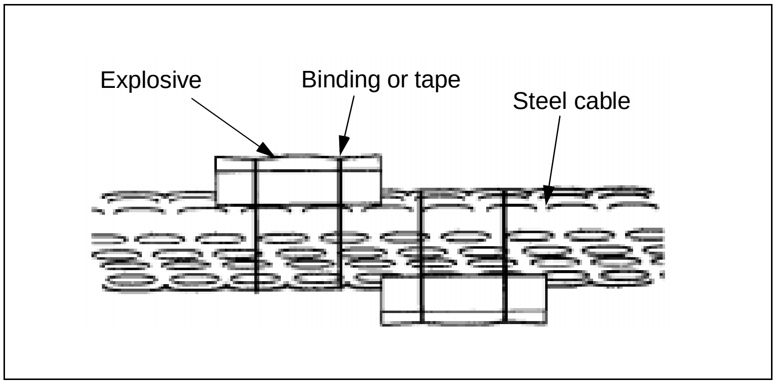


Figure 3-9. Charge placement on steel cable (3 inches or larger)

crossovers, or switches, use 1 pound of explosives. For rails less than 5 inches high, use 1/2 pound of explosive (*Figure 3-10*). Railroad frogs require 2 pounds of explosives. Place the charges at vulnerable points, such as frogs, switches, and crossovers, if possible. Place the charges at alternate rail splices for a distance of 500 feet. Place charges on the inside of the rails.

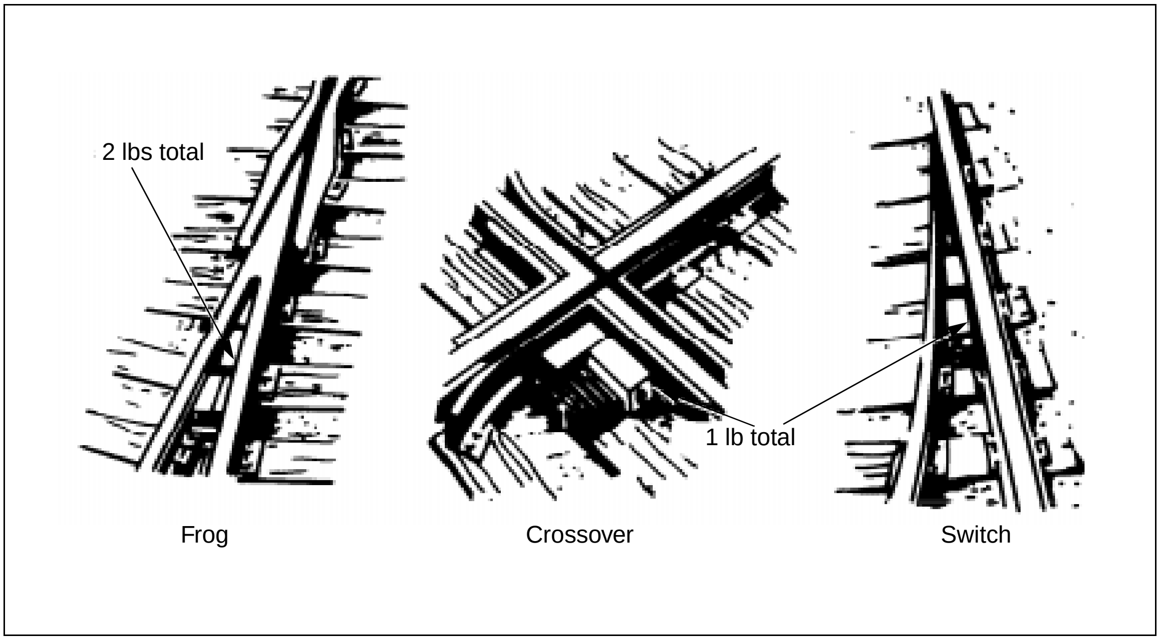


Figure 3-10. Charge placement on railroad rails

SECTION III. SPECIAL CUTTING CHARGES

PURPOSE

3-33. When time and circumstances permit, you can use the special cutting charges (ribbon, saddle, and diamond charges) 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. Use plastic-explosive (M112) or sheet-explosive (M118 or M186) charges as special charges. C4 requires considerable cutting, shaping, and molding, which may reduce its density and, therefore, its effectiveness. Using special cutting charges requires considerable training and practice.

RIBBON CHARGE

3-34. Use ribbon charges to cut flat, steel targets up to 3 inches thick (*Figure 3-11*). Make the charge thickness one-half the target thickness but never less than 1/2 inch. Make the charge width three times the charge thickness and the length of the charge equal to the length of the desired cut. Detonate the ribbon charge 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, place the charge as shown in *Figure 3-12*. The detonating-cord branch lines must be the same length and must connect in a British junction (*Figure 2-34*). *Example G-5* shows how to calculate steel-cutting charges for steel plates. Determine the charge thickness, width, and length as follows:

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

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). Use this charge on mild steel bars, whether round, square, or rectangular shaped, up to 8 inches in diameter (*Figure 3-13*). Make the charge a uniform 1 inch thick. Determine the dimensions, detonation, and placement of the saddle charge as follows (for example calculations on steel cutting charges for steel bars, see *Example G-7*):

- Dimensions
  - — Thickness. Make the charge 1 inch thick (standard thickness of M112 block explosive).
  - — Base width. Make the base width equal to one-half the target circumference or perimeter.

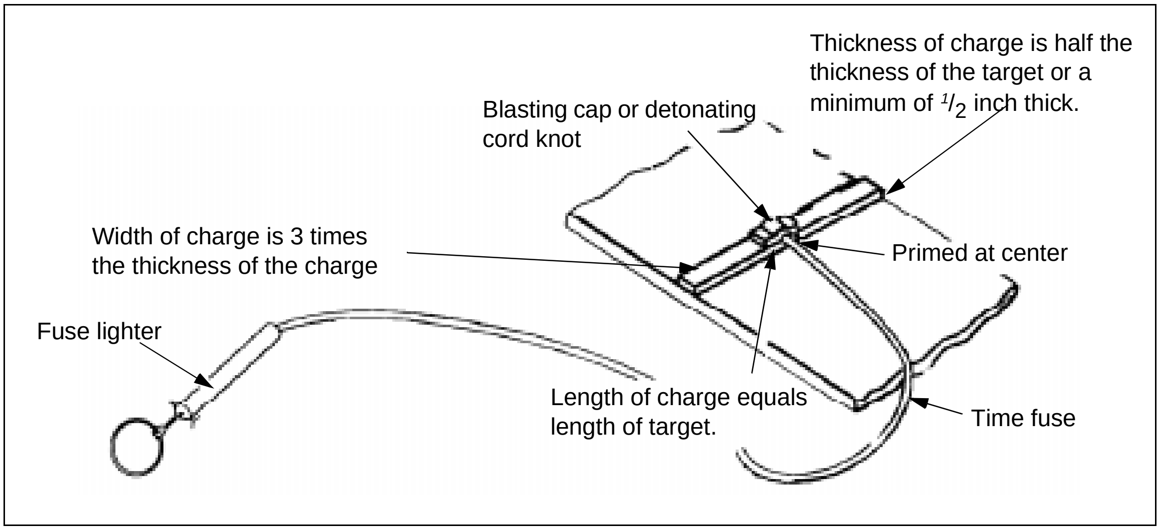


Figure 3-11. Ribbon charge

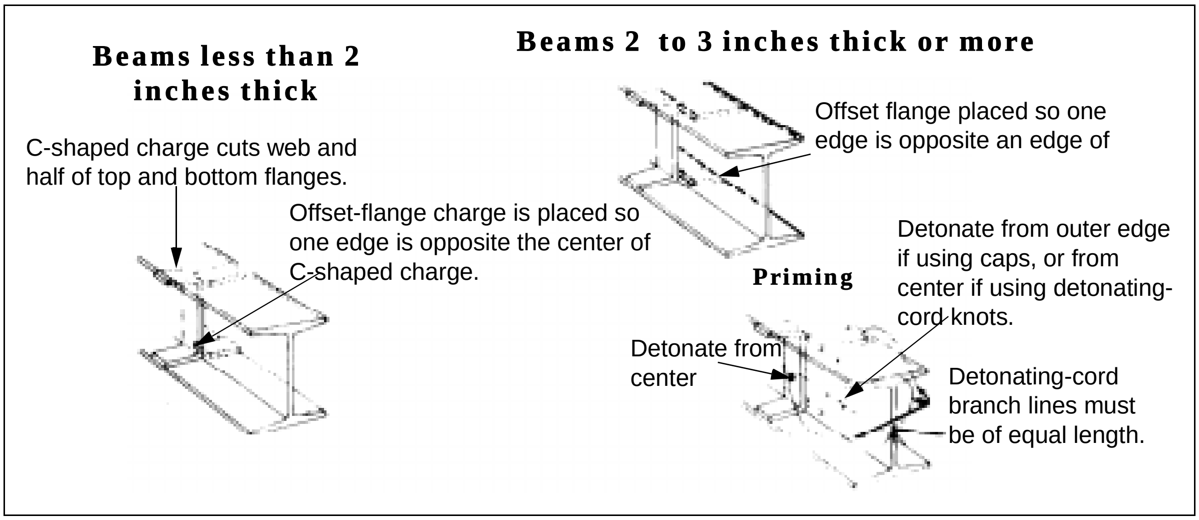


Figure 3-12. Placing ribbon charge on structural steel

— Long-axis length. Make the long-axis length equal to the target circumference or perimeter.

— Volume (cubic inches). Long axis x base x 0.5 = volume.

- Detonation. Detonate the saddle charge by placing a blasting cap, or detonation cord knot at the apex of the long axis.
- Placement**.** The long axis of the saddle charge should be 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.

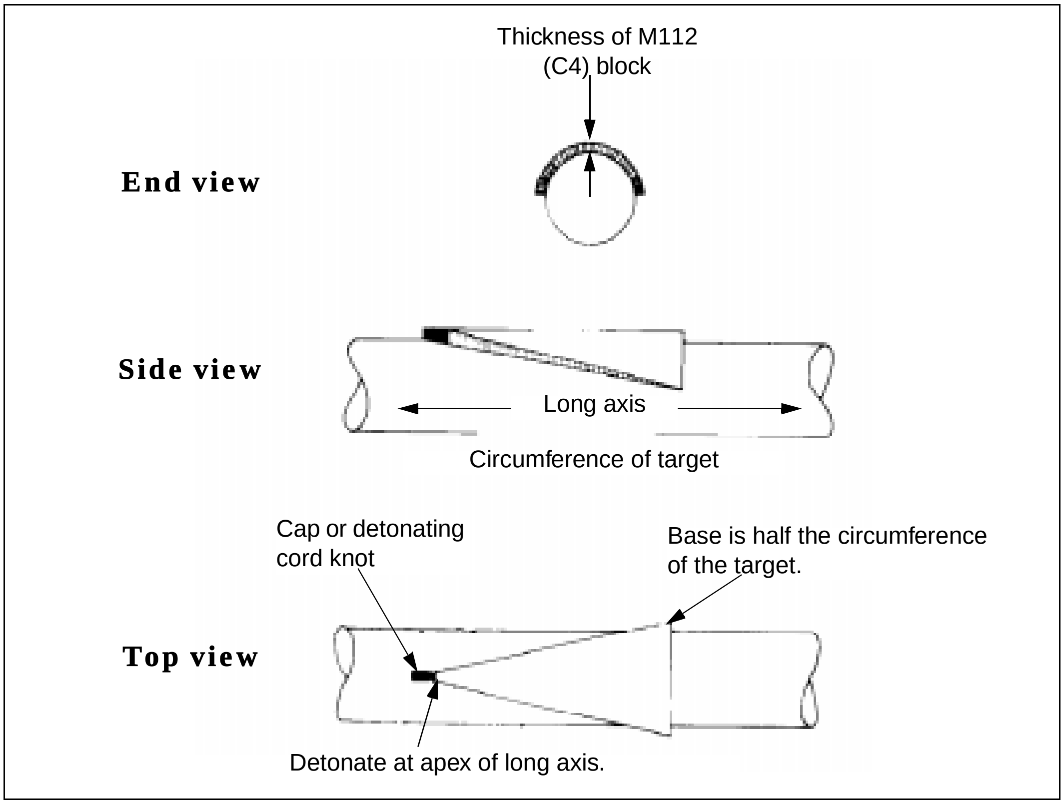


Figure 3-13. Saddle charge

DIAMOND CHARGE

3-36. This technique, the *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. Use the diamond charge on high-carbon or alloy steel bars that are up to 8 inches in diameter. Determine the dimensions, placement, and priming as follows (for example calculations on steel-cutting charges for high-carbon steel, see *Example G-8*):

- Dimensions
  - Thickness. Make the charge 1 inch thick (standard thickness of M112 block explosive).
  - Long-axis length. Make the long-axis length equal to the target circumference or perimeter.
  - Short-axis length. Make the short-axis length equal to one-half the target circumference or perimeter.
  - Volume (cubic inches). Long axis x short axis x 0.5 = volume.
- Placement. Place the explosive completely around the target so that the ends of the long axes touch. You may have to slightly increase the charge dimensions to do this. To ensure adequate contact with the target, tape the charge to the target.

- Priming. Prime the diamond charge (*Figure 3-14*) with two detonating-cord branch lines using one of the following methods:
  - — Detonating-cord knots (*Figure 2-15*).
  - — Two caps.

NOTE: When using a British junction, make sure that the branch lines are the same length.

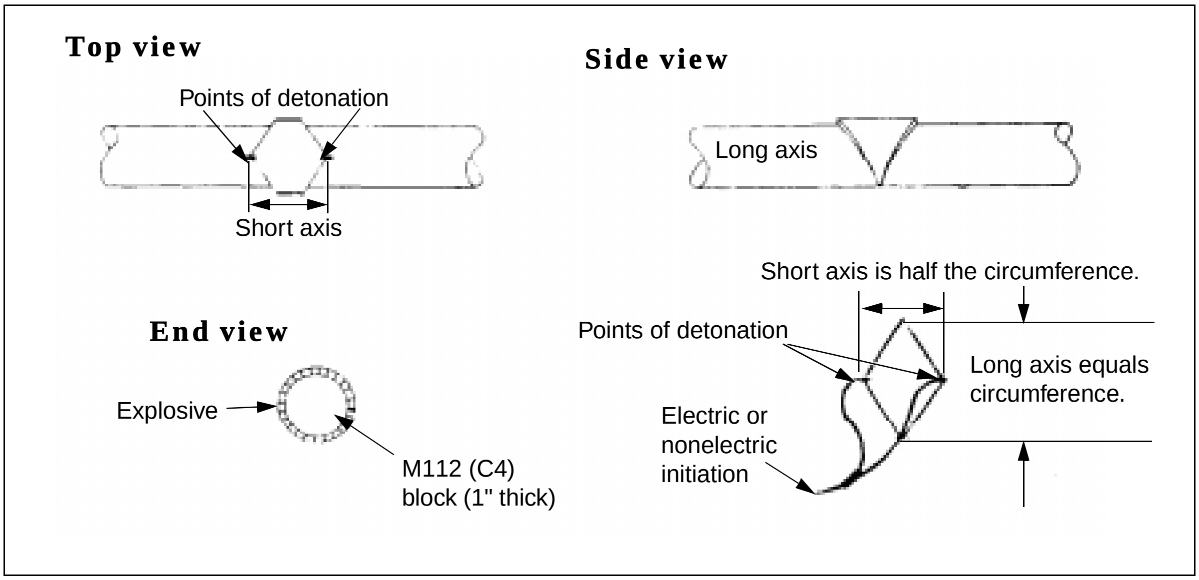


Figure 3-14. Diamond charge

SECTION IV. BREACHING CHARGES

CRITICAL FACTORS

3-37. Use breaching charges to destroy bridge piers, bridge abutments, and permanent field fortifications. The size, shape, placement, and tamping or confinement of breaching charges are 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 sufficient energy to the target to make a crater and create spalling. Breaching charges placed against reinforced concrete will not cut metal reinforcing bars. Remove or cut the reinforcement with a steel-cutting charge after the concrete is breached.

COMPUTATION

FORMULA

3-38. Determine the size of the charge required to breach concrete, masonry, rock, or similar material by using the following formula:

$$P = R^3KC$$

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)

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

Table 3-5. Material factor (K) for breaching charges

Material	R	K
Earth	All values	0.07
Poor masonry, shale, hardpan, good timber, and earth construction	Less than 1.5 m (5 ft)	0.32
	1.5 m (5 ft) or more	0.29
Good masonry, concrete block, and rock	0.3 m (1 ft) or less	0.88
	Over 0.3 m (1 ft) to less than 0.9 m (3 ft)	0.48
	0.9 m (3 ft) to less than 1.5 m (5 ft)	0.40
	1.5 m (5 ft) to less than 2.1 m (7 ft)	0.32
	2.1 m (7 ft) or more	0.27
Dense concrete and first-class masonry	0.3 m (1 ft) or less	1.14
	Over 0.3 m (1 ft) to less than 0.9 m (3 ft)	0.62
	0.9 m (3 ft) to less than 1.5 m (5 ft)	0.52
	1.5 m (5 ft) to less than 2.1 m (7 ft)	0.41
	2.1 m (7 ft) or more	0.35
Reinforced concrete (factor does not consider cutting steel)	0.3 m (1 ft) or less	1.76
	Over 0.3 m (1 ft) to less than 0.9 m (3 ft)	0.96
	0.9 m (3 ft) to less than 1.5 m (5 ft)	0.80
	1.5 m (5 ft) to less than 2.1 m (7 ft)	0.63
	2.1 m (7 ft) or more	0.54

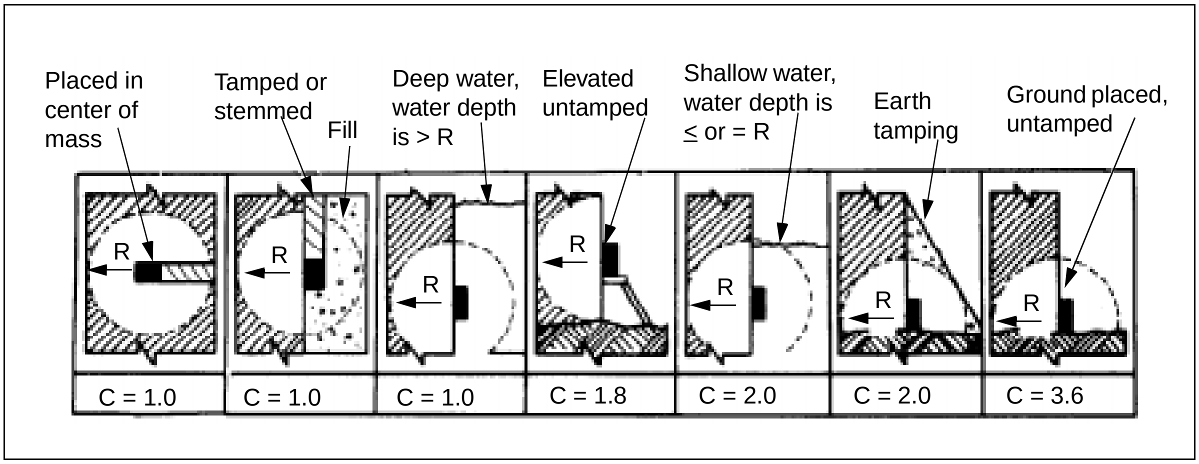


Figure 3-15. Tamping factor (C) for breaching charges

BREACHING RADIUS

3-39. 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's mass, the breaching radius is one-half the thickness of the target. If the charge is placed at less than 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's mass, the explosive's breaching radius is 2 feet (one-half the thickness of the target). The breaching radius is 4 feet for an external charge on this wall. Round values of *R* 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

3-40. 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 you are unable to positively identify the target material, assume the target consists of the strongest type of material in the general group. Always assume that concrete is reinforced and masonry is first-class unless you know the exact condition and construction of the target materials.

TAMPING FACTOR

3-41. The tamping factor depends on the charge location and the tamping materials used. *Figure 3-15* illustrates 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 e arth) as fully tamped unless you cover the charge 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*.

BREACHING REINFORCED CONCRETE

3-42. *Table 3-6* gives the number of C4 packages required for breaching reinforced-concrete targets. The breaching-charge formula does not factor in cutting the steel. Cut the remaining steel using steel-cutting charges. The amounts of C4 in the table are based on the equation in *paragraph 3-38*. To use the table, do the following (for example calculations on breaching charges for a reinforced-concrete pier, see *Example G-9*):

- 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 the *Table 3-6*. If in doubt about which column to use, always use the column that lists the greatest amount of explosive.
- Select the amount of explosive required, based on target thickness, using the column directly under the chosen placement method. For example, 200 packages of C4 are required to breach a 7-foot reinforced-concrete wall with an untamped charge placed 7 feet above ground.

BREACHING OTHER MATERIALS

3-43. You can also use *Table 3-6* to determine the amount of C4 required for other materials by multiplying the value from the table by the proper conversion factor from *Table 3-7*. Use the following procedure:

- Determine the type of material in the target. If in doubt, assume the material to be the strongest type from the same category.
- Determine from *Table 3-6* the amount of explosive required if the object were made of reinforced concrete.
- Find the appropriate conversion factor from *Table 3-7*.
- Multiply the number of packages of explosive required (from *Table 3-6*) by the conversion factor (from *Table 3-7*).

NUMBER AND PLACEMENT OF CHARGES

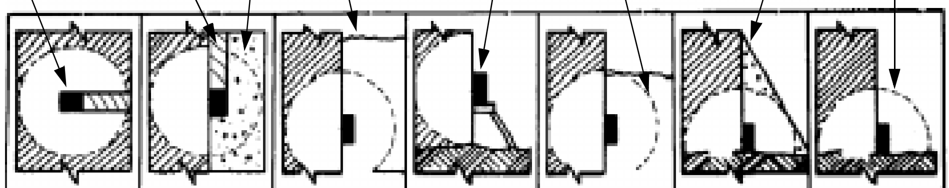
NUMBER OF CHARGES

3-44. Use the following formula for determining the number of charges required for demolishing piers, slabs, or walls:

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

where—

Table 3-6. Breaching charges for reinforced concrete



Rein-forced-Concrete Thick-ness (ft)	Placement Methods						
	Placed in center of mass	Tamped or stemmed / Fill	Deep water	Elevated untamped	Shallow water	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
	Packages of M112 (C4)						
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

NOTE: 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

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

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

3-45. The first charge is placed *R* distance in from one side of the target. The remaining charges are spaced at a distance of 2*R* apart, center to center (*Figure 3-16*).

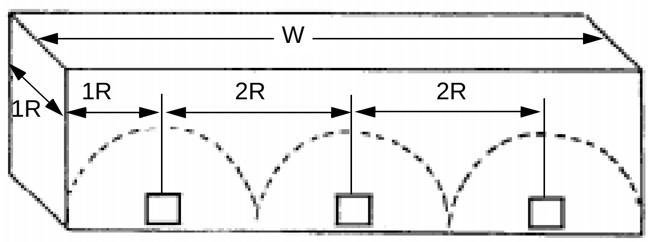


Figure 3-16. Charge placement

CHARGE PLACEMENT

Limitations

3-46. Piers and walls offer limited locations for placing explosives. Unless a demolition chamber is available, place the charge (or charges) against one face of the target. Placing a charge above ground 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 you plan to use elevated charges, distribute the charges 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, place charges at a distance equal to the breaching radius and below the waterline (*Figure 3-15*).

Configuration

3-47. 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*).

COUNTERFORCE CHARGES

USE

3-48. 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 also must have at least three free faces or be freestanding. If constructed of plastic explosives (C4) and 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*).

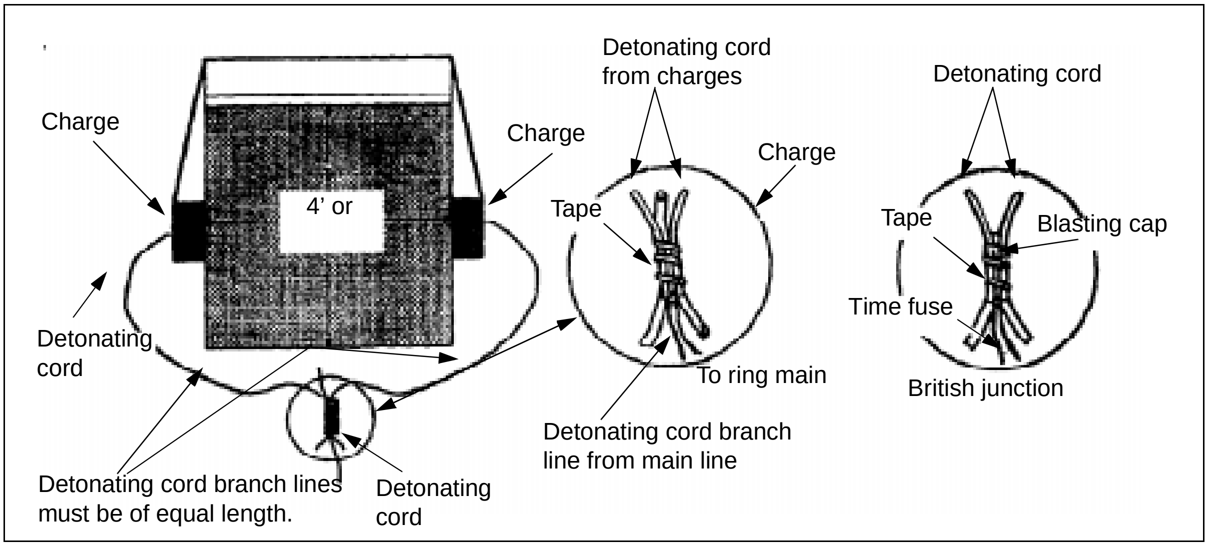


Figure 3-17. Counterforce charge

CALCULATION

3-49. 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 feet). 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 (1.5 pounds per foot x 4 feet).

PLACEMENT

3-50. When placing a counterforce charge, split the charge in half. Place the two halves 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

3-51. Prime a counterforce charge on the face farthest from the target. Join the ends of the detonating-cord branch lines in a British junction (*Figure 3-17*). The length of the branch lines must be equal to ensure simultaneous detonation.

EXAMPLE CALCULATIONS

3-52. For example calculations on counterforce charges, see *Example G-10*.

SECTION V. CRATERING AND DITCHING CHARGES

FACTORS

SIZES

3-53. 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 crater's depth and slope angle. 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. Improve the effectiveness of blasted craters 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 by using other means to further delay enemy armor. Cut craters across the desired gap at a 45° angle from the direction of approach. To obtain this 45° angle use the following formula:

$$width \times 1.414 = length\ of\ crater$$

3-54. To achieve sufficient obstacle depth, place craters in multiple rows, or to enhance some other obstacle, such as a bridge demolition, use single or multiple rows. When creating more than one row of craters, space them far enough apart so that a single armored vehicle-launched bridge (AVLB) will not span them.

EXPLOSIVES

3-55. All military explosives can create AT craters. When available, use the 40-pound, composition H6 cratering charge (*Figure 1-5*) for blasting craters.

CHARGE CONFINEMENT

3-56. Place cratering charges or explosives in boreholes and tamp them.

BREACHING HARD-SURFACED PAVEMENTS

3-57. Breach hard-surfaced pavements so that holes can be dug for the cratering charges. This can be done by exploding tamped charges on the pavement surface. Use a 1-pound charge of explosive for each 2 inches of pavement thickness. Tamp the charges twice as thick as the pavement thickness. Shaped charges also 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, dig the hole for the cratering charge. Do not breach concrete at an expansion joint because the concrete will shatter irregularly. *Table 1-3* lists hole depths and optimum standoff distances when using the 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. You may need to remove some earth or widen narrow areas to accommodate the cratering charge. 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 post-hole diggers.

HASTY CRATER

3-58. The hasty 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 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 25° to 35°. Modern US 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. Use the following procedure to create a hasty crater:

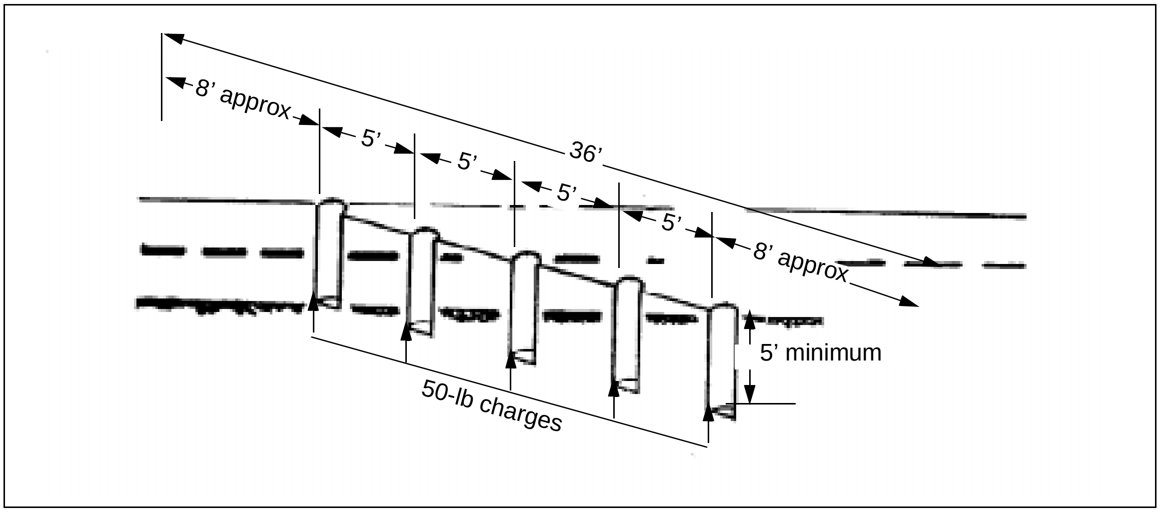


Figure 3-18. Placing charges for a hasty crater

BOREHOLES

3-59. Dig all boreholes to the same depth (5 feet or deeper recommended). Space the boreholes at 5-foot intervals, center to center, across the area to be cratered. Use the following formula in *step 5* of the six step problem-solving format, to compute the number of boreholes:

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

where—

N = number of boreholes; round fractional numbers to 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

3-60. Load the boreholes 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 C4.

FIRING SYSTEM

3-61. Use dual firing systems (*Figure 2-27*). Initiate with either M12, M13, or M14. Dual prime the 40-pound cratering charge as shown in *Figure 2-21*.

TAMPING

3-62. Tamp all boreholes with suitable materials. Refer to *Figure 3-18*.

DELIBERATE CRATER

3-63. *Figure 3-19* illustrates the deliberate-crater method. This method produces a more effective crater than the hasty method. Modern US 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. Use the following procedures to create a deliberate crater:

- Determine the number of boreholes required, using the same formula as for a hasty crater. When there is an even number of holes (*Figure 3-19*), place two adjacent 7-foot boreholes in the middle.
- 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.
- Place 80 pounds of explosive in the 7-foot holes and 40 pounds of explosive in the 5-foot holes.
- Use dual-firing systems (*Figure 2-27*). Dual prime the 40-pound cratering charge as shown in *Figure 2-21*.

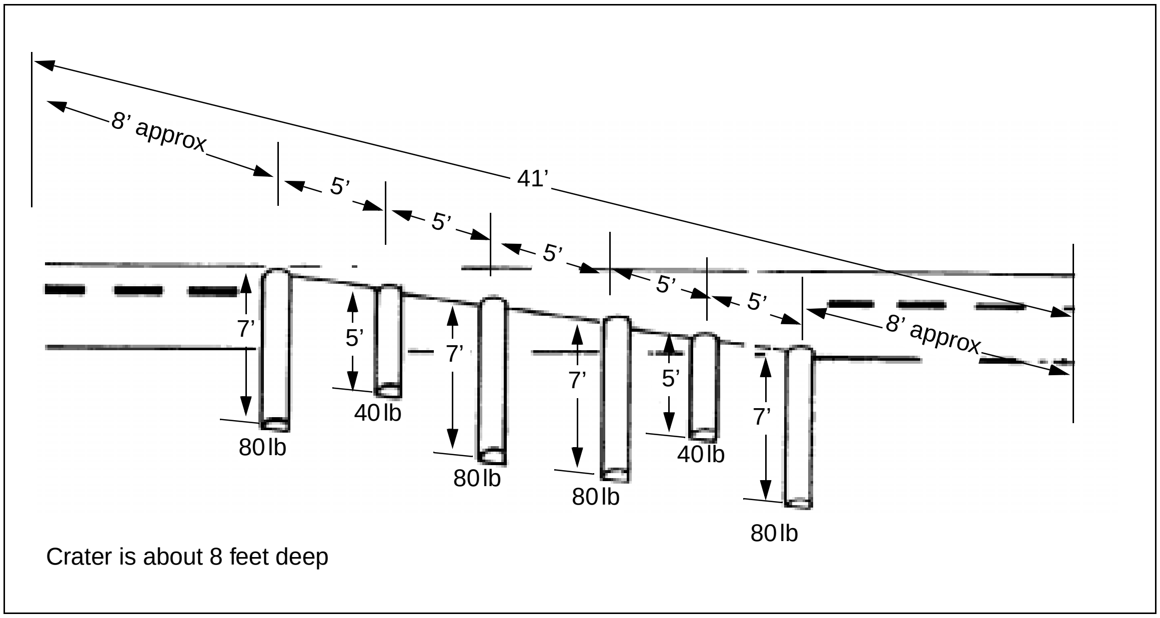


Figure 3-19. Placing charges for deliberate crater

- Tamp all charges with suitable materials.

NOTE: Example calculations. For example calculations on cratering charges, see *Example G-11*.

RELIEVED-FACE CRATER

3-64. The method shown in *Figure 3-20* 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 illustrated 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 type of soil. Use the following procedure 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. On hard-surfaced roads, drill the two lines of boreholes 12 feet apart. 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 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*). 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*.
- Tamp all holes with suitable material.

3-65. There must be a 0.5- to 1.5-second delay in detonation between the two rows of boreholes. Detonate the row on the enemy side first. Then fire the friendly-side row while the earth from the enemy-side detonation is still in the air. Use standard delay caps. If you cannot use standard delay caps, achieve the required delay manually. When using M15s (see *Chapter 7*) to create the required delay, connect firing systems using two M15s, one on each end of the ring mains. This eliminates the need for the second delay initiation system.

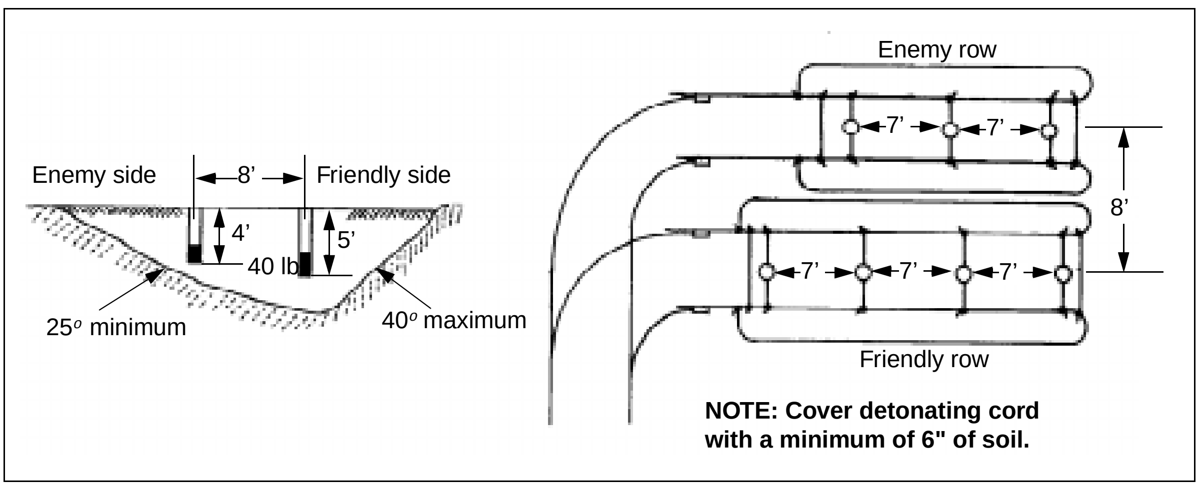


Figure 3-20. Relieved-face crater

MISFIRE PREVENTION

3-66. 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.

CREATING CRATERS IN PERMAFROST AND ICE

BLASTING IN PERMAFROST

3-67. Permafrost can be as hard as solid rock. Therefore, you must adapt the procedures for blasting or cratering to accommodate permafrost conditions. 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

3-68. Before conducting extensive blasting, test the soil in the area to determine the number of boreholes needed. Dig the boreholes with standard drilling equipment, steam-point drilling equipment, or shaped charges. Standard drilling equipment has one serious defect—the air holes in the drill bits freeze. 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. Place the charges immediately after withdrawing the steam point. If you do not, the area around the borehole thaws and collapses. Shaped charges also are effective for producing boreholes, especially when forming craters. *Table 1-3* lists borehole sizes made by shaped charges in permafrost and ice.

Explosives

3-69. If available, use low-velocity explosives, 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

3-70. Access holes in ice are required for obtaining water and determining the ice's capacity for bearing aircraft and vehicles and integrating obstacles. To accommodate rapid forward movements, you must be able to determine ice capacities quickly. Blasting operations provide this ability.

Boreholes

3-71. Make small-diameter access holes 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*). An M3A1 can penetrate deeper, but it has only been tested on ice that is about 12 feet thick. If placed at the normal standoff distance, the charge forms a large crater at the surface, requiring you to do considerable probing to find an actual borehole. Use a standoff distance of 42 inches or more 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

3-72. Make surface craters with composition H6 cratering charges. For the best results, place the charges 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 charge's size.

MAKING VEHICLE OBSTACLES

3-73. Create a vehicle obstacle in ice by first making two or more rows of boreholes. Space the boreholes 9 feet apart, and stagger them in relation to the holes in the other rows. Suspend M112 charges 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. Use test shots to find the optimum amount. This type of obstacle can retard or halt enemy vehicles for about 24 hours at temperatures near -24°F.

CREATING CRATERS FROM CULVERTS

3-74. Destroying a culvert less than 15 feet deep may also produce an effective crater. Prime the charges for simultaneous detonation, and thoroughly tamp all charges with sandbags. Destroy culverts that are no deeper than 5 feet by placing explosive charges the same as for hasty road craters. Space the boreholes at 5-foot intervals in the fill above and alongside the culvert. In each hole, place 10 pounds of explosives per foot of depth.

CREATING CRATERS FROM AT DITCHES

3-75. Excavate AT ditches by either the hasty or deliberate cratering method (*paragraphs 3-58* and *3-63*).

DITCHING METHODS

3-76. Explosives can create ditches rapidly. Slope ditches at a rate of 2 to 4 feet of depth per 100 feet of run. Place ditches in areas where natural erosion will aid in producing the correct grade. If you cannot place a ditch in an area aided by erosion, make the ditch deeper, increasing the depth as the length increases. Use the following methods for creating ditches:

SINGLE LINE

3-77. The single-line method (*Figure 3-21*) is the most common ditching method. Detonate a single row of charges 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.

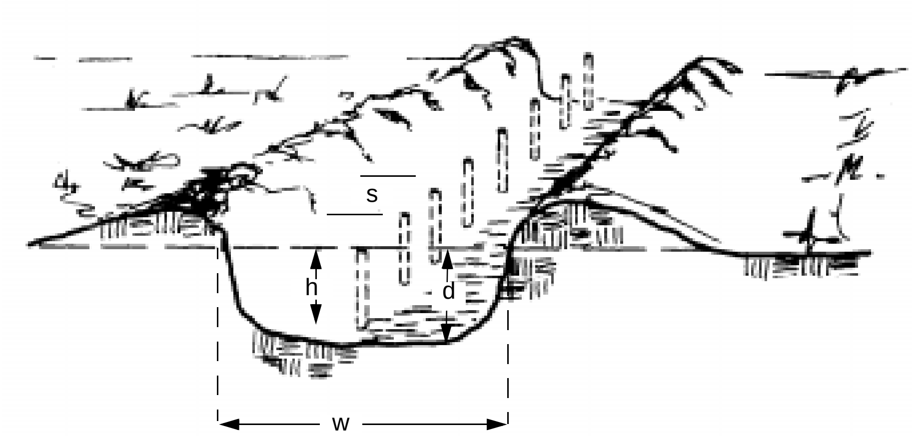


Figure 3-21. Single-line method of ditching

Table 3-8. Single-line ditching explosives data

Serial	Required Ditch Depth (*d*)	Required Width Top of Ditch (*w*) (ft)	Charges per Hole (lb)	Borehole Depth (*h*) (ft)	Borehole Spacing (*s*) (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

3-78. When you must blast the full width of the ditch in one operation, use the cross-section method *(Figure 3-22). Table 3-9* gives charge configurations for the cross-section method. Place an extra charge midway between lines of charges.

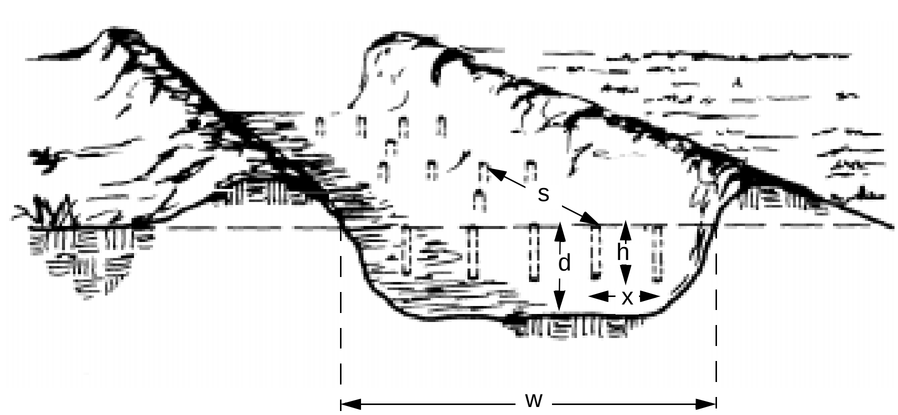


Figure 3-22. Cross-section method of ditching

Table 3-9. Cross-section ditching explosives data

Serial	Required Depth (*d*)	Required Width (*w*) (ft) Number of Boreholes in Each Cross Section					Charge per Hole (lb)	Bore-hole Depth (*h*) (ft)	Bore-hole Spacing (*s*) (ft)	Row Spacing (*x*) (ft)
		3	5	7	9	11				
1	2.5	7.5	11.0	13.0	16.0	18.0	0.5	1.5	1.3	2.5
2	3.0	10.0	13.0	16.0	19.0	22.0	1.0	2.0	1.5	3.0
3	4.0	14.0	19.0	24.0	29.0	34.0	2.0	3.0	2.5	4.5
4	6.0	20.0	28.0	36.0	44.0	52.0	5.0	5.0	4.0	6.0
5	10.0	26.0	33.0	46.0	56.0	65.0	10.0	7.0	5.0	8.0

SECTION IV. LAND-CLEARING CHARGES

STUMP REMOVAL

3-79. Stumps have two general root types, taproot and lateral root (*Figure 3-23*). Measure the stump diameter 12 to 18 inches above ground level. Round the diameter to the next higher 1/2 foot. Use 1 pound of explosive per foot of diameter for dead stumps and 2 pounds of explosive per foot of diameter for live stumps. If removing the complete tree, use 3 pounds of explosive per foot of diameter. If you cannot identify the root type, assume the tree has a lateral root structure and proceed accordingly.

TAPROOTED STUMPS

3-80. 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, place the charges in contact with the root and at a depth about equal to the diameter of the stump.

LATERALLY ROOTED STUMPS

3-81. When blasting laterally rooted stumps, drill sloping holes between the roots (*Figure 3-23*). Drill the holes and place the charges as close to the center of the stump as possible, at a depth equal to the radius of the stump base. Trees with large lateral roots may require additional charges. Place the additional charges directly underneath the large lateral roots.

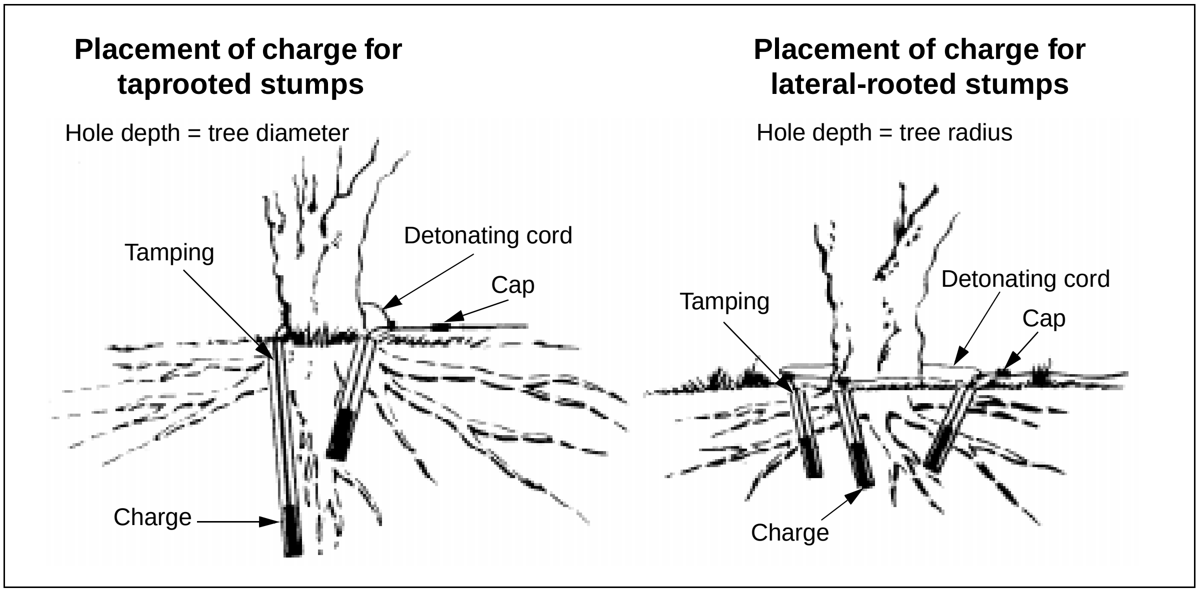


Figure 3-23. Stump blasting

BOULDER REMOVAL

3-82. Blasting is an effective way to remove boulders. The most practical methods are snake-hole, mud-cap, and block-hole.

SNAKE-HOLE METHOD

3-83. This method involves digging a hole beneath the boulder large enough to hold the charge. Pack the charge under and against the boulder as shown in *Figure 3-24*. *Table 3-10* lists the required charge sizes.

MUD-CAP METHOD

3-84. Place the charge in a crack or seam in the boulder (*Figure 3-24*). Cover the charge with 10 to 12 inches of mud or clay. *Table 3-10* lists the required charge sizes.

BLOCK-HOLE METHOD

3-85. Drill a hole in the top of the boulder deep and wide enough to hold the amount of explosive required (*Table 3-10*). Prime the charge with detonating cord and tamp firmly (*Figure 3-24*).

SPRINGING CHARGE

3-86. A springing charge is a comparatively small charge for enlarging a borehole to accommodate a larger charge. At times, you may have to detonate two or more springing charges in succession to make the chamber large enough for the final charge. Wait at least 30 minutes between firing

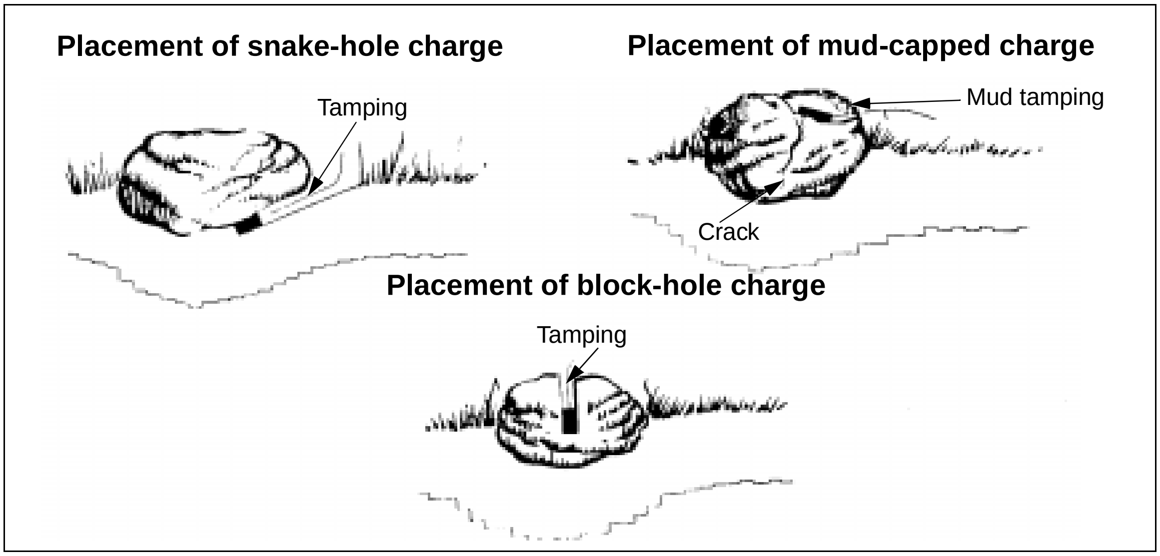


Figure 3-24. Boulder blasting

Table 3-10. Boulder-blasting charges

Boulder Diameter (ft)	Charge Size (lb)		
	Block-Hole Method	Snake-Hole Method	Mud-Cap Method
3	0.250	0.75	2.0
4	0.375	2.00	3.5
5	0.500	3.00	6.0

successive charges to allow the borehole to cool, unless you cool the hole with water or compressed air. For soils, use several strands of detonating cord, 5 to 6 feet long, taped together to form a multicord wick. For best results, extend the wick the full length of the borehole. As a general rule, one strand of detonating cord (single-cord wick) will widen a borehole's diameter by about 1 inch. For example, a 10-cord wick will create a 10-inch diameter borehole. Make the initial borehole by driving a steel rod about 2 inches in diameter into the ground to the required depth. Place the wick into the initial borehole with an inserting rod or some other field-expedient device. The detonating-cord wick works best in hard soils (*paragraph F-6*). If placing successive charges in the same borehole, use water or compressed air, or wait 30 minutes to cool the borehole before placing the next charge.

QUARRYING

3-87. Military quarries are generally open-faced and mined by the single- or multiple-bench method. TM 5-332 gives detailed information on military quarries.

SECTION VII. SPECIAL APPLICATIONS

SURVIVABILITY POSITIONS

3-88. In many circumstances, using explosives can reduce digging time and effort. Use explosives only in soil that would normally be excavated by a pick and shovel. Explosives are not recommended for excavations less than 2 feet deep. Use small charges buried and spaced just enough to loosen the soil, limiting the dispersion of soil to as small an area as possible. Do not attempt to form a crater; this 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. Using explosives in this manner requires 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

3-89. Place charges 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. Make the boreholes with an earth auger, wrecking bar, picket driver, or other expedient device.

SPACING

3-90. For rectangular excavations, dig the boreholes in staggered lines. For circular excavations, dig the boreholes in staggered, concentric rings. The spacing between boreholes in each line or ring and between lines or rings should be between 1 and 1.5 times the borehole's depth. Ensure that all charges are at least 2 feet inside the proposed perimeter of the excavation. Also, dig an 8- by 8-inch channel 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.

CHARGE SIZE

3-91. Use 1/4-pound charges of plastic explosive to dig foxholes. 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

3-92. Reduce explosion noise and spoil scatter by leaving any sod in place and covering the site with a blasting mat. Improvise blasting mats by tying tires together with natural or synthetic rope (steel-wire rope is unacceptable) or by using a heavy tarpaulin.

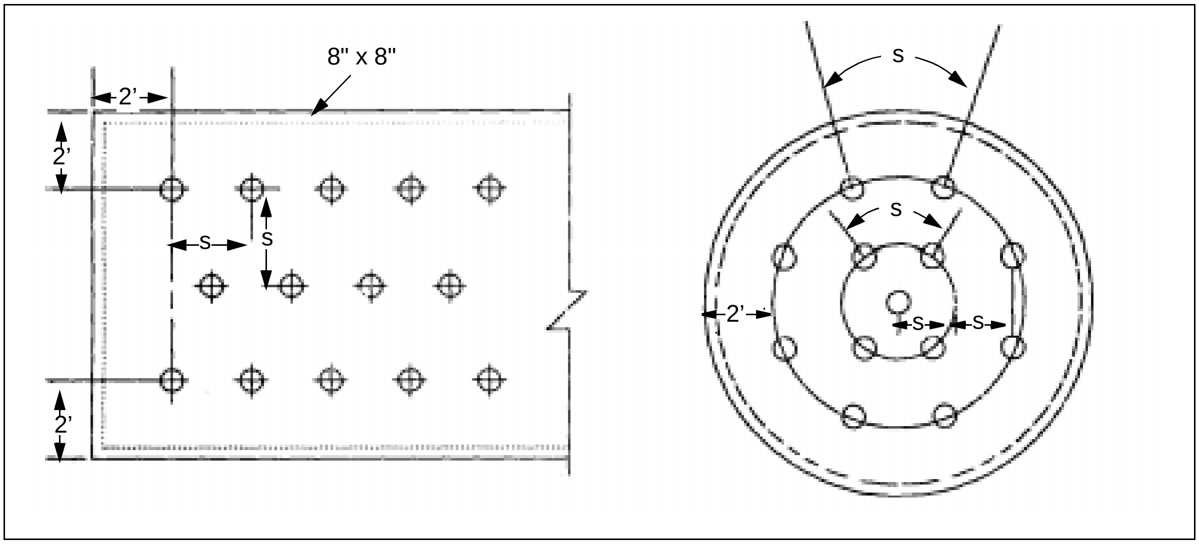


Figure 3-25. Borehole layouts

EQUIPMENT DESTRUCTION

> **WARNING**
> **Steel-cutting charges produce metal fragments. Take proper precautions to protect personnel.**

GUNS

3-93. Destroy gun barrels with explosives or their own ammunition. Also be sure to remove or destroy the small components, such as sights and other mechanisms.

Explosive Method

To prepare a gun for demolition, do the following:

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

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

where—

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

D = bore size of the barrel, in millimeters

636 = Constant

Table 3-11. Gun-destruction charge sizes

Serial	Barrel Size (mm)	Charge Size (lb)
1	76	10
2	105	18
3	120	23
4	155	38
5	203	66
NOTE: Determine appropriate charge sizes for barrel sizes not listed by comparing them to known barrel sizes. For example, you would use the explosive weight in Serial 3 for a 112-mm barrel (23 pounds) and Serial 4 for a 152-mm barrel (38 pounds).		

- Pack the explosive, preferably 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. If time permits, place 15-pound charges on the drive wheels of tracked guns and on the wheels and axles of towed guns. Connect the branch lines in a junction box or use a ring main. Simultaneously detonate all charges.

Improvised Method

3-95. When block explosives are not available, destroy a gun with its own ammunition. Insert and seat one round in the muzzle end and a second charge, complete with propellant charge (if required), in the breach end of the tube. Fire the gun from a safe distance, using the gun's own mechanism. Use a long lanyard and ensure that the firing party is under cover before firing the gun.

VEHICLES

3-96. To destroy friendly vehicles, refer to the applicable TM. Use the following priorities when destroying vehicle components:

- 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 — differentials and transfer case.
- Priority 6 — frame.

Armored Fighting Vehicles (AFVs)

3-97. Destroy AFVs 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 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.

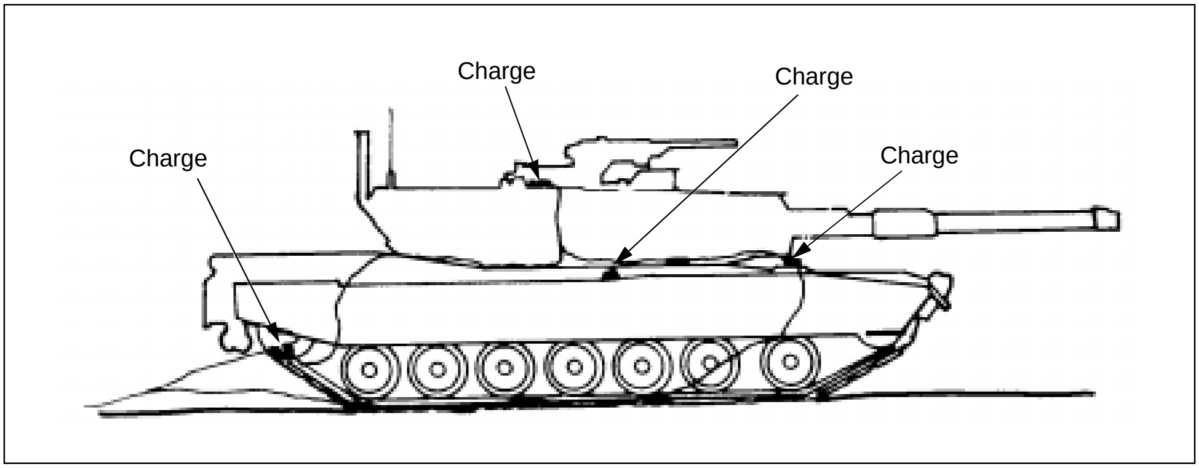


Figure 3-26. Placing charges on an AFV

Wheeled Vehicles

Explosives Method

3-98. Destroy wheeled vehicles beyond repair by wrecking the vital parts with a sledge hammer or explosives. If HEs are available, use 2-pound charges to destroy the cylinder head, axles, and frame.

Improvised Method

3-99. Drain the engine oil and coolant and run the engine at full throttle until it seizes. Finish the destruction by burning the vehicle (ignite the fuel in the tank).

UNDERWATER DEMOLITIONS

3-100. Refer to *Appendix H* for us e and placement of underwater demolitions.

Chapter 4

Bridge Demolition

4-1. The purpose of bridge demolition is to create gaps in bridges by attacking key bridge components. This makes gaps large enough to make repair uneconomical and to force the enemy to construct other bridges on other sites. The minimum gap required must exceed the enemy's assault bridging capability by 5 meters. For planning purposes, use 25 meters as the minimum gap size, but 35 meters is preferred.

4-2. 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 normally required to meet the tactical objective. Select the attack method that achieves the tactical goal, with a minimum expenditure of resources.

4-3. 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.

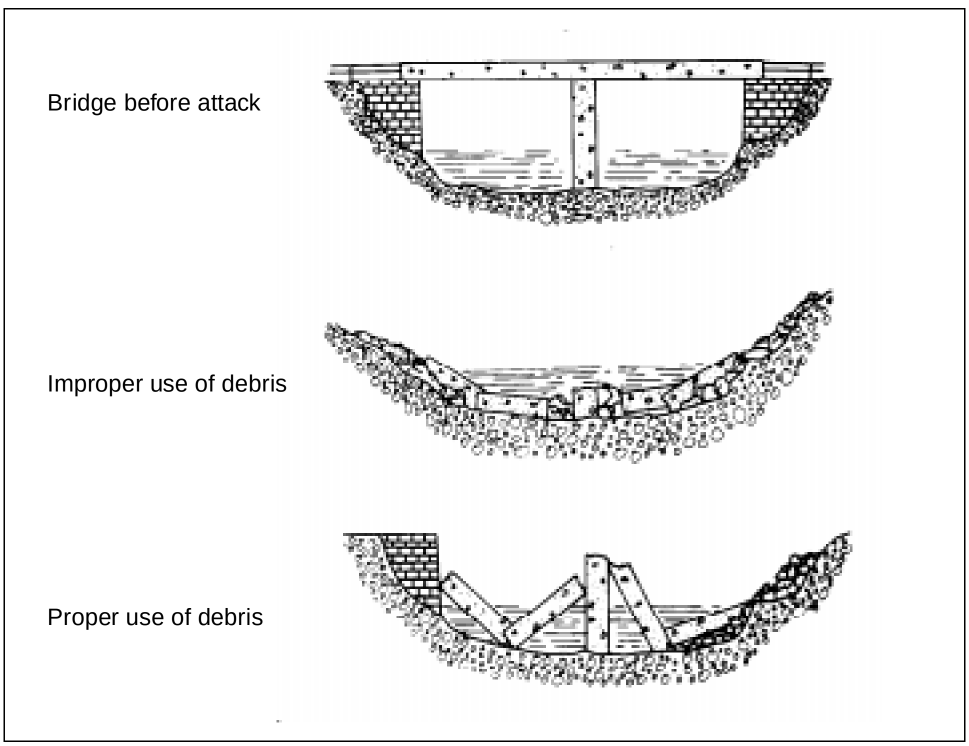


Figure 4-84. Use of debris

BRIDGE CATEGORIES

4-4. 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 three following categories:

SIMPLY SUPPORTED

4-5. In simply supported bridges, the ends of each span rest on the supports; 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).

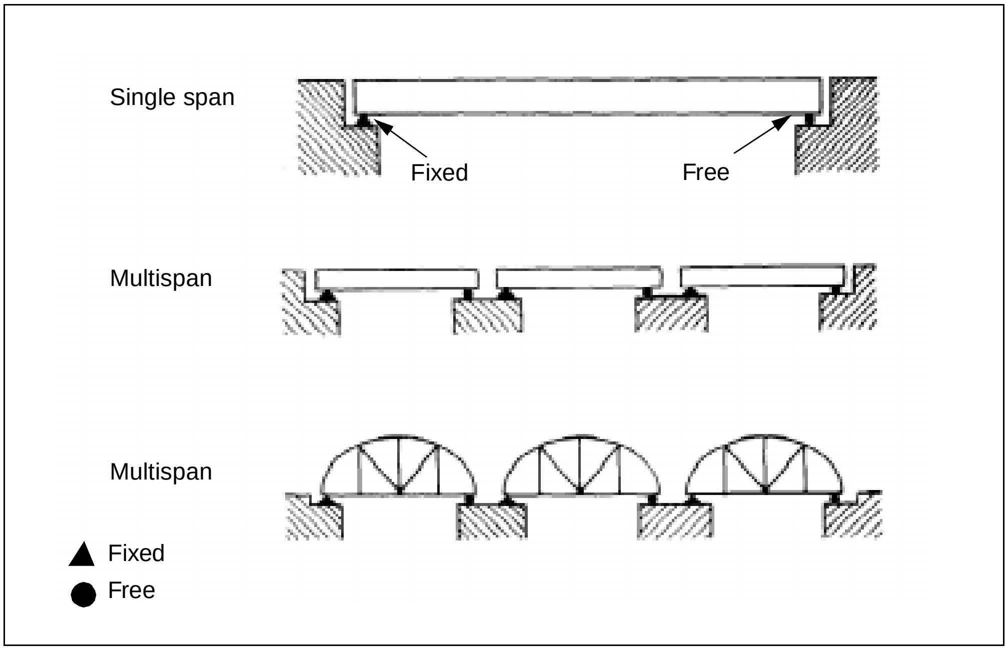


Figure 4-85. Simply supported bridges

MISCELLANEOUS

4-6. Miscellaneous bridges form a small proportion 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

4-7. If a 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, continuous-beam bridges*, as is normally implied.

TYPES OF ATTACK

4-8. 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

4-9. 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 (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.

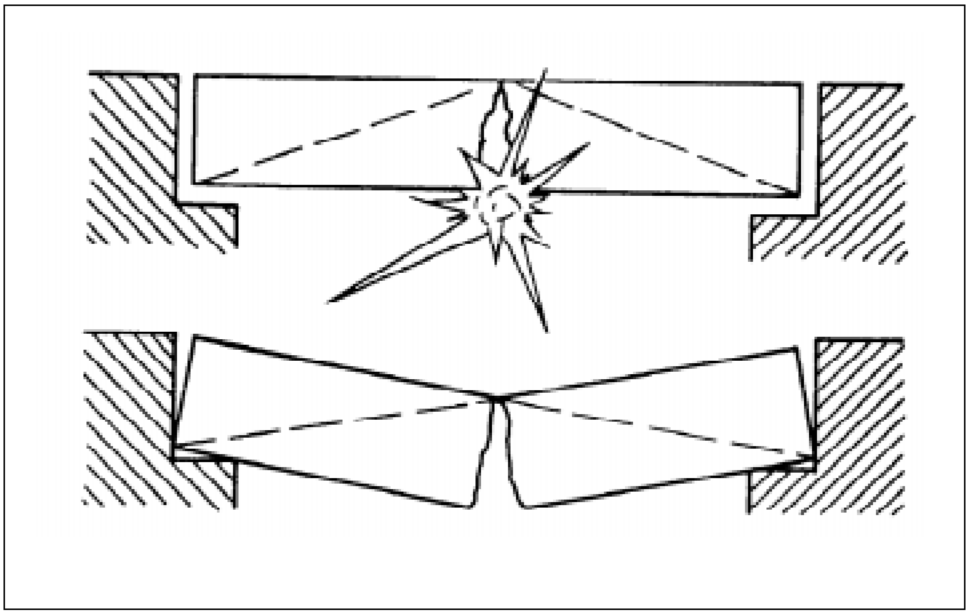


Figure 4-86. Three-pin arch effect

TOP ATTACK

4-10. 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, page 4-4). Ensure that the length of span removed (L_c) at the top is sufficient to prevent the formation of a cranked beam.

SUCCESSFUL BRIDGE DEMOLITIONS

4-11. There are two minimum conditions for successful bridge demolition:

- Condition 1. You must design a proper collapse mechanism.
- Condition 2. You must ensure that the attacked span will be free to move far enough, under its own weight, to create the desired obstacle.

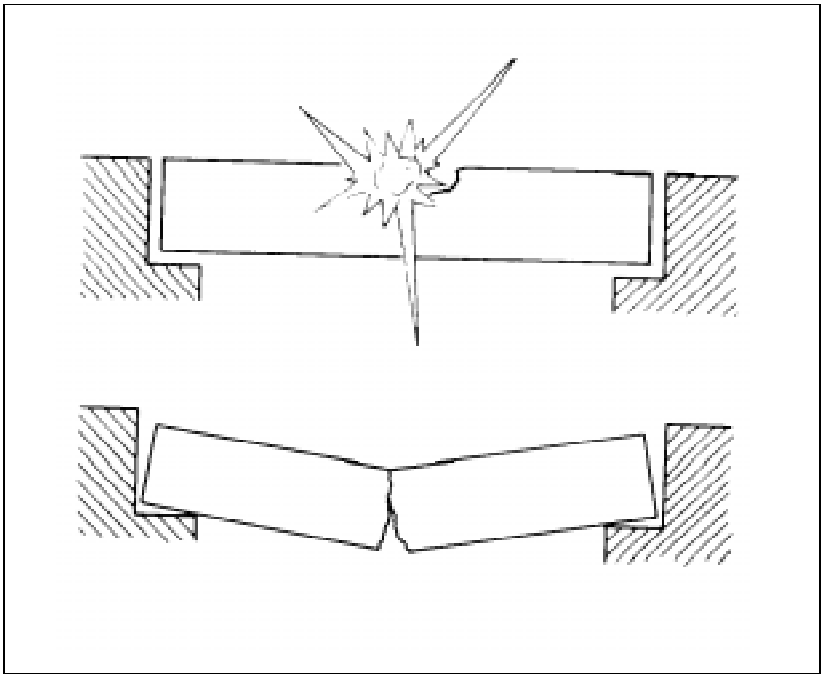


Figure 4-87. Cranked-beam effect

CONDITION 1

4-12. 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, you form a collapse mechanism. This may involve either cutting completely through all structural members or creating points of weakness in certain parts of the bridge. Figure 4-5 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 lost 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.

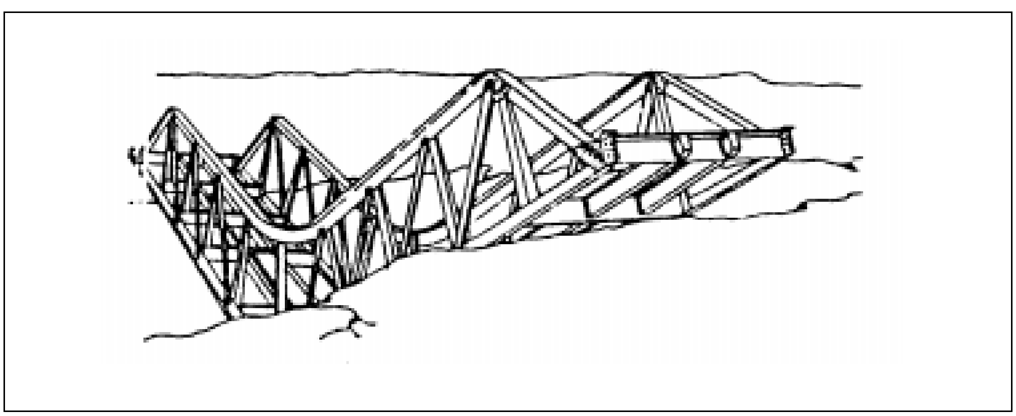


Figure 4-88. Improper collapse mechanism and hinges

CONDITION 2

4-13. 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, you need to remove only a small portion of the abutment to allow the span to swing down freely.

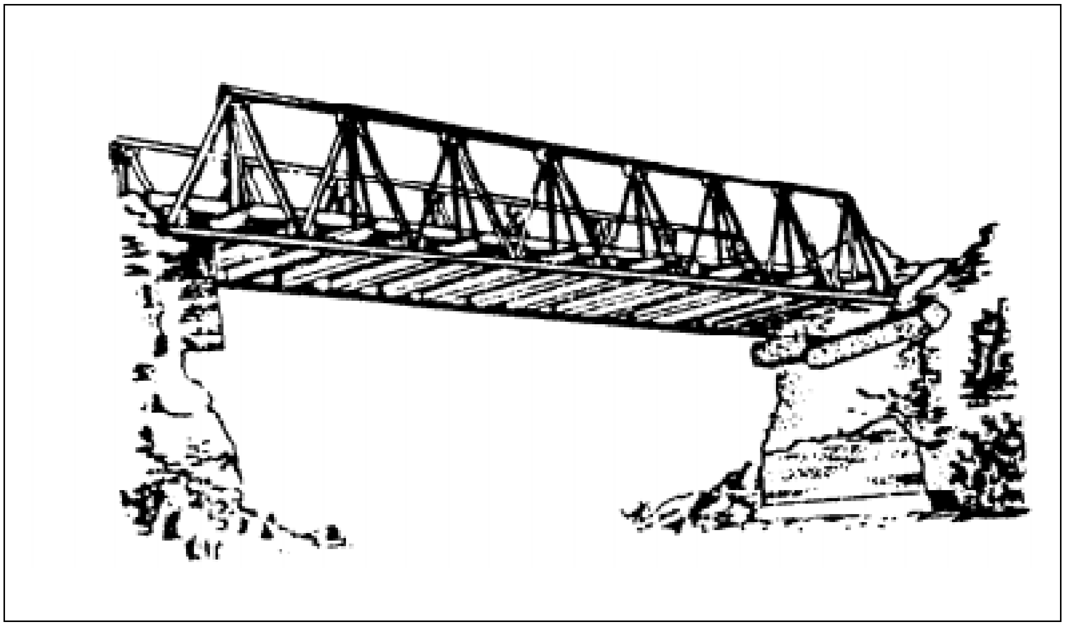


Figure 4-89. Jammed bridge span

TYPES OF COLLAPSE MECHANISMS

4-14. Figures 4-7 through 4-9, page 4-6, illustrate the three basic collapse mechanisms—see-saw, beam, and member without support.

