# CDC 2W151B

# Aircraft Armament Systems Journeyman

## Volume 2. Airmunitions

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Volume 2 of CDC 2W151B, *Aircraft Armament Systems Journeyman*, is devoted to ensuring that you have adequate knowledge of the munitions dealt with as a 2W1X1. Unit 1 provides descriptive information covering the identification, inspection, handling and safety precautions pertaining to aircraft bombs, fuzes, and dispensers. Unit 2 covers aircraft missiles and rockets. Unit 3 wraps up the volume by covering some of the miscellaneous munitions you may be required to work with at some point in your career.

A glossary is included for your use.

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**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. Aircraft Bombs, Fuzes, and Dispensers



THE IDEA OF USING the airplane aggressively in hostilities was in the minds of only a few "visionaries" at the beginning of World War I. Aircraft were flimsy and unpredictable contraptions at best, and the aviators of both sides considered it dangerous enough merely to take off and land. This view resulted in these early aircraft being primarily used for observation—an extension of the principle of "gaining the high ground."

Using aircraft for observation was a step in sealing the doom of the cavalry, which had always had the responsibility for detecting enemy positions. Both sides used observation planes and very little was done to discourage these flights in the early months of the war. These military aircraft were completely unarmed and, according to legend, enemy airmen even exchanged friendly waves when they passed in midair.

At some point, things changed and these same airmen began to use bricks, monkey wrenches, or anything else at hand to inflict damage on each other. How did it begin? No one knows for certain, but, again according to legend, the first step was taken when an unidentified airman, for reasons known only to him, made an insulting gesture in lieu of rendering the customary friendly wave of the hand. The offended party reacted to this insult by throwing the nearest loose object, a wrench or a brick whose normal function was to keep reconnaissance maps from blowing out of the open cockpit. From this meager beginning, airmen began to carry pistols, carbines, rifles, and finally machine guns of greater effectiveness in dealing with the enemy. Bombing ground forces was the next natural step in developing aircraft as an offensive weapon.

From these beginnings, the aircraft, their armaments, and tactics continued to advance in complexity, power, and effectiveness. With the range of aircraft and armaments available today, almost no military action occurs without some type of aircraft participation—whether it's reconnaissance or offensive operations against both aircraft and ground targets. Aircraft armaments developed alongside aircraft themselves eventually reaching the highly technical, accurate, and sophisticated modern weapons that are in use today. Which leads us to this unit's focus of discussing the different types of bombs, fuzes, and dispensers available for use on today's aircraft. In this career development course (CDC), not all of the different classes of bombs are covered, but you will 'get a good representation of our munitions in current use.

# 1–1. Bomb Basics

A bomb is designed to be dropped from an aircraft to inflict damage on an enemy. The typical aircraft bomb is designed with a metal container filled with explosives and a tail fin device to stabilize the bomb so it can be aimed accurately. It also contains a mechanism for exploding the bomb at the target and safety devices to make it reasonably safe to transport, load, and carry. The metal container, called the *bomb body*, is usually streamlined having a pointed nose and a tapered tail. Although there are no specific safety devices built into the bombs themselves, most of the explosives used are not sensitive to normal handling. The stabilizing device—generally a sheet metal fin assembly—is attached to the tail end of the bomb body. The *fuze* is the mechanism within the bomb's body that is used to detonate the explosive. The fuze is placed in either the nose or the tail of the bomb body (sometimes in both) to make sure the bomb explodes. The fuze also contains the safety devices used to render the bomb safe for handling.

## 201. Bomb classifications

Bombs are usually classified by their weight and purpose. The general classifications are high explosive, kinetic energy penetrators, practice/training, and nuclear. We'll take a look at each of these types in this lesson. As you read about these different bombs, keep in mind that low-level bombing needs a specific delivery system and configuration to work safely and effectively, which differs from the delivery system used for normal bomb drops.

### High explosive bombs

A high explosive (HE) bomb is any molecular bomb designed primarily for explosive effect, as distinguished from a chemical bomb, leaflet bomb, incendiary bomb, or other special-purpose bombs. The explosion creates overpressures to damage or destroy targets. The blast is accompanied by case fragments dispersed as high velocity projectiles. This blast and fragmentation are the primary kill mechanisms. HE bombs are classified according to the nature of the kill mechanism or the designed use of the bomb. They are categorized as general purpose, blast, penetration, fragmentation, shaped charge, and precision guided.

#### *General purpose bombs*

The general purpose (GP) bomb combines the effects of the blast, fragmentation, and penetration-type bombs into a single flexible munition to cover most situations. The case is heavy enough to produce some penetrating qualities along with blast effect as well as some fragmentation effects. It is designed for use against both material targets and personnel. The explosive charge of most GP bombs is between 35 percent and 55 percent of the total weight. The total weight for GP bombs in production is anywhere from 250 to 2,000 pounds.

GP bombs can be used against a variety of targets. Since the body is roughly half an inch (½ inch) thick, the casing creates a serious fragmentation effect at the moment of detonation. Also, because the explosive filler makes up about 50 percent of the total weight, considerable damage from the blast effect can be expected at the target. It's because of this versatility we call the bomb "general purpose." GP bombs are loaded primarily with tritonal, which is a mixture of 80 percent TNT and 20 percent aluminum powder.

#### *Blast bombs (light case)*

Blast bombs are designed for maximum blast effect, and they are no't suitable for target penetration because of their light cases. The shock wave and the accompanying impulse damage is primary, while fragmentation is secondary. They're used mainly for the destructive effect caused by blast and vacuum pressures from above-target explosions and the earth shock, or mining effect, resulting from the detonation of buried bombs. These bombs have a cigar-shaped body. "They weigh between 500 to 3,000 pounds, and the explosive charge is about 65 percent of their total weight."

### *Penetration bombs*

Penetration bombs are designed for maximum penetration of reinforced concrete, armor plating, and other objects where maximum destruction is carried out by explosion *within* the target. They're used for damaging bridges, bunkers, strong building structures, reinforced concrete targets, railroad intersections, and heavy revetments. The explosive charge is about 35 percent of each bomb's weight.

### *Fragmentation bombs*

Fragmentation bombs produce their effect by dispersing fragments of the bomb body with considerable force. Most current fragmentation bombs are in the 1- to 15-pound weight class. These bombs are delivered from aircraft dispensers such as the suspension utility unit SUU–30 and SUU–64, which are covered later when cluster bombs are discussed. New fragmentation bombs, as well as new dispensers, are currently under development.

### *Shaped-charge bombs*

Shaped charges are generally small scale munitions that use the physics behind explosive force to create a focused effect to greatly increase the effectiveness of a given charge. These types of munition are used primarily in attacks directed at heavily armored targets like tanks or ships. Conventional shaped charges are constructed with a charge case, a hollow conical liner within the case, and a high explosive material between the liner and case. A detonator is activated to initiate the explosive material which, in turn, generates a *detonation wave*. This wave collapses the liner, forming a high velocity metallic plasma jet. The detonation wave may cause the tip to travel faster than 6 miles per second. The plasma jet pierces the well casing, simultaneously forming a slow moving slug. The jet's properties depend on the charge shape, the energy released, and the liner's mass and composition. A shaped-charge warhead can be expected to penetrate armor equal to 150-250 percent of the warhead diameter (for example, a 6-inch diameter warhead can be expected to penetrate 9 to 15 inches of metallic armor).

Another type of shaped-charge warhead is the explosively formed projectile (EFP). Where the standard shaped charge uses a jet of metal turned into plasma by heat and pressure, the EFP creates a hyper-velocity metal slug to smash its way through the target. EFP warheads consist of an explosive billet and a metal liner. When the explosive is detonated, the detonation wave forms the liner into a high-speed long rod penetrator and propels the penetrator towards the target at speeds greater than Mach 6.

### *Precision guided bombs*

Precision guided bombs are GP bomb bodies with nose or tail guidance units attached. They are usually guided by lasers, inertial navigation system (INS), or by global positioning system (GPS). They are accurate from 1 to 10 meters, depending on the type of guidance system. We will discuss some of the types we have in the inventory within the lesson that covers unguided general purposes bombs and warheads.

## Kinetic energy penetrators

Most munitions use some sort of explosive payload to provide the force necessary to kill their target. The kinetic energy penetrators (KEP), on the other hand, use the sheer force of impact to smash a hole through their target. This is also their primary kill mechanism. The basic theory behind the KEP is accelerating a super dense or hard metal object (commonly tungsten or depleted uranium) to a very high speed and hitting the target with enough force to penetrate it. A common KEP form is the metal slug small arms ammunition.

These munitions items are unique in the fact that although they are used to attack targets, they contain no explosives. They must still be handled carefully because many of their delivery systems do contain explosives or other hazardous components. For example, the common small arms ball ammunition bullet itself contains no explosives; whereas, the complete round contains the gunpowder propellant used to accelerate the bullet.

### Practice bombs

Practice bombs, as their names implies, are used as aircrew and ground crew training devices. There are two types: inert and empty. These bombs have no explosive filler, but they may have spotting charges that cause smoke and a flash upon impact permitting you to visually observe the bombing accuracy. They may either be full size or miniature with weights ranging from 5 to 2,000 pounds. These bombs provide low-cost target practice for fighter and bomber aircraft.

### Load crew training bombs

Load crew training bombs provide training in identifying, fuzing, defuzing, and other bomb handling procedures. They differ from practice bombs in the following two important ways:

1. Practice bombs are expendable and load crew training bombs are not. They are designed to be used for an extended period of time to facilitate the training of load crews.
2. Load crew training munitions and their components are inert; they contain no explosive materials. Practice bombs may or may not contain propellants, spotting charges, or other explosive or pyrotechnic devices depending on their intended use.

Though inert, directions and precautions for handling the corresponding serviceable bombs apply equally in handling these bombs.

### Nuclear bombs

Nuclear bombs are designed somewhat like high-drag bombs; meaning, they normally have parachutes and they may be loaded on the same aircraft and on the same general types of bomb racks. These parachutes deploy automatically and let the aircraft escape safely from the blast area. We're only concerned with two bombs of this type—the B61 and B83.

## 202. Basic bomb components

A complete bomb consists of all the components and accessories necessary for the bomb to function as intended. In general, a bomb is shipped in parts, and these parts are assembled into a complete round by 2W0X1 personnel prior to its delivery to the loading area.

The six components of a complete round, or bomb, are the bomb body, suspension lugs, fin assembly, arming wire assembly, fuzes, and adapter boosters. First, we'll look at each part individually, and then we'll identify the various aircraft bombs and fuzes you'll encounter in your work.

### Bomb body

The typical aircraft bomb is a metal container filled with explosives. The metal container, or body, is usually streamlined with a pointed nose and a tapered tail (fig. 1–1). The body of the GP bomb is usually made of heavy cast iron, about one-half (½) inch thick. The fragmentation bomb is made of spirally wound spring steel so it will break into fragments when the bomb is detonated. Practice bombs are often made of solid metal or are filled with sand or concrete.

### Suspension lugs

Conventional bombs weighing up to 1,000 pounds have a suspension lug spacing of 14 inches, and those weighing over 1,000 pounds have suspension lug spacing of 30 inches. *All nuclear weapons regardless of weight have 30-inch lug spacing.* The lugs on the GP series and low-drag series resemble eyebolts and simply screw into a threaded recess in the bomb body (fig. 1–2). In bomb clusters or practice bombs, the lugs may be welded or screwed directly to the bomb body.

### Fin assemblies

The fin assembly stabilizes the bomb in flight.  The general-purpose bomb comes with a conical fin, which is an elongated fin cone with four blades protruding from it. This is referred to as a general-purpose low-drag bomb. On the bomb stabilization unit (BSU) type high-drag fin, a parachute type device is deployed to slow the descent. Some of the newer fin assemblies include a guidance system to guide the bomb to the target using steerable fins.

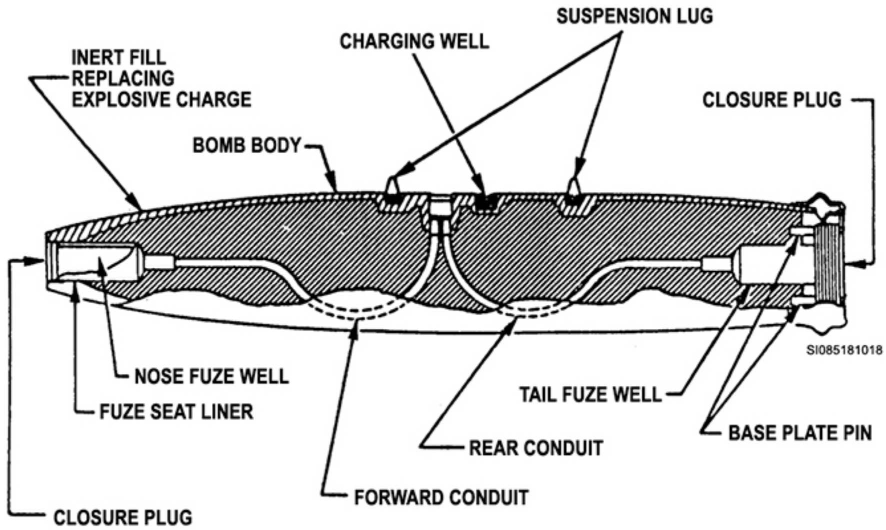



Figure 1––1. Typical bomb components.

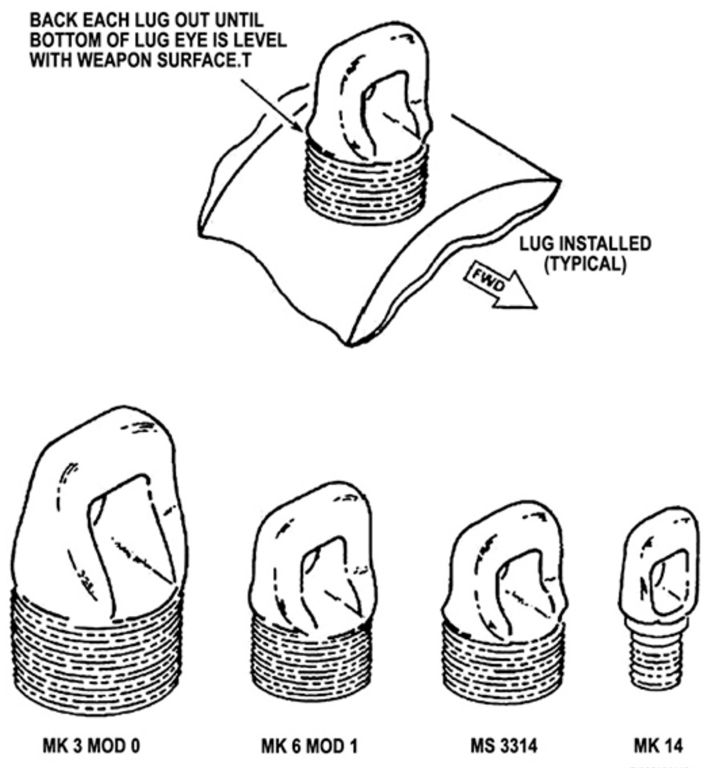



Figure 1––2. Typical bomb lugs.

## Arming wire assembly

The arming wire keeps the fuzes from arming until the bomb is released from the aircraft (fig. 1—3). Arming wires also provide the pilot with fuzing and arming options. They are used to open fins, initiate battery firing devices, and arm fuzes. We'll use the M904 mechanical nose fuze to explain the basic function of the arming wire. As the bomb falls from the bomb rack, the arming wire is pulled free of the fuze letting the vane spin. This spinning aligns the firing pin with the detonating charge. After they are aligned, the fuze is considered armed. Arming wires may be received assembled and cut to standard length for specific bombs. The retaining clips are designed to retain the arming wire in position until the bomb is released.

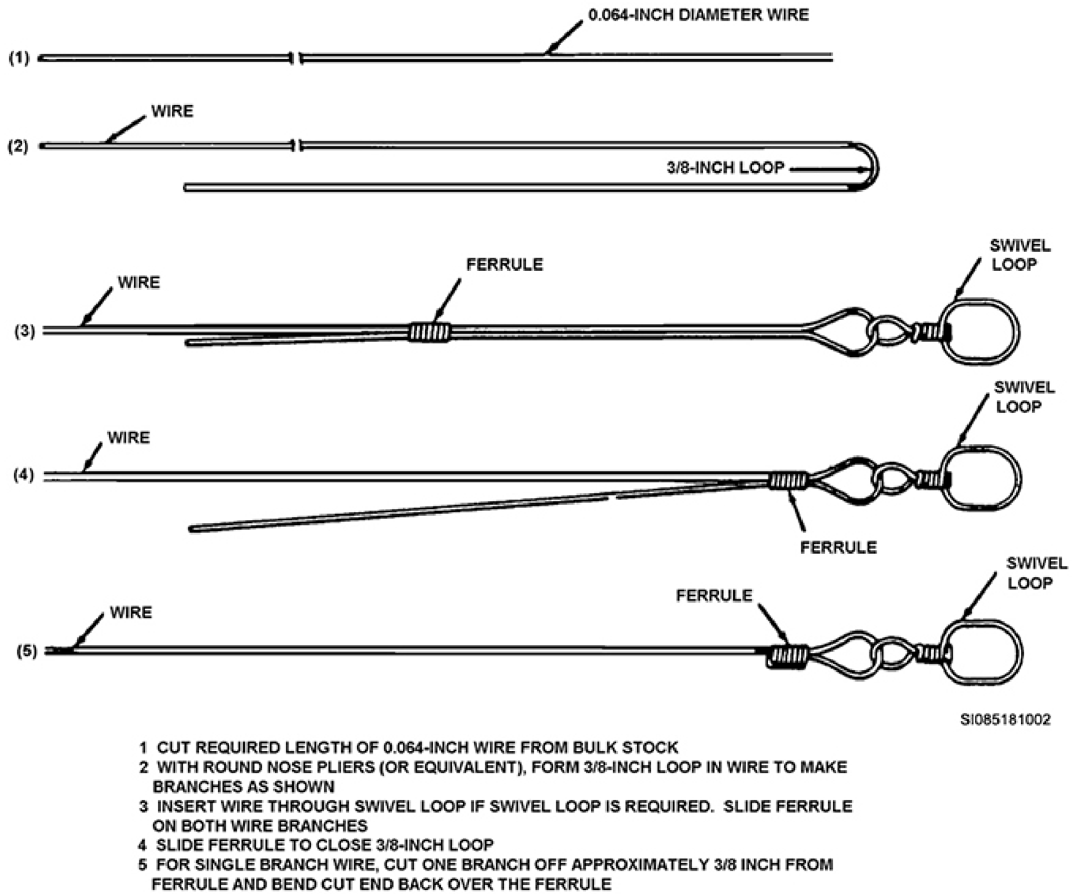



**Figure 1––3. Arming wire fabrication.**

## Bomb fuzes

Each component of a bomb is equally important—without one, the others are useless. For instance, without some type of fuze, a bomb dropped from an aircraft would bury itself deep in the ground and fail to explode. Fuzes are an integral part of the bomb—they initiate detonation. Later in this unit, we'll cover various combinations of fuzes used for different effects in bombing.

In bombs equipped with electrical fuzes initiators (fig. 1—4), the initiators are installed in the charging well of the bomb. They provide electrical power and an interconnect cable to the nose and tail fuzes. The power from the initiator starts or activates the fuzes or sensors when the arming mechanism is actuated upon release of the weapon.

Sensors are designed to sense the proper altitude for the detonation of a weapon via a radio frequency or Doppler radar. A sensor is also used to provide low altitude, proximity functioning for general purpose bombs. These are not fuzes because they do not start the explosive train; they only provide electrical signals to a fuze that conducts that function.

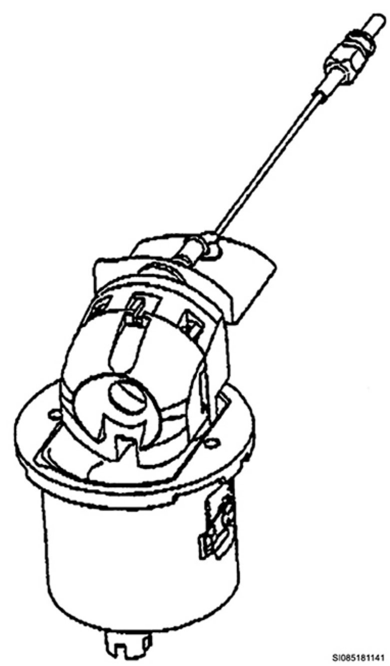


**Figure 1––4. Typical initiator.**

## Adapter booster

The adapter booster is another component used with general-purpose bombs. It's used to adapt small-diameter fuzes to large-diameter nose and tail fuze wells. This component also serves to boost the explosive train between the fuze and the bomb.

## 203. Bomb markings

We keep track of munitions through the use of model numbers, lot numbers, and a marking system. The marking is done by the manufacturer, and we identify munitions by these markings.

### Model number

Model number, lot number and/or serial number, and paint color and markings are used to identify bombs. The markings are generally used on the item packing and on the bomb itself. To distinguish different designs of the same type, a model number is assigned at the time a bomb is adopted for use. The Army model designation consists of the letter “M” followed by an Arabic numeral, such as M117. Adding the letter “A” to the appropriate Arabic numeral of the model designation indicates a modification of the original design. For example, M117A2 designates the second modification of the bomb originally adopted as the M117. Items of Navy design are designated by MK (Mark) and modifications are designated by MOD; for example, MK–82 MOD 1. Items of Air Force design have a component or unit indicator (consisting of three letters), and a model number accompanied by a slash, and an equipment designator or version. Thus, BLU–109/B (bomb, live unit number 109 version B) is an example of the model number for the new 2,000-pound GP bomb.

### Lot number and serial number

When ammunition is manufactured, a lot number is assigned according to pertinent specifications. Since the lot number represents items or components manufactured under conditions as nearly identical as possible, we can expect bombs with the same lot number to function uniformly. This becomes critical information if the lot performs poorly during use (for example, failing to detonate properly). The lot number includes letters and numerals representing the maker’s lot number, symbol or initials, and the manufacture date.

Some munitions items are issued, tracked, and turned in according to serial numbers. Serial numbers are generally assigned to high value items such as complete missiles or seeker heads for guided bomb units. By using serial numbers specific munitions items maintenance or service history can be tracked. This information can then be used by ammo for conducting periodic maintenance on the more complex munitions items.

Serial and lot numbers are critical to the munitions issue, turn-in, and expenditure process conducted by expeditors. When munitions are issued to a unit, both the number of munitions and their serial or lot numbers are recorded. These lot numbers and serial numbers have to be documented on your munitions expenditure sheet, AF Form 2434, to track expenditures and instances of improper munitions functioning.

At the end of the flying period, the expeditor and a representative from ammo will reconcile the day’s expenditures. During this process, both units (ammo and the flying unit) *must* agree on precisely which munitions were expended performing the mission and what munitions remain in the unit’s possession. This process ensures that all munitions are properly accounted for *before* more munitions are issued to a unit. As an aircraft armament systems technician, it is vital that you assist your expeditor in tracking the status and location of all munitions to make sure this process occurs smoothly. Any delays that can be avoided in the process of recon will ensure smooth operation of your work.

### Paint markings

In maintaining aircraft bombs, we speak of both “painting” and “marking,” because bombs are painted primarily to prevent corrosion or rust; but this painting also serves as a ready means of identification for all who work around them. The Air Force has a standard munitions color-coding system covered by technical order 11A–1–53 *Ammunitions color coding, identification of empty and* *inert loaded ammunition items and components, and assignment of version numbers to training and dummy ammunition items*. In applying these standards, the primary-use color code is normally applied to the whole exterior surface of a munition unless a different background color is needed for tactical or technical purposes. An example of this might include ballistic missiles painted white or the olive drab color being used for concealment purposes. If this is the case, the primary explosive identifying color would be found as color bands painted at different locations completely around the munition. These color bands go around the nose on explosive, smoke, and incendiary bombs, and around the nose, midsection, and tail of chemical (gas) bombs. For HE bombs, we use 3 or 3½ inch yellow bands, just as we use yellow for HE in any component. Low explosives carry a brown band; smoke a light-green band; and incendiaries (liquids, jellies, or solids), a light-red band. Inert, target, and practice bombs are light blue; if they carry a low explosive, a brown band is added. If you ever have any questions about the marking on any item during loading, consult your applicable technical order (TO), checklist, or supervisor.

## Self-Test Questions

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

### 201. Bomb classifications

1. The explosive weight of most GP bombs is what percentage of the total weight?

2. What type filler is in GP bombs?

3. What's the difference between blast bombs and penetration bombs?

4. A shaped charge bomb is designed to attack what type of targets?

5. How accurate are precision-guided GP bombs?

6. Why must kinetic energy penetrators be handled carefully even if they contain no explosive?

7. What bomb class usually causes smoke and a small flash upon impact?

8. Nuclear bombs and high-drag GP bombs have what common characteristics?

### 202. Basic bomb components

1. Name the six components of a typical bomb.

2. The bomb body of a general-purpose bomb is usually made of what type material?

3. Fragmentation bomb bodies are made of what type material?

4. A 2,000 pound bomb has what suspension lug spacing?

5. What is the purpose of arming wires?

6. What do initiators provide?

7. What are sensors designed to do?

8. What are boosters for?

### 203. Bomb markings

1. How are bombs identified?

2. Why is it important to keep track of serial numbers of munitions being flown on aircraft?

3. What is the purpose of painting and marking bombs?

4. What do the color bands painted on munitions identify?

## 1–2. Conventional Bombs and Nuclear Weapons

As you already know, there are several different types of aircraft bombs. We'll start this section off with a look at general purpose bombs—low-drag and high-drag—suspended from fighter and bomber aircraft and progress through other types concluding with practice bombs. We won't cover all the variations you may run into during loading and unloading, but we will cover the more common aircraft bombs you're likely to load.

## 204. Unguided general purpose bombs and warheads

GP bombs are used in many different configurations to produce the effects necessary to meet the mission. There are many series and models of bombs we can select from to meet the mission. We'll cover some of them within this lesson.

### MK–80 series

MK–80 series GP bombs now in production range in weight from 250 to 2,000 pounds. The models of the low-drag series, their nominal weights, and fin assemblies are listed in the table below.

| MK–80 Series Low-Drag GP Bombs | | |
|---|---|---|
| **Model** | **Weight in Pounds** | **Fin Assembly** |
| MK–82 | 500 | MAU–93/B |
| MK–83 | 1,000 | MK–83 |
| MK–84 | 2,000 | MK–84 |

High-drag bombs are low-drag bombs fitted with an air-inflatable retarder fin assembly. When this bomb is released from the aircraft, a lanyard pulled from a retaining-type mechanism activates the fin assembly. The models of GP high-drag bombs, their nominal weights, and fin assemblies are listed in the following table.

| MK–80 Series High-Drag GP Bombs | | |
|---|---|---|
| **Model** | **Weight in Pounds** | **Fin Assemblies** |
| MK–82 | 500 | BSU–49 AIR |
| MK–84 | 2,000 | BSU–50 AIR |

The BSU–49 air-inflatable retarder (AIR) used on a MK–82 is a cruciform (X-shaped) fixed-fin stabilizer consisting of a stabilizer housing, a high-drag, air-inflatable retarder, and a lanyard assembly. Four fixed fins on the stabilizer housing provide low-drag aerodynamic stability if the pilot elects to release the bomb in the low-drag mode. The stabilizer housing provides a canister and release mechanism for the AIR. An aft cover closes the aft section of the stabilizer housing. Two spring-loaded latch assemblies secure the aft cover to the stabilizer housing. The retarder is not' deployed for a low-drag release (fig. 1–5).

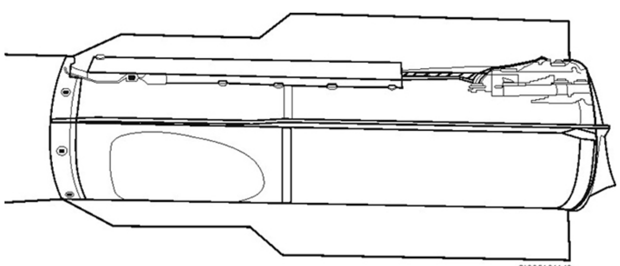



**Figure 1–5. BSU–49 Low-drag position.**

In a high-drag release, the safety-latch pin and lanyard clip are pulled from the cover release mechanism, releasing the spring-loaded cover. The cover pulls the nylon retarder partially from the stabilizer housing. The air stream passing over the cover and retarder then pulls the retarder completely out of the stabilizer housing. The retarder is immediately inflated by ram air entering through four inlets in the retarder itself (fig. 1–6).

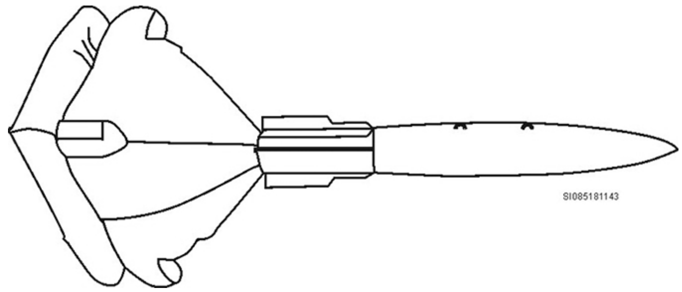



Figure 1–6. BSU with deployed retarder.

The BSU–50 AIR installed on the MK–84 bomb has the same characteristics as the BSU–49, except it is larger and the fins have a different shape.

The MK–80 series bombs are also used as the warheads for a wide variety of guided munitions and mines, as we'll see later explained within lessons that discuss our guided and cluster bomb units. Their general purpose construction creates a very flexible range of capabilities that makes them useable in an incredibly wide number of roles.

### BLU–109/B

The BLU–109/B is a 2,000-pound penetration bomb developed to augment and replace the MK–84 (fig. 1–7). The BLU–109 body is a 25.4 mm (1 in.) thick casing of forged gun-barrel hardened steel. This body is approximately twice the thickness of the MK–84. It was designed to penetrate hard targets built of earth, concrete, rock, and rubble. It can penetrate 4 to 6 feet of reinforced concrete. It's designed to be compatible with the existing MK–84 fin assembly and the guided bomb unit (GBU)–10/15/24/27 guidance air foil assemblies which is discussed in the guided bomb unit lesson.

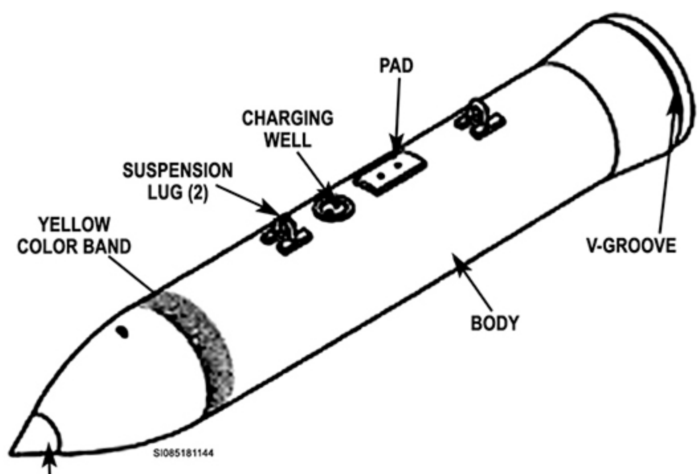



Figure 1–7. BLU–109 penetration bomb.

While most bombs have a fuze well in the nose and one in the tail, the BLU–109/B has a standard single fuze well at the tail position only. The absence of a nose fuze well (cavity) makes the nose stronger and, additionally, the weapon's base plate is reinforced to better protect the fuze from the shock of impact. The existing fuzes and igniters are compatible with the BLU–109/B. The bomb has a hardback bolted to its upper surface to provide a contact surface for the stores-away switch of bomb racks and threaded wells for the 30-inch suspension lugs. The BLU–109 is *never used as a stand-alone free fall bomb*; it is only used as a warhead for these guided bombs and missiles: GBU–10, –15, –24, –27, and –31(V) 3/B.

### BLU–113A/B

The BLU–113A/B (fig. 1–8) is a 4500-pound penetrator warhead which was developed within a very short time span during Operation Desert Storm in early 1991. Early in this war, the USAF found out that the deepest and most hardened bunkers could not be defeated by the existing penetrator warheads. Therefore, a much more powerful “bunker buster” warhead was urgently needed. USAF engineers at Eglin Air Force Base came up with the idea to drop a very heavy guided bomb from high altitude, creating a bomb with powerful kinetic penetration effects.

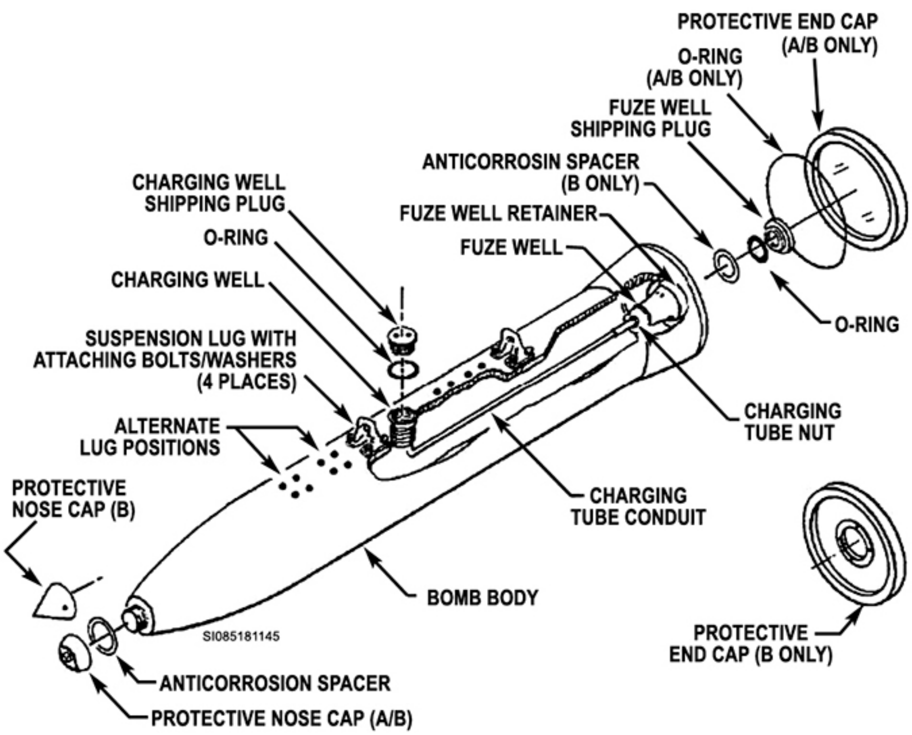



**Figure 1–8. BLU–113A/B penetration bomb.**

The bomb body is loaded with 80/20 (TNT/aluminum) tritonal explosives and, like the BLU–109, uses a single fuze located in the tail of the weapon. The BLU–113A/B is *not* used as a stand-alone free fall bomb. Currently, its sole use is as the warhead used in the GBU–28A/B, B/B.

## 205. Guided bomb units

Because of advances in technology, weapons systems designers are introducing more and more guided weapons into the Air Force inventory. Most current wars require guided weapons for precise targeting and to limit destruction of combat targets. In this lesson, we discuss the guidance systems and a few of the guided weapons.

### Guided bombs

The guided bombs used today are the modern successors to the Vietnam-era guided bombs. They are modular systems consisting of standard GP bomb bodies (warhead), target detecting devices, modular control units, and airfoil groups with a cruciform wing design. These guided bombs are indirect attack weapons having a medium range standoff capability. They typically have a range of 5 to 15 miles but are highly variable depending upon their launch height and the aircraft speed when the weapon is released.

## Guidance systems

During WWII, a thousand bombers could be dispatched to eliminate a single valuable target. Today, military planners make use of guided munitions to take the same target out with a single aircraft and, in some circumstances, a single bomb. Let's talk about some of the systems that make this possible.

### *Laser guided bombs*

Available in several different configurations, laser guided bombs (LGB) operate by homing in on a laser beam reflected from a target illuminated either by the releasing aircraft, another aircraft, or a person on the ground. These lasers use a system called *pulse coding*. Pulse coding is a system of differentiating laser markers so that they "attract" only guidance units set to their specifically coded signal. Using this system, several targets in an engagement area can be illuminated simultaneously and each target receives only a single weapon, because each weapon only homes in on its particular pulse coded laser. The guidance units have dials on the underside of the seeker head that the load crew or air crew members can set to specific codes as needed.

The prime advantage of laser guided munitions is their high degree of accuracy. These munitions can reasonably be expected to strike within 0 to 3 meters of their designated target. They are, however, limited in their effectiveness by the fact that they must have relatively clear atmospheric conditions to operate effectively. Smoke, fog, dust, clouds, or anything else that can disrupt the laser will have a detrimental effect on the accuracy of weapons using this form of guidance.

### *Global positioning system and inertial navigation guidance system guided bombs*

These systems use the GPS and an INS to strike known points on the surface of the earth. The system uses GPS to "know" where it is released and then uses inertial navigation data and continuously updated GPS fixes to make all necessary corrections to its flight path to its target's GPS coordinates.

The prime advantage of this system over purely laser guided systems is that it allows an aircraft to deliver its munitions completely independent of weather conditions as GPS signals are unaffected by the smoke or other atmospheric obscuring phenomena that would hamper laser operations. Using GPS and INS also allows the weapon to be launched from far greater distances because it is independent of a spotter illuminating the target with a laser. The system suffers from the limitations that it is not able to hit moving targets because it is homing in on target coordinates. The system is also not as accurate as laser systems, a GPS and INS guided system can be expected to strike within 10 meters of its target.

