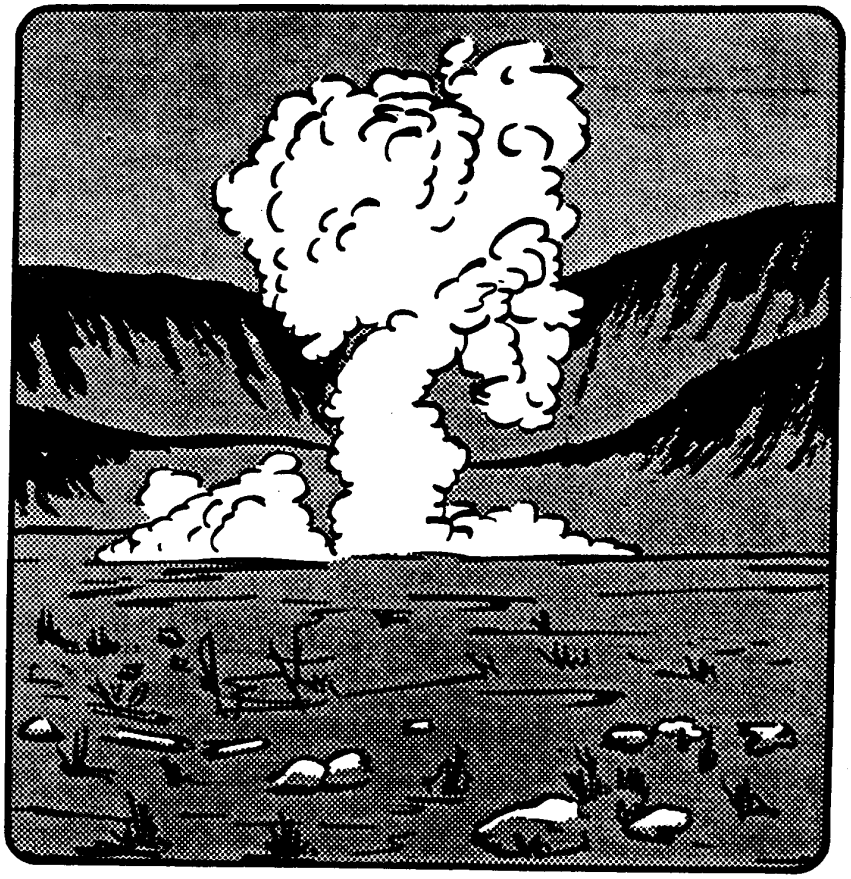
SUBCOURSE
CM3209

EDITION
8

FLAME FIELD EXPEDIENTS



THE ARMY INSTITUTE FOR PROFESSIONAL DEVELOPMENT
ARMY CORRESPONDENCE COURSE PROGRAM

AIPD

READINESS/ PROFESSIONALISM
THRU GROWTH

CHEMICAL OPERATIONS SPECIALIST, MOS 54B SKILL LEVEL 2
US Army Chemical School, Fort McClellan, Alabama

CM3209
FLAME FIELD EXPEDIENTS
EDITION 8
8 CREDIT HOURS
REVISED: 1988
GENERAL

This subcourse is designed to teach the student how to prepare a flame field expedient. The student will learn how to prepare flame fuel by the hand-mixing method. Using the flame fuel, the student will learn to construct flame field expedients (FFEs). This subcourse is presented in three lessons which correspond to the following terminal objectives:

Lesson 1: PREPARE FLAME FUEL

TASK: Prepare flame fuel.

CONDITIONS: Given information about and illustrations of the characteristics of flame fuel, preparation of flame fuel, and the safety precautions to be observed with flame fuel preparation, use, and storage.

STANDARDS: Demonstrate competency in the skills and knowledge of the task by responding to the multiple-choice test covering the characteristics of flame fuel, the preparation of flame fuel, and the safety precautions to be observed with flame fuel preparation, use, and storage.

(This objective supports task 031-508-1048, Prepare Flame Fuel.)

Lesson 2: UNDERSTAND THE FUNDAMENTALS OF FLAME FIELD EXPEDIENTS

TASK: Understand the fundamentals of flame field expedients.

CONDITIONS: Given information about and illustrations of the tactical uses, capabilities, and limitations of flame field expedients; the firing systems to be used with them; and the installation of firing systems.

STANDARDS: Demonstrate competency in the skills and knowledge of the task by responding to the multiple-choice test covering the tactical uses, capabilities, and limitations of flame field expedients; the firing systems to be used with them; and the installation of firing systems.

(This objective partially supports task 031-508-1049, Prepare Flame Field Expedients.)

Lesson 3: PREPARE FLAME DEVICES

TASK: Prepare flame devices.

CONDITIONS: Given information about and illustrations of the procedures for preparing controlled-type exploding flame devices and flame illuminators.

STANDARDS: Demonstrate competency in the skills and knowledge of the task by responding to the multiple-choice test covering the procedures for preparing controlled-type exploding flame devices and flame illuminators.

(This objective supports task 031-508-1049, Prepare Flame Field Expedients.)

Unless otherwise stated, whenever the masculine gender is used, both men and women are included.

CONTENTS

Page

TITLE PAGE 1

GENERAL 1

INTRODUCTION 6

Lesson 1: PREPARE FLAME FUEL 7

Learning Event 1: Describe Blame Fuels 7

Learning Event 2: Observe Safety Precautions 8

Learning Event 3: Prepare Flame Fuel 9

Practice Exercise 12

Answers to Practice Exercise 13

Lesson 2: UNDERSTAND THE FUNDAMENTALS OF FLAME FIELD EXPEDIENTS 14

Learning Event 1: Describe Flame Field Expedients 14

Learning Event 2: Describe Tactical Uses of Flame Field Expedients 15

Learning Event 3: Identify Firing Systems and Primary Explosives 16

Learning Event 4: Prime explosives Electrically and Nonelectrically 19

Practice Exercise 25

Answers to Practice Exercise 26

Lesson 3: PREPARE FLAME DEVICES 27

Learning Event 1: Prepare a Controlled-type Exploding Flame Device 27

Learning Event 2: Prepare a Flame Fougasse 28

Learning Event 3: Prepare a Hasty Flame Illuminator 29

Practice Exercise 33

Answers to Practice Exercise 34

Eight credit hours will be awarded for successful completion of this subcourse.

*** * * IMPORTANT NOTICE * * ***

THE PASSING SCORE FOR ALL ACCP MATERIAL IS NOW 70%

PLEASE DISREGARD ALL REFERENCES TO THE 75% REQUIREMENT.

INTRODUCTION

Flame is a valuable close-combat weapon that produces burns, oxygen depletion, and psychological impact. Since man instinctively fears flame, it is used to demoralize troops and reduce positions that have resisted other forms of attack. Both thickened and unthickened flame fuels are used to kill, dislodge, and demoralize personnel; to neutralize fortifications; and to destroy flammable material. Flame field expedients are effective tools that the commander uses to enhance the battlefield capabilities of the unit.

In Lesson 1 you will learn the characteristics of flame fuels. You will also learn the preparation of flame fuel and the safety precautions to be observed in flame fuel preparation, use, and storage. To understand the preparation of flame fuel, you must be able to describe the --

- Characteristics of flame fuel.
- Preparation of flame fuel.
- Proper safety precautions.

Once the flame fuel is prepared, it becomes a versatile component in many devices.

In Lesson 2 you will learn the fundamentals of FFEs. You will also learn the tactical uses, capabilities, and limitations of FFEs. Further, you will learn the firing systems to be used with FFEs and the installation of firing systems. To understand the fundamentals of flame field expedients, you must be able to describe the --

- Tactical uses of FFEs.
- Capabilities and limitations of FFEs.
- Firing systems used for FFEs.
- Installation of firing systems.

In Lesson 3 you will learn how to prepare flame devices. You will learn the procedures for preparing electrically and nonelectrically detonated FFE devices and flame illuminators. To understand the preparation of flame devices, you must be able to describe the --

- Procedures for preparing electrically detonated exploding flame devices.
- Preparation of nonelectrically detonated exploding flame devices.
- Preparation of flame illuminators.

The information in these three lessons will enable you to safely construct FFEs. Read each lesson carefully. Study the illustrations; they will help you to understand the material. Then perform the practice exercise at the end of the lesson.

After you complete a practice exercise, use the practice exercise answer page to check your answers. Before going on to the next lesson, review any questions you missed. After you complete all three lessons, review the material before proceeding to the exam.

LESSON 1

PREPARE FLAME FUEL

TASK

Prepare flame fuel.