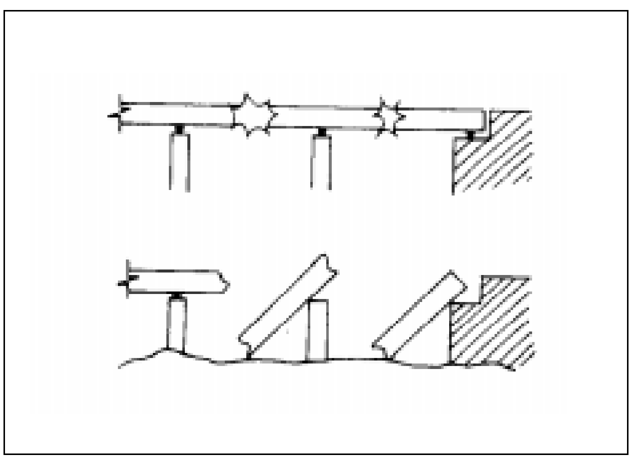


Figure 4-90. See-saw collapse mechanism

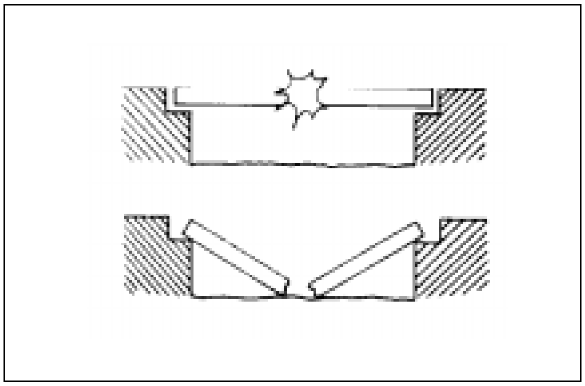


Figure 4-91. Beam collapse mechanism

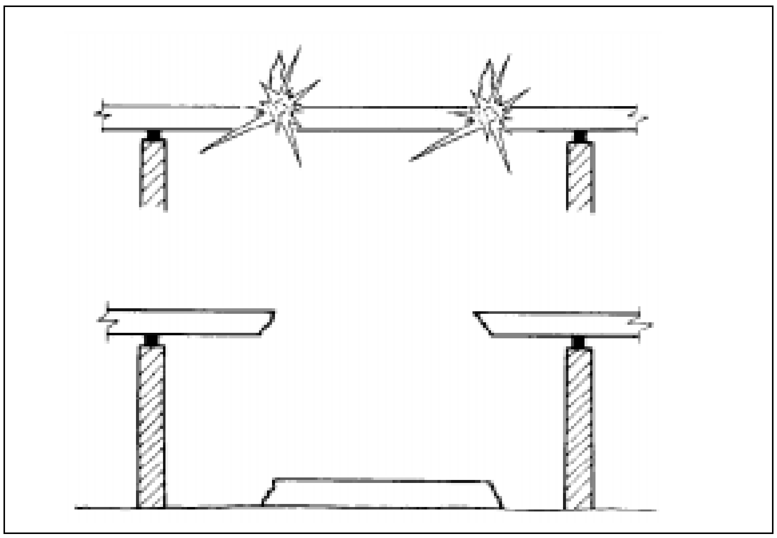


Figure 4-92. Member-without-support collapse mechanism

EFFICIENT DEMOLITION METHODS

4-15. 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 must clearly state the priorities and separately list the requirements for priority 1 actions and priority 2 improvements (priorities are explained below). If a sufficient 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 an unsuitable obstacle unless the gap can be increased. Your engineer effort may be better applied elsewhere. To improve an obstacle, you may have to increase the gap by demolishing the abutments and building craters on the immediate approaches. In this case, you should also attack nearby bypass sites (place mines and craters).

Priority One

4-16. Create the desired obstacle. The minimum gap required is 5 meters greater than the enemy's assault bridging capability. 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 Two

4-17. Make improvements to the gap. Perform this activity 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. Deviate from this sequence only 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.
- To destroy the piers.

CONCRETE-STRIPPING CHARGES

Description

4-18. Concrete-stripping charges are bulk, surface-placed charges designed for removing concrete from reinforced-concrete beams and slabs and exposing the steel reinforcement. Although these charges cause some damage to the reinforcing steel, you will not be able to predict the extent of this damage. These charges are effective against reinforced-concrete beams and slabs up to 2 meters thick. Figure 4-10, page 4-8, 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.

Charge Calculations

4-19. For all simply supported concrete bridges, removing all concrete over a specified L_c will cause collapse. For beam-and-slab bridge spans (T-beam and I-beam bridges), determine the charge sizes for the beams and slab separately. Use the following procedure for determining charge sizes for simply supported spans (See Example G-12, page G-12 for a sample calculation):

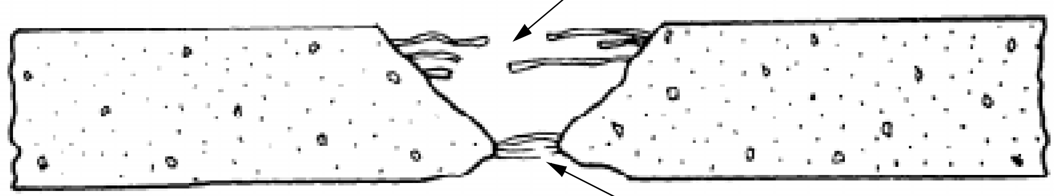


Figure 4-93. Effect of concrete charge

- 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

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

- Calculate the width of the required ditch. The charge will produce a ditch across the width of the bridge. To determine the width of this ditch, use the following formula:

$$W_d = 2h + 0.3$$

where—

W_d = ditch width, in meters

h = overall roadway and 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 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. The shape of the charge's end cross section should be such that the width is between one and three times the height.

- Tamp the charges, if required. No tamping is required for the concrete-stripping charge as calculated, but if tamping with two filled sandbags per pound of explosive is used, reduce the calculated mass of charge by one third.

UNSUCCESSFUL BRIDGE DEMOLITIONS

4-20. 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

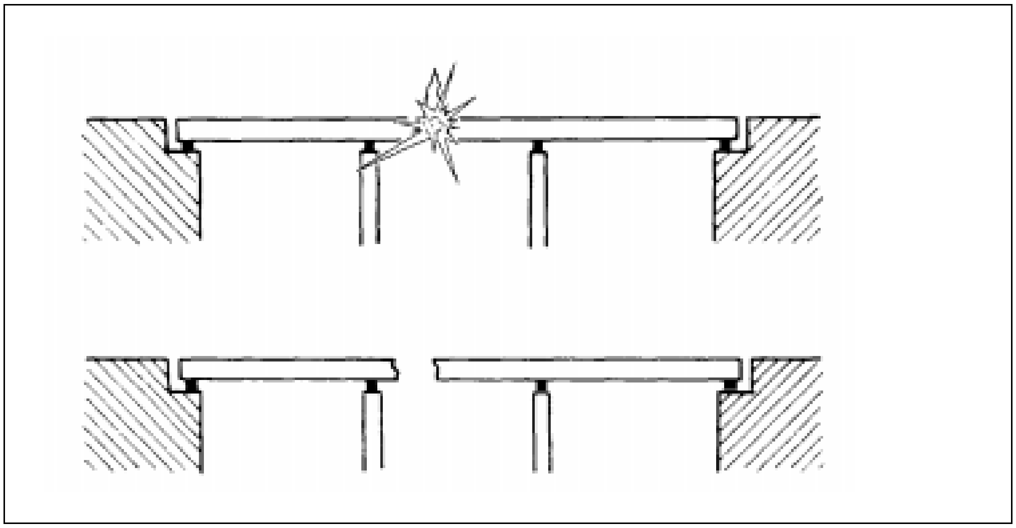


Figure 4-94. Cantilever effect

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 4-10). When attacking bridge spans, always consider the possibility of jamming during bottom and top attacks.

SIMPLY SUPPORTED AND CONTINUOUS BRIDGES

4-21. A bridge's external appearance 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, assuming a continuous construction will provide more than enough explosive to demolish a bridge of unknown construction. The following list describes some differences between simply supported and continuous bridges (see Figure 4-13, page 4-11):

- 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.

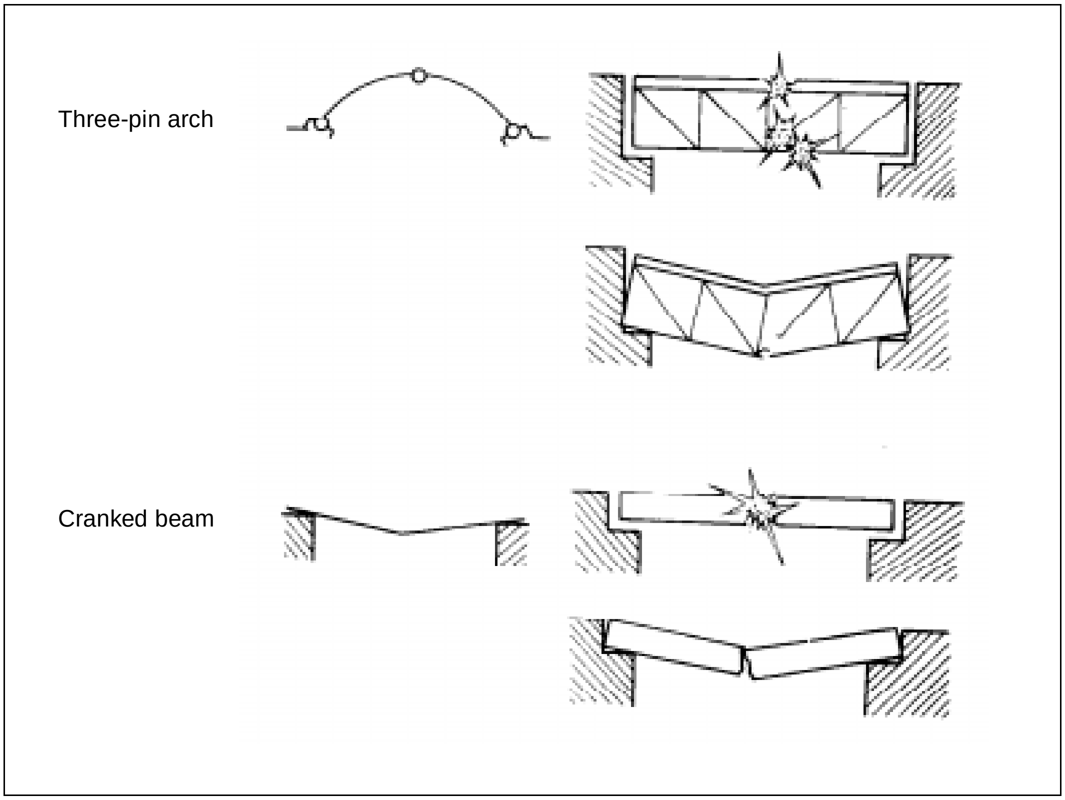


Figure 4-95. Causes of jamming

- 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, you need two lines of bearing at the piers. In continuous bridges you need only one.

4-22. More explosive is necessary to demolish a continuous bridge, assuming a continuous construction will provide more than enough explosive to demolish a bridge of unknown construction. To correctly use the tables in Appendix I, decide whether the bridge is in the simply supported, continuous, or miscellaneous category, and follow the procedures outlined in the appropriate paragraph.

SIMPLY SUPPORTED BRIDGES

4-23. Figure 4-14, page 4-12, is a categorization chart for simply supported bridges. Enter this chart from the left, and follow the lines and arrows across to the right. The path you select must include all categorization terms applicable to the simply supported bridge you plan to demolish. There are four main subcategories: steel beam, steel truss, concrete beam and slab, and

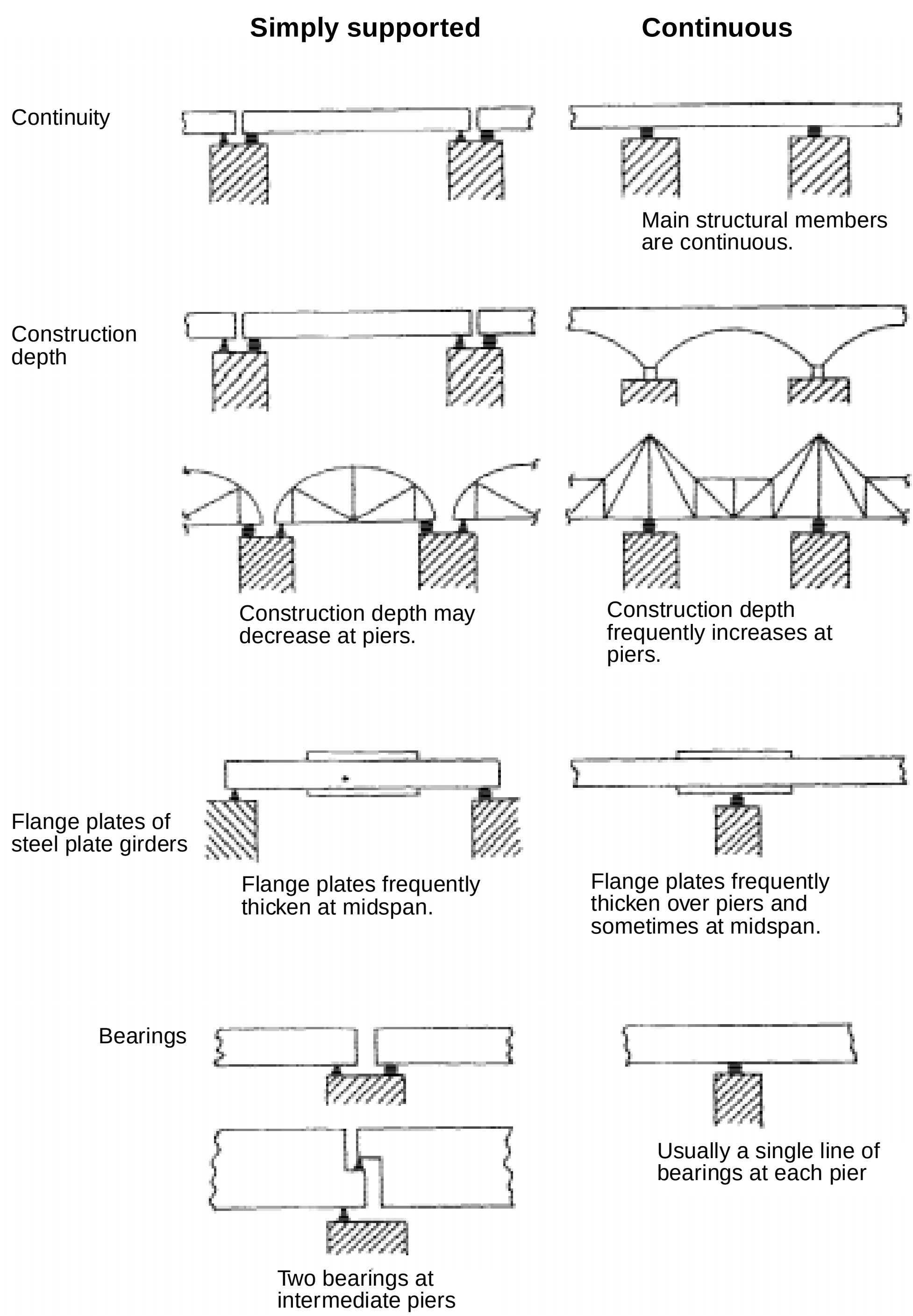


Figure 4-96. Span differences

bowstring. 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 bearing (supporting the top or bottom chord or flange), as this will influence the possibility of jamming.

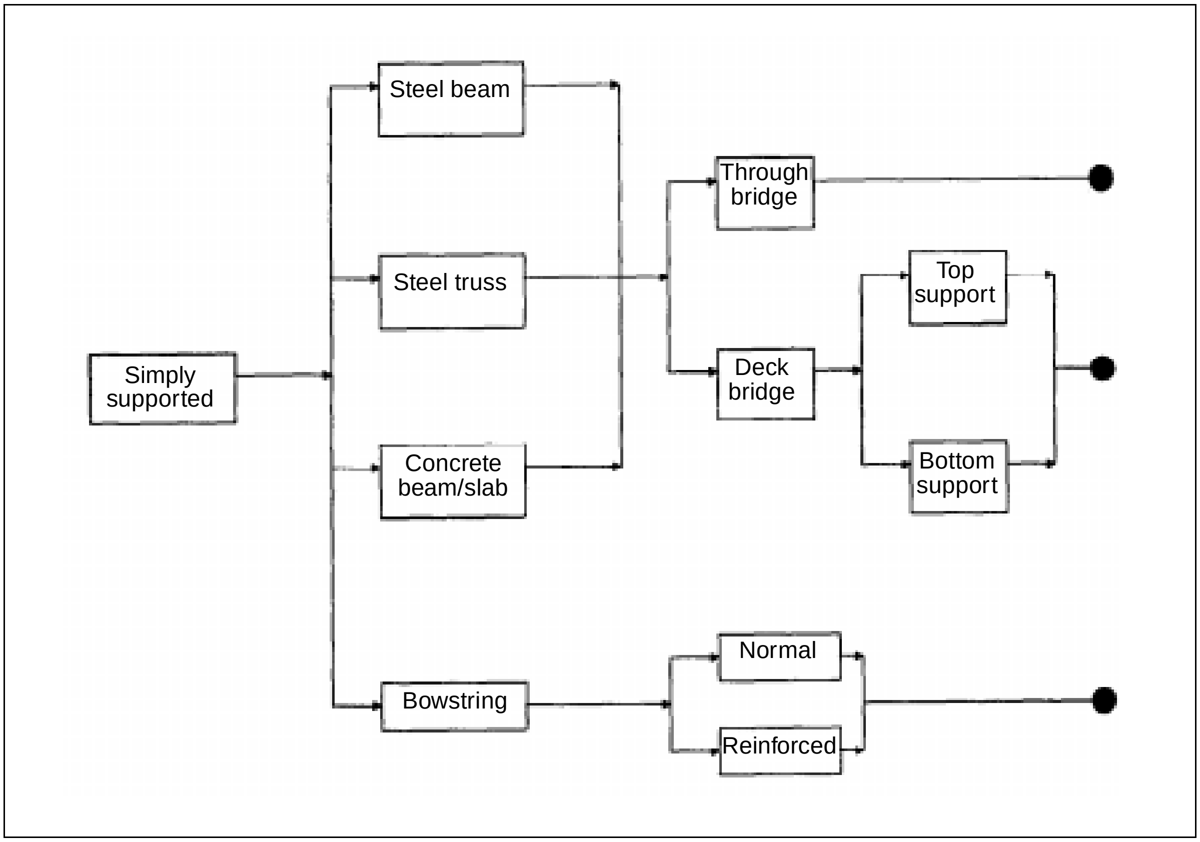


Figure 4-97. Categorization chart for simply supported bridges

Steel-Beam Bridges

4-24. 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 example calculations, see Example G-13, page G-13.

Steel-Truss Bridges

4-25. Figure 4-16 shows the side elevations for three normal steel-truss spans. Note that *all* truss bridges have diagonal members in the trusses.

Concrete-Beam-and-Slab Bridges

4-26. For categorization purposes, you will not have to distinguish between reinforced- and prestressed-concrete bridges, as the methods of attack are the same for both. Figure 4-17, page 4-14, shows midspan, cross-sectional views of these types of bridges. 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 I take this reinforcing condition into account.

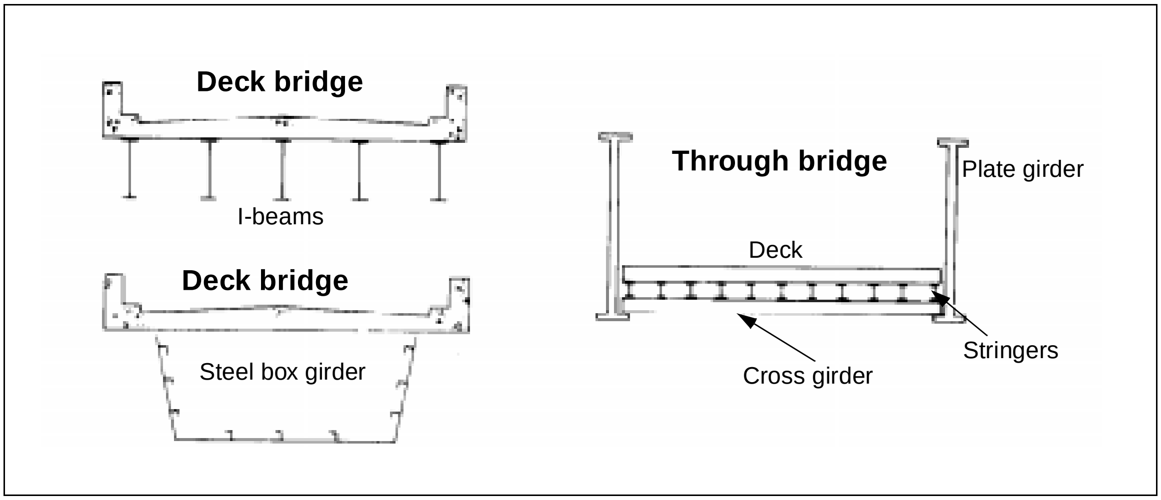


Figure 4-98. Typical cross sections of steel-beam bridges

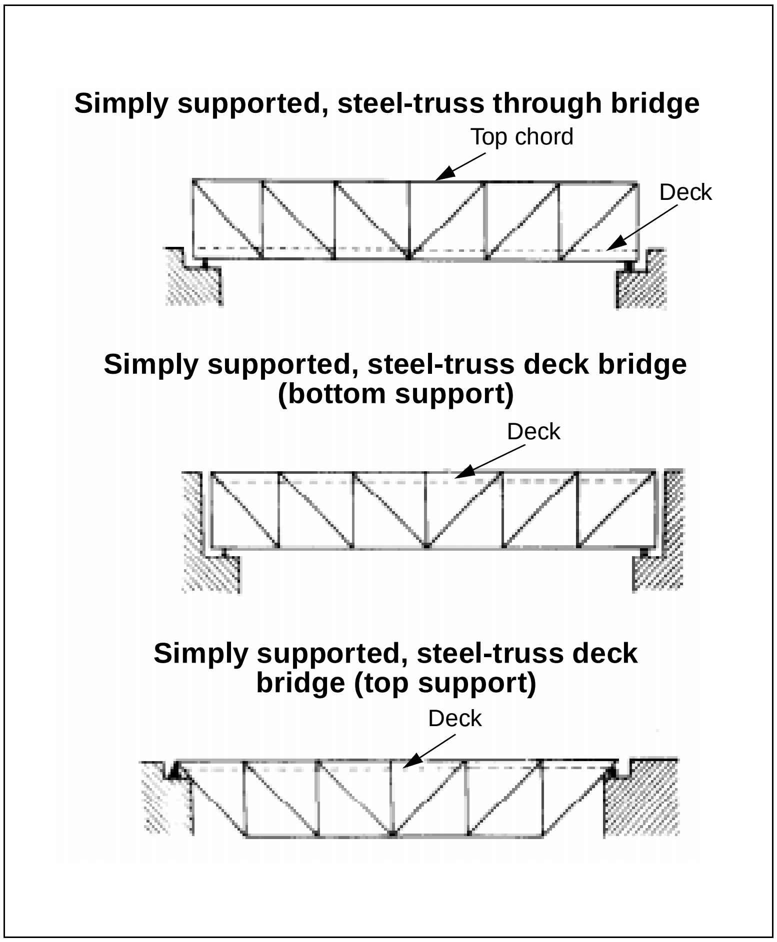


Figure 4-99. Side elevation of steel-truss bridges

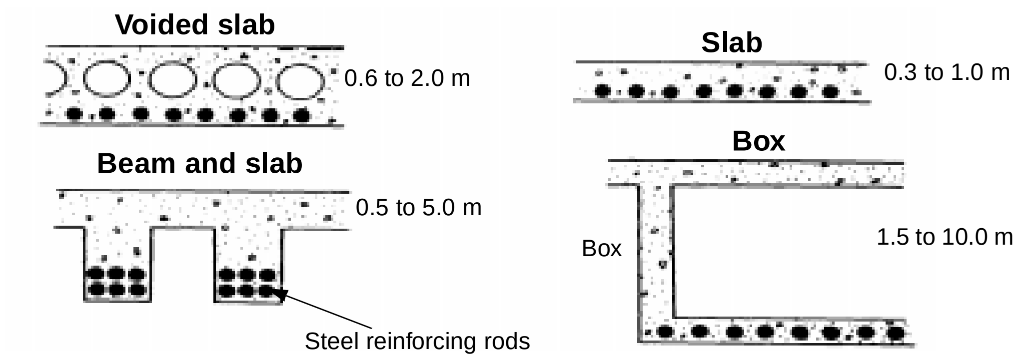


Figure 4-100. Midspan, cross-sectional views of typical concrete bridges

Bowstring Bridges

Features

4-27. 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 bow's depth (thickness) is larger than or equal to the depth of the deck's support members.
- 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.
- There is no diagonal bracing between the hangers.

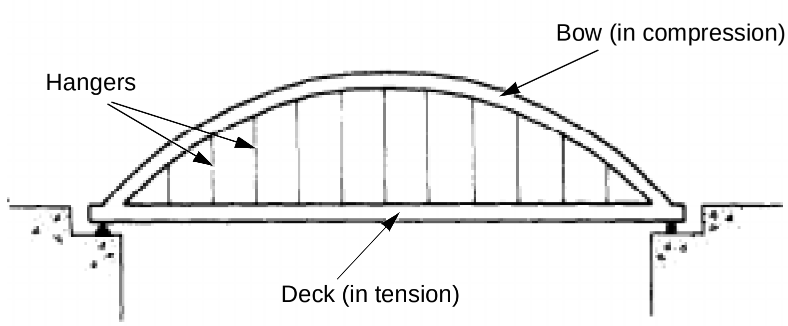


Figure 4-101. Normal bowstring bridge

Uses

4-28. Occasionally, the bow and hangers are used to reinforce a steel-beam or steel-truss bridge. Categorize this type of bridge 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 deck's support members.

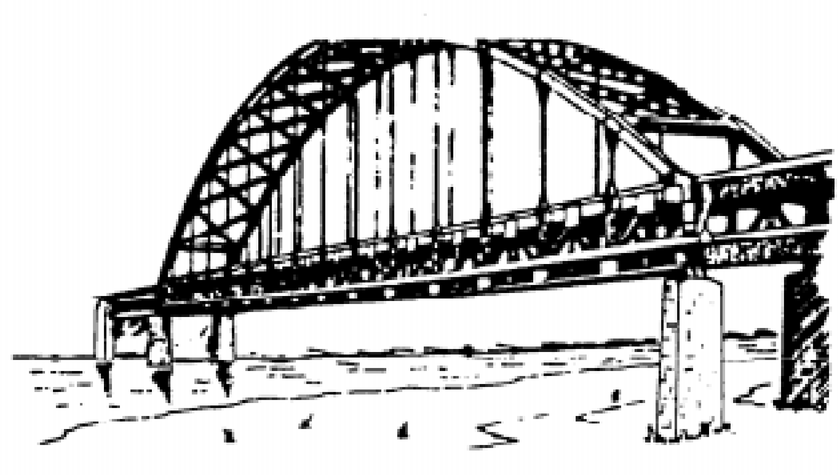


Figure 4-102. Bowstring reinforced-truss bridge

Reconnaissance

4-29. For simply supported bridges, use the following reconnaissance procedure:

- Categorize the bridge.
- Measure the bridge using the following measurements, with Figure 4-20, page 4-16, 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_S). 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 (Appendix I).
- Determine the critical dimensions of the span required for charge calculations.

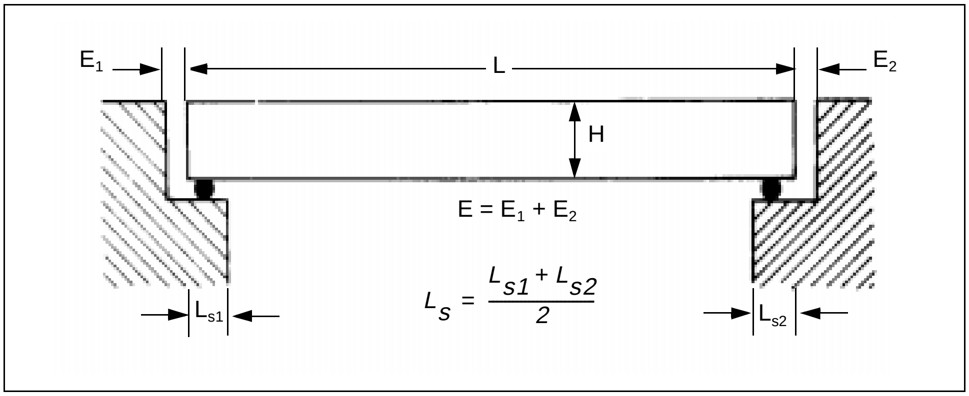


Figure 4-103. Measurements of simply supported spans

Attack

4-30. Two considerations apply when attacking a simply supported span, point of attack and line of attack.

Point of Attack

4-31. Attack simply supported bridges at or near midspan because—

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

Line of Attack

4-32. Make the line of attack 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.

NOTE: For example calculations, see Example G-14, page G-14.

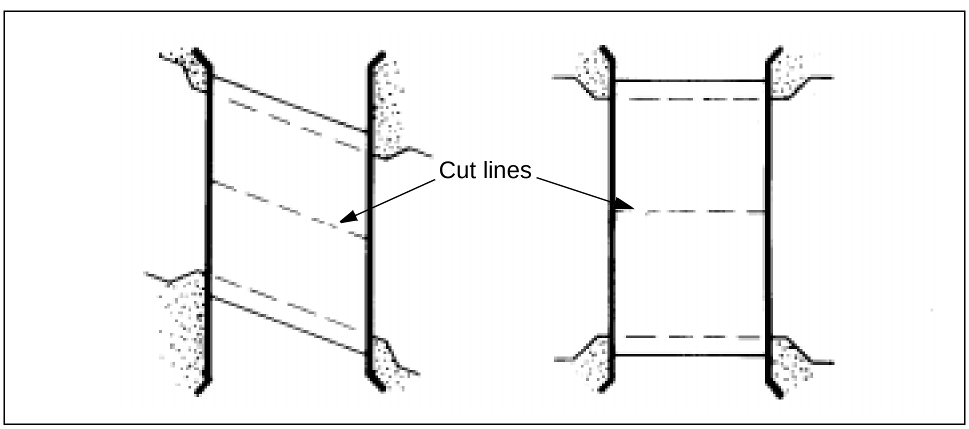


Figure 4-104. Line of attack

Attack Methods

4-33. Table I-4, page I-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 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 I-4, page I-4, to determine the charge location.

Bottom Attack

4-34. Use the bottom attack whenever possible, as it leaves the roadway open and enables you to use the bridge, even when the demolitions are at a ready-to-fire state (state 2). Reinforced and prestressed (tension) beams are very vulnerable to bottom attack, as the steel cables and reinforcing bars run along the bottom portion of the beam and are thus 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 sufficient 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 I-4 for these types of bridges. When Table I-4 lists a bottom attack, determine the required end clearance (E_R) from Table I-1, page I-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. Example G-13, page G-13, explains the method for bottom attack calculations.

Top Attack

4-35. When Table I-4 lists a top attack, L_c must be removed from the top of the bridge to prevent jamming. Determine Lc from Table I-2, page I-2. Remove L_c in a V-shaped section along the full depth of the target. For reinforced-concrete bridges, use a concrete-stripping charge (paragraph 4-18 through 4-19, page 4-7) 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. Example G-14, page G-14, shows the method for top attack calculations.

Angled Attack

4-36. For angled attacks, cut all members (span, hand-rails, service pipes, and so forth) of the bridge. Make the angle of attack about 70 degrees 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 type of bridge, it is essential when the bridge must be kept open to traffic or when there is ample time to prepare demolitions.

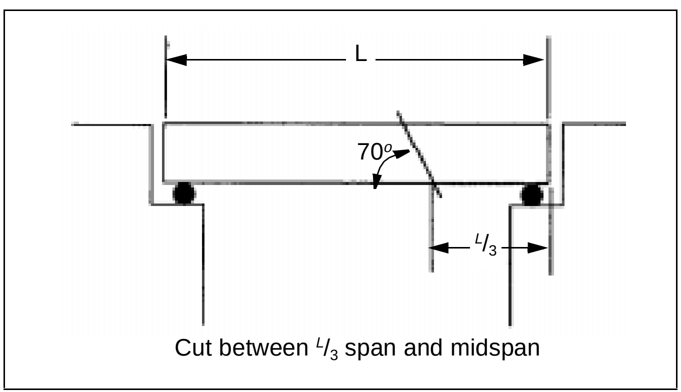


Figure 4-105. Location of angled charge

CONTINUOUS BRIDGES

4-37. Figure 4-23 is a categorization chart for continuous bridges. Use this chart 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, as 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.

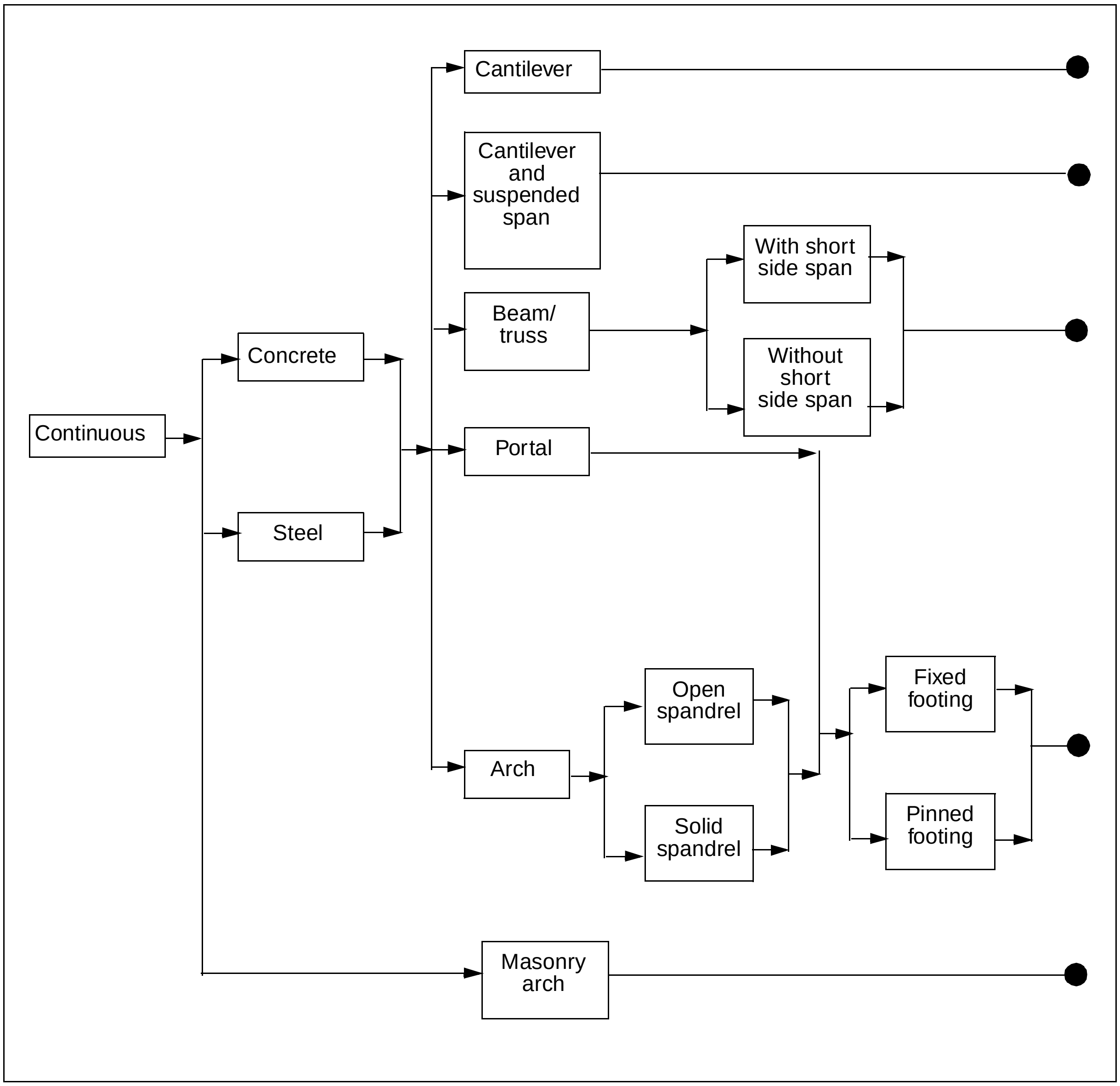


Figure 4-106. Continuous-bridges categorization chart

Cantilever Bridges

4-38. A cantilever bridge (Figure 4-24) has a midspan shear joint. Note that the full lengths of the anchor spans may be built into the abutments, making the cantilever difficult to identify.

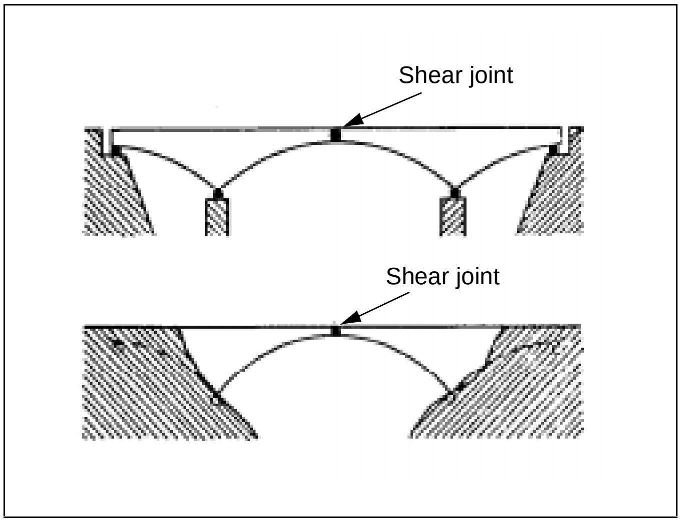


Figure 4-107. Cantilever bridges

Cantilever and Suspended-Span Bridges

4-39. If a cantilever bridge incorporates a suspended span (Figure 4-25) that is at least 5 meters longer than the enemy assault bridging capability, attack this section of the bridge. This requires less preparation. Because suspended spans are simply supported, use the attack method described for simply supported bridges (Table I-4, page I-4).

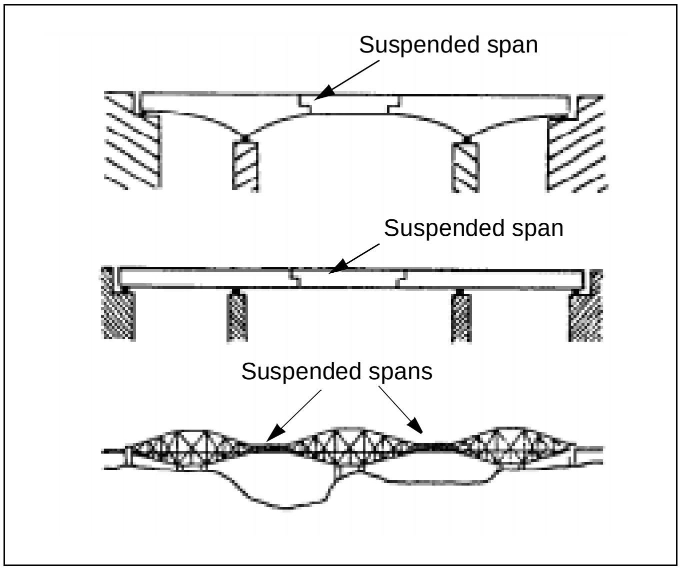


Figure 4-108. Cantilever and suspended span bridges

Beam or Truss Bridges

4-40. For beam or truss bridges (Figures 4-26 through 4-28), 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.

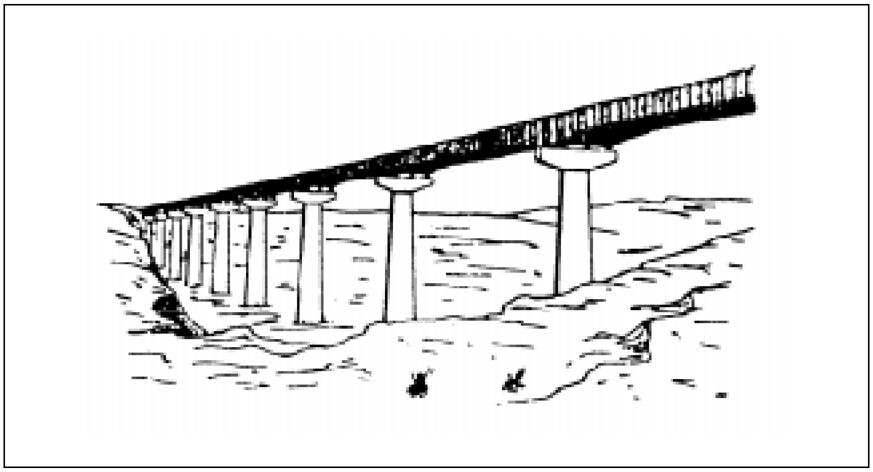


Figure 4-109. Steel-beam bridge without short side span

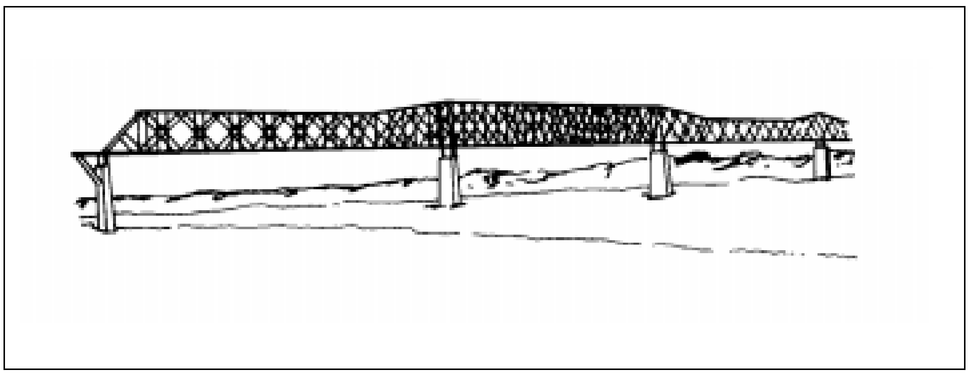


Figure 4-110. Steel-truss bridge with short side span

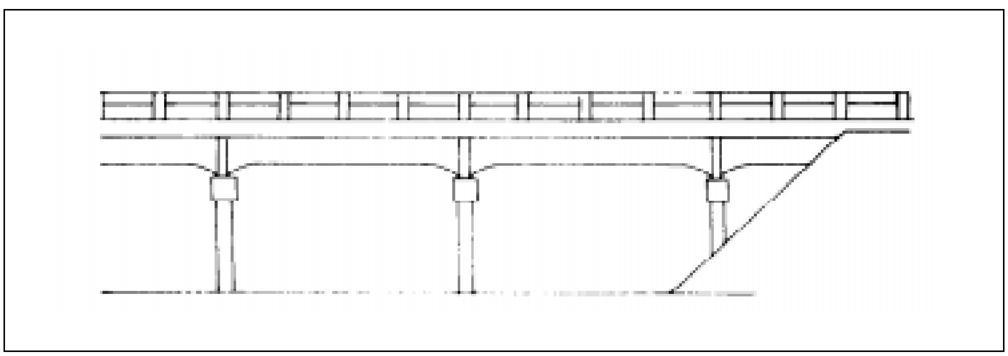


Figure 4-111. Steel-beam bridge with short side span

Portal Bridges

4-41. For portal bridges (Figure 4-29), differentiate between those with fixed footings and those with pinned footings, as this affects the attack method. If you cannot determine the type of footing, assume fixed footings. Portal bridges, as opposed to arch bridges, lack a smooth curve between the bearing point of the span and the span itself.

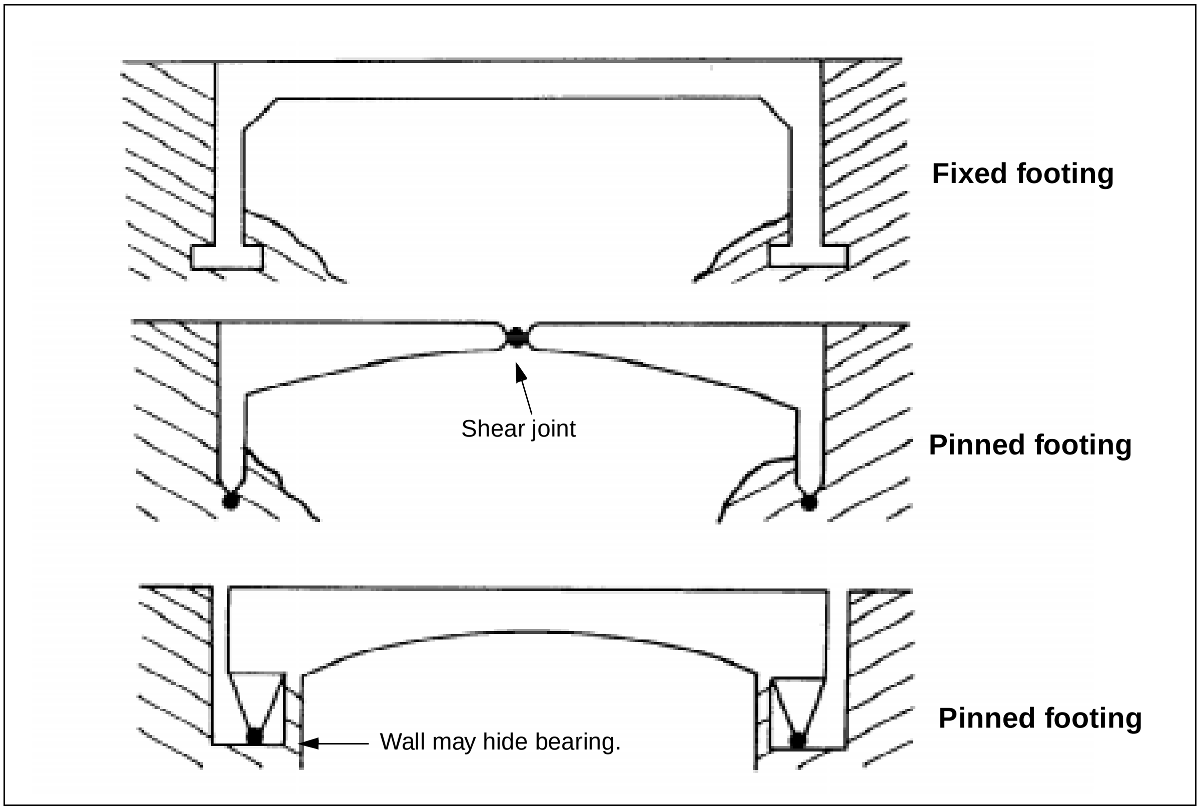


Figure 4-112. Typical portal bridges

Arch Bridges

4-42. In arch bridges (Figure 4-30, page 4-22), determine whether the bridge has an open or solid spandrel and fixed or pinned footings. Again, when in doubt, assume fixed footings.

Masonry Arch Bridges

4-43. Identify masonry arch bridges (Figure 4-31, page 4-22) 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. Always check the underside of the arch. The underside is rarely faced on reinforced-concrete bridges.

NOTE: For example calculations, see Example G-15, page G-15.

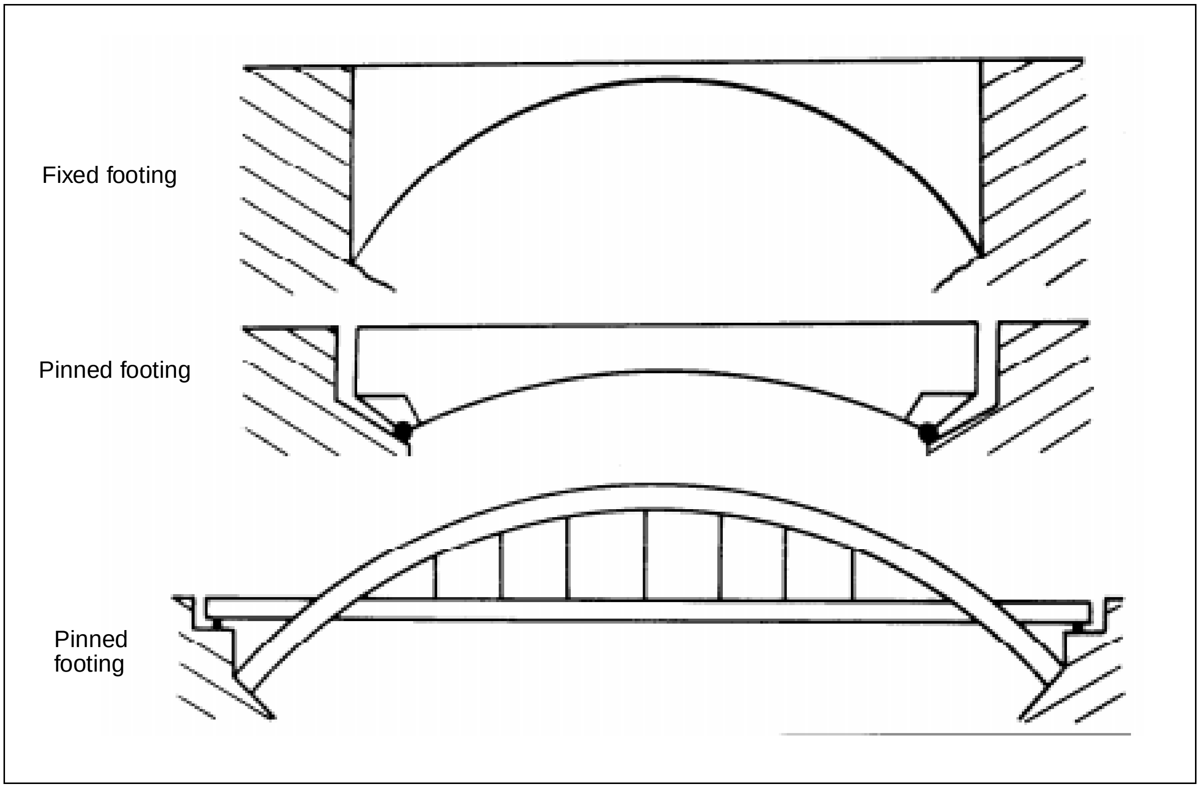


Figure 4-113. Arch bridges

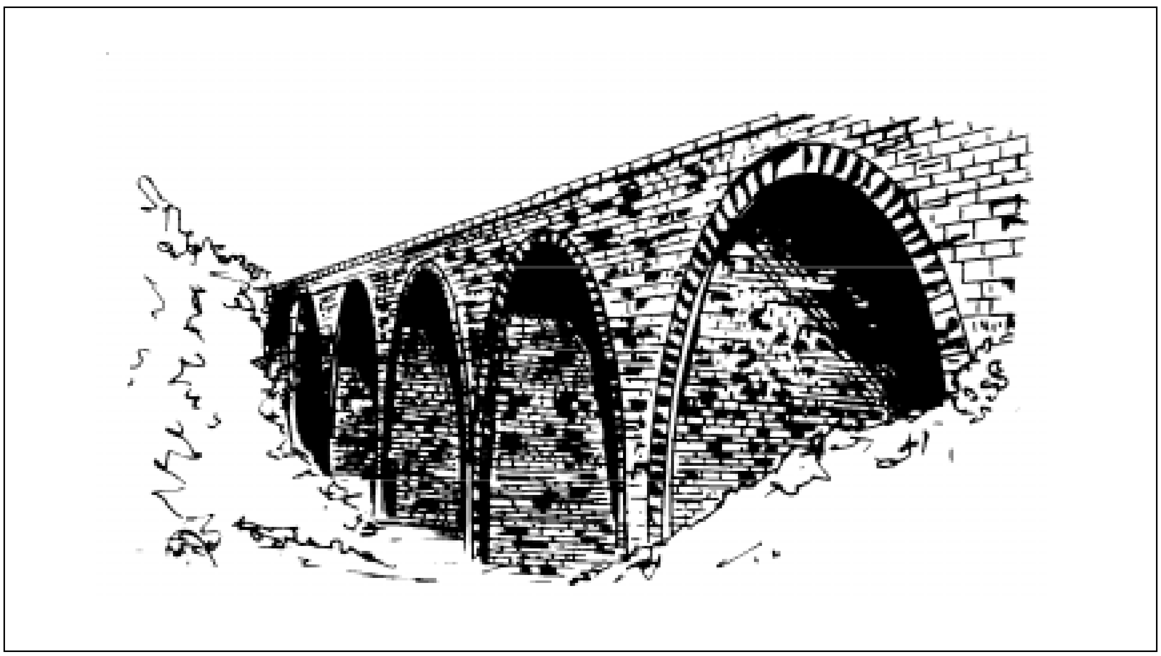


Figure 4-114. Masonry arch bridge

Reconnaissance

4-44. For continuous bridges, use the following reconnaissance procedure:

- Categorize the bridge.
- Measure the bridge using the following measurements, with Figure 4-32 as an example:
  - — Length (*L*). Measure the span you plan to attack, in meters (between 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 I.
- Determine the critical dimensions necessary for charge calculations.

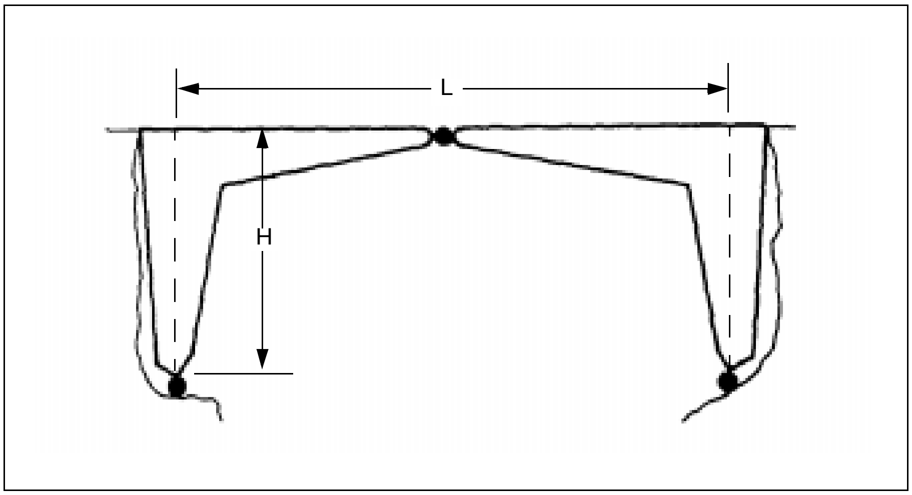


Figure 4-115. Measurements of continuous bridges

Bridge Attacks

4-45. 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, reposition the line to cut between adjacent transverse beams. Table I-5, page I-9, lists attack methods for continuous spans.

Steel Bridges

4-46. When attacking continuous-span steel bridges, use the see-saw or unsupported-member collapse mechanism. Both mechanisms produce complete cuts through the span. Providing you can properly place charges, you may be able to demolish these bridges 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, always plan for the possibility of a two-stage attack on deep, composite superstructures. Make angle cuts at about 70 degrees to the horizontal to prevent jamming during collapse.

Concrete Bridges

4-47. Continuous concrete bridges are the most difficult to demolish and hence 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

4-48. For arch bridges and portal bridges with pinned footings, collapse can be guaranteed only by removing a specified minimum span length. Determine this minimum length by using Table I-3, page I-3, and the *L* and *H* values determined by reconnaissance.

MISCELLANEOUS BRIDGES

SUSPENSION-SPAN BRIDGES

4-49. 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).

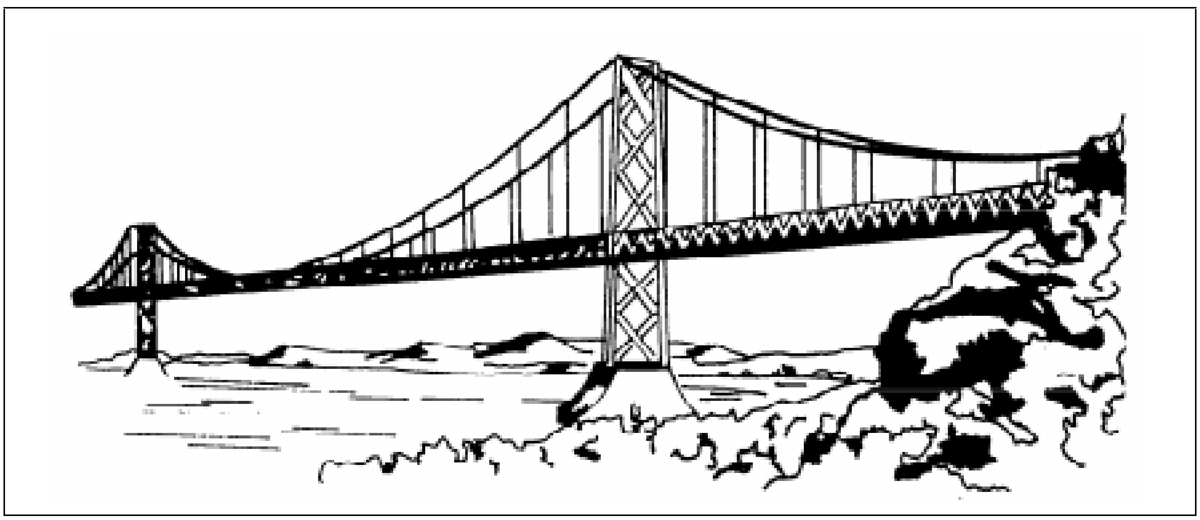


Figure 4-116. Suspension-span bridge

Components

4-50. The components of suspended-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

Major Bridges

4-51. 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 enemy's repair and tactical bridging capabilities 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

4-52. The two vulnerable points on minor suspension bridges are towers and cables. Use the following destruction methods:

- 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. This will prevent the end of a single cut from remaining intact. Demolition chambers in some of the newer bridges make blasting easier, quicker, and more effective.

- Cables. Destroy the cables by placing charges as close as possible to anchor points, such as the top of towers. Cables are difficult to cut because of the air space between the individual wires in the cable. Ensure that the charge extends no more than one-half the cable's circumference. These charges are usually bulky, exposed, and difficult to place. Shaped charges are very effective for cutting cable.

MOVABLE BRIDGES

4-53. 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 next paragraphs.

Swing-Span Bridges

4-54. A swing span is a continuous span capable of rotating on a central pier. The arms of a swing-span 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 span's weight. The swing span is independent from any other span in the bridge. Identify a swing-span bridge 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, page 4-26).

4-55. Because swing-span bridges are continuous bridges, use an attack method from the continuous bridge section in Appendix I. For partial demolition, open the swing span and damage the turning mechanism.

Bascule Bridges

4-56. Bascule bridges are more commonly known as drawbridges. These bridges usually have two leaves that fold upward (Figure 4-35, page 4-26), but

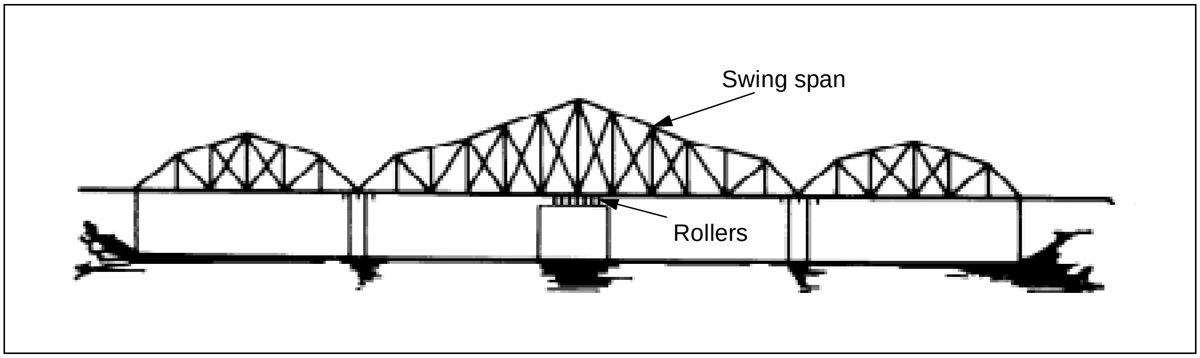


Figure 4-117. Swing-span truss bridge

some bascule bridges may have only one leaf (Figure 4-36). The movable leaves in bascule bridges appear in three general forms: counterweights below the road level (most modern), counterweights above the road level (older type), and no counterweights (the oldest type, usually timber, lifted by cable or rope).

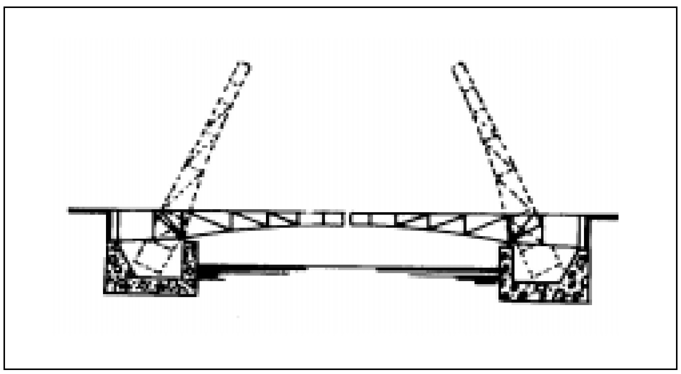


Figure 4-118. Double-leaf bascule bridge

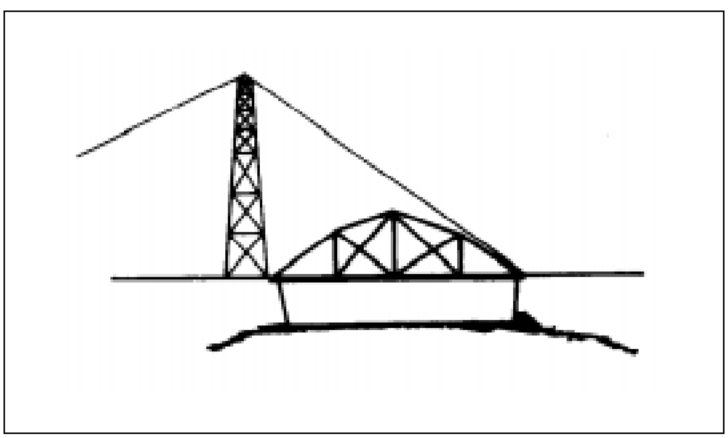


Figure 4-119. Single-leaf bascule bridge

4-57. To destroy this bridge, demolish the cantilever arms with an attack method appropriate for simply supported bridges. For partial demolition, open the bridge and jam or destroy the lifting mechanism.

Vertical-Lift Bridges

4-58. 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).

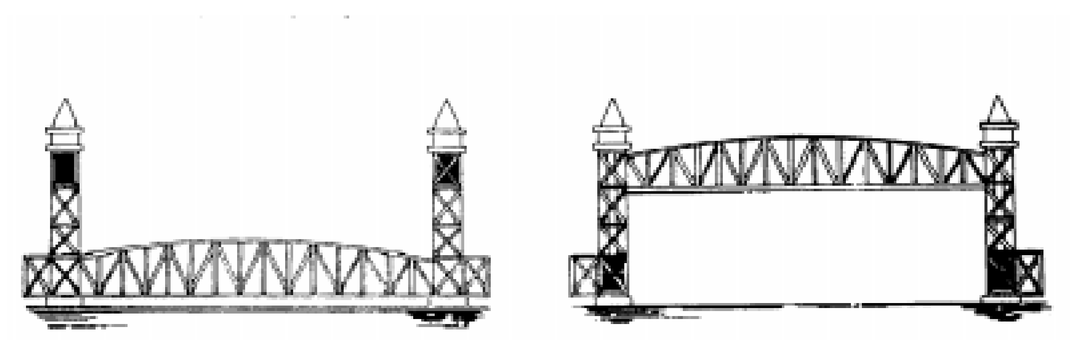


Figure 4-120. Vertical-lift bridge

4-59. To destroy this bridge, demolish the movable span 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

4-60. Floating bridges consist of a continuous metal or wood roadway supported by floats or pontoons (Figure 4-38).

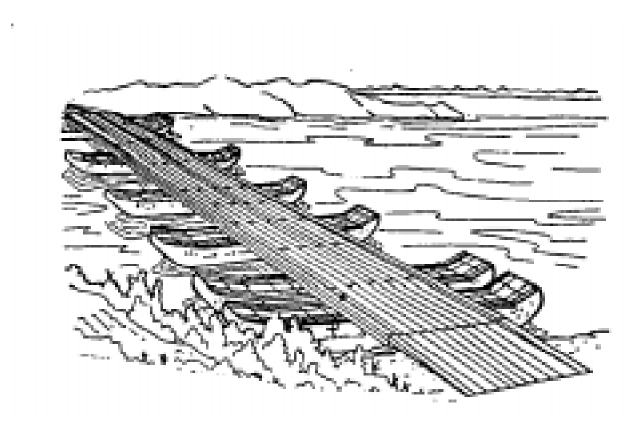


Figure 4-121. Floating bridge

Pneumatic Floats

4-61. Pneumatic floats are airtight compartments of rubberized fabric inflated with air. For a hasty attack of these bridges, cut the anchor cables and bridle lines with axes and the steel cables with explosives. Also, puncture the floats 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, place one turn of a branch-line cord around each inflation valve. This will prevent the raft from being reinflated if it is repaired. Do not use main-line cords to cut valves because the blast wave may fail to continue past any sharp turn in the cord.

Rigid Pontoons

4-62. Rigid pontoons are made of various materials: wood, plastic, or metal. To destroy these bridges, place a $^1/_2$-pound charge on the upstream end of each pontoon at water level. Detonate all charges simultaneously. If the current is rapid, cut the anchor cables so that the bridge will be carried downstream. Another method is to cut the bridge into rafts. Place $^1/_2$-pound charges at each end of each pontoon and detonate them simultaneously. To destroy metal treadways on floating bridges, use the steel-cutting formula (paragraphs 3-21 through 3-33, page 3-10). The placement and size of the charges depend on bridge type. Typically, placing cutting charges at every other joint in the treadway will damage the bridge beyond use.

Bailey Bridges

4-63. To destroy Bailey bridges, place 1-pound charges between the channels of the upper and lower chords. Use $^1/_2$-pound charges for cutting diagonals and 1-pound charges for cutting sway bracing (Figure 4-39).

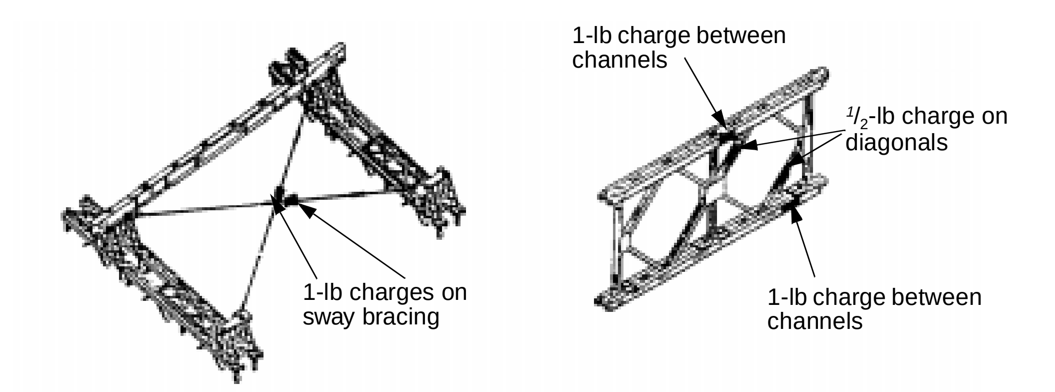


Figure 4-122. Bailey-bridge demolition

In-Place Demolitions

4-64. Cut the bridge in several sections by attacking the panels on each side, including the sway bracing. The attack angle should be 10 degrees 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, place charges on the transoms and stringers.

In-Storage or In-Stockpile Demolition

4-65. When abandoning bridges in storage, do not leave any component that the enemy can use as a unit or for improvised construction. Destroy the essential components that the enemy cannot easily replace or manufacture. Panel sections are considered essential components. To render the panels useless, remove or distort the female lug in the lower tension chord. Destroy all panels before destroying other components.

ABUTMENTS

4-66. To demolish abutments, place charges 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 you know the fill contains large rocks.

ABUTMENTS 5 FEET THICK OR LESS

4-67. Demolish these abutments by placing a line of 40-pound cratering charges, on 5-foot centers, in boreholes 5 feet deep, located 5 feet behind the face of the abutment (*triple-nickel-forty method*). Place the first hole 5 feet from either end of the abutment, and continue this spacing until a distance of 5 feet or less remains between the last borehole and the other end of the abutment (Figure 4-40, page 4-30). If the bridge approach is steep, place the breaching charges against the rear of the abutment. Determine the number of 40-pound cratering charges 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 = centermass distance between boreholes

1 = convert spaces to holes

ABUTMENTS OVER 5 FEET THICK

4-68. Destroy these abutments with breaching charges in contact with the back of the abutment. Calculate the amount of each charge using the breaching formula in the equation in paragraph 3-38, page 3-19. Use the abutment thickness as the breaching radius. Determine the number of charges and their spacing using the equation in paragraph 3-45, page 3-23. Place charges at least three feet below the bridge seat (where the bridge superstructure sits on the abutment) (Figure 4-41, page 4-30).

ABUTMENTS OVER 20 FEET HIGH

4-69. Demolish these abutments by placing a row of breaching charges at the base of the abutment, on the gap side, in addition to the charges specified in paragraphs 4-67 or 4-68. Fire all charges simultaneously. This method tends to overturn and completely destroy the abutment.

