Field Manual
5-250

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EXPLOSIVES AND DEMOLITIONS

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Preface

The purpose of this manual is to provide technical information on explosives used by United States military forces and their most frequent applications. This manual does not discuss all applications but presents the most current information on demolition procedures used in most situations.

If used properly, explosives serve as a combat multiplier to deny maneuverability to the enemy. Focusing mainly on these countermobility operations, this 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.

When faced with unusual situations, the responsible engineer must either adapt one of the recommended demolition methods or design the demolition from basic principles presented in this and other manuals. The officer in charge must maintain ultimate responsibility for the demolition design, ensuring the safe and efficient application of explosives.

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The provisions of this publication are the subject of international agreements: STANAG 2017 (ENGR), *Orders to the Demolition Guard Commander and Demolition Firing Party Commander (Non-Nuclear):STANAG* 2123 (ENGR), *Obstacle Folder;* 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.

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Chapter 1
Military Explosives

Section I. Demolition Materials

1-1. Characteristics. 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.
- Should be composed of high-density materials (weight per unit volume).
- Should be suitable for use underwater or in damp climates.
- Should be minimally toxic when stored, handled, and detonated.

1-2. Selection of Explosives. 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 (page 1-2) contains significant information regarding many of the explosives described below.

1-3. Domestic Explosives.

a. *Ammonium Nitrate.* Ammonium nitrate is the least sensitive of the military explosives. It requires a booster charge to successfully initiate detonation. 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. However, because of its excellent cratering affects and low cost, ammonium nitrate is a component of most cratering and ditching charges. Commercial quarrying operations use ammonium nitrate demolitions extensively. Pack ammonium nitrate in an airtight container because it is extremely hydroscopic (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.

b. *Pentaerythrite Tetranitrate (PETN).* PETN is a highly sensitive and very powerful military explosive. Its explosive potential is comparable to cyclonite (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 (Ml 18 sheet explosive) is a demolition charge. The PETN explosive is a good underwater-demolition because it is almost insoluble in water.

Table 1-1. Characteristics of US demolitions explosives

Name	Applications	Detonation Velocity		RE Factor*	Fume Toxicity	Water Resistance
		M/Sec	Ft/Sec			
Black Powder	Time Fuse	400	1,300	0.55	Dangerous	Poor
Ammonium Nitrate	Cratering Charge	2,700	8,900	0.42	Dangerous	Poor
Amatol 80/20	Bursting Charge	4,900	16,000	1.17	Dangerous	Poor
M1 Dynamite	Demolition Charge	6,100	20,000	0.92	Dangerous	Fair
Detonating Cord	Priming	6,100 to 7,300	20,000 to 24,000	—	Slight	Excellent
TNT	Demolition Charge Composition Explosive	6,900	22,600	1.00	Dangerous	Excellent
Tetrytol 75/25	Demolition Charge	7,000	23,000	1.20	Dangerous	Excellent
Tetryl	Booster Charge Composition Explosive	7,100	23,300	1.25	Dangerous	Excellent
Sheet Explosive M118 and M186	Cutting Charge	7,300	24,000	1.14	Dangerous	Excellent
Pentolite 50/50	Booster Charge Bursting Charge	7,450	24,400	—	Dangerous	Excellent
Nitroglycerin	Commercial Dynamite	7,700	25,200	1.50	Dangerous	Good
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
Composition B	Bursting Charge	7,800	25,600	1.35	Dangerous	Excellent
Composition C4 and M112	Cutting Charge Breaching Charge	8,040	26,400	1.34	Slight	Excellent
Composition A3	Booster Charge Bursting Charge	8,100	26,500	—	Dangerous	Good
PETN	Detonating Cord Blasting Caps Demolition Charges	8,300	27,200	1.66	Slight	Excellent
RDX	Blasting Caps Composition Explosives	8,350	27,400	1.60	Dangerous	Excellent
*TNT equals 1.00						

c. *Cyclotrimethlenetrinitramine (RDX). 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. The principal use for RDX is in composite explosives, such as Composition A, B, and C explosives. RDX is available commercially under the name cyclonite.

d. *Trinitrotoluene.* TNT is the most common military explosive. It maybe in composite form, such as a booster, a bursting, or a demolition charge, or in a noncomposite form. Since TNT is a standard explosive, it is used to rate other military explosives.

e. *Tetryl.* 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.

f. *Nitroglycerin.* Nitroglycerin is one of the most powerful high explosives. Its explosive potential is comparable to RDX and PETN. Nitroglycerin is the explosive base for commercial dynamites. Nitroglycerine is highly sensitive and extremely temperature-sensitive. Military explosives do not use nitroglycerin because of its sensitivity. Do not use commercial dynamites in combat areas.

g. *Black Powder.* 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.

h. *Amatol.* 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 hydroscopic 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.

i. *Composition A3.* 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.

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

k. *Composition B4.* 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.

l. *Composition C4 (C4). C4* is a composite explosive containing 91 percent RDX and 9 percent nonexplosive plasticizers. Burster charges are composed of C4. C4 is effective in temperatures between -70 to+ 170 degrees Fahrenheit; however, C4 loses its plasticity in the colder temperatures.

m. *Tetrytol.* Tetrytol is a composite explosive containing 75 percent tetryl and 25 percent TNT. It is the explosive component in demolition charges. Booster charges require different mixtures of tetryl and TNT. Tetrytol is more powerful than its individual components, is better at shattering than TNT, and is less sensitive than tetryl.

n. *Pentolite.* 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.

o. Dynamites.

(1) Standard Dynamite. 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.

(2) Military Dynamite. 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 dynamiters. Because military dynamite contains no nitroglycerin, it is more stable and safer to store and handle than commercial dynamite.

1-4. Foreign Explosives.

a. *Composition.* 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 and thus forms extremely sensitive compounds.

WARNING
Do not use picric acid in rusted or corroded metal containers.
Do not handle picric acid. Notify explosive ordnance disposal (EOD) personnel for disposition.

b. *Use.* 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.

Section II. Service Demolition Charges

1-5. Block Demolition Charges. Block demolition charges are prepackaged, high-explosive charges for general demolition operations, such as cutting, breaching, and cratering. They are composed of the high-explosive TNT, tetrytol, Composition-C series, and ammonium nitrate. Block charges are rectangular inform except for the 40-pound, ammonium-nitrate block demolition charge, military dynamite, and the ¼-pound-TNT block demolition charge, which are all cylindrical in form. The various block charges available are described in the text that follows, as well as 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 (Pounds)	Size (Inches)	Detonation Velocity		RE Factor	Packaging/ Weight[2]
			M/Sec	Ft/Sec		
TNT	0.25	1½ D x 3½ L	6,900	22,600	1.00	200 per Box/55 Lb
	0.50	1¾ x 1¾ x 3¾	6,900	22,600	1.00	96 per Box/53 Lb
	1.00	1¾ x 1¾ x 7	6,900	22,600	1.00	48 per Box/53 Lb
M112 Block[1]	1.25	1 x 2 x 10	8,040	26,400	1.34	30 per Box/40 Lb
M118 Block	2.00	1 x 3 x 12	7,300	24,000	1.14	4 Sheets per Block; 20 per Box/ 42 Lb
M118 Sheet[1]	0.50	¼ x 3 x 12	7,300	24,000	1.14	
M186 Roll	25.00	¼ x 3 x 50 ft	7,300	24,000	1.14	3 per Box/80 Lb
Ammonium Nitrate	43.00	7 x 24	3,400	11,000	0.42	1 per Box/52 Lb
M1 Dynamite	0.50	1¼ D x 8 L	6,100	20,000	0.92	100 per Box/62 Lb

[1]The volume of M112 is 20 cubic inches. The volume of one sheet of M118 is 9 cubic inches.
[2]Packaging weights include packaging material and weight of container.

1-6. TNT Block Demolition Charge.

a. *Characteristics.* TNT block demolitions, shown in Figure 1-1, are available in three sizes (Table 1-2). The ¼-pound block is issued in a cylindrical, waterproof, olive-drab cardboard container. The ½-pound and l-pound blocks are available in similar rectangular containers. All of the three charges have metal ends with a threaded cap well in one end.

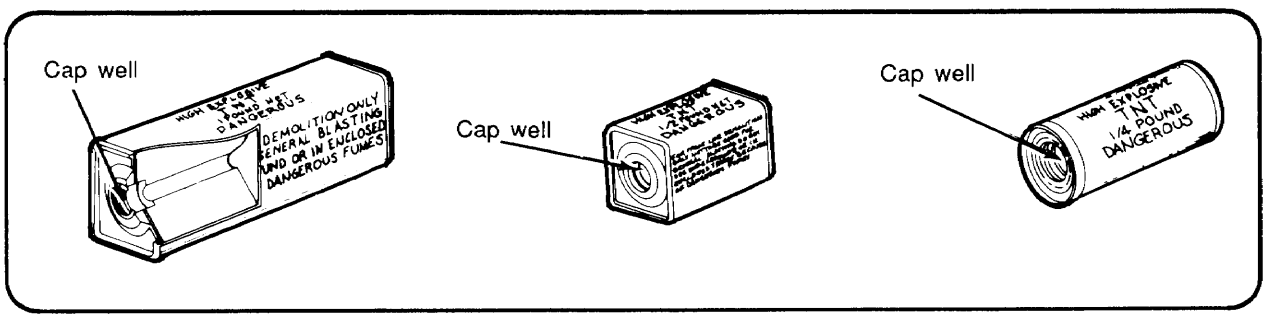


Figure 1-1. TNT block demolition charges

b. *Use.* TNT block demolition charges are effective for all types of demolition work. However, the ¼-pound charge is primarily for training purposes.

c. *Advantages.* TNT demolition 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.

d. *Limitations.* TNT block demolition 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.

1-7. M112 Block Demolition Charge.

a. *Characteristics.* The M112 block demolition 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 (page 1-5) lists additional characteristics of the Ml12 block.

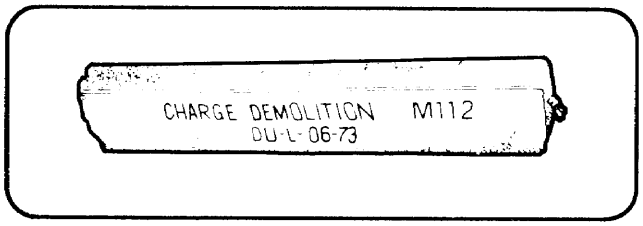


Figure 1-2. M112 block demolition charge

b. *Use.* The M112 block demolition charge is used primarily for cutting and breaching. Because of its high cutting effect and its ability to be cut and shaped, the M1l2 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 Ml12 charge is the primary block demolition charge presently in use.

WARNING

Composition C4 explosive is poisonous and dangerous if chewed or ingested; its detonation or burning produces poisonous fumes. Cut all plastic explosives with a sharp steel knife on a nonsparking surface. Do not use shears.

c. Advantages. You can cut to shape the M112 block demolition charge to fit irregularly shaped targets. The color of the wrapper helps camouflage the charge. Molding the charge will decrease its cutting effect.

d. *Limitations.* The adhesive tape will not adhere to wet, dirty, rusty, or frozen surfaces.

1-8. M118 Block Demolition Charge.

a. *Characteristics.* The M118 block demolition charge, or sheet explosive, is a block of four ½-pound sheets of flexible explosive packed in a plastic envelope (Figure 1-3). Twenty Ml18 charges and a 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 (page 1 -5) lists additional characteristics for the M118 charge.

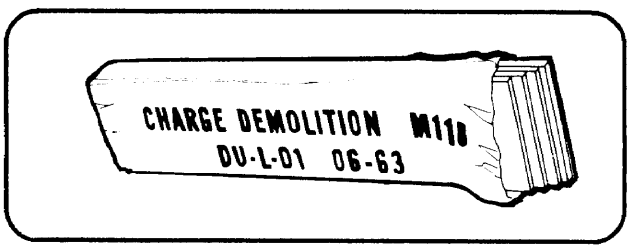


Figure 1-3. M118 block demolition charge

b. *Use.* The Ml18 charges are 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 Ml18 charge is effective as a small breaching charge but, because of its high cost, it is not suitable as a bulk explosive charge.

c. Advantages. The flexibility and adhesive backing of the sheets allow application to a large variety of targets. You can cut the ½-pound sheets to any desired dimension and apply them in layers to achieve the desired thickness. The Ml18 charge is not affected by water, making it acceptable for underwater demolitions.

d. *Limitations.* The adhesive tape will not adhere to wet, dirty, rusty, or frozen surfaces.

1-9. M186 Roll Demolition Charge.

a. *Characteristics.* The Ml86 roll demolition charge, shown in Figure 1-4, is identical to the Ml18 block demolition charge except that the sheet explosive is in roll form on a 50-foot, plastic spool. Each foot of the roll provides approximately a half pound of explosive. Included with each roll are 15 M8 blasting cap holders and a canvas bag with carrying strap. Table 1-2 (page 1-5) lists additional characteristics for the M186 charge.

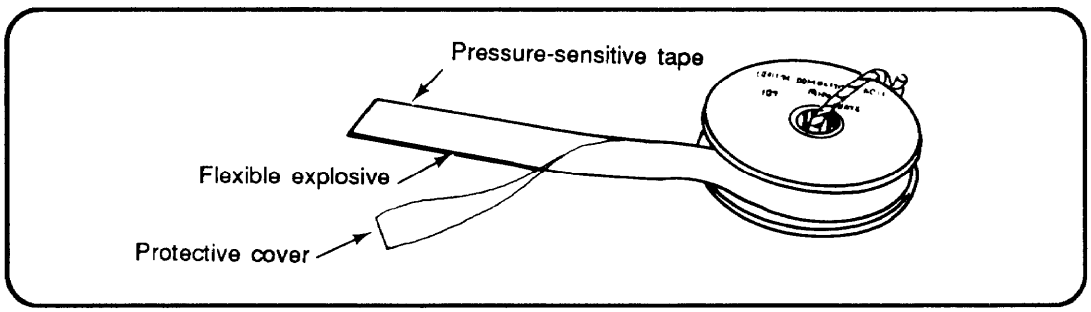


Figure 1-4. M186 roll demolition charge

b. *Use.* Use the M186 roll demolition charge in the same manner as the Ml18 block demolition charge. The Ml86 charge is adaptable for demolishing targets that require the use of flexible explosives in lengths longer than 12 inches.

c. *Advantages.* The Ml86 roll demolition charge has all the advantages of the Ml18 block demolition charge. You can cut the M186 charge to the exact lengths desired.

d. *Limitations.* The adhesive backing will not adhere to wet, dirty, rusty, or frozen surfaces.

1-10. Forty-Pound, Ammonium-Nitrate Block Demolition Charge

a. *Characteristics.* Figure 1-5 (page 1-8) shows the 40-pound, ammonium-nitrate block demolition charge or cratering charge. It is a watertight, cylindrical metal container with approximately 30 pounds of an ammonium-nitrate-based explosive and 10 pounds of TNT-based explosive booster in the center, next to the priming tunnels. The two priming tunnels are located to the outside of the container, midway between the ends. One tunnel serves as a cap well for priming the charge with an M6 electric or M7 nonelectric military blasting cap. The other tunnel series as a priming path, with the detonating cord passing through the tunnel and knotted at the end. There is a cleat between the tunnels to secure the time blasting fuse, electrical firing wire, or detonating cord. There is a metal ring on the top of the container for lowering the charge into its hole. Table 1-2 (page 1-5) lists additional characteristics for the 40-pound, ammonium-nitrate block demolition charge.

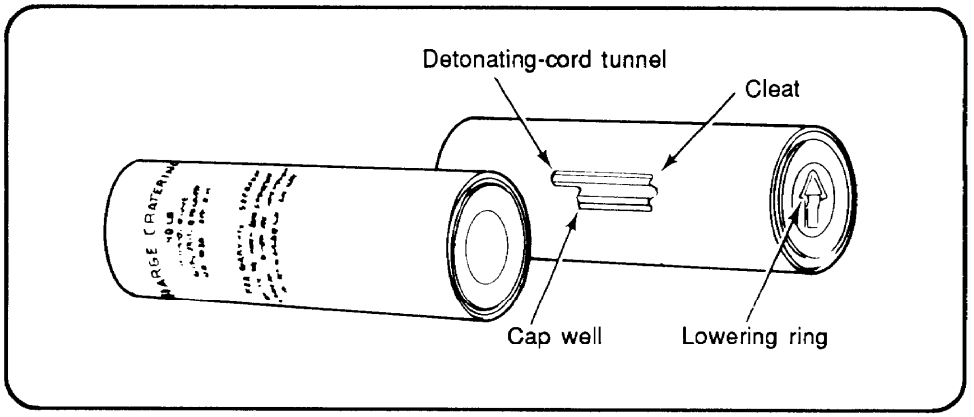


Figure 1-5. Forty-pound, ammonium-nitrate cratering charge

b. *Use.* This charge is suitable for cratering and ditching operations. Its primary use is as a cratering charge, but it also is effective for destroying buildings, fortifications, and bridge abutments.

c. *Advantages.* The size and shape of this charge make it ideal for cratering operations. It is inexpensive to produce compared to other explosives.

d. *Limitations.* Ammonium nitrate is hydroscopic. When wet, it will not detonate. To ensure detonation, use metal containers showing no evidence of water damage. Detonate all charges placed in wet or damp boreholes as soon as possible.

1-11. Ml Military Dynamite.

a. *Characteristics.* M1 military dynamite is an RDX-based composite explosive containing no nitroglycerin (Figure 1-6). M 1 dynamite is packaged in ½-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 (page 1-5) lists additional characteristics for Ml military dynamite.

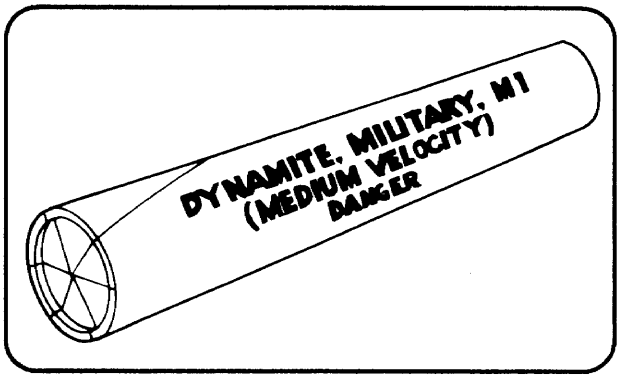


Figure 1-6. M1 military dynamite

b. *Use.* Ml dynamite's primary uses are military construction, quarrying, ditching, and service demolition work. It is suitable for underwater demolitions.

c. *Advantages.* Ml dynamite will not freeze or perspire in storage. The Ml dynamite's composition is not hydroscopic. Shipping containers do not require turning during storage. Ml dynamite is safer to store, handle, and transport than 60-percent commercial dynamite. Unless essential, do not use civilian dynamite in combat areas.

d. *Limitations.* Ml 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. Ml dynamite is not efficient as a cutting or breaching charge.

Section III. Special Demolition Charges and Assemblies

1-12. Shaped Demolition Charge. The shaped demolition charge used in military operations is a cylindrical block of high explosive. It has a conical cavity in one end that directs the cone-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 provided. Never dual prime a shaped charge.

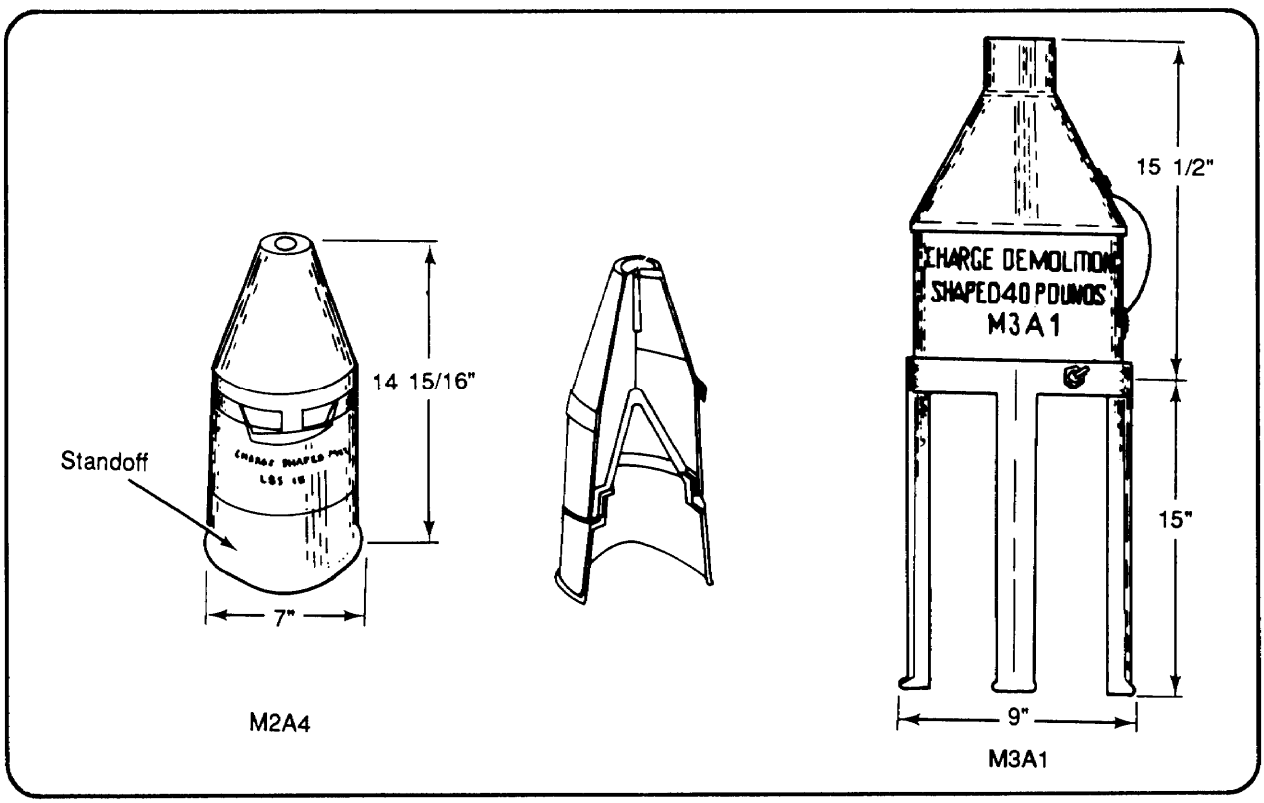


Figure 1-7. Shaped charges

a. *Characteristics.*

(1) Fifteen-Pound, M2A4 Shaped Demolition Charge. The M2A4 charge contains a 0.1 l-pound (50 gram) booster of Composition A3 and a 11.5-pound main charge of Composition B. It is packaged three charges per wooden box (total weight is 65 pounds). This charge has a moisture-resisting, molded-fiber container. A cylindrical fiber base slips onto the end of the charge to provide a 6-inch standoff distance. The cavity liner is a cone of glass. The charge is 14 $^{15}/_{16}$ inches high and 7 inches in diameter, including the standoff.

(2) Forty-Pound, M3A1 Shaped Demolition Charge. The M3A1 charge contains a 0.1 l-pound (50 gram) booster of Composition A3 and a 29.5-pound main charge of Composition B. It is packaged one charge per box (total weight is 65 pounds). The charge is in a metal container. The cone liner also is made of metal. A metal tripod provides a 15-inch standoff distance. The charge is 15 ½ inches high and 9 inches in diameter, not including standoff.

b. *Use.* 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-Pound)*	M3A1 Shaped Charge (40-Pound)**
Armor plate	Penetration	12.00 in	At least 20.00 in
	Average hole diameter	1.50 in	2.50 in
Reinforced concrete	Maximum wall thickness	36.00 in	60.00 in
	Penetration depth in thick walls	30.00 in	60.00 in
	Average hole diameter	2.75 in	3.50 in
	Minimum hole diameter	2.00 in	2.00 in
Concrete pavement (10-inch with 21-inch rock base course)	Optimum standoff	42.00 in	60.00 in
	Minimum penetration depth	44.00 in	71.00 in
	Maximum penetration depth	91.00 in	109.00 in
	Minimum hole diameter	1.75 in	6.75 in
Concrete pavement (3-inch with 24-inch rock base course)	Optimum standoff	42.00 in	—
	Minimum penetration depth	38.00 in	—
	Maximum penetration depth	90.00 in	—
	Minimum hole diameter	3.75 in	—
Permafrost	Hole depth (30-inch standoff)	72.00 in	—
	Hole depth (42-inch standoff)	60.00 in	—
	Hole depth (50-inch standoff)	—	72.00 in
	Hole diameter (42-inch standoff)	1.50 to 6.00 in	—
	Hole diameter (50-inch 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-inch standoff)	7.00 ft	12.00 ft
	Hole diameter (42-inch standoff)	3.50 in	6.00 in
Soil	Hole depth (30-inch standoff)	7.00 ft	—
	Hole depth (48-inch standoff)	—	7.00 ft
	Hole diameter (30-inch standoff)	7.00 in	—
	Hole diameter (48-inch standoff)	—	14.50 in
Graveled roads	Hole depth (30-inch standoff)	7.00 ft	—
	Hole depth (48-inch standoff)	—	9.00 ft
	Hole diameter (30-inch standoff)	7.00 in	—
	Hole diameter (48-inch standoff)	—	7.00 in

*A dash in the M2A4 Shaped Charge column indicates that a M3A1 shaped charge is required.
**A dash in the M3A1 Shaped Charge column indicates that a M2A4 shaped charge is sufficient.

c. *Special Precautions.* 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.

1-13. M183 Demolition Charge Assembly.

a. *Characteristics.* The Ml83 demolition charge assembly 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 11½ by 12½ 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 Ml detonating-cord clips for attaching the priming assembly to a detonating cord ring or line main.

b. *Use.* The M183 assembly is used primarily forereaching obstacles or demolishing structures when large demolition charges are required (Figure 1-8). The M183 charge also is effective against smaller obstacles, such as small dragon's teeth.

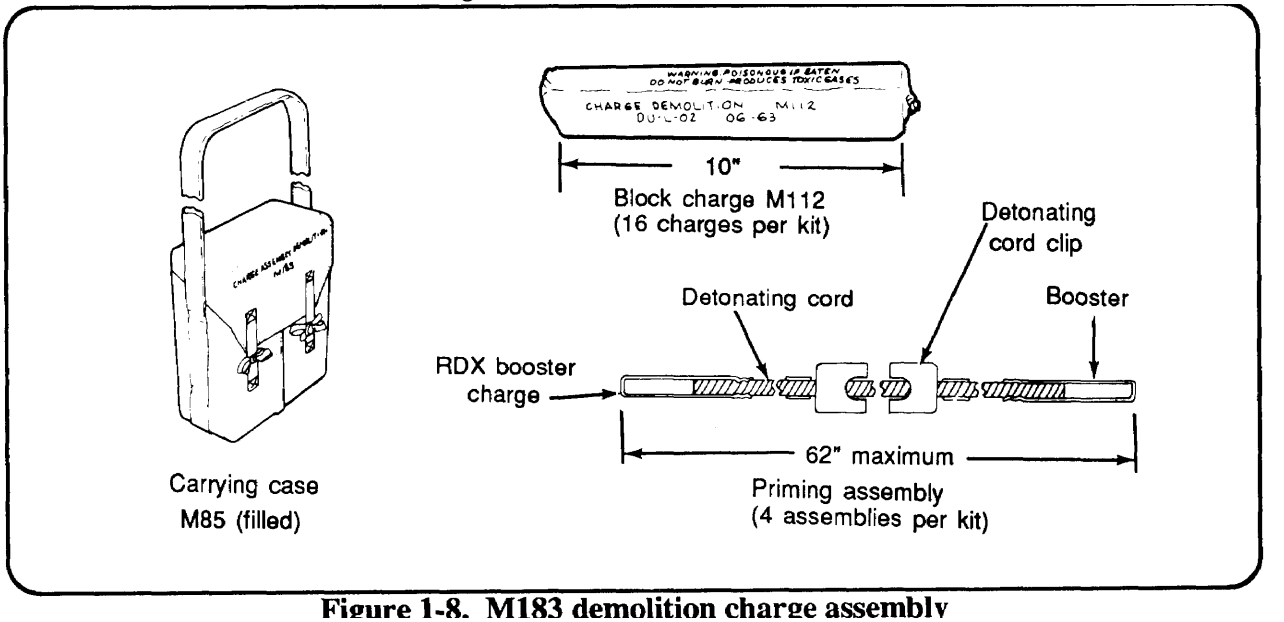


Figure 1-8. M183 demolition charge assembly

c. *Detonation.* Detonate the Ml83 demolition charge assembly with a priming assembly and an electric or a nonelectric blasting cap or by using a detonating-cord ring main attached by detonating cord clips.

1-14. M1A2 Bangtlore-Torpedo Demolition Kit.

a. *Characteristics.* Each kit consists of 10 loading assemblies, 10 connecting sleeves, and 1 nose sleeve. The loading assemblies, or torpedoes, are steel tubes 5 feet long and 2 1/8 inches in diameter, grooved, and capped at each end (Figure 1-9, page 1-12). The torpedoes have a 4-inch, Composition A3 booster (½ pound each) at both ends of each 5-foot section. The main explosive charge is 10½ pounds of Composition B4. The kit is packaged in a 60¾- by 13¾- by 4 9/16-inch wooden box and weighs 198 pounds.

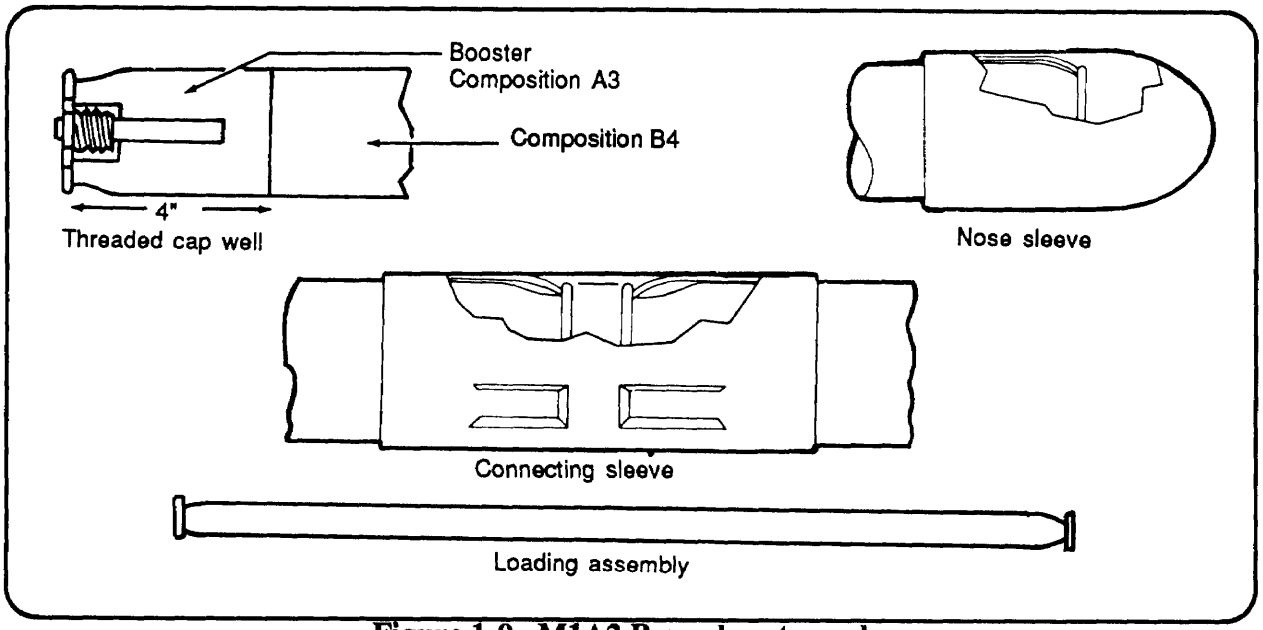


Figure 1-9. M1A2 Bangalore torpedo

b. *Use.* The primary use of the torpedo is clearing paths through wire obstacles and heavy undergrowth. It will clear a 3- to 4-meter-wide path through wire obstacles.

WARNING
The Bangalore torpedo may detonate a live mine when being placed. To prevent detonation of the torpedo during placement, attach the nose sleeve to a fabricated dummy section (approximately the same dimensions as a single Bangalore section) and place the dummy section onto the front end of the torpedo.

c. *Assembly.* 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.

d. *Detonation.* The recommended method to detonate the torpedo is to prime the torpedo with eight wraps of detonating cord and attach two initiation systems for detonation. Another method for priming the Bangalore torpedo is by inserting an electric or a nonelectric blasting cap directly into the cap well. Do not move the torpedo after it has been prepared for detonation. You may wrap the end with detonating cord prior to placing it, but do not attach the blasting caps until the torpedo is in place.

1-15. M180 Demolition Kit (Cratering).

a. *Characteristics.* This kit consists of an M2A4 shaped charge, a modified M57 electrical firing device, a warhead, a rocket motor, a tripod, and a demolition circuit (Figure 1- 10). The shaped charge, firing device, and warhead are permanently attached to the launch leg of the tripod. The rocket motor and the demolition circuit (packed in a wooden subpack) are shipped separately. The

kit weighs approximately 165 pounds (74.25 kilograms). TM 9-1375-213-12-1 provides the assembly procedures, operational description, and maintenance instructions for the Ml80 kit.

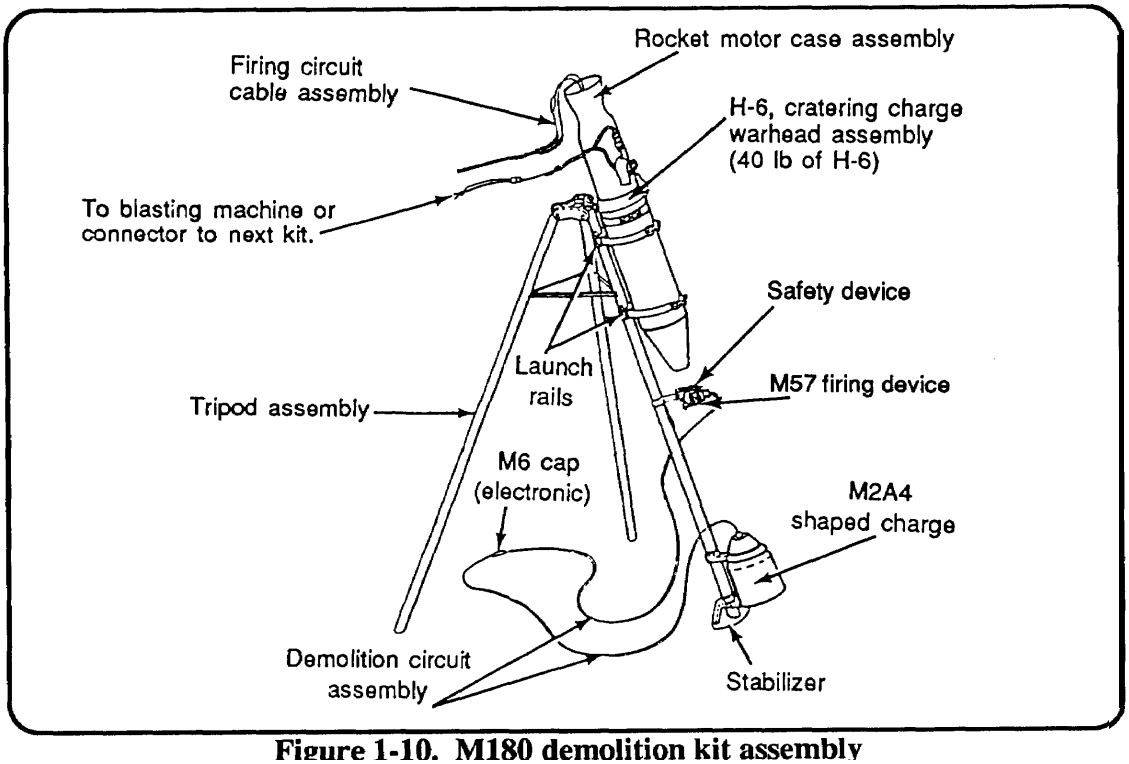


Figure 1-10. M180 demolition kit assembly

b. *Use.* The M180 is designed to produce a large crater in compacted soil or road surfaces, but not in reinforced concrete, arctic tundra, bedrock, or sandy soil. The charge produces a crater in two stages. The shaped charge blows a pilot hole in the surface. Then, the rocket-propelled warhead enters the hole and detonates, enlarging the pilot hole. Up to five kits can be set up close together and fired simultaneously to produce an exceptionally large crater. Up to 15 kits can be widely spaced and freed simultaneously for airfield pocketing.

WARNING
Regardless of the number of kits used, the minimum safe distances for the M180 cratering kit are 1,200 meters for unprotected personnel and 150 meters for personnel under overhead cover.

c. *Detonation.* When firing the M180, use the M34 50-cap blasting machine.

Section IV. Demolition Accessories

1-16. Time Blasting Fuse. The time blasting fuse transmits a delayed spit of flame to a nonelectric blasting cap. The delay allows the soldier to initiate a charge and get to a safe distance before the explosion. There are two types of fuses: the M700 time fuse and safety fuse. Although safety fuse is not often employed, it is still available.

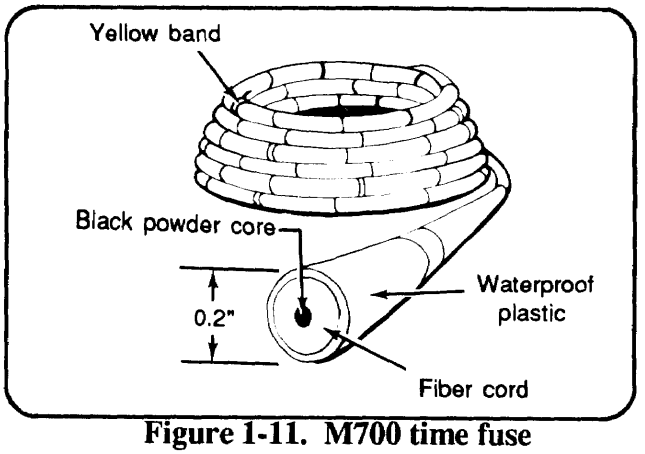


Figure 1-11. M700 time fuse

a. *M700 Time Fuse.* The M700 fuse is a dark green cord, 0.2 inches in diameter, with a plastic cover (Figure 1-1 1). The M700 bums at an approximate rate of 40 seconds per foot. However, test the burning rate as outlined in Chapter 2 (paragraph 2-lb(l), page 2-2). Depending on the date of manufacture, the cover may be smooth or have single yellow bands around the outside at 12- or 18-inch intervals and double yellow bands at 60- or 90-inch intervals. These bands accommodate hasty measuring. The outside covering becomes brittle and cracks easily in arctic temperatures. The M700 time fuse is packaged in 50-foot coils, two coils per package, five packages per sealed container, and eight containers (4,000 feet) per wooden box (30 1/8 by 15 1/8 by 14 7/8 inches). The total package weighs 94 pounds.

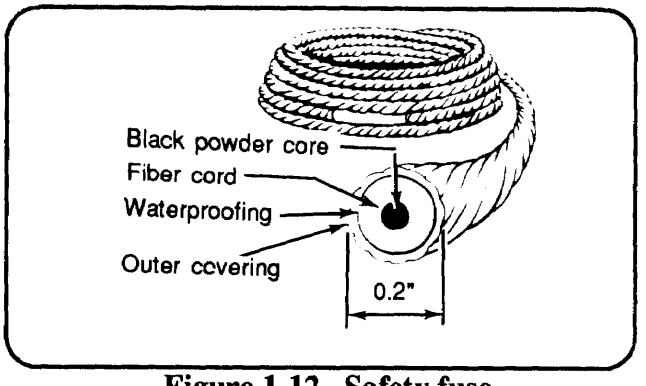


Figure 1-12. Safety fuse

b. *Safety Fuse.* Safety fuse consists of black powder tightly wrapped with several layers of fiber and waterproofing material. The outside covering becomes brittle and cracks easily in arctic temperatures. The burning rate may vary for the same or different rolls (30 to 45 seconds per foot) under different atmospheric and climatic conditions. This fuse may be any color, but orange is the most common (Figure 1-12). Test each roll in the area where the charge will be placed (paragraph 2-lb(l), page 2-2). Since safety fuse burns significantly faster underwater, test it underwater before preparing an underwater charge. Safety fuse is packaged in 50-foot coils, two coils per package, and 30 packages (3,000 feet) per wooden box (24¾ by 15¾ by 12 ½ inches). The total package weighs 93.6 pounds.

1-17. Detonating Cord.

a. *Characteristics. The* American, British, Canadian, and Australian (ABCA) Standardization Program recognizes this Type 1 detonating cord as the standard detonating cord. Detonating cord (Figure 1-13) consists of a core of high explosive (6.4 pounds of PETN per 1,000 feet) wrapped in a reinforced and waterproof olive-drab plastic coating. This detonating cord is approximately 0.2 inches in diameter, weighs approximately 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. For this reason, cut off and discard the first 6 inches of any new or used detonating cord that nonelectric blasting caps are crimped to. Also, leave a 6-inch overhang when making connections or when priming charges.

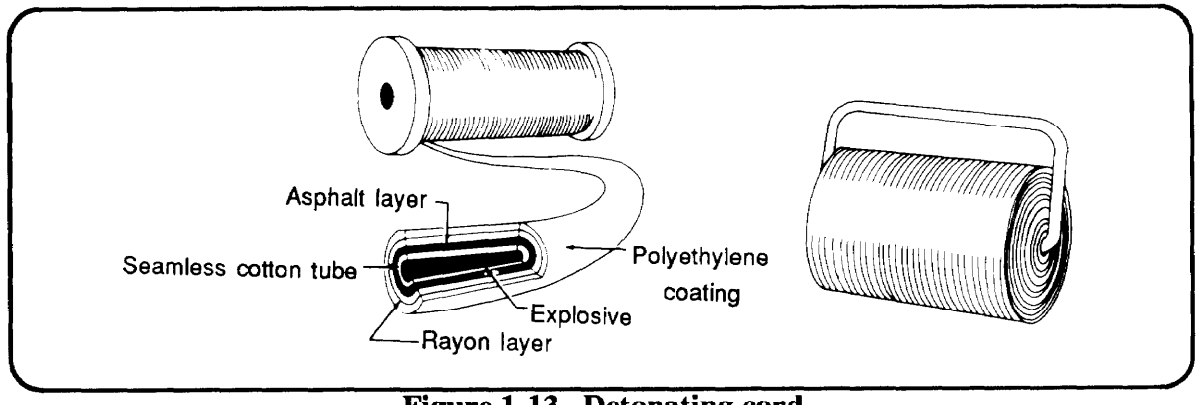


Figure 1-13. Detonating cord

b. *Use.* Use detonating cord to prime and detonate other explosive charges. When the detonating cord's explosive core is initiated by a blasting cap, the core will transmit the detonation wave to an unlimited number of explosive charges. Chapter 2 explains the use of detonating cord for these purposes.

c. Precautions. 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 or sharp bends in priming, as they may interrupt or change the direction of detonation and cause misfires. Avoid unintended cross-overs of the detonating cord where no explosive connection is intended. To avoid internal cracking do not step on the detonating cord.

1-18. Blasting Caps. Blasting caps are for detonating high explosives. There are two types of blasting caps: 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 approximately 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 (paragraph 6-11, page 6-10).

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.

a. *Electric Blasting Caps.* Use electric blasting caps 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 1-14, page 1-6) 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.

WARNING
Do not remove the short-circuiting shunt until ready to test the cap. Doing this prevents accidental initiation by static electricity. If the cap has no shunt, twist the lead's bare ends together with at least three 180-degree turns to provide a shunting action.

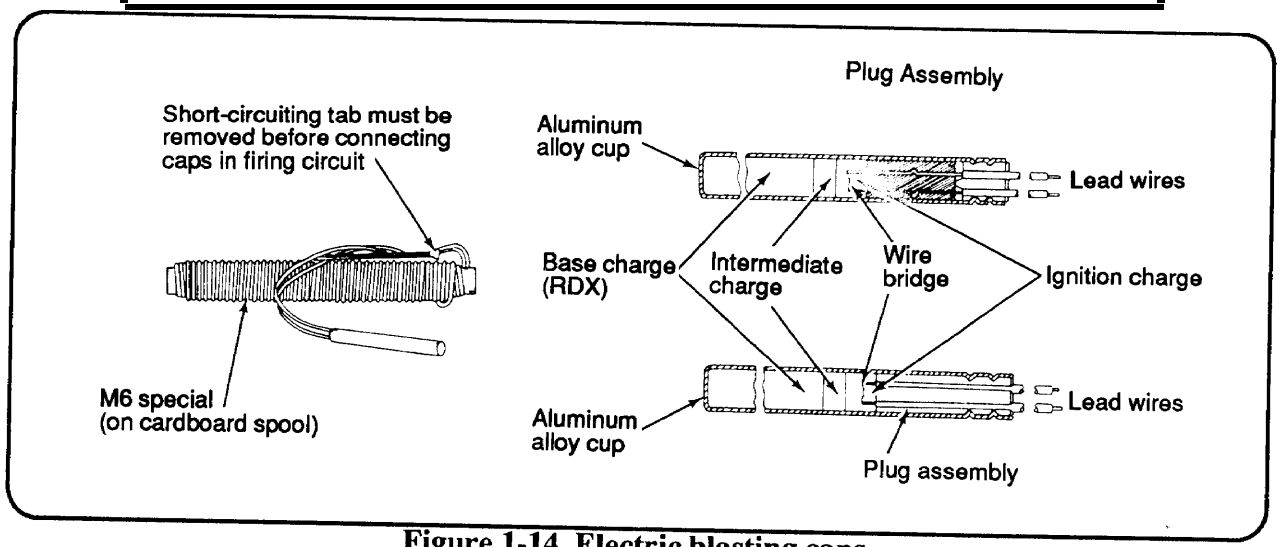


Figure 1-14. Electric blasting caps

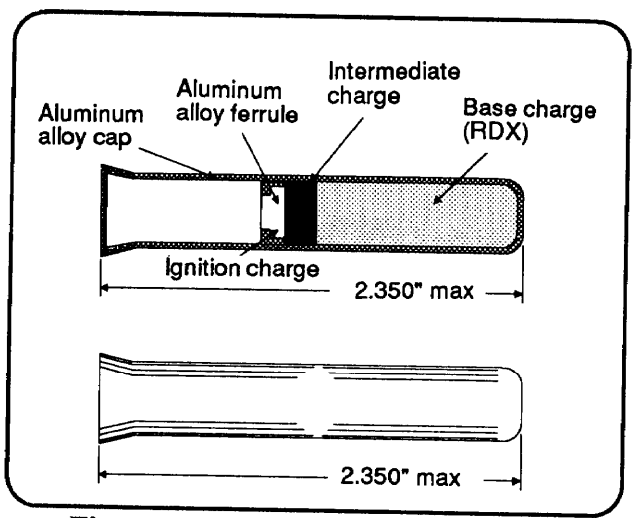


Figure 1-15. Nonelectric blasting cap

b. *Nonelectric Blasting Caps.* Initiate these caps with time-blasting fuse, a firing device, or detonating cord (Figure 1-15). 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 special nonelectric blasting cap is the standard issue. The open end of the M7 special nonelectric blasting cap is flared to allow easy insertion of the time fuse. TM 43-0001-38 gives additional information on blasting caps.

1-19. MlA4 Priming Adapter. The MIA4 priming adapter is a plastic, hexagonal-shaped device, threaded to fit threaded cap wells. The shoulder inside the threaded end will allow 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 quickly and easily installed in the adapter (Figure 1-16).

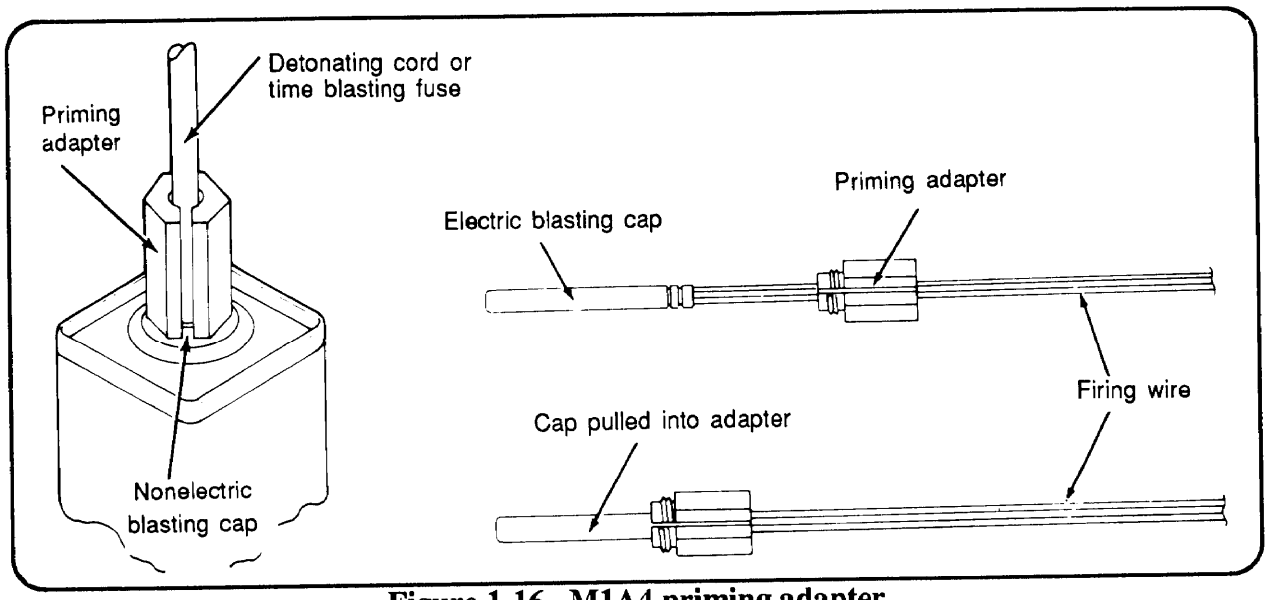


Figure 1-16. M1A4 priming adapter

1-20. M8 Blasting Cap Holder. The M8 blasting cap holder is a metal clip designed to attach a blasting cap to a sheet explosive (Figure 1-17). These clips are supplied with Ml18 sheet demolition charges and Ml86 roll demolition charges. The M8 blasting cap holder is also available as a separate-issue item in quantities of 4,000.

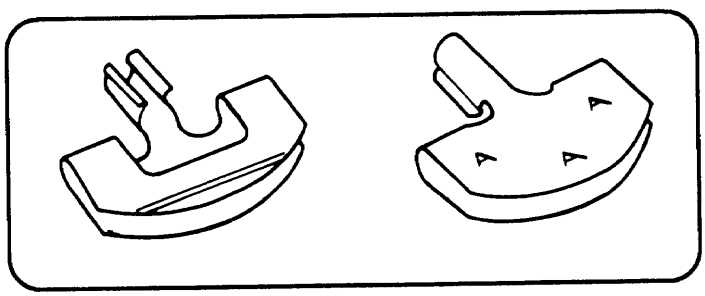


Figure 1-17. M8 blasting cap holder

1-21. Ml Detonating-Cord Clip. The Ml detonating-cord clip is a device for holding two strands of detonating cord together, either parallel or at right angles (Figure 1-18, diagram 1). Using these clips is faster and more efficient than using knots. Knots, if left for extended periods, may loosen and fail to function properly.

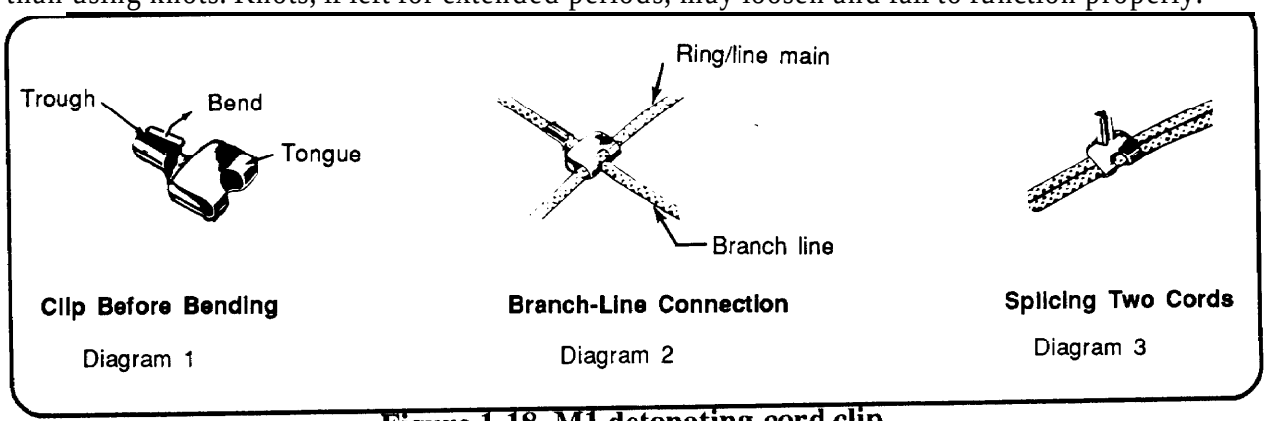


Figure 1-18. M1 detonating-cord clip

a. *Branch Lines.* Connect a detonating cord branch line by passing it through the trough of the Ml detonating cord 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

the crossover is held secure by the tongue; it may be necessary to bend or form the tongue while doing this. (Figure 1-18, diagram 2, page 1-17).

b. *Splices.* 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 1-18, diagram 3, page 1-17).

1-22. Ml Adhesive Paste. Ml 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. Ml adhesive paste becomes useless when softened by water.

1-23. Pressure-Sensitive Adhesive Tape.

a. *Characteristics.* Pressure-sensitive tape is replacing Ml adhesive paste. Pressure-sensitive 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.

b. *Use.* This tape is effective for holding charges to dry, clean wood, steel, or concrete.

c. *Limitations.* This tape does not adhere to dirty, wet, oily, or frozen surfaces.

1-24. Supplementary Adhesive for Demolition Charges.

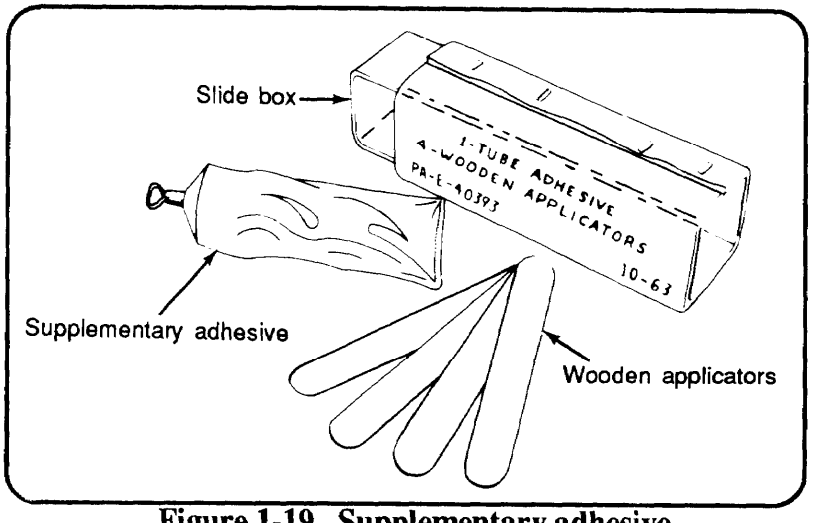


Figure 1-19. Supplementary adhesive

a. *Characteristics.* This adhesive is used to hold demolition charges when the target surface is below freezing, wet, or underwater. The adhesive comes in tubes packed in water-resistant, cardboard slide boxes, with wooden applicators (Figure 1-19).

b. *Use.* Apply the adhesive to the target surface and the demolition block with a wooden applicator and press the two together.

1-25. Waterproof Sealing Compound. 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.

1-26. M2 Cap Crimper. Use the M2 cap crimper (Figure 1-20) 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 rear portion of each jaw 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 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.

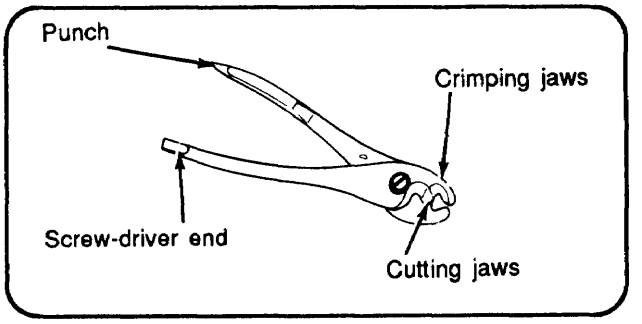


Figure 1-20. M2 cap crimper

1-27. M51 Blasting-Cap Test Set.

a. *Characteristics.* The test set 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 operation at temperatures as low as -40 degrees Fahrenheit (Figure 1-21).

b. *Use.* 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.

c. *Maintenance.* Handle the test set carefully and keep it dry to assure optimum use. Before using, ensure the test set is operating properly by using the following procedure:

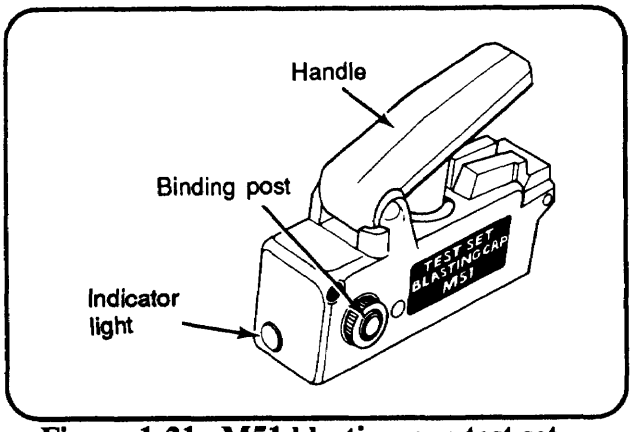


Figure 1-21. M51 blasting-cap test set

(1) Hold apiece of bare wire or the legs of the M2 crimpers between the binding posts.

(2) Depress the handle sharply while observing the indicator lamp. The indicator lamp should flash.

(3) Remove the bare wire or crimper legs from the binding posts.

(4) Depress the handle sharply while observing the indicator lamp. This time the indicator lamp should not flash.

(5) Perform both tests to ensure the test set is operating properly.

1-28. Blasting Machines. Blasting machines provide the electric impulse needed to initiate electric blasting-cap operations. When operated, the M32 and M34 models use an alternator and a capacitor to energize the circuit.

a. *M32 10-Cap Blasting Machine.* This small, lightweight blasting machine (Figure 1-22) produces adequate current to initiate 10 electrical caps connected in series using 500 feet of WD-l cable. To operate the machine, use the following procedure:

(1) Check the machine for proper operation. Release the blasting machine handle by rotating the retaining ring downward while pushing in on the handle. The handle will automatically spring outward from the body of the machine.

(2) Activate 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.

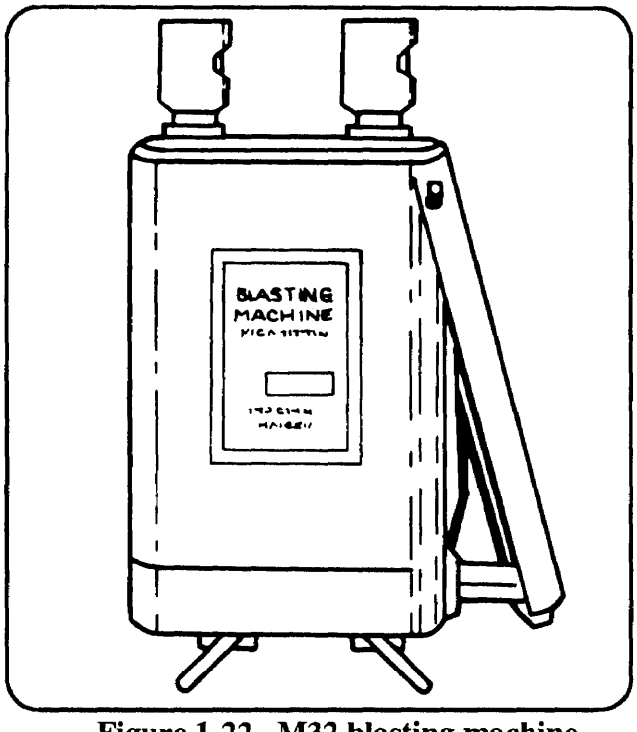


Figure 1-22. M32 blasting machine

(3) Insert the firing wire leads into the terminals by pushing down on each terminal post and inserting the leads into the metal jaws.

(4) Hold the machine upright (terminals up) in either hand, so 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.

(5) Squeeze the handgrip sharply several times until the charge fires. Normally, no more than three or four strokes are required.

b. *M34 50-Cap Blasting Machine.* This small, lightweight machine produces adequate current to initiate 50 electrical caps connected in a series. It looks like the M32 blasting machine (Figure 1-22) except for a black band around the base and a steel-reinforced actuating handle. Test and operate the M34 in the same manner as the M32.

1-29. Firing Wire and Reels.

a. *Types of Firing Wire.* Wire for firing electric charges is available in 200- and 500-foot coils. The two-conductor 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- l/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-l/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.

b. *Reel.* 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 1-23). 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.

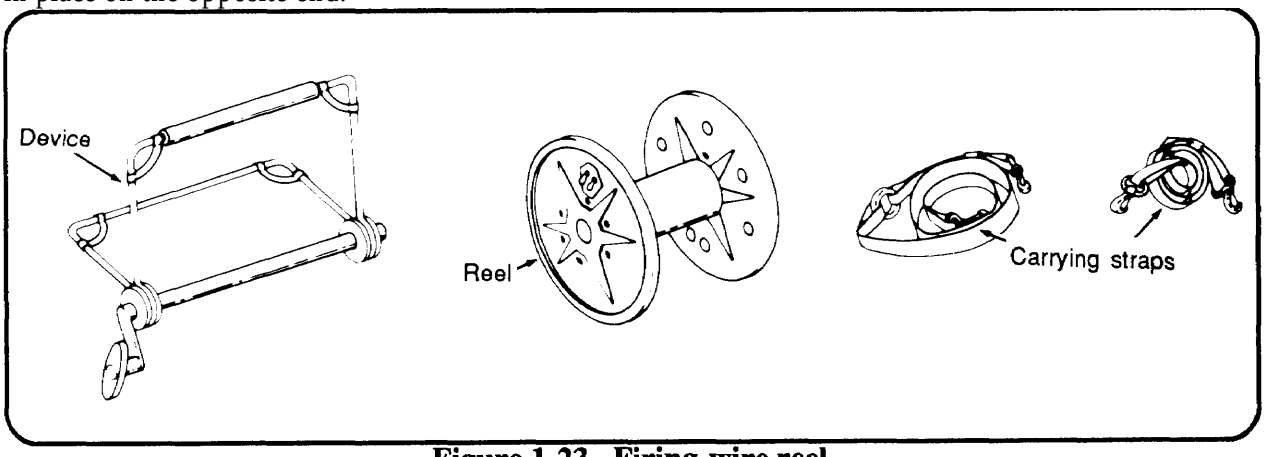


Figure 1-23. Firing-wire reel

1-30. Firing Devices and Other Accessory Equipment

a. *M60 Weatherproof Fuze Igniter.* This device is 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 capon the igniter is tightened (Figure 1-24, page 1-22). Pulling the pull ring releases the striker assembly, allowing the firing pin to initiate the primer, igniting the fuse. Chapter 2 (page 2-4) gives detailed operating instructions for the M60 igniter.

b. *Demolition Equipment Set.* This set (Electric and Nonelectric Explosive Initiating Demolition Equipment Set) is an assembly of tools necessary for performing demolition operations (Table 1-4, page 1-22).

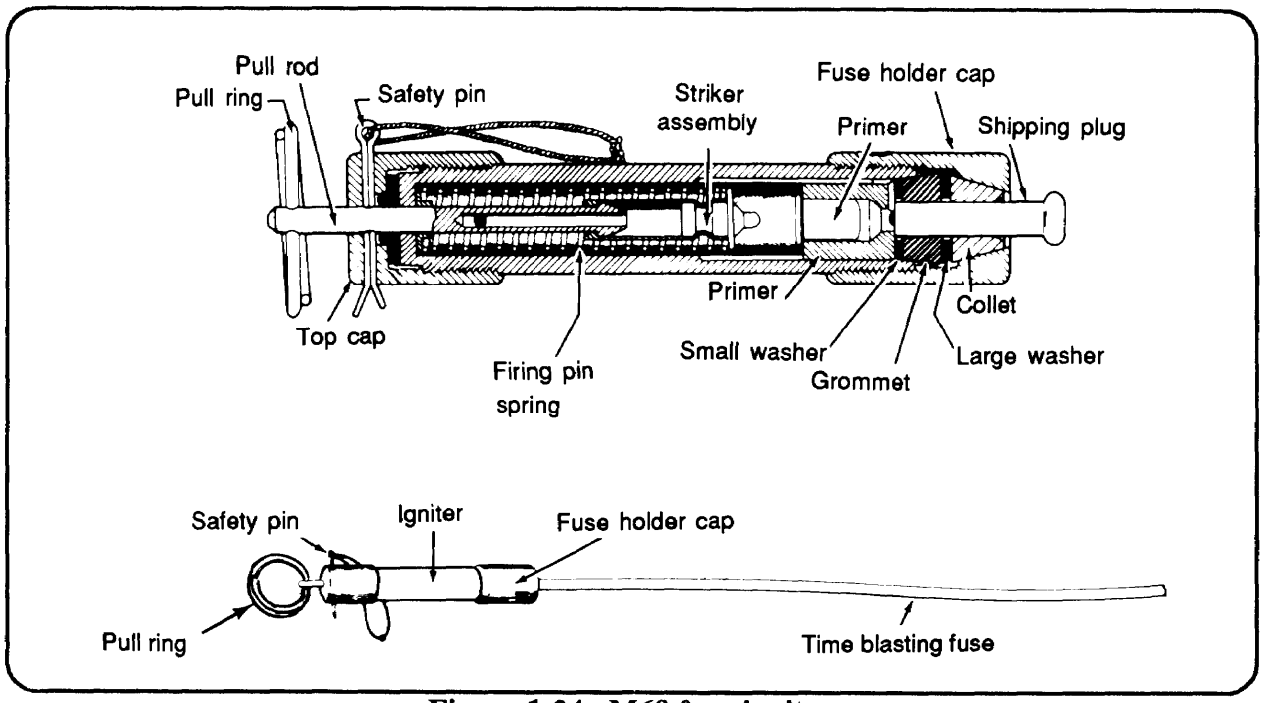


Figure 1-24. M60 fuze igniter

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, w/ Side Cutter, 8-Inch
1	Chest, Demo, Engr Plt, M1931	1	Pliers, Diagonal-Cutting, 6-Inch
4	Crimper, Blasting Cap, M2	4	Reel, Cable
2	Knife, Pocket, w/ Can Opener and Punch	1	Machine, Cable-Reeling, Manual
2	Knife, Pocket, w/ Screwdriver and Wire Scraper	1	Set, Blasting-Cap Test, M51
1	Shears, Metal-Cutting, Manual, 8-Inch	**NOTE:** The individual items listed in this set are available separately.	
2	Tape, Measuring, Steel, Millimeters and Inches		
1	Tape, Measuring, Plastic-Coated, 100-Foot		

Chapter 2
Initiating Sets, Priming, and Firing Systems

Section I. Initiating Sets

WARNING
Refer to the safety procedures in Chapter 6 before undertaking any demolitions mission.

2-1. Nonelectric Initiation Sets.

a. *Components Assembly.* 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), the 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). When combined with detonating cord, a single initiation set can fire multiple charges.

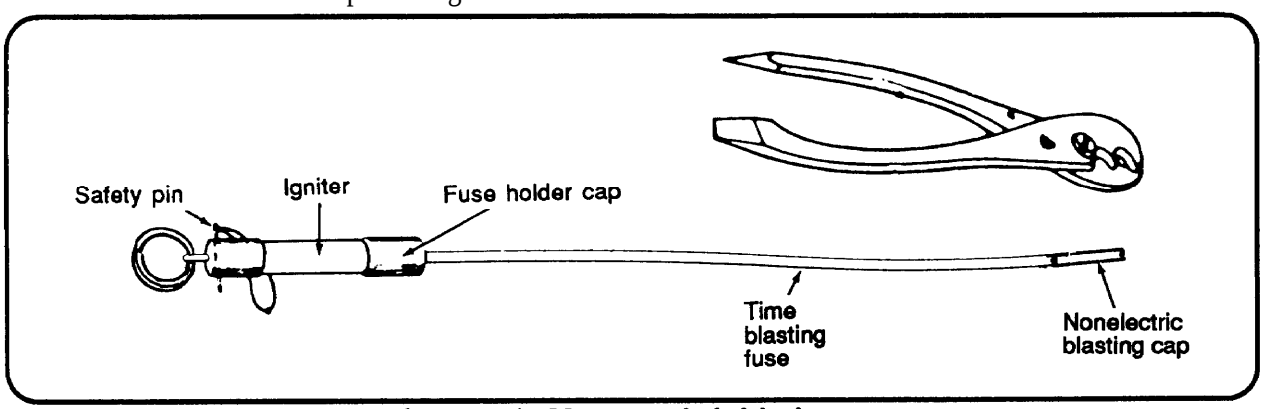


Figure 2-1. Nonelectric initiation set

b. *Preparation Sequence.* Preparing demolitions for nonelectric initiation follows a specified process. This process includes—

- Step 1. Checking the time fuse.
- Step 2. Preparing the time fuse.
- Step 3. Attaching the fuse igniter.
- Step 4. Installing the primer adapter.
- Step 5. Placing the blasting cap.

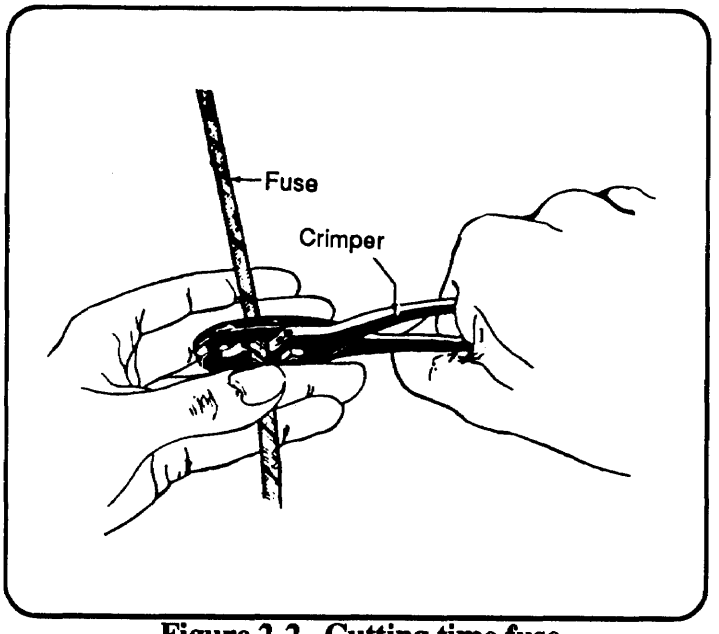


Figure 2-2. Cutting time fuse

(1) Checking Time Fuse. Test every coil of fuse, or remnant of a coil, using the burning-rate test prior to 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 free end of the fuse (Figure 2-2). Cut off and use 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 bum time in seconds by the length in feet. If the test bum does not fall within ± 5 seconds of a 40-second-per-foot burn rate, perform another test to verify your results.

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

(2) Preparing 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 prior to cutting the fuse to length. The formula for determining the length of time fuse required is—

$$\frac{\textit{Time Required (min)} \times 60 \textit{ (sec/min)}}{\textit{Burning Rate (sec/ft)}} = \textit{Fuse Length (ft)} \qquad \textbf{(2-1)}$$

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.