CONDITIONS

Given information about and illustrations of the characteristics of flame fuel, preparation of flame fuel, and the safety precautions to be observed with flame fuel preparation, use, and storage.

STANDARDS

Demonstrate competency in the skills and knowledge of the task by responding to the multiple-choice test covering the characteristics of flame fuel; the preparation of flame fuel; and the safety precautions to be observed with flame fuel preparation, use, and storage.

REFERENCES

FC 3-11-1
FM 5-25
STP 3-54B2-SM

Learning Event 1:
DESCRIBE FLAME FUELS

Thickened flame fuel is a jellylike substance that ranges in consistency from a pourable liquid to a rubbery, very thick gel. Before aging, it looks somewhat like applesauce; after aging, it is a translucent gel. Flame fuel is highly flammable. The basic ingredient is gasoline. Only standard-grade military gasoline should be used. Aviation-type gasoline, such as JP4, should be used only in emergencies. It contains additives that cause the flame fuel to break down, and it is more difficult to obtain and more expensive than standard-grade gasoline.

To ensure good flame fuel, you must ensure that the gasoline is water-free. Water in the gasoline will prevent proper gelling of the fuel and cause the fuel to break down after a short while. To change gasoline into flame fuel, you must add a thickening compound. M4 thickener is the Army's standard thickening compound.

M4 thickener is a fine, white powder that is a by-product of petroleum. It is highly hygroscopic (absorbs moisture from the air). Once you open a can of M4 thickener, you must either use it or discard it.

Unthickened fuel is merely a mixture of gasoline and oil. In an emergency it can be used. Gasoline consumes rapidly, but the oil acts as an extender, allowing a longer burning time.

Learning Event 2:
OBSERVE SAFETY PRECAUTIONS

As stated in learning event 1, gasoline is the main ingredient in flame fuel. Gasoline is a poisonous and flammable substance. You must follow these precautions to ensure your safety and the safety of all personnel:

- Provide sealed 10-pound carbon dioxide fire extinguishers and locate them where they will be easily accessible in case of fire. Throw sand or dirt, not water, on burning fuel if extinguishers are not available. Include a fire blanket or "wet blanket" at the mixing site.

•· Allow no smoking within 50 feet of gasoline or flame fuel. This rule must be strictly enforced. Post NO-SMOKING signs in prominent places around any area in which fuel is being mixed, handled, or stored. If NO SMOKING signs are not available, post guards.

•· Do not permit open flames, heated stoves, or other sources of heat that might cause combustion of gasoline fumes in the immediate vicinity of mixing or filling operations or where fuel is being mixed, handled, or stored.

- Use only electrical equipment approved for class 1, group D hazards, nonsparking motors, and other appliances of approved types around flame fuels or their ingredients. Open switches, relays, or any similar apparatus must not be used where gasoline fumes may be present.

•· Never use oxygen as a source of pressure for mixing or transferring fuels.

If oxygen is introduced into fuel tanks or storage containers, it may cause a violent explosion. Before any cylinders are moved into an area where mixing and transferring operations are being performed, check markings to make certain that the cylinders contain compressed air or nitrogen and not oxygen.

•· Before using mechanical equipment to mix or transfer raw gasoline or fuel, ground it and keep it grounded during use to safeguard against static electricity. See details on grounding procedures in technical manuals for the equipment to be used.

- Since gasoline is highly flammable, take special precautions to prevent metal containers from striking other metal surfaces capable of sparking. (Any metal, except the nonsparking type, such as brass, will spark when struck against another metal surface. For this reason, always use wooden mixing paddles for hand-mixing). Even nails and metal cleats in shoes may cause a spark and, therefore, are potential hazards in the presence of combustible fumes.

•· Do not put hands into the fuel to test the consistency. Fuel on hands and clothes creates a fire hazard. Also, repeated skin exposure to gasoline may be harmful.

- Provide self-closing metal receptacles with metal lids for discarding oily or gasoline-soaked rags. Dispose of these rags daily..

•· Be aware that wooden paddles or other wooden material used to stir or test fuel are potential fire hazards. Dispose of these items as flammable waste, or store them where they will not be exposed to flame or sparks and where they cannot cause spontaneous combustion.

•· Never leave flammable liquids in open cans or barrels. Use safety cans whenever possible for storing small quantities of gasoline and oil.

Learning Event 3:
PREPARE FLAME FUEL

Preparing flame fuel is a very hazardous task. You must follow safety considerations completely. If you have any doubts when preparing flame fuel, stop and refer back to the safety list in learning event 2. When mixing a batch of flame fuel, you may use the field formula (rule-of-thumb method) for any quantity of gasoline. The rule-of-thumb method is an approximation of the amount of M4 thickener to use in a batch of fuel, based on the following equation:

Gallons of gasoline x fuel number = ounces of M4 thickener required

For example, to mix 40 gallons of FFE fuel, calculate: 40 (gallons) x 3 (fuel number) = 120 ounces (M4 thickener).

NOTE: With the rule-of-thumb method for FFE devices, use fuel number 3 as a multiplication factor to determine the amount of m4 thickener to be added to the gasoline.

Hand-mixing flame fuel requires the following equipment (Figure 1):

- A clean, ungalvanized container.
- A wooden paddle about five feet long, marked so that it can be used as a measuring stick for gasoline. Crossbars on the bottom of the paddle permit thorough stirring.
- A bucket and a funnel to transfer flame fuel to the expedient container.

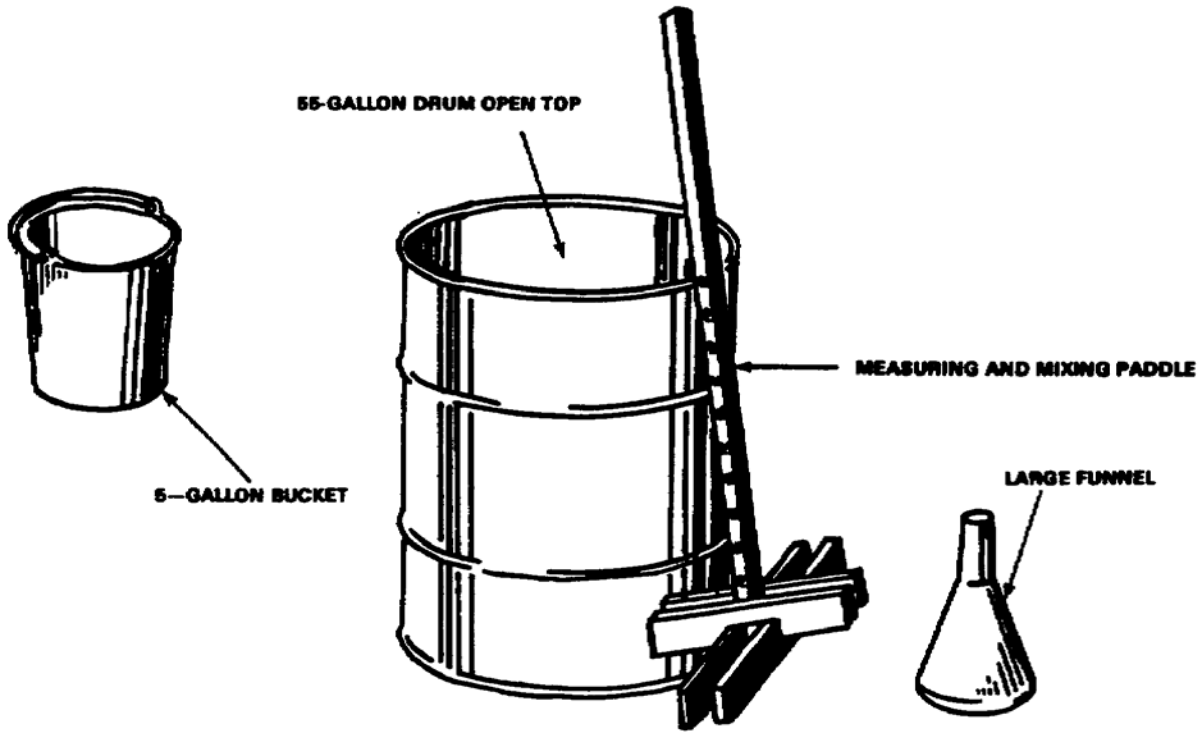


Figure 1. Equipment used in hand-mixing flame fuel.

To produce a good gel, maintain the gasoline temperature between 32°F and 85°F. The procedure for hand-mixing flame fuel at normal temperatures follows:

Step 1. Put the paddle in the drum and pour the required amount of water-free gasoline into the drum.