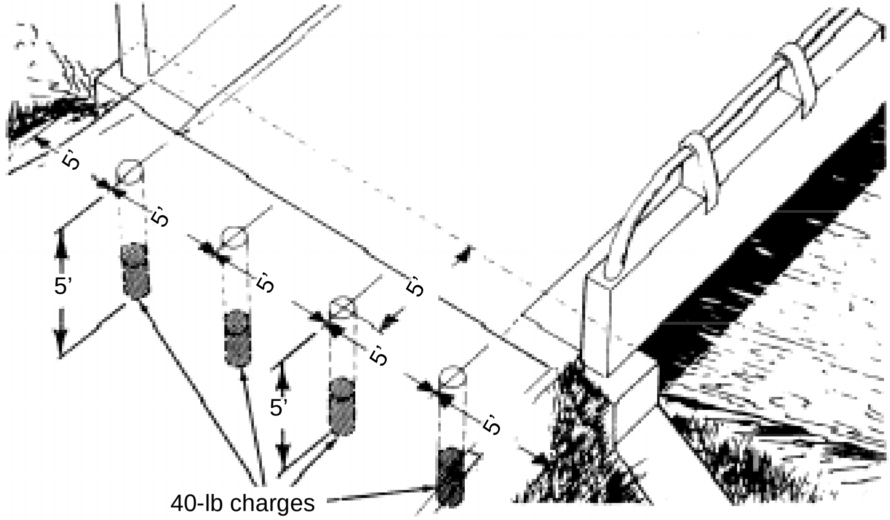


Figure 4-123. Abutment destruction (5 feet thick or less)

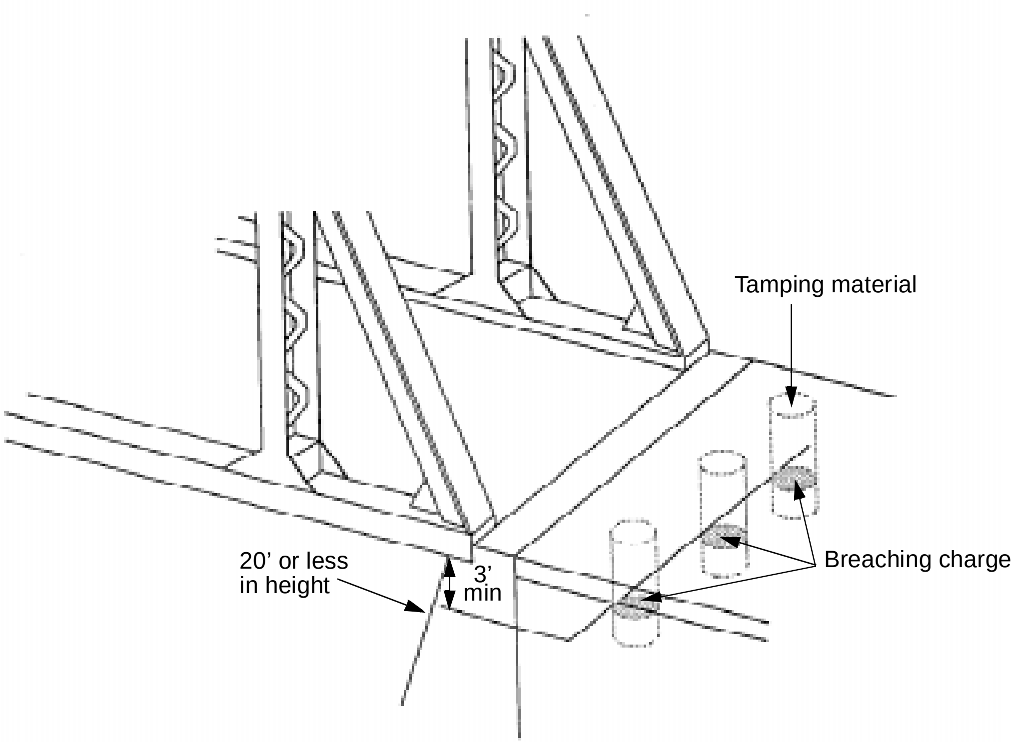


Figure 4-124. Abutment destruction (over 5 feet thick)

WING WALLS

4-70. 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 (Figure 4-40 and Figure 4-41).

INTERMEDIATE SUPPORTS

INTERNAL CHARGES

4-71. Internal charges on intermediate supports require less explosive than external charges. (See Figure 4-42 for charge placement.) However, unless the support has built-in demolition chambers, this method requires an excessive amount of equipment and preparation time. Use the equation in paragraph 3-38, page 3-20, to determine the amount of each charge. M112 (C4) is ideal for internal charges. Thoroughly tamp all charges of this type with nonsparking tools (blunt, wooden tamping sticks or similar tools). If the support has demolition chambers, place the charges 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.

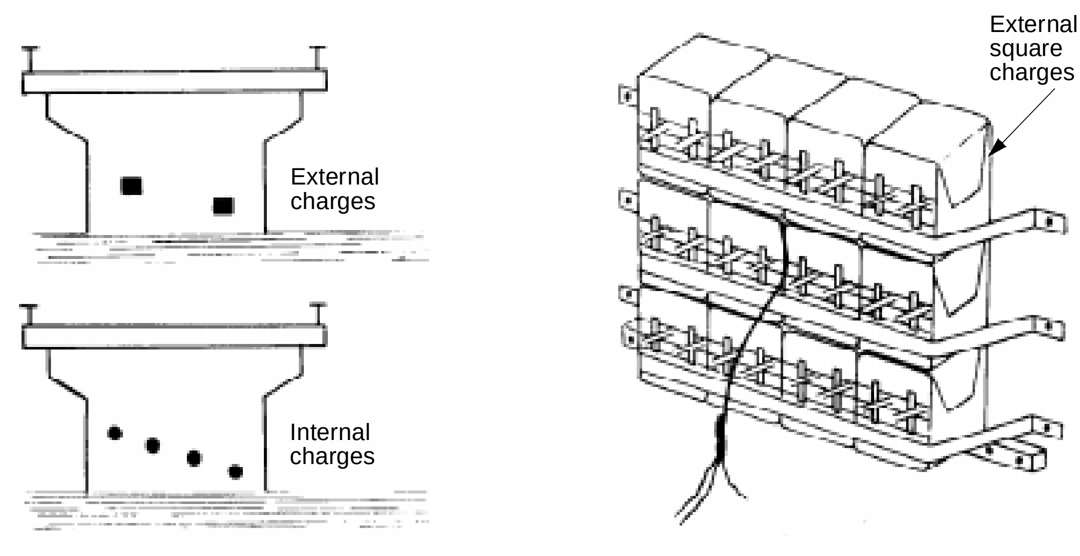


Figure 4-125. Placing charges on intermediate supports

EXTERNAL CHARGES

4-72. Place these charges at the base of the pier or higher, and do not space the charges by more than twice the breaching radius (Figure 4-42). Stagger the charges to leave a jagged surface to hinder future use. Thoroughly tamp all external charges with earth and sandbags, if time, size, shape, and location of the target permit.

This chapter implements STANAG 2017, STANAG 2123, QSTAG 508, AND QSTAG 743.

Chapter 5

Demolition Operations

5-1. 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-R and how to complete an obstacle folder, as outlined in STANAG 2123.

DEMOLITION OBSTACLES

5-2. 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 normally 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. Base any demolition project on careful planning and reconnaissance. Use the following factors as a basis for selecting and planning demolition projects:

- Mission.
- Limitations and instructions from higher authority.
- Current tactical and strategic situation and future plans (conditions that indicate the length of time you must delay the enemy, the time available for demolition, and the extent of denial objectives).
- Enemy capabilities and limitations, as well as the effect our denial operations have on enemy forces, strategically and tactically.
- Likelihood that friendly forces may reoccupy the area, requiring obstacle neutralization.

- Economy of effort.
- Time, material, labor, and equipment available.
- Effect on the local population.
- Target protection required.

DEMOLITION ORDERS

5-5. The authorized commanders use the *Orders for the Demolition* to pass their orders to demolition guards and demolition firing parties. 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. Use this form for preparing all reserved and preliminary demolitions. Page one of the form contains the instructions, duties, and responsibilities of demolition personnel. A sample of the orders is included in the sample target folder in Appendix J.

PRELIMINARY DEMOLITIONS

PURPOSE

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. The advantages of a preliminary demolitions are that—

- 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 the 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 engineers the ability to create effective obstacles even if preparations must stop at any stage.

RESERVED DEMOLITIONS

PURPOSE

5-9. The responsible commander must carefully control a reserved demolition target because the target may be a vital part of the tactical or strategic plan or because 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 usually be kept open until the last moment. This normally means they cannot use the simplest and quickest demolition techniques to accomplish the mission.
- Demolitions must be weatherproof and protected from traffic vibrations and enemy fire over long periods. Use dual firing systems, and carefully place and protect the demolitions from passing vehicles or pedestrians.
- The demolition site must be guarded until the demolitions are fired.

STATE OF READINESS—STATE 1 (SAFE)

5-11. In this readiness state, the demolition charges are in place and secure. Vertical and horizontal ring mains are installed (Figure 2-29, page 2-28) and connected. Charges are primed with detonating-cord knots or wraps to minimize the time necessary to convert the system from state of readiness—state 1 to state of readiness—state 2. Charges that require blasting caps for priming cannot be primed at state of readiness—state 1, and branch lines with caps crimped to them cannot be connected to ring mains. Blasting caps and initiation sets are not attached to charges or firing systems. Detonating cord is the preferred priming method.

STATE OF READINESS—STATE 2 (ARMED)

5-12. In this readiness state, blasting caps are in appropriate charges, and initiation 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

Authorized Commanders

5-13. 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 normally 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, detailing 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. Commanders should carefully select the demolition site and consider all safety precautions necessary when destroying abandoned demolitions. Chapter 6, Section IV covers procedures and methods for destroying explosives.
- Issue the written instructions (demolition orders) to the unit providing the demolition guard and demolition firing party.
- Notify all HQ 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

5-14. 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

5-15. 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 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 engineer chain of command and complete Section 5 (Demolition Report) of the obstacle folder, if issued.
- Maintain succession (chain of command) lists for appointment as demolition-firing-party commander, should the initial commander become injured.

COMMAND AND CONTROL OF RESERVED DEMOLITIONS

Command Post

5-16. Ideally, 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

5-17. The firing point is normally 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

5-18. 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

5-19. 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 withdrawing unit's arrival.

Refugee-Control Points

5-20. 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. The 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

5-21. 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:

- Location and nature of the target.
- Purpose of the demolition operation (for example, to delay an enemy infantry battalion for three hours).
- Proposed classification of the demolition (reserved or preliminary).
- Type of firing system desired (dual or single).
- Economy of effort (whether the demolition must be completed in one stage or multiple stages).
- Utility of the target during demolition operations (whether the target must remain open to traffic during demolition preparations).
- Amount of time allowed or expected between preparation and execution of the demolition operation.
- Amount of time allowed for changing the state of readiness (safe to armed).
- Labor and equipment available for preparing the demolitions.
- Types and quantities of explosives available.

RECONNAISSANCE RECORD

5-22. A reconnaissance party reports the results of its reconnaissance on DA Form 2203-R. Use the form with appropriate sketches, to record and report the reconnaissance of military demolition projects. Figure J-2, page J-38, contains a sample of DA Form 2203-R and instructions to complete it. For sketches, use available paper and attach to the completed DA Form 2203-R.

PURPOSE

5-23. When time and conditions permit, use the reconnaissance report as the source document for preparing the obstacle folder. If the obstacle folder is not available, use this report in its place. In certain instances the report may require a security classification.

INFORMATION REQUIRED

5-24. DA Form 2203-R should contain the following:

- A list of all equipment, including transportation, required for the demolition operation.
- An estimate of time and labor required for preparing the demolitions and placing the charges.
- A time and labor estimate for arming and firing the charges.
- A time, labor, and equipment estimate to complete any required bypass. Specify the bypass location and method. Include details for any supplementary obstacles required.
- A bill of explosives that shows the quantities and types required.
- A situation sketch showing the relative target position, terrain features, and target coordinates.
- A list of all unusual site characteristics. Indicate the location of these unusual characteristics on the situation sketch.
- A plan and elevation (sideview) sketch(es) of the target showing overall dimensions, lines of cut, and demolition chambers.
- A plan and elevation sketch(es) of each member targeted detailing dimensions, chambers, quantity of explosives, lines of cut, charge locations, and priming and initiation methods.
- A sketch showing firing circuits and firing points.

OBSTACLE FOLDER

5-25. The obstacle folder, as outlined in STANAG 2123 and QSTAG 743, provides all of 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. Prepare obstacle folders for reserved and preliminary demolitions. The obstacle folder is not normally used in tactical situations because the detailed information in the obstacle folder, including multiple languages, is not easily completed under field or tactical conditions. A sample obstacle folder is included in the sample target folder in Figure J-1, page J-4.

LANGUAGE

5-26. 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. Determine the languages necessary in an obstacle folder 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

5-27. The obstacle folder contains six parts 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 six parts of the obstacle folder are the—

- Location of target.
- Supply of explosives and equipment.
- Orders for preparing and firing
- Handover and takeover instructions.
- Demolition report.
- Official signature.

SPECIAL INSTRUCTIONS

NOTE: The following paragraph references Figure J-1, page J-19 through J-34.

5-28. The list of explosives, stores, and mines required (paragraph 2d, page J-19, of the obstacle folder) does not cover every possible situation. However, it does indicate a logical order for recording or determining the required materials. Mark only the materials required for your particular target. The transport team leader uses the first list. For major operations, note the size, composition, and mission of the various participating work parties in paragraph 3a, subparagraphs 3 and 4, page J-22, of the obstacle folder. Paragraph 3a, subparagraphs 6(a) and 6(b), page J-23, of the obstacle folder, concerns only nuisance or protective mine fields laid to protect the demolition target and does not apply to tactical (barrier) mine fields. Complete paragraph 5 (Demolition Report), page J-34, upon completion of the demolition. The demolition-firing-party commander may detach the first copy of the demolition report and forward it to a higher-echelon engineer HQ.

Chapter 6

Demolition Safety

6-1. This chapter deals with the safety surrounding demolitions. The main safety points for different types of demolitions and demolition devices are discussed in this chapter. Also outlined in this chapter are the misfire procedures for nonelectric and electric initiated and detonating cord.

SECTION I. GENERAL SAFETY

CONSIDERATIONS

- *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 sufficient explosives in reserve to handle any possible misfires.
- Maintain accurate accountability of all explosives and accessories. Always 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 you give warnings before initiating demolitions; give the warning "*Fire in the hole*!" three times.
- Guard 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.
- Avoid mixing live and inert (dummy) explosives.

> **WARNING**
> **Do not use blasting caps underground. Use detonating cord to prime underground charges.**

EXPLOSIVE MATERIALS

BLASTING CAPS

6-2. 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. Because power requirements for electric caps from different manufacturers vary, never mix caps from different manufacturers or lots, this could result in misfires. When installing caps in explosives, never force them into an explosive or a cap well; use an appropriate tool for making or enlarging the cap well. Ensure that $^{1}/_{8}$ to $^{1}/_{4}$ inch of the cap is clearly visible at both ends when taping it onto the detonation cord. Do not connect blasting-cap initiation sets to ring or line mains or charges when nonessential personnel are on site. Never leave blasting caps unattended before or after attaching them to the charges or firing system.

Nonelectric

- Use only authorized equipment and procedures when crimping nonelectric blasting caps to 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 your pocket or place loose blasting caps in a container; secure them.
- 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 detonation cord into a nonelectric blasting cap. Do not twist time fuse or detonating cord while attempting to insert it into a blasting cap.
- Do not attempt to crimp a blasting cap installed in an explosive. If the blasting cap has come loose from the time fuse or detonating cord, remove the blasting cap from the charge, recrimp the cap, and then reinstall the cap in the charge.
- Avoid striking, pinching, and mashing nonelectric caps during crimping activities. Use only the M2 crimpers for all crimping operations.
- Cut the fuse to allow an interval of not less than 10 seconds between firings, when using nonelectric caps to dual prime demolitions.

Electric

- Do not remove the short-circuiting shunt unless you are testing or connecting the cap. The shunt prevents accidental initiation by static electricity. If the blasting cap has no shunt, twist the bare ends of the lead wires together at least three times (180^o turns) to provide a proper shunt.
- Use proper grounding procedures when static electricity is present, see paragraph 6-5, page 6-5.
- When transporting electric blasting caps near vehicles (including aircraft) equipped with a transmitter, protect the blasting caps by placing them in a metal can with a snug-fitting cover ($^1/_2$ inch or more of cover overlap). 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. If using electric blasting caps near power lines, temporarily cut the power to the lines during blasting operations.
- Be sure to use at least the minimum current required to fire electric blasting caps.
- Be sure to 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.

TIME FUSE AND DETONATING CORD

Time Fuse

- Be sure to conduct a test burn of at least three feet for each roll of time fuse. If you do not use the fuse within 24 hours of the test burn, perform another test burn before using the fuse.
- Use M2 crimpers to cut time fuse. If serviceable M2 crimpers are not available, use a sharp knife to cut fuse. Be sure to cut the fuse end squarely. Make the cut on a nonsparking surface, such as wood. A rough or jagged-cut fuse can cause a misfire.
- Avoid cutting the fuse until you are ready to insert it into the igniter and blasting cap.
- Do not use the first or last 6 inches of time fuse from a new or partial roll; this will avoid problems from moisture infiltration.
- Avoid sharp bends, loops, and kinks in time fuse. Avoid stepping on the fuse. Any of these conditions or actions can break the powder train and result in a misfire.

Detonating Cord

- Do not carry or hold detonating cord by placing it around your neck.

- Do not cut an additional 6-inch tail off when cutting detonation cord because 6-inch tails are standard for taping and on knots to avoid moisture infiltration.
- Avoid sharp bends, loops, and kinks in detonating cord. Avoid stepping on the cord. Any of these conditions or actions can change the path of detonation or cause the cord to cut itself.

PLASTIC AND SHEET EXPLOSIVES

- Be sure to cut plastic and sheet explosives with a sharp knife on a nonsparking surface. Never use shears.
- Avoid handling explosives with your bare skin as much as possible.

PICRIC ACID

- Picric acid degrades with time. Do not use picric acid if its container is rusted or corroded.
- Rusty or corroded containers indicates the explosive is unstable.

WARNING
Do not handle rusty or corroded picric acid. Notify EOD for disposition.

COMMERCIAL EXPLOSIVES

6-3. Commercial dynamite is sensitive to shock and friction and is not recommended for use in combat areas. Do not use old commercial dynamite because it is extremely sensitive and very unstable. Follow the procedures in TM 9-1300-206, Army publications used, or the manufacturer's recommendations to destroy aged commercial dynamite. When commercial dynamite freezes, it becomes covered with crystals and is very unstable. Do not use frozen dynamite. Commercial dynamite containing nitroglycerin requires special handling and storage. Rotate commercial dynamite in storage to prevent the nitroglycerin from settling to the bottom of the explosive.

BOREHOLES

- Do not leave any void spaces 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.
- Tamp all voids with appropriate material. When using springing charges to dig boreholes, allow at least 30 minutes for boreholes to cool between placing and firing successive springing charges, or cool the boreholes with water or compressed air to save time.

TOXICITY

- Allow sufficient time for blast fumes, dust, and mists 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; avoid using TNT to blast in enclosed areas.

- Avoid touching sensitive areas of your body, such as around the face and groin, when working with explosives.
- Wash your hands after working with explosives, especially before consuming food.

NATURAL PHYSICAL PROPERTIES

LIGHTNING

6-4. Lightning is a hazard to both electric and nonelectric blasting charges. A lightning strike or nearby miss is almost certain to initiate either type of system. 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

6-5. 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

6-6. Radio signals can induce a current in electric blasting caps and prematurely detonate them. Table 6-1, page 6-6, lists the minimum safe distances from transmitters for safe electrical blasting. This table applies to operating radio, radar, microwave, cellular telephone, and television transmitting equipment. Keep mobile transmitters and portable transmitters at least 50 meters from any electric blasting cap or electrical firing system. Do not use electric blasting caps within 155 meters of energized power transmission lines.

BLAST EFFECTS

6-7. 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 minimum safe distances for bare charges (see Table 6-2, page 6-6, and Army Regulation (AR) 385-63) generally will not be affected by blast effects. Refer to AR 385-63, Chapter 18, for additional information on blast effect.

Table 6-16. Safe distances for blasting near radio frequency energy

Average or Peak Transmitter Power* (Watts)	Minimum Safe Distance (m)
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 pulsed, continuous-wave type and its pulse widths are less than 10 microseconds, the left-hand column indicates average power. For all other transmitters, including those with pulse widths greater than 10 microseconds, the left-hand column indicates peak power.

Table 6-17. Safe distances for personnel in the open (near bear charges)

Explo-sive Weight (lb)	Safe Distance		Explo-sive Weight (lb)	Safe Distance	
	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

6-8. Explosives can propel lethal missiles great distances. The distances these missiles will travel in air depend 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

EXPLOSIVES

6-9. Explosives are subject to erosion by water. Unprotected explosives will deteriorate rapidly, reducing their effectiveness. Ensure that all exposed explosives are adequately protected when used in water, especially running water.

NONELECTRIC CAPS

6-10. 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, prime explosives with detonating cord.

TIME FUSE

6-11. Time fuse depends on combustion to burn properly. Time fuse burns significantly faster underwater due to water pressure. Place the fuse underwater at the last possible moment before firing.

NOTE: If mission requires using time fuse underwater, then do the test burn underwater.

DETONATING CORD

6-12. Seal the ends of detonating cord 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 normally will protect the remaining line from moisture.

M60 FUSE IGNITER

6-13. The M60 depends on combustion to work properly. Water can penetrate the fuse igniter through the vent hole located in the pull rod. Therefore, if the igniter fails to fire on the initial attempt, it probably will fail on any subsequent attempt after reset. Always use a backup initiation set for underwater demolitions.

SAFE DISTANCES

6-14. The following general rules apply when determining 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 lists safe distances 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 500 pounds. Use the distances in Table 6-2.
- Charges of more than 500 pounds, but less than 2,000 pounds. Use the distances in Table 6-3, page 6-8.
- Charges of more than 2,000 pounds. Use the following formulas:

$$\textit{safe distance (meters)} = 100 \sqrt[3]{\textit{pounds of explosive}}$$

$$\textit{safe distance (feet)} = 300 \sqrt[3]{\textit{pounds of explosive}}$$

- Charges fixed to targets. When charges are fixed to targets and not simply placed on the ground, use the safe distances specified in Table 6-3 or Table 6-4, whichever is farthest. Note that these distances depend on the target configuration, not the quantity of explosive.

Table 6-18. Safe distance conversion chart

Explosive Weight (lb)	Safe Distances		Explosive Weight (lb)	Safe Distances	
	Meters	Feet		Meters	Feet
500	800	2,624	1,275	1,082	3,548
525	805	2,640	1,300	1,089	3,571
550	819	2,686	1,325	1,096	3,594
575	830	2,722	1,350	1,103	3,617
600	842	2,761	1,375	1,109	3,637
625	853	2,797	1,400	1,116	3,660
650	864	2,833	1,425	1,123	3,683
675	875	2,870	1,450	1,129	3,703
700	886	2,906	1,475	1,136	3,726
725	896	2,938	1,500	1,142	3,745
750	907	2,974	1,525	1,148	3,765
775	917	3,007	1,550	1,154	3,785
800	926	3,037	1,575	1,161	3,808
825	936	3,070	1,600	1,167	3,827
850	945	3,099	1,625	1,173	3,847
875	954	3,129	1,650	1,179	3,867
900	963	3,158	1,675	1,185	3,886
925	972	3,188	1,700	1,191	3,906
950	981	3,217	1,725	1,196	3,922
975	989	3,243	1,750	1,202	3,942
1,000	998	3,273	1,775	1,208	3,962
1,025	1,006	3,299	1,800	1,213	3,978
1,050	1,014	3,325	1,825	1,219	3,998
1,075	1,022	3,352	1,850	1,225	4,018
1,100	1,030	3,378	1,875	1,230	4,034
1,125	1,038	3,404	1,900	1,235	4,050
1,150	1,045	3,427	1,925	1,241	4,070
1,175	1,053	3,453	1,950	1,246	4,086
1,200	1,060	3,476	1,975	1,251	4,103
1,225	1,067	3,499	2,000	1,257	4,122
1,250	1,075	3,526			

Table 6-19. Safe distances for personnel (charges on target) in the open

Serial	Charge Type	Target	Charge Size	Radius of Danger Area (m)	Remarks
a	b	c	d	e	f
1	Cutting	Metal girders and plates, guns, and so forth	Any	1,000	Fragments may fly up to 1,000 meters in all directions.
2	Breaching/ counterforce	Reinforced-concrete beams and slabs	Any	1,000	Consider the strong-blast effect when considering buildings as potential blast shelters.
3	Shaped	Concrete and steel	Any	1,000	When these charges are fired into the ground vertically, you may reduce the safe distance to 300 meters.
4	Bangalore torpedo	Wire obstacles	Any	1,000	Use the following MSDs: Missile-proof shelter: 100 m Defilade position with overhead cover: 200 m
NOTE: Always use the greater distance when using Table 6-3, page 6-8, and Table 6-4.					

6-15. Missile-proof shelters can be as close as 100 meters from the detonation site provided it is strong enough to withstand the heaviest possible missile resulting from the demolition.

SECTION II. MISFIRE PROCEDURES

NONELECTRIC MISFIRES

CAUSES

6-16. 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.
- Breaks in the time fuse or detonating cord.
- Time fuse having jagged or uneven ends.
- Failure to seat the blasting caps securely in the cap well or explosive.
- Detonating-cord being loosely or improperly installed.
- Debris in the blasting cap.
- Blasting caps from commercial sources that are not strong enough to detonate military explosives.

PREVENTION

6-17. You can minimize nonelectric misfires 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 for underground demolitions. *Do not bury 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 is completely seated when installing it into a blasting cap or fuse igniter.

CLEARING PROCEDURE

6-18. The soldier who placed the charges should investigate any misfires and correct any problems with the demolition using the following procedures:

- After attempting to fire the demolition, he should delay investigating any detonation problem for at least 30 minutes plus the time remaining on the secondary. Sometimes, tactical conditions may require an investigation before the 30-minute limit.
- For above-ground misfires of charges primed with blasting caps, he should 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. The soldier must not touch scattered charges that contain blasting caps; he must destroy them in place. For charges primed with detonating cord, he should follow the procedures in paragraphs 6-21 and 6-22, page 6-12.
- For a nonelectric cap that has detonated but failed to initiate a detonating-cord branch line, line main, or ring main, he should attach a new cap to the detonating cord and then move to a safe place.
- For buried charges, he must remove the tamping to within one foot of the misfired charge. The soldier must constantly check the depth while digging to avoid striking the charge. When within 1 foot of the misfired charge, he should 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, he should dig a new borehole of the same depth beside the original hole, 1-foot away. The soldier must place a primed, 2-pound charge in the new hole and detonate the new charge.

ELECTRIC MISFIRES

CAUSES

- An inoperable or weak blasting machine or power source.
- Improper operation of the blasting machine or power source.
- Defective or damaged connections. (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 (too many caps, too small a blasting machine).

PREVENTION

6-19. Assign one individual the responsibility for all the electrical wiring in a demolition circuit. This individual should—

- Perform all splicing.
- Install all blasting caps in the firing circuit. *He must not bury 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

6-20. Use the following procedures 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.)
- Inspect the entire circuit for wire breaks or short circuits.

- Do not attempt to remove or handle an electric blasting cap if you suspect it is the problem. Place a primed, 1-pound charge next to the misfired charge and detonate the new charge.

DETONATING-CORD MISFIRES

DETONATING CORD

6-21. If detonating cord fails to function properly, take the following action:

- Attach a new blasting cap to the remaining detonating cord, taking care to fasten it properly, and detonate the new blasting cap.
- Treat branch lines the same as noted above.

DETONATING-CORD PRIMING

6-22. If the detonating cord leading to the charge detonates but fails to explode the charge, take the following action:

- Do not investigate until the charges have stopped burning. Wait 30 minutes if the charge is underground.
- Reprime and attempt to detonate the charge. (Scattered charges that do not contain blasting caps may be collected and detonated together.)
- Dig near underground charges to within one foot of the charge; place a primed, 2-pound charge on top or to the side of the charge; and detonate the new charge.

SECTION III. TRANSPORTATION AND STORAGE SAFETY

TRANSPORTATION

REGULATIONS

6-23. Both military and commercial carriers are subject to regulations when transporting military explosives and other dangerous military materials within the US. AR 55-355 covers the transportation of explosives. TM 9-1300-206 contains minimum safety requirements for handling and transporting military explosives and ammunition. When transporting explosives outside the US, follow the regulations from the host countries as well. All explosives transport personnel must learn the local procedures and safety requirements.

SAFETY PROCEDURES

6-24. 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 the following safety rules:

Vehicles

- Ensure that vehicles are in good condition. Inspect all vehicles intended for hauling explosives before loading any explosives. Pay particular attention to protecting 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-body vehicles hauling explosives with a fire-resistant tarpaulin.
- Mark all vehicles transporting explosives with reflective placards indicating the type of explosives carried (TM 9-1300-206, Chapter 6).
- 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, ready for immediate use. Keep vehicles away from congested areas. Consider congestion when parking.
- 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. This does not apply to convoys or crossings protected by guards or highway workers (flaggers).
- Keep flames at least 50 feet from vehicles or storage points containing explosives.

Cargo (Explosives)

- 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. If you must carry both blasting caps and explosives in the same vehicle, separate the blasting caps from the other explosives by carrying the caps in a closed metal container in the cab of the transport.
- Do not allow anyone other than the primary and the assistant operators to ride on or in a truck transporting explosives. Do not refuel a vehicle while carrying explosives except in an emergency.

Fire

6-25. If fire breaks out in a vehicle transporting explosives, take the following actions:

- Try to stop the vehicle away from any populated areas.

- Stop traffic from both directions. Warn 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. If the fire spreads to the body of the transport or the cargo, stop fighting the fire and evacuate to a distance of at least 2,000 feet.
- Do not attempt to extinguish burning explosives without expert advice and assistance.

STORAGE SAFETY

MAGAZINES

6-26. 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 9-6 and TM 9-1300-206 give details on magazine storage of explosives. Consider the following when constructing magazines:

Permanent

6-27. Consider acceptability of magazine locations based on 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. Clear brush and tall grass from the site to lessen the danger of fire.

6-28. Ensure that all magazines have a grounded, overhead lightning-rod system. Connect all metal parts (doors, ventilators, window sashes, reinforcing steel, and so forth) to buried conduits of copperplate or graphite rods in several places.

6-29. Install barricades around magazines; that is, ensure that there is a substantial obstacle between magazines and inhabited buildings. For certain explosives, effective natural or artificial barricades reduce the required safe distance between magazines and railways and highways by one half. The use of barricades permits 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. TM 9-1300-206 gives more specific guidance on barricades.

6-30. Place guards at all magazines to prevent unauthorized personnel from gaining access to magazine facilities.

Temporary

6-31. When permanent magazine construction is not possible, create temporary magazines by placing explosives on pallets to accommodate ventilation. Store the pallets in a well-drained bunker. Excavate the bunker in a dry area and revert the bunker 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. Mark field-expedient storage facilities on all four sides with signs (TM 9-1300-206).

TEMPORARY STORAGE

6-32. When necessary, store limited supplies of explosives in covered ammunition shelters. Ensure that the temporary facilities are separated adequately to prevent fire or explosion from being transmitted between shelters. Ensure that piles of temporarily stored explosives contain no more than 500 pounds each and are spaced no closer than 140 feet. Pile explosive components separately. Keep explosives, caps, and other demolition materials stored in training areas in covered ammunition shelters and under guard at all times. Use local safety standing operating procedures (SOPs) and TM 9-1300-206, Chapter 4, as guides for temporary storage operations.

NOTE: Any deviation from the requirement for separate storage of blasting caps and explosives should be approved through the US Army Technical Center for Explosive Safety, Savannah, Illinois.

SECTION IV. DESTRUCTION OF MILITARY EXPLOSIVES

CONCEPT

6-33. 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 (AR 75-14, TM 43-0001-38, and FM 21-16). 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 cannibalizing from 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

6-34. Select the demolition materials' destruction site 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 you should adhere to appropriate safety precautions, if possible.

METHODS

6-35. Burning and detonating, in that order, are considered the most satisfactory methods for destroying demolition materials to prevent enemy use. TM 9-1300-206 (Chapter 9) and TM 9-1300-214 (Chapter 15) cover procedures for explosives and ammunition destruction in greater detail.

BURNING

6-36. Destroy packed and unpacked HE items by burning. These explosives include linear, shaped, and block demolition charges; stick dynamite, detonating cord; firing devices; and timed blasting fuse. Do not attempt to destroy blasting caps by burning them since they will detonate from extreme heat. Separate them from other explosives and destroy them by detonation. Personnel should not attempt to extinguish burning explosives without expert advice and assistance. Use the following procedure for burning explosives:

- Place blasting caps in piles separate from explosives and destroy 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. Piles should not exceed 2,000 pounds or be 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 safe distance from the pile using Table 6-2, page 6-6. This distance is never less than 300 meters.
- Do not try to extinguish burning explosives without expert advice and assistance. Burning explosives cannot be extinguished by smothering them or drenching them. In fact, smothering will probably cause an explosion.

DETONATION

6-37. The tactical situation, the commander's intent, the lack of time, the type of explosive, or safety considerations may require an explosive to be detonated instead of burned. Use the following procedures for detonating explosives:

- Establish a safety zone for missile and blast effect by computing the safe distance required for the amount of explosives to be detonated (Table 6-1, page 6-6).
- Do not exceed the limitations of the disposal site. Instead of detonating one large pile of explosives, you may have to make several smaller piles of explosives and stagger their detonating times.
- 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

6-38. Section 107 of the Federal Facilities Compliance Act of 1992 requires the Environmental Protection Agency (EPA), in consultation with the

Department of Defense (DOD) and the States, to issue a rule identifying when conventional and chemical/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 Army's objective 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

6-39. The military is required under Section 107 to comply with the EPAs 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.

6-40. While EPA strongly encourages the States to adopt the terms of the Military Munitions Rule, it acknowledges that States may adopt requirements that are more stringent or broader in scope than federal requirements.

DEFINITION OF SOLID WASTE

6-41. The Military Munitions Rule clarifies when conventional and chemical/military munitions become a hazardous waste under the RCRA.

6-42. 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.

6-43. The 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 storage regulations, (waste, nonchemical, military munitions) that are subject to the jurisdiction of DOD's Defense Environmental Safety Board's storage standards.

6-44. The 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.

6-45. The 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) are repaired, reused, recycled, reclaimed, disassembled, reconfigured, or otherwise subjected to materials recovery activities.

6-46. The rule specifies that used or fired munitions are still solid waste when they are removed from their landing spot and then 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 landfilled).

6-47. Additional information relating to the Military Munitions Rule can be found in 40 CFR, Part 266, Subpart M. This CFR only applies to the continental US and its territories and processions. However, if the military is operating in a foreign country, they must comply with the host nations environmental standards. Use US federal regulations only if the host nations standards are less stringent.

ENVIRONMENTAL RISK MANAGEMENT

6-48. 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 environment risk assessments. Through this process, battle-focused training and operations can still lead to mission completion. Refer to FM 100-14 for further guidance and procedures for conducting environmental risk assessments.

Chapter 7

Modernized Demolition Initiators

7-1. The MDI or shock-tube has been used in the civilian sector for over 20 years. The Army has adopted the MDI as its primary means for initiating demolitions. In this chapter MDI is discussed in detail. It provides explanations of all the components, procedures to prime demolitions using the MDI, procedures to prepare initiation sets and firing systems, and safety considerations when using MDI.

SECTION I. GENERAL DESCRIPTION

CHARACTERISTICS

7-2. MDI are the project name given to a new family of nonelectric blasting caps and associated items. MDI supplement and partially replace the M7 nonelectric blasting cap, the M6 electric blasting cap, and M700 time fuse. The snap-together MDI components simplify initiation systems and some types of explosive priming. MDI will 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 will be significantly degraded due to moisture.

SHOCK TUBES

7-3. The shock tube is a thin, plastic tube of extruded polymer with a layer of cyclotetramethylene tetramitramine (HMX) 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. 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.

7-4. Shock tube functions are usually evidenced by a bright flash within the tube. The flash is very well contained by the olive-drab coating on all military shock tubes. The flash 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. The free end of the shock-tube blasting caps is always sealed. All shock-tubes may be extended by the user, but not the blasting caps. Extend by using leftover pieces of shock tube from previous operations and short pieces of splicing tubing supplied with the M12 and M13 caps. (See *paragraph 7-56* for shock tube splicing.) However, 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. Use care when cutting and splicing shock tubes. If an unsealed shock tube is left unused for extended periods, it may not be reliable and should not be used.

BLASTING CAPS

7-5. Military explosives require a substantial shock to be initiated. This shock is normally provided by a high-strength blasting cap, the nonelectric M7, or the electric M6. To replace the M6 and M7, five new high-strength and two low-strength MDI blasting caps are being introduced. Each shock-tube blasting cap is a factory-crimped and sealed unit that is moisture-resistant (unlike standard nonelectric blasting caps) and extremely reliable.

High-Strength Caps

7-6. The high-strength caps are the M11, M16, M14, M18, and M15. All are nonelectric types, and three come with a length of special shock tubing attached. This tubing's function 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 standard size 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 J-hook. It is used to connect the M11 to the detonation cord, if required.
- The M16 cap comes with a 10-foot length of shock tube factory attached to a standard size aluminum blasting cap tube. The M16 has a plastic connector on the free end of its shock tube called a J-hook. It is used to connect the M16 to the detonating cord (to be fielded in fiscal year 2000).
- The M14 consists of military strength and size nonelectric blasting cap, factory-crimped to a factory-calibrated, 5-minute length of M700 time blasting fuse. It is a standardized delay initiator for shock-tube, blasting-cap priming systems.
- The M18 consists of military strength and size nonelectric blasting cap, factory crimped to a factory-calibrated nominal 20-minute length

of M700 time fuse. It is also a standardized delay initiator for the shock-tube blasting cap (to be fielded in fiscal year 2000).

- The M15 has pyrotechnic devices installed to provide a small time delay between its initiation and the firing of its detonator(s). 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.

NOTE: All high-strength caps will be in a protective cover when carried on the soldier. Covers will be mailed to the battalion levels and they will be responsible to get them down to the company level.

Low-Strength Caps

7-7. The two low-strength MDI blasting caps are the M12 and M13. 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. All of the low-strength shock-tube blasting caps come with a special plastic clamp attached to the detonator. This allows for quick and easy attachment to the shock tube. It is important to remember that the low-strength, relay-type caps (such as the M12 and M13) cannot reliably set off explosives such as detonating cord. The high-strength caps, specifically the M11, M16, M14, M18, and M15 were designed to ignite detonating cord and standard military explosives.

BLASTING-CAP HOLDER (M9)

7-8. Plastic blasting-cap holders allow the connection of several shock tubes to a high-strength M11, M16, M14, or M18 blasting cap. The M9 holder helps secure the connection of up to five shock tubes to the high-strength detonation of an M11 or M14 blasting cap. The M9 holder can also be used to connect the M11 or M14 blasting cap to the detonating cord. When using the M9 holder, tape it closed with electrical tape. This will ensure that it does not come open before system initiation.

NOTE: Do not connect the shock tube and the detonating cord in the same holder. The M9 is not designed to hold the shock tube and the detonating cord simultaneously.

TIME-BLASTING-FUSE IGNITER (M81)

7-9. A new, more powerful igniter will initiate the shock-tube ends of the new blasting caps. 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 the thin shock tube or standard-diameter time blasting fuse (M700).

WARNING
The standard M60 igniter will neither physically secure the shock tube nor reliably initiate it.

NONELECTRIC BLASTING CAP, 30-FOOT SHOCK TUBE (M11)

7-10. The M11 is a high-strength blasting cap, factory-crimped to a 30-foot length of shock tube. A movable plastic connector, called a J-hook, is attached to the free end of the shock tube. The hook allows for 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 one meter from the blasting cap, and a yellow flag is attached two meters from the blasting cap. M11s are packaged with an issue of six M11s per package as shown in *Figure 7-1*.

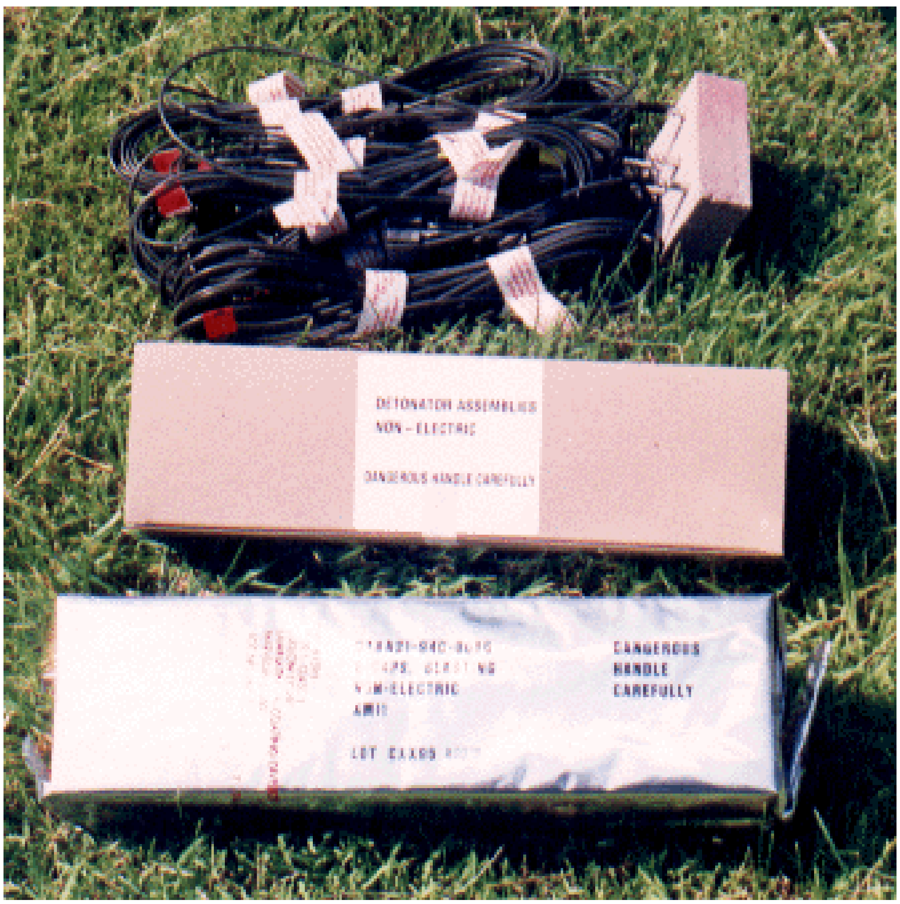


Figure 7-1. M11 blasting caps

USE

7-11. The M11 can be used to prime standard military explosives or to initiate detonating cord or shock tube.

FUNCTIONS

7-12. 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 (M11, M16, M12, M13, M14, or M18) or by a special time-blasting-fuse igniter (M81). The M11's detonation is instantaneous. Refer to *Table 7-1* for characteristics of the M11.

Table 7-1. M11 characteristics

Tabulated Data		
Aluminum tube	Length:	2.35 in
	Diameter:	0.241 in
Shock tube	Material:	Polyethylene
	Length:	30 ft
	Diameter:	0.118 in
Filler	Aluminum tube:	Lead azide, RDX
	Shock tube:	HMX/aluminum
	Method of actuation:	Shock from detonation of a blasting cap
Shipping and Storage Data		
DOD hazard class quality distance/division/storage compatibility group (QD/DIV/ SCG)	1.4B	
Department of Transportation (DOT) hazard class	1.4S	
DOT label	Explosive: 1.4S	
DOT container marking	Proper shipping name:	Detonators, nonelectric for blasting
	United Nations (UN) serial number:	0345
	National stock number (NSN):	1375-01-415-1232
	DODAC:	Live: ML47 Inert: MN36
	Net explosive weight (per cap):	1.175 gr (0.0026 lb)
	Specification:	QAA-1423
	Packaging:	15 units/pack, 14 pack (60 caps)/packing box, 12 boxes/pallet
Packing box	Dimensions:	2 by 18 by 11 in
	Cube:	2.8 cubic ft
	Net explosive weight:	0.16 lb
	Gross weight of package:	57 lb
References		
TM 9-1375-213-34&P		
DOD Consolidated (Cons) Ammunition (Ammo) Supply Catalog		

NONELECTRIC BLASTING CAP, 500-FOOT SHOCK TUBE (M12)

7-13. 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 quick and easy attachment to the shock tube of up to five M11s or other M12s or M13s. The M12 is provided on a spool as shown in *Figure 7-2*.

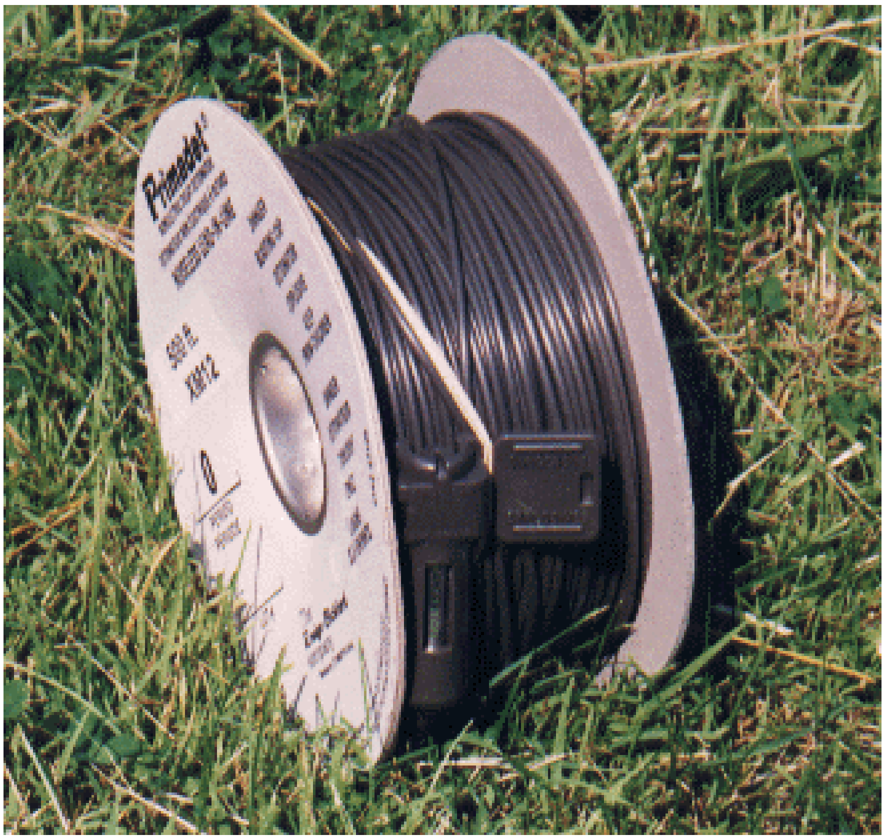


Figure 7-2. M12 blasting cap's shock-tube spool

USE

7-14. The M12 is used to transmit a shock-tube detonation impulse from an initiator (or another relay cap) to another relay cap or to a high-strength shock-tube blasting cap (such as the M11) which initiates standard military explosives. The M12 is used only as a transmission line in a firing system. It does not have enough output to initiate most military explosives reliably.

NOTE: Low-strength relay-type caps cannot reliably set off explosives such as detonating cord. It can only set off shock tubes.

FUNCTIONS

7-15. The M12 functions by sending an initiating shock or small detonation through the shock tube to the blasting cap. This blasting cap then actuates up to five shock tubes held by the plastic connector. The M12's shock tube must be initiated by another blasting cap or by the special M81 fuse igniter. Refer to *Table 7-2* for the characteristics of the M12.

Table 7-2. M12 characteristics

TABULATED DATA		
Aluminum tube detonator	Length:	2.7 in
	Diameter:	0.296 in
Shock tube	Material:	Surlyn covered with polyethylene
	Length:	500 ft
	Diameter:	0.118 in
Filler	Detonator:	Lead azide, PETN
	Shock tube:	HMX/aluminum
	Method of actuation:	Shock from detonation of a blasting cap or the primer in an M81 igniter
SHIPPING AND STORAGE DATA		
DOD hazard class QD/DIV/ SCG	1.4B	
DOT hazard class	1.4S	
DOT label	Explosive: 1.4S	
DOT container marking	Proper shipping name:	Detonators, nonelectric for blasting
	UN serial number:	0455
	NSN:	1375-01-415-1230
	DODAC:	Live: MN02 Inert: MN35
	Net explosive weight (per cap):	2.81 gr
	Drawing:	12972628
	Specification:	QAA-1459
	Packaging:	8/cardboard box, 6 boxes (48 detonators)/packing box
Packing box	Dimensions:	46 by 21 by 21 in
	Cube:	11.74 cubic ft
	Net explosive weight:	0.268 lb
	Gross weight of package:	169 lb
REFERENCES		
TM 9-1375-213-34&P DOD Cons Ammo Supply Catalog		

NONELECTRIC BLASTING CAP, 1,000-FOOT SHOCK TUBE (M13)

7-16. 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 held by the plastic connector. The M13 differs from the M12 only by the size of spool provided.

USE

7-17. The M13 is used to send a shock-tube detonation impulse from an initiator (or another relay cap) to another relay cap or to a high-strength shock-tube blasting cap (such as the M11 or M16), which initiates standard military explosives. The M13 is used only as a transmission line in a firing system. It does not have enough output to reliably initiate most military explosives.

NOTE: Low-strength relay-type caps cannot reliably set off explosives such as detonating cord. It can only set off shock tubes.

FUNCTIONS

7-18. The M13 functions by sending an initiating shock or small detonation through the shock tube to the blasting cap. This blasting cap then actuates up to five shock tubes held by the plastic connector. The M13's shock tube must be initiated by another blasting cap or by a special M81 igniter. Refer to *Table 7-3* for the characteristics of the M13.

Table 7-3. M13 characteristics

TABULATED DATA			
Aluminum tube detonator	Length:	2.7 in	
	Diameter:	0.296 in	
Shock tube	Material:	Surlyn covered with polyethylene	
	Length:	1,000 ft	
	Diameter:	0.118 in	
Filler	Detonator:	Lead azide, PETN	
	Shock tube:	HMX/aluminum	
	Method of actuation:	Shock from detonation of a blasting cap or the primer in an M81 igniter	
SHIPPING AND STORAGE DATA			
DOD hazard class QD/DIV/ SCG	1.4B		
DOT hazard class	1.4S		
DOT label	Explosive: 1.4S		
DOT container marking	Proper shipping name:	Detonators, nonelectric for blasting	
	UN serial number:	0455	
	NSN:	1375-01-415-1231	
	DODAC:	Live: MN03	Inert: None
	Net explosive weight (per cap):	5.06 gr (0.0026 lb)	
	Drawing:	12972629	
	Specification:	QAA-1459	

Table 7-3. M13 characteristics

	Packaging:	4/cardboard box, 6 boxes (24 detonators)/packing box
Packing box	Dimensions:	46 by 21 by 21 in
	Cube:	11.74 cubic ft
	Net explosive weight:	0.268 lb
	Gross weight:	163 lb
REFERENCES		
TM 9-1375-213-34&P DOD Cons Ammo Supply Catalog		

NONELECTRIC BLASTING CAP, DELAY (M14)

7-19. The M14 is a high-strength blasting cap, factory-crimped to about a 7 1/2-foot length of time blasting fuse. Instead of the usual yellow band every 18 inches, the yellow bands represent 1 minute of burn time. The fuse's free end is moisture-sealed so only a small piece (not greater than 1/4 inch) must be cut off when being prepared for ignition (*Figure 7-3*).

Figure 7-3. M14 delay blasting cap

USE

7-20. The M14 is used to detonate all standard military explosives or to initiate shock-tube blasting caps and detonating cord about five minutes after being ignited. The M14 may be connected to an M12's or M13's transmission line to ensure correct safety standoff distance.

FUNCTIONS

7-21. 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 calibrated at sea level at a temperature of 125°F. The burn time will increase with altitude and with colder temperatures. The M14 has been designed to allow a nominal 5-minute delay, under all weather and altitude conditions, allowing personnel to move to the minimum safe distance 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. Refer to *Table 7-4* for the characteristics of the M14.

Table 7-4. M14 characteristics

TABULATED DATA		
Aluminum tube	Length:	2.35 in
	Diameter:	0.241 in
Time-blasting fuse	Material:	Plastic-covered fiber
	Length:	About 7 1/2 ft
	Diameter:	0.25 in
Filler	Detonator:	Lead styphenate, lead azide, PETN
	Method of actuation:	Flame from time blasting fuse igniter or a match
SHIPPING AND STORAGE DATA		
DOD hazard class QD/DIV/ SCG	1.4B	
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:	1375-01-415-1233
	DODAC:	Live: MN06 Inert: MN37
	Net explosive weight (per cap):	11.73 gr
	Drawing	12972630
	Specification:	QAA-1424
	Packaging:	15 units/pack, 4 pack (60 caps)/wood box
Packing box	Dimensions:	26 by 18 by 11 in
	Cube:	2.8 cubic ft
	Net explosive weight:	1.55 lb
	Gross weight of package:	57 lb
REFERENCES		
TM 9-1375-213-34&P DOD Cons Ammo Supply Catalog		

NONELECTRIC BLASTING CAP, DELAY (M15)

7-22. 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's 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 one is attached 2 meters from the blasting cap (*Figure 7-4*).

Figure 7-4. M15 delay blasting cap

DANGER
The M15 delay blasting cap is not to be placed in boreholes or below ground level.

USE

7-23. 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 cratering. Normally several M15s would be used in tandem to obtain a multistage detonation. With a slight delay between each stage, this allows the outer layer of rock or earth to start moving before the next layer's detonation occurs.

FUNCTIONS

7-24. The M15 functions by sending 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 caps with shock-tube connector), and the other is 200 milliseconds (higher-strength, larger caps with shock-tube connector). Both detonators are slightly larger in diameter than a standard blasting cap and will not fit in a standard cap well. The

M15's shock tube must be initiated by another blasting cap (M11, M16, M12, M13, M14, M18, or M15). Refer to *Table 7-5* for the characteristics of the M15.

Table 7-5. M15 characteristics

TABULATED DATA		
Aluminum tube	Length (low strength):	2.5 in
	Length (high strength):	3.5 in
	Diameter (low strength):	0.296 in
	Diameter (high strength):	0.296 in
	Net explosive weight (complete cap with both detonators):	1.63 gr
Shock tube	Material:	Surlyn covered with polyethylene
	Length:	70 ft
	Diameter:	0.118 in
Filler	Aluminum tubes:	Lead azide, PETN
	Shock tube:	HMX/aluminum
	Method of actuation:	Shock from detonation of blasting cap
SHIPPING AND STORAGE DATA		
DOD hazard class QD/DIV/SCG	1.4B	
DOT hazard class	1.4S	
DOT label	Explosive: 1.4S	
DOT container marking	Proper shipping name:	Detonators, nonelectric for blasting
	UN serial number:	0367
	NSN:	1375-01-415-1234
	DODAC:	Live: MN07 Inert: MN38
	Drawing	12972631
	Specification:	QAA-1425
	Packaging:	30 per box, 4 boxes (120 detonators)/packing box
Packing box	Dimensions:	46 by 21 by 21 in
	Cube:	11.74 cubic ft
	Net explosive weight:	0.4 lb
	Gross weight of package:	118 lb
REFERENCES		
TM 9-1375-213-34&P DOD Cons Ammo Supply Catalog		

BLASTING CAP AND SHOCK-TUBE HOLDER (M9)

7-25. The M9 is a black plastic or olive-drab (polyethylene) clamping device designed to hold the shock-tube branch lines secure and close to the high-strength blasting cap of the M11, M16, M14, or M18. The device is a one-piece molding with two hinged snap-together flaps to hold the blasting cap and the shock tubes securely (*Figure 7-5*).

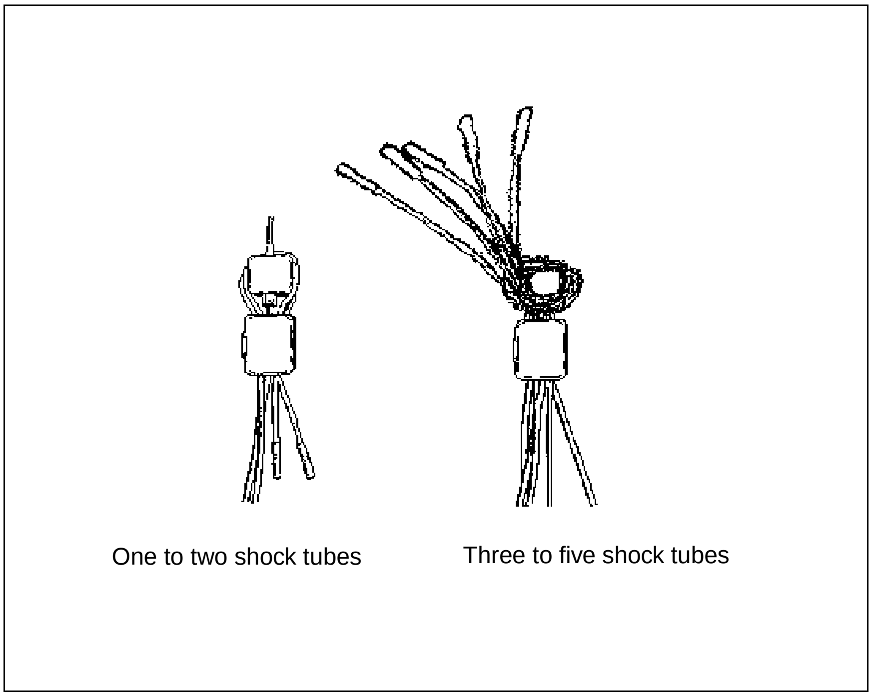


Figure 7-5. M9's shock-tube holder

USE

7-26. The M9 can accommodate and ensure proper proximity for initiating up to five shock tubes from the one blasting cap. The M9 can also be used to connect the MDI blasting cap to a detonating-cord line or a ring main.

FUNCTIONS

7-27. Shock tubes must be positioned straight through the holder with an overhand knot if using more than three (*Figure 7-5*). The blasting cap is inserted and secured by closing the smaller hinged flap. Insert the ends of the shock tubes through the channels in the holder. Loop the shock tubes around the incoming shock tube or time fuse. Then secure the shock tubes next to the blasting cap by snapping the larger flap of the holder closed. Use tape to firmly secure the flap to the holder. Because this item is designed for one-time use, continued use in training will quickly wear out the hinges. Refer to *Table 7-6* for the characteristics of the M9.

Table 7-6. M9 characteristics

TABULATED DATA		
Dimensions (closed)	Length:	3.0 in
	Width:	1.3 in
	Thickness:	0.7 in
	Accommodation:	One detonator/five shock tubes
	Material:	Polyethylene
	Color:	Black
	NSN:	1375-01-415-1229
	DODAC:	ML45
	Drawing:	12972626
	Specification:	QAA-1423
	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.	

TIME-BLASTING-FUSE IGNITER WITH SHOCK-TUBE CAPABILITY (M81)

7-28. The M81 is a small plastic tube with a pull ring on a thin rod projecting from one end. A safety (cotter) pin goes sideways through the tube and a screw cap secures a holding mechanism for the fuse or shock tube on the other end. A small plastic plug comes secured to the hole in the screw-end cap. This is used to accommodate the shock tube or time-blasting fuse (*Figure 7-6*). The

Figure 7-6. M81 fuse igniter

M81 body is olive-drab and the nomenclature is stenciled in yellow. Refer to *Table 7-7* for the characteristics of the M81.

Table 7-7. M81 characteristics

NOTE: The standard M60 igniter (which has an almost identical appearance to the M81) will not secure or reliably initiate the shock tube.		
TABULATED DATA		
Body	Length:	4.0 in
	Diameter:	Pull ring -1.2 in Body - 0.75 in
	Material:	Plastic
Filler	M42 primer:	Primer mix
	Net explosive weight (per igniter):	0.0001 lb (0.05 gr)
	Method of actuation:	Impact of the spring-loaded firing pin on the primer is effected by the operator pulling the pull ring.
SHIPPING AND STORAGE DATA		
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
	Packaging:	5 igniters/paperboard box, one to barrier bag, 6 bags (300 igniters)/ wooden box
Packing box	Dimensions:	17 9/16 by 10 11/16 by 19 17/32 in
	Cube:	2.04 cubic ft
	Net explosive weight:	0.03 lb
	Gross weight (with contents)	37 lb
REFERENCES		
TM 9-1375-213-34&P DOD Cons Ammo Supply Catalog		

USE

7-29. The M81 igniter is used to ignite the time-blasting fuse or to initiate the shock tube of the MDI nonelectric blasting caps.

FUNCTIONS

7-30. To actuate the M81—

- Loosen the screw cap and remove the plug.
- Insert the freshly cut end of the time blasting fuse or shock tube in the hole from which the plug was removed.
- Tighten the screw cap to secure the fuse or shock tube.
- Remove the safety (cotter) pin.
- Pull the pull ring to the limit of its travel. When the M81 reaches its limit of travel, the pull-ring rod releases the firing pin. The spring forces the pin into the M42's primer. The primer fires with a flame, and an explosive shock ignites the fuse or initiates the shock tube.

NONELECTRIC BLASTING CAP, 10-FOOT SHOCK TUBE (M16)

7-31. The M16 has a high-strength blasting cap and a J-hook like the M11, but has a 10-foot length of shock tube instead of 30 foot. The M16's uses and functions are the same as the M11. The NSN for the M16 is 1375-01-449-9601 DODAC is MN39. It is scheduled to be available to the field in fiscal year 2000.

NONELECTRIC BLASTING CAP, DELAY (M18)

7-32. The M18 has a high-strength blasting cap, factory crimped to a nominal 20 minute burn length of time fuse. The fuse's free end is moisture sealed like the M14. The M18's uses and functions are the same as the M14. The NSN for the M18 is 1375-01-449-9602 and the DODAC is MN41. It is scheduled to be available to the field in fiscal year 2000.

SECTION II. PRIMING EXPLOSIVE CHARGES WITH MDI

PRIMING METHODS

7-33. There are two methods of priming explosive charges—nonelectric (MDI) and detonating cord. Only nonelectric (MDI) priming is discussed in this section. Details on detonating-cord priming of charges can be found in *Chapter 2*. The engineer commander in charge of the specific demolition mission has the choice of which priming method to use. For reserved demolition targets, detonating-cord priming is the preferred method since it involves fewer blasting caps and allows charges to be primed at state of readiness—state 1 (safe).

NONELECTRIC PRIMING

7-34. Use only high-strength MDI blasting caps (M11, M16, M14, M15, or M18) for priming explosive charges. M12 and M13 relay-type blasting caps do not have sufficient power to reliably detonate most explosives. Use the M12 and M13 only as transmission lines in firing systems (refer to *Section III* of this chapter).

WARNING
Do not insert blasting caps in explosive charges until ordered to do so.

7-35. MDI priming is safer and more reliable than the current nonelectric cap priming methods. MDI blasting caps 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 in incorrect crimping is removed, thus making MDI blasting caps extremely reliable. You can use MDI blasting caps with priming adapters or insert them directly into the explosive charge and secure them with black electrical tape. If you use priming adapters, place them on M11 blasting caps as outlined in the note below.

NOTE: Older M1A4 priming adapters must be slid down the full length of the shock tube to the blasting cap of the M11. 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 off the J-hook. Newer M1A5 priming adapters have wider slots and can be placed over the shock tube at a point near the blasting cap.

TNT BLOCK DEMOLITION CHARGE

7-36. TNT blocks have threaded cap wells. Use a priming adapter to secure a high-strength (M11, M16, M14, or M18) blasting cap in the cap well of the TNT block as shown in *Figure 7-7*. When priming adapters are not available, prime TNT blocks by inserting a high strength (M11, M16, M14, or M18) blasting cap into the cap well of the charge and secure it with tape.

Figure 7-7. Priming TNT blocks with MDI

MILITARY DYNAMITE

7-37. Military dynamite can be primed with MDI blasting caps using either the end- or side-priming method. Use M2 crimpers or other nonsparking tools 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. Insert the blasting cap nearly parallel to the side of the cartridge. The explosive tip of the cap should be near the middle of the cartridge). Insert an M11, M16, M14, M18, or M15 blasting cap into the cap well. Secure the blasting cap and shock tube/time fuse securely to the cartridge with tape to hold the blasting cap firmly in place (*Figure 7-8*).

Figure 7-8. Priming M1 dynamite with MDI

M112 (C4) DEMOLITION BLOCK

7-38. 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 an M11, M16, M14, M18, or M15 blasting cap. Insert an M11, M16, M14, M18, or M15 blasting cap into the hole produced by the M2 crimpers. Do not force the blasting cap if it does not fit; make the hole larger. Anchor the blasting cap in the demolition block by gently squeezing the C4 plastic explosive around the blasting cap. Use tape to secure the cap in the charge M112 (*Figure 7-9*).

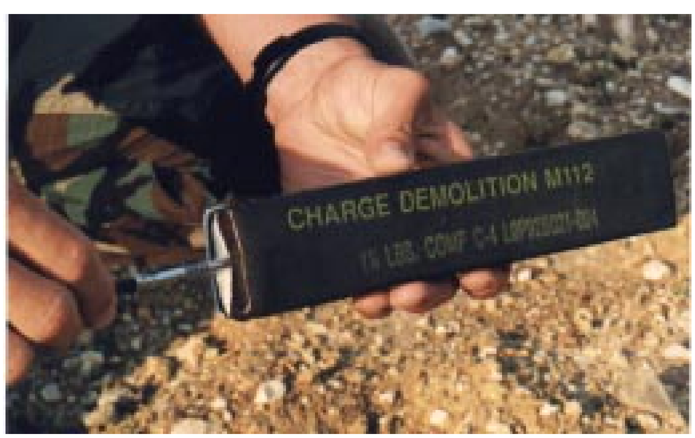


Figure 7-9. Priming C4 demolition blocks with MDI

FORTY-POUND CRATERING CHARGE

7-39. The newer 40-pound cratering charge is primed using two M112 C4 demolition blocks as boosters attached to the side of the charge. Do not prime 40-pound cratering charges with MDI.

DANGER
Do not prime 40-pound cratering charges with MDI.

M2A4 AND M3A1 SHAPED CHARGES

7-40. The M2A4 and M3A1 shaped charges have a threaded cap well at the top of the cone. Use a priming adapter, if available, to secure an M11 or M16 blasting cap in the threaded cap well. If a priming adapter is not available, use tape to secure the blasting cap in the cap well (*Figure 7-10*).

NOTE: Charges will not be primed with caps until the charges are placed on the target.

Figure 7-10. Priming shaped charges with MDI

BANGALORE TORPEDO

7-41. The bangalore torpedo is primed using an M11, M16, M14, or M18 blasting cap. Insert the blasting cap 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 firmly in place (*Figure 7-11*).

Figure 7-11. Priming the bangalore torpedo with MDI

SECTION III. INITIATION SETS AND FIRING SYSTEMS

INITIATION SETS

7-42. All MDI blasting caps can be used to initiate the shock tube. Only use the M11, M16, M14, M18, or M15 blasting caps to initiate the detonation cord or prime and initiate explosive charges directly. Use MDI initiation sets to initiate instantly (using M12 or M13) or an M14 or M18 to create a delay. When using a combination (command and delayed) initiation system on MDI, command initiation will be the primary initiation system and delay initiation will be the secondary initiation system. A sand bag will be placed on the secondary-initiation-system's blasting cap, to reduce fragmentation hazard of the cap. The secondary cap will detonate when the primary initiates the firing system. When using dual delay initiation systems, the shorter delay is the primary initiation system.

WARNING
Always observe the safe distances given in Chapter 6 of this manual.

INSTANTANEOUS OR COMMAND INITIATION

7-43. Lay out one or more M12s or M13s to achieve the necessary safe distance from the explosive charges being emplaced. Connect the blasting cap furthest from the initiation point to the MDI firing system (refer to *paragraph 7-46*) or to the detonating-cord ring main (refer to *paragraph 7-52*). 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, secure an M81 igniter to the M12's or M13's shock tube as follows:

- Turn the M81 end cap a half turn counterclockwise so that the shipping plug can be easily removed. Next, pull the shipping plug out of the igniter.
- Cut off the crimped/sealed end of the relay cap's shock tube using a demolitions knife. Crimpers will not make a smooth enough cut to ensure that the M81 will function in the shock tube. Push the shock tube into the hole in the M81's end cap as far as it will go. Twist the shock tube a little to ensure that it goes in the smaller of the igniter's internal clutching devices. Once the shock tube has seated, turn the igniter's end cap clockwise, finger tight to secure it in the device. Hold the igniter securely and pull lightly on the shock tube to ensure that the shock tube is secure (*Figure 7-12*).
- Ensure that all friendly personnel are at a safe distance from the explosive charge and/or take appropriate cover.
- Squeeze together the spread legs of the safety cotter pin. Use the safety pin's cord to remove the safety cotter pin from the igniter's body. Grasp the igniter body firmly with one hand, with the pull ring fully accessible to the other hand. The M81 igniter can burn at extremely high temperatures.
- Actuate the igniter by sharply pulling its pull ring. The pop of the igniter's primer should be heard.

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 reactuated immediately. Hold the igniter firmly and push the pull rod back into the igniter until a click is heard or felt and again sharply pull the pull ring to actuate it. If the igniter's primer fires but the charge does not, refer to *paragraph 7-64***.**

Figure 7-12. M81 fuse igniter with shock tube

DELAY INITIATION

7-44. The M14 delay blasting-cap assembly has a 7 1/2-foot length of time fuse marked by a yellow band. Each band indicates a minimum delay of 1 minute, giving a total minimum delay of 5 minutes. Before attaching the M14 to the initiation system, visually inspect the initiation sets for possible misfire problems. (This is the only test procedure for the MDI initiation set.) Initiate the M14 by—

- Opening an M9 blasting cap holder and inserting the M14 blasting cap. Snap shut the smaller hinged flap to secure the M14. Loop the shock tube from the next blasting cap in the firing system around the incoming time fuse of the M14. Insert the shock tube in the channels of the holder. Ensure that the shock tube is placed in contact with the M14 blasting cap. Snap shut the larger hinged flap and secure it with tape (*Figure 7-13*).

NOTE: Do not loop more than two shock tubes in the M9 holder.

Figure 7-13. M14 with M9 holder

- Using a sharp knife or M2 cap crimpers to cut 1/4 inch of the time-delay fuse and the metal seal from the free end of the M14's time-blasting fuse (if the maximum 5-minute delay is required). Cut at the marked yellow bands to reduce the delay, if so desired. The delay on the time fuse must allow you to withdraw to a safe distance or to take appropriate cover.
- Securing a M81 fuse igniter to the freshly cut end of the M14's time-blasting fuse (*Figure 7-14*).
- Squeezing the spread legs of the safety cotter pin together. Use the safety pin's cord to remove the safety cotter pin from the igniter's body. Grasp the igniter body firmly with one hand, with the pull ring fully accessible to the other hand. To actuate, sharply pull the igniter's pull ring. The igniter can burn at extremely high temperatures.
- Ensuring that smoke is coming from the fuse (or out of the vent hole in the igniter). Remove the igniter and withdraw to a safe distance or to appropriate cover.

Figure 7-14. M81 fuse igniter with the M14 time fuse delay

SPECIAL CONDITIONS

7-45. The ambient temperature and the site's altitude have an impact on the operation of MDI. Extreme cold weather and high altitudes will extend the delay times on the M14 and M18 and slow down the shock-tube detonation wave. 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 detonation cord for priming and branch line construction.