(3) Attaching Fuze Igniter. To attach an M60 weatherproof fuze 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 1-24, page 1-22). Rotate and remove the plug 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.

(4) Installing 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 the adapter threads are pointing to the end of the time fuse that will receive the blasting cap.

(5) Preparing Blasting Caps.

(a) Inspection. 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.
- If the foreign matter does not dislodge, do not use the cap.

(b) Placing and crimping. Use this procedure for installing blasting caps onto fuse. Using this procedure will allow accurate crimping, even in darkness, because finger placement guides the crimpers to the open end of the blasting cap. Use the following procedures to attach a nonelectric blasting cap onto time fuse:

- 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.

WARNING

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 or any other method. 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 knife to cut the fuse. When using a knife to cut fuse squarely, cut the fuse against a solid, nonsparking surface such as wood.

- While applying slight pressure with the forefinger on the closed end of the cap, grasp the fuse with the thumb and ring finger.
- Using the opposite hand, grasp the crimpers. Place the crimping jaws around the cap at a point 1/8 to ¼ 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, page 2-4).

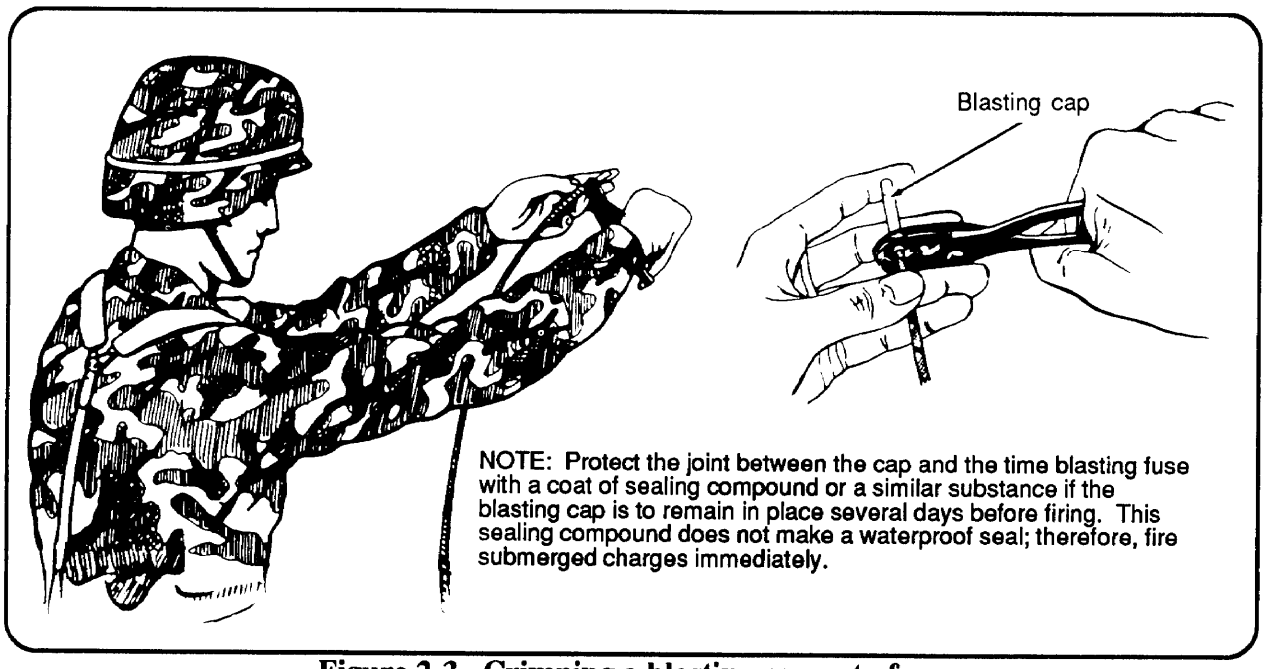


Figure 2-3. Crimping a blasting cap onto fuse

- 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 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. Ensure that the fuse and cap are properly joined by gently trying to pull them apart

NOTE: Attach the M60 fuze 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
Do not crimp too close to the explosive end of the blasting cap; doing this may cause the cap to detonate.
Point the cap out and away from the body during crimping.

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. This sealing compound will not make a waterproof seal; therefore, fire submerged charges immediately.

NOTE: See paragraph 6-8 (page 6-8) for procedures on handling nonelectric misfires.

c. *Fuse Initiation.* 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 and right, and attempt to fire as before.

WARNING
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 fuze 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.

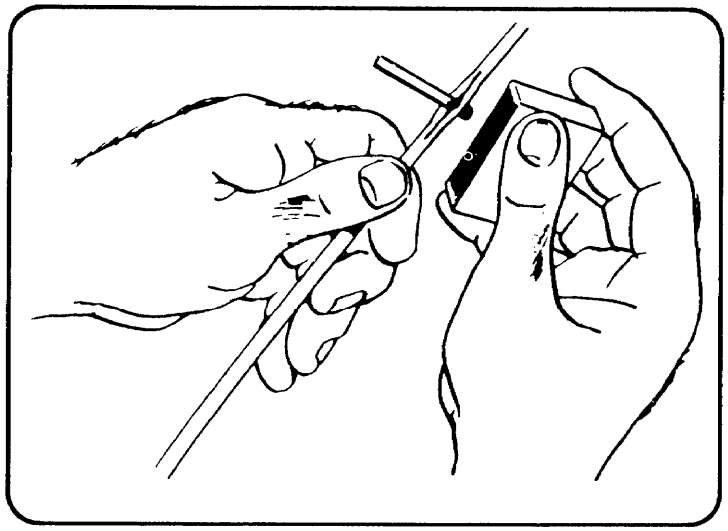


Figure 2-4. Lighting time fuse with a match

2-2. Electric Initiation Sets.

a. *Preparation Sequence.* Use the process below to make an electric initiation set. This process includes—

- Testing and maintaining control of the blasting machine.
- Testing the M51 blasting-cap test set.
- Testing the firing wire on the reel, shunted and unshunted.
- Laying out the firing wire completely off the reel.
- Retesting the firing wire, shunted and unshunted.
- Testing the blasting caps.
- Connecting the series circuit.
- Connecting the firing wire.
- Testing the entire circuit.
- Priming the charges.

b. *Components Assembly.* 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 2-5). An electric impulse (usually provided by a blasting machine) travels through the firing wires 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 Chapter 6 (page 6-5) at all times. When combined with detonating cord, a single initiation set can fire multiple charges. TM 9-1375-213-34 provides detailed information about electric blasting equipment.

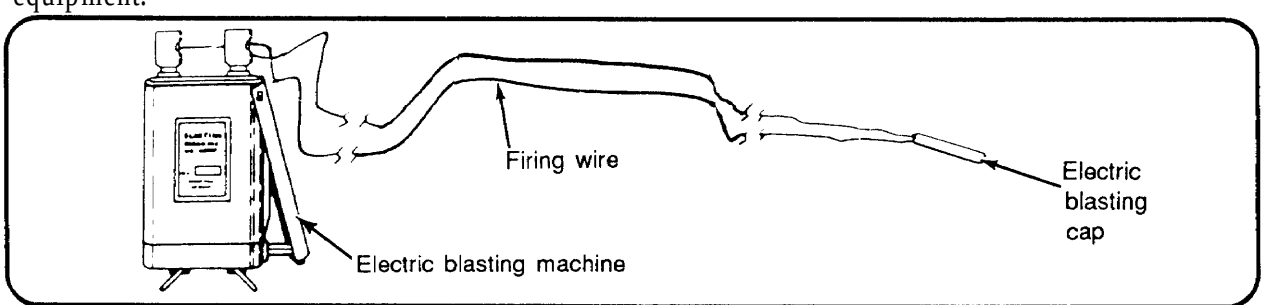


Figure 2-5. Electric initiation set

Always follow the procedure below when preparing an electric initiation set:

(1) Testing and Maintaining Control of Blasting Machine.

(a) Test the blasting machine to ensure it is operating properly (paragraph 1-28, page 1-20).

(b) Control access to all blasting machines. The supervisor is responsible for controlling all blasting machines.

(2) Testing M51 Blasting-Cap Test Set.

(a) Check the M51 test set to ensure it is operating properly (paragraph 1-27, page 1-19).

(b) Perform both the open- and short-circuit tests.

(3) Testing Firing Wire on the Reel.

(a) Separate the firing wire leads at both ends and connect the leads at one end to the posts of the MS 1 test set. Squeeze-tie 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 2-6).

(b) Shunt the wires atone 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 2-6).

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

(c) Shunt both ends of the firing wire after testing.

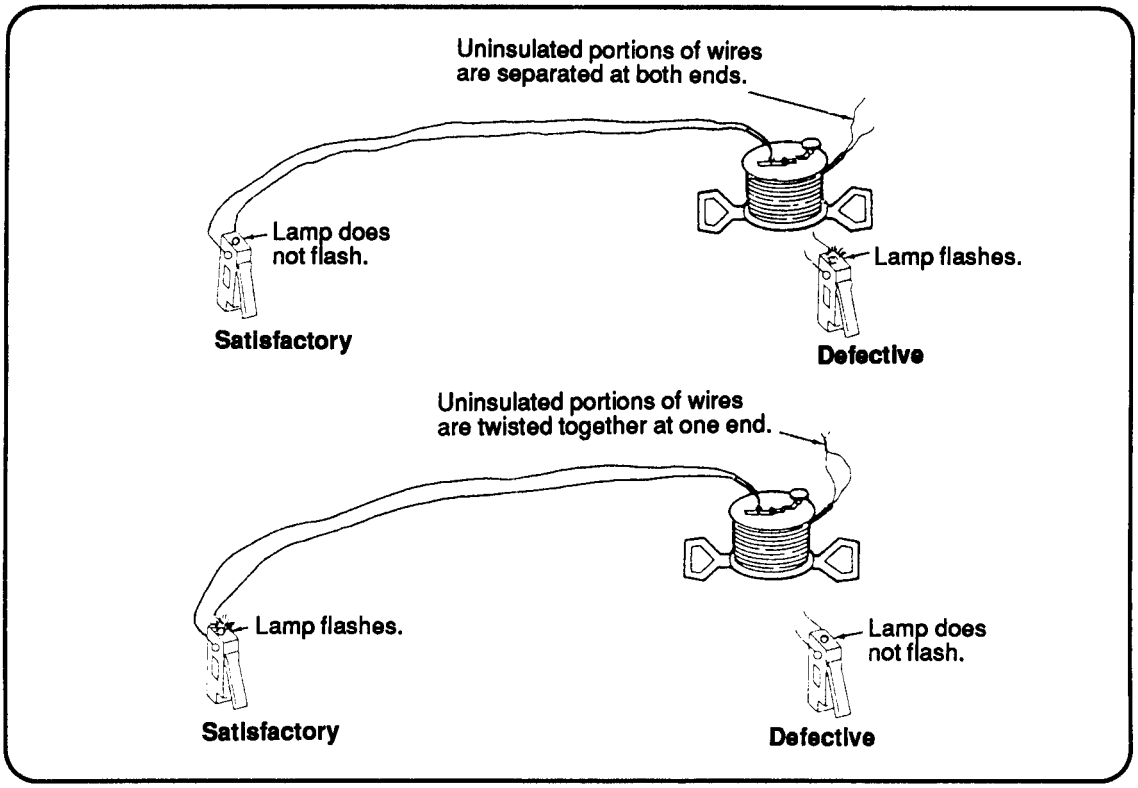


Figure 2-6. Testing firing wire on the reel

(4) Laying Out Firing Wire.

(a) After locating a firing position a safe distance away from the charges (paragraph 6-7, page 6-6), lay out the firing wire between the charges and the firing position. More than one reel of wire may be necessary.

(b) Do not allow vehicles to drive over or personnel to walk on firing wire. Always bury firing wire or lay it flat on the ground.

(c) 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.

(5) Retesting Firing Wire.

(a) Peform the open- and short-circuit tests again. The process of unreeling the wire may have separated broken wires not found when the wire was tested on the reel.

(b) Continually guard the firing position from this point on. Do this to ensure that no one tampers with the wires or fires the charges prematurely.

(c) 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 man 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.

(d) Shunt both ends of the firing wire after the tests are complete.

(6) Testing Electric Blasting Cap.

(a) Remove the cap from its spool. Place the cap in the palm of your hand, lead wires passing between your thumb and index finger.

(b) 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.

(c) 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 offends of the cardboard spool, since this will cause excessive twists and kinks in the wires and prevent the wires from separating properly.

(d) Place the blasting cap under a sandbag or helmet while extending the wires to their full length.

(e) Test blasting caps away from all other personnel. Keep your back to the blasting cap when testing it.

(f) Remove the short-circuit shunt from the lead wires.

(g) 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.

(h) Always keep the cap wires shunted when not testing them.

(7) Connecting a Series Circuit. When two or more blasting caps are required for a demolition operation. you may use one of the series circuits illustrated in Figure 2-7.

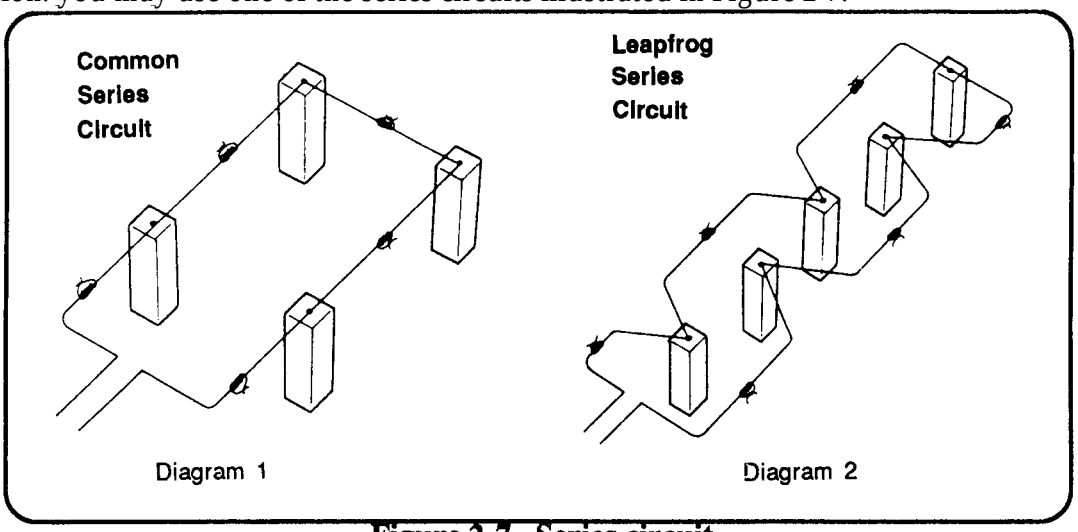


Figure 2-7. Series circuit

Use the following procedure:

(a) Test all blasting caps (paragraph 2-2b(6), page 2-7) separately before connecting them in a circuit.

(b) Join blasting cap wires together using the Western Union pigtail splice (Figure 2-8). 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.

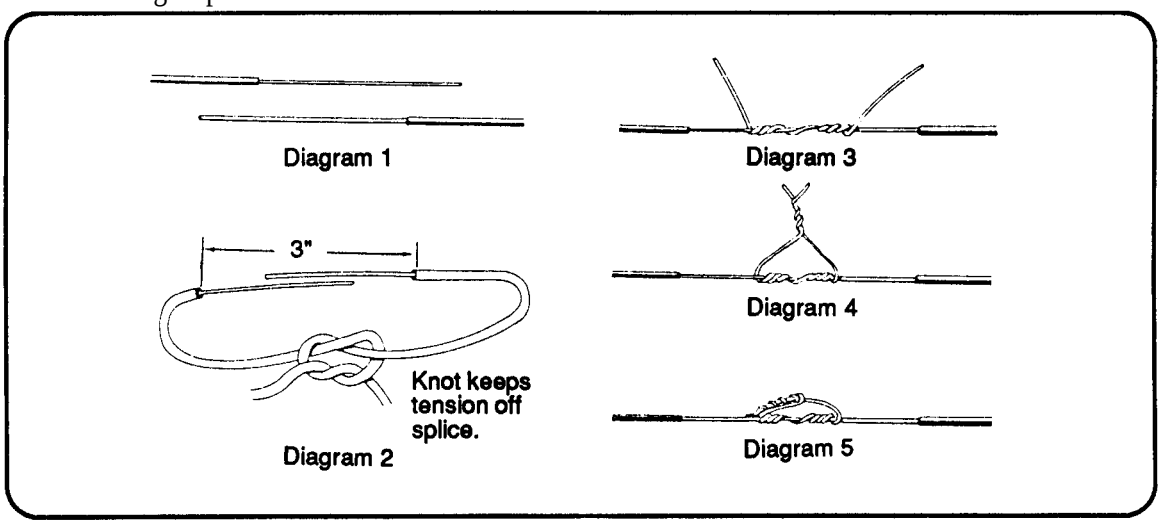


Figure 2-8. Western Union pigtail splice

(c) Test the entire 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 your connections and blasting caps again.

(d) After testing the cap circuit, shunt the two free blasting cap wires until you are ready to connect them to the firing wire.

(8) Connecting the Firing Wire.

(a) 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.

(b) Use a Western Union pigtail splice to connect the firing wire to the blasting cap wires.

(c) 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.

(9) Testing the Entire Firing Circuit. Before priming the charges or connecting blasting caps to ring mains, test the circuit from the firing point. Use the following procedure:

(a) Ensure the blasting caps are under protective sandbags while performing this test.

(b) Connect the ends of the firing wire to the M51 test set. Squeeze the firing handle. The indicator lamp should flash, indicating a proper circuit.

(c) Shunt the ends of the firing wire.

WARNING
Do not prime charges or connect electric blasting caps to detonating cord until all other steps of the preparation sequence have been completed.

(10) Priming the Charges. Prime the charges and return to the firing point. This is the last step prior to actually returning to the firing point and firing the circuit.

WARNING
Prime charges when there is a minimum of personnel on site.

c. *Circuit Initiation.* At this point the initiation set is complete. Do not connect the blasting machine until all personnel are accounted for and the charge is ready to fire. When all personnel are clear, install the blasting machine and initiate the demolition. Chapter 6 (page 6-9) covers procedures for electric misfires.

d. *Splicing Electric Wires.*

(1) Preparation. Strip the insulating material from the end of insulated wires before splicing. Remove approximately 1 ½ inches of insulation from the end of each wire (Figure 2-8, diagram 1). 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.

(2) Method. Use the Western Union pigtail splice (Figure 2-8, page 2-8) 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:

(a) 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 2-8, diagram 2, page 2-8).

(b) Make three wraps with each wire (Figure 2-8, diagram 3, page 2-8).

(c) Twist the ends together with three turns (Figure 2-8, diagram 4, page 2-8).

(d) Flatten the splice, but not so far that the wire crimps itself and breaks (Figure 2-8, diagram 5, page 2-8).

(3) Precautions. A short circuit may occur at a splice if you do not practice some 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 other electric insulating tape. Always insulate splices.

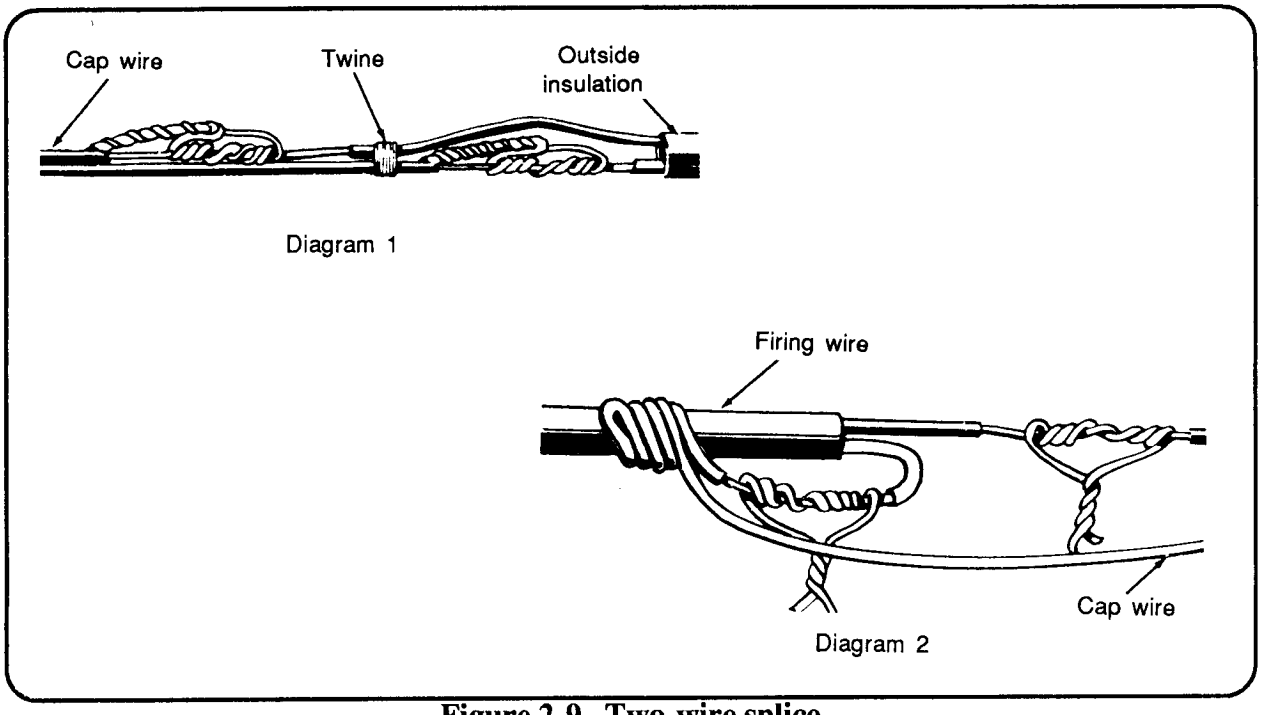


Figure 2-9. Two-wire splice

e. *Series Circuits.*

(1) Common. Use this circuit to connect two or more electric blasting caps to a single blasting machine (Figure 2-7, diagram 1, page 2-8). Prepare a common series circuit by connecting one blasting cap to another until only two end wires are free. Shunt the two end wires until you are ready to proceed with the next step. Connect the free ends of the cap 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 lead wires.

(2) Leapfrog. The leapfrog method of connecting caps in a series is useful for firing any long line of charges (Figure 2-7, diagram 2, 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. Appendix E has additional information on series circuits. There is seldom a need for this type of circuit, since detonating cord, when combined with a single blasting cap, will fire multiple charges.

Section II. Priming Systems

2-3. Methods. 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 prefered 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 1 (safe) when in place on a reserved demolition.

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.

2-4. Priming TNT Demolition Blocks.

a. *Nonelectric.* 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:

(1) Wrap a string tightly around the block of TNT and tie it securely, leaving approximately 6 inches of loose string on each end (Figure 2-11).

(2) Insert a blasting cap with the fuse attached into the cap well.

(3) Tie the loose ends of the string around the fuse to prevent the blasting cap from being separated from the block. Adhesive tape can also effectively secure blasting caps in charges.

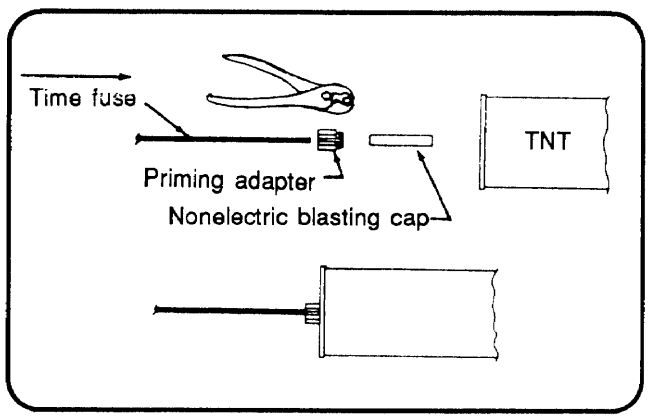


Figure 2-10. Nonelectric priming with adapter

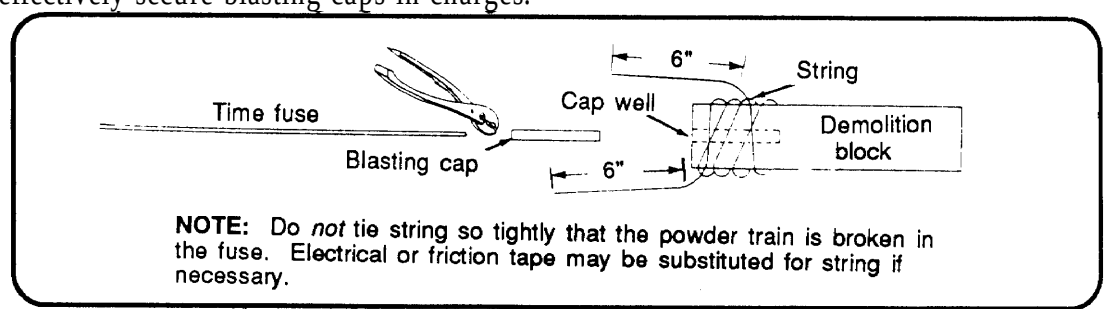


Figure 2-11. Nonelectric priming without adapter

b. *Electric.*

(1) With Priming Adapter. Use the following procedure for priming TNT block, using the priming adapter:

(a) Prepare the electric initiation set before priming.

(b) Pass the lead wires through the slot of the adapter, and pull the cap into place in the adapter (Figure 2-12). Ensure the blasting cap protrudes from the threaded end of the adapter.

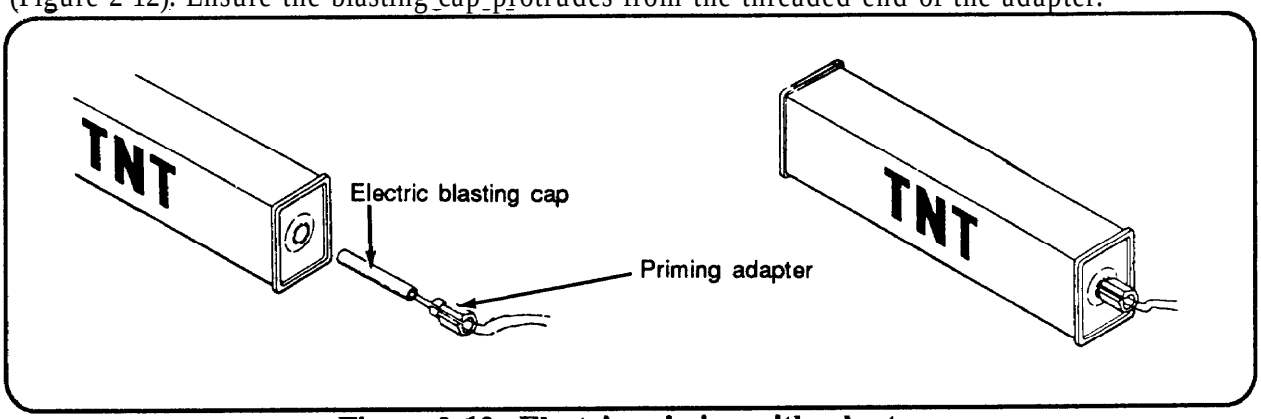


Figure 2-12. Electric priming with adapter

(c) Insert the blasting cap into the threaded cap well of the TNT block and screw the adapter into place.

(2) Without Priming Adapter. If a priming adapter is not available, use the following procedure:

(a) Prepare the electric initiation set before priming.

(b) 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). Allow some slack in the wires between the blasting cap and the tie to prevent any tension on the blasting-cap lead wires.

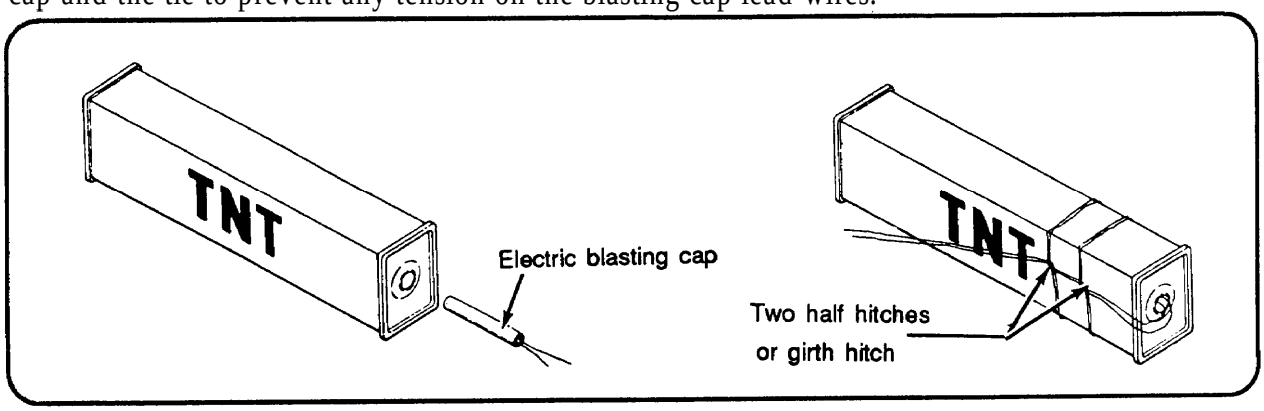


Figure 2-13. Electric priming without adapter

c. *Detonating Cord.* Use the following methods to prime TNT blocks with detonating cord:

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.

(1) Method 1 (Figure 2-14). Lay one end (l-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. Doing this forms a clove hitch with two extra turns.

(2) Method 2 (Figure 2-14). Tie the detonating cord around the explosive block with a clove hitch and two extra turns. Fit the cord snugly against the block, and push the loops close together.

(3) Method 3 (Figure 2-14). Place a loop of detonating cordon 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.

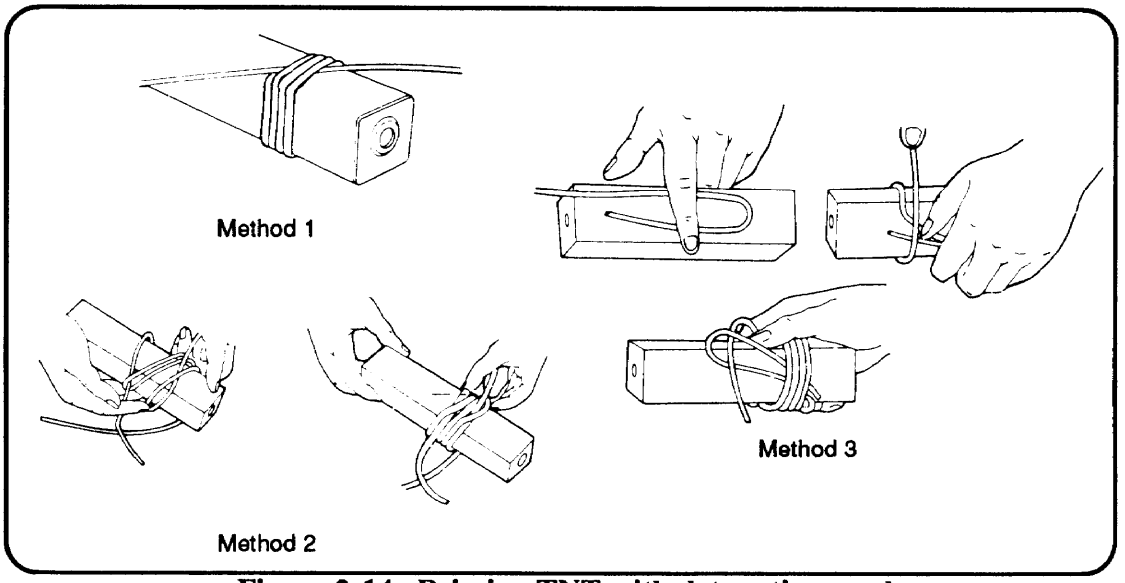


Figure 2-14. Priming TNT with detonating cord

2-5. Priming M112 (C4) Demolition Blocks.

a. *Nonelectric and Electric.* C4 blocks do not have a cap well; therefore, you will have to make one. Use the following procedure:

(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.

(2) Insert the blasting cap into the hole or cut. If the blasting cap does not fit the hole or cut, do not force the cap, make the hole larger.

(3) Anchor the blasting cap in the block by gently squeezing the lastic explosive around the blasting cap.

b. *Detonating Cord.* To prime plastic explosive with detonating cord, use the following procedure:

(1) Form either a Uli knot, double overhand knot, or triple roll hot as shown in Figure 2-15.

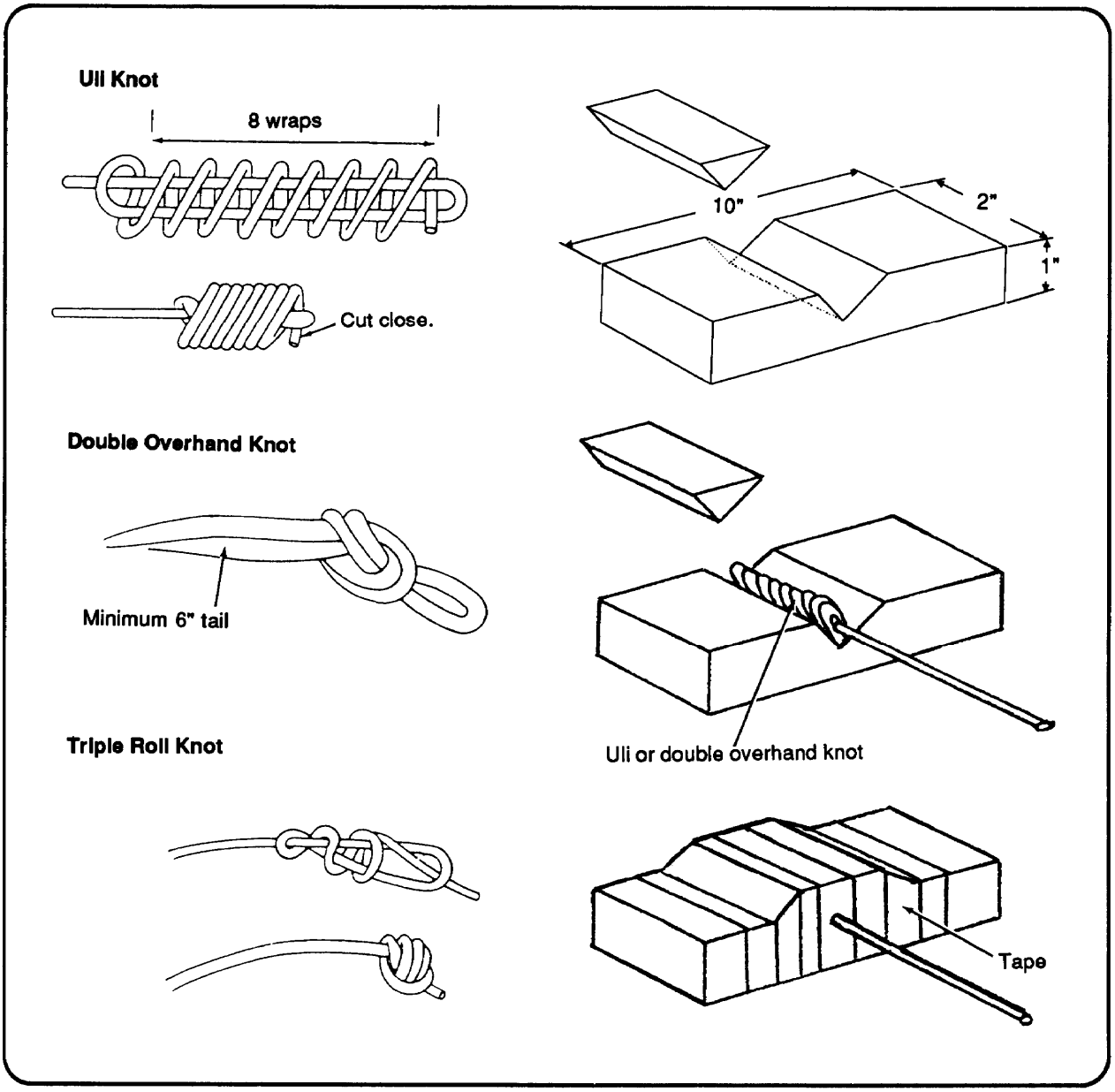


Figure 2-15. Priming plastic explosives with detonating cord

(2) Cut a notch out of the explosive, large enough to insert the knot you formed.

WARNING
Use a sharp knife on a nonsparking surface to cut explosives.

(3) Place the knot in the cut.

(4) Use the explosive you removed from the notch to cover the knot. Ensure there is at least ½ inch of explosive on all sides of the knot.

(5) Strengthen the primed area by wrapping it with tape.

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

2-6. Priming M118 and M186 Demolition Charges.

a. *Nonelectric and Electric.* Use one of the following methods to prime M118 and M186 demolition charges:

(1) Method 1 (Figure 2-16, page 2- 16). 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.

(2) Method 2 (Figure 2-16, page 2-16). Cut a notch in the sheet explosive (approximately 1½ inches long and ¼ inch wide). Insert the blasting cap to the limit of the notch. Secure the blasting cap with a strip of sheet explosive.

(3) Method 3 (Figure 2-16, page 2-16). Place 1½ inches of the blasting capon top of the sheet explosive and secure it with a strip of sheet explosive (at least 3 by 3 inches).

(4) Method 4 (Figure 2-16, page 2- 16). Insert the end of the blasting cap 1½ inches between two sheets of explosive.

b. *Detonating Cord.* 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 ½ inch of explosive.

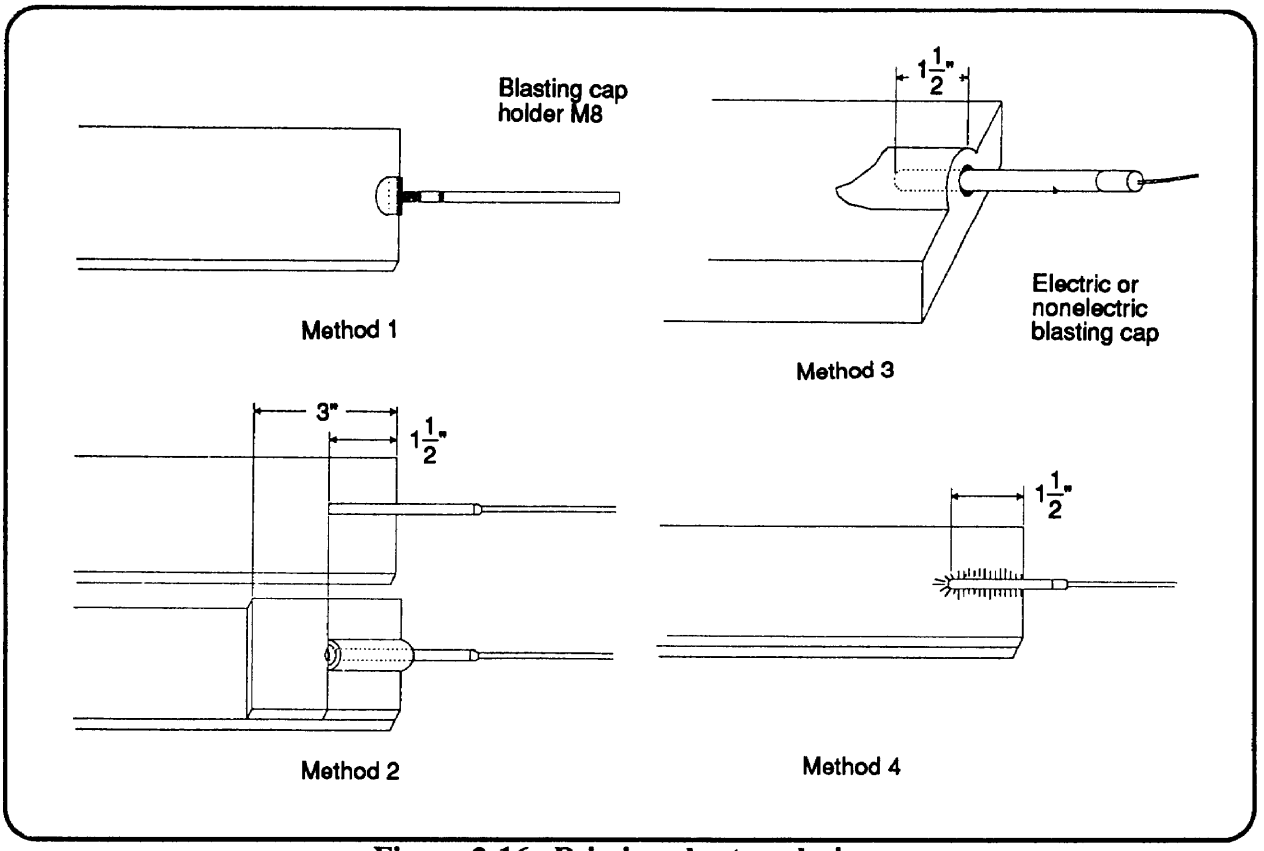


Figure 2-16. Priming sheet explosives

2-7. Priming Dynamite. Prime dynamite at either end or side. Choose the method that will prevent damage to the primer during placement.

a. *Nonelectric.* There are three methods for priming dynamite nonelectrically:

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

(a) Using the M2 crimpers, make a cap well in the end of the dynamite cartridge.

(b) Insert a fused blasting cap into the cap well.

(c) Tie the cap and fuse securely in the cartridge with a string.

(2) Weatherproof, End-Priming Method (Figure 2-17).

(a) Unfold the wrapping at the folded end of the dynamite cartridge.

(b) Using the M2 crimpers, make a cap well in the exposed dynamite.

(c) Insert a fused blasting cap into the cap well.

(d) Close the wrapping around the fuse and fasten the wrapping securely with a string or tape.

(e) Apply a weatherproof sealing compound to the tie.

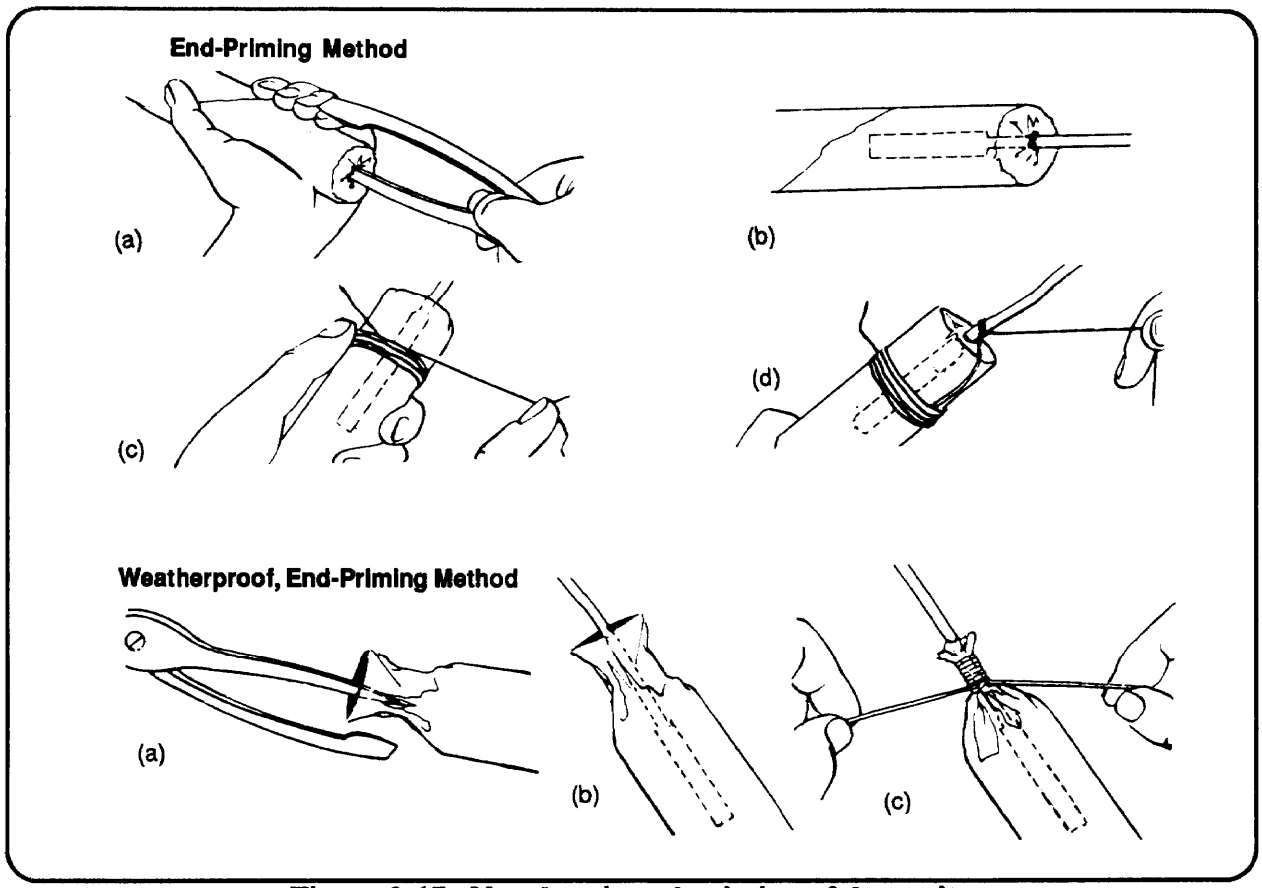


Figure 2-17. Nonelectric end priming of dynamite

(3) Side-Priming Method (Figure 2-18, page 2-18).

(a) Using the M2 crimpers, make a cap well (approximately 1½ inches long) into the side of the cartridge at one end. 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.

(b) Insert a fused blasting cap into the cap well.

(c) Tie a string securely around the fuse. Then, wrap the string tightly around the cartridge, making two or three turns before tying it.

(d) Weatherproof the primed cartridge by wrapping a string closely around the cartrdge, extending it an inch or so on each side of the hole to cover it completely. Cover the string with a weatherproof sealing compound.

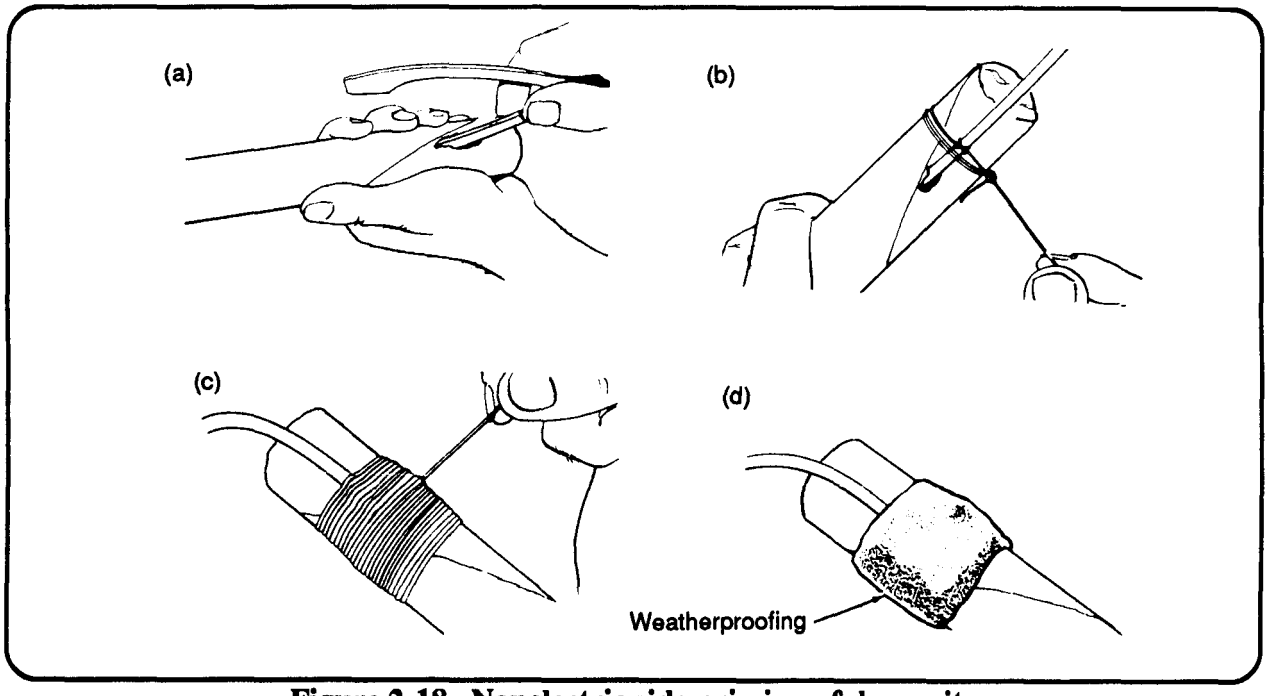


Figure 2-18. Nonelectric side priming of dynamite

b. *Electric.* Use the following method for priming with electric blasting caps:

(1) End-Priming Method (Figure 2-19).

(a) Using the M2 crimpers, make a cap well in the end of the cartridge.

(b) Using the M2 crimpers, insert an electric blasting cap into the cap well.

(c) Tie the lead wires around the cartridge with two half hitches, a string, or tape.

(2) Side-Riming Method (Figure 2-19).

(a) Using the M2 crimpers, make a cap well (approximately 1½ inches long) into the side of the cartridge at one end. 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.

(b) Using the M2 crimpers, insert an electric blasting cap into the cap well.

(c) Tie the lead wire around the cartridge with two half hitches, a string, or tape.

c. *Detonating Cord.* You also can use detonating cord to prime dynamite. Using the M2 crimpers, start approximately 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 degrees after punching each hole to keep the holes parallel. Lace detonating cord through the holes in the same direction the holes were punched. 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.

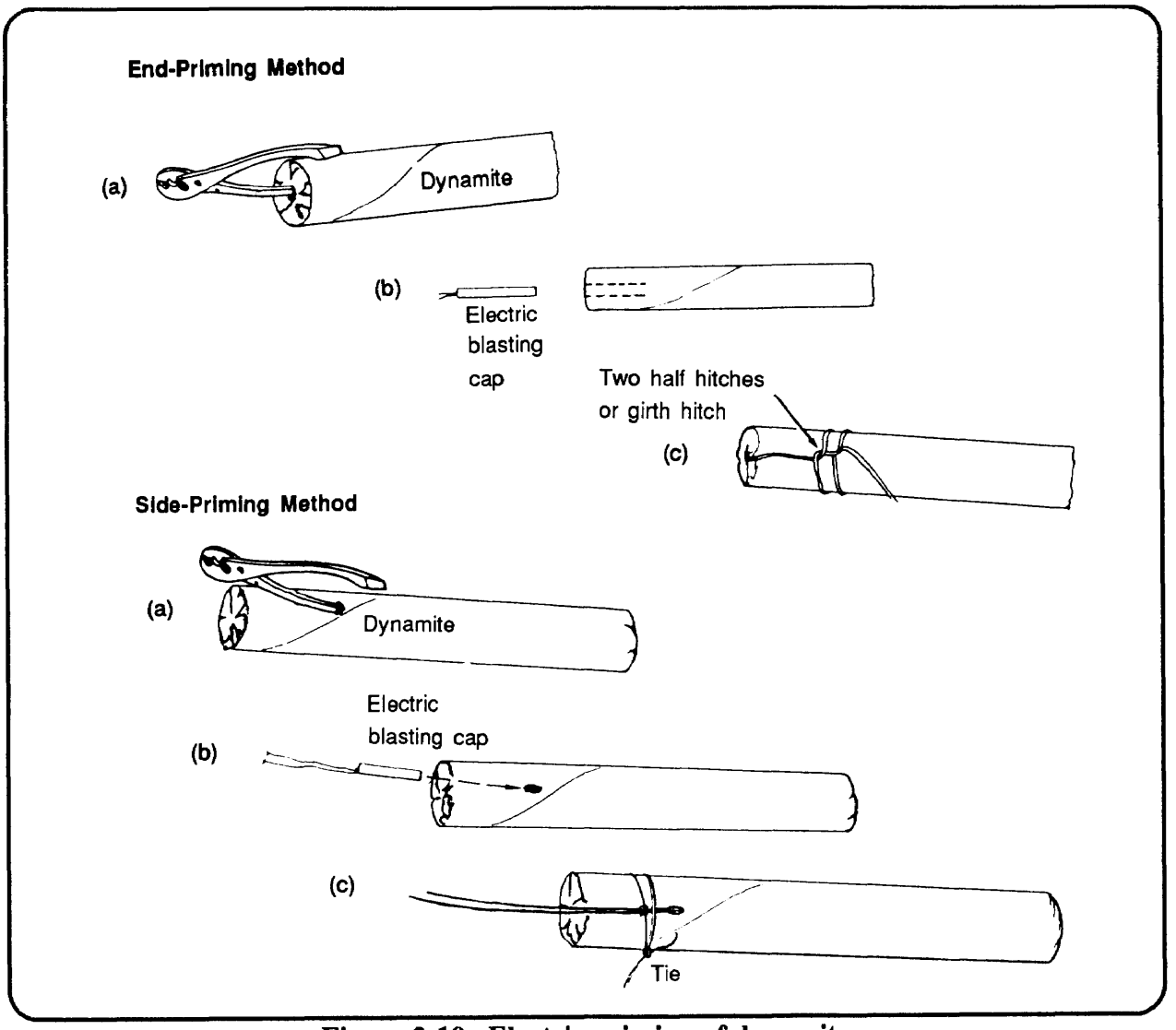


Figure 2-19. Electric priming of dynamite

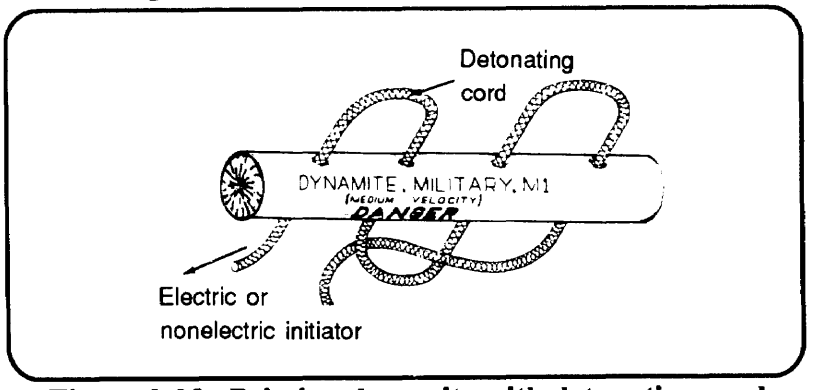


Figure 2-20. Priming dynamite with detonating cord

2-8. Priming 40-Pound, Ammonium-Nitrate Cratering Charges. Because the cratering charge is primarily an underground charge, prime it only with detonating cord. Use dual priming to protect against misfires (Figure 2-21, diagram 2, page 2-20). Use the following procedure:

a. Tie an overhand knot, with a 6-inch overhang, at one end of the length of detonating cord.

b. Pass the opposite end of the detonating cord up through the detonating cord tunnel (Figure 2-21, diagram 1) of the cratering charge.

WARNING
Ammonium nitrate is hydroscopic. When wet, ammonium nitrate is ineffective. Therefore, inspect the metal container for damage or rust. Do not use damaged or rusty charges.

c. When dual priming a single 40-pound cratering charge, use a minimum of one pound of explosive. Prime a block of TNT or package of C4 with detonating cord (paragraphs 2-4c, page 2-13, and 2-5b, page 2-14, respectively) and tape this charge to the center of the cratering charge (Figure 2-21, diagram 2). The detonating cord branch lines must be long enough to reach the detonating-cord ring mains after the cratering charge is in the ground. Twelve-foot branch lines should be adequate. When placing two cratering charges in the same borehole, prime only the detonating cord tunnels of each charge. In this manner, the borehole is dual-primed and extra explosives are not required, as shown in Figure 2-21, diagram 3.

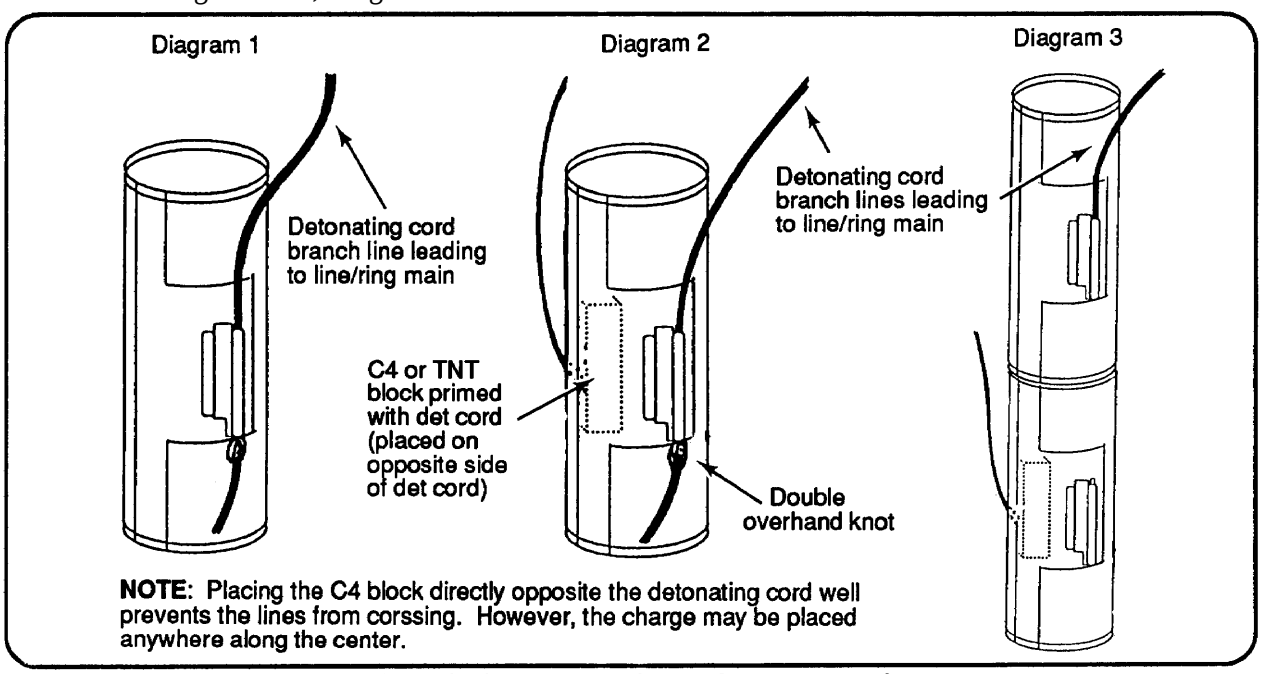


Figure 2-21. Priming ammonium-nitrate cratering charge

2-9. Priming M2A4 and M3A1 Shaped Charges. 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. Use the following procedure for priming shaped charges:

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

a. Crimp a nonelectric blasting cap to a branch line.

b. Connect the branch line to the ring main.

c. Insert the blasting cap into the blasting cap well of the shaped charge.

d. When detonating multiple shaped charges, make all branch-line connections before priming any shaped charges.

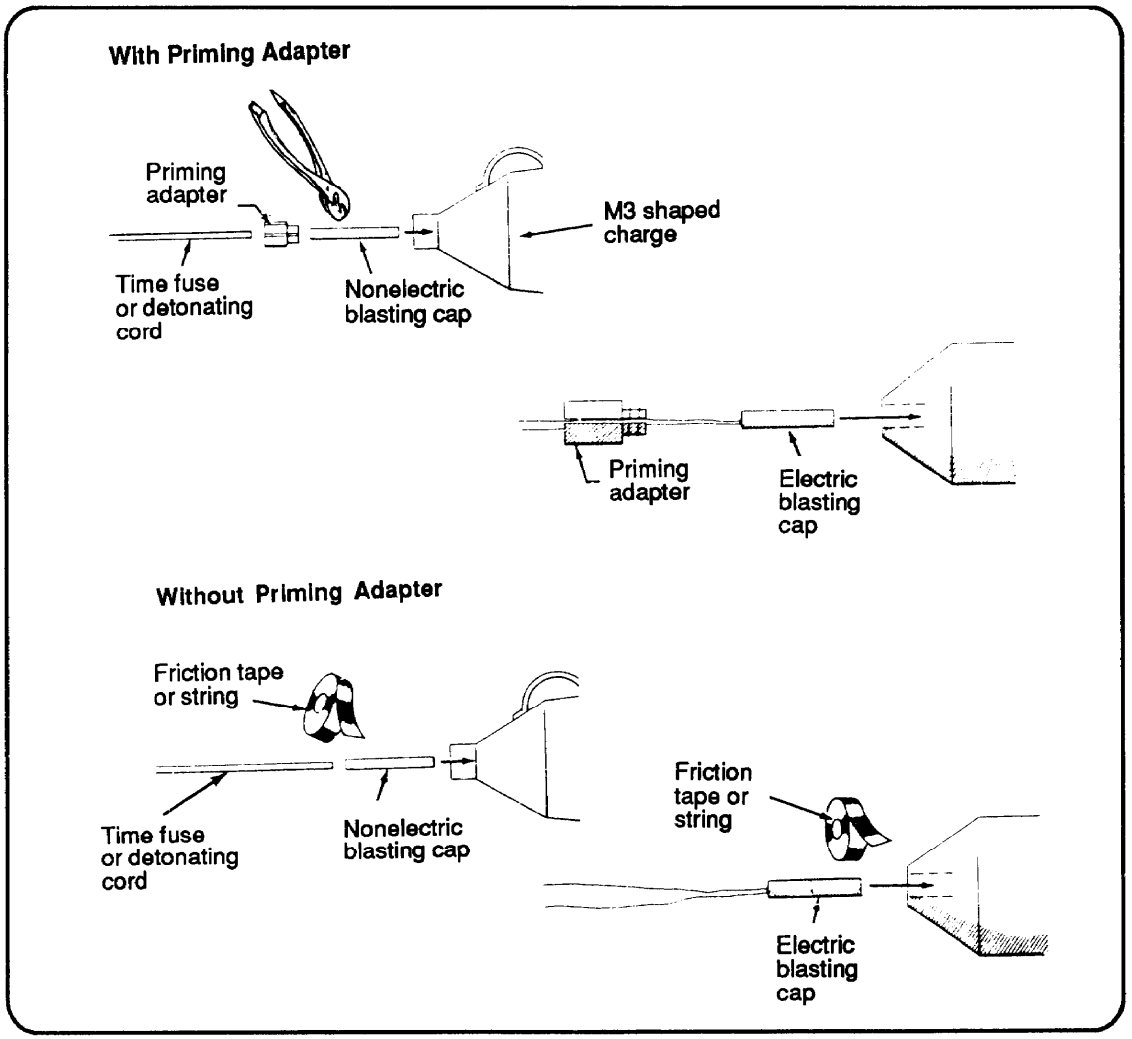


Figure 2-22. Priming shaped charges

2-10. Priming the Bangalore Torpedo.

a. *Nonelectric.* Insert the blasting cap of a nonelectric initiation set directly into the cap well of a torpedo section. If a priming adapter is not available, use tape or string to hold the blasting cap in place (Figure 2-23, diagram 1, page 2-22).

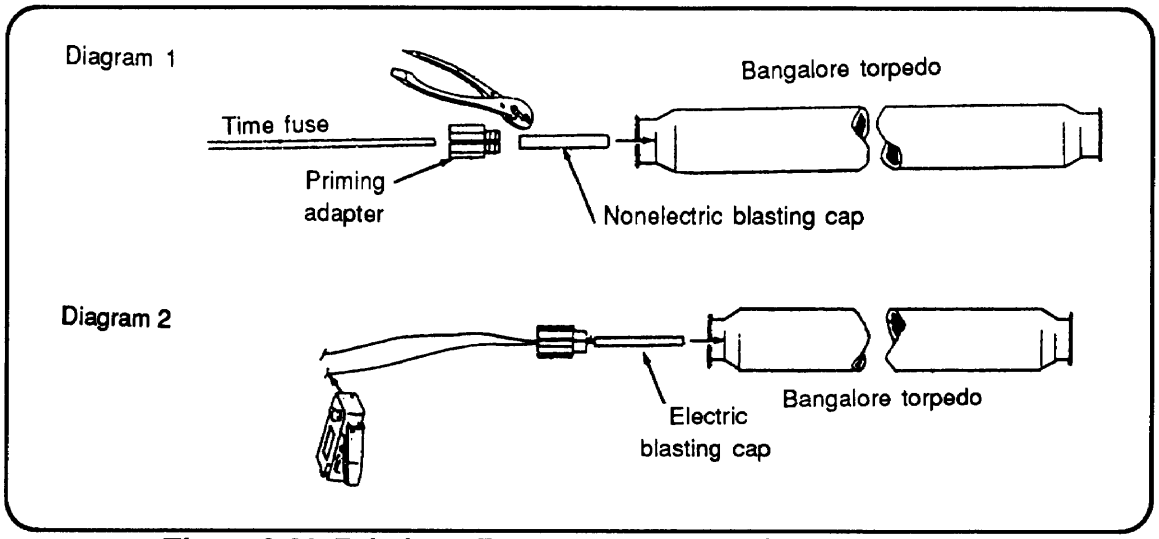


Figure 2-23. Priming a Bangalore torpedo with a blasting cap

b. *Electric.* 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.

c. *Detonating Cord.* Prime the torpedo by wrapping 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. Never use the short end (tail) of the detonating cord to initiate the torpedo. Initiation must come from the running end of the detonating cord.

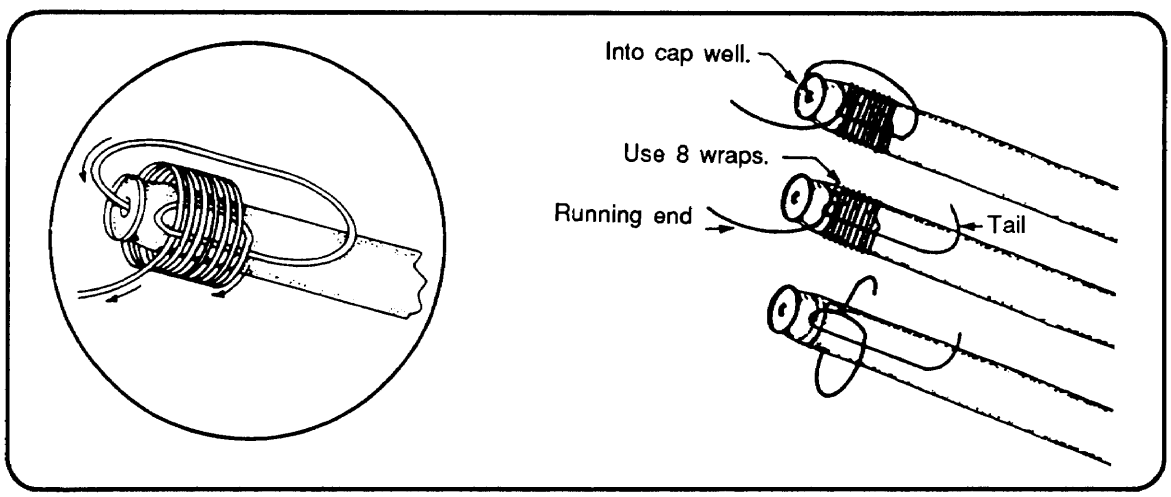


Figure 2-24. Priming a Bangalore torpedo with detonating cord

WARNING

Do not use more than or less than eight wraps to prime the Bangalore 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 crimped, without detonating.

Section III. Firing Systems

2-11. Types of Firing Systems. There are two types of firing systems: single and dual. Chapter 5 covers the tactical applications for these systems.

a. *Single.* Figure 2-25 shows a single-firing system Each charge is singly 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 should a break or cut occur anywhere within the ring main.) The electric, nonelectric, or combination initiation systems are then taped onto the firing system. When using a combination initiation system, the electric initiation system is always the primary means of initiation. When using dual, nonelectric initiation systems, the shorter time fuse is the primary initiation system (Figure 2-26).

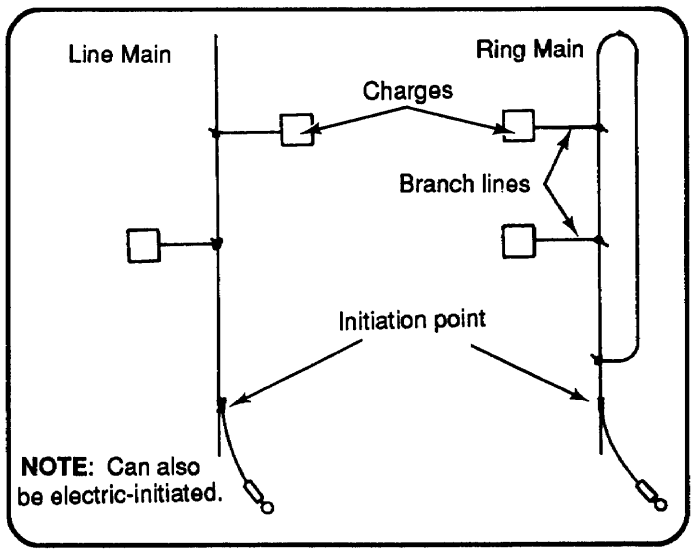


Figure 2-25. Single-firing system (single-initiated, single-fired, single-primed)

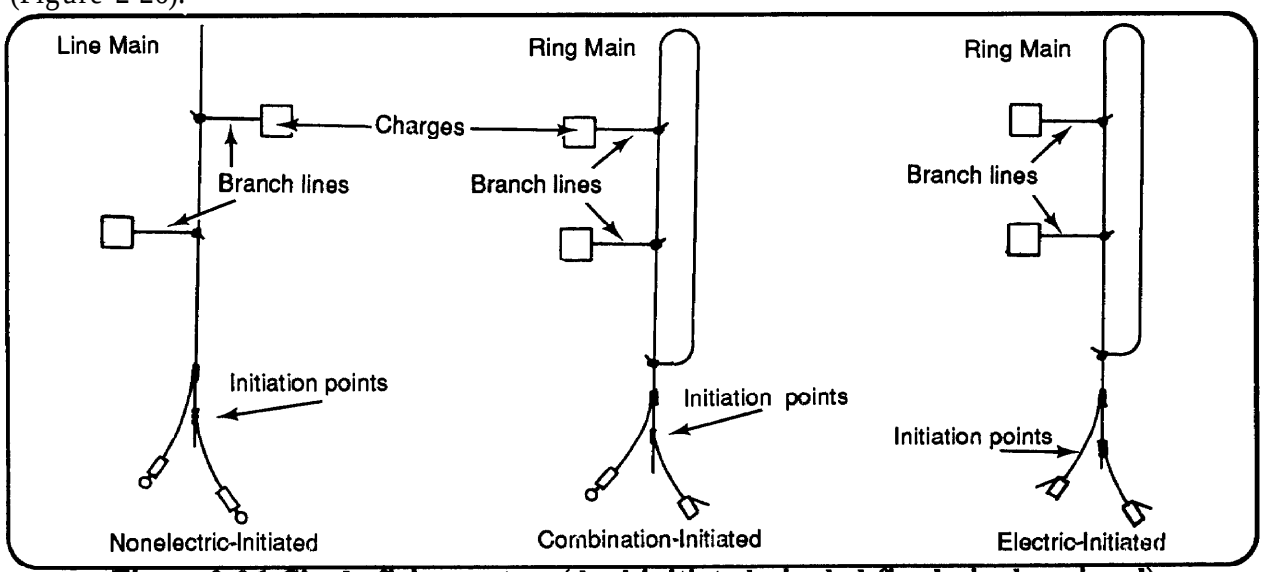


Figure 2-26. Single-firing system (dual-initiated, singled-fired, single-primed)

b. *Dual.* Figure 2-27 (page 2-24) shows a dual-firing system. Each charge is dual-primed with two branch lines (Figure 2-28, page 2-24). 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 systems are taped in—the primary initiation system goes to one firing system, the secondary goes to the other.

