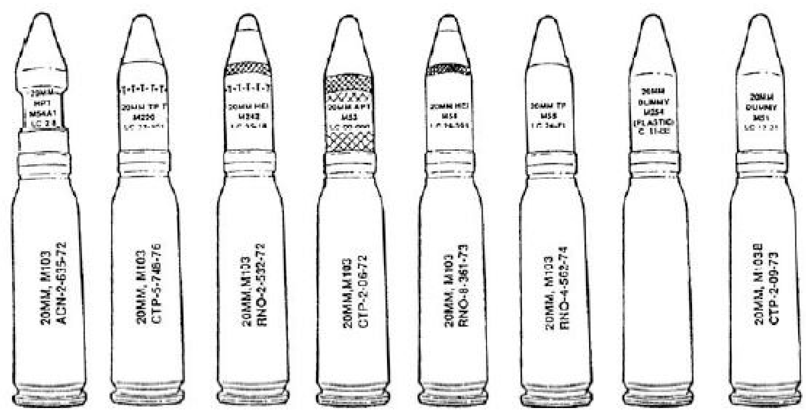
CDC 2W051B

Munitions Systems Journeyman

Volume 2. Conventional Munitions



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THIS SECOND VOLUME of career development course (CDC) 2W051B covers the principles of conventional munitions. Unit 1 covers general munitions principles including basic explosive principles, pyrotechnics, air base ground defense, and munitions demolition. Unit 2 covers aerospace munitions which includes fuzes, general-purpose bombs, and cluster bomb units. Unit 3 covers aircraft munitions including cannon ammunition and aircraft munitions systems.

A glossary is included for your use.

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This volume is valued at 15 hours and 5 points.

NOTE:

In this volume, the subject matter is divided into self-contained units. A unit menu begins each unit, identifying the lesson headings and numbers. After reading the unit menu page and unit introduction, study the section, answer the self-test questions, and compare your answers with those given at the end of the unit. Then complete the unit review exercises.

Page

Unit 1. General Munitions Principles

MOST MUNITIONS, HOWEVER DIFFERENT in size, shape, chemical composition, or function, share one characteristic—they burn, burst, explode, or detonate violently. Since explosives are inherent components of munitions, it is obvious that a thorough knowledge of explosives is critical for the munitions systems specialists responsible for maintaining munitions items. Their lives, the lives of coworkers, and the success of the mission depend on this knowledge.

We use different types of explosives—each having a specific role—to ensure a munitions item functions at the time, place, and manner the mission demands. Explosives suitable for one purpose may be entirely unsatisfactory for another. For example, the explosive used to detonate a bomb would be unsuitable and highly dangerous if it were used to propel a small-arms projectile or a missile. Understanding only one or two types of explosives is not enough. Familiarity with *all types used* by the Air Force is a must for the munitions systems specialist.

1–1. Basic Explosive Principles

The lessons in this section deal with the nature of explosives and explosive trains. The emphasis is on the characteristics and requirements that make them suitable for military use. We'll begin with explosive characteristics and the move on to basic explosive trains.

201. Explosive characteristics

An explosive is a substance or mixture that, under external influences, can rapidly release energy in the form of gases and heat. The amount of energy created varies with the type of explosive used. Trinitrotoluene (TNT) is the comparative yardstick we use to measure explosive power. It creates a pressure of more than 100 tons per square inch. The term "explosives" refers to all ammunition, demolition material, solid rocket motors, liquid propellants, cartridges, pyrotechnics, mines, bombs, grenades, and warheads of all types.

Requirements for military explosives

Of all the explosives developed throughout the years, relatively few are suitable for military use. Those rejected were too costly, too sensitive or insensitive, or not compatible with military requirements.

In the table below, we look at each requirement for a military explosive.

Requirements for Military Explosives	
Requirement	**Description**
Availability and cost	Because of the huge quantity of explosives needed to wage a war successfully, the material used to manufacture the explosives must be cheap, plentiful, and not vital to any other phase of the war effort. In addition, the manufacturing process must be relatively cheap, simple, and safe.
Brisance and power	A military explosive must have enough shattering or fragmentation effect (*brisance*) and energy potential to make it suitable as a bursting charge. It must be able to detonate other explosives and be sensitive enough itself to be initiated by percussion, friction, flame, or electric current.
Stability	Because of the extremes to which military explosives are subjected (long storage periods, adverse temperatures, arctic and tropic climates, etc.) they must have maximum chemical and physical stability. The types of explosives stored in igloos in North Dakota are the same as those used in the heat of the Middle East. The variety of conditions a military explosive must withstand is ever changing.
Density	In general, the greater the loading density an explosive has the greater explosive effect (energy) it will have. This is true up to a certain point, but if the explosive is too closely (or too loosely) pressed or cast, it will not detonate. Each explosive has its own optimum density for maximum explosion. This is the goal all explosive manufacturers aim to achieve.
Volatility	The tendency of a substance to produce vapors is known as *volatility*. The MJU–7 flare is a good example of a volatile item. These flares can produce a gas that balloons or expands its barrier bag. High volatility can lead to an undesirable pressure in ammunition rounds, or it can separate the individual ingredients of the explosive mixture.
Reactivity	An acceptable military explosive must not react with metal that encases it or with another explosive. When there is no reaction created, there is natural compatibility. Reaction, particularly in the presence of moisture, may produce sensitive metallic salts, cause deterioration and loss of power or sensitivity, or liberate gaseous products of reaction. Compatibility is particularly important when mixing the explosive with liquid TNT for loading by casting.
Toxicity	Many explosives are somewhat toxic because of their chemical structures. *Toxicity* refers to the poisonous properties of an explosive and must be at a minimum before an explosive is acceptable for military use. Manufacturers pay careful attention to this feature because the effects of toxicity on personnel can vary from a mild dermatitis or a headache to serious damage to internal organs.
Sensitivity	While all explosives are sensitive to a degree, some are too sensitive for general handling, and others are too insensitive for practical application. A good military explosive must fall somewhere between the two extremes. It must be capable of being detonated and yet be as insensitive as possible. Propellants are not extremely sensitive to shock or friction, but they are sensitive enough to ignite by flame to ensure uniform burning.
Hygroscopicity	Hygroscopicity is the moisture-absorbing property of an explosive. Moisture

Requirements for Military Explosives	
Requirement	**Description**
	adversely affects the sensitivity, stability, or reactivity of some explosives. This is why some explosives require the use of waterproof containers.

Rate of transformation

Explosives can vary considerably in their rate of transformation during detonation. Low explosives, which include smokeless and black powders, undergo autocombustion (burning) at rates that vary from a few inches per minute to approximately 1,300 feet-per-second. A second group, high explosives (HE)—which include TNT and nitroglycerin—undergo detonation at rates from 3,200 to 28,000 feet-per-second.

Explosive characteristics

Explosives exhibit two specific characteristics that make them suitable for military use; they either deflagrate or they detonate.

Deflagration

The tendency of a substance to burn with a rapid and sparkling combustion is *deflagration*. If a particle of an explosive is subjected to enough heat to increase its temperature rapidly, a point is reached at which the heat causes decomposition.

If an explosive is composed of finely divided particles, all the particles can deflagrate almost at the same time. In this case, the confinement of the particles within the mass of the explosive increases the pressure. An increase in pressure, in turn, increases the rate of reaction and temperature.

The final effect of deflagration under confinement is *explosion*, which may be violent deflagration or even detonation. In low explosives, such as loose black powder and pyrotechnic compositions, only violent deflagration can take place.

Detonation

In most cases, a confined explosive that is heated will detonate. Confinement is essential to detonation and is part of the theory of detonation. The theory is based on the physical theories of shock waves and the chemical theory of reaction rates in explosives under complete confinement. The explosive is confined by a container (a bomb) or is shaped in a cartridge or block with the material near the center of the mass confined, as in demolition explosives.

Figure 1–1 shows the detonation process. After the detonator functions, a “detonation zone” in which the chemical reaction is taking place travels through the column of explosive. This detonation zone is generally considered to include a very narrow “shock zone” or “shock wave.” While the chemical reaction at this point is only slight, the pressure produced reaches its peak. The *detonation zone* includes this shock zone and the “chemical reaction zone.”

Following the detonation zone are the “detonation products”: heat, light, gases, and great pressure. In front of the shock zone is the unreacted explosive. At or near the beginning of the chemical reaction zone, the chemical reaction is initiated by the high temperature the material is raised to by compression in the shock zone.

Maximum density and pressure occur at the beginning of the reaction zone, while the temperature and velocity reach their peak at the completion of the chemical reaction. The detonation products flow with great velocity (but less than in the detonation zone) toward the undetonated explosive. This is characteristic of detonation and in contrast to deflagration, in which the reaction products flow away from the unreacted material. The velocity of the detonation zone’s advance is the *detonation rate*.

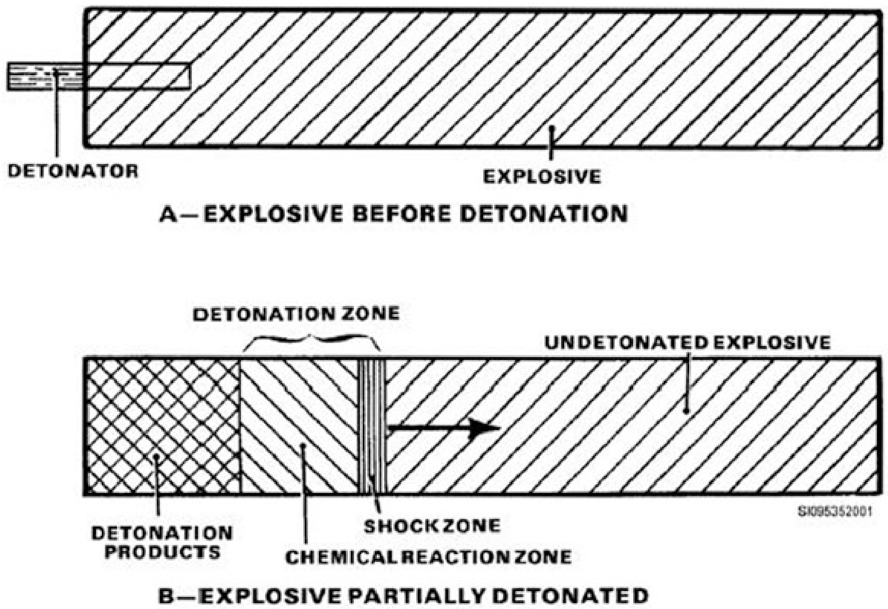

Figure 1–1. Detonation process.

The *rate of detonation* of an explosive with an adequate initiator or booster explosive depends on its degree of confinement and loading density. A cylindrical column of HE detonates at a lower rate when it is confined in a cardboard or glass tube than it does when confined in a heavy steel tube. The reason for the lower rate is that energy is lost in all directions at right angles to the axis of the column.

We see the same effect if the diameter of the column of explosive is decreased. In the smaller diameter—also depending upon the degree of confinement—the detonation cannot propagate (spread and affect a greater area) itself throughout the length of the column of explosive. In practice, detonation rates are determined by the use of explosive columns that are at least 1 inch in diameter and encased in steel tubing. A decrease in loading density causes a decrease in the rate of detonation, and vice versa.

Each explosive has its own rate of detonation for a given density. Although in the least sensitive explosives, the size of the explosive particles has some effect on the detonation rate. If an explosive is not properly initiated or becomes insensitive, a detonation wave can sometimes progress through it at less than its normal rate.

202. Basic explosive trains

An *explosive train* consists of elements arranged according to *decreasing sensitivity and increasing potency*. A very basic explosive train consists of a detonator, a booster, and a bursting charge. The more sophisticated may employ any or all of these. So, let's look at other explosive train components in addition to the basic components. The table below covers the primer, detonator, delay, and booster charge and is followed by a discussion of the bursting charge.

Explosive Train Components	
Component	**Description**
Primer	A primer is a relatively small and sensitive initial component that, upon actuation, begins the functioning of the explosive train. The primer is usually so small that it cannot reliably initiate the main charge. In general, we classify the primer by the way it is initiated, such as percussion, electric, or friction.
Detonator	A detonator is activated either by a primer or by a non-explosive impulse. The detonator initiates the next larger components of the explosive train. When a non-

Explosive Train Components	
Component	**Description**
	explosive impulse initiates the detonator, the detonator also functions as the primer; hence, we sometimes use the term “primer-detonator.” As with primers, we usually classify detonators according to their method of initiation.
Delay	A delay controls the time delay in the functioning of the explosive train.
Booster charge	The component that finally accomplishes the purpose of the explosive train (detonates the main charge) is the booster. The booster amplifies the detonation received from the detonator.

Bursting charge

The bursting charge is the final explosive train component that produces the tactical result. Three components are essential to any high-explosive train:

- Detonator.
- Booster.
- Bursting charge.

When the detonator is initiated, it sets up a high-explosive wave but this detonation is so small and weak that it cannot initiate the bursting charge unless a booster is placed between the two. The inability of a detonator to initiate the bursting charge is illustrated in figure 1–2 (A). The shock wave produced by the detonator is not powerful enough. In figure 1–2 (B), you can see that the booster placed between the detonator and the bursting charge amplifies the shock wave enough to do the job.

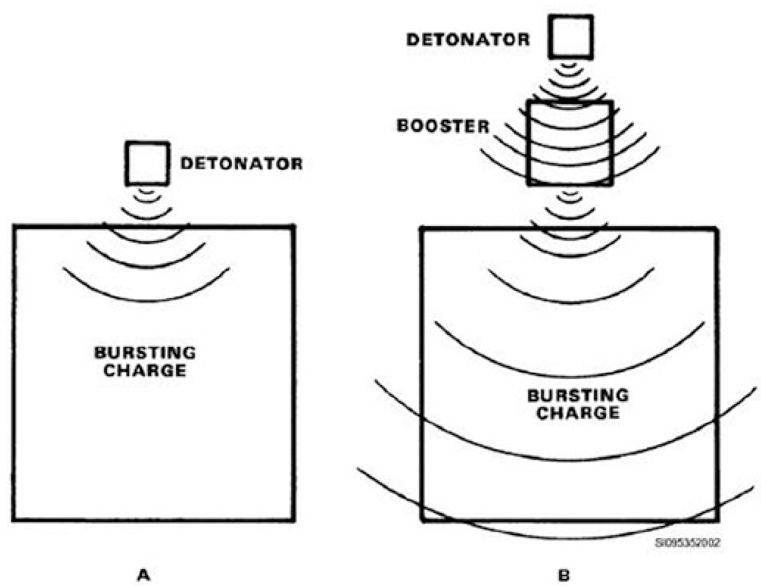

Figure 1–2. Detonation wave effect amplified by a booster.

To be effective, a munition must function at the time and place required by the tactical mission. The action desired may be an airburst, a ground impact burst, or a burst after the target is penetrated. To gain the necessary controls, other components are added to the basic detonator, booster, and bursting charge. A primer, delay, upper detonator, or any combination of these may be used.

Figure 1–3 shows the basic high-explosive train; parts B, C, and D of the figure show how other high-explosive trains are modified.

Modified HE Trains	
HE Train	**Description**
Time action	With a *time action HE train* (fig. 1–3 B), we can get an airburst by placing a primer (which is fired when the bomb is dropped) and a black powder, time-delay train in front of the basic chain. The primer ignites the time train (delay), which burns for a predetermined length of time and then initiates the action of the detonator, booster, and bursting charge.
Superquick action	A *superquick action HE train* (fig. 1–3 C) detonates the munition immediately upon impact with the ground. We usually get this quick action by placing an upper detonator and flash tube at the front of the fuze train and a lower detonator near the booster charge. In this way, the detonating wave is transmitted instantly to the bursting charge.
Delay action	A *delay action HE train* (fig. 1–3 D) penetrates the target before the bursting charge detonates. Placing a clock-like mechanism ahead of the detonator produces the delay action. In some cases, the primer/delay combination is inserted between an upper and lower detonator.

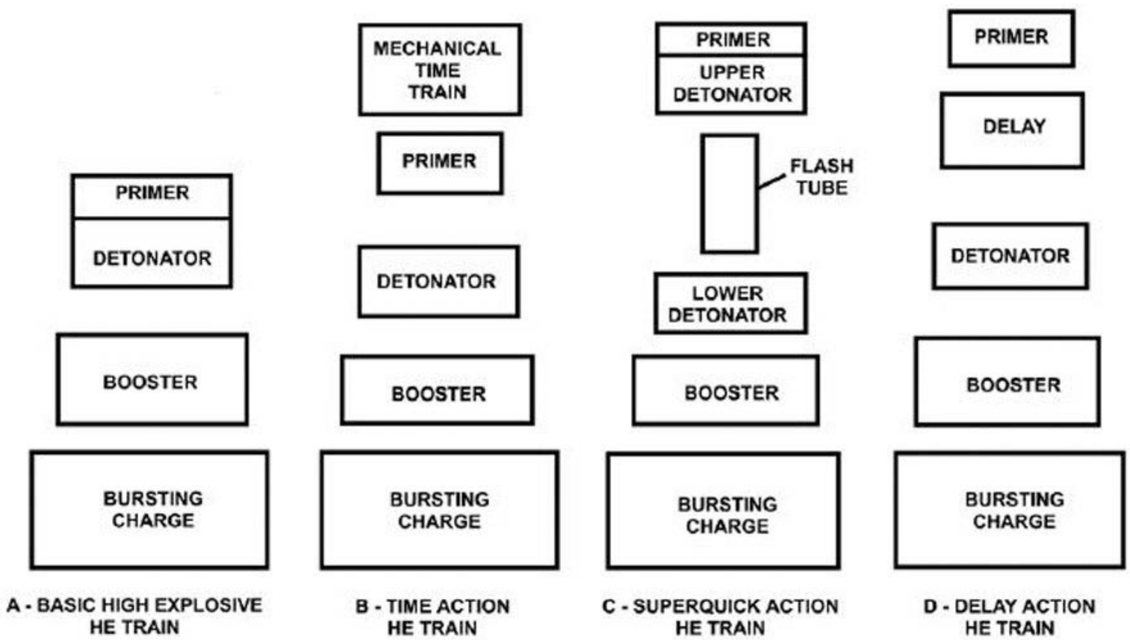

Figure 1–3. High-explosive trains.

Explosive effects

For an explosive to be effective, it must meet the desired result. Different types of munitions provide different types of effects. Two effects achieved are the blast effect and the penetration (Munroe) effect.

Blast effect

The blast effect from a HE bomb can do considerably more damage than the fragmentation effect of the same bomb. True, the rupturing of the bomb casing hurls fragments of steel through the air, providing an effective weapon against personnel, vehicles, aircraft, and other exposed objects.

However, the fragments cause only damage, such as holes in walls and roofs, broken machinery, and so forth, at the point of impact. In contrast, the blast effects compare with those of an earthquake: overthrowing walls, collapsing roofs, and generally destroying everything within range.

It is interesting to note that nearly every other military HE has a greater blast effect than TNT. A munition with a filler of one of these other explosives (tritonal, for example) is likely to be selected for use against a target of substantial construction.

Munroe effect

The *Munroe effect*, otherwise known as the shaped-charge effect, was developed by a chemist named Charles E. Munroe. Munroe discovered that manipulating the shape of an explosive charge along with the distance between the charge and the target would increase the penetrating effect. Munroe found that if a block of nitrocellulose with letters countersunk into its surface is detonated with the lettered surface against a steel plate, the letters are indented into the plate. On the other hand, if the letters were raised above the surface of the nitrocellulose, the detonation reproduced the letters in relief on a steel plate.

Munroe found that by increasing the distance between the explosive and the steel plate (the *standoff distance*) he could gain an even greater penetrating effect. This shaped-charge effect is used in munitions to blast holes in solid targets like hardened structures and tanks. This hole usually becomes the conduit for an explosive blast.

A shaped charge consists of the components illustrated in figure 1–4. The cone liner may be metal, glass, or other inert material. If no cone liner is used, the charge still has nearly the same effect as a lined charge providing the charge is in direct contact with the target.

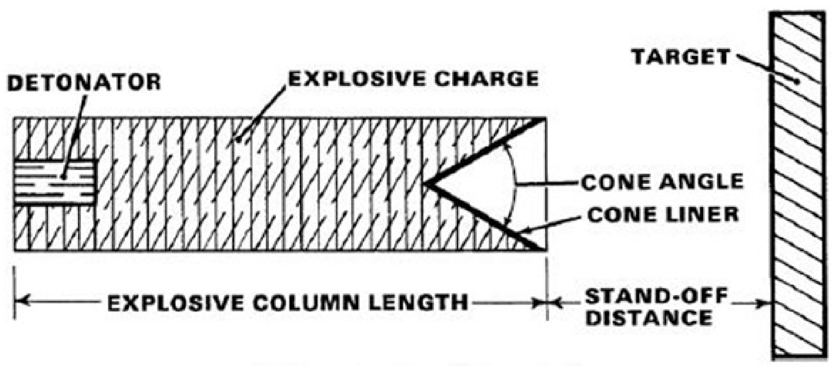

Figure 1–4. Typical shaped charge.

The penetrating action of the shaped charge is the result of the shock wave and a jet of dense gas, which is directed by the shape of the explosive charge and moving with great velocity. By increasing the standoff distance, we increase the penetrating capability of the explosive. This is caused by a jet of gas that is formed by the cone liner and explosive products after explosive detonation occurs.

The penetrating capability increases up to an "optimum point" that is largely determined by the type of linear material and explosive used. After the optimum point is reached, penetrating capability decreases because the jet has time to lose strength and dissipate.

The type of explosive used in the charge is important. TNT has little penetrating effect as a shaped charge, while composition (comp) B and pentolite prove to be quite effective in that function. The Munroe effect, also called the shaped-charge effect, is used in artillery shells, rocket warheads, demolition charges, and antitank mines.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

201. Explosive characteristics

1. What explosive do we use as the comparison for measuring explosive power?

2. What general requirements must material used to manufacture military explosives meet?

3. What is the *brisance* of a military explosive?

4. What term describes the tendency of a substance to produce vapors?

5. When a military explosive does *not* react with the metal that encases it or with another explosive, it is said to have what characteristic?

6. What is meant by *explosive toxicity*?

7. What is *hygroscopicity*?

8. What is the autocombustion rate of low explosives?

9. What term do we use to describe the tendency of a substance to burn with a rapid and sparkling combustion?

10. What condition is *essential for an explosive to detonate* rather than to merely deflagrate?

202. Basic explosive trains

1. What are the basic components of an explosive train?

2. What is the relatively small and sensitive initial component that begins the functioning of the explosive train?

3. What are the two means by which we can activate a detonator?

4. What is the purpose of a delay in an explosive train?

5. What does an explosive *booster* do?

6. Which effect of a general-purpose bomb does the most damage: blast or fragmentation?

7. What effect causes greater penetration of the explosive charge?

8. What happens when you increase the standoff distance of an explosive?

1–2. Pyrotechnics

Pyrotechnic ammunition is a modification of the familiar Fourth of July fireworks, producing colored lights and smoke for signaling purposes. It is used for sending messages from one aircraft to another, from an aircraft to ground units, from one ground installation to another, or from a ground installation to an aircraft in flight. Pyrotechnic ammunition also marks a location, provides cover, or simulates combat.

203. Characteristics

Because there are so many different types of pyrotechnics within the Air Force, it is best that we begin by covering the general characteristics before describing each type you inspect, handle, and store. We'll take a look at visibility, classification, identification, and inspection. Let's begin with visibility.

Visibility

Four factors control the visibility of pyrotechnics: (1) candlepower, (2) color, (3) weather, and (4) light.

Pyrotechnic Visibility Factors	
Factor	**Description**
Candlepower	Candlepower is the amount of light generated by the burning of the pyrotechnics. As the candlepower increases, the range of visibility increases if other factors are constant.
Color	The color of the flame also affects the range of visibility. For example, red, which has a short wavelength, is absorbed by air more quickly than green, which has a longer wavelength.
Weather	Weather has a notable effect on the visibility of pyrotechnics because excessive moisture in the air and rain reduces the range considerably. An extreme example is that a signal that is visible for miles in clear weather might be visible for less than a hundred yards during a rainstorm.
Light	The amount of surrounding light also affects the signal's visibility. With other factors equal, no signal can be seen as far in daylight as it can at night.

Classification

Pyrotechnics are classified according to their purpose as illuminants (photoflash cartridges and flares), signals, combinations of signals and illuminants, and simulators. Other types of ammunition are modified for a pyrotechnic effect (for example, illuminating projectiles) but the item generally falls into one of these four pyrotechnic classes: photoflash cartridges, flares, signals, and simulators—described in the following table.

Pyrotechnic Classifications	
Classification	**Description**
Photoflash cartridges	Photoflash cartridges produce a single flash of light for photography. A cartridge is a single source of illumination that is generally of high candlepower and substantial duration.
Flares	Flares may be parachute-supported, towed, or stationary. While their primary function is illumination, they can be used for identification, ignition, locating positions and targets by producing infrared (IR) energy to draw off enemy missiles, or warning of enemy action.
Signals	Signals are classified according to their effect—light and smoke. A single model may produce both effects.
Simulators	Simulators are training devices that imitate the actual battle sounds and flashes of light produced by combat ammunition.

Identification

You can identify pyrotechnic ammunition by its nomenclature, lot number, model designation, painting, marking, national stock number, and Department of Defense identification code. Most of this information is on the data card that accompanies the munition item from the manufacturer. Pyrotechnics are usually painted white, except for those with an (unpainted) outer case of aluminum or plastic. Pyrotechnics, in general, are marked in black lettering. Signals are marked with colored bands, letters, or patches to indicate the color of the signal produced. Most pyrotechnic items are in Federal Supply Classification 1370.

Inspection

Inspections are performed to ensure serviceability of all pyrotechnics. Inspections are made for all pyrotechnics immediately prior to issue and when maintained in storage. Inspections are visual only as the main objective is to identify discrepancies, not repair them. No maintenance actions will be taken unless specific directions are received from the competent authorities (appropriate MAJCOM or Air Logistics Center). These pyrotechnic inspections include: receiving inspections (RI), shipping inspections (SI), periodic inspections (PI), special inspections (SPI), pre-issue inspections (PII), returned munitions inspections (RMI), and storage monitoring inspections (SMI). When defects are discovered with any pyrotechnic item, it will be classified in accordance with the defects table from the appropriate 11A10–(series) Technical Order and will be segregated, marked/identified as defective, scheduled for maintenance, or reported for disposition in accordance with AFI 21–201.

204. Signal flares (smoke and illumination)

Light producing signals are much smaller and faster burning than flares and consist of a single parachute supported star or one to five freely falling stars, with or without colored tracers. Smoke signals are of either the slow burning, streamer type, which leaves a trail of smoke, or the parachute suspended type, which produces a cloud of smoke. Signals have many different uses: signaling from air-to-air, air-to-surface, surface-to-air, or surface-to-surface under day or night conditions. Most are small and can be packed and carried conveniently in the pockets of the life vests and flight suits of aircrew personnel.

Aircraft smoke and illumination signal, AN–MK6 Mod 3

The AN–MK6 Mod 3 signal provides long burning surface smoke and illumination for day and night use. This signal uses a pull friction igniter, which is covered by adhesive tape and located in the center of the tail end of the body.

The AN–MK6 Mod 3 signal actuates by a sharp pull, either by hand or by a lanyard attached to an aircraft. The igniter charge initiates the first fire decomposition of the first candle. When the candle begins to burn, the resulting gas pressure forces the metal cap out of the escape hole and breaks the adhesive tape, allowing gases to escape and burn. As the first candle burns out, a fuse is ignited, which ignites the next candle. The ignition process is repeated until all four (4) units burn out. The total burning time is approximately 40 minutes.

Marine smoke and illumination signal, AN–MK13 Mod 0

This marine smoke and illumination signal (fig. 1–5) can be used in either day or night conditions. The smoke composition burns for about 18 seconds; the flare burns for 20 seconds at 3,000 candlepower. A soldered cap closes each end of the tube with a pull ring attached. Pulling on the pull ring removes the soldered closing cap and pulls a brass wire through a small cup of friction-igniting composition. The igniting composition ignites and, in turn, ignites the flare composition or the smoke mixture depending on which pull ring is actuated. The AN–MK13 Mod 0 signal is very small (5.125 inches long and 1.63 inches in diameter). These signals are not ignited simultaneously, but the second can be lit after the first burns out. The AN–MK13 Mod 0 signal is designed to be hand held while it is burning. The primary reason for this feature is to enable a downed pilot to be able to tread water while holding the flare instead of allowing it to sink into the water.

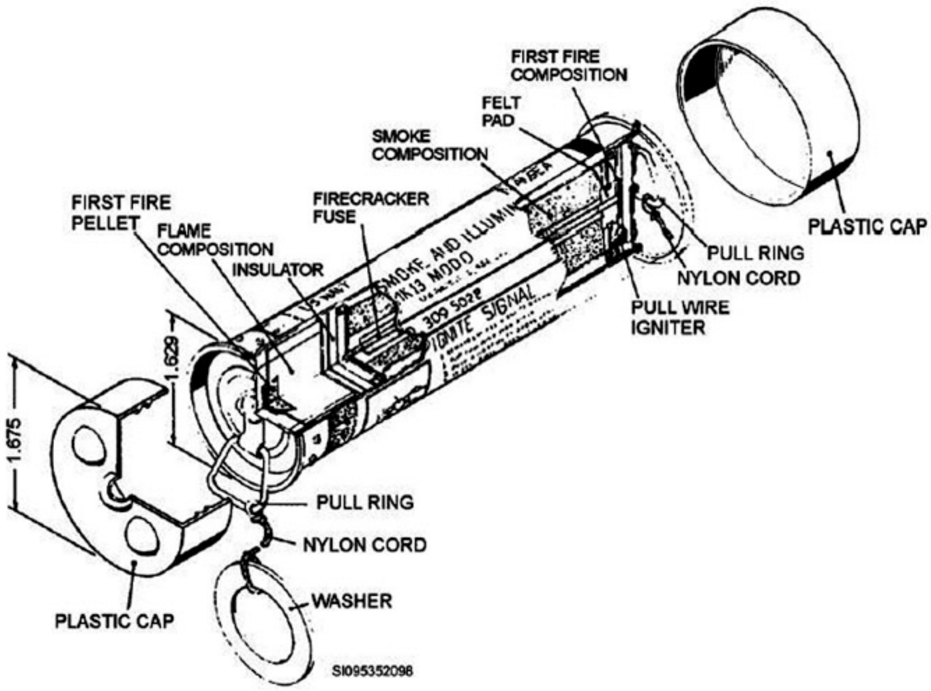

Figure 1–5. Smoke and illumination signal, AN–MK13 Mod 0.

Signal smoke and illumination, marine, MK124 Mod 0

The MK124 Mod 0 is intended for rescue signaling, either day or night, on land or sea. It can be operated with one hand; its weight and size enable it to be carried in life vests or flight-suit pockets and on life rafts. Its aluminum case has a protective cap at each end (fig. 1–6), with two embossed rings around its circumference on the flare (night) end. A label on the outer surface further identifies the smoke (day) and flare (night) end and provides precise instructions for use. The case contains four subassemblies: smoke candle, smoke igniter, flare candle, and flare igniter. The igniters consist of a mousetrap-type firing pin and arming lever that must be extended before functioning. Pressing the extended lever (armed position) cocks and releases the firing pin, letting the striker (firing pin) hit the primer and igniting the flare candle or the smoke candle.

Personnel distress signal kit, A/P 25S–1

Aircrews carry this distress signal kit as personal equipment for emergency signaling. It consists of a seven-signal bandolier and projector. The bandolier's seven signals are attached in a row by pressure-sensitive cloth tape that has an eyelet with a 40-inch nylon cord at one end and descriptive markings at the other end. Each signal is an anodized, red-dyed, aluminum case containing a pyrotechnic candle, an expelling charge, and a primer. The primer end is threaded for installation in the projector. A plastic cap covers the threaded primer end; the date of manufacture is painted in black letters at the opposite end.

The projector is a black, anodized-aluminum case threaded internally at one end to receive the signal. A round trigger-screw protrudes from the side of the case in an offshoot slot; a 24-inch nylon cord is attached to a swivel at the other end.

To operate the signal, release the trigger-screw from the offshoot slot. This causes the firing pin to strike the primer on the case of the signal. The primer ignites a black-powder propelling charge, which ignites the first-fire composition of the star and propels the star to the right height. The signal produces a red display at a minimum height of 300 feet for 5 seconds.

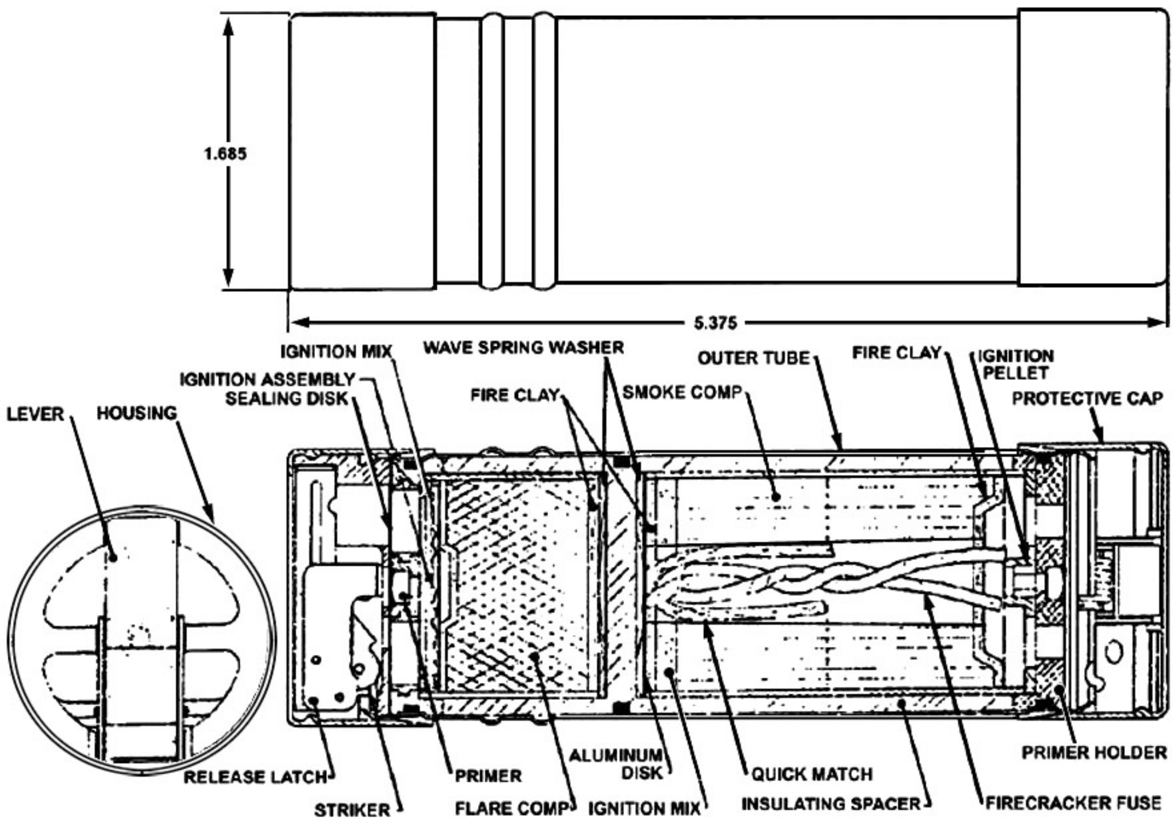

Figure 1–6. MK124 Mod 0 signal smoke and illumination.

Personnel distress signal kit, A/P 25S–5A

The A/P 25S–5A distress signal kit (fig. 1–7) consists of a launcher assembly, bandolier assembly, signal, and instruction sheet in a plastic bag. The handheld launcher assembly has a knurled handle, a signal hold-down device, and a firing pin with an actuation knob and a spring. A lanyard is attached to the knurled end of the launcher. The molded plastic bandolier assembly protects the seven signals.

The signal consists of a small rocket motor actuated by a percussion primer, a delay element, and a pyrotechnic candle in a metal case. The signal is red, green, or white to indicate the color of its pyrotechnic candle. The basic kit has a red signal, but you can get bandoliers of red, green, or white signals (without launchers). The instruction sheet provides operating instructions and warnings.

Unlike the A/P 25S–1, the A/P 25S–5A is designed to launch a pyrotechnic signal that will penetrate a heavy foliage canopy and deliver an illuminating display up to a minimum altitude of 700 feet and a maximum of 1,250 feet. A firing pin initiates a *percussion primer,* which, in turn, ignites the rocket propellant. Gases exhausting through the canted nozzles furnish propulsion and spin stabilization. The delay composition allows time for the signal to reach the desired altitude before the candle ignites and separates from the rocket motor. The signal display lasts about 9 seconds.

Ground-illumination signal, white star parachute, M127A1

The M127A1 signal is rocket propelled and fin stabilized. The handheld expendable launcher is integral with the signal. The signal produces a parachute-suspended white star. The candle, parachute, and expelling charge are contained within a tube that is affixed to the rocket motor and fin assembly. The launcher tube contains a primer and an initiating charge. A firing cap is stored on the ejection end of the signal and must be removed and placed on the opposite end of the signal prior to operation.

When the primer is fired, the initiating charge is ignited and propels the signal to a distance approximately 20 feet from the launcher. The initiating charge is relatively small and produces a slight recoil. As the signal is expelled, four flexible steel fins unfold to stabilize the rocket, which was ignited by the gases of the initiating charge. After attaining a maximum height of 650 to 700 feet, the parachute and candle are expelled—the candle being ignited through a pyrotechnic train by the expelling charge and rocket motor. The M127A1 produces 50,000 candlepower, descends at 10 to 15 feet-per-second, and burns for 36 seconds.

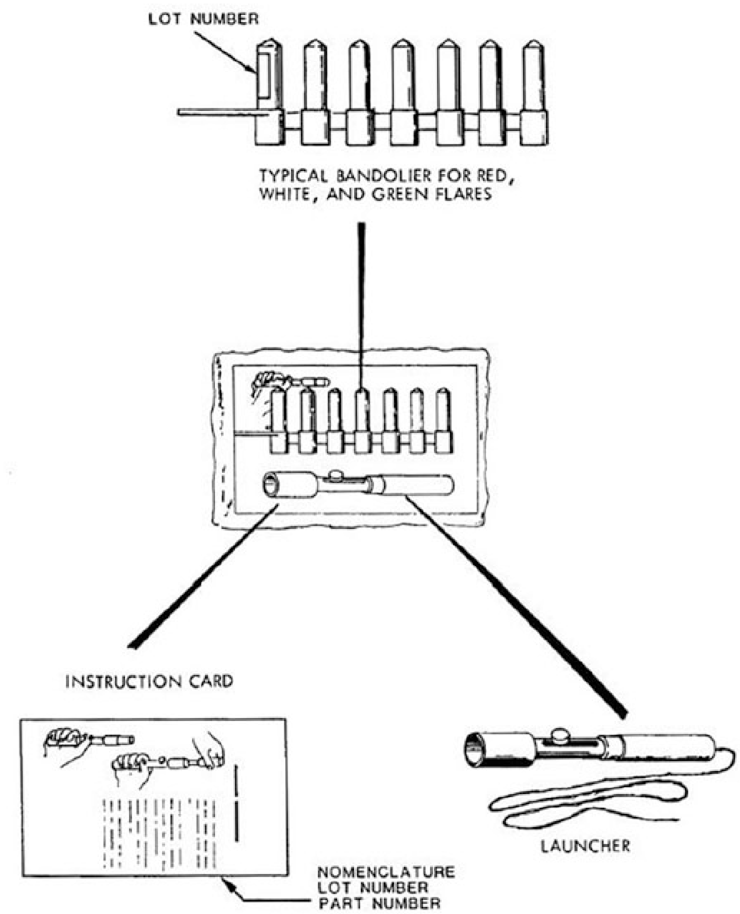

Figure 1–7. A/P 25S–5A personnel distress kit.

Ground-illumination signal, red star parachute, M131

The M131 signal is a rocket propelled, spin-stabilized signal that is fired from a handheld expendable launcher. As issued, the M131 signal is assembled within two tubes. The outer tube essentially is a sealed, waterproof container. The inner tube, after removal of the metal cap and the outer tube, serves as an expendable launcher. The signal consists of five main assemblies: launcher, igniter, delay, parachute, and illuminant composition. When fired, the M131 signal attains an altitude of 1,500 feet and produces a parachute-supported, single red star that burns for 30 seconds and is identifiable at distances up to 30 or 35 miles. The M131 is designed to produce a distinctive red light above ground fog, haze, or overcast; such conditions are commonly encountered in arctic regions.

Decoy flare, MK50 Mod 0

This pyrotechnic countermeasure device is encased in a typical aircraft illumination signal cartridge case. It uses a percussion primer and a black-powder expelling charge. The MK50 Mod 0 decoy flare is fired from an AN–M8 pyrotechnic pistol. The smoke and/or fumes of a burning MK50 Mod 0 decoy flare contain highly toxic fluoride compounds. If a flare ignites in a confined space, the toxic fumes may cause metal and/or polymer fume fever. A protective mask and butyl rubber gloves must be available during handling of the MK50 Mod 0 flare.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

203. Characteristics

1. What are the four factors that control the *visibility* of pyrotechnics?

2. What type of weather reduces the visibility range of pyrotechnics?

3. How do we classify pyrotechnics?

4. What are the two effects of signals?

5. How can you identify pyrotechnic ammunition?

204. Signal flares (smoke and illumination)

1. What is the total burn-time for the AN–MK6 Mod 3 signal?

2. What is the candlepower rating of the AN–MK13 flare?

3. Which day/night signal is designed to be used with only one hand?

4. What is the A/P 25S–5A distress kit designed to do that the A/P 25S–1 is not?

5. What is the candlepower of the M127A1 ground illumination signal?

6. What are the five main assemblies of the M131 ground illumination signal?

7. What is the M131 signal designed to do?

8. What safety equipment is required for handling the MK50 Mod 0 flare?

1–3. Air Base Ground Defense Munitions

In these times of sophisticated and complex aircraft munitions, we sometimes forget that a few of the older, simpler munitions are still very much a part of our arsenal of weapons. Our effectiveness as a combat unit would be wasted if, upon return from the first mission of the war, our pilots returned to an enemy controlled base. To ensure that does not happen we must be prepared to defend ourselves and the valuable resources we need to conduct the war. Small arms, grenades, and mines are the basic munitions items needed to prepare/defend against an enemy. The purpose of this section is to familiarize you with these munitions.

205. Small arms ammunition

The Air Force uses many types of small arms weapons, including revolvers, rifles, carbines, shotguns, and automatic weapons. As you might suspect, most of these weapons fire several different types of ammunition according to the tactical situation. The problem of keeping abreast of all the ammunition currently in use is substantial. This lesson deals with the various types of small-arms ammunition and their components.

Classification of small-arms ammunition

In the military, weapons with a bore diameter (inside diameter of the barrel) of 0.50 inch or less, are classified as “small arms.” The types of small arms currently in the Air Force inventory (and their principal uses) are listed in the table below.

AF Small Arms Inventory	
Type	**Use**
Caliber .22	Training and Survival
Caliber .30	Combat
Caliber .38	Sidearm
Caliber .50	Combat
5.56 millimeter (mm)	Combat
7.62 mm	Combat
9.00 mm	Sidearm
.410-gauge shotgun	Survival
12-gauge shotgun	Combat, Police, and Guard

NOTE: We use the terms “caliber” and “gauge” to measure small-arms weapons and ammunition.

Caliber

The caliber of a weapon is the diameter of its bore measured between opposite lands and expressed in inches or mm. When the caliber is expressed as a decimal without the unit, inches is understood. For example, a .50 caliber bullet is about .50 inch in diameter, not .50 millimeter in diameter. The lands of the rifling of a weapon are the raised spiral parts of the rifling formed by steel grooves, usually 0.003 or 0.004 inch deep, which are cut into the surface of the bore. The diameter of a lead alloy bullet is generally 0.003 inch greater than the bore diameter between the grooves. The diameter of a jacketed bullet should not be more than 0.001 inch greater than the diameter between the grooves.

Gauge

This term refers to shotgun ammunition gauges. Simply put, gauging is the process we use to determine a number value for diameter of the bore; that is, how many lead balls the same diameter as the gun's bore equal 1 pound. A 12-gauge shotgun is called this because its bore is 0.729 inch and 12 lead balls that weigh 1 pound.

The .410 shotgun is the only exception to gauging. We measure its bore diameter the same way we measure other small-arms ammunition. Thus, a .410 shotgun cartridge is fired from a bore with a diameter of 0.410 inch.

NOTE: All shotgun ammunition is classified as "small-arms ammunition."

Combat ammunition

Combat ammunition is a large category with several subtypes, such as armor-piercing (AP), armor-piercing incendiary (API), armor-piercing incendiary-tracer (APIT), ball, grenade, incendiary, shotgun cartridges, spotter-tracer, and tracer. These are described more fully in the following table.

Combat Ammunition

Type	Description
AP	This cartridge is designed for use against aircraft and armored vehicles, concrete shelters, and similar bullet-resisting targets. AP bullets are jacketed and have a core of hardened steel, which may be of tungsten-chromium or manganese-molybdenum steel. The 7.62 mm AP bullet has both a point and a base filler of lead antimony. These bullets have smooth cannelures cut into the jacket for crimping the cartridge case. The tips of AP bullets are painted black for identification.
API	This cartridge is used in 50-caliber weapons as a combination cartridge in lieu of the separate AP and incendiary cartridges. The bullets have a hardened steel core and a point filler of incendiary mixture instead of lead. API cartridges have silver-tipped bullets.
APIT	This type of cartridge is also used in 50-caliber weapons. The bullets are similar to the API bullets except they also have a tracer composition in the base end. The APIT small-arms round can be identified by its red bullet tip with a silver ring or annulus behind it.
Ball	The ball cartridge, which is intended for use against personnel and light materiel targets, is the oldest service type. Ball bullets are metal jacketed, with cores or slugs of various compositions, depending on the intended use. Most metal jacketed ball bullets have a lead-antimony slug. The ball cartridge bullet is unpainted.
Grenade	Grenade cartridges are special blank cartridges used to propel grenades and ground signals from launchers attached to rifles or carbines. We can identify them by a rose-petal crimp at the mouth of the case.

Combat Ammunition	
Type	**Description**
Incendiary	This cartridge is similar to ball or AP ammunition in outward appearance. It is used for incendiary purposes against aircraft and flammable targets. The bullets contain a core incendiary mixture with a lead-antimony slug at the base end. Its blue tipped bullet identifies the incendiary cartridge.
Spotter-tracer	The M48 (.50 cal) spotter-tracer bullet contains a tracer element and an incendiary charge that emits a puff of smoke and a flash on impact with the target.
Tracer	The tracer cartridge is used with other types of ammunition to illuminate a gunner's path of the bullets, thus helping correct the gunner's aim. It can also be used for incendiary purposes. The burning propellant gases ignite an igniter composition that, in turn, ignites the tracer composition. Some tracer bullets are visible the instant of firing, while others have a dim trace for a short distance from the muzzle of the gun and then a bright trace thereafter. You can identify a tracer round by its orange- or red-colored bullet tip.

Noncombat ammunition

Noncombat ammunition is a category of ammunition used for testing weapons and special training (i.e., blank, dummy, high-pressure test, match, and miscellaneous small arms cartridges). The following table provides more information about these ammunition types.

Noncombat Ammunition	
Type	**Description**
Blank	The blank cartridge has no bullet. It is used for simulated fire, in maneuvers, and for firing salutes. It is also used in machine guns equipped with blank firing attachments when those weapons are operated for instructional purposes. Extruded case blank fire propellant is used to produce the noise. Even though these rounds do not contain a "projectile," the noise, flash, and the wad used to hold the propellant can cause injury or death.
Dummy	Dummy rounds are primarily used to practice loading weapon systems and for aircrew training purposes. • The older type of dummy ammunition has a tin coating. • The newer type has holes drilled through the sides of the case and an empty primer pocket.
High-pressure test	This ammunition produces higher pressures than those specified for the corresponding combat round. It is used to proof-fire weapons after manufacture and to test weapons after repairs. Because of the high pressure developed and the danger involved in firing it, only authorized personnel and mechanical firing devices can fire the weapon under test from fixed rests under hoods.
Match	This cartridge is used in marksmanship competition. Match ammunition is manufactured to more exact standards than regular rounds and is available for rifles, revolvers, and pistols.
Miscellaneous small-arms cartridges	Other types of noncombat cartridges for special or auxiliary purposes include caliber .38 special cartridges, caliber .38 tracer rounds, and caliber .45 blank line-throwing cartridges for use in the Navy line-throwing gun.

Components of small-arms ammunition

A small-arms cartridge is a complete assembly of all components necessary to fire the weapon once. Usually a cartridge consists of a cartridge case, primer, bullet, and propellant. The four components of a small arms cartridge are shown in figure 1–8. A shotgun cartridge differs because it contains shot, pellets, or a single slug inside the cartridge which does not protrude from the mouth of the case.