WARNING

The M14 and M18 time-blasting fuse 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.

WARNING

When using MDI in extreme cold temperatures and/or high altitudes, dual prime and dual initiate the charges.

MDI FIRING SYSTEMS

7-46. With the introduction of MDI components, there will be two types of firing systems: a stand-alone firing system 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.

STAND-ALONE SYSTEM

7-47. The stand-alone firing system is one in which the initiation sets and transmission and branch lines are constructed using only MDI components and the explosive charges are primed with MDI blasting caps. It is important to ensure that the firing system is balanced. All charges must have the same distance in shock-tube length from the firing point to the charge. *Figure 7-15* shows the single-firing MDI system and *Figure 7-16* shows the dual MDI firing system.

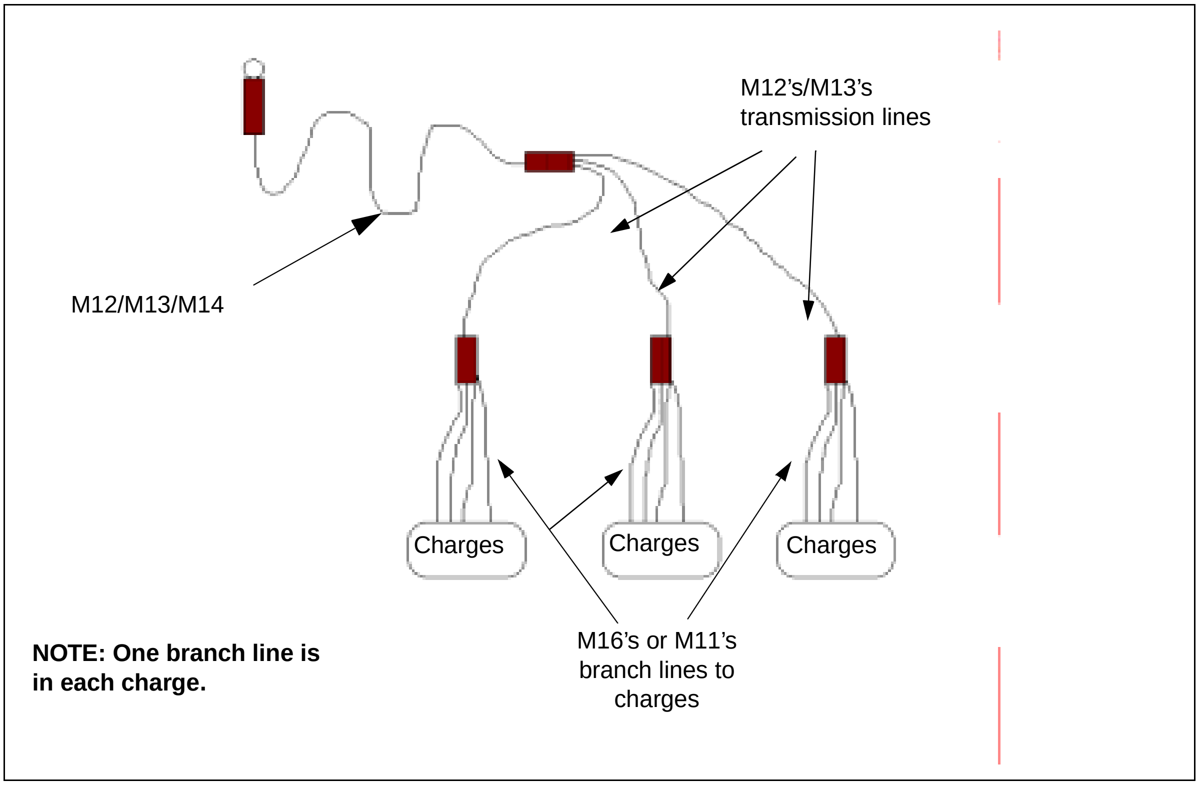


Figure 7-15. MDI firing system (single-primed)

7-48. The disadvantages of a single-firing system is that if the transmission line is cut, any 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 7-16*. Note that the charges in this case are now dual-primed, the transmission line is

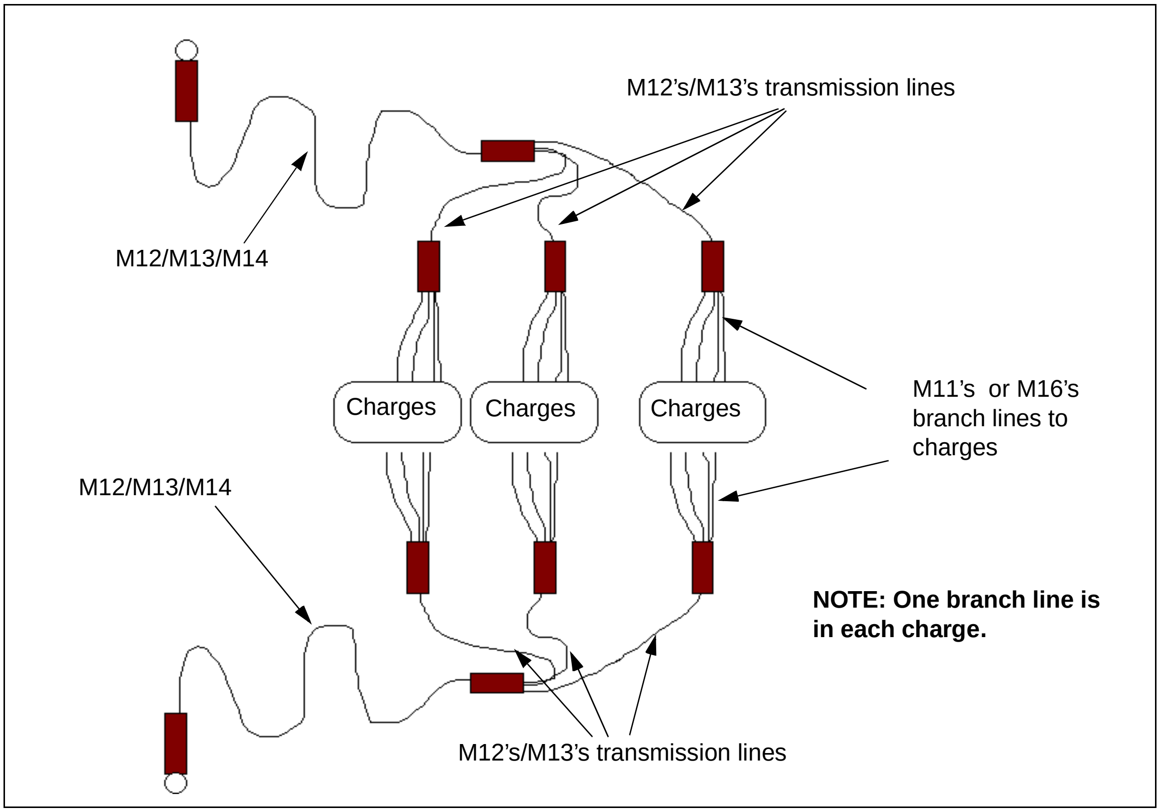


Figure 7-16. MDI dual-firing system (dual-primed)

laid in the opposite direction of the first transmission line, and the system is a balanced system.

> **CAUTION**
>
> When making multi-shock-tube installations, take care to protect the shock tubes from the effects of nearby relay caps and charges. The shrapnel produced by a cap or charge could easily cause a (partial or complete) misfire. When there are many shock tubes involved in a shot, place them carefully away from the junction.

Uses

7-49. Use the stand-alone MDI firing system for all types of demolition missions, including bridge demolitions. The MDI firing system can be used to initiate reserved demolition targets. However, 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 detonating cord is the preferred method on reserved demolition targets.

Construction Sequence

7-50. Thoroughly reconnoiter the demolition site before emplacing explosive charges on the firing system. Use the steps below to reconnoiter the site:

Step 1. Identify the firing point and observe the safe distances as given in *Chapter 6*.

Step 2. Emplace and secure 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 markers over the M12 blasting cap. Then, unreel the M12's transmission line toward the next set of charges in the direction of the firing point. If the distance between the sets of charges is less than 30 feet, use an M11.

Step 4. Place the shock tube of the first M12 into the blasting cap holder of the second M12's transmission line. This is done at the second set of charges.

NOTE: Do not close the hinged flap of the holder at this stage.

Step 5. Place a sandbag or another easily identifiable markers over the holder. Unreel the second M12's transmission line toward the third set of charges in the direction of the firing point.

Step 6. Repeat procedures steps 3 and 4 for each set of charges.

Step 7. Unreel the last transmission line to the firing point from the set of charges closest to it. To achieve the necessary safe distance, you may need several M12s/13s.

Step 8. Lay out, at each set of charges, the M11's or M16's branch lines from the charges to be primed toward the transmission lines blasting-cap holder. Ensure that when building the firing system, it is a balanced system. The shock wave in the shock tube must travel the same distance to all charges to effectively prevent a misfire. No more than five M11's or M16's branch lines can be connected to the transmission line's blasting-cap holder. If there are more than five charges, group the branch lines from the charges, and connect them to the M9's blasting-cap holder of another M11's or M16's branch line. Connect the branch line to the transmission line's blasting-cap holder as shown in *Figure 7-17*. (Secure the transmission and branch lines by taping all the holders closed.)

Step 9. Prime the explosive charges by inserting the blasting caps of the M11 or M16 branch lines, using minimum personnel on the site.

Step 10. Visually inspect the firing system for possible misfire indicators.

Step 11. Return to the firing point and initiate the system using the procedures in *paragraph 7-43*.

Follow-up

7-51. After the charges have been successfully fired, the unit commander is responsible for ensuring 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.

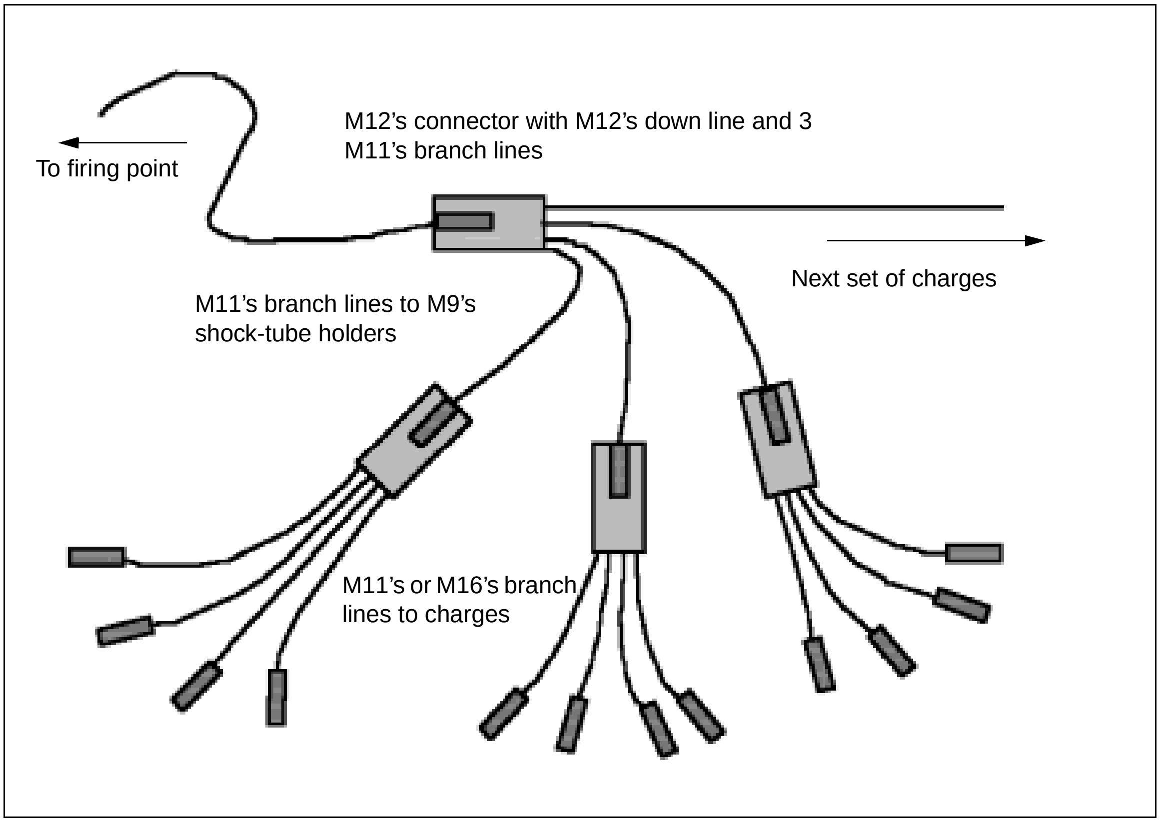


Figure 7-17. M11 or M16 branch-line array

WARNING
Do not dispose of used shock tubes by burning them because of potentially toxic fumes given off from the burning plastic.

COMBINATION FIRING SYSTEM

7-52. A combination firing system is one which consists of the MDI initiation set; either a detonating-cord line or ring main; and branch lines that can be either MDI, detonating cord, or a mix of both. *Figure 7-18* shows a combination firing system.

Uses

7-53. 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

7-54. Thoroughly reconnoiter the site before emplacing explosive charges on the firing system. Use the steps below to reconnoiter the site:

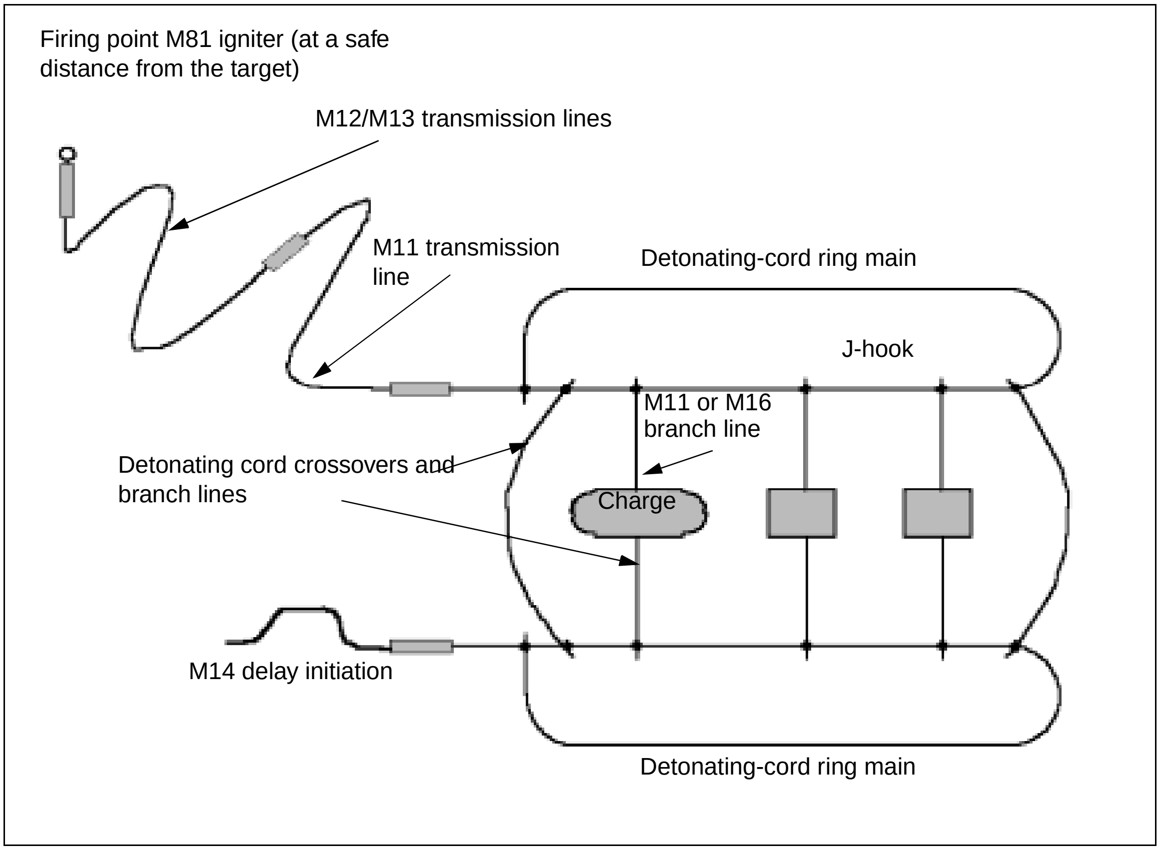


Figure 7-18. Combination (MDI and detonating cord) firing system (dual)

Step 1. Identify the firing point and observe the safe distances as given in *Chapter 6* of this manual.

Step 2. Emplace and secure the explosive charges on the target. If priming with MDI, wait until step 6.

Step 3. Construct detonating-cord line or ring mains according to procedures in *Chapter 2* of this manual.

Step 4. Cover the blasting cap of the M12's/13's transmission line with a sandbag or an other easily identifiable marker at the connection between the detonating cord line or ring main to the MDI initiation set. Unreel the M12's/ 13's transmission line to the firing point. Observe the safe distances given in *Chapter 6* of this manual.

Step 5. Tie in any detonating-cord branch lines to the line or ring main. If priming with MDI, clip the M11 or M16 branch lines to the detonating-cord line or ring main using the M11 or M16 J-hook.

- Wrap the shock tube around and to the J-hook (refer to *Figure 7-19*).
- Pull the shock tube tight. This prevents the J-hook from slipping.
- Clip the detonating cord line or ring main into the J-hook (refer to *Figure 7-20*).
- Lay out the M11 or M16 branch lines toward the charges.

Step 6. Prime the remaining charges by inserting the M11 or M16 blasting caps, using minimum personnel on the site.

Step 7. Lay out an M11 or M16 transmission line from the detonation-cord ring main to the M12's/M13's transmission line.

Step 8. Attach the M11 or M16 to the holder on the M12's/M13's transmission line and tape to secure.

Step 9. Attach an M9 holder on the M11 or M16 transmission line cap and tape.

Step 10. Loop, secure, and tape the detonating-cord line of the ring main in the M9 blasting cap holder that is attached to the M11 or M16 transmission line.

Step 11. Perfrom a visual inspection of the entire firing system for any flaws which might cause a misfire.

Step 12. Return to the firing point and initiate the system using the procedures in *paragraph 7-41*.

Figure 7-19. M11 or M16 J-hook

Follow-up

7-55. After the charges have been successfully fired, the unit commander is responsible for ensuring proper disposal of the residue. The used shock tube is a 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.

Figure 7-20. M11 or M16 branch lines connected to the detonating cord

> **WARNING**
> **Do not dispose of used shock tubes by burning them because of potentially toxic fumes given off from the burning plastic.**

SPLICING THE SHOCK TUBE

7-56. The MDI are extremely reliable because all of the components are sealed. Unlike standard nonelectric priming components, they cannot be easily degraded by moisture. Cutting the shock tube makes the open ends vulnerable to moisture. Dampening the explosive film on the inside of the shock tube will stop a detonation from going beyond such a damp spot. Use care when cutting and splicing the shock tube. When cutting the shock tube, always tie an overhand knot in the leftover shock tube. Use splicing to repair a break in the shock tube of a transmission or branch line (caused, for example, by shrapnel from artillery fires) or to extend the shock tube of another MDI blasting cap, but only when necessary. This is done by using excess shock tube from an M12's or M13's shock-tube blasting cap when the entire length is not needed. Every splice in the shock tube reduces the reliability of the firing system. Keep the number of splices in a shock-tube line to as few as practicable. Unless splicing is absolutely necessary, use of a full, sealed MDI component is recommended. (Do not splice the shock tube while conducting water or diving demolition missions.) The following is the proper splicing procedure for the shock tube:

- Use a sharp knife or razor blade to cut about 3 feet from the previously cut-off end of leftover shock tube, whether or not it was knotted according to the guidance above. Immediately seal off the shock tube remaining on the spool by tying a tight overhand knot in the cut-off end. Cut the metal seal off the end of the shock-tube blasting cap to be extended. Repair a break in the shock tube by cutting it 3 feet on both sides of the break. Use a minimum 4-foot length of shock tube to repair the break.

- Tie loosely the two shock-tube ends to be spliced together in a overhand knot. Leave at least 2 inches free at the end of each shock tube beyond the knot. Pull the shock tubes lightly to tighten the knot, but not so tight as to significantly deform the shock tube in the knot.
- Push one of the free shock-tube ends to be spliced firmly into one of the precut splicing tubes at least l/4 inch. Push the other shock-tube end firmly into the other end of the splicing tube at least l/4 inch. It is not necessary for the two ends of the shock tube meet; the detonation wave in the shock tube will still generate over a small gap (of up to six inches).

CAUTION

Taping two cut ends of the shock tube together does not make a reliable splice.

SECTION IV. SAFETY PROCEDURES

CONSIDERATIONS

7-57. When conducting training and missions with MDI, follow the general safety considerations for demolitions as given in *Chapter 6* and AR 385-63.

7-58. Because MDI components are delivered from the factory precrimped, they are more reliable and safer to handle and use than the current standard military blasting caps. During testing of the MDI components, it was found that the blasting caps would always function correctly if the shock tube was properly initiated. Misfires only occurred when the—

- M81 fuse igniter was not properly connected to the shock tube before initiation.
- Shock tube was cut by shrapnel during the initiation process.
- Shock tube was incorrectly inserted into the holders on the M12 or M13 blasting caps or into the M9 holder.
- Shock tube was cut using crimpers.

WARNING

MDI is not authorized for below-ground or internal charges.

7-59. When transporting or storing MDI blasting caps, do not mix them with other explosives. Transporting blasting caps requires special consideration. The caps must be placed in a suitable container or in a separate vehicle.

MISFIRES WITH MDI

7-60. Working on or near a misfire is the most hazardous of all blasting operations.

> **WARNING**
> **Do not handle misfires downrange until the required 30-minute waiting period for both primary and secondary initiation systems has elapsed and other safety precautions have been taken.**

PREVENTION

7-61. A misfire in the MDI system should be 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 or shock tube in the relay-cap holders is in contact with the blasting cap. Do not mix the detonating cord and the shock tube 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 procedures.
- Emplace and prime all charges carefully.
- Prime all buried charges with 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.
- Visually inspects the firing system before initiation.
- Cover the M14 or M18 delay cap when used as a secondary initiation set. This prevents cap fragments if the M14 or M18 does not fire with the primary initiation set.

MISFIRES

7-62. The most common cause of a misfire in a shock-tube firing system is the initiating element, usually an M81 igniter. The misfire steps below are for both the command-initiated and delay-initiated systems.

7-63. The most common failure with the M81 is the primer not firing. To correct this, recock the M81 by pushing in on the pull rod to reengage the firing pin and then actuate the igniter again. 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.

7-64. Another misfire mode with 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 about 3 feet from the end of the shock tube, replace it with a new igniter, and repeat the firing procedure. Use the following steps to correct misfire problems:

Step 1. If the igniter appears to have functioned properly (primer pops and smokes), but the charge did not fire, cut a 1-foot section from the shock tube starting about 6 inches from the igniter. Hold the 1-foot piece of shock tube so that one end is over the palm of your hand and gently blow through the other end. If a fine 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 priming shock tube and repeat the firing procedure.

Step 2. If the igniter/initiating element functioned properly and no fine powder was blown from the shock tube in the previous step, or the shock tube was hard to fire or its flash was seen, observe the standard 30 minutes waiting time before going downrange to check the components in the firing system. Shock-tube blasting caps are nonelectric blasting caps, and the standard rules apply in the event of a misfire.

Step 3. After waiting 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 plastic connectors of the M12s/M13s or the M9 holder (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, step 1 above may be done 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 (M12 or M13) by cutting the shock tube down line from the defective shock tube 1 foot past the relay-cap block. Seal the shock tube by bending it 2 inches from the cut and taping it with electrical tape. Move down the defective tube, and cut it 10 feet from the blasting cap. Remove and dispose of the defective shock tube and cap according to local misfire policies. 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 (such as when range clearance is received).

Step 5. If the shock tube contains no explosive dust because it has been fired, the problem is probably with the blasting cap. Cut the shock tube down line from the defective blasting cap 1 foot past the relay-cap block. Seal the shock tube by bending it 2 inches from the cut and taping it with electrical tape. Move down the shock tube of the defective blasting cap, and cut it 10 feet from the blasting cap. Remove and dispose of the defective shock tube and cap according to local misfire policies. 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 (such as when range clearance is received).

WARNING

Never yank or pull hard on the shock tube. This may actuate the blasting cap.

Step 6. If the first component of the firing train was not the one which failed, check out each succeeding component until you find the failed one. Replace the failed or fired relay components back to the initiating site as in steps 4 and 5 above.

Step 7. If the failed component appears to be the final high-strength blasting cap (such as a M11 or M16 branch line), replace if it is easily accessible. If it is used to prime an explosive charge, do not disturb it. Place a new, primed 1-pound explosive charge next to the misfired charge, and detonate it when it is safe to do so.

SECTION V. MDI USE WITHIN COMMON DEMOLITION MISSIONS

FIRING SYSTEMS PLANNING

7-65. The MDI system has many components which 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.

STEEL-CUTTING CHARGES

7-66. Emplace steel-cutting charges according to the procedures outlined in *Chapter 3* of this manual. Explosive calculations and emplacement procedures are the same for MDI systems. Use the procedures below to emplace firing systems:

STEEL I-BEAM

- Place explosives according to the procedures outlined in *Chapter 3*.
- Lay out transmission lines from the charge to the firing point. Transmission lines consist of M16s, M12s or M13s.
- Lay out M11 or M16 branch lines from the C-shaped charge and the flange charges to the holder on the transmission line. Make an overhand knot in the shock tube. Ensure that the distance from the cap ends to the knot is the same on all three shock tubes. Insert the branch lines into the holder on the M12's transmission line, snap the hinged flap shut, and tape it closed. Refer to *Figure 7-21*.
- Prime the C-shaped charge and flange charges according to the procedures outlined in *Chapter 3*, using minimal personnel on site.
- 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's/M13's transmission line and initiate the firing system.

SADDLE, RIBBON, AND DIAMOND CHARGES

- Place explosives according to the procedures outlined in *Chapter 3*.
- Lay out transmission lines from the charge to the firing point. Transmission lines consist of M16s, M11s, M12s, or M13s.

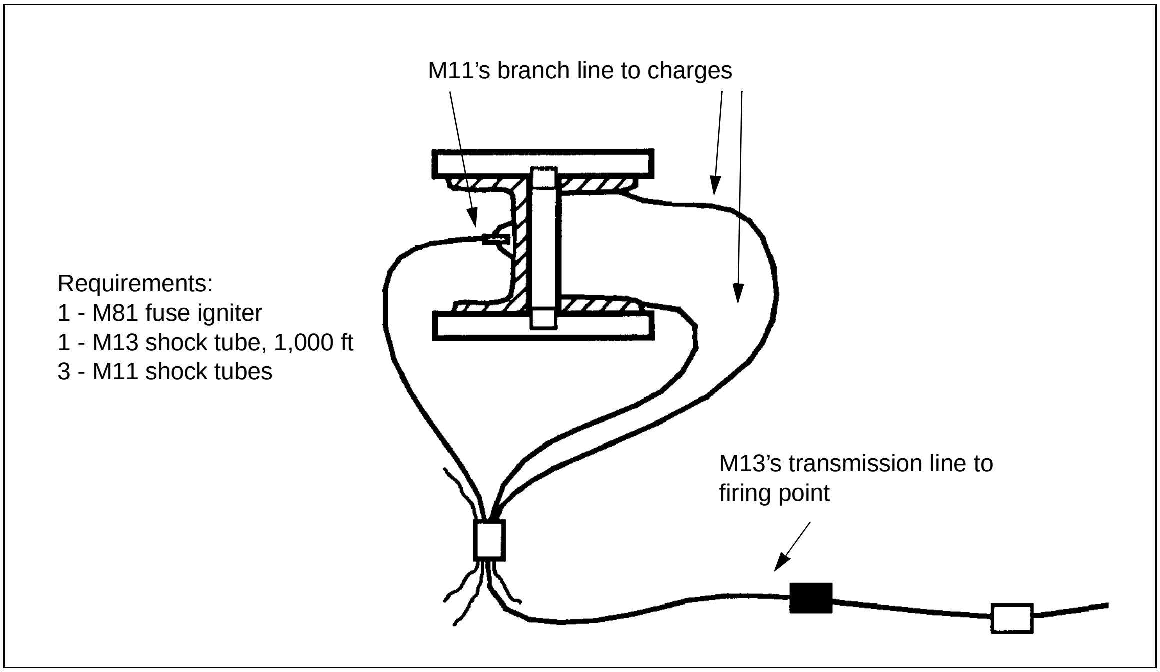


Figure 7-21. Steel I-beam

- Lay out M11 or M16 branch lines from the center of the charge to the holder on the transmission line. Insert the branch lines into the holder on the M12's transmission line, snap the hinged flap shut, and tape it closed.
- Prime the charge according to the procedures outlined in *Chapter 3*, using minimal personnel on site.
- 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's/M13's transmission line and initiate the firing system.

BRIDGE DEMOLITION CHARGES

7-67. Emplace bridge demolition charges according to the procedures outlined in *Chapter 4*. Explosive calculations and emplacement procedures are the same for MDI systems. Emplace firing systems using the steps below:

Step 1. Place explosives according to the procedures outlined in *Chapter 4*.

Step 2. Lay out transmission lines from the farthest charge to the firing point. Transmission lines consist of M16s, M11s, M12s, M13s, or detonating cord.

Step 3. Lay out M11 or M16 branch lines from the C-shaped charge and the flange charges to the transmission line.

- Use the following procedure if the transmission lines are MDI:
  - — Lay out M11 M16 transmission lines from the M12/M13 to each charge. Insert the lines into the holder on the M12/M13, snap the hinged flap shut (only five shock tubes per holder), tape it closed,

and repeat the process until all transmission lines are connected (*Figures 7-22* and *7-23*).

- Insert the explosive charge's branch lines into an M9 holder on the M11's transmission line, snap the hinged flap shut, and tape it closed.
- Prime the C-shaped charge and flange charges according to the procedures outlined in *Chapter 3*, using minimal personnel on site.
- Repeat the last two points for each charge.

• Use the following procedure if you use a line or ring main of detonating cord is used between charges.

- Lay out the M11 transmission line from the M12/M13 to the closest charge. Insert the M11 into the holder on the M12/M13, snap the hinged flap shut, and tape it closed. Lay out a detonating-cord line main or ring-main line from the M11 or M16 to the farthest charge. Connect the detonating cord to the M11 or M16 transmission line by inserting it into the M9 holder on the M11 or M16, snap the hinged flap shut, tape the M9 holder closed (*Figure 7-23*).
- Use the J-hook device to connect the M11 or M16 branch lines to the detonating-cord transmission line.
- Prime the C-shaped charge and flange charges according to the procedures outlined in *Chapter 3,* using minimal personnel on site.
- Repeat the second and third points for each charge.

Step 4. 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/M13 transmission line and initiate the firing system.

TIMBER-CUTTING CHARGES

7-68. Emplace timber-cutting charges according to the procedures outlined in *Chapter 3* of this manual. Explosive calculations and emplacement procedures will be the same for MDI systems. Emplace firing systems as follows.

EXTERNAL TIMBER CHARGE

7-69. Use the following steps when placing external timber charges (*Figure 7-24*):

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. Transmission lines consist of M12s or M13s.

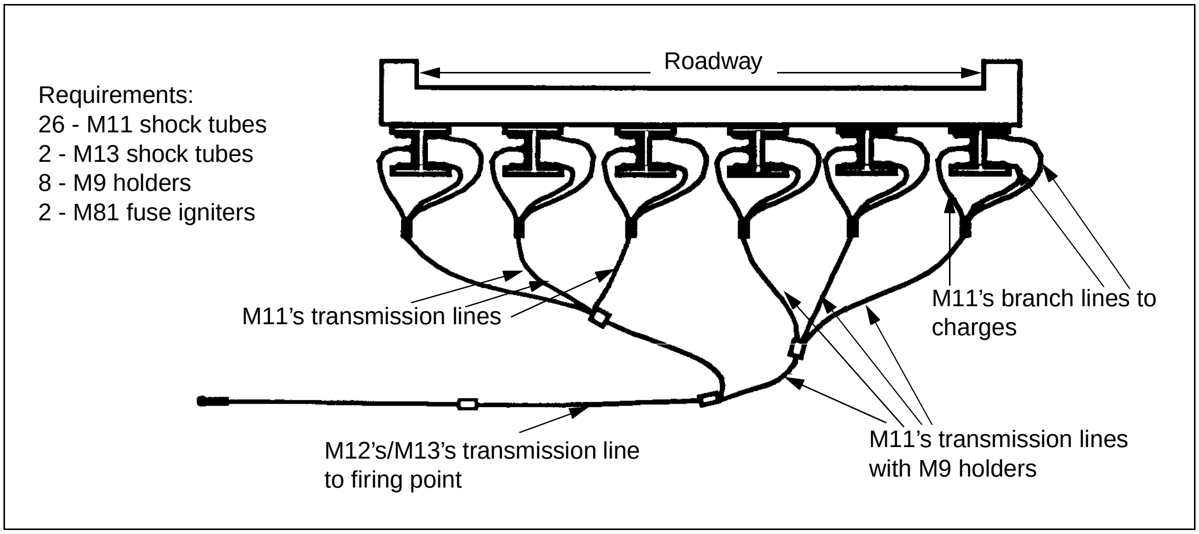


Figure 7-22. MDI balanced firing system for bridge demolition charges

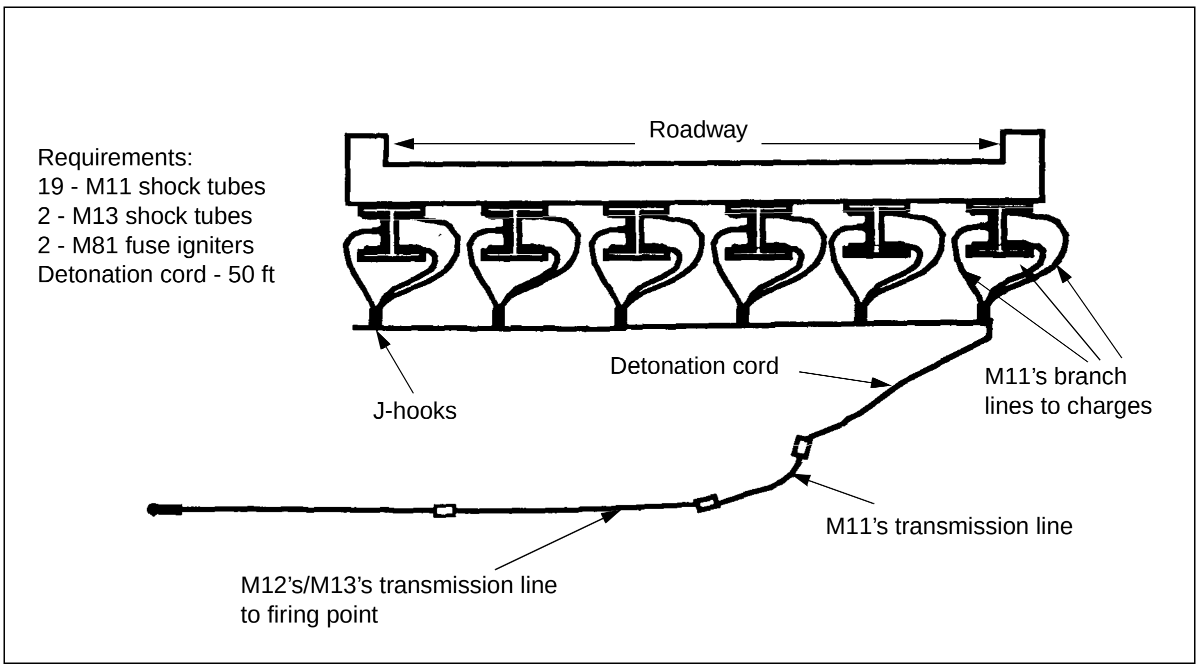


Figure 7-23. Bridge demolition charges (combination MDI/detonation cord)

Step 3. Lay out M11 or M16 branch lines from the charges to the holder on the M12 transmission line. Insert the branch lines 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 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's/M13's transmission line and initiate the firing system.

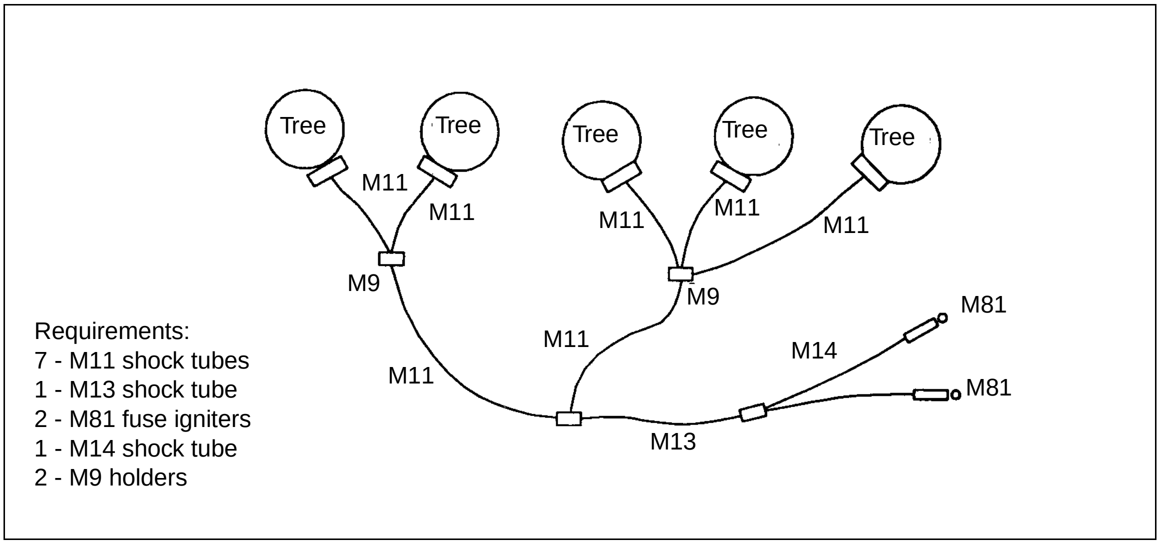


Figure 7-24. External timber charges

INTERNAL TIMBER CHARGE

7-70. Use the following steps when placing internal timber charges (*Figure 7-25*):

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. Transmission lines consist of M11s, M16s, M12s, and M13s. You will need an M9 holder for the M11 or M16 transmission lines.

Step 3. Lay out branch lines. Tie the detonating-cord branch lines into the line main. Construct the line main according to the procedures outlined in *Chapter 2*. Connect the M11 or M16 transmission line to the detonating cord using a M9 holder, tape it closed, and tie an overhand knot with the MDI tails. Insert the M11 or M16 transmission line into the holder on the M12's/M13's transmission line, snap the hinged flap shut, and tape it closed.

WARNING
Do not use MDI for priming internal charges.

Step 4. 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's/M13's transmission line and initiate the firing system.

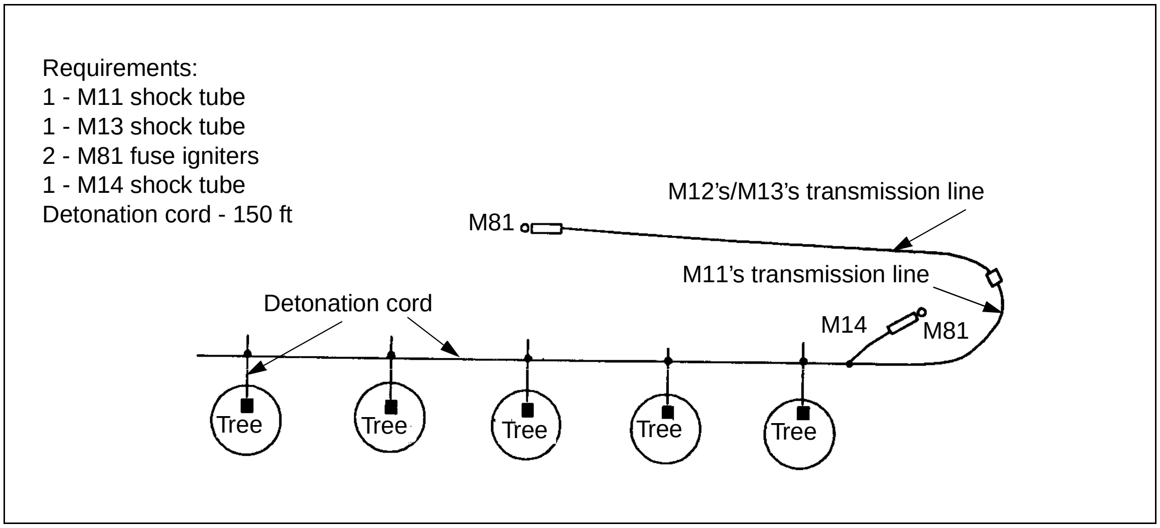


Figure 7-25. Internal timber charges

BREACHING CHARGES

7-71. Emplace breaching charges according to the procedures outlined in *Chapter 3*. Explosive calculations and emplacement procedures are the same for MDI systems. Use the following steps to emplace firing systems:

Step 1. Place explosives according to the procedures outlined in *Chapter 3*.

Step 2. Lay out transmission lines.

- Use the following procedure if the transmission lines are MDI.
  - — Lay out transmission lines from the farthest charge to the firing point. Transmission lines consist of M12s/M13s.
  - — Lay out M11 or M16 transmission lines from the M12/M13 to each charge. Insert the lines into the holder on the M12/M13, snap the hinged flap shut (use only five shock tubes per holder), and tape it closed (*Figure 7-26*).
  - — Insert the explosive charges branch lines into an M9 holder on the M11 or M16 transmission line, snap the hinged flap shut, and tape it closed.
  - — Prime the charges according to the procedures outlined in *Chapter 3,* using minimal personnel on site.
- Repeat the third and fourth points for each charge.
- Use the following procedure if you use a detonating-cord line main or ring main.
  - — Lay out transmission lines from the closest charge to the firing point. Transmission lines consist of M12s/M13s with an M11 or M16 closest to the charges. You need a M9 holder to connect the detonating cord to the M11 or M16.

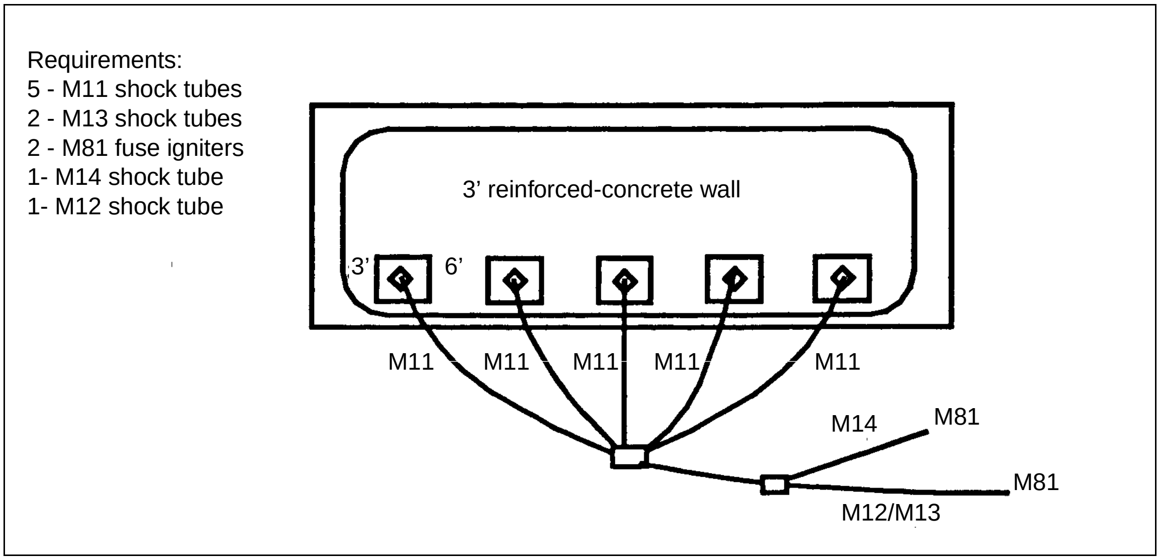


Figure 7-26. Breaching MDI

— Lay out a detonating-cord line main or ring main from the M11 or M16 to the farthest charge. Connect the M11 or M16 transmission line by inserting the detonating cord into the M9 holder on the M11 or M16, snap the hinged flap shut, and tape it closed (*Figure 7-27*).

— Lay out M11's branch lines from the charges to the detonating-cord line main or ring main. Connect the M11 or M16 branch lines onto the detonating-cord transmission line using the J-hook device.

— Prime the charges according to the procedures outlined in *Chapter 3*, using minimal personnel on site.

— Repeat the third and fourth points for each charge.

Step 3. 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's/M13's transmission line and initiate the firing system.

MINEFIELD BREACHING CHARGES

7-72. Emplace (mine/countermine) breaching charges according to the procedures outlined in FM 20-32. However, note that using MDI is not very efficient due to time constraints and direct-fire exposure. Therefore, detonation cord is the preferred method for minefield-breaching charges during tactical or protective minefield breaches.

QUARRYING

7-73. The M15 delay blasting cap is specially designed for quarry operations. It is a 70-foot length of shock tube with a high-strength 200-millisecond delay

Requirements:
5 - M11 shock tubes
2 - M13 shock tubes
2 - M81 fuse igniters
1- M14 shock tube
1- M12 shock tube
Detonation cord - 50 ft

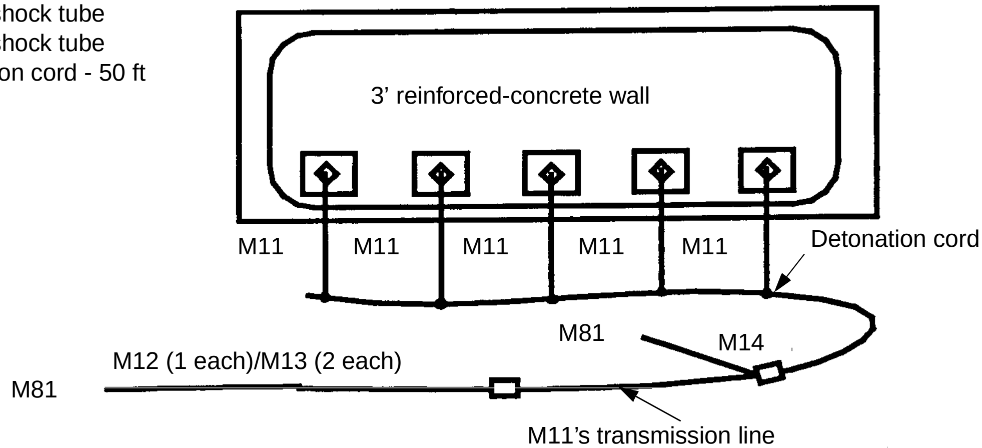


Figure 7-27. Breaching detonation cord

blasting cap on one end and a low-strength (relay cap) 25-millisecond delay blasting cap on the other. The 25-millisecond blasting cap is fitted with a plastic connector to allow connection to the shock tube of another MDI component (refer to *Figure 7-28*). The M15 delay high-strength blasting cap can only be used underground with water-gel explosives.

DANGER
The M15 delay blasting cap is not to be placed below ground level in quarrying operations.

WARNING
Always use the 25-millisecond delay blasting cap only to initiate other shock-tube blasting caps. This blasting cap is low-strength and may cause a misfire if used to initiate detonating cord. The 200-millisecond delay blasting cap is used to initiate detonating cord.

.

Figure 7-28. M15 25-millisecond delay blasting cap with a plastic connector

BLAST DESIGN

7-74. As in any quarry blasting operation, the first step in removing rock from a quarry is to design a cut. It is important to do calculations for the blast before starting drilling operations. In the calculations, the burden, subdrilling, stemming, and spacing are determined based on the type of rock and the geologic condition. The type of drilling equipment available is also considered, as well as the type of explosive. The type of explosive will be determined based on the rock type, the geologic conditions, and the size of the borehole drilled. Refer to Chapter 6 of TM 5-332 for cut design calculations. Using *Figure 7-29* as an example, assume blasting of a multiple-row square pattern with 3 rows and 5 holes per row.

CHARGE LOADING

7-75. Several steps are necessary to do charge loading:

Step 1. Prime the borehole charges with detonating cord.

Step 2. Run out detonating-cord line mains and connect the branch lines.

INITIATION/FIRING SYSTEM

7-76. Connect the surface blasting caps in the following sequence (*Figure 7-29*):

- Run out the M12s/M13s from the detonating-cord line main closest to the face to the minimum safe distance.
- Lay out the M11s from the two line mains closest to face.
- Connect the M12 to the M15, so that the low-strength cap is then connected to the M11 for the line main closest to the face. The high-strength cap should connect to the M11 for the middle line main and to the M15 for the line main furthest from the face.

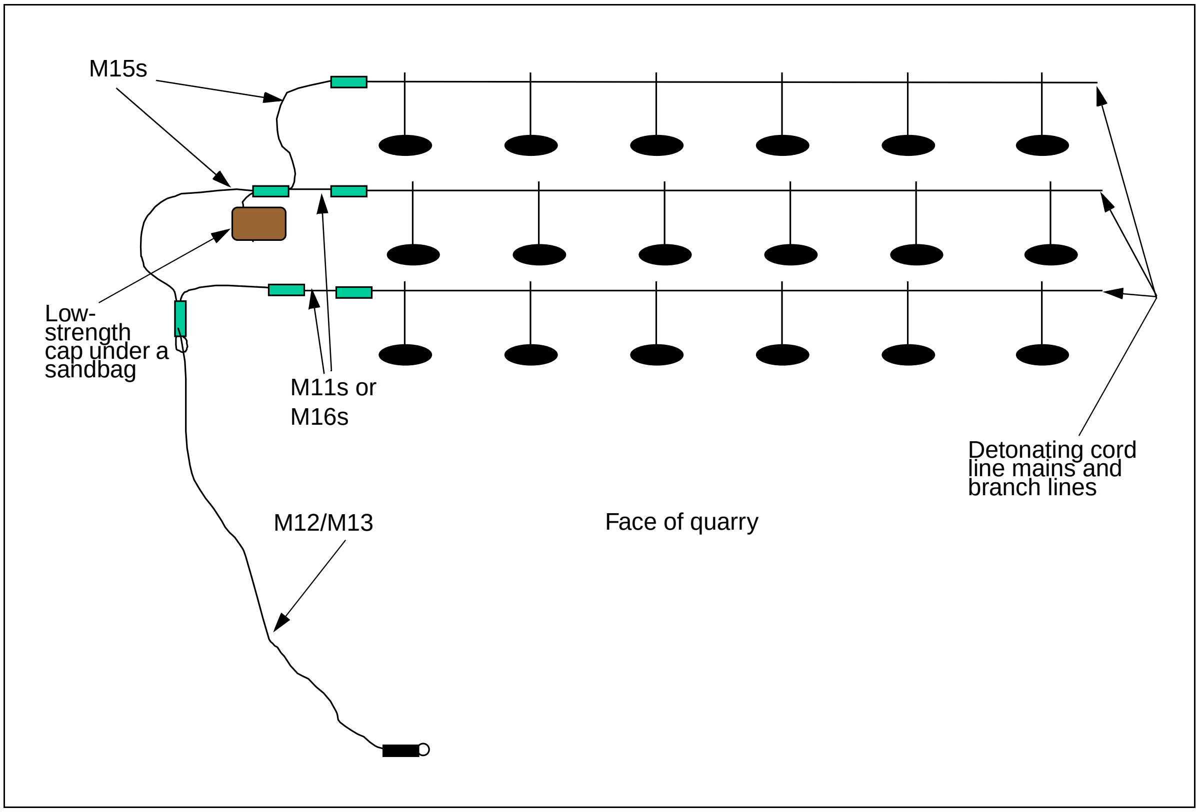


Figure 7-29. MDI firing system for blasting pattern layout

- The M15 for the line main furthest from the face will have the high-strength cap ready to connect to the detonating cord and the low-strength placed under a sandbag.
- Connect all high-strength caps to the detonating cord, working from rear to face.

Chapter 8

Demolition Effects Simulators

8-1. The DESs are described in this chapter. It provides details for each type of simulated demolition, the priming methods for each type, the initiation set preparation, and the set-up of firing systems.

SECTION I. DES DEVICES

8-2. To meet field requirement, all 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 produce sufficient visual and sound effects to enhance battlefield realism. Follow all safety precautions for live explosives and demolitions when using DESs. All soldiers will observe the standard operational and safety procedures in this manual when using DESs. Observe all minimum safe distances (MSDs), even though, realistically, these safety distances are less for DESs.

OVERVIEW

8-3. Currently, 10 DESs are available for field-training exercises. These devices simulate the—

- M118 sheet explosive.
- M112 (C4) block.
- One-pound TNT block.
- M5A1 demolition block.
- M183 demolition (satchel) charge.
- M2A3 fifteen-pound shape charge.
- M3 forty-pound shape charge.
- Forty-pound cratering charge.
- Bangalore torpedo.
- M1 military dynamite.

8-4. 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 military operations on urbanized terrain (MOUT). (Primary uses for each DES are listed in Section II, page 8-2.) All of these missions can be executed safely with little or no damage to facility infrastructures.

8-5. All charges except the M112 (C4) block and the M118 sheet explosive are chalk charges. The chalk charges are various containers filled with a chalk powder and sand mixture and detonating cord. Detonating cord is the explosive propellant that discharges the chalk powder. The M112 DES block is a nonexplosive clay compound that replicates C4. The M118 is made of nonexplosive rubber matting. The explosive signatures come strictly from the detonating-cord blast.

PREREQUISITES

8-6. Soldiers who assemble DES devices must be familiar with all detonating-cord priming methods (refer to Section III, page 8-19). The eight-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 II. CHARACTERISTICS AND ASSEMBLY INSTRUCTIONS

8-7. 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 K for a list of DES materials.)

M118 SHEET EXPLOSIVE DES

CHARACTERISTICS

8-8. The M118 block demolition charge DES, or *sheet explosive*, 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

8-9. This charge is primarily used for ribbon, saddle, diamond, and steel-cutting charges.

ASSEMBLY INSTRUCTIONS

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 8-1) 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 8-1) 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 8-1) 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 DESs charges into each shipping container. Label each container.

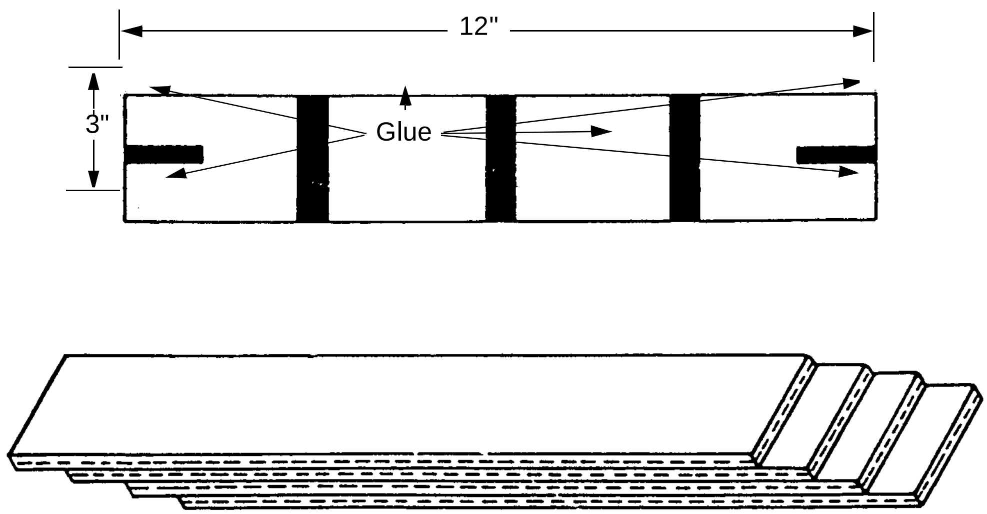


Figure 8-155. M118 sheet explosive DES

SPECIFICATIONS

8-10. M118 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 (BOM)

8-11. The BOM is shown in Table 8-1, page 8-4.

M112 (C4) BLOCK DES

CHARACTERISTICS

8-12. The M112 (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.

Table 8-27. BOM for M118 sheet explosive DES

Rubber matting, $^{1}/_{8}$ inch	8 ea
Glue	6 oz
Clear plastic bag	1 ea
Clear tape	2 ft
Adhesive tape, two-sided	2 ft
DES label	1 ea

PRIMARY USES

8-13. The M112 charge is used primarily for steel-cutting charges, building forced entry, breaching, cutting timber, demolishing bridges, and neutralizing mines.

ASSEMBLY INSTRUCTIONS

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 correctly form the clay (1 by 2 by 10 inches) (Figure 8-2).

Step 3. Cover the block with a thin covering of mineral oil.

Step 4. Place it 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. Label each container.

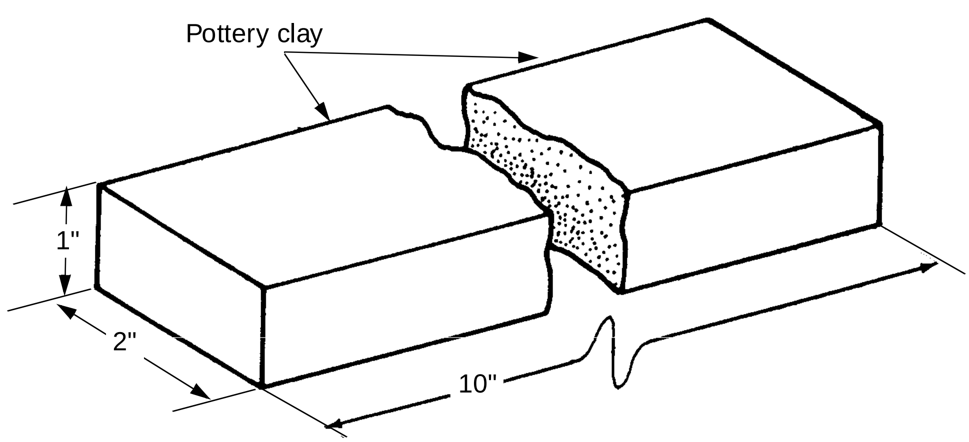


Figure 8-156. M112 (C4) block DES

SPECIFICATIONS

8-14. 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.

BILL OF MATERIALS

8-15. The BOM is shown in Table 8-2.

Table 8-28. BOM for M112 (C4) block DES

Moist pottery clay	$1^1/_4$ lb
Mineral oil	1 oz
Clear plastic bag	1 ea
Clear tape	10 in
Tape, two-sided	9 in
DES label	1 ea

ONE-POUND TNT-BLOCK DES

CHARACTERISTICS

8-16. The TNT-block DES is made of 1 pound of chalk-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

8-17. This charge used primarily for neutralizing mines, reducing fortifications, MOUT, breaching, and cutting timber.

ASSEMBLY INSTRUCTIONS

Step 1. Assemble the box by folding along the creases (Figure 8-3, page 8-6). Tape it to prevent it from unfolding.

Step 2. Fill half of the box with a 50:50 mixture of chalk and sand.

Step 3. Tie a Uli knot and place it in the box.

*Step 4***.** Finish filling the box with the chalk-and-sand mixture.

Step 5. Make a small hole in the top flap. Thread the free end of the detonating cord through the hole at least 18 inches.

Step 6. Close the top flap and completely tape the outside with olive-drab fabric tape.

Step 7. Label each block with a DES label.

Step 8. Place 48 TNT DES devices in each shipping crate. Label each crate.

NOTE: Omit steps 3 and 5 if using detonating cord as an external primer or if priming with a blasting cap (nonelectric or electric) inserted in a cap well.

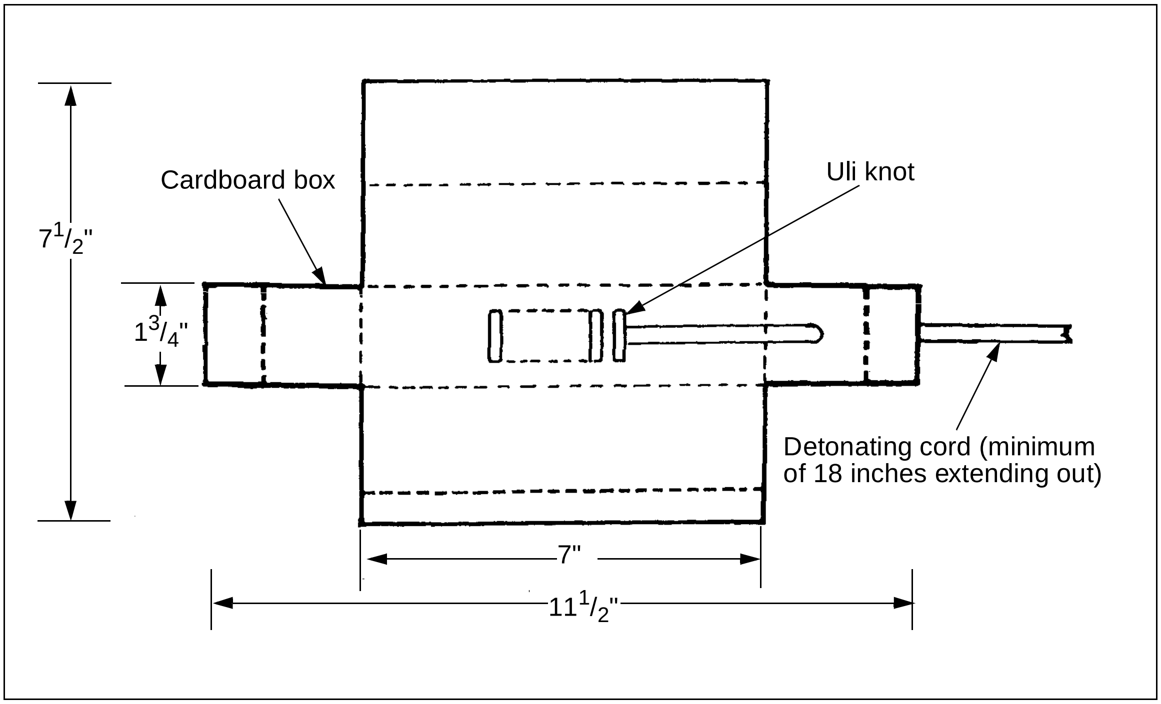


Figure 8-157. One-pound TNT-block DES

SPECIFICATIONS

8-18. One-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

8-19. The BOM is shown in Table 8-3.

Table 8-29. BOM for 1-pound TNT-block DES

Cardboard box	1 ea
Detonating cord	4 ft
50:50 mixture of chalk and sand	1 lb
Olive-drab fabric tape	4 ft
DES label	1 ea

M5A1 DEMOLITION-BLOCK DES

CHARACTERISTICS

8-20. The M5A1 demolition block charge DES is a rectangular cardboard box filled with $2^1/_2$ pounds of chalk and sand. This device can be made *with* or *without* an internal detonating-cord booster.

PRIMARY USES

8-21. The M5A1 charge is used primarily for demolishing bridges, breaching, neutralizing mines, reducing fortifications, and cutting timber.

ASSEMBLY INSTRUCTIONS

Step 1. Assemble the box by folding along the creases (Figure 8-4). Tape the box to prevent it from folding.

Step 2. Fill half of the box with a 50:50 mixture of chalk and sand.

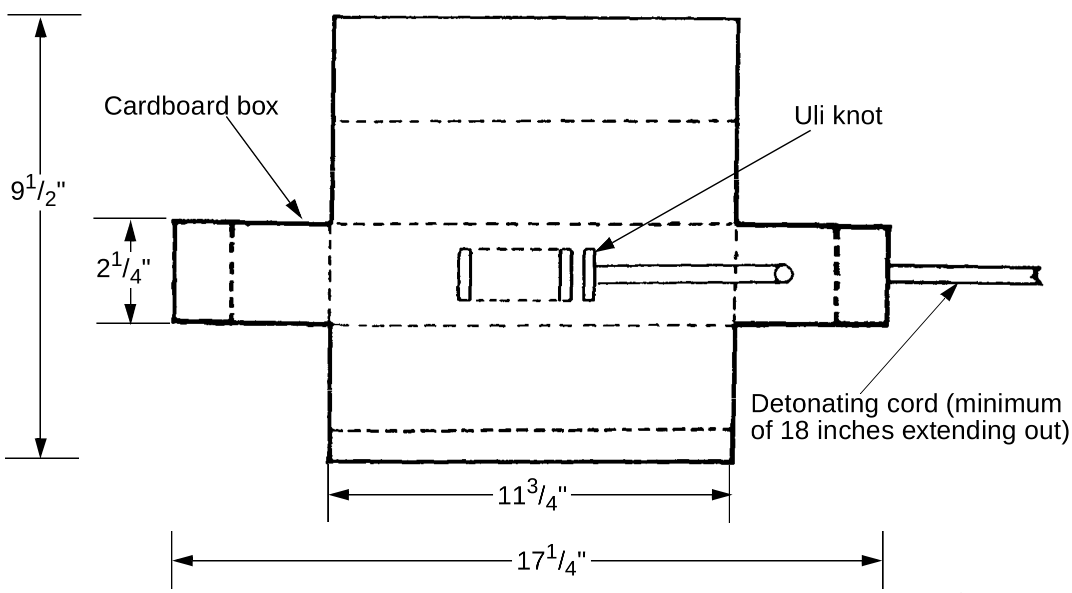


Figure 8-158. M5A1 demolition-block DES

Step 3. Tie a Uli knot and place it in the box.

Step 4. Finish filling the box with the chalk-and-sand mixture.

Step 5. Make a small hole in the top flap. Thread the free end of the detonating cord through the hole at least 18 inches.

Step 6. Close the top flap and completely tape the outside with olive-drab fabric tape.

Step 7. Label each block with a DES label.

Step 8. Place 24 demolition blocks in each container. Label each container.

NOTE: Omit steps 3 and 5 if using detonating cord as an external primer or when priming with a blasting cap (nonelectric or electric) inserted in a cap well.

SPECIFICATIONS

8-22. 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.

BILL OF MATERIALS

8-23. The BOM shown in Table 8-4.

Table 8-30. BOM for M5A1 demolition block DES

Cardboard box	1 ea
Detonating cord	4 ft
50:50 mixture of chalk-and-sand	$2^1/_2$ lb
Olive-drab fabric tape	5 ft
DES label	1 ea

M183 DEMOLITION (SATCHEL) CHARGE DES

CHARACTERISTICS

8-24. The M183 demolition-charge assembly DES, or *satchel charge*, consists of 8 M5A1 DES blocks. The blocks come in two sandbags, 4 blocks per bag. The two bags come in an M85 canvas carrying case (Figure 8-5). Two M85 cases come in a wooden box.

PRIMARY USES

8-25. This charge is used primarily for breaching, demolishing bridges, reducing fortifications, and destroying cache sites.

ASSEMBLY INSTRUCTIONS

Step 1. Construct four M5A1 DES demolition blocks using assembly instructions for the M5A1 in paragraph 8-6, page 8-2, except the M5A1 should have an 8-inch tail of detonating cord coming out the bottom. Only one of the blocks should have the 18-inch length of cord extending out of the top; all others should be trimmed evenly with the top of the box and taped 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 8-6).

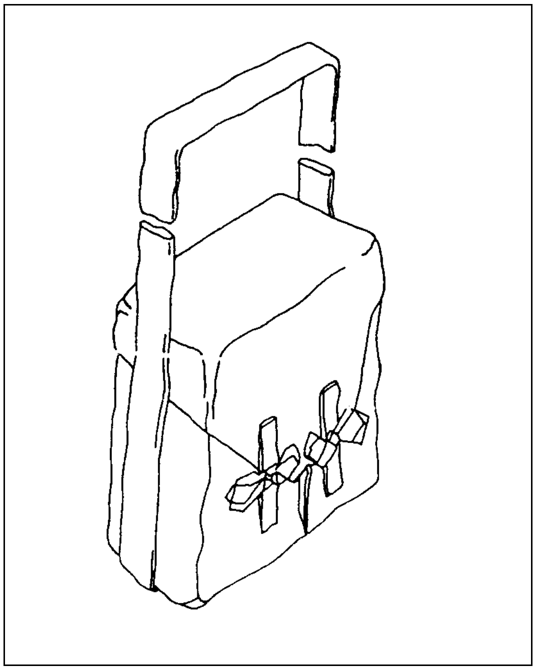


Figure 8-159. M85 carrying case (filled)

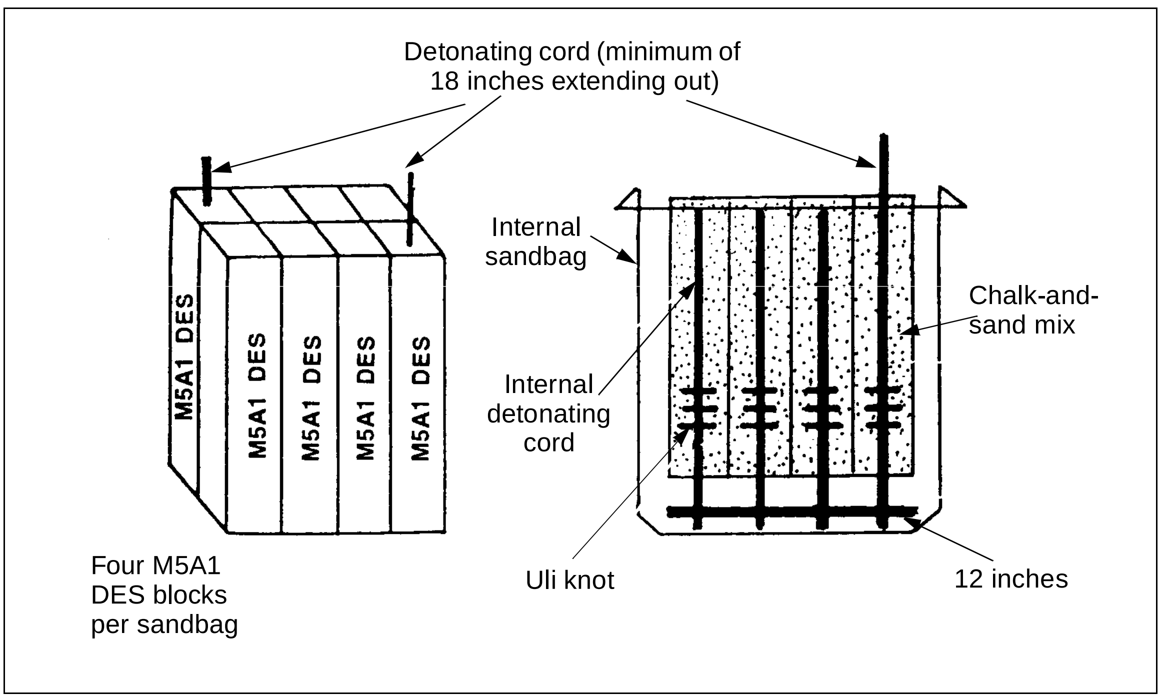


Figure 8-160. M183 satchel-charge DES

*Step 4***.** Tape or tie the 8-inch tails of the M5A1 blocks to the 12-inch detonating cord along the bottom. Trim off and tape all detonating cord ends.