Step 2. Open the container of thickener, break up any lumps by hand, and pour the required amount into the gasoline. Stir the gasoline continuously while adding the thickener.

Step 3. Continue to stir the mixture until the fuel has the appearance of applesauce.

Step 4. Sample the fuel and observe the particles of thickener. If the thickener begins to settle, mix the fuel longer. Figure 2 compares the appearance of insufficiently mixed fuel with that of properly mixed fuel.

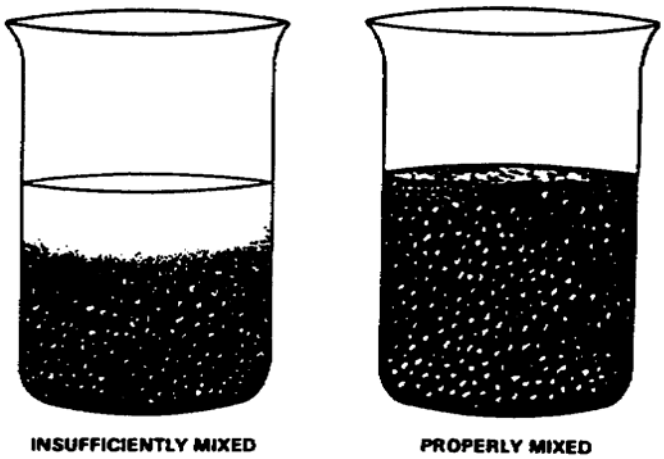


Figure 2. Contrasting appearance of flame fuel.

Even when the weather is less than ideal, thickened flame fuel can still be prepared. Mixing procedures in cold weather remain the same. You must understand that under extremely cold conditions, fuel will gel more slowly. The time required to produce a usable flame fuel may increase to as much as one hour. You may shorten cold weather mixing time with the following procedure, but it must be closely supervised:

Step 1. In a location a safe distance from the gasoline, heat a large container of water.

Step 2. Remove the warm water from the heat source and move it to where the gasoline is located.

Step 3. Place a container of gasoline into the heated water. This will raise the temperature of the gasoline.

Step 4. Add the proper amount of M4 thickener while vigorously stirring the gasoline. A gel will form.

In hot weather when the temperature rises above 85°F, the thickener tends to react more quickly. Vigorous stirring and rapid addition of thickener are necessary to form a proper gel.

WARNING
NEVER mix the fuel near a heat source or open flames.

Situations can exist when thickening compound is not available. When this happens, flame fuel can still be prepared in the form of unthickened fuel -- a simple mixture of gasoline and oil. Unthickened fuel will do the same thing that thickened fuel will, except it has no residual capability. Once fired, unthickened fuel will burn up rapidly, but it produces a hot fire while burning. Unthickened fuel can be employed in all flame devices except a fougasse, which requires the jellylike, thickened fuel.

Unthickened fuel is a mixture of 60 percent gasoline and 40 percent oil. For example, 30 gallons of gasoline and 20 gallons of oil in a 55-gallon drum will make a good unthickened flame fuel.

PRACTICE EXERCISE

You have just finished the instruction material for Lesson 1. This lesson covered the characteristics of flame fuels and the safety precautions to observe in preparation, use, and storage of flame fuels. It is time to check your understanding of the lesson. Do this by completing the practice exercise. All of the questions are multiple-choice and are intended to measure your understanding of the procedures used to perform the task. There is only one correct answer to each question. Try to answer all of the questions without referring to the lesson.

After you complete all of the questions, check your answers against the answers that follow this practice exercise. Each correct response is referenced to a specific learning event in the lesson to allow you to review any question you missed or did not understand. After you complete your review, proceed to the next lesson.

1. What is the basic ingredient of thickened flame fuel?

   a. Alcohol.
   b. Gasoline.
   c. M4 thickener.
   d. Motor oil.

2. What should you use to hand-mix flame fuel?

   a. Your hand.
   b. An entrenching tool.
   c. A wooden paddle.
   d. A steel pole.

3. Why is M4 thickener used?

   a. To raise the fuel temperature.
   b. To lower the fuel temperature.
   c. To gel the fuel.
   d. To slow the mixing process.

4. No smoking will be allowed within how many feet of gasoline or flame fuel?

   a. 10.
   b. 50.
   c. 100.
   d. 1,000.

5. If the thickener begins to settle in a flame fuel mixture, what must you do to the mixture?

   a. Heat it.
   b. Strain it of excess thickener.
   c. Mix it longer.
   d. Cool it.

6. When mixing unthickened flame fuel, what is the correct ratio of gasoline to oil?

   a. 60 to 40.
   b. 40 to 60.
   c. 50 to 50.
   d. 75 to 25.

ANSWERS TO PRACTICE EXERCISE

1. b (Refer to learning event 1.)
2. c (Refer to learning event 3.)
3. c (Refer to learning event 1.)
4. b (Refer to learning event 2.)
5. c (Refer to learning event 3.)
6. a (Refer to learning event 2.)

LESSON 2

UNDERSTAND THE FUNDAMENTALS OF FLAME FIELD EXPEDIENTS

TASK

Understand the fundamentals of flame field expedients.

CONDITIONS

Given information about and illustrations of the tactical uses, capabilities, and limitations of flame field expedients; the firing systems to be used with them; and the installation of firing systems.

STANDARDS

Demonstrate competency in the skills and knowledge of the task by responding to the multiple-choice test covering the tactical uses, capabilities, and limitations of flame field expedients; the firing systems to be used with them; and the installation of firing systems.

REFERENCES

FC 3-11-1
FM 5-25
STP 3-54B2-SM

Learning Event 1:
DESCRIBE FLAME FIELD EXPEDIENTS

Flame field expedients are primarily defense weapons used to complement other weapons in fire plans. They may be used for illumination, signaling, and casualty-producing effects. These expedients include exploding flame devices and flame illuminators. Directional fougasses may also be used as improvised flame mines. The FFEs discussed in this lesson have been used in combat and found to be effective. Variations and adaptations of these field expedients to meet specific situations are limited only by the imagination and initiative of the combat personnel using them.

Controlled FFEs are fired on the order of the commander of the using unit. They are considered to be part of the final protective fires of that unit. They are not reported as mines; however, unless the FFEs are turned over to another unit by mutual agreement, the using unit must detonate or remove them before leaving the area.

Uncontrolled or contact weapons, such as exploding flame devices detonated by the enemy (employing trip wire), are considered improvised flame mines. Their locations are marked, reported, and recorded according to the procedures set forth in FM 20-32.

Flame field expedients are capable of providing an effective deterrent against enemy personnel and vulnerable armor. Careful planning is needed to ensure the use of sufficient flame weapons of effective size in the right

places. The plans must allow enough time to procure the materials, assemble them, and emplace the completed weapons.

Exploding flame devices and other FFEs should be prepared and stored as far forward as possible. This minimizes the labor involved in bringing them up to using units and reduces the amount of fuel that will be lost by evaporation and deterioration. Components of FFEs are both explosive and flammable. Care must be exercised during transport, assembly, and installation to avoid accidental detonation or ignition. For additional information on mine safety, refer to FM 20-43.

Learning Event 2:
DESCRIBE TACTICAL USES OF FLAME FIELD EXPEDIENTS

Flame field expedients are used chiefly in defensive operations; however, they may also be used in offensive operations. They may be used in all types of minefields --protective, defensive, barrier, nuisance, or phony. Tactically, they are used --

- In defiladed areas or during periods of limited visibility to warn of enemy approach.
- To produce casualties by spattering personnel with thickened fuel or by striking personnel with fragments of the container. The intense, radiant heat of the fireball will also cause casualties.
- To deter the enemy by psychological impact.
- To produce limited battlefield illumination to silhouette the opposing force.
- To restrict the use of most likely avenues of approach that cannot be covered easily by direct-fire weapons. Exploding flame devices can be used for this purpose.
- To force the enemy into areas where it may be more profitably engaged.
- To support offensive operations. Flame field expedients may be used close to friendly positions, alone or with barbed wire or other obstacles. They may be used either by themselves or with high-explosive (HE) and chemical land mines in a composite minefield. When exploding flame devices are emplaced in a composite minefield, consider the effects of flame on other obstacle components, such as trip wires. If FFEs are to be placed in a field containing chemical mines, emplace them so that the flame will not vaporize or burn the chemical agent.