### *Enhanced guided bomb unit systems*

The latest guidance system is used in the enhanced guided bomb unit (EGBU). The EGBU is a hybrid system using both a laser guidance system and a GPS and INS system in a single guidance package. These munitions allow the aircrew to choose the system which will most accurately deliver the weapon. The main drawback to this system is in its complexity. Having both systems in a single package makes the weapon more expensive and more complicated to load and maintain than a weapon using either guidance system independently.

### *Electro-optical guidance systems*

The last system that we will talk about is the electro-optical (EO) system. This system uses a visible light spectrum video or infrared (IR) spectrum picture transmitted to the operator. It allows the operator to choose a target and let the weapon guide itself or with some advanced systems the operator can use a data link with the weapon to "fly" the weapon all the way to its intended target. When the weapon is used in the operator guided mode, it has the capability to be incredibly accurate since the operator not only picks and chooses the target but can also change aim points while the weapon is in route to the target as mission parameters dictate. However, these weapons are subject to most of the same limitations as laser guided munitions: anything that degrades either the video or IR image also limits the weapon's accuracy.

### GBU–10

The GBU–10 (fig. 1–9) is a laser guided 2,000 pound weapon. The GBU–10 C/B, D/B, and E/B models differ in the design of the computer control groups, airfoil groups, and warheads used to make them. The warhead is either the MK–84 or the BLU–117 GP bombs. The computer control group, mounted on the nose of the warhead, has a laser illumination detector, bomb guidance computer, and a guided bomb control unit. The detector has the optics and electronics to determine the direction of the target reflecting the laser energy. The computer converts signals from the detector into up, down, left, and right commands to operate solenoids in the control unit. The computer also has a thermal battery that provides power to the computer control group after release. The control unit's guidance fins are moved in response to the command signals from the computer. These fins provide directional control of the bomb while the wings provide aerodynamic stability. The Paveway II system uses spring loaded folding wings that are only deployed after release from the aircraft; this decreases the overall size of the bomb allowing for increased aircraft payload and maneuverability. You must be very careful around these folding wings because they deploy with significant force and can injure personnel.

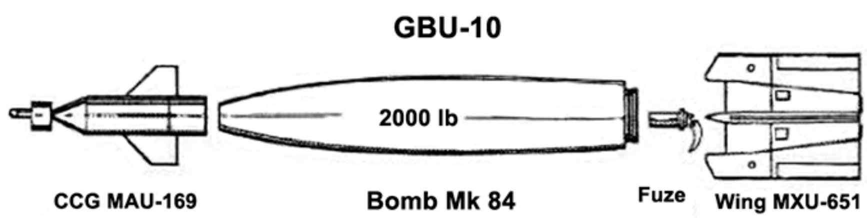



**Figure 1–9. GBU–10.**

### GBU–12

The GBU–12 (fig. 1–10) is a laser guided 500 pound weapon. The GBU–12/B, A/B, B/B, C/B and D/B models differ in the design of the computer control groups, airfoil groups, and warheads used to make them. The warhead for all GBU–12 models is the MK–82. This bomb is fundamentally a smaller version of the GBU–10 and shares most of the general characteristics of the larger model.

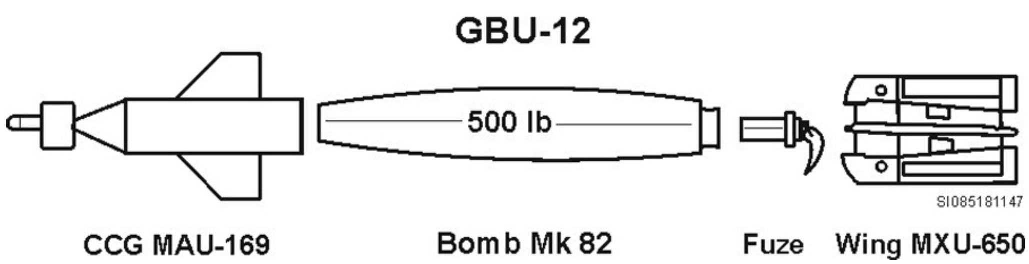



**Figure 1–10. GBU–12.**

There are three different airfoil groups used with the GBU–12. The different models of airfoil groups facilitate high- and slow-speed bomb delivery.

### GBU–15

The GBU–15 (fig. 1–11) is an EO guided 2,000 pound weapon. The warhead for this munition is either a BLU–109 or MK–84 2,000-pound bomb. The GBU–15 has 10 different configurations. The GBU–15(V) 1/B uses the MK–84 and with an FMU–124 fuze in the nose and a TV seeker. The GBU–15(V) 2/B uses the MK–84 warhead with an IR heat seeking target-detecting device. The target-detecting devices are for target acquisition and lock on before or after launch from an aircraft. The casing attached to the rear of the bomb houses the autopilot unit, battery, control module, and data link module—essentially all the electrical controls needed to control and guide the bomb. The bomb becomes a complete unit when either the MXU–724/B, A/B or MXU–787/B airfoil group is added. The airfoil group consists of four *strakes* (stabilizing wings) at the nose and four large rear wings with powered control surfaces on the trailing edges. The four strakes on the front of the weapon are for aerodynamic stability and the rear wings guide the weapon to the target. The bomb is attached to bomb racks by two suspension lugs spaced at 30 inches.

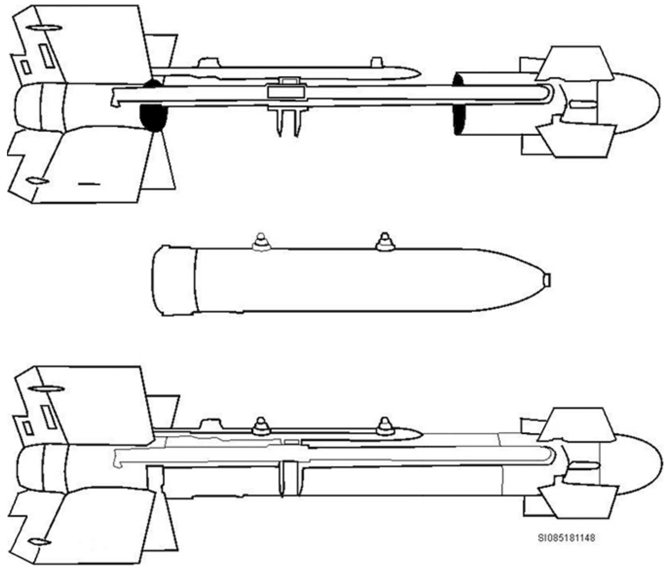



Figure 1–11. GBU–15.

## GBU–24

The GBU–24 is a laser guided 2,000 pound weapon (fig. 1–12). The GBU–24 has the same basic components as other LGBs, but its design is considerably different. Its guidance control unit (GCU) mounts on the nose of the bomb using a forward adapter assembly similar to the GBU–12. The GCU provides autopilot control, target detection, and weapon guidance. The GCU's three major subassemblies are a seeker platform assembly, a guidance electronic unit, and a control assembly. The warhead for the GBU–24/B is the MK–84 and the warhead for the GBU–24 A/B is the BLU–109/B. The airfoil group provides aerodynamic lift and stability during flight. The bomb's accessory kit consists of a hardback assembly, lug sleeves (two), aft faring assembly, and FZU extender. The hardback assembly and lug sleeves provide more distance between the bomb and bomb rack. The aft fairing assembly provides an aerodynamic interface between the bomb and wing assembly. The FZU extender extends the bomb charging tube conduit through the hardback assembly to facilitate proper fuze initiator installation.

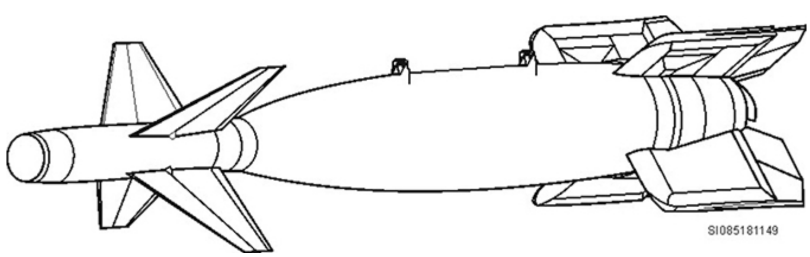



Figure 1–12. GBU–24.

## GBU/EGBU–27

The GBU–27 is a 2,000 pound weapon. The GBU–27 is laser guided only; while the GBU–27A/B also incorporates a GPS/INS capability. The EGBU–27 A/B is in essence a GBU–24 system modified to incorporate a hybrid guidance system to increase its capabilities for employment to engage targets. The GBU/EGBU–27 exclusively uses the BLU–109 warhead to defeat hardened targets.

### GBU/EGBU–28

The GBU/EGBU–28 is a 5,000 pound weapon (fig. 1–13). The GBU–28 A/B is laser guided only; whereas, the EGBU–28 B/B also incorporates a GPS/INS capability. The GBU/EGBU–28 A/B are special weapons developed for penetrating hard and deeply buried targets. The GBU/EGBU–28 is a conventional munition that exclusively uses the BLU–113 series 4,500 pound penetrating bomb as a warhead.

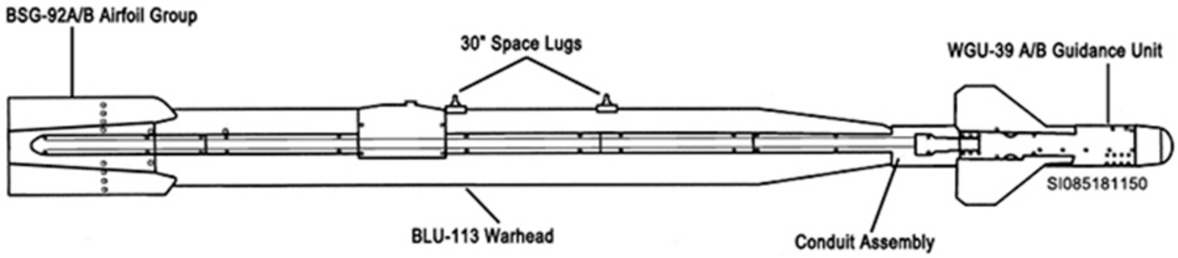



**Figure 1–13. GBU–28.**

### GBU–31/32/38 Joint Direct Attack Munition

The Joint Direct Attack Munition (JDAM) is an existing unguided free-fall general purpose bomb converted into an accurate, adverse weather, “smart” munition (fig. 1–14). The guidance set consists of a tail kit, which contains an INS and GPS systems, a set of aero-surfaces, and an umbilical cover, which allows the JDAM to improve the accuracy of unguided, general purpose bombs in any weather condition. The KMU–5XXB/B configurations are equipped with a selective availability anti-spoofing module (SAASM) added to existing tail kits. The SAASM electronics module is capable of using new GPS security features. The KMU–5XXC/B configurations are equipped with anti-jam (AJ) equipment consisting of a new antenna and associated electronics on the tail kit. Anti-jam variants allow the JDAM to navigate with precision using GPS signals in regions containing active GPS jamming. JDAM can be launched from very low to very high altitudes in a dive, toss, and loft delivery. JDAM enables multiple weapons to be directed against single or multiple targets on a single pass. JDAM is a joint Air Force and Department of Navy program.

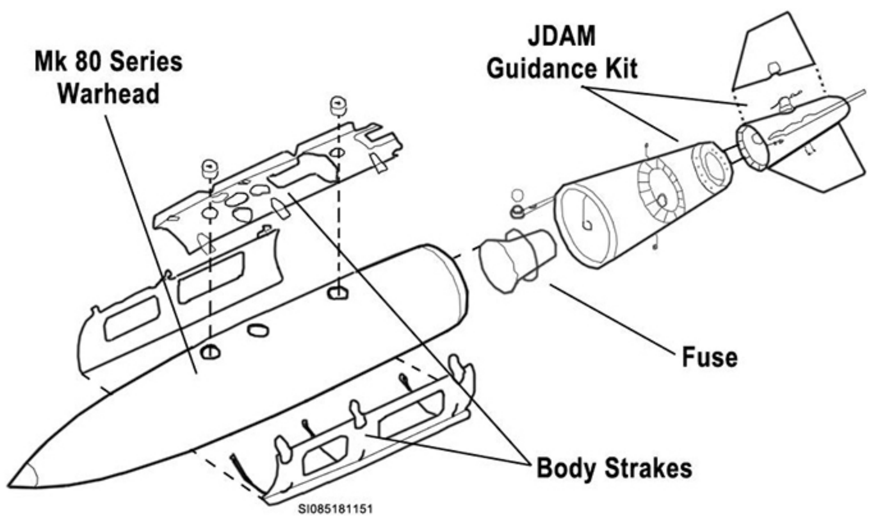



**Figure 1–14. JDAM guidance kit.**

JDAMs are compatible with MK–82, MK–83, MK–84, BLU–109, BLU–110, and BLU–117 warheads, and are available for B–1B, B–2 and B–52H bombers; A–10C, F–15E, F–16A-D, and F–22 fighters.

The designations change when different JDAM tail kits are installed on different warheads as you can see in the following table.

| JDAM Types | |
|---|---|
| **Designation** | **Warhead** |
| GBU–31 | MK–84, BLU–109, BLU–117 (fig. 1–15) |
| GBU–32 | MK–83 and BLU–110 (fig. 1–15) |
| GBU–38 | MK–82 (fig. 1–16) |

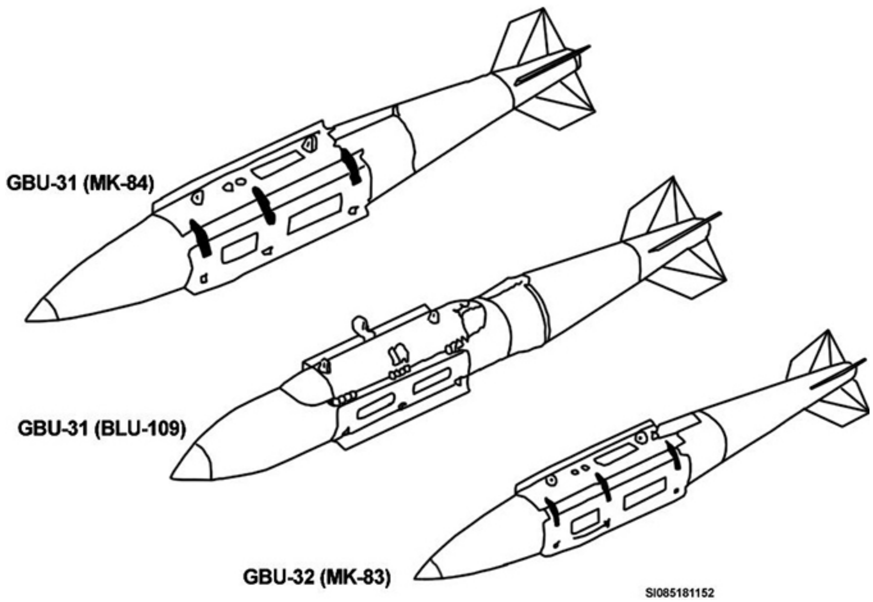



**Figure 1–15. GBU–31 and GBU–32.**

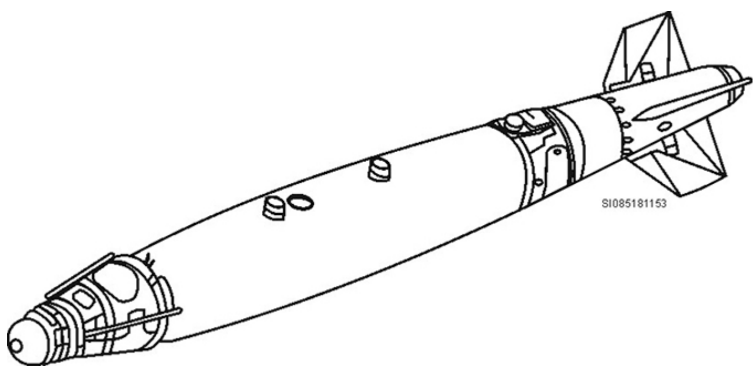



**Figure 1–16. GBU–38.**

## GBU–39

The GBU–39, also known as the small diameter bomb (SDB**),** is a 250 pound weapon designed as a small autonomous, conventional, air-to-ground, precision glide weapon able to strike fixed and stationary re-locatable targets from standoff range (fig. 1–17). The SDB weapon system consists of the weapon, the BRU–61/A (4-place pneumatic carriage system), shipping and handling containers for a single weapon, and the BRU–61/A either empty or loaded, and a weapon planning module. The SDB I advanced anti-jam GPS-aided initial navigation system provides guidance to the coordinates of a stationary target. The payload/warhead is a very effective multipurpose penetrating and blast fragmentation warhead coupled with a cockpit selectable electronic fuze. A proximity sensor provides a height of burst capability. It is compatible with all Air Force platform internal carriage systems and its low-drag carriage rack characteristics enhance external carriage.

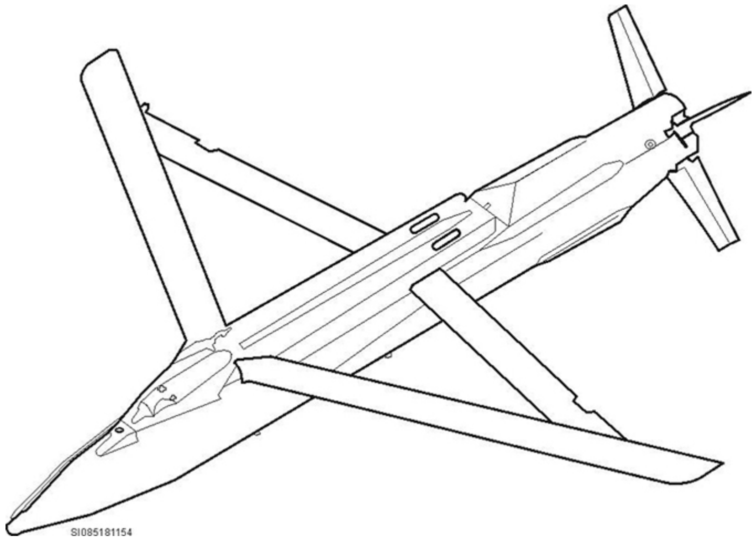



Figure 1–17. GBU–39.

## 206. Cluster bomb units

Although we call these weapons "cluster bomb units," or CBUs, they're not bombs in the true sense of the word. They are a delivery system for smaller munitions or "submunitions" that will damage or destroy the target.

### CBUs

They are a combination of a dispenser and a quantity of small submunitions. The dispenser is simply a device for attaching the bomblets or mines to a delivery aircraft. There is one thing you must remember—a CBU includes the dispenser and its submunitions. A dispenser like those in the SUU–6X series can be used with four or five different CBUs. Refer to the table below for specific configurations.

| Cluster Bomb Units | |
|---|---|
| **CBU** | **= Dispenser + Submunitions** |
| CBU–87 | = SUU–65/B + BLU–97/B |
| CBU–89 | = SUU–64/B + BLU–91 & BLU–92 |
| CBU–105 | = SUU–66/B + BLU–108B |
| CBU–107 | = SUU–65/B + kinetic energy penetrators |

The CBU–87 and CBU–89 series munitions are aircraft-launched, free-fall, unguided cluster bombs designed for tactical use against targets such as light materiel, tanks, and personnel (fig. 1–18). CBUs are released from the carrying aircraft like any GP bomb, withdrawing the arming wire from the fuze and initiating the fuze arming and time-delay cycle. On the SUU–64, SUU–65, and the SUU–66 canisters, when the fuze functions, three linear shaped charges are ignited, cutting the canister into three longitudinal sections and removing the tail section. The air stream opens the canister sections and disperses the submunitions (bomblets) into the atmosphere (fig. 1–19).

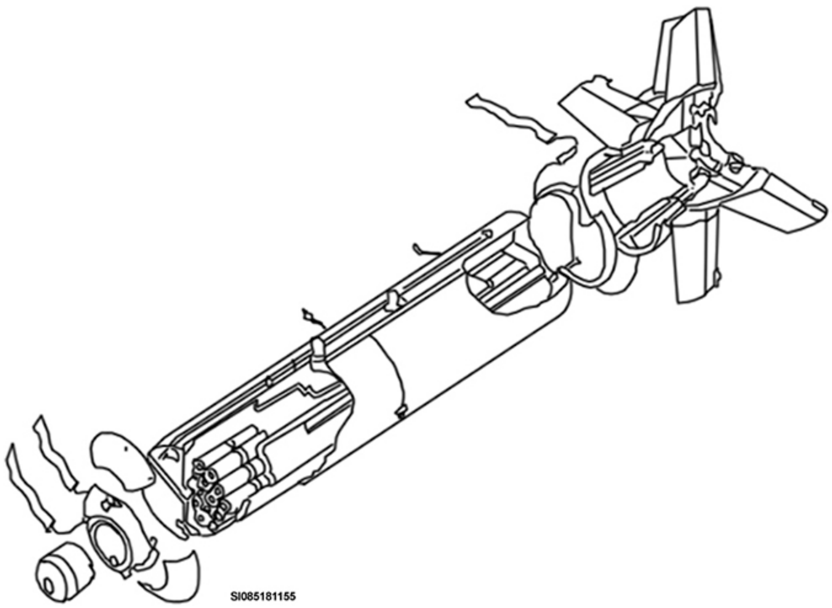



**Figure 1–18. Typical CBU (CBU–87 exploded view).**

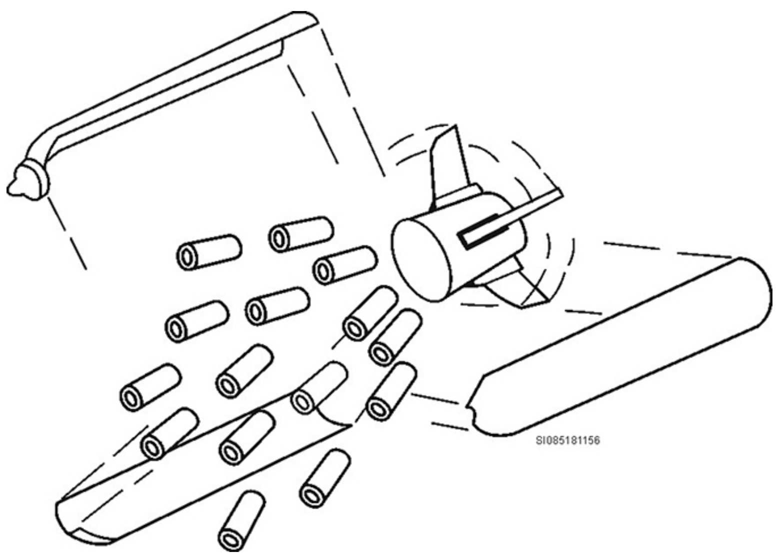



**Figure 1–19. Typical CBU operation.**

## Submunitions

These are the explosive or non-explosive components within a dispenser, designed to be released against target(s). There are many types but we will discuss only the five listed in the table below.

| Submunitions | |
|---|---|
| **Type** | **Target** |
| BLU–91 | Anti-tank |
| BLU–92 | Anti-personnel |
| BLU–97/B | Combined effects munition (CEM) |
| BLU–108/B | Anti-tank; armor piercing (EFP) |
| Kinetic energy penetrators (KEP) | Anti-material/Anti-personnel |

### *BLU–91/B*

The BLU–91/B anti-tank mine is a cylindrical mine inserted into a plastic aero-ballistic housing (fig. 1–20). About 2 minutes after the mine hits the ground, the mine is armed. Once the mine is armed, detonation is initiated by target detection, mine disturbance, low battery voltage, self-destruct time out, or by detecting a timing-circuit error. The mine uses a magnetic sensor to detect a valid target and initiate the explosive train of the mine. It has a bi-directional, mass-focused warhead.

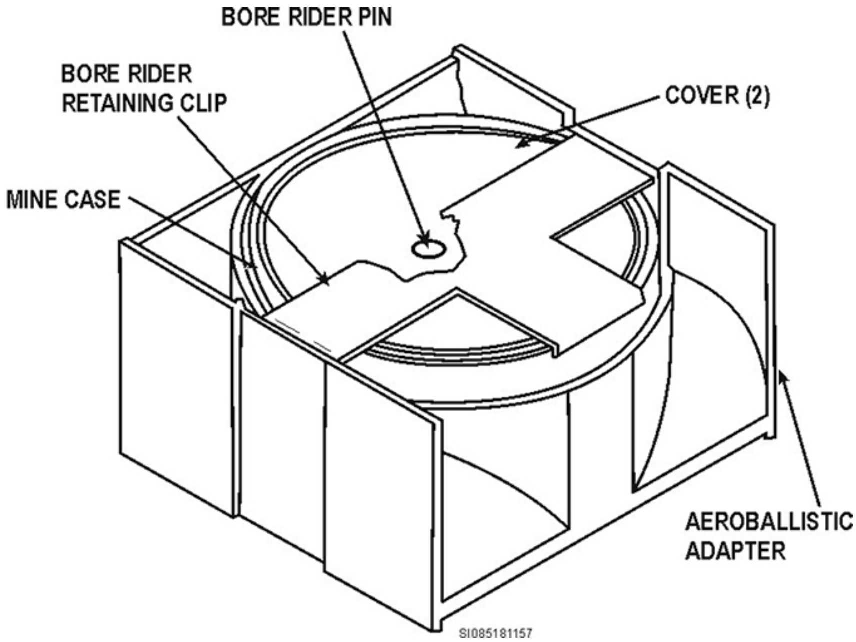



**Figure 1–20. BLU–91.**

### *BLU–92/B*

The BLU–92 anti-personnel mine (fig. 1–21) is also armed about two minutes after the mine hits the ground. There is four tripwire sensors mounted on the face of the mine. Each tripwire sensor is inside a bobbin. When the mine impacts the ground, an electrical signal ignites a gas generator. The pressure from the gas generator removes the locking mechanism on the bobbin and a spring behind each bobbin ejects the bobbins to deploy the tripwires in each direction—approximately 40 feet. When enough force is applied on any tripwire, a contact is opened and an electrical signal initiates the explosive train of the mine; this action causes the warhead to detonate. The BLU–92/B mine also detonates by mine disturbance, low battery voltage, or the expiration of the self-destruct time. The mine uses a fragmenting-case, ground-burst warhead.

### *BLU–97/B*

The BLU–97/B combined effects munition (CEM) (fig. 1–22) is an aerially dispensed multi-purpose (anti-personnel, anti-armor, incendiary) bomblet. After they are released from the dispenser, each BLU–97/B descends under a cone-shaped decelerator and detonates on ground impact. A CEM has a triple charge, incorporating a fragmenting case against soft targets, an anti-armor shaped charge, and an incendiary device.

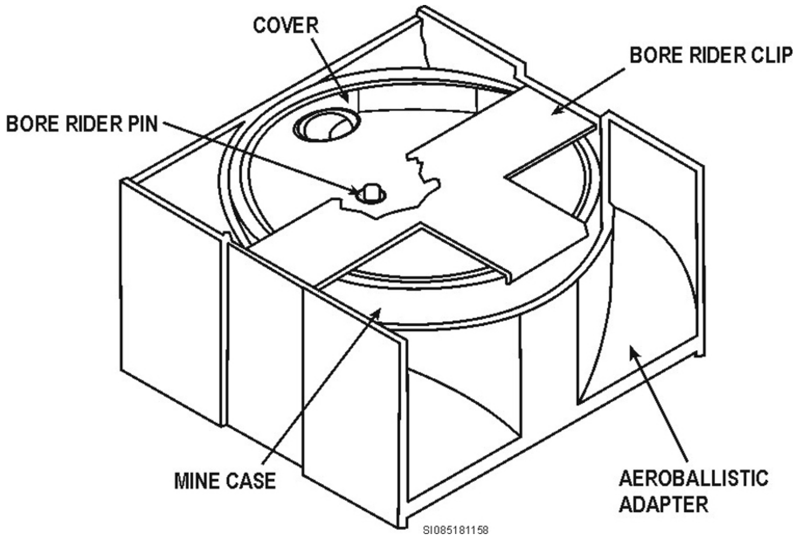



Figure 1–21. BLU–92.

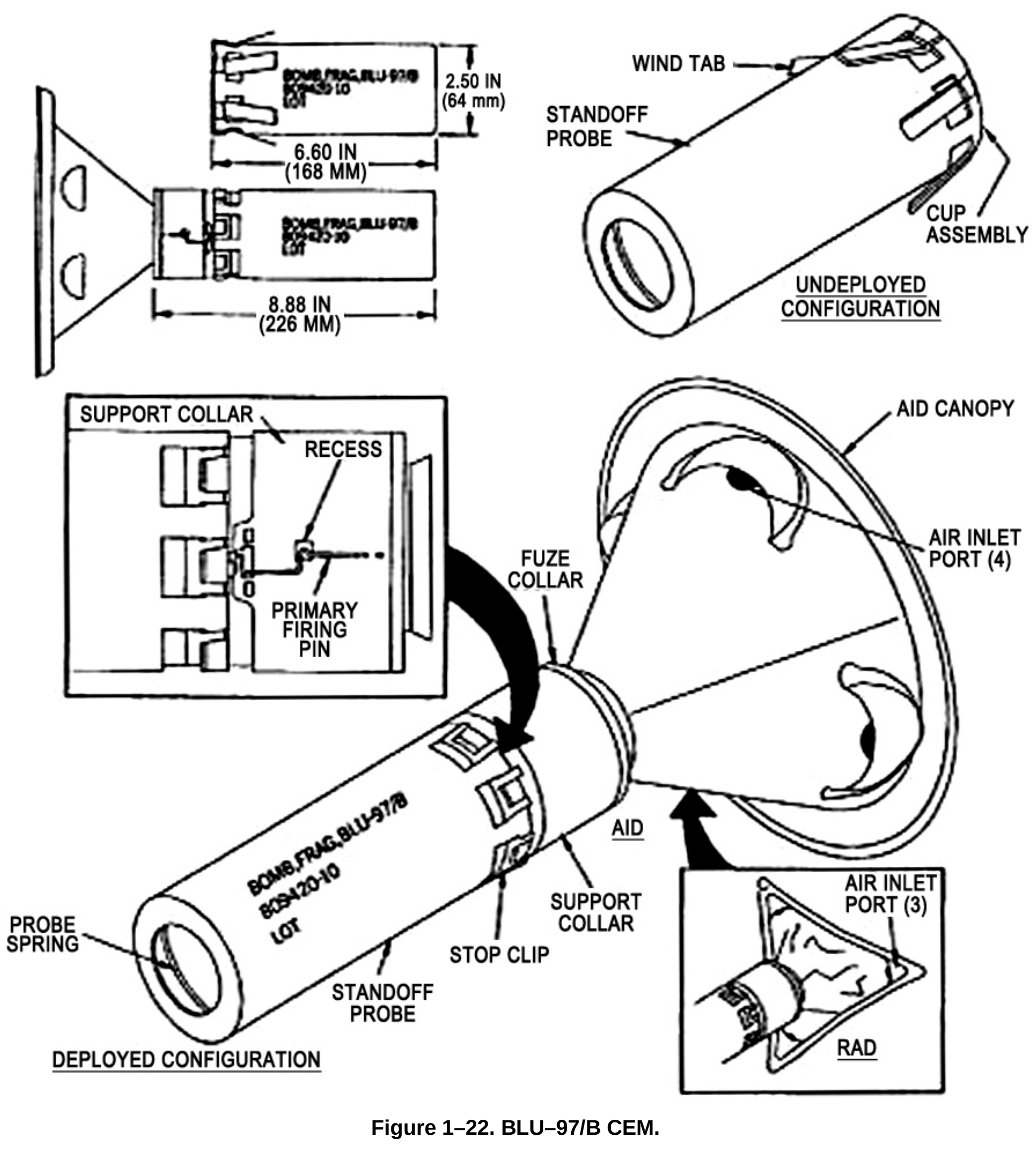



Figure 1–22. BLU–97/B CEM.

### *BLU–108/B*

The BLU–108/B sensor fuzed weapon (SFW) is a special-purpose aerially dispensed anti-armor munition used in the CBU–105 (fig. 1–23, A). A BLU–108/B unit carries four independent skeet anti-tank submunitions. After they are released from the dispenser, each BLU–108/B descends under a parachute to a pre-set altitude. Then a small rocket sends the BLU–108/B upwards and into a rapid spin, so that the skeet warheads (fig. 1–23, B) are released outwards to more effectively distribute skeet munitions over a wide area. Each skeet munition falls independently, scanning the ground with its IR sensor for the signature of a tank or other vehicle. When a target is detected, the skeet detonates, firing an explosively formed projectile (EFP) directly downward through the top of the target vehicle, and a ring of fragments outwards (against soft targets in the vicinity) (fig. 1–24). If no target is detected, the skeet self destructs immediately above the ground.

### *Kinetic energy penetrator*

Kinetic energy penetrators (KEP) are used in the CBU–107 (figs. 1–25 and 1–26). These submunitions are an explosive-free series of fin stabilized rods used in an anti-material setting where preserving the surrounding area is required. The KEPs are arranged into “packs” of varying sizes when contained in the dispenser. The standard configuration of the weapon’s payload is 362 large (590 grams), 1004 medium (86 grams), and 2406 small (5.5 and 3.9 grams) rods. They are unique in the fact that once deployed, they are incapable of contaminating the target area with unexploded ordinance (also known as UXO).