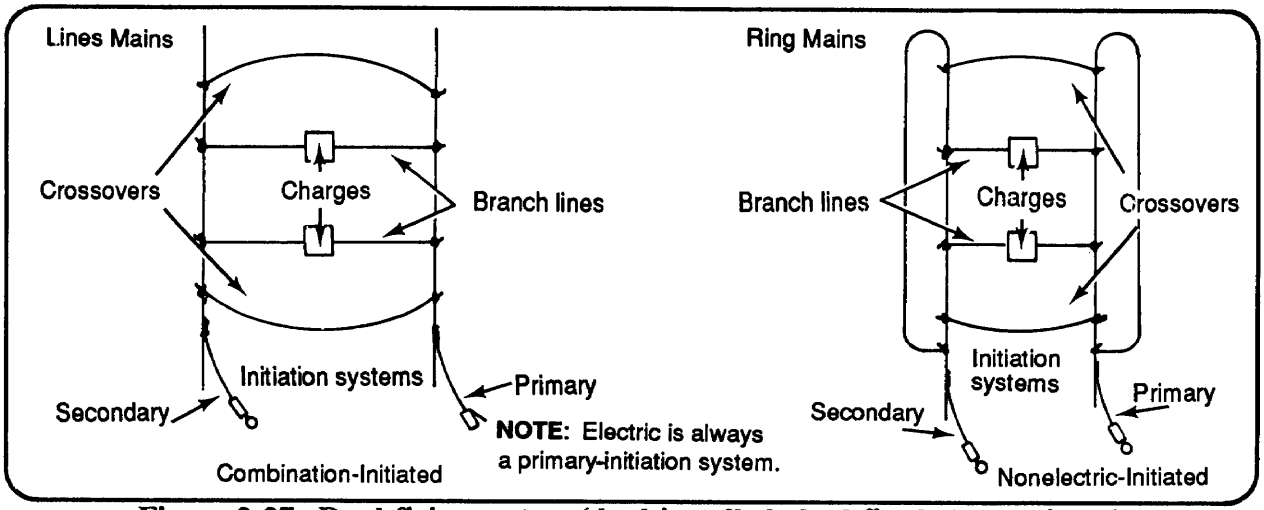


Figure 2-27. Dual-firing system (dual-installed, dual-fired, dual-primed)

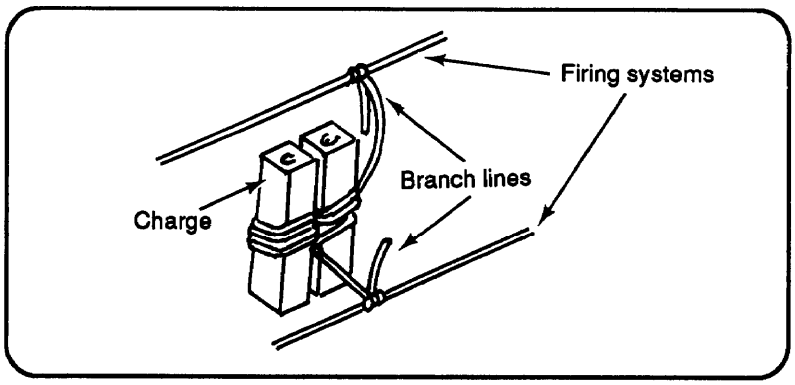


Figure 2-28. Dual-primed charge

Figure 2-29 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.

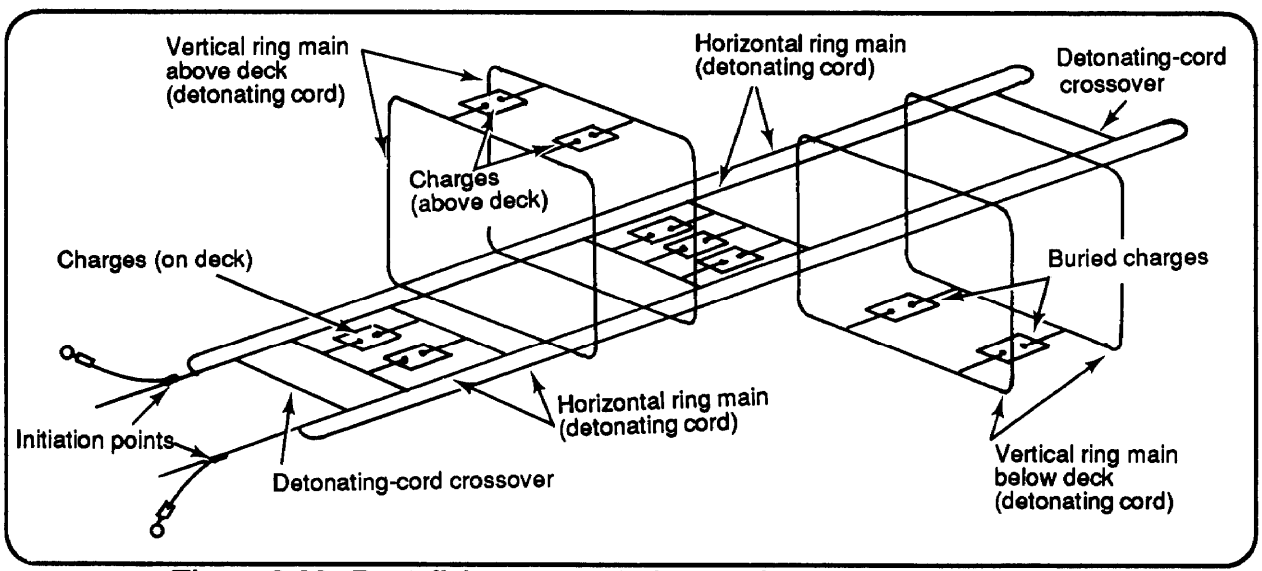


Figure 2-29. Dual-firing system (using a bridge as a possible target)

2-12. Detonating Cord. 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 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 only with nonelectric or electric initiation sets.

2-13. Attaching the Blasting Cap. 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. No more than 1/8 inch of the cap needs to be left exposed for inspection (Figure 2-30).

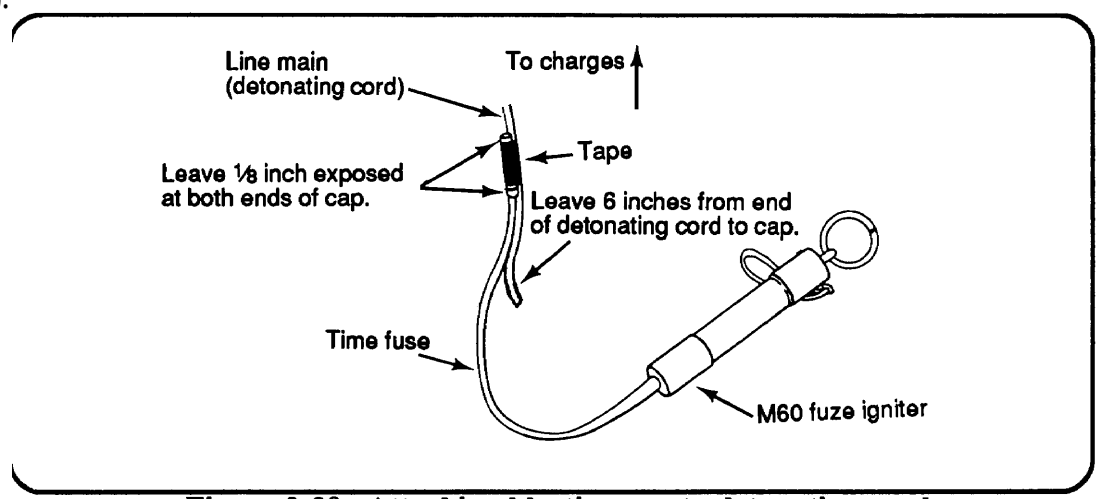


Figure 2-30. Attaching blasting cap to detonating cord

2-14. Detonating-Cord Connections. Use square knots or detonating-cord clips to splice the ends of detonating cord (Figure 2-31). 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 1-21 (page 1-17) describes the process for connecting detonating cord with detonating-cord clips.

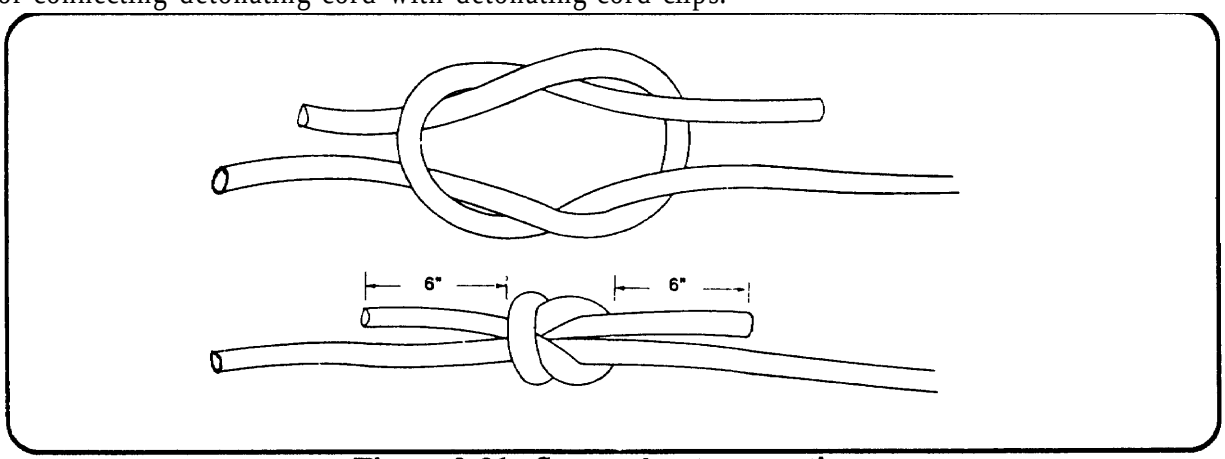


Figure 2-31. Square-knot connections

a. *Branch Line.* A branch line is nothing more than a length of detonating cord. 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. If possible, branch lines should not be longer than 12 feet from the charge to the ring or line main. A longer branch line is too susceptible to damage that may isolate the charge. Fasten a branch line to a main line with a detonating-cord clip (Figure 1-18, page 1-17) or a girth hitch with an extra turn (Figure 2-32). The connections of branch lines and ring or line mains should intersect at right (90-degree) 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 your 6-inch overhang is on at the connection of the ring or line main.

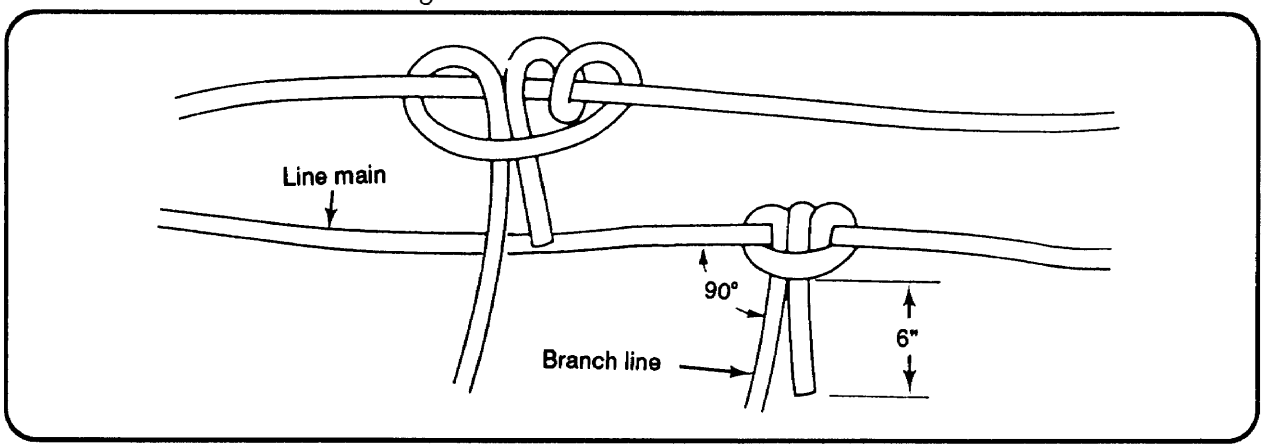


Figure 2-32. Girth hitch with an extra turn

b. *Ring Main.* Ring mains are preferred over line mains because the detonating wave approaches the branch lines from two directions. The charges will detonate even when them is a break in the ring main. A ring main will detonate an almost unlimited number of charges. Branch-line connections at 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 will cut each other and destroy the firing system.

(1) Method 1. Make a ring main by bringing the line main back in the form of a loop and attaching it to itself with a girth hitch with an extra turn (Figure 2-33, diagram 1).

(2) Method 2. Make a ring main by making a U-shape with the detonating cord, and then attaching a detonating-cord crossover at the open end of the U. Use girth hitches with extra turns when attaching the crossover (Figure 2-33, diagram 2). An advantage of the U-shaped ring main is that it provides two points of attachment for initiation sets.

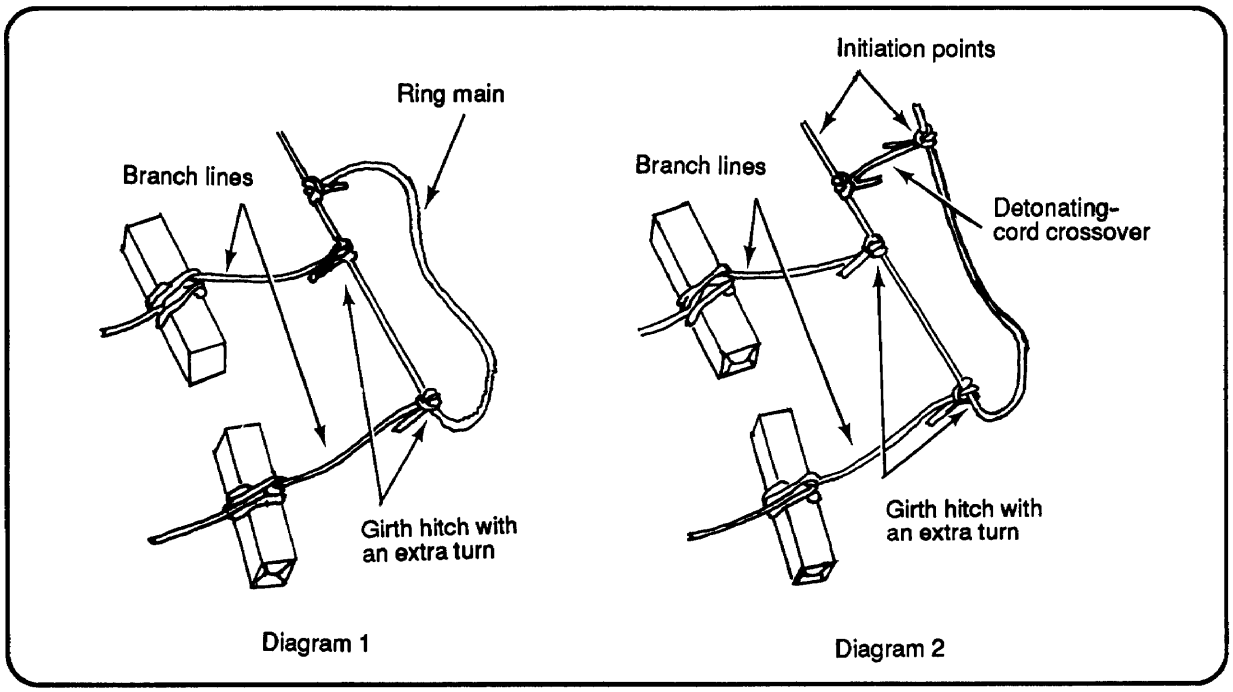


Figure 2-33. Ring mains

c. *Line Main.* A line main will fire multiple charges (Figure 2-34), 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 and a risk of failure is acceptable. You can connect any number of branch lines to a line main. However, connect only one branch line at any one point unless you use a junction box (Figure 2-35, page 2-28).

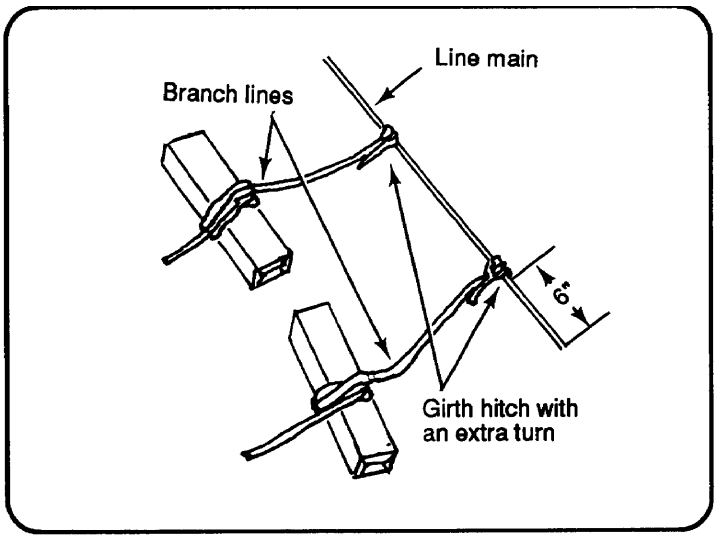


Figure 2-34. Line main with branch lines

2-15. Initiating Lines and Mains.

a. *Line Main and Branch Line.* Whenever possible, dual initiate a line main or a branch line (Figure 2-36, page 2-28). 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 when the first cap detonates and fails to initiate the line main. Do not try to get both caps to detonate at the same time. This is virtually impossible to do with time fuse. Stagger the detonations a minimum of 10 seconds.

b. *Ring Main.* Initiate ring mains as shown in Figures 2-33. The blasting caps are still connected as shown in Figure 2-36 (page 2-28), but by having one on each side of the ring main, the chances of both caps becoming isolated from the ring are greatly reduced.

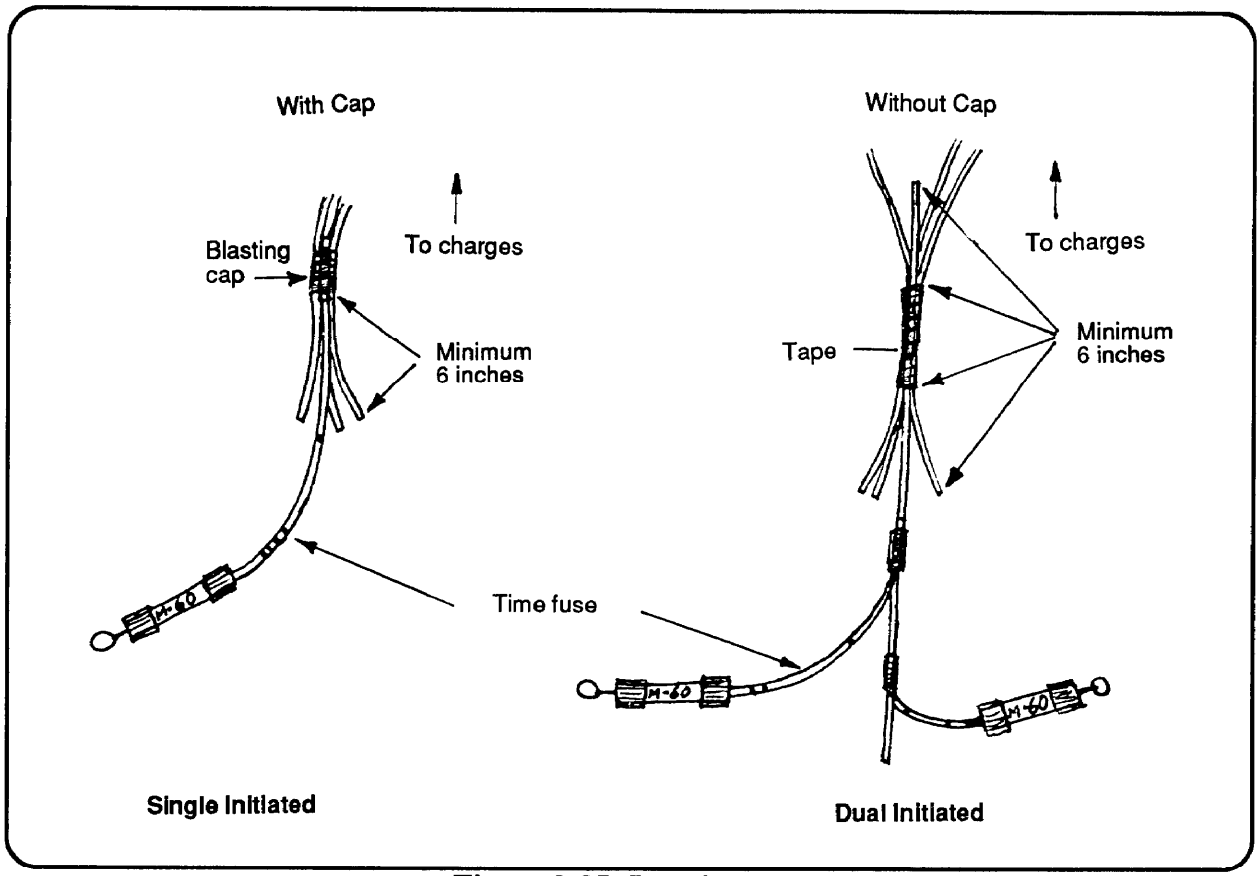


Figure 2-35. Junction box

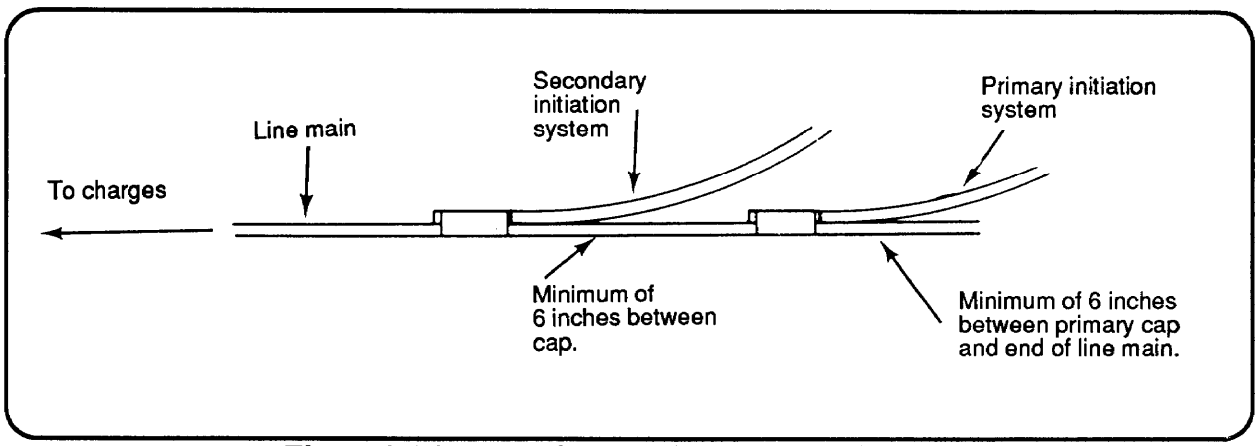


Figure 2-36. Attaching blasting caps to a line main

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
Calculation and Placement of Charges

Section I. Demolition

3-1. Principles. The amount and placement of explosives are key factors in military demolition projects. Formulas are available to help the engineer calculate the required amount of explosives. Demolition principles and critical-factor analysis also guide the soldier in working with explosive charges. The available formulas for demolition calculations are based on the follwing factors:

a. *Effects of Detonation.* 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 high-explosive charge detonated in direct contact with a solid object produces three detectable destructive affects:

(1) 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 contact area of the charge.

(2) Spall. 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 span 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 spans may meet to forma hole through the wall in concrete demolitions. On a steel plate, the charge may create one span in the shape of the explosive charge, throwing the spall from the plate.

(3) Radial Cracks. 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.

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

c. *Significance of Charge Placement.* The destructive effect of an explosive charge also depends on the location of the charge in relation to the target 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 force of the shock wave. Cut explosives (such as sheet or plastic explosives) to fit odd-shaped targets. Whenever possible, place explosive charges to act 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.

3-2. Types of Charges.

a. *Internal Charges.* Place internal charges 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 drill holes, tamp the explosive as it is loaded into the hole. Tamp stemming material only with nonsparking equipment.

b. *External Charges.* Place external charges on the surface of the target. 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.

3-3. Charge Calculations. Determine the amount of explosives required for any demolition project by calculation, based on the following critical factors:

a. *Type and Strength of Materials in Targets.* A target may be timber, steel, or other material. Concrete may be reinforced with steel, thereby increasing the concrete's strength.

b. *Size, Shape, and Configuration of Target.* 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.

c. *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.

d. *Type of Explosive.* The characteristics of each type of explosive determine its application for demolition purposes. Tables 1-1 and 1-2 (pages 1-2 and 1-5) list these characteristics.

e. *Size and Placement of Charge.* 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.

f. *Method of Tamping.* If you do not completely seal or confine the charge or if you do not ensure the material surrounding the explosive is balanced on all sides, the 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 instrument.

g. *Direction of Initiation.* The direction in which the shockwave travels through the explosive charge will affect the rate of energy transmitted to the target. If the shock wave travels parallel to the surface of the target (Figure 3-1, diagram 1), the shock wave will transmit less energy over a period of time than if the direction of detonation is perpendicular to the target (Figure 3-1, diagram 2). For best results, initiate the charge in the center of the face opposite the face in contact with the target.

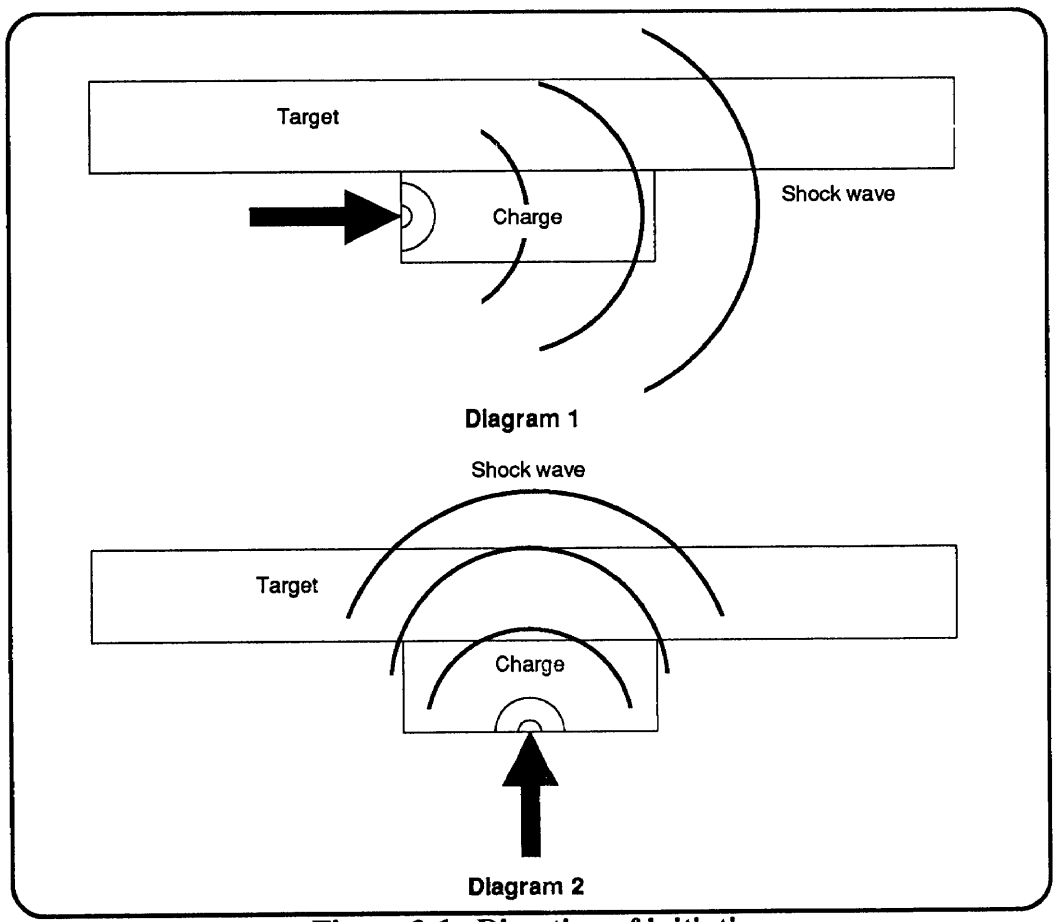


Figure 3-1. Direction of initiation

3-4. Charge Selection and Calculation.

a. *Selection.* Explosive selection for successful demolition operations is a balance between the critical factors listed above 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.

b. *Calculation.* Use the following procedure 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 relative effectiveness (RE) factor of the explosive you

plan to use (Table 1-1, page 1-2). Use the following six-step, problem-solving format for all charge calculations:

(1) Determine the critical dimensions of the target.

(2) Calculate the weight of a single charge of TNT to two decimal places by using the appropriate demolition formula (do not round). If your calculations are for TNT, skip to Step 4.

(3) Divide the quantity of explosive by the RE factor (carry the calculations to two decimal places, and do not round). If you are using TNT, skip this 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).

(5) Determine the number of charges for the target.

(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

3-5. Timber-Cutting Charges. Plastic explosives are the best timber-cutting charges for both internal and external placement. These explosives are good internal charges because you can easily tamp them 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. Example A-1 (page A-1) shows how to calculate internal timber-cutting charges.

a. *Internal Charges.* Use the following formula to calculate internal cutting charges:

$$P = \frac{D^2}{250} \text{ or } P = 0.004D^2 \qquad \textbf{(3-1)}$$

where–

P = TNT (or equivalent) required per tree, in pounds.
D = diameter or least dimension of dressed timber, in inches.

Use one hole to place the explosive in trees 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. Doing 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 diameter of the hole. Try to minimize the amount of molding so as not to reduce the density of the explosive. Prime the charge with detonating cord (paragraph 2-5b, page 2-14) 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 junction box (Figure 2-35, page 2-27).

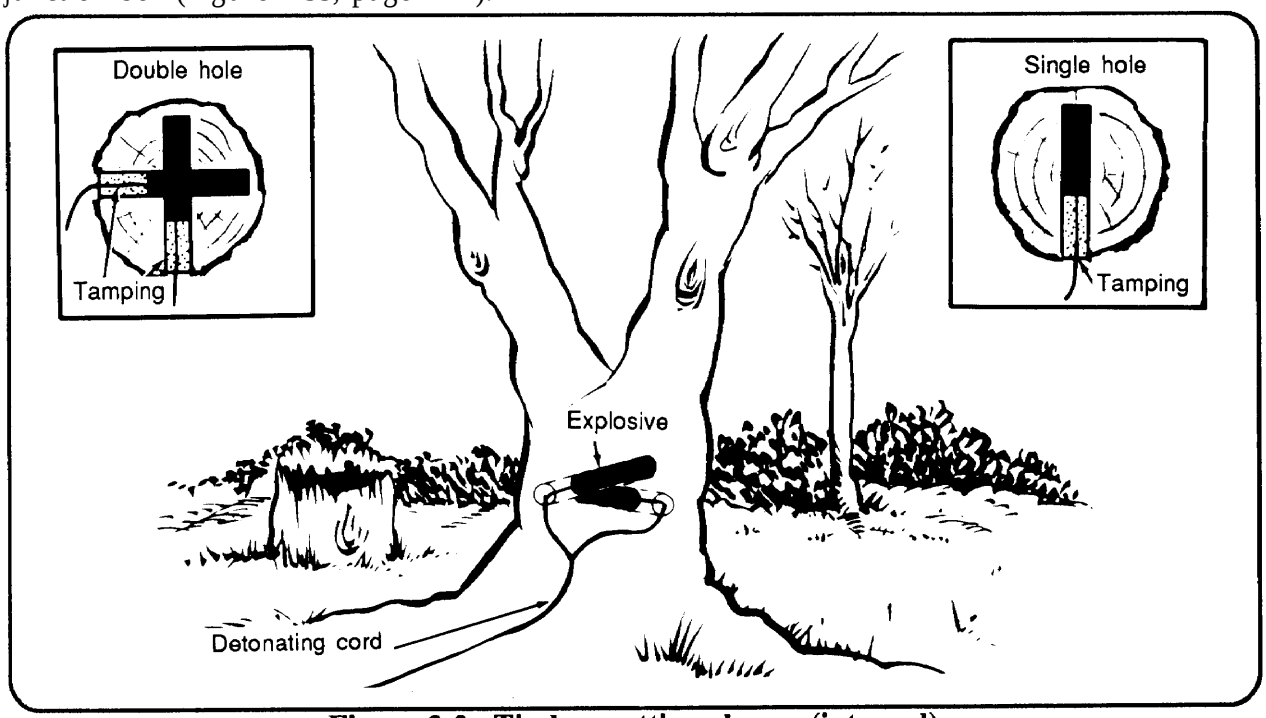


Figure 3-2. Timber-cutting charge (internal)

b. *External Charges.* 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 indirect 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. Doing 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 wind or lean of the tree (Figure 3-3). If the tree is leaning the wrong way or a strong wind is blowing, place a l-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. Example A-2

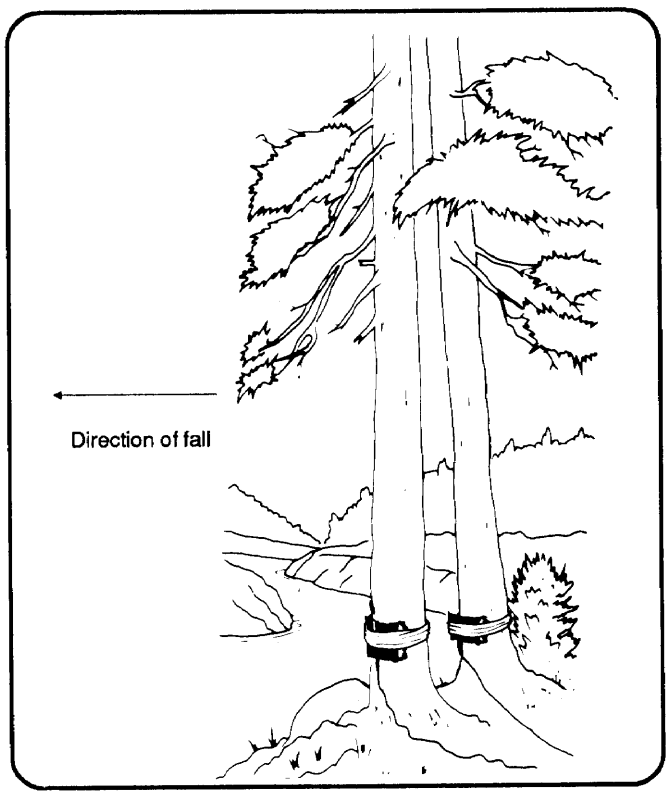


Figure 3-3. Timber-cutting charge (external)

(page A-2) shows how to calculate external timber-cutting charges. Use the following formula to determine the amount of explosive needed for cutting trees, posts, beams, or other timber, using untamped external charges:

$$P = \frac{D^2}{40} \text{ or } P = 0.025D^2 \qquad \textbf{(3-2)}$$

where–

P = TNT required per target, in pounds.
D = diameter or least dimension of dimensioned timber, in inches.

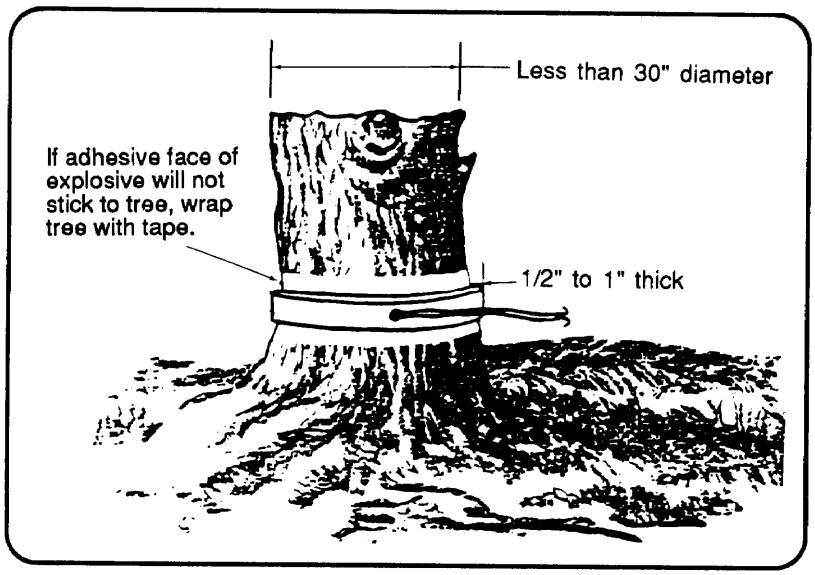


Figure 3-4. Timber-cutting ring charge

c. *Ring Charge.* The ring charge is a band of explosives completely circling 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 10 inches in diameter) and 1 inch thick for medium- and large-diameter trees (up to 30 inches in diameter). Use this technique when stump elimination is important and the direction of fall is not. For example, removing stumps would be important when clearing timber for a helicopter landing zone. 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 junction box (Figure 2-35, page 2-27).

d. *Underwater Charge.* To cut a timber pile underwater, use a method similar to the one illustrated in Figure 3-5. Determine the size of the charge using the external-charge formula. Place the charge on the upstream side of the pile and as deep as possible. The stream flow on this part of the pile will maximize the tamping effect on the explosive.

e. *Abatis.* 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 is required. Use the following formula to compute the amount of TNT required for the test shot:

$$P = \frac{D^2}{50} \text{ or } P = 0.02D^2 \qquad \textbf{(3-3)}$$

where—

P = TNT required per tree, in pounds.
D = diameter or least dimension of dimensioned timber, in inches.

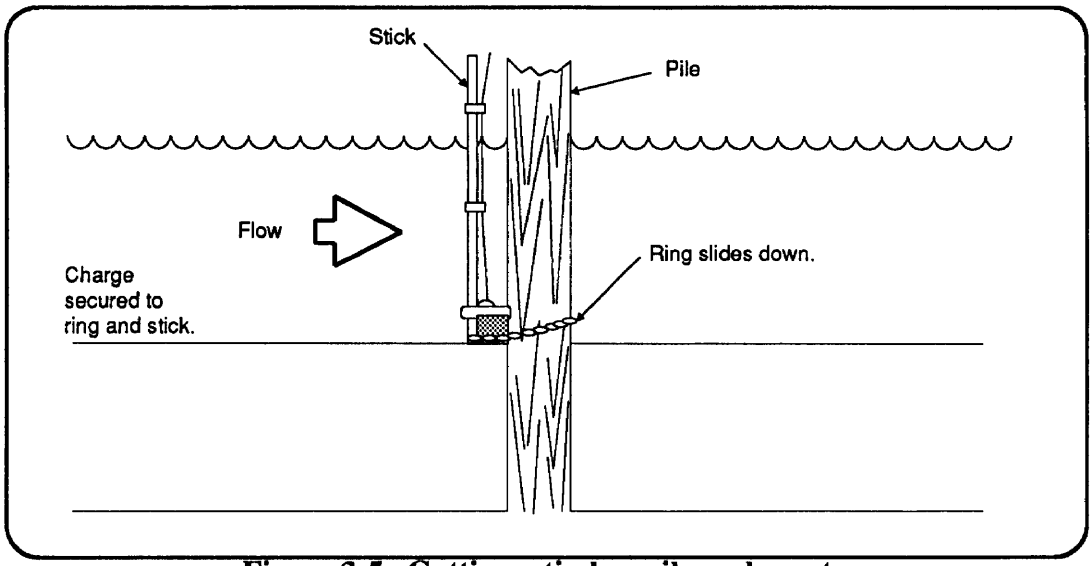


Figure 3-5. Cutting a timber pile underwater

(1) Placement. Place abatis charges in the same way as external timber charges except place the charges 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 wind.

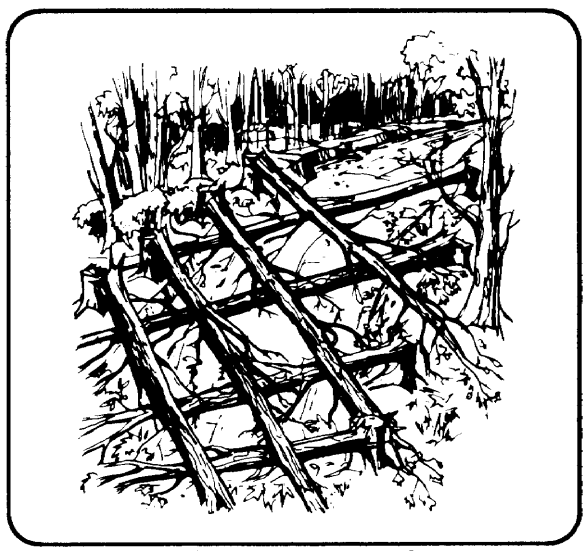


Figure 3-6. Abatis

(2) Special Considerations. Consider the following when creating an abatis:

- Make sure the obstacle will cover at least 75 meters from end to end.
- Make sure the individual trees are at least 24 inches in diameter. Smaller trees are not effective obstacles against tracked vehicles.
- Fell trees 3 to 4 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-degree angle toward the enemy.
- Simultaneously detonate the charges on the trees on one side of the road at a time. Then, fell the trees on the other side of the road. Delay blasting of the trees on the other side of the road until the frost trees have completely fallen.
- To make obstacles harder to remove, place mines, booby traps, or barbed or concertina wire in the obstacle, and cover the obstacle with director indirect fire.

f. *Hasty Timber Calculations.* Table 3-1 (page 3-8) lists the required number of C4 packages for cutting timber with internal, external, and abatis charges.

Table 3-1. Timber-cutting charge size

Charge Type	Packages of Composition C4 Required (1.25-Pound Packages) by Timber Diameter (Inches)											
	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	13	16
NOTE: Packages required are rounded UP to the next whole package.												

3-6. Steel-Cutting Charges.

WARNING
Steel-cutting charges produce metal fragments. Proper precautions should be taken to protect personnel. Refer to Table 6-3, page 6-7.

a. *Target Factors.* The following target factors are critical in steel-structure demolitions, more so than with other materials:

(1) Target Configuration. 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 tees, and steel plates used in building or bridge construction. Example A-3 (page A-3) shows how to calculate steel-cutting charges for wide-flange beams and girders.

(2) Target Materials. In addition to its configuration, steel also has varied composition:

(a) High-carbon steel. Metal-working dies and rolls are normally composed of high-carbon steel and are very dense.

(b) 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.

(c) Cast iron. Some steel components (such as railroad rails and pipes) are composed of cast iron. Cast iron is very brittle and easily broken.

(d) 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 or acetylene or electrical cutting tools.

b. *Explosives Factors.* 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:

(1) Type. Select steel-cutting charges that operate with a cutting effect. Percussive charges are not very effective for steel cutting. Plastic explosive (C4) and sheet explosive (Ml 18) are best. These explosives have very effective cutting power and are easily cut and shaped to fit tightly into the grooves and angles of the target. These explosives are particularly effective when demolishing structural steel, chains, and steel cables.

(2) Placement (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, page 3-3).

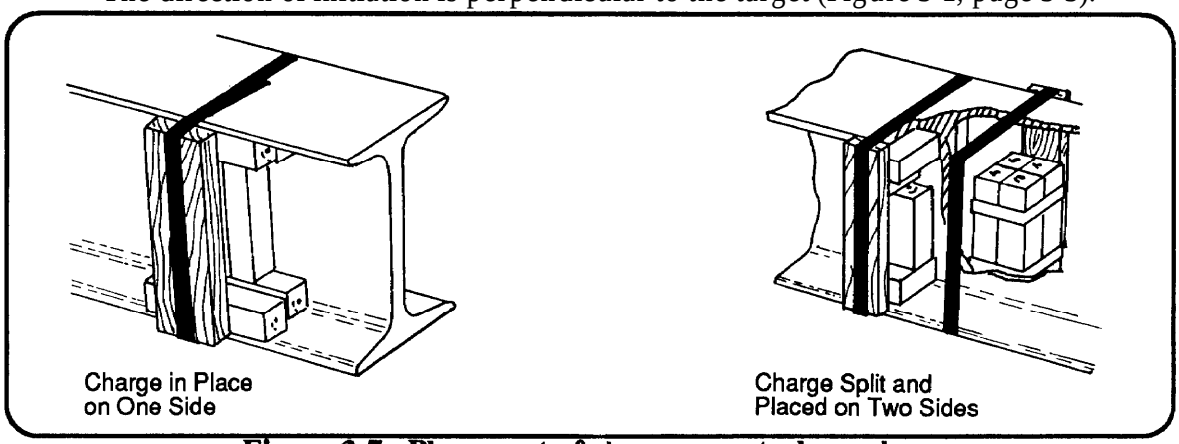


Figure 3-7. Placement of charges on steel members

(3) Size. The size of the charge is dictated by the target steel's type and size 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.

(a) Block charge. Generally, the following formula will give you the size of charge necessary for cutting I-beams, built-up girders, steel plates, columns, and other structural steel sections. (When calculating cutting charges for steel beams, the area for the top flange, web, and bottom flange must be calculated separately.) 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 3-2 and 3-3 (page 3-10) to determine the correct amount of C4 necessary for cutting steel sections. Use the following formula to determine the required charge size (Table 3-3, page 3-10, is based on this formula):

$$P = (\frac{3}{8})A \text{ or } P = 0.375A \quad (3\text{-}4)$$

where–

P = TM required, in pounds.
A = cross-sectional area of the steel member, in square inches.

Table 3-2. Hasty steel-cutting chart for TNT

Average Thickness of Section (in)	Pounds of explosive* 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
¼	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
⅜	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
½	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
⅝	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
¾	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
⅞	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

*TNT

Table 3-3. Hasty steel-cutting chart for C4

Section Thickness (inches)	Weight of Composition C4 Required for Rectangular Steel Sections (Height or Width, in Inches)													
	2	3	4	5	6	8	10	12	14	16	18	20	22	24
1/4	0.2	0.3	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.2	1.3	1.5	1.6	1.8
3/8	0.3	0.4	0.5	0.6	0.7	0.9	1.1	1.3	1.5	1.8	2.0	2.1	2.4	2.6
1/2	0.3	0.5	0.6	0.8	0.9	1.2	1.5	1.8	2.1	2.3	2.6	2.9	3.2	3.4
5/8	0.4	0.6	0.8	0.9	1.1	1.5	1.8	2.2	2.5	2.9	3.2	3.5	3.9	4.3
3/4	0.5	0.7	0.9	1.1	1.3	1.8	2.1	2.6	3.0	3.4	3.8	4.3	4.7	5.1
7/8	0.6	0.8	1.1	1.3	1.5	2.1	2.5	3.0	3.5	4	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 sizes.

To use this table:
1. Measure each rectangular section of the total member separately.
2. Find the approparite 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.

(b) High-carbon or alloy steel. Use the following formula to determine the required charge for cutting high-carbon or alloy steel:

$$P = D^2 \qquad (3\text{-}5)$$

where–

P = TNT required, in pounds.
D = diameter or thickness of section to be cut, in inches.

(c) Steel bars, rods, chains, and cables (up to 2 inches). The size of these materials makes proper charge placement difficult. For example, Figure 3-8 shows 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 charge. If the explosive is not large enough to bridge both sides, use two charges. Use the following amount of explosive:

- For materials up to 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.

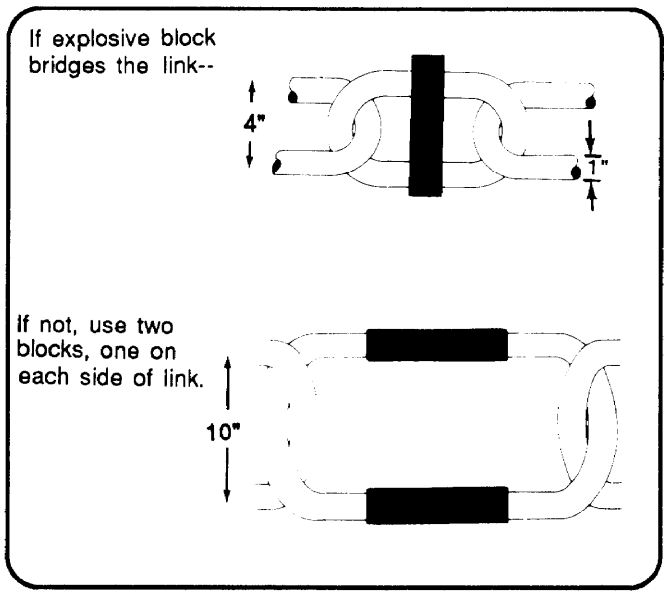


Figure 3-8. Charge placement on chains

(d) Steel bars, rods, chains, and cables (over 2 inches). When the target diameter or thickness is 2 inches or greater, use equation 3-4. 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).

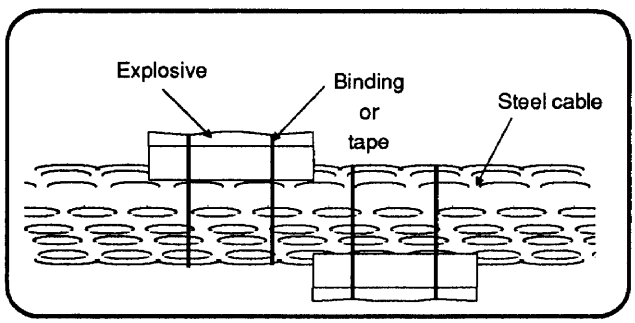


Figure 3-9. Charge placement on steel

(e) Railroad rails. The height of the railroad rail is the critical dimension for determining the amount of explosive required. For rails 5 inches or more in height, crossovers, and switches, use 1 pound of C4 or TNT. For rails less than 5 inches high, use 1/2 pound of C4 or TNT (Figure 3-10, page 3-12). Railroad frogs require 2 pounds of C4 or TNT. Place the charges at vulnerable points, such as frogs, curves, switches, and crossovers, if possible. Place the charges at alternate rail splices for a distance of 500 feet.

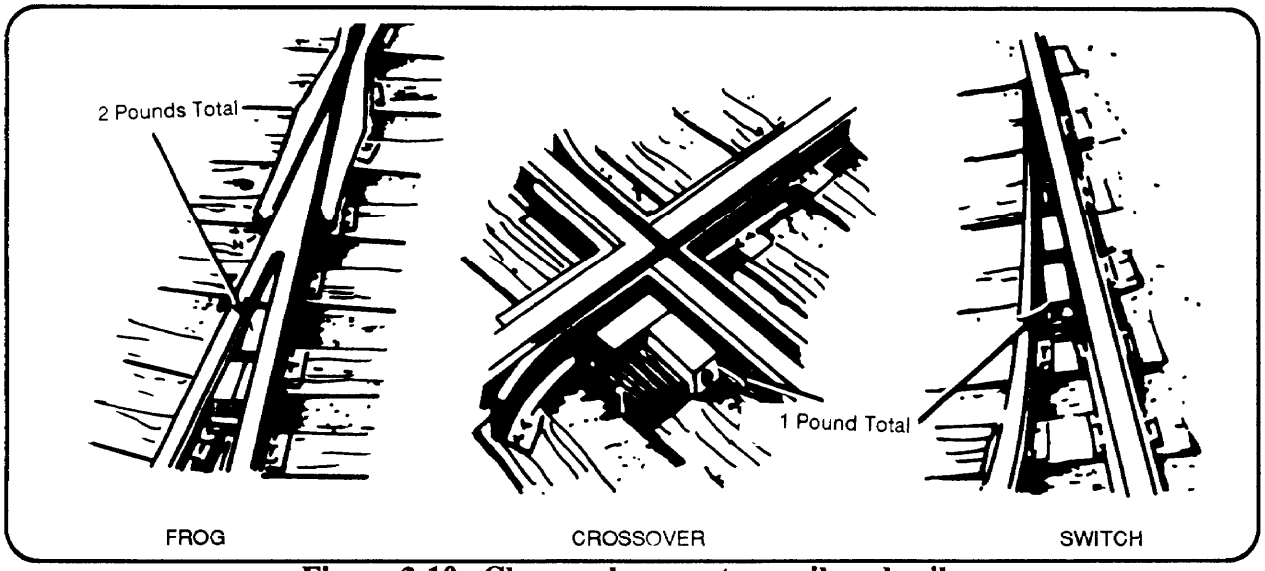


Figure 3-10. Charge placement on railroad rails

Section III. Special Cutting Charges

3-7. Purpose. 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 (Ml18 or Ml86) charges as special charges. C4 requires considerable cutting, shaping, and molding, which may reduce its density and, therefore, its effectiveness. Sheet explosive is more suitable than C4, since sheet explosive is more flexible and requires less cutting. Use of these charges requires considerable training and practice. The charges are thin and require blasting caps crimped to a detonating-cord branch line for initiation. (A detonating-cord knot will work but is difficult to place and can ruin the advantage of the special charge shape).

3-8. Ribbon Charges. Use these 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 or from either end. 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 junction box (Figure 2-35, page 2-27). Example A-5 (page A-5) shows how to calculate steel-cutting charges for steel plates. The formula for the ribbon charge is as follows:

a. *Charge Thickness.* The charge thickness equals one half the target's thickness; however, it will never be less than 1/2 inch.

b. *Charge Width.* The charge width is three times charge thickness.

c. *Charge Length.* The charge length equals the length of the desired cut.

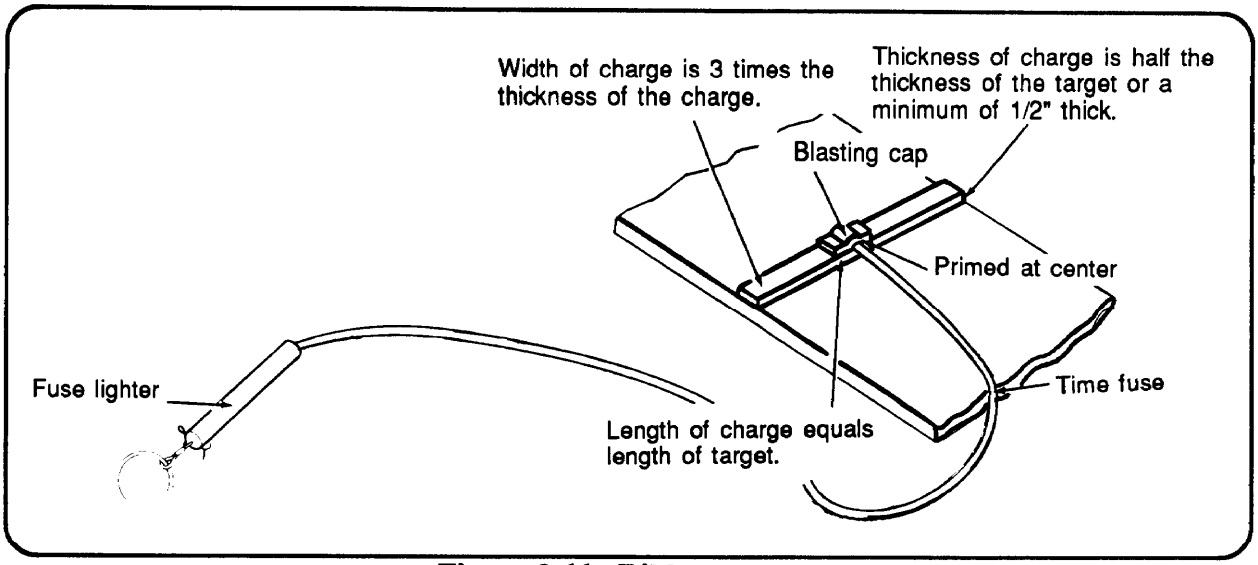


Figure 3-11. Ribbon charge

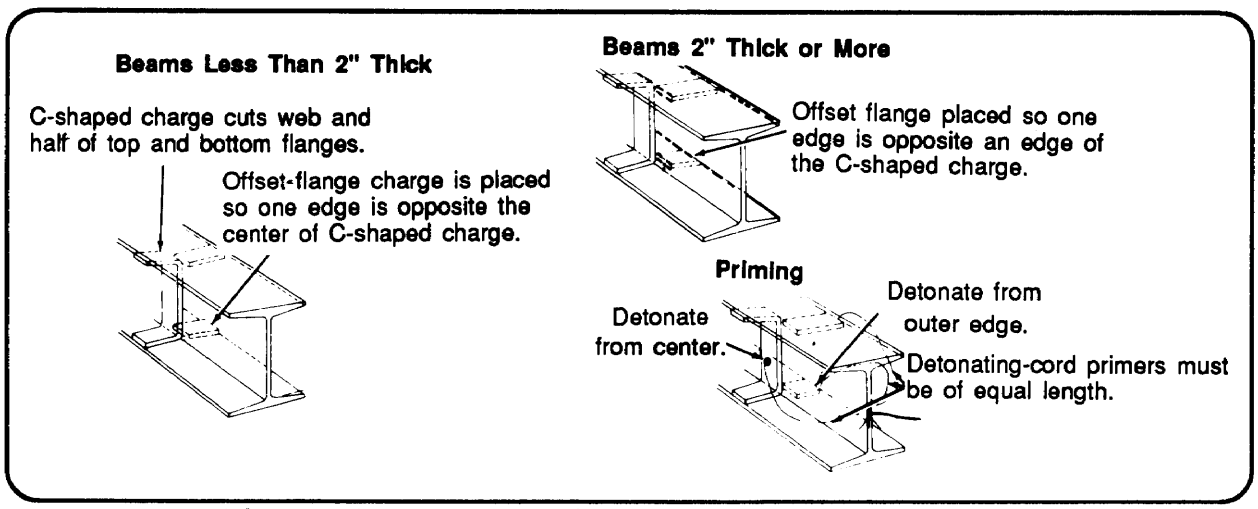


Figure 3-12. Placement of ribbon charge on structural steel

3-9. Saddle Charge. This steel-cutting method uses the destructive effect of the cross fracture formed in the steel by the base of the saddle charge (end opposite the point of initiation). Use this charge on mild steel bars, whether round, square, or rectangularly shaped, up to 8 square inches or 8 inches in diameter (Figure 3-13, page 3-14). Make the charge a uniform l-inch thick. Example A-7 (page A-7) shows how to calculate steel-cutting charges for steel bars, Determine the dimensions of the saddle charge as follows:

a. *Dimensions.*

(1) Thickness. Make the charge 1 inch thick (standard thickness of Ml 12 block explosive).

(2) Base Width. Make the base width equal to one-half the target circumference or perimeter.

(3) Long-Axis Length. Make the long-axis length equal to the target circumference or perimeter.

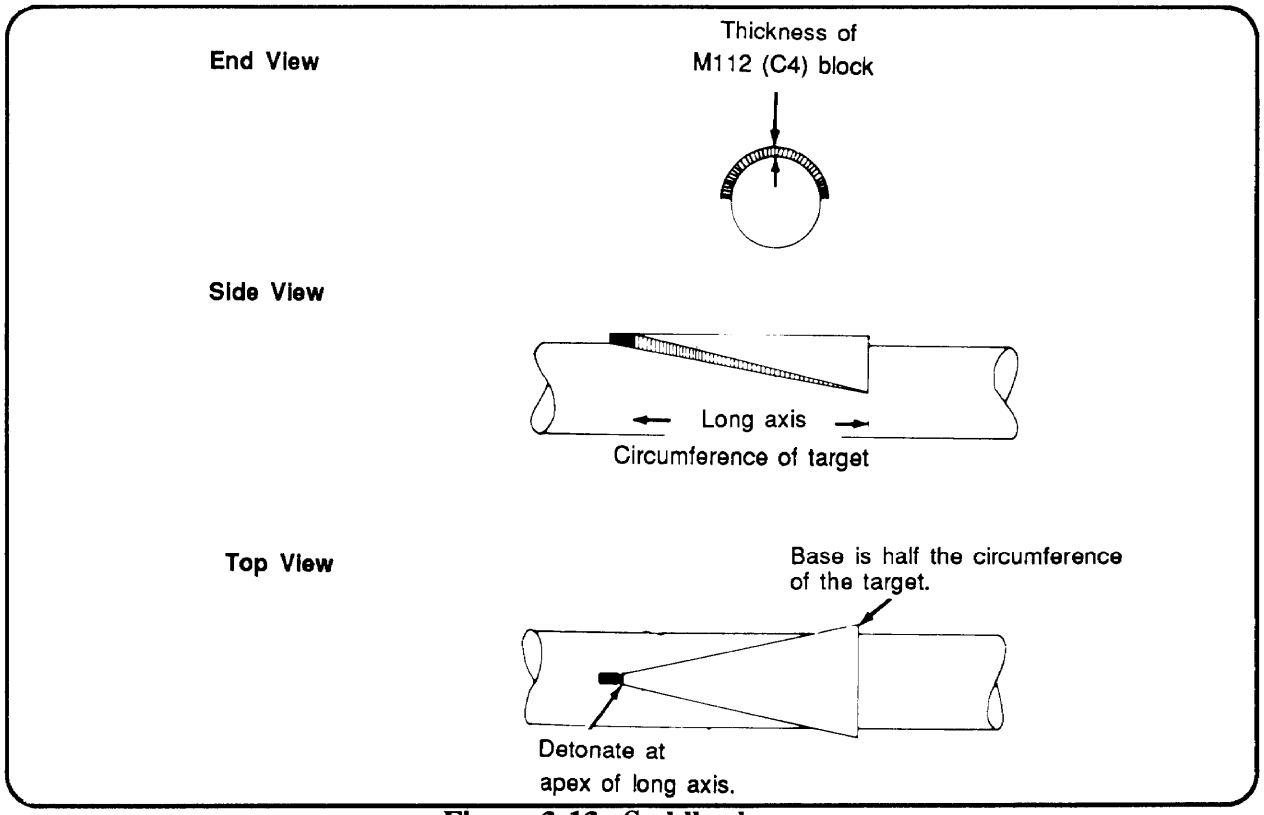


Figure 3-13. Saddle charge

b. *Detonation.* Detonate the saddle charge by placing a blasting cap at the apex of the long axis.

c. *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 the charge maintains close contact with the target by taping the charge to the target.

3-10. Diamond Charge. 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 up to 8 inches in diameter or having cross-sectional areas of 8 square inches or less. Example A-8 (page A-7) shows how to calculate steel-cutting charges for high-carbon steel.

a. *Dimensions.*

(1) Thickness. Make the charge 1 inch thick (standard thickness of Ml12 block explosive).

(2) Long-Axis Length. Make the long-axis length equal to the target circumference or perimeter.

(3) Short-Axis Length. Make the short-axis length equal to one-half the target circumference or perimeter.

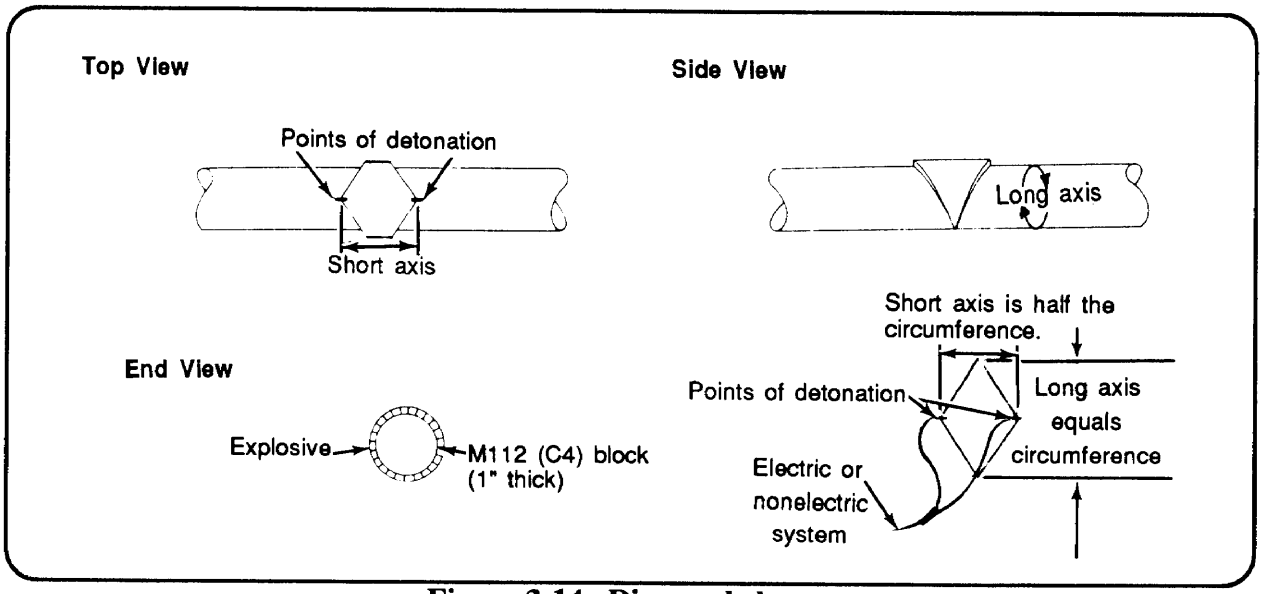


Figure 3-14. Diamond charge

b. *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.

c. *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, page 2- 14).
- Two electric blasting caps in a series circuit (Figure 2-7, page 2-8).
- Two nonelectric blasting caps (Figure 2-35, page 2-27).

NOTE: When using detonating cord knots or nonelectric blasting caps, the branch lines must be the same length.

Section IV. Breaching Charges

3-11. Critical Factors. 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.

3-12. Computation.

a. *Formula.* Determine the size of the charge required to breach concrete, masonry, rock, or similar material by using the following formula:

$$P = R^3KC \qquad (3\text{-}6)$$

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 3-4).*
C = *tamping factor, which depends on the location and tamping of the charge (Figure 3-15).*

Table 3-4. Material factor (*K*) for breaching charges

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

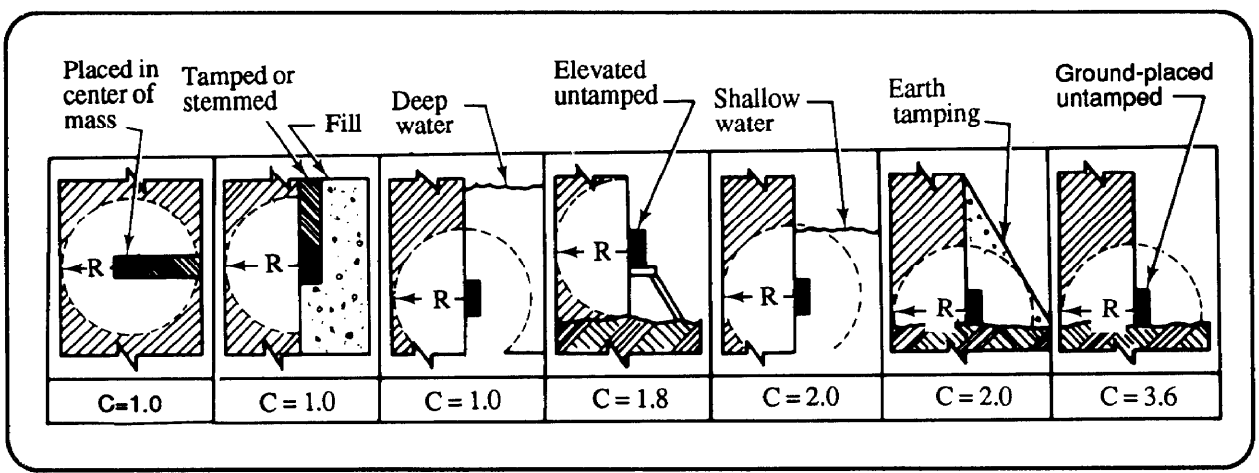


Figure 3-15. Tamping factor (*C*) for breaching charges

b. *Breaching Radius (R).* 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 ¼-foot distance for internal charges and to the next-higher ½-foot distance for external charges.

c. *Material Factor (K).* K represents the strength and hardness of the target material. Table 3-4 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 concrete is reinforced and masonry is first-class unless you know the exact condition and construction of the target materials.

d. *Tamping Factor (C).* C depends on the charge location and materials used for tamping. 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 earth) as fully tamped unless you cover the charge to a depth equal to or greater than the breaching radius.

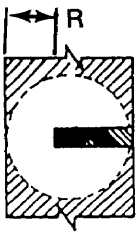
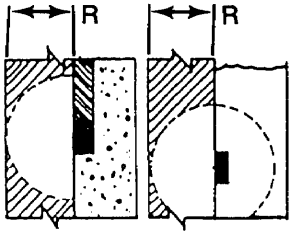
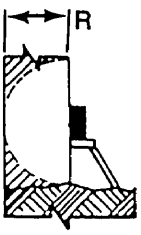
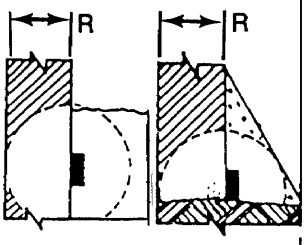
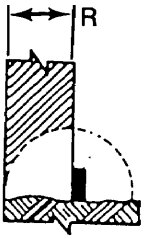
3-13. Breaching Reinforced Concrete. Table 3-5 (page 3-18) gives the number of C4 packages required for breaching reinforced-concrete targets. Example A-9 (page A-8) shows how to calculate the breaching charge for a reinforced-concrete pier. The amounts of C4 in the table are based on equation 3-6. To use the table, do the following:

a. Measure the concrete thickness.

b. Decide how the charge will be placed against the target. Compare the method of placement with the diagrams at the top of the Table 3-5 (page 3-18). If in doubt about which column to use, always use the column that lists the greatest amount of explosive.

c. Using the column directly under the chosen placement method, select the amount of explosive required, based on target thickness. 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.

Table 3-5. Breaching charges for reinforced concrete

Concrete Thickness (Feet)	Placement Methods				
					
	C = 1.0	C = 1.0	C = 1.8	C = 2.0	C = 3.6
	Packages of M112 (Composition C4)				
2.0	1	5	9	10	17
2.5	2	9	17	18	33
3.0	2	13	24	26	47
3.5	4	21	37	41	74
4.0	5	31	56	62	111
4.5	7	44	79	88	157
5.0	9	48	85	95	170
5.5	12	63	113	126	226
6.0	13	82	147	163	293
6.5	17	104	186	207	372
7.0	21	111	200	222	399
7.5	26	137	245	273	490
8.0	31	166	298	331	595

NOTE: The results of all calculations for this table have been rounded UP to the next whole package.

3-14. Breaching Other Materials. You can also use Table 3-5 to determine the amount of C4 required for other materials by multiplying the value from the table by the proper conversion factor from Table 3-6. Use the following procedure:

a. Determine the type of material in the target. If in doubt, assume the material to be the strongest type from the same category.

b. Determine from Table 3-5 the amount of explosive required if the object were made of reinforced concrete.

c. Find the appropriate conversion factor from Table 3-6.

d. Multiply the number of packages of explosive required (from Table 3-5) by the conversion factor (from Table 3-6).

Table 3-6. 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

3-15. Number and Placement of Charges.

a. *Number of Charges.* Use the following formula for determining the number of charges required for demolishing piers, slabs, or walls:

$$N = \frac{W}{2R} \qquad \textbf{(3-7)}$$

where–

N = *number of charges. (If N is less than 1.25, use one charge; if N is 1.25 but less than 2.5, use two charges; if N is equal to or greater than 2.5, round to the nearest whole number and use that many charges.)*
W = *pier, slab, or wall width, in feet.*
R = *breaching radius, in feet.*

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

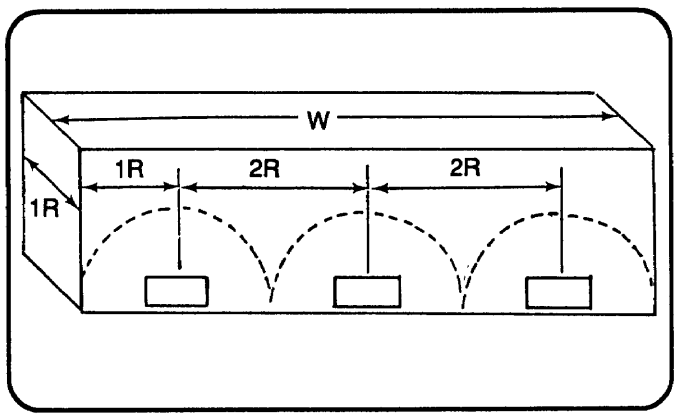


Figure 3-16. Charge placement

b. *Placement.*

(1) Limitations. 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. Doing 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 equal to or greater than the breaching radius below the water line, if possible (Figure 3-15, page 3-16).