The unit commander is responsible for the emplacement and removal of all FFEs. Flame devices should be emplaced --

- Within the perimeter defense barrier and, whenever possible, covered by supporting fire to prevent destruction or removal by the enemy.
- In the field of observation of the individual assigned to fire them.
- Completely wired in, marked, recorded, and reported when used as part of the mine defense plan.
- Irregular in layout and not easily disclosed so that the enemy cannot determine the pattern.
- Concealed from hostile ground and air observation to maintain surprise and minimize destruction by enemy long-range weapons. They should be emplaced for maximum protection from fire.
- Compatible with natural obstacles and arranged to obtain overlapping flame dispersion that cannot be bypassed or outflanked.

- Coordinated with other elements of the defense in the planned fire support.
- Used in sufficient quantity to be effective for the purpose intended.
- Planned to permit the passage of friendly patrols and vehicles.
- Checked periodically to make certain that the firing system is functional and the explosives and fuel have not deteriorated.

Figure 3 shows two examples of emplacement patterns for FFEs.

NOTE: The separation distance between exploding FFE devices will be governed by the size of the devices used. Fifty-five-gallon devices can be emplaced 20 to 30 meters apart; 20-gallon devices, 10 to 15 meters apart; and 1 to 5-gallon devices, 7 to 10 meters apart.

Figure 3. Emplacement patterns.

Learning Event 3:
IDENTIFY FIRING SYSTEMS AND PRIMARY EXPLOSIVES

Firing systems and primary explosives are simply a means to detonate flame field expedients.

Firing Systems

Descriptions of the firing systems most commonly used for flame field expedients follow:

M700 Time Fuse. This fuse (Figure 4) is a dark green cord, filled with black powder and covered with plastic. There are yellow bands at specific intervals. Single, yellow bands are spaced at one-minute intervals, and double, yellow bands indicate five-minute intervals. These bands aid in determining the length of fuse for a given burning time. The fuse burns at approximately 40 seconds per foot.

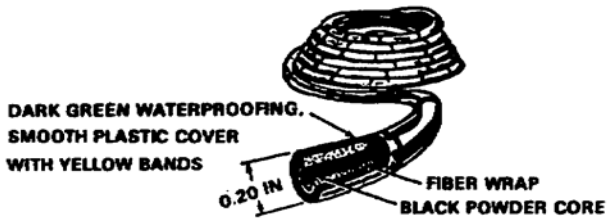


Figure 4. M700 time fuse.

Detonating Cord. This cord (Figure 5) is used to prime and detonate other explosive charges. It has a light green, plastic cover and a detonating rate of 20,000 to 21,000 feet per second.

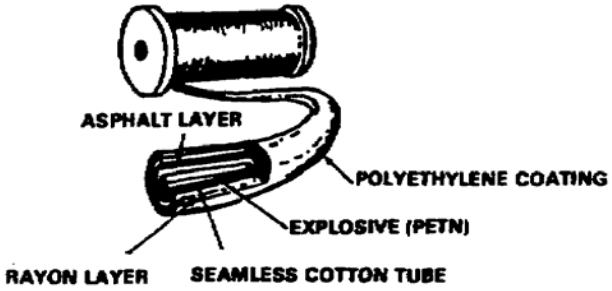


Figure 5. Detonating cord.

M6 Blasting Cap. This blasting cap (Figure 6) is used when a source of electricity, such as a blasting machine or a battery is available.

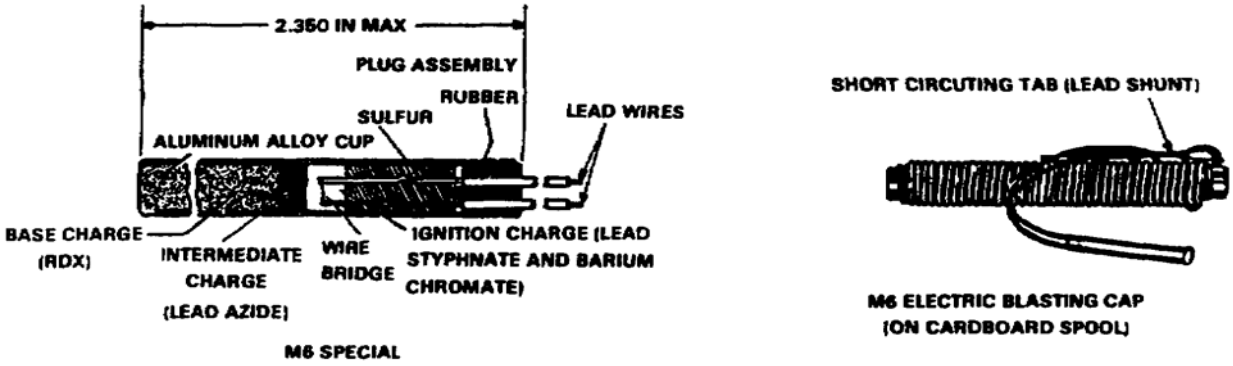


Figure 6. M6 electric blasting cap.

M7 Nonelectric Blasting Cap. This blasting cap (Figure 7) is normally detonated by a time fuse. Under certain conditions a detonating cord or other firing device may be used.

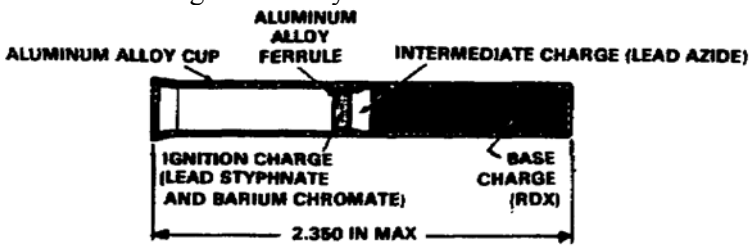


Figure 7. Nonelectric blasting cap.

Ten-Cap Blasting Machine. This is a DC electrical generator that produces adequate current to detonate ten electric blasting caps connected in a common series (Figure 8).

Figure 8. Ten-cap blasting machine.

M34 50-Cap Blasting Machine. This is a larger-capacity DC generator that produces adequate current to detonate 50 electric blasting caps connected in a common series (Figure 9).

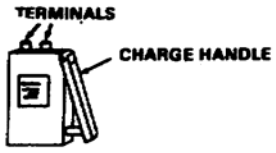


Figure 9. M34 50-cap blasting machine.

M60 Weatherproof Fuse Igniter. This device (Figure 10) is designed to ignite a time fuse in any sort of weather conditions. The fuse is inserted through a split collet, which clutches the fuse, and into a sealing rubber grommet, which helps to weatherproof the fuse-end.

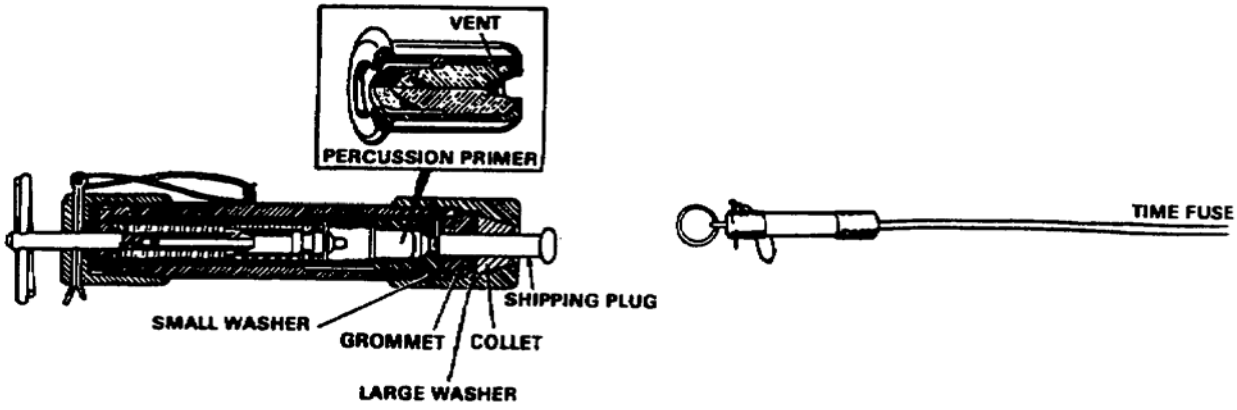


Figure 10. M60 weatherproof fuse igniter.

Switchboard. A switchboard is a locally fabricated device. It is merely a board with a series of nails protruding on one side (Figure 11). It enables an individual to control two or more FFEs from one location. Wires for each circuit are tied to the nails and tagged for identification.

Figure 11. Switchboard.

Primary Explosives

Primary explosives are a means of detonating the FFE. Descriptions of commonly used explosives follow:

M4 Incendiary Burster. This burster (Figure 12 on page 19) is used in cans or drums of flame fuel to rupture the container, scatter and ignite the flame fuel.