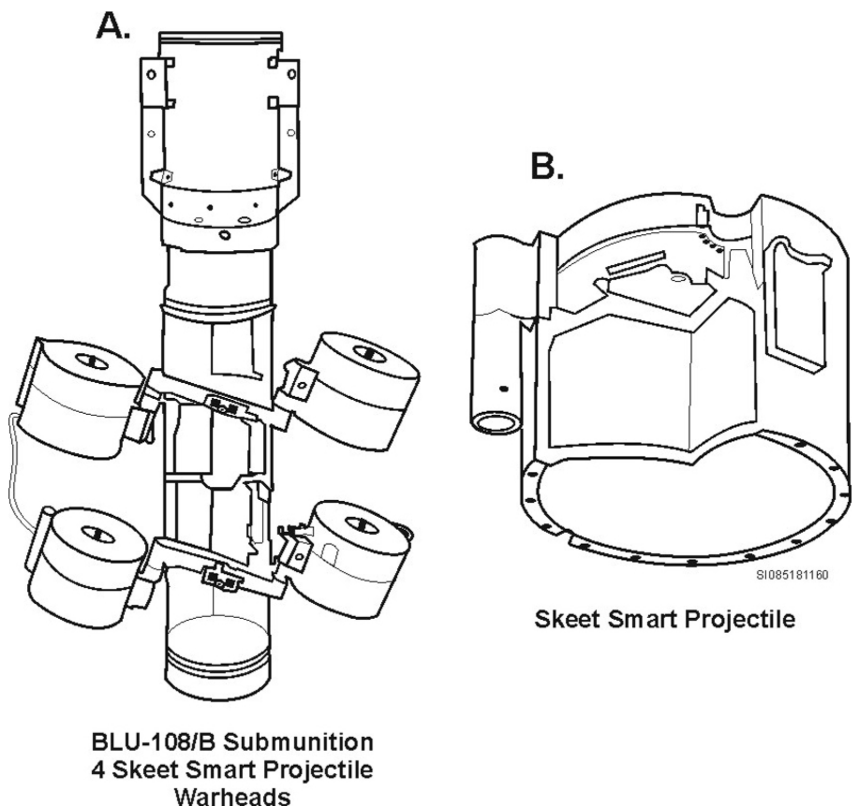



**Figure 1–23. BLU–108/B SFW.**

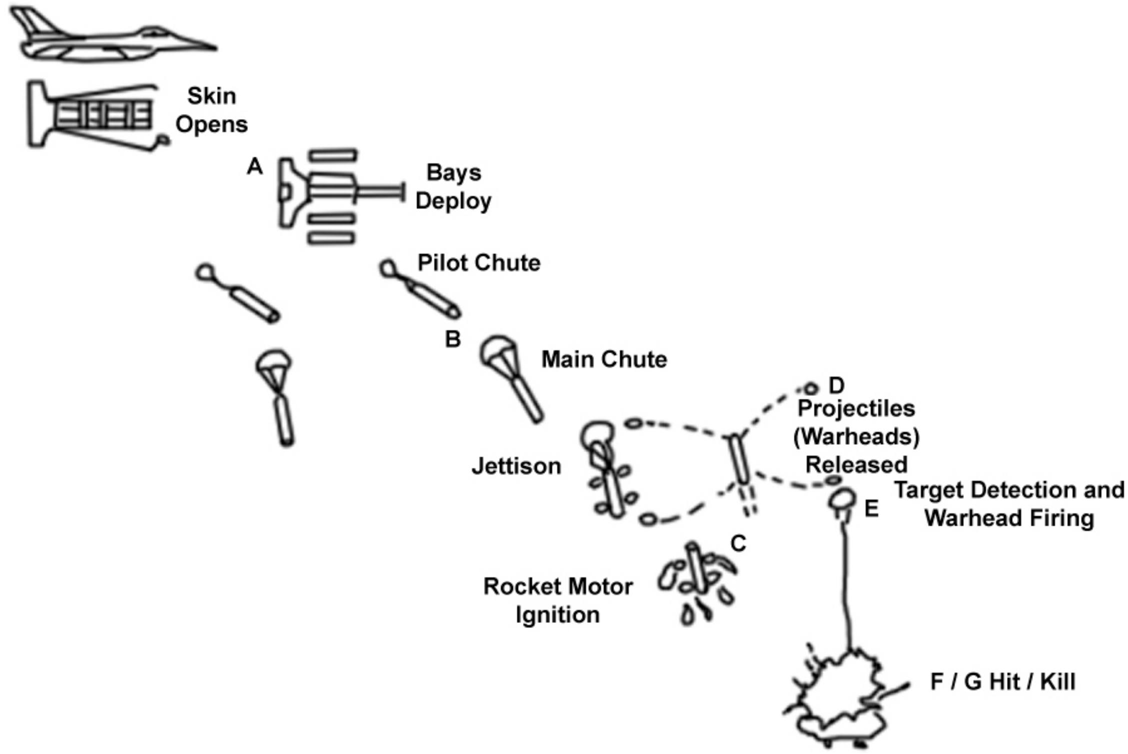



**Figure 1–24. BLU–108 operation.**

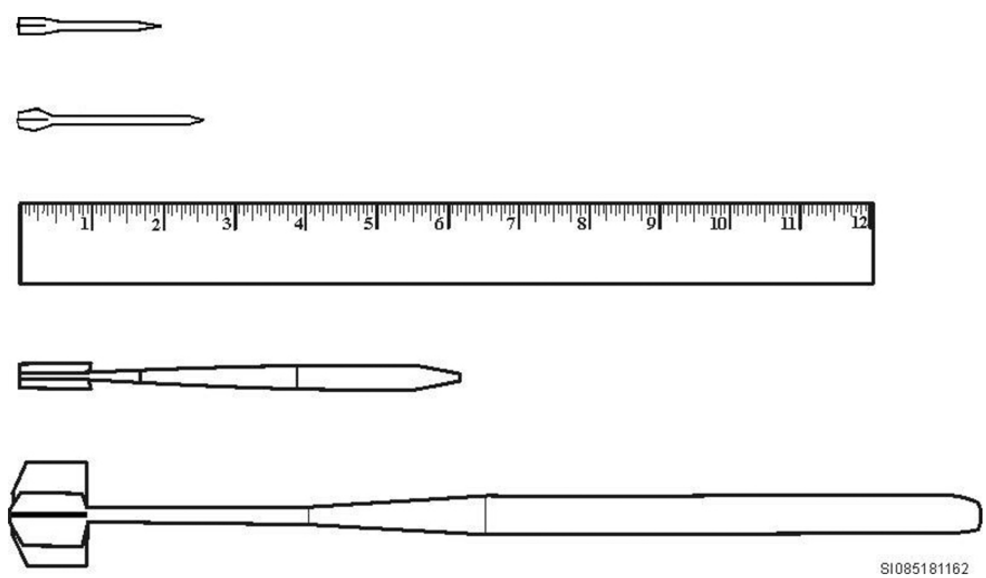



**Figure 1–25. Kinetic energy penetrators.**

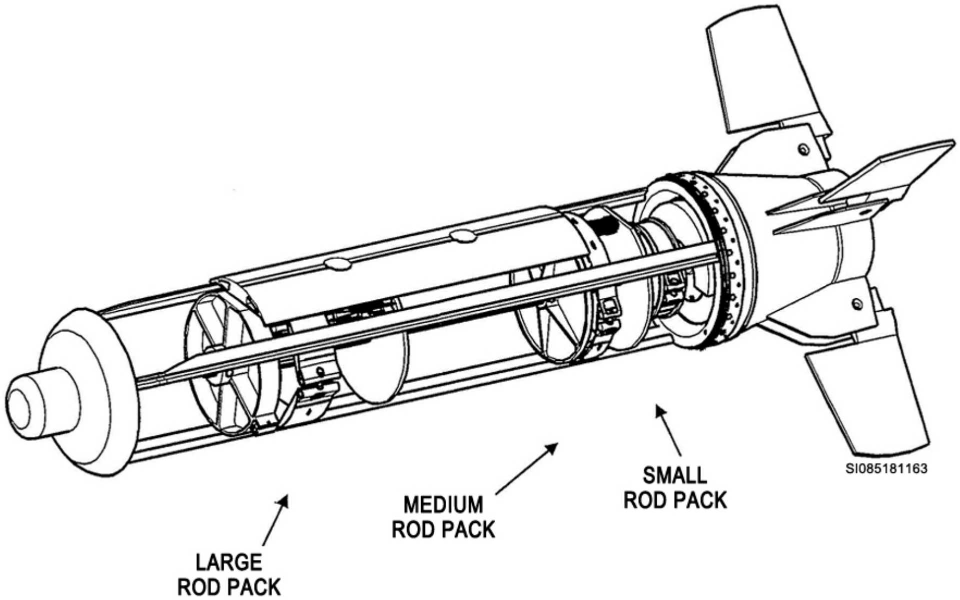



Figure 1–26. CBU–107.

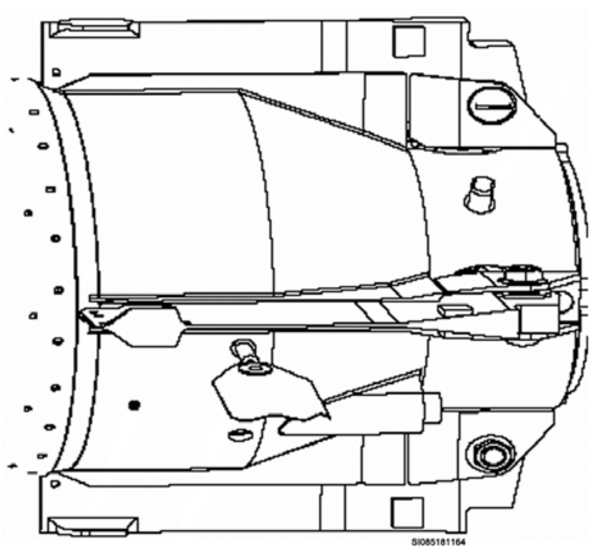


Figure 1–27. WCMD tail kit.

### Tail kits

A CBU–87 and CBU–89 can be fitted with the standard folding fin kit. Now, there is a replacement tail kit that can be used called the Wind Corrected Munitions Dispenser (WCMD). This tail kit (fig. 1–27) was designed for high speed deliveries consistent with tactics used against heavily defended target sets. The tail kit uses the same system as the previously covered Joint Direct Attack Munition (JDAM) systems to steer the munition from a known release point to precise target coordinates while compensating for launch transients, winds aloft, surface winds, and adverse weather. This tail kit provides the Air Force with the first capability to deliver submunitions accurately from medium or high altitudes.

When the WCMD tail kit is installed on a CBU–87, it becomes a CBU–103. It follows the same pattern with CBU–89 as well. With the WCMD tail kit installed, they become CBU–104. The CBU–105 and CBU–107 are always configured with the WCMD tail kit; there is no unguided version.

## 207. Practice bombs

As you're already learned, practice bombs come in different sizes and are either inert or empty. Let's start our discussion with the full size practice bombs and end up with miniature practice bombs.

### Full size practice bombs

The most common full size practice bombs are the 500 pound MK–82 and BDU–50 practice bombs. The MK–82 practice bombs are relatively thin-cased, with a slender body and a long, pointed nose and are used for load crew training. Two conduits for FMU-type lanyards connect the nose and tail fuze wells to the charging well between the suspension lug wells. The fuze wells are closed by shipping plugs when they aren't in use.

The BDU–50 modified 500-pound bomb is an MK–82 bomb case with no conduits or fuze wells, and the case can't accommodate spotting charges. On the BDU–50A/B, a thinner forward plug in the nose of the bomb allows full engagement of the GBU–12 (covered earlier) retainer bolt and forward adapter. Conical-finned inert-filled GP bombs *without* a spotting charge fall free when they're released and follow a ballistic path to impact on the target area. Conical-finned bombs *with* a spotting charge have a component reaction. The bomb is released from the aircraft, withdrawing the arming wire from a fuze-arming device. Withdrawal of the arming wire from the arming drive allows a vane to rotate, arming the fuze. Impact at the target area makes the armed fuze detonate a booster initiating the spotting charge. Spotting charges in bombs with a retarder fin have another component reaction. As the bomb is released from the aircraft, a fin-release lanyard is withdrawn, letting leaf springs open the fin blades into the air stream which, in turn, forces the fins fully open. Simultaneously the fuze lanyard is pulled, transmitting the pulling force to the fuze-arming device. When the fuze senses the deceleration caused by the fin opening, it arms and functions on impact. Initiation of the spotting charge causes smoke and a flash, permitting visual observation of bombing accuracy.

### Miniature practice bombs

Miniature practice bombs provide low-cost target practice for fighter and bomber aircraft crews. While there are multiple types of miniature practice bombs, we'll limit our discussion to the most widely used example of these bombs—the BDU–33B/B series.

#### *BDU–33B/B*

This small, 25-pound practice bomb (fig. 1–28) is carried in the SUU–20 practice bomb dispensers, triple ejector racks (TER), and external bomb racks. As you can see, it's a tear-drop shaped, with a tube cavity lengthwise through the center. Its conical fin assembly stabilizes it after release from an aircraft. It comes equipped with a single suspension lug screwed into the bomb body and a safety pin or clip, depending on whether it's carrying a signal cartridge or a spotting charge.

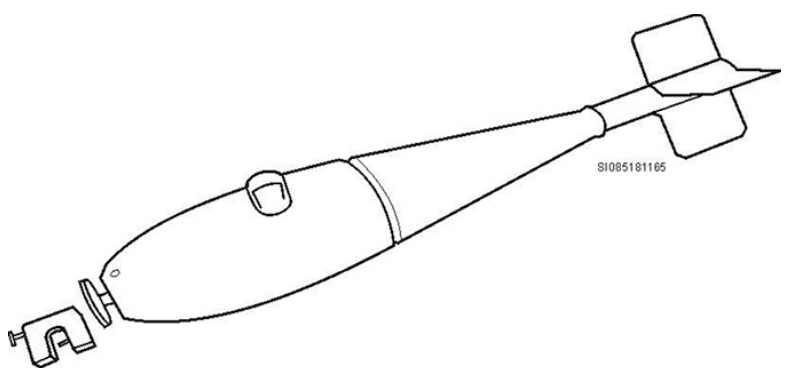



**Fig. 1–28. BDU–33.**

The signal cartridge, designated MK 4 Mod 3, holds a charge of smokeless powder and a marker load of stabilized red phosphorus. If the safety pin comes out while you're handling a bomb equipped with this cartridge, you cannot reinstall it until the bomb is disassembled.  Since we aren't authorized to do this kind of maintenance, just notify your supervisor so the bomb can be returned to the bomb dump for repair.

**NOTE:** Don't load or handle one of these bombs if it doesn't have a safety pin; the cartridge's explosive force is lethal.

The BDU–33 equipped with the CXU–2/B spotting charge is normally used in areas where the danger of starting brush or forest fires is high. This cartridge is made up of an expelling charge of propellant and a marker of titanium tetrachloride. With the CXU–2/B spotting charge, you *can* reinstall the safety clip if it comes out.

## 208. Nuclear weapons

Nuclear weapons are a vital part of the Air Force munitions inventory. As a 2W1X1, you may be involved in handling and loading these special weapons. Within Volume 2, Safety and Security, Unit 3, Nuclear Safety, we discussed the Nuclear Surety program and procedures for working around nuclear weapons. Now, let's take a look at two types of special weapons: the B61 and the B83.

### The B61 nuclear bomb

The B61 is the most easily identified bomb in the Air Force inventory; it's the only one so far with a silver colored painted skin.

This special weapon was designed for freefall or retarded (high drag) delivery from any nuclear-capable aircraft. It weighs roughly 755 lbs and has 30-inch suspension lugs. There are several different models of the B61. Like most munitions, the B61 has a practice model designed for training aircrews to deliver the B61 in the retarded mode of delivery. This practice bomb is designated as a BDU–38/B. The BDU–38/B simulates the B61 flight characteristics by having the same configuration, weight, and center of gravity. All attaching and handling equipment for the parent weapon can be used with the BDU–38/B. You apply the same safety precautions in handling the BDU–38/B as you would apply in handling or loading the B61. The B61's four subassemblies are the radar nose, center bomb, preflight selection, and tail subassemblies. Let's take a look at each of these subassemblies. Refer to figure 1–29 for an illustrated breakdown of the different subassemblies.

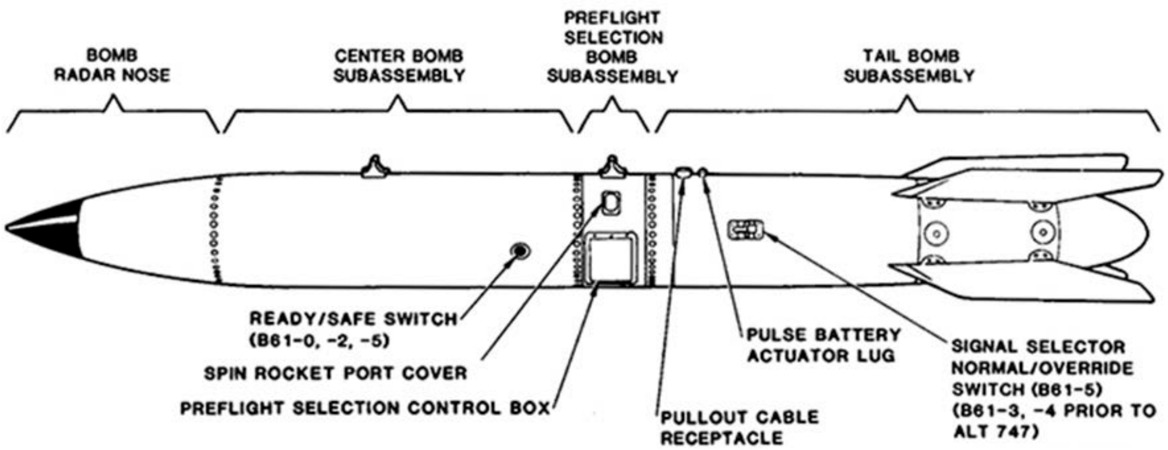



**Figure 1–29. B61 nuclear bomb.**

| B61 Nuclear Bomb Subassemblies | |
|---|---|
| **Subassembly** | **Description** |
| Radar nose | The radar nose subassembly is at the front of the bomb and houses the radome and radar package. The radome is made from a fiberglass-like material that chips easily. Some munitions have a removable cover to protect the radome. However, the B61 doesn't, so you have to be extremely cautious in working around this area of the bomb. |
| Center | The center bomb subassembly has the fuzing components, warhead, and one of the two suspension lugs. |
| Preflight selection | This subassembly contains the preflight selection access panel, the spin rocket with exhaust ports, and the second suspension lug. The preflight selection access panel (fig. 1–30) is on the lower left side of the weapon. The controls on this panel are set before loading or mating the weapon to the aircraft. Some of the controls you should be concerned with are the permissive action link (PAL) enabling receptacle, the indicator piston, the T-handle, the function selector switch, and the strike enable plug. This |

| B61 Nuclear Bomb Subassemblies | |
|---|---|
| **Subassembly** | **Description** |
| | subassembly also has a dual-exhaust rocket motor, with its exhaust ports 180° apart to make the bomb spin during freefall delivery (fig. 1–31). |
| Tail | The tail subassembly contains four fins, a parachute, a bomb pullout receptacle, and the pullout switch actuator lug. You should find the fins in the “X” position, however, the bomb is capable of being configured in the “+” position if required. Like all fin assemblies, they serve to stabilize the bomb during freefall delivery. The parachute slows the bomb during a high-drag (retarded) delivery to give the delivery aircraft time to clear the area before bomb impact. An explosive cartridge inside the tail subassembly creates gas pressure to eject the parachute.<br><br>The pullout cable receptacle (fig. 1–32) lets you connect an electrical cable (pullout cable) to the bomb during loading. Communication signals between the aircraft and the bomb are transferred through this cable and receptacle. The cable is “pulled out” of the bomb upon release from the aircraft. The actuator lug is a small metallic pole where a wire rope assembly is attached between the bomb and aircraft pylon assembly (fig. 1–32). When the bomb is released this actuator lug is pulled up, firing the bomb’s spin rocket. |

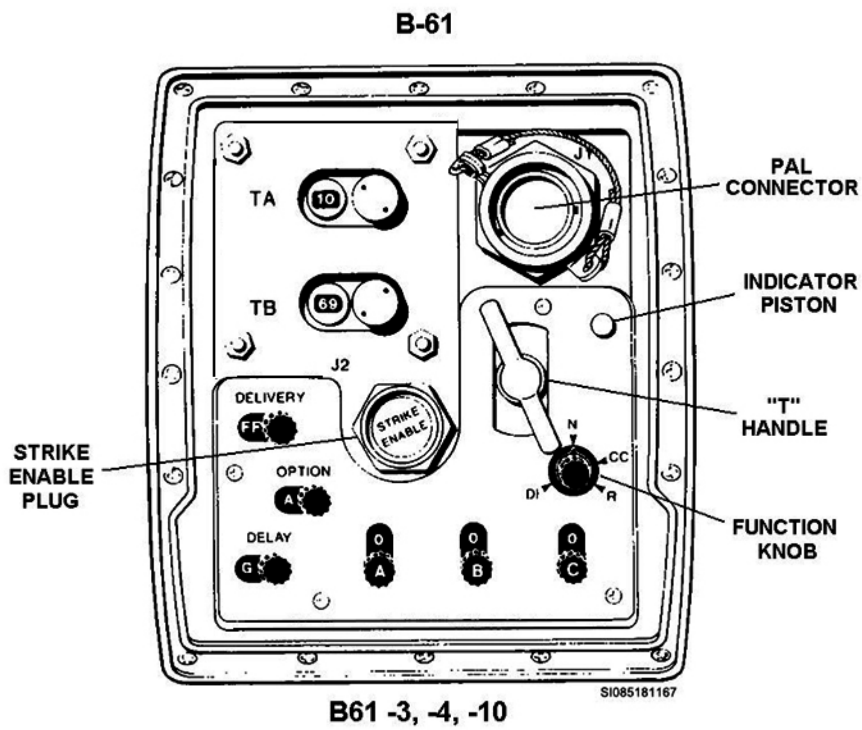



**Figure 1–30. Preflight selection panel.**

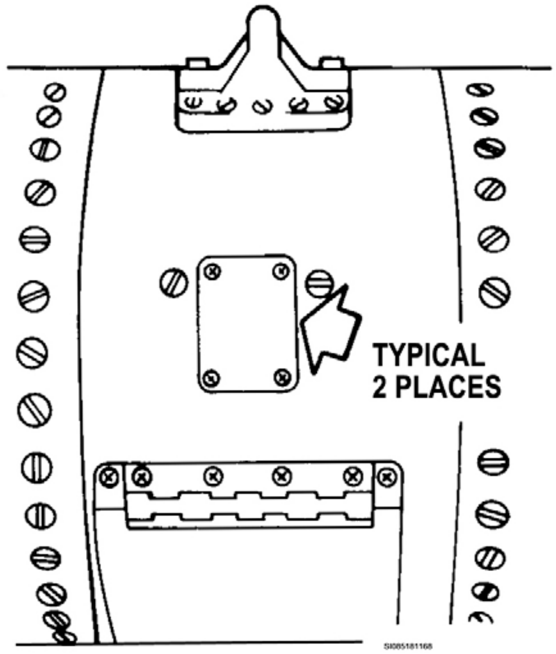



**Figure 1–31. Spin rocket exhaust port.**

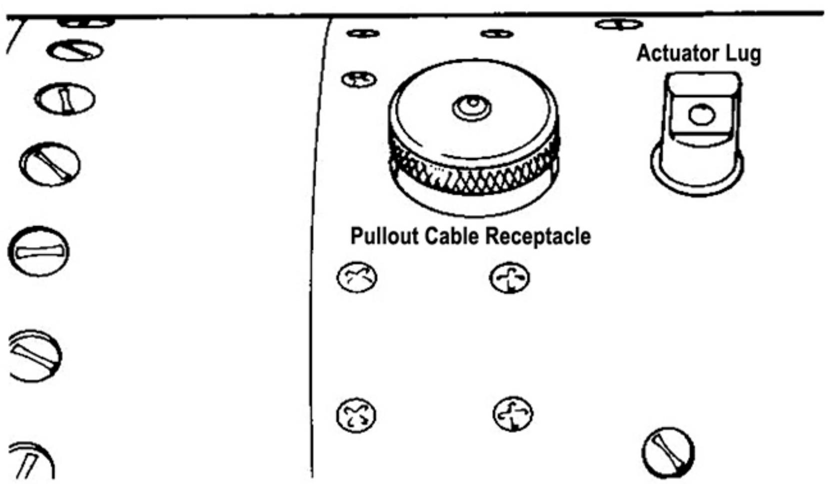



**Figure 1–32. Pullout cable receptacle and actuator lug.**

This brief breakdown of the B61 should familiarize you very generally with the bomb's overall construction, its components, and their locations. The main purpose here is to help you recognize quickly any obvious deficiency if it occurs.

### The B83 nuclear bomb

The newest model of nuclear bomb to be used by the Air Force is the B83. As the B61 is easily identified by its shiny metallic painted skin, the B83 is identified by its shiny white exterior.

Like the B61, the B83 has a practice version, the BDU–46E which is an exact replica of the B83 when it's seen from the outside. The inside contains nothing more than "filler." The B83 weighs about 2455 pounds, and the two main assemblies (fig. 1–33) are the forward and aft assemblies. We'll start with the forward assembly and its unique nose.

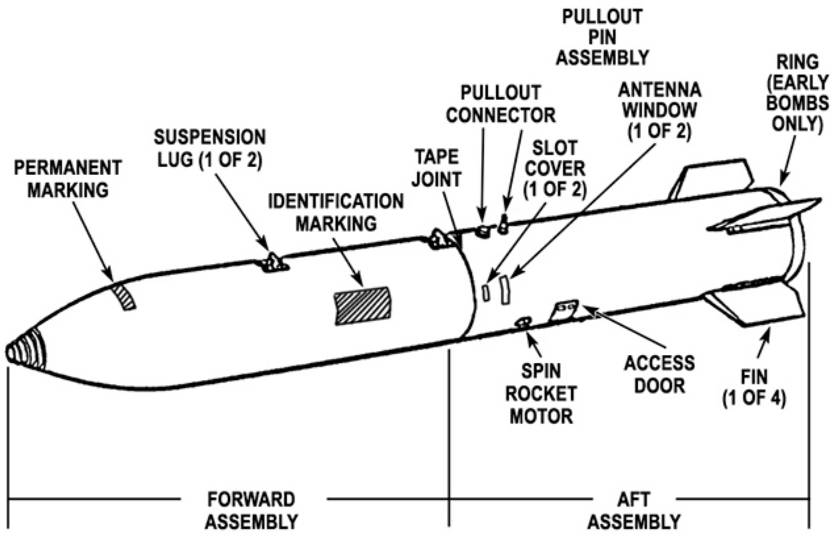



**Figure 1–33. B83 nuclear bomb.**

## Forward assembly

The forward assembly contains the "meat" of the bomb, including all of the nuclear and some electronic components contributing to the bomb's functioning. Looking at figure 1–33, you should notice the nose of the B83 is a different shape than what you would expect on a bomb. Several circular patterns form the tip of the bomb. This design wasn't undertaken to make a fashion statement in the world of munitions; it has a very real purpose. When the B83 impacts with the ground, the nose will crush. When the nose crushes, the bomb doesn't skip or bounce as much as normal, so it stays closer to the actual target, thus increasing its reliability. The forward assembly contains two suspension lugs spaced 30 inches apart.

## Aft assembly

Although all of the nuclear components are in the forward assembly, the aft assembly has a good share of the electronics and a large variety of other components all working in unison. These are described in the table below.

| B83 Nuclear Bomb Aft Assembly Components | |
|---|---|
| **Component** | **Description** |
| Radar package | Unlike most munitions with radar systems, the B83's radar package is in the aft assembly rather than in the nose. |
| Access door | Behind this door are all the available settings for the bomb.<br><br>Settings such as time-to-arm (TA) and time-to-burst (TB) are set according to the individual mission before the weapon is loaded, and must to be verified by the load crew. |
| Spin rocket | The spin rocket is near the tape joint, where the forward and aft assemblies are connected.<br><br>You can't actually see the rocket, but there are two exhaust ports 180° apart, covered by thin material. It will burn away when the rocket ignites.<br><br>Like any other spin rocket, it spins the bomb to make its trajectory more accurate. |
| Bomb pullout cable receptacle | The aircraft needs to communicate with the B83 to find out the bomb's condition (ready or safe) and transmit the arming enable codes.<br><br>Like the B61 pullout cable, it plugs into the bomb pullout cable receptacle and is |

| B83 Nuclear Bomb Aft Assembly Components | |
|---|---|
| **Component** | **Description** |
| | "pulled out" when the bomb is released. |
| Pullout switch actuator eyelug | This small post sticks out of the bomb just behind the bomb pullout cable receptacle.<br>When the bomb falls away from the aircraft, a wire rope assembly will "pull out" the pullout switch actuator eye lug, setting off several events.<br>Simultaneously, the pulse thermal battery is activated to supply the bomb with its own power source and the spin rocket ignites.<br>Soon after, the pulse thermal battery initiates the detonators to explosively deploy the parachute for a retarded (slow) delivery. |
| Fins | Throughout the history of bombs, fins have always been an essential component. Their main purpose is to stabilize the weapon in flight by keeping it from tumbling.<br>It's interesting to note that the B83 can be configured with 10 different fin positions including the "+", "X", or inverted "Y." Why so many configurations? All of our aircraft have their own method for carrying munitions. To make a bomb flexible enough to use on several aircraft, the fins were made adjustable.<br>The inverted "Y" position is a new configuration designed for use with the common strategic rotary launcher (CSRL).<br>Due to this variety of fin positioning, the B83 can be loaded on all special-weapon-capable aircraft. |

## Self-Test Questions

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

### 204. Unguided general purpose bombs and warheads

1. How is the MK 82 high-drag bomb's flight slowed?

2. What GP bomb is used to make the BSU–49 AIR high-drag bomb?

3. What bomb was designed to augment and replace the MK–84, 2,000-pound GP bomb?

4. How many fuze wells are in the BLU–109/B?

5. The BLU–109/B can be used with what GBU configurations?

6. How much does the BLU–113A/B weigh?

### 205. Guided bomb units

1. What components make up modular guided bombs?

2. What is the prime advantage of laser guided munitions?

3. How close to its target can a GPS/INS guided munition be expected to strike?

4. What is the main drawback to the EGBU hybrid system using both laser guidance and GPS/INS systems?

5. What GP bomb is used as the warhead for the GBU–12?

6. What two munitions may be used as the warhead for a GBU–15?

7. What is the purpose of the target-detecting devices on the GBU–15?

8. What warhead is used for the GBU–24A/B?

9. What is the purpose of the hardback assembly and lug sleeves supplied with the GBU–24A/B?

10. What warhead is used for the GBU/EGBU–28?

11. What warheads are compatible with JDAM tail kits?

### 206. Cluster bomb units

1. What two components comprise a CBU?

2. After a CBU–87, –89, –105, or –107 is released from an aircraft, how does the dispenser open?

3. What forces the CBU–87/89/105/107 apart to release the submunitions?

4. The BLU–91/B submunition is used against what type of target?

5. What type of mine is the BLU–92/B submunition?

6. How many independent Skeet anti-tank submuntitions are contained in the BLU–108/B unit?

7. What is installed on a CBU–87 to convert it to a CBU–103?

### 207. Practice bombs

1. What are the most commonly used full size practice bombs?

2. What is the weight of the BDU–33 practice bomb?

3. If the safety pin comes out while you're handling a BDU–33 practice bomb that has a MK 4 MOD three signal cartridge, what must you do?

4. Can you reinstall a safety clip equipped with a CXU–2/B spotting charge if it falls off during loading or handling?

### 208. Nuclear weapons

1. What type of weapon delivery is used with the B61 weapon?

2. What practice bomb is used to simulate the B61?

3. What part of the B61 conatins the access door?

4. What is the purpose of the exhaust ports on the B61?

5. In what position should you find the B61 fin assembly?

6. What is the practice version of the B83?

7. What is the purpose of the circular patterns on the nose of the B83?

8. Where is time-to-arm (TA) and time-to-burst (TB) set on the B83?

9. Where is the spin rocket on the B83?

10. How many different fin configurations are used for the B83?

## 1–3. Bomb Fuzes and Munition Related Components

A bomb fuze is either a mechanical or electrical device used to initiate a detonation at a specific time under desired circumstances. By selecting a certain type of fuze, or by adjusting the fuze, you can control the time of explosion. Fuzes come in many sizes, shapes, and types to match the different types of bombs used by the Air Force. If you are on a load crew, you will inspect, handle, and install bomb fuzes. Because these items contain sensitive and dangerous explosive compounds, it's important that you understand their characteristics and how they function.

### 209. Fuze classification methods, action types, and safety features

Bombs can be configured to perform many different applications or functions. These functions dictate the type of fuze used. In this lesson, we look at the different types of fuzes you will encounter.

#### Classification of bomb fuzes

Fuzes are classified by their position (nose or tail) and by their method of arming. As a general rule, most GP bomb fuzes are screwed into the bombs fuze well and have thread diameters of 2 inches. The fuze may either be a nose or tail fuze. Their positions of installation in the bomb should be rather self-explanatory. Fuzes are made so they can't function while they're unarmed. A fuze is *considered armed* when the next normal event will initiate the fuze function. That event may be impact (impact fuze); the time train running to completion (mechanical time fuze); completion of a chemical action on a firing mechanism (long-delay anti-withdrawal fuze); completion of an electronically timed firing circuit; or the approach of the fuze to its target, as in the case of the proximity fuze. A thermal battery activated at bomb release by the extraction of the arming lanyard arms the electric fuze.

In the *arming vane-type fuze,* the vane rotates in the air stream as the arming wire is withdrawn when the bomb is released from the aircraft. The rotation 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. Safety blocks, installed on certain types of fuzes, are also ejected from between the striker and the fuze body, thus, freeing the firing pin. In tail fuzes, the rotation unscrews an arming stem from an inertia-type firing pin or 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 of the vane are required to arm each model of fuze. Anemometer wind vanes (with cup-shaped blades) rotate in the air stream. Such vanes are used to arm tail fuzes used on some bombs.

On the *arming-pin-type fuze*, the arming wire is withdrawn when the bomb is released, causing the arming pin to be ejected. The ejection of the arming pin may arm the fuze directly, but usually it starts a power train or a clockwork mechanism which arms the fuze after a predetermined time. This type fuze is usually in smaller bombs that are normally clustered together, such as chemical bombs. All mechanical time fuzes use the combination of arming pin and vane methods of arming. The rotation of the vane is transmitted through a reduction gear train aligning the detonator with a cocked firing pin. The ejection of the arming pin causes a time mechanism to start operating.

## Types of fuze function

There are four main types of fuze functions—impact, time, proximity, and hydrostatic (fig. 1–34). These are discussed in more detail in the table below.

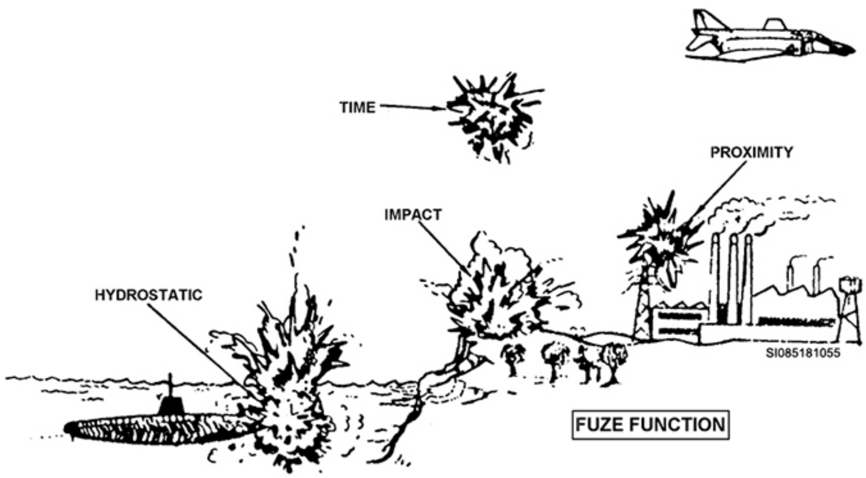



Figure 1–34. Fuze functions.

| Fuze Functions | |
|---|---|
| **Type** | **Description** |
| Impact | Impact fuzes start their function when the bomb strikes a resistant material.<br>• *Instantaneous*, or non-delay fuzes, explode the bomb immediately.<br>• *Delay-type fuzes* have an element to delay the bomb explosion until a definite time has elapsed to let the bomb penetrate the target or let a low-altitude aircraft clear the danger area before the bomb explodes.<br>Some of the newer fuzes in this category even have a void sensing capability allowing them to delay activation until they have penetrated the hardened outside of a facility to detonate in the space protected by the facility.<br>Another feature of newer fuzes is “layer counting”; this allows the weapon to penetrate a predetermined number of floors of a structure before fuze activation. |
| Time | Mechanical time-type nose and tail fuzes explode the bomb a certain number of seconds after release.<br>This type has an arming pin as well as an arming vane.<br>The operating time is adjustable and may be set when the complete round is assembled.<br>A typical time range is 5 to 92 seconds.<br>When the set time expires, a spring-loaded firing pin is triggered and driven into the |

| Fuze Functions | |
|---|---|
| **Type** | **Description** |
| | detonator exploding the bomb. |
| Proximity | Standard proximity bomb fuzes are self-contained, electronically operated fuzes used to function as automatic time fuzes, without setting or adjustment, to detonate the bomb as it approaches the target.<br><br>They produce airbursts at heights between 20 and 125 feet above land.<br><br>A proximity fuze is a nose fuze with a vane to arm the fuze mechanically and electrically, and also drives an electric generator. |
| Hydrostatic | The hydrostatic fuze is used for underwater demolition and mining work.<br><br>The fuze operates on the principle of a bellows, or diaphragm, expanding, due to an increase in water pressure as the bomb sinks, to counteract the force exerted by a spring.<br><br>When the spring force is overcome, the firing pin is released and driven against the primer by spring action. |

## Built-in safety features

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” when you inspect and handle bomb fuzes. Our study includes the different types of built-in safety features, as well as those installed by munitions personnel. The most widely known of these are the seal wires, cotter pins, warning windows, safety blocks, and a detonator safe. Each of these is covered in the following table.

| Bomb Fuze Built-in Safety Features | |
|---|---|
| **Feature** | **Description** |
| Seal wires | These consist of two twisted strands of copper wire and either a lead or sheet metal seal, sometimes referred to as “car seals.”<br><br>These seal wires are commonly used to seal fuze box hasps and fuze priming mechanisms.<br><br>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.<br><br>They prevent movement of arming heads, arming stems, and strikers while the fuzes are being handled, and assembled or disassembled from the bomb.<br><br>Usually, the cotter pin also has a warning tag attached to it; in most cases, this tag has warning instructions printed on it. |
| Warning windows | Warning windows are small circular holes covered with glass or plastic through which you may inspect to see if the fuze’s arming mechanism is in the safe position.<br><br>*The color red showing through the window indicates the fuze is armed.* |
| Safety blocks | The small metal disks or C-shaped blocks installed in fuzes at the time of manufacture are referred to as safety blocks.<br><br>Placed between the striker head and the fuze body, they keep the striker stem (firing pin) from moving into the detonator. |

| Bomb Fuze Built-in Safety Features | |
|---|---|
| **Feature** | **Description** |
| Detonator safe | A detonator must move in line with the striker or firing mechanism to allow detonation.<br>There are several different ways of moving the detonator in line.<br>• One is the “slider,” containing the detonator and simply slides in line with the striker as the fuze is armed.<br>• Proximity fuzes move a “rotor” in line with an electrical firing circuit.<br>• More recent models of this fuze have a pivot rotor snapping in line with the detonator. |

## 210. Mechanical fuzes

Now that you have a general idea of the characteristics, classification, and safety features of the fuzes used with aircraft bombs, let’s look at several representative mechanical fuzes. Then we’ll follow up with some electrical fuzes. We won’t try to cover every fuze you might find in your loading section; you can check the pertinent publications for fuzes we don’t cover here.

### M904 nose fuze

The M904 fuze (fig. 1–35) is a mechanical, impact type, nose fuze commonly used with GP bombs. All fuzes in this series are similar in appearance, with firing delay times provided by inserting an M9 delay element ranging from instantaneous through .01, .025, .05, .10, and .25 seconds 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 18 seconds in 2-second increments.The bent-strap-type arming vane is kept from rotating by a sealing wire, which is removed only after the arming wire is inserted.

When the bomb is released armed, the arming wiring is pulled from the vane eyelets, letting the arming vane rotate to start the arming delay time. The firing delay time begins after the bomb has impacted. Safety features of the M904 series fuzes include a seal wire and the delay element cavity. The seal wire is installed through the arming vane and arming vane stop strap to keep the arming vane from rotating.

**NOTE:** The seal wire is removed only after the arming wire is inserted. The M9 delay element is not inserted until just before installing the fuze. The empty delay cavity acts as an interrupter to the explosive train of the fuze during handling.