(2) Configuration. For maximum effectiveness, place the explosive charge in the shape of a flat square. The charge width should be approximately three times the charge thickness. The thickness of the charge depends on the amount of explosive required (Table 3-7).

Table 3-7. Breaching charge thickness*

Charge Weight (Pounds)	Charge Thickness (Inches)
Less than 5	1
5 to less than 40	2
40 to less than 300	4
300 or more	8
*Approximate values	

3-16. Counterforce Charge.

a. *Use.* 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).

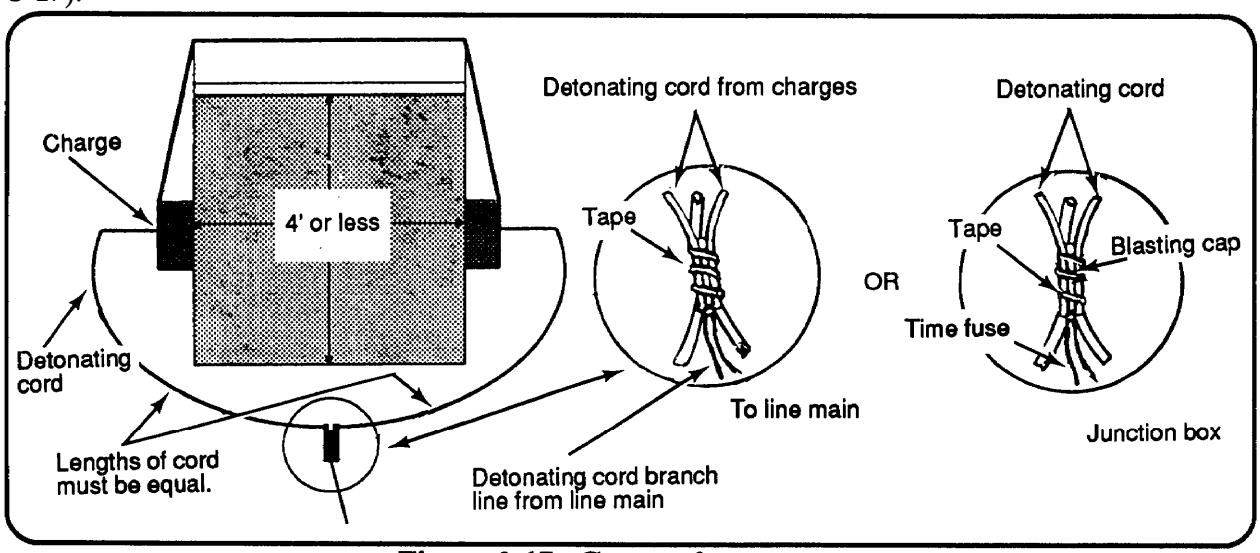


Figure 3-17. Counterforce charge

b. *Calculation.* The thickness or diameter of the target determines the amount of plastic explosive required. The amount of plastic explosive equals 1½ times the thickness of the target, in feet (1 ½ 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 lb / foot x 4 feet).

c. *Placement.* 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 the charges will fit flush against their respective target sides.

d. *Priming.* Prime both charges on the face farthest from the target. Join the ends of the detonating-cord branch lines in a junction box (Figure 3- 17). The length of the branch lines from both charges must be equal to ensure simultaneous detonation.

Section V. Cratering and Ditching Charges

3-17. Factors.

a. *Sizes.* To be effective obstacles, road craters must be too wide for track vehicles to span and too deep and steep-sided for any vehicle to pass through. Blasted road craters will not stop modern tanks indefinitely. A tank, making repeated attempts to traverse the crater, will pull soil loose from the slopes of the crater, filling the bottom and reducing both the crater's depth and angle of slope. Road craters are effective antitank obstacles if a tank requires three or more passes to traverse the crater, thereby providing enough time for antitank weapons to stop the tank. Road craters should be large enough to tie into natural or constructed obstacles at each end. Improve the effectiveness of blasted road craters by placing log hurdles on either side, digging the face of the hurdle vertically on the friendly side, mining the site with antitank and antipersonnel mines, filling the crater with water, or by using other means to further delay enemy armor. Cut road craters across the desired gap at a 45-degree angle from the direction of approach. This angled cut will increase the tank's tendency to slip sideways and ride off its track. To achieve sufficient obstacle depth, place craters in multiple or single rows, enhancing some other obstacle, such as a bridge demolition. When creating more than one row of craters, space them far enough apart so that a single armored vehicle launch bridge (AVLB) will not span them.

b. *Explosives.* All military explosives can create antitank craters. When available, use the 40-pound, ammonium-nitrate cratering charge (Figure 1-5, page 1-8) for blasting craters.

c. *Charge Confinement.* Place cratering charges in boreholes and tamp them.

3-18. Breaching Hard-Surfaced Pavements. 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 l-pound charge of explosive for each 2 inches of pavement thickness. Tamp the charges twice as deep 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 first, eliminating the need to breach the pavement with explosive charges and then digging the hole for the cratering charge. Do not breach concrete at an expansion joint because the concrete will shatter irregularly. Table 1-3 (page 1-10) 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.

3-19. Hasty Crater. This method takes the least amount of time to construct, based upon the number and depth of the boreholes. However, it produces the least effective barrier because of its depth and shape (Figure 3-1 8). The hasty method forms a V-shaped crater about 6 to 7 feet deep and 20 to 25 feet wide, extending approximately 8 feet beyond each end borehole. The sides of the crater slope 25 to 35 degrees. Modern US tanks require an average of four attempts to breach a hasty crater. To forma 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 road crater:

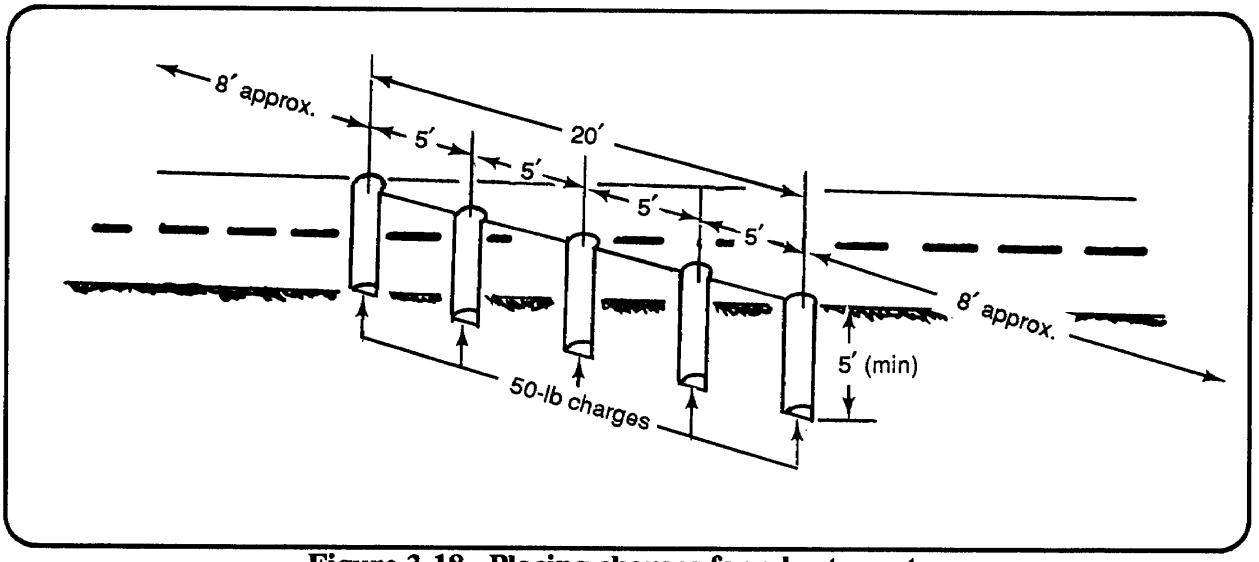


Figure 3-18. Placing charges for a hasty crater

a. *Boreholes.* Dig all boreholes to the same depth (5 feet or deeper recommended). Space the boreholes at 5-foot intervals, center to center, across the road. Use the following formula to compute the number of boreholes:

$$N = \frac{L - 16}{5} + 1 \qquad \textbf{(3-8)}$$

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 each side.*
5 = *5-foot spacing.*
1 = *factor to convert from spaces to holes.*

b. *Charge Size.* 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 C4.

c. *Firing System.* Use dual firing systems when time and explosives permit (Figures 2-27, page 2-24). Initiate with either electric or nonelectric caps. Dual prime the 40-pound cratering charge as shown in Figure 2-21 (page 2-20).

d. *Tamping.* Tamp all boreholes with suitable materials.

3-20. Deliberate Crater. Figure 3-19 illustrates a method that produces a more effective crater than the hasty method. Modem US tanks require an average of eight attempts to breach a deliberate crater. Placing charges deliberately produces a V-shaped crater, approximately 7 to 8 feet deep and 25 to 30 feet wide, with side slopes of 30 to 37 degrees. The crater extends approximately 8 feet beyond the end boreholes. Example A-11 (page A-9) shows how to calculate a cratering charge.

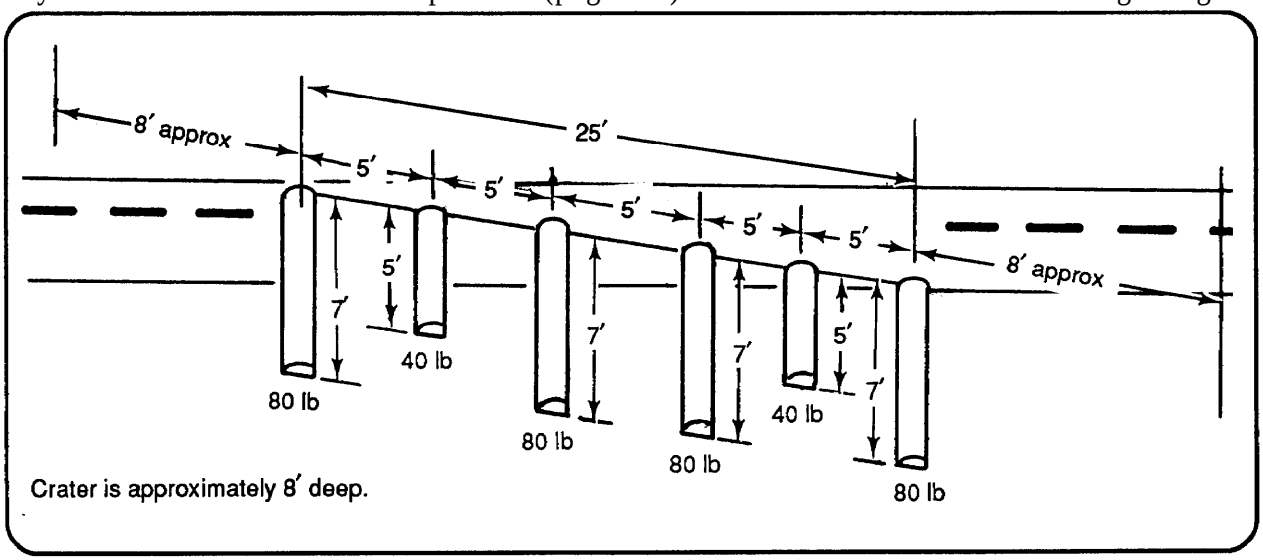


Figure 3-19. Placing charges for a deliberate crater

a. Determine the number of boreholes required, using the same formula as for a hasty crater. When there is an even number of holes (Figure 3-20, page 3-24), place two adjacent 7-foot boreholes in the middle.

b. 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.

c. Place 80 pounds of explosive in the 7-foot holes and 40 pounds of explosive in the 5-foot holes.

d. Use dual firing systems (Figure 2-27, page 2-24). Initiate with either electric or nonelectric caps. Dual prime the 40-pound cratering charge as shown in Figure 2-21 (page 2-20).

e. Tamp all charges with suitable materials.

3-21. Relieved-Face Crater. The method shown in Figure 3-20 (page 3-24) produces a crater that is a more effective obstacle to modern tanks than the standard V-shaped 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 (page 3-24). The side nearest the enemy slopes approximately

25 degrees from road surface to crater bottom. The opposite (friendly) side slopes approximately 30 to 40 degrees from road surface to 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:

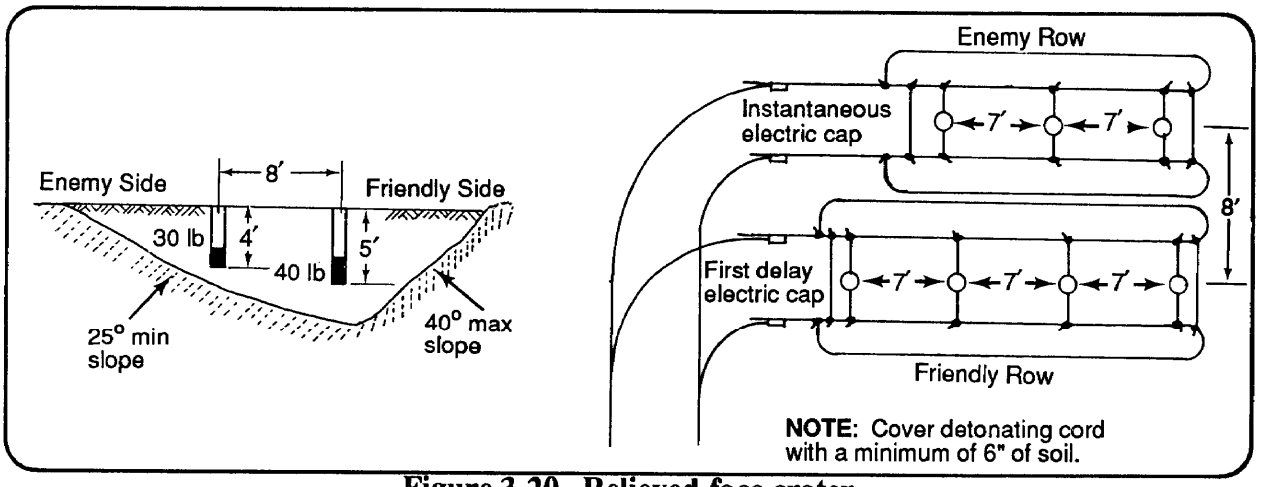


Figure 3-20. Relieved-face crater

a. On dirt or gravel-surfaced roads, drill two lines of boreholes 8 feet apart, spacing them at 7-foot centers. 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:

$$N = \frac{L - 10}{7} + 1 \qquad \textbf{(3-9)}$$

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.*

b. 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.

c. 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.

d. Use a dual firing system for each line of boreholes. Prime any 40-pound cratering charge as shown in Figure 2-21 (page 2-20).

e. Tamp all holes with suitable material.

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 frost. Then fire the friendly-side row while the earth from the

enemy-side detonation is still in the air. Use standard delay caps. If the firings cannot be staggered, fire both rows simultaneously. However, the crater produced by a simultaneous detonation will not have the same depth and trapezoidal shape as a relieved-face crater.

3-22. Misfire Prevention. The shock and blast of the first row of charges may affect the delayed detonation of the friendly-side charges. To prevent misfires of the friendly-side charges, protect its detonating-cord lines by covering them with approximately 6 inches of earth.

3-23. Creating Craters in Permafrost and Ice.

a. *Blasting in Permafrost.* 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 approximately 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 span falls back into the crater when the blast subsides.

(1) Boreholes. Before conducting extensive blasting, perform a test on 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; otherwise, the area around the borehole thaws and collapses. Shaped charges also are effective for producing boreholes, especially when forming craters. Table 1-3 (page 1-10) lists borehole sizes made by shaped charges in permafrost and ice.

(2) Explosives. If available, use low-velocity explosives, such as ammonium nitrate, 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.

b. *Blasting in Ice.* Access holes in ice are required for obtaining water and determining the capacity of the ice for bearing aircraft and vehicles. To accommodate rapid forward movements, you must be capable of quickly determining ice capacities. Blasting operations provide this ability.

(1) Boreholes. Make small-diameter access holes using shaped charges. The M2A4 charge will penetrate ice as thick as 7 feet; the M3A1 charge will penetrate over 12 feet of ice (Table 1-3, page 1-10). The M3A1 can penetrate deeper, but it has only been tested on ice approximately 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 the actual borehole. Use a standoff distance of 42 inches or more with the M2A4 shaped charge to avoid excessive crater formation. The M2A4 creates an average borehole diameter of 3 ½ 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.

(2) Craters. Make surface craters with ammonium-nitrate cratering charges or demolition blocks. 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.

c. *Making Vehicle Obstacles.* 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 Ml12 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 approximately 24 hours at temperatures near -24 degrees Fahrenheit.

3-24. Craters as Culverts. Destroying a culvert not more 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 in the same way 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

3-25. Craters as Antitank Ditches. Excavate antitank ditches by either the hasty or deliberate cratering method (paragraphs 3-19 and 3-20, pages 3-22 and 3-23).

3-26. Ditching Methods. 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:

a. *Single Line.* 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.

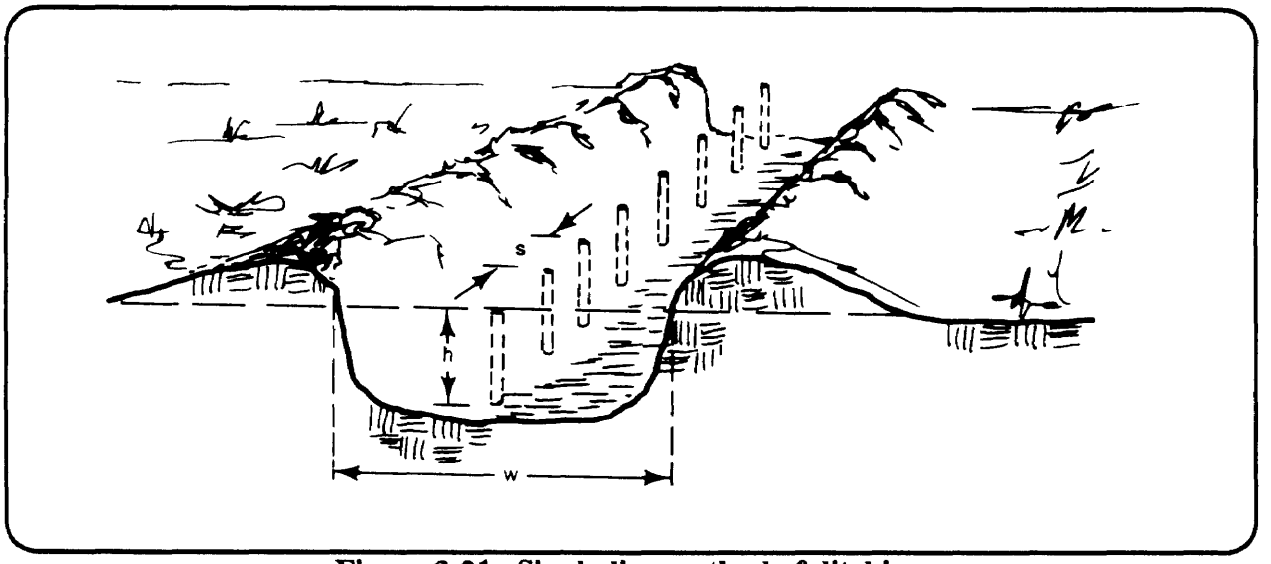


Figure 3-21. Single-line method of ditching

Table 3-8. Single-line ditching explosives data

Serial	Required Ditch Depth (*d*)	Required Width Top of Ditch (*w*) (Feet)	Charges per Hole (Pounds)	Borehole Depth (*h*) (Feet)	Borehole Spacing (*s*) (Feet)
a	b	c	d	e	f
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

b. *Cross Section.* When it is necessary to 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.

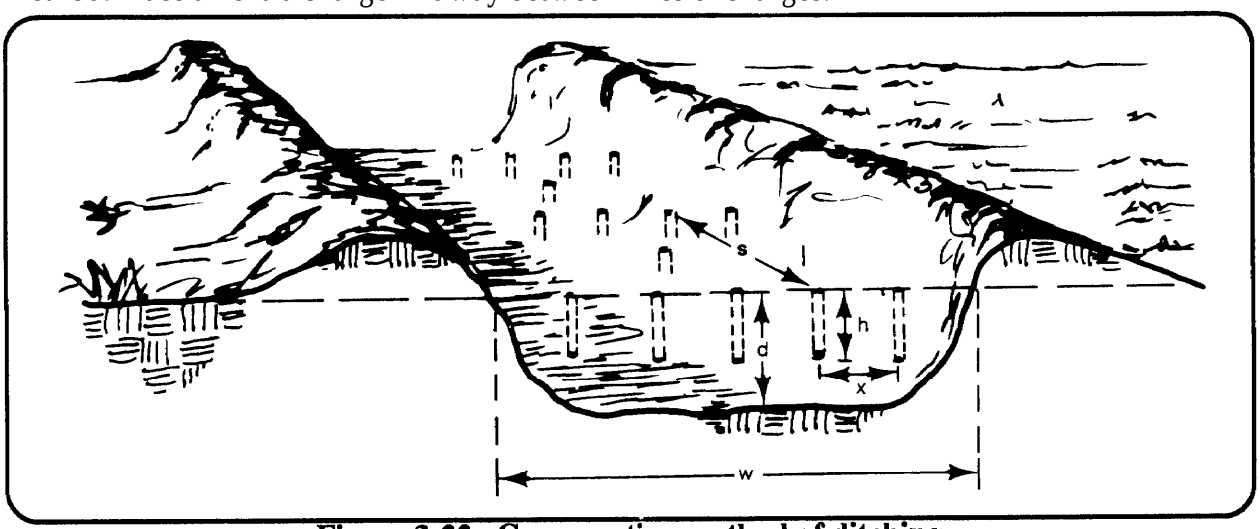


Figure 3-22. Cross-section method of ditching

Table 3-9. Cross-section ditching explosives data

Serial	Required Depth (*d*)	Required Width (*w*) in Feet — Number of Boreholes in Each Cross Section					Charge per Hole (Pounds)	Borehole Depth (*h*) (Feet)	Borehole Spacing (*s*) (Feet)	Row Spacing (x) (Feet)
		3	5	7	9	11				
a	b	c	d	e	f	g	h	l	j	k
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 VI. Land-Clearing Charges

3-27. Stump Removal. 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 ½ 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, increase the amount of explosive by 50 percent. If you cannot identify the root type, assume the tree has a lateral root structure and proceed accordingly.

a. *Taprooted Stumps.* 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 approximately equal to the diameter of the stump.

b. *Laterally Rooted Stumps.* When blasting laterally rooted stumps, drill sloping holes between the roots (Figure 3-23). Drill the holes and place the charges as closely 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 lame lateral roots.

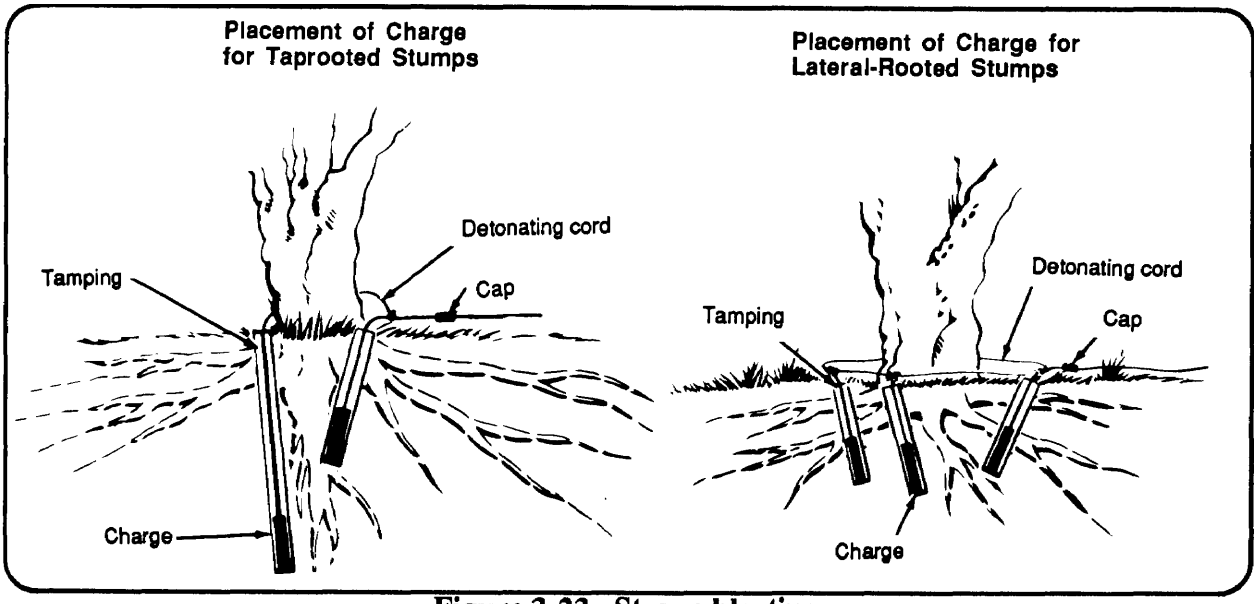


Figure 3-23. Stump blasting

3-28. Boulder Removal. Blasting is an effective way to remove boulders. The most practical methods are snake-hole, mud-cap, and block-hole:

a. *Snake-Hole Method.* 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.

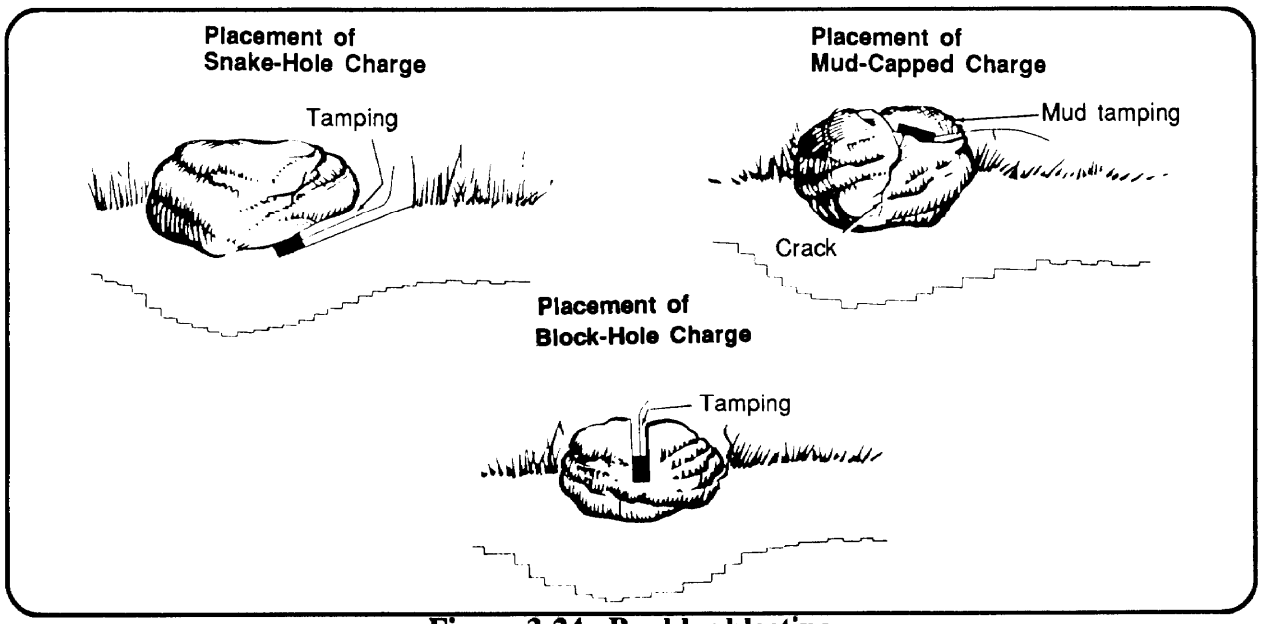


Figure 3-24. Boulder blasting

Table 3-10. Boulder-blasting charges

Boulder Diameter (Feet)	Charge Size (Pounds)		
	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

b. *Mud-Cap Method.* Place the charge in a crack or seam in the boulder (Figure 3-24, page 3-28). Cover the charge with 10 to 12 inches of mud or clay. Table 3-11 lists the required charge sizes.

c. *Block-Hole Method.* Drill a hole in the top of the boulder deep and wide enough to hold the amount of explosive required (Table 3-11). Prime the charge with detonating cord and tamp firmly (Figure 3-24, page 3-28).

3-29. Springing Charge. 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 two hours between firing 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 forma 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 approximately 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 D-7, page

D-4). If placing successive charges in the same borehole, use water, or compressed air, or wait two hours to cool the borehole before placing the next charge.

3-30. Quarrying. 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

3-31. Survivability Positions. In many circumstances, the use of explosives can reduce digging time and effort. Use explosives only in soil that would normally be excavated by 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 doing 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 time required to prepare the position by traditional methods.

a. *Depth.* 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.

b. *Spacing.* 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 depth. Ensure 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.

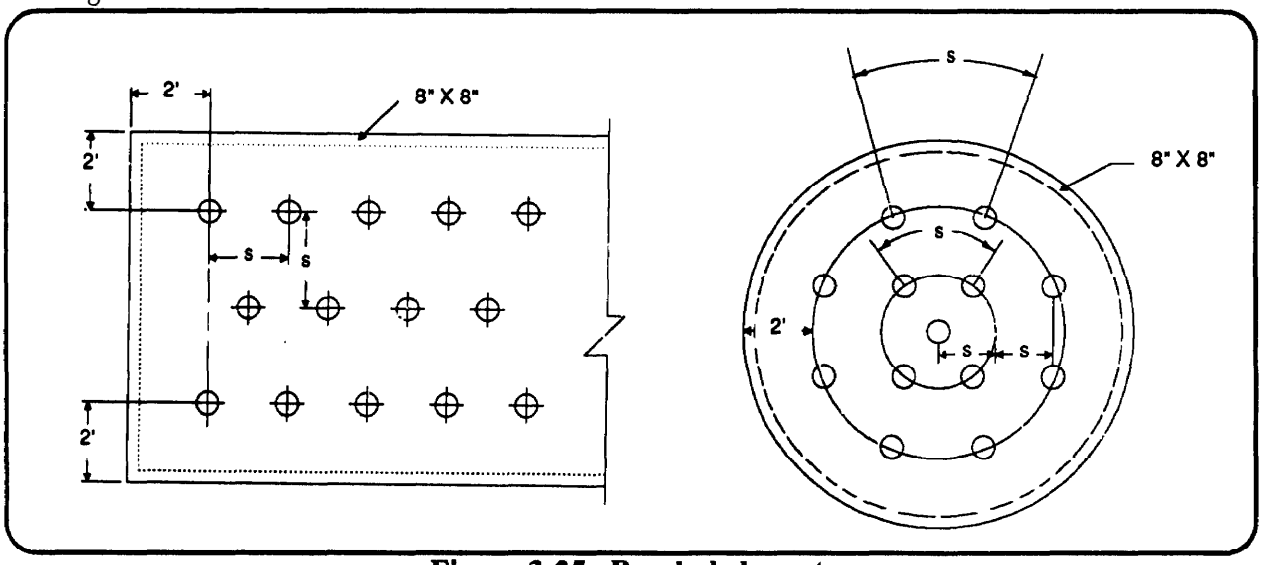


Figure 3-25. Borehole layouts

c. *Charge Size.* Use ¼-pound charges of plastic explosive to dig foxholes. For large excavations, use charges between ½ and 1 ½ pounds, depending on spacing and soil characteristics. A test shot is usually necessary to determine the correct charge size.

d. *Concealment.* 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.

3-32. Equipment Destruction.

WARNING
Steel-cutting charges produce metal fragments.
Proper precautions should be taken to protect personnel.
Refer to Table 6-3, page 6-7.

a. *Guns.* 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.

(1) Explosive Method.

(a) To prepare a gun for demolition, first 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 should the round be ejected.

(b) Charge Size. Table 3-11 (page 3-32) details the charge size required for standard barrel sizes. If necessary, determine the required charge size using the following formula:

$$P = \frac{D^2}{636} \qquad \textbf{(3-l0)}$$

where–

P = *quantity of explosive (any high explosive), in pounds.*
D = *bore size of the barrel, in millimeters.*

(c) Placement. 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.

Table 3-11. Gun-destruction charge sizes

Serial	Barrel Size (Millimeters)	Charge Size (Pounds)
a	b	c
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); Serial 4 for a 152-mm barrel (38 pounds).		

(2) Improvised Method. 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 the firing party is under cover before firing the gun.

b. *Vehicles.* 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.

(1) Armored Fighting Vehicles (AFVs). 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 the ammunition within the AFV detonates simultaneously with the other charges, and ensure 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 antitank weapons or fire, or destroy the main gun with its own ammunition.

(2) Wheeled Vehicles.

(a) Explosives method. Destroy wheeled vehicles beyond repair by wrecking the vital parts with a sledgehammer or explosives. If high explosives are available, use 2-pound charges to destroy the cylinder head, axles, and frame.

(b) Improvised method. Drain the engine oil and coolant and run the engine at full throttle until it siezes. Finish the destruction by burning the vehicle (ignite the fuel in the tank).

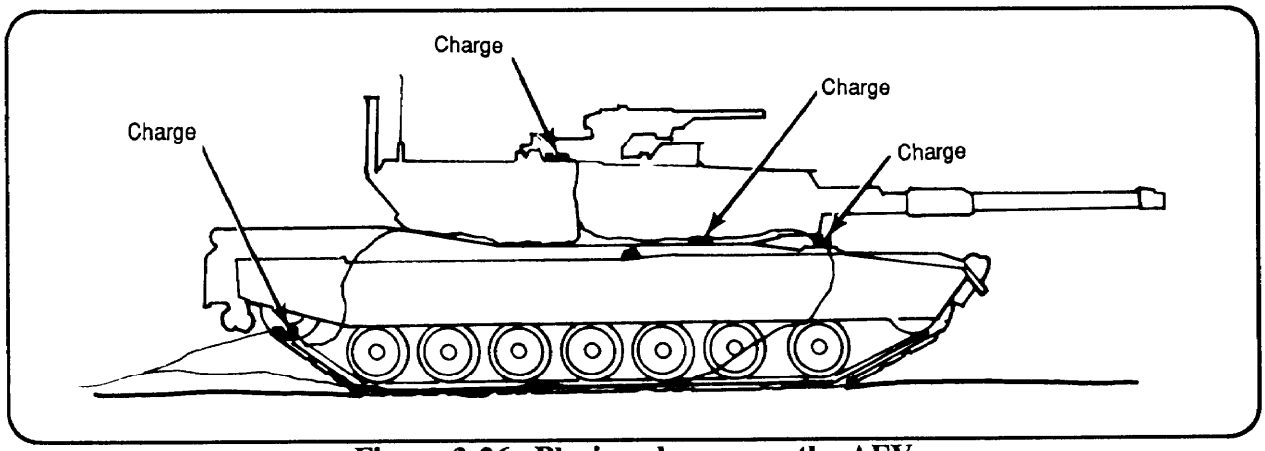


Figure 3-26. Placing charges on the AFV

Chapter 4
Bridge Demolition

Section I. Requirement

4-1. Purpose of Bridge Demolition. The purpose of bridge demolitions is to create gaps in bridges by attacking key components of the bridge. 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 better. The gap may be less than 25 meters if enemy forces must depend on the demolished bridge components to bear their assault bridging and there is insufficient bearing capacity in the remains to carry the loads.

4-2. Degree of Destruction. The complete demolition of a bridge usually involves the destruction of 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 method of attack that achieves the tactical goal, with a minimum expenditure of resources.

4-3. Debris. Debris may cause enemy forces serious delays if it obstructs the gap (Figure 4-l). Debris also provides excellent concealment for mines and booby traps. Whenever possible, demolish bridges in such a way that the resulting debris hinders reconstruction.

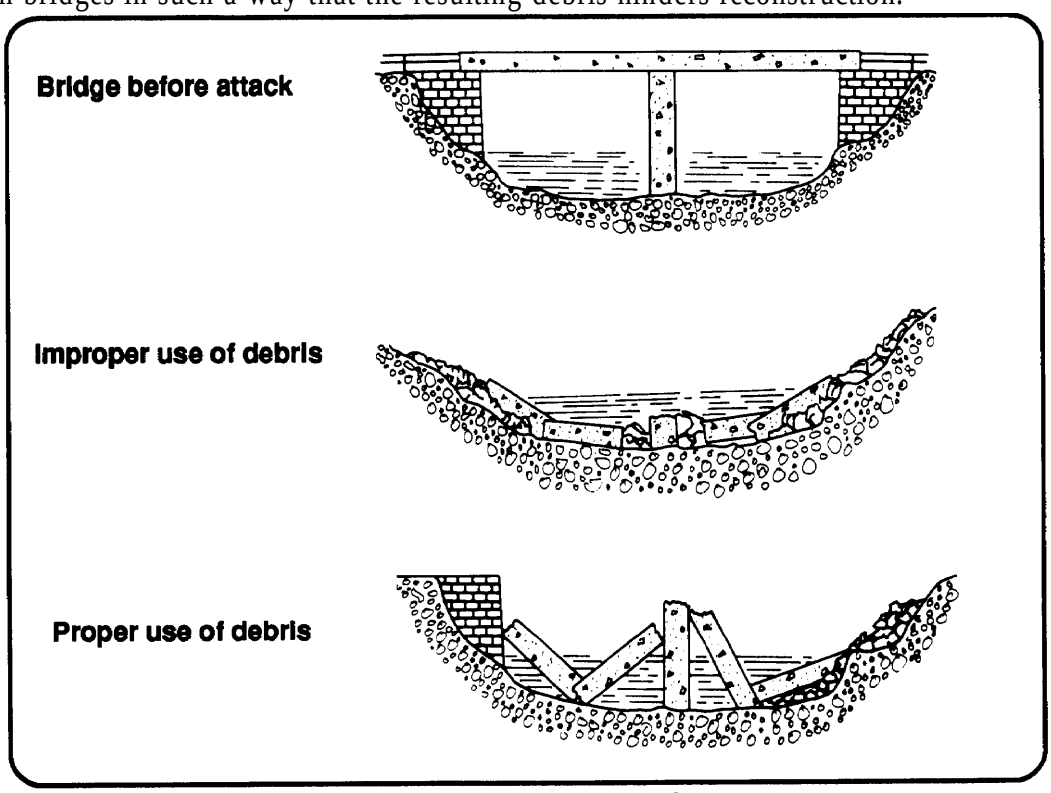


Figure 4-1. Use of debris

Section II. Considerations

4-4. Bridge Categories. 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 three categories:

a. *Simply Supported.* 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).

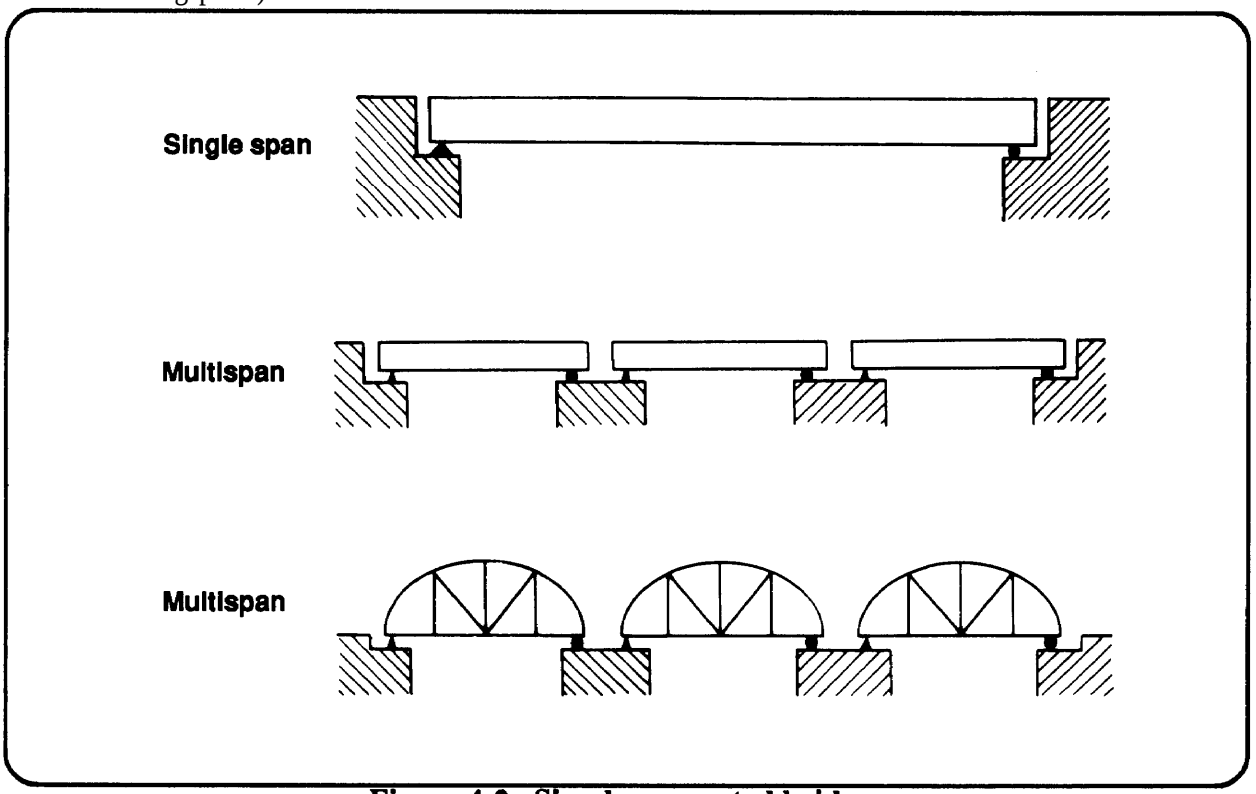


Figure 4-2. Simply supported bridges

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

c. *Continuous.* 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.

4-5. Stages of Destruction. When designing a bridge demolition, the first priority is to create a gap. Accomplishing this may require one or two attacks. Further actions that improve the obstacle may follow, if the situation permits.

a. *Minimum Conditions.* There are two minimum conditions for successful bridge demolition:

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

(1) Condition 1. 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 4-3 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.

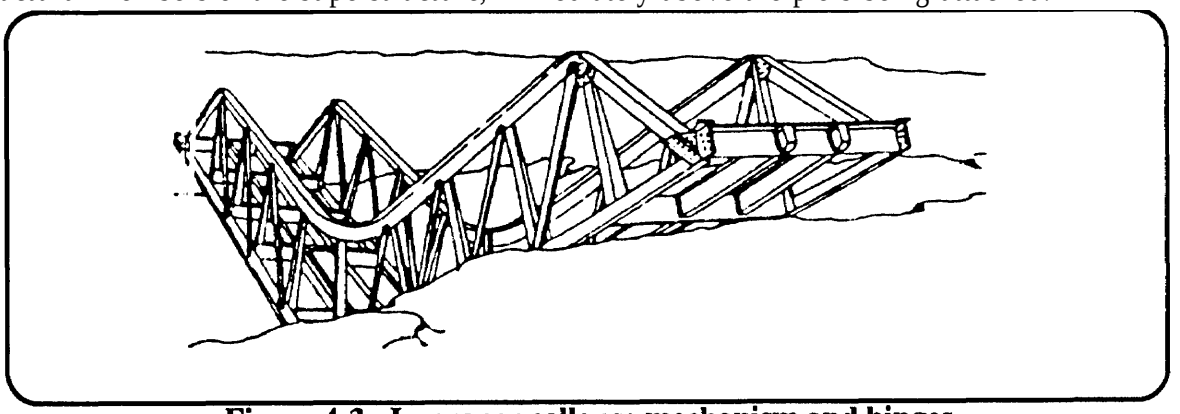


Figure 4-3. Improper collapse mechanism and hinges

(2) Condition 2. Figure *4-4* shows a bridge demolition where the collapse mechanism has formed, but where, because the bridge span has jammed before moving far enough, it has failed to form the desired obstacle. 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.

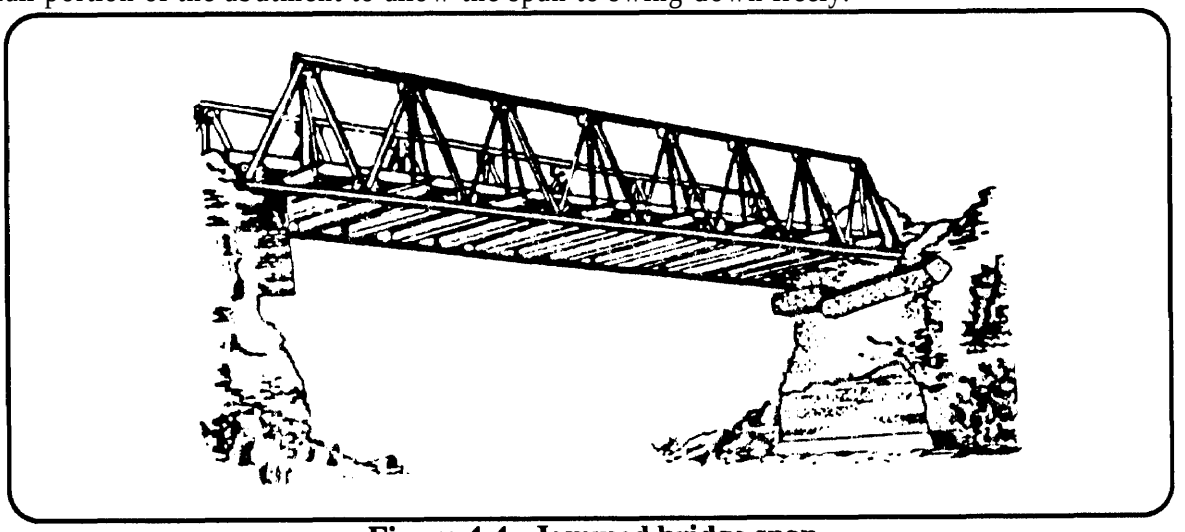


Figure 4-4. Jammed bridge span

b. *Types of Collapse Mechanism.* Figures 4-5 through 4-7 illustrate the three basic collapse mechanisms.

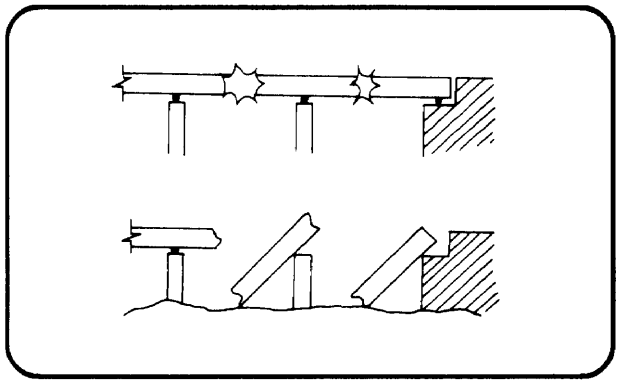


Figure 4-5. See-saw collapse mechanism

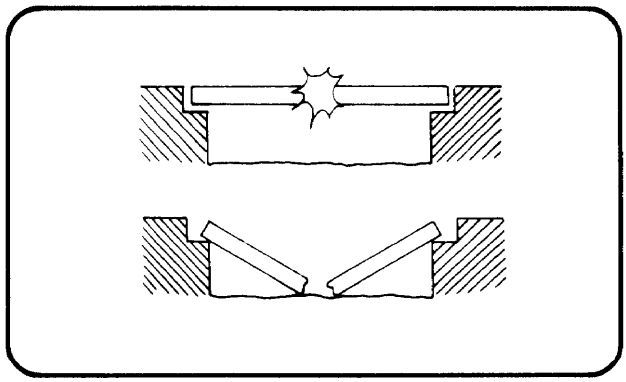


Figure 4-6. Beam collapse mechanism

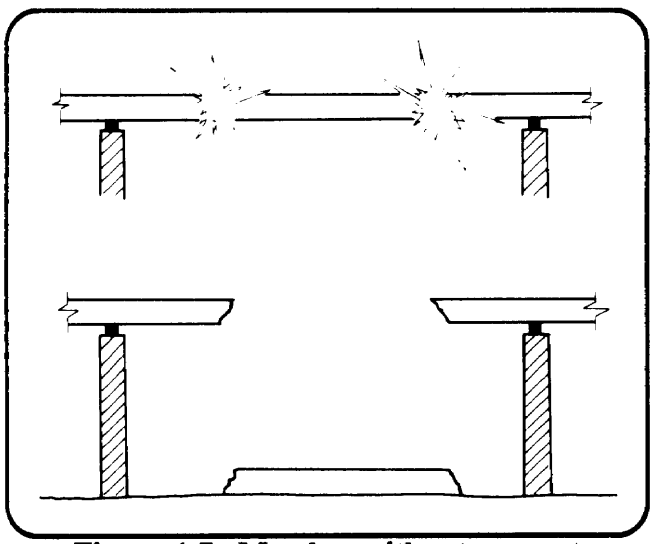


Figure 4-7. Member without support collapse mechanism

c. Unsuccessful Bridge Demolitions. Two possible reasons for unsuccessful bridge demolitions are—

(1) No-Collapse Mechanism. The formation of cantilevers (Figure 4-8) is a typical example of a no-collapse mechanism being formed. The likelihood of this occurring is high when attacking continuous bridges.

(2) Jamming. The span, once moved by the collapse mechanism, jams before moving far enough to create the desired obstacle. The most likely causes of jamming are the formation of a three-pin arch or a cranked beam (Figure 4-9). When attacking bridge spans, always consider the possibility of jamming during bottom and top attacks.

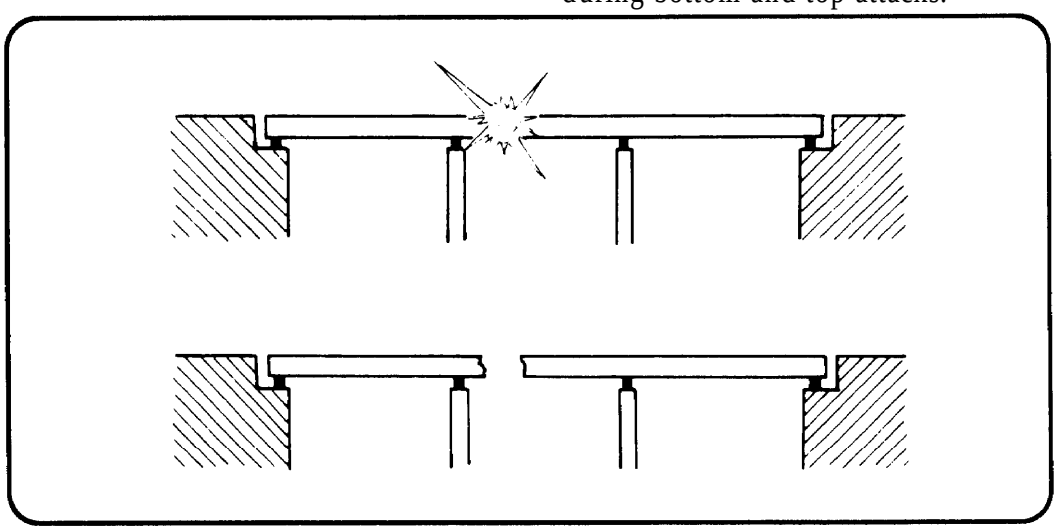


Figure 4-8. Cantilever effect

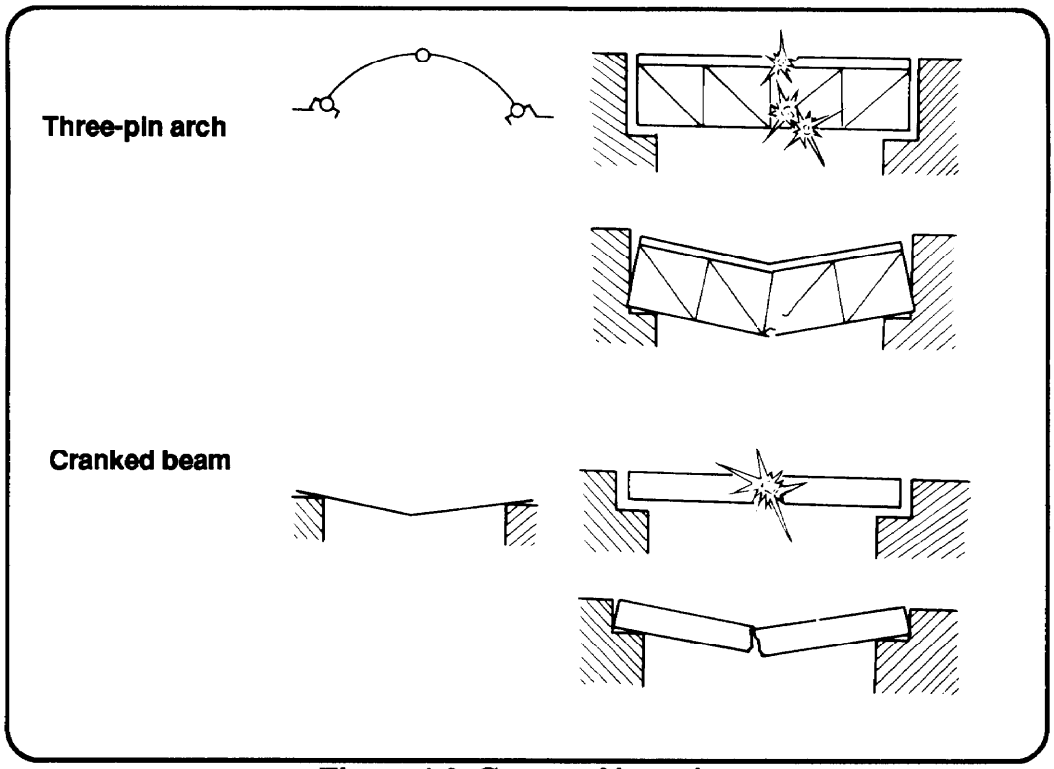


Figure 4-9. Causes of jamming

4-6. Bottom Attack. In the bottom attack, the 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 between the span ends and the pier or abutment faces (Figure 4-10). If a three-pin arch situation is likely, do not attempt a bottom attack.

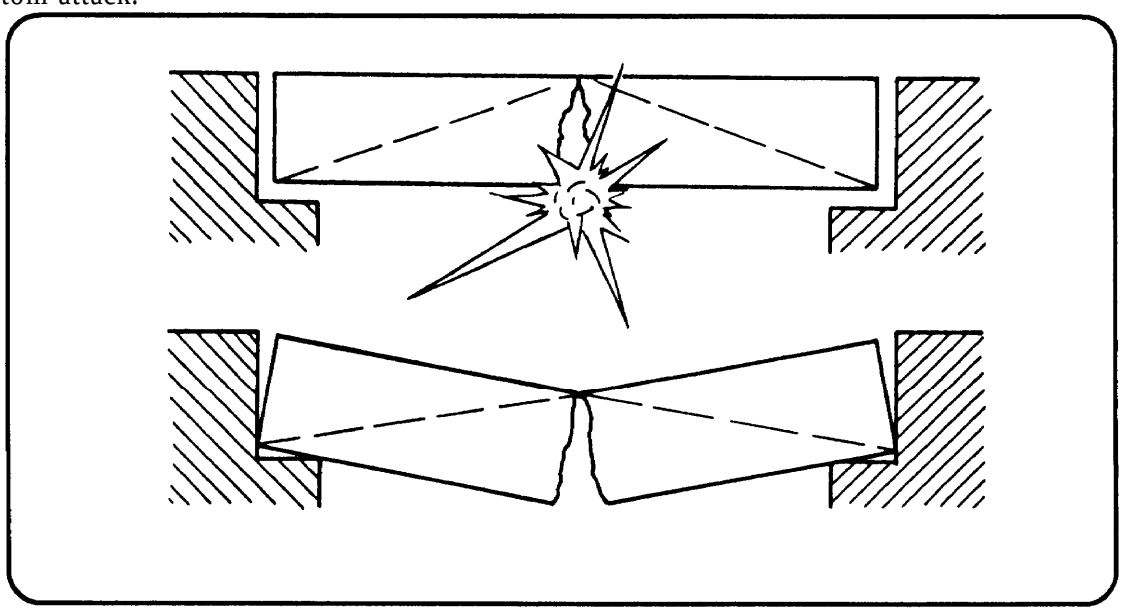


Figure 4-10. Three-pin arch effect

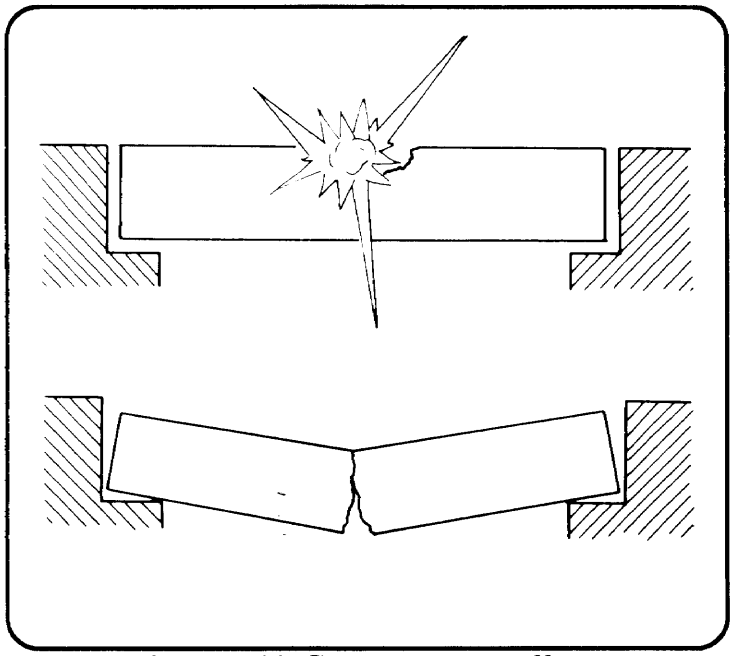


Figure 4-11. Cranked-beam effect

4-7. Top Attack. In a top attack, the 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 have fallen off the abutments, forming a cranked beam (Figure 4-11). Ensure the length of span removed (L_C) at the top is sufficient to prevent the formation of a cranked beam.

4-8. Efficient Demolition Methods. 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—

a. Achieve the desired effect.

b. Use the minimum amount of resources (time, manpower, and explosives).

c. 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. Alternatively, to improve an obstacle, it may be necessary 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).

(1) Priority One. Create the desired obstacle. The minimum gap required is 5 meters greater than the enemy's assault bridging capability. Ideally, accomplish the demolition 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.

(2) Priority Two. 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-

(a) Destroy and mine the blown abutment.

(b) Lay mines in likely bypasses.

(c) Blast craters and lay mines in likely approaches.

(d) Destroy the piers.

4-9. Concrete-Stripping Charges.

a. *Description.* 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 4-12 shows the effect of the concrete-stripping charge. Using the proper charge size for the thickness of the target will—

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

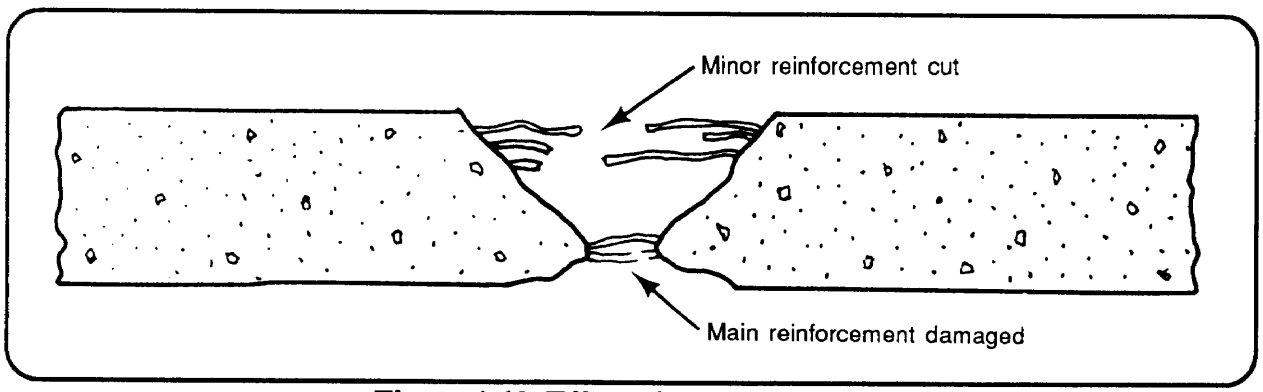


Figure 4-12. Effect of concrete charge

b. *Charge Calculations (Simply Supported Bridges).* 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. Example A-12 (page A-10) shows how to calculate beam-and-slab bridge charges. Use the following procedure for determining charge sizes for simply supported spans:

(1) Calculate the mass of the charge required:

$$P = 3.3(3.3\,h + 0.5)^3 \qquad (4\text{-}1)$$

where—

P = *required charge size, in pounds per meter of bridge width.*
h = *beam or slab plus roadway depth, in meters (minimum is 0.3 meters and maximum is 2 meters).*

(2) 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:

$$W_d = 2h + 0.3 \qquad (4\text{-}2)$$

where-

W_d = *ditch width, in meters.*
h = *overall roadway and beam or slab depth, in meters.*

(3) 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 charge by 10 percent.
- If L_c is twice W_d, double the charge and place them in two lines, side by side.

(4) Place charges in a continuous line across the full width of the bridge at the point of attack. The shape of the end cross section of the charge should be such that the width is between one and three times the height.

(5) 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. The width of ditch formed will remain the same as for the original mass of charge.

Section III. Bridge Attacks

4-10. Guidelines (Continuous and Simply Supported Bridges). There are a number of factors that will assist you inadequately differentiating simply supported bridges from continuous bridges. Figure 4-13 and the subparagraphs below describe these factors.

a. *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.

b. *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.

c. *Flange Thickness (Steel-Girder Bridges).* In simply supported, steel-girder bridges, the thickness of the flange frequently increases at midspan. In continuous bridges, the size of the flange frequently increases over the piers.

d. *Bearing.* Multispan, simply supported bridges require two lines of bearing at the piers; continuous bridges require only one.

e. *Category Selection.* The external appearance of a bridge can sometimes be deceptive. Whenever possible, consult construction drawings to ascertain 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.

f. *Reconnaissance Procedures.* To correctly use the tables in Appendix H, decide whether the bridge is in the simply supported, continuous, or miscellaneous category, and follow the procedures outlined in the appropriate paragraph.

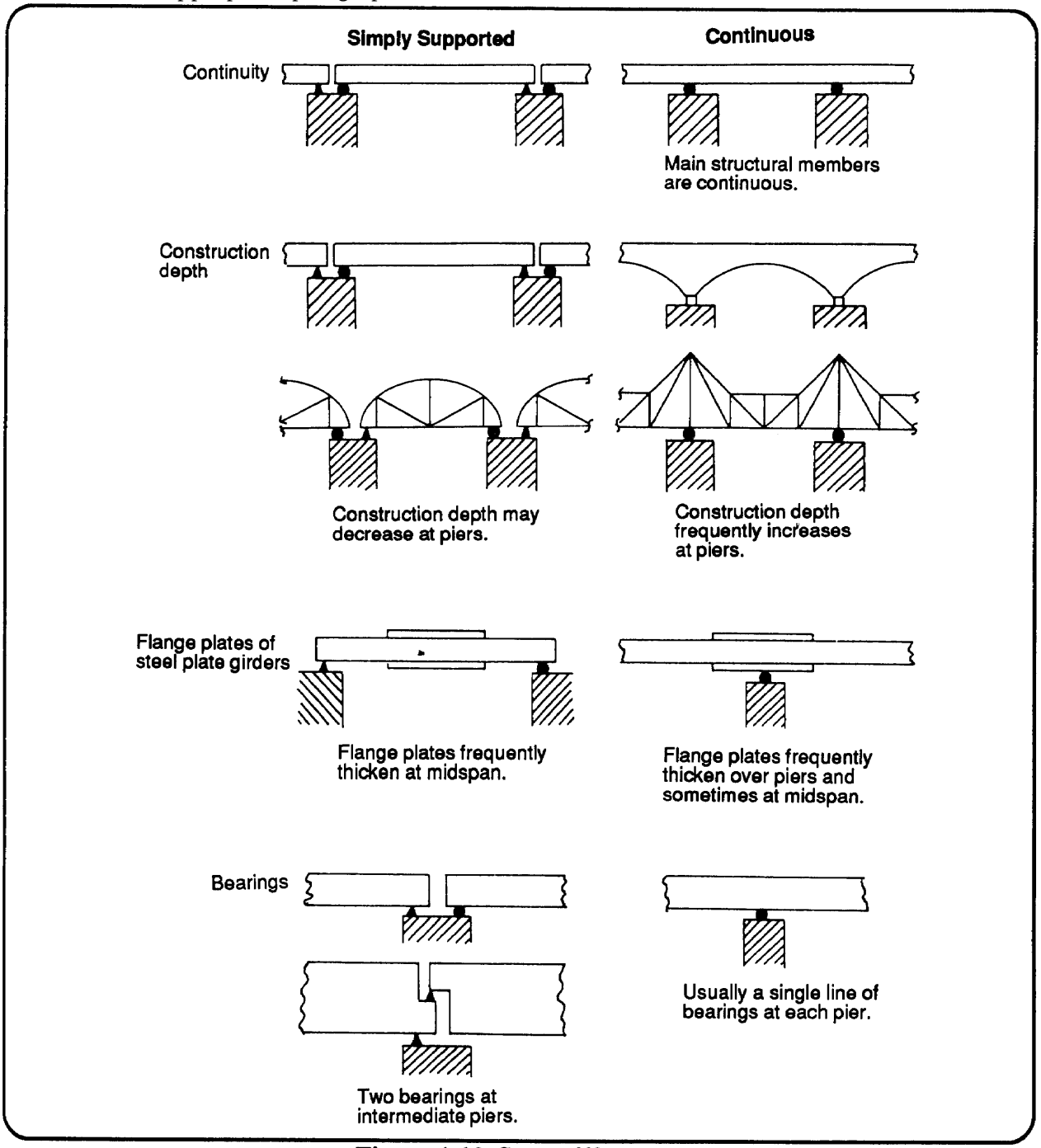


Figure 4-13. Span differences

4-11. Simply Supported Bridges.

a. *Categorization.* Figure 4-14 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 bowstring. The first three are further subdivided into deck bridges, which carry their loads on top of the main structural members. 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.

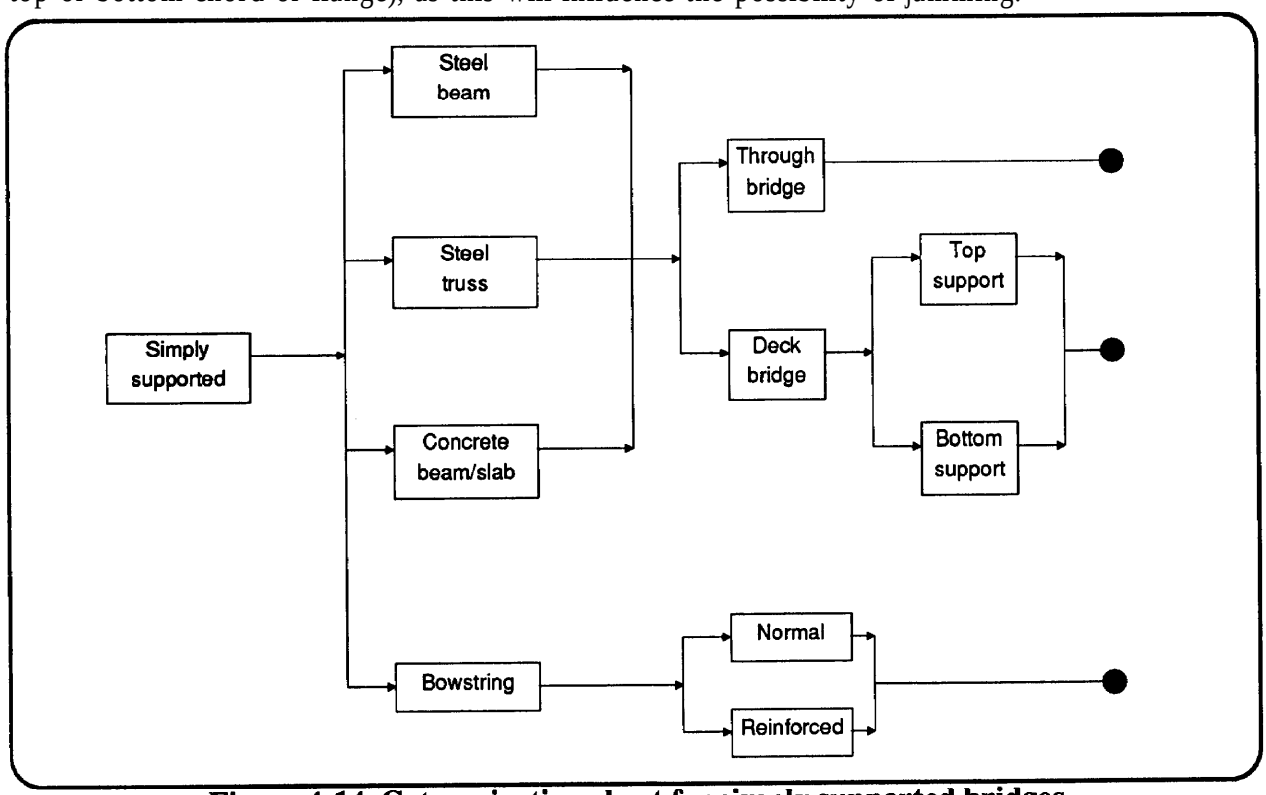


Figure 4-14. Categorization chart for simply supported bridges

(1) Steel-Beam Bridges. Stell-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.

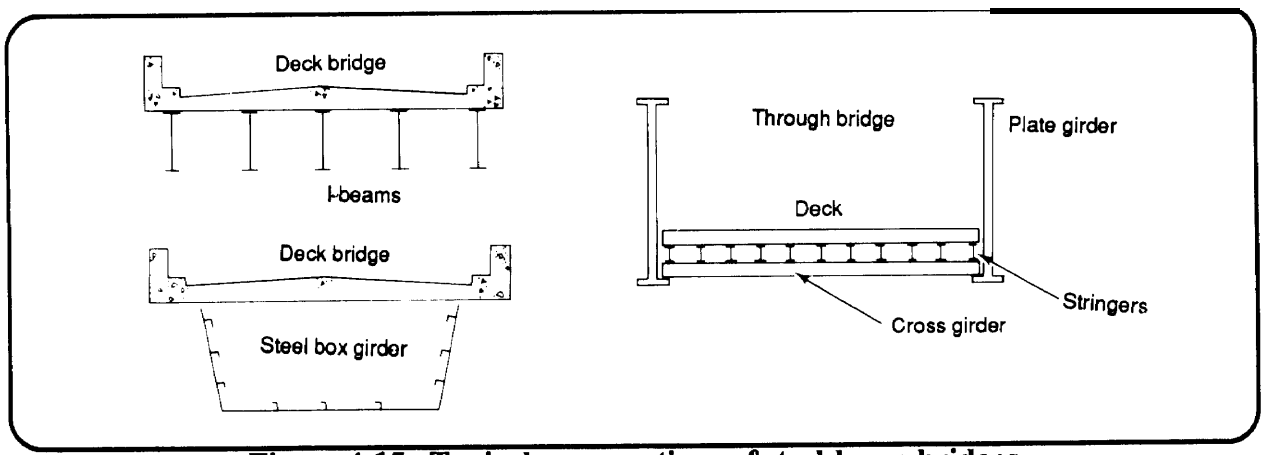


Figure 4-15. Typical cross sections of steel-beam bridges

(2) Steel-Truss Bridges. Figure 4-16 shows the side elevations for three normal steel-truss spans. Note that *all* truss bridges have diagonal members in the trusses.