Step 5. Place the 4 demolition blocks in a sandbag that has been cut or rolled back, exposing the top edge of the 4 blocks (Figure 8-6, page 8-9).

Step 6. Repeat steps 1 through 5 for the second half of the M183.

Step 7. Place the two complete sandbags into the canvas satchel charge bag and tie it shut. Place a DES label on the satchel charge.

Step 8. Place two satchel charges in each shipping container. Label each container.

SPECIFICATIONS

8-26. 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.

BILL OF MATERIALS

8-27. The BOM is shown in Table 8-5.

Table 8-31. BOM for M183 demolition-charge DES

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 FIFTEEN-POUND SHAPE CHARGE DES

CHARACTERISTICS

8-28. This charge is made of one steel shape charge training aid filled with $1^1/_2$ pounds of chalk-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

8-29. This charge is primarily used for cratering and destroying abutments.

ASSEMBLY INSTRUCTIONS

Step 1. Cut the cardboard tube insert (10 inches) and glue a plastic cap on one end (Figure 8-7). Allow it to dry.

Step 2. Fill half of the tube with a 50:50 mixture of chalk and sand.

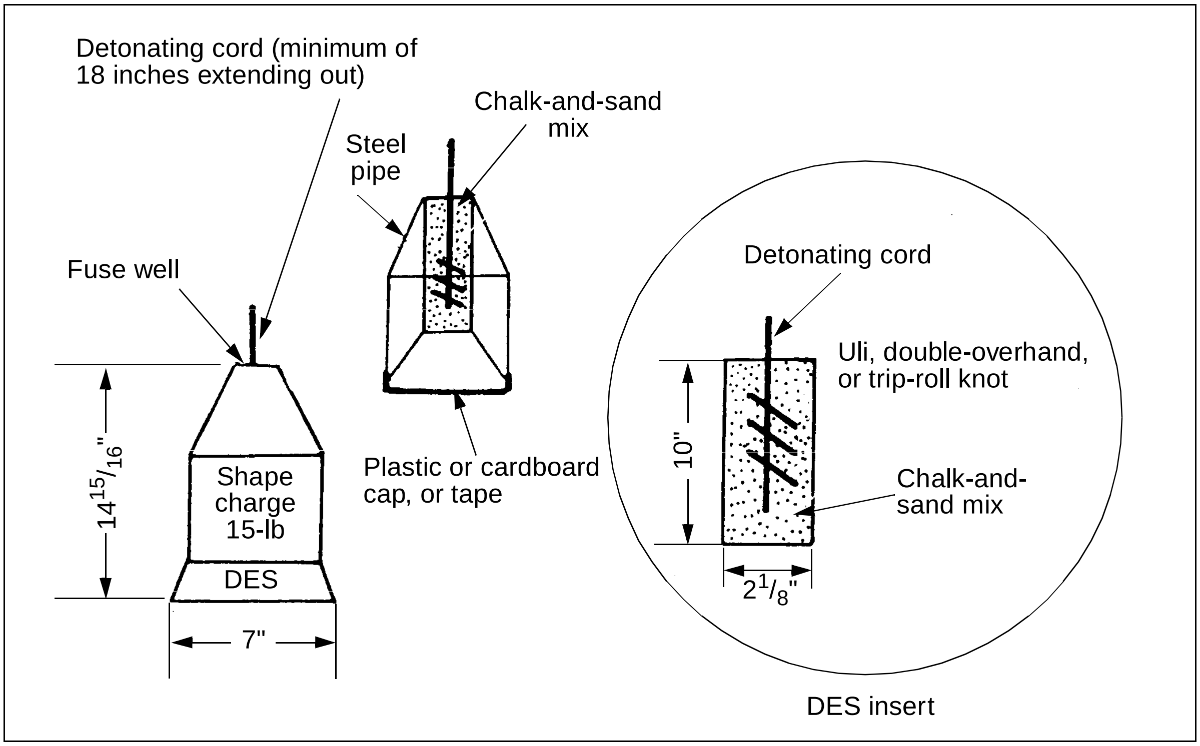


Figure 8-161. Fifteen-pound shape charge DES

Step 3. Tie a Uli knot or double-overhand knot in 36 inches of detonating cord. Place the knot inside the tube (Figure 8-7). Finish filling the tube with the chalk-and-sand mixture.

Step 4. Cut a $^{1}/_{8}$-inch hole in the center of a second plastic cap. Thread the detonating cord through the hole in the cap with a minimum of 18 inches extending out. Glue the cap on the open end of the tube and allow it to dry.

Step 5. Place tape over the free running end of the detonating cord.

Step 6. Place the cardboard tube into the steel shape charge training device, threading the detonating cord up through the fuse well at least 18 inches (Figure 8-7).

Step 7. Tape the end of the detonating cord to the charge.

Step 8. Label each charge with a DES label.

Step 9. Place three DES shape charges into an old shipping container, or four if using a new container. Label the container.

SPECIFICATIONS

8-30. Fifteen-pound shape 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

8-31. The BOM is shown in Table 8-6.

Table 8-32. BOM for 15-pound shape charge DES

M2A3 steel shape charge DES	1 ea
Cardboard tube	1 ea
Detonating cord	4 ft
50:50 chalk-and-sand mixture	1.5 lb
Plastic cap	2 ea
Glue	1 container
Fabric tape	4 ft or 2 ea
DES label	1 ea

M3 FORTY-POUND SHAPE CHARGE DES

CHARACTERISTICS

8-32. This charge is made of one steel shape charge training aid filled with $1^1/_2$ pounds of chalk. The chalk is placed into a 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

8-33. This charge is used primarily for cratering and destroying abutments.

ASSEMBLY INSTRUCTIONS

Step 1. Cut a cardboard tube insert (12 inches), and glue a plastic cap on one end (Figure 8-8). Allow it to dry.

Step 2. Fill half of the tube with a 50:50 mixture of chalk and sand.

Step 3. Tie a Uli knot or double-overhand knot in 36 inches of detonating cord. Place the knot inside the tube. Finish filling the tube with the chalk-and-sand mixture (Figure 8-8).

Step 4. Cut a $^1/_8$-inch hole in the center of a second plastic cap. Thread the detonating cord through the hole in the cap with a minimum of 18 inches extending out. Glue the cap on and allow it to dry.

Step 5. Place tape over the free running end of the detonating cord.

Step 6. Place the cardboard tube into the steel shape charge training device, threading the detonating cord up through the fuse well at least 18 inches (Figure 8-8).

Step 7. Tape the bottom end of the detonating cord to the charge.

Step 8. Label each charge with a DES label.

Step 9. Place one DES shape charge in each shipping container. Label each container.

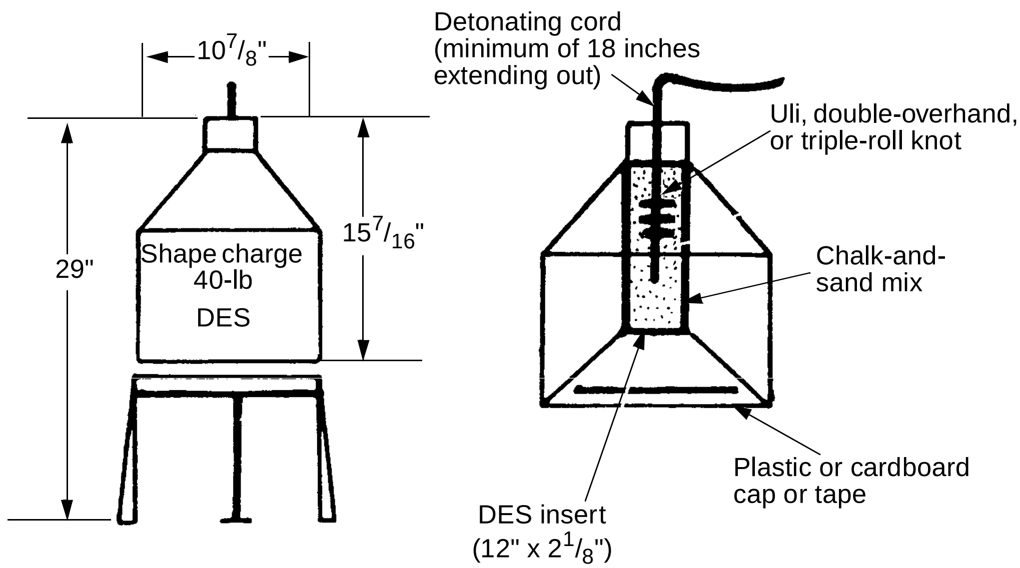


Figure 8-162. Forty-pound shape charge DES

SPECIFICATIONS

8-34. Forty-pound shape 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

8-35. The BOM is shown in Table 8-7.

Table 8-33. BOM for 40-pound shape charge DES

M3 steel shape charge, DES	1 ea
Cardboard tube	1 ea
Detonating cord	4 ft
50:50 chalk-and-sand mixture	10 lb
Glue	1 container
Fabric tape or plastic cap	4 ft or 2 ea
DES label	1 ea

FORTY-POUND CRATERING-CHARGE DES

CHARACTERISTICS

8-36. This charge is made of a cardboard tube, 24 inches long by 7 inches in diameter, filled with about 40 pounds of chalk-and-sand mix. Detonating cord is used internally as the basic propellant charge.

PRIMARY USES

8-37. This charge is used primarily for cratering and destroying abutments.

ASSEMBLY INSTRUCTIONS

Step 1. Glue a plastic cap in the bottom of 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 8-9).

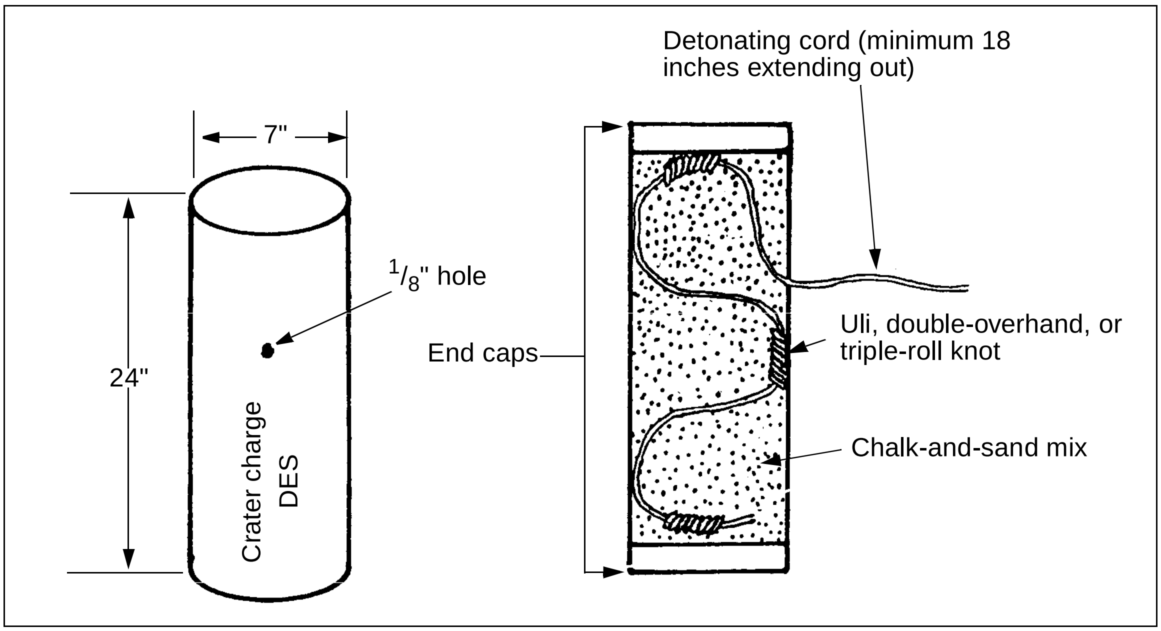


Figure 8-163. Forty-pound cratering-charge DES

Step 3. Tie three Uli knots or a double-overhand knots about 10 inches apart in a length of detonating cord, leaving about 18 inches after the last knot (Figure 8-9). Place the first knot along the bottom of the tube. Tape the remaining knots to the inside of the tube, ensuring that the detonating cord does not cross over itself.

Step 4. Fill the tube halfway with the chalk-and-sand mixture.

Step 5. Thread the running end of the detonating cord through the 1/8-inch hole (Figure 8-9). Ensure that at least 18 inches of detonating cord extends out of the hole.

Step 6. Finish filling the tube with the chalk-and-sand mixture. Use a scale to ensure proper weight.

Step 7. Glue a plastic end cap in the top of the tube.

Step 8. Place a DES label on the tube.

Step 9. Place one DES cratering charge in each shipping container. Label each container.

SPECIFICATIONS

8-38. Forty-pound cratering-charge DES specifications are as follows:

- Weight: 40 pounds.
- Dimensions: 24 by 7 inches.
- Packing: One charge per box.

BILL OF MATERIALS

8-39. The BOM is shown in Table 8-8.

Table 8-34. BOM for 40-pound cratering-charge DES

Cardboard tube	1 ea
Detonating cord	8 ft
50:50 chalk-and-sand mixture	40 lb
Plastic bag	1 ea
Plastic end cap	2 ea
Glue	1 container
DES label	1 ea

BANGALORE-TORPEDO DES

CHARACTERISTICS

8-40. 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-and-sand mixture. Detonating cord is used for the internal booster charge.

PRIMARY USES

8-41. The bangalore torpedo DES is used primarily for clearing wire obstacles and clearing AP minefields.

ASSEMBLY INSTRUCTIONS

Step 1. Tie at least three Uli knots, equally spaced, in an 18-foot length of detonating cord (Figure 8-10, page 8-16).

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 to keep it in place.

Step 5. Thread the detonating cord through one of the holes at the bottom of the coupling.

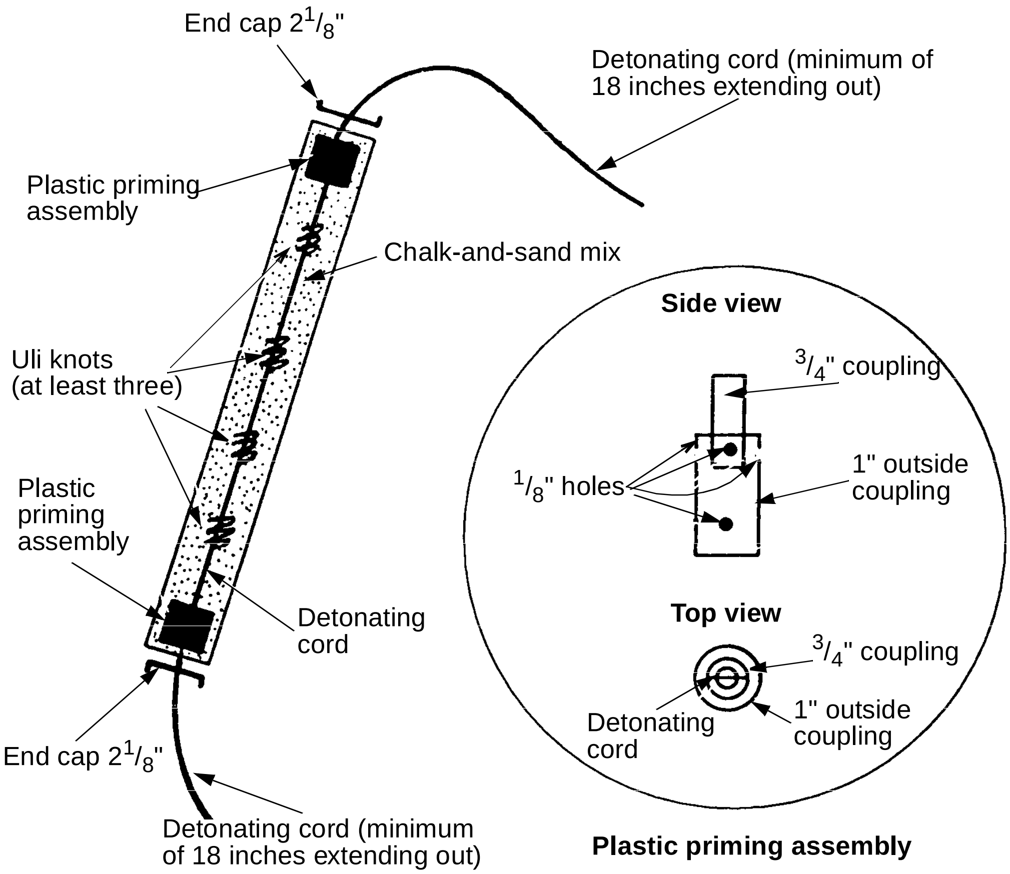


Figure 8-164. Bangalore-torpedo DES

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 8-10).

Step 8. Insert the coupling assembly into the cardboard tube, keeping it flush with the end of the tube. Wrap the assembly with fabric tape to keep a tight fit in the main tube.

Step 9. Cut an eyelet in the plastic cap and glue it into the end of the tube.

Step 10. Gently pull any of the slack out of the detonating cord through the opposite end of the cardboard tube.

Step 11. Fill the tube with 15 pounds of 50:50 mixture of chalk and sand.

Step 12. Repeat steps 3 through 8 at the other end.

Step 13. Cut an eyelet in the plastic cap and glue it into the end of the tube.

Step 14. Label all DES tubes.

Step 15. Box 10 tubes per shipping container. Label each container.

SPECIFICATIONS

8-42. 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

8-43. The BOM is shown in Table 8-9.

Table 8-35. BOM for bangalore-torpedo DES

Cardboard tube, 5 ft by 2$^1/_8$-in diameter	1 ea
Detonating cord	18 ft
Plastic coupling (1 inch)	2 ea
Plastic coupling (3/4 inch)	2 ea
Plastic end cap	2 ea
50:50 chalk-and-sand mixture	15 lb
Glue	6 oz
Fabric tape	2 ft
DES label	1 ea

M1 MILITARY-DYNAMITE DES

CHARACTERISTICS

8-44. The M1 military-dynamite DES is an 8- by 1$^1/_4$-inch cardboard tube filled with $^1/_2$ pound of chalk-and-sand mixture. The device has no internal detonating cord.

PRIMARY USES

8-45. The military-dynamite DES is used primarily for cratering, removing stumps, and breaching.

ASSEMBLY INSTRUCTIONS

8-46. Use the following steps to prime with detonation cord:

Step 1. Glue an end cap into one end of the tube. Allow it to dry.

Step 2. Punch four $^1/_8$-inch holes through both sides of the tube at designated locations (Figure 8-11, page 8-18).

Step 3. Fill the tube up almost to the first hole with the chalk-and-sand mixture.

Step 4. On top of the chalk-and-sand mixture, tamp a $^1/_2$-inch piece of pottery clay past the first hole.

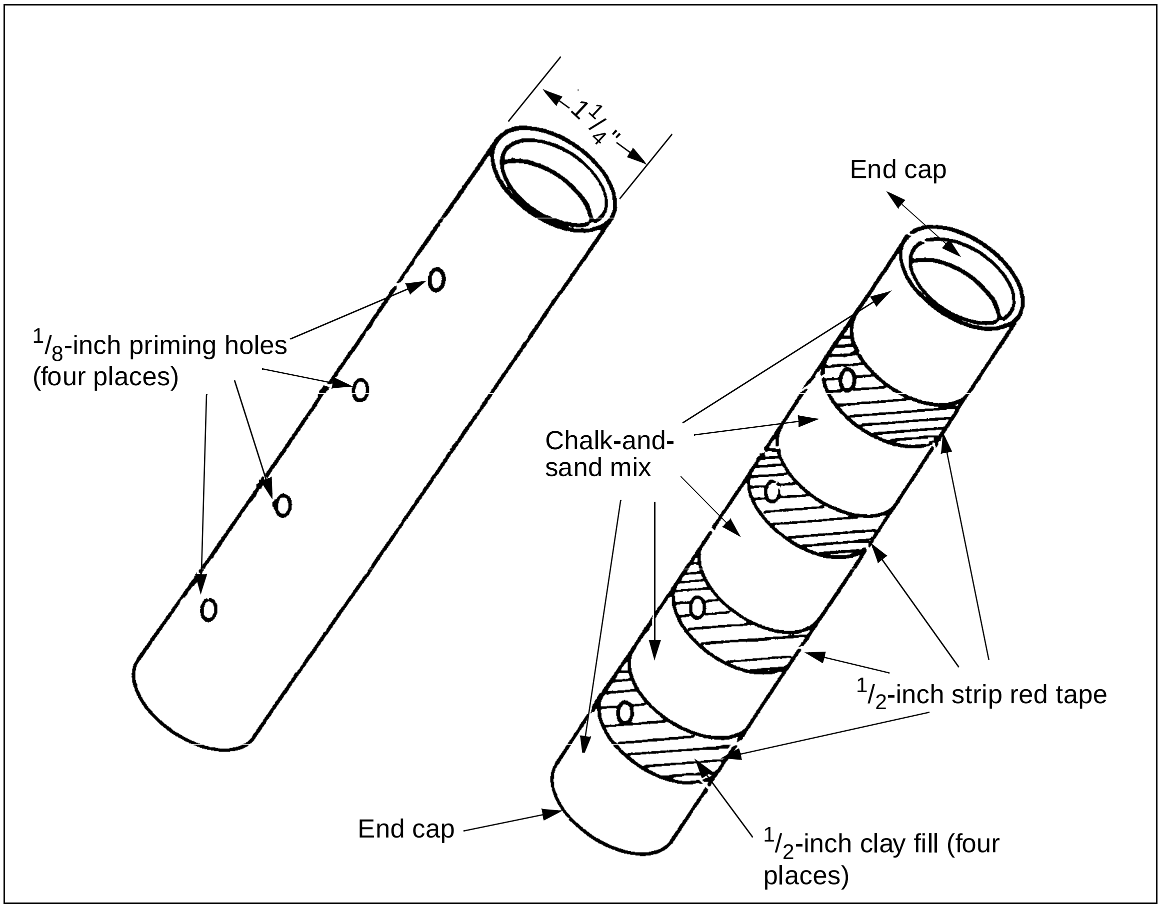


Figure 8-165. M1 military dynamite DES

Step 5. Fill the tube with the chalk-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 let 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 fabric tape.

Step 11. Label with a DES label.

Step 12. Package 100 per shipping container. Label each container.

8-47. Use the following assembly instructions 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-and-sand mixture.

Step 3. Glue the second end cap in place and let 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. Label each container.

SPECIFICATIONS

8-48. 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

8-49. The BOM is shown in Table 8-10.

Table 8-36. BOM for M1 military dynamite DES

Cardboard tube, 8 in by $1^1/_4$-in diameter	1 ea
50:50 chalk-and-sand mixture	8 oz
Clay, pottery	6 oz
End cap	2 ea
Glue	3 oz
Olive-drab tape, fabric,	2 ft
Red tape, fabric	6 in
DES label	1 ea

SECTION III. PRIMING METHODS

8-50. This section covers priming steps for each DES device. Using the 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. (Refer to Chapter 2 for assembly instructions for initiation sets.) DES devices are primed with either 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 detonation-cord boosters.

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.

DESs WITHOUT INTERNAL DETONATING-CORD BOOSTERS

8-51. These DESs are primarily chalk-and-sand-filled devices, except for the M118 and M112 DESs, which are made from rubber matting and moist pottery clay. They have priming procedures identical to real explosive devices, which are primed with the detonating cord. The following paragraphs contain priming instructions for the following DESs:

- M118 sheet explosive.
- M112 (C4) block.
- One-pound TNT block and M5A1 demolition block.
- M1 military dynamite.

M118 SHEET EXPLOSIVE DES

Detonating Cord

8-52. Use either a Uli knot, a double-overhand knot, or a triple-roll knot (Figure 8-12) and one of the following methods to prime sheet explosives: (1) Insert the knot between two sheets of explosive, or (2) place the knot on top of the sheet explosive, and secure it with a small strip of sheet explosive (Figure 8-13). Strengthen the primed area by wrapping it with green duct tape or electrical tape.

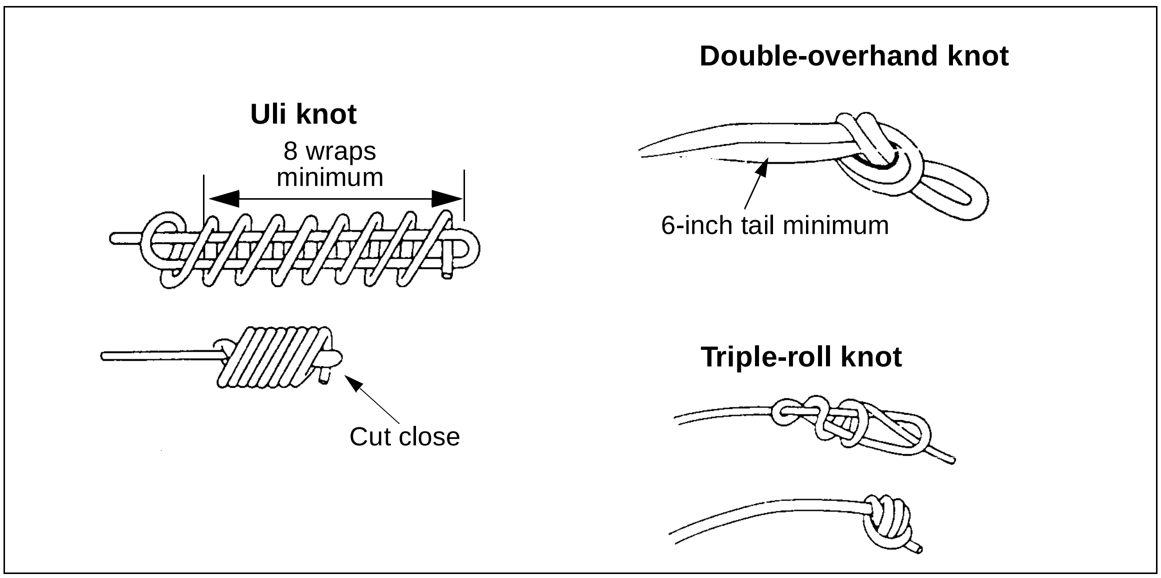


Figure 8-166. Knots

Modernized Demolition Initiator

8-53. Use Figure 8-14 and one of the following methods to prime M118 DES charges:

- Method 1. Attach an M8 blasting-cap holder to the end or side of the sheet explosive DES. Insert an M11 into the holder until the end of the blasting cap presses against the sheet explosive DES. The M8 blasting-cap holder has three teeth, which prevent the clip from

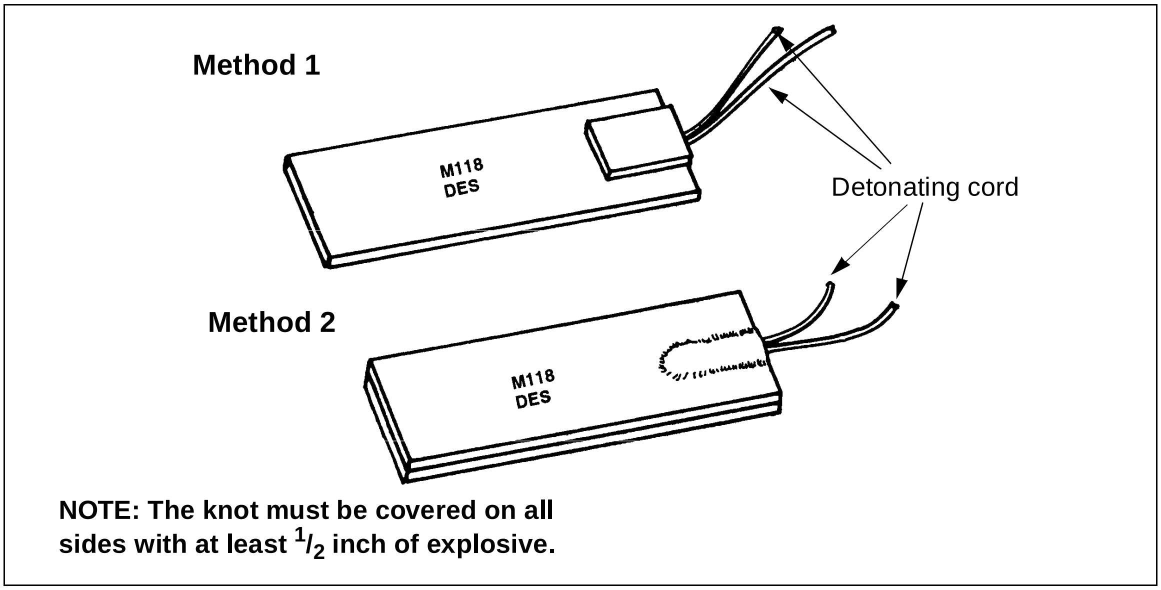


Figure 8-167. Priming M118 DES with detonating cord

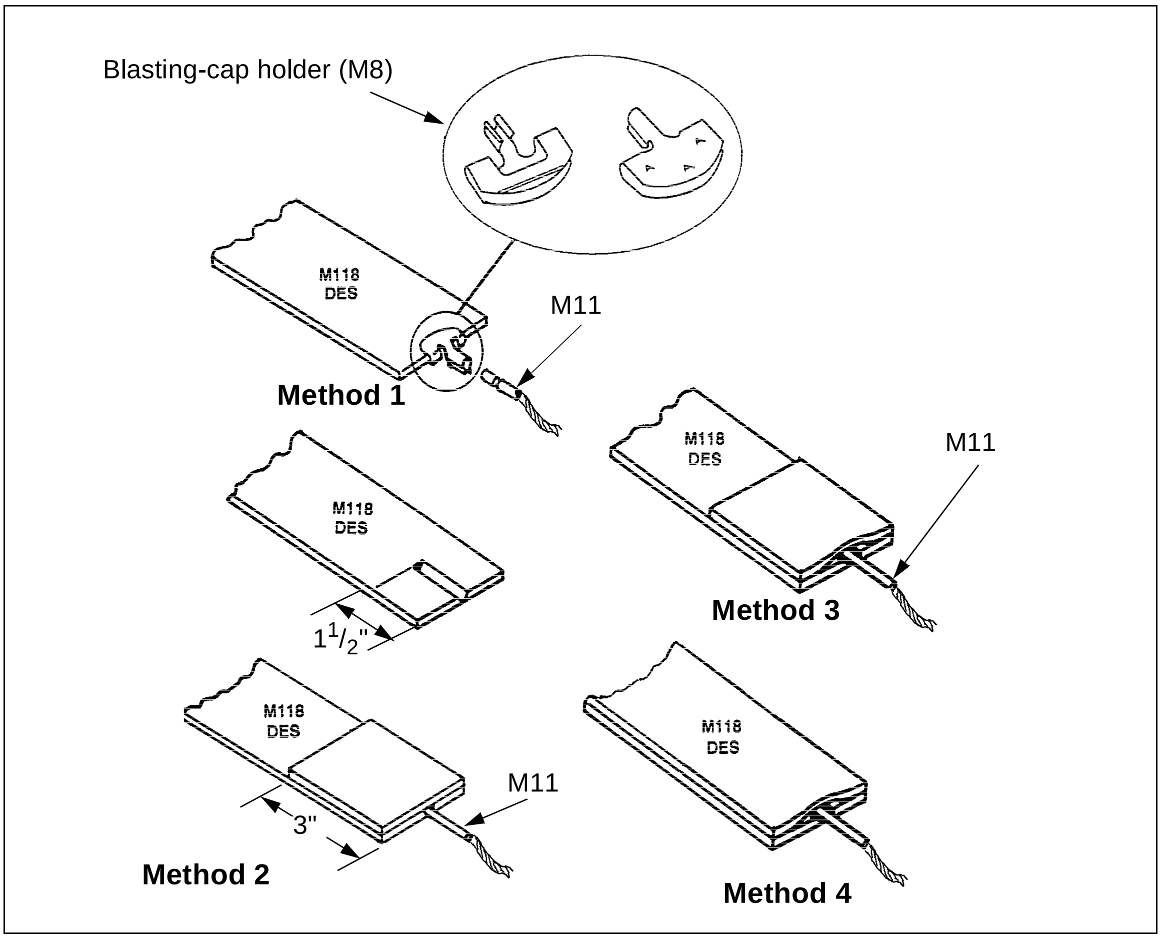


Figure 8-168. M11 priming M118 DES

withdrawing from the explosive; two spring arms firmly hold the M11 cap in the M8 holder.

- Method 2. Cut a notch in the DES sheet explosive (about $1^1/_2$ inches long and $^1/_4$-inch wide). Insert the M11 cap 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 cap on top of the DES sheet explosive, and secure it with a strip of DES sheet explosive (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 explosive. Wrap the sheets with tape to secure the M11 cap.

M112 (C4) Block DES

Detonating Cord

8-54. To prime M112 (C4) blocks DES with detonating cord, use Figure 8-15 and the following steps:

Step 1. Form either a Uli knot or a triple-roll knot. (See Figure 8-12, page 8-20.)

*Step 2***.** Cut a notch out of the DES large enough to insert the knot you formed.

WARNING
Use a sharp, nonsparking knife on a nonsparking surface to cut explosive.

Step 3. Place the knot in the cut.

Step 4. Use the clay you 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 M112 (C4) blocks DES be primed by wrapping them with detonating cord, since wraps will not properly detonate the actual explosive charge.

Modernized Demolition Initiator

8-55. M112 (C4) blocks DES do not have a cap well. Use the following steps to make a cap well and to prime the DES with an M11 cap:

Step 1. With the M2 crimpers or other nonsparking tool, make a hole in the end or on the side (at the midpoint) large enough to hold the blasting cap.

Step 2. Insert the M11 cap into the hole or cut. If the M11 cap does not fit the hole or cut, do not force the cap—make the hole larger.

Step 3. Anchor the M11 cap in the DES block by gently squeezing the clay around the blasting cap.

Step 4. Strengthen the primed area by wrapping it with tape.

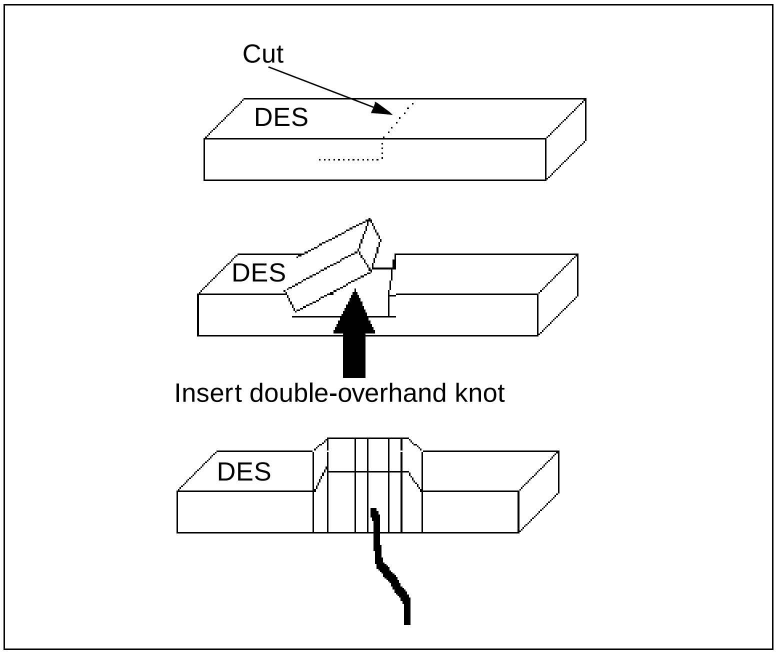


Figure 8-169. Priming M112 DES with detonating cord

ONE-POUND TNT-BLOCK DES AND M5A1 DEMOLITION-BLOCK DES

8-56. Use the same methods to prime both the one-pound TNT-block DES. (Only the TNT is shown in Figure 8-16, page 8-24.)

Detonating Cord

8-57. DES blocks without internal detonating-cord boosters can be primed with detonating cord in several manners (Figure 8-16, page 8-24). The two standard methods are the—

- Common method (method 1). Lay one end (2-foot length) of detonating cord at an angle across the DESs block. Then 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.

- Alternate method (method 2). Place a loop of detonating cord on the DESs block, leaving sufficient length on the end to make four turns around the block and loop. When starting the first wrap, 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. This forms a knot around the outside of the block.

Modernized Demolition Initiator

8-58. Some TNT/M5A1 DES blocks may have threaded cap wells. If so, use a priming adapter (if available) to secure the M11 cap to the DES block (see Figure 8-17, page 8-24). 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 as follows:

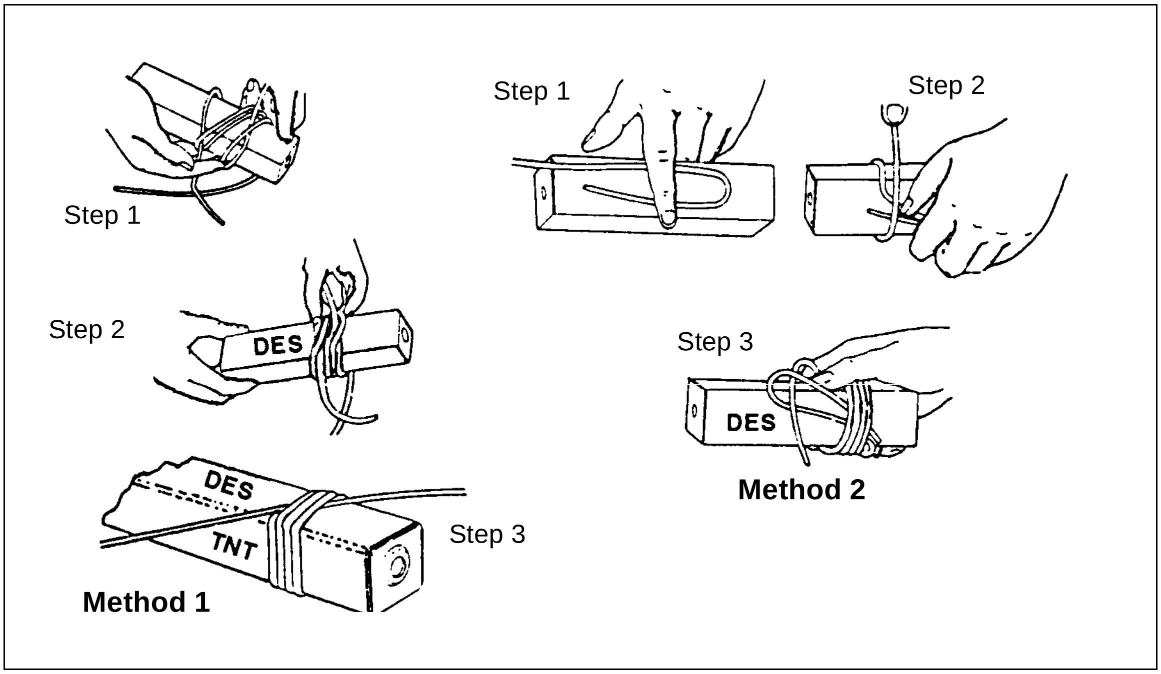


Figure 8-170. Priming TNT block DES with detonating cord

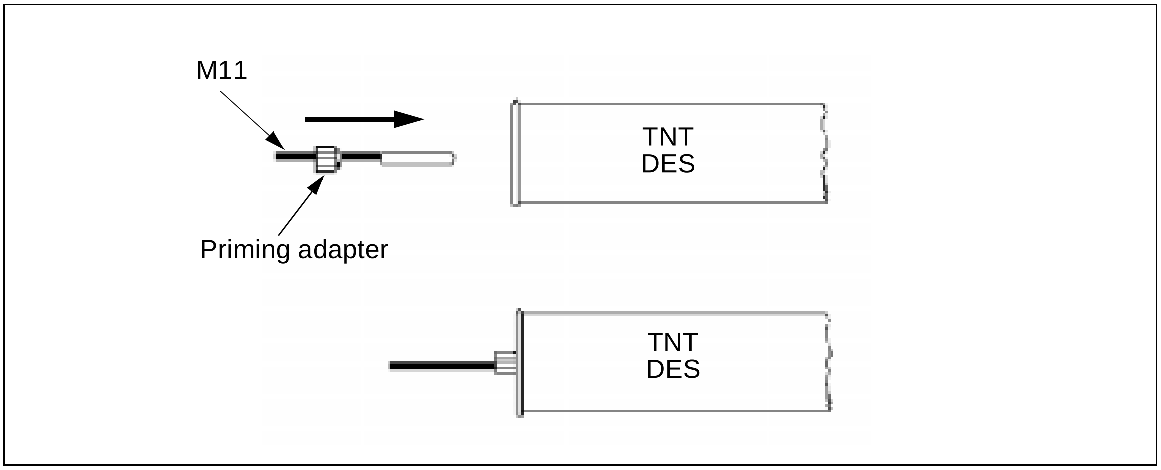


Figure 8-171. M11 priming TNT DES (with adapter)

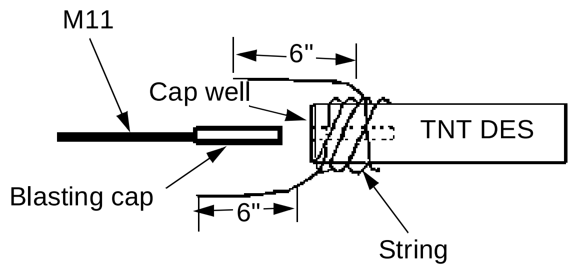
Step 1. Use M2 crimpers or other nonsparking tool to make a hole in the end. If the M11 cap does not fit the hole or cut, do not force the cap—make the hole larger.

NOTE: Prepare the initiation 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 into the cap well. If there is no cap well, make one.

Step 4. Tie the loose string around the fuse to prevent the M11 cap from separating from the block (Figure 8-18). Electrical or friction tape can also effectively secure M11 caps in the DES.



NOTE: Ensure that the string does not cut the powder train. Substitute electrical or friction tape for string.

Figure 8-172. M11 priming TNT DES (without adapter)

M1 MILITARY-DYNAMITE DES

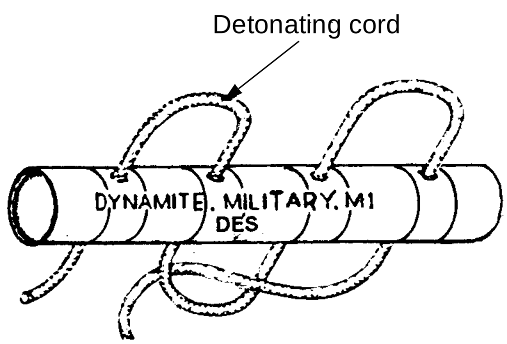
Detonating Cord

8-59. Use Figure 8-19 and the following steps to prime with detonating cord:

Step 1. Use the M2 crimpers to punch four holes through the DESs dynamite cartridge in areas covered by red tape. Make sure to rotate the DES cartridge 180 degrees 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 DESs dynamite charge.



WARNING
Do not pull the loops of the detonating cord too tight or the dynamite will break.

Figure 8-173. Priming M1 dynamite DES with detonating cord

Modernized Demolition Initiators

8-60. Prime at the end or side. Choose the method that will prevent damage to the primed block of explosive during placement.

End-Priming Method (Figure 8-20).

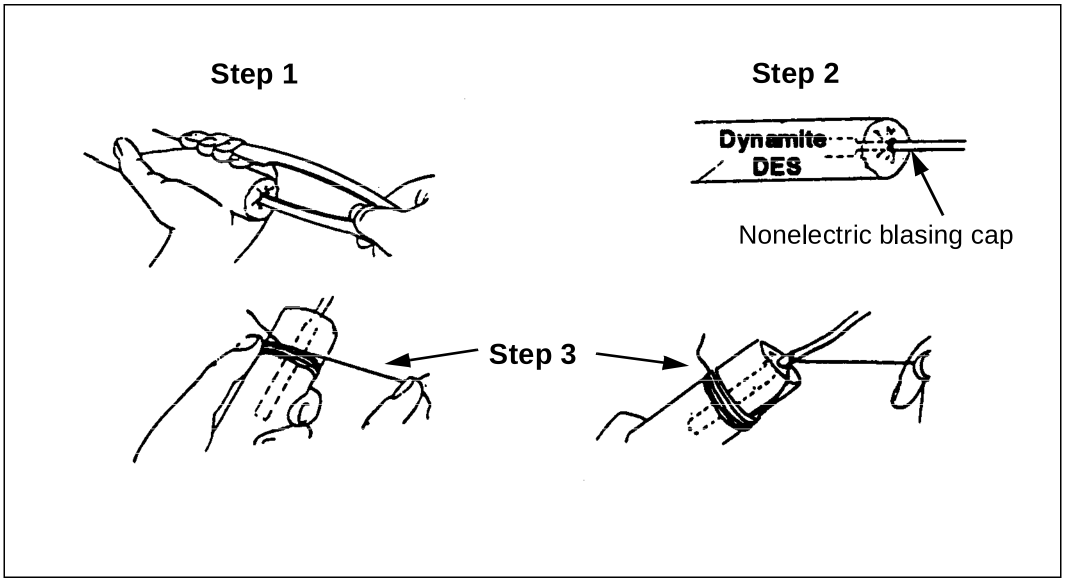


Figure 8-174. End-priming M1 military dynamite DES

- *Step 1.* Using the M2 crimpers, make a cap well in the end of the dynamite cartridge.
- *Step 2.* Insert a M11 cap into the cap well.
- *Step 3.* Tie the M11 cap and fuse securely in the cartridge with a string.

Side-Priming Method (Figure 8-21)

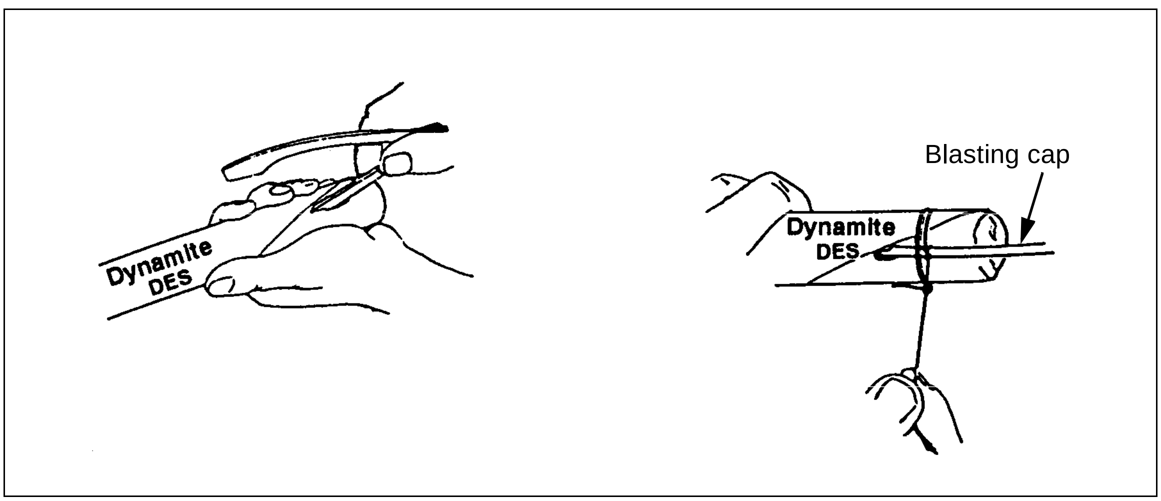


Figure 8-175. Side-priming M1 military dynamite DES

- *Step 1.* Using the M2 crimpers, make a cap well (about $1^1/_2$ inches long) in the side of the DESs cartridge at one end. Slightly slant the cap well so the M11 cap, when inserted, will be nearly parallel to the side of the DESs cartridge and the explosive end of the cap will be at a point nearest the middle of the cartridge.

- *Step 2.* Insert a M11 cap into the cap well.
- *Step 3.* Tie a string securely around the fuse. Then, wrap the string tightly around the cartridge, making two or three turns before tying it.

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 weather-proof sealing compound.

DESs WITH INTERNAL DETONATING-CORD BOOSTERS

8-61. These "explosive DESs," have an internal Uli or double-overhand knot with 18 inches of detonating cord extending out (running end). Use this running end to prime the DES using either detonating cord or a M11 or M14.

- Detonating-cord method. Tape detonating cord to the running end of the internal detonating cord.
- Nonelectric or electric method. Tape an M11 or M14 cap to the running end of the internal detonating cord.

8-62. This device also has an internal propellant (detonating cord) to expel the chalk-and-sand mixture.

8-63. The following paragraphs contain priming instructions for—

- One-pound TNT-block DES.
- M5A1 demolition-block DES.
- M183 demolition-(satchel) charge DES.
- M2A3 fifteen-pound shape charge DES.
- M3 forty-pound shape charge DES.
- Forty-pound cratering-charge DES.
- Bangalore-torpedo DES.

ONE-POUND TNT-BLOCK DES

Detonating Cord

8-64. Use the method shown in Figure 8-22, page 8-28. You can also use one of the three methods for TNT without internal detonating-cord booster except place the 18-inch tail under the wraps of the detonating cord.

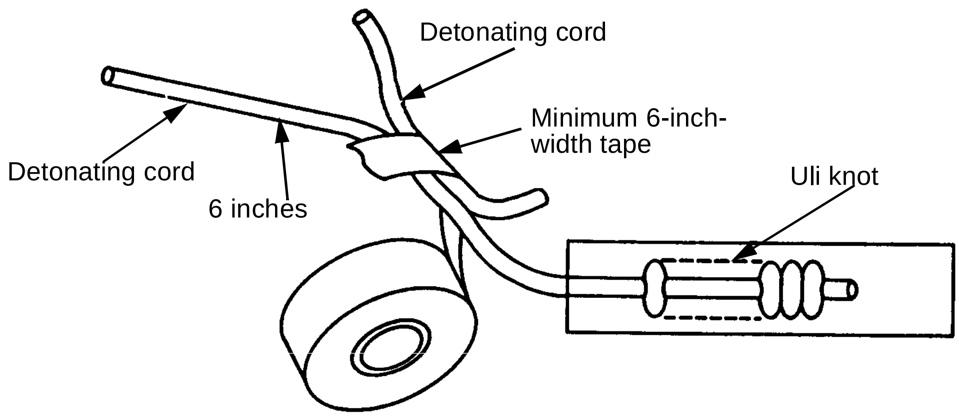
Modernized Demolition Initiator

8-65. Tape an M11 cap to the detonating cord as shown in Figure 8-23, page 8-28.

M5A1 DEMOLITION BLOCK DES

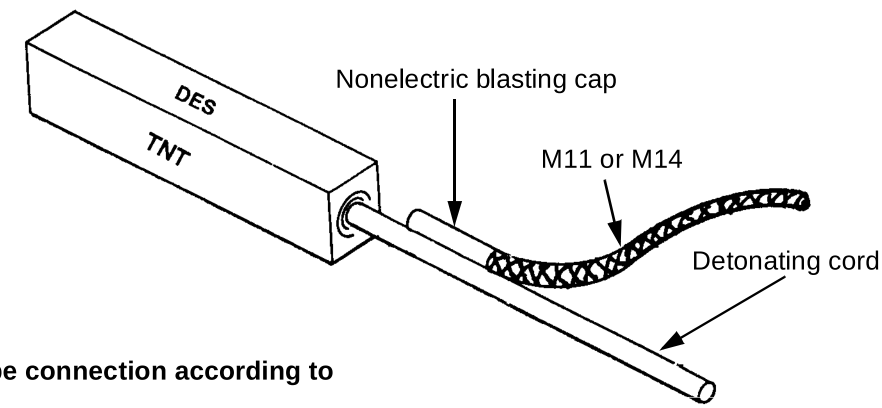
Detonating Cord

8-66. Same as TNT priming, paragraph 8-64.



NOTE: CTP according to Chapter 2.

Figure 8-176. Priming TNT DES (with booster) with detonating cord



NOTE: Tape connection according to Chapter 2.

Figure 8-177. MDI priming TNT DES (with booster)

Modernized Demolition Initiator

8-67. Tape a M11 or M14 cap to the detonating cord as shown in Figure 8-24.

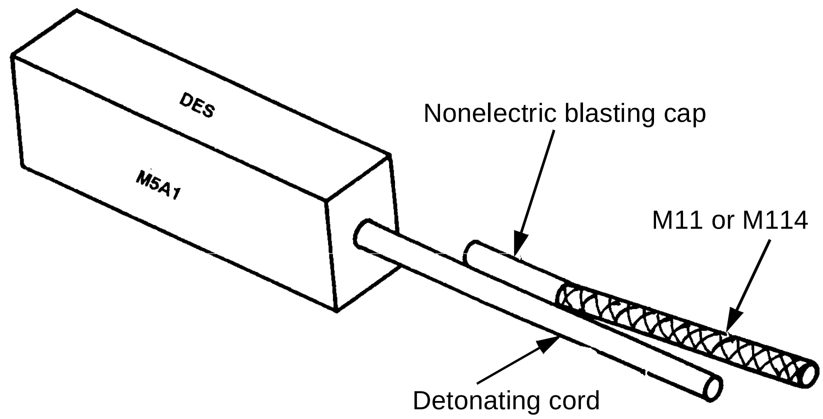
M183 DEMOLITION-(SATCHEL) CHARGE DES

Detonating Cord

8-68. Figure 8-25 shows how to prime the M183 demolition (or satchel charge) assembly with detonating cord.

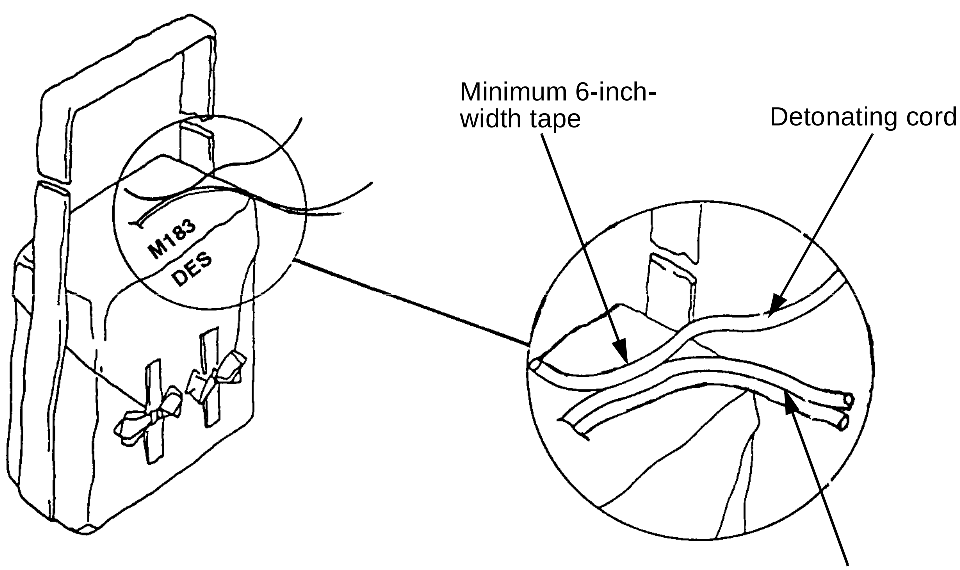
Modernized Demolition Initiator

8-69. Tape a M11 cap to the detonating cord as shown in Figure 8-26, page 8-30.



NOTE: Tape connection according to Chapter 2.

Figure 8-178. MDI priming M5A1 DES



NOTE: Tape connection according to Chapter 2.

Figure 8-179. Priming M183 DES with detonating cord

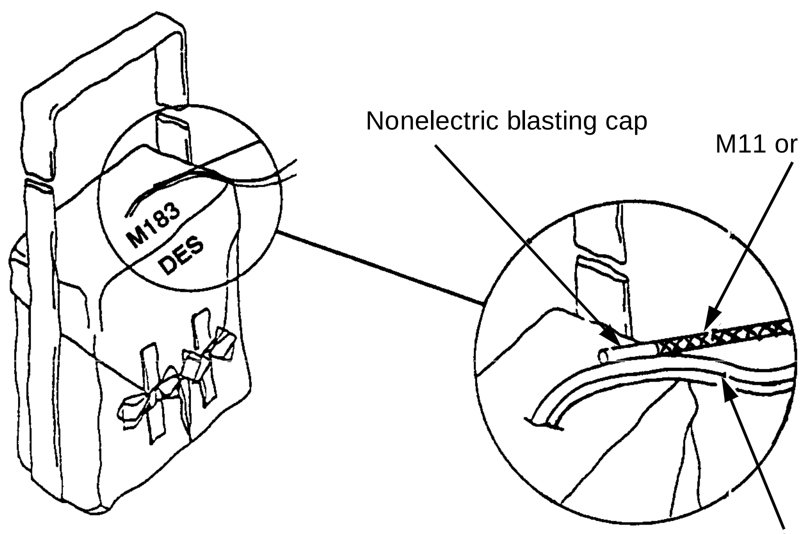


Figure 8-180. MDI priming M183 DES

M2A3 Fifteen-Pound Shape Charge DES

Detonating Cord

8-70. Figure 8-27 shows how to prime a 15-pound shape charge DES with detonating cord.

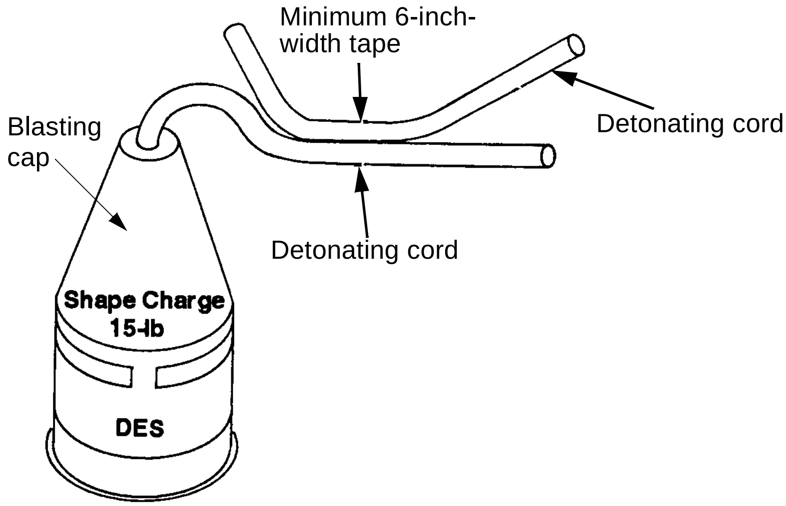


Figure 8-181. Priming 15-lb shape charge DES with detonating cord

Modernized Demolition Initiator

8-71. Figure 8-28 shows M11 priming.

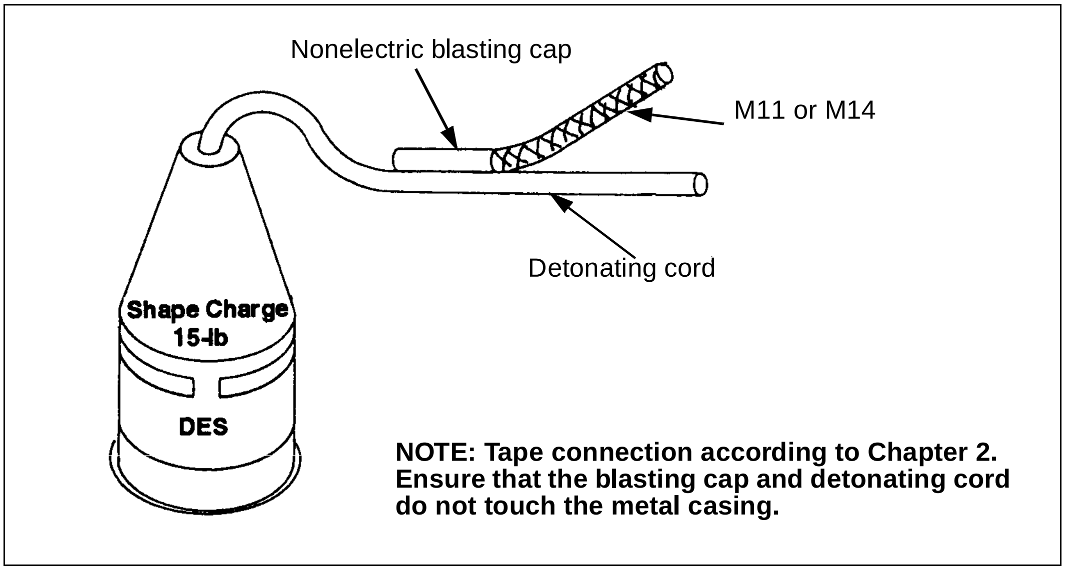


Figure 8-182. MDI priming 15-pound shape charge DES

M3 Forty-Pound Shape Charge DES

Detonating Cord

8-72. Figure 8-29 shows how to prime a 40-pound shape charge DES with detonating cord.

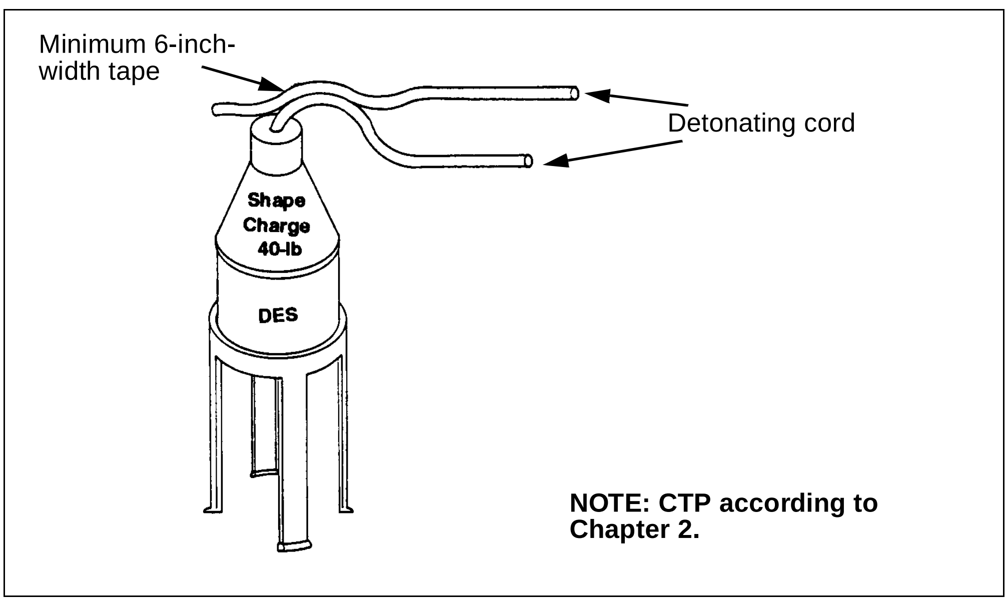


Figure 8-183. Priming 40-pound shape charge DES with detonating cord

Modernized Demolition Initiator

8-73. Tape a M11 cap to the detonating cord as shown in Figure 8-30.

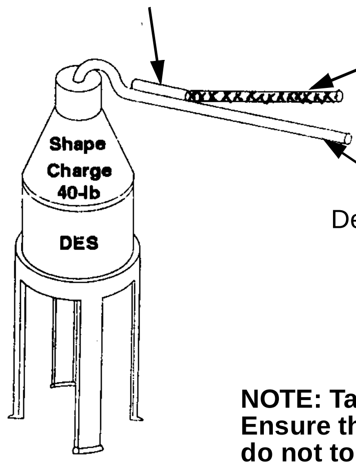


Figure 8-184. MDI priming 40-pound shape charge DES

FORTY-POUND CRATERING-CHARGE DES

8-74. *Above ground*, tape detonating cord or an M11 cap directly to the internal detonating-cord booster that is sticking out of the DES's charge. *Below ground*, tape the detonating cord to the internally charged detonating-cord branch line with a minimum of 6-inch-width tape.

NOTE: Do not use caps below ground. All below-ground charges must be dual-primed with a minimum of 1 pound of explosive.

Detonating Cord

8-75. Figure 8-31 shows how to prime a 40-pound cratering-charge DES with detonating cord.

Modernized Demolition Initiators

8-76. Tape a M11 or M14 cap to the detonating cord as shown in Figure 8-32.

BANGALORE-TORPEDO DES

Detonating Cord

8-77. Prime as shown in Figure 8-33, page 8-34, or tie 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 above ground.

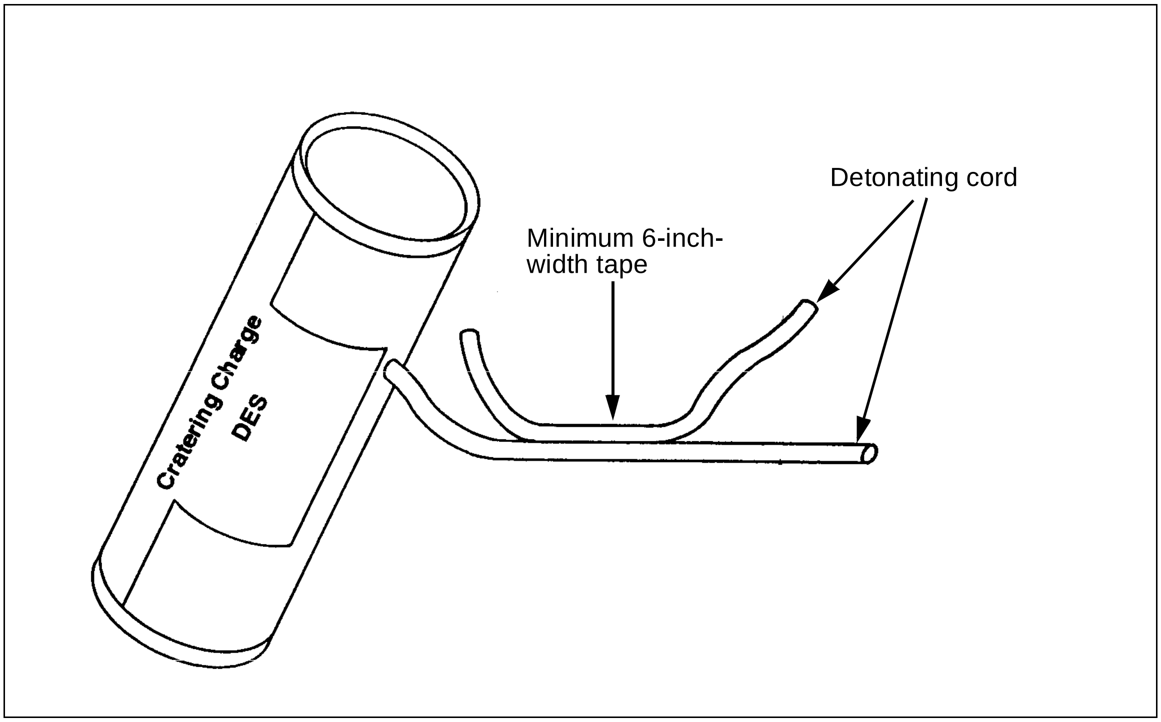


Figure 8-185. Priming 40-pound cratering-charge DES with detonating cord

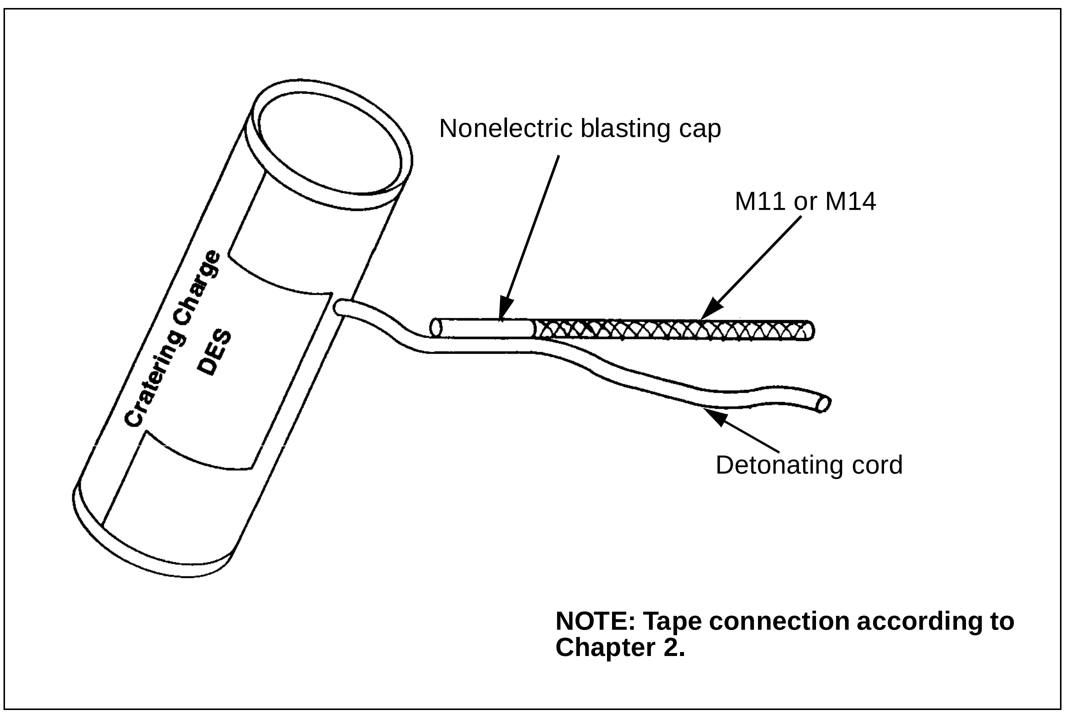


Figure 8-186. MDI priming 40-pound cratering-charge DES

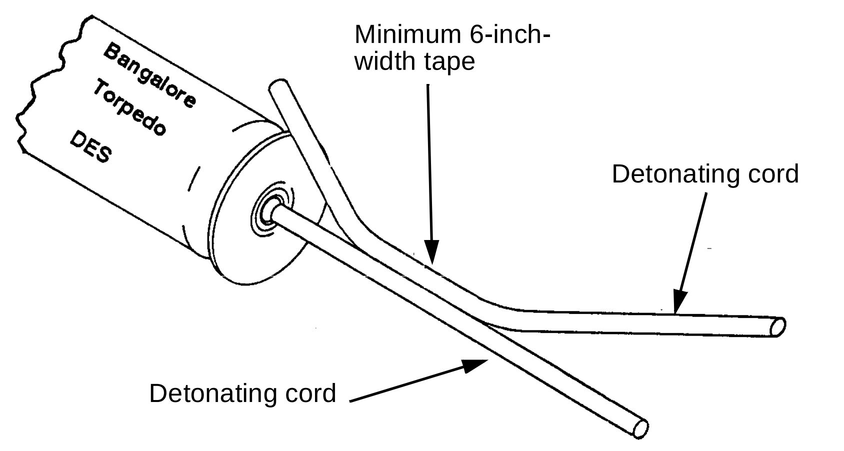
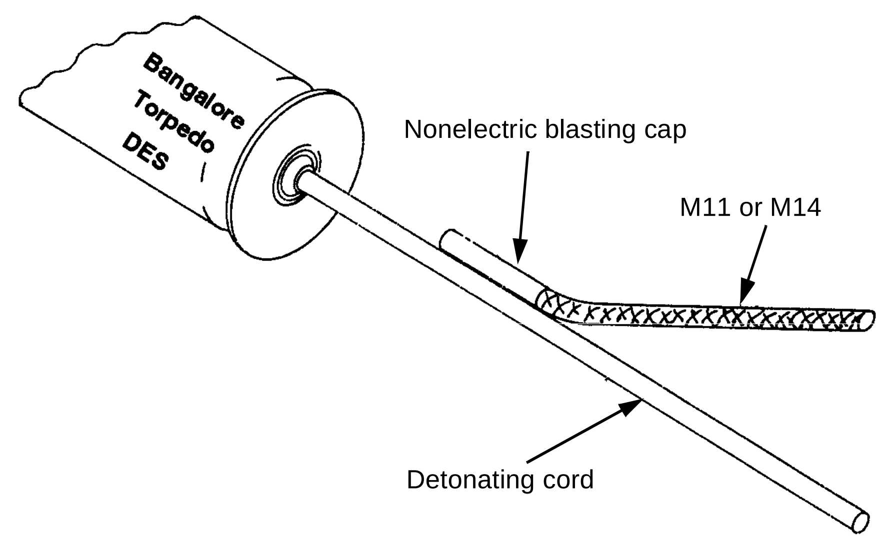


Figure 8-187. Priming bangalore-torpedo DES with detonating cord

Modernized Demolition Initiator

8-78. Tape a M11 or M14 cap to the detonating-cord booster (Figure 8-34).