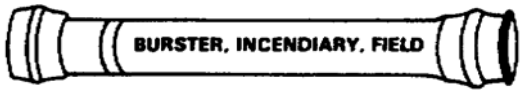


Figure 12. M4 incendiary burster.

Composition C4. This explosive (Figure 13) is used as a bursting charge.

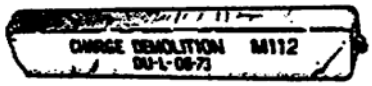


Figure 13. M112 composition C4.

White Phosphorus (WP) Hand Grenade. This white phosphorus-filled grenade (Figure 14) is used to ignite flame fuel. M34 WP grenades may not be used in CONUS training programs because of hazards of phosphorus residue in the soil that may ignite when exposed to the air.

NOTE

To conform with EPA requirements, M49 trip flares should be used for training, rather than white phosphorus grenades.

Figure 14. M34 white phosphorus grenade.

Learning Event 4:
PRIME EXPLOSIVES ELECTRICALLY AND NONELECTRICALLY

Explosives can be primed by either electric or nonelectric firing systems.

Electric Firing Systems

An electric firing system is one in which electricity is used to fire the primary initiating element. Components and equipment (Figure 15) used to construct an electric firing system consist of an electric blasting machine, firing wire, an electric blasting cap, crimpers, and a galvanometer or the M51 test set.

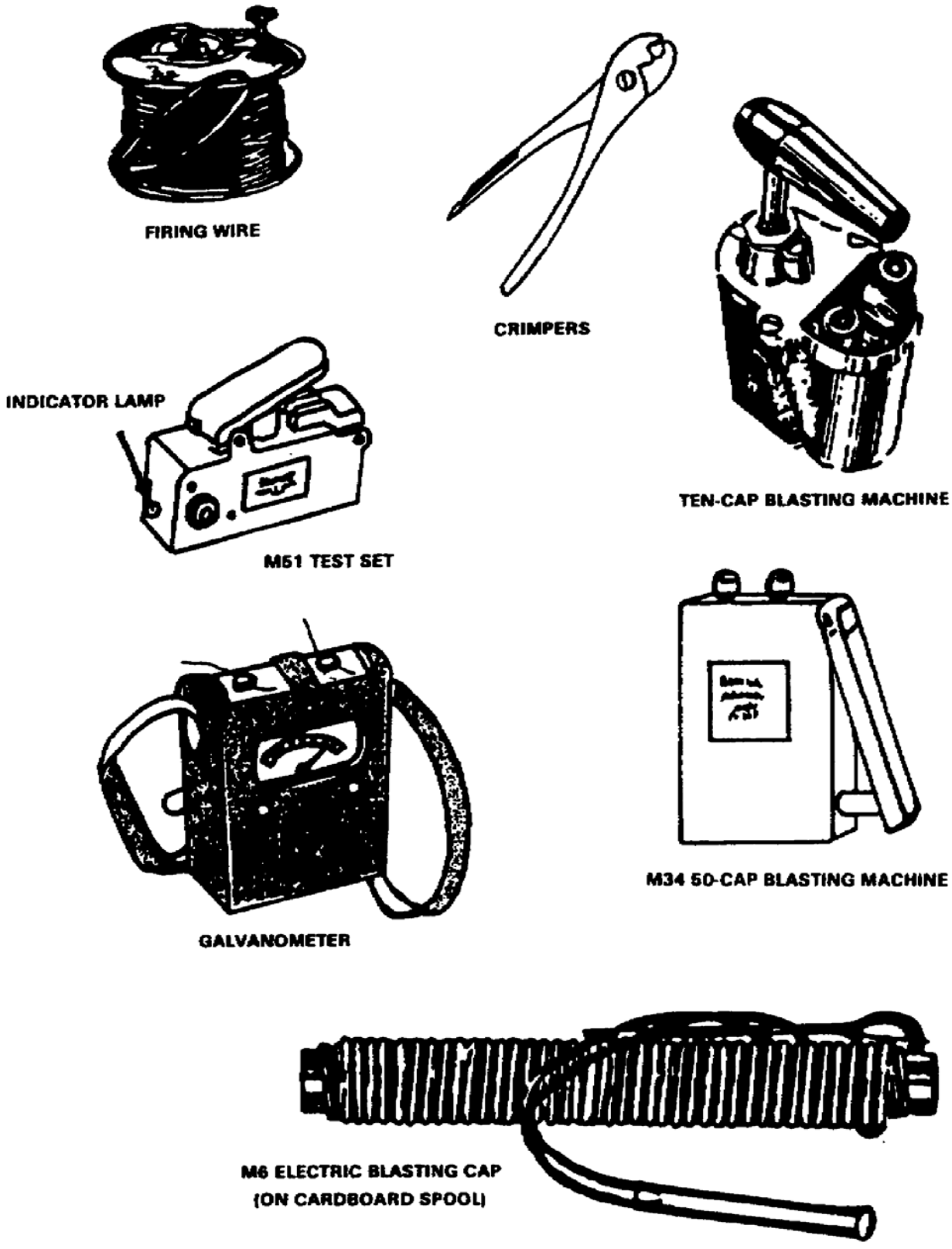


Figure 15. Electric firing system components and equipment.

The procedure for assembling an electric firing system follows:

Step 1. Locate a firing position a safe distance from the expedient and lay out the firing wire from the expedient to the firing position.

Step 2. Twist the wires together at the expedient end and connect the galvanometer to the firing position end. This should cause a wide deflection of the needle on the galvanometer. Failure of the needle to move indicates a break in the firing wire. A slight movement of the needle indicates a point of high resistance which may be caused by a dirty wire, loose wire connections, or wires with several strands broken off at the connections. After testing, remove the galvanometer and twist the wire ends together to prevent an electric charge from building up in the firing wire. The M51 test set may also be used to test the firing circuit. This device is a small, hand-held instrument with terminals on each side to receive the firing wire (or wires from an electric blasting cap). Upon connection, squeeze the handle sharply; a red indicator light will flash if the wires have continuity. If the circuit is not complete, the red lamp will not flash.

WARNING

Always attach the blasting cap to the firing wires with the cap under a sandbag, behind a tree, or otherwise protected. Then unite the cap with the explosive charge. NEVER UNITE THE CAP WITH THE EXPLOSIVE CHARGE FIRST. Static electricity in the firing wire could cause detonation at the moment the firing wires and cap wires are connected while you are still located near the charge.

Step 3. Test the electric blasting cap by removing the metal shunt on the wires and connecting the wires to the galvanometer. If the galvanometer battery is fresh, the meter should read about 24 units (2 ohms). During the test the blasting cap should remain under a sandbag, behind a tree, or otherwise protected to prevent injury should premature detonation of the cap occur during testing.

Step 4. Splice the cap wires to the firing wire at the expedient end.

Step 5. Join the blasting cap with the explosive charge and fasten securely (Figure 16).

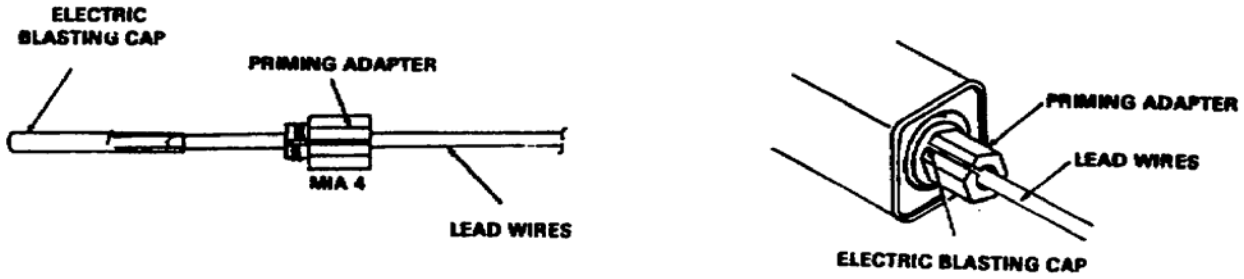


Figure 16. Electric blasting cap and explosive.

Step 6. Move to the firing position and test the entire firing circuit by connecting the wires to the galvanometer. The galvanometer should show a wide angle of deflection. Or, if using the M51 test set, connect the wires and squeeze the handle. The red indicator light will flash if the wires have continuity.

Step 7. Connect the firing wires to the two terminals on the blasting machine. Figure 17 shows an example of a completed electric firing circuit.