(3) Concrete-Beam-and-Slab Bridges. For categorization purposes, you will not need to distinguish between reinforced- and prestressed-concrete bridges, as the methods of attack are the same for both. Figure 4-17 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 H take this reinforcing condition into account.

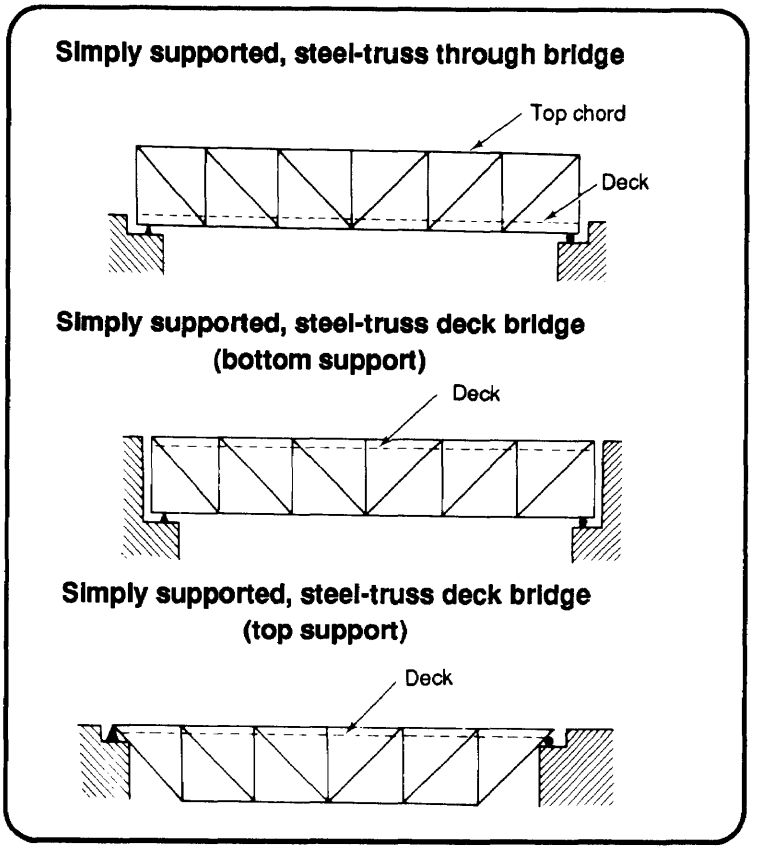


Figure 4-16. Side elevation of steel-truss bridges

(4) Bowstring Bridges. Note the following about bowstring bridges:

(a) Features. Figure 4-18 (page 4-12) shows the features of a normal bowstring bridge. Recognize that—

- 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 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.

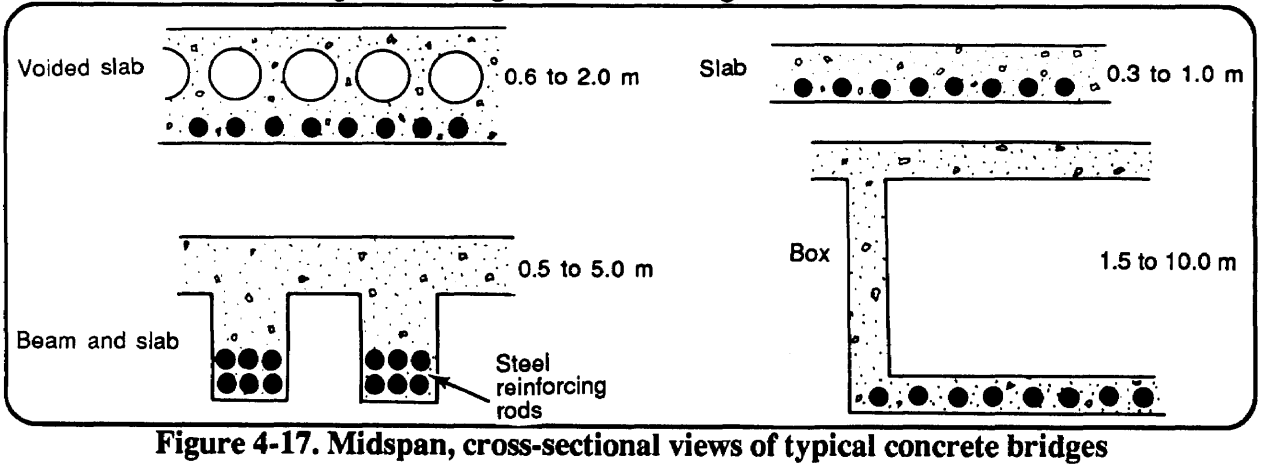


Figure 4-17. Midspan, cross-sectional views of typical concrete bridges

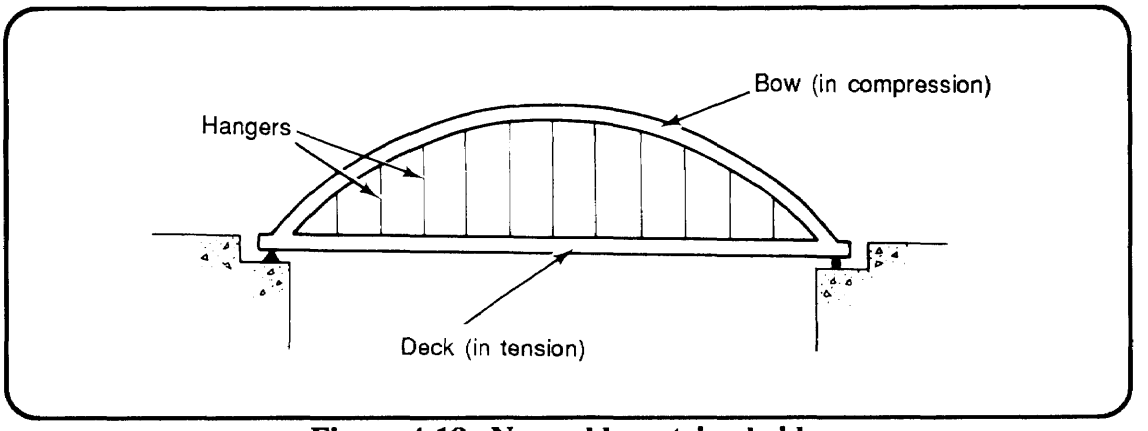


Figure 4-18. Normal bowstring bridge

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

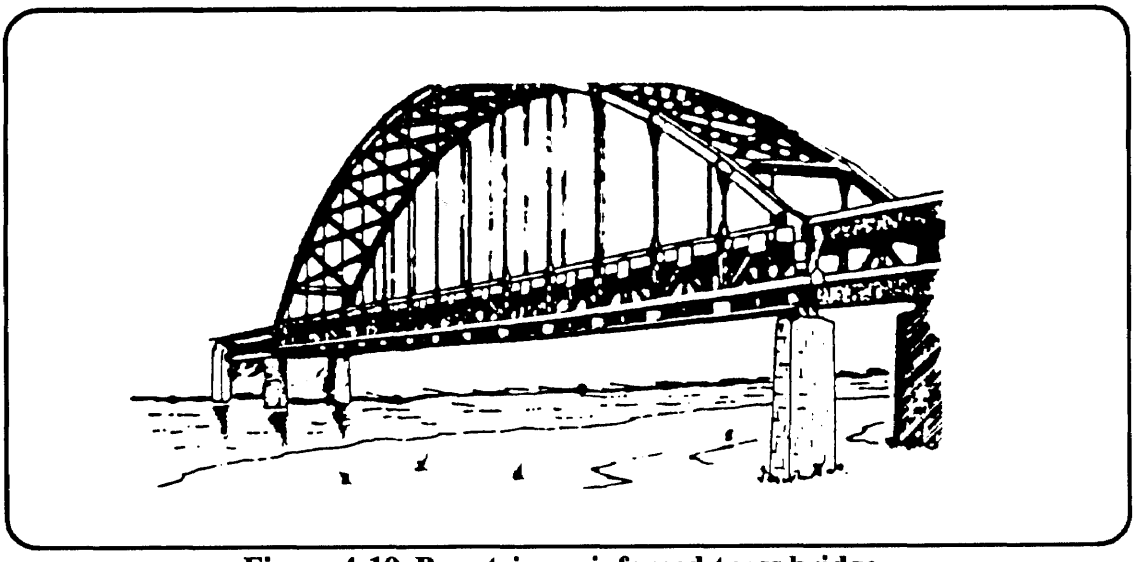


Figure 4-19. Bowstring reinforced-truss bridge

(c) Pseudo-bowstring bridges. The bridge illustrated in Figure 4-20 is not a bowstring, but an arch bridge. Categorize this type of bridge as an arch bridge because the outward forces of-the arch (pseudo bow) are restrained primarily by the abutments, not the deck.

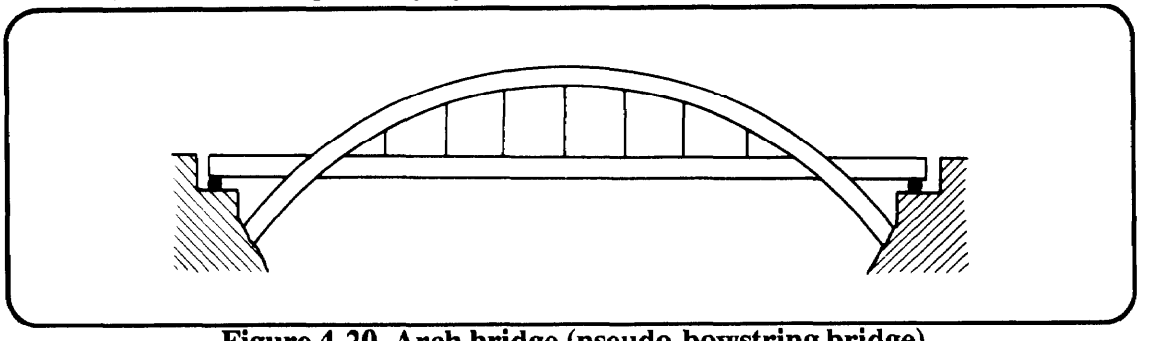


Figure 4-20. Arch bridge (pseudo-bowstring bridge)

b. *Reconnaissance.* For simply supported bridges, use the following reconnaissance procedure:

(1) Categorize the bridge.

(2) Measure the bridge (Figure 4-21):

(a) 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.

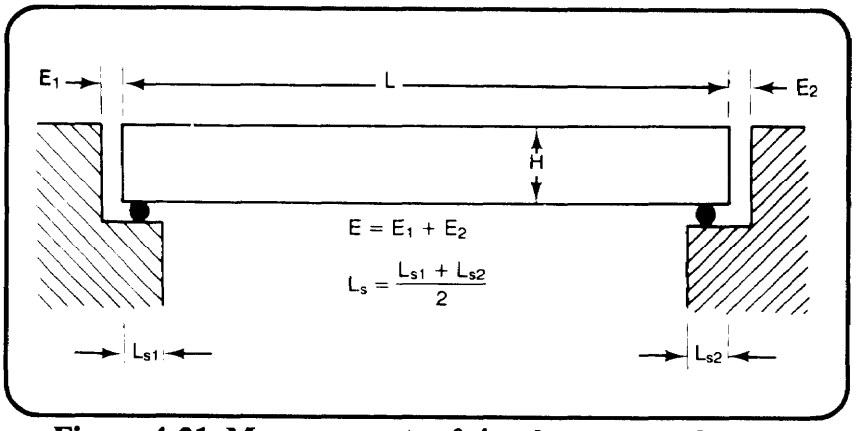


Figure 4-21. Measurements of simply supported spans

(b) Depth *(H).* Measure the depth of the beam, truss, or bow, in meters (include the deck with the beam or truss measurement).

(c) Total end clearance *(E).* Total the amount of end clearance at both ends of the span, in meters.

(d) 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.

(3) Determine the attack method (Appendix H).

(4) Determine the critical dimensions of the span required for charge calculations.

c. *Attack.* Two considerations apply when attacking a simply supported span:

(1) Point of Attack. 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.

(2) Line of Attack. Make the line of attack parallel to the lines of the abutments (Figure 4-22). Doing 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 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.

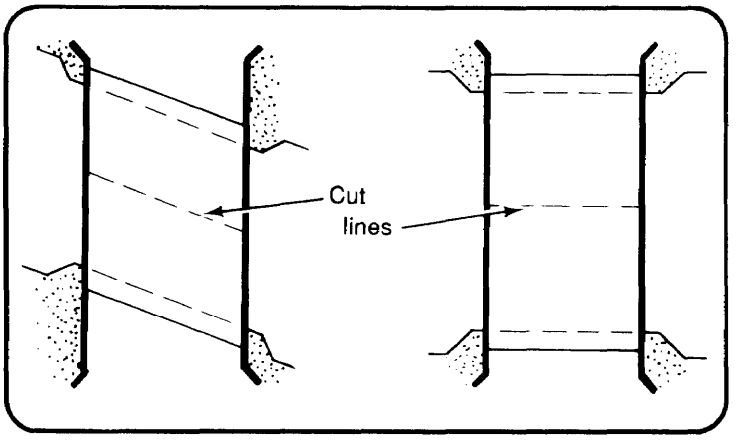


Figure 4-22. Line of attack

d. *Attack Methods.* Table H-3 (page H-3) lists in recommended order, attack methods likely to produce the most economical demolition, by bridge category. 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 jamming cannot occur during collapse.

(1) Bottom Attack. 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 meters, used the top or angled attacks listed in Table H-3 (page H-3) for these types of bridges. When Table H-3 (page H-3) lists a bottom attack, determine the required end clearance *(ER)* from Table H-1 (page H-1) to prevent jamming. If the total end clearance *(E)* is greater than *ER*, jamming will not occur. If *E* is less than *ER*, use a top or angled attack or destroy one abutment at the places where jamming would occur. Example A-13 (page A-12), explains the method for bottom attack calculations.

(2) Top Attack. When Table H-3 (page H-3) lists a top attack, L_C must be removed from the top of the bridge to prevent jamming. Determine L_C from Table H-2 (page H-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 4-9, 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 A-14 (page A-13) shows the method for top attack calculations.

(3) Angled Attack. For angled attacks, cut all members (span, hand-rails, service pipes, and so forth) of the bridge. Make the angle of attack approximately 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 4-23). 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.

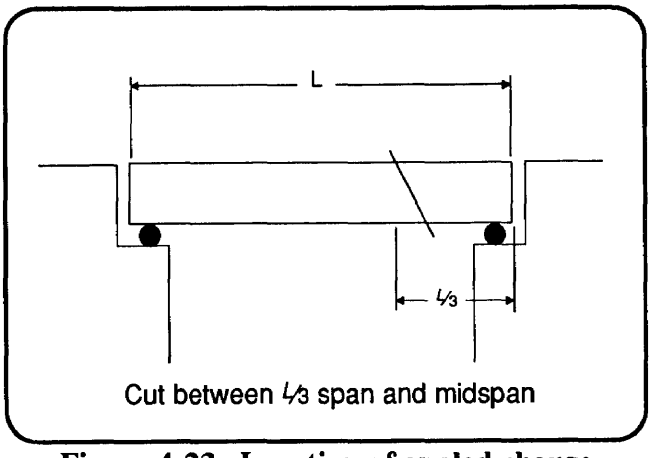


Figure 4-23. Location of angled charge

4-12. Continuous Bridges.

a. *Categorization.* Figure 4-24 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.

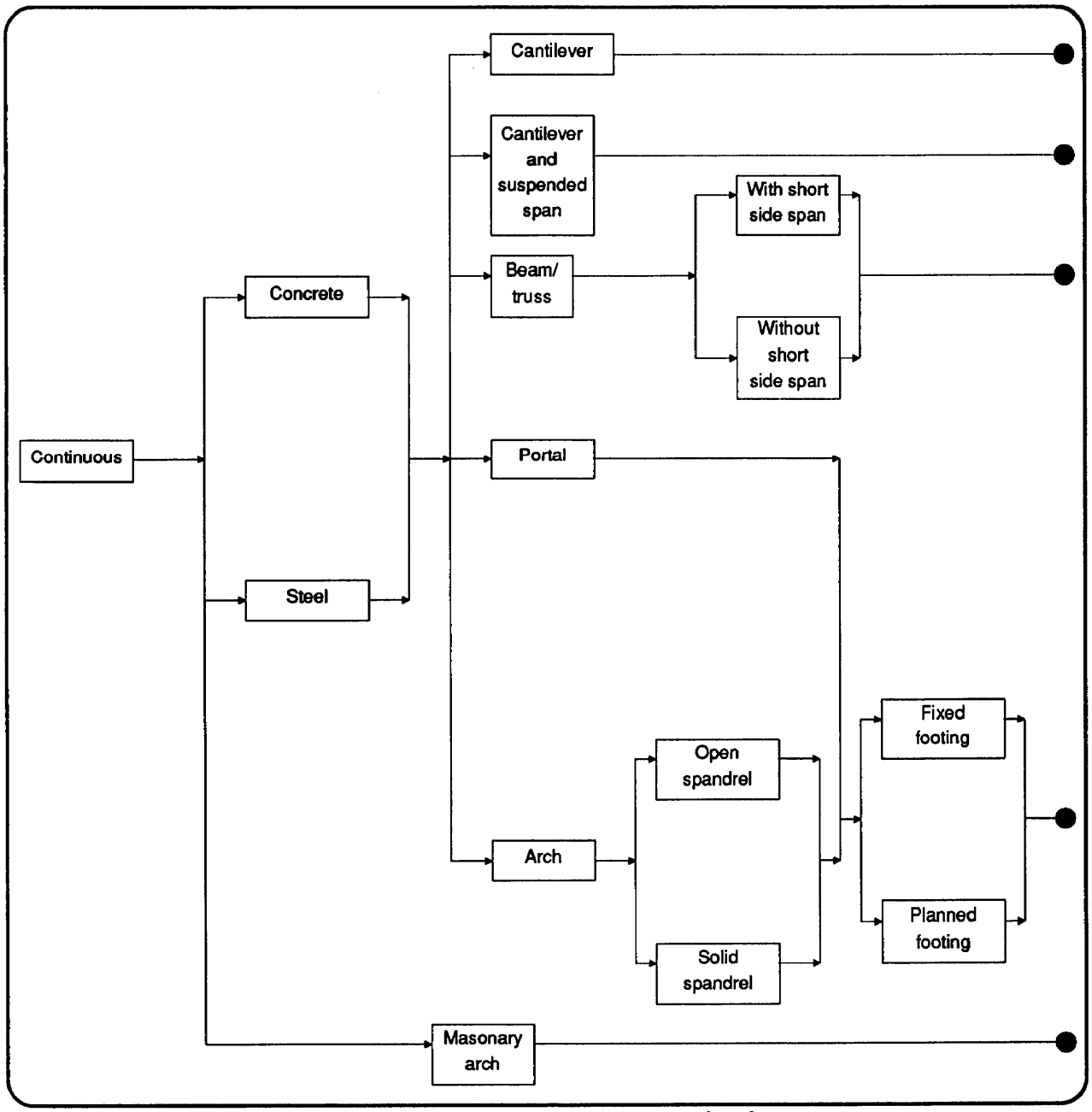


Figure 4-24. Continuous-bridges categorization chart

(1) Cantilever Bridges. A cantilever bridge (Figure 4-25, page 4-16) 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.

(2) Cantilever and Suspended-Span Bridges. If a cantilever bridge incorporates a suspended span (Figure 4-26, page 4-16) that is at least 5 meters longer than the enemy assault bridging capability, attack this section of the bridge; attacking this section requires less preparation. Because

suspended spans are simply supported, use the attack method described for simply supported bridges (Table H-3, page H-3).

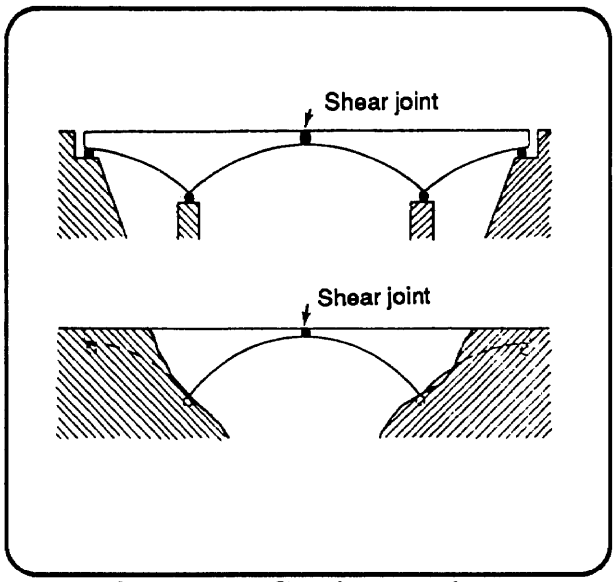


Figure 4-25. Cantilever bridges

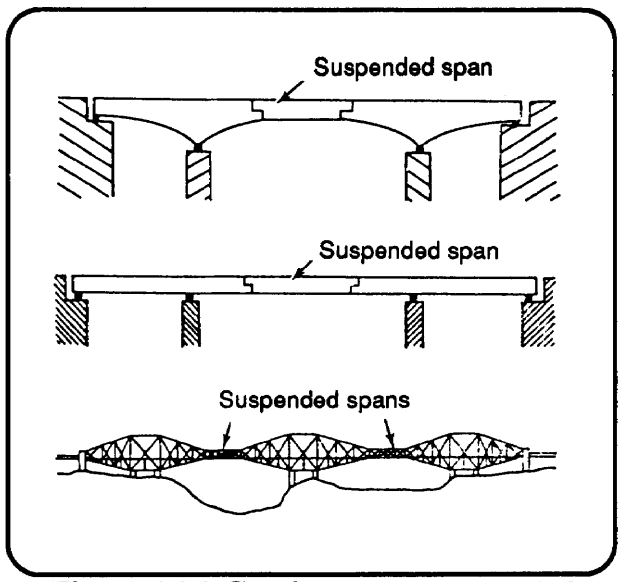


Figure 4-26. Cantilever and suspended span bridges

(3) Beam or Truss Bridges. For beam or truss bridges (Figures 4-27 through 4-29), 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.

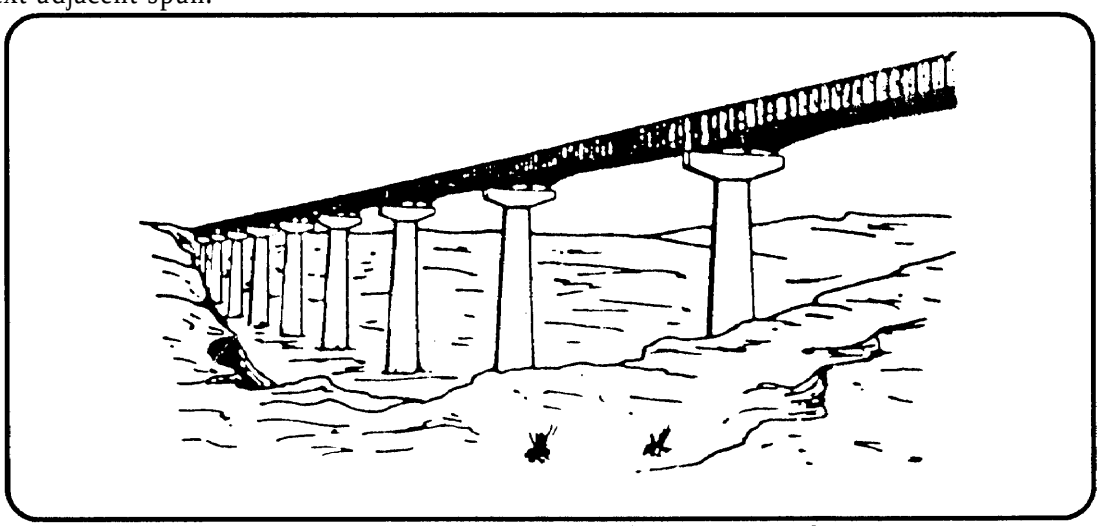


Figure 4-27. Steel-beam bridge without short side span

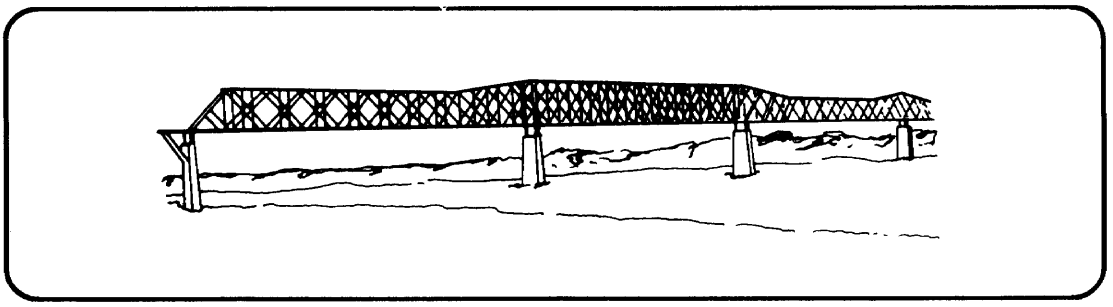


Figure 4-28. Steel-beam bridge with short side span

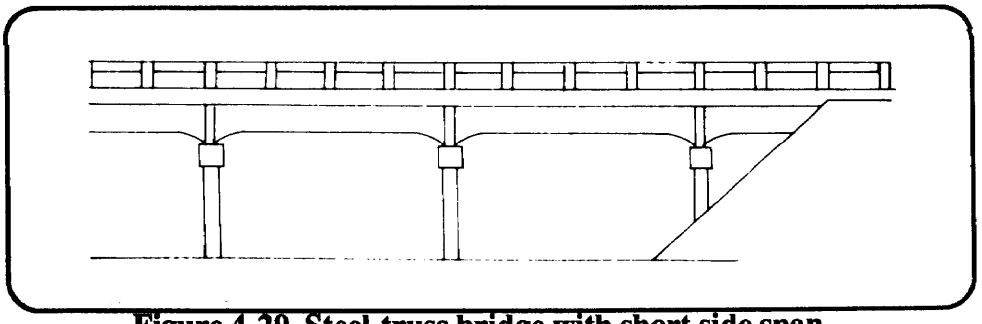


Figure 4-29. Steel-truss bridge with short side span

(4) Portal Bridges. For portal bridges (Figure 4-30), 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.

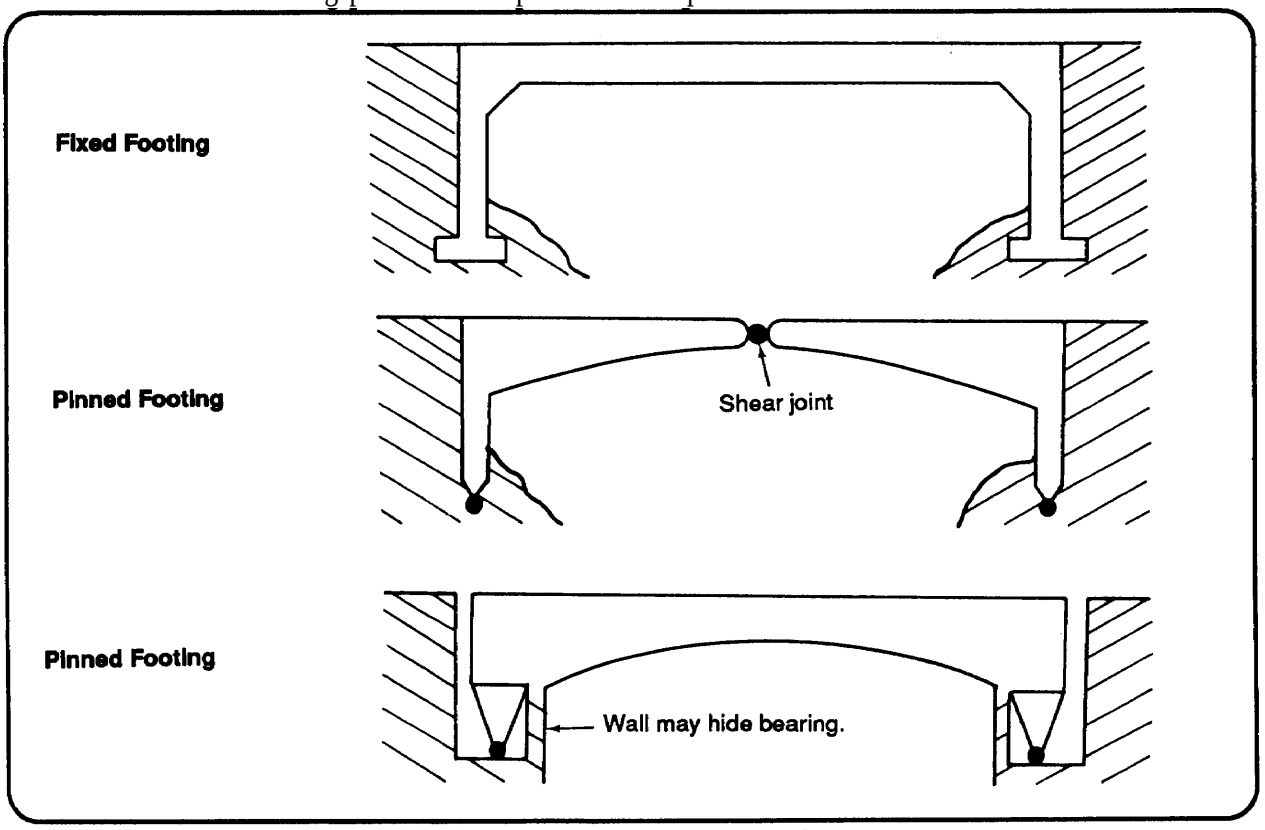


Figure 4-30. Typical portal bridges

(5) Arch Bridges. In arch bridges (Figure 4-31), determine whether the bridge has an open or solid spandrel and fixed or pinned footings. Again, when in doubt, assume fixed footings.

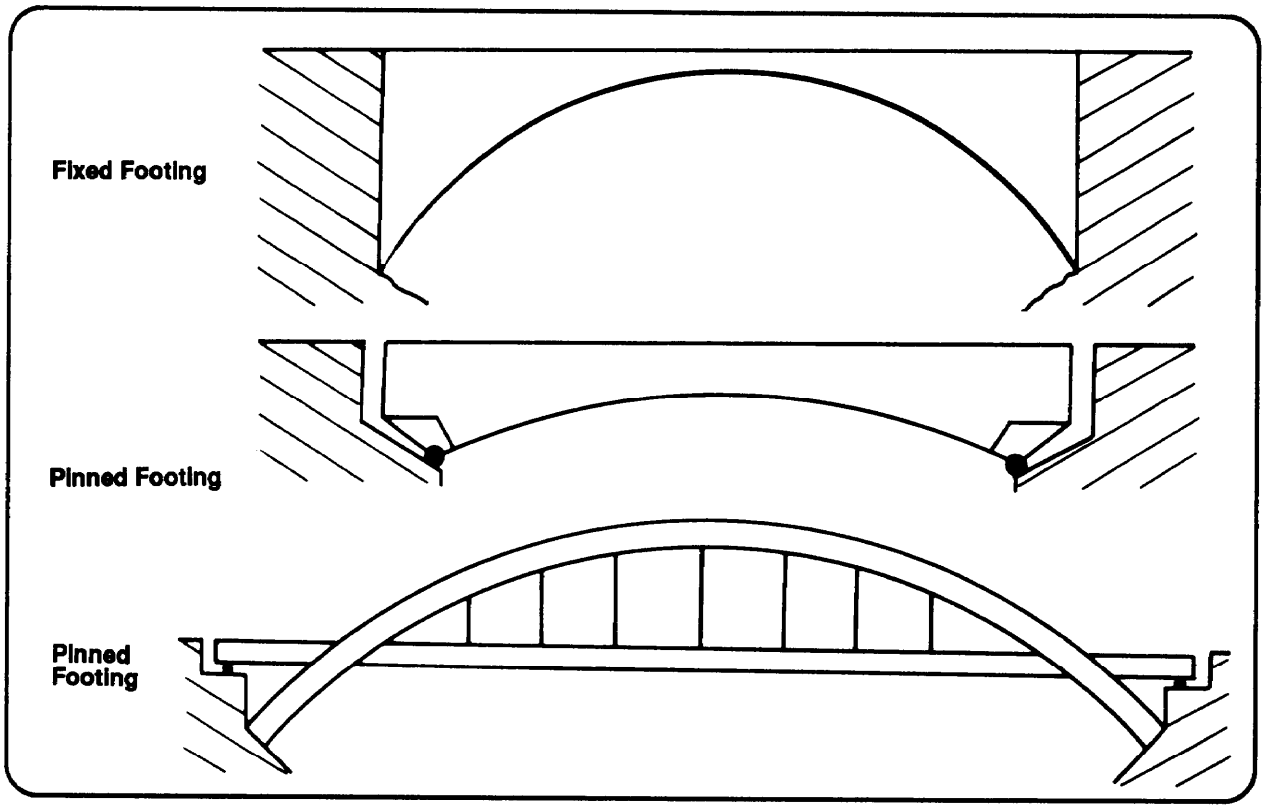


Figure 4-31. Arch bridges

(6) Masonry Arch Bridges. Identify masonry arch bridges (Figure 4-32) by their segmental arch ring. However, 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.

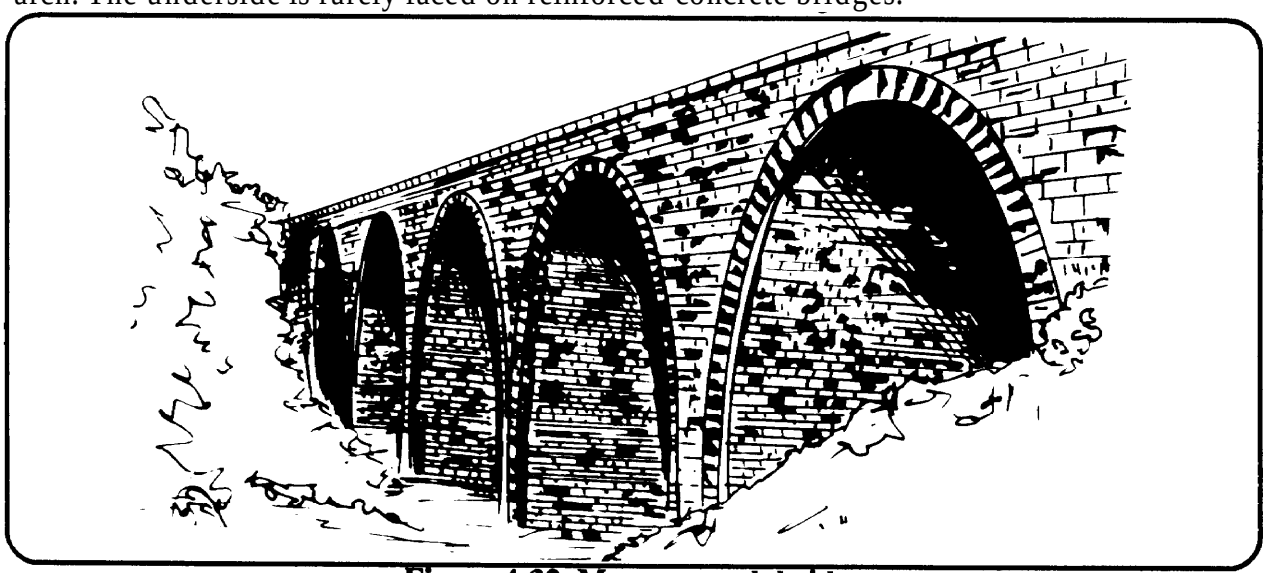


Figure 4-32. Masonry arch bridge

b. *Reconnaissance.* For continuous bridges, use the following reconnaissance procedure:

(1) Categorize the bridge.

(2) Measure the bridge (Figure 4-33):

(a) Length *(L).* Measure the span you plan to attack, in meters (between centerlines of the bearings).

(b) 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).

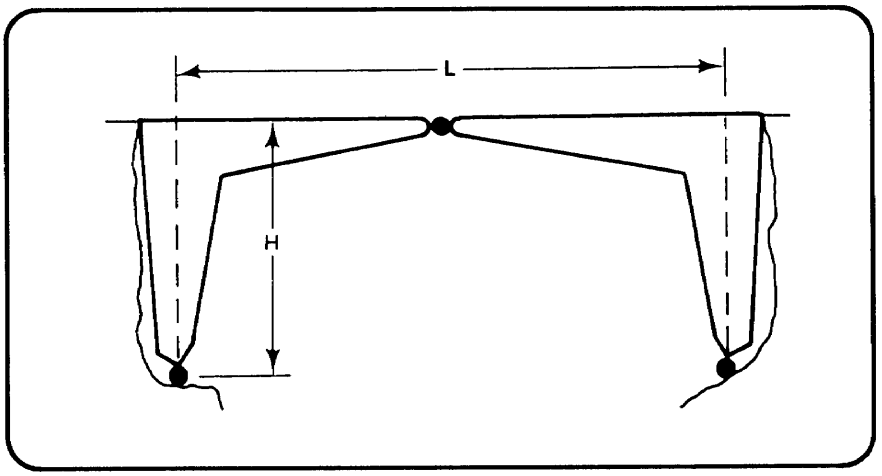


Figure 4-33. Measurements of continuous bridges

(c) Determine the attack method from Appendix H.

(d) Determine the critical dimensions necessary for charge calculations.

c. *Bridge Attacks.* As with simply supported spans, two considerations apply when attacking continuous spans: the point of attack and 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 H-4 (page H-7) lists attack methods for continuous spans.

(1) Steel Bridges. 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.

(2) Concrete Bridges. 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. Consider using a bottom attack for this bridge type.

(3) Arch and Portal Bridges. For arch bridges and portal bridges with pinned footings, collapse can be guaranteed only be removing a specified minimum span length. Determine this minimum length by using Table 4-1 (page 4-20) and the *L* and *H* values determined by reconnaissance. Example A-15 (page A-14) explains the method for arch bridge attack calculations.

Table 4-1. 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	

NOTES:

1. The values in this table are based on the following formula:

$$\frac{L_c}{L} = 1 - [1 - 4(\frac{H}{L})^2]^{1/2}$$

2. If the result of $\frac{H}{L}$ is not on the chart exactly as calculated, round UP to the next higher value on the chart. For example, if $\frac{H}{L} = 0.089$, use the column headed 0.10 to determine $\frac{L_c}{L}$. In this case, $\frac{L_c}{L} = 0.02$. Multiply the $\frac{L_c}{L}$ value by L to get L_c. For example, $0.02 \times L = L_c$.

4-13. Miscellaneous Bridges.

a. *Suspension-Span Bridges.* 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 4-34).

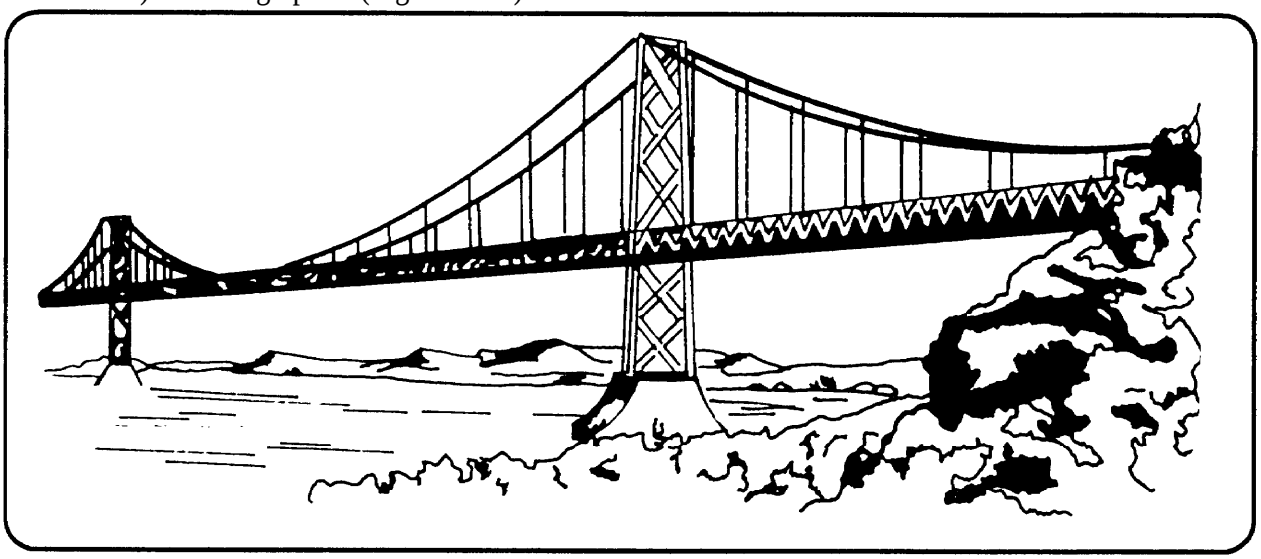


Figure 4-34. Suspension-span bridge

(1) Components. 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.

(2) Demolishing Methods.

(a) Major bridges. Anchors for major suspension bridges are usually too massive to be demolished. The cables are usually too thick to be effectively cut 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.

(b) Minor bridges. The two vulnerable points on minor suspension bridges are towers and cables. Use the following 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. Doing this will prevent the end of a single cut from remaining intact. Demolition chambers, provided 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 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 cable cutting.

b. *Movable Bridges.* These 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.

(1) Swing-Span Bridges.

(a) Characteristics. 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. If the arms are not of equal length, weights are added to balance them. 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 4-35).

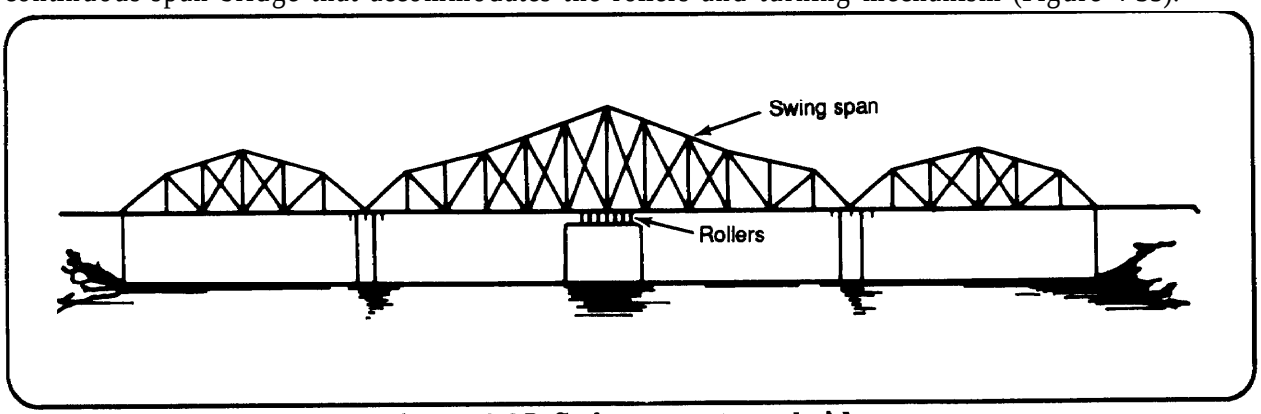


Figure 4-35. Swing-span truss bridge

(b) Demolition methods. Because swing-span bridges are continuous bridges, use an attack method from the continuous bridge section in Appendix H. For partial demolition, open the swing span and damage the turning mechanism.

(2) Bascule Bridges.

(a) Characteristics. Bascule bridges are more commonly known as drawbridges. These bridges usually have two leaves that fold upward (Figure 4-36), but some bascule bridges may have only one leaf (Figure 4-37). The movable leaves in bascule bridges appear in three general forms: counterweights below the road level (most modem), counterweights above the road level (older type), and no counterweights (lifted by cable or rope; oldest type; usually timber).

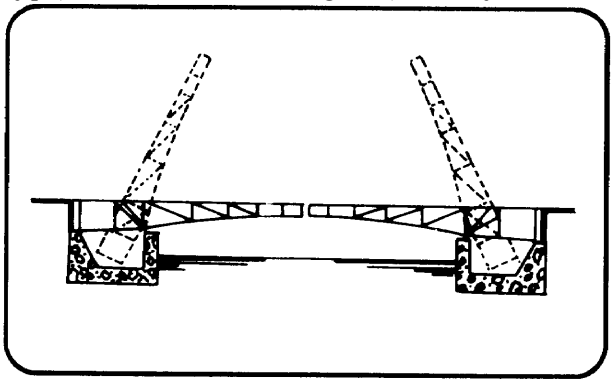


Figure 4-36. Double-leaf bascule bridge

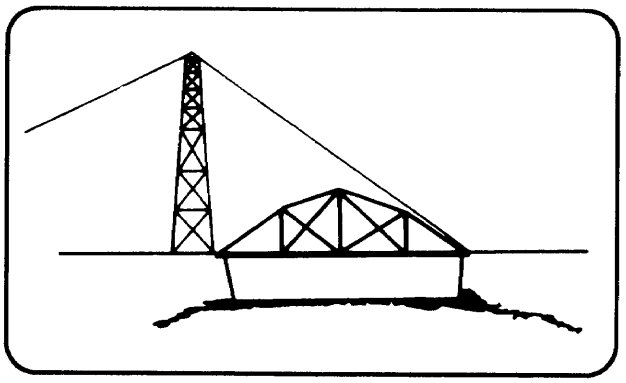


Figure 4-37. Single-leaf bascule bridge

(b) Demolition methods. 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.

(3) Vertical-Lift Bridges.

(a) Characteristics. 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 4-38).

(b) Demolition methods. 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.

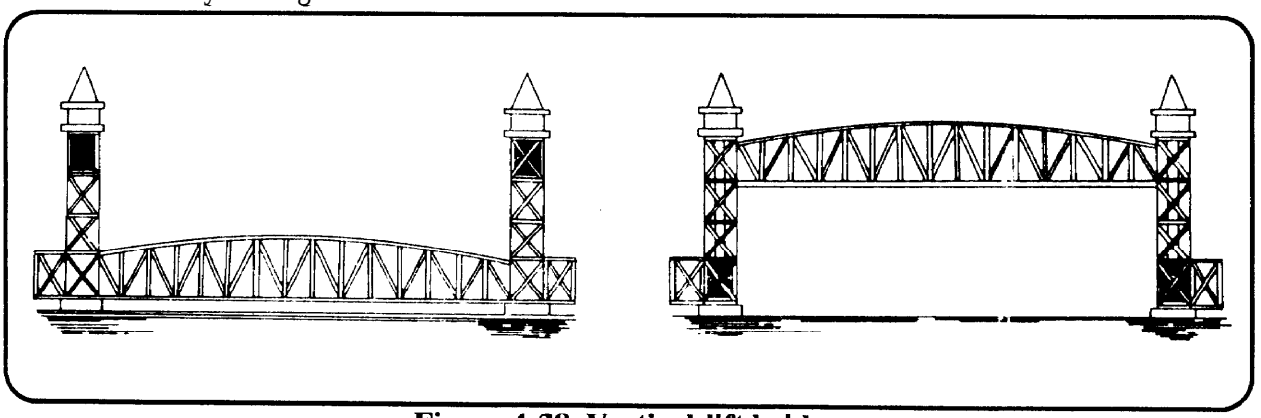


Figure 4-38. Vertical-lift bridge

(4) Floating Bridges. Floating bridges consist of a continuous metal or wood roadway supported by floats or pontoons (Figure 4-39).

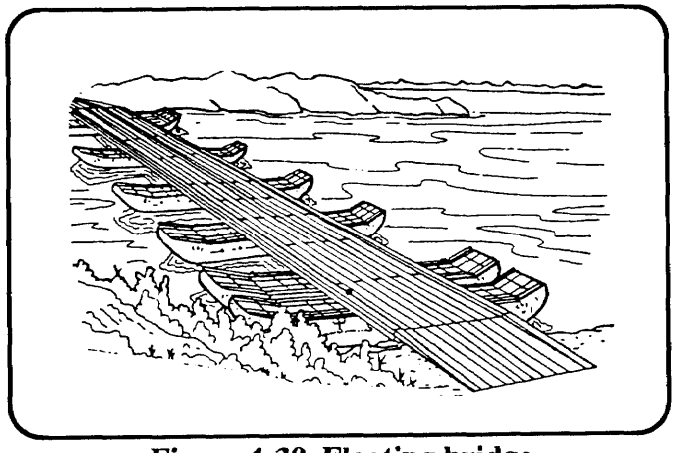


Figure 4-39. Floating bridge

(a) Pneumatic floats. Pneumatic floats are airtight compartments of rubberized fabric inflated with air. For 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.

b) Rigid pontoons. Rigid pontoons are made of various materials: wood, plastic, or metal. To destroy these bridges, place a ½-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 ½-pound charges at each end of each pontoon and detonate them simultaneously. To destroy metal treadways on floating bridges, use the steel-cutting formula (paragraph 3-6, page 3-8). 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.

(5) Bailey Bridges. To destroy these bridges, place l-pound charges between the channels of the upper and lower chords. Use ½-pound charges for cutting diagonals and l-pound charges for cutting sway bracing (Figure 4-40).

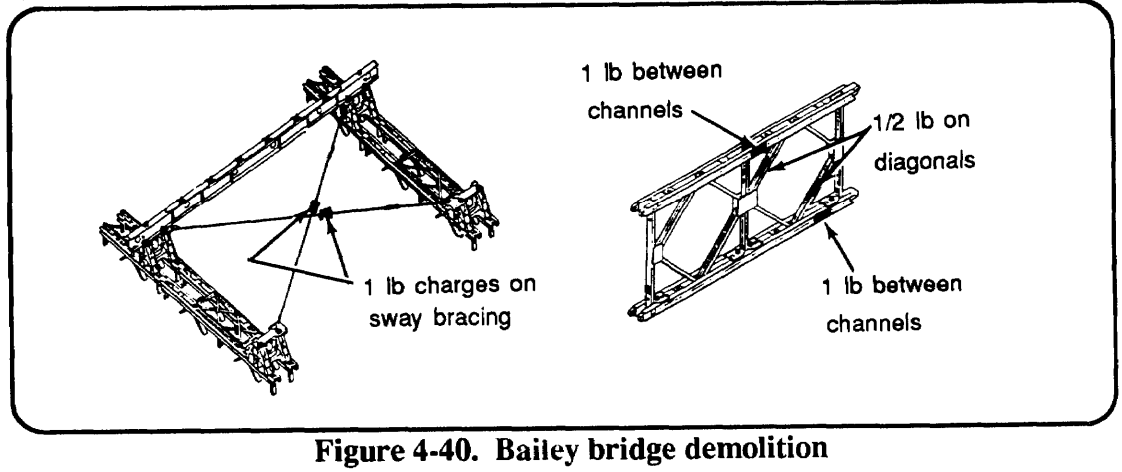


Figure 4-40. Bailey bridge demolition

(a) In-place demolitions. Cut the bridge in several sections by attacking the panels on each side, including the sway bracing. The angle of attack 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.

(b) In-storage or-stockpile demolition. When abandoning bridges in storage, do not leave any component the enemy can use as a unit or for improvised construction. Do this by destroying the essential components that the enemy cannot easily replace or manufacture. Panel sections fulfill the role of essential components. To render the panel useless, remove or distort the female lug in the lower tension chord. Destroy all panels before destroying other components.

Section III. Abutments and Intermediate Supports

4-14. Abutments. 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.

a. *Abutments (5 Feet Thick or Less).* 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 4-41). 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:

$$N = \frac{W}{5} - 1 \qquad \textbf{(4-3)}$$

where—

N = number of charges; round UP to next higher whole number.
W = abutment width, in feet.

b. *Abutments (0ver 5 Feet Thick).* 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 equation 3-6 (page 3-16). Use the abutment thickness as the breaching radius. Determine the number of charges and their spacing using equation 3-7 (page 3-19). Place charges at least three feet below the bridge seat (where the bridge superstructure sits on the abutment) (Figure 4-42).

c. *Abutments (Over 20 Feet High).* 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 4-14a or 4-14b above. Fire all charges simultaneously. This method tends to overturn and completely destroy the abutment.

d. *Wing Walls.* If the wing walls can support a rebuilt or temporary bridge, destroy the wing walls by placing charges behind them in the same manner as for abutments (Figures 4-41 and 4-42).

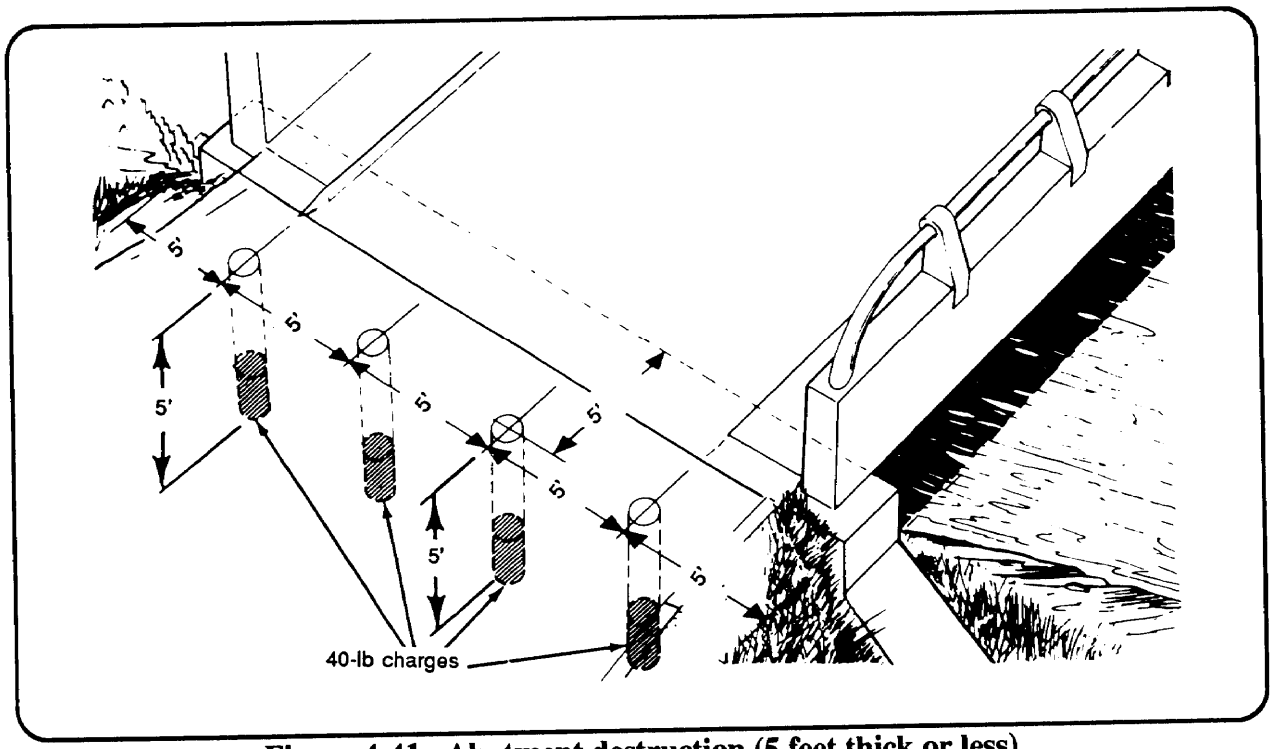


Figure 4-41. Abutment destruction (5 feet thick or less)

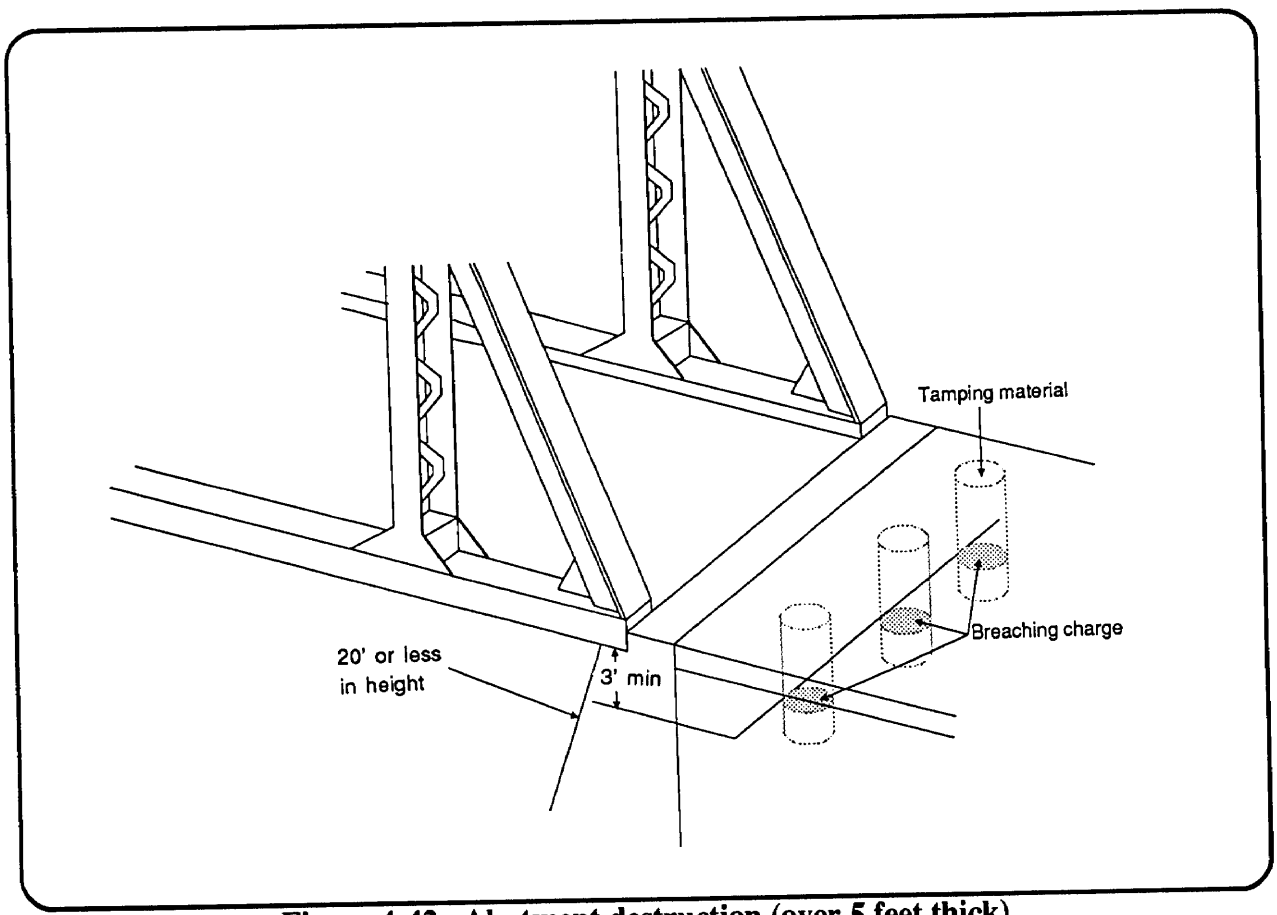


Figure 4-42. Abutment destruction (over 5 feet thick)

4-15. Intermediate Supports. Demolish concrete and masonry piers with internal or external charges (Figure 4-43).

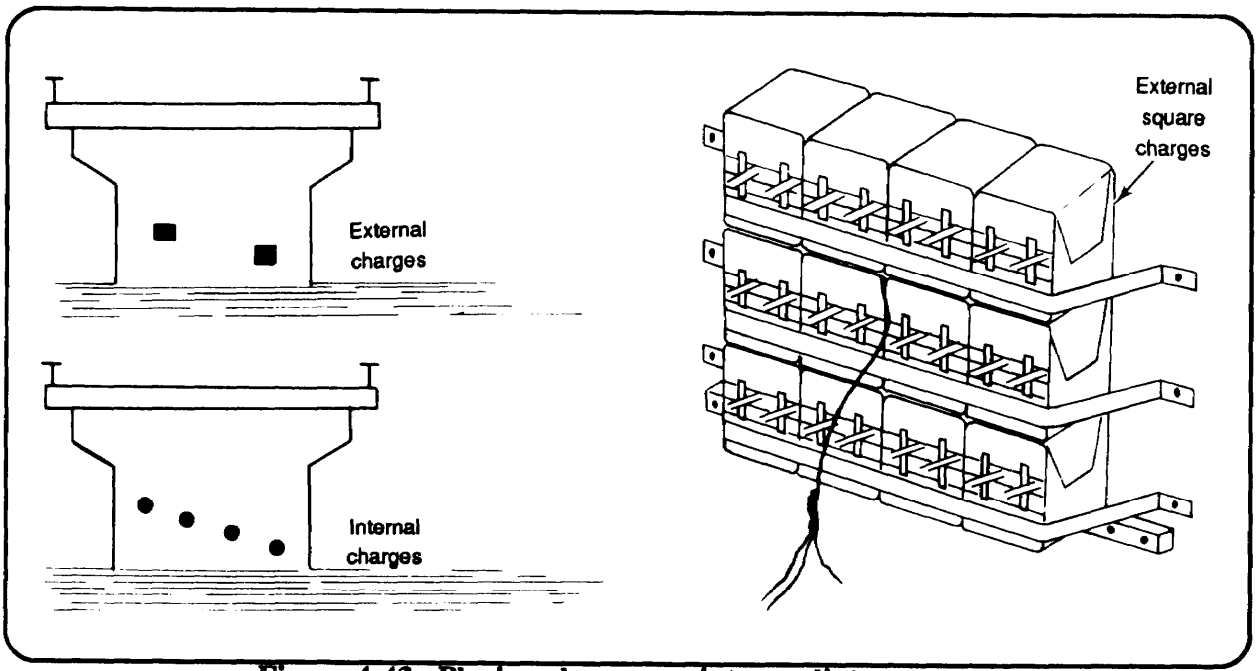


Figure 4-43. Placing charges on intermediate supports

a. *Internal Charges.* These charges require less explosive than do external charges. However, unless the support has built-in demolition chambers, this method requires an excessive amount of equipment and preparation time. Use equation 3-6 (page 3-16) to determine the amount of each charge. Ml12 (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 approximately 2 pounds of explosive per foot of depth. The steel reinforcing bars, however, make drilling in heavily reinforced concrete impractical.

b. *External Charges.* Place these charges at the base of the pier or higher, and do not space the charges by more than twice the breaching radius. 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.

Chapter 5
Demolition Operations

This chapter implements STANAG 2017 (ENGR), STANAG 2123 (ENGR), QSTAG 508, and QSTAG 743.

Section I. Demolition Plan

5-1. Demolition Obstacles. Although engineers use explosives for quarrying, land clearing, and other projects, their most important military application 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).

5-2. Barriers and Denial Operations. 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.

5-3. Demolition Planning. 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.

Section II. Types of Military Demolitions

5-4. Demolition Orders. 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 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 F (page F-4).

5-5. Preliminary Demolitions.

a. *Purpose.* Provided you have prior authority, detonate a preliminary demolition immediately after preparation. These demolitions present fewer difficulties to both commanders and engineers than do reserved demolitions. Commanders may restrict preliminary demolitions for tactical, political, or geographical reasons.

b. *Advantages.* The advantages of a preliminary demolitions are—

- 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.

c. *Progressive Preparation.* When preparation time is limited, engineers prepare the demolition in progressive stages. Doing this gives engineers the ability to create effective obstacles even if preparations must stop at any stage. For example, in the case of a bridge demolition, engineers would make one span the top priority, completely preparing it before continuing with other spans, piers, or abutments. As they complete other stages, engineers incorporate them into the firing system.

5-6. Reserved Demolitions.

a. *Purpose.* The responsible commander must carefully control a reserved demolition target because the target may be a vital part of the tactical or strategical plan or because the demolition will be performed in the face of the enemy.

b. *Considerations.* Occasionally, errors in orders, control, or timing cause serious consequences during demolition operations. In addition, engineers may encounter special problems when dealing with reserved demolition targets:

- Engineers must usually keep traffic lanes open until the last moment. This normally means they cannot use the simplest and quickest demolition techniques to accomplish the mission.

- The 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.
- A guard must remain at the demolition site until the demolitions are fired.

c. *States of Readiness.*

(1) State of Readiness 1 (Safe). The demolition charges are in place and secure. Vertical and horizontal ring mains are installed (Figure 2-33, page 2-27) but are not connected. Charges are primed with detonating-cord knots or wraps to minimize the time necessary to convert the system from State of Readiness 1 to State of Readiness 2. Charges that require blasting caps for priming cannot be primed at State of Readiness 1 nor can branch lines with caps crimped to them be connected to ring mains. Blasting caps and initiation sets are not attached to charges or firing systems.

(2) State of Readiness 2 (Armed). All vertical and horizontal ring mains are connected. Blasting caps are inappropriate 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.

d. *Responsibilities.*

(1) Authorized Commanders. 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 comrnanders—

- 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.
- May give the demolition guard or the 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 (page 6-13), covers procedures and methods for destroying explosives.
- Issue the written instructions (demolition orders) to the unit providing the demolition guard and firing party.
- Notify all headquarters of any delegation of authority or reclassification of any demolition from a reserved to a preliminary status.
- Establish effective channels for communicating firing orders and readiness states to demolition guard commanders or firing-party commanders.

(2) Demolition Guard Commanders. These commanders are normally the infantry or armor task-force commanders who control the target area. These 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 commanders of demolition firing parties, 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 results of demolitions to authorized commanders.
- Maintain succession (chain of command) lists for appointment to demolition guard commander and demolition firing-party commander.

(3) Firing-Party Commanders. 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. 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 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, pages 33 through 36, 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.

e. *Command and Control of Reserved Demolitions.*

(1) Command Post. 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. 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.

(2) Firing Point. 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.

(3) Alternate Positions. 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.

(4) Check Point. When units are withdrawing from a 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 check point. The demolition guard commander may use military police to perform this duty. Good communication is essential between the check point 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.

(5) Refugee Control Points. The demolition guard commander may need to establish and operate a refugee control point for civilian traffic. He should place a check point 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 check points 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.

Section III. Demolition Reconnaissance

5-7. Reconnaissance Orders. Thorough reconnaissance is necessary before planning a demolition operation. Reconnaissance provides detailed information in all areas related to the project. Prior to 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.

5-8. Reconnaissance Record. The reconnaissance party reports the results of their reconnaissance on DA Form 2203-R. Use the form with appropriate sketches, to record and report the reconnaissance of military demolition projects. Appendix F contains a sample of DA Form 2203-R (Figure F-2, pages F-38 through F-42) and instructions to complete it. For sketches, use available paper and attach to the completed DA Form 2203-R.

a. *Purpose.* When time and conditions permit, use this 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.

b. *Information Required.* DA Form 2203-R should contain the following:

- A bill of explosives that shows the quantities and types required.
- 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 situation sketch showing the relative position of the target, terrain features, and coordinates of the target.
- A list of all unusual site characteristics. Indicate the location of these unusual characteristics on the situation sketch.
- Plan and elevation (side-view) sketches of the target, showing overall dimensions, lines of cut, and demolition chambers.
- Plan and elevation sketches 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.

Section IV. Obstacle Folder

5-9. Purpose. 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 Appendix F (page F-4).

5-10. Language. 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. Use the following guidelines when determining the languages necessary in an obstacle folder:

- Languages of the units involved in the demolitions.
- Language of the host nation.
- One of the two official NATO languages (English or French).

5-11. Contents. 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, "see page 4a"). The six parts of the obstacle folder are—

- Location of target (pages 1-5).
- Supply of explosives and equipment (pages 6-17).
- Orders for preparing and firing (pages 18-28).
- Hand-over and take-over instructions (pages 29-32).
- Demolition report (pages 33-37).
- Official signature (page 38).

5-12. Special Instructions. The list of explosives, stores, and mines required (paragraph 2d, pages 14 and 16 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 work parties participating in paragraph 3a, subparagraph 5. Paragraph 3a, subparagraph 6 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 of the Demolition Report upon completion of the demolition. The firing party commander may detach the first copy of the demolition report (pages 33-37) and forward it to a higher-echelon engineer headquarters.

Chapter 6
Demolition Safety

Section I. General Safety

6-1. Considerations.

- Do *not* attempt to conduct a demolitions mission if you are unsure of 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 demolitions mission.
- Take your time when working with explosives; make your actions deliberate.
- Always post guards to prevent access inside the danger radius.
- Always maintain control of the blasting machine or initiation source.
- 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 all personnel and equipment are accounted for prior to detonating a charge.
- Ensure you give warnings before initiating demolitions; give the warning "Free in the hole!" three times.
- Always guard firing points.
- 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.

6-2. Explosive Materials.

a. *Blasting Caps.* 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 they are powerful enough to detonate the explosives, thus, avoiding misfires. Because power

requirements for caps from different manufacturers vary, never mix caps from different manufacturers; mixing caps could result in rnisfires. 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 1/8 to 1/4 inch of the cap is clearly visible at both ends when taping onto 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.

(1) 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.
- Never 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.
- Never 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 into a blasting cap.
- Never 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.
- When using nonelectric caps to dual prime demolitions, cut the fuse to allow an interval of not less than 10 seconds between firings.

(2) Electric.

- Do not remove the short-circuiting shunt unless 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-degree turns) to provide a proper shunt.
- Use proper grounding procedures when static electricity is present, see paragraph 6-5b (page 6-4).
- 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 (½ 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.
- Always use at least the minimum current required to fire electric blasting caps.

- Always 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.

b. *Time Fuse and Detonating Cord.*

(1) Time Fuse.

- Always 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.
- To avoid problems from moisture infiltration, never use the first or last 6 inches of time fuse from a new or partial roll.
- 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.

(2) Detonating Cord.

- Do not carry or hold detonating cord by placing it around your neck.
- To avoid problems from moisture infiltration, never use the first or last 6 inches of detonating cord from anew or partial roll.
- 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.

c. *Plastic and Sheet Explosives.*

- Always 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.

d. *Picric Acid.* Picric acid degrades with time. Do not use picric acid if its container is rusted or corroded. A rusty or corroded container indicates the explosive is unstable.

WARNING
Do not handle picric acid. Notify EOD for disposition.

e. *Commercial Explosives.* 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 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.

6-3. 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 2 hours for boreholes to cool between placing and firing successive springing charges, or cool the boreholes with water or compressed air to save time.

6-4. Toxicity. Most military explosives are poisonous if ingested and will produce lethal gases if detonated in confined areas such as tunnels, caves, bunkers, and buildings. Allow sufficient time for blast fumes, dust, and mists to clear before inspecting or occupying a blasting area. 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.

6-5. Natural and Physical Properties.

a. *Lightning.* 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, 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.

b. *Static Electricity.* 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.

c. Induced Currents. Radio signals can induce a current in electric blasting caps and prematurely detonate them. Table 6-1 lists the minimum safe distances from transmitters for safe electrical blasting. This table applies to operating radio, radar, microwave, 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.

d. *Blast Effects.* Personnel in close proximity 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 6-1 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 6-1. Safe distances for blasting near radio frequency energy

Average or Peak Transmitter Power (Watts*)	Minimum Safe Distance (Meters)
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 width 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.	

e. *Missile Hazards.* 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 angle of projection, and initial speed. Under normal conditions, the missile-hazard area of steel-cutting charges is greater than that of cratering, quarrying, and surface charges.

6-6. Underwater Operations.

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

b. *Nonelectric Caps.* 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, aviod using them to prime underwater charges or charges placed in wet boreholes.

c. *Time Fuse.* Time fuse depends on combustion to burn properly. Time fuse burns significantly faster underwater due to water pressure. Waterproof sealing compounds will not make a permanent waterproof seal between the fuse and a nonelectric blasting cap. Place the fuse underwater at the last possible moment before firing.

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

d. *Detonating Cord.* 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 detonating cord normally will protect the remaining line from moisture for 24 hours.

e. *M60 Fuze Igniter.* The M60 depends on combustion to work properly. Water can penetrate the fuze 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.