A *cartridge case* is a container designed to hold a primer and propellant, which may have a bullet affixed. Its profile and size conform to the chamber of the weapon. The cartridge case is fashioned from a circular brass disk punched into the form of a cup and drawn into shape through successive dies. The closed end is pressed to form the head which forms the primer pocket and vent. An extracting groove machined around the head provides a grip for the weapon's mechanical extractor.

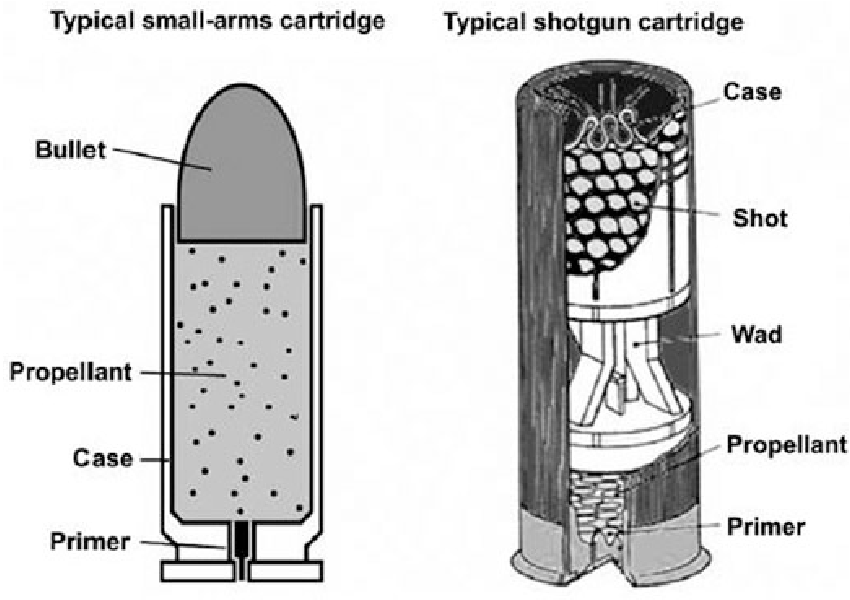

Figure 1–8. Typical small-arm cartridge components.

Typical cartridge case for rifled weapons

Before studying the cartridge case further, take a look at the names for the various parts of the cartridge in the following table.

Parts of the Cartridge	
Parts	**Description**
Mouth	The opening for inserting the bullet and propellant.
Lip	The edge around the mouth.
Neck	The area from the lip to the shoulder of the cartridge case that holds the bullet in place.
Shoulder	The tapered section at the base of the neck; it provides a greater powder capacity with a shorter overall length.
Body	The section between the shoulder and the rear of the case.
Head	The part at the base of the cartridge case that includes the extracting groove, primer pocket, and primer vent.
Extracting groove	The recess cut in the head of the case for removing (extracting) the cartridge.
Primer pocket	The recess punched in the center of the head, which provides a pocket for a primer.

Parts of the Cartridge	
Parts	**Description**
Primer vent	The hole from the primer pocket into the propellant cavity that lets the flame or spark enter and ignite the propellant.
Propellant cavity	The hollow inside the cartridge case that holds the propellant.
Wall	The sides of the cartridge.

The cartridge case serves three functions. First, it is the receptacle in which the other components (primer, propellant, and bullet) are assembled. Second, it is a waterproof container for the primer and propellant. Third, it expands, seals, and prevents the escape of gases to the rear when the weapon is fired.

The *propelling charge* is in the main body of the cartridge case and is measured by weight. The weight of the charge in the same type of ammunition may vary because each lot of manufactured powder varies slightly in characteristics. You may need to use 15 grains of one lot of powder and 17 grains of another lot to get the same bullet velocity within the prescribed limits of chamber pressure.

The table below provides more detailed information about the cartridge case components.

Cartridge Case Components	
Component	**Description**
Bullet	The bullet, which is located in the front (neck) of the cartridge case, is the part that is forced out of the barrel of the weapon and sent toward the target. The term “ball” was used to describe the bullet in early small-arms ammunition because the bullet was actually a ball. With the advent of rifled weapons, the modern bullet took on a cylindrical shape, enabling it to engage the rifling and start to spin. This spinning stabilizes the bullet in flight and improves ballistic accuracy. Even a bullet has component parts, which include: the jacket, core, point filler, base filler, and cannelure.
Jacket	The jacket of a bullet is made of gilding metal and serves two purposes. First, the weapon lands cut into the jacket that rotates the bullet. Second, the jacket holds the bullet tightly in the bore to prevent the escape of gas past the bullet.
Core	The core of the bullet, sometimes referred to as the “filler,” may be lead alloy, common steel, hardened steel alloy, a tracer mixture, or an incendiary mixture, depending on the ammunition’s purpose. For example, AP bullets contain a core of hardened steel; either a tungsten-chromium steel or a manganese-molybdenum steel. Except for the 50-caliber ball ammunition (which has a core of soft steel), metal-jacketed ball bullet cores are lead-antimony alloy.
Point filler	The point filler may be lead, antimony-lead, or an incendiary mixture, and is placed between the jacket and core. In AP ammunition, the point filler is an antimony-lead alloy.
Base filler	The base filler, or “base seal,” consists of gilding metal and, in some cases, a tracer or igniter composition. Again, the material used as a base filler depends upon the purpose of the ammunition.
Cannelure	The cannelure is the groove around the bullet; the recess into which the mouth of the

Cartridge Case Components	
Component	**Description**
	cartridge case is crimped during assembly. This holds the bullet and keeps it from being pushed back into the cartridge case when it is handled or fed into a weapon.

Cartridge case for shotguns

The head of a shotgun cartridge is crimped to the cartridge body and reinforced by a base of compressed paper in which the primer pocket is formed. Additional components include a propelling charge, cardboard or felt wads, a load of lead shot, and a closing wad. Some paper or plastic body cartridges have a steel reinforcement under the metal head called the lining. The paper and plastic body cartridges are waterproofed.

Inspection

Inspections are performed to ensure serviceability of all small arms ammunition maintained in storage or issued to fulfill requirements of using organizations. These small arms inspections are limited to visual inspections in accordance with (IAW) the item technical order (TO) and TO 11A–1–10, *Air Force Munitions Surveillance Program and Serviceability Procedures*. Lot/serial numbers will be checked against the Conventional Munitions Restricted or Suspended (CMRS) database located in AMMO and Agile Munitions Support Tool (AMST)-Global Ammunition Control Point (GACP) Web site through the Air Force Portal. Deficiency reports are submitted IAW TO 00–35D–54, *USAF Deficiency Reporting, Investigation, and Resolution.*

206. Grenades

Although grenades are not often used by the Air Force, they are very important to base defense. Grenades used by the Air Force are classified as service, practice, and training.

- The *service grenade* is a combat item filled with a HE or chemical.
- The *practice grenade* simulates the service grenade for training purposes.
- *Training grenades* are completely inert and are used only for handling and throwing practice.

Hand grenades can be placed, thrown, or projected against enemy personnel or equipment to inflict casualties or damage and can also be used for screening and signaling.

Rifle grenades are fin-stabilized projectiles filled with HE or chemicals and can be launched by a rifle with a grenade launcher. A rifle grenade may be used against armor or personnel for screening, signaling, illumination, or incendiary effects.

Service grenades

Service grenades are further classified according to their tactical use as fragmentation, irritant, riot control, screening smoke, signaling smoke, and incendiary. Let’s look at a few typical service grenades.

M26, M26A1, and M26A2 fragmentation hand grenade

This grenade is shaped like a large lemon, with a thin metal body lined with a wire-wound coil in place of the cast iron body used in earlier types of grenades (fig. 1–9). A safety lever, which is curved to fit the shape of the grenade, is attached to the fuze and held in place by a safety pin. The M26-series grenade is filled with 0.39 pound of composition B and is issued with the fuze cocked and ready to fire. An olive-drab body and the half-inch yellow band at the neck identifies all fragmentation grenades.

When the safety pin is removed and the safety lever is released, the striker, driven by the striker spring, forces the safety lever clear. The striker is then free to strike the percussion primer, which emits a small, intense spit of flame and ignites the delay element. The delay element burns for 4 to 5 seconds and initiates the detonator, which explodes to detonate the main charge.

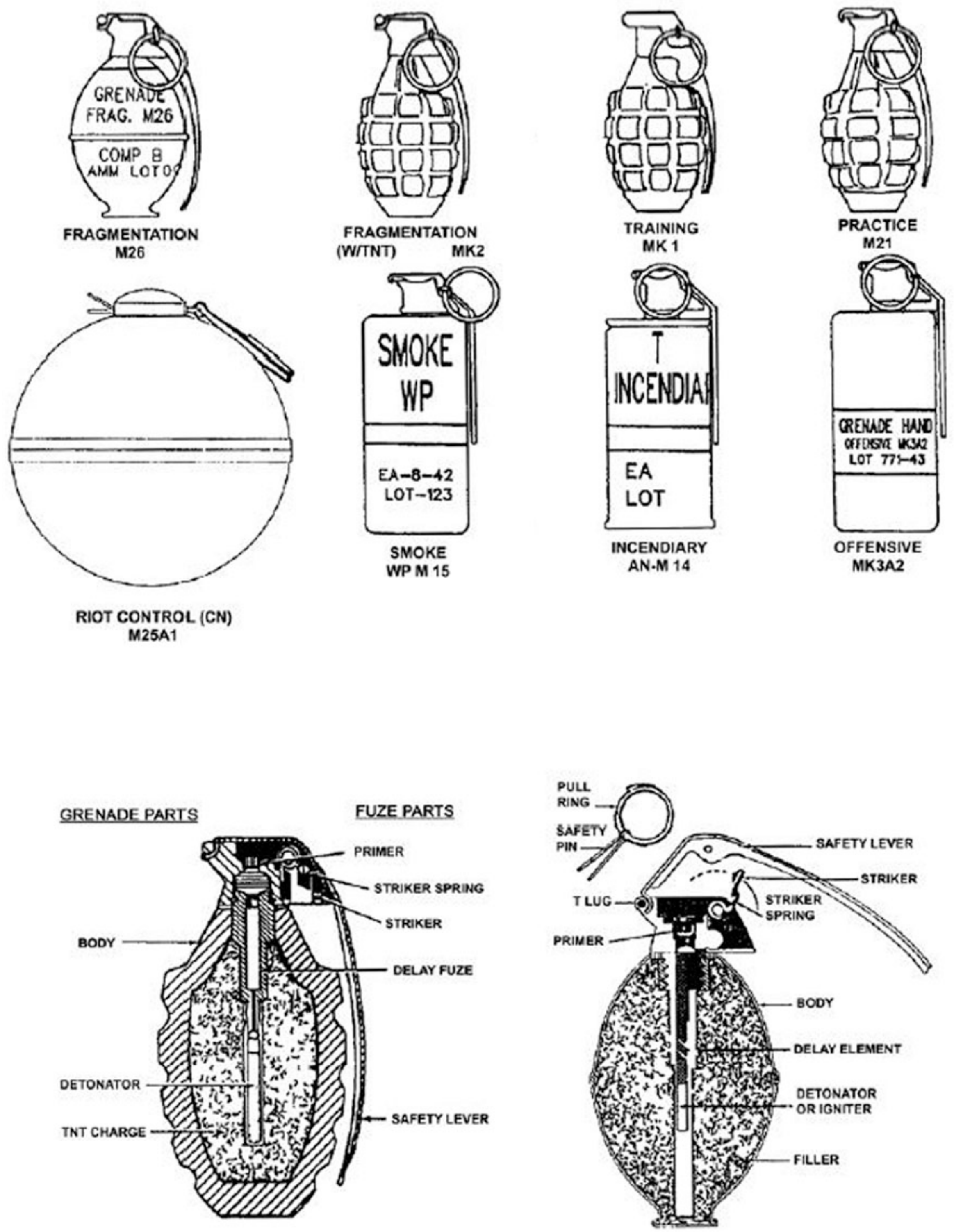

Figure 1–9. Typical hand grenades.

M34 white phosphorous smoke hand and rifle grenades

The M34 white phosphorous (WP) smoke hand and rifle grenade is a bursting, multi-purpose munition used for antipersonnel, screening, and incendiary effects. This grenade is a grooved, cylindrical steel container quite different in shape and design from the M26 grenade you studied earlier. Its base is tapered so that the grenade can be mounted on an M1A2 grenade projection adapter. The body is grooved to ensure uniform breakup of the case. The body holds 15 ounces of WP filler and a detonating fuze. Delay time is 4 to 5 seconds. The bursting charge scatters WP particles over a 40-yard radius; these particles burn for about 60 seconds.

The M34 grenade functions in the same way as the M26 fragmentation grenade except the filler does not detonate. M34 grenades of earlier manufacture were painted gray with a yellow band and yellow markings; current models are light green with a yellow band and light red markings.

M25 riot control hand grenade

This grenade is a special-purpose, bursting munition used to control riots and disturbances. The M25A1 and M25A2 models differ only in the type of filler. The M25A1 is filled with about 3.2 ounces of chloroacetophenone and magnesium oxide. The M25A2 grenade is filled with 3.2 ounces of chloroacetophenone and silica aerogel, or 2 ounces of chloroben-salmalononitrile and silica aerogel, or 2.3 ounces of adamsite and silica aerogel. Chloroacetophenone and magnesium oxide, chloroacetophenone and silica aerogel, and chloroben-salmalononitrile and silica aerogel all cause irritation and watering of the eyes which results in temporary, partial, or total blindness. The adamsite and silica aerogel compound is not a tear agent, but a vomiting agent that causes sneezing, coughing, nausea, and vomiting. Large concentrated doses of adamsite can cause death.

The M25 grenade is identified by a gray body, half-inch red band, and red markings. A detonator-type fuze with a delay of 1.4 to 3.0 seconds is installed in the fuze well. The M25 grenade is issued with the fuze cocked and ready to fire. The grenade functions when the safety pin is removed.

Practice grenades

The M30 practice hand grenade is painted blue to indicate a practice round and has a reusable cast iron body. The grenade resembles the M26 grenade and is used for throwing practice. The M30 fuze has a short length of time. The M30 fuze and a charge of black powder simulate the detonator fuze and the high-explosive charge. The body is recoverable; you can reuse it by installing a new fuze, black-powder charge, and stopper. The grenade functions like the M26, but instead of detonating, the igniter ignites the low-explosive black-powder charge, forcing the stopper from the body and emitting a loud report and small amount of white smoke.

Smoke grenades

Smoke grenades produce smoke for screening friendly forces from enemy observation or as a signal to mark locations (e.g., enemy locations, friendly forces positions, and helicopter landing zones).

AN–M8 smoke (HC) hand grenade

The AN–M8 smoke grenade produces a white-colored smoke. It is a cylindrical metal container filled with a hexachloroethane (HC) smoke mixture and fitted with an M201A1 grenade igniting fuze (fig. 1–10). The AN–M8 grenade is issued with the fuze cocked and ready to fire. The grenade functions if the safety lever is released. The pressure sensitive tape is blown off the emission holes and the smoke is released.

M18 colored smoke hand grenade

The M18 grenade uses colored smoke for signaling (red, green, yellow, or violet). The M201A1 igniting fuze is screwed into an adapter in the top of the grenade. Just like the AN-M8, the M18 smoke grenade is issued with the fuze cocked and ready to fire. Once the safety pin is removed and the safety lever is released, the grenade is ready to be thrown. Once ignited the thermite filler burns for approximately 40 seconds.

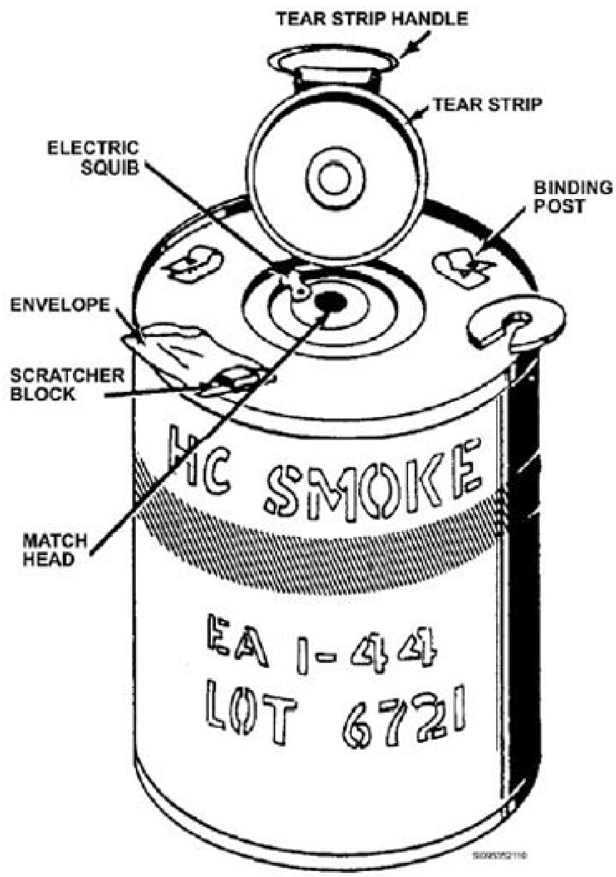

Figure 1–10. HC smoke grenade.

Grenade projection adapters

As we previously mentioned, grenades can be launched from rifles to gain greater range and accuracy. Rifle grenades, however, are designed and manufactured for use only with rifles. You need a grenade projection adapter to launch a standard hand grenade from a rifle. Two types of adapters are currently in use, the M1A2 and M2A1.

M1A2 grenade projection adapter

The M1A2 adapter (fig. 1–11) is a sheet steel assembly designed to adapt a fragmentation hand grenade to a rifle grenade launcher. It consists of a stabilizer tube, a fin, a grenade retainer cup, two short grenade retainer claws, and a long retainer claw with an arming clip attached. When the adapter is attached to a grenade, the grenade safety lever is inserted through the arming clip as the grenade is seated in the cup. The arming clip safes the grenade until launch. When the adapter and grenade are launched, inertial reaction causes the arming clip to move backward and strike a small, brittle metal tip on the arming clip retainer causing the metal tip to break off. The arming clip then falls free of the assembly and releases the grenade safety lever, starting the grenade’s explosive train sequence.

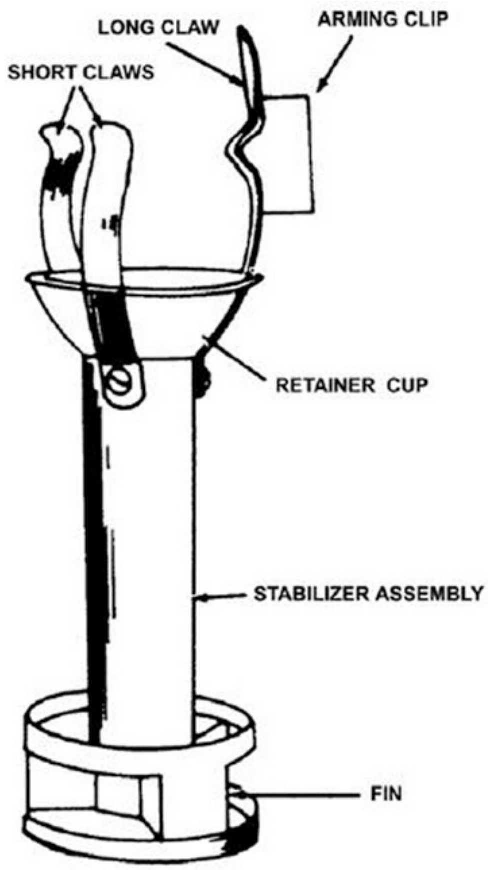

Figure 1–11. M1A2 grenade projection adapter.

M2A1 chemical grenade projection adapter

This adapter is designed to adapt a cylindrical, chemical hand grenade to a rifle grenade launcher (fig. 1–12). It consists of a sheet-metal stabilizer assembly and a metal setback band. The stabilizer is a tube with a fin at one end and a grenade-attaching base plate and claws at the other end. The setback band is a flat strip of metal formed into a circle with a metal coil spring attached between the ends of the metal strip. When a grenade is installed in the adapter, the setback band restrains the grenade's safety lever until the grenade is launched. When the adapter and grenade are launched, inertial reaction causes the setback band to move toward the base of the grenade, releasing the safety lever of the grenade and starting the grenade's explosive train.

Safe storage, handling, inspection, and testing

All types of grenades must be stored and handled in accordance with the procedures in Air Force Manual (AFMAN) 91–201, *Explosives Safety Standards*, and in applicable technical data.

Storage

In general, we store grenades like the other munitions you have studied. However, there are several requirements peculiar to the storage of grenades that you must know.

- Store WP grenades at temperatures below 111° Fahrenheit (°F). Higher temperatures can cause the phosphorous to fume; people can suffer bone decay from breathing these fumes.
- As a general rule, the desirable storage temperature for most types of grenades is 70 °F.
- To avoid the possibility of leakage, store the M34 grenade with the fuze end up.

- Concrete floors are preferred for magazines that store chemical grenades. Before storing the grenades, the floors must be made nonabsorbent by treating them with a compound called sodium silicate.
- To stop pilferage, be sure to use locks and other security measures that meet Air Force standards.

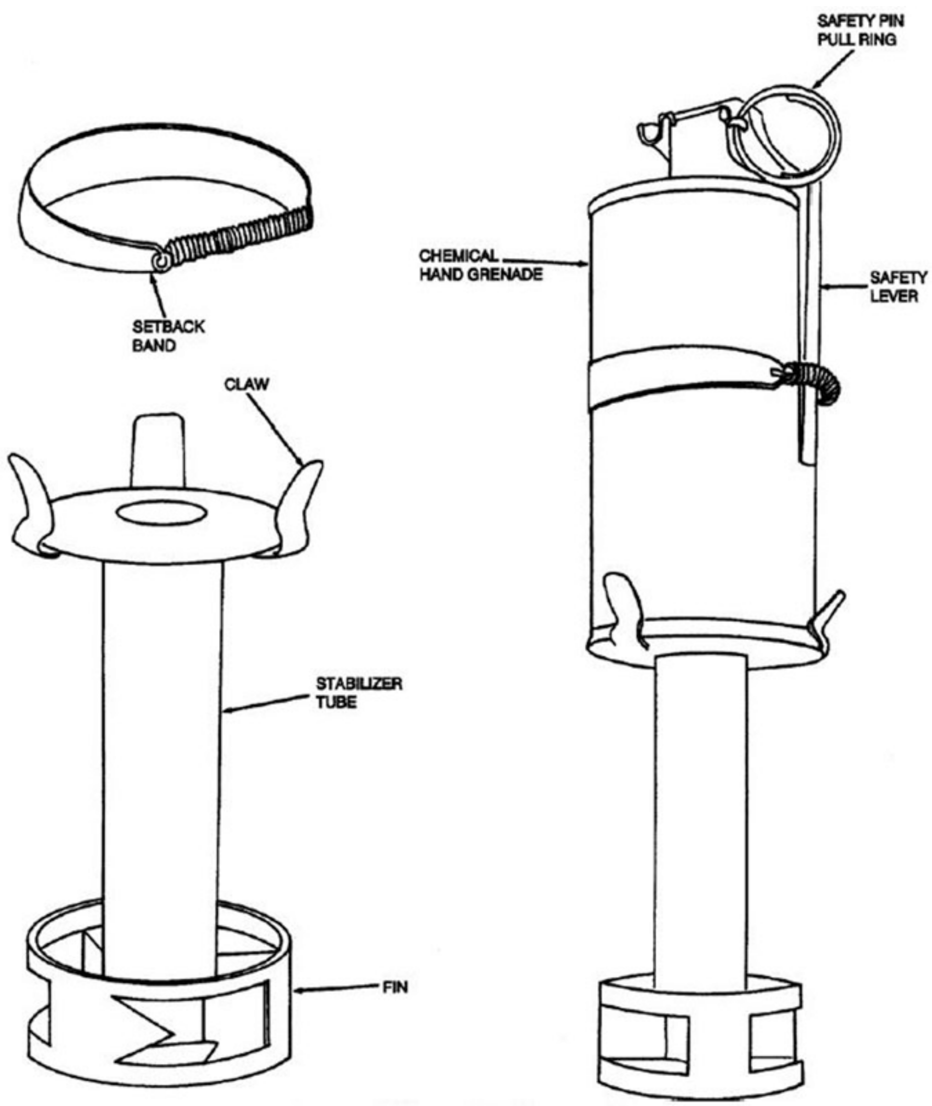

Figure 1–12. M2A1 grenade projection adapter.

Handling

Grenades contain explosive material and must not be handled roughly, thrown, or dropped. One important point you must remember is that you must *never handle grenades by their pull rings*. Repair any damaged containers immediately, and be sure to restore the markings on the container. If you are handling WP grenades, make sure that appropriate protective and first-aid equipment is available. If you accidentally drop a fragmentation grenade after you remove the safety clip or pin, quickly pick it up and throw it toward a safe area. *A grenade can be thrown much further than personnel can run before it functions.*

Inspection and testing

You must inspect grenades periodically to determine their serviceability status. When inspecting grenades, be alert for damaged, rusted, or poorly marked inner or outer containers. Look for unauthorized fuzes assembled to grenades and for deformed or missing safety pins. Look for leaking or exuding fillers; cracked, damaged, or corroded grenade body or fuze; loose fuze; fuze or grenade lot number unknown; markings missing from grenade body; or lots mixed in boxes without notation on the outer containers. Remember, grenades are packed in their containers with the fuze up. If you find a grenade packed upside down or the safety pin is not in place, reject the grenade and contact explosive ordnance disposal.

207. Mines

While mines are primarily the tools of the Army and the Marines, the Air Force does maintain a limited selection of antipersonnel mines for base defense and aerial mines for antipersonnel and antimateriel applications.

M18A1 antipersonnel mine

The M18A1 antipersonnel mine, commonly called a *claymore*, is a very potent antipersonnel weapon (fig. 1–13). When detonated, these mines deliver 700 steel balls in a fan shaped pattern approximately 2 meters high and 60-degrees wide at a range of 50 meters. These balls have an effective kill range up to 100 meters and can be dangerous up to 250 meters in front of the mine. While the primary blast is toward the front, the M18A1 has a back blast range of approximately 16 meters. Concussion or secondary missiles can cause injury. Personnel up to 100 meters to the sides and rear of these mines should take cover for protection. Although the front of the claymore mine is marked “Front toward enemy”, you should always take caution whenever you are in close proximity to an armed mine.

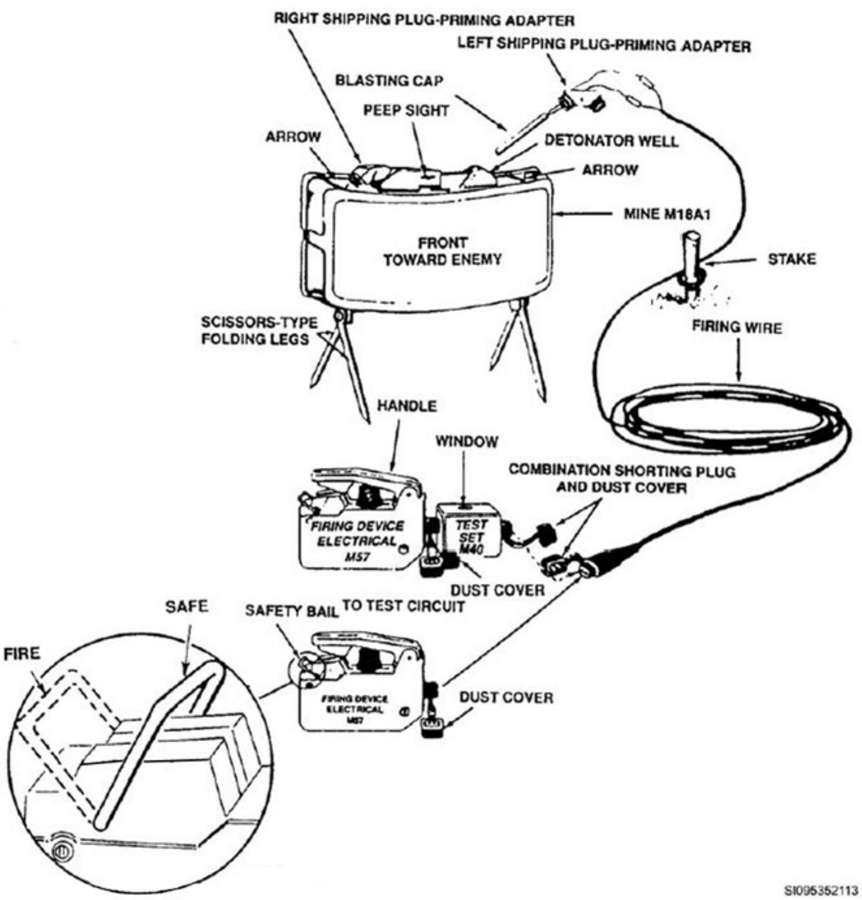

Figure 1–13. M18A1 antipersonnel mine.

M14 nonmetallic antipersonnel mine

This is a nonmetallic, blast-type, HE antipersonnel mine consisting of a main charge of tetryl (1ounce) and an all-plastic body with an integral plastic fuze having a steel firing pin (fig. 1–14). This mine is capable of inflicting a serious casualty since it explodes in direct contact with the enemy. Since it is practically an all plastic construction, it is *not detectable* by magnetic mine detectors.

The mine is cylindrical in shape and has six ribs on the outside of the body to add strength and to serve as a means for identifying it in the dark. For safety, the plug-type plastic detonator holder with detonator is packaged separately within the same shipping container as the mine. Two letters, "*A* and *S*", on top of the fuze body signify ARMED and SAFE respectively. A force of 20 to 35 pounds depresses the pressure plate, which allows the mine to function. When handling any mine, be aware that the principal hazards involved are blast and fragments.

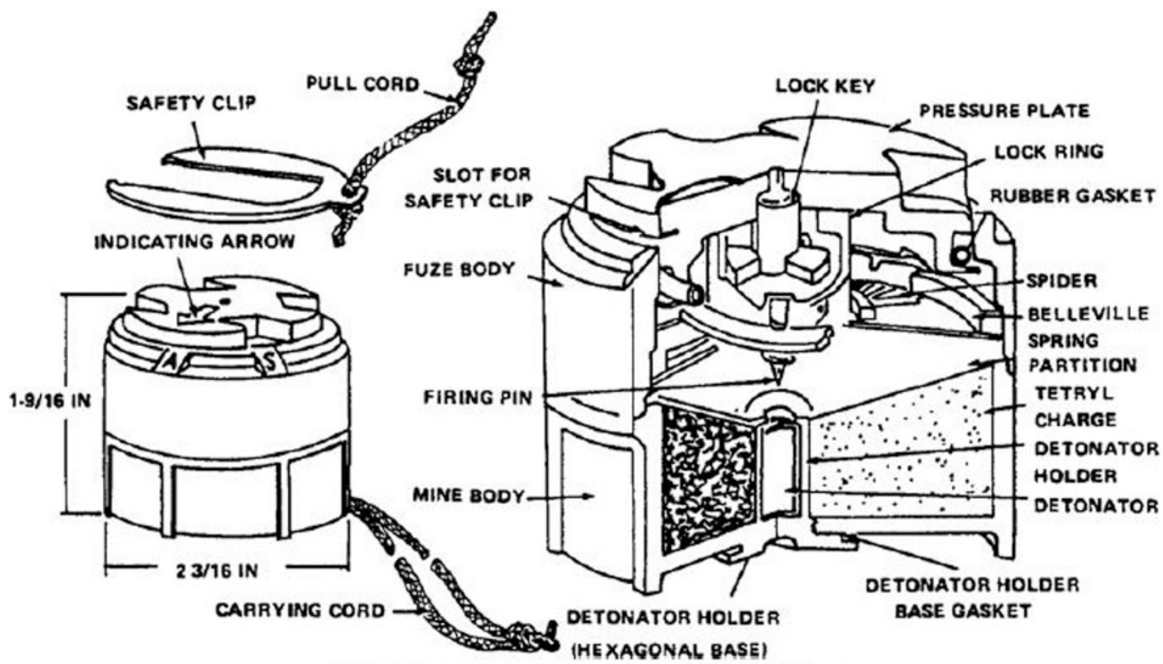

Figure 1–14. M14 nonmetallic antipersonnel mine.

Inspection

Inspections are performed to ensure serviceability of all land mines maintained in storage or issued to fill requirements of using organizations. Inspections of land mines are limited to visual inspections in accordance with Table 1 of the item TO and TO 11A–1–10. Lot numbers are checked for current status/restrictions and deficiency reports are submitted in accordance with TO 00–35D–54.

208. Mortars

Mortars play a unique and vital role on the battlefield by placing indirect fire on the enemy's position from high angles without relying on airstrikes. Forces can use either carrier-mounted mortars, wheeled mortars, or hand-carried mortars depending on the distance/terrain. Mortars exist to provide responsive fire that can be used to meet the rapid changes in the tactical situation on the battlefield. The United States military uses three classes of mortars: light, medium, and heavy.

Light mortars

The 60 mm mortar provides air assault, airborne, ranger, and light infantry rifle companies with an effective, efficient, and flexible weapon. We can minimize the limitations of a light mortar (short-range and small explosive charge) by careful planning and a thorough knowledge of its capabilities. It can be employed in several different configurations. The lightest configuration weighs about 18 pounds; the heaviest weighs about 45 pounds. Each round for the 60 mm mortar weighs approximately four pounds.

Medium mortars

The 81 mm mortar is the current US medium mortar. Medium mortars offer a compromise between the light and heavy mortars. Their range and explosive power is greater than the light mortar, yet they are still light enough to be hand-carried over long distances. These mortars weigh about 95 pounds, but can be broken down into several smaller loads for easier carrying. Rounds for these mortars weigh approximately 15 pounds each.

Heavy mortars

The 107 mm mortars and the 120 mm mortars are the current US heavy mortars. The 107 mm is a rifled mortar, which stabilizes its projectile by spinning it rapidly. The 120 mm, like all other US mortars, fires fin-stabilized ammunition from a smooth bore. Although heavy mortars require trucks or tracked mortar carriers to move them, they are still much lighter than field artillery equipment. They outrange light and medium mortars, and their explosive power is much greater. The 107 mm weighs approximately 675 pounds. The 120 mm is much lighter at approximately 320 pounds. Rounds for the 107 mm mortar weigh approximately 28 pounds. Those for the 120 mm mortar weigh almost 33 pounds each.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

205. Small arms ammunition

1. Which military weapons do we classify as “small arms”?

2. What terms do we use to describe the measurement of small arms?

3. Which cartridge is the exception to shotgun gauging?

4. What color is the tip of an AP bullet painted?

5. Ball ammunition is used against what type of targets?

6. What is the purpose of tracer rounds?

7. What is *noncombat* ammunition used for?

8. Which type of round do we use for *weapons load training*?

9. What is a small-arms cartridge?

10. What causes a bullet to spin?

11. What determines the core/filler of a bullet?

12. What is the term for the recess groove part of the bullet into which the cartridge case is crimped during assembly?

206. Grenades

1. What are the classifications of Air Force grenades?

2. What can functional hand grenades be used for?

3. What are the *tactical* classifications of service grenades?

4. What is the explosive filler for M26-series grenades?

5. Why is the base of the M34 grenade tapered?

6. What are the uses of the M25-series grenades?

7. Which type of grenades are used with the M1A2 grenade projection adapter?

8. Which type of grenades are used with the M2A1 grenade projection adapter?

9. Why must M34 grenades be stored fuze end up?

10. What are some of the things that you look for in inspecting grenades?

207. Mines

1. What is the *killing agent* of the M18A1 antipersonnel mine?

2. What is the *effective kill range* of the M18A1 mine?

3. What safety precaution must you observe with the *detonation of a claymore* mine?

4. What is the special feature that makes the M14 nondetectable by magnetic mine detectors?

208. Mortars

1. What are the two limitations of 60 mm light mortars?

2. What type of mortar can be broken down into several smaller loads for easier carrying?

3. What is required to move heavy mortars?

1–4. Munitions Demolition

There are many reasons for the disposal of munitions. For example, they may be damaged beyond use, obsolete, excess, unneeded due to mission change, and so forth. In most cases, the demolition of munitions is *not* performed by munitions systems specialists. Depending on your location, the unserviceable assets are usually shipped in accordance with disposition instructions originating from the ammunition distribution request. Only certain agencies may authorize the demolition of munitions—while others agencies such as explosive ordnance disposal (EOD) actually perform the task. In this section, we take a look at various explosives that are used to destroy unserviceable munitions.

209. Initiation sources for demolition explosives

In this lesson, the term demolition explosives/material means those explosive charges and incendiaries (together with necessary accessories) that we deliberately place for the express purpose of destroying/disposing of US Government material and/or resources. Such materials include explosive charges, explosive initiating devices designed for use with such charges, explosive and non-explosive mechanical devices, and apparatus such as instruments, tools, and equipment we use with charges for performing various demolition operations.

Demolition charge initiators include a wide range of devices and materials which contain explosives. The initiator is used to detonate a demolition charge. In the following table we discuss the most common types you use.

<table>
<tr><th colspan="2">Initiation Sources for Demolition Explosives</th></tr>
<tr><th>Type</th><th>Description</th></tr>
<tr><td>Blasting caps</td><td>
Blasting caps are used to detonate high explosives. They are designed to be inserted into cap wells and into the detonating element of certain firing devices.
Blasting caps are rated in power according to the size of their main charge.

Commercial blasting caps are normally No. 6 or 8 and are used to detonate the more sensitive explosives, such as commercial dynamite and tetryl.
Military blasting caps (M6 and M7) are used to ensure positive detonation of the generally less sensitive military explosives. Their main charge is approximately twice that of the commercial No. 8 cap.

Blasting caps are fired electrically or nonelectrically.
<table>
<tr><th colspan="2">Blasting Caps</th></tr>
<tr><th>Type</th><th>Description</th></tr>
<tr><td>Electric</td><td>
These are used when a source of electricity, such as a blasting machine, is available.
Electric caps have lead wires of various lengths for connection into a circuit. The most commonly used electric caps are 12 feet long.
To prevent accidental firing, they have a short circuiting shunt which must be removed before use. If you find a cap without the shunt, twist the bare end of the lead wires together to provide the short in the circuit.
</td></tr>
<tr><td>Nonelectric</td><td>
These caps may be initiated by time blasting fuse, firing devices, and detonating cord.
The military M7 nonelectric blasting caps are flared at the open end for easy insertion of a time fuse and detonating cord.
</td></tr>
</table>
</td></tr>
<tr><td>Blasting safety fuse (time)</td><td>
Safety fuse consists of black powder tightly wrapped with several layers of fiber waterproofing and may be any color. The most common color of military safety fuse is green; commercial safety fuse is orange.
In order to facilitate estimates of length for tactical situations, manufacturers mark the covering of military safety fuse with painted yellow bands.

Single bands designate 1 minute lengths.
Double bands designate 5 minute lengths.

</td></tr>
</table>

Initiation Sources for Demolition Explosives	
Type	**Description**
Detonating cord	Detonating cord consists of a core of pentaerythritol tetranitrate covered by layers of fabric and waterproofing materials. It transmits a detonating wave from one point to another at a rate of between 20,000 and 21,000 feet-per-second. In real terms, this equates to a 10 minute burn time for a length of detonating cord to detonate from the East coast of the US to the West coast.
Igniter, time blasting fuse, M60	We use the M60 igniter to light a time fuse. The M60 igniter is weatherproof and has a pull-type, percussion igniter.
Squib, electric, M1	This squib, also known as a flash vented squib, is a small explosive initiating device we use to ignite pyrotechnic or incendiary compositions or black powder. This squib requires an electric source (such as a blasting machine) to function.

210. Demolition charges and accessories

Demolition charges used in military operations consist of many different kinds of commercial and military explosives. The type operation with which you are involved determines the specific type of charge you will use. In this lesson we only discuss the most commonly used charges. For additional information pertaining to other military demolition charges, refer to TO 11A20–7–7, *Specialized Storage and Maintenance Procedures, Demolition Charges*.

Demolition accessories perform particular functions in detonation systems and are used to ensure the explosive train performs as designed.

Demolition charges

There are three basic types of demolition charges—two block types, commercial dynamite, and military dynamite—described in the following table.

Demolition Charges	
Type	**Description**
Charge, demolition, block M112	A M112 demo block is a one and one-quarter (1¼) pound block of comp C–4. It is a rectangular block and is dull gray in color. It is in a Mylar-film wrapper with pressure sensitive adhesive tape on one side. This tape is protected by a peel-off paper cover. The adhesive feature and C–4 explosive make this demo block an excellent tool for demolition operations.
Charge, demolition block, ½ and 1 pound, TNT	This charge consists of a rectangular block of compressed flake TNT enclosed in a yellow or olive drab (green), water-resistant, fiberboard container with metal end plates. One end of the charge contains a threaded or unthreaded initiator well for receiving the initiating explosive/charge.
Commercial dynamite	There are three different types of commercial dynamite used for military operations: (1) ammonia dynamite, (2) gelatin dynamite, or (3) ammonia-gelatin dynamite. Commercial dynamite is designated by the percentage by weight of the nitroglycerin content.

Demolition Charges	
Type	**Description**
Military dynamite, M1	Military dynamite is a medium velocity blasting explosive that is standardized to replace commercial dynamite in military operations. Military dynamite contains no nitroglycerin and will not freeze in cold storage nor exude in hot storage. Military dynamite is safer to store, transport, and handle than commercial dynamite. Military dynamite is packaged in paraffin-treated paper cartridges.

Demolition accessories

Accessories used for demolition include priming adapters, detonating clip cords, connectors, blasting machines, a galvanometer, blasting cap test set, cap crimper, and firing wire. We'll discuss each of these in the following paragraphs.

Priming adapters, M1A4

We use priming adapters to secure an electric or nonelectric blasting cap in a threaded activator well of a standard demolition charge. The adapter is made of plastic and is externally threaded at one end so that it can be screwed into the activator well of any standard demolition charge. The bore in the threaded end is large enough to receive a blasting cap. A smaller bore in the opposite end is large enough to receive safety/time fuse or detonating cord. A blasting cap is held in place by a shoulder that is formed where the bores meet. A slot along the length of the adapter allows insertion of the lead wires of an electric blasting cap.

Clip, cord, detonating, M1

The detonating cord clip is a steel device and is used to hold together two strands of detonating cord either parallel or at right angles to each other. We can make connections more quickly with these clips than with knots.

Connector, detonating cord

The detonating cord connector is cylindrical and is composed of either white or blue plastic molding material. It is approximately 1.72 inches long and 0.62 inches in diameter with a 0.12-inch diameter hole located through the body of the connector. Also, two 60 degree slots are located on the same end as the holes and aid in easy installation of detonating cord. We use the detonating cord connector to connect two strands of detonating cord.

Blasting machines

Blasting machines are used to provide the electrical impulse needed in electrical detonation procedures. The machines most often used are the 10 and 50 cap machines. These machines include a built-in safety circuit. This circuit prevents current from reaching the terminals until the machine's handle (or plunger) is actuated with sufficient energy to gain nearly the maximum output from the machine.

Galvanometer

We use the galvanometer to check electrical circuits and their components. It works by sending a minute amount of electrical current from a silver chloride battery through the blasting circuit and through a D'Arsonval meter. The meter's needle responds in proportion to the amount of resistance current it encounters in the circuit. The type of battery authorized is dependent on operating temperatures.

Blasting cap test set, M51

The blasting cap test set was developed as a replacement for the galvanometer and is used to test the continuity of electrical blasting circuits. The M51 is a handheld, plastic bodied, rectangular prismoid with a protruding squeeze handle. There are two screw-type contact terminals, one on either side of the instrument body, and a test light near one corner of the instrument body. The test set contains a magneto-type electrical impulse generator.

When the handle of the test set is pressed, a minute amount of current flows from the impulse generator through the blasting and switching circuit. If the blasting circuit is continuous and has less than 200 ohms resistance, current can flow through the blasting circuit and actuate the switching circuit, which lights the indicator light. If the blasting circuit is open or contains a high resistance, no current (or a very small amount) flows and the switching circuit is *not* actuated.

The test set is waterproof and may be used at temperatures as low as –40 °F. Continuity testing is accomplished by connecting the firing circuit to the test set binding posts and then pressing the handle sharply. If there is a continuous (intact) circuit (even one created by a short), an indicator lamp will flash.

Cap crimper

The cap crimper looks like a pair of pliers. You use it to cut the safety fuse and to close the extending lip of the blasting cap around the fuse. It is made of either blue steel or a non-sparking metal and is seven-inches long. There is a hole in the nose just big enough to avoid squeezing the fuse and cracking the explosive. *Do the actual crimping out and away from the body in case the cap explodes.*

Firing wire

Fire wire is issued in 500-foot lengths of double conductor, number 18 gauge rubber-covered wire. Sometimes the wire is wound on metal reels. This wire is independently insulated. The inner end of the wire is attached to the reel and protrudes through the side for convenient connection to the blasting machine. The other end is free to be unrolled for connection to the blasting cap lead wires. If the amount of wire on one reel is not sufficient to provide an ample margin of safety, you may splice two reels of wire together.

CAUTION: Never connect the wires to the blasting machine until you check all of the connections with a galvanometer or an M51 test set and the rest of the firing circuit and all personnel are safely behind barricades or similar protection.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

209. Initiation sources for demolition explosives

1. What initiation source do we primarily use to detonate *high explosives*?

2. What are the two ways in which blasting caps can be fired?

3. What is the purpose of the yellow painted bands covering military safety fuses?

4. What is the *rate of detonation* for detonating cord?

5. What is the purpose of the M60 igniter?

6. For what do we use a flash vented squib?

210. Demolition explosives and accessories

1. What is the purpose of the *initiator well* on the trinitrotoluene (TNT) demo block?

2. What is the advantage of military dynamite over commercial dynamite?

3. What is the purpose of the M1A4 priming adapter?

4. What is the M1 clip used to hold together?

5. What do we use a galvanometer for?

Answers to Self-Test Questions

201

1. TNT.
2. Must be cheap, plentiful, and not vital to any other phase of the war effort.
3. The shattering or fragmentation effect.
4. Volatility.
5. A natural compatibility.
6. An explosive's poisonous characteristics.
7. The moisture-absorbing property of an explosive.
8. A few inches per minute to 1,300 feet per second.
9. Deflagration.
10. It must be confined.

202

1. Detonator, booster, and bursting charge.
2. Primer.
3. The action of a primer or by a non-explosive impulse.
4. A delay controls the timed delay in the functioning of the train.
5. Amplifies the detonation received from the detonator to detonate the main charge.
6. Blast.

7. Munroe effect.
8. Its penetrating capability is increased.

203

1. (1) Candlepower.
   (2) Color.
   (3) Weather.
   (4) Light.
2. Moist weather, rain.
3. According to their purpose as illuminants, signals, combinations of signal and illuminants, and simulators.
4. Light and smoke.
5. By its nomenclature, lot number, model designation, painting, marking, national stock number, and Department of Defense identification code.

204

1. Approximately 40 minutes.
2. 3,000 candlepower.
3. The MK124 Mod 0.
4. Penetrate a heavy foliage canopy.
5. 50,000.
6. (1) Launcher.
   (2) Igniter.
   (3) Delay.
   (4) Parachute.
   (5) Illumination composition.
7. To produce a distinctive red light above the ground fog, haze, or overcast.
8. Protective mask and butyl rubber gloves.

205

1. Those with a bore diameter (inside diameter of the barrel) of 0.50 inch or less.
2. Gauge and caliber.
3. The .410 shotgun cartridge.
4. Black.
5. Personnel or light materiel targets.
6. To illuminate the path of the bullets so the gunner can correct his/her aim.
7. Training and weapons testing.
8. Dummy.
9. A complete assembly of all components necessary to fire the weapon once.
10. The rifling in the gun barrel.
11. The ammunition's purpose.
12. Cannelure.

206

1. Service, practice, and training.
2. Inflict casualties or damage and for screening and signaling.
3. Fragmentation, irritant, riot control, screening smoke, signaling smoke, and incendiary.
4. 0.39 pound of composition B.
5. So that the grenade can be mounted on an M1A2 grenade projection adapter.
6. Riot and disturbance control.

7. Fragmentation grenades.
8. Chemical grenades.
9. To avoid possible leakage of the filler.
10. Damaged, rusted, or poorly marked inner or outer containers. Unauthorized fuzes and for deformed or missing safety pins. Look for leaking or exuding fillers; cracks, damage, or corroded grenade body or fuze; loose fuze; lot number of fuze or grenade unknown; missing markings.

207

1. 700 steel balls.
2. 100 meters.
3. Personnel up to 100 meters to the sides and rear of these mines should take cover for protection.
4. The M14 is constructed of practically all plastic components.

208

1. They have a short range and a small-explosive charge.
2. Medium mortar (the 81-mm).
3. Trucks or tracked mortar carriers.