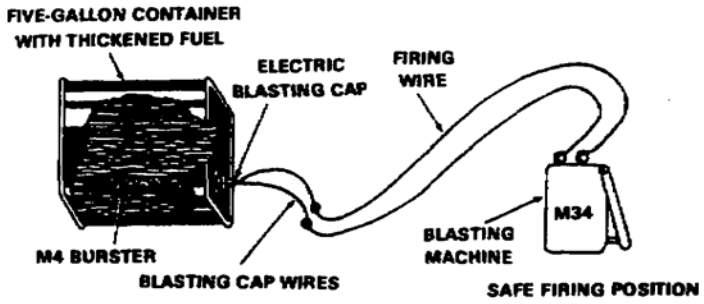


Figure 17. Controlled exploding five-gallon flame device.

Nonelectric Firing System

A nonelectric firing system is one in which an explosive charge is prepared for detonation by means of a nonelectric blasting cap. Components of a nonelectric firing system consist of a fuse igniter, a time fuse, and a nonelectric blasting cap. These components, along with the M2 cap crimpers, are shown in Figure 18.

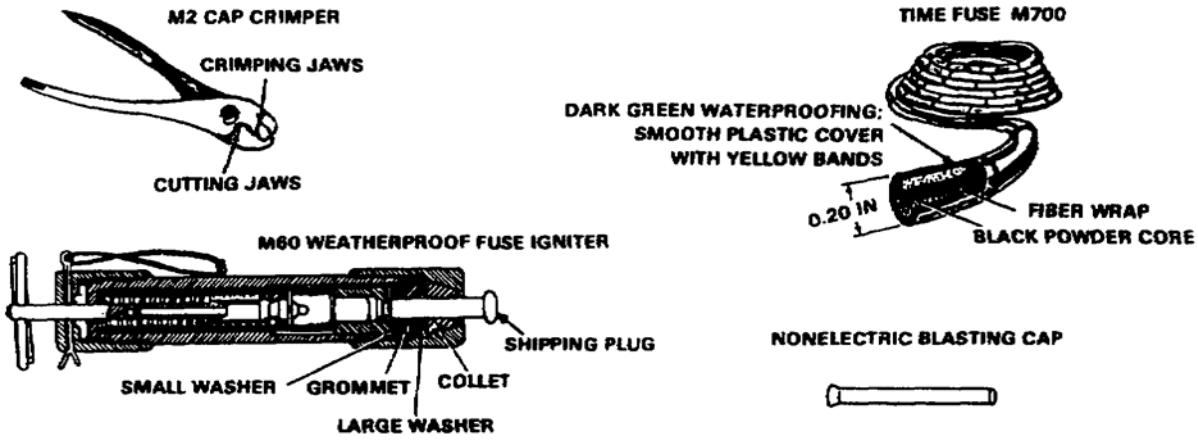


Figure 18. Nonelectric firing system components and crimpers.

The procedure for assembling the nonelectric firing system follows:

Step 1. Cut and discard a six-inch length from the free end of the time fuse. This prevents a misfire caused by the exposed powder absorbing moisture from the air.

Step 2. Cut off a three-foot length of fuse to check the burning rate.

Step 3. Light the three-foot length of fuse and note the time it takes to burn. This time is the burning rate.

WARNING
DO NOT crimp the cap more than 1/4 inch from the open end.
Detonation may occur.

Step 4. Cut the time fuse long enough to permit the person detonating the charge to reach a safe distance by walking at a normal pace before the explosion.

Step 5. Attach the fuse igniter as follows:
- Unscrew the fuse-holder cap two or three turns, but do not remove it.
- Press the shipping plug (Figure 10 on page 18) into the igniter and rotate the plug as you remove it.
- Insert one end of the time fuse in place of the plug until it rests against the primer.
- Tighten the cap sufficiently to hold the fuse in place. This weatherproofs the joint.

Step 6. Hold the time fuse vertically with the free end up and slip the blasting cap gently down over it so that the flash charge in the cap is in contact with the end of the time fuse. NEVER force the fuse into the cap.

Step 7. Grasp the time fuse between the thumb and the third finger of the left hand and extend the forefinger over the end of the cap to hold it firmly against the time fuse.

Step 8. Crimp the blasting cap at a point 1/8 to 1/4 inch from the open end by using the crimping jaws of the M2 cap crimper.

WARNING
A crimp too near the explosive in the blasting cap may cause detonation. Point the cap out and away from your body during crimping (Figure 19).

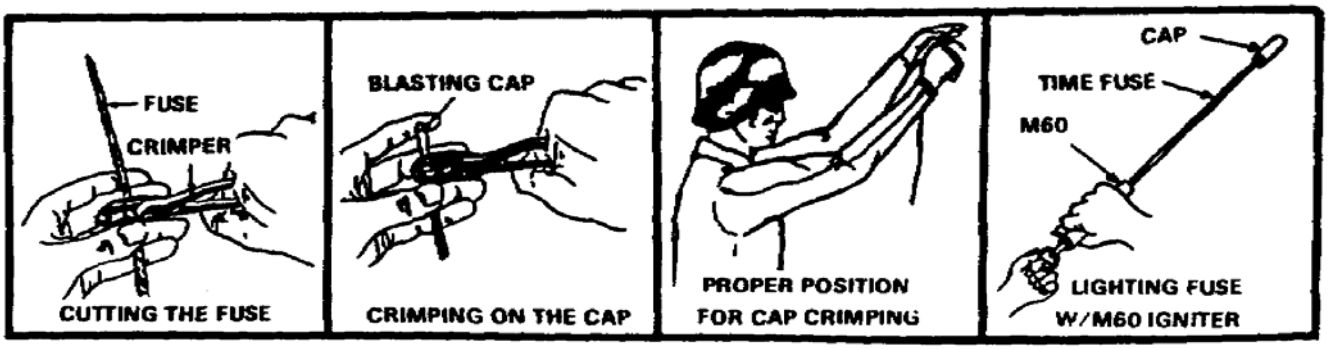


Figure 19. Procedures for crimping and igniting.

Step 9. Join the blasting cap with the explosive charge and fasten securely.

Figure 20 shows a completed nonelectric firing system.

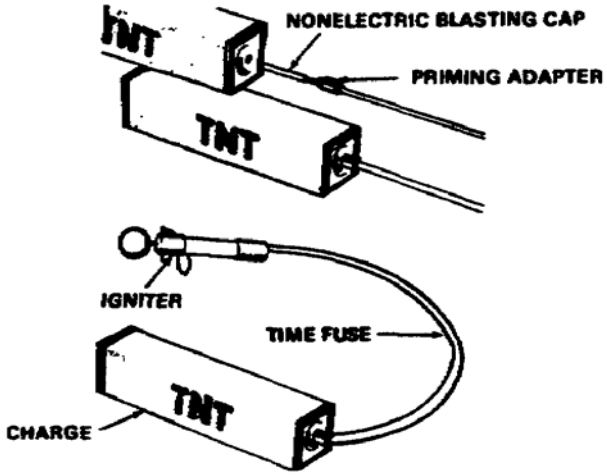


Figure 20. Assembled nonelectric firing system.

PRACTICE EXERCISE

You have just finished reading the instructional material for Lesson 2. This lesson covered the tactical uses, capabilities, and limitations of FFEs. Also covered were the firing systems, primary explosives, and the installation of firing systems used with FFEs. It is time to check your understanding of the lesson. Do this by completing the practice exercise. All of the questions are multiple-choice and are intended to measure your understanding of the procedures used to perform the task. There is only one correct answer to each question. Try to answer all of the questions without referring to the lesson.

After you complete all of the questions, check your answers against the answers that follow this practice exercise. Each correct response is referenced to a specific learning event in the lesson to allow you to review any question you missed or did not understand. When you complete your review, proceed to the next lesson.

1. Which of the following is descriptive of correctly emplaced flame devices?

   a. Outside the perimeter defense barrier.
   b. Easily identified from the air.
   c. Concealed from friendly ground observation.
   d. Irregular in layout.

2. At what fraction of an inch from the open end should you crimp the nonelectric blasting cap?

   a. 1/16.
   b. 1/4.
   c. 3/8.
   d. 1/2.

3. Where should electric blasting caps be located while being tested?

   a. Under a sandbag.
   b. Joined with the explosive charge.
   c. In the cap holding bunker.
   d. In a cap box.

4. Where should exploding flame devices be prepared and stored?

   a. In the rear areas.
   b. As far forward as possible.
   c. At the ammunition supply point.
   d. Within 50 feet of the fuel supply point.

5. How fast does the detonating wave of the detonating cord travel?

   a. 40 seconds per foot.
   b. 60 seconds per foot.
   c. 6,000 feet per second.
   d. 20,000 feet per second.