6-7. Safe Distances. The following criteria give 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. The following general rules apply:

- 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 More Than 500 Pounds. Use the following formulas:

$$\textit{Safe Distance (meters)} = 100\sqrt[3]{\textit{Pounds of Explosive}} \qquad (6\text{-}1)$$

$$\textit{Safe Distance (feet)} = 300\sqrt[3]{\textit{Pounds of Explosive}} \qquad (6\text{-}2)$$

- Missile-Proof Shelters. A missile-proof shelter 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.
- Charges Fixed to Targets. When charges are fixed to targets and not simply placed on the ground, use the safe distances specified in Tables 6-2 or 6-3, whichever is farthest. Note that these distances depend on the target configuration, not quantity of explosive.

Table 6-2. Safe distances for personnel (near bare charges)

Explosive Weight (Pounds)	Safe Distance		Explosive Weight (Pounds)	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			

Table 6-3. Safe distances for personnel (charges on target)

Serial	Charge Type	Target	Charge Size	Radius of Danger Area (m)	Remarks
a	b	c	d	e	f
1	Blasting caps Primers Detonating cord (in the open)	—	—	20	For service personnel under supervision. Applicable to all serials.
2	Cutting	a. Trees	Any	300	
		b. Concrete columns and beams	Any	500	—
		c. Metal girders and plates, guns, and so forth	Any	1,000	Fragments may fly up to 1,000 meters in all directions.
3	Concussion	Buildings and AFV	Any	1,000	If personnel are wearing helmets, you may reduce the safe distance to 500 meters. Consider the strong blast effect when considering buildings as potential blast shelters.
4	Cratering	Roads and airfields	a.. Up to 2 kg	100	
			b. Up to 30 kg	300	
			c. Over 30 kg	500	
5	Mines	Piers Abutments Retaining walls	Any	500	
6	Borehole	Rock Masonry Concrete Brick	Any	300	
7	Breaching	Reinforced-concrete beams and slabs Mass-concrete walls and obstacles	Any	1,000	If personnel are wearing helmets, you may reduce the safe distance to 500 meters. Consider the strong blast effect when considering buildings as potential blast shelters.
8	Shaped	Concrete Steel	Any	1,000	When these charges are fired into the ground vertically, you may reduce the safe distance to 300 meters.
9	Bangalore Torpedo	Wire obstacles	—	a. All right angles to axis, 1,000 meters	
			—	b. In the line of the axis, 200 meters for standing personnel and 100 meters for prone personnel	
10	M180	Roads and airfields	1-15 kits	1,200	Fragments may fly up to 1,000 meters in all directions.

NOTES:

1. The air clearance required is the ground safety distance plus 500 meters above the explosive area.
2. The ship clearance required is the same distance as for the ground safety distance.

Section II. Misfire Procedures

6-8. Nonelectric Misfires.

a. *Causes.*

- Moisture in the time fuse, detonating cord, or explosives.
- Time fuse not seated completely in blasting cap or in fuse igniter.
- Breaks in time fuse or detonating cord.
- Jagged or uneven ends on time fuse.
- Blasting caps not seated securely in cap well or explosive.
- Loose or improper detonating-cord installation.
- Debris in the blasting cap.
- Commercial blasting caps were not strong enough to detonate military explosives.

b. *Prevention.* 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 with care to avoid damaging prepared charges.
- Avoid crimping blasting caps onto time fuse in the rain; seek a covered area out of the rain.
- Ensure you completely seat time fuse when installing it into a blasting cap or fuse igniter.

c. *Clearing Procedure.*

- The soldier who placed the charges should investigate and correct any problems with the demolition.
- After attempting to fire the demolition, delay investigating any detonation problem for at least 30 minutes plus the time remaining on the secondary. Tactical conditions may require investigation prior to the 30-minute limit.
- For above-ground misfires of charges primed with blasting caps, place a primed, l-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. Do not touch scattered charges that contain blasting caps; destroy therein place. For charges primed with detonating cord, use the procedures in paragraph 6-10 (page 6-10).
- For a nonelectric cap that has detonated but failed to initiate a detonating-cord branch line, line main, or ring main, attach a new cap to the detonating cord, and then move to a safe place.

- For buried charges, remove the tamping to within one foot of the misfired charge. Constantly check depth while digging to avoid striking the charge. When within 1 foot of the misfired charge, place a primed, 2-pound charge on top of the original charge and detonate the new charge. If digging over the original charge is impractical, dig a new borehole of the same depth beside the original hole, l-foot away. Place a primed, 2-pound charge in the new hole and detonate the new charge.

6-9. Electric Misfires.

a. *Causes.*

- Inoperable or weak blasting machine or power source.
- Improper operation of 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.
- Blasting caps made by different manufacturers in the same circuit.
- Power source inadequate for the number of blasting caps in the circuit (too many caps, too small a blasting machine).

b. *Prevention.* Assign one individual the responsibility for all the electrical wiring in a demolition circuit. This individual should do the following:

- Perform all splicing.
- Install all blasting caps in the firing circuit. *Do not bury caps!*
- Make all of the connections between blasting cap wires, connecting wires, and firing wires.
- Inspect system for short circuits.
- Avoid grounding out the system.
- Ensure the number of blasting caps in any circuit does not exceed the rated capacity of the power source.

c. *Clearing Procedure.* 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.
- When employing *only one* electrical initiation system, disconnect the blasting machine, shunt the wires, and investigate immediately. When employing *more than one* electrical initiation system, wait 30 minutes before inspecting. Tactical conditions may require investigation prior to the 30-minute limit.

- Inspect the entire circuit for wire breaks or short circuits.
- If you suspect an electric blasting cap is the problem, do not attempt to remove or handle it. Place a primed, 1-pound charge next to the misfired charge and detonate the new charge.

6-10. Detonating-Cord Misfires.

a. *Detonating Cord.* 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 in the same manner as noted above.

b. *Detonating-Cord Priming.* 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.
- For underground charges, dig 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

6-11. Transportation.

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

b. *Safety Procedures. 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:

(1) Vehicles.

- Ensure 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.
- When using vehicles with steel or partial-steel bodies, install fire-resistant and nonsparking cushioning to separate the explosives from the metal truck components.
- 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 1-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 cam. 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.

(2) Cargo (Explosives).

- Never leave explosives unattended.
- Never mix live and inert (dummy) explosives.
- Secure the load of explosives in the transport to prevent shifting during transport.
- Transport blasting caps separately from other explosives. Do not transport blasting caps or other initiators in the same vehicles carrying explosives. If both blasting caps and explosives must be carried in the same vehicle, separate blasting caps from the other explosives by carrying the caps in a closed metal container in the cab of the transport.
- No persons other than the primary and the assistant operators will ride on or in a truck transporting explosives. Do not refuel a vehicle while carrying explosives except in an emergency.

(3) Fire. 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, fire fighters, and other emergency-response personnel that the cargo is explosives.
- If the fire involves only the engine, cab, chassis, or tires, make an effort to extinguish the fire with fire extinguishers, sand, dirt, or water. 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.

6-12. Storage Safety.

a. *Magazines.* There are two types of magazines: permanent and temporary. Although permanent magazines are preferred, temporary or emergency magazines are frequently required when permanent construction is not possible. Field Manual (FM) 9-6 and TM 9-1300-206 give details on magazine storage of explosives. Consider the following when constructing magazines:

(1) Permanent.

(a) Placement. Consider acceptability of magazine locations based on safety requirements, accessibility, dryness, and drainage. Safety and accessibility are the most important. 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.

(b) Lightning protection. All magazines must have a grounded, overhead lightning-rod system. Connect all metal parts (doors, ventilator, window sashes, reinforcing steel, and so forth) to buried conduits of copperplate or graphite rods in several places.

(c) Barricades. Install barricades around magazines; that is, there must be 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.

(d) Security. Place guards at all magazines to prevent unauthorized personnel from gaining access to magazine facilities.

(2) Temporary.

(a) Placement. 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 revet 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.

(b) Identification. Mark field-expedient storage facilities on all four sides with signs (TM 9-1300-206).

b. *Temporary Storage.* When necessary, store limited supplies of explosives in covered ammunition shelters. Ensure the temporary facilities are separated adequately to prevent fire or explosion from being transmitted between shelters. Piles of temporarily stored explosives should contain no more than 500 pounds each and be 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. Local safety standing operating procedures (SOPS) and TM 9-1300-206, Chapter 4, are guides for temporary storage operations.

Section IV. Destruction of Military Explosives

6-13. Concept. Destruction of demolition materials is a unit commander's decision. The purpose of this intentional destruction is to prevent the enemy from capturing stockpiles of explosives. Whenever the 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 9- 16). Completely destroy explosive and nonexplosive demolition materials in a combat zone. Damage essential components of sets and kits to prevent complete assembly by cannibalizing from undamaged components. Such destruction is a command decision based on the tactical situation, security classification of the demolition materials, their quantity and location, facilities for accomplishing destruction, and time available. In general, burning and detonating or a combination of both are the most effective means of destruction.

6-14. Site Selection. Select the 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.

6-15. Methods. 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.

a. *Burning.* Destroy packed and unpacked high-explosive items by burning. These explosives include linear demolition charges, shaped demolition charges, block demolition charges, stick dynamite, detonating cord, firing devices, timed blasting fuse, and similar items. 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 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 6-1 (page 6-5). This distance is never less than 300 meters.
- Do not try to extinguish burning explosives. Burning explosives cannot be extinguished by smothering them or drenching them. In fact, smothering will probably cause an explosion. Personnel should not attempt to extinguish burning explosives without expert advice and assistance.

b. *Detonation.* The tactical situation, the commander's intent, the lack of time, the type of explosive, or the 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 6-5).
- Do not exceed the limitations of the disposal site, Instead of detonating one large pile of explosives, it may be necessary 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.

Appendix A
Example Calculations

A-1. Application. This appendix contains examples of charge, demolition, and attack calculations. Users should be familiar with the discussions in Chapters 3 and 4. Use TNT in the l-pound package and C4 in the 1.25-pound package when calculating the following problems. The volume of a package of C4 is 20 cubic inches.

A-2. Charge Calculations.

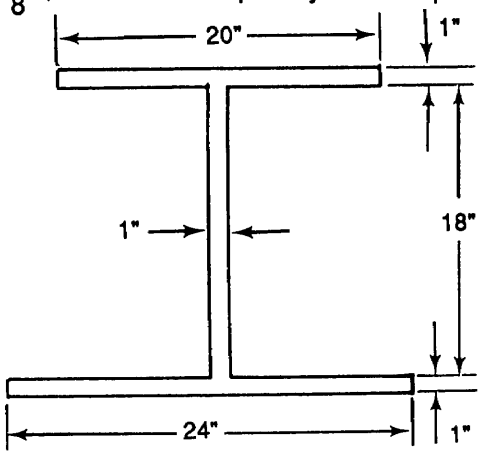
Problem: Determine the quantity of C4 required to cut a 30-inch diameter tree, using an internal timber charge.	
Step 1	Obtain critical dimensions: $D = 30$ inches.
Step 2	Calculate for TNT/Rule of Thumb: $P = \frac{D^2}{250} = \frac{30^2}{250} = \frac{900}{250} =$ 3.6 *pounds of TNT*
Step 3	Divide by the RE factor, if required: $\frac{P}{RE} = \frac{3.6}{1.34} = 2.68$ *pounds of C4*
Step 4	Divide by package weight/volume and round UP to next whole package: $\frac{P}{1.25} = \frac{2.68}{1.25} = 2.14$ *packages of C4*, round up to 3 packages of C4.
Step 5	Calculate number of charges: *One Tree = One Charge*
NOTE: You must split the charge between two boreholes because the tree is larger than 18 inches in diameter. See paragraph 3-5a (page 3-4).	
Step 6	Calculate total amount of explosives: *Step 4 x Step 5 = Total Packages = 3 x 1 = 3 packages of C4*
Solution: Three packages of C4, placed in two boreholes, are required to cut a 30-inch diameter tree, using an internal timber charge. For placement of charge, see Figure 3-2 (page 3-5).	

Example A-1. Timber-cutting charge calculation (internal)

Problem: Determine the quantity of TNT required to cut a 30-inch diameter tree using an external timber charge.	
Step 1	Obtain 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 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 next whole package: $\frac{P}{1} = \frac{22.5}{1} = 22.5$ Round up to 23 packages of TNT.
Step 5	Calculate number of charges: *One Tree = One Charge*
Step 6	Calculate total amount of explosives: *Step 4 x Step 5 = Total Packages = 23 x 1 = 23 packages of TNT*
Solution: 23 packages of TNT are required to cut a 30-inch diameter tree, using an external timber charge. For placement of charge, see Figure 3-3 (page 3-5).	

Example A-2. Timber-cutting charge calculation (external)

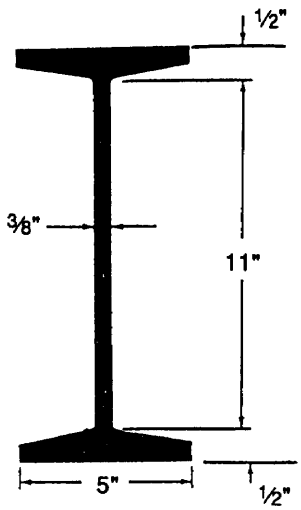
Problem: Using the formula $P = \frac{3}{8}A$, determine the quantity of C4 required to cut the two steel beams shown below.



Step 1	Obtain 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 $P = \frac{3}{8}A = \frac{3}{8} \times 62 = 23.25$ *pounds of TNT*
Step 3	Divide by RE factor, if required: $\frac{23.25}{1.34} = 17.35$ *pounds of C4*
Step 4	Divide by package weight/volume and round UP to next whole package: $\frac{17.35}{1.25} = 13.88$ Round up to 14 packages of C4.
Step 5	Calculate number of charges: *Two Beams = Two Charges*
Step 6	Calculate total amount of explosives: *Step 4 x Step 5 = Total Packages = 14 x 2 = 28 packages of C4*
Solution: 28 packages of C4 are required to cut the two beams. For placement of charge, see Figure 3-7 (page 3-9).	

Example A-3. Steel-cutting charge calculation

Problem: Using Table 3-3 (page 3-10), determine the quantity of C4 required to cut the steel beam shown below.



$P = \frac{3}{8} A$

Area of flange = 2 x ½ x 5 = 5 square inches

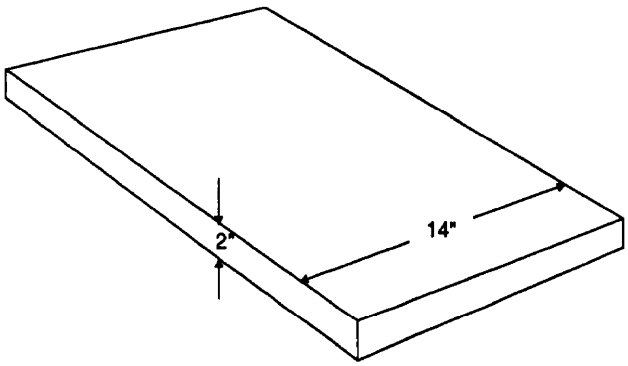
Area of Web = ⅜ x 11 = 4⅛ square inches

Total area (A) = 9⅛ square inches

Step 1	Otain 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 3-3 b. Web: 11 x 3/8 = 1.3 pounds from Table 3-3 c. Bottom Flange: 5 x 1/2 = 0.8 pounds from Table 3-3 d. Total: = 2.9 pounds of C4
Step 3	Divide by RE factor, if required: Not required
Step 4	Divide by package weight/volume and round UP to next whole package: $\frac{P}{\textit{Package Weight}} = \frac{2.9\ \textit{Pounds of C4}}{1.25\ \textit{Package Weight}} = 2.32$ Round up to 3 packages of C4.
Step 5	Calculate number of charges: *One Beam = One Charge*
Step 6	Calculate total amount of explosives: *Step 4 x Step 5 = Total Packages = 3 x 1 = 3 packages of C4*
Solution: Three packages of C4 are required. For placement of charge, see Figure 3-7 (page 3-9).	

Example A-4. Hasty steel-cutting charge calculation

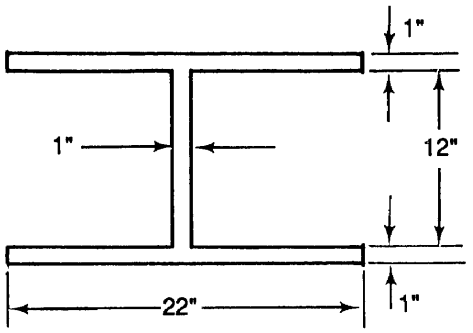
Problem: Using ribbon charge, determine the quantity of C4 required to cut the steel plate shown below.

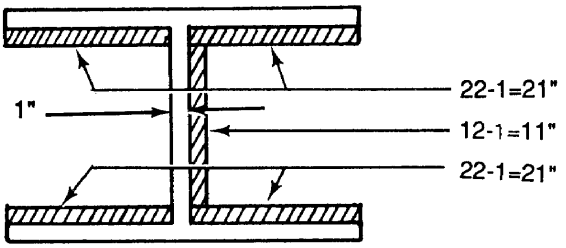


Step 1	Obtain the critical dimensions: a. Cut Length: 14 inches b. Target Thickness: 2 inches
Step 2	Calculate for TNT/Rule of Thumb: a. Thickness: 1/2(Target Thickness) = 1 inch b. Width: 3(Charge Thickness) = 3 inches c. Length: Cut Length = 14 inches *Volume = T x W x L = 1 x 3 x 14 = 42 cubic inches*
Step 3	Divide by RE factor, if required: Not required because only C4 or sheet explosives are used.
Step 4	Divide by package weight/volume and round UP to next whole package: $N = \frac{Charge\ Volume}{Package\ Volume} = \frac{42}{20} = 2.1$ Round up to 3 packages of C4.
Step 5	Calculate number of charges: *One Plate = One Charge*
Step 6	Calculate total amount of explosives: *Step 4 x Step 5 = Total Packages = 3 x 1 = 3 packages*
Solution: Three packages of C4 are required to cut the steel plate. For placement of charge, see Figure 3-11 (page 3-13).	

Example A-5. Steel-cutting charge calculation (steel plate)

Problem: Using ribbon charge, determine the quantity of C4 required to cut the I-beam shown below.



Step 1	Obtain 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 x W x L = 1/2 x 1 1/2 x 53 = 39.75 cubic inches of C4*  **NOTE:** Length of cut is 53".
Step 3	Divide by RE factor, if required: No required because only C4 or sheet explosives are used.
Step 4	Divide by package weight/volume and round UP to 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 number of charges: *One I-beam = 1 Charge*
Step 6	Calculate total amount of explosives: *Step 4 x Step 5 = Total Packages = 2 x 1 = 2 packages of C4*
Solution: Two packages of C4 are required to cut the I-beam. For placement of charge, see Figure 3-12 (page 3-13).	

Example A-6. Steel-cutting charge claculation (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.
Step 3	Divide by RE factor, if required: Not required because only C4 of sheet explosives are used.
Step 4	Divide by package weight/volume and round UP to 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 number of charges: One Bar = One Charge
Step 6	Calculate total amount of explosives: Step 4 x Step 5 = Total Packages = 7 x 1 = 7 packages of C4
Solution: Seven packages of C4 are required to cut the steel bar using a saddle charge. For placement of charge, see Figure 3-13 (page 3-14).	

Example A-7. Steel-cutting charge calculation (steel bar)

Problem: Determine the quantity of C4 required to cut a 9-inch, high-carbon-steel bar using a diamond charge.	
Step 1	Obtain critical dimensions: a. Target Diameter: 9 inches. b. Target Circumference: 3.14 x 9 = 28.26 inches.
Step 2	Determine the required charge dimensions: a. Thickness: 1.00 inch. b. Short Axis: 1/2 (Target Circumference) = 14.13 inches. c. Long Axis: Target Circumference = 28.26 inches. d. Total Volume: 1/2 (Thickness x Long Axis x Short Axis) = 199.65 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), not TNT.
Step 4	Determine the number of required packages of C4: $N = \frac{Charge\ Volume}{Package\ Volume} = \frac{199.65}{20} = 9.98$ (*Round up to* 10)
Step 5	Determine the number of charges required. The 9-inch, high-carbon steel bar requires only one charge.
Step 6	Determine the total number of packages required: *Packages (Step 4) X Charges (Step 5) = Total Packages*
Solution: Since only one charge is required to cut the high-carbon steel bar, you will need 10 packages of C4 to cut the steel bar. For placement of charge, see Figure 3-14 (page 3-15).	

Example A-8. Steel-cutting charge calculation (high-carbon steel)

Problem: Using the formula R^3KC, determine the number of Composition-C4 packages required to breach a reinforced-concrete pier, 5 feet thick and 30 feet wide. The charges will be elevated 5 feet and untamped.	
Step 1	Obtain the critical dimensions: a. *Breaching Radius (R) = 5 feet.* b. *Pier Width (W) = 30 feet.*
Step 2	Calculate for TNT/Rule of Thumb: $P = R^3KC = 5^3(0.54)1.8 = 121.50$ *pounds of TNT*
Step 3	Divide by RE factor, if required: $\frac{121.5}{1.34} = 90.67$ *pounds of C4*
Step 4	Divide by package weight/volume and round UP to next whole package:: $N = \frac{Charge\ Weight}{Package\ Weight} = \frac{90.67}{1.25} = 72.53$ Round up to 73 packages of C4.
Step 5	Calculate number of charges:: $N = \frac{W}{2R} = \frac{30}{2(5)} = 3$ *charges*
Step 6	Calculate total amount of explosives: *Step 4 x Step 5 = Total Packages = 73 x 3 = 219 packages of C4*
Solution: 219 packages of C4 are required to breach the pier. For placement of charge, see Figure 3-16 (page 3-19).	

Example A-9. Breaching charge calculation (reinforced-concrete pier)

Problem: Determine the required amount of C4 needed to counterforce four concrete cubes three feet thick.	
Step 1	Obtain critical dimensions: *Circumference of Target = 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 x 3 = 4.5 pounds of C4*
Step 3	Divide by RE factor, if required: Not required because only C4 or sheet explosives are used.
Step 4	Divide by package weight/volume and round UP to 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 number of charges: *Four Cubes = Four Charges*
Step 6	Calculate total amount of explosives: *Step 4 x Step 5 = Total Packages = 4 x 4 = 16 packages of C4*
Solution: 16 packages of C4 are required to counterforce four cubes. For placement of charges, see Figure 3-17 (page 3-20).	

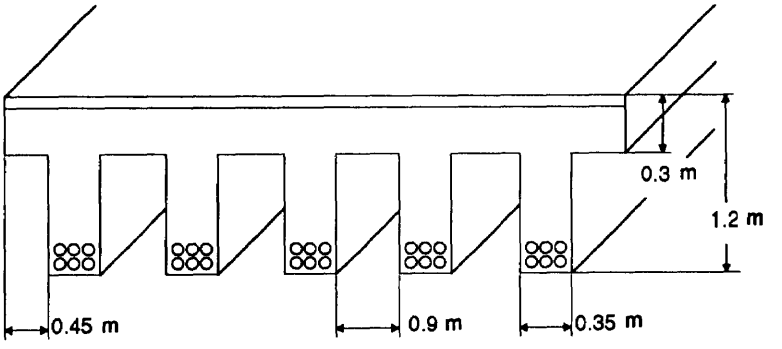
Example A-10. Counterforce charge calculation

Problem: Determine the quantity of cratering charges and C4 required to create a deliberate crater 146 feet long.	
Step 1	Obtain critical dimensions: *Crater Length (L) = 146 feet*
Step 2	Calculate for TNT/Rule of Thumb: a. *7-Foot Borehole = 80 pounds* b. *5-Foot Borehole = 40 pounds + 1 pound for dual priming*
Step 3	Divide by RE factor, if required: Not required
Step 4	Divide by package weight/volume and round UP to next whole package:: a. *7-Foot Borehole = 2 cratering charges* b. *5-Foot Borehole = 1 cratering charge and 1 package of C4.*
Step 5	Calculate 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 total amount of explosives: a. 7-Foot Boreholes: 2 charges x 14 boreholes = 28 cratering charges b. 5-Foot Boreholes: 1 charge x 13 boreholes = 13 cratering charges and 13 packages C4 Total = 41 cratering charges and 13 packages of C4
Solution: 41 cratering charges and 13 packages of C4 are needed to create a deliberate crater 146 feet long. For charge placement, see Figure 3-19 (page 3-23).	

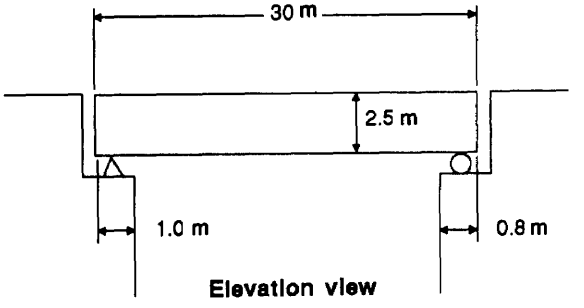
Example A-11. Cratering charge calculation

A-3. Demolition Calculation.

Problem: A simply supported, reinforced-concrete, beam-and-slab span must be destroyed with a concrete-stripping charge. The diagram below shows the span dimensions. Determine the quantity of C4 required and the resulting ditch width.



Cross section at midspan



Elevation view

	Beam Calculations
Step 1	Determine the amount of TNT required per meter: $P = 3.3(3.3h + 0.5)^3 = 3.3[3.3(1.2) + 0.5]^3 = 292.76$ *pounds TNT per meter*
Step 2	Determine the amount of explosive (TNT) per beam: $P = (Pounds\ ^{TNT}/_{meter})(Beam\ width,\ in\ meters)$ $P = 292.76(0.35) = 102.47$ *pounds per beam*
Step 3	Determine the equivalent amount of C4: $\frac{P}{RE} = \frac{102.47}{1.34} = 76.47$ *pounds C4 per beam*
Step 4	Determine the required packages of C4 per beam: $N = \frac{Charge\ Weight}{Package\ Weight} = \frac{76.47}{1.25} = 61.18$ (*Round up to* 62)
	Slab Calculations
Step 1	Determine the amount of TNT required per meter of slab between beams: $P = 3.3(3.3h + 0.5)^3 = 3.3[3.3(0.3) + 0.5]^3 = 10.92$ *pounds TNT per meter*
Step 2	Determine the amount of TNT required per slab: $P = (Pounds\ TNT\ per\ meter)\ (Slab\ width,\ in\ meters) = 10.92(0.9) = 9.83$ *pounds TNT*

Example A-12. Beam-and-slab bridge demolition calculation

Step 3	Determine the equivalent amount of C4: $\frac{P}{RE} = \frac{9.83}{1.34} = 7.34$ *pounds C4 per slab*
Step 4	Determine the required packages of C4 per slab: $N = \frac{\textit{Charge Weight}}{\textit{Package Weight}} = \frac{7.34}{1.25} = 5.87$ (*Round up to* 6)

Total Charge

$P = 5(\textit{Beam Charge}) + 5(\textit{Slab Charge}) = 5(62) + 5(6) = 310 + 30 = 340$ *packages of C4*

Ditch Width

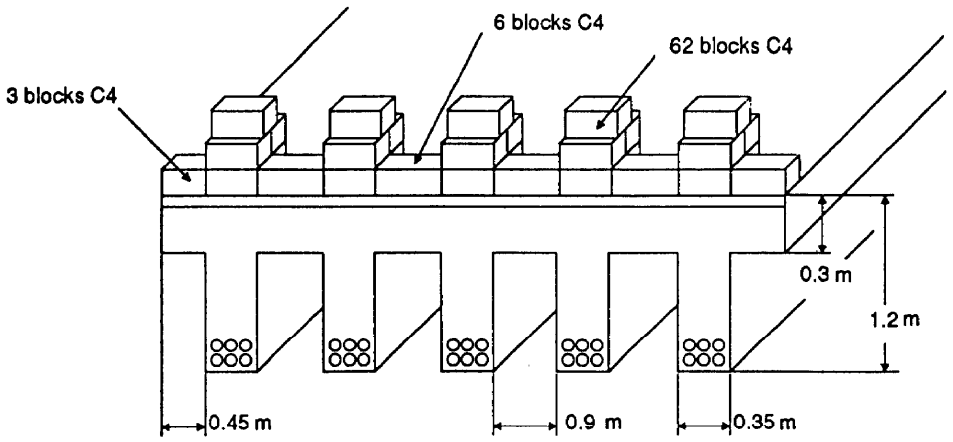
$W_d = 2h + 0.3 = 2(1.2) + 0.3 = 2.7$ *meters*

$\frac{H}{L} = \frac{2.5}{30} = 0.0833$ meters $\qquad \frac{L_s}{L} = \frac{0.9}{30} = 0.03$ meters

From Table 4-2 (page 4-18), $\frac{L_c}{L} = 0.060$ meters.

Therefore, $L_c = 0.060\ (30) = 1.8$ meters.

Since $L_c < W_d$, use $P = 340$ packages of C4, as calculated.

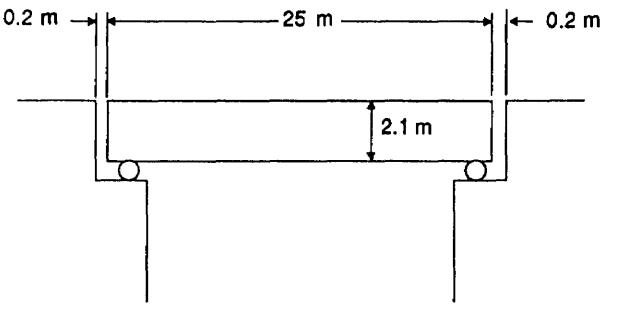


Example A-12. Beam-and-slab bridge demolition calculation (continued)

A-4. Attack Calculations.

Problem: Determine the attack method for demolishing a simply supported, steel-beam 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.



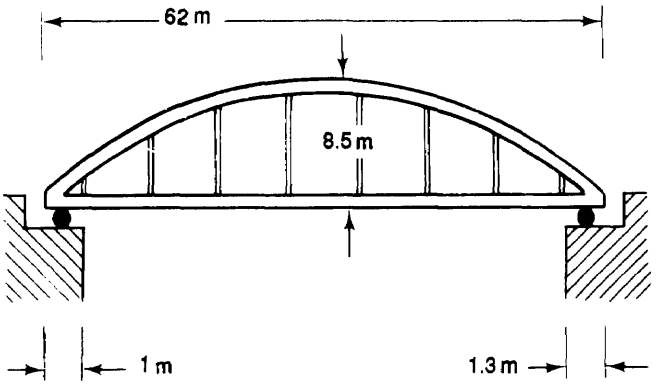
Step 1	Consult Appendix H. Table H-1 (page H-1) lists bottom attack method for this bridge, provided that the actual end clearance (*E*) is greater than *E*.
Step 2	Perform the calculation to determine whether *E* is greater than E_R. a. Determine the height-to-length ratio (*H*/*L*): $\frac{H}{L} = \frac{2.1}{25} = 0.084$ b. Find the corresponding *E*/*L* value (Table H-1, page H-1). Since 0.084 is not found on the table, round UP to 0.09. (interpolate, if necessary). c. Determine the required end clearance. Use the following formula to find *E*. $E_R = (\frac{E_R}{L})L = 0.016(25) = 0.40$ *meters*

Solution: Compare the actual and required end clearances. Since the actual end clearance (0.4 meters) is equal to the required end clearance (0.40 meters), a bottom attack is possible without any likelihood of the span jamming.

Example A-13. Bottom attack 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.



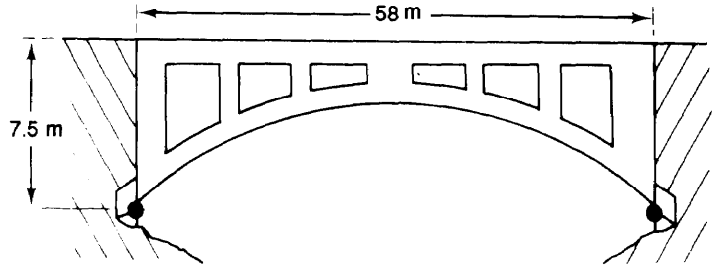
Step 1	Consult Appendix H. Table H-2 (page H-2) lists the top attack method for this bridge.
Step 2	Determine the height-to-length ratio (H/L). Since 0.137 is not found on the table, round UP to 0.014. $\frac{H}{L} = \frac{8.5}{62} = 0.137$
Step 3	Determine the required-gap ratio (L_S/L). $\frac{L_S}{L} = \frac{1.15}{62} = 0.0186$
Step 4	Find the corresponding L_S/L value (Table H-2, page H-2). Since 0.0186 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. $L_C = 0.082 \times 62 = 5.08$ 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 midspan. Mark the bridge in this location. This location is the centerline for the proposed cut.

Example A-14. Top attack 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 H. Table H-2 (page H-2) 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 4-1, page 4-20). 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 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 A-15. Arch bridge attack calculation

Appendix B
Metric Charge Calculations

B-1. Equivalent Metric Weights for Standard Explosives. NATO requirements make metric conversions necessary. The following formulas are metric equivalents for charge calculations. Table B-1 lists the metric equivalents for standard US Army demolition charges.

Table B-1. Standard US demolition charges (metric equivalents)

Explosive	Unit (Pounds)	Detonation Velocity		RE Factor	Weight (Metric) (Kilograms)
		M/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 Comp C2 or C3	2.25	7,625	25,000	1.34	1.021
M5A1 Comp 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
Ammonium Nitrate	43.00	3,400	11,000	0.42	18.14
M1 Dynamite	0.50	6,100	20,000	0.92	0.227
M2A4 Shaped Charge	15.00	NA	NA	NA	6.80
M3A1 Shaped Charge	40.00	NA	NA	NA	18.14
M183 Assembly	NA	NA	NA	1.34	9.07

B-2. Timber-Cutting Formulas. The formulas on the following pages are examples of charge calculations converted to their metric equivalents.

a. *Tamped Internal Charges.*

$$K = \frac{D^2}{3{,}500} \quad \text{(B-1)}$$

where—

K = *TNT required, in kilograms.*
D = *timber diameter, in centimeters.*

b. *Untamped External Charges.*

$$K = \frac{D^2}{560} \quad \text{(B-2)}$$

where—

K = *TNT required, in kilograms.*
D = *timber diameter, in centimeters.*

c. *Abatis Charges.*

$$K = \frac{D^2}{700} \quad \text{(B-3)}$$

where—

K = *TNT required, in kilograms.*
D = *timber diameter, in centimeter.*

B-3. Steel-Cutting Formulas. Table B-2 gives the correct metric weight of TNT necessary to cut structural steel sections of various dimensions. Use Table B-2 or use the following formulas:

a. *Structural Steel.*

$$K = \frac{A}{38} \quad \text{(B-4)}$$

where—

K = TNT required, in kilograms.
A = cross-sectional area of the steel, in square centimeters.

b. *Other Steel.*

$$K = \frac{D^2}{14} \quad \text{(B-5)}$$

where—

K = *TNT required, in kilograms.*
D = *section diameter, in centimeters.*

Table B-2. TNT steel-cutting charges (metric)

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

B-4. Pressure Charges for T-Beams. Use the following formula to determine the metric size of T-beam pressure charges:

$$K = 48H^2T \qquad \text{(B-6)}$$

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.

B-5. Breaching Charges.

$$K = R^3MC \qquad \text{(B-7)}$$

where—

K = *TNT required,* in *kilograms.*
R = *breaching radius, in meters (Chapter 3, page 3-17).*
M = *material factor (Table B-3, page B-4).*
C = *tamping factor (Figure 3-16, page 3-19).*

a. *Breaching Radius.* 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).

b. *Material Factor.* Table B-3 (page B-4) lists material factors.

c. *Tamping Factor.* 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 3-16 (page 3-19) gives values for the tamping factor.

Table B-3. Material factors (*M*) for breaching charges (metric)

Material	Breaching Radius (*R*)	*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 concrete)	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

Appendix C
Use of Demolition Charges

C-1. Sources.

a. *Primary Charges.* When using land mines, aerial bombs, shells, and foreign explosives as demolition charges, take the appropriate precautions outlined in the paragraphs below. The use of such explosives is usually uneconomical but may occasionally become necessary or desirable. Obtain such materials from captured or friendly supply stocks or, in the case of land mines, those recovered from enemy or friendly minefield. Never use unexploded duds (shells or bombs) for demolition purposes.

b. *Supplementary Charges.* When necessary, use allied-nation or captured explosives to supplement or replace standard explosive charges.

C-2. Land Mines.

a. *Safety Precautions.* 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 use of salvaged or captured threat mines.

b. *Charges.* When calculating charges using mines, consider only the explosive weight. Use normal explosive quantities for cratering or pressure charges. However, the mine case does not allow proper contact of the explosives against irregularly shaped objects. You may find it necessary to increase the size of 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 antitank mines by country of origin. The US mines are current; foreign mines may be current or obsolete.

c. *Priming.* Detonate a land mine by placing a l-pound charge on the pressure plate. 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.

C-3. Aerial Bombs.

a. *Safety Precautions.* General-purpose, 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 general-purpose bomb.

Table C-1. Antitank (AT) mine explosives content (by nation)

Country	Mine Type	Weight/Explosive
United States	M15 AT (Metallic)	22 lb/TNT
	M19 AT (Nonmetallic)	21 lb/TNT
	M21 AT (Metallic)	10.5 lb/Comp H6
Belgium	PRB-4 AT	20 lb/Hexogen
Communist China	Dual-Purpose No. 4 (Metallic)	4.5 lb/TNT
Czechoslovakia	PT-Mi-K AT (Metallic)	11 lb/TNT
	PT-Mi-Ba AT (Plastic)	12 lb/TNT
	Na-Mi-Ba AT (Plastic)	5.3 lb/Tritol
	TQ-Mi AT (Cardboard)	11.5 lb/TNT
Finland	M36 AT (Metallic)	8 lb/TNT
	M39 AT (Metallic)	8.8 lb/TNT
France	M1948 AT (Metallic)	11.5 lb/TNT or Military Dynamite
	M1948 Plate Charge AT (Metallic)	15.2 lb/TNT or Picric Acid
	M1951 Shaped Charge AT (Metallic)	4 to 5 lb/Kexolite
	M1951 AT (Caseless)	14.3 lb/TNT (Cast)
	M1951 AT (Plastic "grille")	11 to 16 lb/PETN
Japan	Model 63 Heavy AT	24.2 lb/Comp B
Netherlands	Type II AT (Metallic)	9 lb
South Korea	Heavy AT (Metallic)	22 lb/TNT
	Type I Dual Purpose (Metallic)	5.7 lb/TNT
	Type II Dual Purpose (Metallic)	4.5 lb/TNT
Former Soviet Union	TMD-B AT (Wooden)	11 to 15 lb/Amatol, DTNT, or Picric Acid*
	TMN-46 AT (Metallic)	12.6 lb/TNT
	YaM-5 AT	8 to 11 lb/TNT or Amatol
United Kingdom	Mark 4 GS AT (Metallic)	8.25 lb/TNT
	Mark 5 GS AT (Metallic)	4.5 lb/TNT
	Mark 5 HC AT (Metallic)	8.3 lb/TNT
	Mark 7 AT (Metallic)	19.6 lb/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.

b. *Charges.* The explosive content of an aerial bomb is approximately half its total weight. Table C-2 lists the explosives content for various general-purpose bombs. Approximately 20 percent of the explosive potential of an aerial bomb is expended in shattering the casing.

c. *Priming.* 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.

Table C-2. General-purpose, aerial bombs (explosive contents)

Bomb	Explosive Weight	Total Weight
Old Series		
AN-30A1, 100-pound GP	57	120
AN-M57A1, 250-pound GP	125	261
AN-M64A1, 500-pound GP	266	549
AN-M65A1, 1,000-pound GP	555	1,064
AN-M66A2, 2,000-pound GP	1,098	2,113
New Series		
M117, 750-pound GP	386	823
M118, 3,000-pound GP	1,975	3,049
Low-Drag		
MK81, Mod 1, 250-pound GP	100	260
MK82, Mod 1, 500-pound GP	192	531
MK83, Mod 3, 1,000-pound GP	445	985
MK84, Mod 1, 2,000-pound GP	945	1,970
Low-Drag, Snakeye I		
MK81, Mod 1, 250-pound GP	100	300
MK82, Mod 2, 500-pound GP	192	560

C-4. Artillery Shells (Nonnuclear).

a. *Safety Precautions.* 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.

b. *Charges.* Any artillery shell fits this category; however, avoid shells smaller than 100 millimeters. The 105-millimeter howitzer, high-explosive shell, which weighs 33 pounds, contains only 5 pounds of explosive. The 155-millimeter howitzer shell contains only 15 pounds of explosive.

c. *Priming.* Detonate shells up to 240 millimeters by placing 2-pound charges on the case, just forwar of the rotating band. To ensure complete detonation of multiple shells simultaneously, place a charge on each shell. Use the M10 universal destructor to detonate shells that have threaded

fuse wells of 1.7- or 2-inch diameters. Fill the booster cavities of bombs and large projectiles fully by adding booster cups to the M10 destructor, as required.

C-5. Foreign Explosives.

a. *Safety Precautions.* Use foreign explosives to supplement standard US charges or, in certain cases, instead of US charges. However, 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.

b. *Priming.* 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 find it necessary to initiate the explosives by using a standard US demolition block primed with a blasting cap.

Appendix D
Expedient Demolitions

D-1. Expedient Techniques. These 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.

D-2. Shaped Charges.

a. *Description.* 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-l). 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.

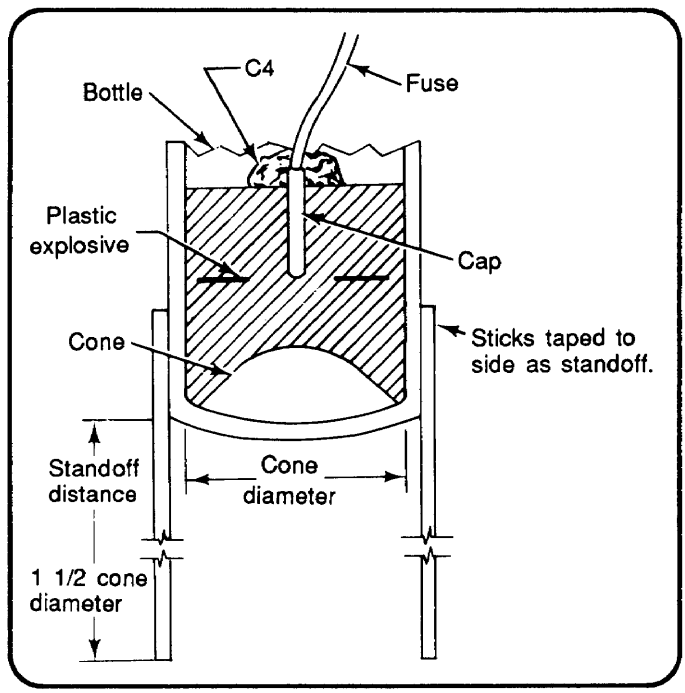


Figure D-1. Improvised shaped charge

b. *Fabrication.* Obtain a container for the shaped charge and remove both ends. Almost any kind of container will work. Cans, jars, bottles, or drinking glasses will do. 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:

(1) 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, a workable but less effective shaped charge can be made by cutting a coned-shaped cavity in a block of explosive.

(2) 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.

(3) 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 the explosive is tightly packed and is free of any air pockets.

(4) Standoff Distance. The normal standoff distance is one and one-half cone diameters. Use standoff sticks to achieve this.

(5) 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 using string or twine.

D-3. Platter Charge. This device uses the Miznay-Shardin effect. It turns a metal plate into a powerful, blunt-nosed projectile (Figure D-2). Use a round, steel platter, if available. Square platters also will work. The platter should weigh 2 to 6 pounds.

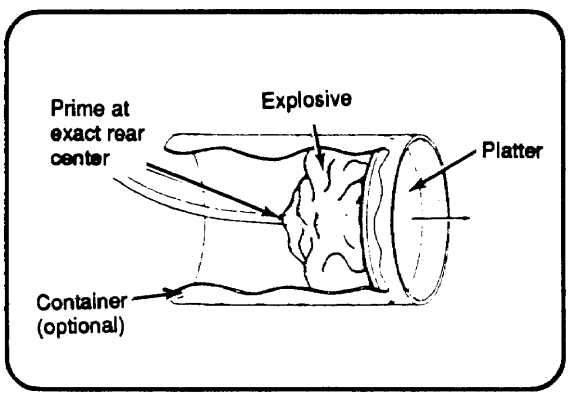


Figure D-2. Platter charge

a. *Charge Size.* Use a quantity of explosive equal to the platter weight.

b. *Fabrication.*

(1) 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.

(2) 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.

(3) If available, use a gutted M60 fuze igniter as an expedient aiming device and aim the charge at the direct center of a target. Ensure 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.

D-4. Grapeshot Charge. 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. Assemble these components as as shown in Figure D-3.

a. *Charge Size.* Use a quantity of explosive equal to one quarter the projectile weight.

b. *Fabrication.*

(1) Make a hole in the center of the bottom of the container large enough to accept a blasting cap.

(2) Place the components in the container in the following sequence:

(a) Explosive. Place the plastic explosive uniformity in the bottom of the container, remove all voids or air spaces by tamping with a nonsparking instrument.

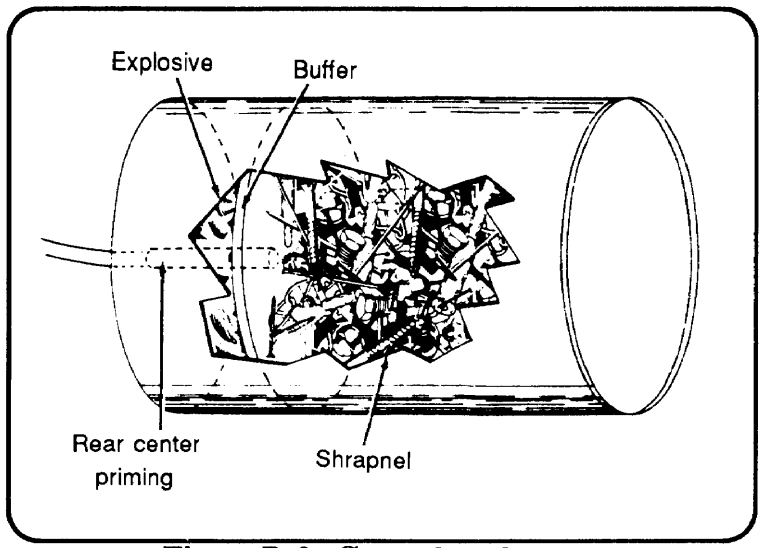


Figure D-3. Grapeshot charge

(b) Buffer. Place 2 inches of buffer material directly on top of the explosive.

(c) Projectiles. Place the projectiles on top of the buffer material, and place a covering over the projectiles to prevent them nom spilling out when handling the charge.

(3) 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

(4) Aim the charge at the center of the target from approximately 100 feet.

D-5. Dust Initiator. Dust-initiator charges use small quantities of explosives with larger amounts of powdered materials (dust or cover) to destroy thin-walled, wooden buildings or railroad boxcars. These charges work best in an enclosed area with few windows. At detonation, the dust or cover is distributed in the air within the target and ignited by an explosive-incendiary charge. The dust-initiator charge consists of an explosive, mixed with equal parts of incendiary mix, and a cover of finely divided organic material.

a. *Charge Computations.*

(1) Charge Size. One pound of explosive-incendiary mixture will effectively detonate up to 40 pounds of cover. To make a l-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.

(2) 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.

b. *Fabrication.* Place the TNT or C3 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.

c. *Detonation.* The charge can be detonated by attaching initation sets to the detonating cord.

D-6. Improvised Cratering Charge. This charge 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:

a. Measure the fertilizer and fuel for the size charge you require.

b. Add the fuel to the fertilizer and mix thoroughly.

c. Allow the fuel to soak into the fertilizer for an hour.

d. Place half of the ammonium nitrate charge in the borehole. Then, place two l-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.

e. Detonate the charge.

D-7. Improvised Borehole Method (Detonating-Cord Wick). This method (Figure D-4) is used to enlarge boreholes in soil. The best results are obtained in hard soil. Use the following procedure:

a. Tape together several strands of detonating cord 5 to 6 feet long. Generally, one strand enlarges the diameter of the hole by about one inch. Tape or tie the strands together into a wick for optimum results.

b. Make a hole by driving a steel rod approximately 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.

c. 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.

d. Fire the cord either electrically or nonelectrically. An unlimited number of wicks can be fired atone time by connecting them with the detonating cord ring main or line main. If successive charges are placed in the holes, blowout excess gases and inspect the hole for excessive heat.

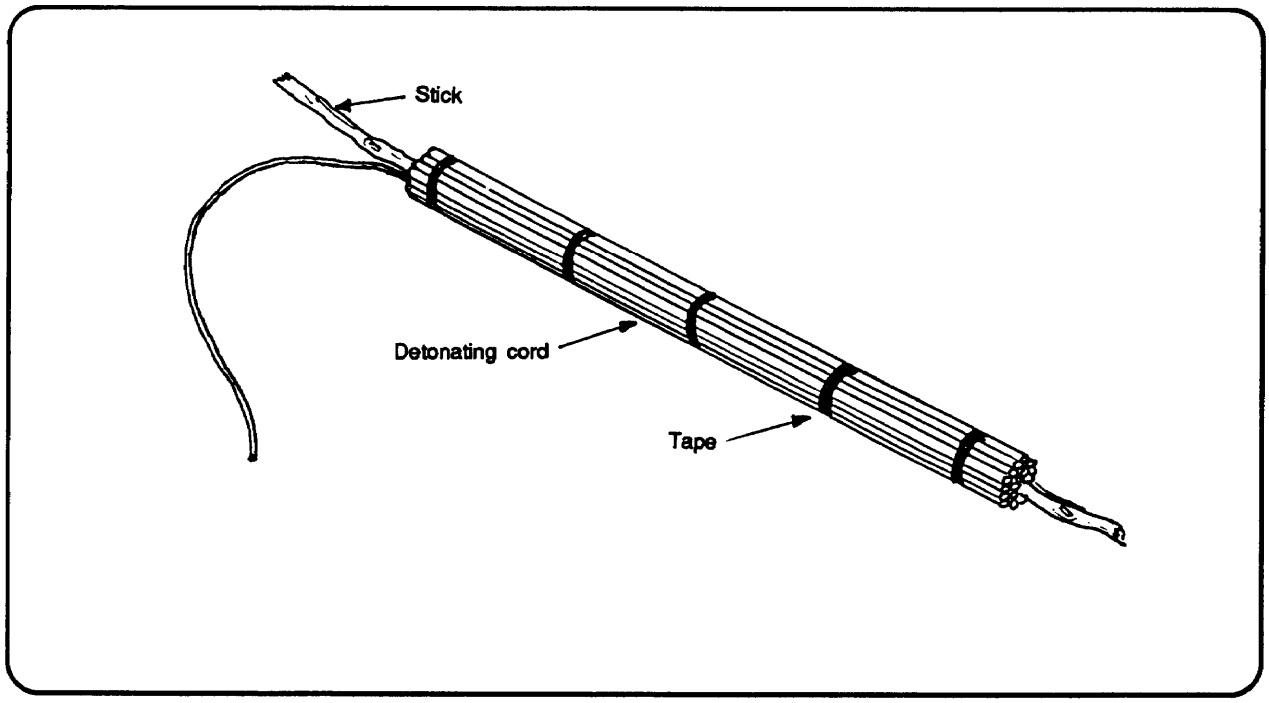


Figure D-4. Detonating-cord wick

D-8. Ammonium-Nitrate Satchel Charge. Although the satchel charge is excellent, it is mostly 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.

a. *Preparation.*

(1) Melt the wax in a container and stir in the ammonium-nitrate pellets, making sure that the wax is hot while mixing.

(2) Before the mixture hardens, add a 1/2-pound block of explosive primed with detonating cord. Ensure the primed charge is in the center of the mixture and that there is sufficient detonating cord available to attach initiation sets.

(3) 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.

(4) Detonate the charge by attaching initiation sets to the detonating cord coming from the satchel charge.

b. *Use.* 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.

D-9. Expedient Flame Fougasse. 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, page D-6). A 55-gallon drum containing a fougasse mixture is effective for a controlled-direction burst.

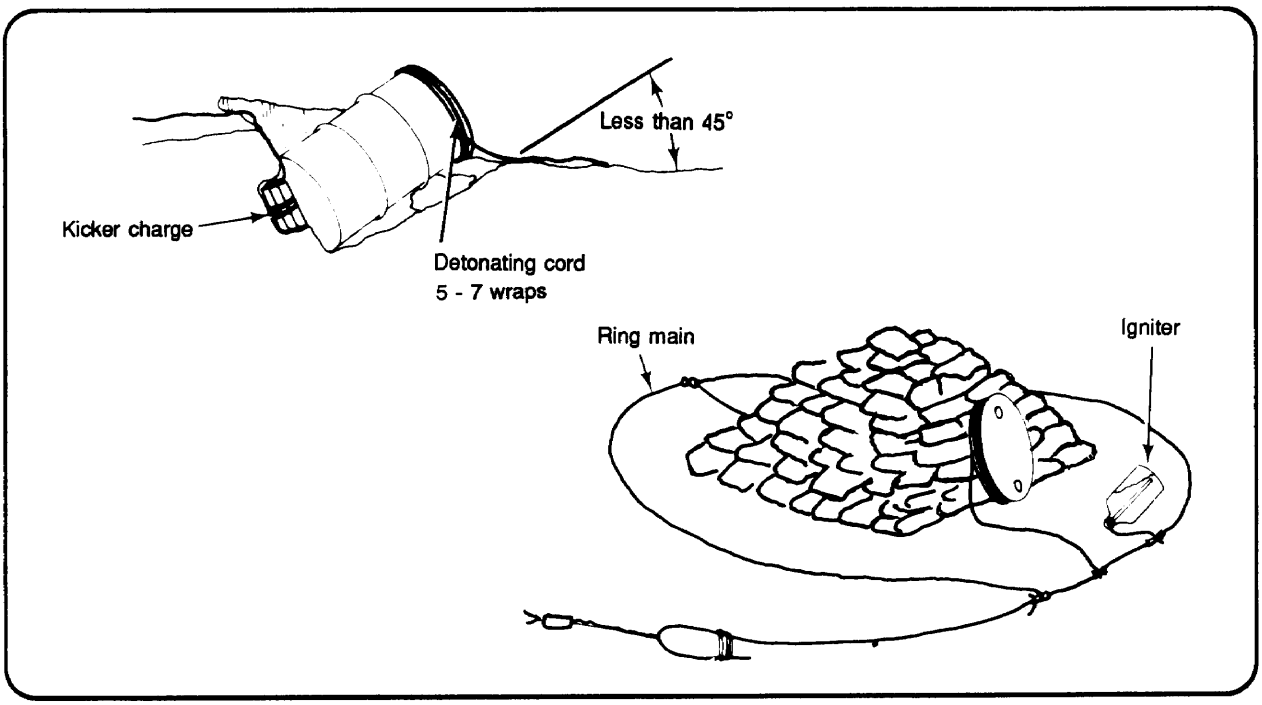


Figure D-5. Expedient flame fougasse

a. *Preparation.*

(1) Make the fougasse mixture by mixing 3 ounces of M4 thickening compound per gallon of gasoline or 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.

(2) Dig an angled trench for the 55 gallon drum that will allow the best coverage and dispersion of the flame fougasse. However, 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 2 blocks of C4).

(3) Prime the kicker charge with detonating cord, leaving 6 to 10 feet of detonating cord free to tie into a ring main (6 to 10 feet).

(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.

(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 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. The running ends of detonating cord for the kicker charge and drum top should extend from the trench. Avoid kinks or sharp bends in the detonating cord.

(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.

(7) Cover the entire 55-gallon drum with a minimum of 1 foot of tamped soil, leaving the front of the drum exposed or uncovered.

(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 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.

(9) Attach initiation sets to the ring main.

b. *Function.* 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 propells the thickened fuel outward, and the trip flare ignites the thickened fuel as it travels downrange. The result is a flash of flame that spreads downrange for approximately 100 meters.

Appendix E
Power Requirements for Series Firing Circuits

E-1. Series Circuits. Electric blasting caps are connected in series and fried 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. The connection of more than 50 caps in a series circuit increases the chances of breaks in the firing line or cap leads.

E-2. Ohm's Law. *Ohm's Law* defines the amount of voltage necessary to detonate the blasting caps. Determine the required voltage for your firing circuit as follows:

$$E=IR \qquad \text{(E-1)}$$

where—

E = *electric potential, or voltage, in volts.*
I = *current, in amperes.*
R = *resistance, in ohms.*

E-3. Electric Power Formula. Determine the amount of electric power (watts) necessary to detonate blasting caps:

$$W= I^2R \qquad \text{(E-2)}$$

where—

W = electrical power, in watts.
I = *current, in amperes.*
R = *resistance, in ohms.*

E-4. Electric Blasting Caps. 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 military electric blasting cap is 2 ohms.

E-5. Circuit Resistance. Ensure that the power source is adequate to fire all charges connected to the circuit. Firing wire, as well as 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 in the wire depends on the wire's size and length. Table E- 1 (page E-2) gives the resistance per 1,000 feet of various sizes of copper wire.

Table E-1. Resistance in copper wire

Wire Characteristics			Resistance per 1,000 Feet (Ohms)
AWG (B&S) Gauge No.	Diameter (In)	Weight (Lb/Ft)	
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	4.0
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.			

E-6. Series Circuit Calculations. 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:

a. *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.

b. *Resistance.* Determine the resistance in the circuit (paragraph E-5, page E-l).

c. *Voltage.* Determine the required voltage for the circuit (paragraph E-2, page E- 1).

d. *Power.* Determine the required power for the circuit (paragraph E-3, page E-l).

e. *Example.* 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.

(1) Current. The amount of current required to detonate this circuit is 1.5 amperes

(2) Resistance.

Caps: 2.0 ohms (20 caps)= 40.0 ohms
Wire: 500 feet (2 strands)= 1,000 feet= 6.4 ohms (Table E-1)
Total Resistance: 46.4 ohms

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).

(3) Voltage.

$E = IR = 1.5(46.4) = 69.6$ *volts* (E-3)

where-

E = *voltage, in volts*
I = *current, in amperes*
R = *resistance, in ohms*

(4) Power.

$W = 1^2(R) = 1.5^2(46.4) = 104.4$ *WattS* (E-4)

where—

W = *power, in watts*
I = *current, in amperes*
R = *resistance, in ohms*

E-7. Voltage Drop. *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.

E-8. Blasting Machines. The name plate 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 E-2 (page E-4). This table lists the sizes of circuits that power sources can support. If you must determine the power source's capabilities from the name plate, use the following procedure:

a. *Determining Circuit Capacity*.

- 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 (Step 1) 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 from the firing wire (Table E-l).
- 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 E-2. Power source capacities

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 (115V, 13.5A)	x	x	—
Generator, 3-kw, Portable (115V, 26A)	x	x	—
Generator, 5-kw, Portable (115V, 43.5A)	x	x	—
Generator, 3-kw, Portable (220V, 13.5A)	x	x	x
Generator, 5-kw, Portable (220V, 22.5A)	x	x	x

b. *Example.* 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).

(1) Allowable Resistance.

$$\frac{0.90(220\ volts)}{1.5\ amperes} = 132\ ohms \qquad \text{(E-5)}$$

(2) Resistance in Firing Wire.

$$\frac{10.2\ ohms\ (500\ feet)}{1{,}000} = 5.2\ ohms \qquad \text{(E-6)}$$

(3) Allowable Resistance in Blasting Caps.

$$132\ ohms - 5.2\ Ohms = 126.8\ Ohms \qquad \text{(E-7)}$$

(4) Number of Blasting Caps.

$$\frac{126.8\ ohms}{2\ ohms} = 63.4\ caps\ (Round\ down\ to\ 63\ caps) \qquad \text{(E-8)}$$

E-9. Batteries and Dry Cells. Use the procedure in paragraph E-8 (page E-3) to determine the size of a circuit supported by a battery or dry cell.

Appendix F
Instructions for Completing Demolitions-Related Reports

F-1. Target Folder. A completed target folder contains demolition orders and an obstacle folder. A sample target folder is shown in Figure F-1 (page F-4). Refer to Chapter 5, Section III (page 5-2), for a discussion of the demolition orders. Refer to Chapter 5, Section IV (page 5-6) for a discussion of the obstacle folder.

F-2. Instructions for DA Form 2203-R. Use the following instructions and the sample form shown in Figure F-2 (pages F-38 through F-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.

a. *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.

b. *Block 2 (DML RECON RPT 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.

c. *Block* 3 *(DATE).* Enter the date the reconnaissance was performed.

d. *Block 4 (TIME).* Enter the time the reconnaissance party arrived at the target site (local or ZULU time).

e. *Block 5 (RECON ORDERED BY).* Enter the command authority authorizing the reconnaissance action.

f. *Block* 6 *(PARTY LEADER).* Enter the name of NCOIC or OIC of the reconnaissance party who was physically at the site when the reconnaissance was performed.

g. *Block 7 (MAP NAME, SCALE, SHEET #, and SERIES #).* Obtain this information from a map of the reconnaissance area and enter the information in this block.

h. *Block 8 (TARGET AND LOCATION).* Enter a brief description of the target and the distance and direction from an identifiable landmark (railroad bridge, crossroad, hilltop, and so forth). For example, "Target is 275 degrees, 300 meters from the railroad bridge, 2 miles east of Hanesville, on Route 2."

i. *Block 9 (TIME OBSERVED).* Enter the time you last saw the target as you departed the site.

j. *Block 10 (COORDINATES).* Enter the complete 8-digit map coordinates of the target.

k. *Block 11 (GENERAL DESCRIPTION (attach 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."

l. *Block 12 (NATURE OF PROPOSED DEMOLITION (attach 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.

m. *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.

n. *Block 14 (EXPLOSIVES REQUIRED).* Indicate the types, quantities, caps, detonators, and so forth proposed for the demolition.

o. *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 on the reverse side of the form.

NOTE: Troops may not ride in vehicles transporting explosives.

p. *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.

q. *Block 17 (TIME, LABOR, AND EQUIPMENT REQUIRED FOR BYPASS; SPECIFY 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 on the reverse side of the form.

r. *Block 18 (REMARKS).* Include any appropriate remarks that are not covered in Blocks 1 through 17. Comments may be continued on the reverse side of the form.

s. *Block* 19 *(ADDITIONAL COMMENTS).* Use this block as a continuation for Blocks 1 through 18. Identify the block being continued.

F-3. Instructions for Sketches. Use the following instructions and the sample form shown in Figure F-2 (pages F-38 through F-42) to complete the necessary sketches for DA Form 2203-R.

a. *General Description Sketch.* This 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.

b. *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.

Unclassified
(Security Classification)

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 demolition from State of Readiness 1 (SAFE) to State of Readiness 2 (ARMED), pass this information to the Authorized Commander and record it in para 10a.

vii. 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 must be made known to the Demolition Firing Party Commander.

viii. Once State of Readiness 2 (ARMED) has been ordered, either you or your deputy must always be at your command 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 are to give the Demolition Firing Party protection until such time as it has completed the demolition.

x. 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 new form handed to the new Demolition Guard 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.

xi. When the demolition has been completed, you are to report its effectiveness to the Authorized Commander by the fastest means available, and return Copy No 1 to him with para 14 completed.

xii. If you receive orders to fire the demolitions other than those given in para 6, you should refer to the Authorized Commander.

ORDERS TO THE DEMOLITION FIRING PARTY COMMANDER

xiii. You are in technical charge of the preparation, charging, and firing of the demolition.

xiv. The Demolition Guard Commander (if one is provided) is responsible for:

a. Tactical command of all troops at the demolition site, you are therefore under his command.

b. Giving you in writing (para 10) the order to change the State of Readiness.

c. Giving you in writing (para 13) the order to fire 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).

Unclassified
(Security Classification)

SAMPLE

Figure F-1. Sample target folder

Unclassified
(Security Classification)

COPY NO 2 OF 3

DEMOLITION ORDER
SERIAL NO 004

From John P. Smith, Gen. USA
X 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 3170 3330 .....
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

a. The demolition target is to be prepared to State of Readiness 1 ..... by 271500 (DTG).
b. ☒ All other orders will be issued to you by the Demolition Guard Commander. Record their receipt in Part II.
c. ☐ There is no Demolition Guard. You are to act as instructed in para 5, 6, and 7, recording the orders received in Part II.
(Only one box is to be crossed)

4. Orders to the Demolition Guard Commander

Your responsibilities are detailed in Part IV. You are to act as instructed in para 5, 6, and 7, recording the orders received in Part II.

5. Demolition is to be fired

a. ☐ Immediately upon being 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)

SAMPLE

Unclassified
(Security Classification)
2

Figure F-1. Sample target folder (continued)

Unclassified
(Security Classification)

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]	[illegible]

9. Authorized Commander

Signature [illegible] Rank/Name [illegible]

Appointment [illegible] Date/Time Group [illegible]

PART II

10. Changing State of Readiness:

a. Time estimated by Firing Party Commander to change from State of Readiness I (SAFE) to State of Readiness 2 (ARMED) is ..... minutes.

b.

State of Readiness Ordered	Originator	Date/Time Group of:	
		Receipt of Order	Change Completed

11. Handover and Takeover of Demolition Target:

	Rank, Name, and Unit	Signature	Date/Time Group
Transferring Commander			
Accepting Commander			

Unclassified
(Security Classification)

3

SAMPLE

Figure F-1. Sample target folder (continued)

Unclassified
(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 para 8c)

PART II

14. Demolition Report

a. Bridge
Estimated width of gap ..... No of craters .....
No of spans down ..... Diameter/Depth .....
c. Other target .....
d. Mines laid: AT mines ..... AP mines .....

Sketch

Signature ..... Rank/Name/Unit .....

Unclassified
(Security Classification)

SAMPLE

Figure F-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

Type of obstacle	Concrete Arch Bridge
Type d'obstacle	
Art der Sperre	

CLASS 1.++PRELIMINARY 2.++~~RESERVED~~	CATEGORIE 1.++Préliminaire 2.++DE MANOEUVRE (1) RESERVE (1)	DRINGLICHKEIT 1.++Sofort-Maßnahme 2.++Reserviert	

Serial number 004	
Numero d'ordre	
Laufende Nummer	

Target no.	
Dispositif No.	
Objektnummer	

Copy	Exemplaire	Ausfertigung	
2	No.		

SAMPLE

NOTE Anmerkung

\+ When blank
Si laisse en blanc
Wenn unausgefüllt

++ Strike out item not applicable
Rayer la mention inutile
Nicht zutreffendes streichen

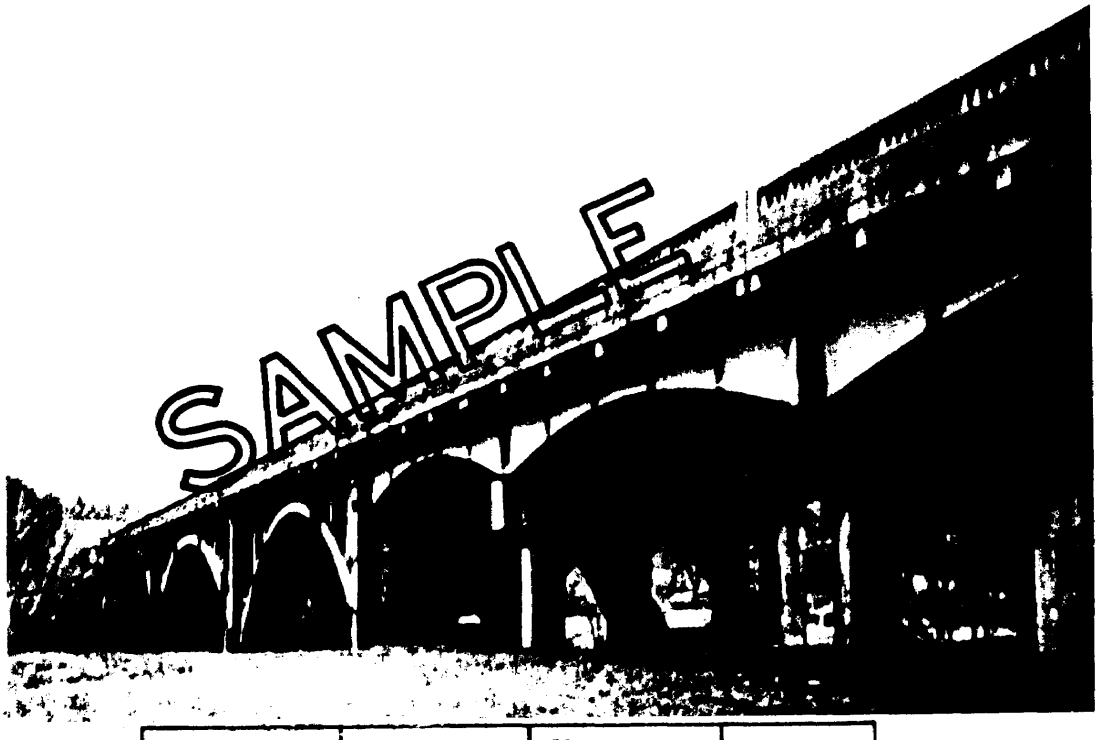
(1) Delete the term NOT used
Barrer la mention NON utilisée

Figure F-1. Sample target folder (continued)

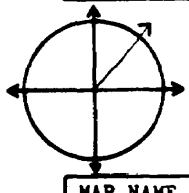
NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(1) PHOTOGRAPH OF TARGET — PHOTOGRAPHIE DE L'OUVRAGE

FOTOGRAPHIE DES SPERROBJEKTS



DESCRIPTION	DESCRIPTION	BESCHREIBUNG	



Indicate direction of view

Richtung, in der das Objekt gesehen wurde, einzuzeichnen

Indiquer direction de prise de vue

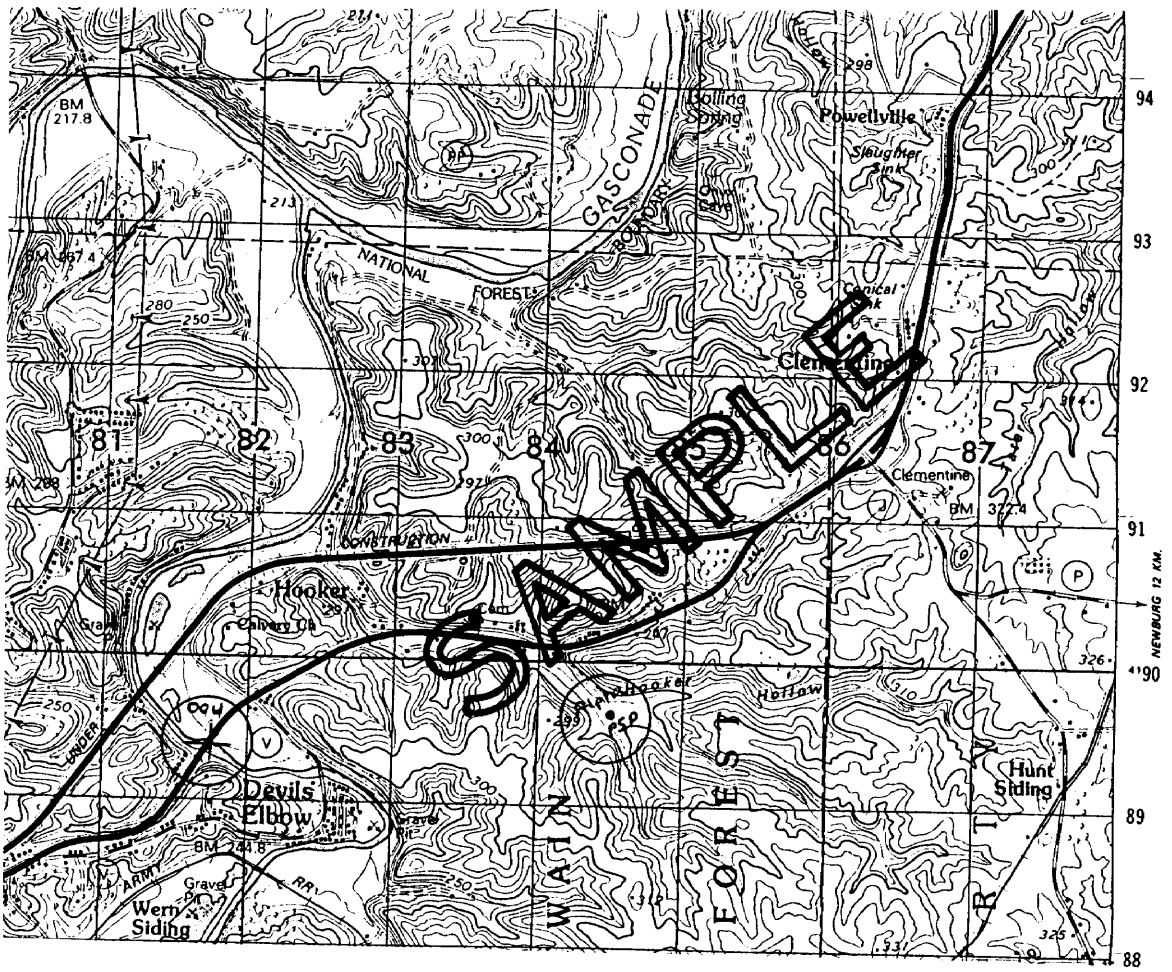
MAP NAME AND SCALE	NOM ET ÉCHELLE DE LA CARTE	KARTENBEZEICHNUNG UND MASS-STAB
Waynesville	1:50,000	

GRID REFERENCE OF TARGET	COORDONNEES DU DISPOSITIF	KOORDINATEN DES OBJEKTS
WM 8170 8935		

Figure F-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 MUNITIONSLAGERPLATZ.