The M904 series fuzes also have two warning windows, an upper window on the side of the fuze (fig. 1–36) and a lower window above the booster. The characteristics of each are described in the following list:

- *When the upper window of the M904E2 shows full red or its lower window shows red, it is armed.*
- *When either window of the M904E3 shows a black A on a red background, it is armed.*

In the *safe condition*, the 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 six on a green background, 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. The time lock must be held depressed to change the SECONDS TO ARM settings. Also, the stop setscrew must be removed for settings *below* 6 seconds.

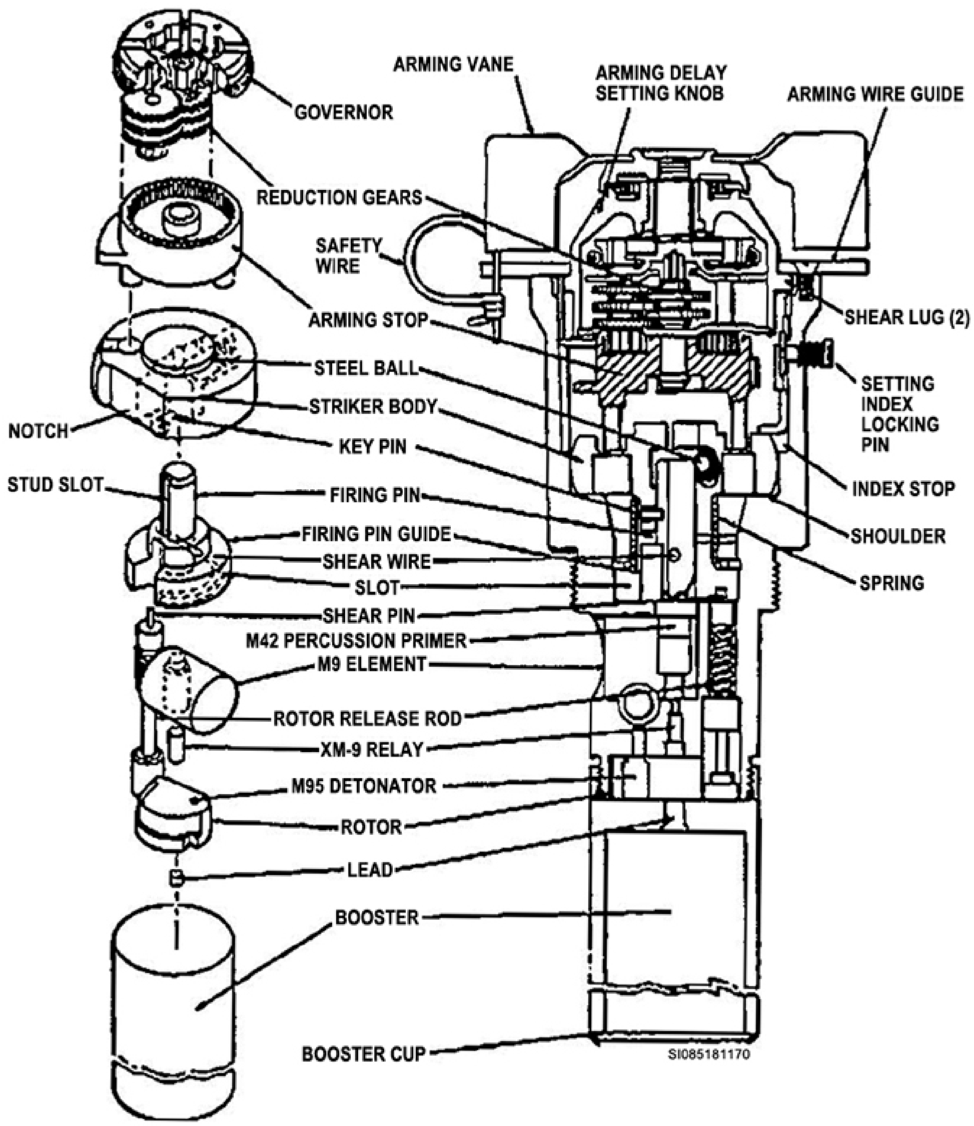



**Figure 1–35. M904 nose fuze.**

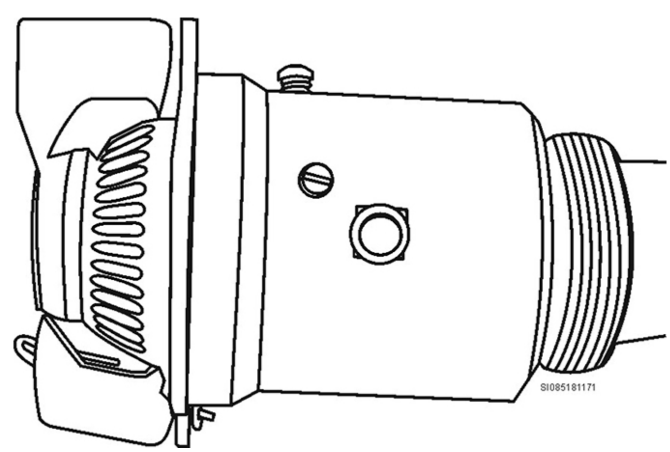



**Figure 1–36. Upper warning window.**

### M905 tail fuze

The M905 (fig. 1–37) is a mechanical, impact, tail fuze commonly used with GP bombs. It's armed by the ATU–35 series drive assembly. The arming time may be set at 4, 6, 8, 12, 16, or 20 seconds on a calibrated scale. The timing lock must be depressed to change the arming time settings. Also; the stop screw must be removed for settings *below* 6 seconds. Inserting an M9 delay element in the cavity just beyond the firing pin provides impact detonation delay times. The delay elements are available in instantaneous action, .01, .025, .05, .10, and .25 seconds. Like the M904 fuze, the M9 delay element is not inserted until just before installing the fuze. The empty delay cavity acts as an interrupter to the explosive train of the fuze during handling.

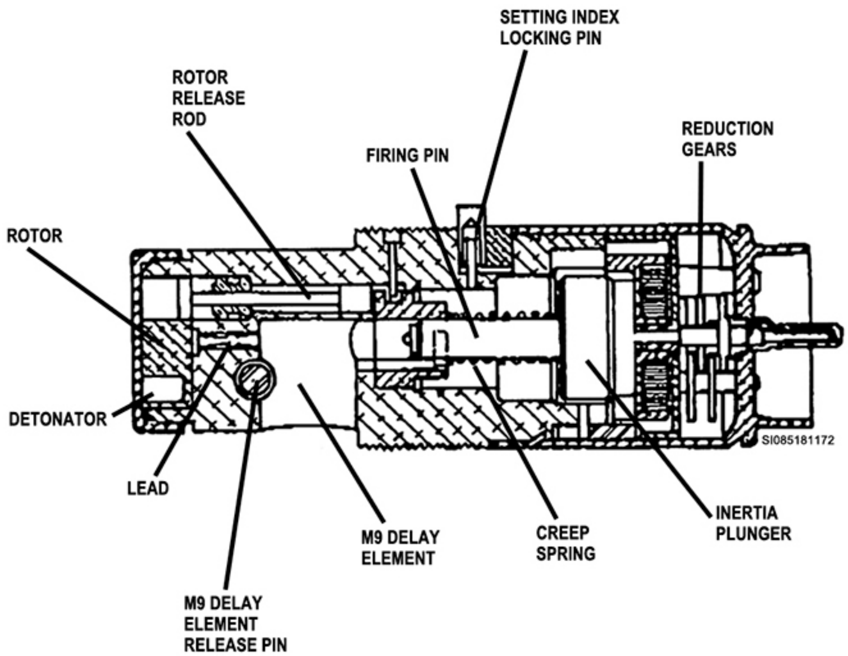



**Figure 1–37. M905 tail fuze.**

Safety features of the M905 fuze include a key spring on the base of the input shaft to keep the shaft from rotating until the drive assembly coupler is connected. The M905 also has two warning windows which are listed in the following list:

- *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; when it shows red, the fuze is armed.*

The ATU–35 series drive assembly (fig. 1–38) is an anemometer vane-type assembly providing the rotational force to arm the M905 fuze. It consists of a vane, housing, a mounting plate, a restraining pin, and a safety cotter pin with a streamer.

**NOTE:** The safety cotter pin should not be removed until the arming wire is inserted.

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. A MAU–86 flexible shaft connects the ATU–35 to the MAU–87 fuze coupler (fig. 1–39). 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.

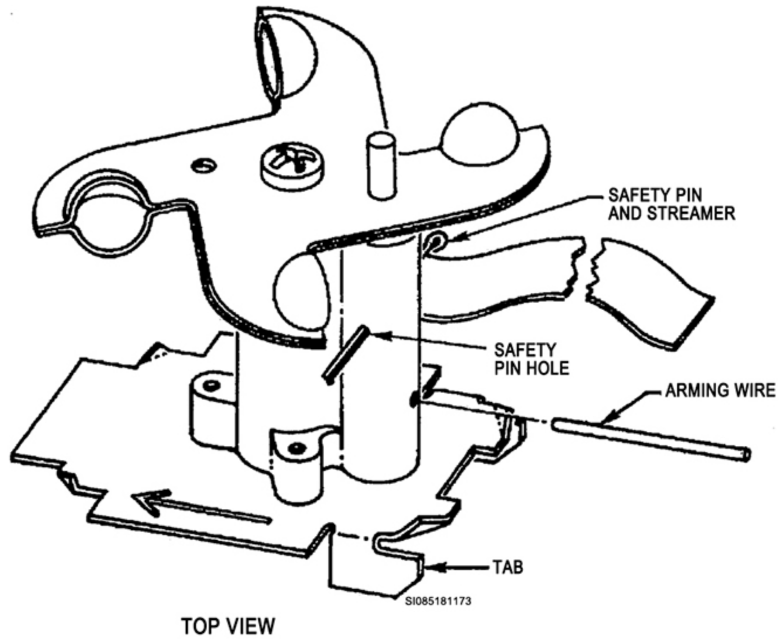



**Figure 1–38. ATU–35 drive assembly.**

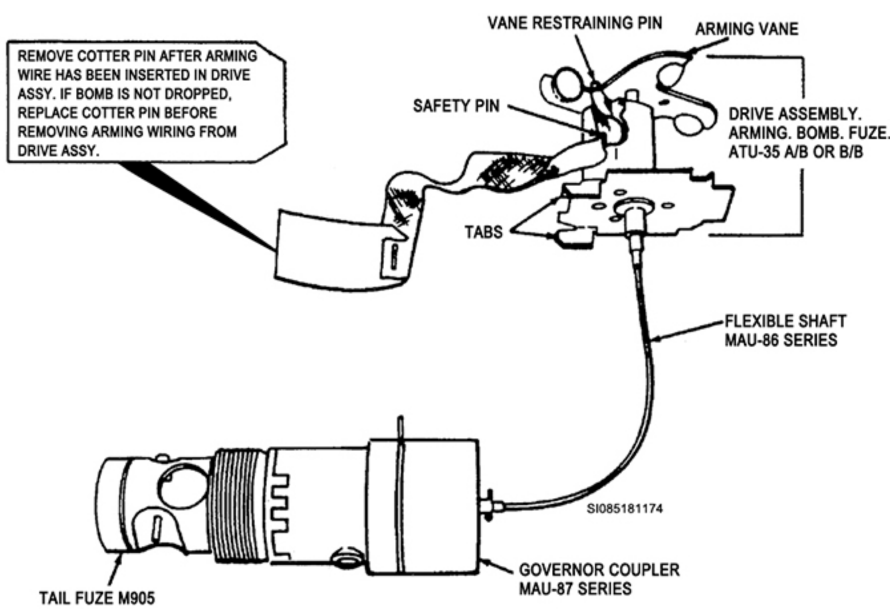



**Figure 1–39. ATU–35 drive assembly coupled to M905 tail fuze.**

## 211. Electrical fuzes

Electrical fuzes are a radical departure from the items and components normally associated with fuzes. With electrical fuzes there’s no arming vane—the arming wire has been replaced with a battery firing device (BFD) and a lanyard, and mechanical timers are actuated with miniaturized electronic packages. Releasing the bomb pulls the lanyard, and the BFD 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.

### Multiple position fuzes

By multiple positions, we mean each of these fuzes may either be installed in the nose or tail of a bomb without affecting their proper functions. At the moment, there are five multiple position fuzes and one sensor. We are only going to cover two of the multiple position fuzes.

#### *FMU–124A/B fuze*

This nose/tail fuze (fig. 1–40) used in the GBU–15. The fuze functions upon receipt of an electrical signal from another component in the weapon system or upon impact. Using an electrical signal provides an excellent airburst capability for two selectable arming times (5.5 and 12 seconds) and three impact delay settings (.00, .010, and .025 seconds). You select these times by rotating the selector switch with a screwdriver. A retractable cable connects to the rear end of the fuze. It's fed through the bomb's conduit into the charging well, where it's attached to an adapter connecting the nose and tail fuzes. The only safety device on this fuze is a safety pin installed through the safety release shaft and safety device assembly.

**NOTE:** The fuze is considered safe when the pin is installed and armed when the pin is removed and the release shaft is extended.

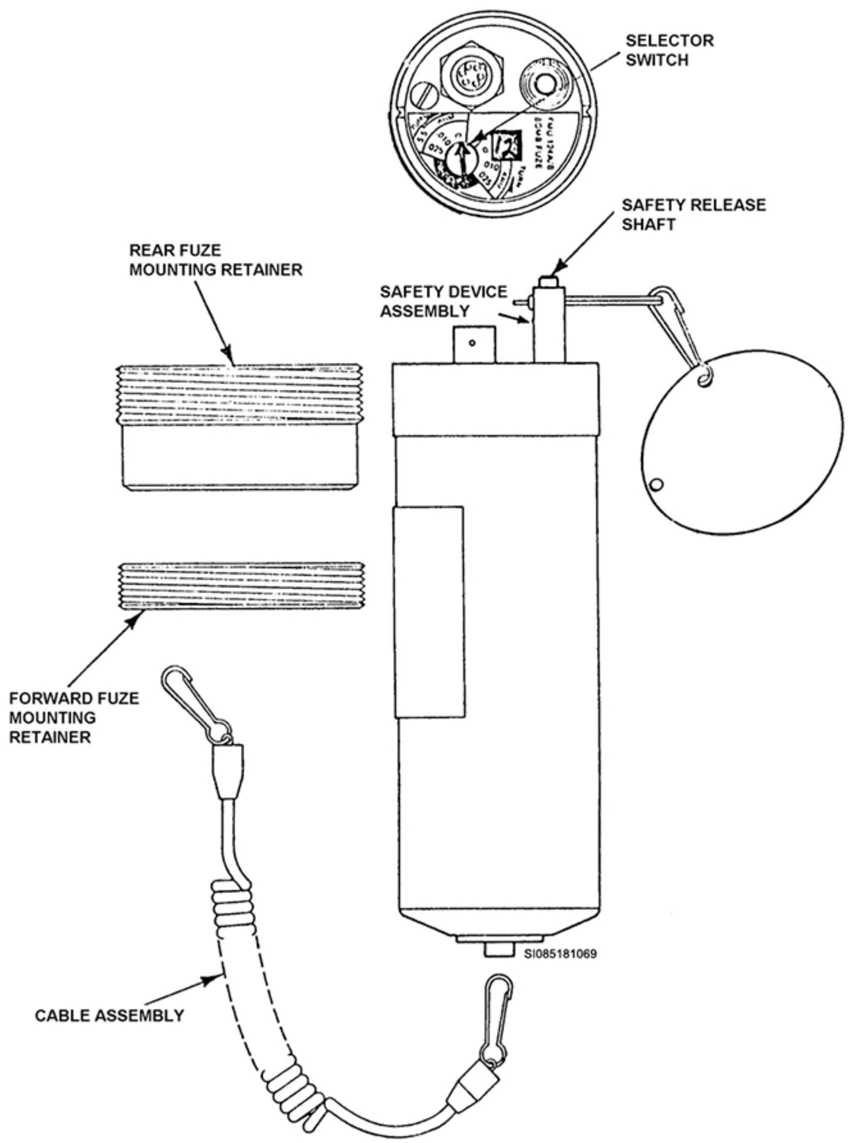



**Figure 1–40. FMU–124 fuze**

### *FMU–139A/B fuze*

The FMU–139A/B is a joint-service (Navy and Air Force), common bomb fuze designed to be used with the MK–80 series GP bombs, the M117, and the BSU–49 and BSU–50. It's a solid-state, electromechanical, multi-option arming and functioning time fuze used with both low-drag and high-drag bombs. It is cylindrical (fig. 1—41), about 3 inches in diameter, 9 inches long, and weighs about 3 pounds. It's completely enclosed in the bomb fuze well and locked in place with a mounting retainer. Associated components include an FZU–48/B initiator, mounting retainer, safety pin, shipping plug, power cable assembly, bomb nose, and diverter (used with T-lug installations). It's designed for electrical initiation but doesn't have any electrical power. The arm and delay times are set on the ground by rotating two knobs on the fuze's faceplate. As a safety precaution; a lockout (interlock) button must be depressed to rotate the high-drag arm/delay switch into a position to arm the fuze in 2 seconds if a high drag is sensed.

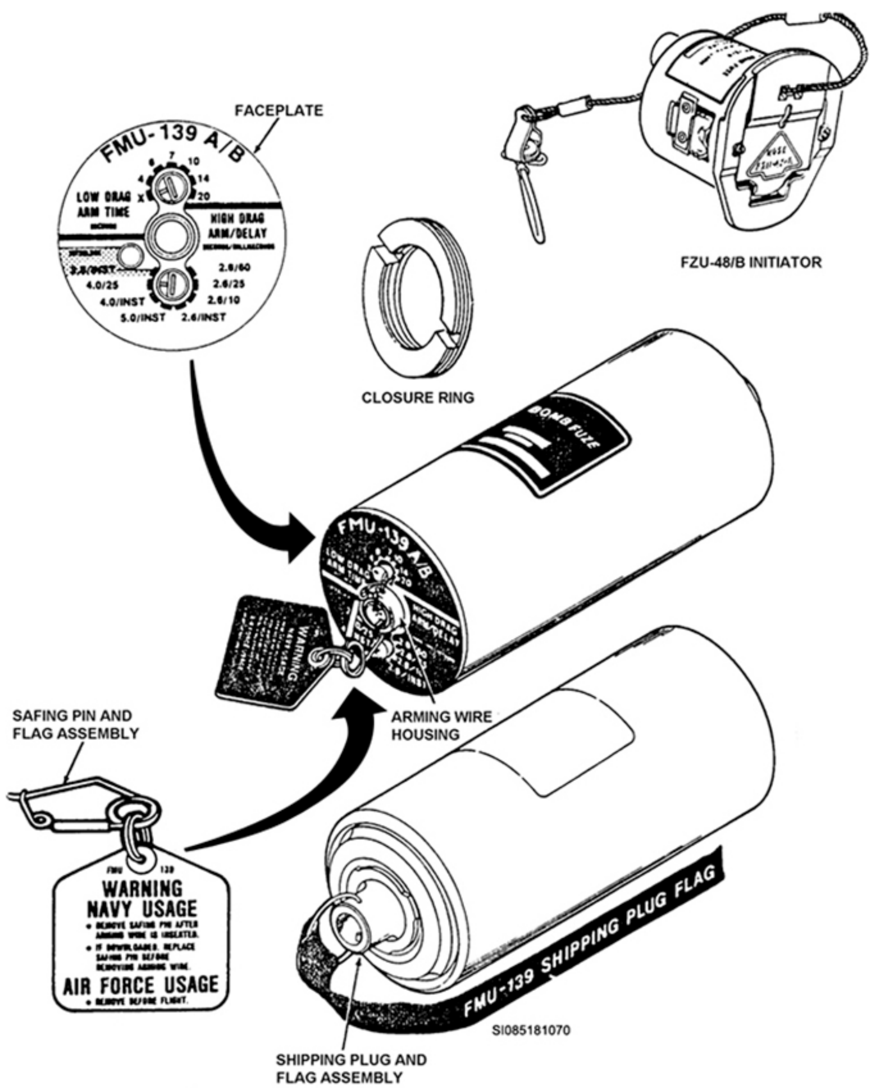



**Figure 1–41. FMU–139A/B fuze.**

Electrical power for fuze operation is provided by the FZU–48/B initiator. The FZU–48/B can supply power to either one or two FMU–139A/B fuzes. It can also be used with a nose-mounted proximity sensor. The initiator is mounted in the bomb's charging well, on top of the bomb between the suspension lugs (fig. 1–42). A pull lanyard is attached from the cover to the bomb rack to start the initiator functioning. When the bomb is released from the aircraft, the lanyard pulls on the FZU–48/B cover with a force greater than 30 pounds, breaking a shear wire in the initiator and letting 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 also generates a release signal for at least 10 but not more than 150 seconds. If the cover is opened while the munition is on the ground, the release signal won't be present when the bomb is released from the aircraft.

Once the cover has been opened, the initiator can't be reused. If the fuze doesn't get a release signal, it will abort and not arm. Once the cover has opened, it takes at least 250 KCAS (knots, calibrated air speed) wind velocity for the turbine alternator to generate any power.

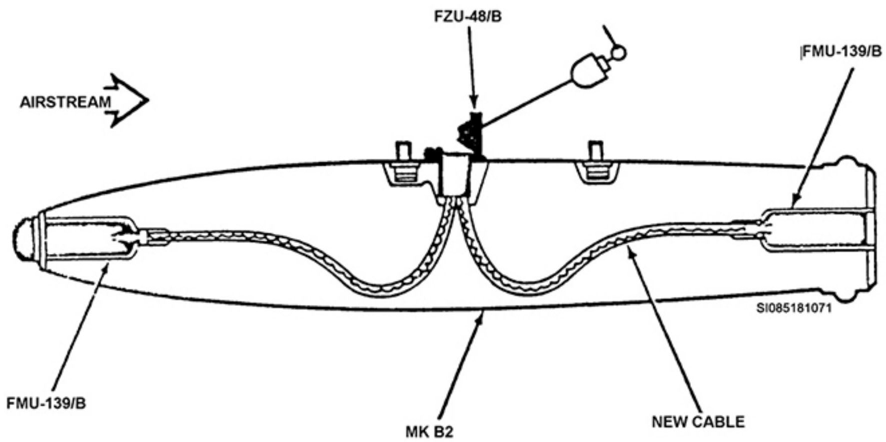



**Fig. 1–42. Location of FZU–48 initiator.**

The FMU–139A/B fuze is designed for maximum safety in handling and delivery. The gag rod keeps the safe and arm rotor from rotating into the ARM position, so it must be removed before the rotor can rotate. It's held in the locked position by a lock, and can only be removed by firing the piston actuator. If the gag rod is unlocked, a red indicator is visible in the center of the gag rod housing around the gag rod. *If red is visible, assume the fuze is armed.* The safing pin keeps the gag rod from moving, and keeps the safe and arm rotor locked in the safe position. If the safing pin isn't removed before flight, the fuze will sense this and abort when it's released. If, during sampling of the retard sensors, at least 1 second of retard is not indicated, the low-drag arm time will be selected. If the LOW DRAG ARM TIME knob is set to the X position when the fuze is powered up, the fuze will abort and not arm. The FMU–139A/B has functioning delay times of .000, .010, .025, and .060 seconds, selected by the HIGH DRAG ARM/DELAY selector switch. The high drag arm time must be set at a point less than the low drag arm time in order for the fuze to function.

## Nose fuzes

These fuzes have the same basic design, related components, and operation as some of the fuzes we just covered, their only difference is they are installed in the nose position only.

### *FMU–113/B Nose Fuze*

This fuze (fig. 1–43) is a Doppler radar, air turbine powered, proximity fuze used to detonate the MK–82 GP bomb at low altitude or on impact if the proximity mode fails. The fuze has selectable arm times of 5, 6, 7, 8, 9, 10, and 18 seconds. The height of burst, about 15 feet above ground level, is built into the fuze at the time of manufacture.

Safety devices 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 can't be retracted and the lanyard pull mechanism can't be actuated. The velocity sensor keeps the air turbine from rotating unless the air velocity through the fuze exceeds 250 knots. The rotor lock mechanically locks the S and A rotor in the SAFE position. The rotor lock is removed by initiation (pulling) of the lanyard. The arm indicator window appears green if the S and A rotor is in the SAFE position. With the arm time ring set in the SAFE position, the safe separation timer won't release the S and A rotor. The fuze is safe when the safing pin is installed, when the arm indicator is green, or when the arm time ring is set on the SAFE position. *If any position of the armed indicator is red, treat the fuze as armed.*

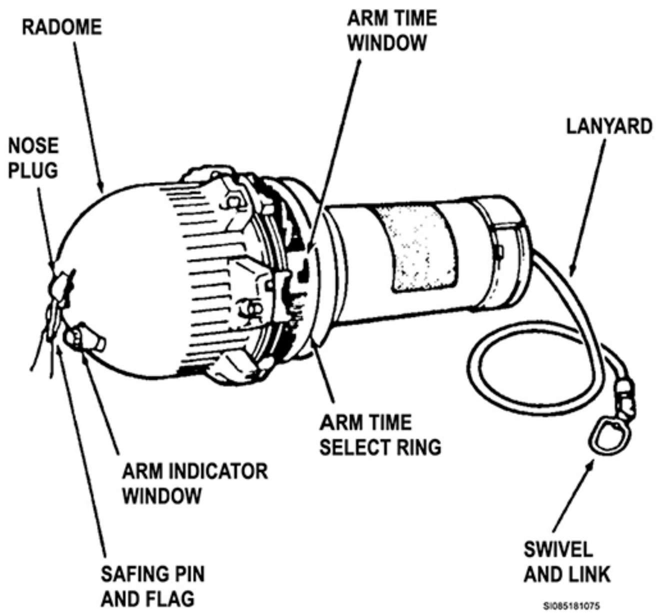



**Figure 1–43. FMU–113/B nose fuze.**

### *FZU–39/B Proximity Sensor*

The FZU–39/B (fig. 1–44) is a cylindrical sensor with a front radome. It has height of function (HOF) and electronic counter measure (ECM) switches on the side of the housing, aft of the radome. Its 10 selectable function heights range 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. This sensor also operates on the Doppler radar concept, to provide the high-altitude functions required for the SUU–64/B and SUU–65/B dispensers.

## Tail fuzes

These fuzes have the same basic design, related components, and operation as some of the fuzes we just covered, their only difference is they are installed in the tail position only.

### *FMU–143 series tail fuze*

The FMU–143/B, A/B (fig. 1–45) is very similar to the FMU–124 fuze except it is only a tail fuze. Used in penetration bombs such as the BLU–109 and GBU–24, the FMU–143 has selectable arming and functional delay times that are set the same way as was those of the FMU–124. The FMU–143 has a safety pin inserted through the safety release mechanism. Its arm/safe indicators are the same as those for the FMU–124.

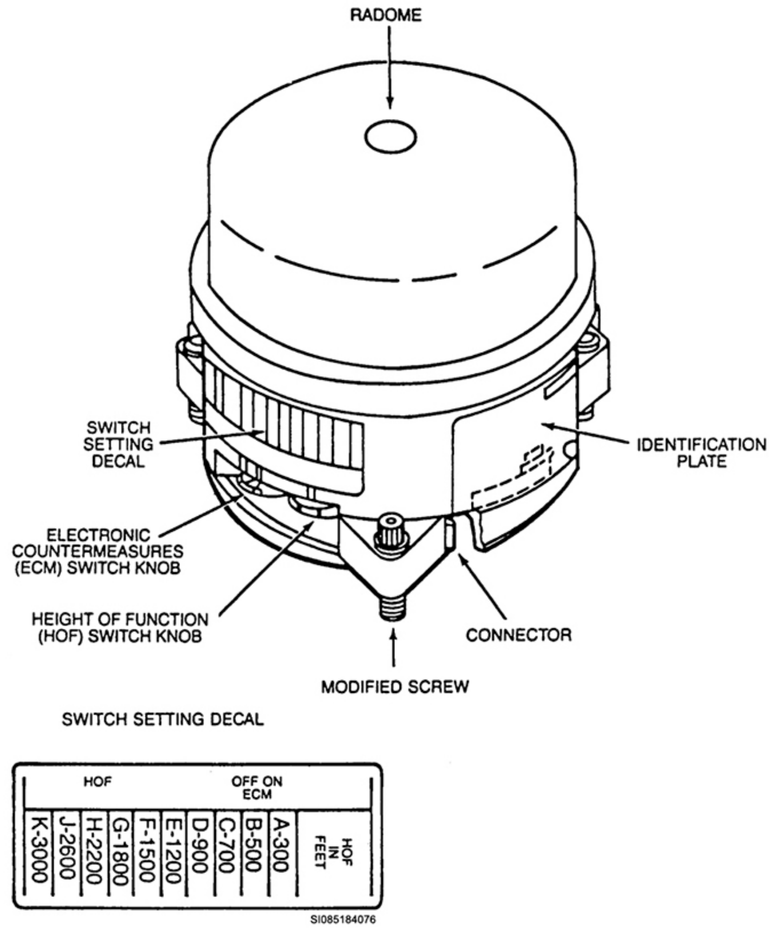



Figure 1–44. FZU–39/B proximity sensor.

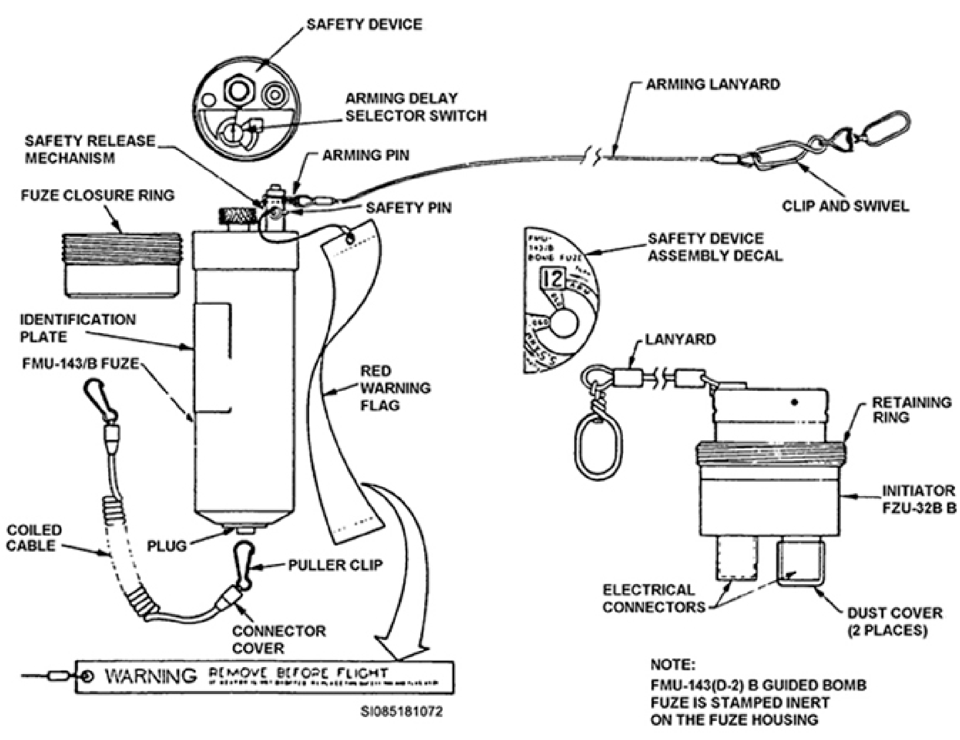



Figure 1–45. FMU–143 typical.

### *FMU–152 series tail fuze*

The FMU–152 (fig. 1–46) 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. 1–47) 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*.

The FZU–55 bomb fuze initiator 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.

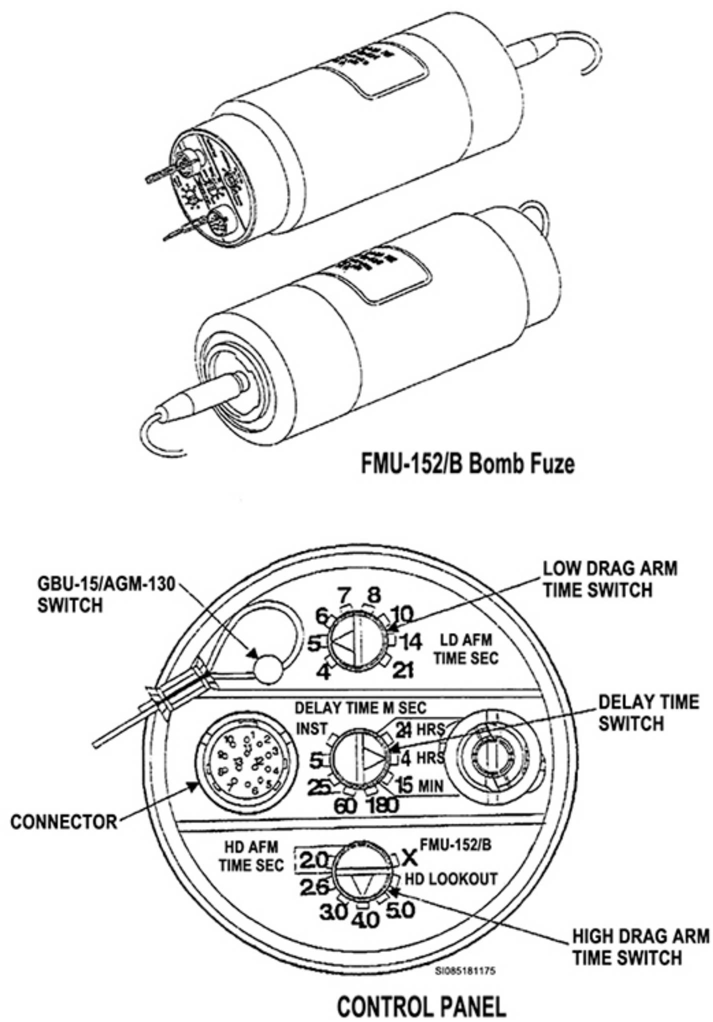



**Figure 1–46. FMU–152 fuze.**

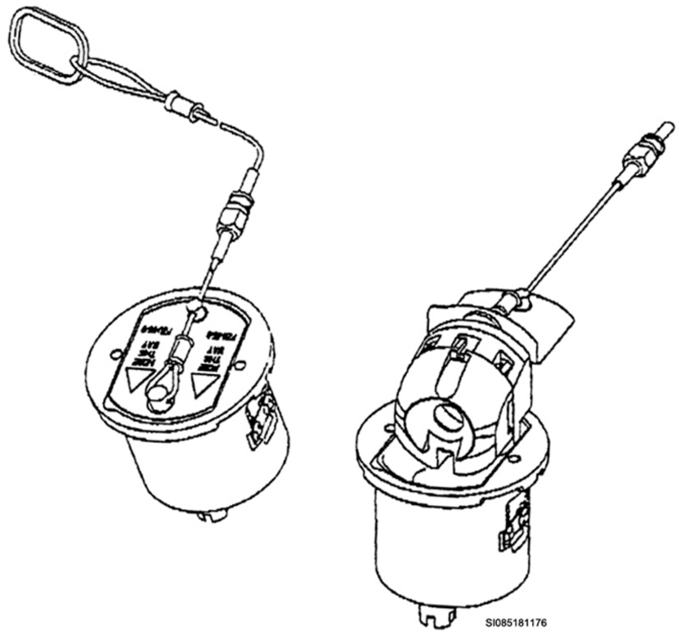



Figure 1–47. FZU–55/B initiator.

## Self-Test Questions

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

### 209. Fuze classification methods, action types, and safety features

1. What are the two methods of classifying bomb fuzes?

2. Name four types of fuze actions.

3. Name the five built-in safety features used in most bomb fuzes.

4. What is the meaning of detonator safe?

### 210. Mechanical fuzes

1. What component provides firing delay times in the M904 fuze?

2. What action begins the arming delay time of the M904 fuze?

3. When is the seal wire removed from the M904 fuze?

4. What should be removed from the M904 fuze to allow SECOND TO ARM settings below 6 seconds?

5. What are the arming times of the M905 tail fuze?

6. When should the M904 and M905 delay element be inserted? Why?

7. What provides the rotational force to arm the M905 fuze?

### 211. Electrical fuzes

1. What replaces the arming wire in electrical fuzes?

2. The FMU–124 A/B functions in what two ways?

3. What serves as a safety device on the FMU–124A/B?

4. What type of fuze is the FMU–139?

5. How is the arming and delay time set on the FMU–139?

6. Where does the FMU–139 get its electrical power for operation?

7. At what height is the FMU–113/B fuze designed to function?

8. What safety device(s) does the FMU–113/B have?

9. The FZU–39/B proximity sensor is used with what dispensers used?

10. The FMU–143 fuze is presently being used with what munitions?

11. Which initiator provides electrical power to the FMU–152 tail fuze?

12. When would you consider the FMU–152 tail fuze armed?

## Answers to Self-Test Questions

### 201

1. Between 35 percent and 55 percent.
2. Tritonal.
3. Blast bombs have light cases and poorer penetration, whereas penetration bombs have cases hard enough to penetrate concrete and armor plating.
4. Heavily armored targets like tanks or ships.
5. From 1 to 10 meters depending on the guidance system.
6. Many of their delivery systems do contain explosives or other hazardous components.
7. Practice bombs.
8. They're both normally equipped with parachutes to produce the high-drag effect, and they may be loaded on the same bomb racks on most aircraft.