6. Components of an electric firing system may include which of the following?

   a. Time fuse.
   b. M60 fuse igniter.
   c. M34 blasting machine.
   d. Trip wire.

7. Who has the responsibility for the emplacement and removal of all flame field expedients?

   a. Supply section.
   b. Smoke operations specialist.
   c. Unit commander.
   d. First sergeant.

ANSWERS TO PRACTICE EXERCISE

1. d (Refer to learning event 2.)
2. b (Refer to learning event 4.)
3. a (Refer to learning event 3.)
4. b (Refer to learning event 1.)
5. d (Refer to learning event 3.)
6. c (Refer to learning event 4.)
7. c (Refer to learning event 2.)

LESSON 3

PREPARE FLAME DEVICES

TASK

Prepare flame devices.

CONDITIONS

Given information about and illustrations of the procedures for preparing controlled-type exploding flame devices and flame illuminators.

STANDARDS

Demonstrate competency in the skills and knowledge of the task by responding to the multiple-choice test covering the procedures for preparing controlled-type exploding flame devices and flame illuminators.

REFERENCES

FC 3-11-1
FM 5-25
STP 3-54B2-SM

Learning Event 1:
PREPARE A CONTROLLED-TYPE EXPLODING FLAME DEVICE

Controlled exploding flame devices are composed of containers, thickened fuel, bursting and/or incendiary explosives, electric blasting caps, firing wire, and a blasting machine. An example controlled exploding flame device is produced by the following method:

Step 1. Emplace a 5- to 55-gallon container (filled with thickened fuel) on the surface or in a V trench.

Step 2. Locate a firing position a safe distance from the expedient and lay out the firing wire from the expedient to the firing position.

Step 3. Attach the cap wires to the firing wires and test with the galvanometer or the M51 test set.

Step 4. Insert the electric blasting cap into the burster.

Step 5. Insert an M4 burster into the container.

NOTE: Use one burster for a 5- to 20-gallon container and a minimum of three M4 bursters for a 55-gallon container (except during training when only two bursters should be used for safety reasons).

Step 6. Attach the firing wire to the blasting machine (Figure 21 on page 28).

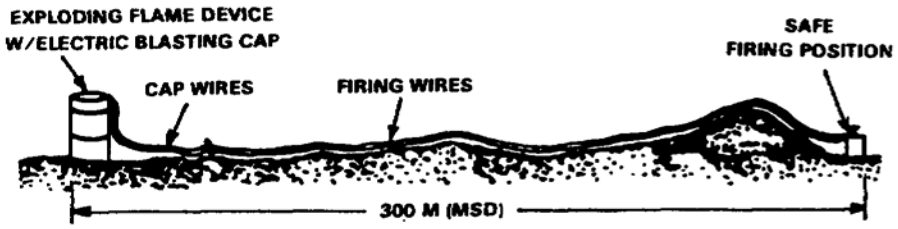
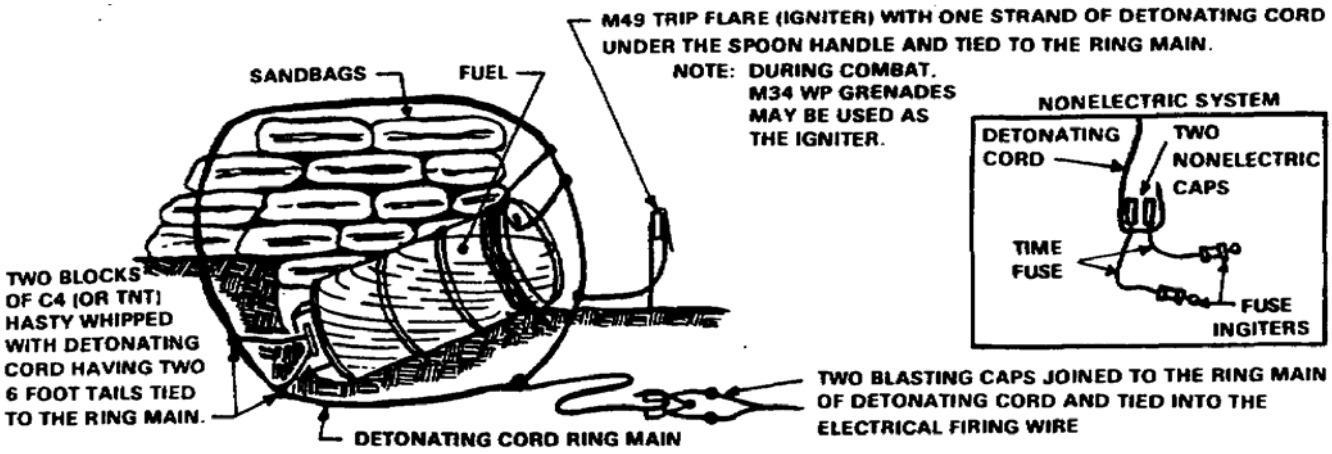


Figure 21. Controlled-type exploding flame device.

Learning Event 2:
PREPARE A FLAME FOUGASSE

The flame fougasse is one form of exploding FFE in which the flame fuel is projected by explosive means over a preselected area. The flame fougasse may also be used as a controlled weapon or an improvised flame mine. Commonly used components of a flame fougasse include containers of flame fuel, an explosive charge, detonating cord, an igniter, blasting caps (electric or nonelectric), a time fuse, a fuse igniter, firing wire, and a blasting machine. An example flame fougasse (Figure 22) is produced by the following method:



WARNING:
CAPS MUST BE TESTED AND CONNECTED TO THE FIRING CIRCUIT PRIOR TO JOINING THEM TO THE EXPLOSIVE

Figure 22. Fougasse made with a 55-gallon drum.

Step 1. Wrap two blocks of explosives with detonating cord and place at the back of a V trench.

Step 2. Place a 55-gallon drum filled with flame fuel in the V trench at an angle that will give maximum effect over the area selected for attack.

Step 3. Using the free ends of the detonating cord, place 10 to 12 wraps outside the top lip of the drum.

NOTE: An alternate method of priming C4 explosive with detonating cord follows:
Step a. Tie an overhand or triple-roll knot in the free end of the detonating cord.

Step b. Place the knot between the C4 blocks.
Step c. Tape the C4 blocks together.

Step 4. Implant a stake (engineer picket) 3 feet away from the top of the drum.

Step 5. Using a free end of the detonating cord, place three wraps of cord around a WP grenade (or place a strand of detonating cord under the spoon handle of an M49 trip flare).

Step 6. Cut off any excess detonating cord and secure this assembly to the stake with tape.

NOTE: To conform to Environmental Protection Agency requirements, use M49 trip flares rather than WP grenades for training. WP grenades are not authorized for training in CONUS.

Step 7. Tie in the rear charge, the front wrap, and the igniter to a ring main of detonating cord laid completely around the entire device.

Step 8. Test electric caps and tie them into the firing wire.

Step 9. Attach caps to trail end of detonating cord from the ring main.

Step 10. Cover the entire device with earth and camouflage it thoroughly.

When the device is detonated, three things will happen almost simultaneously:

- The explosive charge will push the flame fuel upward.
- The detonating cord will cut the top off the drum.
- The igniter will set the fuel on fire.

After leaving the drum, the burning flame fuel will spread out over the preselected area.

Learning Event 3:
PREPARE A HASTY FLAME ILLUMINATOR

A number of flame devices may be used to produce limited battlefield illumination. All FFEs give an initial flash from the detonation and ignition of the thickened fuel. Thickened fuel thrown on the ground as a result of the detonation continues to burn for five to ten minutes and provides some illumination. True flame illuminators consist of a container, fuel and an igniter. They are constructed to provide extended burning time with maximum illumination. Although they may also produce casualties, flame illuminators may be used for warning as well as illumination by contact detonation. Discussion of some improvised flame illuminating devices follows; others are described in FC 3-11-1.

A 5-to 55-gallon container filled with thickened fuel, tightly sealed, and set in a hole so that the top is slightly below the surface of the ground can be used. Coils of detonating cord are wound around the inside edge of the top of the drum. The coil is tightly tamped with earth. Upon detonation the

cord cuts off the top of the drum and a trip flare or WP hand grenade ignites the fuel. It burns for several hours. Time of burning can be controlled to some extent by the size of the container, by the thickness of the fuel mixture, and/or by the addition of straw or dirt. The flame can be extinguished by covering it with dirt to smother it.

An example illuminator (Figure 23) is constructed by the following method:

Step 1. Set a 55-gallon drum filled with flame fuel in a hole so that the top is slightly below the surface of the ground.