NOTE: Tape connection according to Chapter 2.

Figure 8-188. MDI priming bangalore-torpedo DES

SECTION IV. SAFETY PROCEDURES AND RISK ASSESSMENT

8-79. 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. (Refer also to the safety procedures in Chapter 6.)

SAFETY GUIDELINES

8-80. 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.

8-81. Before using DESs, units must perform a risk assessment. (See Appendix L for the safety risk assessment.)

LEADER RESPONSIBILITIES

8-82. 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. One individual should be 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. Leaders should consult AR 385-63 or this manual. Table 6-2, page 6-7, gives safe distances for personnel that are near bare charges.
- Ensure that soldiers handle and inspect all DESs and live munitions according to this manual.
- Ensure that transportation and storage are according to the local demolitions SOP. Units will 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 and approves.

Appendix A

Conversion Factors (US Units and Metric)

Table A-37. Conversion factors

Multiply	By	To Obtain
Feet	0.3048	Meters
Inches	0.0254	Meters
Inches	2.54	Centimeters
Yards	0.9144	Meters
Pounds	0.4536	Kilograms
Pounds	453.59	Grams
Meters	3.2808	Feet
Meters	39.37	Inches
Meters	1.0936	Yards
Centimeters	0.3937	Inches
Kilograms	2.2046	Pounds
Grams	0.001	Kilograms
Grams	1,000	Milligrams

Appendix B

Metric Charge Calculations

B-1. NATO requirements make metric conversions necessary. The following formulas are metric equivalents for charge calculations.

EQUIVALENT METRIC WEIGHTS FOR STANDARD EXPLOSIVES

B-2. Table B-1 lists the metric equivalents for standard US Army demolition charges.

Table B-38. Standard US demolition charges (metric equivalents)

Explosive	Unit (lb)	Detonation Velocity		RE Factor	Weight (Metric) (kg)
		Min/Sec	Ft/Sec		
TNT	0.25	6,900	22,600	1.00	0.113
	0.50	6,900	22,600	1.00	0.227
	1.00	6,900	22,600	1.00	0.454
M2 tetrytol	2.50	7,000	22,900	1.20	1.134
M3 composition C2 or C3	2.25	7,625	25,000	1.34	1,021
M5A1 composition C4	2.50	8,040	26,400	1.34	1.134
M112 block (C4)	1.25	8,040	26,400	1.34	0.567
M118 block (PETN)	2.00	7,040	23,600	1.14	0.907
M118 sheet (PETN)	0.25	7,040	23,600	1.14	0.113
M186 roll (PETN)	25.00	7,040	23,600	1.14	11.34
Composition H6	43.00	7,190	23,600	1.33	18.14
M1 dynamite	0.50	6,100	20,000	0.92	0.227
M2A4 shaped charge	15.00	7,800	25,600	1.17	6.80
M3A1 shaped charge	40.00	7,800	25,600	1.17	18.14
M183 assembly	20.00	8,040	26,400	1.34	9.07

TIMBER-CUTTING FORMULAS

B-3. 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 (kg)

D = timber diameter, in centimeters (cm)

- 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-4. Table B-2 gives the correct metric weight of TNT necessary to cut structural-steel sections of various dimensions. Use Table B-2 or the following formulas:

- 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-39. 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-5. Use the following formula to determine the metric size of T-beam pressure charges:

$$K = 48^2T$$

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-6. Use the following formula to determine the metric size of breaching charges:

$$K = R^3MC$$

where—

K = *TNT required, in kilograms*

R = *breaching radius, in meters (Chapter 3)*

M = *material factor (Table B-3, page B-4)*

C = *tamping factor (Figure 3-15, page 3-20)*

Table B-40. Material factors for breaching charges

Material	Breaching Radius (R)	Material Factor (M)
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 7.69 6.41 5.13 4.32
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 9.93 8.33 6.57 5.61
Reinforced concrete (Factor does not consider 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 8.65

BREACHING RADIUS

B-7. 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 target's depth to the next higher quarter meter (2.9 becomes 3.0, 2.54 becomes 2.75, and so forth).

MATERIAL FACTOR

B-8. Table B-3 lists material factors.

TAMPING FACTOR

B-9. The value of the tamping factor depends on the location and tamping of the charge. A charge is not adequately tamped unless the tamping material's depth equals or exceeds the breaching radius. Figure 3-15, page 3-20, gives values for the tamping factor.

Appendix C

Using Demolition Charges

C-1. When using land mines, 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

PRIMARY CHARGES

C-2. Obtain such materials from captured or friendly supply stocks or, in the case of land mines, those recovered from enemy or friendly minefields. Never use unexploded duds (shells or bombs) for demolition purposes.

SUPPLEMENTARY CHARGES

C-3. When necessary, use allied-nation or captured explosives to supplement or replace standard explosive charges.

LAND MINES

SAFETY PRECAUTIONS

C-4. Use only 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-5. When calculating charges using mines, consider only the explosive weight. 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, you may find it 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. The US mines are current; foreign mines may be current or obsolete.

PRIMING

C-6. Detonate a land mine 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.

Table C-41. AT mine explosives content (by nation)

Country	Mine Type	Weight/Explosive
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
Communist 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 general-services (GS) AT (metallic)	8.25 lb of TNT
	Mark 5 GS AT (metallic)	4.5 lb of TNT
	Mark 5 high-capacity (HC) AT (metallic)	8.3 lb of TNT
	Mark 7 AT (metallic)	19.6 lb of TNT
*Picric acid corrodes metals, 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.		

AERIAL BOMBS

SAFETY PRECAUTIONS

C-7. General-purpose (GP) aerial bombs make satisfactory demolition charges but are more effective as cratering charges. Their shape makes them inefficient for demolitions requiring close contact between the explosive and the target. Take precautions against fragmentation, as the steel fragments from bomb cases may fly great distances. Before using any bomb, positively identify it as a GP bomb.

CHARGES

C-8. 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-42. GP aerial bombs (explosives content)

Bomb	Explosive Weight	Total Weight
Old Series		
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
New Series		
M117, 750-lb GP	386	823
M118, 3,000-lb GP	1,975	3,049
Low-Drag		
MK81, modification (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
Low-Drag, Snakeye I		
MK81, mod 1, 250-lb GP	100	300
MK82, mod 2, 500-lb GP	192	560

PRIMING

C-9. Detonate bombs under 500 pounds by placing a 5-pound explosive charge on the middle of the casing; bombs exceeding 500 pounds require a 10-pound charge. Do not place fuses on the nose or tail of the bomb. To ensure detonation, prime large bombs separately.

ARTILLERY SHELLS (NONNUCLEAR)

SAFETY PRECAUTIONS

C-10. Use artillery shells for demolition when only fragmentation is desired. Because of their low explosive content, artillery shells are generally not adequate for other demolition purposes.

CHARGES

C-11. Any artillery shell fits this category; however, avoid shells smaller than 100 millimeters. The 105-millimeter howitzer HE shell, which weighs 33 pounds, contains only 5 pounds of explosive. The 155-millimeter howitzer shell contains only 15 pounds of explosive.

PRIMING

C-12. Detonate shells up to 240 millimeters 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. Use the M10 universal destruction device 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

SAFETY PRECAUTIONS

C-13. Use foreign explosives to supplement standard US charges or, in certain cases, instead of US charges. Only experienced demolition personnel should work with such 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-14. Most foreign explosive blocks have cap wells large enough to receive US military blasting caps. However, test fire these charges with US military blasting caps to ensure positive detonation. In certain instances, you may have to initiate the explosives by using a standard US demolition block primed with a blasting cap.

Appendix D

Expedient Demolitions

D-1. 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 CHARGES

DESCRIPTION

D-2. 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 those with armor plating. You can improvise a shaped charge (Figure D-1). Because of the many variables (configuration, explosive density, liner 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 type of charge. However, dynamite and molten TNT can be effective expedients.

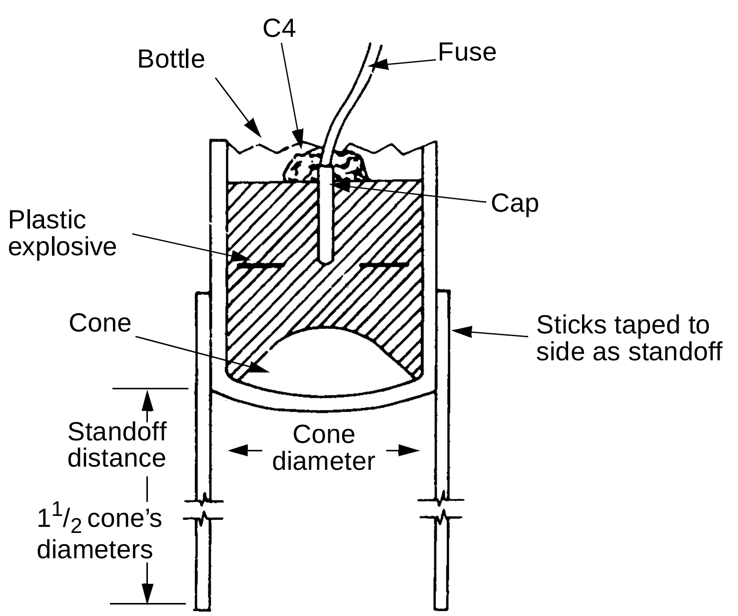


Figure D-189. Improvised shaped charge

FABRICATION

D-3. Obtain a container for the shaped charge and remove both ends. Almost any kind of container will work (cans, jars, bottles, 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 are the following:

- Cavity liner. Make a cone-shaped cavity liner 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, you can make a workable but less effective shaped charge by cutting a coned-shaped cavity in a block of explosive.
- Cavity angle. For most high-explosive antitank (HEAT) ammunition, the cavity angle is 42 to 45 degrees. Expedient charges will work with cavity angles between 30 and 60 degrees.
- Explosive height (in container). The explosive height is two times the cone height, measured from the base of the cone to the top of the explosive. Press the explosive into the container, being careful not to alter the cavity angle of the cone. Ensure that the explosive is tightly packed and free of any air pockets.
- Standoff distance. The normal standoff distance is one and one-half the cone's diameters. Use standoff sticks to achieve this.
- Detonation point. The exact top center of the charge is the detonation point. Cover the blasting cap with a small quantity of C4 if any part of the blasting cap is exposed or extends above the charge.

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. To heat the glass uniformly, turn the bottle or stem continuously with the neck up. After the twine or plastic has burned, submerge the neck of the bottle in water and tap it against some object to break it off. Tape the sharp edge of the bottle to prevent cutting hands while tamping the explosive in place. A narrow band of plastic explosive placed around the neck 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. This device 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 shape charges or as a penetrator for demolition missions. Use a round, steel platter, if available. However, a square platter also will work. The platter should weigh 2 to 6 pounds.

CHARGE SIZE

D-5. Use a quantity of explosive equal to the platter's weight.

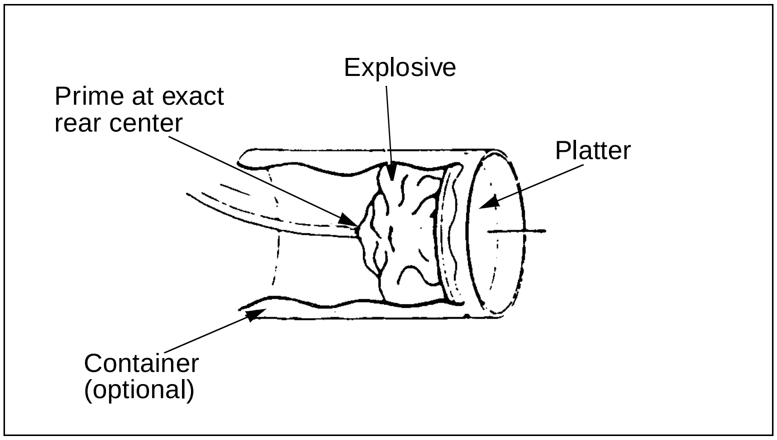


Figure D-190. Platter charge

FABRICATION

D-6. Uniformly pack the explosive 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.

D-7. Prime the charge at the exact, rear center. Cover the blasting cap with a small quantity of C4 if any part of the blasting cap is exposed.

D-8. If available, use a gutted M60 fuse igniter as an expedient aiming device, and aim the charge at the direct center of a target. Ensure that the explosive is on the side of the platter opposite the target. With practice, you can hit a 55-gallon drum, a relatively small target, at 25 yards about 90 percent of the time with a platter charge.

GRAPESHOT CHARGE

D-9. This charge consists of a container (an ammo can or Number 10 can), projectiles (nails, bolts, glass, small pieces of scrap metal, or rocks), buffer material (soil, leaves, felt, cloth, cardboard, or wood), a charge (plastic explosive like 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, page D-4. Use a quantity of explosive equal to one quarter the projectile weight.

D-10. Make a hole in the center of the bottom of the container large enough to accept a blasting cap or a detonating cord knot. Place the components in the container in the following sequence:

- Explosive. Place the plastic explosive uniformly in the bottom of the container. Remove all voids or air spaces by pressing the C4 into the container using a nonsparking instrument.
- Buffer. Place 2 inches of buffer material directly on top of the explosive.
- 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.

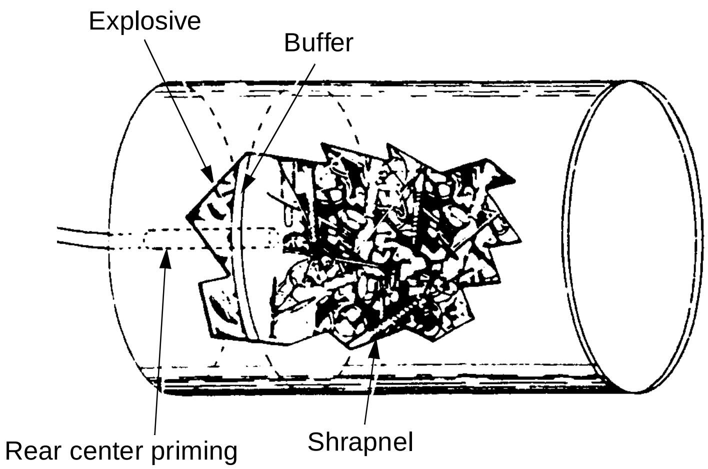


Figure D-191. Grapeshot charge

D-11. Make a cap well in the plastic explosive charge through the hole in the bottom of the container and insert the blasting cap of the initiation set. Cover the blasting cap with a small quantity of C4 if any part of the blasting cap is exposed. Aim the charge at the center of the target from about 100 feet.

DUST INITIATOR

D-12. 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 box cars. 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 initiation sets to the detonating cord.

CHARGE COMPUTATIONS

D-13. 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 C3 and $^1/_2$ pound of incendiary mix (two parts aluminum powder or magnesium powder and three parts ferric oxide). Do not use C4 because the explosive component in C4 will not combine properly with the incendiary mixture.

D-14. Cover (dust) size. Use 3 to 5 pounds of cover for each 1,000 cubic feet of target (3 pounds for enclosed buildings, 5 pounds for partially enclosed buildings). The cover can consist of coal dust, cocoa, powdered coffee, confectioners' sugar, tapioca, wheat flour, corn starch, hard-rubber dust, aluminum powder, magnesium powder, powdered soap, or a volatile fuel such as gasoline.

FABRICATION

D-15. Place the TNT explosive in a canvas bag, and crush it into a powder with a wooden mallet. In the same bag that contains the crushed explosive, add an equal amount of incendiary mixture and mix thoroughly. Prime this explosive incendiary charge with a detonating-cord knot. Place the primed charge in the center of the target and pour or place the cover on top of it, forming a pyramid. When using gasoline as the cover, do not use more than 3 gallons, since greater quantities will not evenly disperse in the air, giving poor results.

IMPROVISED CRATERING CHARGE

D-16. 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. You may fabricate almost any size of improvised charge from this mixture. Proceed as follows:

- Measure the fertilizer and fuel for the size charge you require.
- Add the fuel to the fertilizer and mix thoroughly.
- Allow the fuel to soak into the fertilizer for an hour.
- 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.

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-17. This method (Figure D-4, page D-6) is used to enlarge boreholes in soil. The best results are obtained in hard soil. Use the following procedure:

- 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. According to the rule of thumb, a hole 10 inches in diameter requires 10 strands of detonating cord.
- Place the detonating-cord wick into the hole using an inserting rod or some other field expedient. The strands must extend the full length of the hole.
- Fire the cord either electrically or nonelectrically. An unlimited number of wicks can be fired at one time by connecting them with the

detonating-cord ring main or line main. If you place successive charges in the holes, blow out excess gases and inspect the hole for excessive heat.

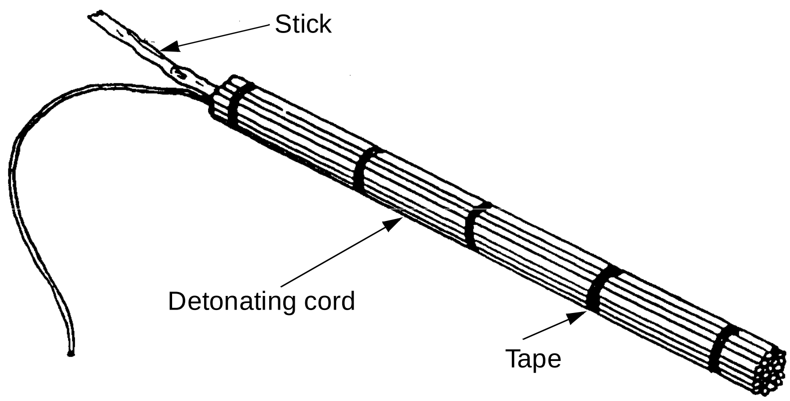


Figure D-192. Detonating-cord wick

AMMONIUM-NITRATE SATCHEL CHARGE

D-18. 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. Set the primer in place before the mixture hardens.

PREPARATION

D-19. Melt the wax in a container and stir in the ammonium-nitrate pellets, making sure that the wax is hot while mixing. Before the mixture hardens, add a $^{1}/_{2}$-pound block of explosive primed with detonating cord. Ensure that the primed charge is in the center of the mixture and that there is sufficient detonating cord available to attach initiation sets.

D-20. Pour the mixture into a container. Add shrapnel material to the mixture if desired, or attach the shrapnel on the outside of the container to give a shrapnel effect. Detonate the charge by attaching initiation sets to the detonating cord coming from the satchel charge.

USE

D-21. Because the wax and fertilizer may be molded into almost any size or shape, it may be applied to a great many demolition projects with satisfactory results.

EXPEDIENT FLAME FOUGASSE

D-22. Use this device 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, a trip flare, and detonating cord (Figure D-5). A 55-gallon drum containing a fougasse mixture is effective for a controlled-direction burst.

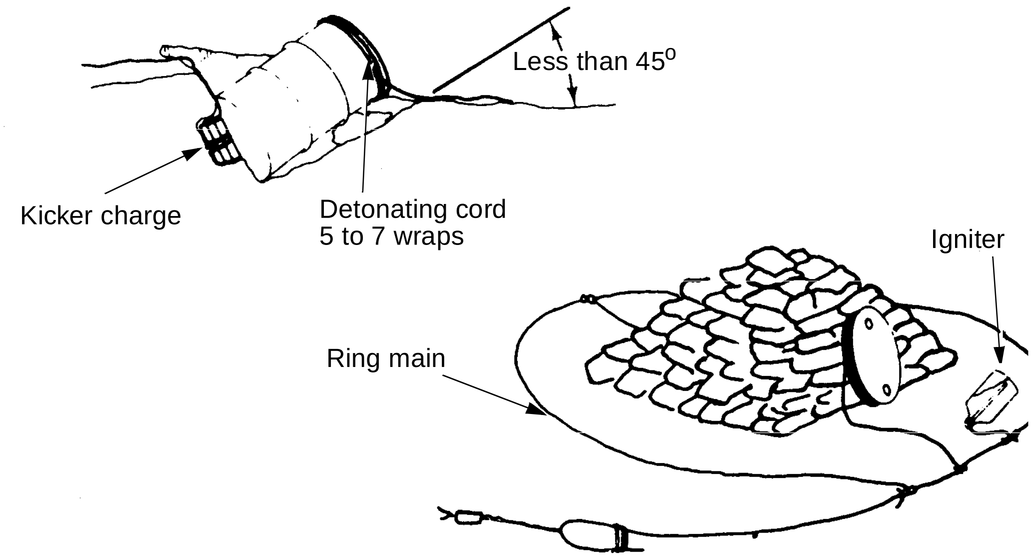


Figure D-193. Expedient flame fougasse

PREPARATION

D-23. Use the following steps to prepare flame fougasse:

Step 1. Make the fougasse mixture by mixing 3 ounces of M4 thickening compound per gallon of gasoline or jet petroleum 4 (JP4) fuel. 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 JP4 fuel.

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 degrees. Make a small cutout area in the back of the trench for the kicker charge (2 pounds of TNT or 1 block of 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 soil around the charge to properly center the kicker charge 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. Using a length of detonating cord, 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 secured to the trip flare to the ring main. During combat, a white phosporous (WP) grenade (M34) will work in place of the trip flare. If trip flares are not available, do the following:

- Take a 2-liter plastic bottle and fill it half full with raw gasoline or JP4 (unthickened).
- Punch a hole in the cap of the bottle, and 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, and secure the cap onto the bottle.
- Take the opposite end of the detonating cord and attach it to the ring main.

Step 9: Attach initiation sets to the ring main or junction box.

FUNCTION

D-24. 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 down range. The result is a flash of flame that spreads downrange for about 100 meters.

ALTERNATE EXPEDIENT FLAME FOUGASSE USING STEEL WOOL

D-25. Steel wool can be used to ignite the thickened fuel if fuel igniters or trip flares are not available. Use the same amount of explosives for the kicker charge (2 pounds of TNT or 1 block of C4). Prime the explosives with detonating cord. Attach a buffer material such as cardboard around the kicker charge and secure it with tape. Attach steel wool 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-26. This torpedo is used to defeat wire obstacles. Use the following steps when using this torpedo:

- Separate the packaging material from C4 (M112), and place it in the concave portion of two U-shaped pickets which are not bent or damaged.
- Mold the C4 explosive, using a nonsparking tool, into the concave position that runs the entire length of the U-shaped pickets.
- Place a line of detonating cord, after tamping the C4, on top of the C4 of one of the pickets and make a single overhand knot every 6 to 8 inches. Make sure the detonating cord runs several feet past the U-shaped picket length so that it can be tied into a firing system.
- Place the other U-shaped picket tamped with C4 onto the picket with the detonating cord previously set in. The C4 explosive from each picket will be touching, with the detonating cord in the middle.
- Secure the two U-shaped pickets together with tape or wire.

EXPEDIENT BRANCH-LINE CONNECTION (GREGORY KNOT)

D-27. The Gregory knot (Figure D-6, page D-10) is a detonating-cord knot tied at the end of a branch line to connect the branch line 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.

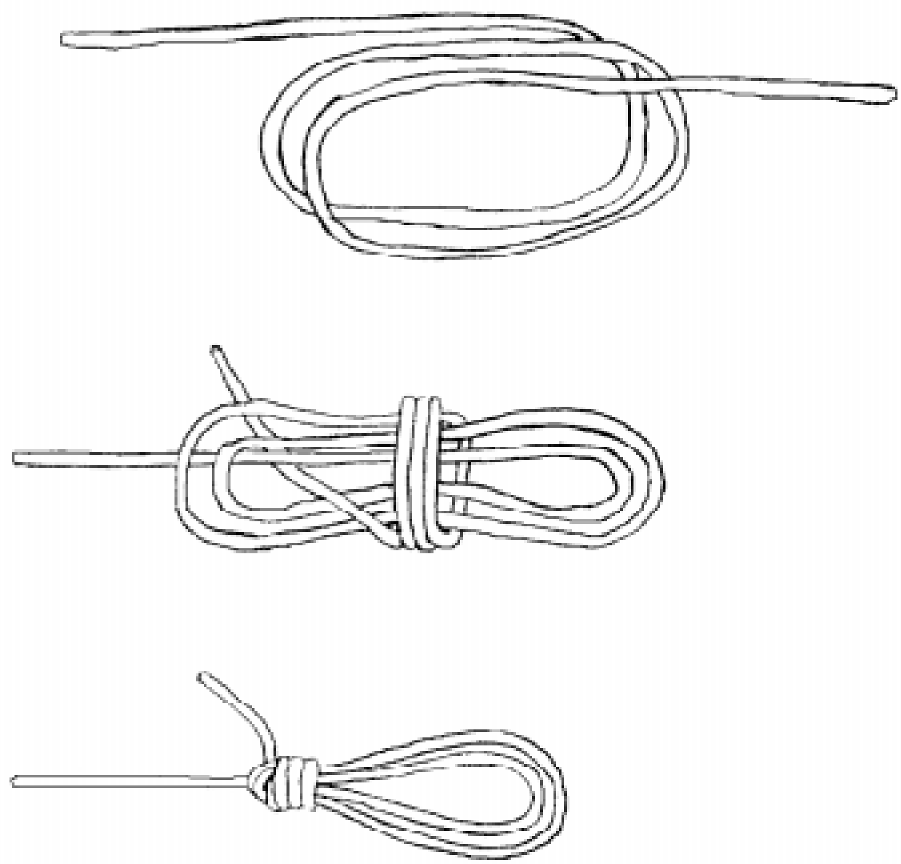


Figure D-194. Gregory knot

Appendix E

Explosives Identification

E-1. The purpose of this appendix is to provide a quick reference for demolition materials common to combat engineering. The following is not a comprehensive list and is subject to change.

E-2. Table E-1, page E-2, and Table E-2, page E-5, list materials by type, item, status, NSN, and DODIC. To avoid problems when requesting materials, use current supply publications.

E-3. Use Table E-3, page E-6, to cross reference demolition materials by DODIC. Materials are listed by DODIC in ascending order and by nomenclature.

Table E-43. Demolition materials

Type	Item	Status	NSN	DODIC
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 and 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 cap	M11	Live	1375-01-415-1232	ML47
	M11, practice	Inert	1375-01-412-0160	MN36
	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
Blasting cap and shock-tube holder	M9	Live	1375-01-415-1229	ML45
Igniter	M81	Live	1375-01-415-1235	MN08

Table E-1. Demolition materials (continued)

Type	Item	Status	NSN	DODIC
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	M118	Live	1375-00-728-5941	M024
	M186	Live	13735-00-728-4108	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 torpedo	M1A1	Live	1375-00-028-5247	M026
	M1A2	Live	1375-00-926-1948	M028
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
	Mine-clearing line charge (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

Table E-1. Demolition materials (continued)

Type	Item	Status	NSN	DODIC
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
	Detonating cord	Inert	1375-00-621-8373	M458
	Priming adapter	N/A	1375-00-565-4141	M002
	M8, cap holder	N/A	1375-00-926-4105	M166
	M2, crimpers	N/A	5120-00-029-0683	N/A
	Galvanometer	N/A	6625-00-539-8444	N/A
	BA245/U battery	Live	6135-00-128-1632	N/A
	BA2245/U battery	Live	6135-00-833-9909	N/A
	M51, test set	N/A	6625-00-999-3454	N/A
	Blasting machine, 10 cap	Live	1375-00-782-5541	N/A
	Blasting machine, 10 cap	Live	1375-00-935-9173	N/A
	Blasting machine, M32	Live	1375-00-212-4614	N/A
	Blasting machine, M34	Live	1375-00-567-0223	N/A
	DR8, reel	N/A	8130-00-407-7859	N/A
	RL39A, reel cable	N/A	3895-00-498-8343	N/A
	18AWG, firing wire	N/A	6145-00-299-6172	N/A
	Electric wire	N/A	6145-00-542-3968	N/A
	Electric wire	N/A	6145-00-284-0394	N/A
	Detonating-cord clip	N/A	1375-00-212-4602	N/A

Table E-2. US mines

Type	Item	Status	NSN	DODIC
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
Ground-Emplaced Mine-Scattering System (GEMSS)	M128, dispenser	N/A	1095-00-397-3456	N/A
	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 E-3. DODIC index for demolition materials

DODIC	Nomenclature	DODIC	Nomenclature
K001	Activator, AT mine, M1	K092	Mine, AP, M16
K002	Activator, AT mine, practice, M1	K105	Mine, AP, practice, M8
K003	Activator, AT mine, M2	K120	Mine, AP, M3
K004	Trip-wire assembly, F/M 16A2	K121	Mine, AP, M14
K005	Intervalometer, 38/A	K122	Mine, AP, practice, M17T34
K008	Firing device, AP mine, M57	K139	Mine, AP, practice, M68
K009	Firing device, AP mine, XM123	K140	Mine, AP, empty, M3
K010	Burster, incendiary, M4	K141	Mine, AP, M18
K013	Spool, AP mine	K143	Mine, AP, M18
K015	Dispense and mine, aircraft, practice, M132	K144	Mine, AP, inert, M18
K016	Dispense and mine, aircraft, training, M133	K145	Mine, AP, M18A1
K018	Can, crew-trained, M133	K146	Mine, AP, M26
K020	Dispense and mine, aircraft, M56	K150	Mine, AP, inert, M16
K021	Intervalometer, system, F/M47	K151	GEMSS, AP, M74
K027	Chg, mine ejection	K170	Mine, AT, M7
K028	Chg, mine ejection	K250	Mine, AT, M19
K030	Primer igniter, AP mine, fuse, M10A1	K917	Thickener, fuel
K031	Primer igniter, AP mine, fuse, M10A2	M001	Adapter, priming, plastic, M1A3 (round)
K040	Chg, spotting, AP mine, M8	M002	Adapter, priming, plastic, M1A4 (hex)
K041	Chg, spotting, AP mine, M8A1	M020	Chg, shaped, RDX, 0.062 lb
K050	Fuse, AT mine, M603	M022	Chg, shaped, PETN, 827 lb
K051	Fuse, AT mine, M604	M023	Chg, block, C4, 1.25 lb
K054	Fuse, AP mine, combination, M7A1	M024	Chg, block, PETN or RDX, 2 lb
K055	Fuse, AP mine, combination, M10A1	M025	Chg, C4, HE, M58/M58A1, 2,000 lb
K056	Fuse, AP mine, combination, M10A2	M026	Kit, demolition, bangalore torpedo, M1A1
K058	Fuse, AP mine, combination, M605	M027	Chg, block, practice, MK37-0
K060	Fuse, AT mine, M619	M028	Kit, demolition, lin, PETN, 0.75 lb
K061	Fuse, AT mine, XM608	M029	Chg, flex, lin, PETN, 0.75 lb
K062	Fuse, mine FMU-30/B	M030	Chg, block, TNT, 0.25 lb
K063	Fuse, mine, inert, FMU-30/B	M031	Chg, block, TNT, 0.5 lb
K064	Fuse, AT mine, M616	M032	Chg, block, TNT, 1 lb
K065	Fuse, AT mine, M606	M034	Chg, block, TNT, 8 lb
K066	Fuse, AT mine, dispense, M56	M035	Chg, chain, TNT, 20 lb
K067	Fuse, F/M 21	M036	Chg, chain, TNT, 2.5 lb
K090	Mine, AP, M2	M037	Chg, block, C2, 2.25 lb
K091	Mine, AP, inert, M2	M038	Chg, block, C4, 2.25 lb

Table E-3. DODIC index for demolition materials (continued)

DODIC	Nomenclature	DODIC	Nomenclature
M039	Chg, block, cratering, 40 lb	M118	Cap, SP electric, 6.4-sec delay
M040	Chg, block, TNT, 55 lb	M120	Cap, electric, No. 8
M041	Chg, block, C2, 0.5 lb	M125	Cap, electric, No. 8, 2nd delay
M043	Chg, block, TNT, 49 lb	M126	Cap, electric, No. 8, 3d delay
M044	Chg, block or shaped, HDX1, 12 lb	M127	Cap, electric, No. 8, 4th delay
M046	Chg, flexible (flex), lin, composition A, MK8-3, 50-lb	M128	Cap, SP electric, 7.6-sec delay
M048	Chg, block, C2, 2.5 lb	M129	Cap, electric, SP strength
M051	Chg, lin, practice, M68/M68A1, 2,000 lb	M130	Cap, SP electric, submersible, J2/M6
M060	Chg, roll, PETN, M186, 25 lb	M131	Cap, nonelectric, nonsubmersible, M7
M065	Chg, block, H6, 4 lb	M138	Cap, electric, nonsubmersible
M078	Cap, electric, nonsubmersible, M4	M153	Cap, electric, nonsubmersible
M080	Chg, flex, lin, practice, PETN, 0.007 lb	M236	Destructor, explosive, PETN
M081	Chg, flex, lin, PETN, 14 oz	M240	Destructor, explosive, PETN
M082	Chg, flex, lin, PETN, 22 oz	M241	Destructor, explosive, universal, M10
M083	Chg, flex, lin, PETN, 28 oz	M327	Base, coupling, with primer
M084	Chg, flex, lin, PETN, 36 oz	M328	Base, coupling, without primer
M085	Chg, flex, lin, PETN, 43 oz	M405	Chg, propelling, earth rod, M112
M086	Chg, flex, lin, PETN, 50 oz	M418	Chg, shaped, RDX, MK47-0, 1.5 lb
M087	Chg, flex, lin, PETN, 57 oz	M420	Chg, shaped, comp B, M2A4/M2A3E1, 15 lb
M091	Cap, special purpose (SP) electric,10-sec delay	M421	Chg, shaped, comp B, M3A2, 40lb
M092	Cap, SP electric, 11.2-sec delay	M431	Chg, rigid, lin, Amatol, 35 lb
M093	Cap, SP electric, 12.5-sec delay	M442	Kit, demolition, practice, M174
M094	Cap, SP electric, 14-sec delay	M443	Kit, demolition, projected chg, M173
M095	Cap, SP electric, 15.6-sec delay	M444	Kit, demolition, projected chg, M157
M097	Cap, nonelectric, practice	M446	Kit, demolition, projected chg, M1
M098	Cap, electric, inert	M455	Cord, detonating, primacord, PETN
M101	Cap, SP electric, 0.8-sec delay	M456	Cord, detonating, reinforced, waterproof
M102	Cap, SP electric, 1.4-sec delay	M457	Cord, detonating, PETN
M103	Cap, SP electric, 2.2-sec delay	M458	Cord, detonating, inert
M104	Cap, SP electric, 2.9-sec delay	M466	Detonating, percussion, MK2
M107	Cap, SP electric, 3.7-sec delay	M482	Chg, steel
M108	Cap, SP electric, 4.5-sec delay	M483	Chg, controlled, steel
M109	Cap, SP electric, instantaneous	M485	Cutter, HE, 1-inch jaw
M110	Cap, electric, high-strength	M486	Cutter, HE, 2-inch jaw
M112	Cap, electric, nonsubmersible, practice, M10	M540	Kit, detonator, percussion, M1
M117	Cap, SP electric, 5.3-sec delay	M541	Detonator, friction, M2, 8-sec delay

Table E-3. DODIC index for demolition materials (continued)

DODIC	Nomenclature	DODIC	Nomenclature
M559	Kit, demolition, M175	M670	Fuze, timed, M700
M587	Dynamite, nitroglycerin	M671	Fuze, timed, inert
M591	Dynamite, military, M1	M680	Cylinder, ignition, flame thrower, M1
M598	Destroyer, crypto equip, M1A2	M745	Kit, conversion, depth chg
M600	Destroyer, crypto equip, incindiary, M2A1	M756	Assembly, chg, M37, 20 lb
M601	Destroyer, crypto equip, incindiary, M1A2, TH1	M757	Assembly, chg, C4, M183
M605	Destroyer, document, emergency, incindi-ary, M1A2, TH4	M767	Igniter, fuse, timed, practice, XM77
M606	Destroyer, crypto equip, M1A2, TH4	M784	Chg, shaped, practice, inert, MK37-1, 7 lb
M607	Destroyer, crypto equip, M2A1	M790	Assembly, composition C2 or C3, MK127-0, 20 lb
M608	Destroyer, crypto equip, TH4	M791	Assembly, tetrytol, MK133-0, 20 lb
M609	Destroyer, crypto equip, M2A1, TH4	M792	Assembly, block, C4, MK138-0, 20 lb
M610	Destroyer, file, incindiary, ABC-M4	M810	Primer, percussion, improved, No. 3
M611	Destroyer, file, incindiary, ABC-M4	M814	Destroyer, document, 55 gal, M4
M612	Destroyer, incindiary, TH3	M820	Kit, explosive, earth rod, No. 1
M615	Igniter, document destroyer, M25	M821	Kit, explosive, foxhole digger
M616	Device, firing, M1, 6- to 14-min delay	M832	Chg, shaped, composition H6, MK74-1, 1.5 lb
M617	Set, device, firing, M1	M833	Chg, shaped, practice, inert, MK74-0, 1.3 lb
M619	Device, firing, M1, 12- to 32-min delay	M836	Cap, elec, dry, instantaneous
M620	Device, firing, M1, 45- to 115-min delay	M855	Cap, elec, dry, 0.5-sec delay
M622	Device, firing, M1, 210- to 570-min delay	M910	Igniter, primer and base, XM110
M623	Device, firing, M1, 610- to 1,130-min delay	M913	Chg, flex, lin, composition C4, M58A1, 2,000 lb
M624	Device, firing, brass	M914	Chg, lin, practice, M68A1, 2,000 lb
M625	Device, firing, zinc	M916	Chg, shaped, practice, inert, MK47-0, 1.5 lb
M626	Device, firing, zinc	M936	Chg, block, inert, 0.25 lb
M627	Device, firing, steel	M957	Chg, shaped, composition H6, MK47-0, 1.13 lb
M630	Device, firing, pull type, M1	M974	Cap, electric, submersible
M631	Device, firing, pressure release, M1	M975	Fuze, crypto equip, M210, 0.7-sec delay
M632	Device, firing, zinc	M976	Chg, block, composition H6, 4-lb
M635	Device, firing, pull type, M1	M977	Cord, detonating, PETN
M637	Device, firing, zinc	M980	Chg, roll, PETN, 20 lb
M639	Device, firing, pressure release, M5	M981	Chg, roll, PETN, 20 lb
M641	Device, firing, tension release	M982	Chg, roll, PETN, 20 lb
M643	Device, firing, tension release	M983	Chg, roll, PETN, 20 lb
M644	Device, firing, aluminum	M984	Chg, roll, PETN, 20 lb M766
M650	Device, firing, aluminum	M986	Chg, roll, PETN, 20 lb

Table E-3. DODIC index for demolition materials (continued)

DODIC	Nomenclature	DODIC	Nomenclature
M987	Chg, block, C4, 2 lb	ML78	Chg, shaped, practice, MK47-0
M988	Chg, block, C4, 0.5 lb	ML82	Kit, fuse, live, M1134
M989	Initiator, explosive	MN02	Cap, blasting, nonelectric, M12
M990	Detonator, flash	MN03	Cap, blasting, nonelectric, M13
M992	Chg, shaped, practice, inert, M3, 40 lb	MN06	Cap, blasting, nonelectric, M14
M993	Chg, roll, PETN, 20 lb	MN07	Cap, blasting, nonelectric, M15
M994	Chg, roll, PETN, 20 lb	MN08	Igniter, M81
M995	Chg, lin, composition H6, MK86-0, 0.002 kg	MW02	Valve, explosive, electrically initiated
M996	Chg, lin, composition H6, MK87-0, 0.013 kg	MW26	Cell, arming, MK1-8, 80-min delay
M997	Chg, lin, composition H6, MK88-0, 1 kg	MW27	Clip, detonating cord, M1
M998	Chg, rigid, lin, composition C3, MK89-0, 14 kg	MW28	Connector, plastic
ML03	Device, firing, plastic, M142	MW29	Element, delay, DE, MK19-0
ML04	Cutter, HE	MW30	Kit, demo, bangalore torpedo, M1 or M1A1
ML05	Cutter, HE	MW31	Holder, detonator, MK2-0
ML07	Cap, electric, nonsubmersible	MW37	Driver, power actuated, MK22-0
ML08	Kit, demolition, XM268	MW38	Float, rigid, polyurethane
ML09	Chg, shaped, flex, lin, 20 gr/ft	MW49	Connector, detonating cord, plastic
ML10	Chg, shaped, flex, lin, 30 gr/ft	MW52	Chg, sheet, MK57-0
ML11	Chg, shaped, flex, lin, 40 gr/ft	MW53	Chg, sheet, MK56-0
ML12	Chg, shaped, flex, lin, 60 gr/ft	MW56	Device, safety and arming, MK39-0
ML13	Chg, shaped, flex, lin, 75 gr/ft	MW84	Kit, demo, tubular SWS, MK75-0
ML14	Chg, shaped, flex, lin, 125 gr/ft	MW85	Kit, accessory, demolition, MK29-0
ML15	Chg, shaped, flex, lin, 225 gr/ft	MW86	Kit, firing device, MK48-0
ML16	Chg, shaped, flex, lin, 300 gr/ft	MW87	Kit, firing device, training, MK122-0
ML17	Chg, shaped, flex, lin, 400 gr/ft	MX14	Kit, centering, cavity chg
ML18	Chg, shaped, flex, lin, 500 gr/ft	MY01	Clip, detonating cord, M1
ML19	Chg, shaped, flex, lin, 600 gr/ft	SS89	Chg, shock test, R/U725
ML23	Cap, bridge wire, X175E	XW60	Kit, firing device, MK138-0
ML25	Chg, flex, lin, M59	XW65	Chg, shock tube, R/U1260
ML26	Chg, lin, practice, M69	XW66	Chg, shock test, R/U1259
ML27	Detonator, percussion, MK53	XW67	Chg, shock test
ML32	Primer, percussion, M27	YW05	Kit, chg, training, MK75-0
ML36	Kit, fuse, inert, M1147	MZ21	Cap, nonelectric, inert, 500 ft
ML37	Kit, fuse, live, M1133	MZ22	Cap, nonelectric, inert ,30 ft
ML45	Blasting cap and shock-tube holder, M9	MZ23	Cap, delay, nonelectric, inert
ML47	Cap, nonelectric, M11	MZ24	Cap, delay, nonelectric, inert, 70 ft

Appendix F

Power Requirements for Series Firing Circuits

F-1. Electric blasting caps are connected in 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 caps in a series circuit increases the chances of breaks in the firing line or cap leads.

OHM'S LAW

F-2. *Ohm's Law* defines the amount of voltage necessary to detonate the blasting caps. Determine the required voltage for your firing circuit as follows:

$$E = IR$$

where—

E = electric potential, or voltage, in volts

I = current, in amperes

R = resistance, in ohms

ELECTRIC-POWER FORMULA

F-3. Determine the amount of electric power (watts) necessary to detonate blasting caps:

$$W = I^2R$$

where—

W = electrical power, in watts

I = current, in amperes

R = resistance, in ohms

ELECTRIC BLASTING CAPS

F-4. Military electric blasting caps connected in 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

F-5. Ensure that the power source is adequate to fire all charges connected to the circuit. Firing wire and blasting caps contribute to total resistance in the circuit. Determine the amount of resistance by combining the individual resistances of the blasting caps and the wires. The resistance of the wire depends on the wire's size and length. Table F-1 gives the resistance per 1,000 feet of various sizes of copper wire.

SERIES CIRCUIT CALCULATIONS

F-6. Complete calculations for any series circuit involved in determining the amount of current (amperes), voltage (volts), and power (watts) needed to fire the circuit. Use the following procedure:

- Current. 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 F-5, page F-1.
- Voltage. Determine the required voltage for the circuit using the formula in paragraph F-2, page F-1.
- Power. Determine the required power for the circuit using the formula in paragraph F-3, page F-1.

F-7. Determine 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:

- Current. The amount of current required to detonate this circuit is 1.5 amperes.
- Resistance
  - — Caps: 2.0 ohms (20 caps) = 40.0 ohms
  - — Wire: 500 feet (2 strands) = 1,000 feet = 6.4 ohms (Table F-1)
  - — Total resistance: 46.4 ohms

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).

- Voltage:

$$E = IR = 1.5(46.4) = 69.6 \text{ volts}$$

- Power:

$$W = I^2(R) = 1.5^2(46.4) = 104.4 \text{ watts}$$

VOLTAGE DROP

F-8. 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.

Table F-1. Resistance of copper wire

Wire Characteristics			
AWG (B&S) Gauge Number	**Diameter (in)**	**Weight (lb/ft)**	**Resistance per 1,000 ft (ohms)**
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.			

BLASTING MACHINES

F-9. The nameplate on power sources normally states the amperage and the voltage ratings. Before using any power source, determine whether it is suitable for your firing circuit. Generally, you can determine the adequacy of a power source by consulting Table F-2, page F-4. This table lists the sizes of circuits that power sources can support. If you must determine the power source's capabilities from the nameplate, use the following procedure:

- *Step 1.* Multiply the power source's voltage rating by 90 percent to get an adjusted voltage rating.
- *Step 2.* Divide the adjusted voltage rating by the circuit's amperage rating (1.5 amperes). At this point, you have the maximum allowable resistance in the circuit, in ohms.
- *Step 3.* Determine the total resistance of the firing wire (Table F-1).
- *Step 4.* Subtract the wire's resistance 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 F-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

F-10. Determine 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):

- Maximum allowable resistance (steps 1 and 2).

$$\frac{0.90(200\ volts)}{1.5\ amperes} = 132\ ohms$$

- Total resistance of the firing wire (step 3).

$$\frac{10.2\ ohms(500\ feet)}{1,000} = 5.1\ ohms$$

- Maximum allowable resistance of the blasting caps (step 4).

$$132\ ohms - 5.1\ ohms = 126.9\ ohms$$

- Maximum number of blasting caps.

$$\frac{126.9\ ohms}{2\ ohms} = 63.45\ caps\ (round\ down\ to\ 63\ caps)$$

BATTERIES AND DRY CELLS

F-11. Use the procedure in paragraph F-9, page F-3, to determine the size of a circuit supported by a battery or dry cell.

Appendix G

Example Calculations

G-1. 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 C4 when calculating the problems that follow.

G-2. For examples of charge calculations, refer to Examples G-1 through G-11, page G-1 through G-11. For examples of demolition calculations, refer to Example G-12, page G-12. For examples of attack calculations, refer to Examples G-13 through G-15, pages G-13 through G-15.

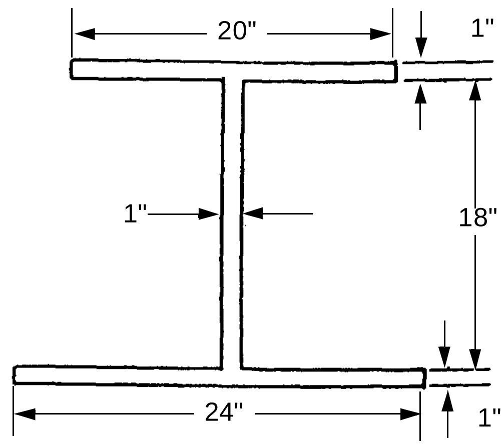
Problem: Using an internal timber charge, determine the quantity of C4 required to cut a 30-inch diameter tree.	
Step 1	Obtain the critical dimensions: $D = 30 \text{ inches}$
Step 2	Calculate for TNT/rule of thumb: $P = \frac{D^2}{250} = \frac{30^2}{250} = \frac{900}{250} = 3.6 \text{ pounds of TNT}$
Step 3	Divide by the RE factor, if required: $\frac{P}{RE} = \frac{3.6}{1.34} = 2.68 \text{ pounds of C4}$
Step 4	Divide by package weight/volume and round UP to the next whole package: $\frac{P}{\text{package weight}} = \frac{2.68}{1.25} = 2.14\text{, round up to 3 packages of C4}$
Step 5	Calculate the number of charges: $\text{one tree} = \text{one charge}$
NOTE: You must split the charge between the two boreholes because the tree is larger than 18 inches in diameter. See paragraph 3-13, page 3-5.	
Step 6	Calculate the total amount of explosives: $\text{step 4} \times \text{step 5} = \text{total packages} = 3 \times 1 = 3 \text{ packages of C4}$
Solution: You need 3 packages of C4, placed in two boreholes, to cut a 30-inch diameter tree, using an internal timber charge. See Figure 3-2, page 3-5, for the placement of the charge.	

Example G-195. Timber-cutting charge calculations (internal)

Problem: Using an external timber charge, determine the quantity of TNT required to cut a 30-inch diameter tree.	
Step 1	Obtain the critical dimensions: $D = 30\ inches$
Step 2	Calculate for TNT/rule of thumb: $P = \frac{D^2}{40} = \frac{30^2}{40} = \frac{900}{40} = 22.5\ pounds\ of\ TNT$
Step 3	Divide by the RE factor, if required: $\frac{P}{RE} = \frac{22.5}{1} = 22.5\ pounds\ of\ TNT$
Step 4	Divide by package weight/volume and round UP to the next whole package: $\frac{P}{package\ weight} = \frac{22.5}{1} = 22.5\ packages\ of\ TNT;\ round\ up\ to\ 23\ packages\ of\ TNT$
Step 5	Calculate the number of charges: $one\ tree = one\ charge$
Step 6	Calculate the total amount of explosives: $step\ 4 \times step\ 5 = total\ packages = 23 \times 1 = 23\ packages\ of\ TNT$
Solution: You need 23 packages of TNT to cut a 30-inch diameter tree, using an external timber charge. See Figure 3-3, page 3-7, for the placement of the charge.	

Example G-196. Timber-cutting charge calculations (external)

Problem: Using the formula $P = \frac{3}{8}A$, determine the quantity of C4 required to cut the two steel beams shown below.



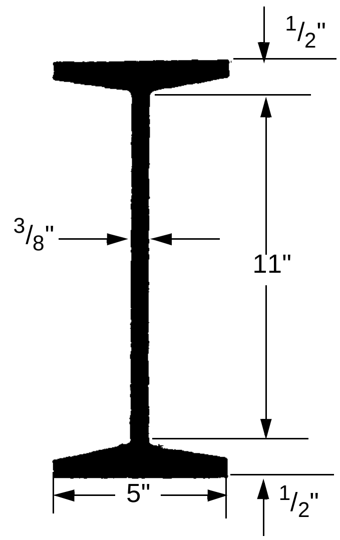
Step 1	Obtain the critical dimensions: *a. Top flange: 20 x 1 = 20 square inches* *b. Web: 18 x 1 = 18 square inches* *c. Bottom flange: 24 x 1 = 24 square inches*
Step 2	Calculate for TNT/rule of thumb: *a. Top flange: 20 x 1 = 20 square inches* *b. Web: 18 x 1 = 18 square inches* *c. Bottom flange: 24 x 1 = 24 square inches* *d. Total square inches = 62 square inches (a + b + c)* $P = \frac{3}{8}A = \frac{3}{8} \times 62 = 23.25 \text{ pounds of TNT}$
Step 3	Divide by the RE factor, if required: $\frac{23.25}{1.34} = 17.35 \text{ pounds of C4}$
Step 4	Divide by the package weight/volume and round UP to the next whole package: $\frac{17.35}{1.25} = 13.8; \text{ round up to 14 packages of C4}$
Step 5	Calculate the number of charges: *two beams = two charges*
Step 6	Calculate the total amount of explosives: $\text{step 4} \times \text{step 5} = \text{total packages} = 14 \times 2 = 28 \text{ packages of C4}$

Solution: You need 28 packages of C4 to cut the two beams. See Figure 3-7, page 3-11, for the placement of the charge.

Example G-197. Steel-cutting charge calculations

Problem: Using Table 3-4, page 3-13, determine the quantity of C4 required to cut the steel beam shown below.

Area of flange = 2 x 1/2 x 5 = 5 square inches
Area of web = 3/8 x 11 = 4 1/8 square inches
Total area (A) = 9 1/8 square inches

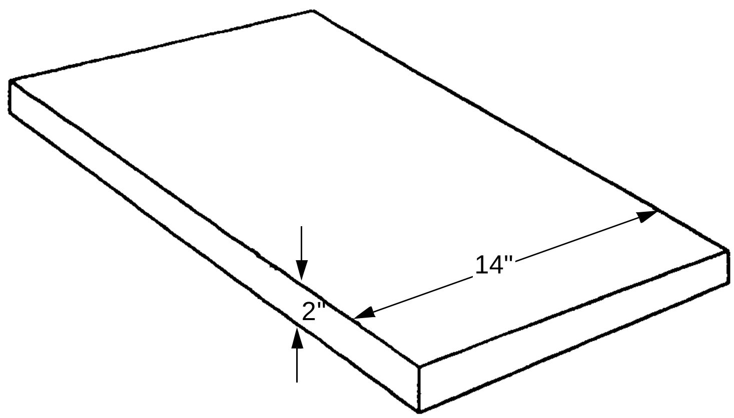


Step 1	Obtain the critical dimensions: *a. Top flange: 5 x 1/2 inches* *b. Web: 11 x 3/8 inches* *c. Bottom flange: 5 x 1/2 inches*
Step 2	Calculate for TNT/rule of thumb: *a. Top flange: 5 x 1/2 = 0.8 pounds from Table 3-4, page 3-13* *b. Web: 11 x 3/8 = 1.3 pounds from Table 3-4* *c. Bottom flange: 5 x 1/2 = 0.8 pounds from Table 3-4* *d. Total = 2.9 pounds of C4 (a + b + c)*
Step 3	Divide by the RE factor, if required: Not required.
Step 4	Divide by the package weight/volume and round UP to the next whole package: $\frac{P}{package\ weight} = \frac{2.9\ pounds\ of\ C4}{1.25\ package\ weight} = 2.32;\ round\ up\ to\ 3\ packages\ of\ C4$
Step 5	Calculate the number of charges: $one\ beam = one\ charge$
Step 6	Calculate the total amount of explosives: $step\ 4 \times step\ 5 = total\ packages = 3 \times 1 = 3\ packages\ of\ C4$

Solution: You need 3 packages of C4. See Figure 3-7, page 3-11, for the placement of the charge.

Example G-198. Hasty steel-cutting charge calculations

Problem: Using a ribbon charge, determine the quantity of C4 required to cut the steel plate shown below.

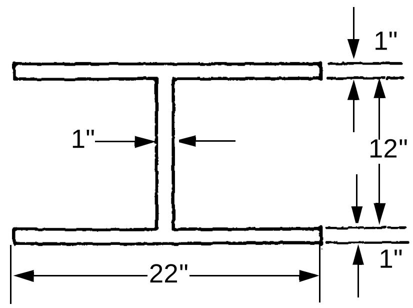


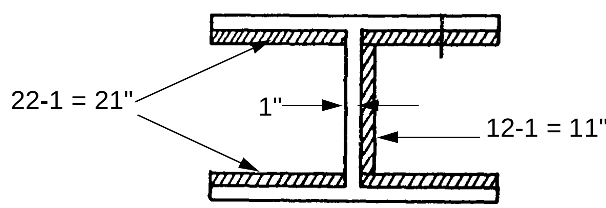
Step 1	Obtain the critical dimensions: *a. Cut length: 14 inches* *b. Target thickness: 2 inches*
Step 2	Calculate for TNT/rule of thumb: *a. Thickness: 1/2 (target thickness) = 1 inch* *b. Width: 3 (charge thickness) = 3 inches* *c. Length: cut length = 14 inches* $volume = T \times W \times L = 1 \times 13 \times 14 = 42 \text{ cubic inches}$
Step 3	Divide by the RE factor, if required: Not required because only C4 or sheet explosives are used.
Step 4	Divide by the package weight/volume and round UP to the next whole package: $N = \frac{charge\ volume}{package\ volume} = \frac{42}{20} = 2.1; \text{ round up to 3 packages of C4}$
Step 5	Calculate the number of charges: $one\ plate = one\ charge$
Step 6	Calculate the total amount of explosives: $step\ 4 \times step\ 5 = total\ packages = 3 \times 1 = 3\ packages\ of\ C4$

Solution: You need 3 packages of C4 to cut the steel plate. See Figure 3-11, page 3-16, for the placement of the charge.

Example G-199. Steel-cutting charge calculations (steel plate)

Problem: Using a ribbon charge, determine the quantity of C4 required to cut the I-beam shown below.



Step 1	Obtain the critical dimensions: *a. Top flange: 22 x 1 = 22 inches* *b. Web: 12 x 1 = 12 inches* *c. Bottom flange: 22 x 1 = 22 inches*
Step 2	Calculate for TNT/rule of thumb: *a. Thickness = 1/2 (target thickness) = 1/2 inches* *b. Width = 3 (charge thickness) = 1 1/2 inches* *c. Length = Cut length = 21 + 21 + 11 = 53 inches* $volume = T \times W \times L = 1/2 \times 1\ 1/2 \times 53 = 39.75$ *cubic inches of C4* 
Step 3	Divide by the RE factor, if required: Not required because only C4 or sheet explosives are used.
Step 4	Divide by the package weight/volume and round UP to the next whole package: $N = \frac{charge\ volume}{package\ volume} = \frac{39.75}{20} = 1.98$; *round up to 2 packages of C4*
Step 5	Calculate the number of charges: *one I-beam = 1 charge*
Step 6	Calculate the total amount of explosives: $step\ 4 \times step\ 5 = total\ packages = 2 \times 1 = 2$ *packages of C4*

Solution: You need 2 packages of C4 to cut the I-beam. See Figure 3-12, page 3-16, for the placement of the charge.

Example G-200. Steel-cutting charge calculations (I-beam)

Problem: Determine the quantity of 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 x 7 = 21.98 inches*
Step 2	Calculate for TNT/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 C4 or sheet explosives are used.
Step 4	Divide by the package weight/volume and round UP to the next whole package: $N = \frac{charge\ volume}{package\ volume} = \frac{120.78}{20} = 6.039;\ round\ up\ to\ 7\ packages\ of\ C4$
Step 5	Calculate the number of charges: $one\ bar = one\ charge$
Step 6	Calculate the total amount of explosives: $step\ 4 \times step\ 5 = total\ packages = 7 \times 1 = 7\ packages\ of\ C4$
Solution: You need 7 packages of C4 to cut the steel bar using a saddle charge. See Figure 3-13, page 3-17, for the placement of the charge.	

Example G-201. Steel-cutting charge calculations (steel bar)

Problem: Determine the quantity of C4 required to cut a 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 x 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 C4 because this charge uses and is computed for plastic explosive (C4) or sheet explosive, not TNT.
Step 4	Determine the number of required packages of C4: $N = \frac{charge\ volume}{package\ volume} = \frac{157.7536}{20} = 7.88768;\ round\ up\ to\ 8\ packages\ of\ C4$
Step 5	Calculate the number of charges. $one\ bar = one\ charge$
Step 6	Calculate the total amount of explosives required: $step\ 4 \times step\ 5 = total\ packages\ 8 \times 1 = 8\ packages\ of\ C4\ is\ required$
Solution: You will need 8 packages of C4 to cut one high-carbon steel bar. See Figure 3-14, page 3-18, for the placement of the charge.	

Example G-202. Steel-cutting charge calculation (high-carbon steel)

Problem: Using the formula R^3KC, determine the number of 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 for TNT/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 C4*
Step 4	Divide by the package weight/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 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: *step 4* $\times$ *step 5* = *total packages* = $85 \times 3 = 255$ *packages of C4*
Solution: You need 255 packages of C4 to breach the pier. See Figure 3-16, page 3-23, for the placement of the charge.	

Example G-203. Breaching charge calculation (reinforced-concrete pier)

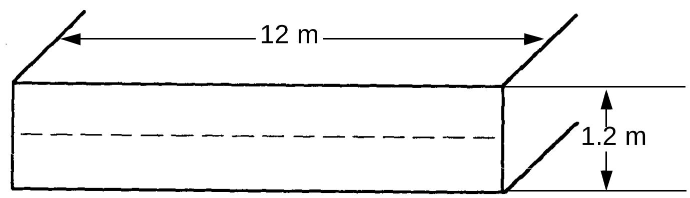
Problem: Determine the required amount of C4 needed to counterforce four concrete cubes 3 feet thick.	
Step 1	Obtain the critical dimensions: $target\ thickness = 3\ feet$
Step 2	Calculate for TNT/rule of thumb: $P = 1\ 1/2\ pounds\ of\ C4\ per\ foot\ of\ diameter$ $P = 1\ 1/2 \times 3 = 4.5\ pounds\ of\ C4$
Step 3	Divide by the RE factor, if required: Not required because only C4 or sheet explosives are used.
Step 4	Divide by the package weight/volume and round UP to the next whole package: $N = \frac{charge\ weight}{package\ weight} = \frac{4.5}{1.25} = 3.6$; round up to 4 packages of C4
Step 5	Calculate the number of charges: $four\ cubes = four\ charges$
Step 6	Calculate the total amount of explosives: $step\ 4 \times step\ 5 = total\ packages = 4 \times 4 = 16\ packages\ of\ C4$
Solution: You need 16 packages of C4 to counterforce four cubes. See Figure 3-17, page 3-24, for the placement of the charges.	

Example G-204. Counterforce charge calculation

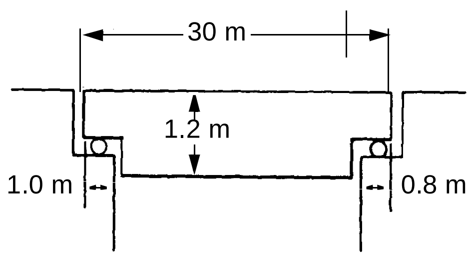
Problem: Determine the quantity of cratering charges (cc) and C4 required to create a deliberate crater 146 feet long.	
Step 1	Obtain the critical dimensions: $$crater\ length\ (L) = 146\ feet$$
Step 2	Calculate for TNT/rule of thumb: a. 7-foot borehole = 80 pounds of explosive b. 5-foot borehole = 40 pounds of explosive
Step 3	Divide by the RE factor, if required: Not required.
Step 4	Divide by the package weight/volume and round UP to the next whole package: a. 7-foot borehole = 2 cratering charges and 2 packages of C4 b. 5-foot borehole = 1 cratering charge and 2 packages of C4
Step 5	Calculate the number of charges $$N = \frac{L - 16}{5} + 1 = \frac{146 - 16}{5} + 1 = 27\ holes$$ 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-ft boreholes: 14 holes (2 cc + 2 pkg C4) = 28 cc + 28 pkg C4 b. 5-ft boreholes: 13 holes (1 cc + 2 pkg C4) = 13 cc + 26 pkg C4 TOTAL = 41 cc & 54 pkg of C4
Solution: You need 41 cratering charges and 13 packages of C4 to create a deliberate crater 146 feet long. See Figure 3-19, page 3-28, for charge placement.	

Example G-205. Cratering charge calculation

Problem: A simply supported, concrete-deck, top-support bridge span must be destroyed with a concrete-stripping charge. The diagram below shows the span dimensions. Determine the quantity of C4 required.



Cross section at midspan



Elevation view

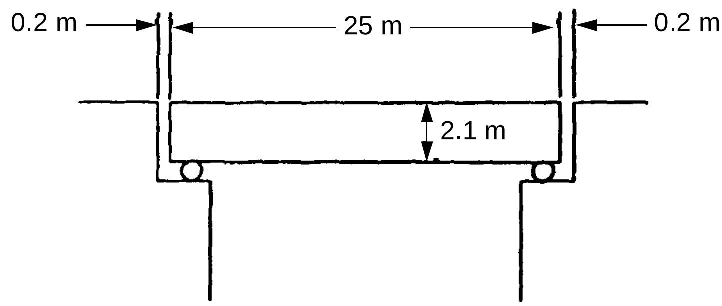
Beam Calculations	
Step 1	Determine the amount of TNT required per meter: $P = (3.3h + 0.5)^3 3.3 = [3.3(1.2) + 0.5]^3 3.3 = 292.76456 \text{ pounds of TNT per meter}$
Step 2	Determine the amount of explosive (TNT) per beam: $P = (\text{pounds TNT/meter})(\text{bridge width, in meters})$ $P = 292.76456(12 \text{ meters}) = 3{,}513.1747 \text{ pounds of TNT}$
Step 3	Determine the equivalent amount of C4: $\frac{P}{RE} = \frac{3,513.1747}{1.34} = 2{,}621.7721 \text{ pounds of C4}$
Step 4	Determine the required packages of C4 per beam: $P = \frac{\text{charge weight}}{\text{package weight}} = \frac{2{,}621.7721}{1.25} = 2{,}097.4176; \text{ round up to } 2{,}098 \text{ of C4}$
Step 5	Calculate the number of charges: $\text{one bridge} = \text{one charge}$
Step 6	Calculate the total amount of explosives: $\text{step 4} \times \text{step 5} = \text{total packages} = 2{,}098 \times 1 = 2{,}098 \text{ packages of C4}$

Solution: You need 2,098 packages of C4 to destroy this simply-supported-concrete deck, top-support bridge span.

Example G-206. Concrete stripping charge calculation

Problem: Determine the attack method for demolishing a simply supported, steel-beam deck bridge with bottom supports and the following measurements:

a. Length (L): 25.0 meters
b. Height (H): 2.1 meters
c. End clearance (E): 0.4 meters



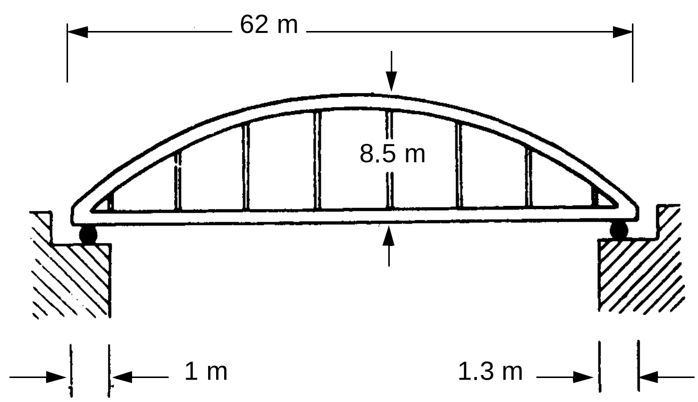
Step 1	See Appendix I. Table I-1, page I-1, lists the bottom attack method for this bridge, provided that the actual end clearance (E) is greater than E_R.
Step 2	Perform the calculation to determine whether E is greater than E_R. a. Determine the height-to-length ratio (H/L): $\frac{H}{L} = \frac{2.1}{25} = 0.084$ b. Find the corresponding E/L value (Table I-1). Since 0.084 is not found on the table, go to the next higher value, 0.09. c. From the higher value, 0.09, move directly below and find value 0.0160. d. Determine the required end clearance. Use the following formula to find E_R: $E_R = \text{Value found } (0.0160) \times \text{length}(25) = 0.4 \text{ meters}$

Solution: Compare the actual and required end clearances. Since the actual end clearance (0.4 meter) is equal to the required end clearance (0.40 meter), a bottom attack is possible without any likelihood of the span jamming.

Example G-207. Bottom-attack bridge calculation

Problem: Determine the attack method for demolishing a simply supported bowstring bridge with the following measurements:

a. Length (L): 62.0 meters
b. Height (H): 8.5 meters
c. Average length of bearing supports (L_S): 1.15 meters



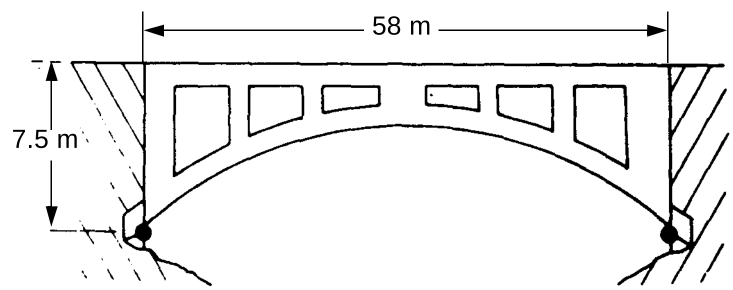
Step 1	Consult Appendix I. Table I-2, page I-2, lists the top attack method for this bridge.
Step 2	Determine the height-to-length ratio (H/L). Since 0.137 is not found on the table, round UP to 0.014. $$\frac{H}{L} = \frac{8.5}{62} = 0.137$$
Step 3	Determine the required-gap ratio (L_S/L): $$\frac{L_s}{L} = \frac{1.15}{62} = 0.0185$$
Step 4	Find the corresponding L_S/L value (Table I-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 to place the charges. To accomplish this, divide L_C in half (5.08/2 = 2.54 meters).

Solution: 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.

Example G-208. Top-attack bridge calculation

Problem: Determine the attack method for a continuous, concrete-arch bridge with open spandrels and pinned footings, having the following measurements:

a. Length (L): 58.0 meters
b. Rise (H): 7.5 meters



Step 1	Consult Appendix I. Table I-4, page I-4, 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 I-3, page I-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: $$L_c = \frac{L_c}{L}(L) = (0.04)58 = 2.32\ meters$$
Step 5	Determine where to place the charges. Place the charges at the midspan.

Solution: The proposed cut must be at the midspan. Mark the bridge in this location. This location is the centerline for the proposed cut.

Example G-209. Arch-bridge attack calculation

Appendix H

Underwater Demolitions

H-1. This appendix outlines 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 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, alteration of channel or harbor bottoms, concrete and masonry blasting, breaking and cutting steel, ship cutting, and removal of the ships' propellers. These operations may be independent or they may be used alone or with harbor clearance.

HARBOR CLEARANCE

H-2. 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.

WARNING
THE RENDERING SAFE OF UNDERWATER EXPLOSIVE ORDNANCE IS OUTSIDE THE SCOPE OF SALVAGE OPERATIONS. WHENEVER EXPLOSIVES IS KNOWN OR SUSPECTED, EOD PERSONNEL SHOULD CLEAR THE AREA BEFORE SALVAGE OPERATIONS ARE STARTED.

SHIP SALVAGE

H-3. Before salvage operations are started, determine whether sunken ships are to be dispersed by explosives, converted to mooring or docking facilities, salvaged for reuse, or for 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.