209

1. Blasting caps.
2. Electrically or nonelectrically.
3. To estimate the length for tactical situations, the single bands are designated for 1-minute lengths and the double bands are designated for 5-minute lengths.
4. Between 20,000 and 21,000 feet per second.
5. It is used to light a safety/time fuse.
6. It is used to ignite pyrotechnic or incendiary compositions or black powder.

210

1. Receiving the initiating explosive/charge.
2. Military dynamite is safer to store, transport and handle.
3. It is used to secure electric or nonelectric blasting caps in a threaded activator well of a demolition charge.
4. Two strands of detonating cord.
5. To check electrical circuits and their components.

Complete the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field-Scoring Answer Sheet.

Do not return your answer sheet to the Air Force Career Development Academy (AFCDA).

1. (201) A requirement for military explosives is that *raw materials* must be
   a. cheap.
   b. non-hygroscopic.
   c. common to America.
   d. vital to the war effort.

2. (201) Volatility is the tendency of a substance to produce
   a. pressure.
   b. energy.
   c. vapors.
   d. heat.

3. (201) The word *hygroscopicity* refers to what *property of an explosive*?
   a. Moisture-absorbing.
   b. Tendency to produce sensitive metallic salts.
   c. Ability of an explosive to be cast into a mold or form.
   d. Ability to liberate gaseous products during detonation.

4. (201) The *rate of transformation* for *high explosives* is between 3,200 and
   a. 25,000 feet per second (fps).
   b. 28,000 fps.
   c. 31,000 fps.
   d. 32,000 fps.

5. (201) The tendency of a substance to burn with a *rapid and sparkling combustion* is called
   a. detonation.
   b. disposition.
   c. deflagration.
   d. decomposition.

6. (202) *Explosive train primers* are classified
   a. by the size of the primer.
   b. according to their location.
   c. by the way they are initiated.
   d. according to their functioning.

7. (202) What does an *explosive train booster* do?
   a. Detonates the fuze.
   b. Detonates the main charge.
   c. Transmits energy from one detonating component to the next.
   d. Controls the delay in the functioning of the fuze’s explosive train.

8. (202) How can you achieve an *airburst* with a *general-purpose* bomb?
   a. Use a time action high-explosive (HE) train.
   b. With a super quick action HE train.
   c. With a delay action HE train.
   d. Use a non-delay element.

9. (202) How can you *increase the penetration effect* of a *shaped charge*?
   a. Decrease standoff distance.
   b. Decrease explosive charge.
   c. Increase standoff distance.
   d. Increase explosive charge.

10. (202) What is a *shaped charge* used for?
   a. Bring down walls and collapse roofs.
   b. Any application in the munitions field.
   c. Ignite rocket motors equipped with electric squibs.
   d. To produce an explosive penetration of a solid target.

11. (203) The four factors that control the *visibility of pyrotechnics* are candlepower, color, weather, and
   a. light.
   b. altitude.
   c. humidity.
   d. chemical composition.

12. (203) The *classifications of pyrotechnics* include illuminants
   a. and signals only.
   b. and igniters only.
   c. and combinations of signals only.
   d. signals, combinations of signals and illuminants, and simulators.

13. (203) What do the colored bands, letters, or patches on *signal munitions* indicate?
   a. Color of the signal produced.
   b. Type of pyrotechnic ammunition.
   c. Different factory modification of signals.
   d. Different manufacturer identification codes.

14. (204) Approximately how many minutes does the MK6 signal flare burn?
   a. 3.
   b. 10.
   c. 30.
   d. 40.

15. (204) What *pyrotechnic effects* are produced by the AN–MK13 signal?
   a. Flare and noise.
   b. Smoke and noise.
   c. Signal and illumination.
   d. Smoke and illumination.

16. (204) The primary reason the AN–MK13 Mod 0 signal can be *handheld while burning* is to allow a downed pilot to
   a. hold the flare while treading water.
   b. climb a tree and push the flare above the forest canopy.
   c. wave the flare, causing movement that helps attract attention.
   d. throw the flare into a clearing without risking undue exposure.

17. (204) How is the A/P25S–5A *distress signal kit ignited*?
   a. Electric igniter.
   b. Percussion primer.
   c. By lighting the fuze.
   d. Concentrated laser beam.

18. (204) How much light does the M127A1 signal produce?
    a. 50,000 candlepower.
    b. 100,000 candlepower.
    c. 1,000,000 candlepower.
    d. 2,000,000 candlepower.

19. (204) What altitude is attainable by the M131 signal when fired?
    a. 1,000 feet.
    b. 1,500 feet.
    c. 2,000 feet.
    d. 2,500 feet.

20. (205) The *largest* caliber ammunition that we classify as “small arms” is
    a. caliber .38.
    b. caliber .50.
    c. 5.56 millimeter.
    d. 7.62 millimeter.

21. (205) The components of a typical small-arms cartridge are cartridge case,
    a. primer, bullet, and propellant.
    b. primer, bullet, and detonator.
    c. shot pellets, and propellant.
    d. propellant, and tracer.

22. (206) What type of *explosive filler* does an M26 fragmentation grenade have?
    a. Composition B.
    b. Composition C.
    c. Cyclonite (RDX).
    d. White phosphorus.

23. (206) The *filler* for the M34 *smoke* grenade is
    a. adamsite and silica aerogel.
    b. chloroacetophenone.
    c. white phosphorus.
    d. magnesium oxide.

24. (206) What is the *explosive filler* for the M30 *practice* grenade?
    a. Inert powder.
    b. Black powder.
    c. Composition B.
    d. White phosphorus.

25. (206) The AN–M8 smoke grenade uses hexachloroethane as a chemical filler to produce what kind of smoke?
    a. Poisonous.
    b. Orange.
    c. White.
    d. Black.

26. (207) Which antipersonnel mine is commonly called the *claymore*?
    a. M14.
    b. M18A1.
    c. M27A1.
    d. M28A1.

27. (207) How much force pressed against the pressure plate is required to set off the M14 anti-personnel mine?
    a. 1 to 10 pounds.
    b. 10 to 15 pounds.
    c. 15 to 30 pounds.
    d. 20 to 35 pounds.

28. (208) Which type of mortar has a short range and a small explosive charge?
    a. Light.
    b. Small.
    c. Heavy.
    d. Medium.

29. (208) Which type of mortar can be broken down into several smaller loads for easier carrying?
    a. Light.
    b. Small.
    c. Heavy.
    d. Medium.

30. (209) What device is used to *detonate* a high explosive (HE)?
    a. Firing wire.
    b. Blasting cap.
    c. Galvanometer.
    d. Detonating cord clip.

31. (209) What *weatherproof* device is used to *initiate a time fuze*?
    a. Firing wire.
    b. M60 igniter.
    c. Galvanometer.
    d. Blasting machine.

32. (210) The M112 *demo block* is made of
    a. ammonia.
    b. nitroglycerin.
    c. black powder.
    d. composition C–4.

33. (210) Blasting machines are used to provide the impulse needed in
    a. percussion detonations.
    b. electrical detonations.
    c. priming adapters.
    d. blasting caps.

34. (210) The *firing wire* used in detonation systems is issued in what lengths?
    a. 50-foot.
    b. 100-foot.
    c. 500-foot.
    d. 1000-foot.

Please read the unit menu for unit 2 and continue ➔

Unit 2. Aerospace Munitions

WITHOUT MUNITIONS TO drop on the enemy, the Air Force would be just another airline. The same philosophy holds true for munitions. If the munitions did not have a fuze to ensure they function, we might as well be throwing rocks. This unit helps build the foundation of knowledge about bombs, fuzes, fins, and other assorted munitions items that you will use throughout your career.

2–1. Fuzes and Fuze Components

Bomb fuzes are designed and manufactured to meet specific operational needs of a tactical or strategic situation. As a munitions systems specialist, your job is to store, handle, inspect, issue, and install bomb fuzes. There are numerous bomb configurations and fuzing options available to meet the mission. While it would be difficult to memorize every bomb/fuze configuration—you should at least know the basic characteristics and functions of the different types of fuzes in the USAF inventory. The lessons in this section will provide that basic information.

211. Characteristics and applications of bomb fuzes

This lesson focuses on basic information of bomb fuzes, how fuzes are classified, the different ways they are armed, and the safety devices we use to keep them safe. Bomb fuzes are classified by position (nose or tail), action, and method of arming.

Position

Bomb fuzes are designed for installation in the nose or the tail of the bomb. Some fuzes have the flexibility to be installed in either the nose or the tail. These dual-use fuzes save time in training, money, and storage space.

Action

There are three main types of bomb fuze actions: impact, time, and proximity; described in the table below.

Bomb Fuze Actions	
Type	**Description**
Impact	Impact fuzes start their function when the bomb strikes a resistant material. *Instantaneous* or *non-delay* fuzes explode the bomb immediately (within about 0.00005 of a second). In contrast, *delay-type* fuzes have an element that delays the bomb explosion until a definite time elapses. This allows the bomb to penetrate the target and the aircraft to clear the danger area before the bomb explodes.
Time	Mechanically timed-type nose and tail fuzes explode the bomb a certain number of seconds after release. This fuze has an arming pin and arming vane. The operating time is adjustable and is set when the complete round is assembled. A typical time range is 5 to 92 seconds. Upon expiration of the set time, a spring-loaded firing pin triggers, drives into the detonator, and explodes the bomb.
Proximity	A *proximity* fuze is *always used* in the nose of the bomb. This type fuze uses a sensing/radar device to determine the height of the bomb above the target. An electrical generator supplies power to the sensing/radar device by either velocity (wind) drive or by a battery-firing device. Once the bomb reaches the preset height of function above the target, it detonates.

Method of arming

Fuzes cannot function while they are unarmed. A fuze is considered *armed* when the next normal event initiates its functioning. That event is impact (impact fuze), time train running to completion (mechanical time fuze), or the completion of electronically timed firing circuits. The two main types of fuze arming methods are mechanically timed and electronically timed.

Mechanically timed

In the *arming-vane-type fuze*, when the arming wire is withdrawn on release of the bomb from the aircraft, the vane rotates in the airstream. This movement is transmitted, usually through a reduction gear train, to a shaft or threaded stem in the fuze.

- In the *nose fuze*, the rotation unscrews an arming screw and releases an arming stem, causing the detonator to move into line with the firing pin.
- In *tail fuzes*, the rotation unscrews an arming stem from an inertia-type firing pin or a cocked (spring-loaded) firing pin, thus releasing the firing pin to function at a preset time (mechanical-time fuze) or on impact.

A definite number of turns on the vane at a specific speed are required to arm each model of fuze.

On the *arming-pin-type fuze*, the arming wire is withdrawn on release of the bomb from the aircraft causing the arming pin to eject. The ejection of the arming pin may arm the fuze directly, but usually the ejection of the pin starts a powder train or a clockwork mechanism that arms the fuze after a predetermined time.

All mechanically timed fuzes use a combination of the arming pin and vane methods of arming. The rotation of the vane is transmitted through a reduction gear train, which causes the detonator to become aligned with a cocked firing pin. Arming pin ejection starts the operation of a time mechanism.

Electronically timed

The development of electrical fuzes helped compensate for the problems created by increased delivery speeds and changes in bombing tactics. In this type of fuze, an electric charging assembly replaces the arming vanes used in other bomb fuzes. The arming and firing circuits activate upon release from the aircraft. In addition, an electronically timed circuit within the fuze activates the arming sequence to arm the fuze after a specified time.

Types of fuze safety devices

Bomb fuzes are relatively safe to handle provided certain safety devices are properly assembled or installed. Knowledge of these devices and their proper application is an absolute "must" in the inspection and safe handling of bomb fuzes. The most widely known safety devices are seal wires, cotter pins, safety blocks, and the "detonator safe" feature. These are described in the following table.

Fuze Safety Devices

Type	Description
Seal wires	These safety devices consist of two twisted strands of copper wire and either a lead or sheet metal seal. Seal wires are sometimes referred to as "car seals" and are commonly used to seal fuze box hasps and to fuze priming mechanisms. An *undamaged* wire and seal properly placed on the fuze indicates the arming mechanism has *not* been tampered with.
Cotter pins	Cotter pins are used extensively with bomb fuzes. Their purpose is to prevent movement of arming heads, arming stems, and strikers while the fuzes are being handled. Usually, the cotter pin also has a warning tag attached; in most cases, this tag has warning instructions printed on it.
Safety blocks	Safety blocks are the small metal disks or C-shaped blocks installed in fuzes at the time of manufacture. They are placed between the striker head and the fuze body to keep the striker stem (firing pin) from moving into the detonator.
Detonator safe	Detonator safe means the detonator must move into line with the striker or firing mechanism. There are several different ways of moving the detonator into line. • One is the "*slider*," which actually contains the detonator and simply slides into line with the striker as the fuze is armed. • Another is the *proximity fuze* which moves a "rotor" into line with an electrical firing circuit. Recent models of the proximity fuze have a pivot rotor that snaps over to align the detonator with the firing pin.

212. Mechanical fuzes

The oldest type fuze is the mechanical type. Most mechanical fuzes use some type of adapter booster to complete the explosive train and allow the fuze to fit in the fuze well of the bomb. General-purpose (GP) bombs and cluster bombs most often use these types of fuze.

M904 nose fuze

The M904 nose fuze is a mechanical, impact nose fuze commonly used with GP bombs (fig. 2–1). All fuzes in this series are similar in appearance and have firing delay times provided by inserting or changing an M9 delay element (fig. 2–2). These delay times range from instantaneous non-delay through 0.01, 0.025, 0.05, 0.10, and 0.25 second of delay. You set the desired arming time on a calibrated dial. The selective arming delay times for the M904 fuze range from 2 to 20 seconds in 2 second increments. When the bomb is released, the arming wiring is pulled from the arming vane. Rotation of the arming vane (by the airstream) causes the fuze to arm. The firing delay time begins after the bomb impacts.

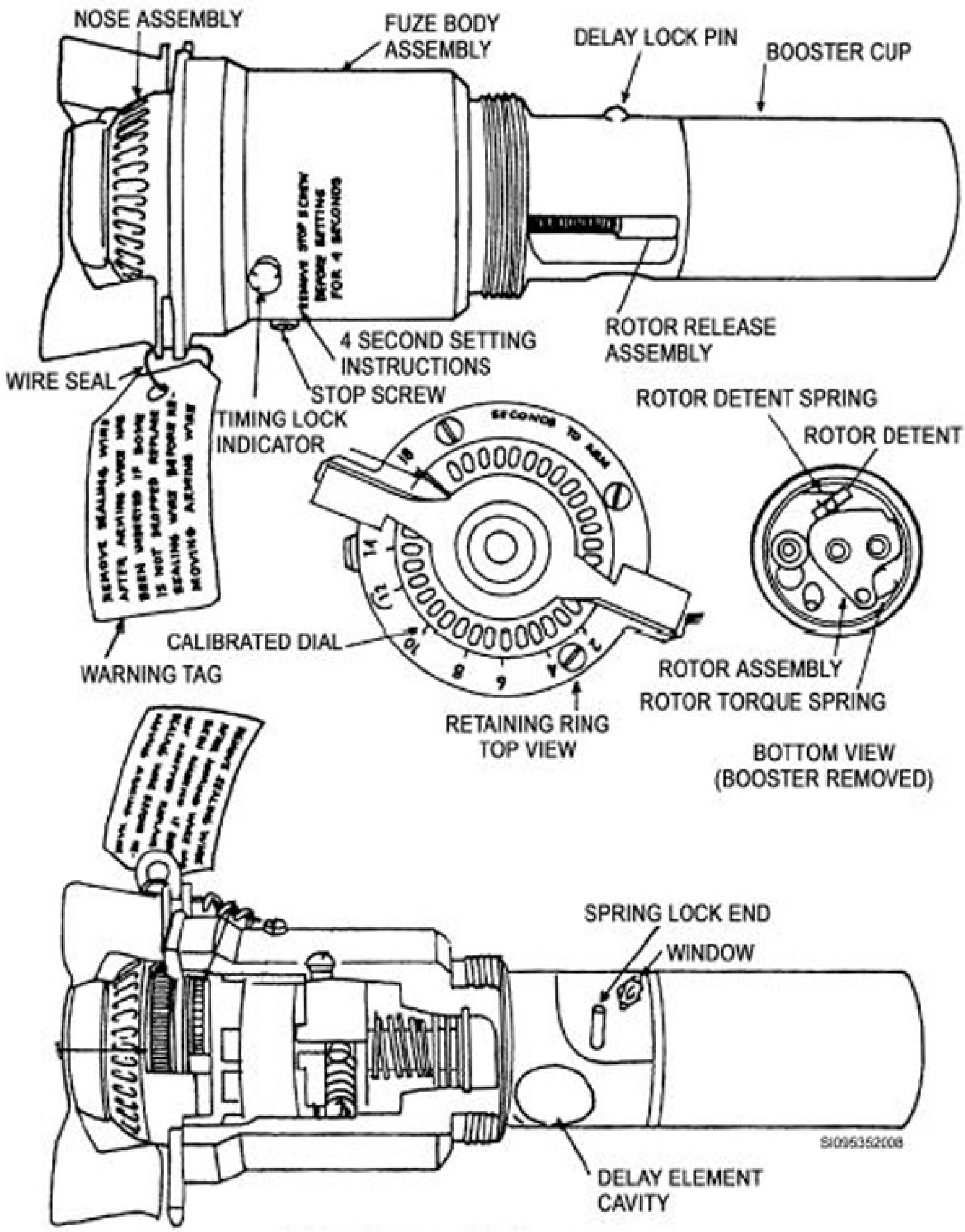

Figure 2–1. M904 nose fuze.

Safety features

The safety features of the M904 series fuze include a seal wire and the delay element cavity. During ground handling, the bent-strap type arming vane is kept from rotating by a sealing wire. You remove the seal wire just prior to takeoff. The M9 delay element is not inserted until just before you install the fuze. The delay element is cylindrical-shaped and available as a non-delay or a delay. It is installed in the delay cavity of the M904 to complete the explosive train within the fuze. If a non-delay is used, the fuze functions upon impact. If a delay is used, the fuze functions after the bomb penetrates the target. One non-delay and five time delays are available. The empty delay cavity acts as an interrupter to the explosive train of the fuze during handling.

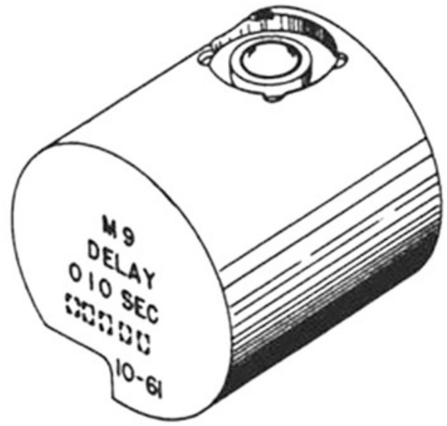

Figure 2–2. M9 delay element.

The M904 series fuze also has two arming windows: an upper window on the side of the fuze and a lower window above the booster. When handling or inspecting an M904 fuze, perform a safe and arm check and verify the following:

- The safety device (wire seal) is installed through the arming vane.
- Full red or black “A” on red background is *not visible* in the lower or the upper window.

To verify the safe condition, loosen or remove the setscrew, press the time lock, and rotate the nose housing. You must remove the stop screw from the fuze body for settings *below* 6 seconds (fig. 2–1). In the safe condition, the M904E1 and M904E2 should have a white stripe visible in the upper window at “6” and “18 SECONDS TO ARM” settings. The white stripe should *not* be visible at any other settings. The M904E3 should have a white “S” or “6” on a green background, which is visible in the upper window at the “6 SECONDS TO ARM” setting. A white “S” or “18” on a green background should be visible in the upper window at the “18 SECONDS TO ARM” setting. The white “S” or numbers should *not* be visible at any other setting.

T45 adapter booster

Installing the M904 nose fuze in an MK 80 series or M-series GP bomb requires the use of a T45 adapter booster (fig. 2–3). The T45 adapter booster has tetryl explosive filler and performs two functions. First, it adapts the fuze thread to the fuze well thread on the bomb. Second, when the fuze detonates, the booster acts as an important link in the explosive train and amplifies the explosion to detonate the bomb. To simplify, when the fuze (primer/detonator) functions, the adapter booster (booster charge) detonates, which in turn detonates the bomb body (burster). This is an example of a basic high explosive train.

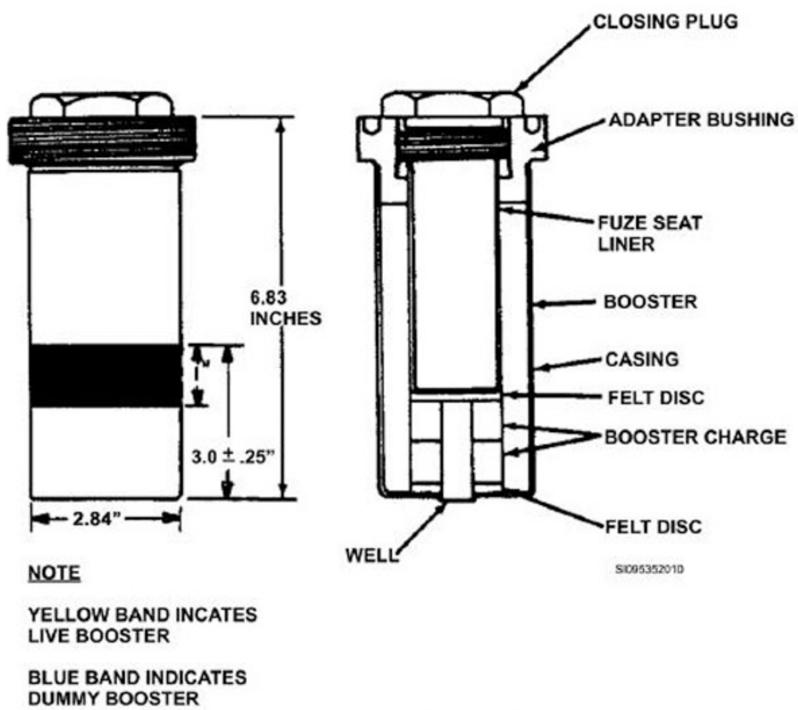

Figure 2–3. T45 adapter booster.

M905 tail fuze

The M905 tail fuze is a mechanical, impact fuze installed in the tail fuze well of GP bombs (fig. 2–4). It is armed by the ATU–35 series drive assembly. The arming time can be set at 4, 6, 8, 12, 16, or 20 seconds on a calibrated scale. Press the timing lock to change the arming time settings. Like the M904, remove the stop screw for settings *below* 6 seconds. You can provide impact detonation delay times by inserting an M9 delay element in the cavity. This fuze uses the same delay elements as those in the M904.

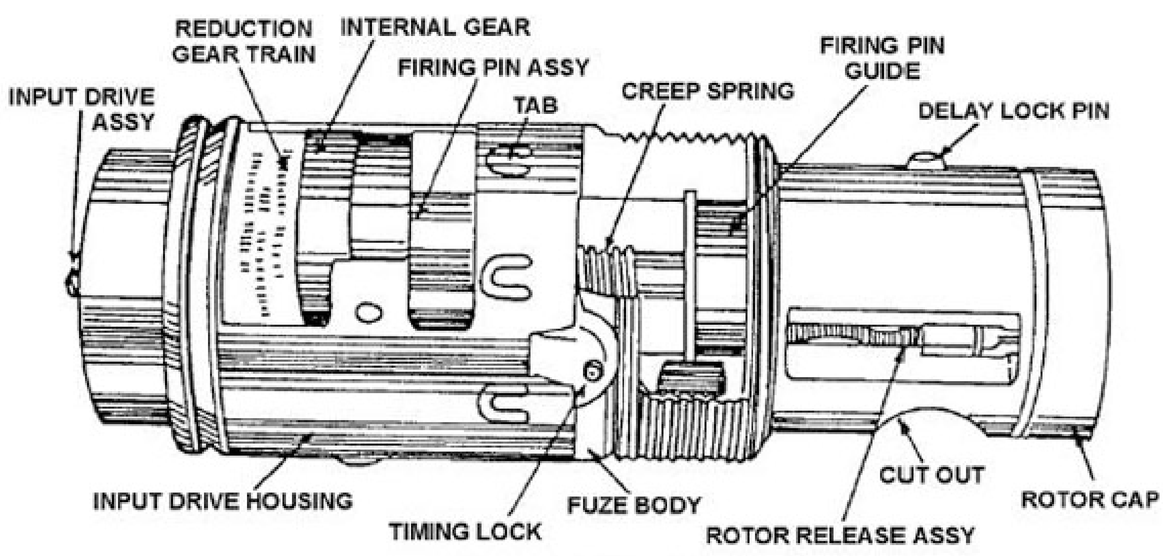

Figure 2–4. M905 tail fuze.

Safety features

The M905 fuze safety features include a key spring on the base of the input shaft to keep the shaft from rotating until the drive assembly coupler is connected. Like the M904 nose fuze, do *not* install the delay element into the fuze until just before you install the fuze. The empty delay element cavity acts as an interrupter to the fuze's explosive train during handling.

The M905 also has two arming windows. An upper window on the side of the fuze *shows full red when the fuze is armed*. A lower window above the rotor cavity indicates the rotor position. The fuze is *armed when this lower window shows red*.

The ATU–35 series drive assembly is an anemometer vane-type assembly that provides the rotational force to arm the M905 fuze (fig. 2–5). It consists of a vane, housing, mounting plate, restraining pin, and safety cotter pin with a streamer. Do *not* remove the safety cotter pin until just prior to aircraft takeoff.

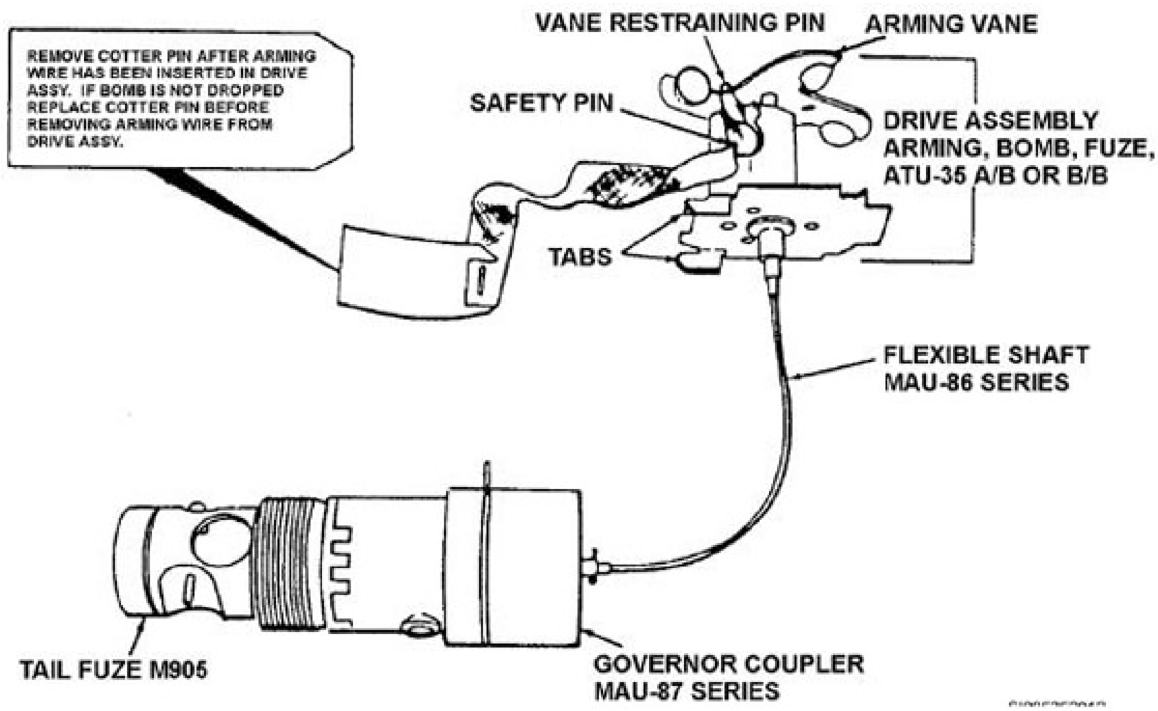

Figure 2–5. M905 tail fuze with arming components.

The drive assembly is available in two types: the ATU–35A/B and the ATU–35B/B. They differ in that the ATU–35B/B restraining pin dimensions have been changed to prevent reinstallation of the safety cotter pin when the restraining pin is retracted. An MAU–86 flexible shaft connects the ATU–35 to the MAU–87 fuze coupler. The coupler is attached to the M905 fuze with a fast-connect, spring-loaded connecting clamp and transmits torque from the flexible shaft to the fuze to initiate the arming sequence.

T46 adapter booster

Installing the M905 tail fuze in an MK 80 series or M-series GP bomb requires the use of a T46 adapter booster. Much like the T45, the T46 adapter booster has tetryl filler, but with *double* the net explosive weight (NEW). The T46 enables the M905 fuze to fit the tail fuze well. Once the T46 is initiated by the M905 fuze, it detonates the main explosive filler (burster) of the bomb (fig. 2–6).

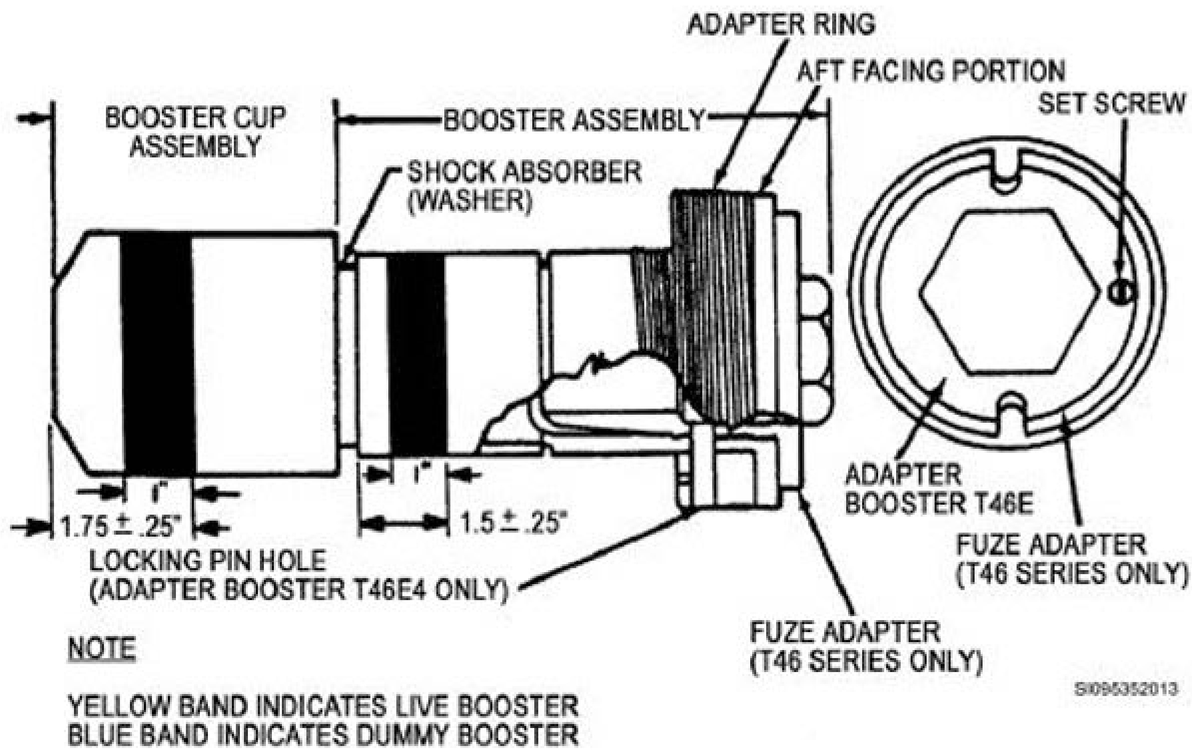

Figure 2–6. T46 adapter booster.

FMU–54/B tail fuze

The FMU–54/B fuze is a mechanically operated retardation sensing device with a predetermined arming delay of 0.75 to 3.5 seconds in intervals of 0.25 (fig. 2–7). The fuze fits into the tail fuze well of the MK 80 series general-purpose bomb equipped with an air inflatable retarder (AIR) fin.

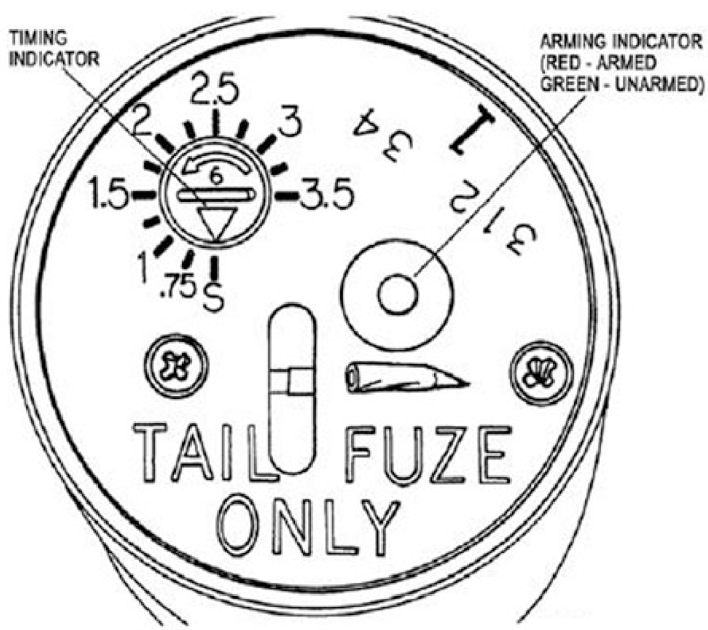

Figure 2–7. Face of FMU–54/B fuze.

Upon release, the high-drag fin causes the bomb to decelerate rapidly, initiating the fuze arming cycle and giving a safe separation distance from the delivery aircraft. In the event of a fin malfunction, the fuze will not arm.

FMU–54A/B tail fuze

This is a modified version of the FMU–54/B. The FMU–54A/B timing indicator provides delays of 2.5 to 6.0 seconds in 0.25 second intervals. The safety features of the FMU–54A/B include an arming indicator and a safing pin with a cable attached. The arming indicator shows the position of the detonator slider. A green color indicates an out-of-line condition, while *red indicates a fully armed condition*. Figure 2–8 shows the face of the FMU–54 and the position of the arming indicator. The safing pin provides ground-handling safety of the fuze and is removed by pulling the cable through the AIR fin.

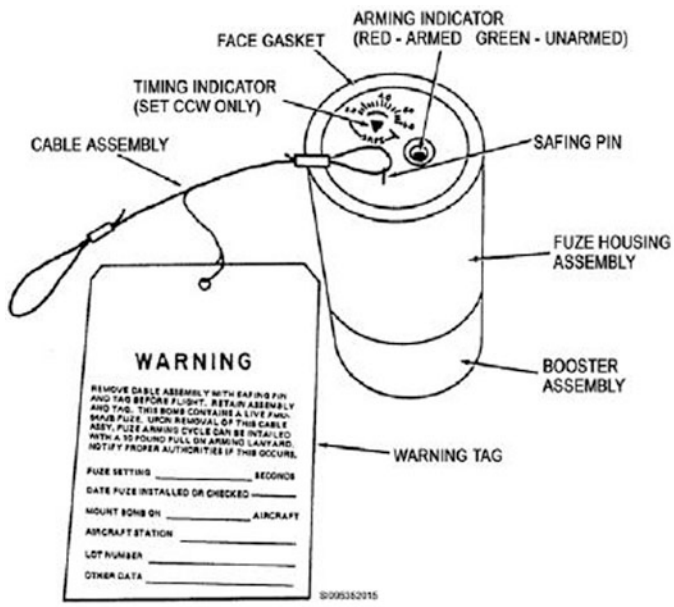

Figure 2–8. Face of FMU–54A/B fuze.

213. Electrical fuzes

There's no arming vane with the electrical fuze. In addition, the arming wire is replaced with a battery-firing device, a lanyard, and mechanical timers that are actuated with miniaturized electronic packages. Releasing the bomb pulls the lanyard, and the battery-firing device initiates the fuze battery. The fuze starts to operate when the battery voltage powers the solid-state electronic devices for various timing and control options.

FMU–81/B fuze

This electrical nose and tail fuze also provides a wide range of selective arming and impact functioning delays (fig. 2–9). Thumbwheels on each side of the fuze face are used to set the arming and impact functioning delays. The fuze arming circuit is inoperable when the arming thumbwheel is positioned to SAFE (S); locking plates behind the thumbwheels prevent their accidental movement.

A safe pin reveals the fuze's armed condition by protruding through a seal plug or the fuze nose. The safe pin holds the rotor out of line until the pin is driven through the plug by the arm enable bellows.

The FMU–81/B fuze is considered armed (fig. 2–10) when any of these conditions are met:

- The safety clip and warning tape are missing from the fuze nose.
- The safe pin protrudes through the seal plug in the fuze nose.
- The safe pin cannot be seen through the window in the fuze body.

If any of these conditions are present, notify the appropriate personnel.

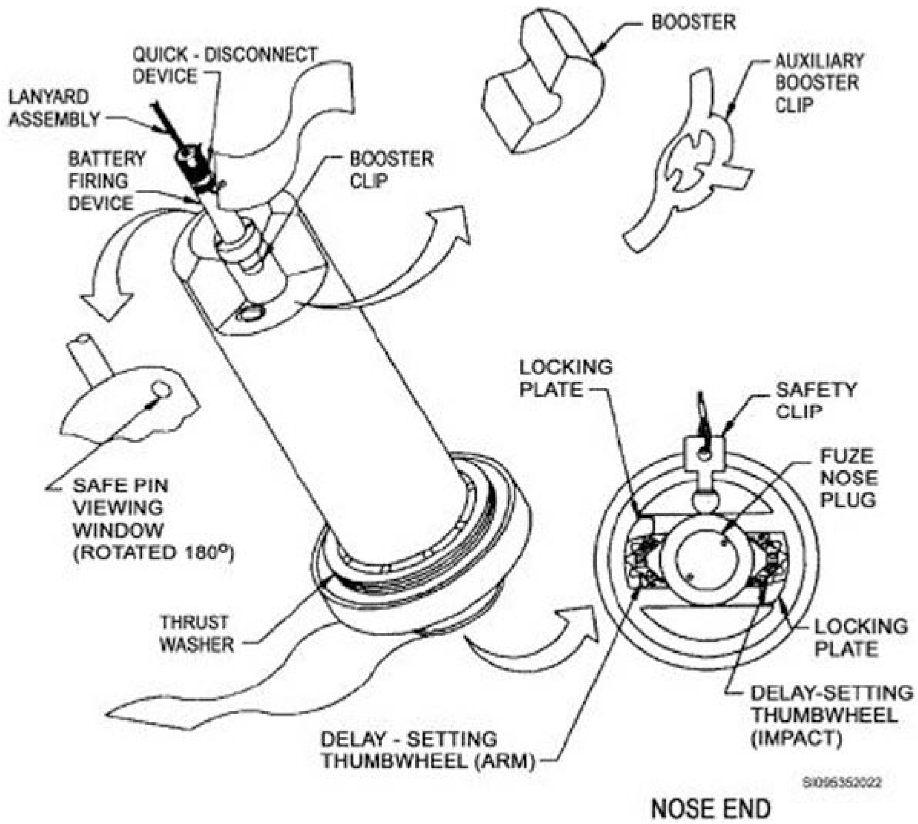

Figure 2–9. Typical FMU–81 fuze.

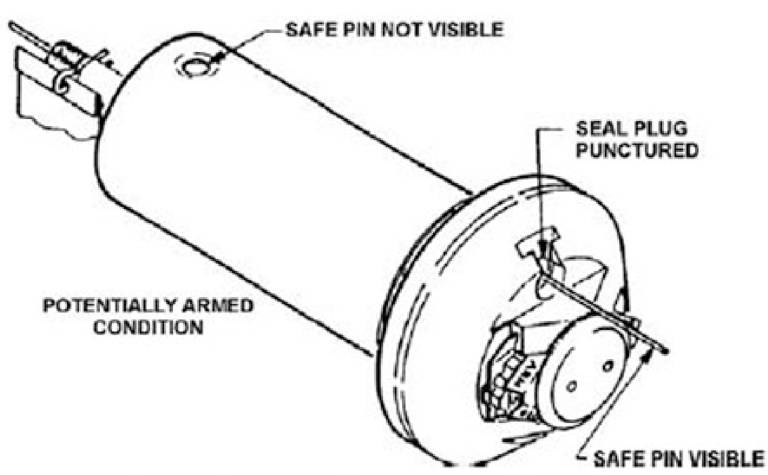

Figure 2–10. Potentially armed FMU–81 fuze.

The FMU–81/B fuze installed in the nose fuze well with four FZU–2/B boosters. When installed in the tail fuze well, only one FZU–2/B booster is installed.

FMU–124 series fuze

The FMU–124 series fuze is a nose or tail fuze for guided bombs and functions upon receipt of an electrical signal or on impact (fig. 2–11). An electrical signal provides airburst capability with two selectable arming times or a ground burst capability with three impact delay settings. A retractable cable connects to the rear end of the fuze. This cable is fed through the bomb's conduit into the charging well, where it is attached to the ADU–421A/B fuze adapter. The adapter electrically connects the nose and tail fuze.

The FMU–124 differs from other USAF munitions fuzes in that it only uses one safety device. The FMU–124 uses a safety pin, which is installed through the safety release shaft and safety device assembly. The fuze is considered:

- *Safe* when the *safety pin is installed.*
- *Armed* when the *safety pin is removed* and the *release shaft is extended*.

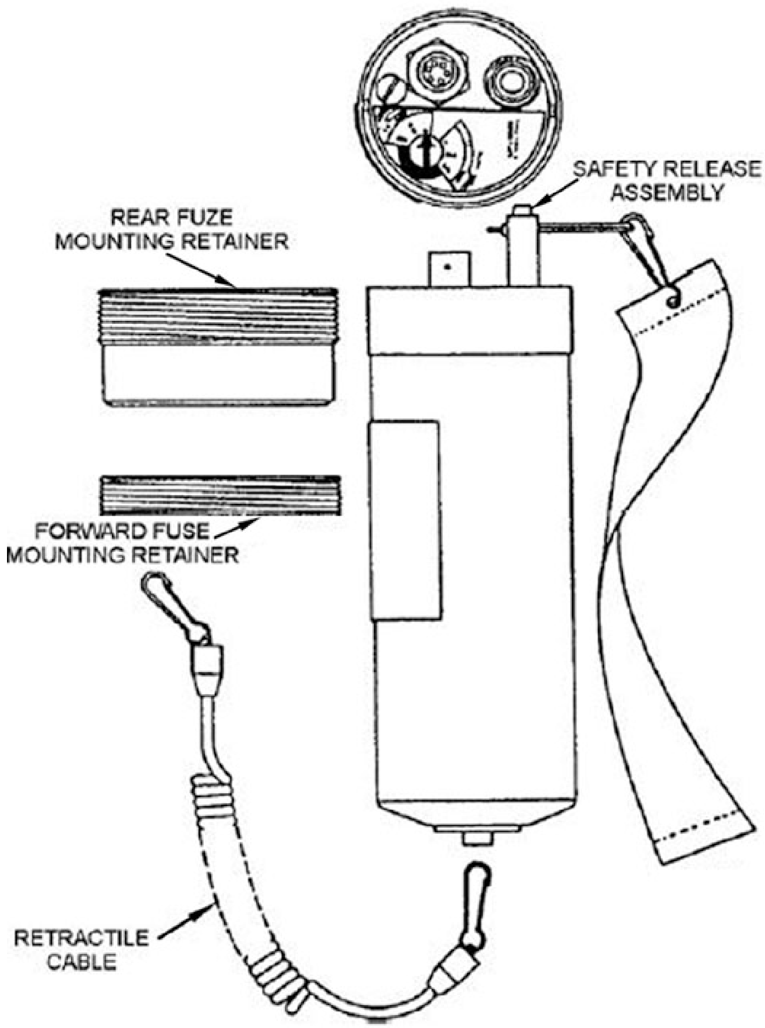

Figure 2–11. FMU–124 series fuze.

FMU–139A/B fuze

The FMU–139A/B is a joint-service (Navy and Air Force) common bomb fuze designed for use with the MK 80 series GP bombs. It is a solid-state, electromechanical, multi-option arming and functioning time nose or tail fuze (fig. 2–12). It is cylindrical, about 3 inches in diameter, 8 inches long, and weighs about 3 pounds. Once installed, it is completely enclosed in the bomb fuze well and locked in place with a closure ring. Associated components include an FZU–48/B initiator (generates power), closure ring, safety pin, shipping plug, power cable assembly, and air deflector (used with T-lug installations).

The FMU-139A/B is designed for electrical initiation but does not have any internal electrical power. The arm and delay times are set on the ground by rotating two knobs on the fuze faceplate. As a safety precaution, you must press a lockout (interlock) button to rotate the high-drag arm and delay switch.

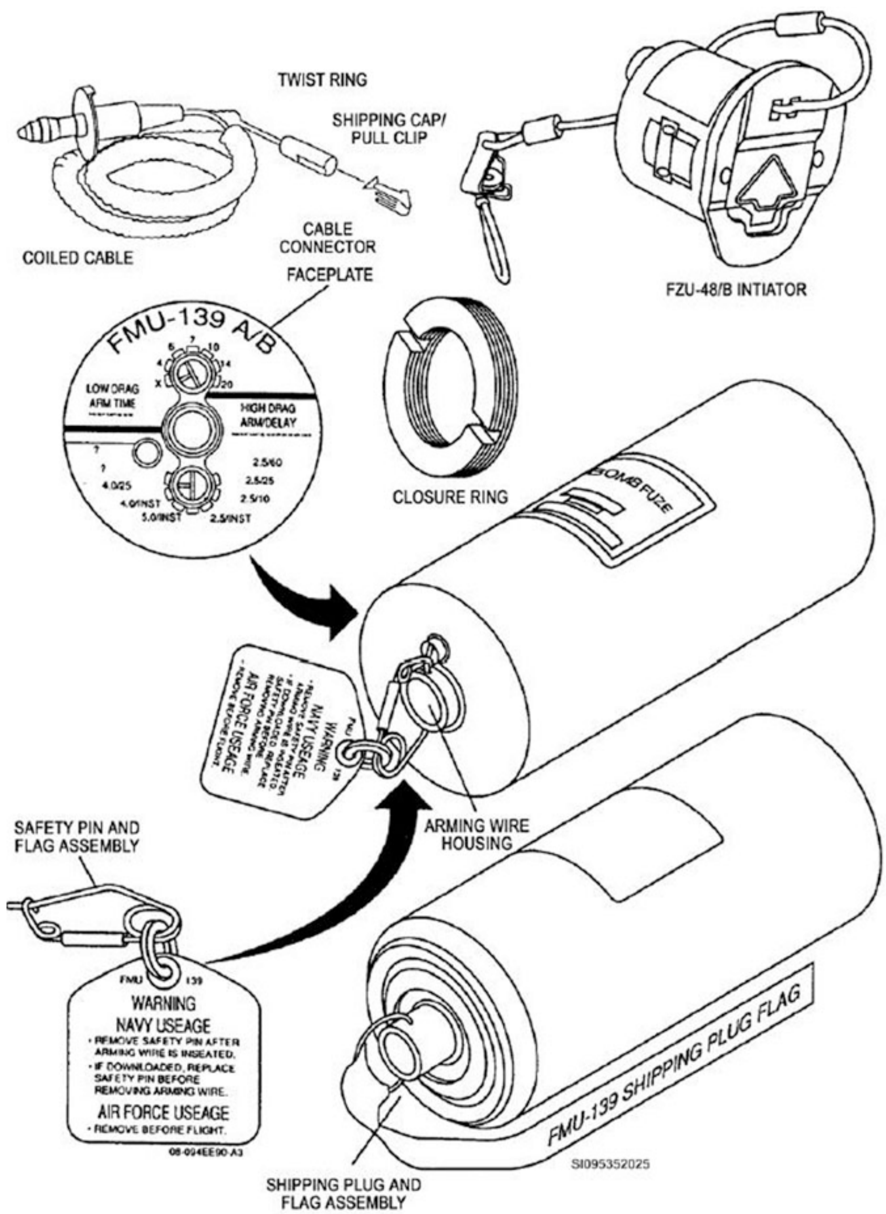

Figure 2–12. FMU–139A/B fuze and FZU–48/B initiator.

The FMU–139A/B fuze is designed for maximum safety in ground handling and delivery. A gag rod keeps the safe and arm rotor from rotating into the armed position. The gag rod is held in the locked position by a lock that can only be removed by firing the piston actuator. If the gag rod is unlocked, a red and black indicator is visible in the center of the gag rod housing around the gag rod. *If the indicator is visible, assume the fuze is armed.* The safing pin keeps the gag rod from moving, which keeps the safe and arm rotor locked in the safe position. If the safing pin is not removed before flight, the fuze senses this and aborts when it is released. If, during sampling of the retard sensors, at least 1 second of retard is not indicated, the low-drag arm time is selected. If the LOW-DRAG ARM TIME knob is set to the X position when the fuze is powered up, the fuze aborts and will not arm.