Step 2. Wind five coils of-detonating cord around the inside edge of the top of the drum. The coils are tightly tamped with mud.

Step 3. Connect an electric blasting cap to a firing line and test for continuity.

WARNING

Always attach the blasting cap to the firing wires with the cap under a sandbag, behind a tree, or in a position that otherwise protects you. Then unite the cap with the explosive charge. NEVER UNITE THE CAP WITH THE EXPLOSIVE CHARGE FIRST. Static electricity in the firing wire could cause detonation at the moment the firing wires and cap wires are connected while you are still located near the charge.

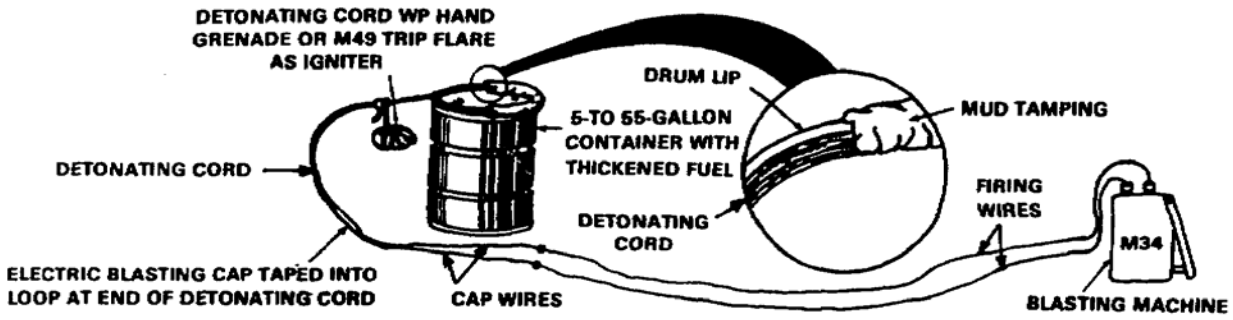


Figure 23. Hasty flame illuminator.

Step 4. Place a single strand of detonating cord under the spoon handle of a trip flare, and tie the detonating cord into the main line of detonating cord from the drum, using a girth hitch with an extra turn.

NOTE: Be sure to pull the pin on the flare before use; otherwise, the spoon handle will not come off upon detonation.

Step 5. Tape the electric blasting cap to the free end of the detonating cord.

Step 6. Connect the firing line to a blasting machine.

Other types of hasty flame illuminators, which should be fired within 12 hours after emplacement, can be constructed by digging shallow holes or

trenches in selected avenues of approach, filling the holes or trenches with previously thickened fuel, and adding an igniter system.

Water illuminators can be set up by pouring gasoline, oil, or thickened fuel on the surface of calm water and igniting it.

Illuminators for defensive perimeters can be constructed by using No. 10 food cans, empty .50-caliber ammunition cans, or similar containers. Half-fill each container with sand, add diesel fuel until the container is full, and cover with paper. Use a trip flare to ignite the fuel. Strategically emplace the containers (with trip wires or remote-control wires) at 50-meter intervals within the forward edge of the defensive perimeter. Upon activation, these devices will provide some illumination for about 45 minutes.

An illuminating signal arrow, consisting of a series of used cans filled with an equal mixture of diesel fuel and JP4 (or equivalent) fuel, may be used. The number of cans on the stem of the arrow indicates the number of meters or increments to the enemy location. When a unit is under attack at night, arrange the cans to form an arrow pointing toward the direction from which the position is being attacked. Then ignite the fuel in the cans. This arrow can be clearly seen by pilots of supporting aircraft.

Coating the water of canals, ditches, and moats with petroleum products and then command-igniting them can provide an effective illuminator and a formidable obstacle.

The Husch flare (Figure 24) is a device that uses the burning vapor of thickened flame fuel to provide illumination. This flare is a sealed metal container (powder canister) that is half-full of thickened fuel and has a 1/8- to 3/16-inch hole in the top. The container is placed cap down in half of a 55-gallon drum that is three-fourths full of thickened fuel. When the fuel in the drum half is ignited, the heat from the burning fuel produces a vapor in the powder canister; this vapor is expelled as a burning jet through the hole in the powder canister. A reflector assembly made from 24-inch culvert should extend about 60 centimeters (about 24 inches) above the top of the rim of the drum half. Fuel in the drum half can be ignited with a trip flare or WP grenade.

This type of flare is reusable. It will illuminate an area with a radius of 30 to 50 meters for 2 to 5 hours. If the flare is not to be used immediately, cover it with some kind of waterproof material, such as plastic or tarp, until it becomes necessary to ignite the device.

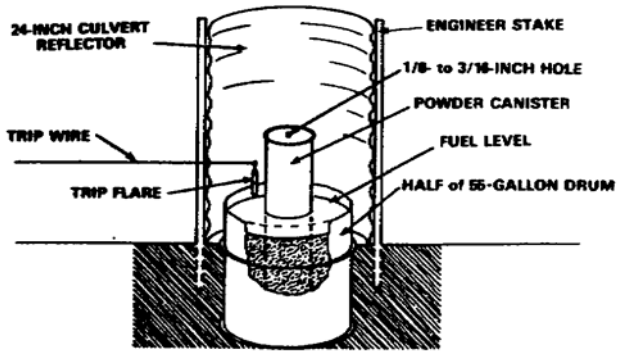


Figure 24. Husch flare.

To construct a Husch flare, follow this procedure:

Step 1. Prepare drum half: Wrap 12 to 14 turns of detonating cord around the center of an empty 55-gallon drum. Attach an electric or nonelectric firing system to the detonating cord and fire it. The drum will quickly separate into two equal halves. Each drum half can be used as the base for an individual Husch flare.

Step 2. Obtain an empty 155-millimeter propellant charge container. Using an engineer pick, puncture the closed end of the container.

Step 3. Turn the container-over, remove the plug, and fill halfway with flame fuel.

Step 4. Place the drum half in a shallow hole in the ground.

Step 5. Place the prepared propellant charge container (hole up) in the center of the drum half.

Step 6. Fill with dirt so the propellant charge container will stand alone.

Step 7. Pour flame fuel into the drum half to be absorbed by the dirt.

Step 8. Ignite the fuel in the drum half.

The heating process will change the fuel in the propellant charge container from a liquid to a gas. The gas will spew from the small hole in the top and ignite.

PRACTICE EXERCISE

You have just finished reading the instructional material for Lesson 3. This lesson covered procedures for preparing controlled-type exploding flame devices, flame fougasses, and flame illuminators. It is now time to check your understanding of the lesson. Do this by completing the practice exercise. All of the questions are multiple-choice and are intended to measure your understanding of the procedures used to perform the task. There is only one correct answer to each question. Try to answer all of the questions without referring to the lesson.

After you complete all of the questions, check your answers against the answers that follow this practice exercise. Each correct response is referenced to a specific learning event in the lesson to allow you to review any question you missed or did not understand. After you complete this practice exercise, you should review all of the subcourse material before starting the examination.

1. What is the size of the area, in meters, that a Husch flare will illuminate?

   a. 5 to 10.
   b. 10 to 15.
   c. 30 to 50.
   d. 80 to 100.

2. In combat a 55-gallon drum of flame fuel set as an exploding flame device will require how many M4 bursters?

   a. None.
   b. One.
   c. Two.
   d. Three.

3. During training, what should be used instead of WP grenades to ignite FFE devices?

   a. Smokeless powder.
   b. Blasting caps.
   c. Time fuse.
   d. Trip flares.

4. Within how many hours after emplacement should some forms of hasty flame illuminators be fired?

   a. 2.
   b. 12.
   c. 24.
   d. 48.

5. When an M49 trip flare is used as an igniter for a flame device, under what part is the detonating cord placed?

   a. Bottom lip.
   b. Spoon handle.
   c. Striker arm.
   d. Firing pin.

6. Electric blasting caps must remain under a sandbag or otherwise shielded while you are doing what?

   a. Connecting the cap to the charge.
   b. Connecting the firing wires to the blasting machine.
   c. Attaching time fuse.
   d. Connecting the cap wires to the firing wires.

7. What initiates (triggers) controlled-type exploding flame devices?

   a. Time fuse.
   b. fuse igniters.
   c. Electric blasting caps.
   d. Nonelectric blasting caps.

ANSWERS TO PRACTICE EXERCISE

1. c (Refer to learning event 3.)
2. d (Refer to learning event 1.)
3. d (Refer to learning event 2.)
4. b (Refer to learning event 3.)
5. b (Refer to learning event 3.)
6. d (Refer to learning event 3.)
7. c (Refer to learning event 1.)