H-4. 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

H-5. Sectioning involves cutting the vessel into manageable pieces and removing it designated locations.

FLATTENING

H-6. 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 first removed, 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 weights of and existing tresses in structural members. The greater the stress on the member, the less explosive needed to cut or break it.

DISPERSAL

H-7. 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. To disperse the hull, place heavy demolition charges inside each end of the hull and one heavy charge in the center. Detonation of the charges are 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

H-8. Explosives may be used to prevent the ship from settling on the bottom. Explosives can be used to make the ship settle farther on the bottom as follows:

- 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 ships hull 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.

NOTE: Removing large sections of steel may require a surface crane or winch from the supported unit.

IMPALEMENT BLASTING

USE

H-9. Using explosives to remove an impaling point is a slow process. Use extra caution when blasting rock or coral that is in contact with a watercraft's hull. 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. Check the results after each blast, and either increase the charge size or repeat the step 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

H-10. Use a hydraulic sinker drill to drill a pattern of small boreholes along the planned cutline, leaving some holes uncharged. Relief holes will vent explosive pressure and increase the shattering effect by decreasing the lateral burden about the charge (Figure H-1).

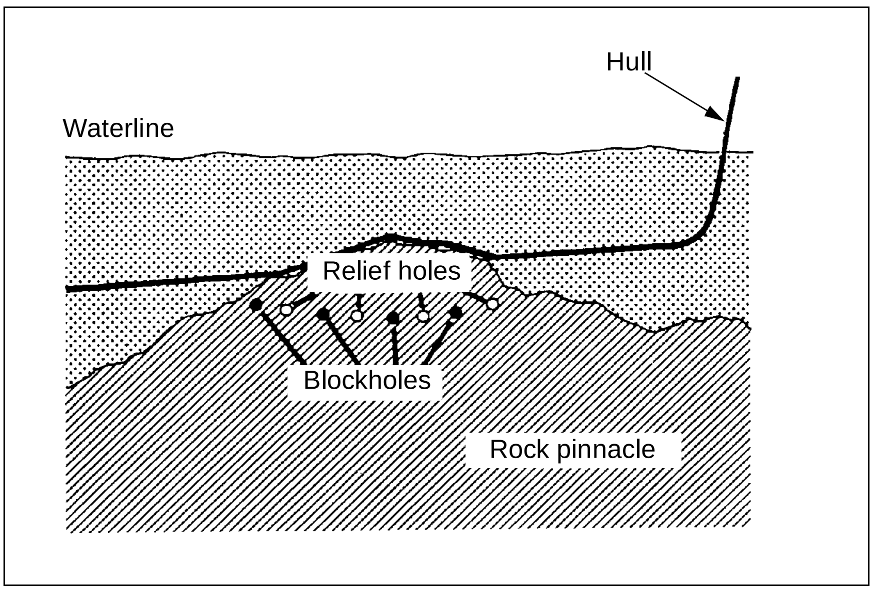


Figure H-210. Impalement blasting outside the hull

H-11. Pour a large internal patch of concrete, if available, into a form inside the hull around the point of impalement. This establishes a medium which 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 as one-shot solutions.

H-12. Use small charges initially (about $^1/_8$ to $^1/_4$ pound of explosives). Use them in a delay sequence to avoid creating a large shock wave. Continue this process until the impaling point is removed.

IMPALEMENT BLASTING WITHIN THE HULL

H-13. Attack the pinnacle from within the ship when external access to the impaling point is dangerous or impossible (Figure H-2) Attack the pinnacle by—

- Cementing the rock to the hull so that it plugs the hole. The ship can then be freed by shattering small portions of the impaling point and breaking the rock free, about two feet outside the hull, with each round of explosives (Figure H-3).

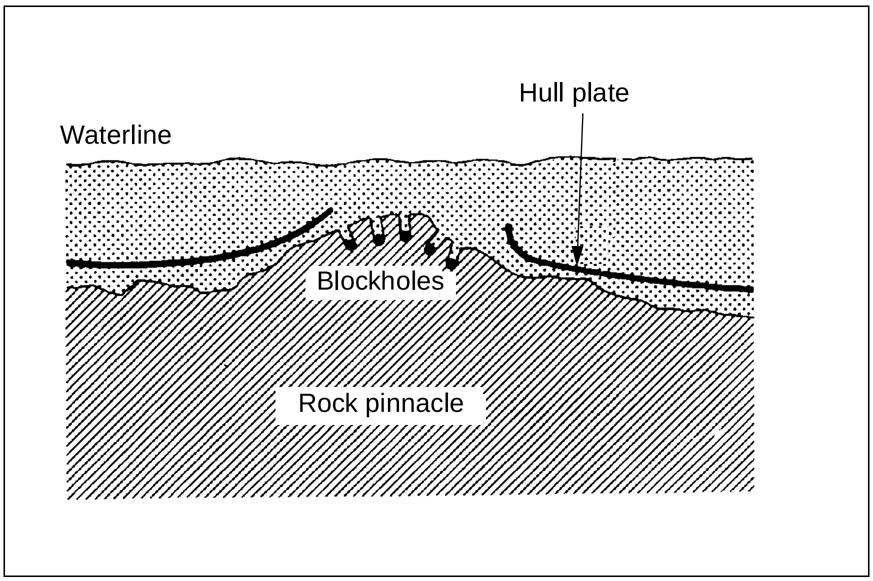


Figure H-211. Impalement blasting within the hull

- Using a hydraulic sinker drill to drill a pattern of small boreholes along the planned cutline, leaving some of the holes uncharged. 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.

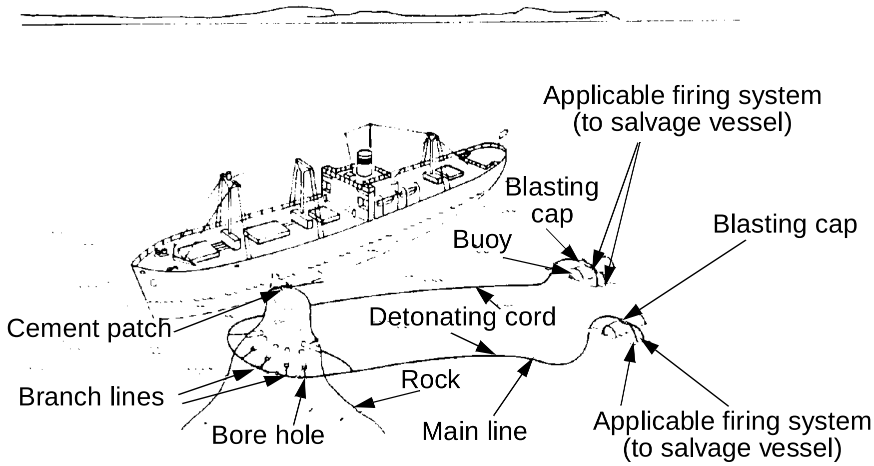


Figure H-212. Freeing ship from rock pinnacle

> **CAUTION**
> Open doors and cargo hatches to prevent an internal over pressurization of the hull. A flood-control plan is required.

TRENCHING AND TUNNELING

USE

H-14. 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 light enough charges so that the ship itself will not be damaged. After blasting in rock, an airlift may be needed to remove material (Figure H-4, page H-6).

POWDER POINTS

H-15. 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. Make the charges above the water, then have a diver place them into the pipes. To construct powder points, use the following procedure:

- Above water—
  - — Prepare the plastic explosive charges.
  - — Tie a double overhand knot in the detonating cord of sufficient length to lower the charge to the bottom of the pipe.
- Below water—
  - — Place the powder point perpendicular to the material to be moved.

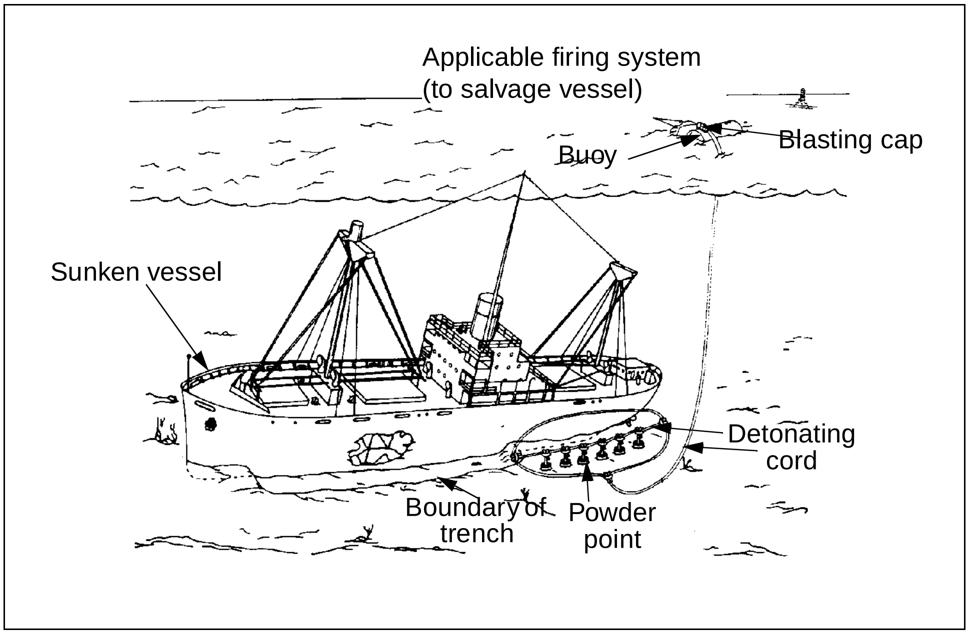


Figure H-213. Trenching and tunneling with explosives alongside a ship

— 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. Alternate points should contain different charges so that the detonation effects will not cancel each other.

— Join individual charges together by a branch line and connect them to the surface initiating system by using a double-main line of detonating cord.

BOREHOLES

H-16. Place charges in boreholes spaced and staggered the same way as powder points, when powder points cannot be used. Construct boreholes for powder charges 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.

NOTE: Enlarge boreholes by using additional explosives.

CHANNEL ALTERATION

USE

H-17. Channeling 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 H-5).

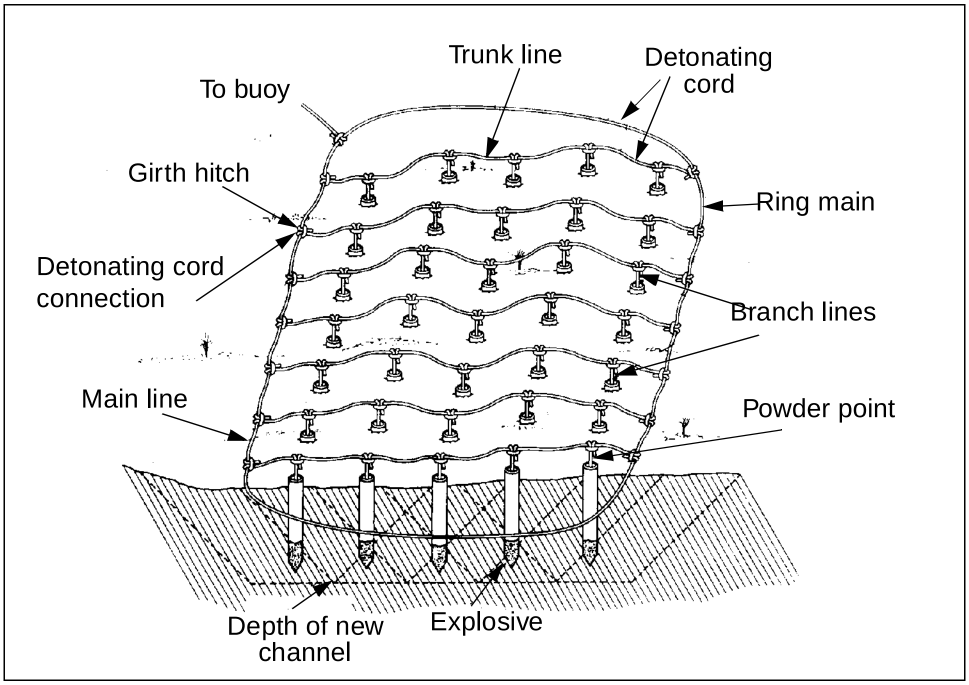


Figure H-214. Channel alteration

POWDER POINTS

H-18. Refer to paragraph H-15, page H-5, for the powder-point procedures. Use the following paragraph as the last procedure for completing below-water procedures (use this procedure for channel alteration only):

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

H-19. Where you cannot use powder points, place charges in boreholes spaced and staggered the same way as powder points. Construct the boreholes for powder charges 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.

NOTE: Enlarge boreholes by using more explosives.

SANDBAR REMOVAL

H-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 using powder points. See the powder points listed under trenching and tunneling operations in paragraphs H-14 through H-16, pages H-5 and H-6, (Figure H-6, page H-8).

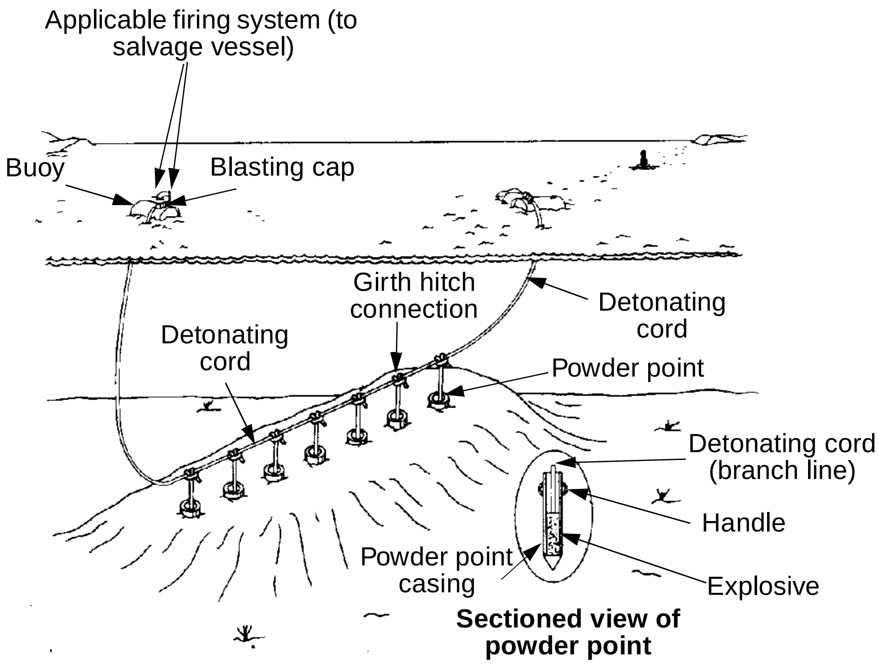


Figure H-215. Sandbar removal

DOUBLE WATERPROOF FIRING ASSEMBLY (DWFA)

USE

H-21. The 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 H-7).

DWFA BOARD/BUBBLE WRAP PREFIRING PROCEDURES

- Observe standard explosive and nonelectric firing-safety precautions. The DWFA must remain on the surface of the water with the fuse-ignitor end securely taped to board or bubble wrap. This prevents the rapid burning of the time fuse due to water pressure, which could cause premature detonation.
- 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 water to prevent them from burning through. This could result in premature detonation.
- Use multiple DWFAs on larger targets; if necessary.

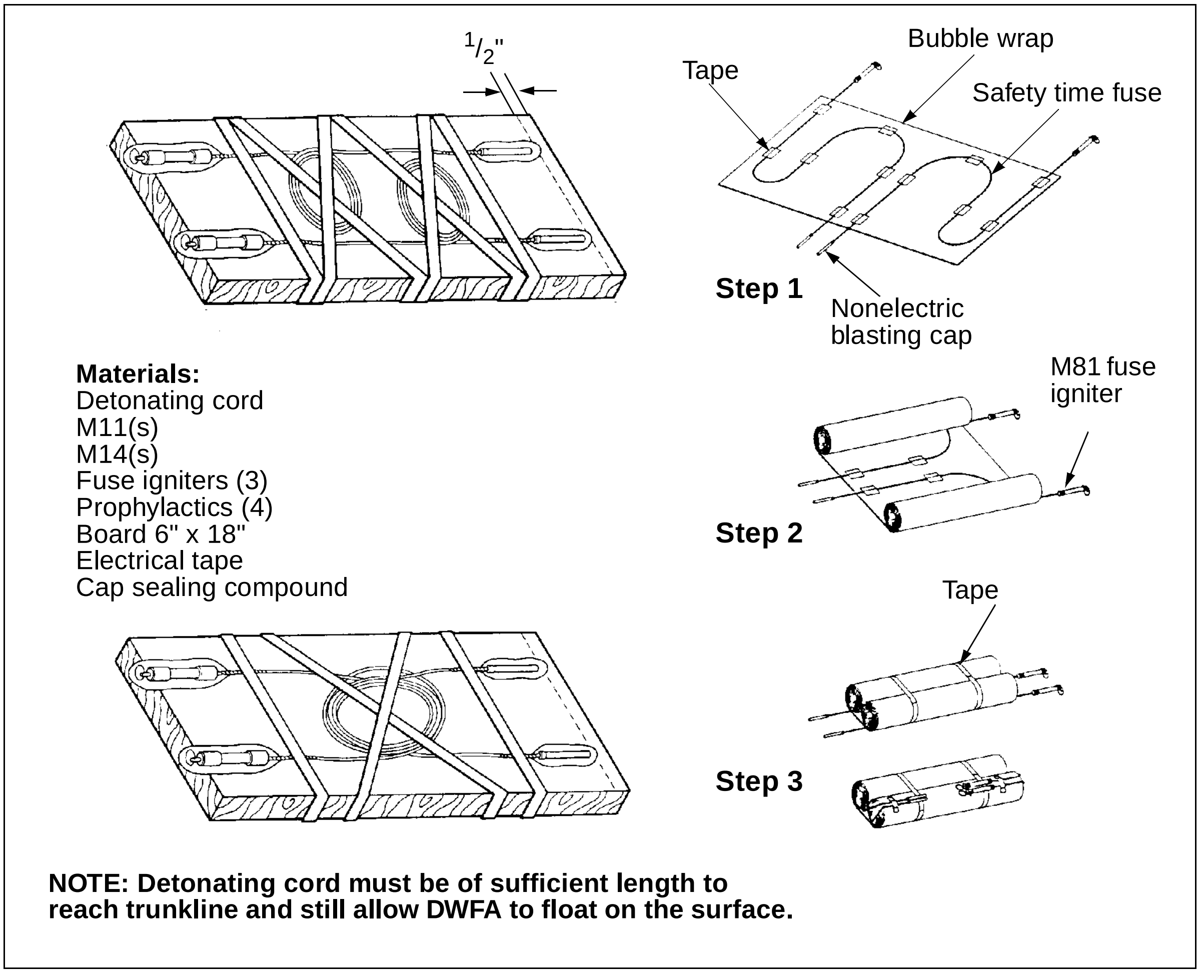


Figure H-216. DWFA

DETONATING-CORD PREPARATION

SUPPORT OR STRAIN-RELIEF LINE

H-22. 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 H-8, page H-10).

H-23. 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. Attach the detonating cord to the support or strain-relief line with plastic tie straps (zip ties). Attach the tie straps about every 3 feet with a 2- to 3-inch catenary (slack) between connecting points.

H-24. Use one of the following to attach the detonating cord to the trunk line:

- Gregory knot.
- Girth hitch with an extra turn connection.
- Detonating-cord connector, right-angle connection.

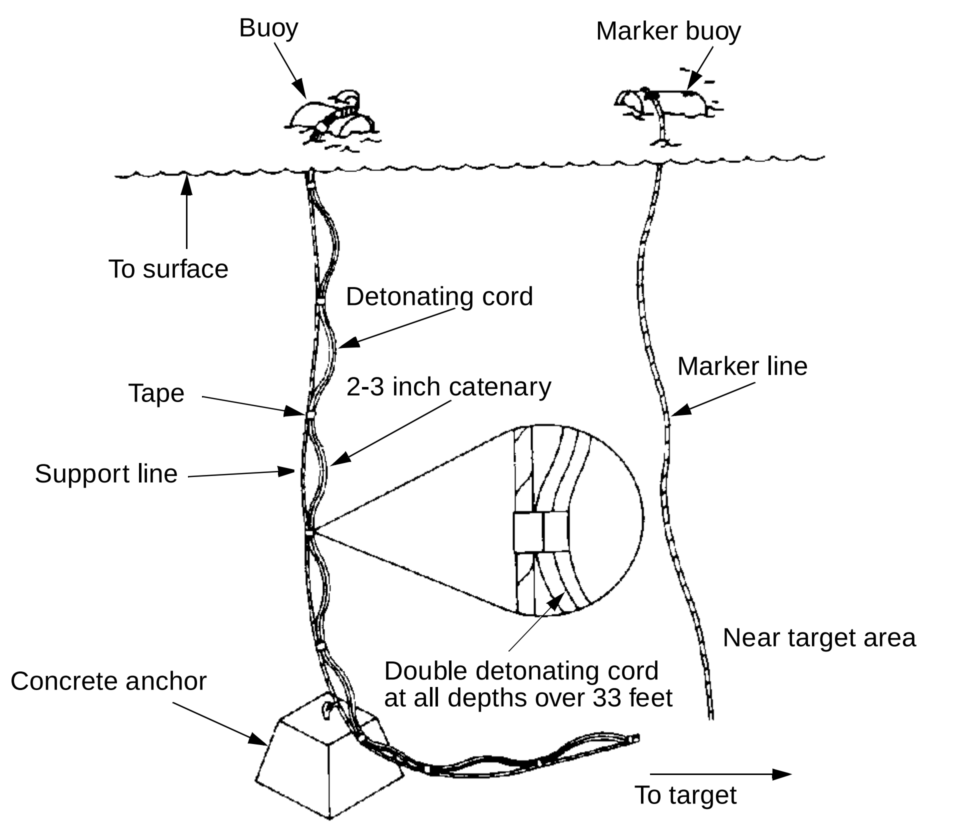


Figure H-217. Typical detonating cord preparation

NOTE: You can use several unconventional knots such as the cherry knot and right-angle knot connection to attach the detonating cord to the trunk line.

ANCHOR

H-25. Attach the support or strain-relief line 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.

DOUBLING DETONATING CORD

H-26. 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

H-27. Attach an additional marker buoy to the target area for relocation when returning for shot investigation.

Appendix I

Methods of Attacking Bridges With Demolitions

I-1. The methods of attack in this appendix are for the most common types of bridges; however, they are not all inclusive.

I-2. When faced with unusual construction methods or materials (for example, Hayricks which 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 in Chapter 4. Use Tables I-1 through I-3, pages I-1 through I-3, to determine the required clearance to prevent jamming. Use Table I-4, page I-4 and Table I-5, page I-9, for methods of attack.

Table I-3. Minimum E_R values for bottom attack (percent)

$\frac{H}{L}$	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10
$\frac{E_R}{L}$	0.0002	0.0008	0.0020	0.0030	0.0050	0.0070	0.0100	0.0130	0.0160	0.0200
$\frac{H}{L}$	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20
$\frac{E_R}{L}$	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 = 0.013.

2. Multiply the E_R/L value determined from the chart by L to get E_R.

Table I-2. Minimum L_c values for top attack (midspan)

$\frac{L_s}{L}$ \ $\frac{H}{L}$	Ratio of Section Removed to Span Length $\left(\frac{L_c}{L}\right)$														
	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	0.100
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 I-3. Minimum L_c values for arch and pinned-footing bridge attacks

$\frac{H}{L}$	0.040	0.060	0.080	0.100	0.120	0.140	0.160	0.180	0.200
$\frac{L_C}{L}$	0.003	0.007	0.013	0.020	0.030	0.040	0.053	0.067	0.083
$\frac{H}{L}$	0.220	0.240	0.260	0.280	0.300	0.320	0.340	0.360	
$\frac{L_C}{L}$	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, (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 the column headed 0.10 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 x L = L_c.

Table I-4. Methods of attack on simply supported bridges

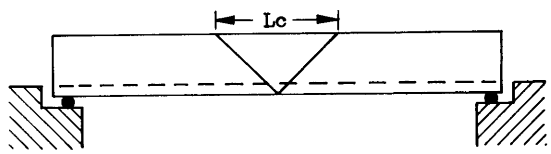
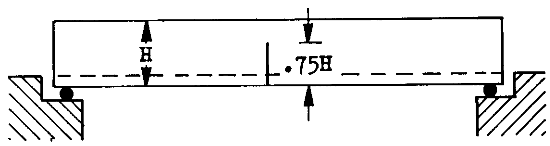
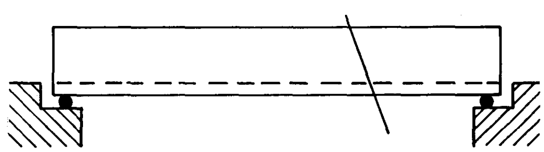
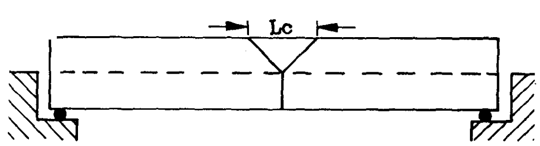
Serial	Sub-category	Type	Attack Method	Remarks
a	b	c	d	e
1	Steel beam	Through bridge, Method I	Top attack:  1. Cut at the midspan. 2. Cut beams, including bottom flange in a "V." 3. Do not consider cutting the deck.	None
2		Through bridge, Method II	Bottom attack: *E* is greater than E_R  1. Cut at the midspan to 0.75h, as shown. 2. Cut the deck across the full bridge width.	None
3		Through bridge, Method III	Angled attack:  1. Cut between 1/3 span and the midspan. 2. Cut the deck across the full bridge width.	End clearance is not a consideration.
4		Through bridge, Method IV	Bottom attack: *E* is less than E_R 1. Cut at the midspan to 0.75h. 2. Cut the deck across the full bridge width. 3. Attack one abutment or pier to create sufficient end clearance.	None
5		Through bridge, Method V	Top attack:  1. Cut at the midspan. 2. Cut the bridge as shown where the deck is located well above the beam bottom. 3. Do not consider cutting the deck.	None

Table I-4. Methods of attack on simply supported bridges (continued)

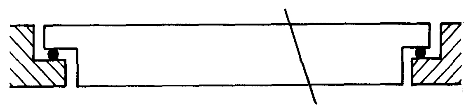
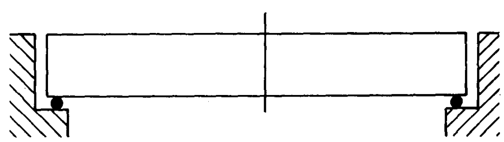
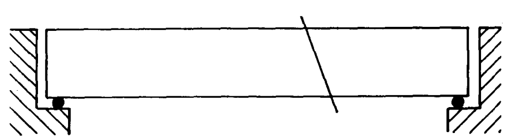
Serial	Sub-category	Type	Attack Method	Remarks
a	b	c	d	e
6		Deck Bridge, Top Support	Angled attack:  1. Cut between 1/3-span and the midspan. 2. Cut the deck across the full bridge width.	1. Configuration found in cantilever and suspended-span bridges. 2. End clearance is not a consideration.
7	Steel Beam	Deck Bridge, Bottom Support, Method I	Bottom attack: *E* is greater than E_R  1. Cut at the midspan. 2. Do not consider cutting the deck.	None
8		Deck Bridge, Bottom Support, Method II	Bottom attack: *E* is less than E_R 1. Cut at midspan. 2. Do not consider cutting deck. 3. Attack one abutment or pier to create sufficient end clearance.	None
9		Deck Bridge, Bottom Support, Method III	Angled attack:  1. Cut between 1/3-span and the midspan. 2. Cut the deck across the full bridge width.	End clearance is not a consideration.

Table I-4. Methods of attack on simply supported bridges (continued)

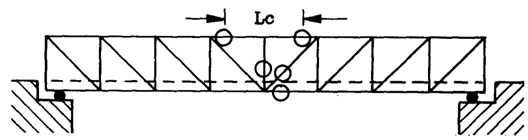
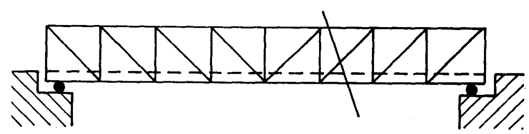
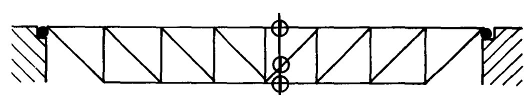
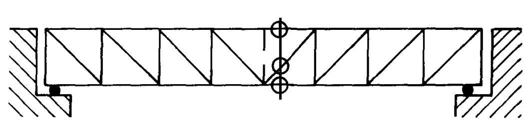
Serial	Sub-category	Type	Attack Method	Remarks
a	b	c	d	e
10		Through bridge, method I	Top attack:  1. Cut at the midspan. 2. Cut the top chord twice, vertically (if necessary), and diagonals and bottom chord. 3. Remove the wind bracing over the midspan. 4. Do not consider cutting the deck.	None
11	Steel truss	Through bridge, Method II	Angled attack:  1. Cut between 1/3 span and the midspan. 2. Cut top chord, diagonals, and bottom chord in one bay only. 3. Cut the deck across the full bridge width.	None
12		Deck bridge, top support	Bottom attack:  1. Cut between 1/3 span and the midspan. 2. Cut the top chord, diagonals, and bottom chord in one bay only. 3. Do not consider cutting the deck.	1. Configuration found in cantilever and suspended-span bridges. 2. End clearance is not a consideration.
13		Deck bridge, bottom support, Method I	Bottom attack: *E* is greater than E_R  1. Cut at the midspan. 2. Cut top chord, diagonals, and bottom chord in one bay only. 3. Do not consider cutting the deck.	None

Table I-4. Methods of attack on simply supported bridges (continued)

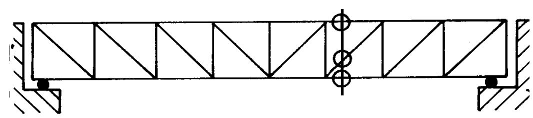
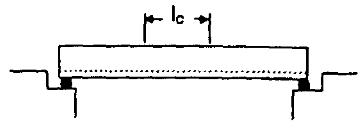
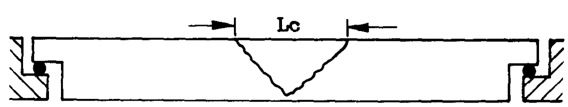
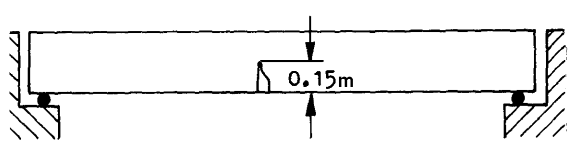
Serial	Sub-category	Type	Attack Method	Remarks
a	b	c	d	e
14	Steel truss	Deck bridge, bottom support, Method II	Bottom attack: *E* is less than E_R 1. Cut at the midspan. 2. Cut top chord, diagonals, and bottom chord in one bay only. 3. Do not consider cutting the deck. 4. Attack one abutment or pier to create sufficient end clearance.	None
15		Deck bridge, bottom support, Method III	Angled attack:  1. Cut between 1/3 span and the midspan. 2. Cut the deck across the full bridge width.	End clearance is not a consideration.
16	Concrete	Through bridge	Bottom attack:  1. Cut at the midspan. 2. Cut the deck across the full bridge width.	This method applies to slab bridges only.
17		Deck bridge, top support	Top attack:  Cut at the midspan with a concrete-stripping charge.	1. Configuration found in cantilever and suspended-span bridges. 2. Remove concrete for L_c distance to full width and depth of beams.
18		Deck bridge, bottom support, Method I	Bottom attack: *E* is greater than E_R  Cut at the midspan with hayricks.*	1. This method applies to slab bridges only. 2. Sufficient reinforcing bars are cut to cause bridge collapse.

Table I-4. Methods of attack on simply supported bridges (continued)

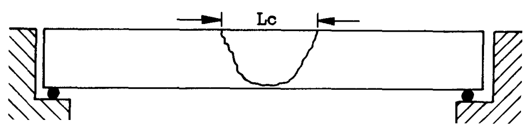
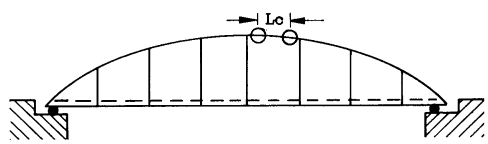
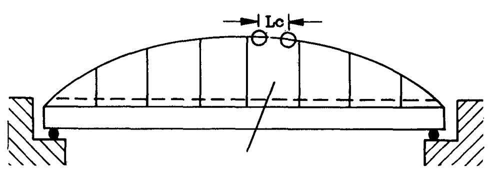
Serial	Subcategory	Type	Attack Method	Remarks
a	b	c	d	e
19	Concrete	Deck bridge, bottom support, Method II	Bottom attack: *E* is less than E_R 1. Cut at the midspan with hayricks.* 2. Attack one abutment or pier to create sufficient end clearance.	This method applies to slab bridges only.
20		Deck bridge, bottom support, Method III	Top attack: *E* is less than E_R  Cut at the midspan with a concrete-stripping charge.	Remove concrete for L_c distance to full width and depth of beams.
21	Bowstring	Normal	Top attack:  1. Cut at the midspan. 2. Cut the bow in two places. 3. Cut all hangers between the bow cuts. 4. Do not consider cutting the deck.	None
22		Reinforced beam or truss	Top attack, plus girders:  1. Cut the truss or beam with the appropriate method (Serials 1 through 15). 2. Cut the bow in two places, including the hangers.	None
*** Hayricks are not in the US Army supply system.**				

Table I-5. Methods of attack on continuous bridges

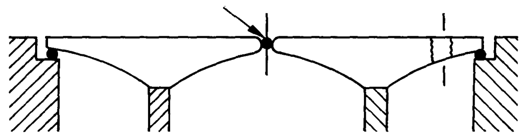
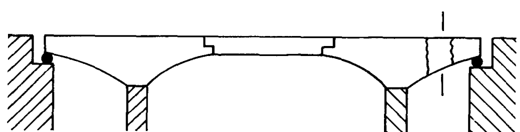
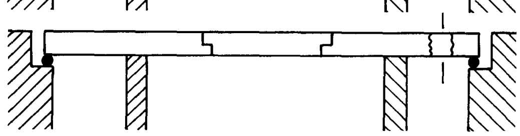
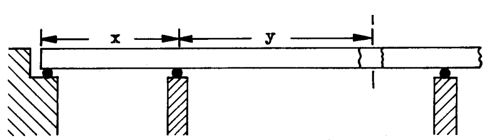
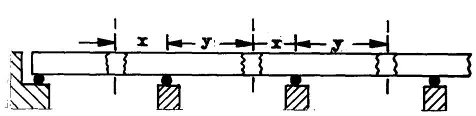
Serial	Subcategory	Type	Attack Method	Remarks
a	b	c	d	e
1	Concrete	Cantilever	Two cuts:  1. Cut the anchor span as closely to the pier as practical. 2. Cut the midspan shear joint.	1. Cutting the anchor span may require a two-stage attack. 2. Use a concrete-stripping charge for the first stage.
2		Cantilever and suspended span	One cut:   Cut the anchor as closely to the pier as practical.	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.
3		Beam or truss with short side span	One cut:  1. Cut interior span so *y* is greater than 1.25x. 2. If necessary, cut other interior spans as in Serial.	1. Cutting longer spans may require a two-stage attack. 2. Use a concrete-stripping charge for the first stage.
4		Beam or truss without short side span	Two or more cuts:  Cut the interior span so *y* is greater than 1.25x.	1. Cutting these spans may require a two-stage attack. 2. Use a concrete-stripping charge for the first stage.

Table I-5. Methods of attack on continuous bridges (continued)

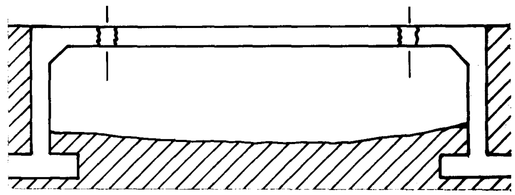
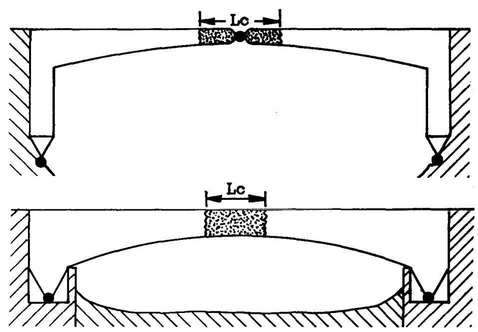
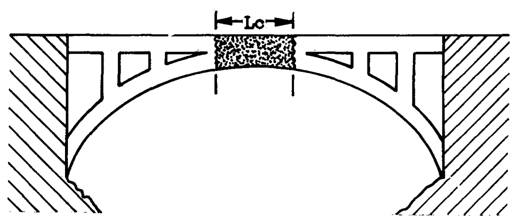
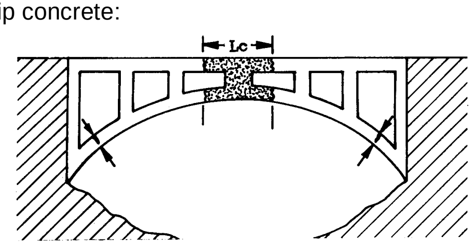
Serial	Subcategory	Type	Attack Method	Remarks
a	b	c	d	e
5	Concrete	Portal, fixed footing	Two cuts:  Cut the span twice, close to the pier.	1. Cutting these spans may require a two-stage attack. 2. Use a concrete-stripping charge for the first stage.
6		Portal, pinned footing	Strip concrete:  Remove concrete from the midspan over length L_c with a concrete-stripping charge.	1. Remove all concrete for L_c. 2. A one-stage attack should be adequate. 3. When footing conditions are unknown, use Serial 5. 4. For L_c use Table I-3.
7		Arch, open spandrel, fixed footing, Method I	Strip concrete:  Remove the concrete from the midspan over length L_c with a concrete-stripping charge.	1. Applies to arches greater than 35 meters. 2. A one-stage attack should be adequate. 3. For L_c use Table I-3.
8		Arch, open spandrel, fixed footing, Method II	Strip concrete:  1. Remove the concrete from the midspan over length L_c with a concrete-stripping charge. 2. Attack springing with hayricks* at the top face of the arch ring.	1. Applies to arches less than 35 meters. 2. A one-stage attack should be adequate. 3. For L_c use Table I-3.

Table I-5. Methods of attack on continuous bridges (continued)

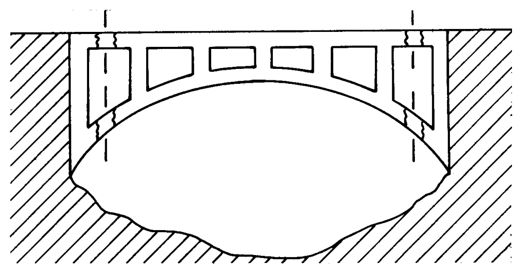
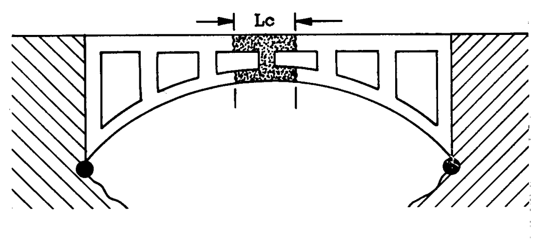
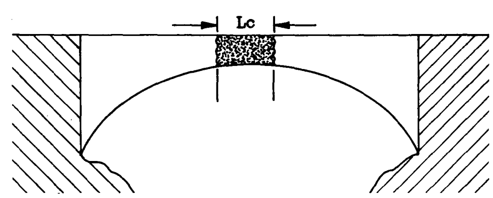
Serial	Subcategory	Type	Attack Method	Remarks
a	b	c	d	e
9		Arch, open spandrel, fixed footing, Method III	Four cuts: 	1. Alternative to Method II, applies to arches less than 35 meters. 2. Two-stage attack will probably be required. 3. Use concrete-stripping charge for first stage. 4. For L_c use Table I-3.
10	Concrete	Arch, open spandrel, pinned footing	Strip concrete:  Remove concrete from the midspan over length L_c with a concrete-stripping charge.	1. A one-stage attack should be adequate. 2. For L_c use Table I-3.
11		Arch, solid spandrel, fixed footing, Method I	Strip concrete:  Remove the concrete from the midspan over length L_c with a concrete-stripping charge.	1. This applies to arches of span greater than 35 meters only. 2. A one-stage attack should be adequate. 3. For L_c use Table I-3.

Table I-5. Methods of attack on continuous bridges (continued)

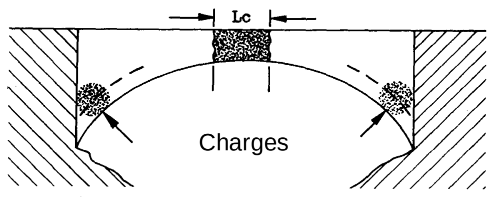
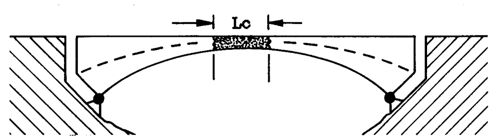
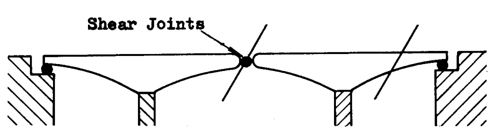
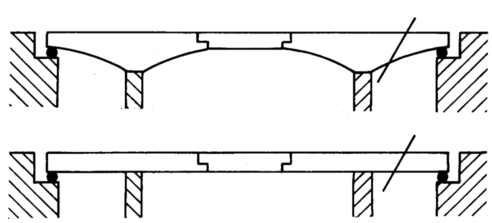
Serial	Subcategory	Type	Attack Method	Remarks
a	b	c	d	e
12	Concrete	Arch, solid spandrel, fixed footing, Method II	Strip concrete:  1. Remove concrete from the midspan over length L_c with a concrete-stripping charge. 2. Attack both springing points with concrete-stripping charges: a. Against bottom face of arch ring. b. Against the top face (must remove the fill beneath the roadway to access the arch ring).	1. Applies to arches less than 35 meters. 2. A one-stage attack should be adequate. 3. For L_c use Table I-3.
13		Arch, solid sprandral, pinned footing	Strip concrete:  Remove concrete from the midspan over length L_c with a concrete-stripping charge.	1. A one-stage attack should be adequate. 2. For L_c use Table I-3.
14	Steel	Cantilever	Two cuts:  1. Cut the anchor span as closely to the pier as practical. 2. Cut the midspan shear joints.	None
15		Cantilever and suspended span	One cut:  Cut anchor span as closely to the pier as practical.	If demolition of the suspended span will create the desired obstacle, regard the span as simply supported and attack accordingly.

Table I-5. Methods of attack on continuous bridges (continued)

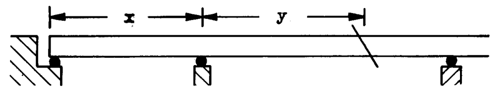
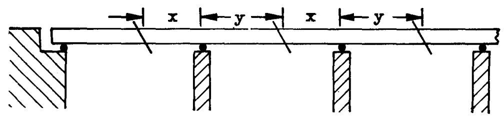
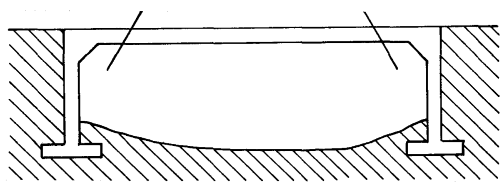
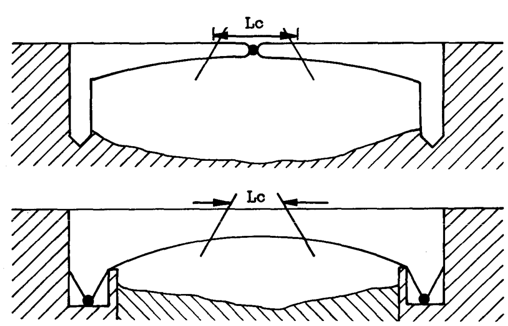
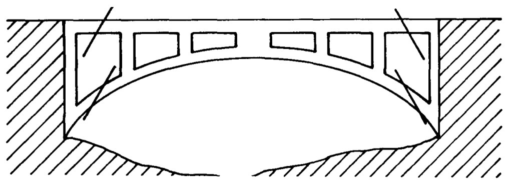
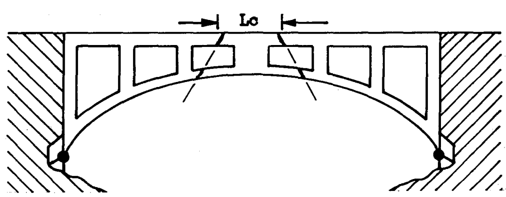
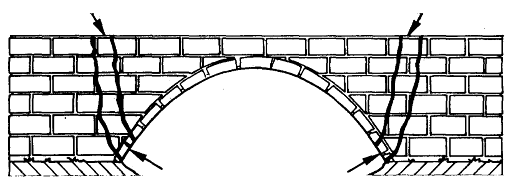
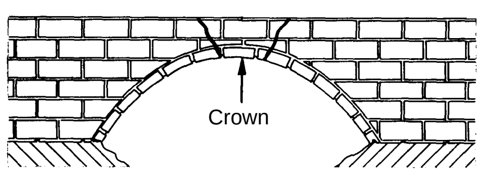
Serial	Subcategory	Type	Attack Method	Remarks
a	b	c	d	e
16		Beam or truss with short side span	One cut:  1. Cut interior span so *y* is greater than 1.25x. 2. If necessary, cut other interior spans as in Serial 17.	None
17		Beam or truss without short side span	Two or more cuts:  Cut spans so *y* is greater than 1.25x.	None
18	Steel	Portal, fixed footing	Two cuts:  Cut the span twice and close to the piers.	None
19		Portal, pinned footing	Two Cuts:  Remove section from midspan over length L_c.	For L_c use Table I-3.

Table I-5. Methods of attack on continuous bridges (continued)

Serial	Subcategory	Type	Attack Method	Remarks
a	b	c	d	e
20	Steel	Arch, open spandrel, fixed footing	Four cuts: 	1. Angle cuts about 70 degrees. 2. For L_c use Table I-3.
21		Arch, open spandrel, pinned footing	Two cuts:  Remove section from the midspan over length L_c.	For L_c use Table I-3.
22	Masonry	Arch, Method I	Two cuts:  1. Cut at haunches. 2. Attack arch ring, spandrel walls, and parapet.	None
23		Arch, Method II	One cut:  Breach arch ring at the crown.	1. Use this method as an alternate to Method I, only when time is insufficient to allow attack at the haunches. 2. For L_c use Table I-3.
*** Hayricks are not in the US Army supply system.**				

Appendix J

Instructions For Completing Demolitions-Related Reports

J-1. A completed target folder contains demolition orders and an obstacle folder. A sample target folder is shown in Figure J-1, pages J-4 through J-37. Refer to Chapter 5, paragraph 5-5, page 5-2, for a discussion of the demolition orders. Refer to Chapter 5, paragraph 5-25, page 5-7, for a discussion of the obstacle folder.

J-2. Use the following instructions and the sample form shown in Figure J-2, pages J-38 through J-42, to complete DA Form 2203-R. A blank DA Form 2203-R is at the end of this manual. It may be locally reproduced on 8 1/2- by 11-inch paper.

BLOCK 1 (FILE NUMBER)

J-3. Leave blank unless a higher HQ provides this number. Generally, higher HQ provides this number or enters it after you submit the form.

BLOCK 2 (DEMOLITION RECONNAISSANCE REPORT NUMBER)

J-4. Leave blank unless a higher HQ provides this number. Generally, higher HQ provides this number or enters it after you submit the form. The company SOP may specify the procedures for determining this number.

BLOCK 3 (DATE)

J-5. Enter the date the reconnaissance was performed.

BLOCK 4 (TIME)

J-6. Enter the time the reconnaissance party arrived at the target site (local or Zulu time).

BLOCK 5 (RECONNAISSANCE ORDERED BY)

J-7. Enter the command authority for the reconnaissance action.

BLOCK 6 (PARTY LEADER)

J-8. Enter the name of the NCOIC or the OIC of the reconnaissance party who was physically at the site when the reconnaissance was performed.

BLOCK 7 (MAP INFORMATION)

J-9. Obtain this information from a map of the reconnaissance area, and enter the information in this block.

BLOCK 8 (TARGET AND LOCATION)

J-10. Describe, briefly, the target and its distance and direction from an identifiable landmark (railroad bridge, crossroad, hilltop). For example, "Target is 275 degrees, 300 meters from the railroad bridge, 2 miles east of Hanesville, on Route 2."

BLOCK 9 (TIME OBSERVED)

J-11. Enter the time you last saw the target as you departed the site.

BLOCK 10 (COORDINATES)

J-12. Enter the complete 8-digit map coordinates of the target.

BLOCK 11 (GENERAL DESCRIPTION (USE BLOCK 20 FOR SKETCHES))

J-13. When applicable, include the type of construction, roadway width, number of lanes or tracks, payment type, 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."

BLOCK 12 (NATURE OF PROPOSED DEMOLITION (USE BLOCK 21 FOR SKETCHES))

J-14. 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.

BLOCK 13 (UNUSUAL FEATURES OF SITE)

J-15. 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.

BLOCK 14 (MATERIAL REQUIRED)

J-16. Indicate the types, quantities, caps, detonators, and other materials proposed for the demolition.

BLOCK 15 (EQUIPMENT AND TRANSPORT REQUIRED)

J-17. 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 18 on page 2 of the form.

NOTE: Troops may not ride in vehicles transporting explosives.

BLOCK 16 (PERSONNEL AND TIME REQUIRED FOR)

J-18. Complete subsections a and b, indicating the number of personnel and the 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.

BLOCK 17 (TIME, LABOR, AND EQUIPMENT REQUIRED FOR BYPASS)

J-19. Specify the equipment necessary to clear the site after demolition and the available bypasses that allow units to bypass the site. Continue comments in Block 18 on page 2 of the form.

BLOCK 18 (REMARKS)

J-20. Include any appropriate remarks that are not covered in Blocks 1 through 17.

BLOCK 19 (ADDITIONAL COMMENTS)

J-21. Use this block as a continuation for Blocks 1 through 18. Identify the block being continued.

BLOCK 20 (GENERAL DESCRIPTION SKETCH)

J-22. The sketch should include the following:

- The avenues of approach to the target and possible bypasses around the target to indicate route numbers and direction of cities and towns.
- Rivers or streams including name, direction of flow, and velocity in meters per second.
- Terrain features, including observation points, cover and concealment, swampy areas, deep valleys, and so forth.
- A compass arrow indicating north (indicate grid or magnetic).
- Dimensions of the proposed target.
- Number and length of bridge spans.
- Height of the bridge from the ground or water.

BLOCK 21. (NATURE OF PROPOSED DEMOLITION SKETCH)

J-23. This sketch should include the following:

- Dimensions of the members to be cut.
- Placement of charges.
- Charge calculations. Use either the formula or table method, but show your work.
- Priming of charges.
- Branch lines.
- Ring mains.
- Firing systems.
- Firing points.

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ORDERS FOR THE DEMOLITION
(USAEREUR Reg 525-2: STANAG 2017)

INSTRUCTIONS FOR PREPARING THIS FORM

i. Paragraphs 1-9 are to be completed, placing a cross in each box where applicable.

ii. Copy No 1 is to be issued to the Demolition Guard Commander and Copy No 2 to the Firing Party Commander. Copy No 3 is retained by the Authorized Commander. If there is no Demolition Guard, Copy No 1 is issued to the unit providing the firing party.

iii. If the Demolition Guard Changes, a new form should be issued.

ORDERS TO THE DEMOLITION GUARD COMMANDER

iv. You are responsible for:

a. Command of the Demolition Guard and Demolition Firing Party.

b. The security of the demolition site from enemy attack or sabotage, and the control of traffic and refugees at the demolition site.

c. Giving the order to the Demolition Firing Party Commander in writing (para 10 of Copy No 2) to change the State of Readiness.

d. Giving the order to the Demolition Firing Party Commander in writing (para 13 of Copy No 2) to fire the demolition.

e. Keeping the Authorizing Commander informed of the operational situation at the demolition site.

v. The Demolition Firing Party Commander is in technical control of the demolition but you must ensure that he keeps you informed of all action he takes. Your command post should be co-located with the firing point if possible.

vi. You are to find out from the Demolition Firing Party Commander the time required to change the [illegible]molition from State of Readiness 1 (SAFE) to State of Readiness 2 (ARMED), pass this information to the Authorized Commander and [illegible] it in para 10a.

vii. You are to nominate a deputy forthwith and compile a seniority roster. You are to ensu[illegible] each man knows his place in the roster, understands his duties, and knows where to find this form if you become a casualty or are un[illegible]bsent. The seniority roster must be made known to the Demolition Firing Party Commander.

viii. Once State of Readiness 2 (ARMED) has been ordered, either you or your dep[illegible]s be at [illegible]nd post so that orders can be passed immediately to the Demolition Firing Party Commander.

ix. In the event of a misfire or only partially successful demolition, you ar[illegible] F[illegible]ty protection until such time as it has completed the demolition.

x. If you are ordered to hand over the demolition to another unit w[illegible] is[illegible] new form [illegible]a 11 is to be completed and the new form handed to the new Demolition Guard Commander. A receipt [illegible] be[illegible]d [illegible] by you. If a new form has been issued, para 11 is to be completed on the old form which you will retain.

xi. When the demolition has been completed, you are [illegible] repor[illegible] the [illegible]thorized Commander by the fastest means available, and return Copy No 1 to him with para 14 com[illegible]

xii. If you receive orders to fire the demolitions ot[illegible]se g[illegible]5, you should refer to the Authorized Commander.

ORDERS TO THE DEMOLITION FIRING PAR[illegible]MAN[illegible]

xiii. You are in technical charge of the [illegible]n, char[illegible] of the demolition.

xiv. The Demolition Guard Commander [illegible]ed) [illegible]ponsible for:

a. Tactical command of all troops at t[illegible]ite, you are therefore under his command.

b. Giving you in writing (para 10) the ord[illegible] the State of Readiness.

c. Giving you in writing (para 13) the order [illegible] the demolition.

xv. You are to consult with the Demolition Guard Commander over the siting of your firing point, which is to be co-located with his command post whenever practicable. It should be within sight of the target.

xvi. You are to nominate a deputy forthwith, and compile a seniority roster. You are to ensure that each man knows his place in the roster, understands his duties, and knows where to find this form if you become a casualty or are unavoidably absent. The seniority roster is to be made known to the Demolition Guard Commander.

xvii. You are to complete para 10e of the form and to report this information to the Demolition Guard Commander, if provided, otherwise to the Authorized Commander.

xviii. Once State of Readiness 2 (ARMED) has been ordered, either you or your deputy must remain at the Firing Point.

xix. When there is no Demolition Guard and you receive orders to fire the demolition other than those given in para 5, you should refer to the Authorized Commander or to your immediate superior.

xx. If you are ordered to hand over the demolition to another unit without the issue of a new form, para 11 is to be completed and the form handed to the new Demolition Firing Party Commander. A receipt is to be issued and retained by you. If a new form has been issued, para 11 is to be completed on the old form, which you will retain.

xxi. When the demolition has been completed, you are to report its effectiveness to your Unit Commander by the fastest means available, and return Copy No 2 to him with para 14 completed. If there is no Demolition Guard, the Unit Commander must pass the results and the completed Copy No 1 to the Authorized Commander. If mines are laid, they are to be reported and recorded on a minefield record (STANAG 2036).

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Figure J-218. Sample target folder

Unclassified
(Security Classification)

COPY NO 2 OF 3

DEMOLITION ORDER
SERIAL NO 004

From John P. Smith, Gen. USA
V Corps, Commanding
(Authorized Commander)

1. Demolition Guard Commander
2. Demolition Firing Party Commander
3. Retained by the Authorized Commander
4. ....

PART I

1. Demolition Target Details:

a. Description ..Concrete Arch Bridge ....

b. Location (grid coordinates) WM 31703236 ....

c. Target nickname, number, or code
(All orders are to be prefixed by target identifying nickname, number, or code.)

d. Technical instructions ....

....

2. Executing Units:

a. Demolition Guard ....

b. Demolition Firing Party ....

3. Orders to the Demolition Firing Party Commander [illegible]

a. The demolition target is to be prepared [illegible] o[illegible]s .... by 271500 (DTG).

b. ☒ All other orders will be issue[illegible] Guard [illegible]mander. Record their receipt in Part II.

c. ☐ There is no Demoliti[illegible]d. Y[illegible]tr[illegible]d in para 5, 6, and 7, recording the orders received in P[illegible]
(Only one box is to be c[illegible])

4. Orders to the D[illegible] Gua[illegible]der

Your respon[illegible]det[illegible]IV. You are to act as instructed in para 5, 6, and 7, recording the orders re[illegible] II.

5. Demolition is to be fi[illegible]

a. ☐ Immediately up[illegible]g prepared.

b. ☒ Upon receipt of code in para 8c by radio.

c. ☐ Upon receipt of the order from the Authorized Commander or his Liaison Officer personally.

d. ☐ (Other orders) ....

6. Emergency Firing Orders

a. ☒ You will NOT fire the demolition except as ordered in para 5.

b. ☐ You WILL fire the demolition on your own initiative if the enemy is in the act of capturing it.
(Only one box is to be crossed)

7. Orders other than for firing will be given:

a. ☐ By the Authorized Commander personally.

b. ☐ By the Authorized Commander's Liaison Officer personally.

c. ☒ By radio.

d. ☐ .... (other means)

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2

SAMPLE

Figure J-1. Sample target folder (continued)

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8. Code

Action to be taken	Code
a. Change from State 1 (SAFE) to State 2 (ARMED)	Brad
b. Change from State 2 (ARMED) to State 1 (SAFE)	Bill
c. Fire the demolition now	Dick
d. Para 3b cancelled, para 3c applies	Bruce
e. Para 3c cancelled, para 3b applies	
f. Para 5c cancelled, para 5b applies	
g. The Authorized Commander is changed to	
h. ..[illegible].....	[illegible]
i. ...[illegible]...........	John

9. Authorized Commander

Signature ...[illegible]... [illegible] ...[illegible]...

Appointment ...[illegible]... [illegible]/Time [illegible] ...[illegible]...

SAMPLE

10. Changing State of R[illegible]ss:

a. Time estimated [illegible] Firing Party [illegible] to change from State of Readiness 1 (SAFE) to State of Readiness 2 (A[illegible] ...... [illegible]nutes.

b. .

State of Readiness Ordered	Originator	Date/Time Group of: Receipt of Order	Date/Time Group of: Change Completed

11. Handover and Takeover of Demolition Target:

	Rank, Name, and Unit	Signature	Date/Time Group
Transferring Commander			
Accepting Commander			

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Figure J-1. Sample target folder (continued)

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(Security Classification)

12. Record of Other Changes to Part I (if any)

Detail	Date/Time of Receipt

13. FIRE THE DEMOLITION NOW

Signed ....

(Rank, name, unit) ....

(Date/Time Group) ....

(or enter date/time group of receipt of code in pa[illegible]

R[illegible]

14. Demolition Report

a. Bridge B[illegible]/Runwa[illegible]ailway

Estimated width of gap ...... [illegible]aters ....

No of spans down ...... [illegible]ter/Depth ....

c. Other target ....

d. Mines laid: [illegible]T mi[illegible] .... AP mines ....

Sketch

Signature .... Rank/Name/Unit ....

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4

Figure J-1. Sample target folder (continued)

Annex/annexe 'A' (DofA) (MdeA) to/au STANAG 2123
Anhang 'A' (DofA) zum STANAG Nr. 2123

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

+NATO-RESTRICTED
+DIFFUSION RESTREINTE
+VS-NUR FÜR DEN DIENST- GEBRAUCH
ab Alarmmaßnahme

OBSTACLE FOLDER
CARNET D'OBSTACLE
SPERRHEFT

SAMPLE

Type of obstacle	Concrete Arc...
Type d'obstacle	
Art der Sperre	

CLASS	...ORI...	DRINGLICHKEIT	
1.++PRELIMINAR... 2.++~~RESERVED~~	1.++...re 2.++D... ...UVRE (1) RE...VE (1)	1.++Sofort-Maßnahme 2.++Reserviert	

Serial number 004						
Numero d'ordre						
Laufende Nummer						

Target no.							
Dispositif No.							
Objektnummer							

Copy	Exemplaire	Ausfertigung	
2	No.		

NOTE Anmerkung

+ When blank
  Si laisse en blanc
  Wenn unausgefüllt

++ Strike out item not applicable
  Rayer la mention inutile
  Nicht zutreffendes streichen

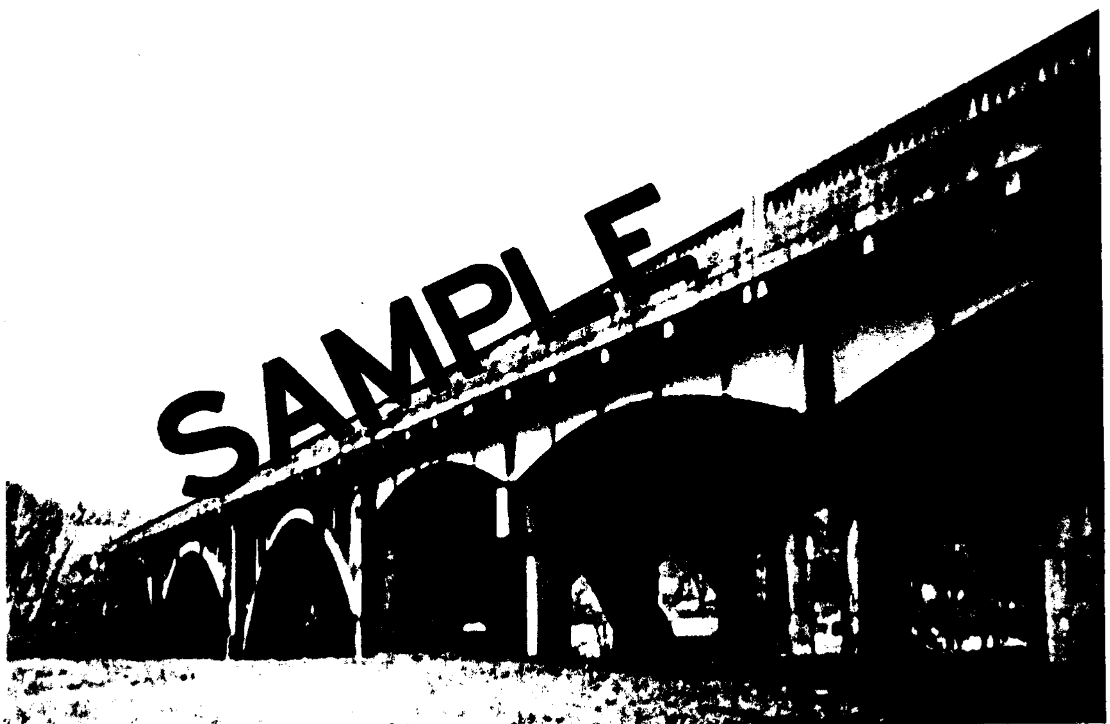
(1) Delete the term NOT used
  Barrer la mention NON utilisée

Figure J-1. Sample target folder (continued)

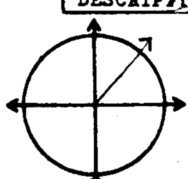
NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(1) PHOTOGRAPH OF TARGET PHOTOGRAPHIE DE L'OUVRAGE

FOTOGRAPHIE DES SPERROBJEKTS



DESCRIPTION	DESCRIPTION	BESCHREIBUNG	



Indicate direction of view

Indiquer direction de prise de vue

Richtung, in der das Objekt gesehen wurde, einzuzeichnen

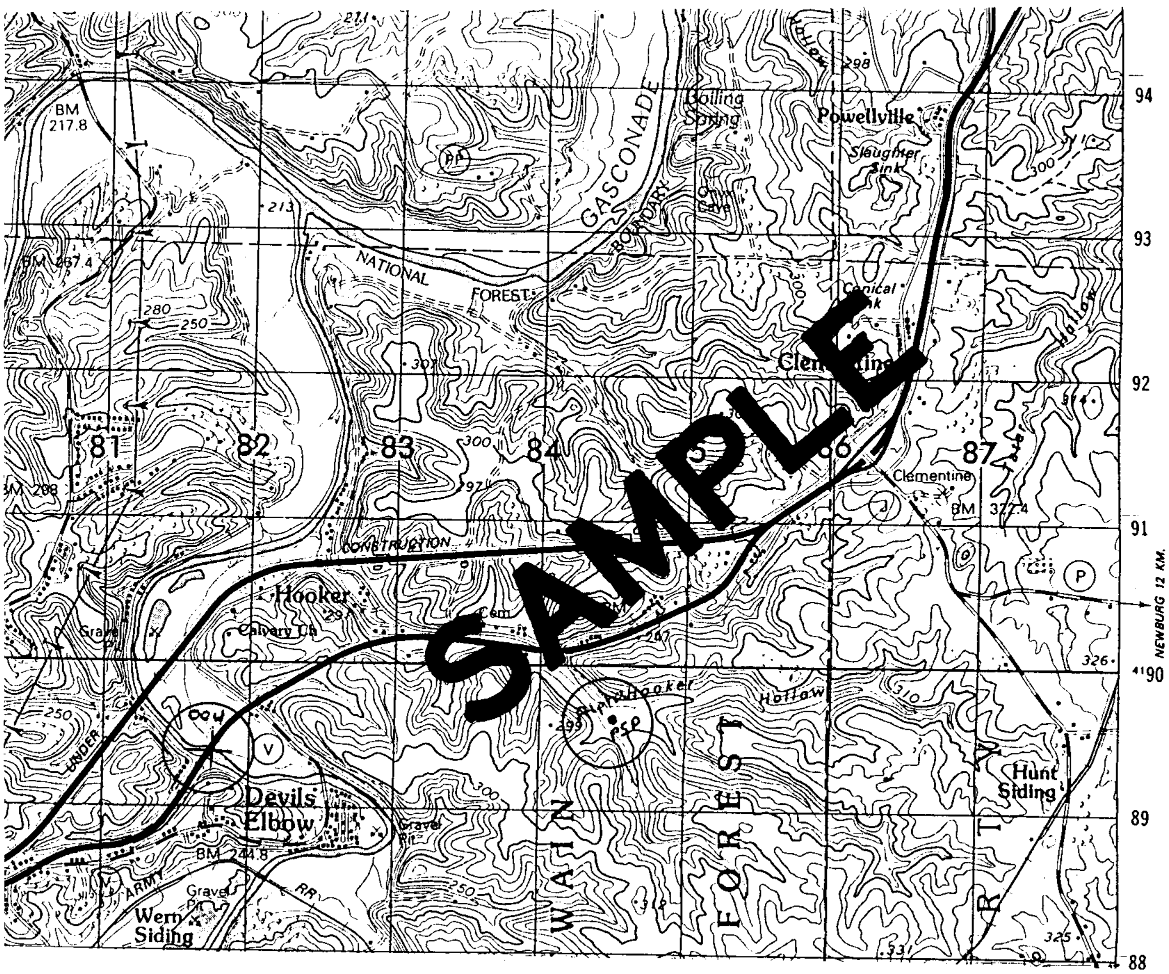
MAP NAME AND SCALE	NOM ET ÉCHELLE DE LA CARTE	KARTENBEZEICHNUNG UND MASS-STAB
Waynesville 1:50,000		

GRID REFERENCE OF TARGET	COORDONNEES DU DISPOSITIF	KOORDINATEN DES OBJEKTS
Wm 81708935		

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(a) LOCATION OF TARGET AND PRESTOCK POINT.	EMPLACEMENTS DU DISPOSITIF ET DU CENTRE DE RATTACHEMENT (PRESTOCKAGE).	LAGE DES OBJEKTS UND MUNITIONS-LAGERPLATZ.



SCALE	ÉCHELLE	Maßstab	1:~~250.000~~ 50,000

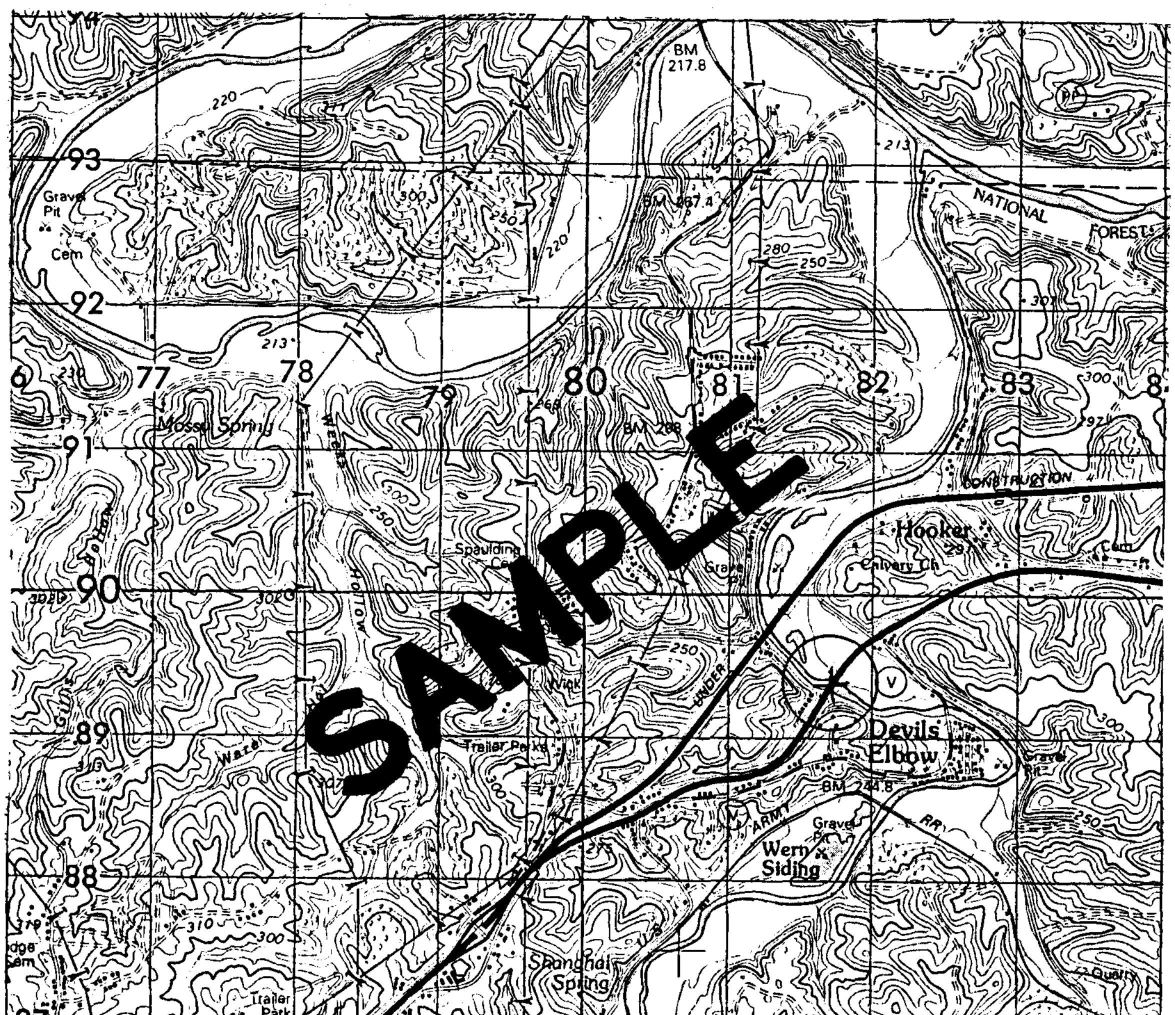
Figure J-1. Sample target folder (continued)

SAMPLE

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completions
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(1b) LOCATION OF TARGET	EMPLACEMENT DU DISPOSITIF	LAGE DES OBJEKTS	



SCALE	ÉCHELLE	Maßstab	1:50.000

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH
AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(2) SUPPLY OF EXPLOSIVES AND STORES FOR TARGET	APROVISIONNEMENT DU CHANTIER DU DISPOSITIF	VERSORGUNG MIT SPRENG- UND ZÜNDMITTELN SOWIE GERÄT FÜR DAS OBJEKT
1-PRESTOCK POINT.	CENTRE DE RATTACHEMENT (PRESTOCKAGE)	MUNITIONS-LAGERPLATZ

NAME	NOM	NAME
Alpha		

LOCATION: See maps pages 3, 6, 7	EMPLACEMENT: Voir cartes pages 3, 6, 7	LAGE: Siehe Karten Seite 3, 6, 7
2-TRANSPORT required	VEHICULES nécessaires	Erforderlicher Transportraum

TRUCKS of	(No) (Anzahl)...3...	Lkw je
Tons.	...2...	