The FZU–48/B initiator provides electrical power for fuze operation and supplies power to either one or two FMU–139A/B fuzes. The initiator mounts in the bomb's charging well, on top of the bomb between the suspension lugs. A pull lanyard attaches from the cover to the bomb rack. When the bomb releases from the aircraft, the lanyard pulls on a shear wire in the initiator, and lets the cover open into the air stream. Once the cover is open, the FZU–48/B's voltage alternator starts generating power.

Opening the cover requires a force greater than 30 pounds. If the cover inadvertently opens on the ground during handling, the initiator cannot be used and must be rejected. Pushing the cover closed will *not* reset the spring that generates the release signal. If the fuze does not get a release signal, it aborts and does not arm. Once the cover opens, it takes at least 250 knots calibrated airspeed or 400 knots calibrated airspeed with the T-lug for the turbine alternator to generate any power.

FMU–143 series fuze

The FMU–143 series fuze (fig. 2–13) detonates after the bomb penetrates its target. The fuze can only be armed if it is connected to an electrical power source and the shaft of the safety release assembly is extended. The fuze is *safe* when the shaft is retracted into the safety release mechanism housing and both the safety pin and the arming pin are installed.

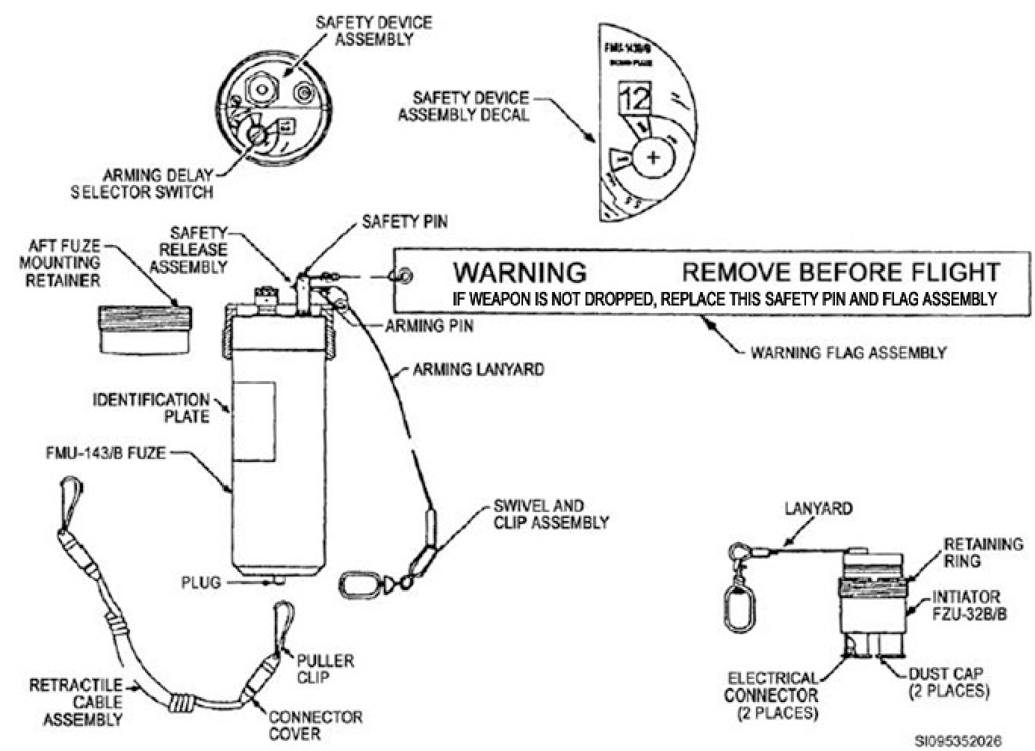

Figure 2–13. Typical FMU–143 series fuze.

Upon weapon release, the FMU–143 fuze arming lanyard removes the safety clip from the fuze safety device assembly and the fuze mechanical timer begins to operate. After approximately 1 second, the mechanical timer allows the FZU–32 to apply electrical power to the fuze, which arms after the selected electronic time delay has expired. The fuze then awaits bomb impact for the firing circuit to initiate detonation—approximately 60 milliseconds after impact. The fuze also has a selectable delay of 5.5 or 12 seconds in lieu of the 60-millisecond delay.

The FZU–32 series initiator (fig. 2–14) is a turbine generator that fits into the charging well to power the FMU–143 fuze. A retractile cable connects the initiator to the fuze. Upon weapon release, a hinged air scoop intake assembly is pulled open allowing air to drive the turbine. A *minimum* of 133 knots airspeed is required to start the turbine. The generator can provide 41 to 53 volts alternating current at 270 knots calibrated airspeed.

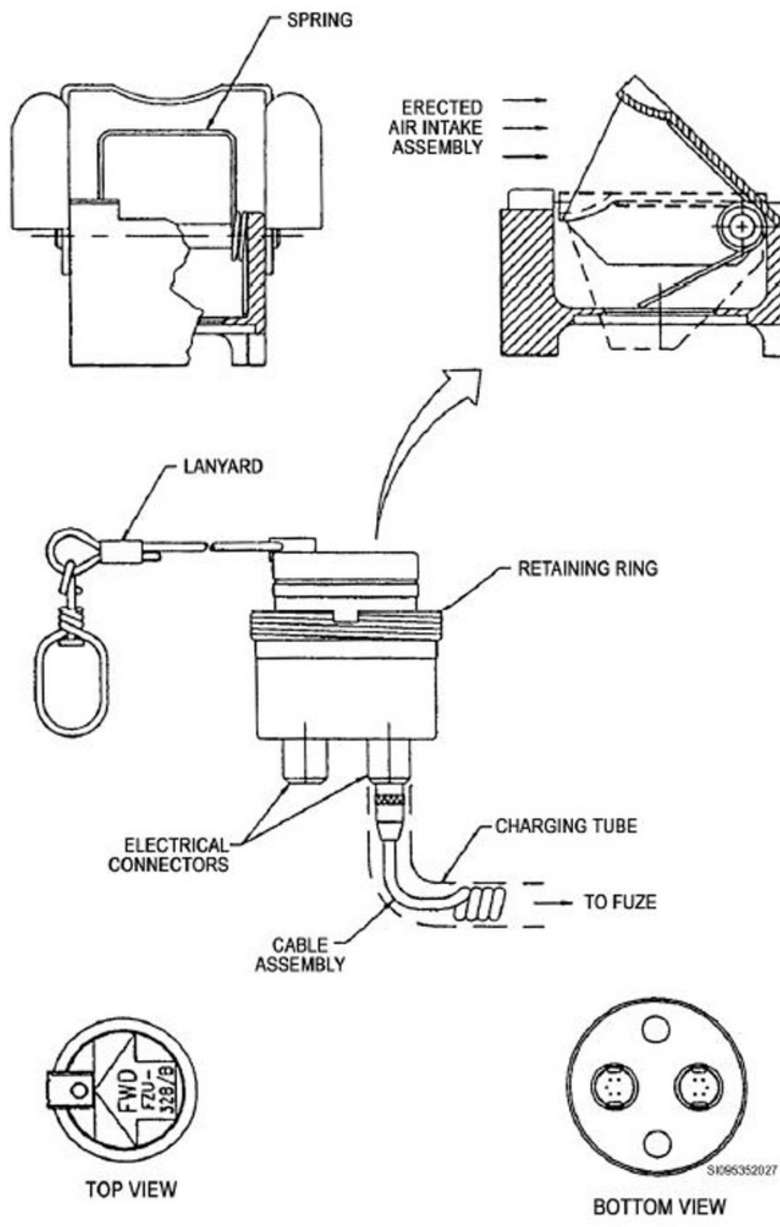

Figure 2–14. FZU–32/B fuze initiator.

FMU–152 series bomb tail fuze

The FMU–152 (figs. 2–15 and 2–16) is a joint-service (Navy and Air Force) bomb fuze. It is a multifunction, multiple delay tail fuze system with hardened target capability that provides safing, in-flight cockpit selection, and arming fuzing functions for general purpose and penetrating unitary warheads. The FZU–55 initiator (fig. 2–17) provides electrical power in the fuze. Once armed, the fuze can be initiated by either an external proximity sensor or the internal impact sensor. The FMU–152 is designed for maximum safety for handling and delivery. Consider the fuze *armed* and notify the appropriate personnel if the *gag rod indicator is showing red* and *protruding from the safety pin housing*.

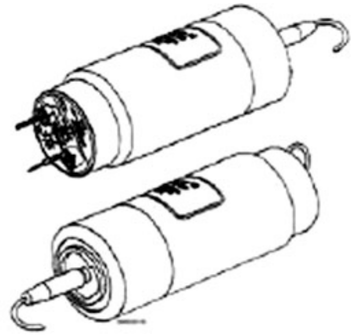

Figure 2–15. FMU–152 series bomb tail fuze.

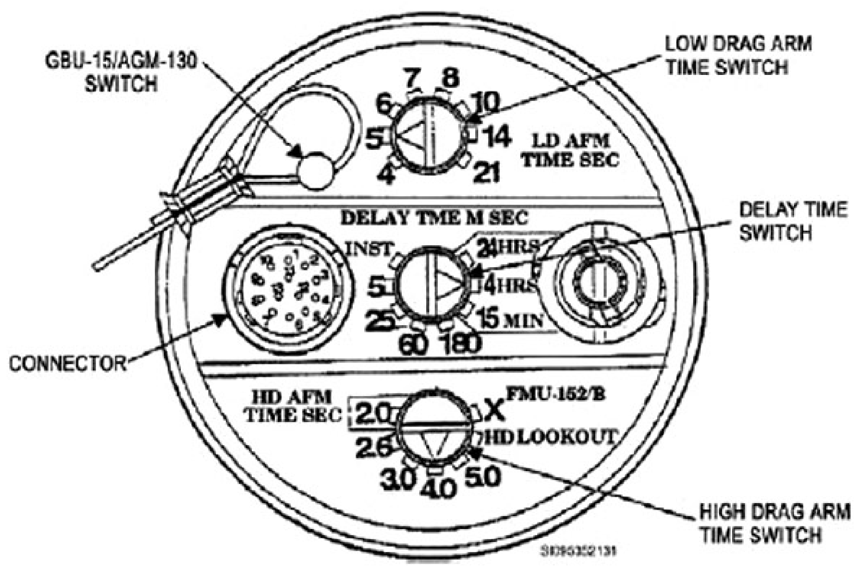

Figure 2–16. FMU–152 series control panel.

The FZU–55 bomb fuze initiator (fig. 2–17) is an air-driven turbine generator power supply used with the FMU–152 fuze. The initiator installs in the charging well and provides electrical power to the tail fuze. When the bomb drops from the aircraft, the tear seal pulls a lanyard which then exposes the turbine to the air stream, where it begins sustained power generation at a minimum 250 knots calibrated airspeed.

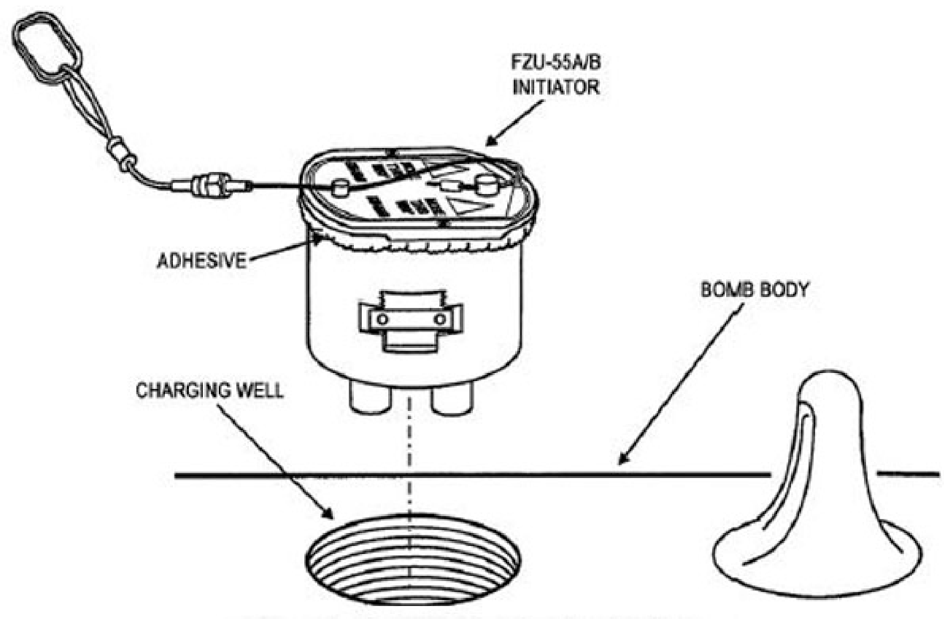

Figure 2–17. FZU–55 series fuze initiator.

214. Proximity fuze/sensors

All proximity fuze/sensors are placed in the nose of the warhead (bomb). They have the same basic design, related components, and operation as some of the fuzes we already discussed. The only difference is they have a preset height at which the bomb detonates; the fuze determines when that height is reached and detonates the bomb.

DSU–33 proximity sensor

The DSU–33 series (fig. 2–18) is a Doppler ranging radar proximity sensor that can be installed in the nose of a MK 80 series bomb (DSU–33A/B) or joint direct attack munition (DSU–33B/B). The sensor unit contains no explosives and is used in conjunction with either the FMU–139 or FMU–152 series tail fuzes. The only hazard associated with the DSU–33 is a thermal battery.

The DSU–33 provides a proximity signal to the bomb fuze through the FZU–48/B or FZU–55/B turbine alternator via the retractile cable (fig. 2–19). The sensor receives a thermal battery initiation signal from the FZU–48/B or FZU–55/B as the bomb is released from the aircraft. Once the sensor is operating, the normal height of burst above ground level is 20 feet over all surfaces. The height of burst is derived from the comparison of two Doppler signals. When the comparison meets the preset requirements of the sensor, a proximity signal is generated. The signal is processed and applied to the bomb fuze in the tail of the bomb.

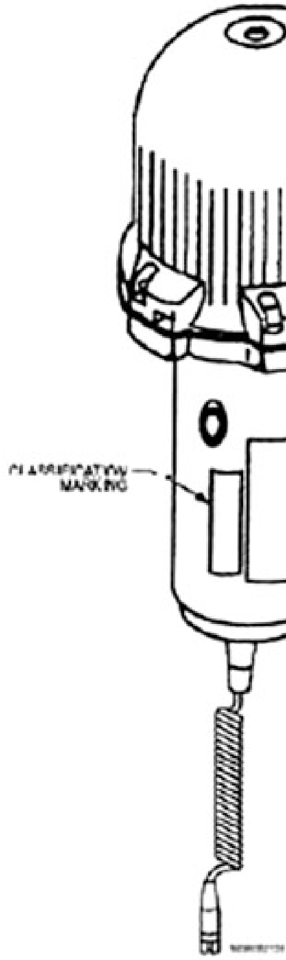

Figure 2–18. DSU–33.

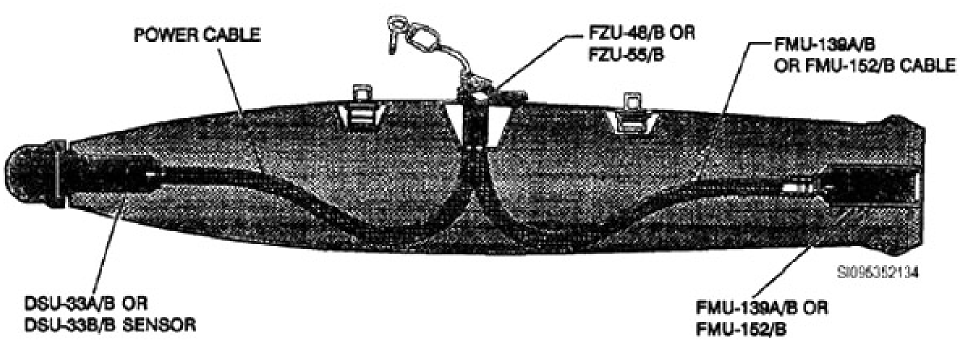

Figure 2–19. DSU–33 installed in general–purpose bomb.

FZU–39/B proximity sensor

The FZU–39/B proximity sensor (fig. 2–20) is a radio frequency radar ranging system providing high altitude functions for the suspension utility unit (SUU)–64/B, SUU–65/B and SUU–66/B dispensers. The FZU–39/B has provisions for presetting height of function (HOF) and an electronic countermeasures switch. The FZU–39/B sensor has no explosive components.

The proximity sensor has 10 height settings ranging from 300 to 3,000 feet. It's activated when the munitions fuze arming and fuze option lanyards are pulled upon release from the aircraft. The sensor operates using Doppler radar concepts. The transmitting antenna transmits a radar pulse to the ground that is reflected back to the sensor. When the height above ground is the same as the preselected height and the sensor measures proper closing velocity, it sends a signal to the integral fuze, which initiates fuze function.

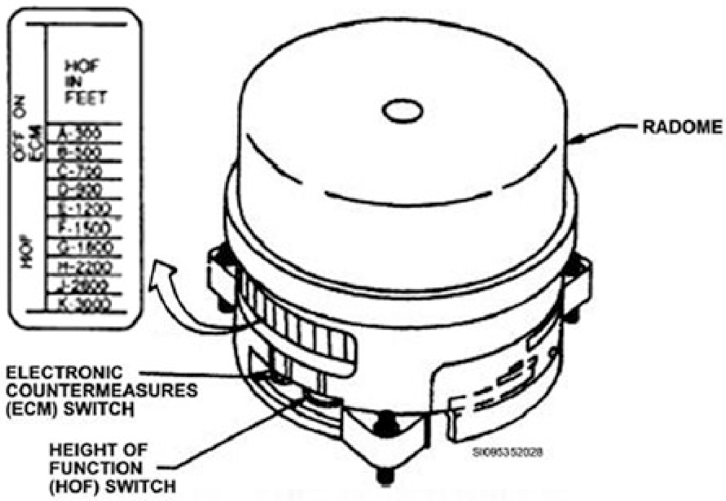

Figure 2–20. FZU–39/B proximity sensor.

FMU–113/B proximity fuze

This FMU–113/B proximity fuze (fig. 2–21) is a turbine-powered, Doppler radar proximity fuze used to detonate GP bombs at low altitude or on impact if the proximity mode fails. This fuze has seven selectable arm times (5, 6, 7, 8, 9, 10, and 18 seconds) and a safe position. The height of burst, which is about 15-feet above ground level, is built into the fuze at the time of manufacture. The FMU–113 series fuze uses the FZU–2/B fuze booster.

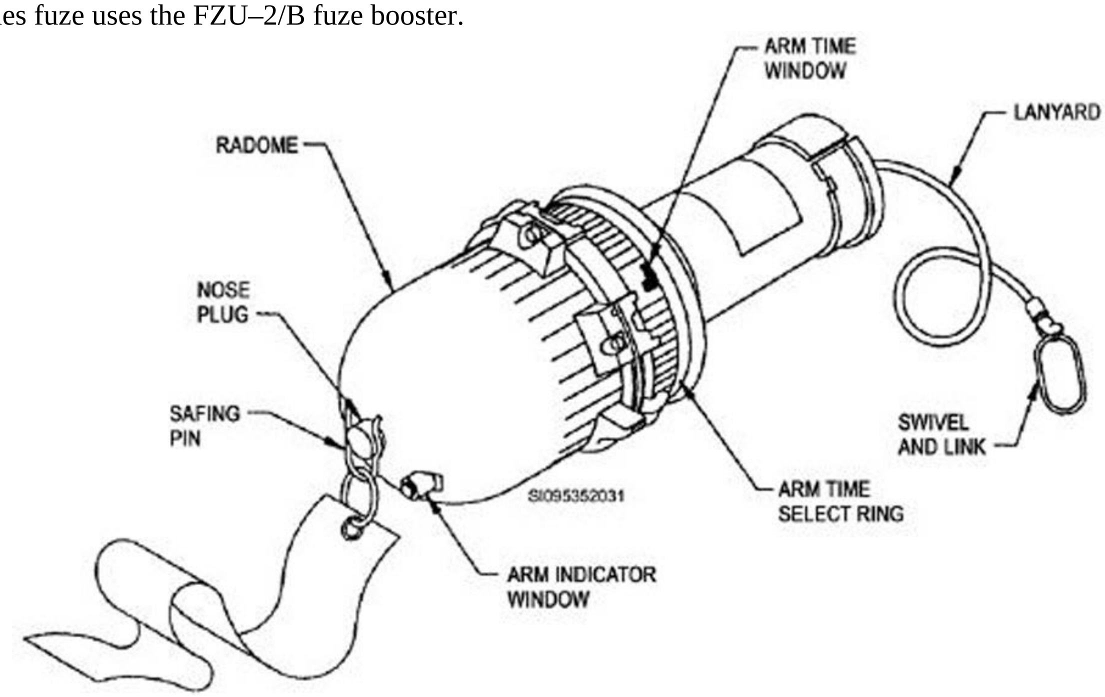

Figure 2–21. FMU–113 series fuze.

Safety features of the FMU–113/B consist of a safing pin, a velocity sensor, a rotor lock, an arm indicator window, and an arm time-select ring. With the safing pin installed in the nose of the fuze, the nose plug cannot be retracted and the lanyard pull mechanism cannot be actuated. The velocity sensor keeps the air turbine from rotating unless the air velocity through the fuze exceeds 200 knots calibrated airspeed. The rotor lock mechanically locks into the SAFE position and removes by initiation of the lanyard. The arm indicator window appears green if the S and A rotor are in the SAFE position. With the arm time-select ring set in the SAFE position, the safe separation timer will *not* release the S and A rotor. The fuze is *safe* when,

- the safing pin is installed.
- the arm indicator is green.
- the arm time-select ring is set on the SAFE position.

Treat the fuze as *armed* if *any position of the armed indicator is red* and notify the appropriate personnel.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

211. Characteristics and applications of bomb fuzes

1. How do we classify bomb fuzes?

2. Name the three main types of fuze action.

3. What determines the detonation of a *proximity* fuze?

4. What are the two main types of fuze arming?

5. What are the *most common safety devices* found in bomb fuzes?

6. What fuze safety device is installed at the *time of manufacture*?

212. Mechanical fuzes

1. When is the *sealing wire* from an M904 nose fuze removed?

2. What is the purpose of the *empty delay cavity* on the M904 and M905 fuze?

3. Which *adapter booster* do we use with the M904 fuze?

4. What provides the rotational force required to arm the M905 fuze?

5. What happens to the FMU–54/B fuze if the *fin malfunctions*?

6. What provides *ground handling safety* for the FMU–54?

213. Electrical fuzes

1. Name at least three different electrical fuzes.

2. How many FZU–2/B boosters are required when an FMU–81/B fuze is *installed in the tail* of a bomb?

3. Which fuze has only one safety device that is installed through the safety release shaft and safety device assembly?

4. Which two fuzes are used by both the Navy and the Air Force?

5. What provides *electrical power* in the FMU–139A/B fuze?

6. What provides *electrical power* in the FMU–143 series fuze?

7. What capability does the FMU–152 series fuze provide?

8. What can be determined if the *gag rod indicator is showing red and protruding from the safety pin housing* of an FMU–152 series fuze?

214. Proximity fuze/sensors

1. What type of sensor is the DSU–33?

2. Which tail fuzes are used with the DSU–33?

3. Which dispenser(s) uses the FZU–39/B proximity sensor?

4. What are the function height settings for the FZU–39/B?

5. Which *booster* does the FMU–113/B fuze use?

6. What indicates the FMU–113/B fuze is *armed*?

2–2. General-Purpose Bombs

A *complete round* is all the components of a munitions item necessary to function that weapon once. The function of a bomb depends on many different accessories. Those accessories include but are not limited to the bomb body, suspension lugs, fin assemblies, arming wire assemblies or lanyards, fuze, adapter boosters, and so forth. There are many different types of bombs as well. The types used throughout our career field are HE bombs, penetrating bombs, leaflet bombs, and incendiary bombs. In this section, we cover the different types of HE or GP bombs used within the Air Force and the devices used to stabilize bombs so they accurately hit their targets.

215. MK80 series bombs

The MK80 series GP bomb has a combination of effects that includes blast, fragmentation, and penetration. The case is heavy enough to produce some penetrating qualities along with the blast and some fragmentation. MK80 series GP bombs weigh from 500 to 2,000 pounds and have a net explosive weight (NEW) of approximately 40 percent of the total weight of the end item.

MK82/BLU-111 (500-pound bomb)

MK82 series bombs are relatively thin cased with a slender body that is designed for improved ballistics. Two conduits for FMU-type fuze lanyards connect nose and tail fuze wells to the charging well. A cutaway of an MK82 bomb is shown in figure 2–22. The body of this bomb is roughly a half-inch thick allowing the casing to create a serious fragmentation effect at the moment of detonation. The MK82 NEW is approximately 192 pounds, which produces considerable damage from the blast effect. In some cases, a mining or penetrating effect is gained by using a delayed-action fuze. Because of this versatility, the bomb is considered GP. The BLU–111 series bomb is identical to the MK82 series bombs with the exception of the explosive filler; it is loaded with 192 pounds of PBXN–109.

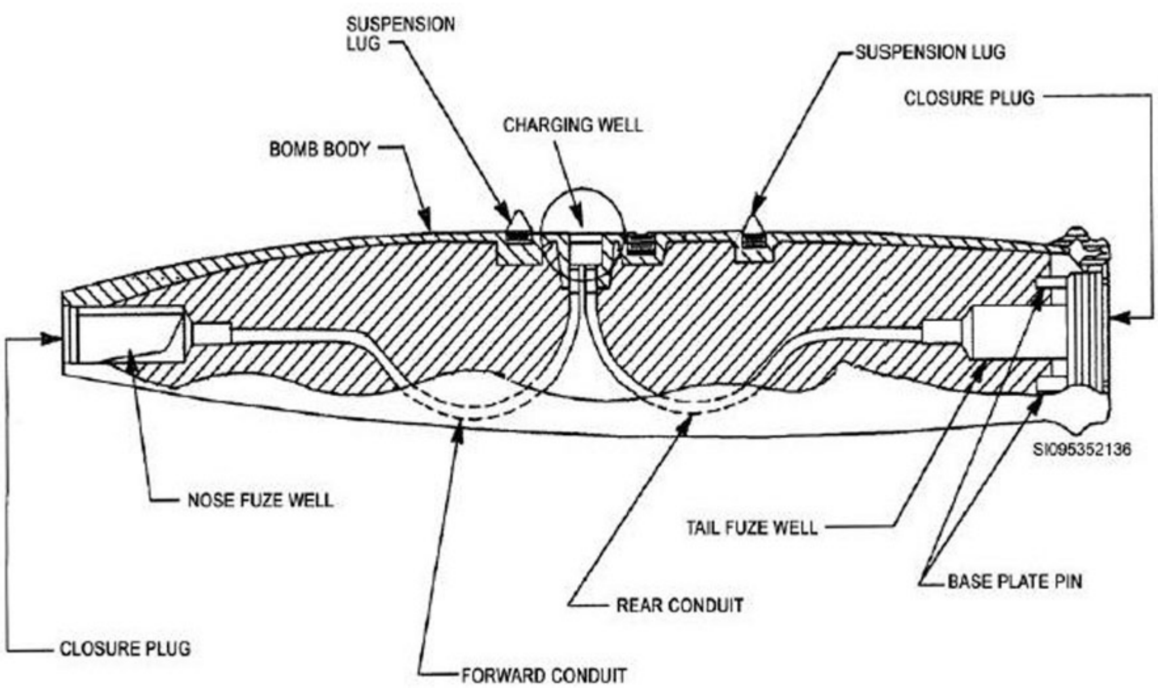

Figure 2–22. MK82 500–pound bomb (cutaway view).

Three types of fin assemblies are used with the MK80 series bombs: the MAU–93/B fin, the BSU–33 conical fin, and the BSU–49B air inflatable retarder fin.

MK 80 Series Fin Assemblies	
Type	**Description**
MAU–93/B fin	The MAU–93/B fin consists of an elongated cone and four streamlined blades assembled perpendicular to the cone at 90° intervals. The fin has one access hole and one rectangular plate for mounting the ATU–35 series drive assemblies. The fin is secured to the bomb with six setscrews and allows for a low-drag delivery to the target.
BSU–33 conical fin	The BSU–33 is a next generation conical fin assembly, which through attrition will eventually replace the MAU–93 conical fin. The BSU–33 fin is of welded construction with one access plate and one rectangular plate for mounting the ATU–35 drive assembly. It also has an arming wire guide in line with a snap bushing hole. The BSU–33 fin is secured to a bomb with a quick attach nyloc-inserted nut. This quick attach device (clamp bolt assembly) uses a single Allen head screw to secure the fin assembly to the bomb body. These two conical fins are used for high altitude delivery. In comparison with its predecessor, the BSU–33 attaches more quickly than the MAU–93/B, thus decreasing assembly time.
BSU–49/B air inflatable retarder (AIR) fin	For high-speed, low-altitude delivery, the MK82 uses a high-drag retarding fin called the BSU-49/B AIR. The BSU-49/B AIR is a fixed finned stabilizer that consists the housing, a high-drag AIR, and a lanyard assembly. One trailing edge fin wedge installed on each fin provides stabilizing spin during low-drag release.

MK 80 Series Fin Assemblies	
Type	**Description**
	Eight socket head setscrews secure the fin to the bomb. The fin provides a high-drag, low-altitude bombing capability that ensures safe aircraft separation from the bomb's blast and fragmentation envelope. A *low-drag release* is achieved by *not* deploying the AIR. When the bomb is released from the aircraft, a lanyard is pulled which releases a spring-loaded aft cover that will, in turn, pull the nylon retarder partially out of the fin. The air stream then forces air into the retarder causing it to immediately inflate and rapidly slow the bomb's descent.

MK83/BLU–110 (1,000-pound bomb)

MK83 series bombs are relatively thin cased with a slender body for improved ballistics. Two conduits for FMU-type fuze lanyards connect nose and tail fuze wells to the charging well. A cutaway of an MK83 bomb is shown in figure 2–23.

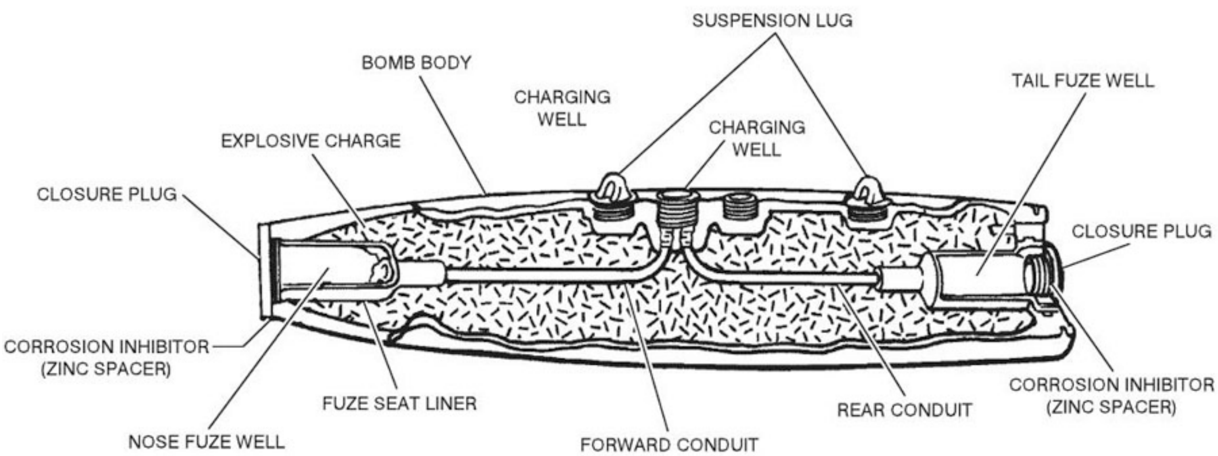

Figure 2–23. MK83/BLU–110 1000-pound bomb.

The MK83 series is employed as general-purpose bombs delivered in high drag or low drag modes with ground burst, air burst, or delayed fuzes. With the right fin/airfoil group and fuzing, these bombs can be used as precision guided munitions. The NEW is approximately 445 pounds—about 40 percent of the total assembled weight of the bomb—of explosive. Detonation occurs when the explosive train progresses through the fuze (delay, instantaneous, or proximity) which detonates the booster and explosive charge.

The BLU–110 series bombs use the MK83 Mod 4 bomb body, and share the same features of the MK83 general-purpose bombs with the exception of the explosive filler which is loaded with PBXN–109.

MK84/BLU–117 (2,000-pound bomb)

Besides size, the MK84 series bombs are much like the MK83 series bombs in that they are relatively thin cased with a slender body for improved ballistics. Two conduits for routing electrical connections extend from the nose and tail fuze wells to the charging well. A cutaway of an MK84 bomb is shown in figure 2–24.

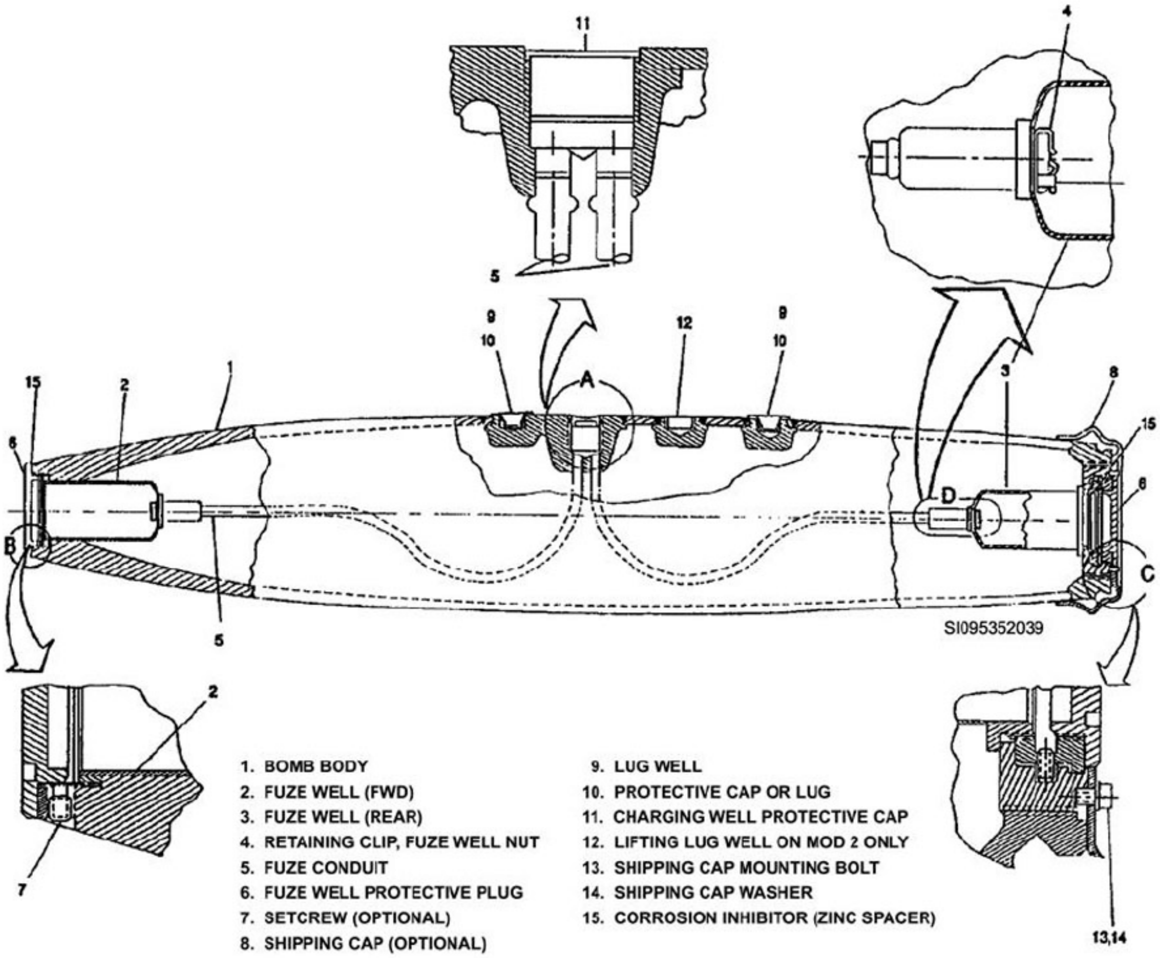

Figure 2–24. MK84 GP bomb.

The body of this bomb is roughly a half-inch thick which allows the casing to create a serious fragmentation effect at the moment of detonation. The MK84 NEW is approximately 945 pounds, which produces considerable damage from the blast effect. The difference between the MK84 Mod 2 and the MK84 Mod 4 is that the Mod 2 has a hoisting lug (located between the aft lug and charging well) in it. Two types of fin assemblies are available for the MK84 GP bomb: the MK84 fin, which is a conical (low-drag) type, and the BSU–50/B AIR, which uses a retarding (high-drag) fin.

The BLU–117 series bomb is identical to the MK84 series bombs, with the exception of the explosive filler—loaded with 930 pounds of AFX–795.

216. Penetrator bombs

The BLU–109, BLU–113, BLU–118, and BLU–122 series penetrator bombs are designed to be used on hardened targets. Delayed fuzing allows penetration and destruction at desired times. The absence of a nose fuze well (cavity) makes the nose stronger. The stronger nose assists these bombs in the penetration of hardened aircraft shelters, reinforced concrete buildings, underground command and control facilities, and runways. Penetrator bombs are capable of being delivered as either precision-guided munitions or as GP low-drag bombs when pinpoint accuracy is not required.

BLU–109 series penetrator bomb

The BLU–109 series penetrator bomb is a 2,000-pound class hard target penetrator warhead (fig. 2–25). The BLU–109/B is filled with a 80/20 tritonal explosive (80 percent TNT and 20 percent aluminum powder) while the BLU–109 B/B is filled with PBXN–109 which is less sensitive to shock and heat. The BLU–109 body is a 25.4 mm (1 in.) thick casing of HP9420 alloy steel. This body is approximately twice the thickness of the MK84. The shape and heavy-walled steel case provide penetration of hard targets built of earth, concrete, and rock. This bomb can penetrate 4 to 6 feet of reinforced concrete.

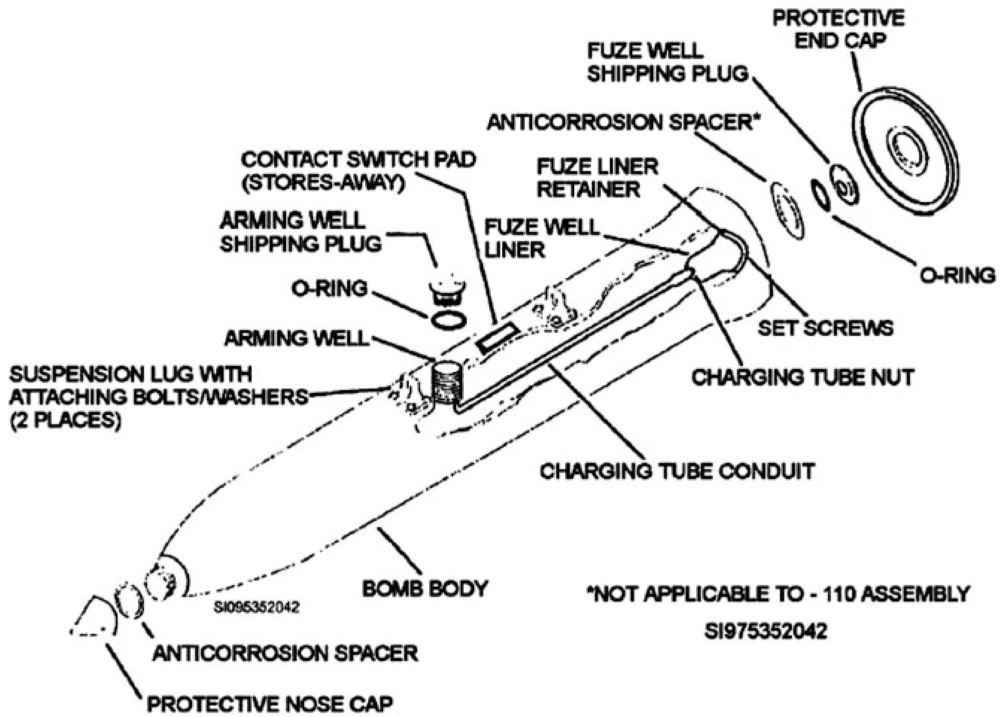

Figure 2–25. Typical BLU–109.

BLU–113 series penetrator bomb

The BLU–113 series penetrator bomb is an improved 4,000-pound bomb (fig. 2–26). Its case is made from modified HP9420 alloy steel, basically the same material from which large gun barrels are made. The shape and heavy-walled steel cases provide penetration of hard targets built of earth, concrete, rock, and cave complexes. It is filled with an 80/20 tritonal explosive (80 percent TNT and 20 percent aluminum powder). The BLU–113 is *not* used as a standalone free-fall bomb. It is a warhead used in the GBU-28A/B and B/B.

BLU–118 thermobaric bomb

Sometimes operations required us to wage war deep within caves and bunkers. This became evident as Al Qaeda and Taliban forces hid within elaborate cave complexes in Afghanistan. The answer to these cave fortifications was the use of a 2000-pound BLU–118 thermobaric bomb (fig. 2–27) The BLU–118 uses the same penetrator body as the standard BLU–109 bomb, but the biggest difference is the filler. The BLU–118 is filled with a thermobaric explosive that is more lethal in confined spaces than other explosives. The BLU–118 is filled with PBXIH–135, which is a mixture of 45 percent HMX, 35 percent aluminum powder, and 20 percent polyurethane binder.

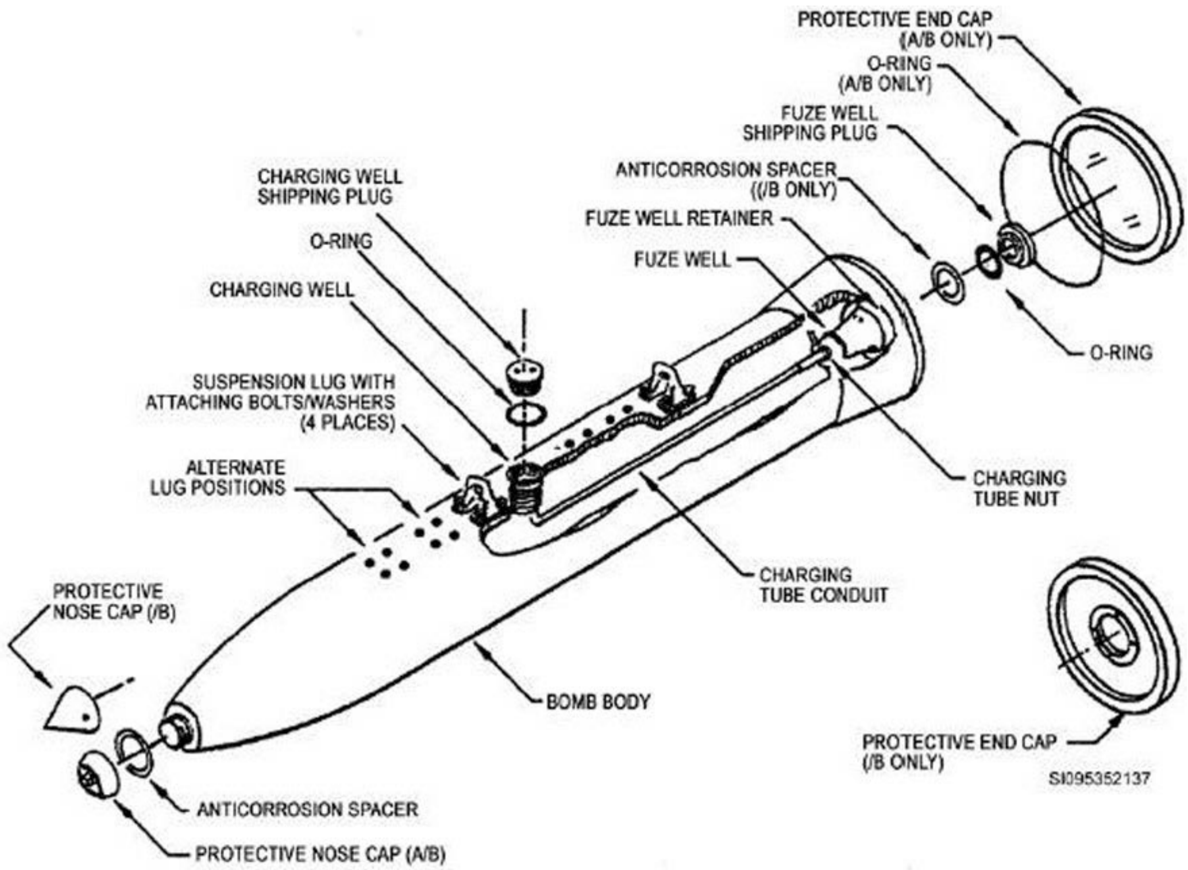

Figure 2–26. Typical BLU–113.

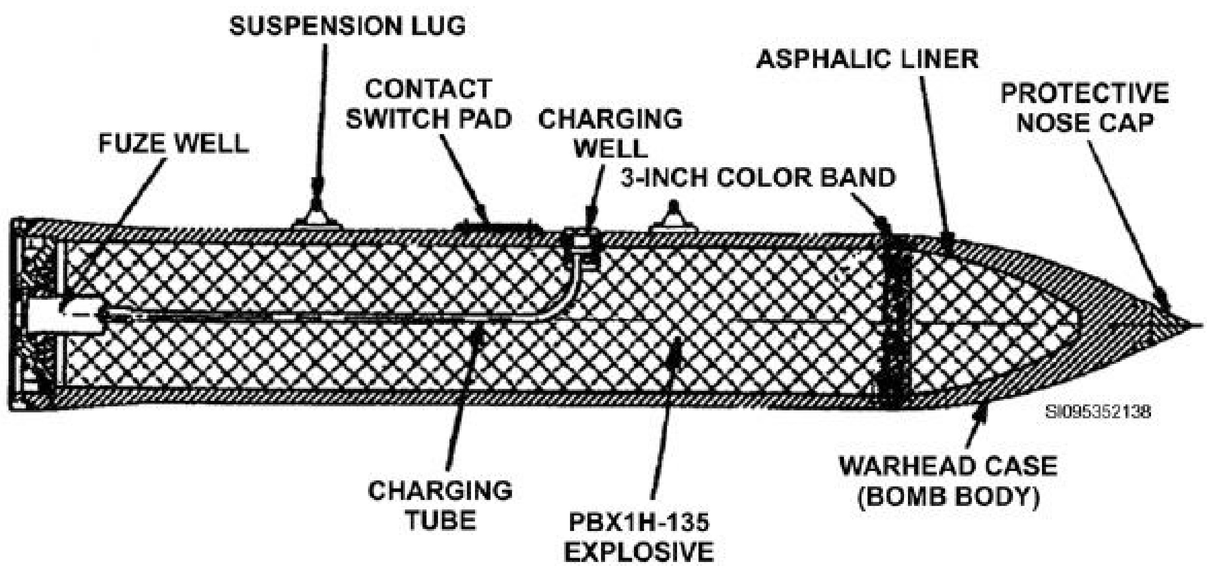

Figure 2–27. BLU–118.

BLU–122 series penetrator bomb

The BLU–122 series bomb is a 5000-pound class penetrator measuring in at 13.5 feet long (fig. 2–28). The BLU–122 improves upon the BLU–113 in terms of penetration, survivability, lethality, explosive insensitivity, and targets held at risk. The case is made from Eglin Steel to provide deeper target penetration capabilities and survivability over the BLU–113. The bomb body is filled with AFX–757 explosive and uses an auxiliary booster explosive, PBXN–110. The BLU–122/B is *not* used as a standalone free fall bomb, it is a warhead used in the GBU–28C/B to penetrate hard and deeply buried targets.

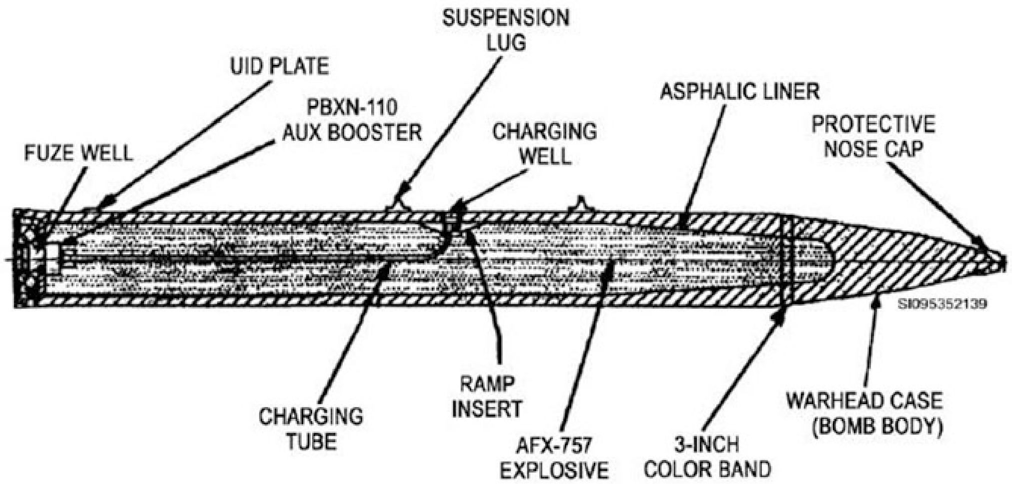

Figure 2–28. BLU–122.