SCALE	ÉCHELLE	Maßstab	1: ~~250.000~~

Figure F-1. Sample target folder (continued)

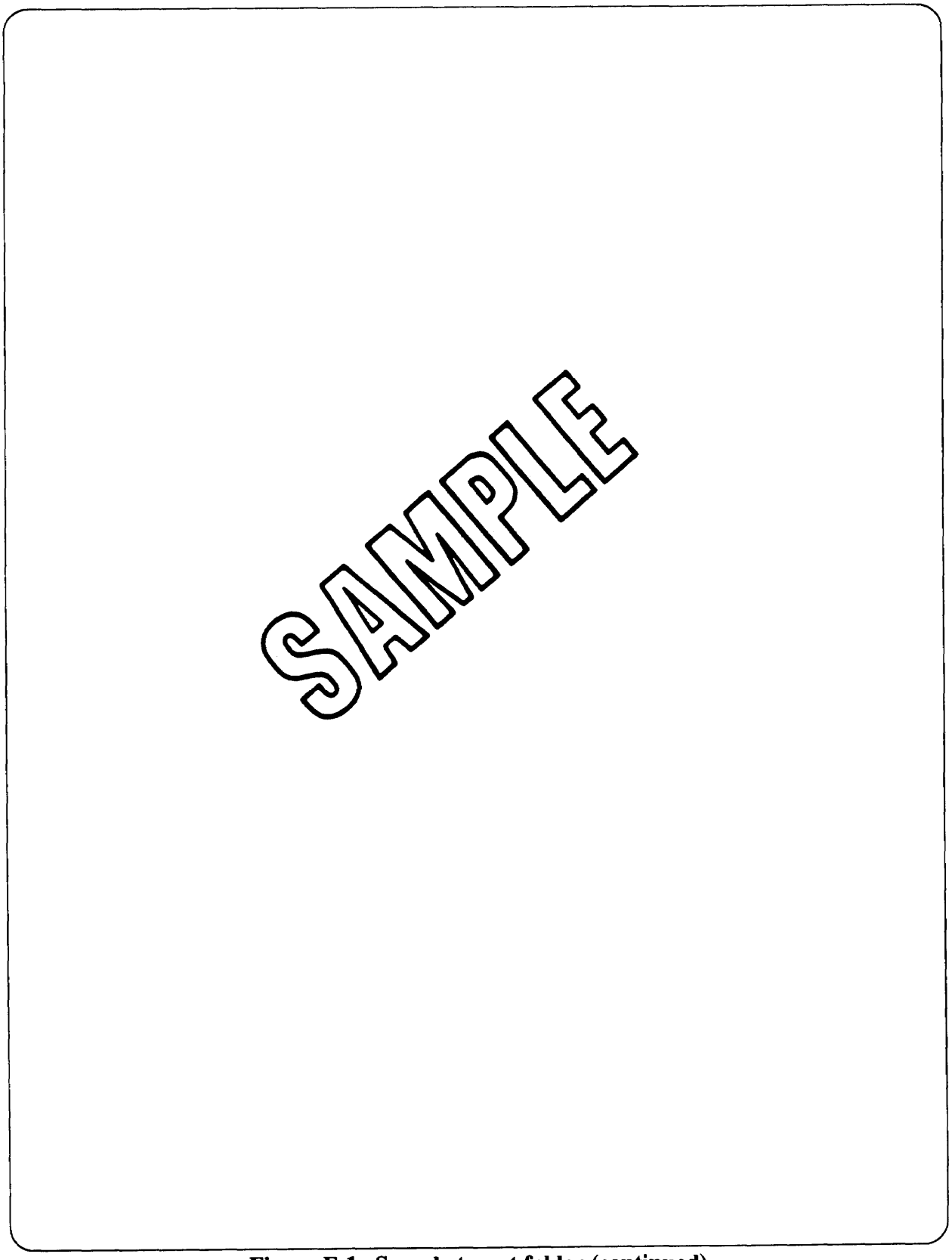
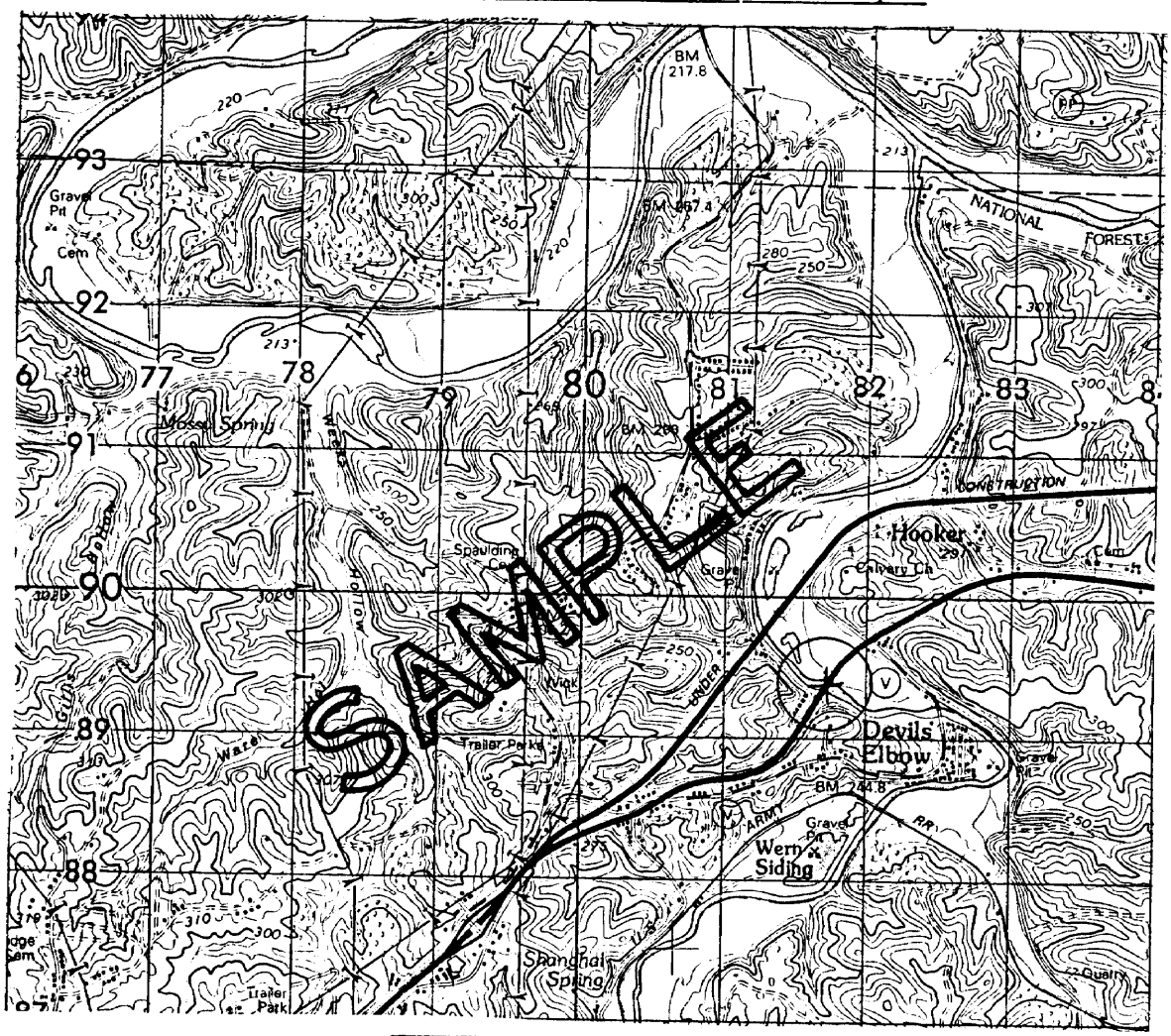


Figure F-1. Sample target folder (continued)

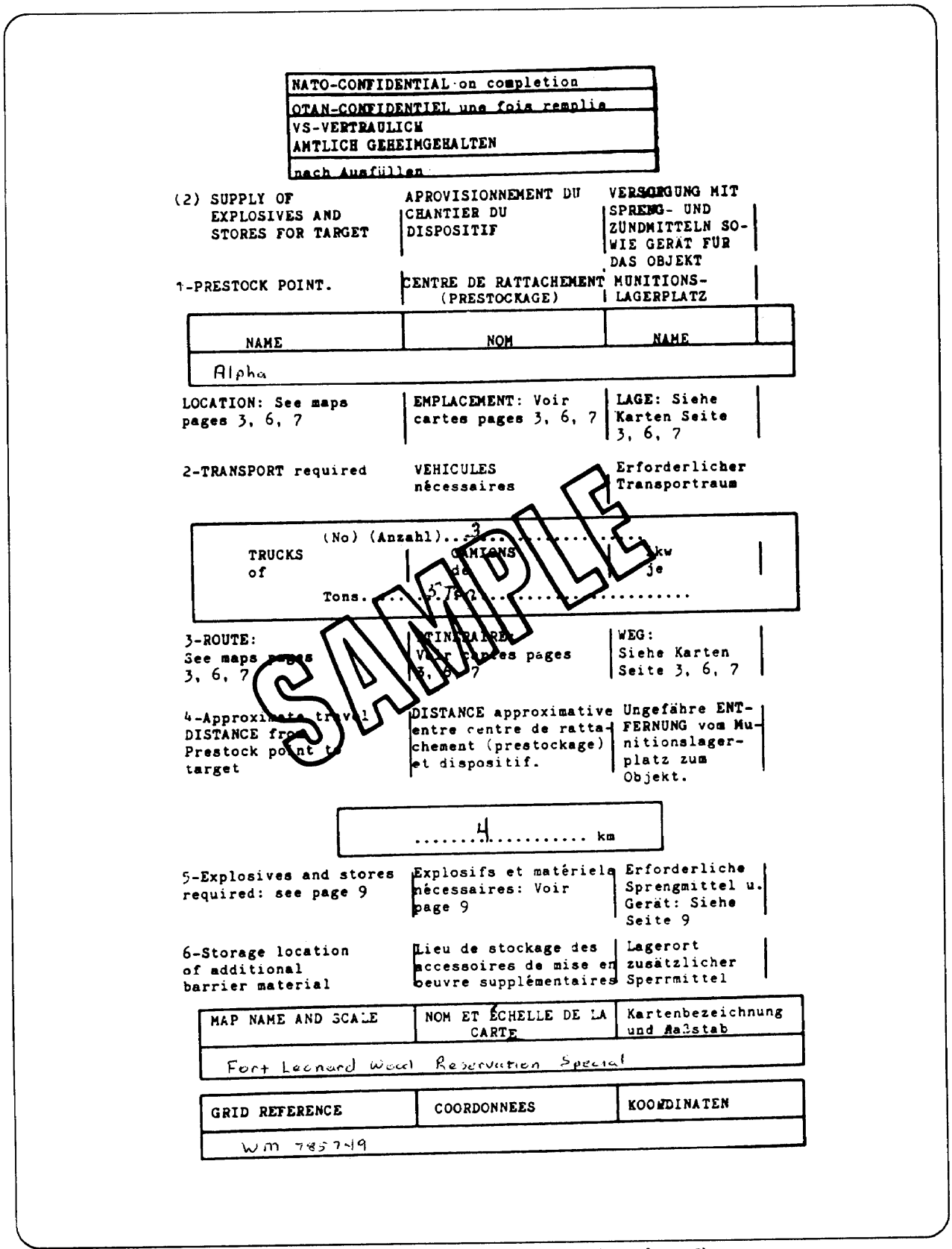
NATO-CONFIDENTIAL on completions
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(1b) LOCATION OF TARGET	EMPLACEMENT DU DISPOSITIF	LAGE DES OBJEKTS



SCALE	ÉCHELLE	Maßstab	1:50.000

Figure F-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... CAMIONS de	...kw ...je
	Tons...5 Tn...	

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		

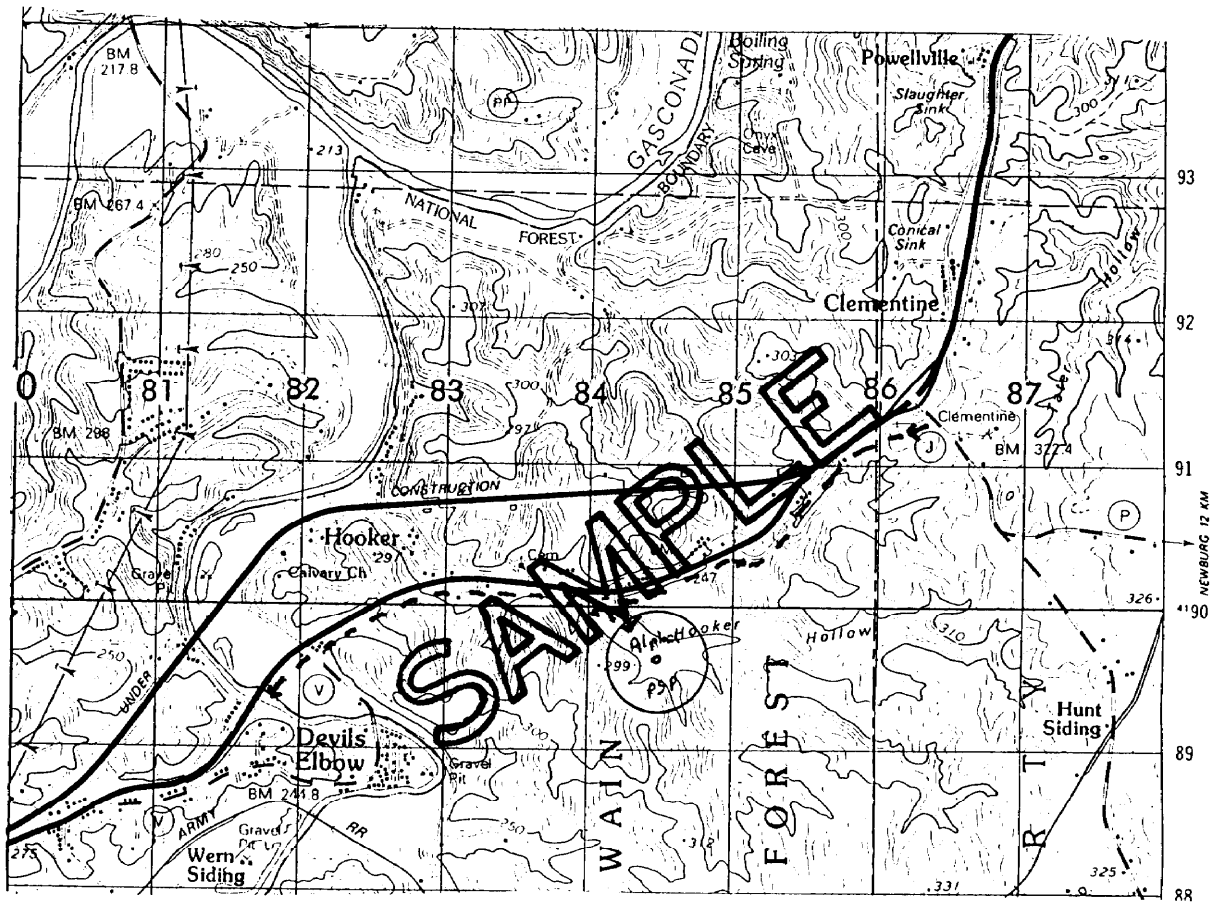
GRID REFERENCE	COORDONNEES	KOORDINATEN
WM 785749		

SAMPLE

Figure F-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



		Maßstab	1:50.000

Figure F-1. Sample target folder (continued)

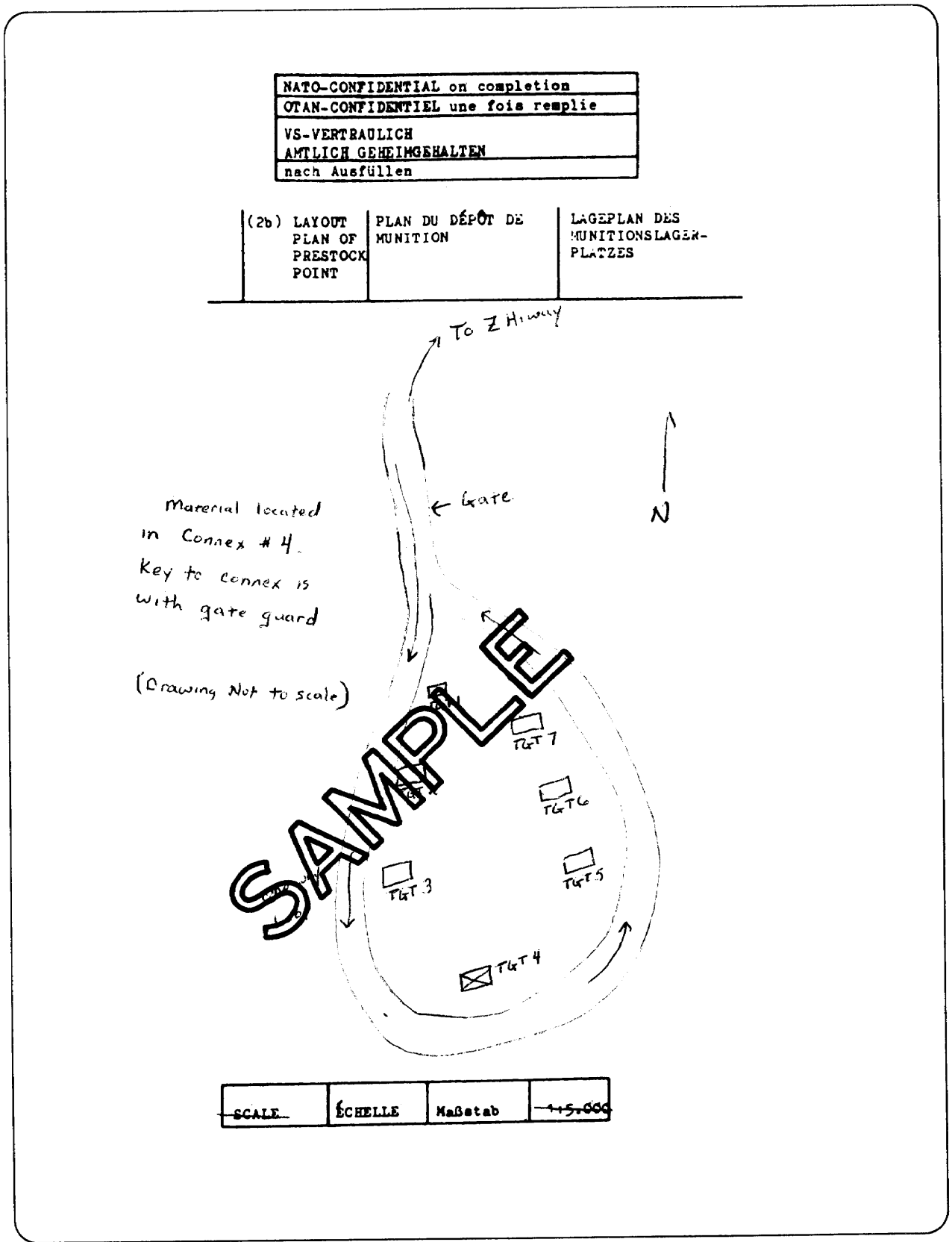


Figure F-1. Sample target folder (continued)

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

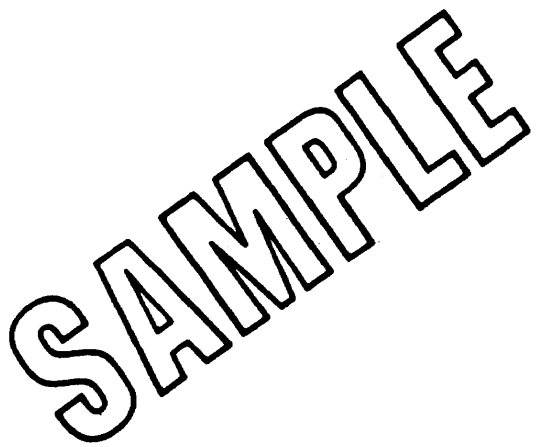


Figure F-1. Sample target folder (continued)

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

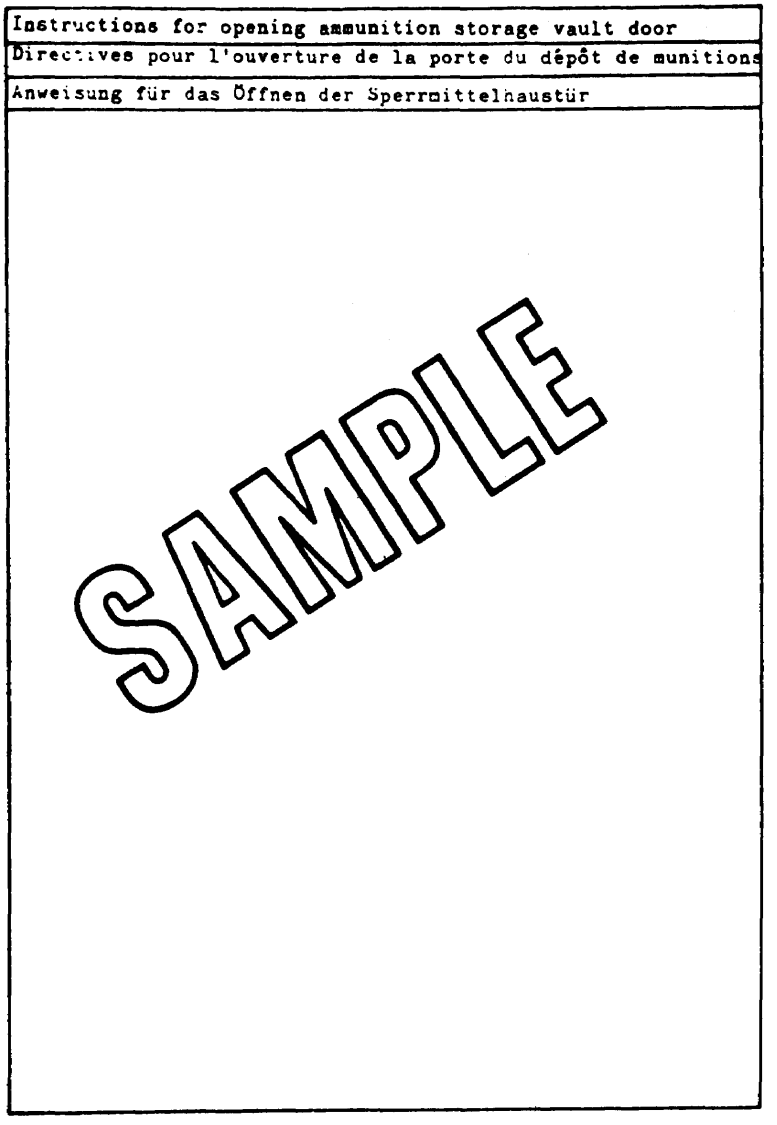


Figure F-1. Sample target folder (continued)

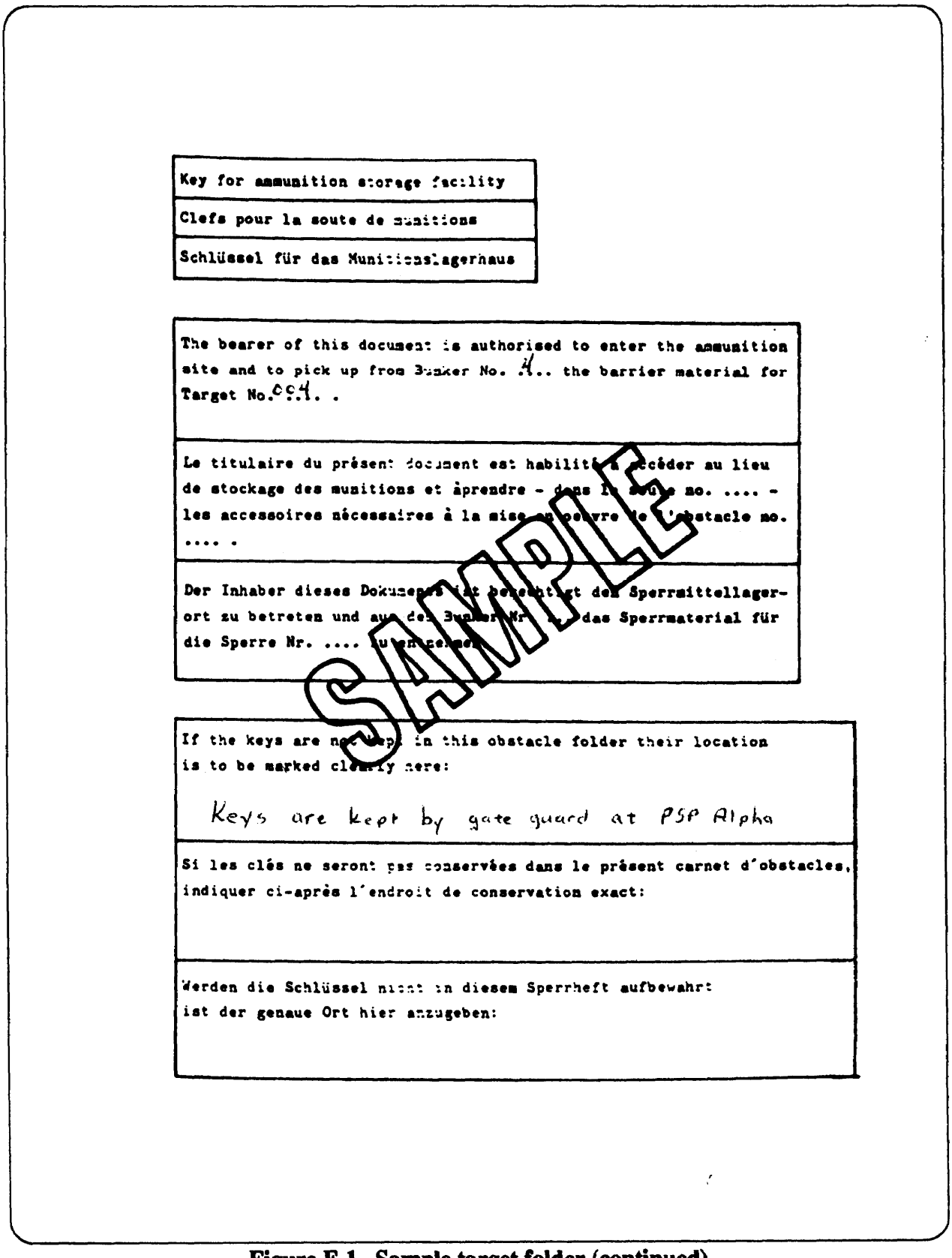


Figure F-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completation
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN nach Ausfüllen

(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 POIDS TOTAL
(1)	(2)	(3)	(4)	(5)	(6) (kg)
1	EXPLOSIVES	EXPLOSIFS	SPRENGMITTEL		
a	Cratering charges	Expl. progressifs	Trichter-sprengladungen		
b	High TNT explosives	Expl. brisants	Hochbrisante Brisanzsprengm.	1336	1336 lbs
c	Plastic C-4 explosives	Plastique	Sprengmasse Formbar	489 PKG	610 lbs
d	Shaped charges	Charges creuses	Hohlladungen		
e	Cutting charges	Charges coupantes	Schneid-ladungen		
2	ACCESSOIRES ARTIFICES		ZÜNDMITTEL		
a	Safety Fuze	Mèche lente	Anzündschnur	100 FT	2 lbs
b	Detonating cord	Cordeau détonant	Sprengschnur	4,000 FT	88 lbs
c	Non electric Detonators	détonateurs pyro technique	Sprengkapseln	10 EA	
d	Electric Detonators	détonateurs electrique	Sprengkapseln elektrisch		
e	Prime cap	Détonateur d'amorce	Sprengkapsel-zünder		
f	Booster cap	Renforcateur	Sprengschnur-kapsel		
g	Blasting machine (exploder)	Exploseur	Zünd-maschine		
h	Cable electric (2 wire)	Cable electrique (2 file)	Zündkabel (zweiadrig)		

Fuse Igniter M-60 10 EA

SAMPLE

Figure F-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	TOOLE	OUTILLAGE	WERKZEUG		
a	Quarrying bars	Barres a 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	GERÄT		
a	Nails 10d	Pointes	Nägel	4 lbs	4 lbs
b	Wire	Fil de Fer	Draht		
c	Timber 2x12x10'	Planches	Bohlen	100'	160 lbs
	Rope ½ nylon			300'	100 lbs
5	MINES	MINES	MINEN		
a	Mines AP	Mines AP	SchAbwMi		
b	Mines AT	Mines AC	PzAbwMi		
c	Fuzes	Allumeurs	Zünder(Minen)		
	TOTAL WEIGHT	POIDS TOTAL	GESAMTGEWICHT		2307

SAMPLE

Figure F-1. Sample target folder (continued)

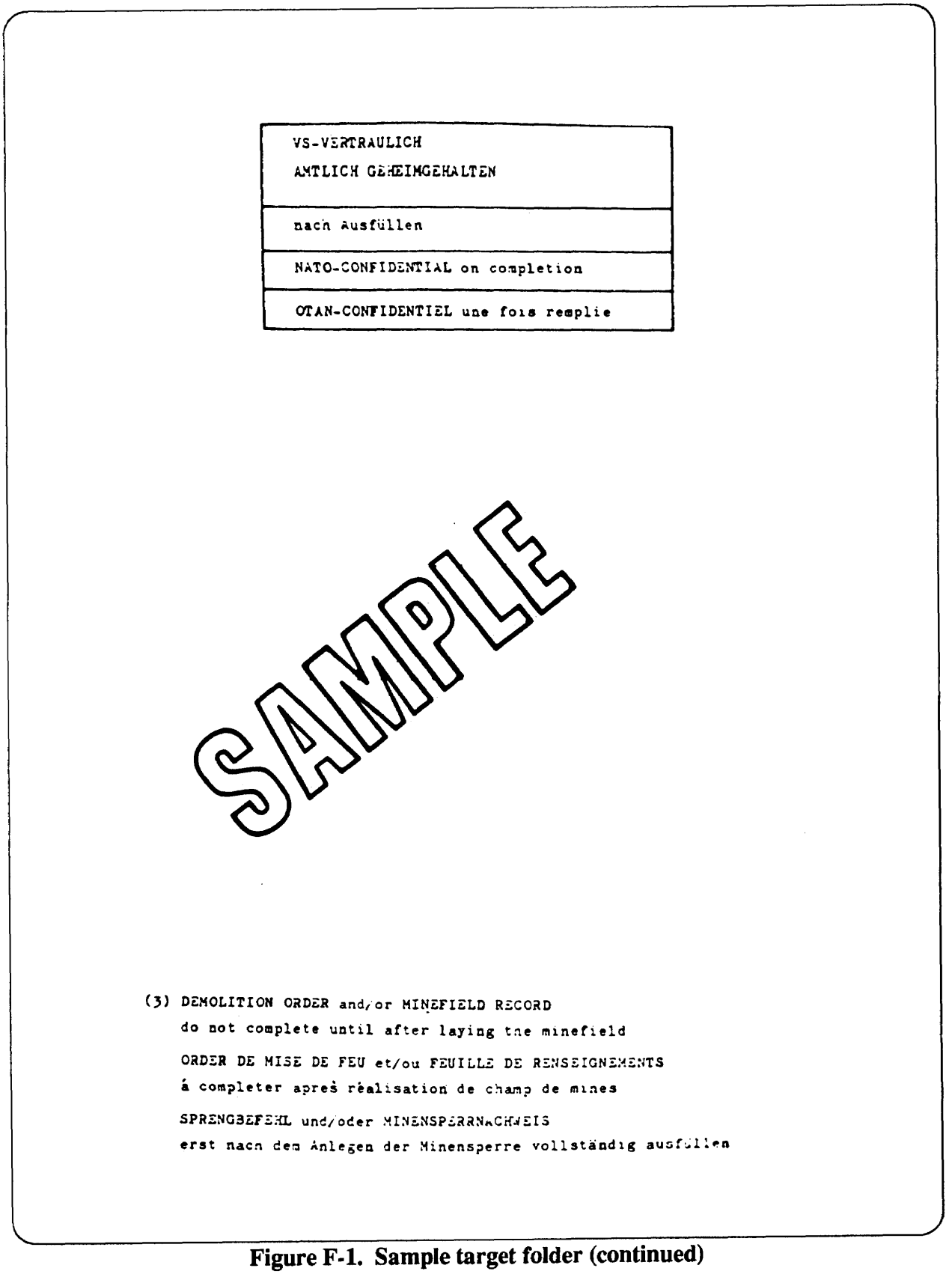


Figure F-1. Sample target folder (continued)

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 (NON AMORCE) à 2 (AMORCE) — Zeitbedarf für Änderung der Zündbereitschaft von 1 (GESICHERT) in 2 (ENTSICHERT)

Min
30

3. Personnel required for preparing and charging — Personnel nécessaire pour préparation et chargement — Personalbedarf für die Vorbereitung zur Sprengung

N.C.O.	S/Officier	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 F-1. Sample target folder (continued)

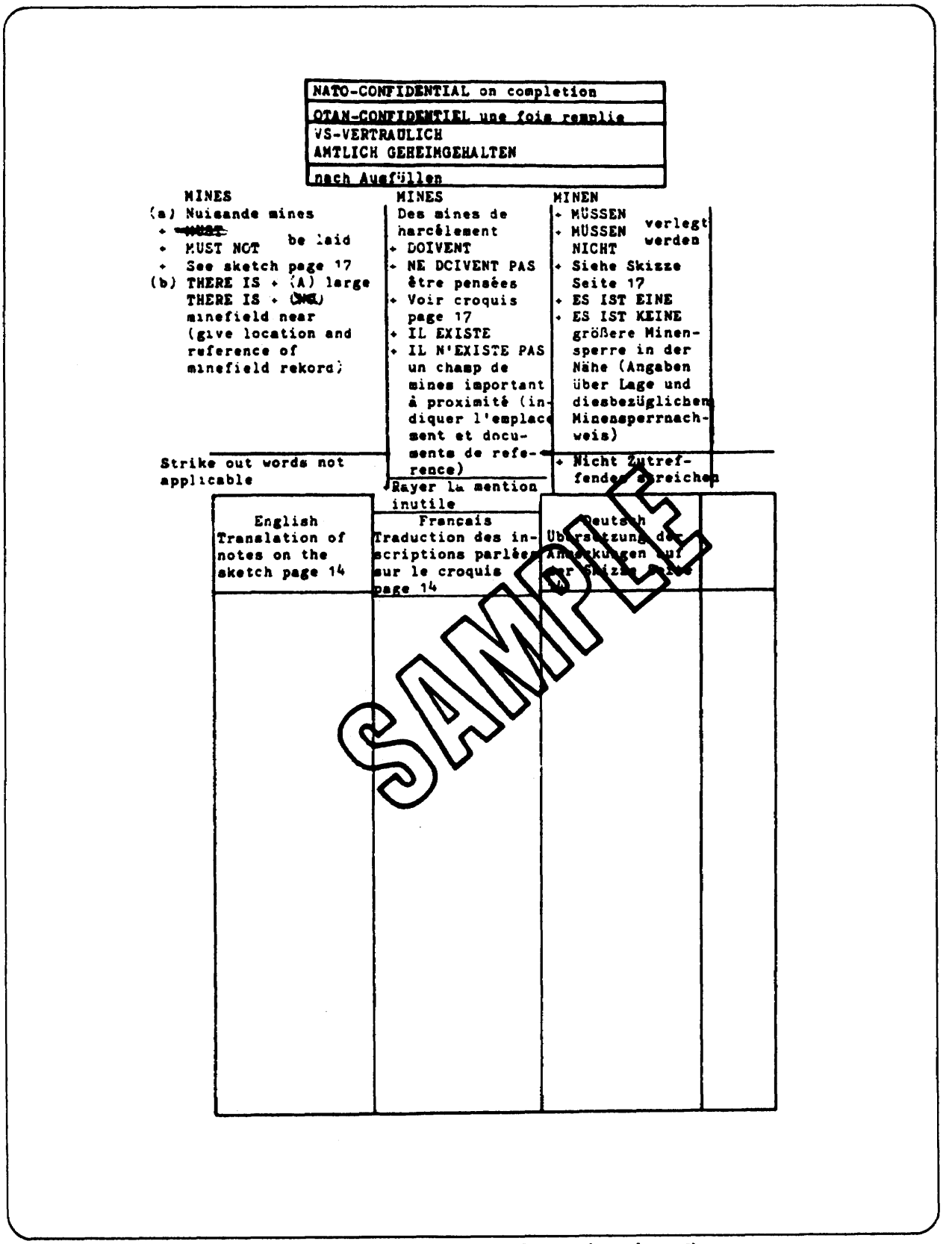


Figure F-1. Sample target folder (continued)

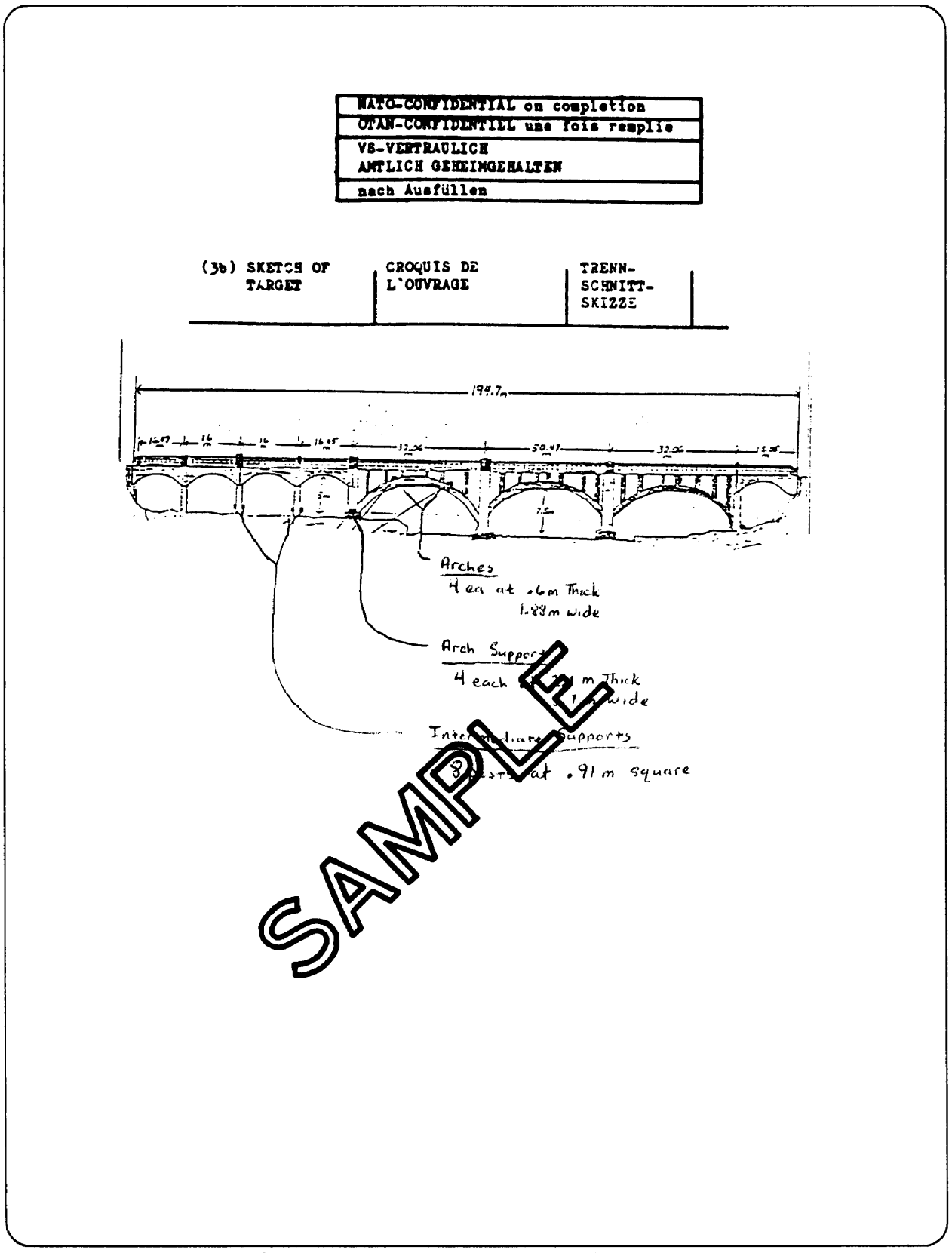


Figure F-1. Sample target folder (continued)

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 inscriptions portées sur le croquis page 15	Deutsch Übersetzung der Anmerkungen auf der Skizze Seite 15	

SAMPLE

Figure F-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

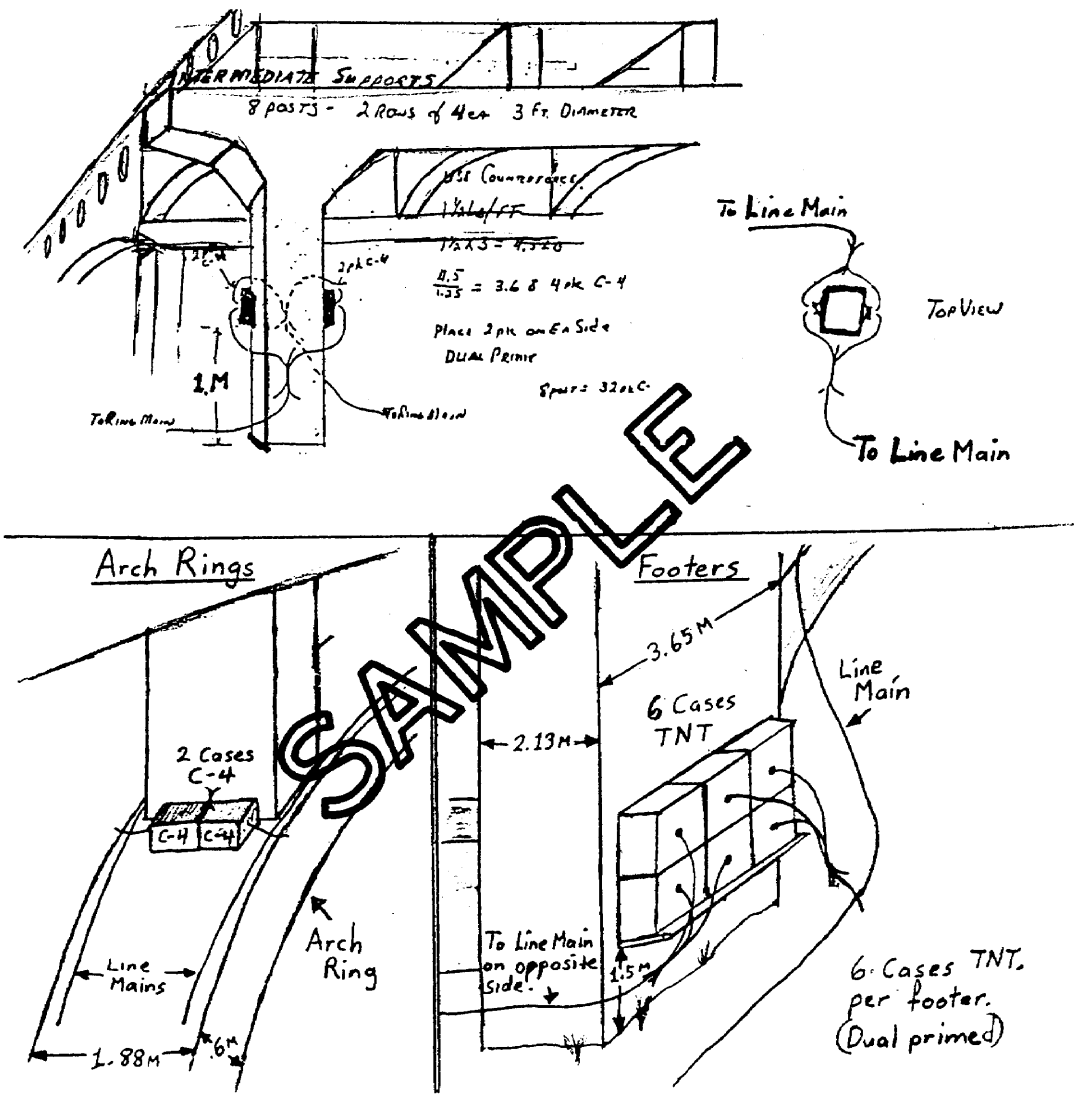


Figure F-1. Sample target folder (continued)

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 Übersetzung der Anmerkungen auf der Skizze Seite 16	

SAMPLE

Figure F-1. Sample target folder (continued)

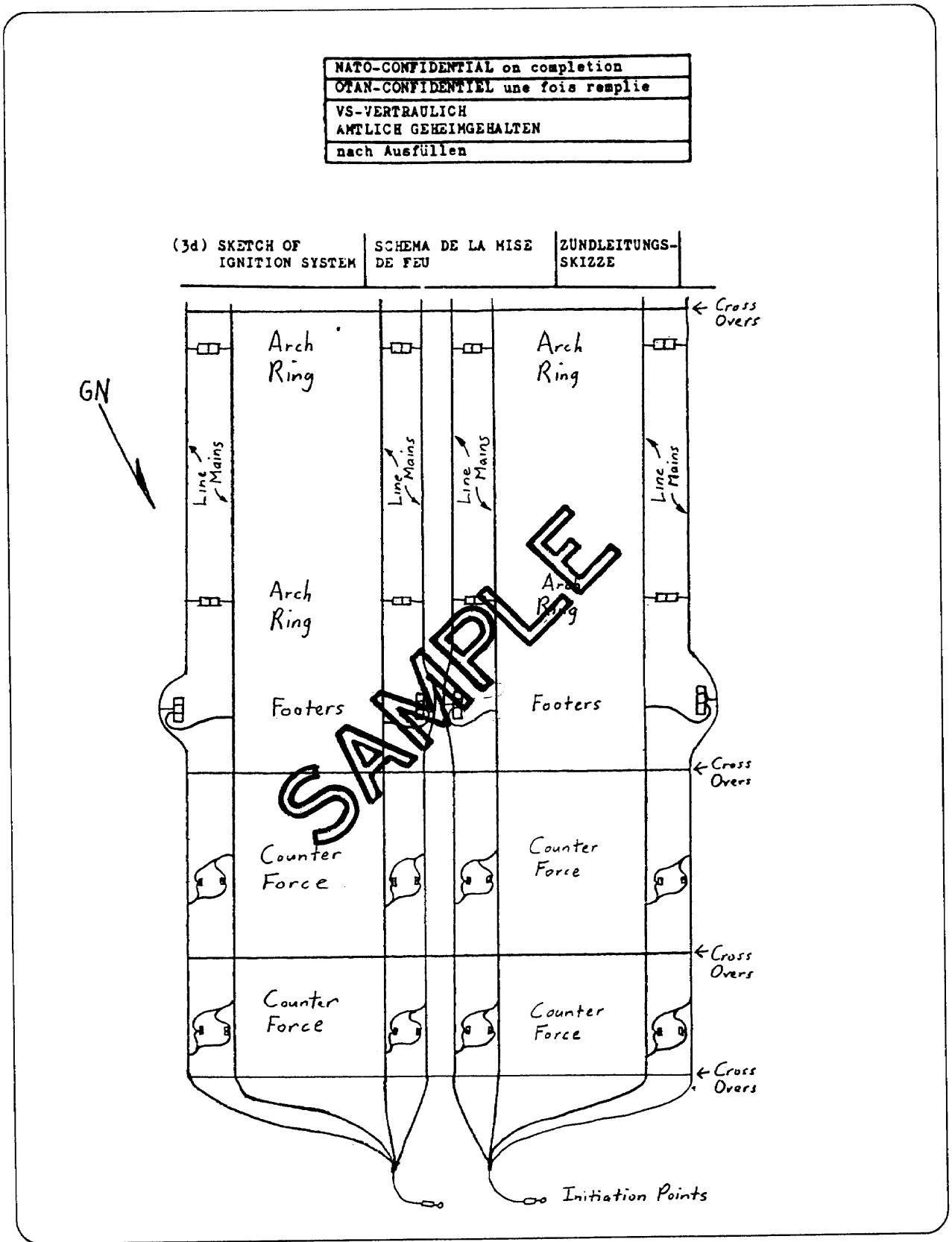


Figure F-1. Sample target folder (continued)

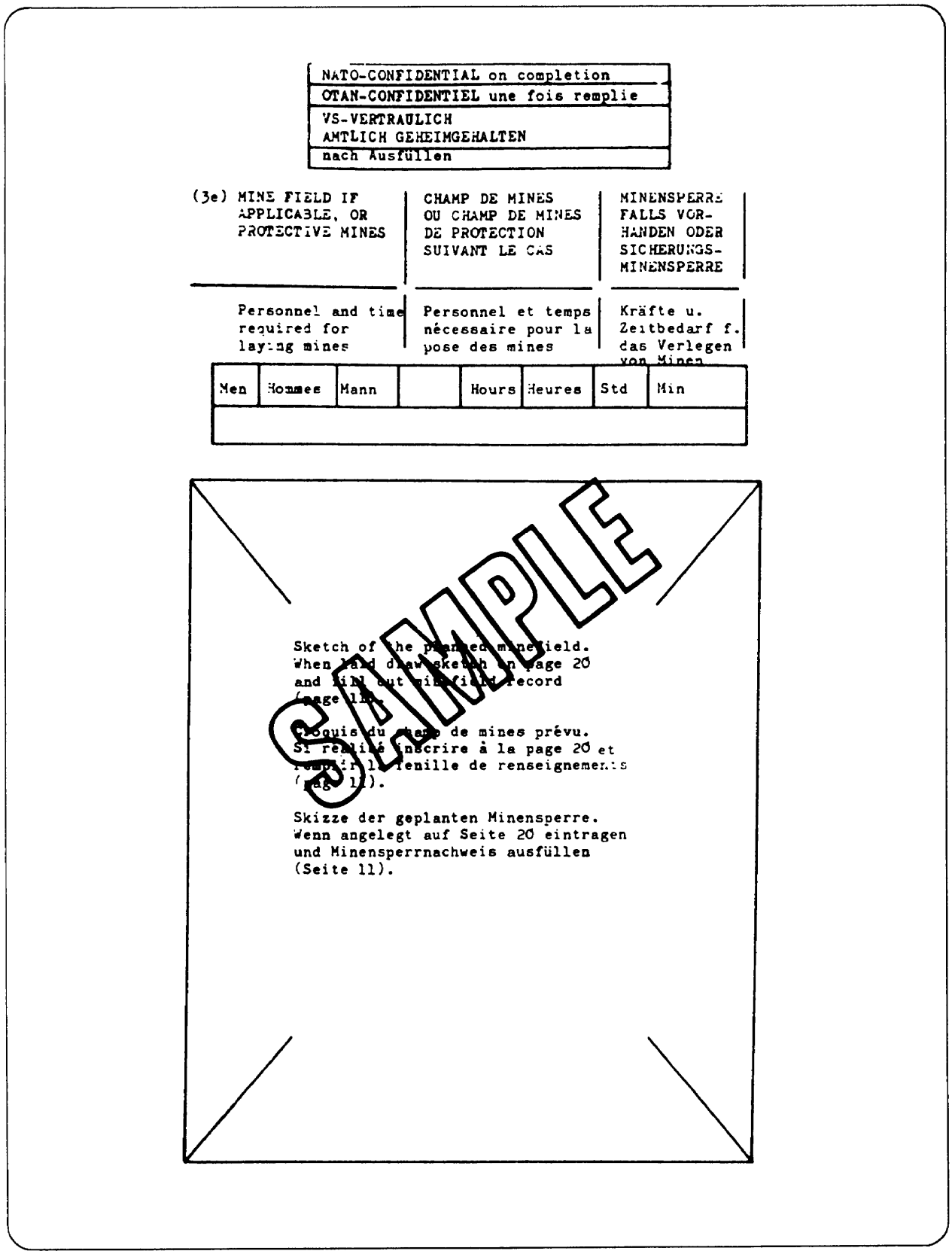


Figure F-1. Sample target folder (continued)

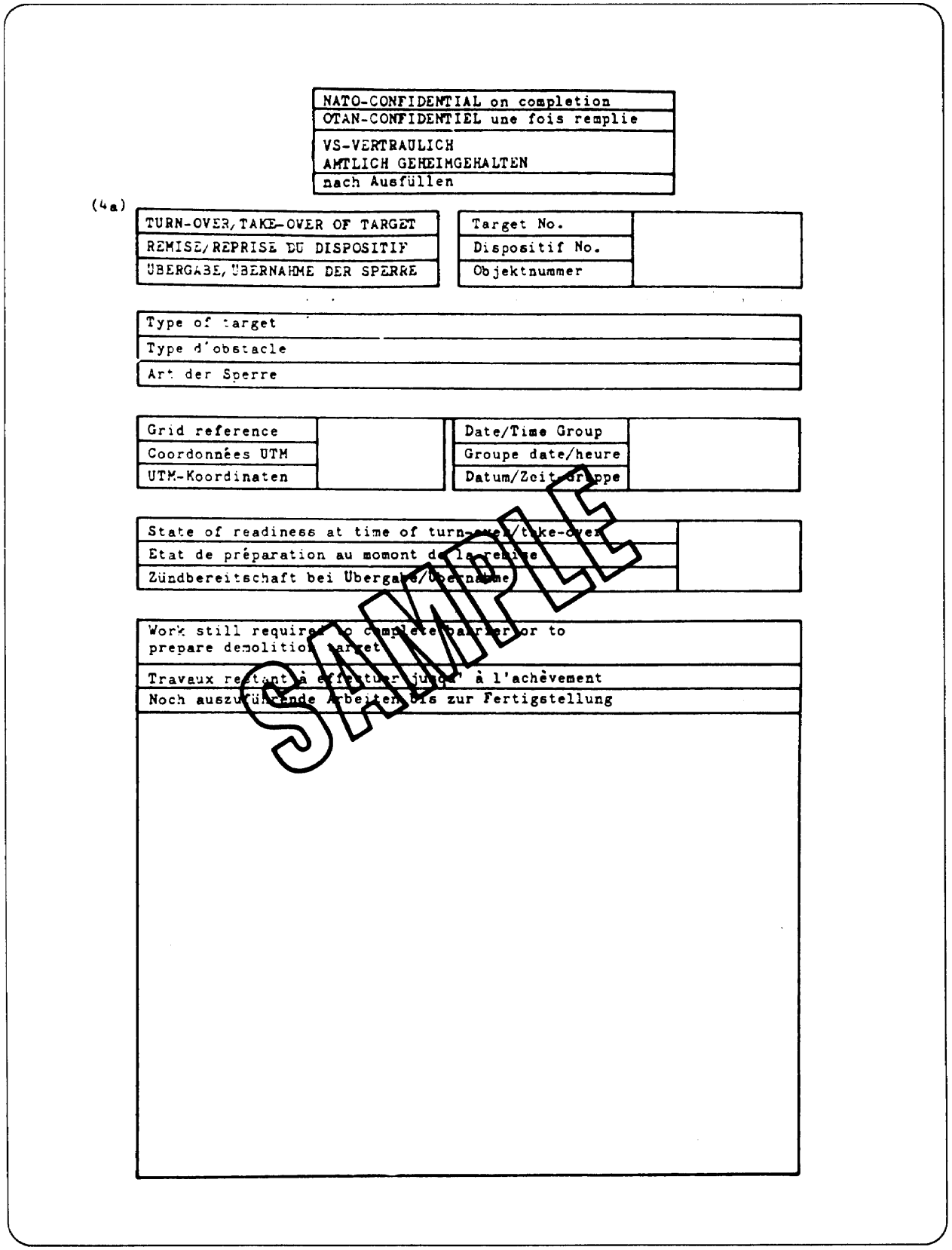


Figure F-1. Sample target folder (continued)

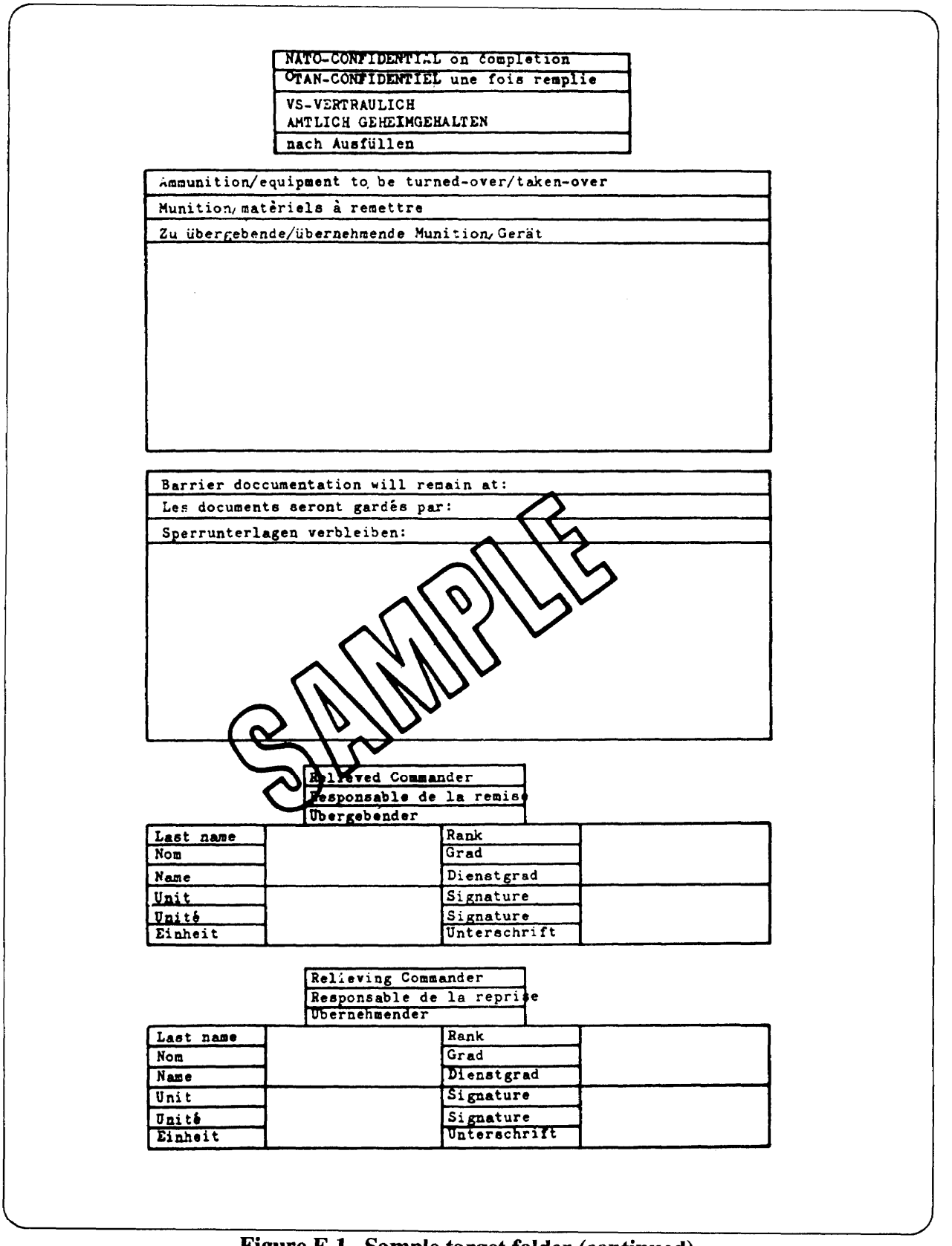


Figure F-1. Sample target folder (continued)

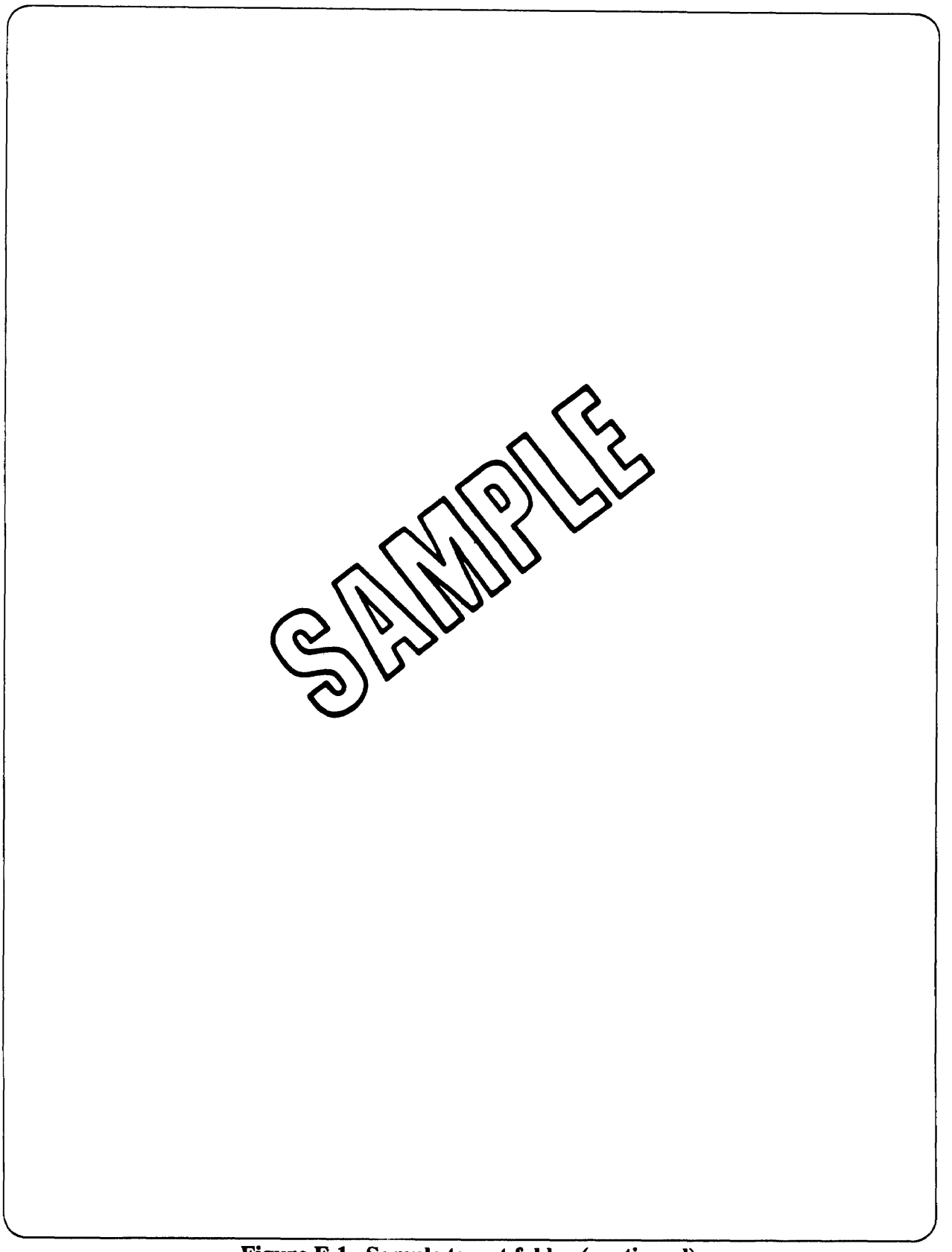


Figure F-1. Sample target folder (continued)

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) Case d'un pont	Umfang der Zerstörungen (1) im Falle einer Brücke	
Width of gap ..... meters	Largeur de la brèche ..... mètres	Weite der Unterbrechung ..... m	
NO. of spans down	Nbre de travées détruites	Anzahl der herabgefallenen Strecken	
(2) In a road or runway size, depth and location of craters:	(2) Sur une route ou 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 F-1. Sample target folder (continued)

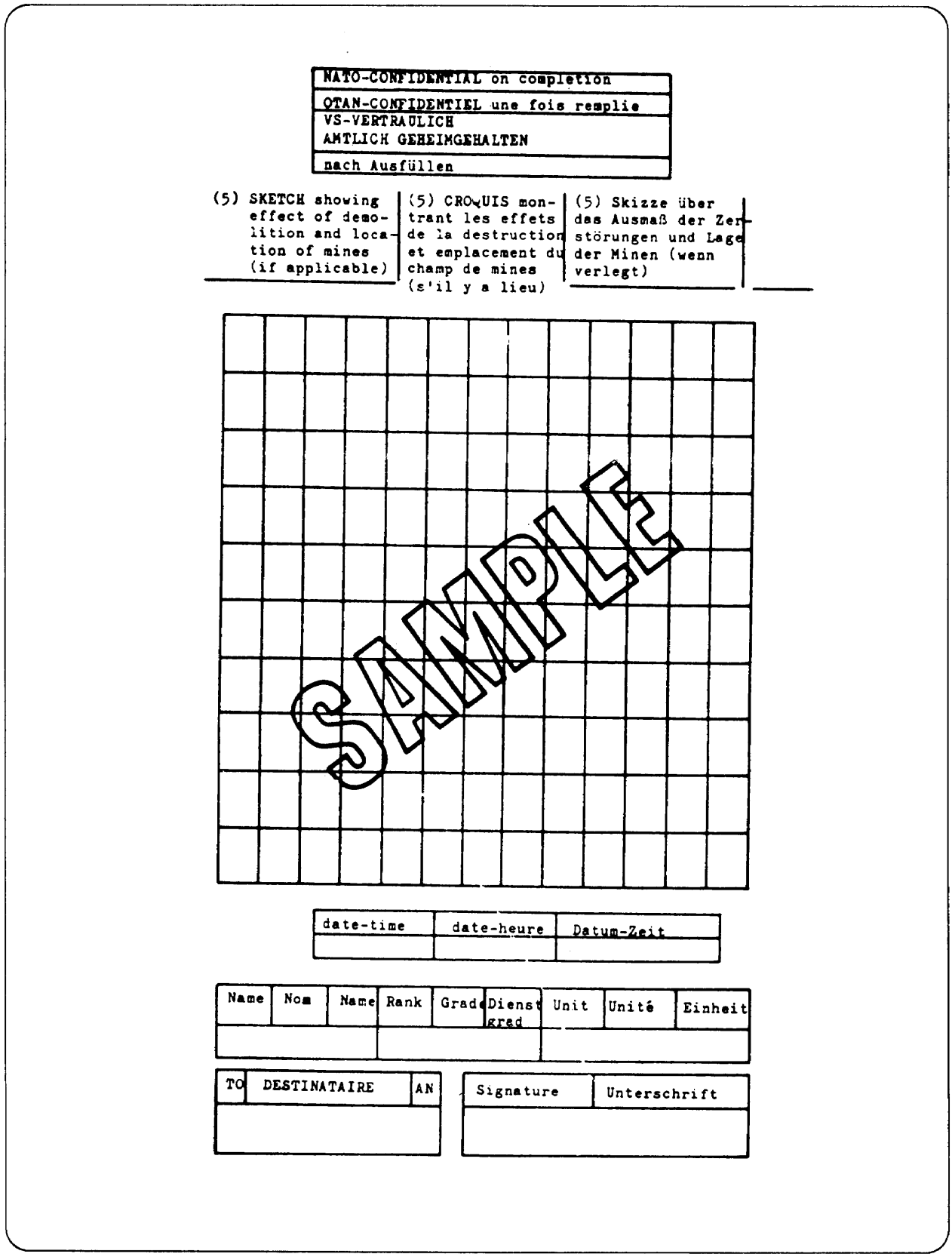


Figure F-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH
AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

TABLE OF CONTENTS

	Target Identification	Front Cover
(1)	Photograph of Target	Page 2
(1a)	Map of Target, Prestock Point and Route between	Page 3
(1b)	Map of Target, Large Scale	Page 5
(2)	Prestock Point, Transport required Route, Travel Distance, Explosives, required, Data	Page 6
(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	Page 16
(3a)	Special Technical instructions	Page 17
(3b)	Sketch of Target	Page 19
(3c)	Sketch of Charges	Page 21
(3d)	Sketch of Ignition System	Page 23
(3e)	Minefield	Page 24
(4)	Hand-over/Take-over	Page 25
(5)	Demolition Report	Page 29
(6)	Official Signature	Page 32

INHALTSVERZEICHNIS

	Identifizierung des Sperrobjekts	Vordere Umschlagseite
(1)	Fotografie des Sperrobjekts	Seite 2
(1a)	Karte des Objekts, des Munitionslagerplatzes und des Marschweges zwischen beiden	Seite 3
(1b)	Karte des Objekts in großem Maßstab	Seite 5
(2)	Munitions-Lagerplatz erforderlicher Transportraum, Marschweg, Entfernung, erforderliche Sprengmittel	Seite 6
(2a)	Karte des Munitions-Lagerplatzes in großem Maßstab	Seite 7
(2b)	Lageskizze des Munition -Lagerplatzes	Seite 8
(2c)	Munitionslagerhaus(Öffnungsanweisung, Berechtigungsnachweis, Schlüssel)	Seite 9
(2d)	Erforderliche Sprengmittel, Gerät und Minen	Seite 12
(3)	Sprengbefehl/Minensperrnachweis	Seite 16
(3a)	Technische Einzelanweisungen	Seite 17

TABLE DE MATRES

	Identification du dispositif	Recto de la 1ère page
(1)	Photographie de l'ouvrage	Page 2
(1a)	Carte montrant l'emplacement du dispositif et du centre de rattachement (préstockage) ainsi que le chemin entre les deux	Page 3
(1b)	Plan du dispositif à grande échelle	Page 5
(2)	Centre de rattachement (préstockage), véhicules nécessaires, itinéraire, distance, explosifs nécessaires, données	Page 6
(2a)	Plan du centre de rattachement (préstockage) à grande échelle	Page 7
(2b)	Croquis - plan du centre de rattachement (préstockage)	Page 8
(2c)	Dépôt de munitions (permis, directives d'ouverture, clés)	Page 9
(2d)	Explosifs, matériels mines nécessaires	Page 12
(3)	Ordre de mise de feu et/ou feuille de renseignements	Page 16
(3a)	Consignes techniques particulières	Page 17
(3b)	Croquis de l'ouvrage	Page 19
(3c)	Croquis de chargement	Page 21
(3d)	Schéma de la mise en feu	Page 23
(3e)	Champs de mines de harcèlement	Page 24
(4)	Procédé de remise	Page 25
(5)	Compte-rendu de destruction	Page 29
(6)	Signature pour annotation	Page 32

(3b)	Trennschnittskizze	Seite 19
(3c)	Ladungsskizze	Seite 21
(3d)	Zündleitungsskizze	Seite 23
(3e)	Stürminensperre	Seite 24
(4)	Übergabe/Übernahmeverhandlungen	Seite 25
(5)	Meldung über durchgeführte Sprengung	Seite 29
(6)	Unterschrift	

SAMPLE

Figure F-1. Sample target folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-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'enlévement 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 Vorgesetzten zu melden.