3-ROUTE: See maps pages 3, 6, 7	ITINERAIRE: Voir cartes pages 3, 6, 7	WEG: Siehe Karten Seite 3, 6, 7
4-Approximate travel DISTANCE from Prestock point to target	DISTANCE approximative entre centre de rattachement (prestockage) et dispositif.	Ungefähre ENTFERNUNG vom Munitionslagerplatz zum Objekt.

........4........... km

5-Explosives and stores required: see page 9	Explosifs et matériels nécessaires: Voir page 9	Erforderliche Sprengmittel u. Gerät: Siehe Seite 9
6-Storage location of additional barrier material	Lieu de stockage des accessoires de mise en oeuvre supplémentaires	Lagerort zusätzlicher Sperrmittel

MAP NAME AND SCALE	NOM ET ÉCHELLE DE LA CARTE	Kartenbezeichnung und Maßstab
Fort Leonard Wood Reservation Special		

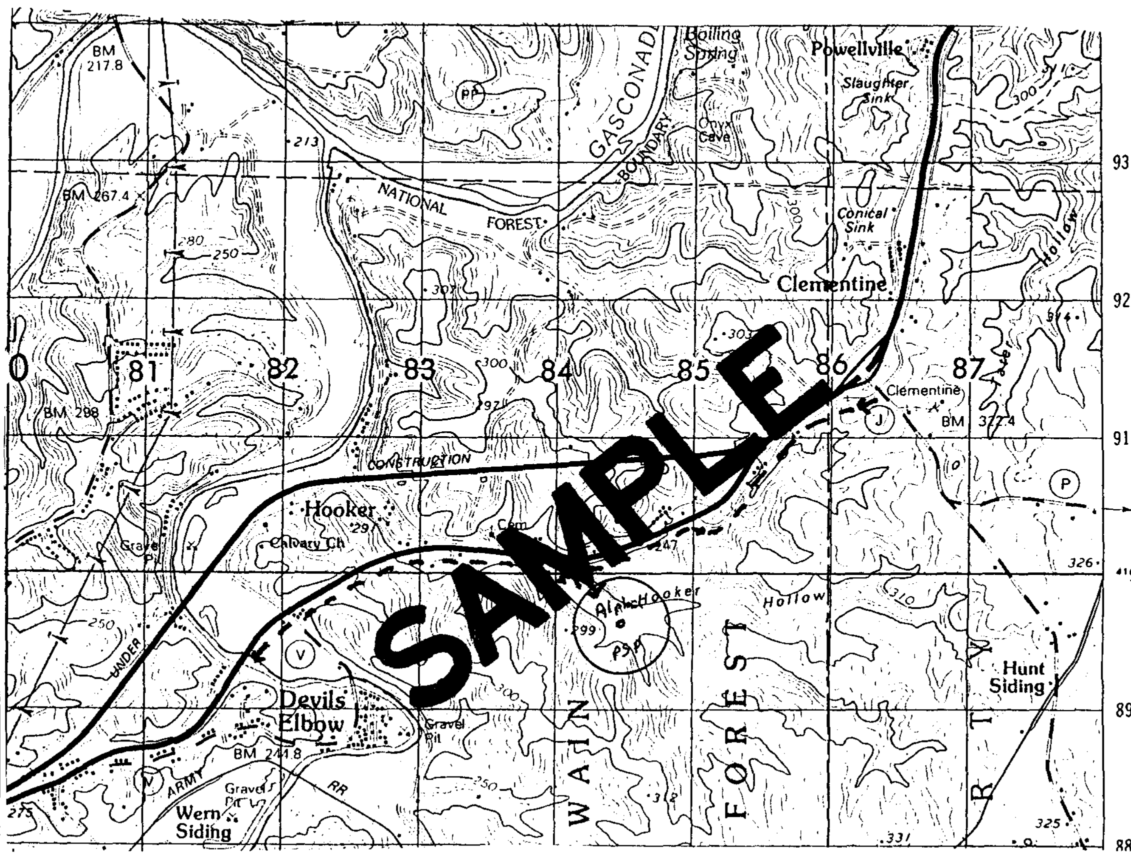
GRID REFERENCE	COORDONNEES	KOORDINATEN
WM 785749		

SAMPLE

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(2a) LOCATION OF PRESTOCK POINT	EMPLACEMENT DU DÉPÔT DE MUNITION	LAGE DES MUNITIONS-LAGERPLATZES

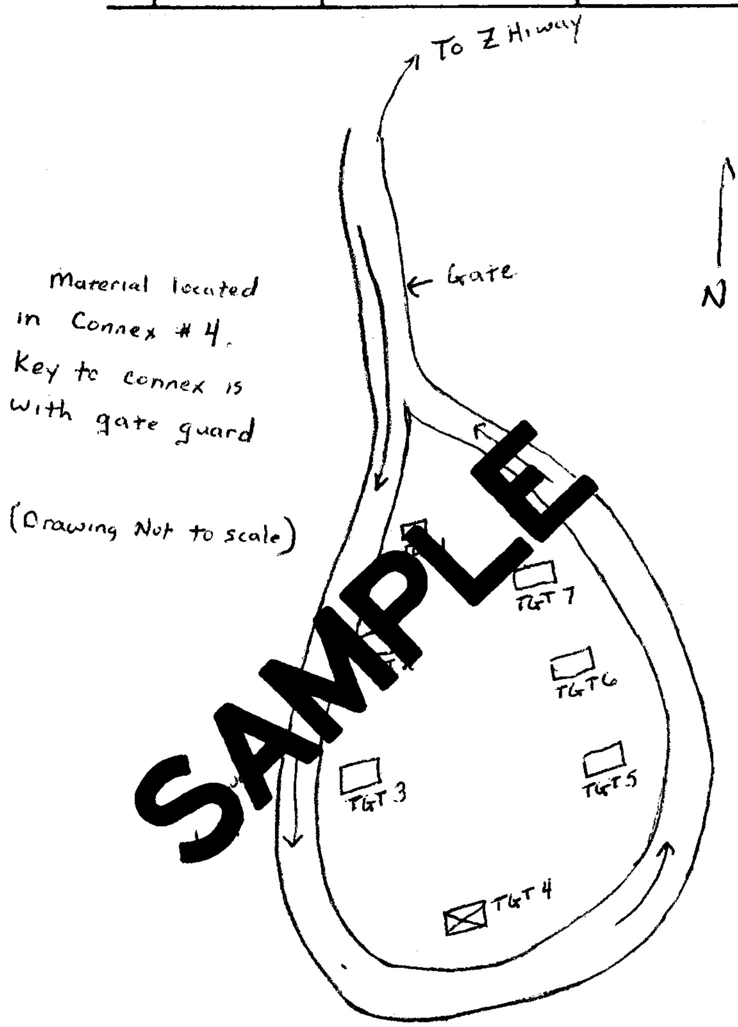


SCALE	ÉCHELLE	Maßstab	1:50.000

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(2b)	LAYOUT PLAN OF PRESTOCK POINT	PLAN DU DÉPÔT DE MUNITION	LAGEPLAN DES MUNITIONSLAGER-PLATZES



~~SCALE~~	ÉCHELLE	Maßstab	~~1:5,000~~

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(2c)

Instructions for opening ammunition storage vault door
Directives pour l'ouverture de la porte du dépôt de munitions
Anweisung für das Öffnen der Sperrmittelhaustür

SAMPLE

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

2c)

Instructions for opening ammunition storage vault door
Directives pour l'ouverture de la porte du dépôt de munitions
Anweisung für das Öffnen der Sperrmittelhaustür

SAMPLE

Figure J-1. Sample target folder (continued)

Key for ammunition storage facility
Clefs pour la soute de munitions
Schlüssel für das Munitionslagerhaus

The bearer of this document is authorised to enter the ammunition site and to pick up from Bunker No. .4.. the barrier material for Target No.CC4. .
Le titulaire du présent document est habilit[illegible]céder au lieu de stockage des munitions et àprendre - d[illegible] no. .... - les accessoires nécessaires à la mise [illegible]vre [illegible]'obstacle no. .... .
Der Inhaber dieses Dokume[illegible]gt de[illegible] Sperrmittellager-ort zu betreten und au[illegible] de[illegible] das Sperrmaterial für die Sperre Nr. .... [illegible]

SAMPLE

If the keys are n[illegible] in this obstacle folder their location is to be marked cl[illegible]y here: *Keys are kept by gate guard at PSP Alpha*
Si les clés ne seront pas conservées dans le présent carnet d'obstacles, indiquer ci-après l'endroit de conservation exact:
Werden die Schlüssel nicht in diesem Sperrheft aufbewahrt ist der genaue Ort hier anzugeben:

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completation
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH
AMTLICH GEHEIMGEHALTEN
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(2d) EXPLOSIVES, STORES MINES REQUIRED | EXPLOSIFS, MATERIELS MINES NECESSAIRES | BEDARF AN SPRENG- UND ZÜNDMITTELN GERÄT, MINEN

TARGET No	DISPOSITIF No	OBJEKT No	
ØØ4			

PRESTOCK POINT	DEPOT DU MUNITION	MUNITIONS-LAGERPLATZ	
Alpha			

	ITEM (English)	DESIGNATION (Francais)	ART (Deutsch)	MENGE AMOUNT QUANITÉ	GESAMTGEWICHT TOTAL WEIGHT POINS TOTAL
(1)	(2)	(3)	(4)	(5)	(6) (kg)
1	EXPLOSIVES	EXPLOSIFS	SPRENGMITTEL		
a	Cratering charges	Expl. progressifs	Trichter spren[illegible]		
b	High TNT explosives	Expl. brisants	[illegible]	1336	1336 lbs
c	Plastic C-4 explosives	Plastiq[illegible]	[illegible]	488 PKG	610 lbs
d	Shaped charges	Ch[illegible] cre[illegible]	[illegible]ungen		
e	Cutting charges	Charg[illegible]	Schneid-ladungen		
2	ACCESSO[illegible]	[illegible]ICES	ZÜNDMITTEL		
a	Safety Fuze	Meche lente	Anzündschnur	100 FT	2 lbs
b	Detonating cord	Cordeau détonant	Sprengschnur	4,000 FT	88 lbs
c	Non electric Detonators	détonateurs pyro technique	Spreng-kapseln	10 EA	
d	Electric Detonators	détonateurs electrique	Sprengkapseln elektrisch		
e	Prime cap	Détonateur d'amorce	Sprengkapsel-zünder		
f	Booster cap	Renforca-teur	Sprengschnur-kapsel		
g	Blasting machine (exploder)	Exploseur	Zünd-maschine		
h	Cable electric (2 wire)	Cable electrique (2 fils)	Zündkabel (zweiadrig)		
	Fuse Ignitor M-60			10 EA	

SAMPLE

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH
AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(1)	(2)	(3)	(4)	(5)	(6)
3	TOOLS	OUTILLAGE	WERKZEUG		
a	Quarrying bars	Barres à mine	Brech-stangen		
b	Shovels	Pelles	Schaufeln		
c	Picks	Pioches	Kreuzhacken		
d	Saws Cross Cut	Scies	Sägen	3	3 lbs
	Hammer			3	4 lbs
4	STORES	MATERIEL	GERÄ[illegible]		
a	Nails 10d	Pointes	[illegible]	4 lbs	4 lbs
b	Wire	Fil d[illegible]er	[illegible]		
c	Timber [illegible]	[illegible]anch[illegible]	[illegible]len	100'	160 lbs
	Rope, 1/2 in nylon			100'	100 lbs
5	MINES	MINES	MINEN		
a	Mines AP	Mines AP	SchAbwMi		
b	Mines AT	Mines AC	PzAbwMi		
c	Fuses	Allumeurs	Zünder (Minen)		
	TOTAL WEIGHT	POIDS TOTAL	GESAMTGEWICHT		2307

SAMPLE

Figure J-1. Sample target folder (continued)

VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen
NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie

SAMPLE

(3) DEMOLITION ORDER and/or MINEFIELD RECORD
do not complete until after laying the minefield

ORDER DE MISE DE FEU et/ou FEUILLE DE RENSEIGNEMENTS
à completer après réalisation de champ de mines

SPRENGBEFEHL und/oder MINENSPERRNACHWEIS
erst nach dem Anlegen der Minensperre vollständig ausfüllen

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTREULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(3a) SPECIAL TECHNICAL INSTRUCTIONS	CONSIGNES TECHNIQUES PARTICULIERES	TECHNISCHE EINZELANWEISUNGEN
1. Time required for preparing and charging	Temps nécessaire pour préparation chargement	Zeitbedarf für die Vorbereitung zur Sprengung

Hours	Heures	Std	Min
2			

2. Time required for passing from state of readiness 1 (SAFE) to 2 (ARMED)	Temps nécessaire pour passer de l'état de préparation 1 (N... AMORCE) à 2 ...	...tbedarf für ...ng der Zu...ereitschaft von ... (...SICHERT) in ... (...SICHERT)
3. Personnel required ... preparin... charging	...so... ...cessaire ...p...aration et ...ment	Personalbedarf für die Vorbereitung zur Sprengung

N.C.O.	...icier	Uffz	.....5.....
Men	Hommes	Mannsch.	....24.....

4. Personnel required for firing	Personnel nécessaire pour mise de feu	Personalbedarf für Zündtrupp

N.C.O.	S/Officier	Uffz	....1.....
Men	Hommes	Mannsch.	....2.....

5. Organization of work (attached if necessary)	Organisation du chantier (si nécessaire)	Arbeitsplan (falls erforderlich)
6. Drawings and sketches See page 13, 14	Plans et croquis Voir pages 13, 14	Zeichnungen und Skizzen Siehe Seite 13, 14

SAMPLE

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion

OTAN-CONFIDENTIEL une fois remplie

VS-VERTRAULICH
AMTLICH GEHEIMGEHALTEN

nach Ausfüllen

MINES	MINES	MINEN
(a) Nuisande mines + ~~MUST~~ be laid + MUST NOT + See sketch page 17 (b) THERE IS + (A) large THERE IS + ~~(NO)~~ minefield near (give location and reference of minefield rekord)	Des mines de harcèlement + DOIVENT + NE DOIVENT PAS être pensées + Voir croquis page 17 + IL EXISTE + IL N'EXISTE PAS un champ de mines important à proximité (in- diquer l'emplace ment et docu- ments de refe- rence)	+ MÜSSEN + MÜSSEN NICHT verlegt werden + Siehe Skizze Seite 17 + ES IST EINE + ES IST KEINE größere Minen- sperre in der Nähe (Angaben über Lage und diesbezüglichen Minensperrnach- weis)
Strike out words not applicable	+Rayer la mention inutile	+ Nicht Zutref-fendes streichen

English Translation of notes on the sketch page 14	Francais Traduction des inscriptions parlées sur le croquis page 14	Deutsch Übersetzung der Eintragungen der Skizze Seite 14	

SAMPLE

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(3b) SKETCH OF TARGET	CROQUIS DE L'OUVRAGE	TRENN-SCHNITT-SKIZZE

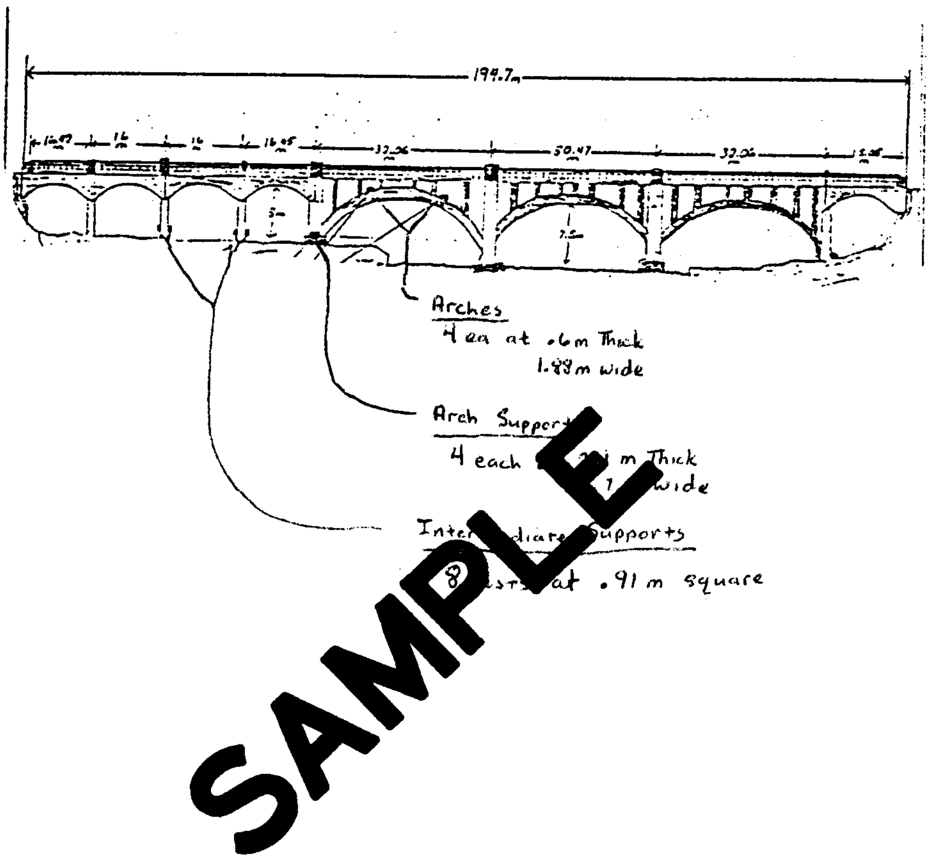

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

English Translation of notes on the sketch page 15	Francais Traduction des inscrip- tions portées sur le croquis page 15	Deutsch Übersetzung der Anmerkungen auf der Skizze Seite 15	

SAMPLE

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(3c) SKETCH OF CHARGES	CROQUIS DE CHARGEMENT	LADUNGS-SKIZZE

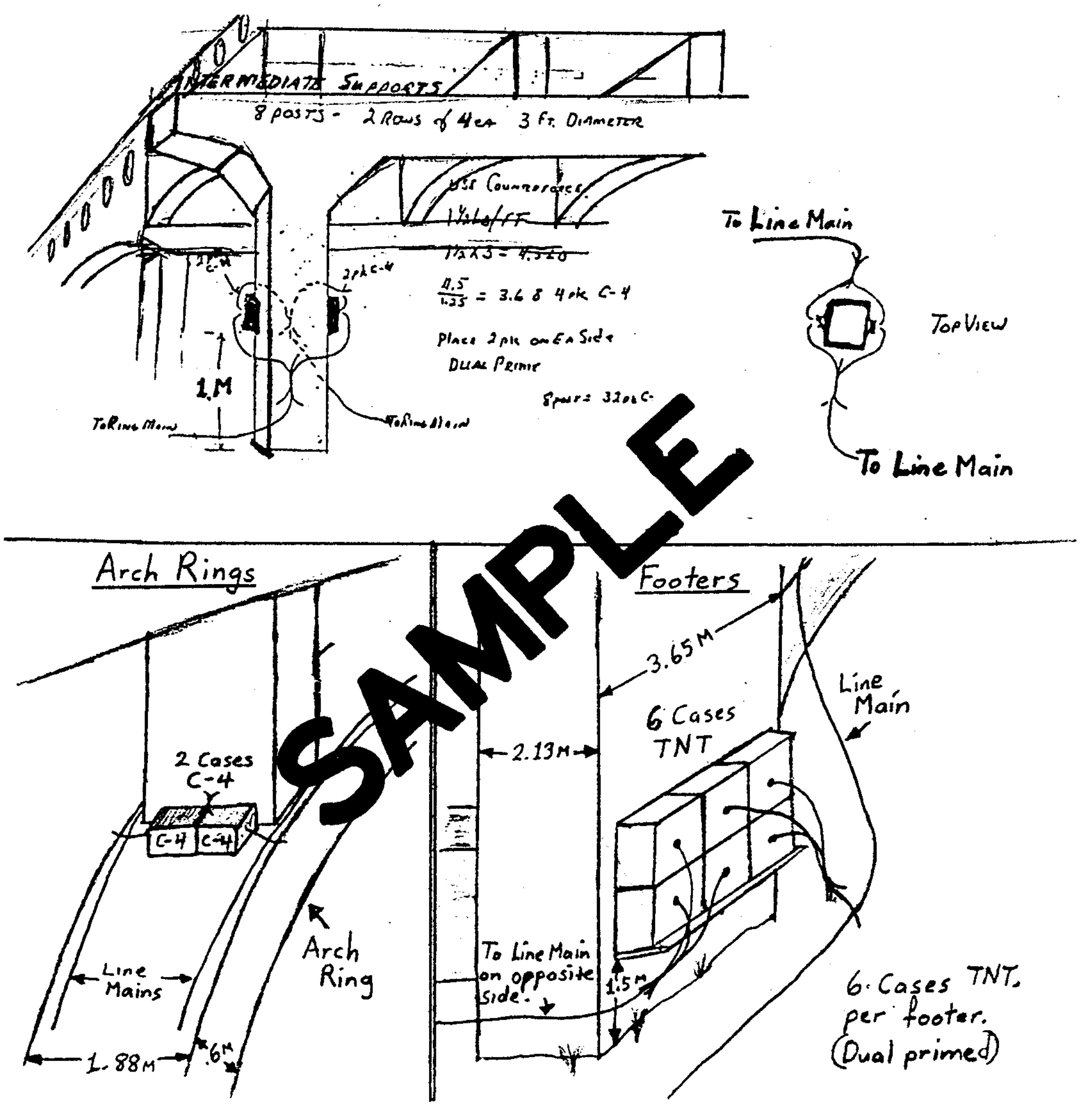

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

English Translation of notes on the sketch page 16	Francais Traduction des inscriptions portées sur le croquis page 16	Deutsch Ubersetzung der Anmerkungen auf der Skizze Seite 16	

SAMPLE

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(3d) SKETCH OF IGNITION SYSTEM	SCHEMA DE LA MISE DE FEU	ZÜNDLEITUNGS-SKIZZE

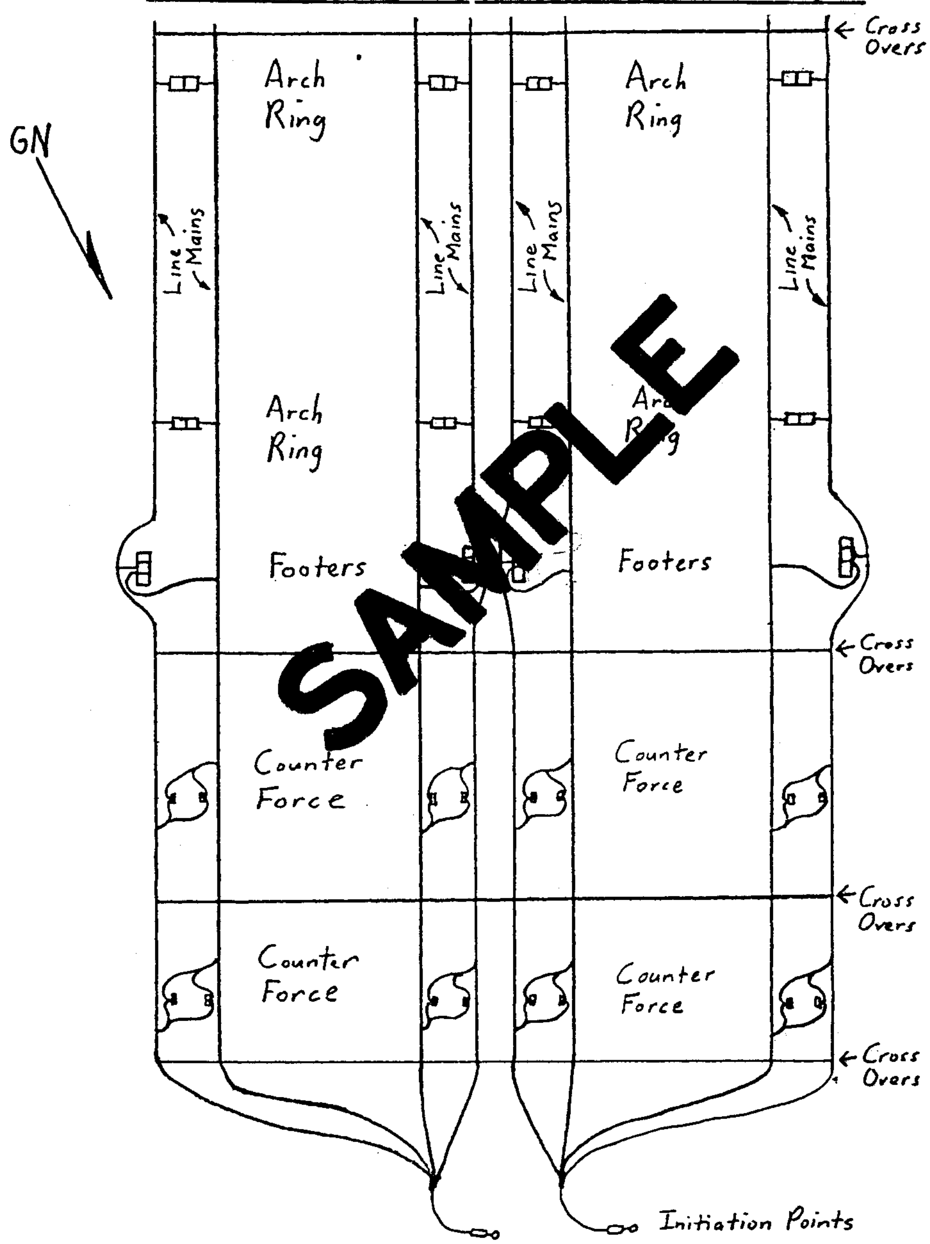

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH
AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(3e) MINE FIELD IF APPLICABLE, OR PROTECTIVE MINES	CHAMP DE MINES OU CHAMP DE MINES DE PROTECTION SUIVANT LE CAS	MINENSPERRE FALLS VORHANDEN ODER SICHERUNGS-MINENSPERRE
Personnel and time required for laying mines	Personnel et temps nécessaire pour la pose des mines	Kräfte u. Zeitbedarf f. das Verlegen von Minen

Men	Hommes	Mann		Hours	Heures	Std	Min

Sketch of [illegible] m[illegible]ield.
When [illegible] d[illegible] n page 20
and [illegible] ut [illegible] ecord
([illegible]age [illegible]

[illegible]oquis [illegible] de mines prévu.
[illegible] i[illegible] nscrire à la page 20 et
[illegible] l[illegible] feuille de renseignements
([illegible]).

Skizze der geplanten Minensperre.
Wenn angelegt auf Seite 20 eintragen
und Minensperrnachweis ausfüllen
(Seite 11).

SAMPLE

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(4a)

TURN-OVER/TAKE-OVER OF TARGET		Target No.	
REMISE/REPRISE DU DISPOSITIF		Dispositif No.	
ÜBERGABE/ÜBERNAHME DER SPERRE		Objektnummer	

Type of target
Type d'obstacle
Art der Sperre

Grid reference		Date/Time Group	
Coordonnées UTM		Groupe date/heure	
UTM-Koordinaten		Datum/Zeit[illegible]ppe	

State of readiness at time of turn-[illegible]ke-o[illegible]	
Etat de préparation au momont d[illegible]	
Zündbereitschaft bei Überga[illegible]	

Work still require[illegible] c[illegible]or to prepare demolitio[illegible]et
Travaux re[illegible] à e[illegible] à l'achèvement
Noch auszu[illegible]ende A[illegible] bis zur Fertigstellung

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
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Ammunition/equipment to be turned-over/taken-over
Munition/matèriels à remettre
Zu übergebende/übernehmende Munition/Gerät

Barrier doccumentation will remain at:
Les documents seront gardés par:
Sperrunterlagen verbleiben:

SAMPLE

Relieved Commander
Responsable de la remise
Übergebender

Last name Nom Name		Rank Grad Dienstgrad	
Unit Unité Einheit		Signature Signature Unterschrift	

Relieving Commander
Responsable de la reprise
Übernehmender

Last name Nom Name		Rank Grad Dienstgrad	
Unit Unité Einheit		Signature Signature Unterschrift	

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(4b)

TURN-OVER/TAKE-OVER OF TARGET	Target No.	
REMISE/REPRISE DU DISPOSITIF	Dispositif No.	
ÜBERGABE/ÜBERNAHME DER SPERRE	Objektnummer	

Type of target
Type d'obstacle
Art der Sperre

Grid reference		Date/Time group	
Coordonnées UTM		Groupe date/heure	
UTM-Koordinaten		Datum-Zeit-Gruppe	

SAMPLE

Handing-over officer
Responsable de la remise
Übergeber

Last name		Rank	
Nom		Grad	
Name		Dienstgrad	
Unit		Signature	
Unité		Signature	
Einheit		Unterschrift	

Relieving Commander
Responsable de la reprise
Übernehmender

Last name		Rank	
Nom		Grad	
Name		Dienstgrad	
Unit		Signature	
Unité		Signature	
Einheit		Unterschrift	

Copy for the unit handing over.

Exemplaire pour l'unité remettante.

Ausfertigung für die übergebende Einheit.

Figure J-1. Sample target folder (continued)

SAMPLE

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(5)	DEMOLITION REPORT	COMPTE RENDU DE DESTRUCTION	MELDUNG ÜBER DURCHGEFÜHRTE SPRENGUNG	
a.	TARGET NO.	DISPOSITIV NO.	Objekt Nr	
b.	MAP REFERENCE	COORDONNÉES	KOORDINATEN	
c.	Demolition was fired at	La mise de feu a été faite à	Die Sprengung erfolgte	
	Date-Time	Date-heure	Datum-Zeit	
	....	....	....	....
d.	Extent of damage (1) In case of a bridge	Résultats obtenus (1) Cas [illegible]	[illegible] Brücke	
	Width of gap .... meters	[illegible]	Weite der Unterbrechung . ... m	
	NO. of spans dow[illegible]	[illegible]	Anzahl der herabgefallenen Strecken	
	(2) In a r[illegible] runway size, [illegible] and location [illegible] craters:	[illegible] une route [illegible] piste: Dimensions, profondeur et emplacement des entonnoirs:	(2) Auf einer Straße oder Rollbahn: Größe, Tiefe und Lage von Trichtern	
	(3) Mines laid, type and number	(3) Mines posées, type et nombre	(3) Anzahl und Art verlegter Minen	
	(4) Any other details	(4) Autres renseignements	(4) Sonstige Anmerkungen	

SAMPLE

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH
AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(5) SKETCH showing effect of demolition and location of mines (if applicable)	(5) CROQUIS montrant les effets de la destruction et emplacement du champ de mines (s'il y a lieu)	(5) Skizze über das Ausmaß der Zerstörungen und Lage der Minen (wenn verlegt)

SAMPLE

date-time	date-heure	Datum-Zeit

Name Nom Name	Rank Grade Dienstgrad	Unit Unité Einheit

TO DESTINATAIRE AN

Signature Unterschrift

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH
AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

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(2a)	Map of Prestock Point, Large Scale	Page 7
(2b)	Sketch, Layout Plan of Prestock Point	Page 8
(2c)	Ammunition Storage Facility (Authorisation, Keys, Opening instructions	Page 9
(2d)	Explosives Stores, Mines required	Page 12
(3)	Demolition Order, Minefield record	Pag[illegible]
(3a)	Special Technical instructions	P[illegible]7
(3b)	Sketch of Target	[illegible]
(3c)	Sketch of Charges	[illegible]
(3d)	Sketch of Ignition S[illegible]	[illegible]
(3e)	Minefield	[illegible]
(4)	Hand-over/Take-over	[illegible]
(5)	Demolition R[illegible]	Pa[illegible]29
(6)	Official Si[illegible]	[illegible]e 32

TABLE DE MATRES

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(1b)	Plan du dispositif à grande échelle	Page 5
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(2[illegible])	[illegible]n d[illegible]t[illegible] de [illegible]ache[illegible]ré-[illegible]) [illegible]rande [illegible]c[illegible]	Page 7
[illegible]	Cro[illegible] - plan du centre de rattache-[illegible]nt (préstockage)	Page 8
(2c)	Dépôt de munitions (permis, directives d'ouverture, clés)	Page 9
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(3a)	Consignes techniques particulières	Page 17
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INHALTSVERZEI[illegible]

	Identifizierung [illegible] Sperrobjekts	Vordere Umschlagseite
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(3)	Sprengbefehl/Minensperrnachweis	Seite 15
(3a)	Technische Einzelanweisungen	Seite 17
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(6)	Unterschrift	

SAMPLE

Figure J-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
CTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH
AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

Notes:

1. Pages 3; 7-12; 14 can be detached from the target folder and handed to the soldier detailed to pick up the barrier material.
2. The commander of the closing/executing unit will use pages 29/30 to report the results to his immediate superior.

Remarques:

1. Les pages 3; 7-12;14 peuvent être retirées du carnet de dispositif de destruction preparée et remises au responsable de l'enlèvement des explosifs.
2. Le chef du détachement de protection/de mise à feu emploiera les pages 29/30 pour faire rapport à son chef immédiat.

Anmerkungen:

1. Die Seiten 3; 7-12;14 können dem Sperrheft entnommen und dem Soldaten übergeben werden, der die Sperrmittel abholt.
2. Das Ergebnis ist vom Führer der schließenden/auslösenden Einheit/Teileinheit mit Seite 29/30 an den unmittelbaren Vorgeset[illegible] zu melden.

TARGET folder completed by — CARNET d'[illegible] établi [illegible] par — [illegible]rrheft aufgestellt [illegible]rch:

Name	Nom	Name	Rank	[illegible]	[illegible]	[illegible]igna-	Fonction	Dienststellung
Brazeal, Gregory E[illegible]						[illegible] A Co 657th Engr Bn.		

Signature	U[illegible]sch[illegible]	Date	Datum
Gregory B[illegible]		20 March 92	

Name	Nom	Name	[illegible]	Grade	Dienstgrad	Designation	Fonction	Dienststellung
Brown, David CPT						A Co, 657th Engr Bn		

Signature	Unterschrift	Date	Datum
David Brown		20 March 92.	

Folder reviewed by — Carnet controlé par — Sperrheft geprüft

Name	Rank	Designation	Date	Signature

Figure J-1. Sample target folder (continued)

DEMOLITION RECONNAISSANCE RECORD

Instructiuons for use of this form are on page 4 of this form and FM 5-250; the proponent agency is TRADOC.

SECTION I - GENERAL

1. FILE NO.			NAME AND RANK	ORGANIZATION
2. DEMOLITION RECON REPORT NO.	5	RECON ORDERED BY	COL JOHN SMITH	3RD ENGR BDE
3. DATE 01 MAY 1992 / 4. TIME 1200	6	PART LEADER	SSG JOE BROWN	B CO, 294 ENGR BN

7. MAP INFORMATION

- Name WAYNESVILLE
- Scale 1: 50,000
- Sheet No. 7759-1
- Series No. V-779

11. GENERAL DESCRIPTION *(Use block 20 for sketches.)*

- Type Construction: ☐ Earth ☐ Timber ☒ Concrete ☐ Asphalt ☐ Steel

Other Data: ☒ Roadway width 18 M; ☒ Number of bridge spans 8; ☒ Number of lanes 4; ☒ Bridge class: W-100 T-100

Condition: NO VISIBLE DAMAGE TO KEY COMPONENTS

8. TARGET AND LOCATION
HIGHWAY BRIDGE (CONTD - BLOCK 19)

12. NATURE OF PROPOSED DEMOLITION *(Use block 21 for sketches.)*
PARTIAL DESTRUCTION

9. TIME OBSERVED
1730

10. COORDINATES
WM 81708935

13. UNUSUAL FEATURES OF SITE:

- ☐ High tension
- ☐ Radar installation
- ☐ Underwater blasting
- ☒ WATER UNDER BRIDGE
- ☒ HOUSE WITHIN 100 YARDS
- ☒ AT/AP MINEFIELD 20 YARDS NORTHWEST OF BRIDGE (CONTD - BLOCK 19)

SECTION II - ESTIMATES

Determine availability of items 14, 15, and 16 before conducting reconnaissance.

14. MATERIAL REQUIRED	UNIT OF ISSUE	TYPE MISSION: CRATERING	CUTTING	OTHER/SPEC PURPOSE
Modernized Demolition Initiators:				
M11 Shock tube	ea		4	
M12 Shock tube	ea		4	
M13 Shock tube	ea		4	
M14 Delay Fuse	ea			
Firing Device *(Specify type):*	ea			
Electric caps	ea			
Detonating cord	ft		2[illegible]00	
Firing wire	ft			
Igniters:				
M60	ea			
M81	ea			
Explosive:				
TNT:	lb		1200	
C4:	lb		272	
(Other)				
Cratering:				
Crater charge, 40-lb	ea			
Shape charge, 15-lb	ea			
Shape charge, 40-lb	ea			
Other Demolitions:				

15. EQUIPMENT AND TRANSPORT REQUIRED *(Examples: trucks, ram sets and cartridges, demolition sets, post-hole diggers, nails, adhesives, tape, sandbags, and lumber.)*

NOTE: Troops may not ride in vehicles transporting explosives.

LIFE JACKETS (6)
DEMO SETS (2)
RAM SET GUN (1)
POST HOLE DIGGER (2)
LUMBER FOR BRACING (100 FT)

(CONTD ON REVERSE)

16. PERSONNEL AND TIME REQUIRED FOR:	NCOs	ENL	Time
a. Preparing and placing charges	2	10	2 hr
b. Arming and firing demolition	2	0	10 M

17. TIME, LABOR, AND EQUIPMENT REQUIRED FOR BYPASS *(Specify location and method.) Specify equipment to clear the site after demolition and available bypasses that allow units to bypass the site.*

AVAILABLE BYPASS - I-44 BRIDGE 1.2 MILES NORTHWEST
– AT BIG PINEY / DEVIL'S ELBOW 2 MILES EAST
BYPASS AT DEMO SITE AFTER BLAST – TO FORD, 1 DOZER, 1 BUCKET LOADER 2 HRS (CONTD)

18. REMARKS

A CRATER BETWEEN THE NORTHWEST CORNER OF BRIDGE AND MINEFIELD WOULD ENHANCE THE OBSTACLE AND SLOW DOWN THE ENEMY.

SAMPLE

DA Form 2203-R Edition of May 92 is obsolete.

Figure J-2. Sample DA Form 2203-R

DEMOLITION RECONNAISSANCE RECORD

Instructiuons for use of this form are on page 4 of this form and FM 5-250; the proponent agency is TRADOC.

SECTION I - GENERAL

1. FILE NO.				NAME AND RANK	ORGANIZATION
2. DEMOLITION RECON REPORT NO.		5	RECON ORDERED BY		
3. DATE	4. TIME	6	PART LEADER		

7. MAP INFORMATION

Name

Scale

Sheet No.

Series No.

11. GENERAL DESCRIPTION *(Use block 20 for sketches.)*

- Type Construction	Other Data	Condition
☐ Earth	☐ Roadway width ______	______
☐ Timber	☐ Number of bridge spans ______	______
☐ Concrete	☐ Number of lanes ______	______
☐ Asphalt	☐ Bridge class: W- T-	______
☐ Steel		

8. TARGET AND LOCATION

12. NATURE OF PROPOSED DEMOLITION *(Use block 21 for sketches.)*

9. TIME OBSERVED

10. COORDINATES

13. UNUSUAL FEATURES OF SITE:

- ☐ High tension
- ☐ Radar installation
- ☐ Underwater blasting
- ☐ ______
- ☐ ______
- ☐ ______

SECTION II - ESTIMATES

Determine availability of items 14, 15, and 16 before conducting reconnaissance.

14. MATERIAL REQUIRED	UNIT OF ISSUE	TYPE MISSION		
		CRATERING	CUTTING	OTHER/SPEC PURPOSE
Modernized Demolition Initiators:				
M11 Shock tube	ea			
M12 Shock tube	ea			
M13 Shock tube	ea			
M14 Delay Fuse	ea			
Firing Device *(Specify type):*	ea			
Electric caps	ea			
Detonating cord	ft			
Firing wire	ft			
Igniters:				
M60	ea			
M81	ea			
Explosive:				
TNT:	lb			
C4:	lb			
(Other)				
Cratering:				
Crater charge, 40-lb	ea			
Shape charge, 15-lb	ea			
Shape charge, 40-lb	ea			
Other Demolitions:				

15. EQUIPMENT AND TRANSPORT REQUIRED *(Examples: trucks, ram sets and cartridges, demolition sets, post-hole diggers, nails, adhesives, tape, sandbags, and lumber.)*

NOTE: Troops may not ride in vehicles transporting explosives.

16. PERSONNEL AND TIME REQUIRED FOR:	NCOs	ENL	Time
a. Preparing and placing charges			
b. Arming and firing demolition			

17. TIME, LABOR, AND EQUIPMENT REQUIRED FOR BYPASS *(Specify location and method.) Specify equipment to clear the site after demolition and available bypasses that allow units to bypass the site.*

18. REMARKS

DEMOLITION RECONNAISSANCE RECORD

Place additional comments in the appropriate blocks.

15. EQUIPMENT AND TRANSPORT REQUIRED *(Continued)*
17. TIME, LABOR, AND EQUIPMENT REQUIRED FOR BYPASS *(Continued)*
18. REMARKS *(Continued)*
19. ADDITIONAL COMMENTS *(Specify block)*

DEMOLITION RECONNAISSANCE RECORD

Place additional comments in the appropriate blocks.

20. GENERAL DESCRIPTION SKETCH *(Attach additional sketches if required)*:

21. NATURE OF PROPOSED DEMOLITION SKETCH *(Attach additional sketches if required)*:

DEMOLITION RECONNAISSANCE RECORD

Instructions for Completing the DA Form 22O3-R

Use the following instructions to complete DA Form 2203-R. This form may be locally reproduced on 8 1/2- by 11-inch paper.

1. *Block 1 (FILE NO.).* Leave blank unless a higher headquarters provides this number. Higher headquarters provides this number or enters it after you **submit** the form.

2. *Block 2 (DEMOLITION RECON REPORT NO.).* Leave blank unless a higher headquarters provides this number. Higher headquarters provides this number or enters it after you submit the form. Company SOP may specify the procedures for determining this number.

3. *Block 3 (DATE).* Enter the date the reconnaissance was performed.

4. *Block 4 (TIME).* Enter the time the reconnaissance party arrived at the target site (local or Zulu time).

5. *Block 5 (RECON ORDERED BY).* Enter the command authority authorizing the reconnaissance action.

6. *Block 6 (PARTY LEADER).* Enter the name of the NCOIC or OIC of the reconnaissance party who was physically at the site when the reconnaissance was performed.

7. *Block 7 (MAP NAME, SCALE, SHEET NO., and SERIES NO.).* Obtain this information from a map of the reconnaissance area and enter the information in this block.

8. *Block 8 (TARGET AND LOCATION).* 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 degrees, 300 meters from the railroad bridge, 2 miles east of Hanesville, on Route 2."

9. *Block 9 (TIME OBSERVED).* Enter the time you last saw the target as you departed the site.

10. *Block 10 (COORDINATES).* Enter the complete 8-digit map coordinates of the target.

11. *Block 11 (GENERAL DESCRIPTION (Use block 20 for sketches.)).* 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."

12. *Block 12 (NATURE OF PROPOSED DEMOLITION (Use block 21 for sketches.)).* 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.

13. *Block 13 (UNUSUAL FEATURES OF SITE).* 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.

14. *Block 14 (MATERIAL REQUIRED).* Indicate the types, quantities, caps, detonators, and so forth proposed for the demolition.

15. *Block 15 (EQUIPMENT AND TRANSPORT REQUIRED).* 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). Comments may be continued in block 18 on page 2 of the form.

16. *Block 16 (PERSONNEL AND TIME REQUIRED FOR:).* 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.

17. *Block 17 (TIME, LABOR, AND EQUIPMENT REQUIRED FOR BYPASS (Specifiy location and method.).* Specify the equipment necessary to clear the site after demolition and the available bypasses that allow units to bypass the site. Comments may be continued in Block 18 on page 2 of the form.

18. *Block 18 (REMARKS).* Include any appropriate remarks that are not covered in blocks 1 through 17.

19. *Block 19 (ADDITIONAL COMMENTS).* Use this block as a continuation for blocks 1 through 18. Identify the block being continued.

20. *Block 20 (GENERAL DESCRIPTION SKETCH).* The sketch should include--

- The avenues of approach to the target and possible bypasses in the vicinity of the target. Indicate route numbers and the direction of cities or towns.
- Rivers or streams including name, direction of flow, and velocity in meters per second.
- Terrain features, including observation points, cover and concealment, swampy areas, deep valleys, and so forth.
- A compass arrow indicating north (indicate grid or magnetic).
- Dimensions of the proposed target.
- Number and length of bridge spans.
- Height of the bridge from the ground or water.

21. *Block 21 (NATURE OF PROPOSED DEMOLITION SKETCH).* This sketch should include--

- Dimensions of members to be cut.
- Placement of charges.
- Charge calculations. Use either the formula or table method, but show your work.
- Priming of charges.
- Branch lines.
- Ring mains.
- Firing systems.
- Firing points.

DEMOLITION RECONNAISSANCE RECORD

Place additional comments in the appropriate blocks.

15. EQUIPMENT AND TRANSPORT REQUIRED *(Continued)*

HMMWV (1- TRANSPORT OF CAPS)
2 1/2-T CARGO (1-TRANSPORT OF DEMO)
ROPE 3/4" (200')
SQUAD VEHICLE (1-TRANSPORT OF TROOPS)

17. TIME, LABOR, AND EQUIPMENT REQUIRED FOR BYPASS *(Continued)*

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

SAMPLE

18. REMARKS *(Continued)*

19. ADDITIONAL COMMENTS *(Specify block)*

BLOCK 8 CONTD. BRIDGE IS OVER BIG PINEY RIVER, NEAR TOWN OF DEVIL'S ELBOW.

BLOCK 13 CONTD. ANTI-VEHICLE DITCH (WHEEL ONLY) ON SOUTHEAST SIDE OF BRIDGE.

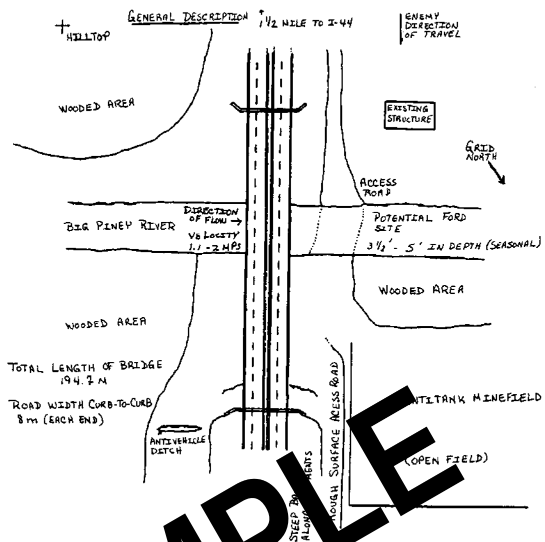
PAGE 2, DA Form 2203-R

Figure J-2. Sample DA Form 2203-R (continued)

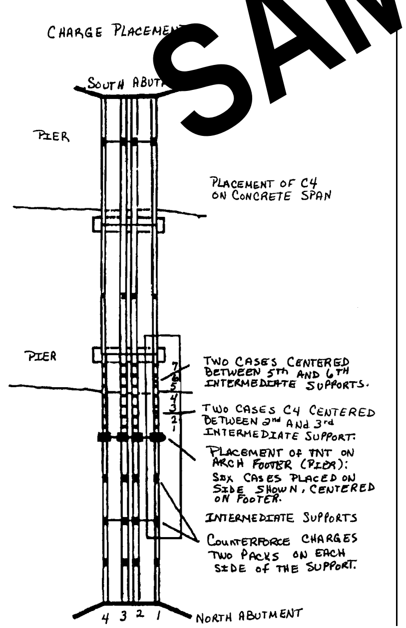
DEMOLITION RECONNAISSANCE RECORD

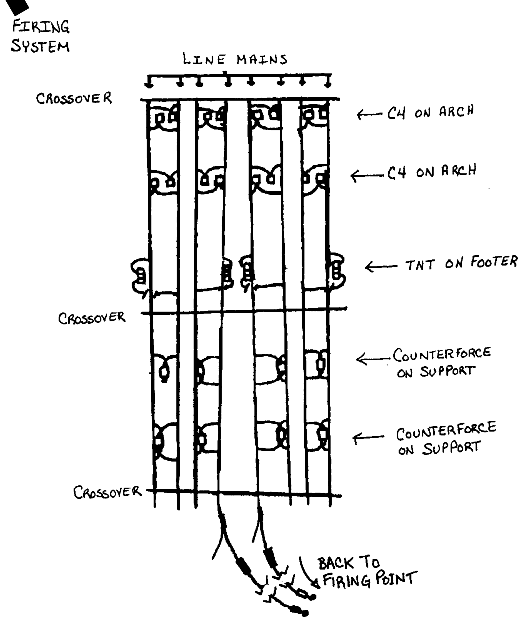
Place additional comments in the appropriate blocks.

20. GENERAL DESCRIPTION SKETCH *(Attach additional sketches if required)*



21. NATURE OF PROPOSED DEMOLITION SKETCH *(Attach additional sketches if required)*





SAMPLE

PAGE 3, DA Form 2203-R

Figure J-2. Sample DA Form 2203-R (continued)

DEMOLITION RECONNAISSANCE RECORD

Instructions for Completing the DA Form 2203-R

Use the following instructions to complete DA Form 2203-R. This form may be locally reproduced on 8 1/2- by 11-inch paper.

1. *Block 1 (FILE NO.).* Leave blank unless a higher headquarters provides this number. Higher headquarters provides this number or enters it after you **submit** the form.

2. *Block 2 (DEMOLITION RECON REPORT NO.).* Leave blank unless a higher headquarters provides this number. Higher headquarters provides this number or enters it after you submit the form. Company SOP may specify the procedures for determining this number.

3. *Block 3 (DATE).* Enter the date the reconnaissance was performed.

4. *Block 4 (TIME).* Enter the time the reconnaissance party arrived at the target site (local or Zulu time).

5. *Block 5 (RECON ORDERED BY).* Enter the command authority authorizing the reconnaissance action.

6. *Block 6 (PARTY LEADER).* Enter the name of the NCOIC or OIC of the reconnaissance party who was physically at the site when the reconnaissance was performed.

7. *Block 7 (MAP NAME, SCALE, SHEET NO., and SERIES NO.).* Obtain this information from a map of the reconnaissance area and enter the information in this block.

8. *Block 8 (TARGET AND LOCATION).* 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 degrees, 300 meters from the railroad bridge, 2 miles east of Hanesville, on Route 2."

9. *Block 9 (TIME OBSERVED).* Enter the time you last saw the target as you departed the site.

10. *Block 10 (COORDINATES).* Enter the complete 8-digit map coordinates of the target.

11. *Block 11 (GENERAL DESCRIPTION (Use block 20 for sketches.)).* 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 32 feet; overall bridge width is 36 feet; height is 16 feet; Class 80; very good condition."

12. *Block 12 (NATURE OF PROPOSED DEMOLITION (Use block 21 for sketches.)).* 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 (tamping or no tamping), where the charges should be placed, and the type of firing system required.

13. *Block 13 (UNUSUAL FEATURES OF SITE).* 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.

14. *Block 14 (MATERIAL REQUIRED).* Indicate the type and quantity of explosives, detonators, and so forth proposed for the demolition.

15. *Block 15 (EQUIPMENT AND TRANSPORT REQUIRED).* 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). Comments may be continued in block 18 on page 2 of the form.

16. *Block 16 (PERSONNEL AND TIME REQUIRED FOR:).* 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.

SAMPLE

17. *Block 17 (TIME, LABOR, AND EQUIPMENT REQUIRED FOR BYPASS (Specifiy location and method.).* Specify the equipment necessary to clear the site after demolition and the available bypasses that allow units to bypass the site. Comments may be continued in Block 18 on page 2 of the form.

18. *Block 18 (REMARKS).* Include any appropriate remarks that are not covered in blocks 1 through 17.

19. *Block 19 (ADDITIONAL COMMENTS).* Use this block as a continuation for blocks 1 through 18. Identify the block being continued.

20. *Block 20 (GENERAL DESCRIPTION SKETCH).* The sketch should include--

- The avenues of approach to the target and possible bypasses in the vicinity of the target. Indicate route numbers and the direction of cities or towns.
- Rivers or streams including name, direction of flow, and velocity in meters per second.
- Terrain features, including observation points, cover and concealment, swampy areas, deep valleys, and so forth.
- A compass arrow indicating north (indicate grid or magnetic).
- Dimensions of the proposed target.
- Number and length of bridge spans.
- Height of the bridge from the ground or water.

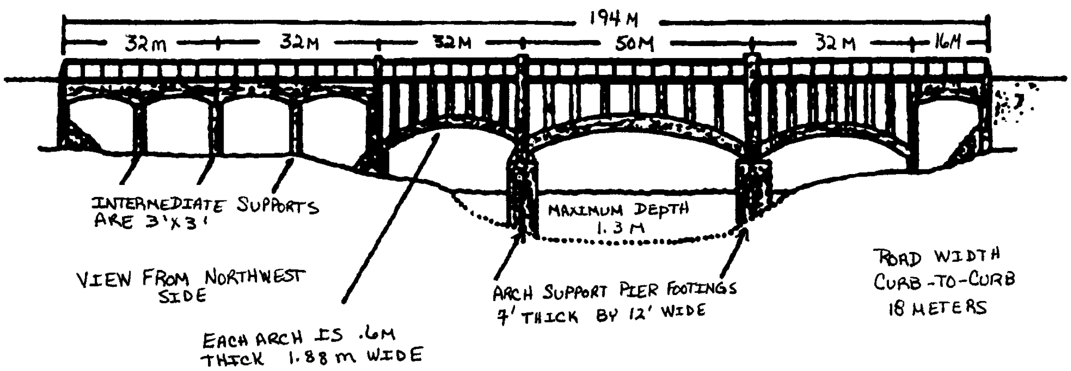
21. *Block 21 (NATURE OF PROPOSED DEMOLITION SKETCH).* This sketch should include--

- Dimensions of members to be cut.
- Placement of charges.
- Charge calculations. Use either the formula or table method, but show your work.
- Priming of charges.
- Branch lines.
- Ring mains.
- Firing systems.
- Firing points.

PAGE 4, DA Form 2203-R

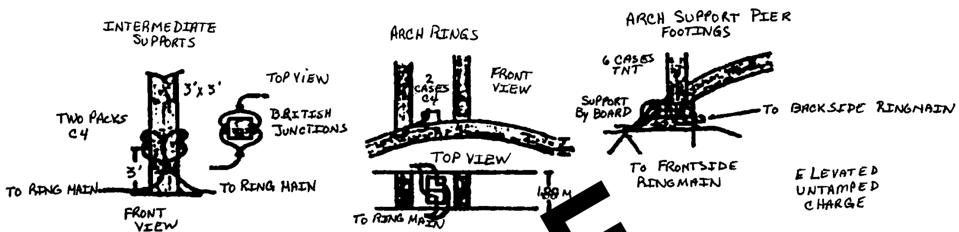
Figure J-2. Sample DA Form 2203-R (continued)

BLOCK 20. GENERAL DESCRIPTION (CONTINUED)



BLOCK 21. NATURE OF PROPOSED DEMOLITION SKETCH (CONTINUED)

METHOD OF PRIMING AND CHARGE CALCULATIONS



SAMPLE

INTERMEDIATE SUPPORT
(USE COUNTERFORCE CHARGE)
1. CRITICAL DIMENSIONS: SUPPORT IS 3'x
2. SOLVE FOR TNT: (1 1/2 lbs per F
1 1/2 x 3 = 4.5 lbs of C C4 RE
3. DIVIDE BY RE: (USING 4, E: 1. 4)
NO CONVERSI EQUIRE TE FORCE
IS CALCULA ED IN C
4. SOLVE FOR HA E PACKAGE:
4.5 ÷ 1.25 (PKG W C4) = 3.6 Ø 4 PACKAGES
5. NUMBER OF GES: 8 SUPPORTS
6. TOTAL REQUIRED: (STEP 4 x STEP 5)
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 X .6 + .5)³ 1.5

P = (.248)³ 1.5
P = 15.25) 1.5 = 22.875 Kg/m
22.875 x 1.88 = 43.005 Kg/Sq M
43.005 x 2.2046 = 94.81 LBS TNT
3. DIVIDE BY RE (RE FOR C4 = 1.34)
94.61 ÷ 1.34 = 70.75 LBS C4
4. SOLVE FOR SINGLE CHARGE:
70.75 ÷ 1.25 = 56.67 Ø 57 PKGS
5. NUMBER OF TARGETS = 8

H RINGS (CONTD)
6. TOTAL REQUIRED: (STEP 4 x STEP 5)
57 x 8 = 456 PKGS
600 PKGS PER BOX = 15.2 Ø 16 CASES

PIER FOOTINGS
(USE BREACHING FORMULA: P = R³ KC)
1. CRITICAL DIMENSIONS: PIER IS 2 1/2' x 7' x 9'
2. SOLVE FOR TNT: R = 7' 7³ = 343
K FOR REINFORCED CONCRETE OR > = .54
C FOR ELEVATED UNTAMPED = 1.8
343 x .34 x 1.8 = 333.39
3. DIVIDE BY RE: (RE FOR TNT = 1)
333.39 ÷ 1 = 333.89
4. SOLVE FOR SINGLE CHARGE PACKAGE:
333.39 ÷ 1 (1 LB PKG OF TNT): 333.39
333.39 Ø = 384 PACKAGES
5. NUMBER OF CHARGES = 4 PIER
6. TOTAL REQUIRED: (STEP 4 x STEP 5)
334 x 4 = 1336 PACKAGES
(36 PKG PER BOX > 23.8 CASES)
23.8 Ø 24 CASES

Figure J-2. Sample DA Form 2203-R (continued)

Appendix K

Demolition Effects Simulator Materials

K-1. This appendix contains information needed to order materials (for BOM) when constructing DES devices. Table K-1 shows the materials available when constructing DES devices and where the materials can be found.

Table K-1. DES materials

	Materials	Sources
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, $11^{3}/4$ by $2^{1}/4$ by $2^{1}/4$ in	Local purchase
5	Box, cardboard, 7 by $1^{3}/4$ by $1^{3}/4$ in	Local purchase
6	Box, wooden, bangalore torpedo	Training Support Center (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	TSC/DRMO
11	Box, wooden, M2A3	TSC/DRMO
12	Box, wooden, M3	TSC/DRMO
13	Box, wooden, M183	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, shape, metal, M2A3	Local fabrication
23	Charge, shape, metal, M3	Local fabrication
24	Clay, pottery, moist	Local purchase
25	Cord, detonating	1375-00-965-0800
26	Coupling, plastic, 1 in	4730-00-472-5056
27	Coupling, plastic, $^{3}/4$ in	4730-00-472-5058
28	Fuse, time	1375-00-628-9033

Table K-1. DES materials (continued)

	Materials	Sources
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	TSC
36	Label, M5A1 DES, ^{3}/8 in and 1^{1}/4 in	TSC
37	Label, TNT DES, ^{3}/8 in and 1^{1}/4 in	TSC
38	Label, shape charge, 15 lb, DES, ^{3}/8 in and 1^{1}/4 in	TSC
39	Label, shape charge, 40 lb, DES, ^{3}/8 in and 1^{1}/4 in	TSC
40	Label, M183 DES,^{3}/8 in and 1^{1}/4 in	TSC
41	M2 crimpers	5120-00-029-0683
42	Matting, floor, ^{1}/8 in	7220-01-0215-1695
43	Oil, mineral	Local purchase
44	Sand	Local purchase
45	Sandbag	Local purchase
46	String	NSN
47	Tape, clear	7510-00-995-0455
48	Tape, duct, green	7510-00-074-5124
49	Tape, electrical, black	5970-00-419-4291
50	Tape, fabric, olive-drab green	7510-00-266-5016
51	Tape, fabric, red	7510-00-074-4969
52	Tape, pressure sensitive adhesive (PSA)	7510-01-057-0096
53	Tube, cardboard, 10 by 2^{1}/8 in	Local purchase
54	Tube, cardboard, 12 by 2^{1}/8 in	Local purchase
55	Tube, cardboard, 24 by 7 in	Local purchase

Appendix L

Risk-Assessment Checklist

L-1. 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. Refer to Table L-1 for the risk assessment for live demolitions. Table L-2, page L-4, shows the risk-assessment factors used in this assessment. Table L-3, page L-5, couples the probability with the severity of the training and provides a level of risk involved for the training.

Table L-2. Commander's risk assessment for live demolitions

Hazards	Probability	Severity	Overall	Countermeasures
1. Charging preparation area				
a. Issue demolitions. Demolition dropped, mishandled, or accidentally discharged.	D	2	M	Demolition instructors supervise closely. Prime charges with detonating cord knots only. Demolition instructors control the caps.
b. Construct charges.				
(1) Explosives stored improperly.	E	1	L	OIC ensures proper storage; for example, MDI is stored in separate bunker from explosives.
(2) Charge has too much demolition.	E	2	L	Training and PE conducted in the classroom. Charges issued to soldiers in correct size by the NCOIC of the range.
(3) Charge detonates during construction.	E	2	L	The demolition instructors control the caps. One-to-one supervision when using caps and placement.
(4) Charge not primed correctly.	D	2	M	Training and PE conducted in the classroom. Demolition instructors supervise and check each charge.
(5) Accident occurs due to improper construction of field-expedient demolition.	E	1	M	Follow instructions in FM 5-250 and FM 5-34. Eliminate excess use of blasting caps.
2. Moving to detonation area				
a. The soldier trips.	C	4	L	Soldier attends safety briefing on watching where to step and range walk only; no running. Ensure that troops are not overloaded.

Table L-2. Commander's risk assessment for live demolitions (continued)

Hazards	Probability	Severity	Overall	Countermeasures
b. The soldier drops or mishandles the demolition.	D	2	M	Slow down movement on the range. The demolition instructor has control of the caps. Carry caps separately from the demolitions.
3. Preparing final demolition charges				
a. Low-strength cap is used instead of high-strength cap.	D	2	M	Training and PE conducted in the classroom. Demolition instructors issues the caps and supervises the crimping.
b. Cap received a shock during preparation or movement.	D	2	M	Slow down movement on the range. Carry caps in a protective case.
4. Detonating charges				
a. Soldier not accounted for.	E	1	M	Leaders conduct a headcount, and it is verified by the range NCOIC. A safety briefing is given to everyone on the range.
b. Soldier does not have sufficient time to reach safety.	D	2	M	Demolition instructors check the time-fuse system during construction. Minimum safe distance 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. Fuse ignitor fails to operate.	D	3	L	Training and PE conducted in the classroom. The safety officer supervises the pulling of the fuse ignitors and ensures that they are burning. If ignitors are not burning, the safety officer talks the soldier through the correct misfire procedure.
d. Soldiers hit by shrapnel or debris.	D	3	L	Ensure that all soldiers are in bunkers or at a minimum safe distance before the blast. Place guards with radios at the four corners of the heavy range (road intersections) when firing a mine or bangalore.
e. Firing system detonates prematurely.	D	2	M	Minimum personnel downrange. Demolition instructor supervises the construction of the firing system.
f. Charge misfires.	D	2	M	Cease fire and use proper clearing procedures according to FM 5-250 (wait 30 minutes). Clearing charges are available at the assembly area. The safety officer will clear the misfire or call EOD, as appropriate. When using MDI, ensure that only M11 high-strength care is used.

Table L-2. Commander's risk assessment for live demolitions (continued)

Hazards	Probability	Severity	Overall	Countermeasures
g. Misfire 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. Soldier improperly constructs initiation system.	D	2	M	One-to-one supervision given when the soldier constructs initiation sets. Demolition instructors and safety officer will check all the work.
i. Soldier does not wait for sufficient time after the blast.	1	E	M	Wait 10 minutes after the blast before going down range. The range safety officer does all inspecting and clearing.
5. Controlling the range				
a. Stranger wanders onto the range.	E	1	M	Establish road blocks and post guards according to installation regulations.
b. Blast limits are exceeded.	E	2	L	NCOIC only issues 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.
c. Range safety officer 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 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. (Refer to AR 385-63.)
e. 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. Soldier gets poison ivy or oak, has an allergic reaction to an insect sting or bit, or is bitten by a snake.	C	4	L	Conduct 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.

Table L-2. Commander's risk assessment for live demolitions (continued)

Hazards	Probability	Severity	Overall	Countermeasures
g. Soldier receives a cold- or hot-weather injury.	E	4	L	Ensures 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 safety briefing.
h. Soldier receives injury requiring first aid.	E	4	L	Have aid bag present with combat medic.
i. Soldier receives serious injury requiring medical evacuation.	D	1	H	Maintain communications with the range control to call for an ambulance.

Table L-3. Factors

Severity	Level	Results
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 accomplishment of mission
Probability	**Level**	**Results**
A	Frequent	- For individual soldier or item, this occurs often in the career or equipment service life. - For all soldiers exposed or item inventory, this is continuously experienced.
B	Likely	- For individual soldier or item, this occurs several times in the career or equipment service life. - For all soldiers exposed or item inventory, this occurs frequently.
C	Occasional	- For individual soldier or item, this occurs sometime in the 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 individual soldier or item, it is possible to occur in the 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 individual soldier or item, one can assume it will occur in the career or equipment service life. - For all soldiers exposed or item inventory, it is possible but improbable; occurs only very rarely.

Table L-4. Severity of training

Severity	A	B	C	D	E
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

ABCA	American, British, Canadian, and Australian
AC	active component
AFR	Air Force regulation
AFV	armored fighting vehicle
ammo	ammunition
AP	antipersonnel
approx	approximately
AR	Army regulation
ASP	ammunition supply point
AT	antitank
ATTN	attention
AVLB	armored vehicle-launched bridge
AWG	American wire gauge
bde	brigade
bn	battalion
BOM	bill of materials

C^2	command and control
C4	composition C4
cc	cratering charge
CFR	Code of Federal Regulations
chg	charge
cm	centimeter(s)
co	company
COL	colonel
cons	consolidated
contd	continued
CPT	captain
crypto	cryptography
CTP	crimp, tie, prime
DA	Department of the Army
DE	demolitions equipment
demo	demolition
DES	demolition effects simulator
det	detonation
div	division

DLAR	Defense Logistics Agency regulation
DOD	Department of Defense
DODAC	Department of Defense ammunition code
DODIC	Department of Defense identification code
DOT	Department of Transportation
DRMO	Defense Reutilization and Marketing Office
DTG	date-time group
DWFA	double waterproof firing assembly
ea	each
elec	electric
engr	engineer
ENL	enlisted
EOD	explosive-ordnance disposal
EPA	Environmental Protection Agency
equip	equipment
expl	explosive
F	Fahrenheit
flex	flexible
F/M	firing mechanism

FM	field manual
FMFM	fleet Marine force manual
FMU	fuse munition unit
ft	foot (feet)
GEMSS	ground-emplaced mine scattering system
GP	general purpose
gr	gram(s)
GS	general services
HC	high capacity
HE	high explosive
HEAT	high-explosive antitank
HEP	high-explosive plastic
hex	hexagon
HMX	cyclotetramethylene tetramitramine
HQ	headquarters
hr	hour(s)
in	inch(es)
INT	intelligence interservice

JP4 jet petroleum 4

kg kilogram(s)

kw kilowatt(s)

lin linear

lb pound(s)

LRA local reproduction authorized

m meter(s)

max maximum

MCO Marine Corps order

MDI modernized demolition initiator

MICLIC mine-clearing line charge

min minute(s)

min minimum

mm millimeter(s)

MO Missouri

mod modification

MOUT military operations on urbanized terrain

MSD minimum safe distance

N	number of charges or boreholes
N/A	not applicable
NATO	North Atlantic Treaty Organization
NAVSEA	Naval Sea Systems Command
NAVSUPINST	Naval supply instruction
NCO	noncommissioned officer
NCOIC	noncommissioned officer in charge
No.	number
NSN	national stock number
OIC	officer in charge
OPNAVINST	Chief of Naval Operations Instruction
oz	ounce(s)
para	paragraph
PE	practice exercise
PETN	pentaerythrite tetranitrate
pkg	package
plt	platoon
PSA	pressure sensitive adhesive

QD	quality distance
QSTAG	Quadripartite Standardization Agreement
RCRA	Resource Conservation and Recovery Act
RDX	cyclotrimethlenetrinitramine (commercial name - cyclonite)
RE	relative effectiveness
recon	resonnaissance
rpt	report
SCG	storage compatibility group
sec	second(s)
SM	soldier's manual
SOP	standing operating procedure
SP	special purpose
sq	square
STANAG	Standardization Agreement
std	standard
t	ton
TC	training circular
TM	technical manual
TNT	trinitrotoluene

TRADOC United States Army Training and Doctrine Command

TSC Training Support Center

TT telegraphic transfer

UN United Nations

US United States

USAES United States Army Engineer School

UXO unexploded ordnance

w/ with

WD wire diameter

WP white phosphorous

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