217. Special-purpose bombs

There are times when a general-purpose bomb does not meet the mission's needs. The mission may call for conducting propaganda operations, or reaching the enemy without unnecessary collateral damage to friendly forces or noncombatants. For these situations, a more efficient way of meeting the mission is to use a special-purpose bomb. This lesson covers a few of the special-purpose bombs the Air Force uses to meet such needs.

M129 series leaflet bomb

Leaflet bombs are fiberglass canisters used to deliver leaflets/literature to persuade the enemy to surrender or to inform the local population of a situation. When the canister or bomb explodes, the leaflets fall free to the earth. One of the many different types of leaflets dropped over Kuwait during the Persian Gulf War is shown in figure 2–29. Several million leaflets were dropped on Iraqi troops prior to the ground invasion. It is reported that the use of leaflets was a major factor in the lack of resistance encountered when the ground war did start.

The M129 series leaflet series bomb (fig. 2–30) is similar in appearance to the 750 pound general-purpose bomb, but weighs a lot less depending on the paper weight of its internal load. The M129 can be loaded with 110 paper rolls, but is stored empty and unfuzed. The cylindrical shaped bomb is split longitudinally into two sections and held together by four latches on each side. A fuze is installed in the nose, with no provisions for a tail fuze. The fuze functions after a preset time and initiates the adapter booster which in turn sets off the detonating cord. The detonating cord separates the two bomb halves dispersing the load (leaflets) into the air.

Figure 2–29. Desert Shield/Storm leaflet.

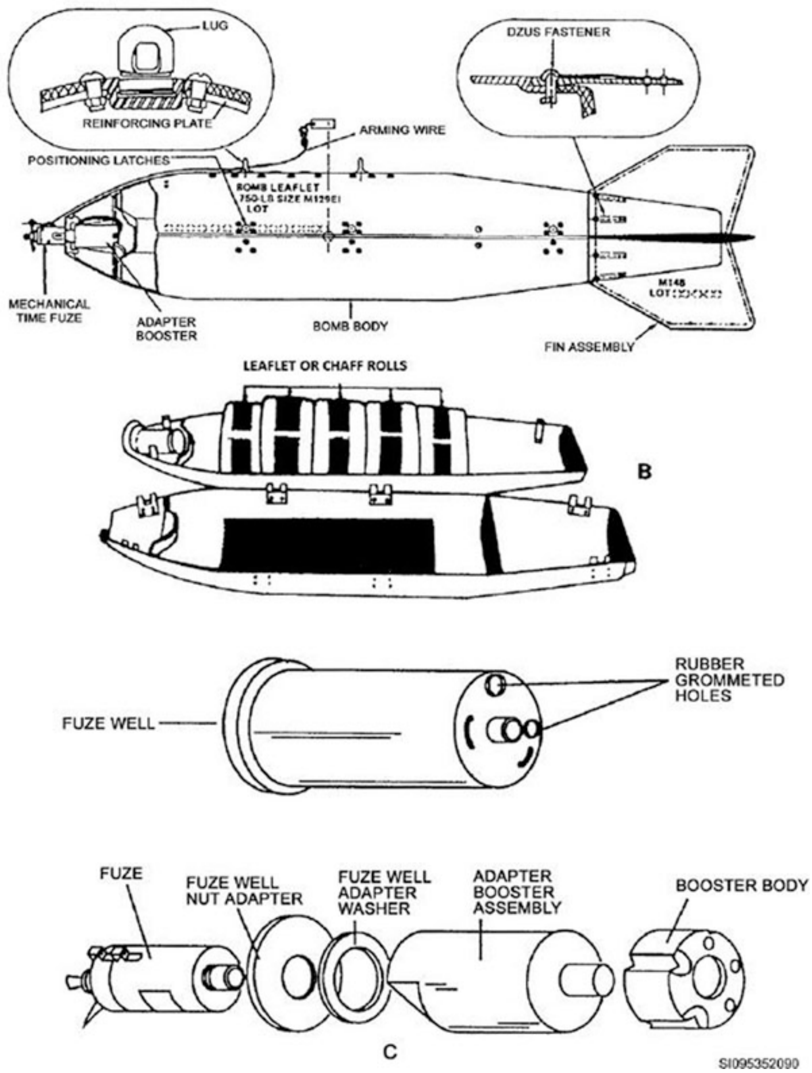

Figure 2–30. M129 series bomb.

PDU–5/B leaflet bomb

The PDU–5/B leaflet bomb (fig. 2–31) was developed to distribute literature much like the M129 series bomb, but uses the SUU–76C/B dispenser. Because this leaflet bomb is housed within the suspension utility unit, it is often referred to as the SUU–76C/B (PDU–5/B) leaflet bomb. Once released from the aircraft the arming and fin release wires are pulled, which unsafe the fuze and release the fins. The fins are snapped open by spring force and stabilize the bomb in flight. In order to arm the MK339 fuze, sufficient airspeed is required to rotate the impeller at least 5400 revolutions per minute (rpm). After a preset delay interval (depending on the required fuze time selected) the fuze initiates a linear-shaped cutting charge secured inside the dispenser skin. The shaped charge separates the dispenser from front to back dispersing the load of leaflets.

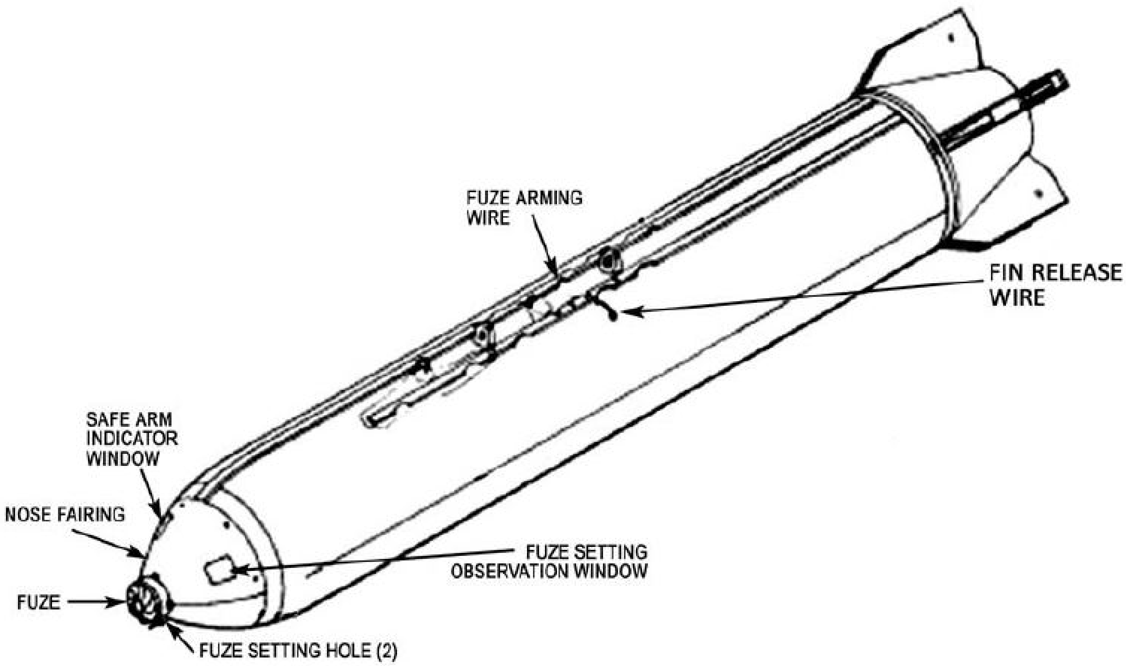

Figure 2–31. PDU–5/B leaflet bomb.

BLU–126/B low collateral damage bomb

The BLU–126/B (fig. 2–32) is a low collateral damage bomb (LCDB) intended for the attack of soft fragment sensitive targets, troops, radars, and unprotected aircraft with reduced collateral damage. The LCDB was developed for use in situations where friendly forces and/or civilians are close to the target. The BLU–126/B bomb is identical to the MK82 MOD 2 bomb, with the exception of the explosive filler. The BLU–126/B is filled with approximately 27 pounds NEW of PBXN–109 in contrast to the MK82’s NEW of 192 pounds. The remainder of the bomb is filled with PBXN–109 inert stimulant. The BLU–126/B is compatible with proximity sensor, mechanical, and electrical or electronic fuzes. It uses either a conical, high drag, laser, global positioning system guidance airfoil kit, or a mine kit for a fin.

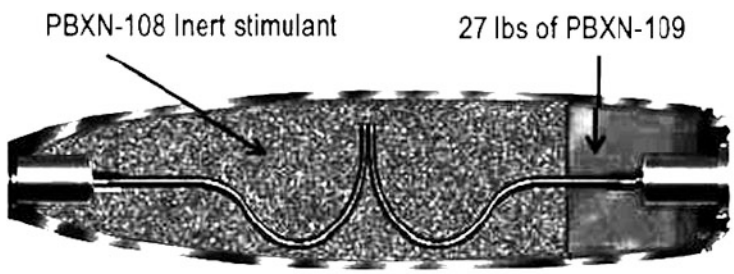

Figure 2–32. BLU–126/B LCDB.

BLU–129/B precision lethality low collateral bomb

The BLU–129 is a precision lethality low collateral bomb intended for a wide range of targets. Much like the BLU–126/B, the BLU–129/B has the same form and fit as the MK82 series bomb. However instead of containing less NEW, pound-for-pound the BLU–129/B has more explosive lethality than any other 500-pound bomb class. This precision lethality low collateral bomb contains 300 pounds NEW of a multiphase blast explosive (AFX–1282) filler. What makes the BLU–129/B a low collateral bomb is the inert fill in the nose which reduces fragmentation. The inert filled nose also explains why this bomb cannot be fuzed from the nose fuzewell.

218. Practice bombs

Practice bombs, as their name denotes, allow for aircrew and ground crew training. There are two types of practice bombs—dummy and training. Munitions designated as training include some type of explosive, burning, or smoke-producing element, which permits a visual observation of bombing accuracy. Dummy munitions are either inert (filler) or empty (no filler). Practice bombs come in either full size or miniature, with weights ranging from 5 pounds to 2,000 pounds. These bombs provide low-cost target practice for the flight crews of fighter and bomber aircraft. Practice bombs are also used by the ground crew for identifying, assembling, fuzing, and bomb handling training.

BDU–33 bomb

The BDU–33 series, 25-pound practice bomb (fig. 2–33) is teardrop shaped with a tube cavity lengthwise through the center. Also, a conical after-body with a cruciform fin is roll-crimped into the aft end of the bomb body. When attaching it to the aircraft, you screw a single suspension lug into the bomb body at its center of gravity.

Depending on local requirements, you use either the MK4 Mod 3 or CXU–3A/B spotting charge with the BDU–33B/B. The spotting charges resemble a 10-gauge shotgun shell. The MK4 Mod 3 holds a charge of smokeless powder and a marker load of stabilized red phosphorous. Use the CXU-3A/B where the danger of starting brush or forest fires is high. It holds an expelling charge of propellant and a marker load of titanium tetrachloride. The CXU-3/B spotting charge uses a commercial shotgun primer. You must install a safety block to prevent accidental firing during handling. *Never force the spotting charge into position in the bomb.*

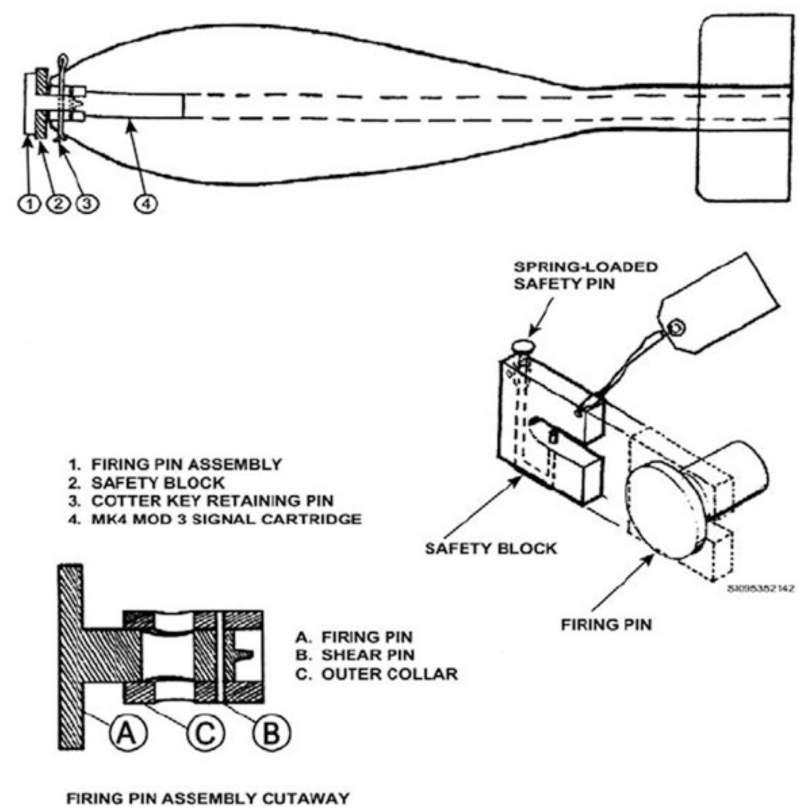

Figure 2–33. BDU–33 series practice bomb.

BDU–48/B bomb

The BDU–48/B practice bomb (fig. 2–34) is 21 inches long, 4 inches in diameter, and weighs approximately 10 pounds. It has an outer cylinder, an inner cylinder, a firing device, signal cartridge, and box-type fin assembly. The BDU-48/B also uses the MK4 Mod 3 or CXU–3A/B signal cartridges. On this bomb, the signal cartridge is held in place by the firing pin and a cotter pin inserted through holes in the forward end of the bomb. It has no safety device, so take extreme caution in handling and loading it. The BDU–48/B resembles the ballistics of the MK82 AIR high-drag bomb.

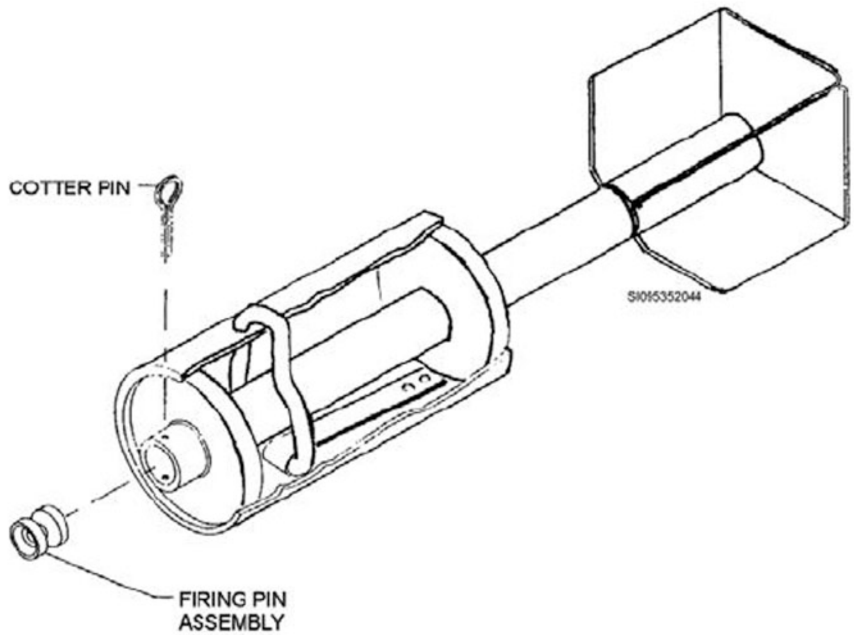

Figure 2–34. BDU–48/B.

BDU–50 bomb

The BDU–50 series practice bomb (fig. 2–35) is essentially an inert filled MK82 bomb casing without plumbing/conduits or fuze wells. The nose of bomb is threaded, but the aft is closed. This inert practice bomb can be fitted with metal nose plugs and fin assemblies. It is used for pilot and load training.

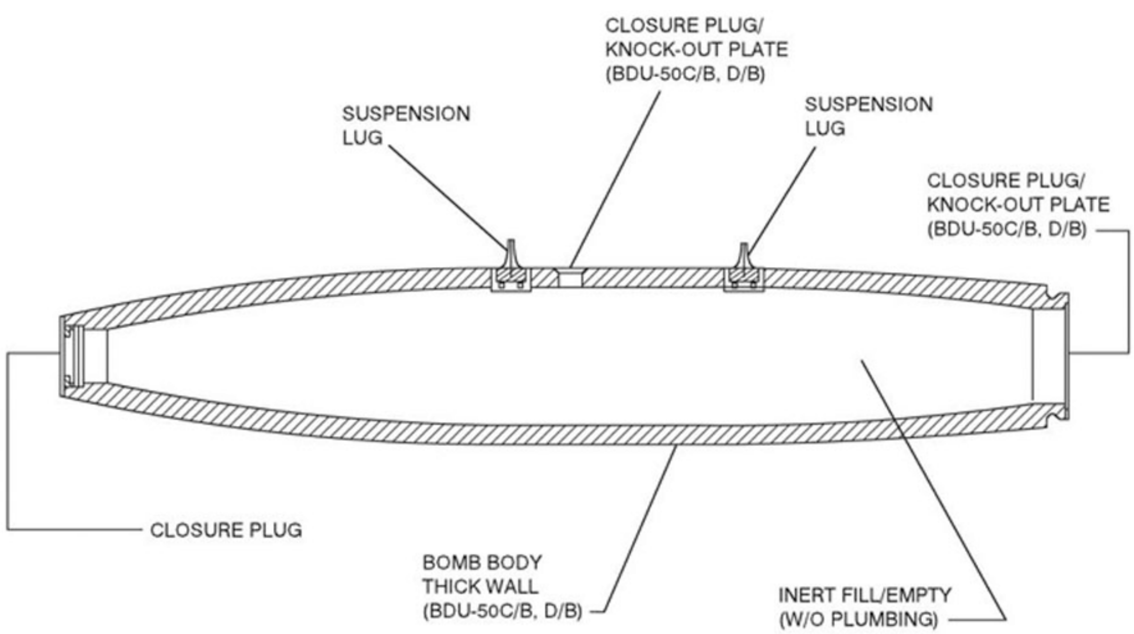

Figure 2–35. BDU–50 (cutaway view).

BDU–56 bomb

The BDU–56 series practice bomb is essentially an inert filled MK84 bomb casing without plumbing/conduits or fuze wells. Similar to the smaller BDU–50 the nose of the bomb is threaded, but the aft is closed. This inert practice bomb can be fitted with metal nose plugs and fin assemblies. It is also used for pilot and load training.

MK106 bomb

The MK106 (fig. 2–36) is a cylindrical shaped practice bomb that, like the BDU–48/B practice bomb, also uses the MK4 Mod 3 and CXU–3A/B signal cartridges. The MK106 is just over 19 inches long, 3.9 inches in diameter, and only weighs approximately 5 pounds. The bomb body consists of an inner and outer cylinder and a fin assembly. This bomb is designed for low-altitude drops and can simulate the MK82 bomb in a high drag configuration.

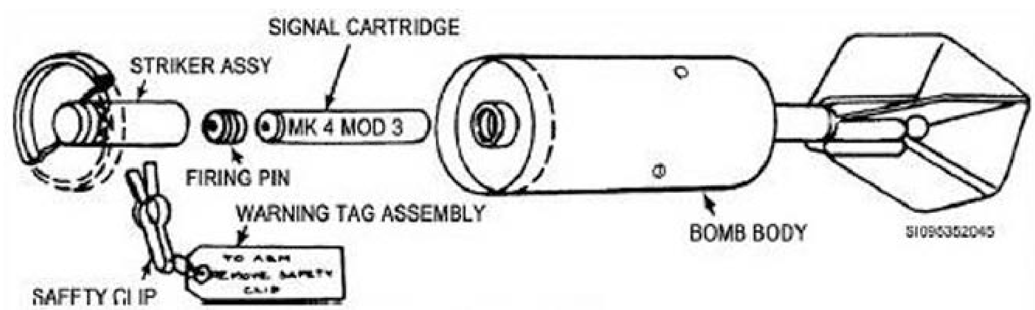

Figure 2–36. MK106.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

215. MK80 series bombs

1. What are the *combined effects* of the MK80 series bombs?

2. Which MK80 series bomb weighs approximately 500 pounds?

3. How can an MK82 series bomb produce a *mining or penetrating effect*?

4. Which BLU series bomb uses the MK83 Mod 4 bomb body?

5. What is the NEW of the MK84 bomb?

216. Penetrator bombs

1. What are penetrator bombs designed to do?

2. What are the four penetrator bombs the Air Force uses?

3. What is the BLU–109/B penetrator bomb capable of doing?

4. What penetrator is a 4,000-pound class penetrator bomb?

5. Which penetrator is used as the *warhead* for the GBU–28 A/B and GBU–28 B/B?

6. What penetrator bomb is designed to be *more lethal in confined spaces*?

217. Special-purpose bombs

1. What is the payload of the M129 series bomb?

2. What bomb was developed to drop leaflets from high-performance aircraft?

3. The BLU–126/B LCDB designed to be used in what type of situations?

4. What is the NEW of the BLU–126/B LCDB?

218. Practice bombs

1. Why are practice bombs used instead of regular live bombs during training?

2. When would you use the CXU–3A/B spotting charge?

3. What practice bomb *simulates* the MK82 high–drag bomb?

4. The MK106 practice bomb *simulates* what live bomb?

2–3. Cluster Bomb Units

Cluster bombs are aircraft-launched, free fall, unguided cluster bombs designed for tactical use against targets such as light materiel, personnel, armored/support vehicles, and tanks. In most cases, cluster bomb units (CBU) are released from the carrying aircraft the same as any GP bomb; that is, by withdrawing the arming wire from the fuze and initiating the fuze-arming and time-delay cycle.

The SUU is the dispenser that carries the bomblets. When loaded with bomblets, we call the weapon a CBU. Although we call these weapons CBUs, they are really not bombs in the common sense of the word. In truth, they are a combination of a dispenser and a quantity of small bomblets or mines. The SUU is simply a device for attaching the bomblets or mines to a delivery aircraft.

219. Cluster bomb unit–87 (SUU–65 dispenser)

The CBU–87 series are delivered as complete rounds. They consist of an SUU–65/B bomb dispenser with an integral fuze, proximity sensor, and 202 bomblets (fig. 2–37). The CBU–87/B comes equipped with a dummy FZU–39 (D–4)/B proximity sensor and a live FZU–39 is packaged separately for optional use. In contrast, both the CBU–87A/B and B/B weapons come with live FZU–39/B proximity sensors installed.

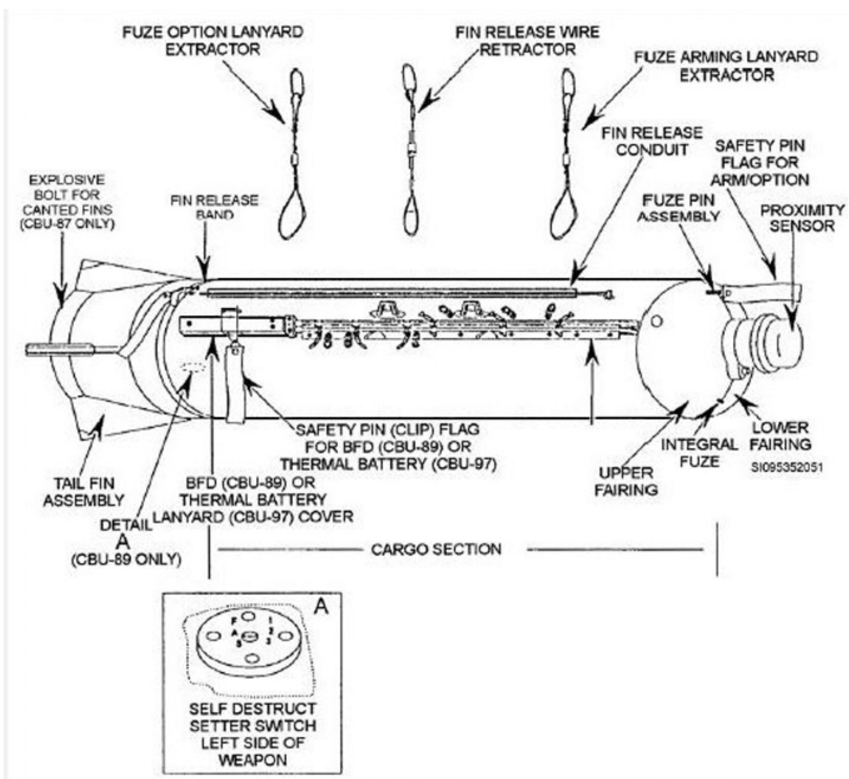

Figure 2–37. Typical CBU–87 and CBU–89 series.

When the aircraft releases the CBU–87/B, extractor D-rings are retained by aircraft arming solenoids. Then, the fuze arm (nose), fuze option (tail), and fin release extractors pull the desired arming wires sufficiently to arm the integral fuze, activate the FZU-39/B sensor (if installed), and release the fins. An internal steel cable and pulley system ensures all four fins deploy in unison, and detent springs retain the fins in an open position. The extractor break links separate after the arming and option wires are pulled to initiate fuze arming and activation of the FZU–39 sensor. Several conditions must be met in order for the CBU–87 to discharge its payload. When the mechanical timer expires or the height of function setting for the proximity sensor is reached, an explosive bolt functions, allowing the fins to cant and spin the dispenser. When the dispenser reaches a preset revolution per minute (rpm), the linear-shaped cutting charge functions and cuts the dispenser into three sections from front to rear. The tail section separates at this time, releasing the bomblets (fig. 2–38).

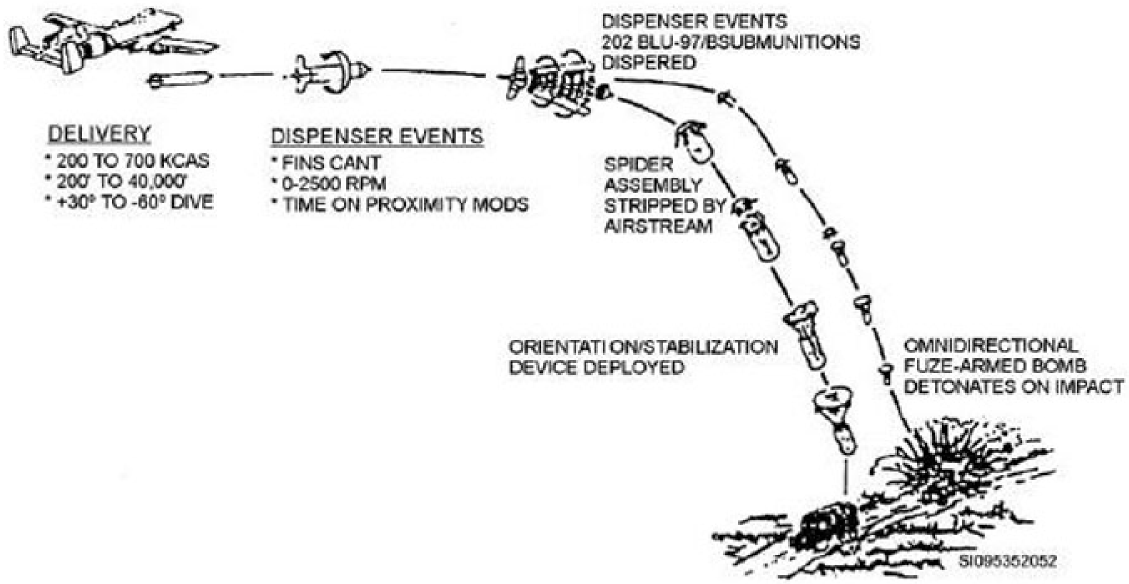

Figure 2–38. CBU–87 operational sequence.

BLU–97/B anti-materiel/anti-tank bomb

The BLU–97/B is an anti-materiel/anti-tank bomblet used in the CBU–87/B (fig. 2–39). It has a fragmenting body with a liner-shaped charge, a fuze assembly with a piezoelectric primary and secondary firing system, a zirconium ring with fire start capability, an attached inflatable decelerator, and a standoff tube for firing the primary circuit of the fuze. The fuze is protected from detonation by physical confinement (it cannot move) inside the dispenser and by being shielded from airstream velocity. After release, the airstream deploys the decelerator (parachute) and provides the mechanical energy for the arming sequence.

BLU–97A/B anti-materiel/anti-tank bomb

The BLU–97A/B anti-materiel/anti-tank bomblets are used in the CBU–87A/B. The only difference between 97/B and 97A/B bomblets is that in the A/B model the fuze assembly uses an all mechanical secondary firing system.

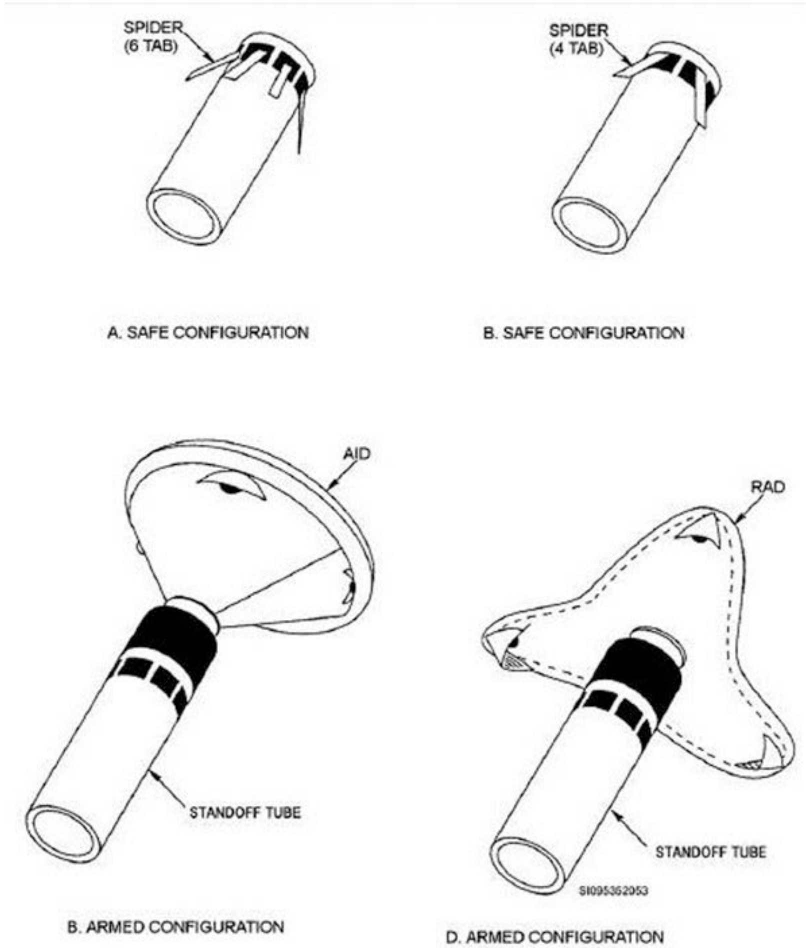

Figure 2–39. BLU–97/B and BLU–97A/B bomblets.

220. Cluster bomb unit–89 (SUU–64 dispenser)

The CBU–89 is physically the same as the CBU–87, except the CBU–89 fins are not canted, it does not have an explosive bolt, and it uses the SUU–64/B dispenser. The CBU–89 carries two types of bomblets—which effectively target tanks and personnel—at one time. The CBU–89/B is delivered from the manufacturer as a complete round with bomb lugs, arming wires, all internal components, and the dummy FZU–39/B sensor installed (fig. 2–40). The major difference between the CBU–89/B and the CBU–89A/B is that the CBU–89A/B comes with a live FZU–39/B proximity sensor installed. Whereas the CBU–89/B has the dummy sensor installed and the live FZU–39/B sensor is packaged separately for optional use.

When the CBU–89 releases from the aircraft, the aircraft extractor D-rings pull the desired arming wires enough to arm the integral fuze, activate the FZU-39/B sensor, and release the firing device that activates the KMU–466/B thermal battery. The thermal battery continues to charge until the mechanically timed fuze expires or the sensor preset height of function is reached. At this time, the fuze functions and the linear-shaped cutting charge cuts the dispenser into three parts from front to rear, letting the submunitions disperse in free-fall trajectories. The CBU–89 carries 72 BLU–91/B anti-tank and 22 BLU–92/B anti-personnel mines within the dispenser. The sequence of events that takes place when the CBU–89 is released from an aircraft is illustrated in figure 2–41.

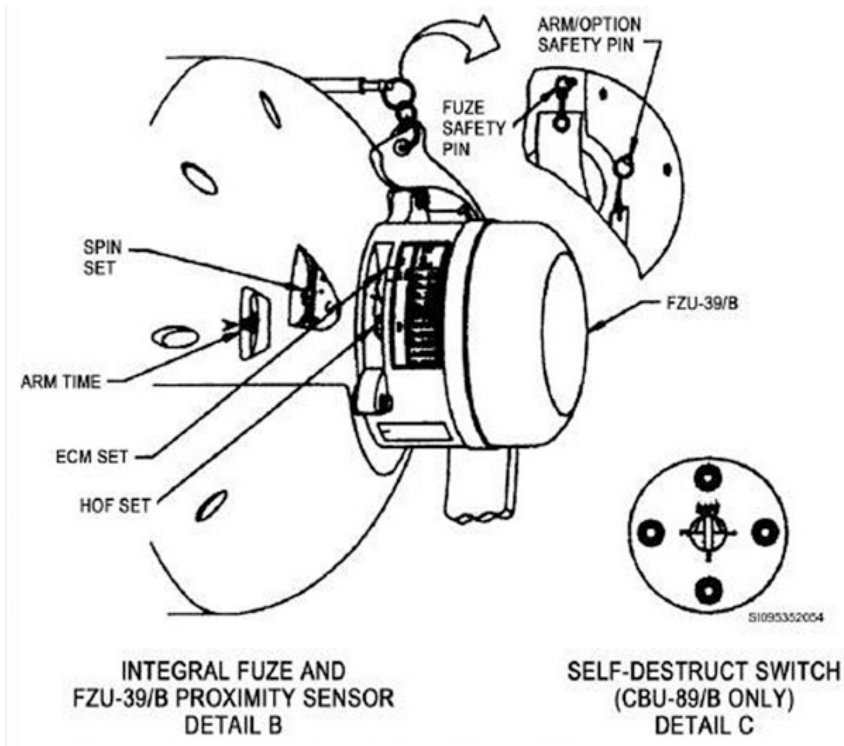

Figure 2–40. CBU–87 and 89 integral fuze/sensor.

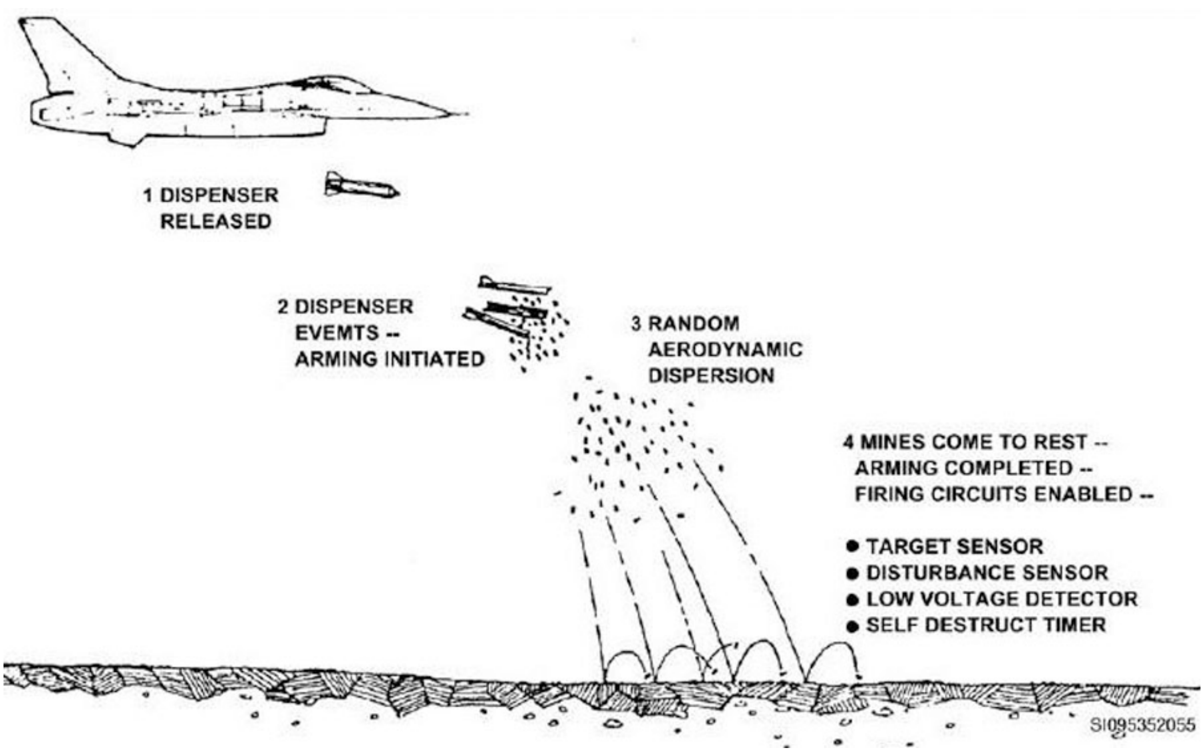

Figure 2–41. CBU–89 operational sequence.

BLU–91/B bomblets

The BLU–91/B anti-tank mine (fig. 2–42) is a cylindrical mine using a mass-focused warhead that is inserted into a plastic housing. Approximately two minutes after the mine hits the ground, the mine is armed. Once it is armed mine detonation can be initiated by target detection, disturbance, low battery voltage, or the self-destruct timer.

BLU–92/B bomblets

The BLU–92 anti-personnel mine uses a fragmenting case and a ground burst warhead that is also armed approximately two minutes after the mine hits the ground (fig. 2–42). There are four tripline sensors mounted on the face of the mine. When the mine impacts the ground, an electrical signal ignites a gas generator. The pressure from the gas generator removes the locking mechanism and a spring ejects the bobbins, which deploy the triplines approximately 40 feet. When enough force is applied on any tripline, a contact is opened and an electrical signal initiates the explosive train of the mine, resulting in warhead detonation. Very similar to the BLU–91/B, the BLU–92/B mine detonates by target detection, disturbance, low battery voltage, or the expiration of the self-destruct timer.

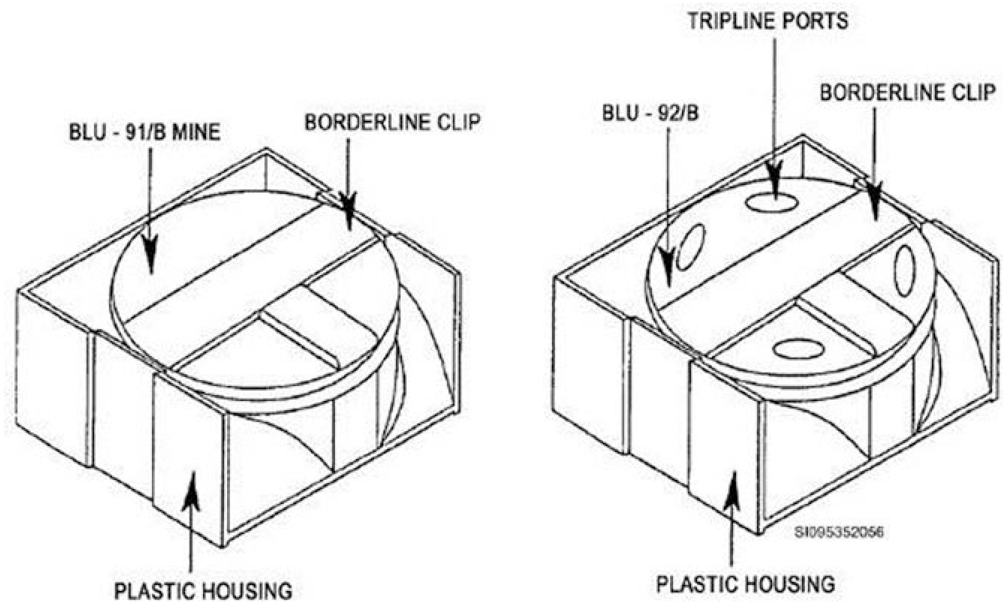

Figure 2–42. BLU–91/B and BLU–92 anti-personnel mine.

221. CBU–105 (SUU–66 dispenser)

The CBU–105 which includes an added wind-corrected munitions dispenser (WCMD), has permanently replaced the CBU-97. The Sensor Fuzed Weapon System is a wide-area cluster bomb consisting of 10 BLU–108/B submunitions contained in an SUU–66/B dispenser. Each submunition has four projectiles containing an infrared sensor, warhead, and associated electronics giving the CBU–105 the capability to destroy 40 targets. The CBU–105 is primarily used against tanks and armored/support vehicles.

Operational sequence of CBU–105 dispenser

The aircraft delivers the CBU–105 from low or high altitudes and functions the same as the CBU–87/B, except that no explosive bolt system is installed and the fins are not canted. The fuze arming lanyard activates the thermal battery for the operation of the submunition ejection system. The fuze functions and initiates the linear-shaped cutting charge when the mechanical timer expires or the preset height of function is reached. When the linear–shaped cutting charge functions, it cuts the dispenser into three sections allowing the dispenser cargo section and tail assembly to fall away. The submunition ejection system will then provide pressure to inflate an airbag ejector. Upon being ejected into the airstream, the nose and fin release lanyards are pulled from each of the10 BLU–108 submunitions to initiate their arming sequence.

Operational sequence of BLU–108 submunitions

Once released from the dispenser, the BLU–108 series submunition's thermal battery will initiate and a drogue parachute will deploy to provide stabilization. A cord cutter then functions to deploy the main parachute which inflates and causes the submunitions to travel over the target area. At a predetermine height of function, the main parachute is jettisoned and the submunitions rocket motor fires. The rocket motor imparts spin and upward thrust for the submunitions. A pair of explosive bolts then fires to release the projectiles and the launcher free falls to the ground. The projectiles will then spin arm while its sensor looks for a target within its flight path. When a target is detected, a final explosive projectile is fired which penetrates and destroys the target.

222. Wind-corrected munitions dispensers

The WCMD include the CBU–103, CBU–104, and CBU–105 as shown in figure 2–43. With the exception of the added WCMD kit in place of the original tail fin assembly, they are essentially the same as the CBU–87, CBU–89, and CBU–97 as shown in the WCMD conversion chart (fig. 2–44). These munitions are used on most bomber and fighter aircraft. It was during Operation Enduring Freedom over Afghanistan that a CBU–103 was first delivered by an F–16 aircraft.

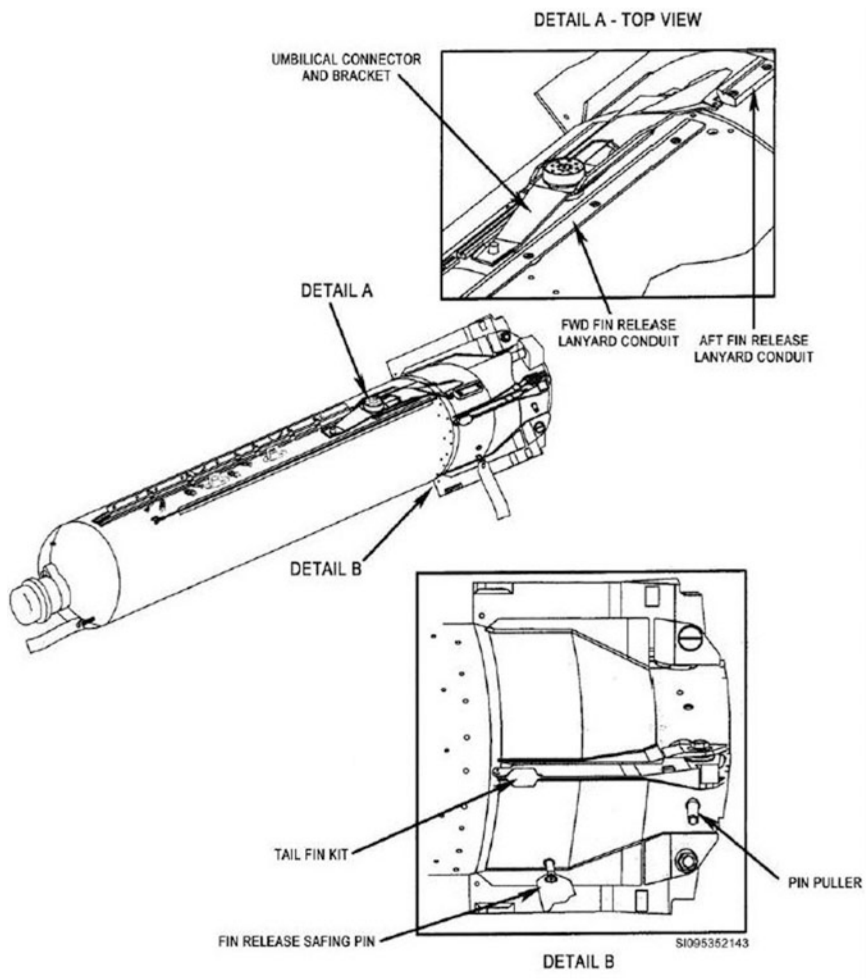

Figure 2–43. Typical CBU–103, –104, –105 wind–corrected dispensers.

Dispenser	Lockheed Martin
CBU-87/B	CBU-103/B
CBU-87A/B	CBU-103A/B
CBU-87B/B	CBU-103B/B
CBU-89/B	CBU-104/B
CBU-89A/B	CBU-104A/B
CBU-97/B	CBU-105/B
CBU-97A/B	CBU-105A/B

Figure 2–44. CBU to WCMD conversion.

Wind-corrected munitions dispenser components

The components of the WCMD consist of a fin guidance system, a variable position umbilical connector located on a bracket for mounting to various aircraft, and operational flight program software. A fin release lanyard installed in a one-groove conduit is routed to the top of the tail kit, and a fin release safing pin is inserted from the bottom to prevent inadvertent fin activation.

Wind-corrected munitions dispenser functional description

The WCMD tail kit provides guidance and navigation during free flight. Correction for wind effects, ballistics dispersion, and launch transients for munitions delivered from high altitude are communicated with the carrier aircraft prior to weapon separation. The control actuation assembly cants the fins to spin the dispenser during flight.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

219. Cluster bomb unit–87 (SUU–65 dispenser)

1. Which CBU–87 series bomb comes equipped with a *dummy proximity sensor*?

2. Explain how a CBU–87 functions once deployed.

3. What bomblets are used in the CBU–87?

4. What is the only difference between the BLU–97/B and BLU–97A/B bomblets?

220. Cluster bomb unit–89 (SUU–64 dispenser)

1. How does the CBU–89/B differ from the CBU–87/B?

2. How many and what type of bomblets are loaded in the CBU–89?

3. The BLU–91/B bomblets are designed for what specific type of target?

4. Besides setting off a tripline, what else would cause a BLU–92/B mine to detonate?

221. CBU–105 (SUU–66 dispenser)

1. How many and what type of bomblets are loaded in a CBU–105?

2. The CBU–105 series is designed for what type of target?

3. How does a BLU–108 submunition device destroy a detected target?

222. Wind-corrected munitions dispensers

1. Which CBU series is considered to be wind-corrected munitions?

2. How does the WCMD function?

Answers to Self–Test Questions

211

1. By their position, action, and method of arming.
2. (1) Impact.
   (2) Time.
   (3) Proximity.
3. The bomb reaching the preset height of function above the target.
4. (1) Mechanically timed.
   (2) Electronically timed.
5. Seal wires, cotter pins, safety blocks, and the detonator safe feature.
6. Safety block.

212

1. Prior to takeoff.

2. It acts as an interrupter to the explosive train of the fuze during handling.
3. T45 adapter booster.
4. ATU–35-series drive assembly.
5. The fuze will not arm.
6. The safing pin.

213

1. Any three of the following:
    (1) FMU–81.
    (2) FMU–124.
    (3) FMU–139.
    (4) FMU–143.
    (5) FMU–152.
2. One.
3. FMU–124.
4. FMU–139 and FMU–152.
5. FZU–48 initiator.
6. FZU–32 initiator.
7. Hardened target capability that provides safing, in-flight cockpit selection, and arming fuzing functions for general purpose and penetrating, unitary warheads.
8. That the fuze is armed.