### 202

1. (1) The bomb body.
   (2) Suspension lugs.
   (3) Fin assemblies.
   (4) Arming wire assembly.
   (5) Bomb fuzes.
   (6) Adapter boosters.
2. Heavy cast iron about ½-inch thick.
3. Spirally wound spring steel that breaks into fragments when the bomb is detonated.
4. Thirty inches.
5. To keep the fuzes from arming until the bombs are released from the aircraft.
6. Electrical power and interconnection cables to the nose and tail fuzes.
7. Sense the proper altitude for the detonation of a weapon via a radio frequency or Doppler radar.
8. Used to adapt small diameter fuzes to large diameter nose and tail fuze wells. This component also serves to boost the explosive train between the fuze and the bomb.

### 203

1. By the model number, lot number and/or serial number, and painting or marking.
2. So that the munitions items maintenance or service history can be tracked.
3. They're painted mainly to prevent corrosion, and they're marked for identification.
4. The primary explosive component used in the munition.

### 204

1. By an air-inflatable retarder.
2. MK–82.
3. BLU–109/B.
4. One, located in the tail.
5. GBU–10/15/24/27.
6. 4,500 pounds.

### 205

1. A standard GP bomb body, a target detecting device, modular control unit, and airfoil group with a cruciform wing design.
2. Their high degree of accuracy. These munitions can reasonably be expected to strike within 1 to 3 meters of their designated target.
3. Within 10 meters of its target.
4. The main drawback to this system is in its complexity. Having both systems in a single package makes the weapon more expensive and more complicated to load and maintain than a weapon utilizing either guidance system independently.
5. The MK–82.
6. A BLU–109 or a MK–84, 2,000-lb bomb.
7. They’re used for target acquisition and lock on before/after the weapon is released from an aircraft.
8. BLU–109/B.
9. They provide more distance between the bomb and bomb rack.
10. The GBU–28 is a conventional munition that exclusively uses the BLU–113 series 4,500 lb penetrating warheads.
11. MK–82, MK–83, MK–84, BLU–109, BLU–110, and BLU–117 warheads.

### 206

1. A dispenser and a quantity of small bomblets or mines inside it.
2. The fuze functions and three linear shaped charges cut the dispenser into thirds and remove the tail section.
3. The air stream.
4. Tanks.
5. Antipersonnel.
6. Four.
7. A Wind Corrected Munitions Dispenser (WCMD) tail kit.

### 207

1. MK–82 and BDU–50/B.
2. 25 pounds.
3. Notify your supervisor so it can be returned to 2W0 personnel for repair, because 2W1s aren’t authorized to reinstall the pin.
4. Yes.

### 208

1. Freefall or retarded (high drag) delivery.
2. BDU–38/B.
3. Preflight subassembly.
4. They make the bomb spin during freefall delivery.
5. Fins should be found in the “X” position.
6. BDU–46E.
7. Allow the nose to crush on impact, decreasing the amount of skip or bounce the bomb would have with a normal nose. This allows the bomb to stay closer to the actual target and increase its accuracy reliability.
8. Aft assembly, behind the access door.
9. It’s near the tape joint, where the forward and aft assemblies are connected.
10. Ten.

### 209

1. Their position in the bomb and the method of arming.
2. (1) Impact.

(2) Time.
(3) Proximity.
(4) Hydrostatic.

3. (1) Seal wires.
(2) Cotter pins.
(3) Warning windows.
(4) Safety blocks.
(5) Detonator safe.

4. The detonator must move into line with the striker or firing mechanism.

**210**

1. The M9 delay element.
2. Rotation of the arming vane.
3. After the arming wire has been inserted.
4. The stop setscrew.
5. 4, 6, 8, 12, 16, or 20 seconds.
6. Just before installing the fuze. Because the empty delay element cavity acts as an interrupter to the explosive train of the fuze during handling.
7. The ATU–35 series drive assembly.

**211**

1. A battery firing device (BFD) and a lanyard.
2. Electrically or on impact.
3. A safety pin installed through the safety release shaft and safety device assembly.
4. A solid-state electromechanical, multi-option arming and functioning time fuze.
5. By rotating the two knobs on the fuze face plate to the desired setting.
6. Supplied by the FZU–48/B initiator.
7. Approximately 15 feet above ground level.
8. Safing pin, a velocity sensor, a rotor lock, an arm indicator window, and an arm time select ring.
9. SUU–64/B and SUU–65/B.
10. BLU–109/B and GBU–24.
11. FZU–55/B initiator.
12. When the gag rod indicator is showing red and protruding from the safety pin housing.

**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) High-explosive (HE) bombs are classified according to their
   a. case material and use.
   b. case material and filler.
   c. kill mechanism or filler.
   d. kill mechanism or designed use.

2. (201) The weight range of general purpose bombs currently in production is
   a. 250 to 2,000 pounds.
   b. 500 to 2,000 pounds.
   c. 250 to 4,500 pounds.
   d. 500 to 4,500 pounds.

3. (201) Which bomb category is *not* suitable for target penetration?
   a. Blast bombs.
   b. Shaped charge.
   c. General purpose.
   d. Precision guided.

4. (201) Which class of bombs is used against targets such as reinforced concrete structures and bridges?
   a. Blast.
   b. Penetration.
   c. Fragmentation.
   d. Shaped charge.

5. (201) The *primary* target for shaped charge munitions is
   a. large troop formations.
   b. heavily armored targets.
   c. bridges and other large structures.
   d. unarmored and lightly armored materials.

6. (201) The *primary* kill mechanism of kinetic energy penetrators is its
   a. blast wave.
   b. shaped charge.
   c. force of impact.
   d. case fragments.

7. (201) Even though kinetic energy penetrator munitions contain no explosive they *must* be handled carefully because
   a. they are a radiation hazard.
   b. they are sensitive to electro static discharge.
   c. many are used as the delivery mechanism for chemical or biological weapons.
   d. many of their delivery systems contain explosives or other hazardous components.

8. (201) The design of nuclear bombs is similar to which type of general-purpose (GP) bomb?
   a. Blast.
   b. Low-drag.
   c. High-drag.
   d. Penetration.

9. (202) The fragmentation bomb is made of
   a. heavy cast iron.
   b. thin aluminum.
   c. spirally wound spring steel.
   d. hollow metal filled with bomblets.

10. (202) How many *inches* is the suspension lug spacing for conventional bombs weighing up to 1,000 pounds?
   a. 10.
   b. 12.
   c. 14.
   d. 30.

11. (202) What is the purpose of the bomb arming wire assembly?
   a. Detonate the fuze.
   b. Provide electrical power to the fuze.
   c. Keep the fuze from arming until the bomb is released.
   d. Keep the bomb from releasing until the fuze is armed.

12. (203) In case of a *malfunction* which bomb marking might require documentation on the AF Form 2434?
   a. Model number.
   b. Position number.
   c. Identification number.
   d. Lot number and serial number.

13. (203) Which color band is painted around high explosive (HE) munitions?
   a. Red.
   b. Blue.
   c. Brown.
   d. Yellow.

14. (203) Smoke munitions have which color band painted around them?
   a. Red.
   b. Brown.
   c. Light-blue.
   d. Light-green.

15. (204) What secures the aft cover to the stabilizer housing of the BSU–49 AIR bomb?
   a. One pip pin.
   b. Two cotter pins.
   c. One spring-loaded lock pin.
   d. Two spring-loaded latch assemblies.

16. (204) The air inflatable retarder (AIR) is inflated by
   a. ram air entering through four inlets in the retarder itself.
   b. a gas grain generator located in the tail fin housing assembly.
   c. a compressed air bottle located in the tail fin housing assembly.
   d. ram air entering through ducts located on the tail fin housing assembly.

17. (204) The BLU–109/B is what type of bomb?
    a. Penetration.
    b. Shaped charge.
    c. Fragmentation.
    d. General purpose.

18. (204) Which of these bombs is designed with only a tail fuze well?
    a. MK–83.
    b. MK–84.
    c. BLU–107/B.
    d. BLU–109/B.

19. (204) The BLU–113A/B penetrator bomb weighs
    a. 2,000 pounds.
    b. 3,000 pounds.
    c. 4,000 pounds.
    d. 4,500 pounds.

20. (204) The BLU–113A/B serves as the warhead for the
    a. GBU–32.
    b. CBU–107.
    c. GBU–15(V)1/B.
    d. GBU–28A/B and B/B.

21. (205) Standard laser guided bombs have their pulse code set by load crews or aircrew members
    a. using dials located on the under side of the seeker head.
    b. using the aircraft's stores management system through the MILSTD–1760 interface.
    c. by a wireless connection to a portable computer system such as the portable maintenance aid (PMA).
    d. by physically connecting to a portable computer system such as the portable maintenance aid (PMA).

22. (205) The enhanced guided bomb unit (EGBU) is a hybrid system using both a
    a. laser and radar guidance systems.
    b. laser and electro-optical guidance systems.
    c. laser and global positioning system and inertial navigation guidance system.
    d. electro-optical and global positioning system and inertial navigation guidance systems.

23. (205) The MK 84 2,000 pound general purpose (GP) bomb or the BLU–117 GP bomb is used as a warhead by the
    a. GBU–10.
    b. GBU–12.
    c. GBU–27.
    d. GBU/EGBU–28.

24. (205) All GBU–12 models use which bomb as a warhead?
    a. MK–82.
    b. MK–84.
    c. BLU–107/B.
    d. BLU–109/B.

25. (205) The GBU–15’s powered control surfaces are located on the
    a. trailing edge of the wings.
    b. leading edge of the wings.
    c. trailing edge of the strakes.
    d. leading edge of the strakes.

26. (205) What is the weight of the GBU–24A/B?
    a. 500 pounds.
    b. 1,000 pounds.
    c. 2,000 pounds.
    d. 5,000 pounds.

27. (205) The GBU–24A/B uses which warhead?
    a. BSU–49.
    b. BSU–50.
    c. BLU–107/B.
    d. BLU–109/B.

28. (205) What is the weight of the GBU/EGBU–28?
    a. 500 pounds.
    b. 1,000 pounds.
    c. 2,000 pounds.
    d. 5,000 pounds.

29. (205) Which model of the Joint Direct Attack Munition (JDAM) family of bombs uses the MK–83 and BLU–110 as a warhead?
    a. GBU–31.
    b. GBU–32.
    c. GBU–38.
    d. GBU–39.

30. (205) The GBU–39 weighs
    a. 250 pounds.
    b. 500 pounds.
    c. 1,000 pounds.
    d. 2,000 pounds.

31. (206) A complete cluster bomb unit (CBU) consists of a quantity of small submunitions and a
    a. container.
    b. disperser.
    c. dispenser.
    d. suspensor.

32. (206) Which cluster bomb unit (CBU) consists of a SUU–65/B dispenser and a submunition payload of kinetic energy penetrators (KEP)?
    a. CBU–87.
    b. CBU–89.
    c. CBU–105.
    d. CBU–107.

33. (206) Which SUU–64 and SUU–65 dispenser component cuts the dispenser into three longitudinal sections removing the tail section?
    a. Demolition cords.
    b. Linear shape charges.
    c. Warhead booster charges.
    d. Ram-air initiator facilitators.

34. (206) Which submuniton is designed as an anti-tank mine?
    a. BLU–89/B.
    b. BLU–91/B.
    c. BLU–92/B.
    d. BLU–108/B.

35. (206) Which submuniton is an anti-personnel munition?
    a. BLU–89/B.
    b. BLU–91/B.
    c. BLU–92/B.
    d. BLU–109/B.

36. (206) Which *submunition* incorporates a spin rocket to more effectively distribute skeet munitions over a wide area?
    a. BLU–89/B.
    b. BLU–91/B.
    c. BLU–92/B.
    d. BLU–108/B.

37. (206) Which cluster bomb unit (CBU) contains kinetic energy penetrators (KEP) arranged into "packs" of varying sizes?
    a. CBU–87.
    b. CBU–89.
    c. CBU–105.
    d. CBU–107.

38. (207) Which of these is a 500-pound practice bomb?
    a. BSU–33.
    b. BSU–50.
    c. BDU–33.
    d. BDU–50.

39. (207) You can reinstall the safety clip in which BDU–33B/B configuration?
    a. Any.
    b. None.
    c. Those equipped with a CXU–2/B spotting charge.
    d. Those equipped with a MK 4 Mod 3 signal cartridge.

40. (208) The B61 suspension lug spacing is how many inches?
    a. 14.
    b. 16.
    c. 20.
    d. 30.

41. (208) The strike enabling plug is on which subassembly of the B61 bomb?
    a. Tail.
    b. Nose.
    c. Center.
    d. Preflight.

42. (208) When the B61 nuclear bomb is released the actuator lug located on the tail assembly is pulled up,
    a. arming the bomb’s warhead.
    b. firing the bomb’s spin rocket.
    c. deploying the bomb’s parachute.
    d. arming the bomb’s linear shaped charges.

43. (208) The time-to-arm (TA) and time-to burst (TB) settings on the B83 are behind the
    a. access door on the aft assembly.
    b. access door on the forward assembly.
    c. preflight panel on the center assembly.
    d. preflight panel on the preflight selection subassembly.

44. (209) How are bomb fuzes classified?
    a. Position and method of arming.
    b. Position and desired functioning characteristics.
    c. Method of arming and desired functioning characteristics.
    d. Design functioning characteristics and the munitions they’re used with.

45. (209) A typical operating range for time fuzes is how many seconds?
    a. 0.5 to 60.
    b. 2 to 62.
    c. 3 to 30.
    d. 5 to 92.

46. (209) Proximity fuzes will produce airbursts at heights between how many feet above ground?
    a. 20 and 125.
    b. 25 and 150.
    c. 125 and 300.
    d. 150 and 500.

47. (210) The M904 mechanical nose fuzes’ firing delay time begins after
    a. the bomb has impacted.
    b. inserting the arming wire.
    c. installing the fuze in the bomb.
    d. inserting the M9 delay element.

48. (210) What *must* you do when changing the arming time settings on the M905 tail fuze?
    a. Remove the seal wire.
    b. Depress the timing lock.
    c. Remove the stop setscrew.
    d. Insert the M9 delay element.

49. (211) Which of these is the *only* safety device on the FMU–124A/B fuze?
    a. Clip.
    b. Pin.
    c. Plug.
    d. Switch.

50. (211) What supplies electrical power to operate the FMU–139A/B fuze?
   a. FZU–1/B booster.
   b. FZU–2/B booster.
   c. FZU–48/B initiator.
   d. A battery-firing device (BFD).

51. (211) The FZU–39/B proximity sensor has how many selectable height range functions?
   a. 6.
   b. 8.
   c. 10.
   d. 12.

52. (211) Which of these bombs may use the FMU–143/B, A/B fuze?
   a. BLU–80 and BLU–109.
   b. BLU–107 and BLU–109.
   c. BLU–109 and GBU–24.
   d. BLU–107 and GBU–24.

53. (211) Which initiator provides electrical power to the FMU–152 tail fuze?
   a. FZU–22/B.
   b. FZU–39/B.
   c. FZU–48/B.
   d. FZU–55/B.

**Please read the unit menu for unit 2 and continue ➔**

# Student Notes

# Unit 2. Aircraft Missiles and Rockets



YOU ARE PROBABLY FAMILIAR with such popular missile names such as Sidewinder, Harm, and Maverick. Besides using the popular names, all air-launched missiles are designated as air intercept missiles (AIM), air training missiles (ATM), or air-to-ground missiles (AGM). Aircraft missiles normally consist of some type of guidance system, a warhead, and a propulsive unit—either a solid motor, liquid motor, or jet engine. You may encounter several different missiles during your career, so we'll cover most of the more common ones, hoping to give you a well-rounded knowledge of the missiles you'll be handling and loading.

## 2-1. Air-To-Ground Missiles

Air-to-ground missiles are nothing more than air-launched missiles used only against ground targets, such as tanks, bridges, railroad or highway junctions, and personnel concentrations. As we did with bombs, we'll use the two basic weapons divisions of conventional and nuclear.

### 212. Conventional air-to-ground missiles

The conventional air-to-ground missiles have been used extensively in current operations. Their ability to strike accurately and precisely makes them a vital munition for ground support efforts.

#### Air-To-Ground Missile 65 Maverick

The four models now in use are the AGM–65/A and B, AGM–65/D, F, and G, AGM–65/E, and the AGM–65/H and K (figs. 2–1 and 2–2). The AGM–65/A and B are electro-optically (EO) guided using standard analog signal methods, the AGM-65/D, F, and G are infrared (IR) guided, the AGM–65/E is laser guided, and the AGM–65/H and K are advanced EO guided using digital imaging and enhanced resolution capabilities. These missiles may be carried on the A–10, F–16, or F–15E aircraft. These EO, IR, or laser guided rocket-propelled air-to-ground missiles are used against field fortifications, surface-to-air missile sites, armored vehicles such as tanks, and even ships at sea.

The Maverick's two major sections are the forward and aft sections. The *forward section* has the guidance unit, guidance window, and dome cover; the *aft section* has the suspension rails, warhead, holdback pin bushing, wings, control surfaces, electrical connectors, and either a hydraulic actuation system (HAS) or a pneumatic actuation system (PAS) that moves the control surfaces. The A, B, H, and the early production D models all contain a HAS, while the G, K, and later production D models include a PAS. Whichever guidance system is used it is located in the forward section, behind the guidance window. The guidance unit for older analog EO guided models uses a gimbal-mounted television camera that works on the same principle as a motion picture camera. This means it depends on available light to detect and track a target. If there isn't enough light for it to operate, it's useless. The more advanced digital imaging EO guided missiles allow pilots to use the AGM–65 at lower light levels than previously possible.

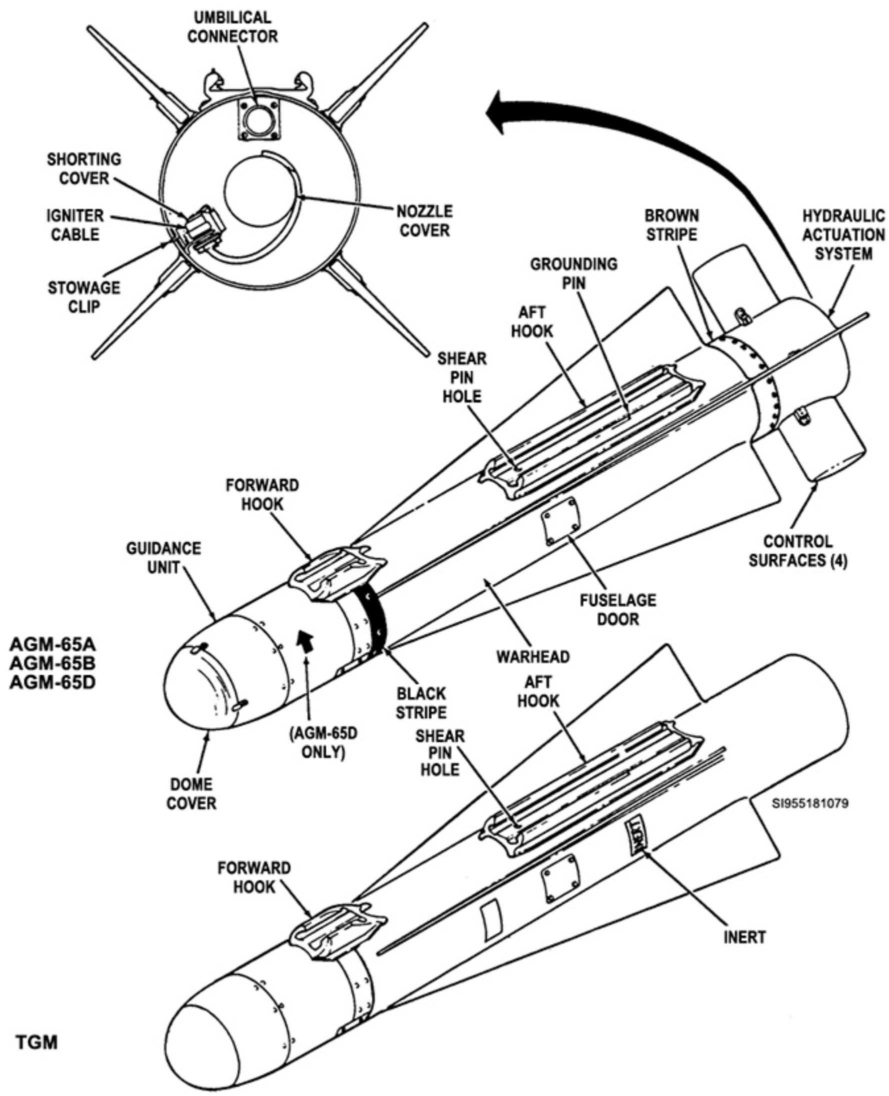



**Figure 2–1. AGM-65 missile.**

## AGM-65K MAVERICK MISSILE

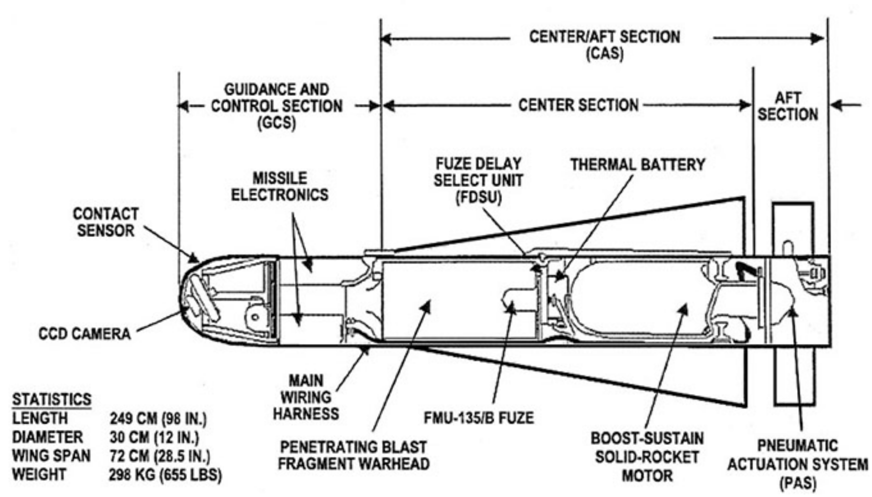



**Figure 2–2. AGM-65 missile cutaway.**

The IR system, on the other hand, doesn't need light to detect and track a target—it uses heat. IR guidance has greatly increased the reliability of the missile especially during inclement weather and at night. It lets the missile lock onto a target at twice the range of standard EO models and lets it distinguish between live targets and decoys. The guidance window and dome cover are in the front of the guidance unit. The guidance window is basically a cover that protects the camera and guidance unit components during flight. There is a humidity indicator inside this window that must be checked before loading. Because this window is extremely fragile, you must be very careful not to damage or break it during loading. The dome cover fits over the top of the glass window to protect it during ground handling, during loading and unloading, and during flight. The dome cover is automatically shattered once the pilot selects a missile during flight.

The Maverick's aft section has two suspension hooks to let you slide it on or off of specially designed rail-type launchers. The aft suspension hook has a shear-pin hole and a grounding pin. You insert a shear pin through the launcher (fig. 2–3), into the hole during missile loading to hold the missile on the LAU–88 launcher after loading and during flight. The grounding pin grounds the missile circuitry.

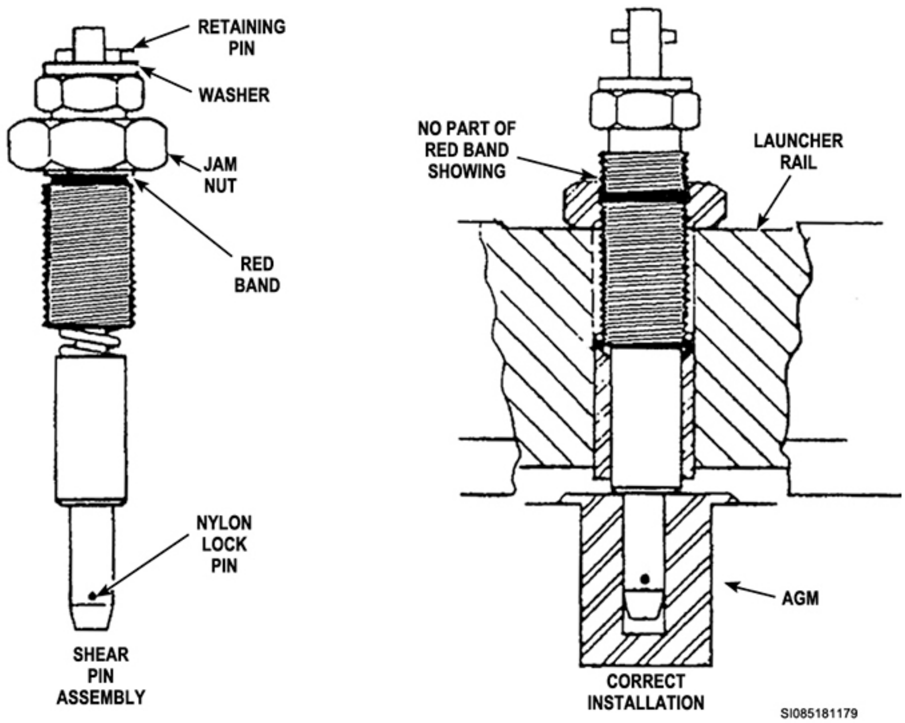



**Figure 2–3. AGM-65 shear pin.**

The AGM–65's rocket motor is not removable; its part of the aft section as is the warhead, safe/arm fuzing (SAF), battery, and HAS. The rocket motor is a solid-fuel motor that generates thrust for the first 4 seconds of the missile's flight, accelerating the missile to over 700 mph.

The warhead on the A, B, D, and H models are 125 pound shaped charges that direct most of the explosive force forward, enabling the blast to penetrate heavily armored targets like tanks. The E, G, and K models are equipped with a 300 pound penetrating blast and fragmentation warhead better suited for destroying reinforced field fortifications and bunkers. The safe/arm device (SAF) unit, to the rear of the warhead, keeps the missile safe until it's supplied with arming power during the launch sequence and until after launch acceleration. After a time delay to allow for safe separation from the launching aircraft, the SAF attains an armed condition. The SAF's primary means of detonating the shaped charge warhead is through contact sensors in the forward section. When the missile impacts the target, the contact sensors close the electrical firing circuit to the SAF, detonating the warhead. On the models equipped with the larger penetration warhead, the action of the fuze is delayed to allow it to penetrate deep into the target using the missiles built up kinetic energy. If either primary system fails, a backup mechanical device built into the SAF is activated by the high deceleration forces from the impact and fires a percussion detonator which, in turn, detonates the warhead.

The PAS or HAS provides power to move the missile's control surfaces to correct the flight to the target. The PAS is powered by a 700cc tank of compressed helium that does not require special action by the load crews. During loading, our major concern with the HAS is to make sure it has *no hydraulic fluid leakage*. *If it does, reject the missile for loading*. The umbilical connector on the aft end of the missile mates with an umbilical connector on the missile launcher to provide the interface between the missile and missile launcher. The pins inside the connector are protected by a shielding cap until just before missile loading. A separate igniter cable connector and an igniter cable are used exclusively for rocket motor ignition. The connector has a spring-loaded shorting cover that shorts the circuit during handling to prevent stray voltage from causing rocket motor ignition. The rocket motor nozzle cover is the last component that concerns us. This cover protects the motor nozzle from damage and keeps dirt and dust from entering the nozzle. It must be installed during ground handling and immediately before loading.

On the aircraft the missile is carried by either the LAU–88/A launcher, which holds up to three missiles, or the LAU–117/A, which is a single-rail launcher. A holdback shear pin on the LAU–88 and a missile restraint device (MRD) on the LAU–117 retain the missiles on the launcher rail. At missile launch, the initial thrust from the ignited rocket motor severs the shear pin and propels the missile off the launcher rail. The igniter cable is severed and the missile umbilical connector separates from the launcher's umbilical adapter.

There are a couple of special safety precautions in handling this missile. If you've any reason to believe that the missile battery has been activated, stay clear. It is possible that the fuselage door could be blown from the missile within 10 to 40 minutes after the battery is activated. Also, since an activated battery gives off toxic fumes and cadmium dust, you need to stay at least 15 feet away from the immediate area until the battery has cooled for at least 1 hour. If the battery is still hot, the missile skin near the fuselage door will be warm and you'll notice a pungent odor. In addition to the battery precautions, *do not* make any type of continuity or functional checks on preloaded launchers; missiles can be fired inadvertently.

### AGM–88 HARM

The high-speed, antiradiation missile (HARM) (fig. 2–4) can detect, acquire, display, and select a transmitting radar installation, guide itself to the target, and damage it to the extent it is inoperable. The F–16 aircraft now carries the HARM. It's about 14 feet long, is 10 inches in diameter, has a 44 inch wing span, and weighs about 800 pounds. Its speed approaches MACH 2, and its range and operational height vary, with its delivery vehicle, up to about 11.5 miles. It's designed to lock-on and hit targets before they can be switched off or take other types of evasive action. It uses a passive broadband RF homing system incorporating the latest microelectronic digital techniques for interfacing with aircraft systems. It has a double-delta moving wing system and a small fixed tail. It has autopilot capabilities and an optical target detector.

The AGM–88 has four sections: guidance, warhead, control, and rocket motor. The *guidance section* is a passive RF tracker used to detect radar signals from a target. The radar signals are detected by antennas, processed by the guidance circuits, and sent to the control section. The *control section* has two functions. First, it is an electrical interface between the aircraft and missile through the umbilical cable (on top of the control section). When the missile is loaded, the cable allows signals back and forth between the missile and aircraft cockpit. The control section's second function is to be a mechanical interface with the guidance section and the missile wings. The control section receives guidance signals and transfers the information to the wings mechanically to provide the missile's steering ability.

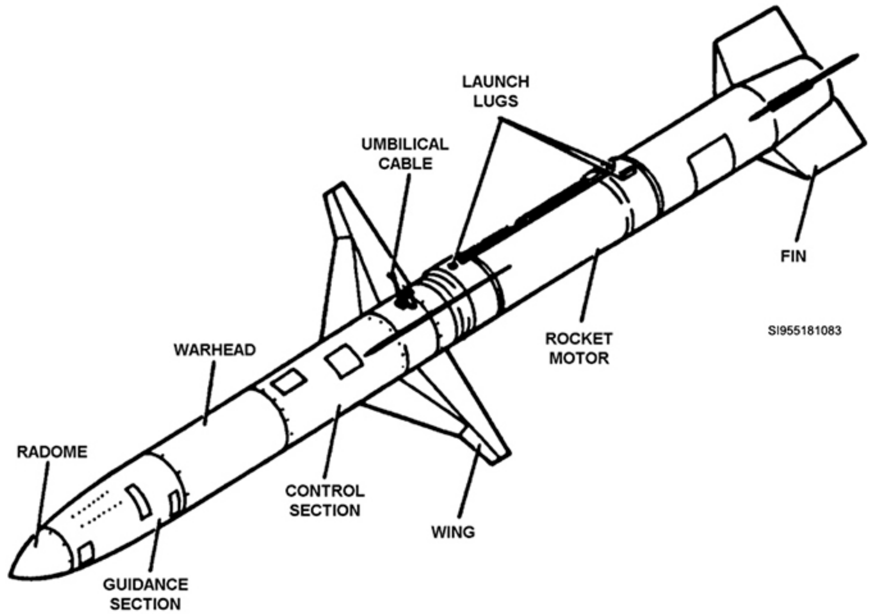



**Figure 2–4. AGM-88 HARM.**

The *rocket motor's* solid propellant can sustain missile flight completely to its target. Launch lugs are located on the outside of the rocket motor to suspend the missile from the launcher's rail and fins to stabilize it during flight. The motor's SAFE/ARM switch is operated with a mechanical key. The switch prevents the missile from launching inadvertently until it is manually set to "ARM" just before take off.

The fragmentation-type *warhead* has the explosive charge, booster, fuze, and wiring harness. The warhead fuze has two major functions: its accelerometer prevents arming until the missile reaches launch acceleration; then, after arming, the fuze will detonate the warhead when it gets a signal from the target detector in the control section. If it doesn't get a signal from the target detector, it will detonate on impact. The wiring harness is the electrical connector between the warhead and the guidance and control sections.

### AGM–114K, Hellfire

Early in the operation of the Predator it was determined that the capability of engaging some targets directly from the aircraft would enhance its usefulness. The Air Force concluded that the most logical approach to arming the aircraft would be to take the off-the-shelf AGM–114 system that the Army had incorporated on their attack helicopters to arm the Predators. This resulted in the MQ–1 Predator becoming the first fully functioning unmanned combat aircraft.

The Hellfire missile is a 100-pound, 64-inch long, rocket-propelled, laser guided, supersonic weapon designed to defeat individual hard point targets. It consists of a guidance section housing a semi-active laser seeker, a warhead section containing either a 19-pound conical shaped charge with a forward precursor warhead or a 24-pound blast-fragmentation warhead, a propulsion (rocket motor) section, and a control section (fig. 2–5). The system provides precision striking power against tanks, armored personnel carriers, air defense sites, patrol boats, bunkers, buildings, and slow-moving fixed wing aircraft and helicopters. The AGM–114K is currently used only on the MQ–1 and MQ–9 aircraft.

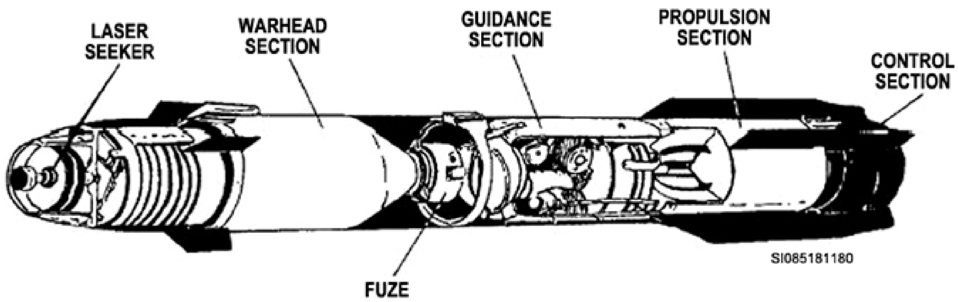



Figure 2–5. AGM–114 cutaway.

## AGM–154A Joint Standoff Weapon

Technically this series of munitions are extended range gliding bombs without a rocket motor which have been given an AGM classification; so we'll cover them here. The joint standoff weapon (JSOW) (figs. 2–6 and 2–7) are a low observable (stealthy), 1000 pound class, INS/GPS guided, family of air-to-ground glide weapons. JSOW consists of an aerodynamically efficient airframe with avionics to provide for a modular payload assembly used to attack stationary and moving massed light-armored and armored vehicle columns, surface-to-air targets, and personnel. The JSOW provides combat forces with all weather, day or night, multiple kills per pass, launch and leave, and a standoff capability.

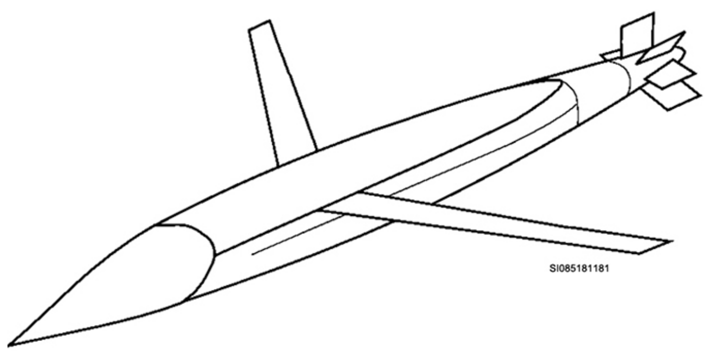



Figure 2–6. AGM–154 JSOW.

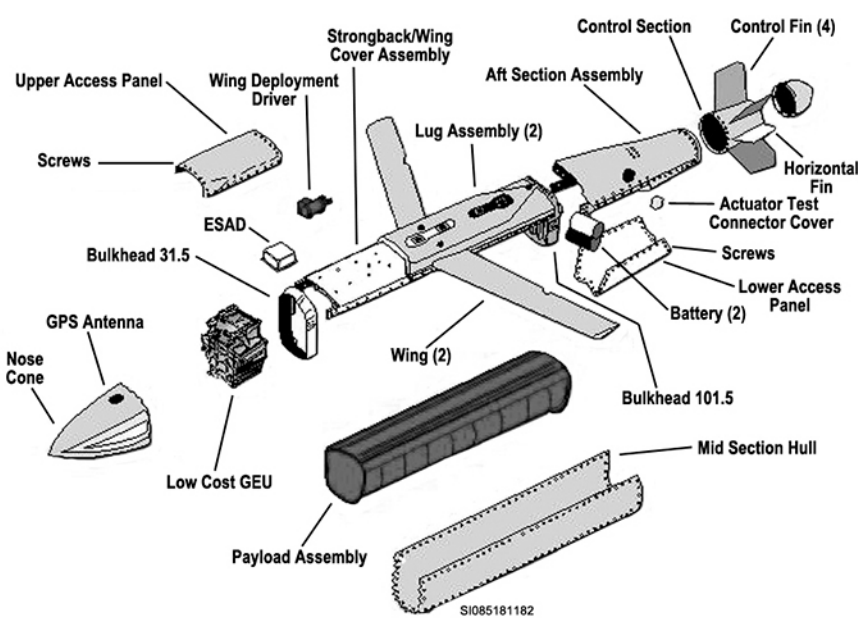



Figure 2–7. AGM–154 exploded view.