TARGET folder completed by | CARNET d'ALERT établi par | Sperrheft aufgestellt durch:

Name	Nom	Name	Rank	Grade	Dienstgrad	Designation	Fonction	Dienststellung
Brazeal, Gregory			SFC				ACo 657th Engr Bn.	

Signature	Unterschrift	Date	Datum
Gregory Brazeal		20 March 92	

Name	Nom	Name	Rank	Grade	Dienstgrad	Designation	Fonction	Dienststellung
Brown, David			CPT				ACo, 657th Engr Bn	

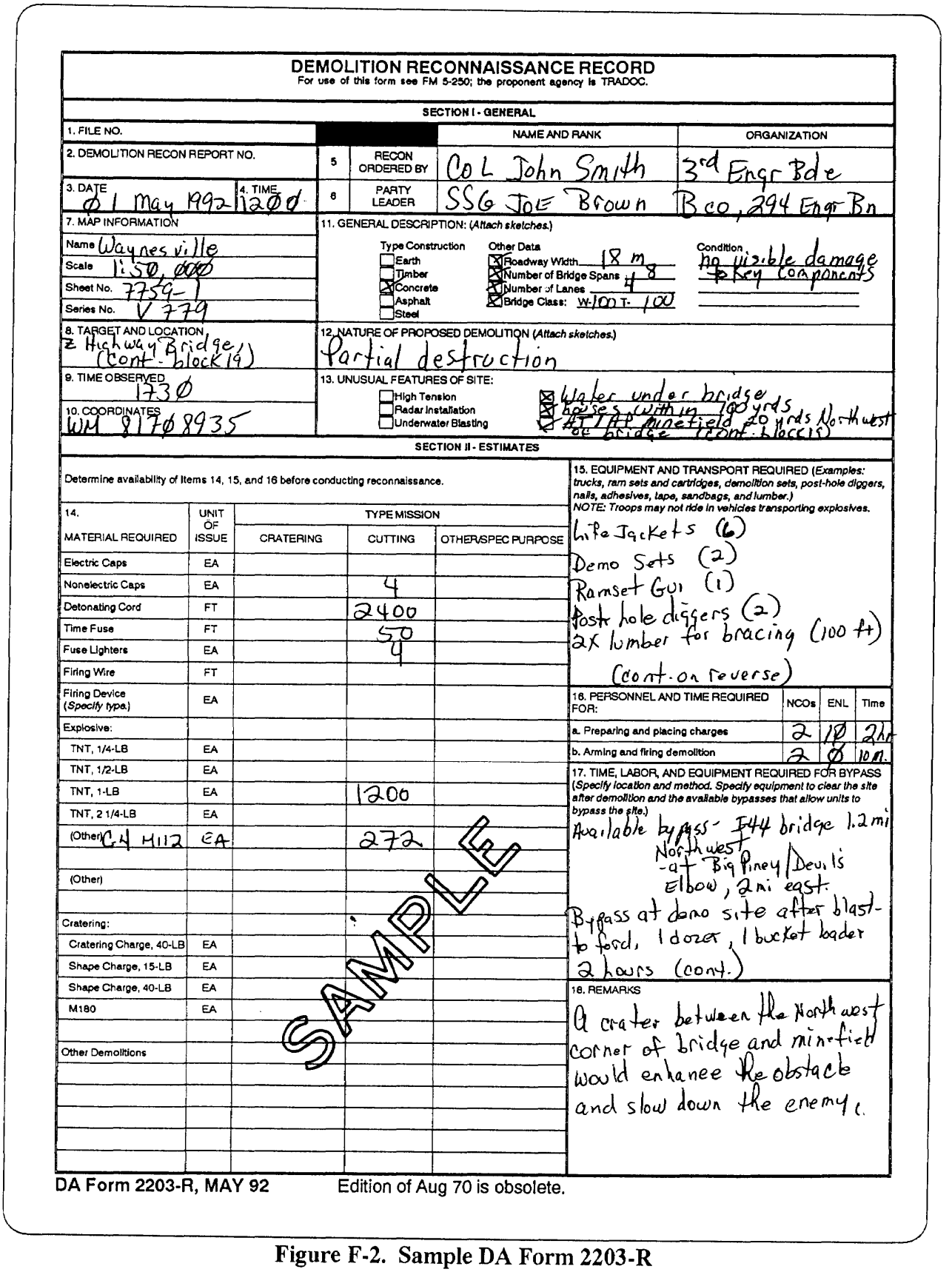
Signature	Unterschrift	Date	Datum
David Brown		20 March 92	

Folder reviewed by | Carnet controlé par | Sperrheft geprüft

Name	Rank	Designation	Date	Signature

SAMPLE

Figure F-1. Sample target folder (continued)



DEMOLITION RECONNAISSANCE RECORD
For use of this form see 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 PARTY LEADER	SSG Joe Brown	B co, 294 Engr Bn

7. MAP INFORMATION
Name: Waynesville
Scale: 1:50,000
Sheet No.: 7754-I
Series No.: V 779

11. GENERAL DESCRIPTION: (Attach sketches.)
Type Construction: ☐ Earth ☐ Timber ☒ Concrete ☐ Asphalt ☐ Steel
Other Data: ☒ Roadway Width 18 m ☒ Number of Bridge Spans 4 ☒ Number of Lanes 4 ☒ Bridge Class: W-100 T-100
Condition: No visible damage to key components

8. TARGET AND LOCATION
2 Highway Bridge (cont. block 19)

12. NATURE OF PROPOSED DEMOLITION (Attach sketches.)
Partial destruction

9. TIME OBSERVED 1730

13. UNUSUAL FEATURES OF SITE:
☐ High Tension ☐ Radar Installation ☐ Underwater Blasting
☒ Water under bridge
☒ houses within 100 yards
☒ AT/AP minefield 20 yards Northwest of bridge (cont. block 15)

10. COORDINATES WM 8170 8935

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
Electric Caps	EA			
Nonelectric Caps	EA		4	
Detonating Cord	FT		2400	
Time Fuse	FT		50	
Fuse Lighters	EA		4	
Firing Wire	FT			
Firing Device (Specify type.)	EA			
Explosive:				
TNT, 1/4-LB	EA			
TNT, 1/2-LB	EA			
TNT, 1-LB	EA		1200	
TNT, 2 1/4-LB	EA			
(Other) C4 M112	EA		272	
(Other)				
Cratering:				
Cratering Charge, 40-LB	EA			
Shape Charge, 15-LB	EA			
Shape Charge, 40-LB	EA			
M180	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)
Ramset Gun (1)
Post hole diggers (2)
2X lumber for bracing (100 ft)
(cont. on reverse)

16. PERSONNEL AND TIME REQUIRED FOR:	NCOs	ENL	Time
a. Preparing and placing charges	2	10	2hr
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 the available bypasses that allow units to bypass the site.)
Available bypass - F44 bridge 1.2 mi Northwest -at Big Piney/Devils Elbow, 2 mi east.
Bypass at demo site after blast- to ford, 1 dozer, 1 bucket loader 2 hours (cont.)

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, MAY 92 Edition of Aug 70 is obsolete.

Figure F-2. Sample DA Form 2203-R

DEMOLITION RECONNAISSANCE RECORD

Place additional comments in the appropriate blocks.

15. EQUIPMENT AND TRANSPORT REQUIRED (*Continued*)

Rope 3/4" (200')
Hummv (1-for transport of caps)
2½-T Cargo (1-for transport of demo)
Squad vehicle (1-for 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 bay, 2 end bays. 30 minutes M4T6 - 1 company, 3 hours

18. REMARKS (*Continued*)

SAMPLE

19. ADDITIONAL COMMENTS (*Specify block.*)

Block 8 cont. Bridge is over Big Piney River, near town of Devil's Elbow

Block 13 cont. Anti vehicle ditch (wheel only) on Southeast side of bridge.

PAGE 2, DA FORM 2203-R, MAY 92

Figure F-2. Sample DA Form 2203-R (continued)

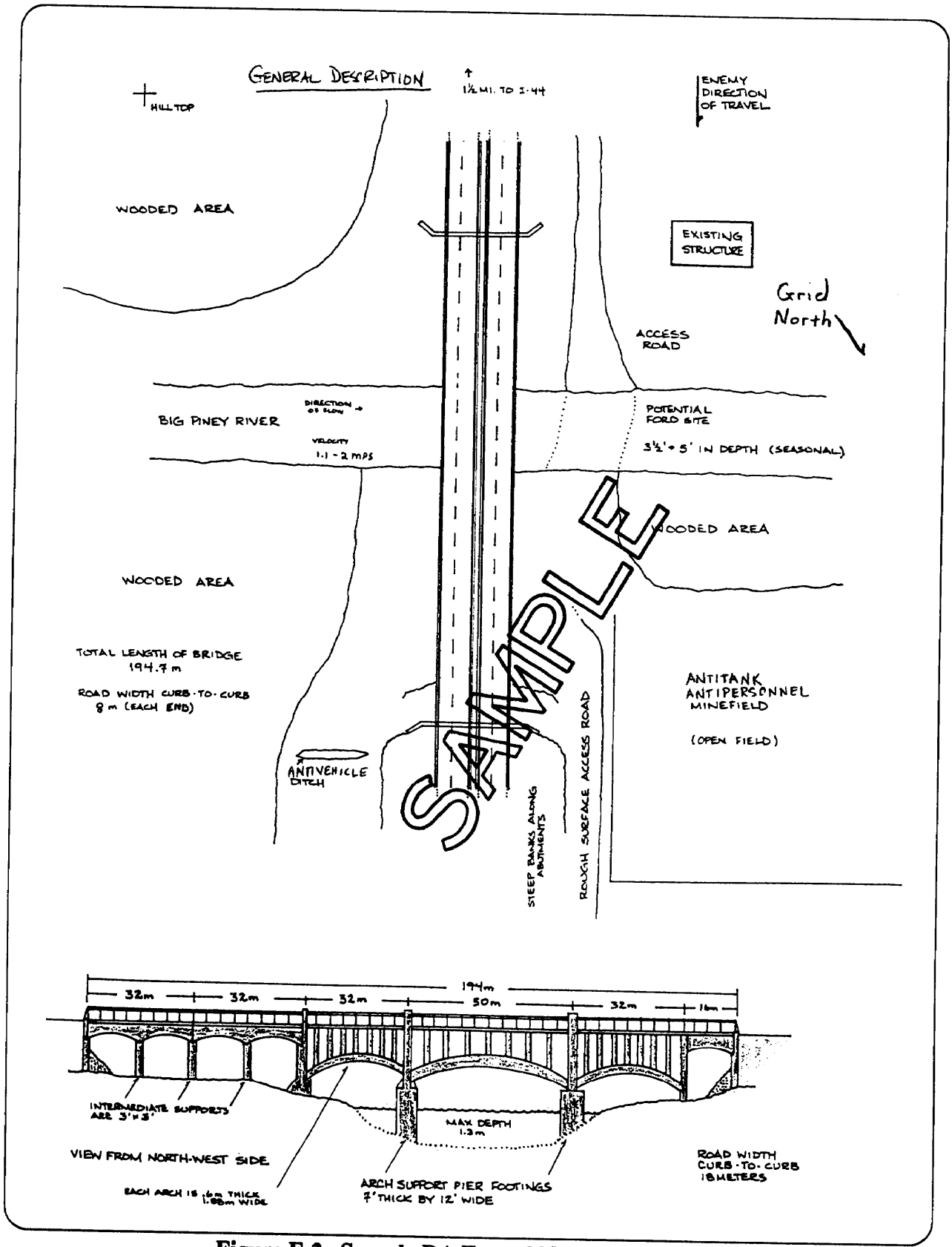


Figure F-2. Sample DA Form 2203-R (continued)

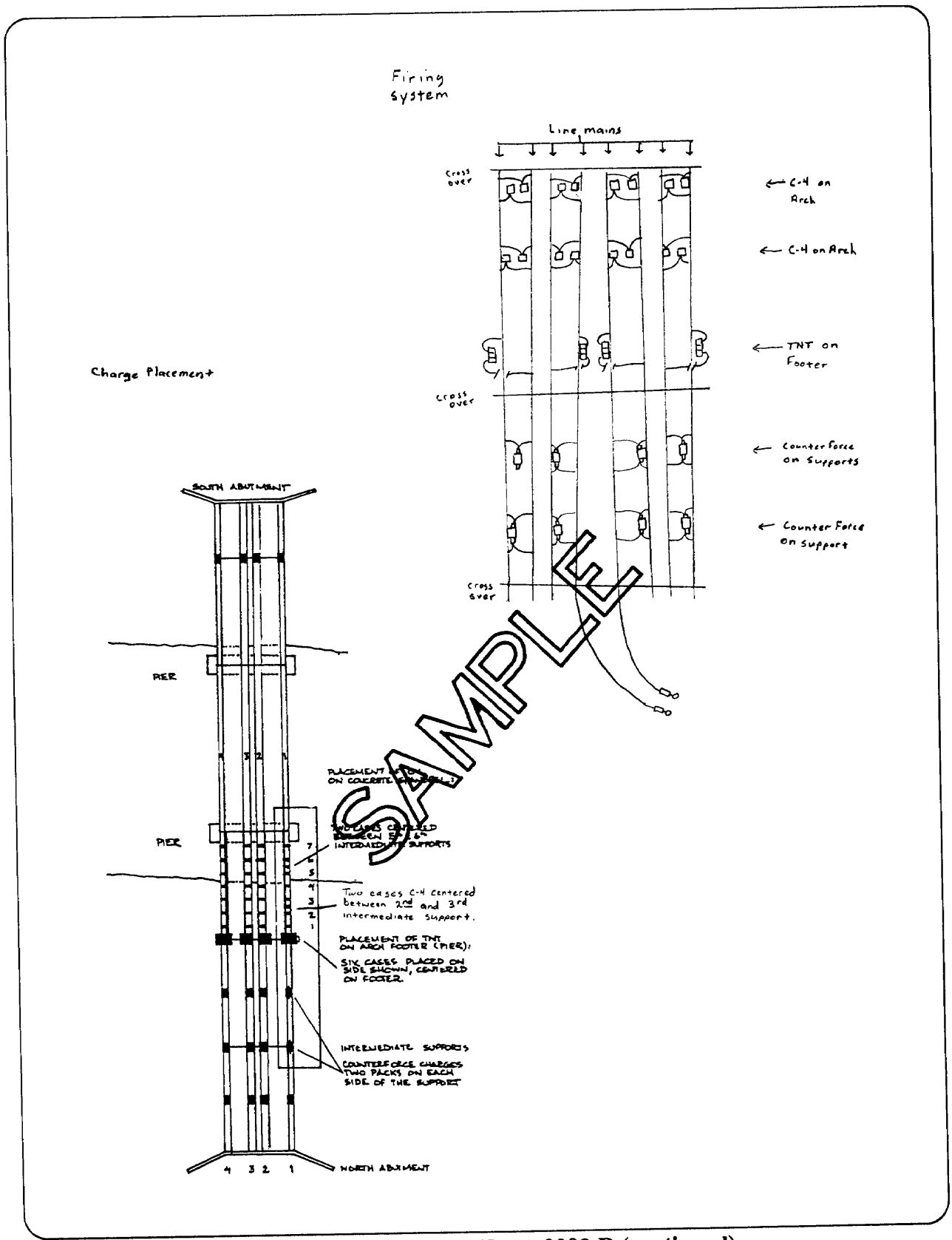
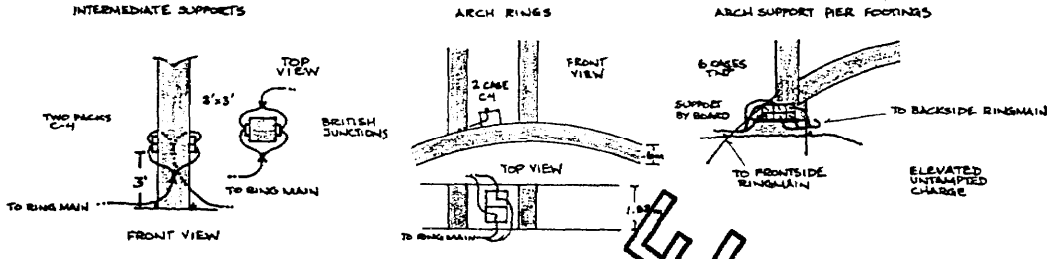


Figure F-2. Sample DA Form 2203-R (continued)

METHOD OF PRIMING
and
Charge Calculations



INTERMEDIATE SUPPORT
(USE COUNTERFORCE CHARGE)

1. CRITICAL DIMENSIONS : SUPPORT IS 3'x3'
2. SOLVE FOR TNT = (1½ LBS PER FOOT)
   1½ x 3 = 4.5 LBS OF C4 (C4 REQUIRED)
3. DIVIDE BY RE : (USING C4, RE = 1.34)
   NO CONVERSION REQUIRED. COUNTERFORCE IS CALCULATED IN C-4
4. SOLVE FOR SINGLE CHARGE PACKAGE:
   4.5 ÷ 1.25 (PKG. WT C4) = 3.6 Ø 4 PACKAGES
5. NUMBER OF CHARGES: 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
   1.88m WIDE BY .6[illegible]
2. SOLVE FOR TNT
   1.5(3.3x.6[illegible]
   1.5 (2.48)[illegible]
   1.5 (14.29) [illegible]
   22.875 x 1.88 [illegible]
   43.005 ÷ .45 = [illegible]
3. DIVIDE BY RE : LBS OF C4 (1.34)
   95.67 ÷ 1.34 = 71.[illegible] LBS C4
4. SOLVE FOR SINGLE CHARGE PKG:
   7[illegible] = 57 PKGS PER ARCH CUT
5. NUMBER OF CUTS : 8
6. TOTAL REQUIRED: (STEP 4 x STEP 5)
   57 x 8 = [illegible] PACKAGES
   [illegible] PER BOX = 15.2 CASES
   5.2 [illegible] 16 cases

PIER FOOTING
(USE BREACHING FORMULA) P = R³KC

1. CRITICAL DIMENSIONS : PIER IS 2½'x 7'x 9'
2. SOLVE FOR TNT: R = 7' T³ = 343
   K FOR REINFORCED CONCRETE 7'OR 7 = .54
   C FOR ELEVATED UNTAMPED = 1.8
   343 x .54 x 1.8 = 333.39
3. DIVIDE BY R.E. : (R.E. FOR TNT = 1)
   333.39 ÷ 1 = 333.39
4. SOLVE FOR SINGLE CHARGE PACKAGE:
   333.39 ÷ 1 (1 LB PKG OF TNT) = 333.39
   333.39 Ø = 334 PACKAGES
5. NUMBER OF CHARGES = 4 PIER
6. TOTAL REQUIRED: (STEP 4 x STEP 5)
   334 x = 1336 PACKAGES
   (56 PKG PER BOX = 23.8 CASES)
   23.8 Ø 24 cases

SAMPLE

Figure F-2. Sample DA Form 2203-R (continued)

Appendix G
Explosives Identification

G-1. Purpose. 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.

G-2. Demolition Materials (By Item). Table G-1 lists materials by type, item, status, national stock number (NSN), and Department of Defense identification code (DODIC). To avoid problems when requesting materials, use current supply publications.

Table G-1. Demolition materials

Type	Item	Status	NSN	DODIC
Initiating and Priming Devices				
Electric Blasting Caps	M6, Special	Live	1375-00-028-5224	M130
	Electric Cap	Inert	1375-00-621-8370	M098
Nonelectric Blasting Caps	JI	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

Table G-1. Demolition Materials (continued)

Type	Item	Status	NSN	DODIC
Military Explosives				
TNT	1/4-Pound	Live	1375-00-926-9394	M030
	1/2-Pound	Live	1375-00-028-5140	M031
	1-Pound	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	1375-00-728-4108	M060
Dynamite	M1	Live	1375-00-724-9613	M591
Special-Purpose Charges				
Cratering Charge	40-Pound	Live	1375-00-028-5145	M039
Shaped Charges	M2A4, 15-Pound	Live	1375-00-028-5237	M420
	M3, 40-Pound	Live	1375-00-088-6691	M421
	40-Pound	Live	1375-00-630-3074	M992
Demolition Assemblies	M183	Live	1375-00-926-3985	M757
	M37	Live	1375-00-028-5245	M756
Bangalore Torpedos	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
	MICLIC, Rocket	Live	1340-01-118-2838	J143
	M180	Live	1375-00-148-7159	M965
	M270	Inert	6920-01-087-0038	—
Boobytrap 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 G-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, Fuze 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	—	1375-00-565-4141	M002
	M8, Cap Holder	—	1375-00-926-4105	M166
	M2, Crimpers	—	5120-00-029-0683	—
	Galvanometer	—	6625-00-539-8444	—
	BA245/U Battery	Live	6135-00-128-1632	—
	BA2245/U Battery	Live	6135-00-833-9909	—
	M51, Test Set	—	6625-00-999-3454	—
	Blasting Machine, 10-Cap	Live	1375-00-782-5541	—
	Blasting Machine, 10-Cap	Live	1375-00-935-9173	—
	Blasting Machine, M32	Live	1375-00-212-4614	—
	Blasting Machine, M34	Live	1375-00-567-0223	—
	DR8, Reel	—	8130-00-407-7859	—
	RL39A, Reel Cable	—	3895-00-498-8343	—
	18AWG, Firing Wire	—	6145-00-299-6172	—
	Electric Wire	—	6145-00-542-3968	—
	Electric Wire	—	6145-00-284-0394	—
	Detonating-Cord Clip	—	1375-00-212-4602	—
US Mines				
Antipersonnel	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

Table G-1. Demolition Materials (continued)

Type	Item	Status	NSN	DODIC
Antitank	M15	Live	1345-00-028-5118	K180
	M12	Practice	1345-00-028-5117	K230
	M20	Practice	1345-00-344-2368	K231
	M21	Live	1345-00-729-4263	K181
	M69	Practice	1345-00-182-3148	K233
	M23, Chemical	Live	1345-00-542-1580	K257
GEMSS	M128, Dispenser	—	1095-00-397-3456	—
	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

G-3. Demolition Materials (By DODIC). Use Table G-2 to cross reference demolition materials by DODIC. Materials are listed by DODIC in ascending order and by nomenclature:

Table G-2. DODIC index for demolition materials

DODIC	Nomenclature	DODIC	Nomenclature
K001	Activator, AT Mine, M1	K065	Fuze, AT Mine, M606
K002	Activator, AT Mine, Practice, M1	K066	Fuze, AT Mine, Disp, M56
K003	Activator, AT Mine, M2	K067	Fuze, F/M21
K004	Trip Wire Assembly, F/M16A2	K090	Mine, AP, M2
K005	Intervalometer, SUU, 38/A	K091	Mine, AP, Inert, M2
K008	Firing Device, AP Mine, M57	K092	Mine, AP, M16
K009	Firing Device, AP Mine, XM123	K105	Mine, AP, Practice, M8
K010	Burster, Incendiary, M4	K120	Mine, AP, M3
K013	Spool, AP Mine	K121	Mine, AP, M14
K015	Disp and Mine, Aircraft, Practice, M132	K122	Mine, AP, Practice, M17T34
K016	Disp and Mine, Aircraft, Training, M133	K139	Mine, AP, Practice, M68
K018	Can, Crew Trainer, M133	K140	Mine, AP, Empty, M3
K020	Disp and Mine, Aircraft, M56	K141	Mine, AP, M18
K021	Intervalometer, System, F/M47	K143	Mine, AP, M18
K027	Chg, Mine-Ejection	K144	Mine, AP, Inert, M18
K028	Chg, Mine-Ejection	K145	Mine, AP, M18A1
K030	Primer-Igniter, AP Mine, Fuze, M10A1	K146	Mine, AP, M26
K031	Primer-Igniter, AP Mine, Fuze, M10A2	K150	Mine, AP, Inert, M16
K040	Chg, Spotting, AP Mine, M8	K151	GEMSS, AP, M74
K041	Chg, Spotting, AP Mine, M8A1	K170	Mine, AT, M7
K050	Fuze, AT Mine, M603	K250	Mine, AT, M19
K051	Fuze, AT Mine, M604	K917	Thickener, Fuel
K054	Fuze, AP Mine, Combination, M7A1	M001	Adapter, Priming, Plastic, M1A3 (Rnd)
K055	Fuze, AP Mine, Combination, M10A1	M002	Adapter, Priming, Plastic, M1A4 (Hex)
K056	Fuze, AP Mine, Combination, M10A2	M020	Chg, Shaped, RDX, 0.062-Lb
K058	Fuze, AP Mine, Combination, M605	M022	Chg, Shaped, PETN, 827-Lb
K060	Fuze, AT Mine, M619	M023	Chg, Block, C4, 1.25-Lb
K061	Fuze, AT Mine, XM608	M024	Chg, Block, PETN or RDX, 2-Lb
K062	Fuze, Mine FMU-30/B	M025	Chg, C4, HE, M58/M58A1, 2,000-Lb
K063	Fuze, Mine, Inert, FMU-30/B	M026	Kit, Demo, Bangalore Torpedo, M1A1
K064	Fuze, AT Mine, M616		

Table G-2. DODIC Index for Demolition Materials (continued)

DODIC	Nomenclature	DODIC	Nomenclature
M027	Chg, Block, Practice, MK37-0	M091	Cap, SP Electric, 10-Sec Delay
M028	Kit, Demolition, Lin, PETN, 0.75-Lb	M092	Cap, SP Electric, 11.2-Sec Delay
M029	Chg, Flex, Lin, PETN, 0.75-Lb	M093	Cap, SP Electric, 12.5-Sec Delay
M030	Chg, Block, TNT, 0.25-Lb	M094	Cap, SP Electric, 14-Sec Delay
M031	Chg, Block, TNT, 0.5-Lb	M095	Cap, SP Electric, 15.6-Sec Delay
M032	Chg, Block, TNT, 1-Lb	M097	Cap, Nonelectric, Practice
M034	Chg, Block, TNT, 8-Lb	M098	Cap, Electric, Inert
M035	Chg, Chain, TNT, 20-Lb	M101	Cap, SP Electric, 0.8-Sec Delay
M036	Chg, Chain, TNT, 2.5-Lb	M102	Cap, SP Electric, 1.4-Sec Delay
M037	Chg, Block, C2, 2.25-Lb	M103	Cap, SP Electric, 2.2-Sec Delay
M038	Chg, Block, C4, 2.25-Lb	M104	Cap, SP Electric, 2.9-Sec Delay
M039	Chg, Block, Cratering, 40-Lb	M107	Cap, SP Electric, 3.7-Sec Delay
M040	Chg, Block, TNT, 55-Lb	M108	Cap, SP Electric, 4.5-Sec Delay
M041	Chg, Block, C2, 0.5-Lb	M109	Cap, SP Electric, Instantaneous
M043	Chg, Block, TNT, 49-Lb	M110	Cap, Electric, High-Strength
M044	Chg, Block or Shaped, HDX1, 12-Lb	M112	Cap, Elec, Nonsubmersible, Prac, M10
M046	Chg, Flex, Lin, Comp A, MK8-3, 50-Lb	M117	Cap, SP Electric, 5.3-Sec Delay
M048	Chg, Block, C2, 2.5-Lb	M118	Cap, SP Electric, 6.4-Sec Delay
M051	Chg, Lin, Prac, M68/M68A1, 2,000-Lb	M120	Cap, Electric, No. 8
M065	Chg, Block, H6, 4-Lb	M125	Cap, Electric, No. 8, 2nd Delay
M060	Chg, Roll, PETN, M186, 25-Lb	M126	Cap, Electric, No. 8, 3rd Delay
M078	Cap, Electric, Nonsubmersible, M4	M127	Cap, Electric, No. 8, 4th Delay
M080	Chg, Flex, Lin, Prac, PETN, 0.007-Lb	M128	Cap, SP Electric, 7.6-Sec Delay
M081	Chg, Flex, Lin, PETN, 14-Oz	M129	Cap, Electric, SP-Strength
M082	Chg, Flex, Lin, PETN, 22-Oz	M130	Cap, SP Electric, Submersible, J2/M6
M083	Chg, Flex, Lin, PETN, 28-Oz	M131	Cap, Nonelectric, Nonsubmersible, M7
M084	Chg, Flex, Lin, PETN, 36-Oz	M138	Cap, Electric, Nonsubmersible
M085	Chg, Flex, Lin, PETN, 43-Oz	M153	Cap, Electric, Nonsubmersible
M086	Chg, Flex, Lin, PETN, 50-Oz	M236	Destructor, Explosive, PETN
M087	Chg, Flex, Lin, PETN, 57-Oz	M240	Destructor, Explosive, PETN

Table G-2. DODIC Index for Demolition Materials (continued)

DODIC	Nomenclature	DODIC	Nomenclature
M241	Destructor, Explosive, Universal, M10	M605	Destroyer, Document, Emergency, Incindiary, M1A2, TH4
M327	Base, Coupling, with Primer	M606	Destroyer, Crypto Equip, M1A2, TH4
M328	Base, Coupling, without Primer	M607	Destroyer, Crypto Equip, M2A1
M405	Chg, Propelling, Earth Rod, M112	M608	Destroyer, Crypto Equip, TH4
M418	Chg, Shaped, RDX, MK47-0, 1.5-Lb	M609	Destroyer, Crypto Equip, M2A1, TH4
M420	Chg, Shaped, Comp B, M2A4/M2A3E1, 15-Lb	M610	Destroyer, File, Incindiary, ABC-M4
M421	Chg, Shaped, Comp B, M3A2, 40-Lb	M611	Destroyer, File, Incindiary, ABC-M4
M431	Chg, Rigid, Lin, Amatol, 35-Lb	M612	Destroyer, Incindiary, TH3
M442	Kit, Demolition, Practice, M174	M615	Igniter, Document Destroyer, M25
M443	Kit, Demolition, Projected-Chg, M173	M616	Device, Firing, M1, 6- to 14-Min Delay
M444	Kit, Demolition, Projected-Chg, M157	M617	Set, Device, Firing, M1
M446	Kit, Demolition, Projected-Chg, M1	M619	Device, Firing, M1, 12- to 32-Min Delay
M455	Cord, Detonating, Primacord, PETN	M620	Device, Firing, M1, 45- to 115-Min Delay
M456	Cord, Detonating, Reinforced, Waterproof	M622	Device, Firing, M1, 210- to 570-Min Delay
M457	Cord, Detonating, PETN	M623	Device, Firing, M1, 610- to 1,130-Min Delay
M458	Cord, Detonating, Inert	M624	Device, Firing, Brass
M466	Detonator, Percussion, MK2	M625	Device, Firing, Zinc
M482	Chg, Steel	M626	Device, Firing, Zinc
M483	Chg, Controlled, Steel	M627	Device, Firing, Steel
M485	Cutter, HE, 1-Inch Jaw	M629	Device, Firing, M3
M486	Cutter, HE, 2-Inch Jaw	M630	Device, Firing, Pull-Type, M1
M540	Kit, Detonator, Percussion, M1	M631	Device, Firing, Pressure-Release, M1
M541	Detonator, Friction, M2, 8-Sec Delay	M632	Device, Firing, Zinc
M559	Kit, Demolition, M175	M635	Device, Firing, Pull-Type, M1
M587	Dynamite, Nitrogylcerin	M637	Device, Firing, Zinc
M591	Dynamite, Military, M1	M639	Device, Firing, Pressure-Release, M5
M598	Destroyer, Crypto Equip, M1A2	M641	Device, Firing, Tension-Release
M600	Destroyer, Crypto Equip, Incindiary, M2A1	M643	Device, Firing, Tension-Release
M601	Destroyer, Crypto Equip, Incindiary, M1A2, TH1	M644	Device, Firing, Aluminum

Table G-2. DODIC Index for Demolition Materials (continued)

DODIC	Nomenclature	DODIC	Nomenclature
M650	Device, Firing, Aluminum	M975	Fuze, Crypto Equip, M210, 0.7-Sec Delay
M670	Fuse, Timed, M700	M976	Chg, Block, Comp H6, 4-Lb
M671	Fuse, Timed, Inert	M977	Cord, Detonating, PETN
M680	Cylinder, Ignition, Flame-Thrower, M1	M980	Chg, Roll, PETN, 20-Lb
M745	Kit, Conversion, Depth-Chg	M981	Chg, Roll, PETN, 20-Lb
M756	Assembly, Chg, M37, 20-Lb	M982	Chg, Roll, PETN, 20-Lb
M757	Assembly, Chg, C4, M183	M983	Chg, Roll, PETN, 20-Lb
M767	Igniter, Fuse, Timed, Practice, XM77	M984	Chg, Roll, PETN, 20-Lb M766
M784	Chg, Shaped, Practice, Inert, MK37-1, 7-Lb	M986	Chg, Roll, PETN, 20-Lb
M790	Assembly, Comp C2 or C3, MK127-0, 20-Lb	M987	Chg, Block, C4, 2-Lb
M791	Assembly, Tetrytol, MK133-0, 20-Lb	M988	Chg, Block, C4, 0.5-Lb
M792	Assembly, Block, C4, MK138-0, 20-Lb	M989	Initiator, Explosive
M810	Primer, Percussion, Improved, No. 3	M990	Detonator, Flash
M814	Destroyer, Document, 55-Gal, M4	M992	Chg, Shaped, Practice, Inert, M3, 40-Lb
M820	Kit, Explosive, Earth Rod, No. 1	M993	Chg, Roll, PETN, 20-Lb
M821	Kit, Explosive, Foxhole-Digger	M994	Chg, Roll, PETN, 20-Lb
M832	Chg, Shaped, Comp H6, MK74-1, 1.5-Lb	M995	Chg, Lin, Comp H6, MK86-0, 0.002-Kg
M833	Chg, Shpd, Practice, Inert, MK74-0, 1.3-Lb	M996	Chg, Lin, Comp H6, MK87-0, 0.013-Kg
M836	Cap, Elec, Dry, Instantaneous	M997	Chg, Lin, Comp H6, MK88-0, 1-Kg
M855	Cap, Elec, Dry, 0.5-Sec Delay	M998	Chg, Rigid, Lin, Comp C3, MK89-0, 14-Kg
M910	Igniter, Primer and Base, XM110	ML03	Device, Firing, Plastic, M142
M913	Chg, Flex, Lin, Comp C4, M58A1, 2,000-Lb	ML04	Cutter, HE
M914	Chg, Lin, Practice, M68A1, 2,000-Lb	ML05	Cutter, HE
M916	Chg, Shpd, Practice, Inert, MK47-0, 1.5-Lb	ML07	Cap, Electric, Nonsubmersible
M936	Chg, Block, Inert, 0.25-Lb	ML08	Kit, Demolition, XM268
M957	Chg, Shaped, Comp H6, MK47-0, 1.13-Lb	ML09	Chg, Shaped, Flex, Lin, 20-Gr/Ft
M965	Kit, Cratering, M180	ML10	Chg, Shaped, Flex, Lin, 30-Gr/Ft
M974	Cap, Electric, Submersible	ML11	Chg, Shaped, Flex, Lin, 40-Gr/Ft

Table G-2. DODIC Index for Demolition Materials (continued)

DODIC	Nomenclature	DODIC	Nomenclature
ML12	Chg, Shaped, Flex, Lin, 60-Gr/Ft	MW30	Kit, Demo, Bangalore Torpedo, M1 or M1A1
ML13	Chg, Shaped, Flex, Lin, 75-Gr/Ft	MW31	Holder, Detonator, MK2-0
ML14	Chg, Shaped, Flex, Lin, 125-Gr/Ft	MW30	Kit, Demo, Bangalore Torpedo, M1 or M1A1
ML15	Chg, Shaped, Flex, Lin, 225-Gr/Ft	MW31	Holder, Detonator, MK2-0
ML16	Chg, Shaped, Flex, Lin, 300-Gr/Ft	MW37	Driver, Power-Actuated, MK22-0
ML17	Chg, Shaped, Flex, Lin, 400-Gr/Ft	MW38	Float, Rigid, Polyurethane
ML18	Chg, Shaped, Flex, Lin, 500-Gr/Ft	MW49	Connector, Detonating Cord, Plastic
ML19	Chg, Shaped, Flex, Lin, 600-Gr/Ft	MW52	Chg, Sheet, MK57-0
ML23	Cap, Bridge-Wire, X175E	MW53	Chg, Sheet, MK56-0
ML25	Chg, Flex, Lin, M59	MW56	Device, Safety and Arming, MK39-0
ML26	Chg, Lin, Practice, M69	MW84	Kit, Demo, Tubular SWS, MK75-0
ML27	Detonator, Percussion, MK53	MW85	Kit, Accessory, Demolition, MK29-0
ML32	Primer, Percussion, M27	MW86	Kit, Firing Device, MK48-0
ML36	Kit, Fuze, Inert, M1147	MW87	Kit, Firing Device, Training, MK122-0
ML37	Kit, Fuze, Live, M1133	MX14	Kit, Centering, Cavity Chg
ML78	Chg, Shaped, Practice, MK47-0	MY01	Clip, Detonating Cord, M1
ML82	Kit, Fuze, Live, M1134	SS89	Chg, Shock-Test, R/U725
MW02	Valve, Explosive, Electrically Initiated	XW60	Kit, Firing Device, MK138-0
MW26	Cell, Arming, MK1-8, 80-Min Delay	XW65	Chg, Shock-Test, R/U1260
MW27	Clip, Detonating Cord, M1	XW66	Chg, Shock-Test, R/U1259
MW28	Connector, Plastic	XW67	Chg, Shock-Test
MW29	Element, Delay, DE, MK19-0	YW05	Kit, Chg, Training, MK75-0

Appendix H
Methods of Attacking Bridges with Demolitions

The methods of attack in this appendix are for the most common types of bridges; however, they are not all inclusive. When faced with unusual construction methods or materials (for example, Hayricks which are linear-shaped charges used by host NATO countries), the responsible engineer shouId adapt one the of the recommended methods or recategorize the bridge as a miscellaneous bridge and design the demolition using the principles in Chapter 4.

Table H-1. 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

NOTES:

1. The values in this table are based on the following formula:

$$\frac{E_R}{L} = [4(\frac{H}{L})^2 + 1]^{1/2} - 1$$

where—

E_R = required end clearance.
L = span length.
H = beam, truss, or bow depth (including deck).

2. If the result of $\frac{H}{L}$ is not on the chart exactly as calculated, round UP to the next higher value. For example, $\frac{H}{L} = 0.076$, use the column headed 0.08. Read down that column to determine $\frac{E_R}{L}$. In this case, $\frac{E_R}{L} = 0.013$.

3. Multiply the $\frac{E_R}{L}$ value determined from the chart by L to get E_R.

Table H-2. Minimum L_C values for top attack (midspan)

$\frac{H}{L}$ \ $\frac{L_s}{L}$	Ratio of Section Removed to Span Length ($\frac{L_c}{L}$)														
	0.004	**0.006**	**0.008**	**0.010**	**0.012**	**0.014**	**0.016**	**0.018**	**0.020**	**0.030**	**0.040**	**0.050**	**0.060**	**0.080**	**0.100**
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

NOTES:

1. Tabulated values are for $\frac{L_c}{L}$, from which you can calculate L_c: $L_c = \frac{L_c}{L}(L)$.
2. This table is based on the formula:

$$\frac{L_c}{L} = \frac{2H[\frac{L_s}{L} - (\frac{L_s}{L})^2]^{1/2}}{L(1/2 - \frac{L_s}{L})}$$

3. If the results of $\frac{L_s}{L}$ or $\frac{H}{L}$ are not on the chart exactly as calculated, round UP to the next higher value on the chart. For example, if $\frac{H}{L} = 0.021$, use 0.03; if $\frac{L_s}{L} = 0.0142$, use 0.016. Intersect the $\frac{L_s}{L}$ and $\frac{H}{L}$ values on the chart to get the value of $\frac{L_c}{L}$. Multiply the $\frac{L_c}{L}$ value by L to get L_c.

Table H-3. Attacks on simply supported bridges

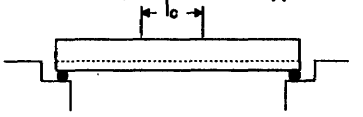
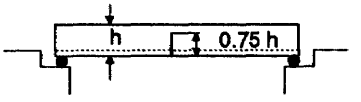
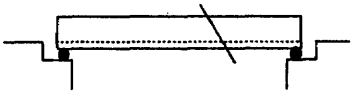
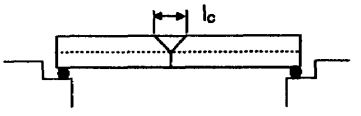
Serial	Subcategory	Type	Attack Method	Remarks
a	b	c	d	e
1	Steel Beam	Through Bridge, Method I	Top Attack: E is less than E_R  1. Cut at midspan. 2. Cut beams, including bottom flange in "V." 3. Do not consider cutting deck.	None
2		Through Bridge, Method II	Bottom Attack: E is greater than E_R  1. Cut at midspan to 0.75h, as shown. 2. Cut deck across full bridge width.	None
3		Through Bridge, Method III	Angled Attack:  1. Cut between 1/3-span and midspan. 2. Cut deck across 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 midspan to 0.75h. 2. Cut deck across full bridge width. 3. Attack one abutment or pier to create sufficient end clearance.	None
5		Through Bridge, Method V	Top Attack: E is less than E_R  1. Cut at midspan. 2. Where deck is located well above beam bottom, cut bridge as shown. 3. Do not consider cutting deck.	None

Table H-3. Attacks on simply supported bridges (continued)

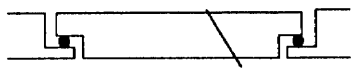
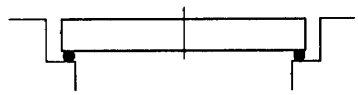
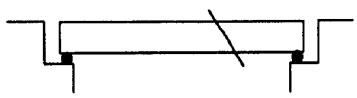
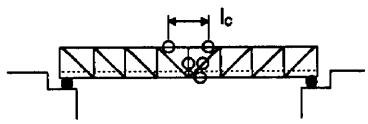
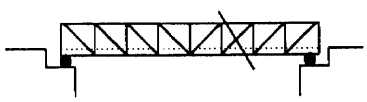
Serial	Subcategory	Type	Attack Method	Remarks
a	b	c	d	e
6	Steel Beam	Deck Bridge, Top Support	Angled Attack:  1. Cut between 1/3-span and midspan. 2. Cut deck across full bridge width.	1. Configuration found in cantilever and suspended-span bridges 2. End clearance is not a consideration.
7		Deck Bridge, Bottom Support, Method I	Bottom Attack: E is greater than E_R  1. Cut at midspan. 2. Do not consider cutting 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 midspan. 2. Cut deck across full bridge width.	End clearance is not a consideration
10	Steel Truss	Through Bridge, Method I	Top Attack: E is less than E_R  1. Cut at midspan. 2. Cut top chord twice, vertically (if necessary), and diagonals and bottom chord. 3. Remove wind bracing over midspan. 4. Do not consider cutting deck.	None
11		Through Bridge, Method II	Angled Attack:  1. Cut between 1/3-span and midspan. 2. Cut top chord, diagonals, and bottom chord in one bay only. 3. Cut deck across full bridge width.	None

Table H-3. Attacks on simply supported bridges (continued)

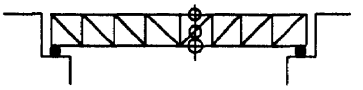
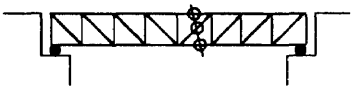
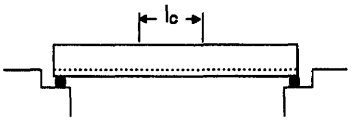
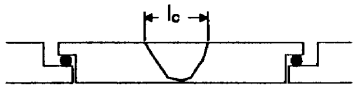
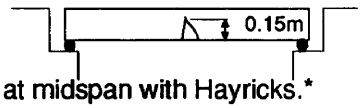
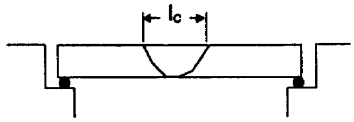
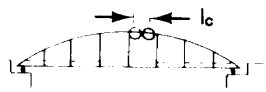
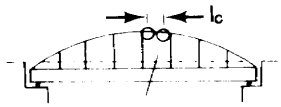
Serial	Subcategory	Type	Attack Method	Remarks
a	b	c	d	e
12	Steel Truss	Deck Bridge, Top Support	Bottom Attack:  1. Cut between 1/3-span and midspan. 2. Cut top chord, diagonals, and bottom chord in one bay only. 3. Do not consider cutting deck.	1. Configuration found in cantilever and suspended-span 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 midspan. 2. Cut top chord, diagonals, and bottom chord in one bay only. 3. Do not consider cutting deck.	None
14		Deck Bridge, Bottom Support, Method II	Bottom Attack: E is less than E_R 1. Cut at midspan. 2. Cut top chord, diagonals, and bottom chord in one bay only. 3. Do not consider cutting 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 midspan. 2. Cut deck across full bridge width.	End clearance is not a consideration
16	Concrete	Through Bridge	Bottom Attack:  1. Cut between midspan. 2. Cut deck across full bridge width.	This method applies to slab bridges only.

Table H-3. Attacks on simply supported bridges (continued)

Serial	Subcategory	Type	Attack Method	Remarks
a	b	c	d	e
17	Concrete	Deck Bridge, Top Support	Top Attack:  Cut at 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 midspan with Hayricks.*	1. This method applies to slab bridges only. 2. Sufficient reinforcing bars are cut to cause bridge collapse.
19		Deck Bridge, Bottom Support, Method II	Bottom Attack: E is less than E_R 1. Cut at 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 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 midspan. 2. Cut bow in two places. 3. Cut all hangers between bow cuts. 4. Do not consider cutting deck..	None
22		Reinforced Beam or Truss	Top Attack plus Girders:  1. Cut truss or beam with the appropriate method (Serials 1 through 15). 2. Cut bow in two places, including hangers.	None

Note: Hayricks are not in the US Army supply system.

Table H-4. Attacks on continuous bridges

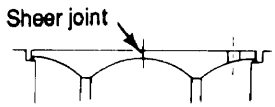
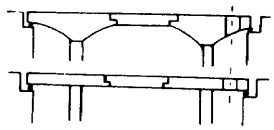
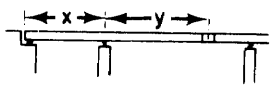
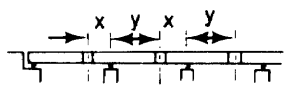
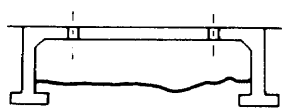
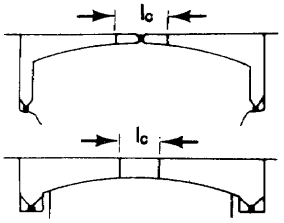
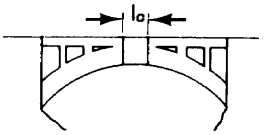
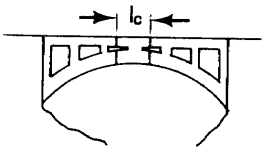
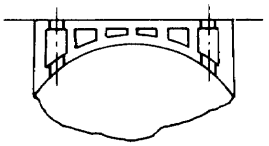
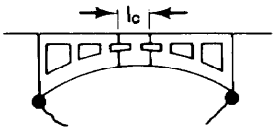
Serial	Subcategory	Type	Attack Method	Remarks
a	b	c	d	e
1	Concrete	Cantilever	Two Cuts:  1. Cut anchor span as closely to the pier as practical. 2. Cut midspan shear joint.	1. Cutting anchor span may require a two-stage attack. 2. Use a concrete-stripping charge for the first stage.
2		Cantilever and Suspended Span	One Cut:  Cut anchor as closely to the pier as practical.	1. Cutting 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 1.25*x*. 2. If necessary, cut other interior spans as in Serial 4.	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 Span	Two or More Cuts:  Cut interior span so *y* is greater than 1.25*x*.	1. Cutting these spans may require a two-stage attack. 2. Use a concrete-stripping charge for the first stage.
5		Portal, Fixed Footing	Two Cuts:  Cut span twice, close to pier.	1. Cutting these spans may require a two-stage attack . 2. Use a concrete-stripping charge for the first stage.

Table H-4. Attacks on continuous bridges (continued)

Serial	Subcategory	Type	Attack Method	Remarks
a	b	c	d	e
6	Concrete	Portal, Pinned Footing	Strip Concrete:  Remove concrete from 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.
7		Arch, Open Spandrel, Fixed Footing, Method I	Strip Concrete:  Remove concrete from 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.
8		Arch, Open Spandrel, Fixed Footing, Method II	Strip Concrete:  1. Remove concrete from 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 greater than 35 meters 2. A one-stage attack should be adequate.
9		Arch, Open Spandrel, Fixed Footing, Method III	Four Cuts: 	1. Alternative to Method II, applies to arches greater than 35 meters 2. Two-stage attack may be required. 3. Use concrete-stripping charge for first stage.
10		Arch, Open Spandrel, Pinned Footing	Strip Concrete:  Remove concrete from midspan over length L_c with a concrete-stripping charge.	A one-stage attack should be adequate.

Note: Hayricks are not in the U.S. Army supply system.

Table H-4. Attacks on continuous bridges (continued)

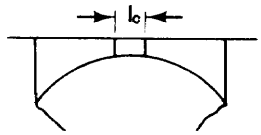
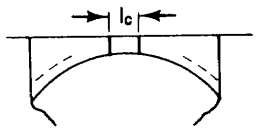
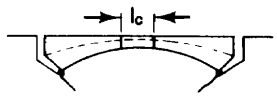
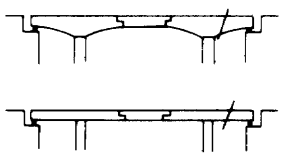
Serial	Subcategory	Type	Attack Method	Remarks
a	b	c	d	e
11	Concrete	Arch, Solid Spandrel, Fixed Footing, Method I	Strip Concrete:  Remove concrete from midspan over length L_c with a concrete-stripping charge.	A one-stage attack should be adequate.
12	Concrete	Arch, Solid Spandrel, Fixed Footing, Method II	Strip Concrete:  1. Remove concrete from 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. Or against top face (must remove fill beneath roadway to access arch ring)	1. Applies to arches greater than 35 meters 2. A one-stage attack should be adequate.
13	Concrete	Arch, Open Spandrel, Fixed Footing, Method II	Strip Concrete:  Remove concrete from midspan over length L_c with a concrete-stripping charge.	A one-stage attack should be adequate.
14	Steel	Cantilever	Two Cuts:  1. Cut anchor span as closely to the pier as practical. 2. Cut midspan shear joints.	None
15	Steel	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 H-4. Attacks on continuous bridges (continued)

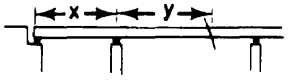
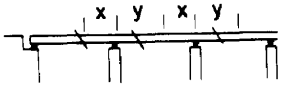
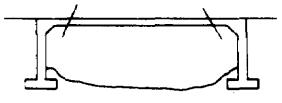
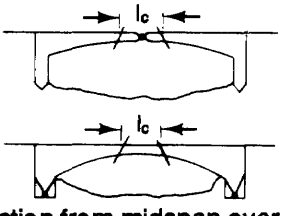
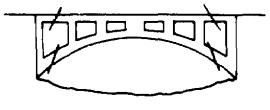
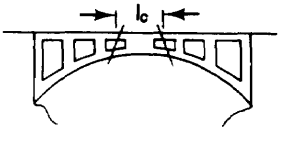
Serial	Subcategory	Type	Attack Method	Remarks
a	b	c	d	e
16	Steel	Beam or Truss with Short Side Span	One Cut:  1. Cut interior span so *y* is greater than 1.25*x*. 2. If necessary, cut other interior spans as in Serial 17.	None
17		Beam or Truss without Short Side Span	Two or More Cuts:  Cut spans so *y* is greater than 1.25*x*.	None
18		Portal, Fixed Footing	Two Cuts:  Cut span twice, close to piers.	None
19		Portal, Pinned Footing	Two Cuts:  Remove section from midspan over length L_c.	None
20		Arch, Open Spandrel, Fixed Footing	Four Cuts: 	Angle cuts about 70 degrees
21		Arch, Open Spandrel, Pinned Footing	Two Cuts:  Remove section from midspan over length L_c.	None

Table H-4. Attacks on continuous bridges (continued)

Serial	Subcategory	Type	Attack Method	Remarks
a	b	c	d	e
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 crown.	None

Glossary

A total area

abatis Fallen-tree obstacles made by cutting trees that remain attached to their stumps.

ABCA American, British, Canadian, and Australian

AFV armored fighting vehicle

amatol A mixture of ammonium nitrate and trinitrotoluene (TNT); a substitute for TNT in bursting charges.

ammonium nitrate The least sensitive of the military explosives; it requires a booster charge to successfully initiate detonation; a component inmost cratering and ditching charges.

ammonium-nitrate satchel charge A mixture of ammonium-nitrate fertilizer and melted wax; the mixing ratio is 4 pounds of fertilizer to 1 pound of wax.

angled attack A method of attack used in bridge demolitions.

AT antitank

Attn attention

AP antipersonnel

approx approximately

ARNG Army National Guard

ASP ammunition supply point

AVLB armored vehicle launch bridge

beam collapse mechanism A method of allowing abridge to collapse under its own weight.

black powder The oldest-known explosive and propellant; a composite of potassium or sodium nitrate, charcoal, and sulfur.

blasting cap Used to detonate high explosives; there are two types: electric and nonelectric.

blasting machine Provides the electric impulse needed to initiate electric blasting-cap operations there are two models: M32 10-cap blasting machine and M34 50-cap blasting machine.

block demolition charge Prepackaged, high-explosive charges for general demolition operations, such as cutting, breaching, and cratering; composed of high-explosive TNT, tetrytol, Composition-C series, and ammonium nitrate.

block-hole method Away of removing boulders; a hole is drilled in the top of the boulder deep and wide enough to hold the required amount of explosive.

bottom attack Forms a hinge at the top of the span; as the span falls, the cut ends at the bottom move outward.

branch line A length of detonating cord.

breaching charges Used to destroy concrete-slab bridges, bridge beams, bridge piers, bridge abutments, and permanent field fortifications; the size, shape, placement, and tamping or confinement of breaching charges are critical to success.

breaching radius (R) For external charges, it is equal to the thickness of the target being breached; for internal charges placed in the center of the target's mass, R is one half the thickness of the target; for internal charges placed at less than half the mass thickness, R is the longer of the distances from the center of the charge to the outside surfaces of the target.

C *See* **tamping** factor **(C).**

C4 *See* **Composition C4 (C4).**

categorization To put into any of several fundamental and distinct classes to which entities or concepts belong; a division within a system of classification.

chg charge

class classification

classification (class) The systematic arrangement in groups based on the load-carrying capacity of bridges.

cm centimeter(s)

command post Located where the demolition guard can best control the defense of the demolition target from the friendly side.

common series circuit Used to connect two or more electric blasting caps to a single blasting machine.

Composition A3 A composite explosive containing 91 percent cyclonite (RDX) and 9 percent wax.

Composition B A composite explosive containing approximately 60 percent RDX, 39 percent TNT, and 1 percent wax.

Composition B4 A composite explosive containing 60 percent RDX, 39.5 percent TNT, and 0.5 percent calcium silicate.

Composition C4 (C4) A composite explosive containing 91 percent RDX and 9 percent nonexplosive plasticizers; it is effective in temperatures between -70 and + 170 degrees Fahrenheit but looses its plasticity in colder temperatures.

concrete-stripping charge Bulk, surface-placed charges designed to remove concrete from reinforced-concrete beams and slabs, exposing the steel reinforcement.

continuous bridge A bridge that does not fit the miscellaneous or simply supported bridge category.

cook off When blasting caps are detonated because of exposure to extreme heat.

counterforce charge A special breaching technique that is effective against rectangular masonry or concrete columns 4 feet thick or less.

cratering charge A calculated amount of explosives placed to create a crater.

cratering effect The cratering effect of high explosives depends on their total energy content, which determines the amount of energy available to throw the broken material from the crater. Because a shattering effect is not required to form a crater, low-velocity explosives are generally more effective for cratering purposes. Therefore, a relative effectiveness factor is not considered in determining the effect of a cratering charge. Blasting road craters or ditches normally requires large amounts of explosives. Because it is effective and inexpensive, an ammonium nitrate-based cratering charge is used as a standard cratering charge.

cross-section ditching method Used when it is necessary to blast the full width of the ditch in one operation.

cyclonite (RDX) A highly sensitive and very powerful military explosive; it forms the base charge in the M6 electric and M7 nonelectric blasting caps; when desensitized, it serves as a subbooster, booster, bursting charge, or demolition charge; used in composite explosives.

d required depth

D depth

DA Department of the Army

deliberate road crater A V-shaped crater approximately 7 to 8 feet deep and 25 to 30 feet wide with side slopes of 30 to 37 degrees; extends about 8 feet beyond the end boreholes.

demolition equipment set An assembly of tools necessary to perform demolition operations.

detonating cord Transmits a shock wave from the initiation set to the explosive charge; useful for underwater, underground, and above-ground blasting because the blasting cap of the initiation set does not have to be inserted directly into the charge.

detonating-cord priming Involves fewer blasting caps, makes priming and misfire investigation safer, and allows charges to be primed at State of Readiness 1 (Safe) when in placed on a reserved demolition.

diamond charge Used on high-carbon or alloy steel bars up to 12 inches in diameter or having a cross-sectional area of 12 square inches or less. *See also* **stress-wave method.**

direction of initiation The direction in which the shock wave travels through the explosive; may be parallel to the surface of the target or perpendicular to the target; determines the rate of energy transmitted to the target.

ditching charge A calculated amount of explosives placed to create a ditch.

DODIC Department of Defense identification code

dust initiator charge Uses small quantities of explosives with larger amounts of powdered materials to destroy thin-walled, wooden buildings or railroad boxcars; works best in an enclosed area with few windows.

dynamite *See* **standard dynamite, military dynamite.**

E total end clearance

E$_R$ required end clearance

elec electric

electric priming The insertion of an electric blasting cap directly into the charge.

end-priming method Priming explosives from the extreme end.

engr engineer

ENL enlisted

EOD explosive ordnance disposal

equip equipment

expedient flame fougasse Consists of a 55-gallon drum of thickened fuel, a kicker charge, a trip flare, and detonating cord; used in defensive and offensive operations for its incendiary, illuminating, and signaling effects.

explosives Substances that, through chemical reaction, violently change to a gaseous form. In doing so, they release pressure and heat equally in all directions. They are classified as low or high according to the detonating velocity or speed (in meters or feet per second) at which this change takes place and other characteristics such as their shattering effect. *See also* **low explosives** *and* **high explosives.**

external charge Placed on the surface of the target.

firing point Located as close to the target as safety allows; must protect the firing party from the effects of blast and falling debris; should be close to or collocated with the command post.

firing system The system placed between the initiation system and the charge.

firing wire The electric wire used between the initiation set and the electric blasting cap.

FM field manual

ft foot, feet

forty-pound, ammonium-nitrate block demolition charge A standard US Army munition consisting of 30 pounds of ammonium nitrate with a 10-pound TNT border.

fps foot/feet per second

GEMSS Ground Emplaced Mine Scattering System

GP general purpose

grapeshot charge Consists of a container, projectiles, buffer material, a charge, and a blasting cap.

H borehole depth

H depth, rise, height

hasty road crater Forms a V-shaped crater about 6 to 7 feet deep and 20 to 25 feet wide, extending approximately 8 feet beyond each end borehole. While it takes the least amount of time to construct, it is also the least effective barrier because of its depth and shape.

HE high explosive

HEAT high-explosive antitank (ammunition)

HEP high-explosive plastic

high explosives Change to a gaseous state almost instantaneously at 1,000 meters (3,280 feet) per second to 8,500 meters (27,888 feet) per second, producing a shattering effect on the target. Use high explosives when a shattering effect, or *brisance,* is required.

HQ headquarters

hydroscopic Material that readily takes up and retains moisture.

improvised cratering charge Consists of a mixture of ammonium nitrate fertilizer and diesel fuel, motor oil, or gasoline; the ratio of fertilizer and fuel is 25 pounds to 1 quart.

in inch(es)

internal charge Placed in boreholes in the target.

jamming Failure to completely collapse the span.

K *See* **material factor (K).**

kg kilogram(s)

kicker charge A l-pound charge of explosive placed high on a tree used to influence the direction of fall when employing timber charges.

kw kilowatt

L length

lb pound(s)

L_c required length of span removed

leapfrog series circuit Useful for firing any long line of charges; starts at one end of a row of charges and primes alternate charges to the opposite end and then primes the remaining charges on the return leg of the series; eliminates the need for along return lead from the far end of the line of charges.

lin line

line main Will fire multiple charges, but if a break in the line occurs, the detonating wave will stop at the break; use only when speed is essential and the risk of failure is acceptable.

low explosives Change from a solid to a gaseous state slowly over a sustained period (up to 400 meters or 1,300 feet per second). This characteristic makes them ideal when a pushing or shoving effect is required. Examples of low explosives are smokeless and black powders.

L_s average length of the bearing supports.

m meter(s)

mm millimeter(s)

Ml adhesive paste A sticky, putty-like substance that is used to attach charges to flat, overhead or vertical surfaces.

Ml detonating-cord clip A device for holding two strands of detonating cord together, either parallel or at right angles.

Ml military dynamite An RDX-based composite explosive containing no nitroglycerin; packaged in 1/2-pound, paraffin-coated, cylindrical paper cartridges that have a nominal diameter of 1.25 inches and a nominal length of 8 inches.

M10 universal explosive destructor A high-explosive charge in an assembled metal device; used to destroy ammunition and to convert loaded projectiles and bombs into improvised demolition charges.

M112 block demolition charge A l¼-pound block of C4 packed in a plastic envelope.

M118 block demolition charge A block of four 1/2-pound sheets of flexible explosive packed in a plastic envelope.

M180 demolition kit, cratering Consists of an M2A4 shaped charge, a modified M57 electrical firing device, a warhead, a rocket motor, a tripod, and a demolition circuit.

M183 demolition charge assembly Consists of 16 Ml 12 (C4) demolition blocks and 4 priming assemblies; is used primarily for breaching obstacles or demolishing structures when large demolition charges are required.

M186 roll demolition charge A 50-foot roll of sheet explosive.

M1A2 Bangalore-torpedo demolition kit Consists of 10 loading assemblies, 10 connecting sleeves, and 1 nose sleeve.

M1A4 priming adapter A plastic, hexagonal-shaped device, threaded to fit threaded cap wells.

M2 cap crimper Used to squeeze the shell of a nonelectric blasting cap around a time blasting fuse, standard coupling base, or detonating cord.

M51 blasting-cap test set A seIf-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 set is waterproof and capable of operating at temperatures as low as -40 degrees Fahrenheit.

M60 weatherproof fuze igniter Used to ignite time blasting fuse in all weather conditions, even underwater, if properly waterproofed.

M700 time fuse A dark green cord, 0.2 inches in diameter, with a plastic cover; burns at approximately 40 seconds per foot.

M8 blasting cap holder A metal clip designed to attach a blasting cap to a sheet explosive.

max maximum

material factor (K) Represents the strength and hardness of the target material.

military demolition The destruction by fire, water, explosive, mechanical, or other means of area structures, facilities, or materials to accomplish a military objective. Demolitions are explosives used for such purposes. Demolitions have offensive and defensive uses. Examples are the removal of enemy barriers to facilitate the advance and the construction of friendly barriers to delay or restrict enemy movement.

military dynamite A composite explosive that contains 75 percent RDX, 15 percent TNT, and 10 percent desensitizers and plasticizers.

min minute(s), minimum

miscellaneous bridge Represents a small portion of bridge structures; examples include suspension, lift, and cable-stayed bridges.

mud-cap method Away of removing boulders in which the charge is placed in a crack or seam in the boulder and covered with 10 to 12 inches of mud or clay.

NA not applicable

NATO North Atlantic Treaty Organization

NCO noncommissioned officer

nitroglycerin Highly sensitive and extremely temperature-sensitive; the explosive base for commercial dynamites; not used in military explosives because of its sensitivity.

No. number

nonelectric priming The insertion of a nonelectric blasting cap directly into the charge.

NSN national stock number

obstacle folder Provides all the information necessary to complete a specific demolition operation.

Ohm's Law Defines the amount of voltage necessary to detonate the blasting caps.

oz ounce(s)

P weight of the explosive

pentaerythrite tetranitrate (PETN) A highly sensitive and very powerful military explosive; its explosive potential is comparable to RDX and nitroglycerin; insoluble in water.

pentolite (PETN-TNT) A mixture of PETN and TNT.

PETN *See* **pentaerythrite tetranitrate (PETN).**

PETN-TNT *See* **pentolite (PETN-TNT).**

platter charge Uses the Miznay-Shardin effect to turn a metal plate into a powerful, blunt-nosed projectile.

Plt platoon

pneumatic floats Airtight compartment of rubberized fabric inflated with air.

prac practice

pressure-sensitive adhesive tape Effective for holding charges to dry, clean wood, steel, or concrete; has better holding properties and is more easily and quickly applied than Ml adhesive paste.

QSTAG Quadripartite Standardization Agreement

qty quantity

R *See* **breaching radius (R).**

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.

RDX cyclotrimethylenetrinitramine. *See also* **cyclonite (RDX).**

RE *See* **relative effectiveness (RE) factor.**

recon reconnaissance

reconnaissance order Specifies the objectives of the reconnaissance party commander.

relative effectiveness (RE) factor The amount of explosive used is adjusted by a relative effective (RE) factor which is based on the shattering effect of the explosive in relation to that of TNT. The shattering effect of a high explosive is related to its detonating velocity. For example, TNT with a detonating velocity of 6,900 meters per second has an RE factor of 1,00, while

Composition C4 with a detonating velocity of 8,040 meters per second has an RE factor of 1.34.

relieved-face crater A trapezoidal-shaped crater about 7 to 8 feet deep and 25 to 30 feet wide with unequal side slopes.

ribbon charge A special cutting charge used to cut flat, steel targets up to 3 inches thick.

ring charge A band of explosives completely circling the tree; it should be as wide as possible and up to 1-inch thick depending on the diameter of the tree.

ring main Will detonate an almost unlimited number of charges; preferred over the line main because the detonating wave approaches the branch lines from two directions.

rqr required

s borehole spacing

saddle charge A special cutting charge that uses the destructive effect of the cross fracture formed in the steel by the base of the charge; used on mild steel bars up to 8 square inches or 8 inches in diameter.

safety fuse Consists of black pow&r tightly wrapped with several layers of fiber and waterproofing material; burn rate varies with atmospheric and climatic conditions; burns significantly faster underwater.

satchel charge *See* **M183 demolition charge assembly.**

sec second(s)

see-saw collapse mechanism A method of allowing abridge to collapse under its own weight.

shaped charge Concentrates the energy of the explosion released on a small area, making a tubular or linear fracture in the target.

sheet explosive *See* **M118 block demolition charge.**

side-priming method A method of priming certain types of explosive, for example, dynamite and 40-pound cratering charge.

simply supported bridge Abridge in which the ends of each span rest on the supports; there are no intermediate supports.

single-line ditching method The most common ditching method; detonates a single row of charges along the centerline of the proposed ditch, leaving further widening for subsequent lines of charges.

shpd Shaped

snake-hole method Removing boulders by digging a hole large enough to hold the charge beneath the boulder.

SOP standing operating procedure

spalling Occurs when the charge's shock wave chips away at the surface of the object directly under the charge; if the charge is large enough, it will span the opposite side of the object.

springing charge A comparatively small charge for enlarging a borehole to accommodate a larger charge.

special cutting charge Uses considerably less explosive than conventional charges; however, it requires exact and careful target measurement to achieve optimal effect; examples include ribbon, saddle, and diamond charges.

STANAG Standardization Agreement

standard dynamite Does not include military dynamite; contains nitroglycerin plus varying combinations of absorbents, oxidizers, antacids, and freezing-point depressants.

State of Readiness 1 (safe) When the demolition charges are in place and secure; vertical and horizontal ring mains are installed but are not connected.

State of Readiness 2 (armed) When all charges and firing systems are complete and ready for detonation; all vertical and horizontal ring mains are connected.

stemming The process of packing material on top of an internal borehole or crater charge.

stress-wave method Employs the destructive effect of two colliding shock waves, which are produced by simultaneously detonating the charge from opposite ends.

supplementary adhesive Used to hold demolition charges when the target surface is below freezing, is wet, or is underwater.

T tracked

tamping Placing a calculated quantity of material on or around a charge to increase its effectiveness.

tamping factor (C) Depends on the charge location and materials used for tamping; do not consider a charge tamped with a solid material as fully tamped unless the charge is covered to a depth equal to or greater than the breaching radius.

tamping material Dirt, mud, sand, sandbags, water, or other available materials.

tetryl An effective booster charge in its noncomposite form and a bursting or demolition charge in composite forms; more sensitive and powerful than TNT.

tetrytol A composite explosive containing 75 percent tetryl and 25 percent TNT; the explosive component in demolition charges.

three-pin arch effect The result of an unsuccessful collapse mechanism.

time blasting fuse Transmits a delayed spit of flame to a nonelectric blasting cap; there are two types: M700 time fuse and safety fuse.

TNT *See* **trinitrotoluene (TNT).**

TNT block demolition charge Standard military munitions packaged in ¼-, ½-, and l-pound blocks.

TM technical manual

top attack Forms a hinge at the bottom; as the span falls, the cut ends at the top move outward.

TRADOC United States Army Training and Doctrine Command

trinitrotoluene (TNT) 'The most common military explosive; may be in a composite or noncomposite form; as a standard explosive, it is used to rate other military explosives.

US United States (of America)

USAR United States Army Reserve

v volt(s)

w required width

W wheeled

W_d required ditch width

x row spacing

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DEMOLITION RECONNAISSANCE RECORD

For use of this form see 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 PARTY LEADER		

7. MAP INFORMATION

Name

Scale

Sheet No.

Series No.

8. TARGET AND LOCATION

9. TIME OBSERVED

10. COORDINATES

11. GENERAL DESCRIPTION: *(Attach sketches.)*

Type Construction	Other Data	Condition
☐ Earth	☐ Roadway Width _____	_____
☐ Timber	☐ Number of Bridge Spans _____	_____
☐ Concrete	☐ Number of Lanes _____	_____
☐ Asphalt	☐ Bridge Class: W- T-	_____
☐ Steel		

12. NATURE OF PROPOSED DEMOLITION *(Attach sketches.)*

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
Electric Caps	EA			
Nonelectric Caps	EA			
Detonating Cord	FT			
Time Fuse	FT			
Fuse Lighters	EA			
Firing Wire	FT			
Firing Device (*Specify type.*)	EA			
Explosive:				
TNT, 1/4-LB	EA			
TNT, 1/2-LB	EA			
TNT, 1-LB	EA			
TNT, 2 1/4-LB	EA			
(Other)				
(Other)				
Cratering:				
Cratering Charge, 40-LB	EA			
Shape Charge, 15-LB	EA			
Shape Charge, 40-LB	EA			
M180	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 the 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.*)

FM 5-250
15 JUNE 1992

By Order of the Secretary of the Army:

GORDON R. SULLIVAN
General, United States Army
Chief of Staff

Official:

MILTON H. HAMILTON
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