214

1. Doppler ranging radar proximity sensor.
2. FMU–139 and FMU–152.
3. The SUU–64/B, SUU–65/B and SUU–66B.
4. Ranges from 300 to 3,000 feet.
5. The FZU–2/B booster.
6. Any position of the armed indicator that is red.

215

1. Blast, penetration, and fragmentation.
2. MK 82 series.
3. By using delayed action fuze.
4. The BLU–110.
5. 945 pounds.

216

1. Designed to be used on hardened targets. Examples are HAS, reinforced concrete buildings, underground command and control facilities, and runways.
2. (1) BLU–109 series.
    (2) BLU–113 series.
    (3) BLU–118 series.
    (4) BLU–122 series.
3. It can penetrate 4 to 6 feet of reinforced concrete.
4. BLU–113.
5. BLU–113.
6. BLU–118.

217

1. 110 paper rolls.
2. PDU–5/B.
3. Situations where friendly forces and/or civilians are close to the target.
4. 27 pounds.

218

1. To provide low-cost target practice for the flight crews of fighter and bomber aircraft.
2. When the danger of starting brush or forest fires is high.
3. The BDU–48/B.
4. MK82 bomb in a high drag configuration.

219

1. The CBU–87/B.
2. When the mechanical timer expires or the height of function setting for the proximity sensor is reached, an explosive bolt functions allowing the fins to cant and spin the dispenser. When the dispenser reaches a preset rpm, the linear-shaped cutting charge functions and splits the dispenser into three sections from front to rear.
3. BLU–97/B or BLU–97A/B anti-materiel/anti-tank bomblets.
4. The only difference between 97/B and 97A/B bomblets is that in the A/B model the fuze assembly uses an all mechanical secondary firing system.

220

1. They are physically the same except the CBU–89/B does not have canted fins, an explosive bolt, and it uses the SUU–64 dispenser.
2. 72 each BLU–91/B bomblets and 22 each BLU–92/B mines.
3. Combat tanks.
4. Mine disturbance, low battery voltage, or the expiration of the self-destruct timer

221

1. 10 each BLU–108/B submunitions.
2. Tanks and armored support vehicles.
3. Fires an explosive forged penetrating projectile at the target.

222

1. CBU–103, CBU–104, and CBU–105.
2. The WCMD tail kit provides guidance and navigation during free flight. Correction for wind effects, ballistics dispersion and launch transients for munitions delivered from high altitude are communicated with the carrier aircraft prior to weapon separation. The control actuation assembly cants the fins to spin the dispenser during flight.

Complete the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field-Scoring Answer Sheet.

Do not return your answer sheet to the Air Force Career Development Academy (AFCDA).

35. (211) The main types of fuze actions are impact, time, and
    a. proximity.
    b. hydraulic.
    c. electrical.
    d. inertia.

36. (211) What component in an *electronically-timed fuze* replaces the arming vanes used in mechanically timed fuzes?
    a. Battery-firing device.
    b. Arming lanyard assembly.
    c. Electric charging assembly.
    d. Electronically timed sensor.

37. (211) Which safety feature is designed to *prevent movement* of the arming heads, arming stems, and strikers *while the fuze is being handled*?
    a. Seal wires.
    b. Cotter pins.
    c. Safety blocks.
    d. “Detonator safe” feature.

38. (212) How do you *change the firing delay times* in a *mechanically-timed* M904 nose fuze?
    a. By rotating the timing lock.
    b. By changing the delay element.
    c. By adjusting the calibrated dial.
    d. The firing delay time is fixed and cannot be changed.

39. (212) What action must you take to set the SECONDS TO ARM setting *below* 6 seconds on an M904 fuze?
    a. Press the time lock.
    b. Install the stop screw in the fuze body.
    c. Remove the stop screw from the fuze body.
    d. Press the detent pin on the arming vane shaft.

40. (212) What *adapter booster* is used with the M904 fuze?
    a. T35.
    b. T45.
    c. T55.
    d. FZU–2/B.

41. (212) Where is the M905 fuze installed in a *general-purpose bomb body*?
    a. Either the nose or the tail.
    b. The nose fuze well.
    c. The tail fuze well.
    d. Between the lugs.

42. (213) Which device is used *in place of arming wire* with *electrical* fuzes?
    a. Bungee cord.
    b. Battery-firing device.
    c. Linear-shaped charge.
    d. Target-detecting device.

43. (213) When installed in the nose fuze well, how many FZU–2/B boosters are used with the FMU–81/B fuze?
    a. 1.
    b. 2.
    c. 3.
    d. 4.

44. (213) What component provides the *electrical power* needed to operate the FMU–139A/B fuze?
    a. FZU–39/B sensor.
    b. FZU–48/B initiator.
    c. Battery-firing device.
    d. MK32 Mod 1 arming device.

45. (214) Which sensor is a radio frequency (RF) radar ranging system used with the suspension utility unit (SUU)–64/B, SUU–65/B, and SUU–66/B dispensers?
    a. FZU–39/B.
    b. FMU–56/B.
    c. FMU–110/B.
    d. FMU–124/B.

46. (214) Which proximity fuze has a height-of-burst (HOB) setting of 15 feet above ground level that is built into the fuze at the time of manufacture?
    a. FZU–39/B.
    b. FMU–56/B.
    c. FMU–110/B.
    d. FMU–113/B.

47. (215) Which air inflatable retarder (AIR) fin is used on the MK82 bomb?
    a. BSU–49/B.
    b. BSU–50/B.
    c. BSU–92.
    d. BSU–93.

48. (216) Which bomb is *not* classified as a *penetrator*?
    a. BLU–113.
    b. BLU–118.
    c. BLU–122.
    d. BLU–126.

49. (216) Which 4,000 pound penetrator bomb is *used as the warhead/bomb body* for the GBU–28A/B?
    a. BLU–113.
    b. BLU–118.
    c. BLU–122.
    d. BLU–126.

50. (216) Which bomb provides *deeper penetration* than the BLU–113 and is used with the GBU–28C/B?
    a. BLU–109.
    b. BLU–118.
    c. BLU–122.
    d. BLU–126.

51. (217) The PDU–5/B uses which suspension utility unit (SUU)?
    a. SUU–64/B.
    b. SUU–65/B.
    c. SUU–66/B.
    d. SUU–76C/B.

52. (217) With the *exception of the explosive filler*, the BLU–126/B and BLU–129/B are *identical* to the
    a. M117 series bomb.
    b. MK82 MOD 2 bomb.
    c. MK84 MOD 3 bomb.
    d. BLU–109 series bomb.

53. (218) The BDU–33 series *practice* bomb weighs
    a. 10 pounds.
    b. 20 pounds.
    c. 25 pounds.
    d. 33 pounds.

54. (218) What is the weight of the BDU–48 series *practice* bomb?
    a. 10 pounds.
    b. 20 pounds.
    c. 25 pounds.
    d. 48 pounds.

55. (218) Which series *practice* bomb only weighs 5 pounds?
    a. BDU–48.
    b. BDU–50.
    c. BDU–56.
    d. MK–106.

56. (219) The CBU–87 uses which suspension utility unit (SUU) dispenser?
    a. SUU–66.
    b. SUU–65.
    c. SUU–64.
    d. SUU–30.

57. (219) The CBU–87/B is loaded with which *submunitions*?
    a. BLU–91/B bomblets.
    b. BLU–92/B bomblets.
    c. BLU–97/B bomblets.
    d. BLU–108/B bomblets.

58. (220) The CBU–89 uses which suspension utility unit (SUU) dispenser?
    a. SUU–66.
    b. SUU–65.
    c. SUU–64.
    d. SUU–30.

59. (220) The CBU–89 is loaded with which *submunitions*?
    a. BLU–91/B bomblets only.
    b. BLU–91/B and BLU–92/B bomblets.
    c. BLU–91/B, BLU–92/B and BLU–97/B bomblets.
    d. BLU–91/B, BLU–92/B, BLU–97/B, and BLU–108/B bomblets.

60. (221) The CBU–105 uses which suspension utility unit (SUU) dispenser?
    a. SUU–66.
    b. SUU–65.
    c. SUU–64.
    d. SUU–25.

61. (221) Once free falling over the target area what imparts spin and upward thrust for BLU–108 submunitions?
    a. MXU–650 airfoil group.
    b. Drogue parachute.
    c. Impulse cartridge.
    d. Rocket motor.

62. (222) The components of a *wind-corrected munitions dispenser* are a fin guidance system, a variable position umbilical connector, and
    a. dummy fuze.
    b. rocket motor.
    c. signal cartridge.
    d. flight program software.

63. (222) Which *wind-corrected munitions dispenser* component cants the fins to *spin the dispenser during flight*?
    a. Gas grain generator.
    b. Fin lanyard assembly.
    c. Fin stabilizer assembly.
    d. Control actuation assembly.

Please read the unit menu for unit 3 and continue ➔

Unit 3. Aircraft Munitions

AS WE SAID IN UNIT 2, without munitions to drop on the enemy, the Air Force would be just another airline. The same thought applies to aircraft countermeasures. If our aircraft did not have defensive capabilities, then we would be just another easy target. In this unit, we move from discussing bombs, fuzes, and fins, to other assorted munitions items that have both offensive and defensive capabilities. We'll begin with a discussion of the cannons used on various aircraft and then discuss the different munitions systems that are also used.

3–1. Cannon Ammunition

The medium and large caliber cannon ammunition used by the Air Force is here to stay. Although not always used as a primary weapon, most pilots consider cannon ammunition essential to any combat mission. With a loaded weapons system like the M61, the pilot is never without options. The 20 millimeter (mm), 25 mm, 30 mm, 40 mm, and 105 mm that the Air Force uses has been improved and modified to meet the needs of our evolving mission. Munitions systems specialists are responsible for inspecting, transporting, storing, and accounting for these five different types of cannon ammunition.

223. 20 millimeter ammunition

The Air Force's most widely used cannon ammunition is the 20 mm round. Like other small-arms ammunition, we classify 20 mm projectiles according to their purpose (fig. 3–1). For example, we classify a 20 mm cartridge with a projectile designed to penetrate armor as "an armor-piercing cartridge."

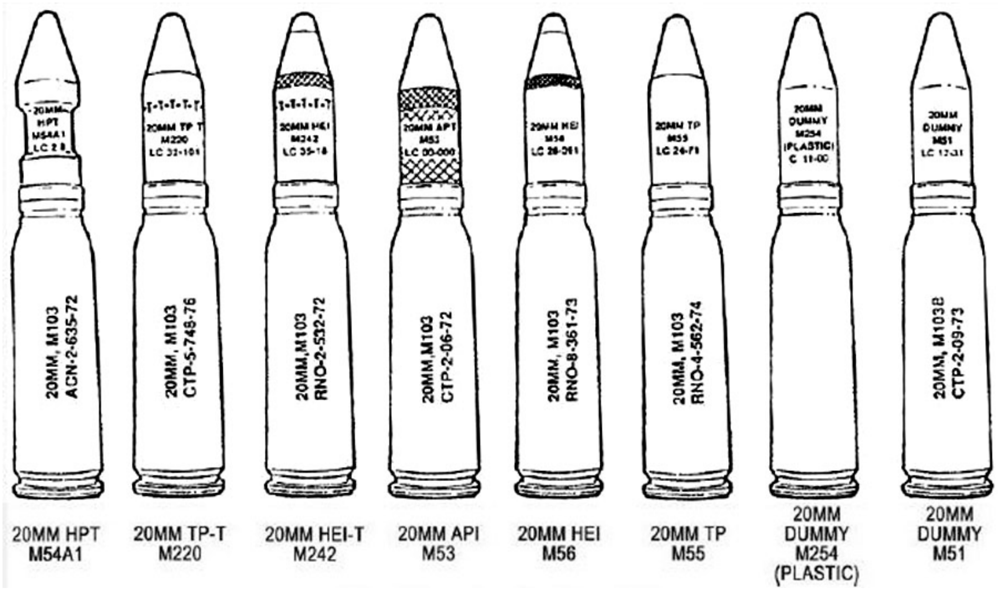

Figure 3–1. Standard 20 mm cartridges.

Classification

In all cartridges, the primer ignites the propellant, which provides hot gas and pressure to eject the projectile from the muzzle of the gun to the target. In the following table we look at several types of 20 mm ammunition classifications.

20 MM Ammunition Classifications	
Classification	**Description**
Armor-piercing incendiary M53 series	This API cartridge is used for a combined armor-piercing and incendiary effect against aircraft, armored vehicles, and concrete shelters. The body of the projectile is made from bar alloy steel. The nose is made of aluminum alloy, contains 85 grams of incendiary composition, and is sealed with a closure disk. The API cartridge does not require a fuze, because it is the impact of the projectile that initiates the incendiary composition.
Semi-armor piercing, high explosive, and incendiary PGU–28 series	This semi-armor piercing, high-explosive and incendiary cartridge is for use against aircraft and light materiel targets. It is filled with zirconium sponge, comp A-4, and an incendiary mix. The aluminum nose contains another incendiary mix that completes the projectile. The projectile uses a copper-rotating band.
High-explosive incendiary M56 series	The high-explosive incendiary (HEI) cartridge is for use against aircraft and targets of light materiel, functioning with a combined explosive and incendiary effect. The M56 cartridge is used with both the M39 and M61 guns. The M56 HEI cartridge has a steel projectile body with a relatively thin walled casing. The filler is 0.0235 pound of incendiary mixture and cyclonite explosive. The cyclonite explosive is loaded between the base of the fuze and the incendiary composition, which occupies the rest of the interior of the projectile body. Upon impact, the charge initiates with a combined detonation and incendiary

20 MM Ammunition Classifications	
Classification	**Description**
	effect. The M505 fuze initiates functioning of the M56 HEI round.
High-explosive incendiary trace M242 series	The M246 high-explosive incendiary tracer cartridge functions the same as the M56 series cartridge except for the added tracer element, which ignites by muzzle flash when the projectile leaves the barrel.
Target practice M55 and PGU–27 series	The target practice (TP) M55 series target practice cartridge is used as a training round for aircrew proficiency training. Because it has an inert projectile, it is sometimes called ball ammunition, after the small-arms ball cartridge. Upon impact, the projectile penetrates the target, causing damage. There is no incendiary or explosive effect. The TP round has a solid nose made of aluminum alloy.
Target practice tracer M22 series	The target practice tracer (TPT) M220 series cartridge functions the same as the M55 series except for the added tracer element, which ignites by the muzzle flash as the projectile leaves the barrel.
High-pressure test M54 series	This high-pressure test cartridge is designed for production testing of gun systems and is *not* for use in gun systems in the field. This cartridge develops pressure between 62,500 and 72,500 pounds per square inch (psi). The high-pressure test cartridge is similar to the M55A1 except the projectile has the physical shape of a lance or dumbbell.
Dummy M51 and M254 series	The completely inert dummy cartridge is used for drill/familiarization and for testing the feeder assembly of the gun system. The cartridge case contains approximately 0.086 pound of inert material to produce an approximate weight to mimic live rounds used in M39 and M61 gun systems Both the M51 and M254 cartridges are cadmium-plated or zinc-coated with black markings.

Components

Although 20 mm cartridges are classified as “fixed light-artillery ammunition,” they differ only slightly from small-arms ammunition in construction. The basic components are the same—a cartridge case, projectile (bullet), propellant, and primer. One additional component, a fuze, is used on high-explosive, incendiary cartridges. Refer to figure 3–2 as you study the various parts of a 20 mm cartridge.

Cartridge case

Twenty-millimeter cartridge cases have the same bottle shape and construction as small-arms ammunition. With the exception of some older ammunition, 20 mm cartridges are made of brass.

Projectile

The 20 mm projectile is made of steel, with a rotating band near the base. The rotating band (*not* found on small-arms projectiles) is made of copper or gilding metal and has a diameter slightly larger than the rifling of the weapon. The lands of the weapon cut into this rotating band; rotating the projectile which stabilizes it in flight. In addition, the rotating band prevents gases from escaping past the projectile. The forward part of the 20 mm projectile has a slight bulge, called the *bourrelet*. The bourrelet is accurately machined to ride on the lands of the weapon preventing the projectile from wobbling as it passes through the bore. Projectiles are manufactured and used in several configurations, according to classification and tactical requirements.

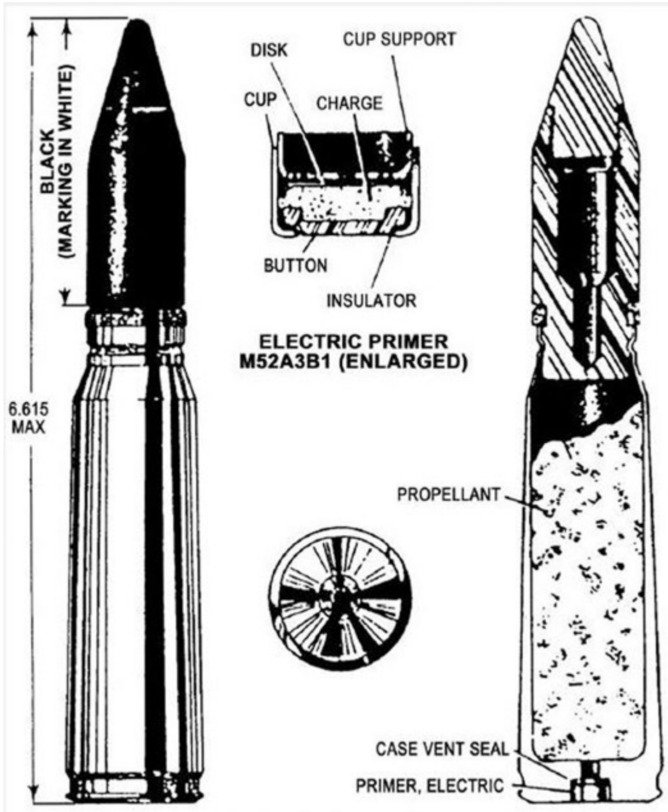

Figure 3–2. Typical 20 mm cartridge components.

Propellant

Some of the older 20 mm ammunition uses a single base powder consisting of 98 percent nitrocellulose and 2 percent other chemicals. The ammunition manufactured for use in M39 and M61 cannons is a double-base propellant with from 77 to 89 percent nitrocellulose and from 9 to 20 percent nitroglycerin by weight. Other chemical ingredients are added to minimize smoke and flash, to increase stability, and to permit uniform loading during manufacture. The double-base propellant currently used in 20 mm cartridges we commonly known as western ball propellant.

Primers

One significant difference in 20 mm ammunitions compared to other cannon ammunition is the 20 mm round is electrically fired. For this reason, we cannot over stress the importance of grounding equipment and frequent grounding of personnel. Although electric, 20 mm ammunition can fire from percussion if roughly handled. The primer assembly is contained in a brass cup with an opening in the cupped end. A brass button is assembled into the opening but is separated from the brass cup by a vinylite insulator. A charge of conductive primer mix is behind the brass cup and is followed by a shellacked foil paper disk. A thin gilding-metal cup support is pressed into the body. A cellulose case vent seal is assembled in the primer recess of the cartridge case between the vent and the primer. The charge of primer mix weighs about 2.75 grains.

When the cartridge fires, the electrical impulse passes from the firing pin to the exposed face of the primer button, through the primer mix and cup support, and into the cartridge case.

Fuze

The HEI cartridge requires a fuze to detonate the projectile. Fuzes are a connected series (train) of small explosive charges and a striker device (firing pin) that are used to initiate the action of the first charge (initiator/detonator) in the explosive train. The mechanical and explosive components are held together in a single housing.

The explosive train consists of a small but highly sensitive primer detonator mixture, followed by a less sensitive and larger explosive charge such as lead azide, which is followed in turn by a still larger and less sensitive charge such as tetryl. The charges function in successive detonation from impact on the striker and initiation of the primer detonator, to the larger charge, to the tetryl. The progressive charges are necessary to build up the detonating effect to ignite the HE charge in the projectile.

The M505 series fuze (fig. 3–3) is bore safe to prevent accidental arming during handling and shipping. A *bore-safe fuze* is one that has the explosive train interrupted (out-of-line rotor assembly) while the projectile is still in the bore of the weapon. Premature action of the booster/bursting charge is prevented if any of the more sensitive explosives in the rotor elements (primer/detonator) functions. The fuze for 20 mm ammunition for Air Force use is too small for external safety devices so it is designed with internal safety devices as an integral part of the fuze mechanism.

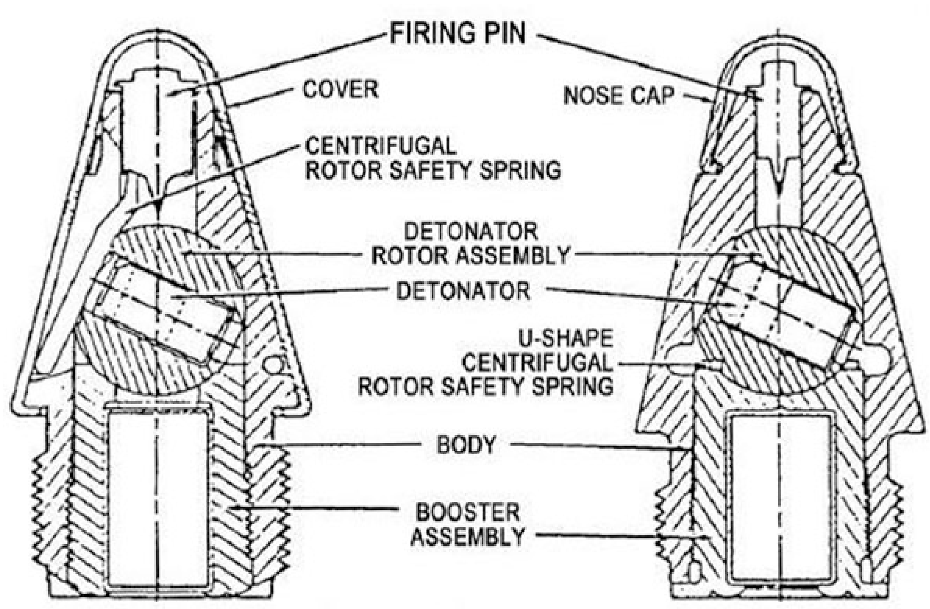

Figure 3–3. M505-series fuze.

The M505 series fuze is a single-action, super quick fuze that functions on impact with aircraft targets. The fuze will not function unless the detonator is in line with the firing pin. The M505 series fuze has a delayed arming distance of 10 to 35 feet from the muzzle of the gun. Prior to firing the rotor assembly—which contains an out-of-line detonator—and firing pin are locked in position by the centrifugal rotor safety spring. Upon firing, centrifugal force created by the rotation of the projectile causes the rotor to move in line with the firing pin. The fuze functions when the nose of the fuze is crushed against the target, forcing the firing pin into the detonator.

Identification

Depending on the date of manufacture, the model number, lot number, and manufacturer's symbol are marked or stamped on the side of the projectile or cartridge case. These numbers identify 20 mm ammunition. The model number identifies a particular design of cartridge after acceptance as an adapted type.

Like small-arms ammunition, 20 mm ammunition is assigned a lot number at the manufacturing plant. Each lot is assembled under uniform conditions and is expected to function in a uniform manner. This lot number becomes a permanent part of the ammunition's identification and is marked or stamped on every complete round and on all packing containers.

The lot number stamped on the side of the projectile controls the 20 mm ammunition complete round. If you do find some rounds downloaded from an aircraft, for example, that have the stamped marking wiped off but you know what lot(s) were originally loaded, you can use the cartridge case lot number to help identify the ammunition. If you cannot determine the correct lot number of a live round, consider the cartridge "unserviceable."

Identifying information is marked or stamped on the components of each round of 20 mm ammunition. The caliber, type, model number, manufacturer's symbol, and ammunition lot number are stamped on the projectile (fig. 3–4). The projectile lot number, year of manufacture, manufacturer's initials, caliber, and model designation are stamped on the rotating band. The model designation and caliber of the case, case lot numbers, manufacturer's initials or symbol, loader's lot number, and the year of loading are stamped in the metal of the head.

Twenty-millimeter ammunition (in fact, all ammunition) is *color-coded* for easy identification. Each cartridge projectile is painted a specific color in accordance with the ammunition color-coding system outlined in TO 11A–1–53, *General Instructions for Ammunition Color Coding, Identification of Empty and Inert Loaded Ammunition Items and Components, and Assignment of Version Numbers to Training and Dummy Ammunition Items.*

SAFETY NOTE: The 20 mm target practice round has a blue painted projectile with white lettering. The blue indicates *practice* ammunition. In this case, *only* the projectile is inert; *not* the cartridge. The cartridge is *live,* just like combat ammunition. The 20 mm round should *not* be mistaken for inert or dummy-type rounds. These rounds can kill if improperly handled.

Packaging

The 20 mm cartridges are available in bulk (linkless) and functional (linked belt) packing in the M548 container (fig. 3–5). When the box is packed in bulk, it contains either 200 or 250 cartridges. In functional packing, the cartridges are linked 100 to a belt, one belt per container. The belts may contain one type of cartridge or a mixture of types in varying ratios. For example, armor-piercing tracer (APT) and HEI ammunition may be combined in one belt, perhaps at a ratio of one APT round to three HEI rounds, for a total of 75 HEI and 25 APT rounds per 100-round belt.

PROJECTILE TYPE (EXCEPT AS NOTED)	COLOR OF PAINTING — LOCATIONS A	B	C	D	COLOR OF MARKING
DUMMY M51A1B1	NO PAINT (COPPER)	CHROMATE FINISH	CHROMATE FINISH	CHROMATE FINISH	BLACK
ARMOR PIERCING INCENDIARY (API, M53)	NO PAINT (COPPER)	BLACK, LIGHT RED BAND IN B_1 AREA	NO PAINT	NO PAINT	WHITE
HIGH PRESSURE TEST (HPT) M54A1	NO PAINT (COPPER)	PURPLE	PURPLE	PURPLE	BLACK
TARGET PRACTICE (TP) M55A2	NO PAINT (COPPER)	BLUE	BLUE	BLUE	WHITE
HIGH EXPLOSIVE INCENDIARY (HEI) M56A3/M56E5	NO PAINT (COPPER)	YELLOW, LIGHT RED BAND IN B_1 AREA	NO PAINT (CHROMATE)	NO PAINT (CHROMATE)	BLACK
M56A1E1/M56E2	NO PAINT (COPPER)	DARK RED, OLIVE DRAB IN B_1 AREA	NO PAINT (CHROMATE)	NO PAINT (CHROMATE)	WHITE
TARGET PRACTICE TRACER (TPT) M221 (M220 CARTRIDGE)	NO PAINT (COPPER)	BLUE	BLUE	BLUE	WHITE STENCILING, LIGHT RED Ts BELOW B AREA
HIGH EXPLOSIVE INCENDIARY TRACER (HEI-T) M242	NO PAINT (COPPER)	YELLOW, LIGHT RED BAND IN B_1 AREA	NO PAINT (CHROMATE)	NO PAINT (CHROMATE)	BLACK STENCILING, LIGHT RED Ts BELOW B_1 AREA
PLASTIC DUMMY CARTRIDGE M254	NO PAINT (NATURAL PLASTIC)	NO PAINT (NATURAL PLASTIC)	NO PAINT (NATURAL PLASTIC)	NO PAINT (NATURAL PLASTIC)	BLACK

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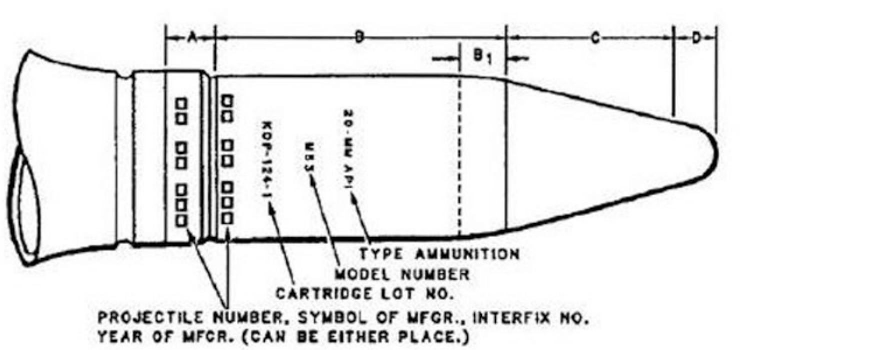


Figure 3–4. Typical markings for M50 series 20 mm.

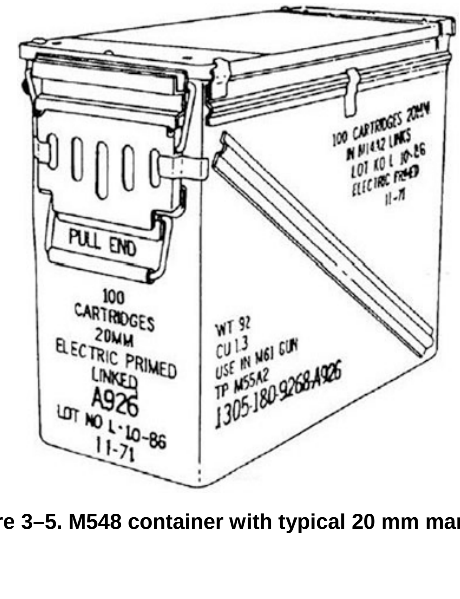


Figure 3–5. M548 container with typical 20 mm markings.

Marking

The self-sealing metal containers are painted olive drab and stenciled in yellow. The outer packing boxes, crates, metal boxes, and inner containers are fully marked to identify the ammunition. The markings include the item nomenclature, lot number, number of rounds, national stock number, Department of Defense code, proper shipping name, average weight and cube, date loaded, and type of links. The letters *R* and *L* indicate right- or left-hand feed for M12 links. “Pull end” is marked for rounds linked in M14 links.

Handling

Because 20 mm ammunition contains explosive materials, you must *not* handle it roughly, throw it, or drop it. You must repair damaged containers *immediately* and restore the container markings.

The electric primers in 20 mm ammunition need special safety precautions and handling procedures. Electric primers can fire by percussion caused by rough handling, static electricity, or electromagnetic energy. Be sure the handling site has an authorized lightning protection system and conforms to the requirements of AFMAN 91–201, *Explosives Safety Standards*, for electromagnetic radiation safety.

Ensure tabletops and equipment (except hand tools) are connected to an earth ground. Wear conductive-soled boots and stand on grounded floors or conductive mats. A grounding bar can be installed at the entrance to the operating building or site. Personnel should discharge static electricity by touching this “slap bar” before entering the work area and at frequent intervals thereafter. Do *not* wear clothing that can generate static electricity charges. Avoid sliding linked belts of ammunition across nonconductive surfaces.

224. 25 millimeter ammunition

Twenty-five millimeter ammunition is widely used by the US Army and Navy. At present, within the Air Force only the Air Force Special Operations Command uses 25 mm ammunition. Many opponents of 25 mm ammunition believed it did not have the punching power to inflict the kind of damage needed in a battle of armored vehicles. The widespread successful use of this ammunition during the Persian Gulf War and the operations since proved skeptics wrong.

Classification

The AC–130 gunship uses the GAU–12, five-barreled Gatling gun (cannon) to deliver the 25 mm round on target. Just like other cannon ammo, we classify the 25 mm round according to its purpose as described in the table below.

25 MM Round Classification	
Classification	**Description**
Target practice PGU–23/U	The target practice (TP) PGU-23/U cartridge consists of a steel cartridge case, an M115 percussion primer, ignition booster pellet, single-base propellant, and an inert projectile used for pilot proficiency training. The projectile is a hollow steel body with an aluminum or steel windscreen. The tracer cavity is not filled. The projectile shape and ballistic properties are similar to the 25 mm HEI ammunition. The 25 mm cartridge uses a percussion primer to ignite the propellant.
HEI PGU–25/U	The HEI PGU–25/U round is employed against light materiel targets. It consists of a steel cartridge case, an M115 percussion primer, an ignition booster, a projectile, and an M505 fuze. This projectile is relatively thin walled and contains an aluminized PBXN–5 explosive incendiary charge.

25 MM Round Classification	
Classification	**Description**
	Once the cartridge is fired, the fuze is fully armed within 20-35 feet after it leaves the gun muzzle.
Dummy PGU–24/U	The dummy PGU-24/U cartridge is a completely inert cartridge configured to match the physical and dynamic properties of actual 25 mm HEI cartridges. 25 mm dummy rounds are used for load crew certification and training, familiarization, and for gun/equipment operational checkouts.

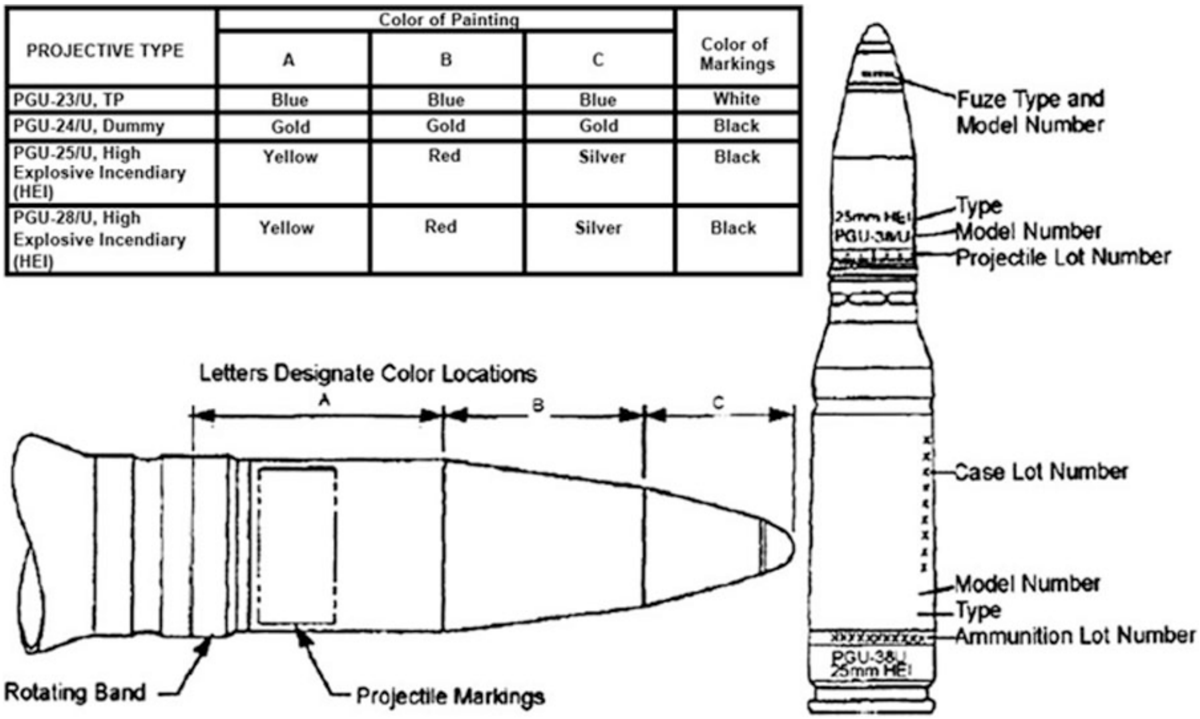
Components

The components of the 25 mm round are the same as the 20 mm round with one exception. The 25 mm round has an ignition booster to ensure consistent propellant ignition. Each round weighs approximately 1.1 pounds, is 8.7 inches in length, and has a muzzle velocity of 3,608 feet-per-second. The 25 mm round's components are described in the following table.

25MM Round Components	
Component	**Description**
Cartridge case	The cartridge case is made of steel and crimped to the projectile using a continuous 360° crimp.
Propellant	Each 25 mm round is loaded with the propellant required by the appropriate military standard for the type of projectile being used and in accordance with each contractor's drawings and specifications.
Percussion primer	Except for dummy rounds, all 25 mm rounds use a functioning M115 percussion primer. The M115 primer was developed primarily for 25 mm ammunition use. This primer was selected based on its sensitivity, ignitability, stability, consistency, and energy release performance.
Ignition booster	The 25 mm ammunition requires a booster for consistent ignition of the propellant. The ingredients for the booster are 90 percent boron potassium nitrate and 10 percent fluid ball powder.
Projectile	Three different companies manufacture the projectiles: Ford Aerospace Corp.; Honeywell, Inc.; and Aerojet Ordnance Company. Each manufacturer has altered the configuration slightly, but each configuration meets the same performance requirements. All projectiles have the same external configuration with a rotating band of sintered metal swaged into the circumferential groove.
Fuze	The HEI round uses the M505 fuze. The fuze functions when the nose of the fuze is crushed against the target, which forces the firing pin against the detonator. The detonator, in turn, ignites the booster. The booster then detonates the projectile's high-explosive charge.

Identification

You can quickly determine the type of 25 mm cartridge you are working with by the color the projectile is painted and by the 4.6 mm high lettering on the body of the cartridge case (fig. 3–6). The lettering is stenciled in waterproof marking ink around the body of the cartridge case after it is painted. It is easy to identify dummy ammunition because it has a nonseparable projectile and the total cartridge is surface treated to give an overall gold color. The markings on the cartridge case include the model number, type, and lot number.



PROJECTIVE TYPE	Color of Painting A	Color of Painting B	Color of Painting C	Color of Markings
PGU-23/U, TP	Blue	Blue	Blue	White
PGU-24/U, Dummy	Gold	Gold	Gold	Black
PGU-25/U, High Explosive Incendiary (HEI)	Yellow	Red	Silver	Black
PGU-28/U, High Explosive Incendiary (HEI)	Yellow	Red	Silver	Black

Figure 3–6. Typical 25 mm cartridge markings.

Packaging

The 25 mm cartridges are packed in CNU–405/E ammunition shipping and storage containers (steel). Bulk 25 mm ammunition is packaged in either 80- or 100-round configurations, depending on the national stock number (NSN).

225. 30 millimeter ammunition

If you are looking for a cannon round that packs a lot of punching power in a small space, that definitely describes a 30 mm round. It only takes seven 30 mm rounds to completely destroy a combat tank. In this lesson, we look at the different classifications of 30 mm rounds, their handling, and 30 mm loading equipment.

Classification

The 30 mm round is classified as a percussion primed fixed projectile that is housed in an aluminum cartridge. Like 20 mm ammunition, 30 mm ammunition is classified according to its purpose. The varieties of rounds depend upon the selected targets and the desired effects—which we will discuss in further detail below.

Target practice, PGU–15 series

The 30 mm TP round has a light blue painted projectile with white lettering (fig. 3–7). The projectile has a steel body with a hollow aluminum windscreen. While the TP round does *not* have a fuze or payload in the projectile, the *cartridge is live*. The PGU–15 is made for pilot training, weapon testing, and aircraft system checkout. When the round is fired, the firing pin strikes the primer which ignites the black powder in the flash tube—causing flames to ignite the propellant in the cartridge case. As the propellant ignites, the built up high-pressure gases drive the projectile down the barrel of the gun to its target.

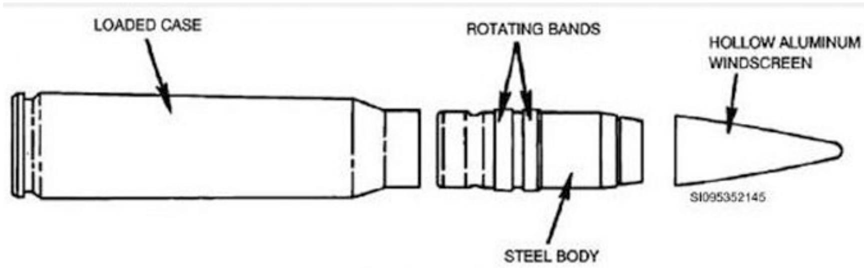


Figure 3–7. 30 mm TP cartridge.

High-explosive incendiary, PGU–13 series

There are two manufacturers of the 30mm HEI round—the Aerojet Ordnance Company and Honeywell, Inc. The HEI round is used against aircraft and targets of light materiel (fig. 3–8).

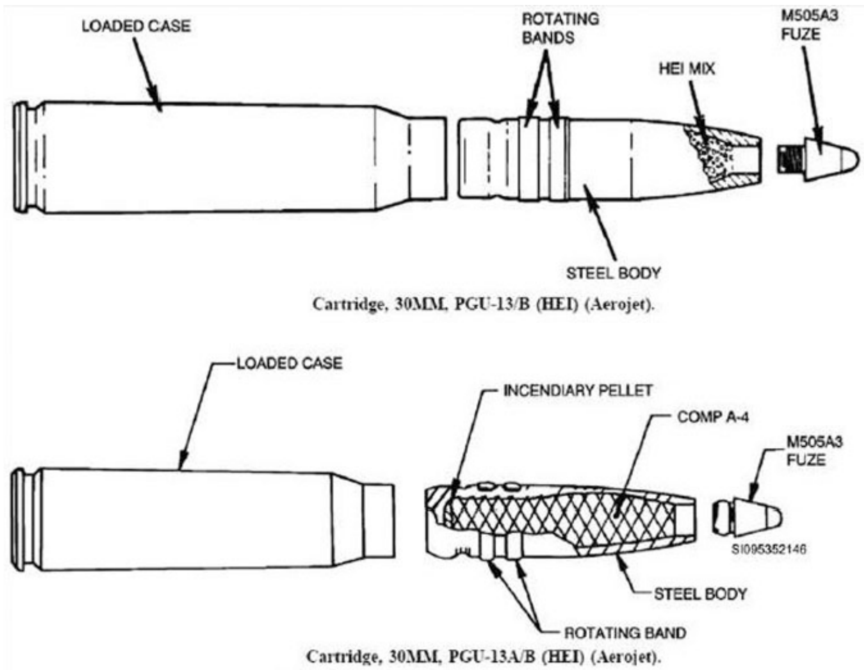


Figure 3–8. 30 mm HEI cartridge.

1. The *Aerojet projectile*, type PGU–13/B, contains approximately 0.1163 pound of H–761 incendiary mix while type PGU–13A/B contains one incendiary pellet weighing approximately 0.0121 pounds and approximately 0.0937 pounds of comp A–4 explosive.
2. The *Honeywell projectile*, type PGU–13/B, contains approximately 0.1215 pound of H–761 incendiary mix. The PGU–13B/B contains recovered HEI projectiles from PGU–13/B and/or PGU–13A/B cartridges.

The 30 mm HEI round has an M505A3 impact fuze in its nose (fig. 3–9). Before the round is fired, the ball rotor in the fuze is held in the unarmed position by the lock ring (also called a rotor safety spring). Centrifugal force from the spinning of the projectile as it travels down the barrel of the gun causes the lock ring to spin. This action lets the ball rotor line up the detonator with the other parts of the explosive train. Complete arming of the fuze takes place about 30 to 65 feet from the muzzle of the gun. On contact with a target, the fuze firing pin is driven into the detonator and the fuze fires. The fuze booster charge detonates the HEI mix in the projectile.

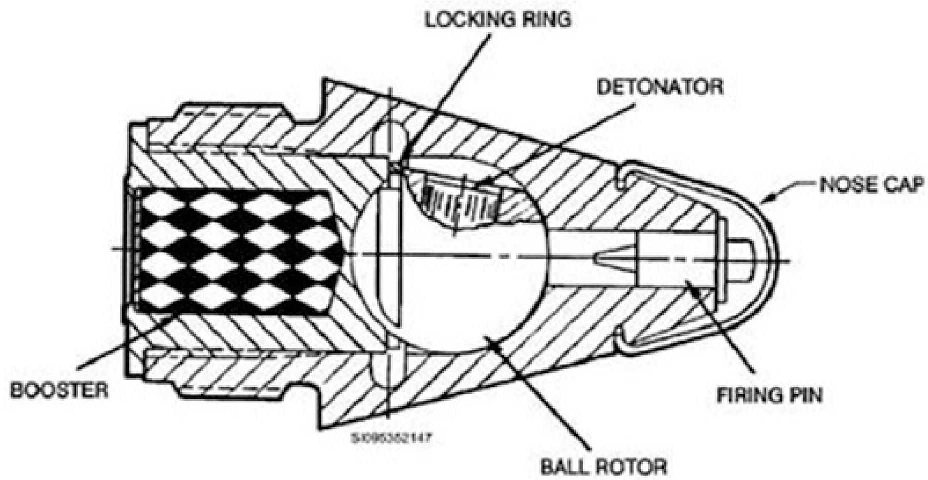


Figure 3–9. M505A3 impact fuze.

Armor-piercing incendiary and tracer, PGU–14 series

The API and the APIT rounds have the same shape as all the other 30 mm rounds. The projectile has an aluminum body, referred to as "a windscreen," which holds a depleted uranium penetrator (fig. 3–10). The APIT cartridge is used against targets such as medium tanks and armored personnel carriers. It functions basically the same as the TP round except at firing a fumer charge in the base of the projectile is ignited by the high temperature propellant gases. The fumer charge burns, releasing gases to reduce air drag during flight to the target and to give a visible trace of the flight path. On impact with a hard target, the aluminum windscreen is stripped away, letting the depleted uranium penetrator continue through the target. Target friction produces a large amount of heat, giving the incendiary effects. The PGU-14A/B and PGU–14B/B are API rounds. They differ in the type windscreen installed and do *not* contain a tracer element.

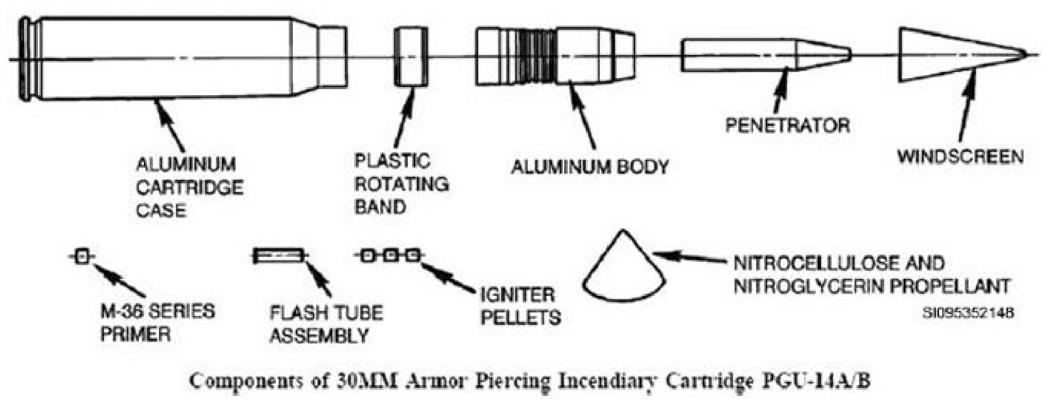


Figure 3–10. 30 mm depleted uranium penetrator round.

Dummy, PGU–16 series

Figure 3–11 shows a 30 mm dummy cartridge that is inert and has no moving parts. It has neither primer nor propellant and is made for familiarization training and for mechanical cycling of the gun system. A projectile retaining screw, located in the primer cavity, holds the projectile in the cartridge and simulates the weight of the propellant and the center of gravity of the round.

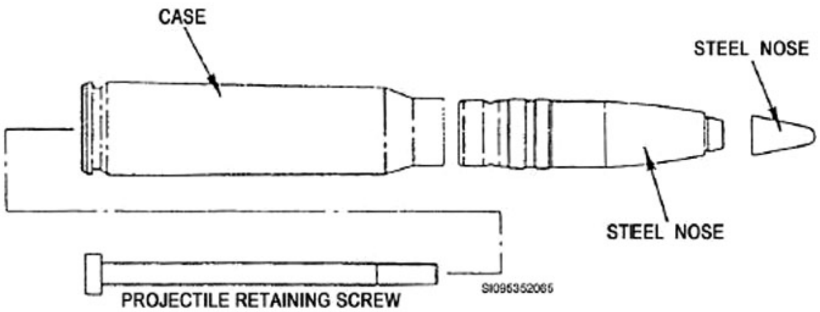


Figure 3–11. 30 mm dummy cartridge.

Components

Thirty millimeter ammunition is a group of percussion-primed, fixed-ammunition cartridges that uses a variety of projectiles, depending on the type of target and the desired effect. Its use has added an extra tactical punch to our combat forces. Its components are described in the table below.

30 MM Ammunition Components	
Component	**Description**
Cartridge case	The 30 mm cartridge case is much larger than the 20 mm cartridge and is made of aluminum. The cylindrical shaped casing is tapered from the base to the neck to hold the projectile.
Propellant	The propellant is a double-base (nitrocellulose and nitroglycerin) type. The high-pressure gases it produces as it burns drive the projectile out of the gun barrel.
Percussion primer	Thirty millimeter ammunition uses the M36-series percussion primer. It ignites when the gun's firing pin strikes it and crushes the material inside. Flash from the burning primer ignites the black powder in the flash tube. Flames from the burning black powder in the flash tube ignite the propellant.
Projectile	There are four types of projectiles: three steel projectiles and one aluminum projectile. Depending on the manufacturer, the Aerojet round has two plastic rotating bands and the Honeywell has only one. They serve the same purpose as they do on the 20 mm you studied earlier.
Fuze	The high-explosive incendiary (HEI) round is the only 30 mm ammunition to use a fuze. The M505A3 point detonating fuze is affixed to the nose of the HEI round and functions upon impact.