The warhead of the AGM–154A consists of the same 145 BLU–97/B CEM submunitions found in the CBU–87 and CBU–103 (figs. 2–8 and 2–9). The bomblets have a shaped charge for armor defeat capability, a fragmenting case for material destruction, and a zirconium ring for incendiary effects. The “A” model of the AGM–154 is the only model of this weapon currently in use by the Air Force.

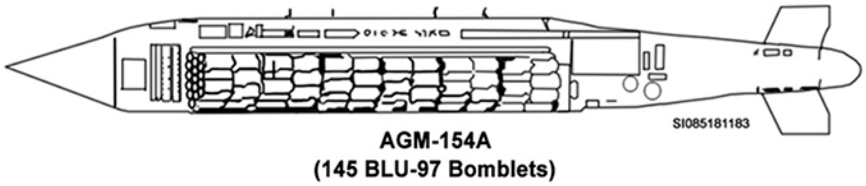



Figure 2–8. AGM–154A.

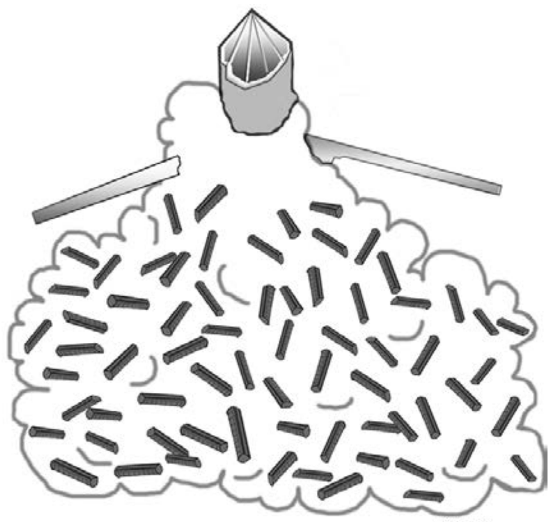


Figure 2–9. AGM–154A deploying munitions.

The JSOW family of, air-to-surface glide weapons, in the 1,000-pound class, provide standoff capabilities from 15 nautical miles (low altitude launch) to 40 nautical miles (high altitude launch). The JSOW is used against a variety of land and sea targets and operates from ranges outside enemy point defenses The JSOW is a launch and leave weapon employing a tightly coupled GPS/INS, and is capable of day or night and adverse weather operations. The JSOW uses both inertial and global positioning systems for midcourse navigation and imaging infrared and data link for terminal homing. The JSOW is just over 13 feet in length and weighs no more than 1,056 pounds. The JSOW is carried on the F–16C/D, F–15E, B–1B, and B–52 aircraft.

### AGM–158, joint air-to-surface standoff missile

Joint air-to-surface standoff missile (JASSM) is a turbojet powered, stealthy precision cruise missile designed for launch from outside area defenses to kill hard, medium-hardened, soft, and area type targets (fig. 2–10). The JASSM is currently carried on the F–16, F–15E, B–1, and B–52. The weapon is designed to attack both fixed and mobile targets at ranges beyond enemy air defenses (~200 nautical miles). After launch, it flies autonomously over a low-level, circuitous route to the area of a target, where its autonomous terminal guidance system guides the missile in for a direct hit. JASSM’s midcourse guidance is provided by a GPS/INS system protected by a new high, anti-jam GPS null steering antenna system. In the terminal phase, JASSM is guided by an imaging infrared seeker and a general pattern match-autonomous target recognition system to provide aim point detection, tracking, and strike. The JASSM contains the WDU–42/B (J–1000), a 1000-pound class, and penetrating warhead with 240 pounds of AFX–757. The fuze is the FMU–156/B employing a 150-gram PBXN-9 booster.

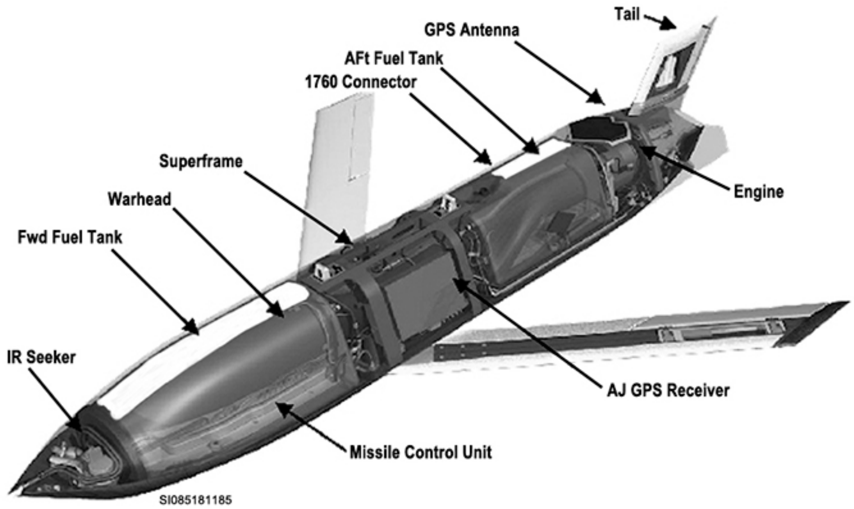



Figure 2–10. AGM–158 JASSM cutaway.

## 213. Nuclear capable air-to-ground missiles

The basic design goal for these missiles was to develop air-to-ground missiles with the ability to substantially increase a bomber's probability of successfully penetrating target defenses. The AGM–86 air launch cruise missile (ALCM) or conventional air launch cruise missile (CALCM) provides this capability.

### AGM–86, air launched cruise missiles and conventional air launched cruise missiles

The AGM–86/B ALCM and the AGM–86/C conventional air launched cruise missiles (CALCM) have proven to be a highly effective addition to the United States weapons arsenal. The cruise missile can be launched in large numbers to saturate the enemy area and dilute their defenses. The cruise missile is a long-range missile with a terrain-recognition characteristic offering a low radar profile. Since the missile can be launched outside the enemy's defense perimeters, it provides a high degree of personnel safety. Its sophisticated guidance system enables the missile to accurately locate and destroy its target. Perhaps most important is its flight path, plus a low-radar profile, which greatly enhances mission success. The AGM–86 (fig. 2–11) is a long-range air-to-ground strategic weapon that is designed to deliver a nuclear payload at subsonic speeds. The B–52 is the carrier aircraft for this missile. The missiles are carried on external pylons, one pylon per wing. Each pylon is capable of carrying six missiles. Additionally the B–52 can carry eight more missiles on a rotary launcher in the weapons bay. Using the long-range capability of these missiles, the B–52 aircraft has a "stand off" capability of about 1300 miles, well outside enemy air defenses.

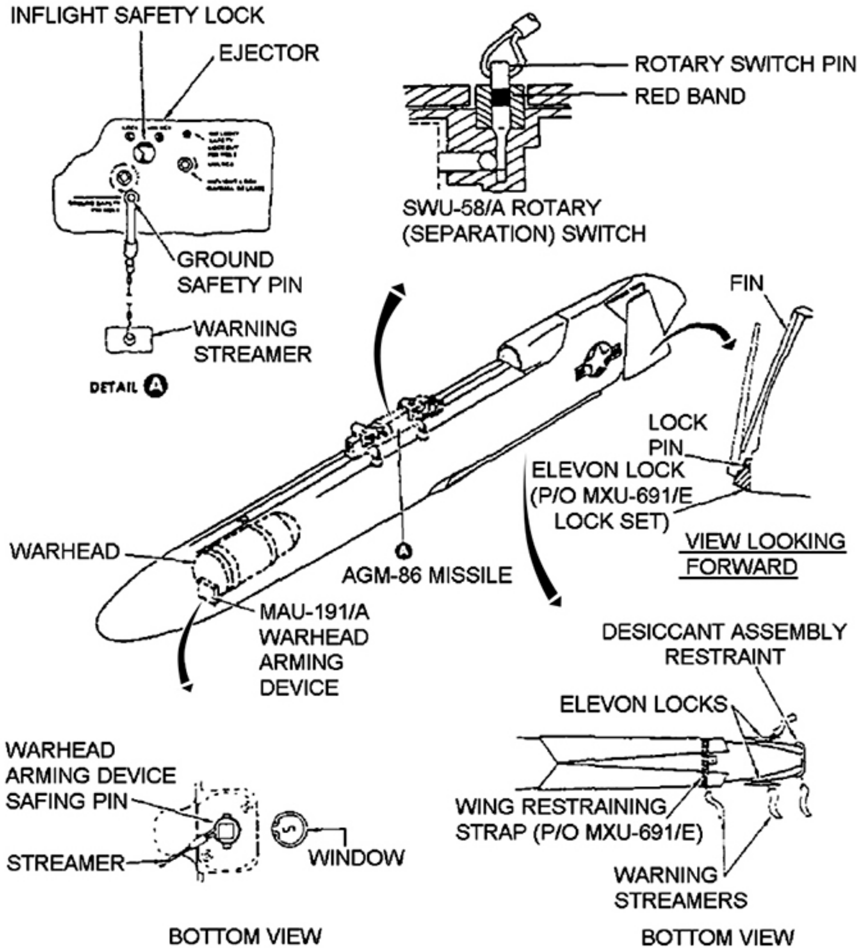



**Figure 2–11. AGM–86 ALCM.**

The ALCM missile is 20 feet 9 inches long and weighs about 3,200 pounds; the CALCM is the same size but weighs 3,250 pounds. The wings, fins, elevons, and engine inlet are folded close to the fuselage while the missile is mated to the aircraft. Extended, the wings have a spread of nearly 12 feet; with the wings folded, the missile's maximum width is 24 inches. The missile's three main sections (forward, center, and aft) include eight subsystems as described in the following table.

| AGM–86, ALCM and CALCM Main Sections | |
|---|---|
| **Section** | **Description** |
| Forward | The forward section has the nose cap, impact fuze, warhead arming device, pitot-static tube, umbilical enclosure, and warhead (payload).<br><br>The AGM-86B ALCM uses the W80 nuclear warhead or the WTU-20/A training payload.<br><br>The AGM–-6C CALCM uses 2000 pound class blast fragmentation explosive or the 1,000 pound class Advanced Unitary Penetrator (AUP-3M) warhead. |
| Center | The center section has the fuel tank, the forward and the aft clevis, the rotary switch, the heat exchangers, the wing assembly, the wing deployment actuator, and the radar transmitter antenna.<br><br>The forward and aft clevises are the attachment points to support the missile by the ejector rack.<br><br>Closing the rotary switch provides 28 volts, direct current (VDC) to the deployment system and enables the warhead arming circuit. |

| AGM–86, ALCM and CALCM Main Sections | |
|---|---|
| **Section** | **Description** |
| Aft | The aft section consists of engine support structure, the engine inlet and inlet support structure, the fin and fin housing, the elevons and elevon support structure, and boattail assembly. |

### Missile subsystems

The eight subsystems integrated throughout the three sections include the airframe, electrical distribution system, deployment system, propulsion system, fuel system, the environmental control system (ECS), the navigation guidance system, and the SAF system. You're mainly concerned with the SAF system, including the warhead, the impact fuze, the warhead arming device, and the rotary switch. The SAF system uses signals from the missile computer to control the warhead enabling and inhibit circuits. These monitoring circuits let the aircrew determine the operational status of the system until launch.

The *impact fuze* is a backup to the inertial fuzing mode for triggering the warhead. The impact fuze is in the missile's nose section. The *warhead arming device* provides the safing control and monitor functions between the warhead and other parts of the system. This multi-pole switch can be armed electrically and safed either electrically or mechanically, providing a visual indication of either condition. There are logic circuits to process arming messages from the missile computer and to provide monitoring signals of the Arm and Safe status. Additional monitor and control signals are hardwired from the aircraft to the warhead. The *rotary switch* is held OPEN by a detent pin connected to a lanyard. When the missile is launched, the lanyard pulls the detent pin, closing the switch contacts and applying 28 volts, direct current (VDC) power to the arming device. This also prepares other circuits for operation, including the deployment cartridges, command destruct system, and the separation arm command to the inertial navigation element.

## Self-Test Questions

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

### 212. Conventional air-to-ground missiles

1. What four types of guidance system are used with the AGM–65 missile?

2. What must you check inside the AGM–65 guidance window before loading?

3. Where is the SAF unit on the AGM–65 missile?

4. What is our main concern with the HAS of the AGM–65 missile, and why?

5. What is the purpose of the spring-loaded igniter cable connector shorting cover on the AGM–65?

6. In addition to the danger from inhaling fumes, what could happen within 10 to 40 minutes after the AGM–65's battery has been activated?

7. What are the component sections of the AGM–88 missile?

8. What provides the electrical interface between the aircraft and missile when the AGM–88 is loaded?

9. What is the weight and length of the AGM–114 Hellfire?

10. What type of guidance system is used for the AGM–114 Hellfire?

11. What warhead is used in the AGM–154A?

12. What is the high altitude and low altitude standoff range of the AGM–154 JSOW?

13. What kind of guidance system is used in the AGM–158 JASSM?

14. What warhead is used in the AGM–158 JASSM?

**213. Nuclear capable air-to-ground missiles**

1. List the three main sections of the AGM–86B.

2. What warheads are used with the AGM–86B?

3. What is the purpose of the forward and aft clevis of the AGM–86B?

4. How can the warhead arming device on the AGM–86B be safed?

5. What holds the rotary switch of the AGM–86B in the open position?

## 2–2. Air Intercept Missiles and Aircraft Rockets

AIMs are normally carried by attack and fighter aircraft for self defense in close air combat maneuvers, better known as dogfights. They can fly at speeds reaching MACH 4. This is an essential part of their overall design, because it lets them overtake an enemy aircraft trying to escape. Like the AGMs, they have homing systems using either radar or IR guidance.

We use rockets for close air support, target marking, area suppression, illumination, and clearing areas. The difference between the two is that rockets do not have guidance units—they are a point-and-shoot weapon. We classify them according to their intended use.

### 214. Air intercept missiles

Survival of aircraft in combat often depends on the air-to-air munitions carried to ward off aggressor forces. In this lesson, we'll cover the AIM–9 and the AIM–120 missiles. The weapons we are discussing here are instrumental in meeting any air-to-air challenge.

#### AIM–9 (L/M) Sidewinder

The AIM–9 L/M series air intercept missile (fig. 2–12) is relatively inexpensive and uncomplicated compared to the other missiles we use. The AIM–9 L/M missiles are supersonic, air-to-air, passive IR target-detecting missiles, relying on the target aircraft to supply the heat it needs for tracking. Many modifications have been made to these missiles to keep them current with the changing weapons systems and targets, so there are many models. They're all about 123 inches long, 5 inches in diameter, and weigh anywhere from 161 to 210 pounds. They're all designed to be launched from an aircraft-mounted, rail-type launcher and may be carried on all tactical aircraft to date. When a target is within range of the missile's seeker, an audio tone (also called an aural tone) is heard in the pilot's head set confirming the seeker is operating and monitoring target lock-on. The pilot then energizes the firing circuits, which fire the missile. The AIM–9 arms after launch as it tracks the target. During its flight, the missile continues to accelerate until it reaches the target or its rocket motor burns out. Each missile has guidance and control section, a warhead, an influence fuze/target detector, and a rocket motor section.

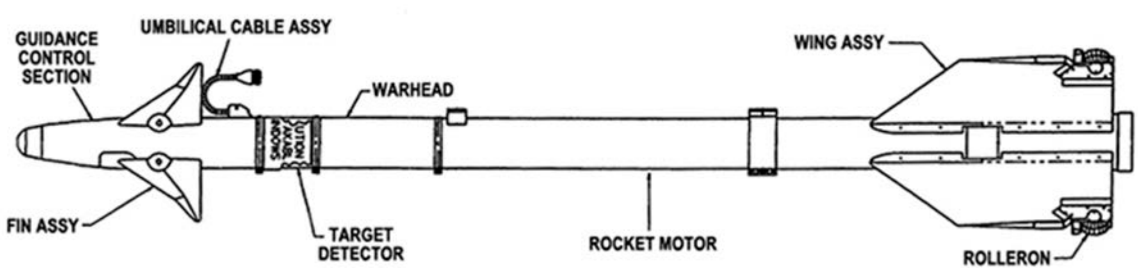



**Figure 2–12. AIM–9L/M sidewinder.**

The *guidance and control section* (G and C section) contains the missile directional control units, electrical generator units, four control canards, a Safe and Arm (S and A) initiator, an umbilical cable, and a coolant pressure tank (fig. 2–13). The G and C converts IR energy to electrical impulses used to steer the missile to a target. A gas grain generator within the G and C unit supplies power to operate the G and C during flight and create gas pressure to move the actuators to control the canards. These units also supply electrical power to a launcher relay activated to allow aircraft power to be transferred through the system to fire the rocket motor and let the S and A initiator send a firing impulse to the S and A device to indicate warhead activation. An umbilical cable, part of the G and C, is the main electrical connection between the aircraft and the missile. It also carries the aural tone we mentioned earlier. The cable is sheared from the missile and stays with the aircraft at missile launch.

A small replaceable argon gas tank supplies coolant for the infrared detector (AIM–9L/M only). A fully serviced coolant tank's pressure indicator will be in the green area for combat and out of the red area for training. During extremely cold weather and for training missions, a yellow indication still provides you with a serviceable missile.

Four canards are located on the G and C and provide steering control to the missile in proportion to the input signal from the seeker, missile velocity, and altitude. The canards are electrically controlled and pneumatically operated by a servo system in the aft part of the G and C unit. The *warhead* is the high-explosive part of the missile. It is either immediately behind the G and C unit (in front of the influence fuze/target detector) or immediately in front of the rocket motor behind the influence fuze/target detector, depending on the missile model. The warhead is normally detonated upon impact with a target, but may also be detonated when there's a near miss by the influence fuze/target detector. If the warhead fails to function, a built-in self-destruct mechanism will detonate it after elapse of a preset time or upon impact with the ground.

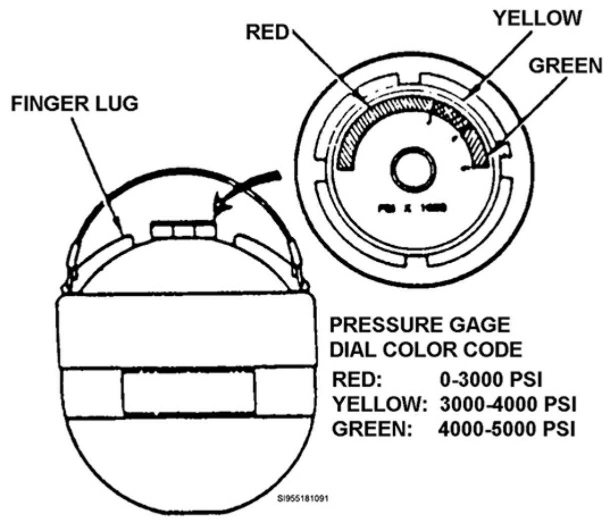



**Figure 2–13. Coolant tank.**

The influence fuze/target detectors for various models of the AIM-9 missiles operate differently, giving the AIM–9 added reliability and almost a 100 percent kill rate. When the missile is launched, a thermal battery in the fuze is activated by the missile firing voltage and supplies power to the fuze. During missile acceleration, the S and A initiator arms the fuze. When the fuze detects a target, it will detonate the warhead. If the missile hits a target before the fuze detects it, the fuze's contact or impact capability will detonate the warhead.

The DSU-21B, active optical target detector (AOTD), may be used in certain AIM–9 models in place of the influence fuze. You can recognize this target detector (TD) by the double ring of windows with two clear KEL-F strips around it. An alternate version has eight glass oval windows. The four forward windows emit a pulse IR beam outward from the missile. This beam is canted forward. Should this beam be reflected back into one of the four rear windows for any reason, the influence fuze immediately detonates the warhead.

The DSU–15/B has the same capabilities, but operates a little differently and incorporates its own S and A device. It will detect an air target within the burst range of the missile's warhead; if there's no target within the warhead's burst range, it won't detonate the warhead. An electromechanical S and A device attached to the target detector has one window for viewing the position of the safe/arm indicator and one for viewing the position of a launch latch. The safe/arm device senses missile acceleration after launch and it arms after a sufficient length of time. When the S and A arms, the warhead can then be detonated by the TD (proximity) or by an inertia (contact) in the S and A.

The rocket motor provides for more than just propulsion of this missile; it has three suspension hangers for loading the missile on the launcher. Two contact buttons or electrical connection points between the missile and launcher are on the forward suspension hanger. When the missile is loaded on the launcher, two striker points within the launcher are in contact with the two contact buttons. The forward contact button is not used and has no electrical connection. When the firing circuit is activated, the GU sends a discrete signal to the launcher which in turn sends a firing voltage through the aft contact button to fire the initiator on the arm/fire assembly. The initiator ignites the rocket motor propellant grain, thrust is developed, and the missile is launched, Four identical wings are attached in the X-configuration to the rear of the motor. A *rolleron assembly* is mounted on the trailing edge of each wing. When the missile is launched, these rollerons are pushed out by the acceleration and swing left and right to effectively oppose the roll rate of the missile during flight. In other words, they keep the missile from rolling over and over during its flight and veering off course. Like the other sections of the missile, the type of rocket motor may vary for different missile models.

The AIM/9L and M missile uses the MK 36 Mod 8, 9, 10, and 11 rocket motors. The MK 36 Mod 8 and Mod 9 rocket motors have an arming key that operates the safe/arm device in the rocket motor, much like the SR–116 motor. The MK 36 Mod 10 and Mod 11 rocket motors have a Safe and Arm handle that is not removable from the motor after the motor is armed.

### AIM–9X Sidewinder

The AIM–9X (fig. 2–14) is the next generation air-to-air missile. The AIM–9X Sidewinder is a supersonic, air-to-air, guided missile, employing a passive infrared target acquisition system, proportional navigational guidance, a closed loop position servo fin actuator unit (FAU), and an AOTD. A solid propellant rocket motor propels the missile and incorporates a manual safe-arm selector assembly. The AIM–9X is configured with an annular blast fragmentation (ABF) warhead controlled by an electronic safety and arming device (ESAD).

Legacy AIM–9 variants all use the standard configuration of steering canards mounted on the front with rigid wings mounted on the aft of the missile. The AIM–9X uses four fixed-mounted forward wings to provide aerodynamic lift and stability while airframe maneuvering is accomplished by four control fins operated by the FAU located on the rear of the missile. The jet vein control (JVC) provides enhanced maneuverability over older Sidewinders by deflecting rocket motor thrust to aid in turning. The AOTD used in the AIM–9X improves missile performance over older AIM–9 models. The AOTD improves missile target acquisition in two ways. First, the improved seeker allows targets to be acquired up to 90° off-boresight, this means that the firing aircraft can lock onto any target within the full 180° hemisphere forward of the missile (fig. 2–15). The missile is now fully compatible with the joint helmet mounted cueing system (JHMCS) (fig. 2–16). Using the JHMCS, a pilot receives all data from the heads up display projected on a visor that attaches to the helmet.

The system tracks the pilot's head movements and allows targeting the AIM–9X missile by simply looking at a target, thereby increasing air combat effectiveness. A key part of the system for maintainers is the missile's onboard internal cooling system that eliminates the need for using an internal argon bottle for seeker head cooling.

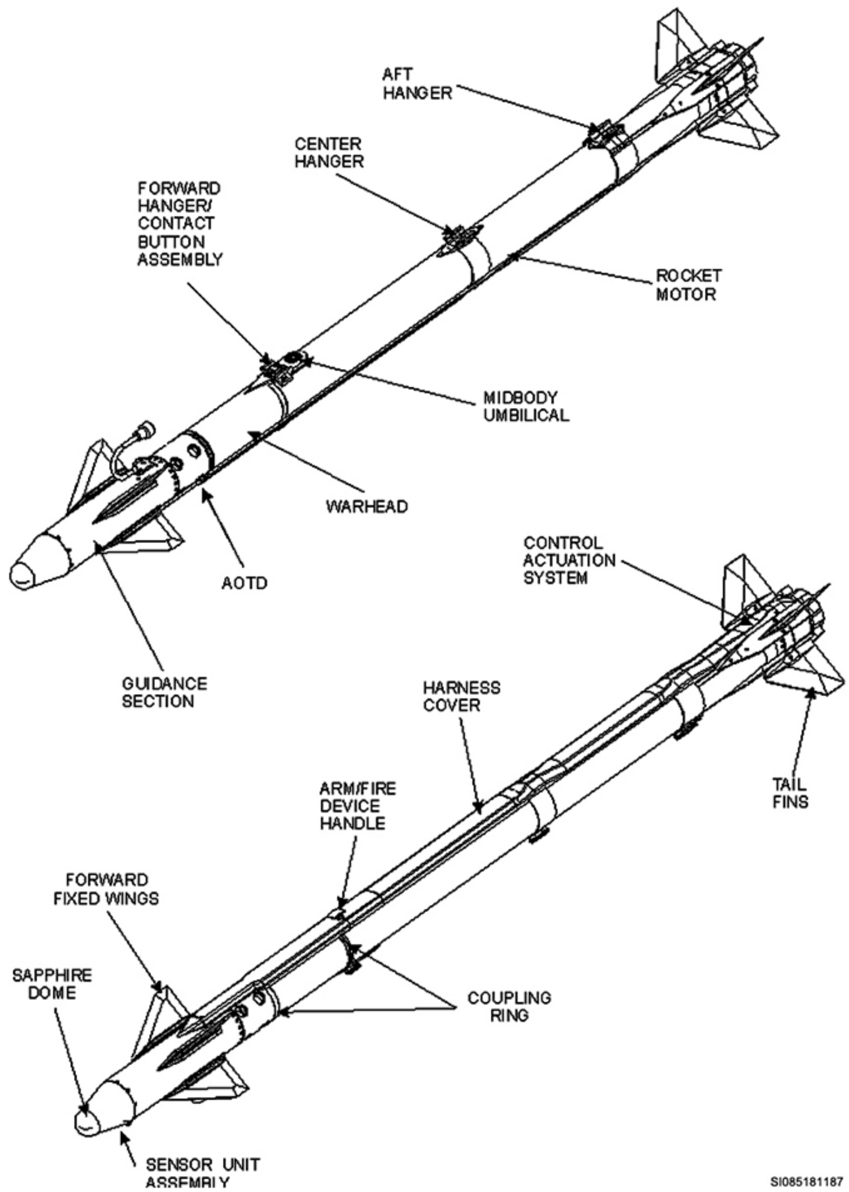



**Figure 2–14. AIM–9X.**

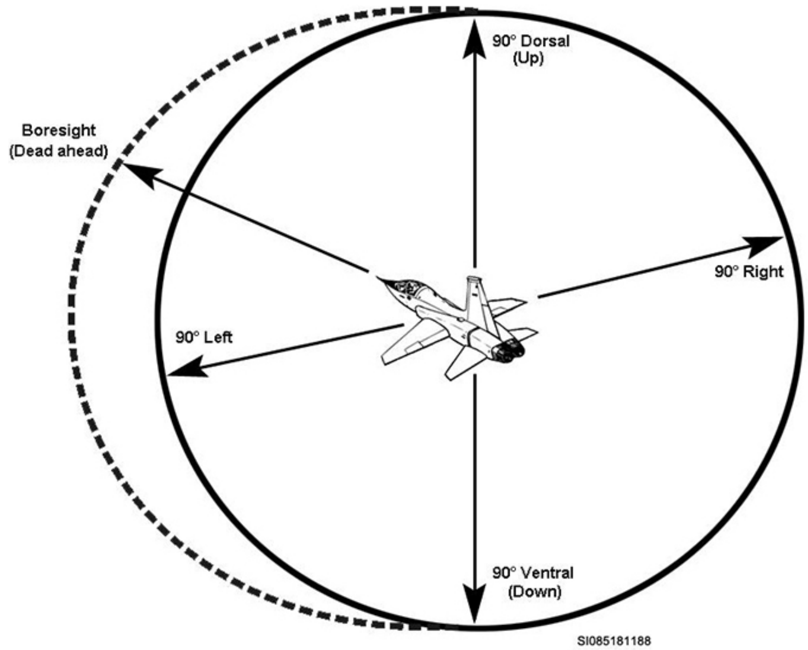



Figure 2–15. AIM–9X targeting envelope.

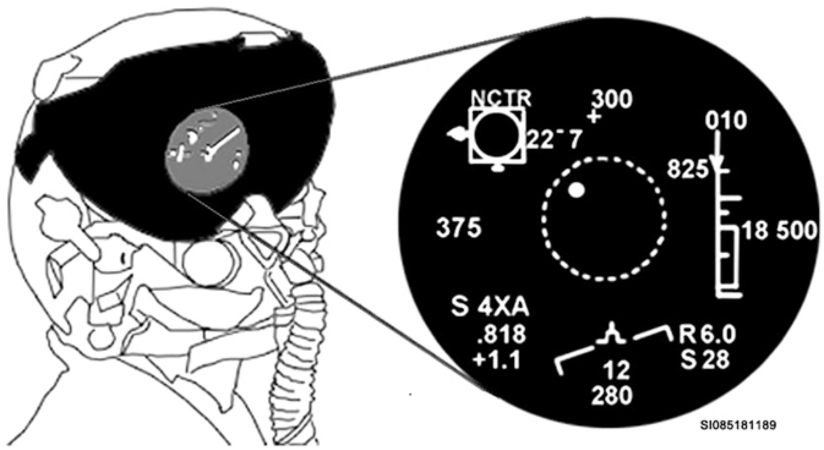



Figure 2–16. JHMCS helmet/display.

## AIM–120, advanced medium-range air-to-air missile

The advanced medium range air-to-air missile (AMRAAM) uses active radar target detection and on-board inertial navigation guidance (fig. 2–17). The missile consists of four sections: guidance, armament, propulsion, and control sections (fig. 2–18). The *guidance section* includes the hardware and software necessary for target acquisition and track, navigation, data link processing, and electrical power distribution. The guidance section contains the seeker/servo electronics, transmitter/electrical conversion unit (ECU), electronics unit, inertial reference unit (IRU), and quad/target detection device (QTDD). The QTDD antennas are mounted in the aft portion of the guidance section and are covered with a fiberglass wrap. The *armament section* has a blast fragmentation warhead and a safe/arm fuze device (SAF) that detonates the warhead after preventing detonation until the missile reaches a safe distance from the aircraft. The *propulsion section* has the rocket motor, rocket motor safe arm/fire device (AFD), hooks for rail and pneumatic ejection launchers, flush-mounted umbilical, and the sockets for the four detachable wings. A buffer connector supplied with the missile connects this umbilical to the launcher umbilical.

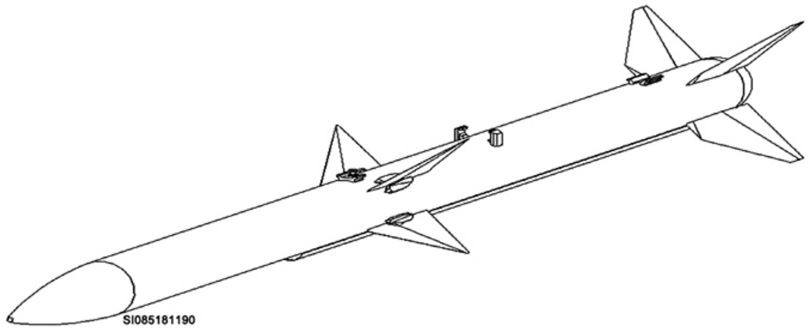



**Figure 2–17. AIM–120 AMRAAM.**

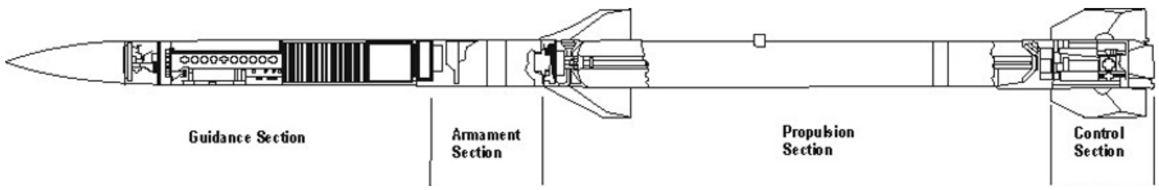



**Figure 2–18. AIM–120 AMRAAM cutaway.**

The rocket motor is a boost-sustained, reduced-smoke, solid-propellant motor. The AFD solenoid is energized after the missile has cleared the ejection launcher or when the launch sequence has begun on the rail launcher. An indicator provides a visible indication of the position of the AFD.

- *Safe* is indicated by a white S on a green background.
- *Arm* is indicated by white A on a red background.

The *control section* has the complete control actuation system, including the electronics and four fins that are positioned in response to steering commands from the missile autopilot. Weighing 327 pounds, the missile is 144 inches long and 7 inches in diameter, with a fin span of 25 inches and a wing span of 21 inches.

## 215. Aircraft rockets

In the 19th century, rocket development gave way to developing other weapons. Then, during the years 1939 to 1941, the British again started producing rockets, this time for antiaircraft purposes. Their effectiveness stimulated interest in this country and resulted in the development of rockets to be used by the ground forces as well as by the air component. We'll begin with a basic description, then, turn our attention to rocket classifications.

### Basic description

In general, the aircraft rocket is composed of two main parts: the warhead and rocket motor assemblies. A *rocket warhead assembly* consists of the warhead or payload and a fuze. The *rocket motor assembly* contains the motor to propel the rocket, the stabilizing fins to control flight, the electrical contacts to ignite the motor, and the detent to hold the rocket in the dispenser pod (fig. 2–19).

### Classifications

Aircraft rockets are classified according to their intended use and according to the filler in the rocket warhead (fig. 2–20). The *classifications by purpose* are service, practice, target, and drill rockets. *Service rockets* are used for combat or combat related applications; *practice rockets* are used to train pilots in the techniques of rocket firing; *target rockets* are used as targets to train pilots in air-to-air rocketry; and *drill rockets*, containing inert components, can't be fired or detonated. Drill rockets are used to train personnel in handling and loading rockets.

*Classifications by the type of filler* in the rocket warhead include such types as high-explosive (HE), illumination, white phosphorus (WP), and inert. *HE rocket heads* produce blast, fragmentation, or mining effects (fig. 2–21). *Illumination rockets* contain a flare suspended by a parachute to illuminate target areas with either visible light or covertly using an IR flare only visible through compatible night vision systems (fig. 2–22). *WP warheads* contain a filler of white phosphorus and are used for target marking or incendiary effects. *Practice warheads* can be of two configurations: inert rockets that contain inert filler, such as sand or plaster, or those containing a spotting charge to more easily detect impact points. Both types of practice warheads usually have a standard propelling charge in the motor. Drill rockets, intended for training in handling rockets, are completely inert.

The following list provides descriptions of the different types of rockets:

- *HE warheads* are black with identification markings in yellow.
- *Illuminating* rockets have an olive drab body with white lettering/markings.
- *WP* warheads have a light-green background with light-red letters and a yellow band.
- *Practice* warheads have a light blue body with white markings.
- *Drill* warheads have a bronze-, gold-, or brass-colored body with black markings.