Identification

You identify 30 mm ammunition by its model number, lot number, part number, and color coding. The lot number, part number, and model number are marked on the cartridge. The model number stamped on the cartridge case identifies a particular design of cartridge.

The current 30 mm model number and color codes are described in the following table.

33 MM Ammunition Model Number and Color Codes	
HEI model numbers	PGU–13/B, PGU–13A/B, and the PGU–13B/B
HEI color code	Identified by a yellow projectile, with red band and black markings.
API model numbers	PGU–14A/B and PGU–14B/B (PGU–14/B for APIT)
API and APIT color code	Identified by a black projectile with a red band and white markings.
TP model numbers	PGU–15/B and PGU–15A/B
TP color code	Identified by a blue projectile with white markings.
Dummy model numbers	PGU–16/A and PGU–16/B
Dummy color code	Identified by a bronze or gold projectile with black markings.

The manufacturing plant assigns three lot numbers to the 30 mm ammunition (fig. 3–12).

- The *cartridge case lot number* is on the bottom of the cartridge.
- The *projectile lot number* is on the projectile.
- The *ammunition lot number* is on the side of the cartridge case.

Use the *ammunition lot number* for control and reporting. It is required for all records, reports on condition, functioning, and accidents in which the ammunition is involved.

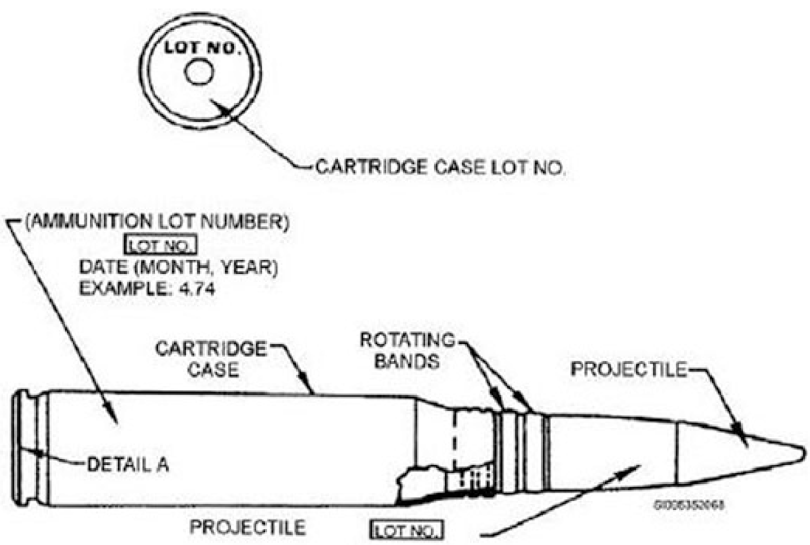


Figure 3–12. 30 mm identification.

Other identification markings that appear on the cartridge case and projectile are the nomenclature, part number, and date of manufacture. The APIT, high-explosive incendiary (HEI), and TP rounds can have one or two part numbers, depending on the manufacturer.

Packaging

Securely close and properly mark incomplete packages in accordance with TO 11A13–14–7, *Specialized Storage and Maintenance Procedures for 30 Millimeter Ammunition*. M548 containers (fig. 3–13) accommodate 36 individually packed rounds. The CNU–309 container (fig. 3–14) accommodates a linked tube carrier consisting of a maximum of 600 individual plastic tubes belted together by woven fabric loops. When belted together, these tubes facilitate mechanized uploading/downloading of the GAU–8/A and the GAU–13 gun systems.

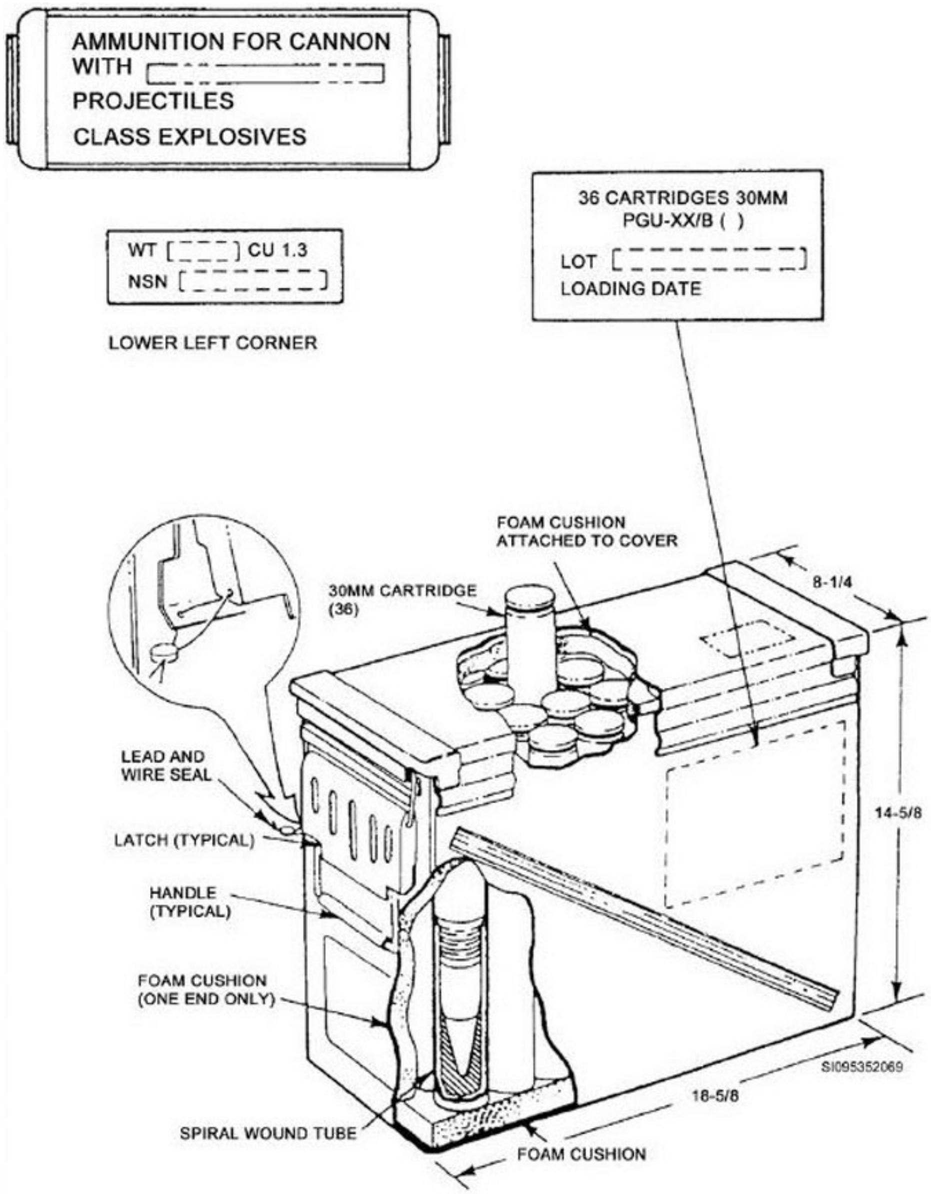


Figure 3–13. M548 container of 30 mm ammunition.

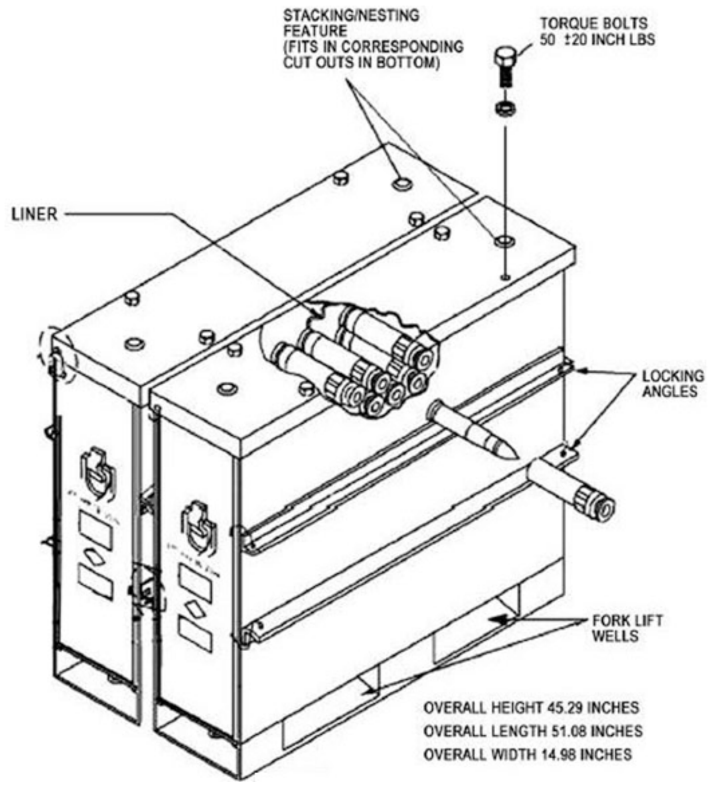


Figure 3–14. CNU–309 container of 30 mm ammunition.

226. 40 millimeter cannon ammunition

The 40 mm airborne artillery ammunition (AAA) round is fired from the M2A1 automatic cannon. The M2A1 cannon was originally designed as an anti-aircraft gun modified by the Air Force for air-to-surface use on the AC–130 gunship. This weapons platform is used to fire 40 mm AAA rounds to suppress and destroy personnel and materiel targets.

Classification

Forty millimeter ammunition is fixed-type percussion ammo. All 40 mm AAA is classified according to the type projectile and/or fuze.

TPT, M91

The 40 mm AAA TPT round is used for pilot training. The steel projectile resembles the APT projectile MK2 with a tracer cavity in the base. The cavity contains a red tracer composition that burns for about 12 seconds. The projectile is fuzed with an M69 dummy fuze. The 40 mm target practice round has a blue painted projectile with white lettering. Remember, the *blue* indicates *practice* ammunition. In this case, only the *projectile is inert*; *not* the cartridge.

HEI

The HEI round is used against aircraft and other light ground targets. The cartridge consists of either a brass or steel cartridge case crimped around the projectile. There are currently eight HEI rounds in the Air Force inventory; however we will limit our focus on the most common round used today. The major difference between them is the projectile and the fuze used with them. Figure 3–15 shows a typical 40 mm round.

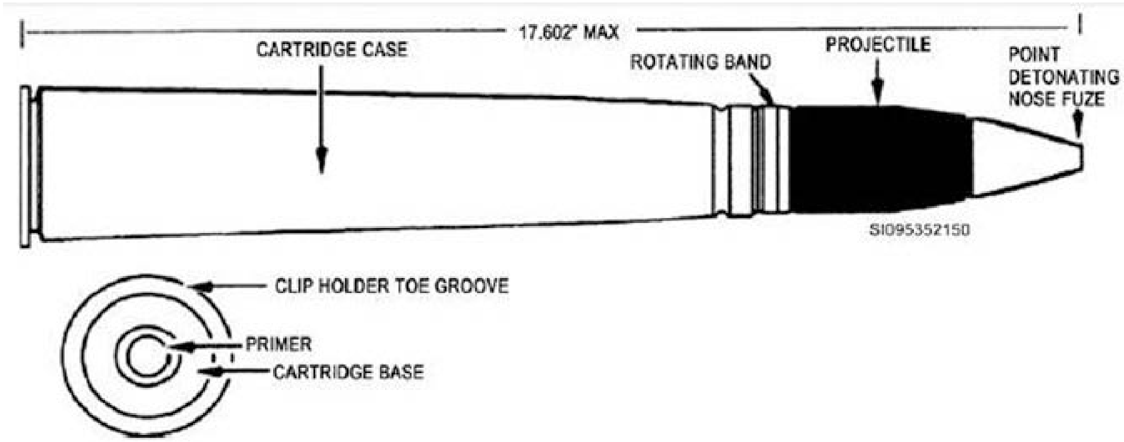


Figure 3–15. Typical 40 mm airborne artillery ammunition.

An effective 40 mm round used today is the HEI, PGU–9 C/B. This cartridge has a one piece forged low-carbon manganese steel projectile body fitted with a FMU–154/B fuze. A 0.030-inch thick zirconium liner is pressed into the projectile body with 2.5 grams of inert filler in the base of the explosive cavity to eliminate the possibility of the explosive being pressed under the liner lip. The projectile is press loaded with 0.22 pounds of comp A3 explosive. The bursting charge, along with the burning zirconium liner, sets the target on fire upon impact.

The FMU-154/B fuze (fig. 3–16) provides two independent locks on the rotor and a minimum specification no arm distance of 140 feet. The fuze maintains the detonator in an out-of-line safe position until safe separation from the gun occurs. After the round exits the gun barrel, rotational forces cause the ball weight to move into a groove and lock the rotor in the armed position. Upon impact, the striker forces the firing pin against the detonator.

APT, M81A1

The armor-piercing tracer (APT) M81A1 round is used for firing against armored and similar targets. The cartridge may be assembled with either the brass or steel cartridge case. The APT round has a projectile made of hardened steel that penetrates the target upon impact. The nose of the projectile is shaped to a relatively blunt ogive (pointed arch); however a long false ogive (windshield) is provided to impart optimum ballistics. The projectile has a tracer cavity in its base that contains a red tracer composition which burns for about 12 seconds.

AP, M81A1

This AP M81A1 round is similar to the APT round except that the tracer cavity in the base of the projectile is plugged and a tracer is *not* installed.

Dummy, M25

Like the 30 mm dummy cartridge, the 40 mm dummy cartridge is inert and has no moving parts. It has neither primer nor propellant and is used for training purposes and for checking support equipment and other mechanisms for proper operation. The dummy cartridge consists of a modified MK2 projectile body and a steel cartridge case. The projectile and cartridge case are held together by a steel retaining rod. One end of the rod is screwed into a threaded tracer cavity in the base of the projectile; the other end is threaded to receive the cartridge case plug assembly. A copper rivet is pressed into the rear of the plug to simulate the primer head and to prevent damage to the weapon firing pin in simulated firings. A dummy nose completes the assembly.

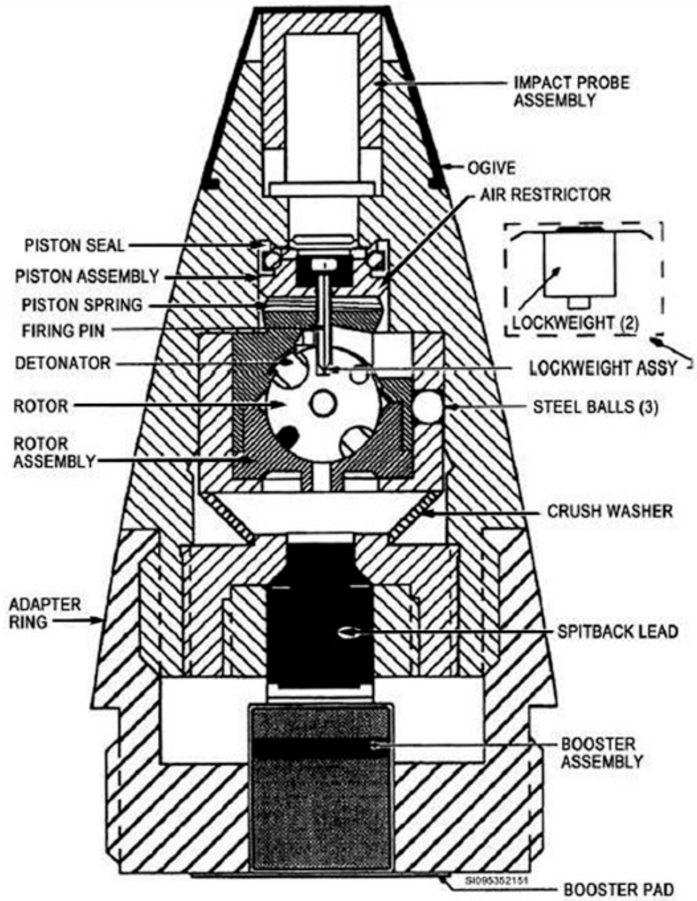


Figure 3–16. FMU–154/B point detonating fuze.

Components

The 40 mm round is issued as a complete round and consists of standard cannon ammo components that we discussed in previous sections. Components of a 40 mm round include the cartridge case, projectile, primer, propellant charge, and fuze. The 40 mm artillery ammo round is approximately 18.0 inches long with a 1.5 inch diameter.

Identification

All components of the 40 mm cartridge are marked with identification markings prior to assembly into a complete cartridge (fig. 3–17). Identification of the complete round is obtained from the information marked on the projectile and the cartridge case. Markings on the projectile include cartridge caliber, filler, type of projectile, and lot number. The *ammunition lot number* is located longitudinally on the cartridge case. The *head stamp* consists of the caliber, model of cartridge case (brass or steel), case lot number, loader’s initials, and year of loading. Like the cannon ammunition discussed previously, 40 mm AAA is color coded for identification of the type of round. Figure 3–18 provides all the color codes for 40 mm AAA.

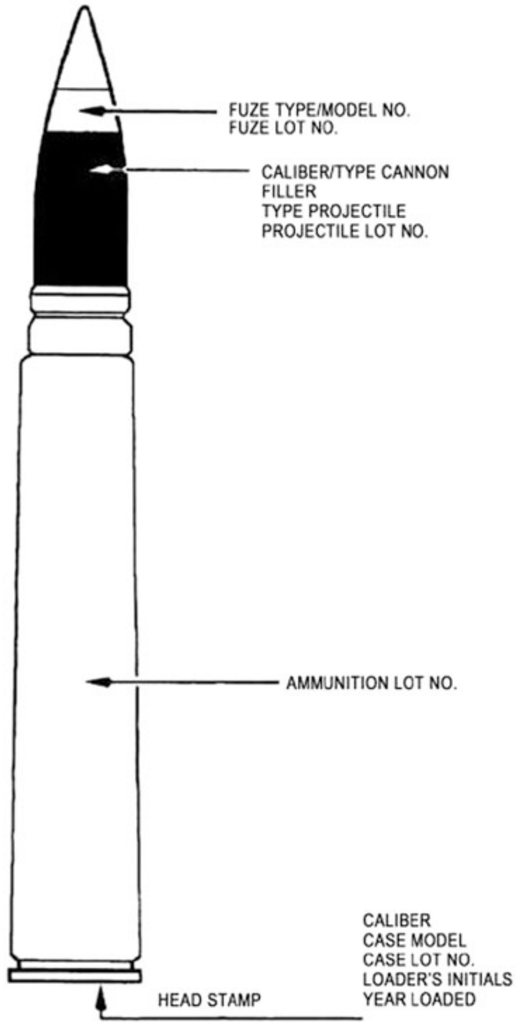


Figure 3–17. Typical 40 mm cartridge markings.

Type	Model	Fuze	Color Code	
HEIP (PGU- 9/B)	PGU- 9/B	MK27	Projectile-Yellow Nose-Red Band	Tip-Unpainted Aluminum Lettering-Black
HEI (PGU- 9A/B)	PGU- 9A/B	MK 27, MOD 1	Projectile-Yellow Nose-Red Band	Tip-Unpainted Aluminum Lettering-Black
HEI (PGU- 9B/B)	PGU- 9B/B	FMU-154A/B	Projectile-Yellow Nose-Red Band	Tip-Unpainted Aluminum Lettering-Black
HEI (PGU- 9C/B)	PGU- 9C/B	FMU-154/B	Projectile-Yellow Nose-Red Band	Tip-Unpainted Aluminum Lettering- Black
HEI (PGU- 37/B)	PGU- 37/B	LI-465 MI	Projectile-Yellow Nose-Red Band	Tip-Unpainted Aluminum Lettering- Black
AP	M81A1	N/A	Projectile-Black Nose-Black	Tip-Black Lettering-White
APT	M81A1	N/A	Projectile-Black Nose- Black	Tip-Black Lettering-White
HEIP	N/A	MK 27	Projectile-Yellow Nose-Red Band	Tip-Unpainted Aluminum Lettering-Black
HEIT- NSD	N/A	MK 27	Projectile- Yellow Nose-Red Band	Tip-Unpainted Aluminum Lettering-Black
HEP	N/A	MK 27	Projectile-Yellow Nose- Yellow	Tip-Unpainted Aluminum Lettering-Black
TPT	M91	M69 (DUMMY)	Projectile-Blue Nose- Blue	Tip-Blue Lettering-White
DUMMY	M25	N/A	Projectile-N/A Nose-N/A	Tip-N/A Lettering- N/A

Figure 3–18. 40 mm color coding.

Packaging

All 40 mm AAA is packed in MK1 ammunition boxes with MK4, MK5 or MK6 clips (fig. 3–19). Each clip holds four rounds. The MK1 ammunition box holds four clips for a total of 16 rounds. Fully loaded, the MK1 ammunition box weighs 116 pounds.

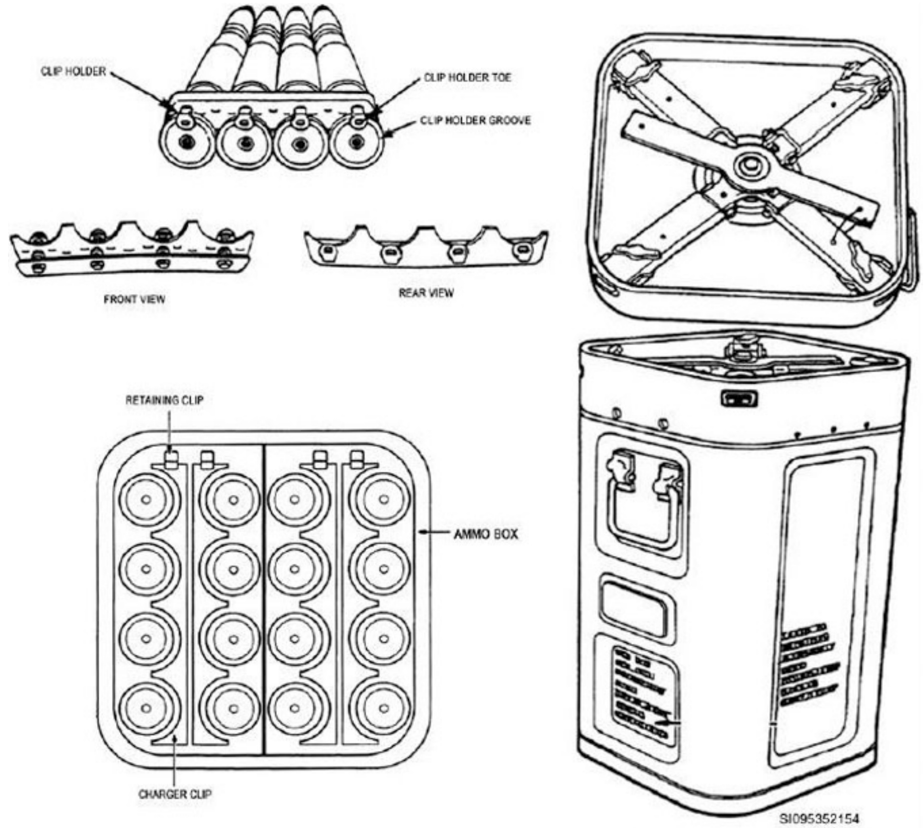


Figure 3–19. 40 mm cartridge clip and ammunition box.

227. 105 millimeter airborne artillery ammunition

Normally, when you think about a 105 mm, what pops into mind is a picture of ground artillery and the US Army. However, the US Air Force has put the 105 mm round to good use on board the AC–130 gunship used by Air Force Special Operations Command. In fact the 105 mm AAA used by the US Air Force is simply a modified US Army M1 projectile crimped/fixed into a brass casing.

Classification

Unlike the Army which uses semi-fixed 105 mm rounds, the Air Force only uses fixed rounds which are required for the projectile to be fully crimped to the cartridge case. This "fixed" condition consists of the maximum propellant charge and is *not* adjustable. This also allows for greater safety during loading and handling of the ammunition. Much like other USAF cannon ammunition, the 105 mm AAA is classified according to its use/function. This includes HE, high fragmentation (HF), TP, and clearing. There are other classifications out there, but we will concentrate on the more common rounds in the USAF inventory.

Cartridge, 105 mm, high-explosive, PGU–44/B

The 105 mm HE round is used for conventional fire support for harassment and interdiction, fragmentation, mining, and blast effect. It can damage/destroy light to medium materiel targets and incapacitate/suppress personnel targets. It consists of the refurbished/modified Army M1 projectile assembly crimped in the CYU–1/B brass cartridge case at the loading plant. The M1 projectile consists of a cylindrical hollow-steel forging with a boat-tailed base with base cover, a streamlined ogive, and gilding metal rotating band. This projectile is the deep cavity type, loaded with 4.6 pounds of composition B and a TNT supplementary charge. The main part of projectile is called the body. The body diameter represents the diameter of the projectile between the bourrelet and the rotating band. The rotating band is a cylindrical ring of relatively soft material (copper or gilding metal) which seats the projectile in a forcing cone, centers the base in bore, and helps prevent escape of propellant gases forward of the projectile. The PGU–44/B uses the CYU–1B brass cartridge case, the M28A2 primer, M67 prop charge, and the FMU–153/B fuze. The FMU–153 point detonating fuze (fig. 3–20) is used with the PGU–44/B for detonation with target on impact. It is threaded onto the front of the steel projectile and contains the MK49 MOD 2 for in-bore and close aboard safety. The fuze is designed so that the projectile will penetrate upon impact. The arming sequence begins after firing when the projectile is subjected to both setback and spin simultaneously. The no-arm spin rate is 1,000 rpm requiring 25 to 30 rotations being completed for arming.

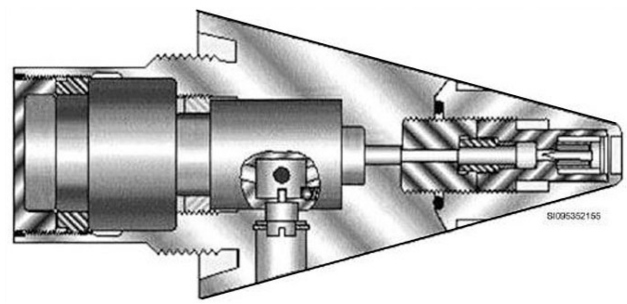


Figure 3–20. FMU–153 point detonating fuze.

Cartridge, 105 mm, high fragmentation, PGU–45/B

The 105 mm HF round is used to incapacitate/suppress personnel targets and damage/destroy light material targets. The 105 mm HE/HF PGU-45/B cartridge consists of a forged HF–1 steel projectile, specifically heat treated to produce multiple fragments appropriately sized to incapacitate personnel targets. Each projectile will produce approximately 13,000 fragments upon detonation. The projectile contains approximately 5 pounds of comp B explosive fill, a CYU–1/B brass cartridge case, M67 propellant charge, M28 Primer and Flash Tube, and a radar proximity FMU–160/B fuze.

The FMU–160/B fuze is used with the 105 mm PGU–45/B and is a radio frequency proximity fuze with a point detonating backup (on impact) if the proximity mode fails. The fuze is factory set to provide a 15-foot height of burst to optimize the lethality. There are no switches or manual settings for the fuze. The fuze consists of a radome, sleeve, MK41 safe & arm assembly, lead block assembly, reserve energizer (battery), and electronics assembly.

Cartridge, 105 mm, TP, PGU–43/B

The 105 mm PGU-43/B TP round with live supplementary charge is used for aircrew training. It was designed to enhance safety in the training environment, reduce training costs, and still provide an impact signature that can be seen on the gunship sensors. The TP round with live supplementary charge consists of a modified M1 projectile, a CYU–1/B brass cartridge case, an M67 propelling charge, a brass M28A2 primer assembly, and less expensive M739A1 fuze. The projectile body is filled with approximately 4.6 pounds of inert filler instead of an explosive fill. The nose of the projectile has a deep intrusion fuze well that contains a 0.3 pound TNT supplementary charge assembly.

The PGU–43/B TP round can also be used in combat as a kinetic energy combat round to limit collateral damage potential. Upon impact with a target, the projectile transfers kinetic and chemical energy to the target.

The 105 mm PGU–45B uses the M739A1 fuze for detonation with target on impact. The firing pin and detonator assembly is located below the rain insensitive sleeve and provides the super quick action on impact. The firing pin is held in position by a firing pin support which prevents initiation of the M99 Stab Detonator until impact.

Cartridge, 105 mm, clearing

The 105 mm clearing cartridge (fig. 3–21) is designed to clear a projectile lodged in the bore of a 105 mm Howitzer cannon. A lodged projectile occurs when the round is downloaded after a misfire or an aborted fire mission. This cartridge consists of a M14B4 brass cartridge case, containing propelling charge M67 with a base charge and six increments of M1 dual granulation propellant. A percussion primer, M28B2, contains 300 grains of black powder. The 105 mm clearing cartridge functions initially in the same way as other 105 mm rounds. When the primer is initiated, the propelling charge is ignited and produces gases which propel the lodged projectile out of the gun tube. The clearing cartridge color code is a natural metal.

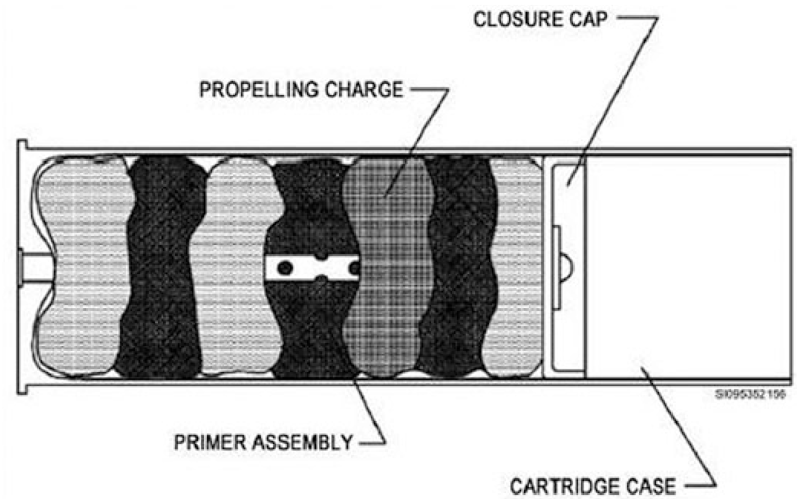


Figure 3–21. 105 mm clearing cartridge.

Components

Depending on the classification of the percussion–fired 105 mm, the round may consist of a cartridge case, primer, propellant charge, projectile, and a fuze. These munitions are delivered to the loading crew as complete rounds.

105 MM Components	
Component	**Description**
Projectile	With a length of 15.3 inches, the 105 mm projectile makes up almost half of the complete round's length. The projectile markings are in yellow with ⅜ inch letters and figures. These markings include model and type of cartridge, filler (TNT, and so forth) type and caliber of weapon, and a weight zone marking (fig. 3–22).
Cartridge case	The cartridge case is made of brass and the complete round is approximately 31 inches long with a 4.13 inch (105 mm) diameter.
Fuze	Fuzes for the 105 mm are classified as either point detonating or proximity. The most common 105 mm fuzes you will likely see are the FMU–160 series, FMU–153 series, and the M739A1.

105 MM Components	
Component	**Description**
	Typical fuze markings are type and model of fuze, manufacturer's initials, lot number of fuze, year of manufacture, and action of fuze (fig. 3–22). All 105 mm fuzes are natural metal in color.

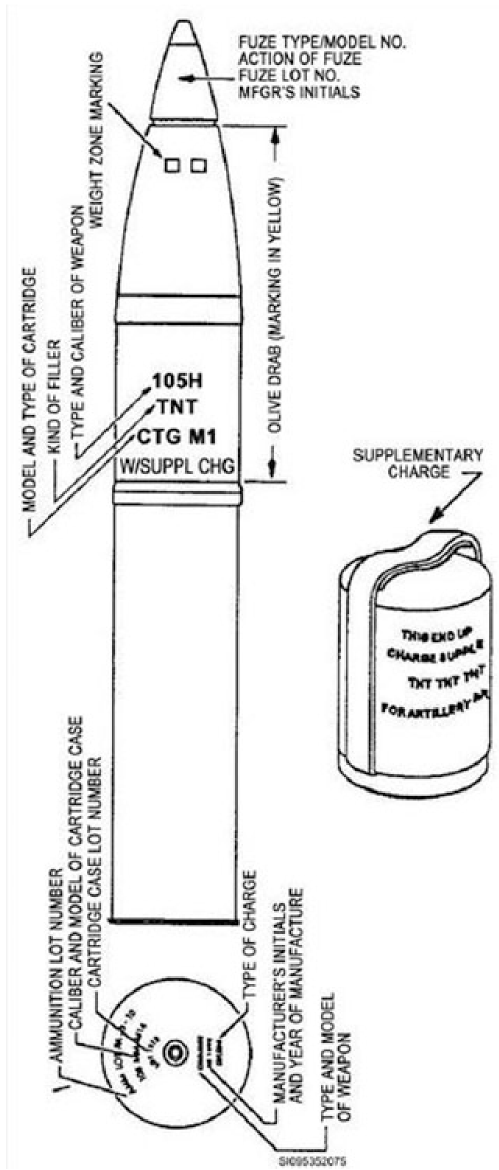


Figure 3–22. Markings, typical 105 mm round.

Identification

Specific identification for the 105 mm round is obtained from TO 11A13–13–7. The complete round typically consists of the following markings: model, type, caliber, fuze, filler, lot number, year of manufacture, and applicable color coding (fig. 3–22).

Packaging

Always package 105 mm AAA in original containers if possible or use a suitable substitute. Since there are various packing configurations depending on round characteristics, it is important to refer to the unpacking and packaging section within TO 11A13–13–7 for information concerning your specific round.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

223. 20 millimeter ammunition

1. How are 20 mm cartridges classified?

2. How is an API round initiated?

3. What is the semi-armor piercing, high-explosive and incendiary PGU-28 series round used for?

4. What are the combat effects of a HEI round?

5. Name two uses for 20 mm dummy ammo.

6. The 20 mm cartridge case is usually made of what material?

7. What is the purpose of the *bourrelet*?

8. What do the other chemicals in *double-base propellant* do?

9. Which 20 mm round *requires a fuze* to detonate the projectile?

10. What is the *safety feature* of the M505 fuze?

11. How can we identify 20 mm ammunition?

12. What container are 20 mm rounds stored in?

224. 25 millimeter ammunition

1. What Air Force aircraft fires the 25 mm round?

2. What is 25 mm PGU–23/U ammunition used for?

3. What does the PGU–25/U high-explosive incendiary round consist of?

4. What is 25 mm cartridge case made of?

5. A functioning M115 percussion primer is used with which 25 mm round(s)?

6. What fuze is used in the 25 mm HEI round?

7. What markings can you find on the *cartridge case* of 25 mm ammo?

8. What are 25 mm rounds packaged into for storage?

225. 30 millimeter ammunition

1. How do we classify 30 mm ammo?

2. PGU–15 ammunition is used for what purpose?

3. What *impact* fuze is used on the 30 mm HEI round?

4. What are the two purposes of the fumer charge in the APIT rounds?

5. What does the *projectile retaining screw* in the PGU–16/A dummy round do?

6. The 30 mm cartridge case is made of what material?

7. What type of *propellant* does the 30 mm round use?

8. How can you identify 30 mm ammo?

9. What color(s) are 30 mm API and APIT rounds painted?

10. How are 30 mm *dummy rounds* identified?

226. 40 millimeter ammunition

1. How is ammunition for M2A1 cannon classified?

2. Which round has a red tracer composition and an M69 dummy fuze?

3. What fuze does the PGU–9 C/B round use?

4. What is the *minimum* specification *no arm distance* for the FMU–154/B?

5. What are all 40 mm airborne artillery ammunition packed in for storage/transporting?

227. 105 millimeter airborne artillery ammunition

1. How are USAF 105 mm rounds classified?

2. What are some uses for the 105 mm high explosive (HE) round?

3. What *point detonating* fuze is used with the PGU–44/B?

4. If the proximity mode fails, how does the FMU–160/B fuze detonate?

5. What is the NEW of the PGU–43/B TP round?

6. What round is designed to remove a projectile lodged in the bore of a 105 mm cannon?

3–2. Aircraft Munitions Systems

Countermeasures are systems or devices used to protect aircraft from enemy detection or attack. The most common countermeasures are electronic devices, flares, and chaff. Most countermeasure munitions, like other air ordnance, require an impulse cartridge to generate gas pressure to deploy the flare or chaff.

228. Countermeasure munitions

Flares can be used as small, finely tuned heat decoys. They produce intense heat to cause the enemy's infrared guided missiles to lock-on to the flare instead of our aircraft. We use chaff (aluminum-type material) to confuse the enemy's radar guided missiles (fig. 3–23). Both chaff and flare are loaded into dispensers sometimes referred to as "mods" (fig. 3–24). As an AMMO Airman, your main function is to "stuff chaff and flare into these mods." These mods are then loaded into an aircraft.

Flares

Countermeasure flares can be carried on all the major USAF tactical aircraft (e.g., A–10, F–15, F–16, and F–22); bombers (B–52, B–1, and B–2); and cargo aircraft (C–130, C–17, and C–5). They produce a high-temperature flame that is designed to divert enemy heat/IR seeking missiles from our aircraft. Since there are far too many flare cartridges to mention here, we will focus on the more common ones you may run into.

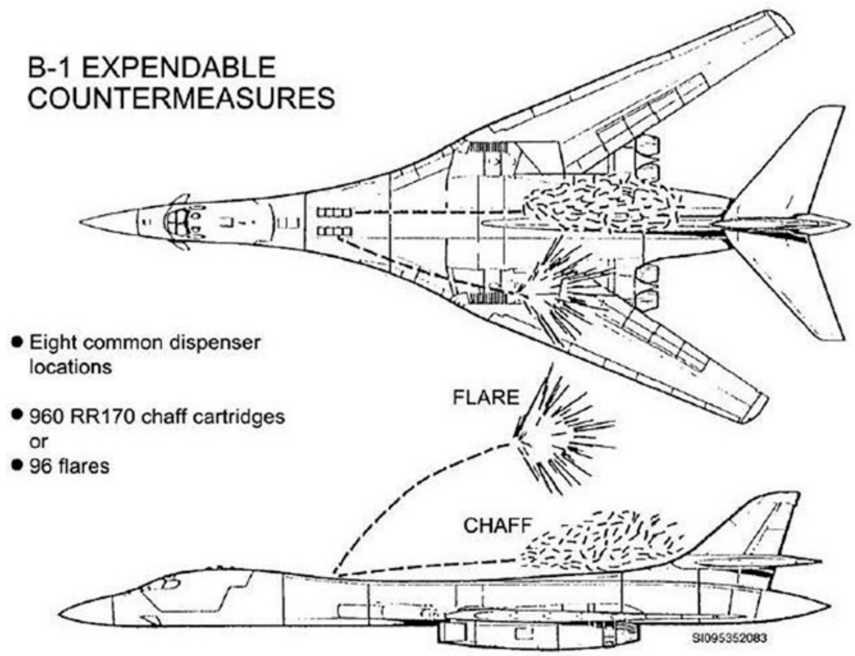


Figure 3–23. Countermeasure operational sequence.

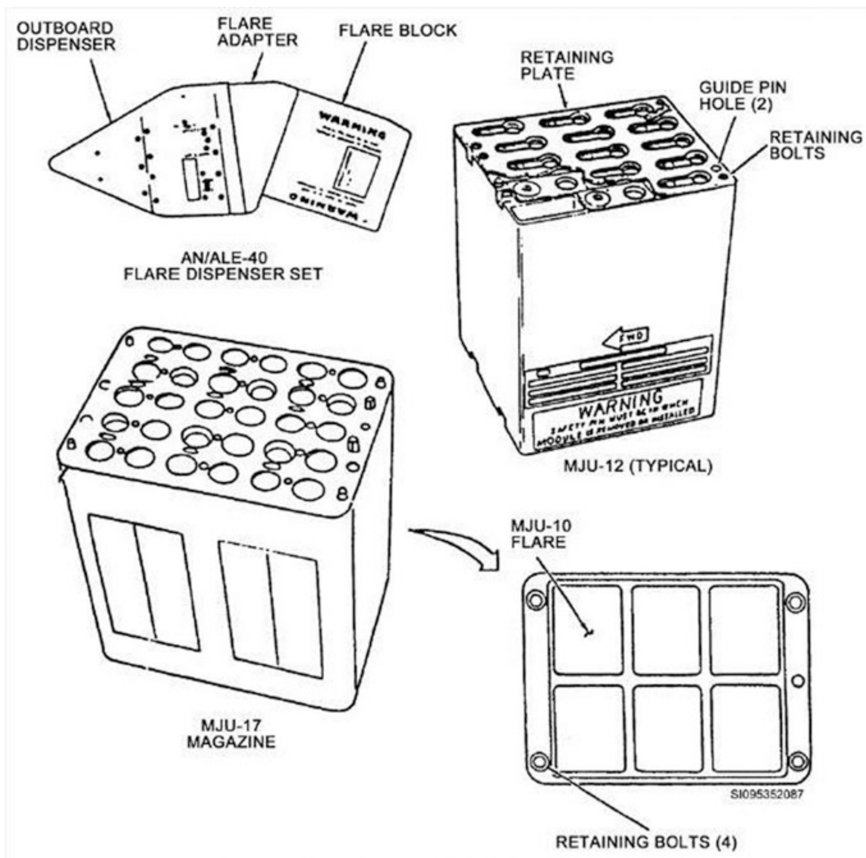


Figure 3–24. Typical aircraft chaff/flare magazines.

ALA–17-series flare cartridges

Each cartridge consists of two flares (upper and lower) with their flare cases crimped together to form a cartridge (fig. 3–25). The ALA–17A and ALA–17B differ from the ALA–17 in flare composition percentage and are grooved to provide an increased flare ignition area. Also, the upper igniter assembly differs in contact points. There is a shorting clip for handling the cartridge when it is not installed in its dispenser.

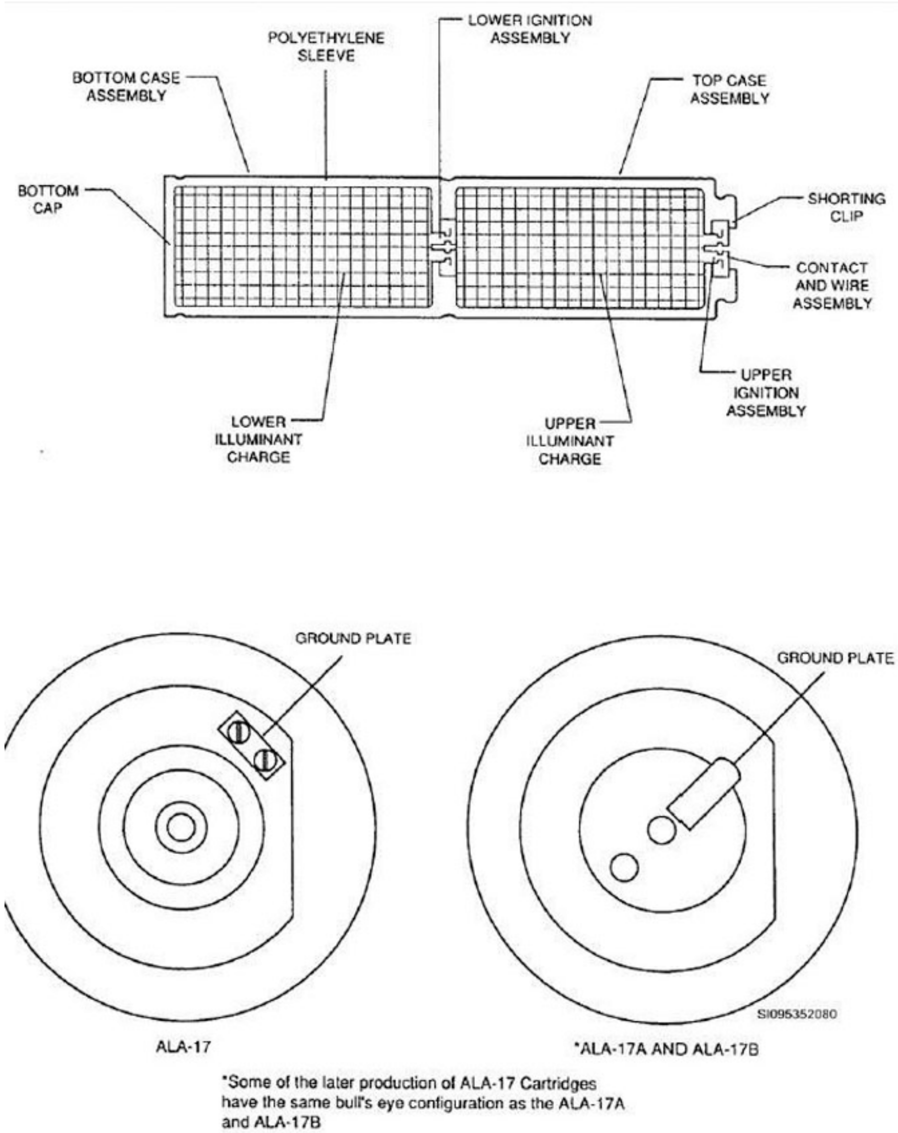
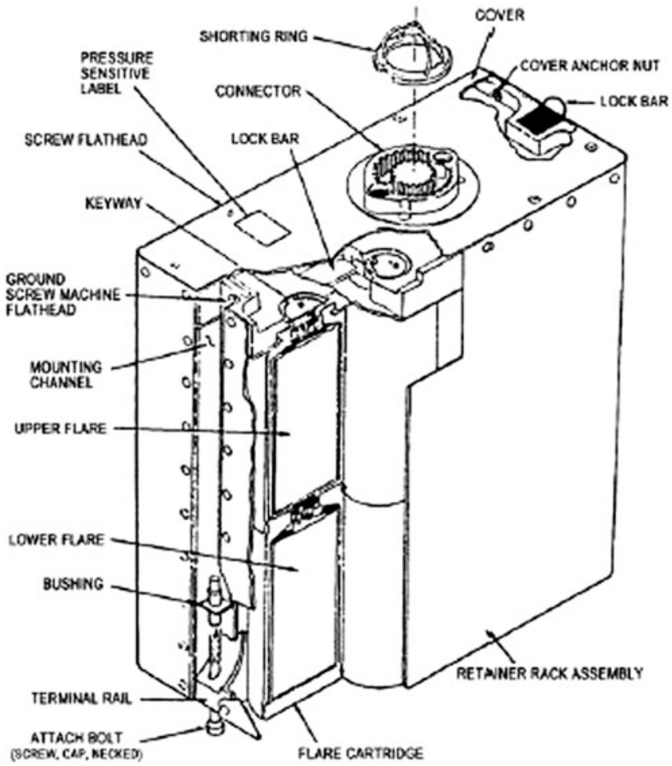


Figure 3–25. ALA–17-series flare cartridge.

Each flare has an electric squib ignition assembly and an illuminant charge. Electrical current applies a fire impulse to the bulls-eye contacts on the end of the flare cartridge. The electrical current fires a squib in the electric ignition assembly on the lower flare. (The upper flare is fired after the lower flare.) The squib, in turn, ignites the ignition charge, which creates an extremely hot ignition flash and ignites the illuminant pellet. The burning gases from this pellet project the flare from the cartridge case and away from the aircraft.

The ALA–17-series flare cartridges are carried in the ALA–17 flare rack (fig. 3–26). Eight flare cartridges (two flares per cartridge) are carried in each flare set. These flare sets can be used on the

B–52. The B–52 aircraft is fitted with 12 flare sets at the aft stabilizer position (six on each side). Each flare set has a shorting ring installed over its connector to ensure safe handling.



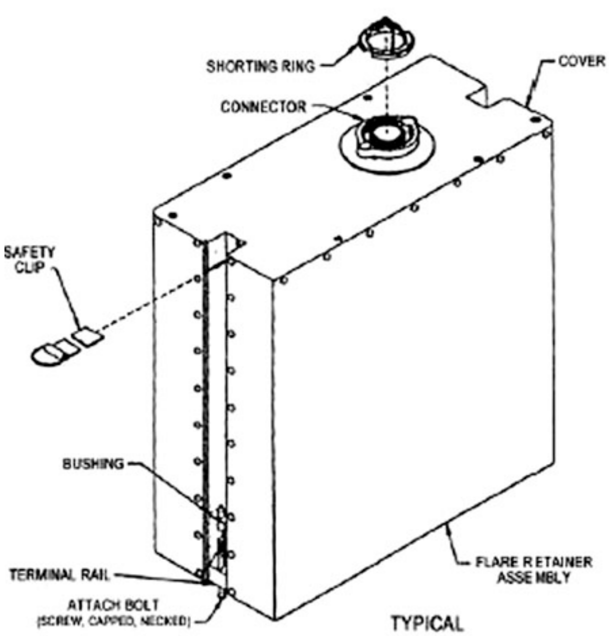


Figure 3–26. ALA–17-series flare rack.

MJU–7-series infrared flare

The MJU–7 series (fig. 3–27) flare consists of a one by two by eight inch (1 x 2 x 8 inch) rectangular case, containing a flare pellet, piston, felt spacer, end cap, initiating mechanism, and a receptacle for the BBU–36/B impulse cartridge. The MJU–7 series flare is loaded and dispensed by aircraft using the MJU–12 flare dispenser.

The MJU–12 flare magazine holds a maximum of 15 MJU–7-series flares. The A–10, C–17, C–130, F–15, and F–16 aircraft use this magazine (fig. 3–27).

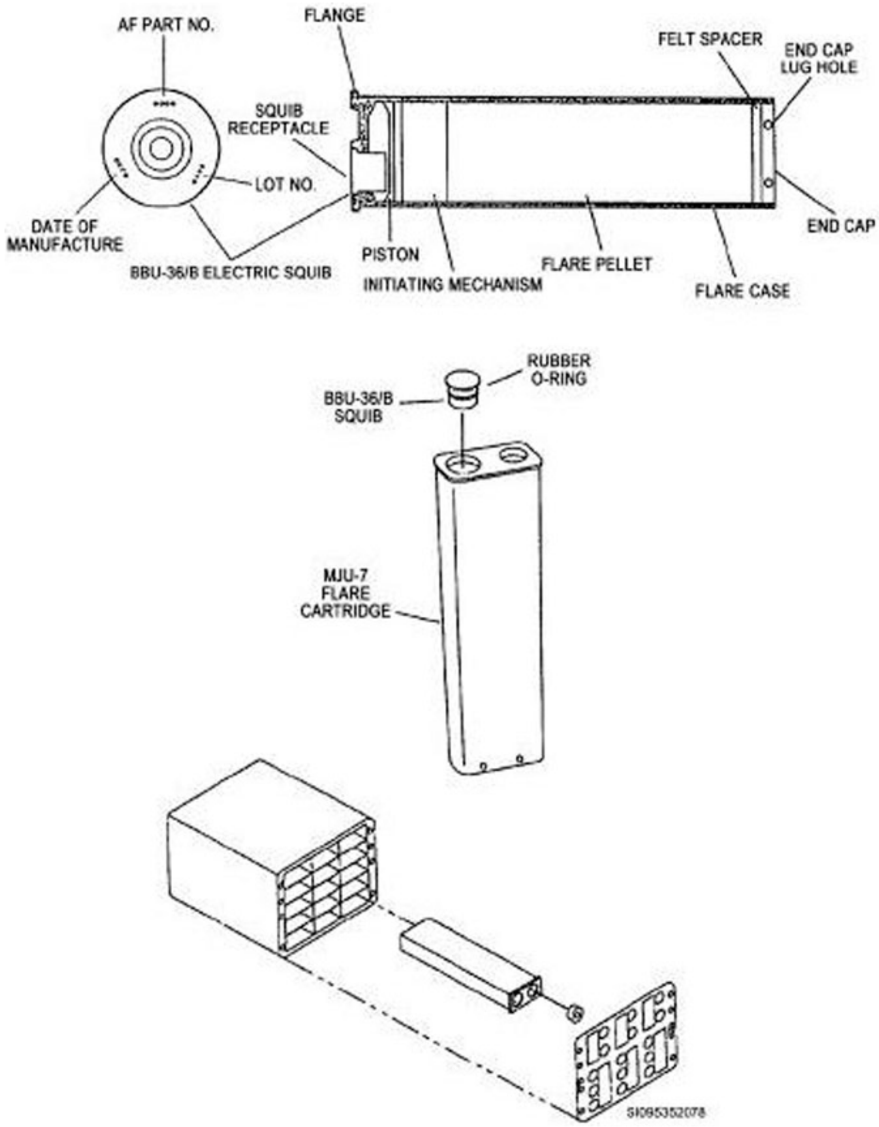


Figure 3–27. MJU–7/B flare cartridge, BBU–36/B electric squib, and MJU–12 flare dispenser.

M206 infrared flare

This decoy flare is physically similar to the MJU–7/B except it is one by one by eight inches (1 x 1 x 8 inches) in size. Another difference between them is the candle output power used to simulate different sized aircraft engines. Different jet engines produce different amounts of infrared (IR) energy. These flares simulate that difference in energy level to decoy the enemy IR missiles away from the aircraft.

SD–206 infrared flare simulator (Smokey Devil)

The Smokey Devil (fig. 3–28) is an infrared simulator and is loaded and dispensed the same as the M206 flare. Instead of burning, it provides a yellowish smoke to simulate a flare for training purposes. Aircraft use the MJU–11 magazine to dispense these infrared flare simulators.

The MJU–11 flare and chaff magazine is similar to the MJU–12 magazine except it as the capacity for 30 M206 flares and flare simulators. The MJU–11 can also hold 30 RR–170 or RR–188 chaff cartridges. The A–10, C–17, C–130, F–15, and F–16 aircraft use this magazine (fig. 3–28).

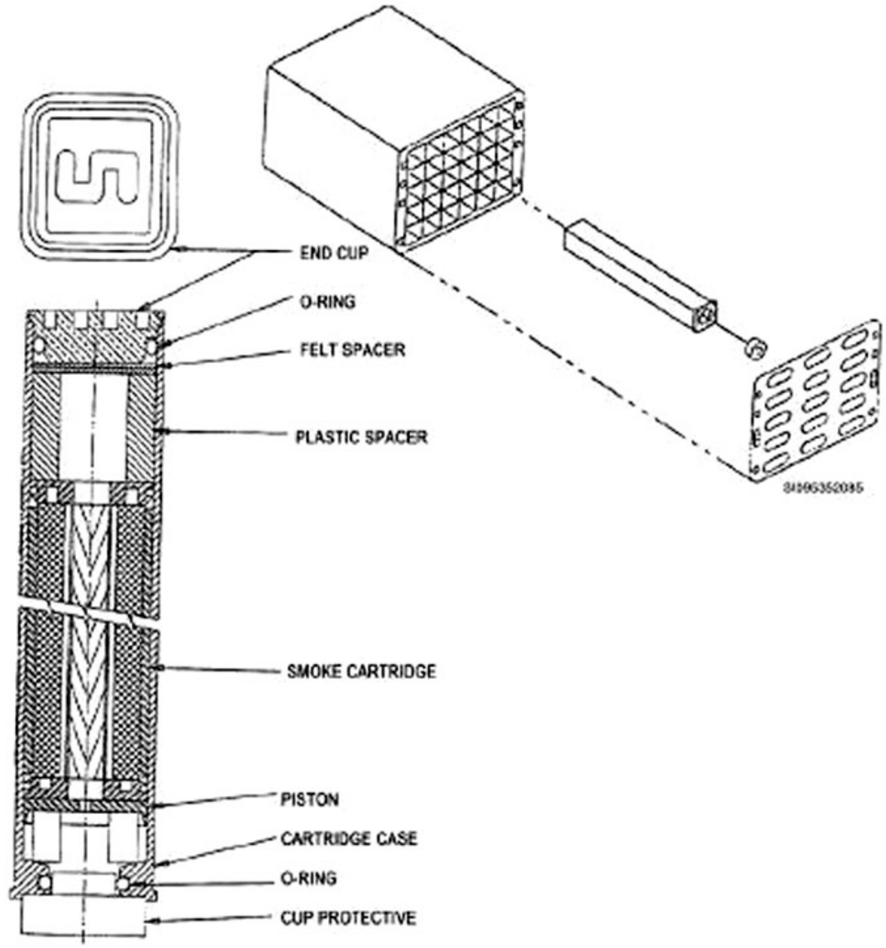


Figure 3–28. SD–206 IR flare and the MJU–11 flare magazine.

M211, MJU–46/B, MJU–50/B, and MJU–51A/B infrared decoys

The M211, MJU–46/B, MJU–50/B, and MJU–51A/B infrared (IR) decoy countermeasures (fig. 3–29) all consist of an aluminum cartridge case purged with nitrogen and containing a payload of special material elements which react with air. Each aluminum cartridge case contains a sealed receptacle cup with an o-ring for a BBU-35/B impulse cartridge, a plastic/nylon piston, crimped and then sealed, and a metal end plate. When the impulse cartridge is fired, the receptacle cup membrane ruptures. Pressure inside the canister increases until the end cap seal breaks—deploying the special material payload into the air stream. The payload reacts with the air generating IR energy to decoy surface-to-air and air-to-air missiles. There are only slight characteristic differences between this group of infrared decoys which are explained in detail in TO 11A16–47–7. All these IR decoy countermeasures (M211, MJU–46/B, MJU–50/B, and MJU–51A/B) are loaded into either the ALE–40, ALE–45, or the ALE–47 dispenser.

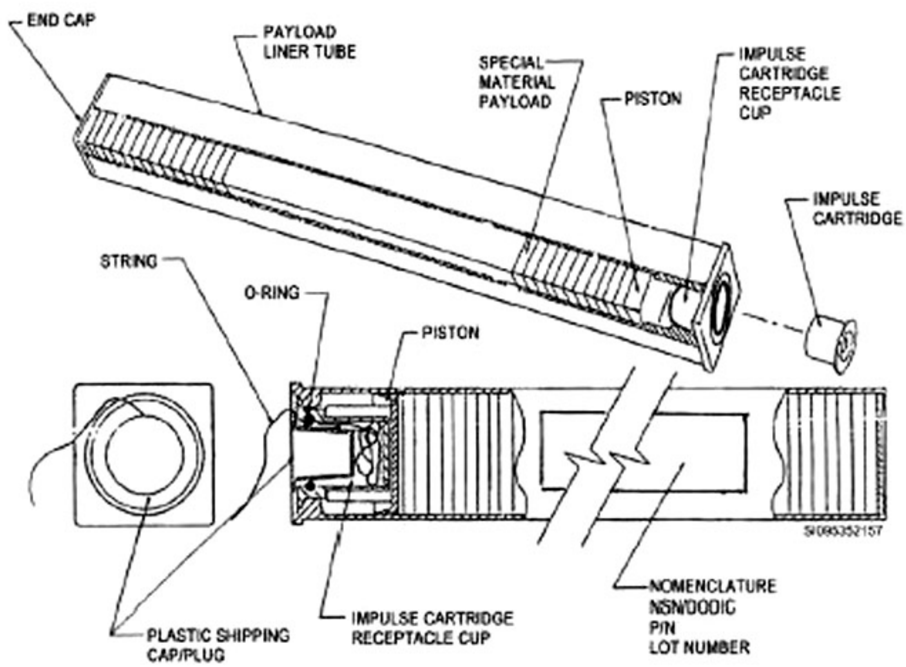


Figure 3–29. M211, MJU–46/B, MJU–50/B IR decoys.

MJU–23 series flare

The MJU–23–series flare cartridge is used in the B–1B and is a magnesium-based IR countermeasure. The MJU–23/B consists of a cylindrical metal cartridge case called an ejector tube. It has a metal end cap and a black closure cap at the forward end to retain the internal components. The MJU–23/B comes as an all-up round, which includes a BBU–46/B impulse cartridge with an attached shunting clip. The MJU–23A/B is very similar to the MJU–23/B. The major physical difference is the MJU–23A/B has a red aluminum closure cap and uses a parasitic interrupted assembly instead of a safe and initiating device. Both series use the AN/ALE–49 flare dispenser which holds 12 MJU–23 flare cartridges. Figure 3–30 shows the MJU–23-series flare cartridge and the AN/ALE–49 flare dispenser.

MJU–39/B and –40/B countermeasure flares

The MJU–39/B and –40/B countermeasure flares are magnesium-based kinematic IR countermeasure devices. They consist of an aluminum case, crimped on aluminum end cap, plastic piston, sequencer device, flare body with nozzle and shroud. The F-22 aircraft dispenses these countermeasure devices using the ALE–52 dispenser and ignites them with impulse cartridges. The difference between these two countermeasures is the impulse cartridge used. The MJU–39/B uses the BBU–59/B impulse cartridge and the MJU–40/B uses the BBU–36/B impulse cartridge.

MJU–47/B infrared flare

The MJU–47/B flare is a magnesium-based kinematic IR countermeasure. It consists of an aluminum case, crimped on aluminum end cap, plastic piston, sequencer device, and flare body with nozzle. It uses the BBU-36/B impulse cartridge. The MJU–47/B is dispensed by the ALE–45 or ALE–47 dispenser used by the F–15 and F–16 aircraft.

MJU–48/B infrared flare

The MJU–48/B flare is combination magnesium-based IR flare and special material decoy countermeasure. It consists of a one by two by eight inch (1 x 2 x 8 inch) aluminum case, crimped and sealed aluminum end cap, felt spacer, special material payload, mid-spacer, flare pellet, safe and initiation device, plastic piston, and a sealed cartridge cup. It uses the BBU–35/B impulse cartridge. The MJU–48/B is dispensed by the ALE–45 or ALE–47 dispenser used by the F–15 and F–16 aircraft.

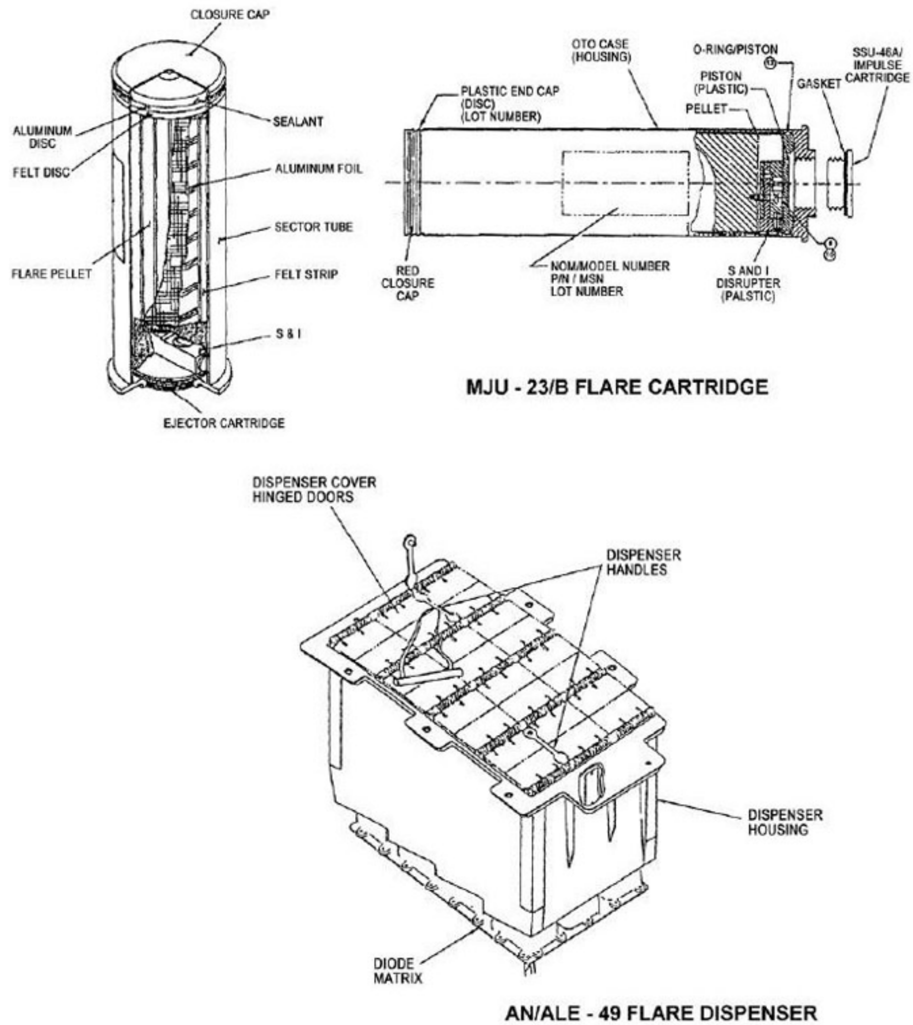


Figure 3–30. MJU–23-series flare.

MJU–52/B infrared decoy

The MJU–52/B IR countermeasure decoy is enclosed in a plastic case. The individual payload is heat sealed in a plastic tray with a plastic cover/strap that is purged with nitrogen and contains a payload of stacked special material foil elements which react with air. The individual tray of MJU–52/B decoy is dispensed in flight mechanically. When the plastic payload tray of special material hits the air stream it breaks apart scattering the special material out into the air stream. The special material payload reacts with air in generating infrared energy to decoy surface-to-air and air-to-air missiles. It uses the BBU–35/B impulse cartridge. The MJU–52/B is dispensed by the AN/ALE–58 dispenser.

AN/ALE–50 series towed decoy system

The AN/ALE–50 towed decoy system (TDS) is an electronic countermeasures system designed for use on multiple US Air Force aircraft. The ALE–50 series consists of a launch controller, launcher, and towed decoy. The launch controller contains the decoy control/monitor electronics and power supply. It can be used on a variety of platforms without modification. The launcher contains the decoy magazine and can be customized to fit various aircraft. The decoy is packaged in a sealed canister and has a 10-year shelf life. When deployed, the ALE–50's expendable aerial decoy is towed behind the aircraft. The decoy protects the host aircraft and its crew against guided missiles by providing a more attractive radar target. It lures radio frequency missiles away from the aircraft and to the decoy. The most rigorously tested electronic countermeasures system in US Air Force and US Navy history, the ALE–50 has successfully countered numerous live firings of both surface-to-air and air-to-air missiles. This stand-alone system requires no threat specific software and communicates health and status to the host aircraft over a standard data bus. The ALE–50/B TDS is currently installed on the F–16 and B–1B. The F–16 TDS can carry two decoys with a maximum of two towed decoy systems per aircraft for a total of four decoys. The B–1B TDS can carry four decoys with a maximum of two towed decoy systems per aircraft for a total of eight decoys.

Chaff

The chaff package provides an aircraft airborne countermeasure capability to dispense multiple frequency reflecting dipoles (metallic strips cut to match different radio frequency wavelengths) for the purpose of interrupting tracking of an aircraft flight path by radar equipment.

RR–170/188 series chaff cartridges

The RR–170 and RR–188 series chaff cartridges (fig. 3–31) consist of a square plastic tube containing a receptacle for a firing device (BBU–35/B impulse cartridge), piston, chaff dipole payload, and a plastic end cap secured with two end-cap lugs. These chaff cartridges are dispensed in flight by the BBU–35/B impulse cartridge from AN/ALE series chaff dispensing systems. When the BBU–35B impulse cartridge is *not installed* the *chaff cartridges contain no explosives or incendiary components*. The RR–170 and RR–188 are identical in size and shape, but the RR–188 can only be loaded on aircraft with training missions.

RR–196/AL chaff cartridge

The RR–196/AL is a bundled chaff countermeasure. It consists of a dual payload plastic case. Each payload has a rubber end cap, aluminum coated glass fiber payload bundled with Kapton wrap in three sections, and a plastic piston with a glued–on felt spacer. It uses the BBU–48/B dual impulse cartridge. The RR–196/AL is dispensed by the ALE–52 dispenser used by the F–22 aircraft.

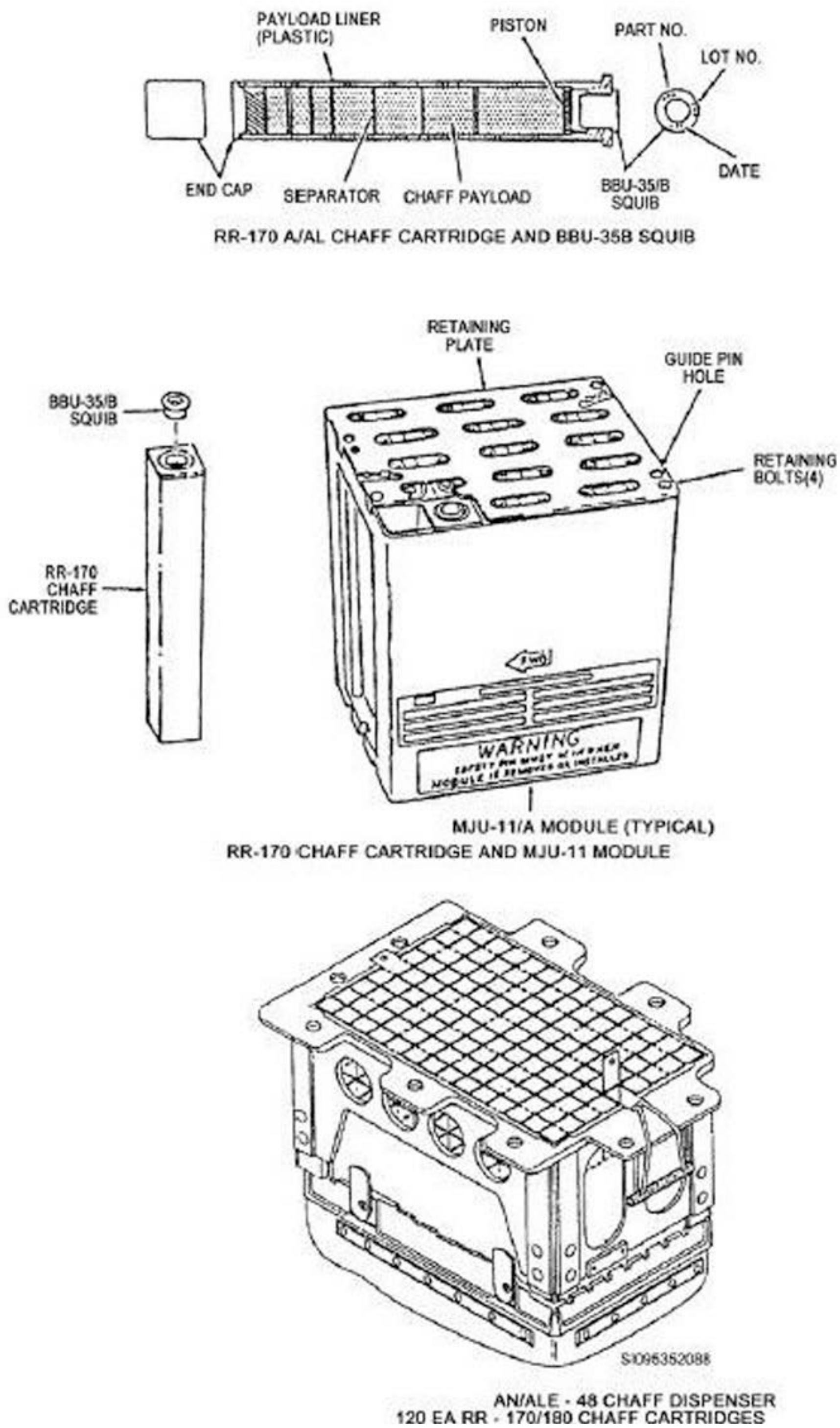


Figure 3–31. RR–170 chaff cartridge and dispenser.

229. Target marker and illuminating flares

Sufficient target identification and area visibility are vital for military operations. The target marker and illuminating flares covered in the lesson are all air-deployed capable from several USAF aircraft (e.g., A–10, C–17, C–130, F–15, and F–16).Target marker flares ignite in the air after a preset time by using an ignition timer, then burn on the ground, providing a highly distinguishable colored flame around the target. The illumination flares that we will discuss also have ignition timers and are parachute supported, but have larger parachutes to retard the speed of fall in order to extend the illumination time while air borne.

LUU–1/B and LUU–5/B target markers

It's important to note the LUU–1B and LUU–5/B target markers are identical, except the LUU–1/B produces a *red* color and the LUU–5/B produces a *green* color. These target marker flares are launched from an aircraft to illuminate targets providing a target area ground reference. The flares ignite in the air at a distance set on an ignition timer, then burn on the ground for an average burning time of 30 minutes, providing a red or green flame that is visible from the air. The flares consist of a cylindrical aluminum outer housing assembly divided internally into three sections. The *upper section* contains a lanyard assembly and two variable time delay fuzes with a safety pin. The *center section* contains the pyrotechnic candle. The *lower section* houses its parachute. Because of the extremely high-velocity reaction forces involved in candle ejection, this flare is *not* hand launched. For the same reason, personnel should *never stand behind the flare while handling it*.

LUU–2 series illuminating flare

The LUU–2 series illumination flare (fig. 3–32) is an airborne-launched illuminating device that produces an off-white light of approximately two million candlepower for an average burn time of 5 minutes. The flare housing holds the parachute, ignition system, explosive bolt, timer and release mechanism, and a pyrotechnic candle in an insulator that bonds the candle and insulation to the thin aluminum flare housing. The LUU–2 illumination flare has a timer that is set to ignite the flare after a predetermined drop distance. The timer deploys a parachute which activates the igniter. The flare illuminates an area from the air, and then the parachute is collapsed by an explosive bolt to clear the air space.

NOTE: If the timer knob is accidentally pulled during handling when it is *not* on the SAFE setting and the timer cycle begins, you can hold the timer and release mechanism on the flare housing to prevent ejection. After the timer runs down completely, tape the mechanism securely to the flare housing and mark the flare for disposal. If the timer ever ejects from the flare, stuff the parachute material back into the housing, tape the timer, and mark it for disposal.

LUU–19 series illuminating flare

The LUU–19 weighs 36 pounds and burns for approximately 10 minutes. It is recommended that this parachute flare *not be ignited below* 10,000 feet in order to prevent a fire hazard. The LUU–19 primarily emits light/energy in the near-infrared region spectrum for night vision illumination, although it can still be seen with the naked eye.

SAFETY NOTE: The LUU–2C/B, LUU–19/B, and LUU–19A/B illumination flares have proven they could ignite when dropped or if the timer knob is accidentally pulled. All handlers of these flares will ensure they are familiar with all cautions and warnings in TO 11A10–24–7, *Specialized Storage and Maintenance Procedures, Aircraft Parachute Flares* and 11A10–33–7, *Specialized Storage and Maintenance Procedures, Target Marker Flares*.

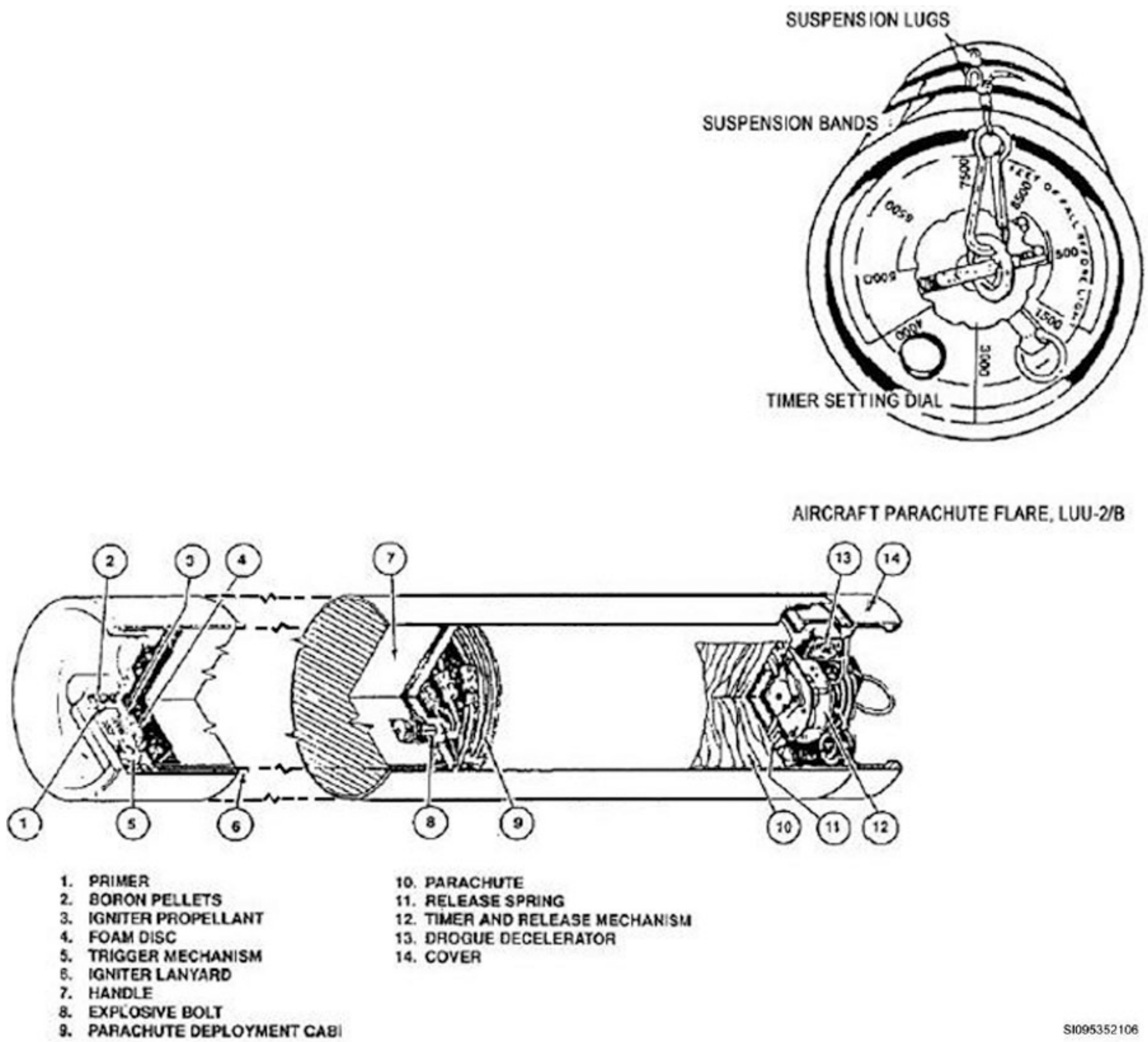


Figure 3–32. LUU–2/B flare face and cutaway.

230. Cartridge-actuated and propellant-actuated devices

Today's high-speed aircraft must have a way for the pilot and crew to escape from the aircraft in an emergency. To meet this need, canopy and seat ejection components were developed. Most are known as cartridge-actuated devices (CAD). As aircraft reach greater and greater speeds, these CADs become more numerous, complicated, and powerful. We use propellant-actuated devices (PAD) to remove munitions from the aircraft launcher and racks. Munitions systems specialists are responsible for inspecting, storing, and delivering these items.

Cartridge-actuated devices

A CAD uses a self-contained removable explosive cartridge to provide a source of gas pressure to perform its intended function. Some examples of cartridge-actuated devices are initiators, thrusters, and catapults.

Initiators

An initiator, like the ones shown in figure 3–33, supplies gas pressure to operate the firing mechanism of other CADs. The more reliable initiator has replaced the cumbersome cable/pulley systems used previously for the mechanical firing of devices.

The initiator has a ported chamber, firing mechanism, and cartridge. It assembles to another CAD with a single length of flexible hose, a metal tube, or a combination of both. All initiators operate reliably over wide temperature ranges and withstand the maximum pressure produced by the burning propellant if the port is blocked.

Mechanically operated initiators fire when a force of 20 to 35 pounds withdraws the initiator pin. The firing pin is locked to the initiator pin with a number of steel balls. The firing pin is then propelled by the compressed spring against the cartridge, which contains a percussion-sensitive primer. The primer ignites the charge in the cartridge, which ruptures, letting the propellant gas flow from the initiator.

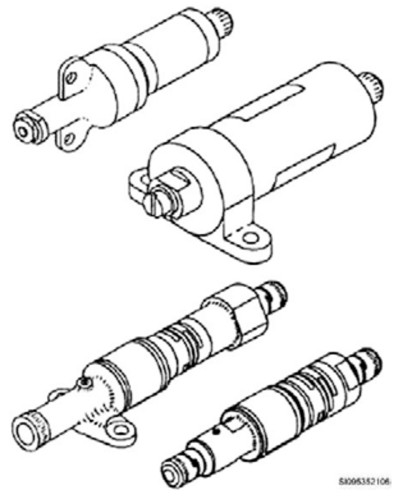


Figure 3–33. Gas pressure-actuated initiators.

Gas-fired initiators contain a firing pin held in position with a shear pin. When gas pressure is supplied from an initiator or other CAD, its force on the firing pin shears the shear pin and propels the firing pin against the cartridge.

Thrusters

Before the seat and occupant can be safely ejected from the aircraft, the escape system must be readied for operation. The seat may need to be positioned, the control column stowed, and the canopy or escape hatch locks opened. The thrusters do these jobs. An initiator develops the gas pressure needed to operate the firing mechanism of the thruster. Thrusters vary in the amount of output they provide from 250 to 6,000 psi.

Catapults

Catapults were designed specifically for ejecting both a seat and a crew member safely from the aircraft under emergency conditions. The typical catapult is a three tube, telescoping ejector, consisting of an outer tube, intermediate tube, inner tube, and cartridge with its firing mechanism. The upper end of the inner tube contains a block assembly that attaches to the receptacles on the ejection seat and incorporates the cartridge and firing mechanism. The upper end of the outer tube contains a male trunnion, which attaches to the aircraft structure. When the catapult fires, the outer and intermediate tubes stay with the aircraft; the inner tube ejects with the seat.

A typical catapult, such as the M3A1, is 50 inches long, weighs about 24 pounds, and can eject a 300-pound “seat man” from the aircraft. The catapult thrust is developed by the burning of a smokeless propellant composition and a black powder igniter contained in an ignition cartridge. The propellant cartridges are hermetically sealed and are not usually affected by changes in temperature, pressure, and moisture. For identification purposes, the lot number, Department of Transportation markings, and date loaded are stenciled on the cartridge case.

Removers

A remover is basically an ejector containing an explosive cartridge that forcibly jettisons the canopy from the aircraft, furnishing a safe path for the ejection of the occupants. The remover usually consists of an outside tube, inner tube, sleeve, explosive cartridge, and block assembly. The cartridge nomenclature, lot number, and date loaded are stenciled on the cartridge case and on the outside tube of the receiver. A warning concerning the actuation of the remover is also stenciled on the remover body. A typical remover is 16 inches long, weighs about 2 pounds, and can remove a 300-pound canopy.

Propellant-actuated devices

A PAD uses a propellant that is an integral part of the device to provide a source of gas pressure to perform its intended function; for example, impulse cartridges, delay cartridges, squibs, and so forth. Since most PADs are electrically initiated, they are susceptible to detonation or ignition by electromagnetic radiation, static electricity, or radio frequency energy. Observe safety rules when working with PADs. Allow only qualified and authorized personnel to handle, install, remove, or dispose of PADs. Leave PADs in their containers until just before use. During storage and handling, short squib lead wires together, but be careful not to twist the leads into a loop or into some other type of antenna configuration. *Do not* remove shunts, clips, and other shorting devices, except for continuity testing or installing the device. Procedures for storing, handling, inspecting, testing, and maintaining specific types of PADs can be found in the item’s technical order.

Electric squibs

Electric squibs are constructed similar to electric blasting caps. The tubing is usually thin copper or aluminum and may be quite small. The tubing contains a rubber plug with a bridge wire, an ignition bead, and a power load. The leg wires are shunted until used. An electric current ignites the ignition bead, which in turn ignites the power load, heating the bridge wire. The ignition of the power load provides a flash that initiates flammable compositions and explosives or generates gas pressure to break explosive bolts or actuate cable cutters.

Impulse cartridges

Nearly all of the bomb suspension and some of the missile-launching equipment in use today require impulse cartridges for normal operations. As the name “impulse cartridge” implies, they are used to furnish explosive power to separate munitions, fuel tanks, launchers, dispensers, racks, etc., from an aircraft. A typical impulse cartridge is electrically initiated and contained in a waterproof aluminum case. The components are an electric primer, an ignition charge, and a propellant charge. When power is applied to the electric primer, it ignites the ignition charge, which in turn ignites the propellant that releases or ejects stores from aircraft.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

228. Countermeasure munitions

1. Which military aircraft carry countermeasure flares?

2. What is used to *safe* an ALA-17 flare set for handling?

3. What is the *maximum* number of MJU–7-series flares that the MJU–12 flare magazine holds?

4. Why is the SD–206 Smokey Devil flare simulator used?

5. Which countermeasure system consists of a *towed decoy*?

6. What is the *maximum* number of decoys that can be carried on a B–1B?

7. What is the purpose of chaff munitions?

8. RR–188 series chaff is restricted to what type of flying missions?

229. Target marker and illuminating flares

1. Which type of flare is designed to ignite in the air, then burn on the ground?

2. How do most illumination flares extend their burn time while airborne?

3. What color light does the LUU–5/B provide?

4. Which illuminating flare produces an off-white light at two-million candlepower for an average of 5 minutes?

5. The LUU–19 series flare provides what *primary type of illumination*?

230. Cartridge-actuated devices and propellant-actuated devices

1. Name three examples of a CAD.

2. When are mechanically-operated initiators fired?

3. Once an initiator supplies the pressure needed for the firing mechanism, what jobs can *thrusters* perform?

4. What are *catapults* specifically designed to do?

5. What do *removers* do?

6. What is a propellant-actuated device (PAD)?

7. What are *impulse cartridges* used for?

Answers to Self-Test Questions

223

1. According to their purpose.
2. On impact.
3. Aircraft and light materiel targets.
4. It is a combined explosive and incendiary effect.
5. (1) Testing feeder assemblies.
   (2) Drill/familiarization.
6. Brass.
7. It acts as a forward-bearing surface to prevent the projectile from wobbling as it passes through the bore.
8. They minimize smoke and flash, increase stability, and permit uniform loading during manufacture.
9. The HEI round.
10. The fuze is bore safe.
11. By model number, lot number, and manufacturer’s symbol, all of which are marked or stamped on the side of the projectile.
12. The M548 container (linkless or linked belt).

224

1. The AC-130 gunship.
2. Target practice for pilot proficiency training.
3. A steel cartridge case, an M115 percussion primer, an ignition booster, a projectile, and an M505 fuze.
4. Steel.
5. All 25 mm rounds except for dummy rounds.
6. M505.
7. Model number, type, and lot number.
8. CNU–405/E ammunition shipping and storage containers.

225

1. According to its purpose.
2. Pilot training, weapon testing, and aircraft system checkout.
3. M505A3.

4. (1) Reduce air drag during flight to the target.
   (2) To give a visible trace of the flight path.
5. It holds the projectile in the cartridge and simulates the weight of the propellant and the center of gravity of the round.
6. Aluminum.
7. Double-base.
8. By its model number, lot number, part number, and color coding.
9. Both rounds have a black projectile with a red band and white markings.
10. Bronze or gold projectile with black markings.

226

1. According to the type of projectile and/or fuze.
2. 40 mm AAA target practice tracer (TPT) round.
3. FMU-154/B fuze.
4. 140 feet.
5. MK1 ammunition boxes.

227

1. As fixed complete rounds depending on their use/function.
2. Conventional fire support for harassment and interdiction, fragmentation, mining, and blast effect.
3. FMU–153.
4. By impact (point detonating backup).
5. 0.3 pound TNT supplementary charge.
6. The 105 mm clearing round.

228

1. All major USAF tactical fighters, bombers, and cargo aircraft.
2. Shorting ring.
3. 15.
4. Instead of burning, it provides a yellowish smoke to simulate a flare for training purposes.
5. AN/ALE–50 TDS.
6. Eight.
7. They are used to scramble enemy radar signal returns.
8. Training.

229

1. Target marker flare.
2. By using large parachutes.
3. Green.
4. LUU–2 series.
5. Light/energy in the near–infrared region spectrum for night vision use.

230

1. (1) Initiators.
   (2) Thrusters.
   (3) Catapults.
2. When the initiator pin is withdrawn by a force of 20 to 35 pounds.
3. Position ejection seats, stow control columns, and open the canopy or escape hatch locks.

4. Eject the pilot’s seat and the pilot from an aircraft under emergency situations.
5. Jettison the canopy forcibly from the aircraft.
6. A device that uses a propellant that is an integral part of the device to provide a source of gas pressure to perform its intended function.
7. To furnish explosive power to separate munitions, fuel tanks, launchers, dispensers, racks, etc., from an aircraft.

Complete the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field-Scoring Answer Sheet.

Do not return your answer sheet to the Air Force Career Development Academy (AFCDA).

64. (223) How is 20 millimeter ammunition classified?
    a. According to its purpose.
    b. As either combat or noncombat ammunition.
    c. By the type of gun system in which it is used.
    d. By its initiation method (electric or percussion).

65. (223) The *incendiary composition* of the 20 millimeter armor-piercing incendiary (API) round is initiated by
    a. impact.
    b. inertia forces.
    c. fuze functioning.
    d. friction during firing.

66. (223) Which 20 millimeter round carries the M505 point-detonating fuze?
    a. Target practice (TP).
    b. Armor-piercing tracer (APT).
    c. High-explosive incendiary (HEI).
    d. Armor-piercing incendiary (API).

67. (223) What 20 millimeter round is used for *drill or testing the feeder assembly* for a M61 gun system?
    a. Target practice tracer.
    b. Target practice.
    c. Dummy.
    d. Inert.

68. (223) What 20 millimeter projectile component enables *spin and stabilization in flight*?
    a. Tail fin.
    b. Bourrelet.
    c. Rotating band.
    d. Aluminum windscreen.

69. (223) The *delayed arming distance* of a M505 series fuze *from the muzzle* of a 20 millimeter cannon is
    a. 1 to 10 feet.
    b. 10 to 35 feet.
    c. 45 to 60 feet.
    d. 65 to 75 feet.

70. (223) The *identifying information* of a 20 millimeter round of ammunition is marked on the
    a. fuze.
    b. primer.
    c. bourrelet.
    d. projectile.

71. (223) When *bulk-packed*, how many rounds of 20 millimeter ammunition do you expect to find in an *M*548 *container*?
    a. 50 to 100.
    b. 150 to 175.
    c. 200 to 250.
    d. 275 to 300.

72. (224) What aircraft cannon fires the 25 millimeter round?
    a. GAU–2.
    b. GAU–8.
    c. GAU–12.
    d. GAU–18.

73. (224) The purpose of the *ignition booster* in the 25 millimeter round is to
    a. detonate the primer.
    b. ensure proper arming of the fuze.
    c. ensure consistent propellant ignition.
    d. increase the velocity of the projectile.

74. (224) How can you tell a 25 millimeter (mm) *dummy cartridge* from other 25 mm rounds?
    a. It is painted blue.
    b. It is hollow and lighter.
    c. The projectile is non-separable and the total cartridge is gold in color.
    d. It is made up of three sections and the total cartridge is gold in color.

75. (224) When 25 millimeter ammunition is *bulk-packed*, how many rounds are found in a *CNU*–405 *container*?
    a. 80 or 100.
    b. 150 or 175.
    c. 200 or 250.
    d. 275 or 300.

76. (225) How is *ignition from the primer* carried to the propellant in a 30 millimeter *target practice round*?
    a. The primer vents directly into the propellant.
    b. The propellant is ignited electrically when the gun is fired.
    c. The primer ignites black powder in a flash tube, which ignites the propellant.
    d. The primer activates the M505 fuze, which ignites the propellant after it is fully armed and detonates.

77. (225) What device holds the ball rotor of the 30 millimeter M505A3 impact fuze in an *unarmed position* until it is fired?
    a. Lock ring.
    b. Split latch.
    c. Safety block.
    d. Detonator safety latch.

78. (225) The 30 millimeter *dummy* ammunition
    a. acts as a ballast.
    b. is for target practice on small ranges.
    c. is for use in static displays and award presentations.
    d. is for familiarization training and mechanical cycling of the gun system.

79. (225) The 30 millimeter *cartridge case* is made of
    a. steel.
    b. brass.
    c. metal.
    d. aluminum.

80. (225) Which fuze is used in 30 millimeter high-explosive incendiary (HEI) ammunition?
    a. M500.
    b. M505A1.
    c. M505A2.
    d. M505A3.

81. (225) How many separate *lot numbers* can you expect to find on a 30 millimeter round of ammunition?
    a. 4.
    b. 3.
    c. 2.
    d. 1.

82. (226) How long does the *red tracer composition burn* in the 40 millimeter AAA, target practice tracer (M91) round?
    a. 10 seconds.
    b. 12 seconds.
    c. 16 seconds.
    d. 20 seconds.

83. (226) What fuze is used in the 40 millimeter high-explosive incendiary (HEI) PGU–9 C/B round?
    a. M505.
    b. M505A3.
    c. FMU–154/B.
    d. FMU–160/B.

84. (227) What aircraft is equipped to fire 105 millimeter ammunition?
    a. B–52.
    b. B–1B.
    c. KC–10.
    d. AC–130.

85. (227) What type of *explosive* is loaded in the projectile of the 105 millimeter high-explosive (HE) round?
    a. Comp B.
    b. Comp C.
    c. Cyclonite (RDX).
    d. Pentaerythritol Tetranitrate (PETN).

86. (227) The high fragmentation (HF) PGU–45/B projectile will produce approximately how many *fragments*?
    a. 300.
    b. 1,300.
    c. 3,300.
    d. 13,000.

87. (227) In order to *optimize lethality* the *factory set height of burst* (HOB) for the FMU–160/B fuze is
    a. 15 feet.
    b. 30 feet.
    c. 32 feet.
    d. 42 feet.

88. (227) The 105 millimeter *clearing cartridge* is designed to
    a. clean the bore of a 105 mm cannon.
    b. prepare the 105 mm cannon for shipping.
    c. clear the immediate area around a ground target.
    d. clear a projectile lodged in the bore of a 105 mm cannon.

89. (227) The approximate length of a *complete* 105 millimeter round is
    a. 18 inches.
    b. 31 inches.
    c. 40 inches.
    d. 105 millimeters.

90. (228) *Countermeasure flares* are designed
    a. as emergency signaling by a downed aircraft.
    b. to illuminate emergency landing fields at night.
    c. for emergency signaling to rescue aircraft from the ground.
    d. to divert enemy infrared/heat-seeking missiles away from original target.

91. (228) How is an ALA–17 series flare *ignited?*
    a. A percussion-type firing pin.
    b. A pull friction-striker in the flare.
    c. An electric squib ignition assembly.
    d. By spontaneous ignition when ejected into the atmosphere.

92. (228) Which impulse cartridge *initiates* the MJU–7/B flare?
    a. BBU–32/B.
    b. BBU–36/B.
    c. BBU–45/B.
    d. BBU–47/B.

93. (228) The SD–206 infrared flare (Smokey Devil) provides
    a. less heat than the M206 flare.
    b. more heat than the M206 flare.
    c. more flexibility due to its smaller size.
    d. smoke to simulate a flare for training purposes.

94. (228) Which component is part of the ALE–50 series *towed decoy system* (TDS)?
    a. Power initiator.
    b. Launch controller.
    c. Gas grain generator.
    d. Battery-firing device.

95. (228) The RR–170 chaff cartridge uses which *impulse cartridge*?
    a. BBU–35/B.
    b. BBU–38/B.
    c. BBU–45/B.
    d. BBU–46/B.

96. (229) The LUU–2 series *aircraft flare* produces
    a. an off-white light of two-million candlepower.
    b. an off-white light of 500,000 candlepower.
    c. white light of one-million candlepower.
    d. white light of 300,000 candlepower.

97. (229) The LUU–19 series *illumination flare* produces
    a. red light.
    b. green light.
    c. visible light.
    d. light in the near-infrared region.

98. (230) How much gas pressure can a *thruster* (cartridge-actuated device) produce?
    a. 9,000 to 10,000 pounds per square inch (psi).
    b. 7,000 to 8,000 (psi).
    c. 250 to 6,000 (psi).
    d. 1 to 250 (psi).

99. (230) *Removers* (cartridge-actuated device) are designed to
    a. remove the pilots' safety harnesses/cables prior to ejection.
    b. remove the control console from the aircraft.
    c. eject crew members out of cockpit.
    d. jettison the aircraft canopy.

100. (230) *Electric squibs* (propellant-actuated device) are similar to
    a. aircraft thrusters.
    b. electrical fuzes.
    c. blasting caps.
    d. arming wire.

Student Notes

Glossary of Abbreviations and Acronyms

AAA	airborne artillery ammunition
AFMAN	Air Force manual
AIR	air inflatable retarder
AMST	Agile Munitions Support Tool
AP	armor-piercing
API	armor-piercing incendiary
APIT	armor-piercing incendiary-tracer
APT	armor-piercing tracer
CAD	cartridge-activated device
CBU	cluster bomb unit
EOD	explosive ordnance disposal
CMRS	Conventional Munitions Restricted or Suspended
GBU	guided bomb unit
GP	general purpose
HC	hexachloroethane
HE	high explosive
HEI	high-explosive incendiary
HF	high fragmentation
HOF	height of function
IAW	in accordance with
IR	infrared
LCDB	low collateral damage bomb
mm	millimeter
NEW	net explosive weight
NSN	national stock number
PAD	propellant-actuated device
PI	periodic inspection
PII	pre-issue inspection
psi	pounds per square inch
RI	receiving inspection
RMI	returned munitions inspection
rpm	revolutions per minute

SI	shipping inspection
SMI	storage monitoring inspection
SPI	special inspection
SUU	suspension utility unit
TDS	towed decoy system
TNT	trinitrotoluene
TO	technical order
TP	target practice
TPT	target practice tracer
WCMD	wind-corrected munitions dispenser
WP	white phosphorous

Student Notes

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