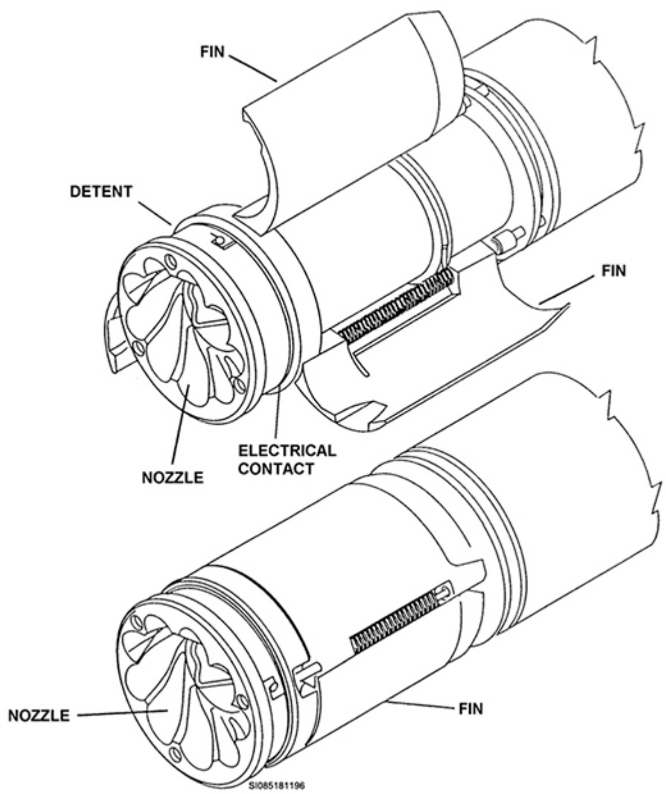



**Figure 2–19. 2.75” rocket motor fin, detent, and contact detail.**

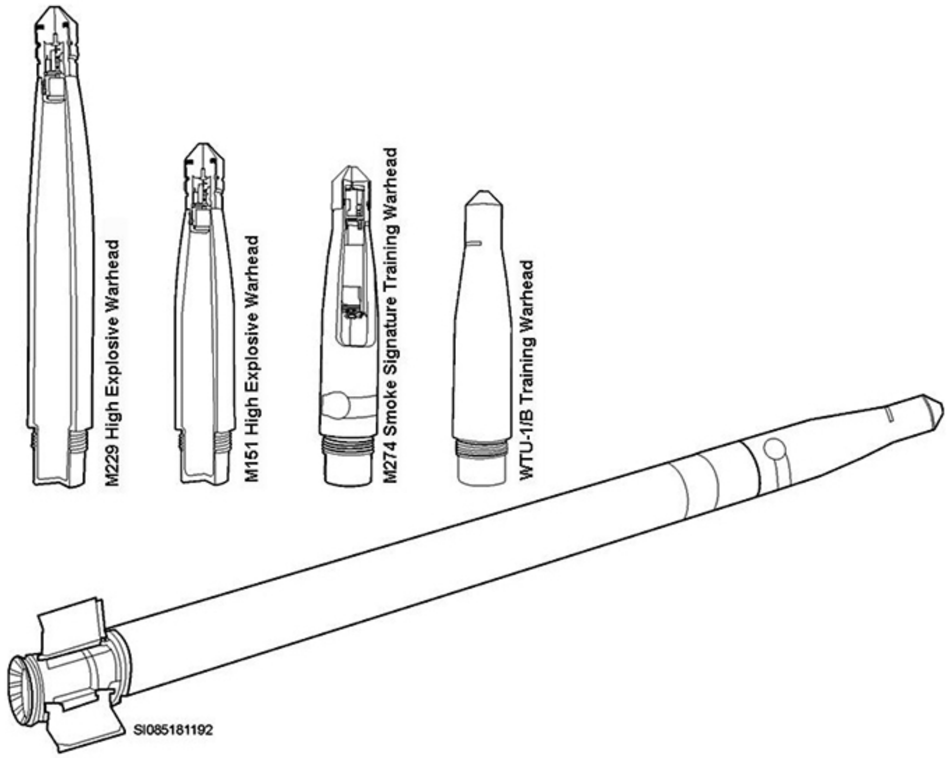



**Figure 2–20. 2.75" rockets.**

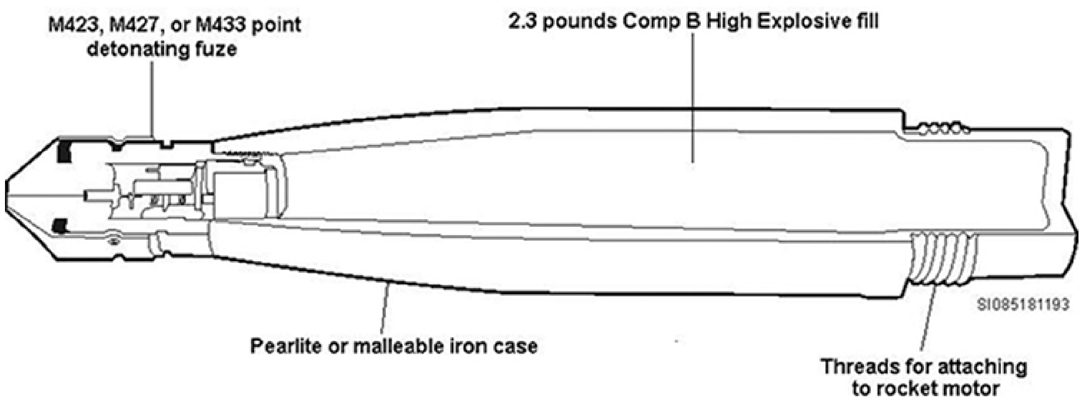



**Figure 2–21. 2.75" rocket HE, warhead cutaway.**

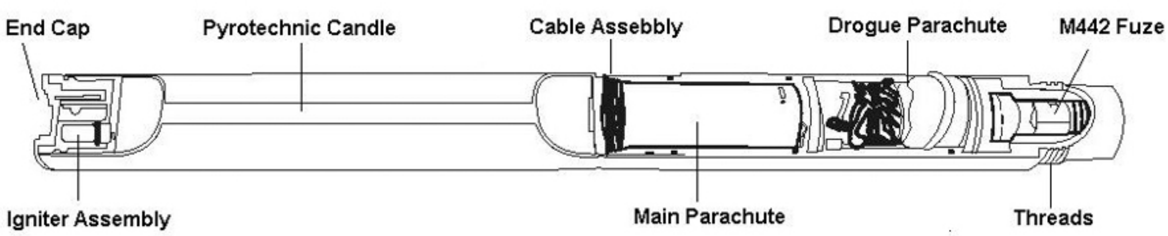



**Figure 2–22. 2.75" rocket, illumination warhead cutaway.**

## Rocket safety

Rockets offer hazards just like every other munition item. And just like every munitions item, rockets can be safely handled when the appropriate precautions and procedures are followed.

All service rockets have two inherent areas of concern: the unique hazards involved with the different warheads and the common hazards due to the rocket motor. The principle hazards of handling rockets and their components are listed in the table below.

| Principal Hazards of Rockets and Components | |
|---|---|
| **Item** | **Hazard** |
| Rocket motors | Intense heat, possible explosion, and directional projectile hazard. |
| HE warheads | Blast and mass detonation. |
| White phosphorus (WP) warhead | Progressive explosions with blast and fragmentation. |
| Fuzes | Blast and mass detonation. |
| Illumination | Intense heat and possible explosion. |

It's important that you be fully qualified to handle aircraft rockets. Don't ever remove the shielding tape (fig. 2–23) until you're ready to load the rocket. Don't drop or mishandle rocket components. You should use extra precaution in cold weather; as the temperature drops, the propellant is more likely to crack if it's handled roughly. Consider dropped rocket motors unserviceable; dropping a rocket frequently causes the propellant to crack and a cracked propellant could cause the rocket to detonate before it leaves the launcher. Don't stand directly in front of or behind a launcher when you're loading it with rockets. Don't mix a launcher with different types of rockets during loading. Each rocket must be grounded immediately before loading to prevent inadvertent firing. Don't store rocket motors near radio or radar transmitters. Don't tamper with, or try to repair, any part of a rocket not authorized by the item TO. Don't damage or mishandle the fins. Even slightly distorted fins can cause erratic flight. Don't remove the fuzes from the warheads. If you find the M156 WP warhead leaking its filler, immerse it in water and notify EOD. When you handle WP rockets, you must have these safety equipment items readily available: flameproof gloves, face shield, gauze sponges, two real or artificial sponges, and one five-gallon container of water.

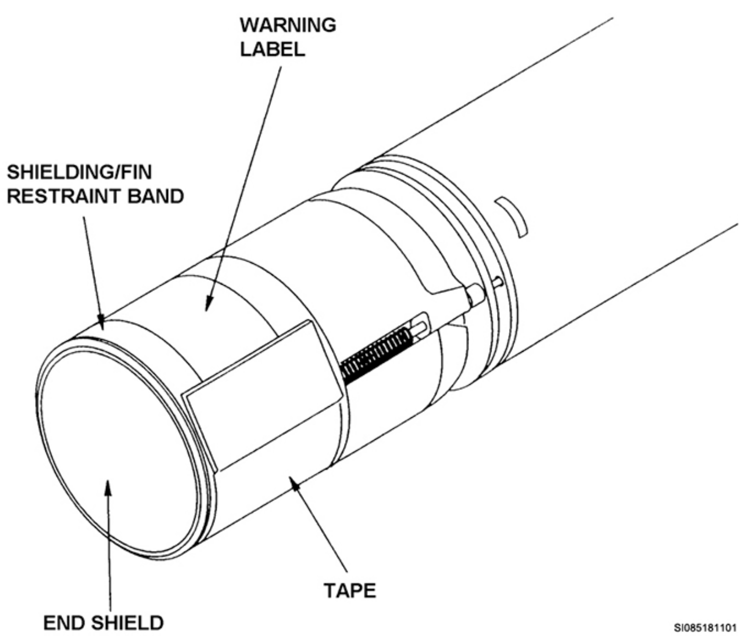



**Figure 2–23. 2.75" rocket motor shielding tape.**

## Self-Test Questions

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

### 214. Air intercept missiles

1. What are the major sections of the AIM–9 missile?

2. What happens to the AIM–9 umbilical cable at missile launch?

3. What two ways may the warhead of the AIM–9 missile be detonated?

4. How does the jet vein control enhance maneuverability over older Sidewinder models?

5. Where is the onboard argon cooling bottle located in the AIM–9X?

6. What type of warhead is used with the AIM–120 missile?

7. What energized solenoid on the AIM–120 lets fire signals ignite the rocket?

### 215. Aircraft rockets

1. What is the general make up of a rocket?

2. How are rockets classified?

3. What marking does the WP warhead have?

4. State the two main uses of aircraft rockets.

5. Why should you be especially careful when you handle rockets during cold weather?

6. What might happen if you load a rocket that was dropped?

7. What must be done to each rocket immediately before loading?

8. What can happen to a rocket in flight if you damage its fins during loading?

9. What must you do if you find a leaking warhead when you’re loading rockets with WP warheads?

## Answers to Self-Test Questions

**212**

1. (1) EO.
   (2) IR.
   (3) Laser.
   (4) Enhanced EO.
2. Humidity indicator.
3. To the rear of the warhead.
4. That the HAS is not leaking; if it is, we must reject the missile for loading.
5. To short the igniter circuit during handling, thus preventing motor ignition due to stray voltage.
6. The missile’s fuselage door could be blown off.
7. Guidance, warhead, control, and rocket motor sections
8. Umbilical cable.
9. 100 pounds and 64 inches long.
10. Laser.
11. 145 BLU–97/B CEM submunitions.
12. 15 nautical miles; 40 nautical miles.
13. A GPS-aided INS protected by a new high, anti-jam GPS null steering antenna system. In the terminal phase, JASSM is guided by an imaging infrared seeker and a general pattern match-autonomous target recognition system to provide aim point detection, tracking and strike.
14. WDU–42/B (J-1000), a 1000-pound class, penetrating warhead with 240 pounds of AFX–(1) 757.

**213**

1. (1) Forward.
   (2) Center.
   (3) Aft sections.
2. W80 nuclear warhead and the WTU–20/A training payload.
3. They are the attachment points for missile support by the ejector rack.
4. Electrically or mechanically.
5. A detent pin connected to a lanyard.

**214**

1. The guidance and control section, a warhead, influence fuze/target detector, and rocket motor.
2. It is sheared from the missile and stays with the aircraft.
3. Upon impact with a target or when a near miss of a target has occurred.
4. By deflecting rocket motor thrust to aid in turning.

5. There is no onboard argon cooling bottle; the missile's onboard internal cooling system eliminates the need one for seeker head cooling.
6. Blast fragmentation.
7. The AFD.

**215**

1. Rocket warhead assembly, consisting of the warhead and a fuze to activate it, and a rocket motor assembly, which propels the rocket and contains the fins that stabilize it during flight, the electrical contacts to ignite the motor, and the detent to hold the rocket in the dispenser pod.
2. According to their purpose and what class of filler the warhead contains.
3. Light-green background with light-red letters and a yellow band.
4. Combat and training.
5. Because the propellant is more likely to crack if the rocket is handled roughly.
6. It could explode before leaving the launcher.
7. Each rocket must be individually grounded.
8. Its flight may become erratic.
9. Immerse it in water and notify EOD.

**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).**

54. (212) Which component inside the guidance window of the AGM–65 *must* be checked before loading?
    a. Infrared indicator.
    b. Humidity indicator.
    c. Fuze status indicator.
    d. Guidance unit status indicator.

55. (212) After loading and during flight the AGM–65 missile is held on the LAU–88 launcher by the
    a. detent.
    b. shear pin.
    c. snubber and detent.
    d. shear pin and snubbers.

56. (212) The AGM–65 can be configured with two warheads, a 125 pound shaped charge or a
    a. W80 nuclear warhead.
    b. 300 pound shaped-charge warhead.
    c. 125 pound blast/fragmentation warhead.
    d. 300 pound blast/fragmentation warhead.

57. (212) Which component protects the pins of the umbilical connector on the AGM–65 until just before loading?
    a. Shorting cap.
    b. Nozzle cover.
    c. Shorting plug.
    d. Shielding cap.

58. (212) Which aircraft carries the AGM–88 high-speed anti-radiation missile (HARM)?
    a. B–52.
    b. F–15E.
    c. F–16.
    d. F–15E, F–16, and B–52.

59. (212) The AGM–158 uses what class of warhead?
    a. 500 pound.
    b. 750 pound.
    c. 1000 pound.
    d. 2000 pound.

60. (213) Which AGM–86 components are the attach points to mate it to its ejector rack?
    a. Center clevises only.
    b. Forward clevises only.
    c. Aft and center clevises.
    d. Forward and aft clevises.

61. (213) The AGM–86 warhead's arming device can be safed
    a. only manually.
    b. only electrically.
    c. only mechanically.
    d. either electrically or mechanically.

62. (214) The AIM–9 L/M series of missile are designed to be launched from what kind of launchers?
    a. Rotary.
    b. Rail-type.
    c. Ejector-type.
    d. Gas-operated.

63. (214) Which AIM–9 L/M section contains the four canards?
    a. Boat-tail.
    b. Rocket motor.
    c. Servo fin actuation unit.
    d. Guidance and control section.

64. (214) Which missile component is the *main* connection between the AIM–9 L/M missiles and the aircraft?
    a. A pullout cable.
    b. An umbilical cable.
    c. The motor striker points.
    d. An umbilical receptacle.

65. (214) How are the guidance canards of the AIM–9 L/M missiles controlled?
    a. Electrically.
    b. Hydraulically.
    c. Mechanically.
    d. Pneumatically.

66. (214) The AIM–9 L/M warhead is *normally* detonated upon impact with a target, but may also be detonated when there's a near miss by the
    a. proximity timer fuze.
    b. timed detection fuze.
    c. influence fuze/target detector.
    d. hydrostatic fuze/proximity detector.

67. (214) WhichAIM–9X component provides *enhanced* maneuverability over older types of Sidewinders missiles by deflecting rocket motor thrust to aid in turning?
    a. Jet vein control.
    b. Directional canards.
    c. Horizontal strake assembly.
    d. Thrust vectoring directional nozzle.

68. (214) The device that provides connection between the umbilical and the launcher umbilical of the AIM–120 is a/an
    a. buffer connector.
    b. umbilical cable.
    c. umbilical wafer.
    d. umbilical connector.

69. (214) What is displayed on the indicator if the rocket motor’s arm/fire device (AFD) is in the safe condition?
    a. The word “Safe.”
    b. A white “S” on a green background.
    c. A green “S” on a white background.
    d. The entire window is green with no red visible.

70. (215) Rockets that are used during *combat* are classified as
    a. drill rockets.
    b. target rockets.
    c. service rockets.
    d. practice rockets.

71. (215) Which type of rocket warhead produces blast, fragmentation, and mining effects?
    a. Flechette.
    b. Fragmentation.
    c. High explosive.
    d. White phosphorus.

72. (215) Which type of rocket is used for target marking or incendiary effects?
    a. Flechette.
    b. Fragmentation.
    c. High explosive.
    d. White phosphorus.

73. (215) When can you *remove* the shielding tape from a rocket motor?
    a. Immediately *after* loading.
    b. Immediately *before* loading.
    c. During end of runway procedures.
    d. Before transporting from the trailer.

**Please read the unit menu for unit 3 and continue ➔**

# Unit 3. Miscellaneous Munitions



THE PREVIOUS TWO UNITS discussed major munitions currently in use by the Air Force. There are, as you're about to find out, other munition items you'll encounter throughout your career. These include such items as ammunition, impulse cartridges, chaff, flares, and naval mines. In this unit, we gather the loose ends, so to speak, and discuss these items. We start with a discussion of ammunition and finally wrap things up with naval mines.

## 3–1 Ammunition and Impulse Cartridges

Depending on the caliber, a basic round of ammunition can have anywhere from four to six components, including the cartridge case, primer, propellant, rotating band, projectile (bullet), and flash tube assembly (fig. 3–1).

### 216. Ammunition

Through technological advances, modern ammunition (commonly called "ammo" or "rounds") has developed into a devastating power coupled with extreme accuracy. Common ammunition types are 20 millimeter (mm), 25 mm, and 30 mm. Other ammunition sizes you may come in contact with during your career are the 7.62 mm, .50 caliber, 40 mm, and 105 mm. All of these may be assembled for target practice, penetration of heavy armor, or have many other uses in air-to-air and air-to-ground warfare. Given the range of ammunition available we can pick, the most effective type for a particular mission, whether it's to punch through a tank or down an enemy aircraft.

#### Cartridge case

This is the container for the ammunition's primer, propellant, and a flash tube (30 mm), and the projectile is affixed to it. The projectile and its size conform to the weapon's chamber. For all ammunition rounds, the cartridge case serves three functions. First, it is the receptacle to which all other components are assembled. Second, it serves as a waterproof container for the primer and propellant. Third, when the round is fired it expands and seals the barrel's chamber preventing gases from escaping to the rear. The cartridge case is either made of aluminum alloy (30 mm), steel (25 mm) or brass (all others). An *extracting groove* is machined around the base of the case. It lets the weapon's mechanical extractor grip the case after firing and pull it from the chamber or the weapon's firing position. For smaller calibers, the cartridge case is then ejected from the weapon. With crew served weapons, the cartridge case is cycled back into the ammunition handling system via a closed-loop system.

#### Primer

The primer actually starts the chain reaction to fire the round. Primers may be either electrically (20 mm) or percussion (7.62 mm, .50 caliber, 25 mm, 30 mm, 40 mm, and 105 mm) fired. The normal sequence is the firing pin strikes the primer, either compressing (percussion) or igniting (electrical) the primer composition, causing a flame. This flame, in turn, ignites the round's propellant charge. Regardless of the type of primer you should always be extremely careful when you handle ammunition. Keep in mind that an electrically primed round may be fired by percussion and a percussion primed round may be fired electrically.

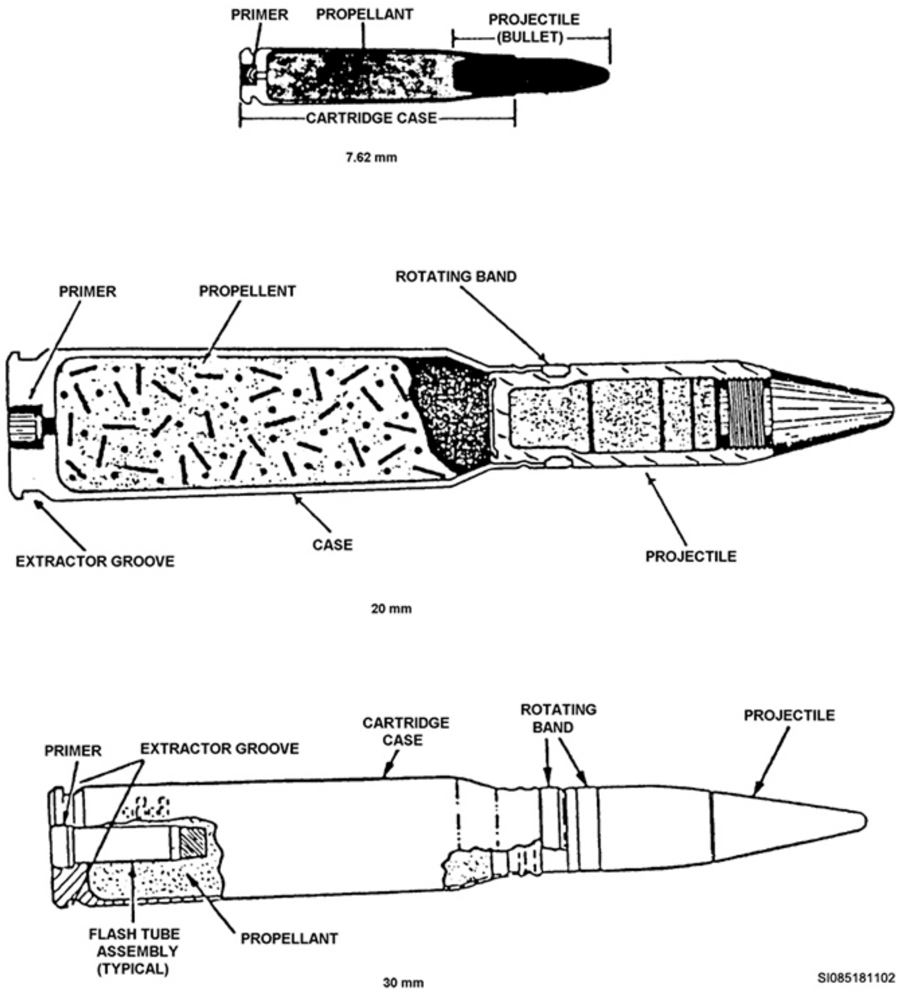



**Figure 3–1. Ammunition components.**

## Propellant

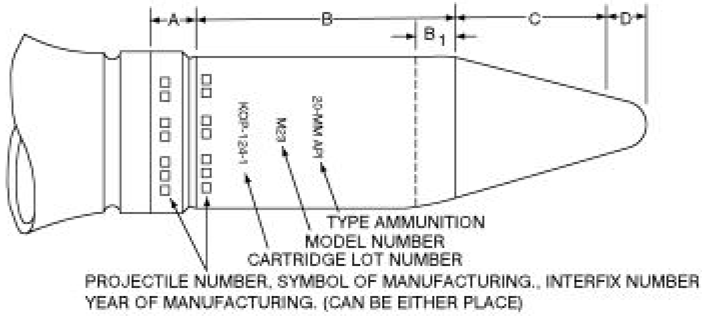
The propellant charge in the main body of the cartridge case consists of a certain amount (by weight) of smokeless powder. It burns when it is ignited by the primer, creating the gas pressure to push the projectile from the barrel of the weapon to the target.

## Projectile

The gas pressure created by the propellant forces the projectile out of the barrel towards the target. The cylindrical projectile is fitted with a rotating band which seals the barrel, forcing the gas to push the projectile out of the barrel. The rotating band also grips the barrel's lands and groves (rifling) causing the projectile to rotate during its flight to the target. This rotation stabilizes the projectile during flight. Projectiles also have components, but they will not be discussed at this time.

Projectiles are color coded for identification during loading and handling. Figure 3–2 lists the colors and markings for the rounds you'll probably handle. These color codes tell you at a glance the type of explosive contained in the ammunition and the specific hazard it presents. This is extremely important on a busy flightline.

Another marking on the case and/or projectile is the *lot number*. You can usually expect all ammunition in the same lot to function identically. If there's a malfunction with a specific lot, you can track these numbers and prevent the defective lot from being used for another mission.




| PROJECTILE TYPE | 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) M56A1, M56A2, M56A3, M56A4 | NO PAINT (COPPER) | YELLOW, LIGHT RED BAND IN $B_1$ AREA | NO PAINT (CHROMATE) | NO PAINT (CHROMATE) | BLACK |
| HIGH EXPLOSIVE INCENDIARY (HEI) M56A1, M56A2 (EARLY MODS) | NO PAINT (COPPER) | DARK RED, OLIVE DRAB IN $B_1$ AREA | NO PAINT (CHROMATE) | NO PAINT (CHROMATE) | BLACK |
| TARGET PRACTICE TRACER (TPT) M221 (M220 CARTRIDGE) | NO PAINT (COPPER) | BLUE | BLUE | BLUE | WHITE STENCILING, LIGHT RED Ts BELOW $B_1$ 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 |

**Figure 3-2. Ammunition color codes.**

## Types of ammunition

Regardless of size, all ammunition comes in various types. The type of ammunition used will vary with the mission being flown. Let's take a brief look at the more common types of ammunition you're likely to see.

### *Armor piercing incendiary*

Armor piercing incendiary (API) is a 30 mm round used for combined armor-piercing and incendiary effects against aircraft, armored vehicles, and concrete shelters. The projectile is made up of four parts: an aluminum body or pusher, glass-reinforced nylon rotating band, depleted uranium (DU) rod penetrator, and aluminum windshield. The projectile has no fuze; its penetration results from the penetrator's shape, the round's kinetic energy, and grazing angle at impact. This round operates in the same way as the KEP we discussed earlier in this volume.

The DU penetrator has several advantages over a standard steel or tungsten core. We use DU in armor-piercing munitions, because it is extremely dense (1.6 to 1.7 times as dense as lead). To give you an idea of its density, a solid mass of DU about the size of a soda can weighs about 15 pounds. A similar volume of lead weighs less than 10 pounds. DU also "self-sharpens" as it penetrates armor rather than "mushrooming" like tungsten giving DU munitions superior penetration at extended ranges. DU's density and ability to self-sharpen make it the best choice for armor-piercing, kinetic energy (KE) rounds.

DU is also *pyrophoric*, which means that small particles may self-ignite when exposed to the friction and heat of a munitions strike. These particles tend to catch fire and burn rapidly at very high temperatures. This adds to the effect of DU munitions strikes, since these burning particles often touch off secondary fuel and ammunition explosions on penetrated vehicles.

When handling DU munitions, it is important to note that the radiation you receive is incredibly low. The levels are so low that you can remain in close proximity to the munitions 24 hours a day, 365 days a year, without exceeding the annual US safety standard of 5 rem/year for radiation workers. No additional protective measures are required for unfired DU munitions beyond those standards for all munitions.

### *Armor piercing tracer*

The armor piercing tracer (APT) round gives the pilot a reference to the path of the projectile as well as the armor-piercing effect. The projectile is made from bar or forged steel with a metal closing cup at the base which holds the red tracer composition. The tracer burns for about 2.25 seconds, during which the projectile travels about 1400 yards. You can identify the APT by a ring of light red Ts stenciled around the projectile for 20 mm and orange Ts for 30 mm.

### *Dummy*

This completely inert round is used for drill, for testing gun mechanisms, and for ballast on certain aircraft. The rounds are easily distinguished from live rounds. Stenciled with the word INERT, they may be complete one-piece rounds or normal rounds with the primer and propellant charge removed. You may also see plastic dummy cartridges. They're like other dummy rounds in size, physical dimensions, weight, and purpose, but they have a plastic body, a steel extractor lip/groove area, and a steel core to control the weight.

### *High explosive incendiary and high explosive incendiary with tracer*

The high explosive incendiary (HEI) round is used for combined explosive and incendiary effects against aircraft and targets of light material. The projectile is steel and relatively thin-walled, containing roughly 0.03 pounds of Cyclotrimethylenetrinitramine (RDX) explosive. The high explosive incendiary with tracer (HEIT) is ballistically and physically identical to the HEI round and has a tracer element added to it. You can identify the HEIT by a ring of light red Ts stenciled around the projectile for 20 mm and orange Ts for 30 mm.

### *Target practice and target practice-tracer*

These rounds are used only for gunnery practice and are designed to simulate the service round in size, weight, and shape. Some models of this type of cartridge were at one time referred to as "ball ammunition." The term "ball" was originally used to describe small-arms ammunitions with a solid projectile. The round's projectile consists of a body, nose, and rotating band. The body is made of steel; it is hollow, and contains no filler. The nose is made of aluminum alloy and is solid. The target practice-tracer (TP-T) round is physically identical to other target practice (TP) rounds differing only by the addition of the tracer element. Like the HEIT round, the (TP-T) is identified by a ring of light red Ts stenciled around the projectile body for 20 mm and orange Ts for 30 mm.

### Ammunition safety precautions

Safety is always a must when working with any munition items. The ammunition used with today's aircraft guns must be handled with care to prevent serious injury to yourself or others.

The ammunition delivered to you could be linked together, and the linking will vary. For example, 20 mm rounds are normally supplied in metallic linked belts of 100 rounds per belt; 25 mm is supplied in a magazine container; 30 mm ammunition is not linked together other than in plastic linked tube carriers on an ammunition loader; 7.62 mm ammo comes linked like the 20 mm, except the number of rounds in a belt is normally 240; 40 mm rounds are linked together in fours, because they're manually fed into the gun in fours; 105 mm rounds are loaded individually, one round at a time, so they can't be linked. At any rate, you must be extremely careful in handling the linked ammo. Be careful not to get your hands cut or pinched by the links.

Ammunition must be handled with care at all times. The explosive elements of these rounds are highly sensitive to shock, high pressure, and static electricity. *Never try to disassemble a complete round or any of its components.* Ammunition should be free of foreign matter, such as sand, mud, grease, and so forth, before it is loaded. If it does get wet or dirty, wipe it dry and clean at once. Because some Air Force ammunition has electrical primers, you must be careful to keep it from coming in contact with electrical wiring or other sources of electricity. *Dud projectiles should not be handled*. Per Air Force regulations, only authorized and qualified personnel can dispose of dud ammunition. Ammunition should never be exposed needlessly to the direct rays of the sun because prolonged exposure to heat will affect its ballistics. Ammunition normally comes in containers with moisture-resistant seals. Do not remove these seals until the ammunition is to be used. Ammunition must not be dropped, rolled, thrown, or handled roughly because shock or friction may cause a fire or explosion.

## 217. Impulse cartridges

Impulse cartridges are used in aircraft systems to furnish gas pressure to separate bombs, fuel tanks, missiles, pylons, alternate mission equipment, and countless other stores from an aircraft. This lesson will familiarize you with the make up of an impulse cartridge, how it works, and the information you need to handle, identify, mark, and store these daily used explosive items.

The success of a mission can largely depend on the impulse cartridges used. Impulse cartridges are an integral part of the loading operation and their use and inspections are discussed here.

### Types and uses

Impulse cartridges are divided into two basic types: explosive and non-explosive (dummy) cartridges. *Explosive impulse cartridges* are used mainly to create gas pressure to operate the mechanical components of launchers and bomb racks for release or ejection of stores (fuel tanks, launchers, dispensers, racks, pylons, and/or munitions) while an aircraft is in flight. This kind of impulse cartridge is found in other applications, such as refueling hose guillotines. The second kind of impulse cartridge, the *non-explosive (dummy)* type, is used strictly for personnel training and testing.

### Physical description

Impulse cartridges (fig. 3–3) are sometimes referred to as ejectors, ejection cartridges, or just "carts," both verbally and in writing. They contain smokeless propellant electrically initiated (fired) charges, case grounded (except BBU-63/B and

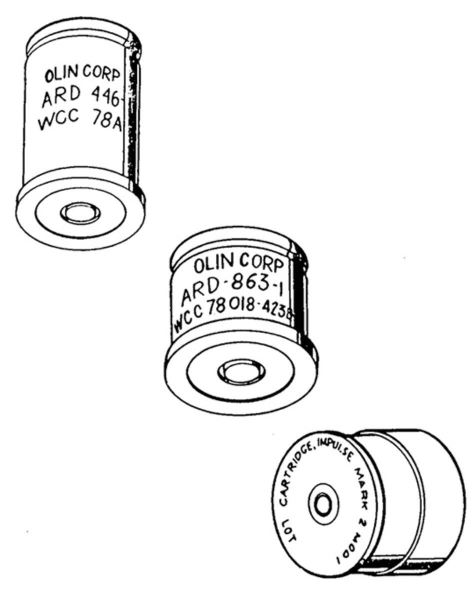
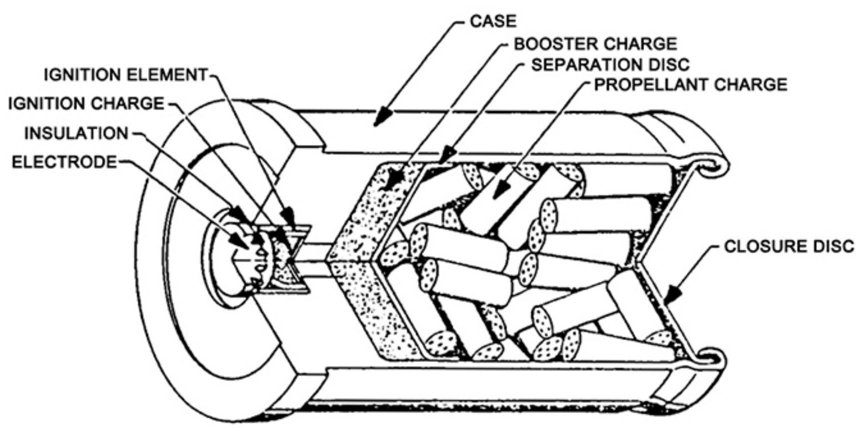



**Figure 3-3. Case grounded impulse cartridges.**

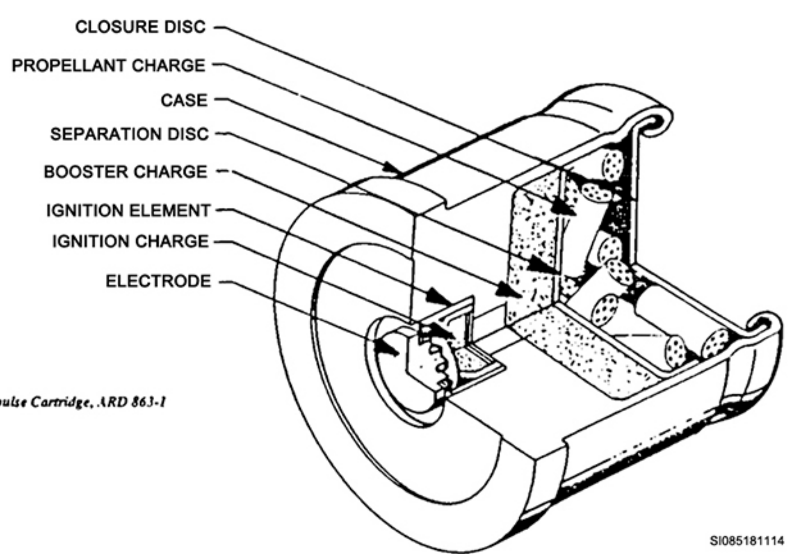
MK 107, Mod 0), and are of the same basic construction (except for the BBU–63/B and MK 107 Mod 0).

The typical impulse cartridge is made of an electrode with necessary insulation, separation and closure discs, ignition and booster charges, a propellant charge, and an aluminum case (figs. 3–4 and 3–5).

The impulse cartridge's aluminum case provides the housing for all of its components and normally provides a ground for electrical firing. The electrode, at the base of the cartridge, is the point where electrical voltage is applied to set off the impulse cartridge function. Although the electrode is made to fire electrically, it can be detonated accidentally by impact or heat. The ignition charge is above the electrode. It creates the heat needed to set off the booster charge. The next component in line is the booster charge, above the ignition charge and below the separation disc. It creates the necessary heat to set off the propellant charge. A separation disc—between the propellant charge and booster charge—increases the compression produced by the booster charge, applying an even amount of heat and pressure to the propellant charge. Any uneven burning of the propellant charge will reduce the amount of gas pressure it produces and, consequently, affects the munitions' release or ejection. The propellant charge generates the gas pressure to operate the release or ejection mechanisms in bomb racks and launchers. The last component is the closure disc on top of the cartridge. This closure disc seals the cartridge and protects the propellant charge from moisture.




*Impulse Cartridge, ARD 446-1*




*Impulse Cartridge, ARD 863-1*

**Figure 3–4. Case grounded impulse cartridge components.**

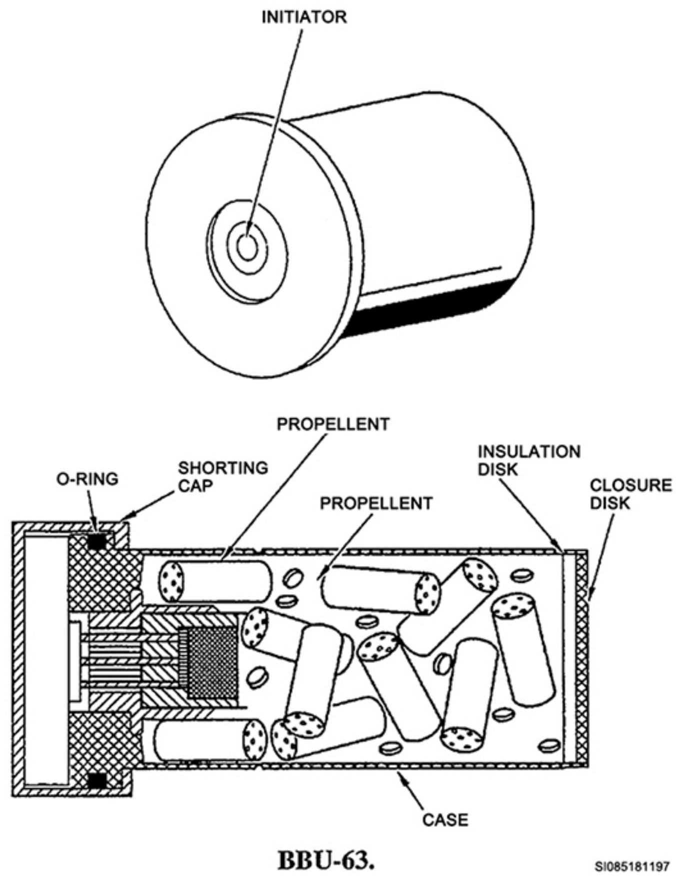



Figure 3–5. Non case grounded impulse cartridge components.

## Functional description

Impulse cartridge operation begins when voltage is applied to the cartridge electrodes. A bridge wire inside the electrode heats up, igniting the ignition charge. The ignition charge sets off the booster charge and, in turn, sets off the propellant charge. This process takes place in a matter of milliseconds and facilitates the release and/or jettison of aircraft stores.

## Cartridge markings

Impulse cartridge cases contain markings just like every other munitions item. However, unlike other munitions, you are responsible for making some of these markings. The following paragraphs will help you make sense of all of the common markings that you will encounter.

### *Packaging*

Impulse cartridges are packed in hermetically sealed (air tight) containers. These containers are then packed in cardboard or wooden boxes. Impulse cartridges are extremely sensitive to atmospheric moisture, so the hermetically sealed container must not be opened until the cartridges are ready for use. Due to this moisture sensitivity, their reliability degrades with time. Air Force Logistics Command (AFLC) has prescribed a maximum time that impulse ejection cartridges packed in hermetically sealed containers can be considered serviceable. Obviously, the time is longer than it would be for those removed from the container; so AFLC assigns different life expectancies for shelf life and service life. Impulse cartridges come from the manufacturer permanently marked with the nomenclature, lot number, date of manufacture, and manufacturer (fig. 3–6).

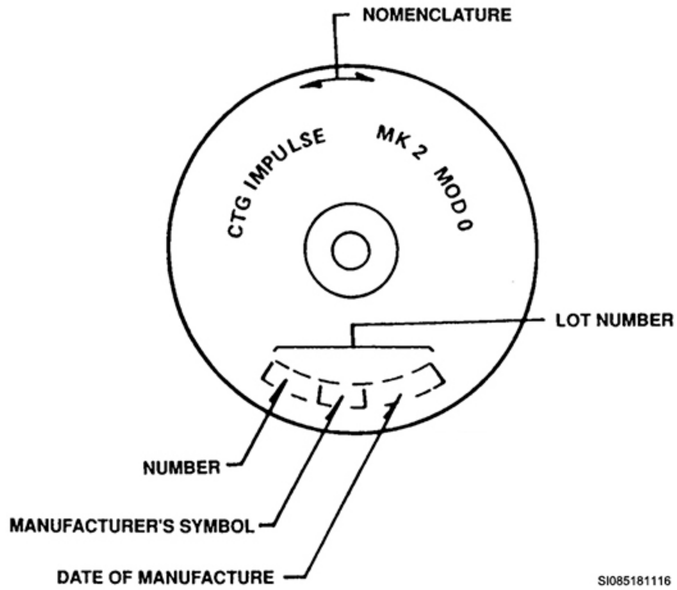



**Figure 3–6. Impulse cartridge markings.**

### *Shelf life markings*

Shelf life is the length of time an impulse cartridge can stay in storage under its prescribed packaging and storage requirements. It starts at the date of manufacture and runs up through a specified expiration date. The impulse cartridges now in use range in shelf life from 5 to 17 years. The expiration date for shelf life is marked with the month and year. Let's say the manufacture date of a sealed container of impulse cartridges is 8/08 and the shelf life is 7 years. The cartridges are serviceable until 8/15 (August of 2015) if they stay in the *unopened* container. They retain their shelf life until the last day of the expiration month.

### *Service life markings*

Service life is the time an item can stay in actual service; obviously it's not as long as shelf life. Service life for the impulse cartridges we use now ranges from 1.5 to 4 years. Each impulse cartridge you deal with must be *individually* marked with a service life expiration date (month and year, and so forth, S/L EXP 3/15) by one of these following methods:

- Placing a strip of pressure-sensitive, self-adhesive tape (no more than ⅜ inch wide and 0.002 inch thick) around the cartridge. This tape must not overlap and must be placed within ⅜ inch of the cartridge base. The service life must be written on the tape with indelible (permanent) ink (fig. 3–7,A).
- Scribing markings on the cartridge case with permanent ink, a metal scribe, or other sharp pointed instrument (fig. 3–7,B). Be especially careful in marking with a metal scribe; if you touch the cartridge electrode, you could cause an inadvertent ignition.
- Placing markings on the cartridge's closure disc with indelible ink (fig. 3–7,C). Be extremely careful here. Too much pressure can loosen (unseal) the closure disk.

There are only two times you might see the service life markings being waived for impulse cartridges: during combat conditions and during training missions.

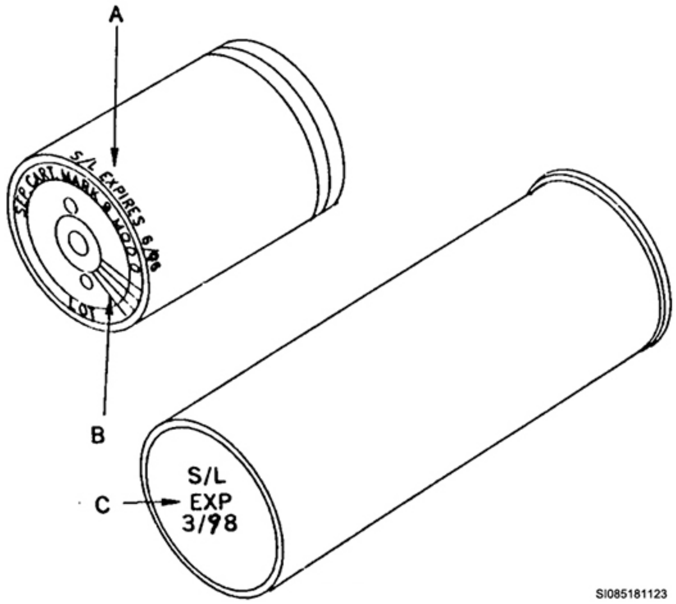



**Figure 3–7. Service life and scribe markings.**

### *Insertion markings*

The equipment impulse cartridges are installed into can have different types of firing pins. Some, like the MAU–12 bomb rack, have fixed (rigid) firing pins, and others, like the TER–9A, have spring-loaded firing pins. The type of firing pin directly affects the markings and service life of an impulse cartridge. Cartridges initially installed in spring-loaded firing pin breeches may be freely interchanged among other spring-loaded firing pin breeches. They may be used an unlimited number of times during their service life. They may also be installed into fixed firing pin breeches, but then they can't be reinstalled in any other type of breech with a firing pin of smaller diameter. It's exceptionally hard to distinguish between firing pin diameters unless they're checked before each cartridge is inserted. *A safe rule is never install an impulse cartridge in any other type of breech once it has been installed in a breech with a fixed firing pin.* Each time you remove an impulse cartridge (except MK 107 MOD 0/1 and CCU series) from a breech having a fixed-firing pin, place a radial mark on the base of the cartridge from the outer edge of the electrode insulation to the edge of the cartridge (fig. 3–7, B). This mark must be either scribed or marked with indelible ink. When an impulse cartridge has 10 marks (or its service life date passes), it's considered unserviceable and may no longer be used. If a cartridge's shelf life or service life expiration date is expired, it cannot be used.

## Self-Test Questions

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

### 216. Ammunition

1. Name the components of a typical round of ammunition.

2. What three purposes does the cartridge case serve?

3. What part of the cartridge case allows for case ejection after firing?

4. How may ammunition primers be activated?

5. What type of ammunition is electrically and percussion primed?

6. What is the purpose of the round's propellant charge?

7. What is the purpose of a projectile's rotating band?

8. What type of ammunition is used against aircraft, armored vehicles, and concrete structures?

9. What does the term pyrophoric mean?

10. What are the additional protective measures required for unfired DU munitions beyond those standard for all munitions?

11. How can a dummy round be distinguished from a live round?

12. What types of ammunition are used for gunnery practice?

13. What marking designates a round of ammunition as tracer?

14. When may a round of ammunition be disassembled?

15. Why should ammunition not be exposed to direct sunlight for long periods?

### 217. Impulse cartridges

1. Name the two types of impulse cartridges.

2. What are impulse cartridges used for?

3. How are impulse cartridges normally initiated and grounded?

4. In what three ways may impulse cartridges be initiated?

5. How does uneven impulse cartridge burning affect munitions release?

6. What two life expectancies do impulse cartridges have?

7. Define shelf life.

8. Define service life.

9. How is service life marked on an impulse cartridge?

10. Why should you be extremely careful in scribing markings on impulse cartridges?

11. What must you watch for in marking the closure disc of an impulse cartridge?

12. How many times may an impulse cartridge be used if it's only used in a breech with a spring-loaded firing pin?

13. What is the status of an impulse cartridge with 10 scribe markings on its case?

# 3–2. Pyrotechnic and Countermeasure Munitions

Pyrotechnic ammunition and munitions are modifications of the familiar Fourth of July fireworks. They produce light or heat and smoke for signaling. Our discussion of pyrotechnics will include items such as signals used by the gunship personnel and various aircraft flares. ECM munitions carried on fighter and bomber aircraft consist of two major categories of items: chaff and decoys. Their purpose is to confuse or blind enemy radar allowing the aircraft to perform the mission by degrading the ability of enemy forces to take actions against them.

## 218. Pyrotechnic ammunitions and munitions

Ground forces rely heavily on the disbursement of pyrotechnic devices in times of darkness. We use them in rescue missions and close air support roles in the hours of darkness. You will need to be familiar with their basic chararistics and identification to support the mission.

### Visibility

Five factors control the visibility of pyrotechnics—candlepower, frequency, color, weather, and ambient light. *Candlepower* is the amount of light generated by burning pyrotechnics. As the candlepower increases, the range of visibility increases if other factors are constant. *Frequency of the light* is the measure of the light spectrum that the flare generates. Some flares generate the majority of their light outside of the range the unaided human eye can detect. For example, covert type flares appear to the naked eye as pale glowing spots in the sky that provides almost no illumination; however, to someone equipped with the appropriate night-vision systems they can provide almost full daylight intensity light over a wide area. The *color of the flame* also affects the range of visibility. For example, ~~red,~~ because of its short wavelength, is absorbed by air more quickly than the longer wavelength ~~green~~. *Weather* has a notable effect on the visibility of pyrotechnics, because excessive moisture in the air reduces the range considerably. An extreme example is a signal visible for miles in clear weather that might be visible for less than a hundred yards during a rainstorm. The amount of *ambient or background light* also affects the signal's visibility. With all 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, combination signaling and illuminating items, and simulators. Other types of ammunition are modified for a pyrotechnic effect (for example, illuminating projectiles), but the item generally falls into one of the four pyrotechnic classes described in the following table.

| Pyrotechnic Classes | |
|---|---|
| **Class** | **Description** |
| Photoflash | These cartridges produce a single flash of light for photography.<br>A *flare* is a single source of illumination generally of high candlepower and substantial duration. |
| Flares | These may be parachute supported, towed, or stationary.<br>While their primary function is illumination, they can be used for identification, ignition, location of position, expendable countermeasures (producing IR energy to draw off enemy missiles), or warning. |
| Signals | These have two types of effect—light and smoke. A single model may produce both effects.<br>A *light-producing signal* is much smaller and faster burning than a flare. It may be a single parachute-supported star, or from one to five freely falling stars, with or without colored tracers.<br>*Smoke signals* are of either the slow-burning, streamer type, leaving a trail of smoke, or |

| Pyrotechnic Classes | |
|---|---|
| **Class** | **Description** |
| | the parachute-suspended type, producing a cloud of smoke. |
| Simulators | These are training devices used to imitate the actual battle sounds and flashes of light produced by combat ammunition.<br>Because their use by the Air Force is very limited, we won't discuss them in this career development course (CDC). |

## Identification

You can identify pyrotechnic ammunition by its nomenclature, lot number, model designation, painting, marking, National Stock Number (NSN), and Department of Defense identification code (DODIC). Most of this information is on the data card that accompanies the munition item from the manufacturer. Since you're already familiar with munition nomenclature, lot numbers, and model numbers, we won't spend more time on them. Pyrotechnics are usually painted white, except for those with an (unpainted) outer case of aluminum or plastic. Pyrotechnics, in general, use black to show the type, model, ammunition or munition lot number, and date of manufacture. Signals are marked with colored bands, letters, or patches to indicate the color of the signal produced. Like other munition items, pyrotechnic ammunition and munitions are assigned NSN and DODIC identifiers. Most pyrotechnic items are in Federal Supply Classification 1370.

## Aircraft parachute flares

These flares provide illumination for reconnaissance, observation, bombardment, landing, and practice firing of antiaircraft guns. They are unlike any other munition, so we'll look at what makes them so different.

Their details vary with their purpose, but all produce white or yellowish light in the visual range or infra red illumination of high intensity for an appreciable length of time, ranging from 60,000 candlepower for 1 minute to 2,000,000 candlepower for 5 minutes or longer. Most are parachute-supported to retard the speed of descent and extend illumination time. All have some form of delayed ignition to ensure they clear the aircraft or reach a specified altitude before starting to burn.

These flares usually depend on the parachute opening to pull the igniter wires through a friction composition. Either quick-match or a delay fuze guides the flame produced to the priming composition, the first-fire charge, and then the candle's illuminant composition. Some flares used below the aircraft (such as those intended for bombardment) have shades to shield the aircrew's eyes from the glare.

Flares released from launching tubes or racks have a hang wire-firing lanyard or ripcord assembly attached to the arming pawl tube of the rack. If the flare is released armed, the hang wire stays attached to the aircraft and actuates the flare; if it's released safe, the flare doesn't function in the air but may ignite on impact. This possibility must be considered in releasing flares in the safe condition over friendly territory. The hang wire is in a container in the base of a flare case, closed with a shipping cover and sealed by a strip of tape or a soft-metal tear strip. The tape or tear strip is torn off and the shipping cover removed *before* loading on the aircraft. When the flare is removed from the aircraft and returned to storage, the shipping cover must be reapplied and sealed with tape.

### *LUU–2/B*

The LUU–2/B, aircraft parachute flare (fig. 3–8) is an air-launched illuminating device producing an off-white light of two-million candlepower for an average burn time of 5 minutes. The flare housing holds the parachute, an ignition system, an explosive bolt, a timer and release mechanism, and a pyrotechnic candle in an insulator to bond the candle and insulation to the thin aluminum flare housing. The face of the timer has eight detent settings. The timer knob's white arrow is preset to the *minimum* of 500-foot detent. The other settings are in 1500-foot increments. A split ring is mounted in the timer knob for single-lanyard hookup, and a split-ring boss is mounted between the 1500- and 3000-foot detents for double-lanyard hookup. Two suspension lugs may be mounted atop the flare and spaced 14 inches apart for attachment to aircraft pylons.

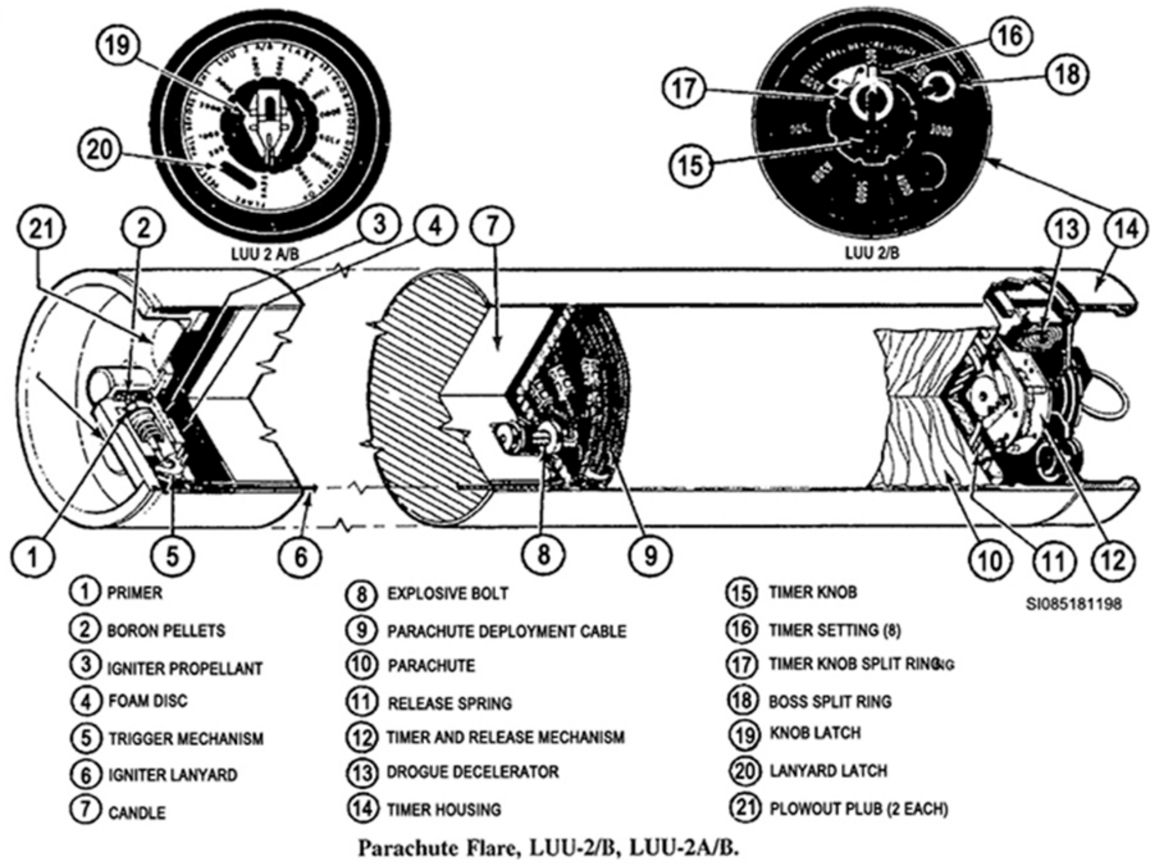



**Figure 3–8. Aircraft parachute flare, LUU–2/B.**

The LUU–2/B flare doesn't have a "safe setting," as other aircraft parachute flares do, because the candle can't function until two separate lanyard-release systems have been actuated. The pyrotechnic candle is suspended on a 19-foot-diameter cruciform-type parachute, designed to reduce flare oscillation. Because the pyrotechnic candle consumes the flare housing, the parachute tends to hover the last 2 minutes of burn time. A drogue decelerator made of a non-woven fabric is mounted in the timer and release mechanism. If, during the free-fall period, the flare spin rate exceeds 100 to 200 revolutions per minute (rpm), the drogue bag deploys to inhibit the spin.

When you handle the flare, if the timer knob is accidentally pulled and the timer cycle commences, you can forcibly hold the time and release mechanism by hand on the flare housing to prevent the timer and release mechanism from ejecting. When the timer completes its cycle, tape the mechanism on the flare housing and mark it for disposal. If the timer is ejected from the flare, stuff the parachute material back into the housing, tape the timer, and mark it for disposal.

### *LUU–2A/B*

The LUU–2A/B aircraft parachute flare is a modified version of the LUU–2/B flare, incorporating a new timer assembly (fig. 3–9). The timer and release mechanism, parachute, ignition assembly, pyrotechnic candle, and explosive bolt are encased in the flare housing. An insulator bonds the candle to the thin aluminum flare housing. On the face of the timer is a phosphorescent plastic decal with calibrated markings from 500 to 11,000 to indicate feet-of-fall before flare functioning. The feet-of-fall settings from 1,000 to 11,000 feet are in 1000-foot increments. Two pegs between the SAFE and

500-foot settings limit timer knob travel. If the timer knob is forced beyond either peg, the clock will run down and release the timer from flare housing. A flexible arm under the pointer on the timer knob retains the knob in the selected detent setting.

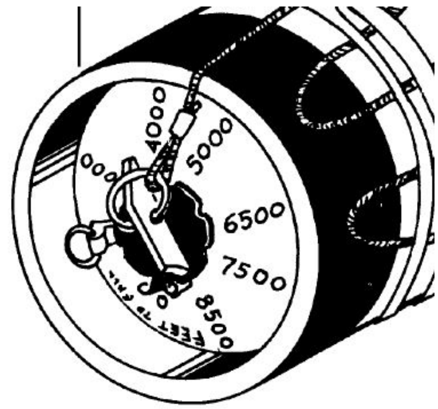



Figure 3–9. LUU–2A/B Flare timer.

The plastic decal shows a SAFE position. When the white plastic timer has been preset to SAFE, a safety device keeps the clock from starting if the knob is inadvertently pulled. The timer knob has a quick attach/detach feature letting you attach a lanyard loop directly to the knob without using a key ring. An auxiliary lanyard attachment device is mounted between the 500-foot and SAFE position for double-lanyard hookup. This device uses the same quick attach/detach feature as the knob. A drogue decelerator is *not* used in this timer. The pyrotechnic candle is suspended on an 18-foot-diameter cruciform parachute, designed to reduce flare oscillation. A lanyard kit with a 36-inch lanyard and a 6-inch lanyard is sealed in a plastic bag and packed in the timer well of each flare. The lanyard kit for the LUU–2A/B has a snap hook, since the loop on the end of the lanyard attaches to the timer knob. The lanyard is configured as the mission dictates. (When you position the timer knob to the SAFE or 500-foot settings, be careful not to exceed the pegs or the clock will run down, releasing the timer from the flare housing.) The timer knob is rotated so the pointer is positioned to the desired setting. As the flare is ejected/released from the SUU–25 dispenser or LAU–74 launcher, a 30-pound pull on the lanyard extracts the timer knob and the timer clock starts its delay-time run. When the delay is completed and the parachute deployed, the candle starts to burn for about 5 minutes, producing an off-white light of two million candlepower. The average rate of descent after the parachute deploys is 3 feet per second, so the flare descends about 2,500 feet while it is burning.

#### *LUU–19A/B and LUU–19B/B*

The LUU–19 series flares are an offshoot of the LUU–2A/B series flares and share many features with them. The arming, deployment mechanisms, safety mechanisms, and basic configuration are identical to the LUU–2A/B series. Where the differences lie is in the flare payload of the illuminator itself. Where the LUU–2 series flares produce visible light, when ignited, the LUU–19 series flares will emit energy primarily in the near infrared (NIR) spectrum. Some of the flare’s energy is emitted in the visible spectrum, but it is of negligible quantities so as not to degrade the performance of night vision equipment. The flare can be expected to burn for approximately 10 minutes during which it can be expected to descend approximately 8,000 feet. At candle burnout, an explosive bolt releases one of the shroud lines, collapsing the parachute which allows the flare remnants to fall quickly to ground.

### Countermeasures/decoy flares

Countermeasure/decoy flares are carried on all the major tactical aircraft (A–10, F–15, F–16, and F–22) and on most of our current bomber (B–52 and B–1B) fleet. They produce a high-temperature flame to divert enemy aircraft infrared missiles. You probably won’t ever have to install the flare cartridges themselves, because you’ll normally be installing complete magazines.

#### *ALA–17, ALA–17A, and ALA–17B cartridge flares*

Each cartridge consists of two flares, upper and lower, with their flare cases crimped together to form a cartridge. 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 which allows us to use more igniter composition. Also, the upper igniter assembly differs in contact points. There is a shorting clip for handling the cartridge when it’s not in its flare magazine. Each flare has an electric squib igniter assembly and an illuminant charge. Electrical current applies a fire impulse to the primer contacts on the end of the flare cartridge. The electrical current fires a squib in the electric ignition assembly on the upper flare. (The lower flare is fired after the upper flare.) The squib, in turn, ignites the ignition charge creating an extremely hot ignition flash and ignites the illuminant pellet. The burning gases from this pellet eject the flare from the cartridge case and away from the aircraft (fig. 3–10).

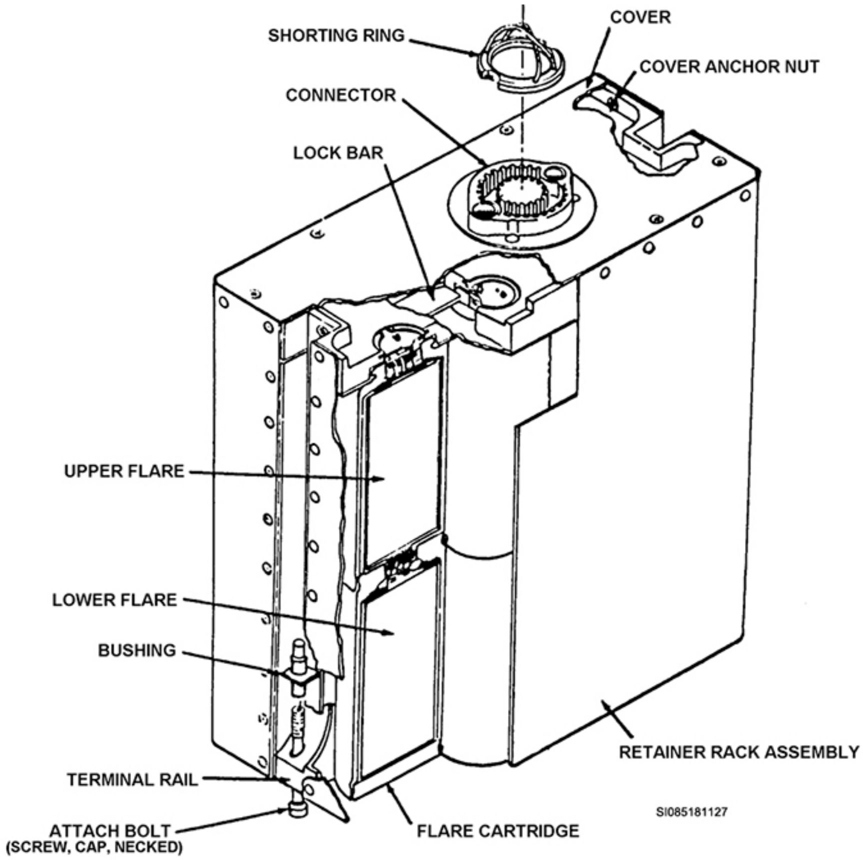



**Figure 3–10. AN/ALA–17 flare set.**

### *MJU–7/B and MJU–10/B IR countermeasures flares*

The MJU–7/B flare consist of a rectangular case containing a flare pellet, a piston, a felt spacer, an end cap, an initiating mechanism, and a receptacle for the BBU-36/B squib. The squib is the initiating mechanism used to fire the flare pellet. The MJU–7/B is carried and dispensed by the A–10, F-15, and F–16 aircraft. The F–16 aircraft can use an AN/ALE–40 or ALE–47 dispenser system. The ALE–47 dispenser is an updated version of the ALE–40, and these changes allow for recognition of loads and updated interface with the weapons system. The F–15 uses the ALE–45 dispenser system.

The MJU–17/A on F–15 and F–16 aircraft uses the MJU–12 flare magazine that holds 15 flare cartridges in each magazine (fig. 3–11). The F–16 aircraft can have up to four magazines installed, one on each side of the aircraft or three on the left side and one on the right, depending upon the model and block modification of the aircraft**.** The F–15's capabilities are somewhat different; it can use either the MJU–12 (15 flares) or MJU–17 (6 flares) flare magazine. It has four flare stations, two on each side of the aircraft, so (depending on which magazine is loaded and assuming their loads aren't mixed); it can carry either 24 or 60 flares.

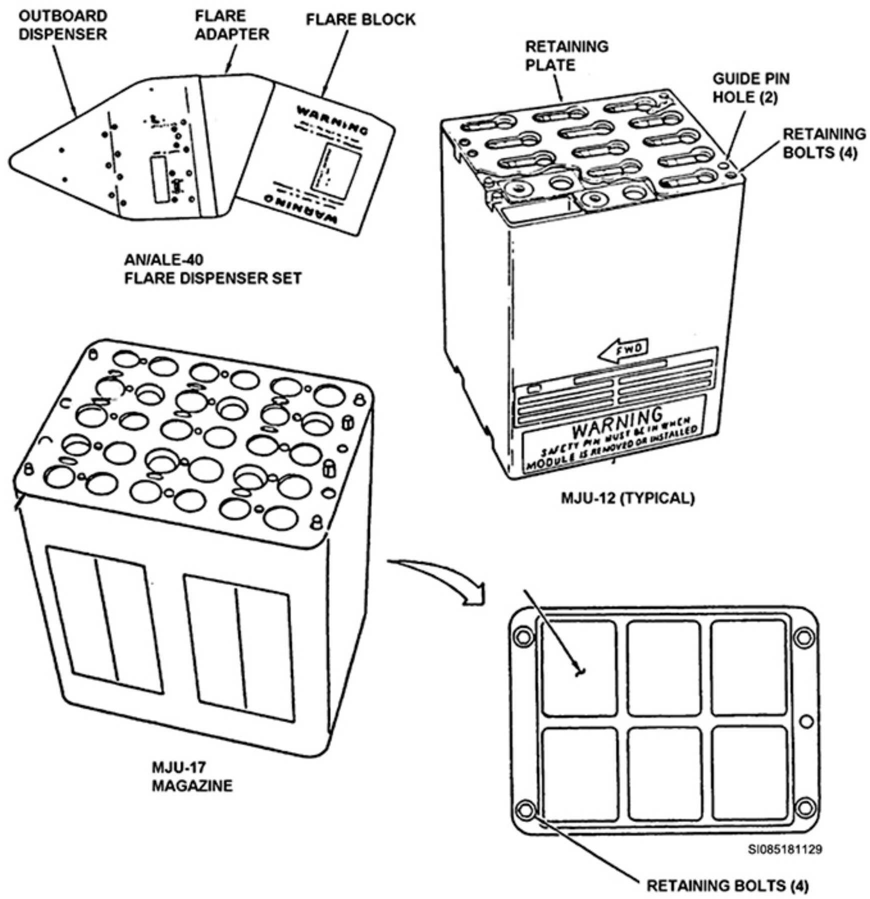



**Figure 3–11. Aircraft flare magazines.**

### *M–206 IR countermeasure flare*

This decoy flare (fig. 3–12) is physically very similar to the MJU–7/B. One main difference between them is the candle output power used to simulate different-sized aircraft engines. The M–206 is used to simulate the engines on the A–10 aircraft. Different jet engines produce different amounts of heat (IR energy), and these flares simulate the difference in energy level to decoy the enemy IR missiles away from the aircraft. The other major difference is its size. The M–206 is smaller, so it takes a different magazine, the MJU–11, which normally carries a chaff payload. This magazine carries 30 flare cartridges, and you'll find it on the A–10 aircraft. Sixteen magazines may be installed on the A–10, four at each wing tip station and four at each main landing gear pod station.

### *MJU–23A/B flare cartridge*

The MJU–23A/B is now being installed in the AN/ALE–49 dispenser for use in the flare cavities of the B–1B (fig. 3–13). Eight of these dispensers may be installed on the B–1 aircraft. There can be a mixed loads of chaff dispensers and flare dispensers if no more than two dispensers on each side of the aircraft contain chaff at any time and if the flare dispensers are installed aft of the chaff dispensers.

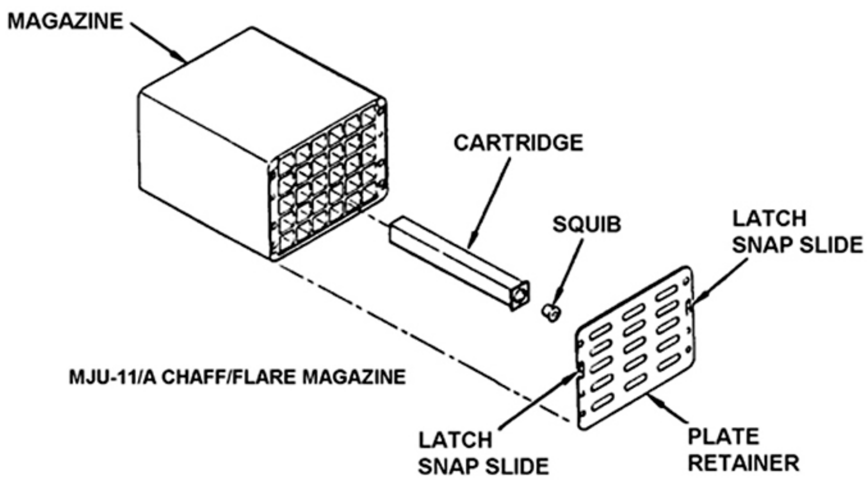



**Figure 3–12. MJU–11 Chaff/flare magazine.**

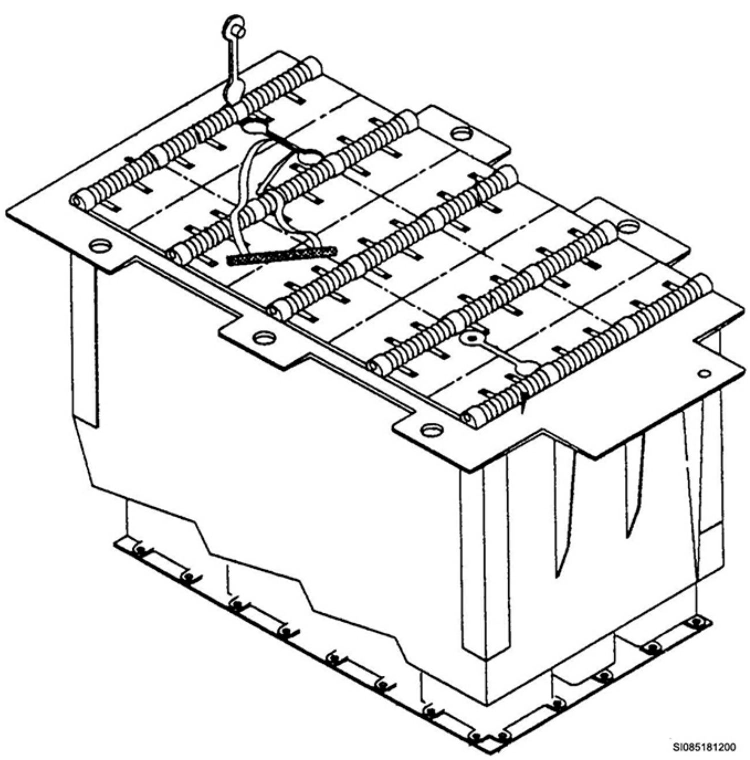



**Figure 3–13. MJU–23/B flare dispenser (B–1B only).**

### *ALE–52 dispenser system*

The F–22 uses the ALE–52 countermeasures system. There are two countermeasure stations on the F–22 each capable of holding three magazines. These stations are situated just aft of the right and left side weapons bays. The ALE–52 magazine differs from other tactical aircraft in the fact that they use three mounting bolts placed laterally across the center of the magazine, as opposed to the four bolt systems with one on the outside corner used on other common magazine systems.

The magazines used with the ALE–52 system are capable of containing one of four different flare payloads—the MJU–10/B, MJU–39/B, MJU–40/B, or the MJU–7A/B. The first three flares share similar physical characteristics such as length or width allowing six individual flares to be mounted in each module regardless of type. The fourth type—the MJU–7A/B—is substantially smaller in size and is usually used for aircrew training. All of the individual flare types function similarly to other IR countermeasure flares and all have the identical safety precautions associated with them.

## 219. Electronic countermeasures munitions

ECM munitions carried on fighter and bomber aircraft consist of two major categories of items: chaff and decoys. Their purpose is to confuse or blind enemy radar allowing the aircraft to perform the mission by degrading the ability of enemy forces to take actions against them.

### Uses and descriptions of chaff packages

Chaff was originally developed during WWII to counter the benefits of radar. During WWII, boxes of aluminum and other metal foils were dumped out of cargo and bomber aircraft to create false radar returns to confuse enemy air defenses as to the location, direction, speed, and size of attacking aircraft formations. By cutting the foil strips to different sizes, different wave-length of radar was affected by the chaff. These systems, while effective, were largely abandoned until the advent of radar guided missiles. With the advent of radar guided missiles aircraft needed a way to breakup radar return signals that were guiding enemy missiles toward them. Chaff was used because it made a cloud of radar reflective material to the rear of the aircraft that would interfere with these signals. While current chaff systems use the same basic theory as their WWII predecessors, modern technology allows much more efficient deployment systems other than a guy standing over an open bomb bay tossing out handfuls of tinfoil. Modern systems incorporate a metallic coating on extremely thin glass fibers of differing lengths packed into bundles of millions of fibers which are deployed by small electrically primed impulse carts sometimes referred to as *squibs*. When the squib fires it produces gas pressure that forces the chaff bundle into the air stream scattering it. This cloud of fibers scatters and diffuses the radar return signal of the aircraft in much the same way as a cloud of smoke would block visible light. The ECM munitions we'll cover in this lesson are the RR–170 and RR–180 chaff packages, RR–196/AL, and the MJU–6/B chaff unit.

### The RR–170/180 series chaff cartridges

This square tube includes a chaff payload and separators, a piston, an end cap, and a receptacle for the BBU–35/B squib or M–796 impulse cartridge. They are carried on tactical fighter aircraft (A–10, F–15, and F–16) and the B–1B bomber. On the A–10, F–15, and F–16, a chaff payload may be carried at the same stations the flares are carried, but it must be loaded in the MJU–11/A magazine shown in figure 3–14. This reusable fiberglass container is chambered to hold 30 (1 x 1 x 8 inch) chaff cartridges and their associated firing devices (BBU–35/B squibs and M–796 impulse cartridges). Although this magazine will accommodate flares (M-206 IR flare cartridges), *chaff and flares are never mixed in the same magazine.*

On the F–16, the chaff payload magazine may be attached to the dispenser. Each module can hold 30 chaff cartridges. The F–16C/D can be configured to carry four chaff payload modules, one on the right side of the aircraft strake and three on the left strake. Three additional modules can be carried on modified armament pylons. The B–1B's chaff dispenser (fig. 3–15) may be installed but only two per side of the aircraft and only in positions 1, 2, 3, and 4 when carrying flares in conjunction with chaff. The C–130 gunship uses 20 dispensers, each holding 30 chaff cartridges, for a total of 600 chaff cartridges.

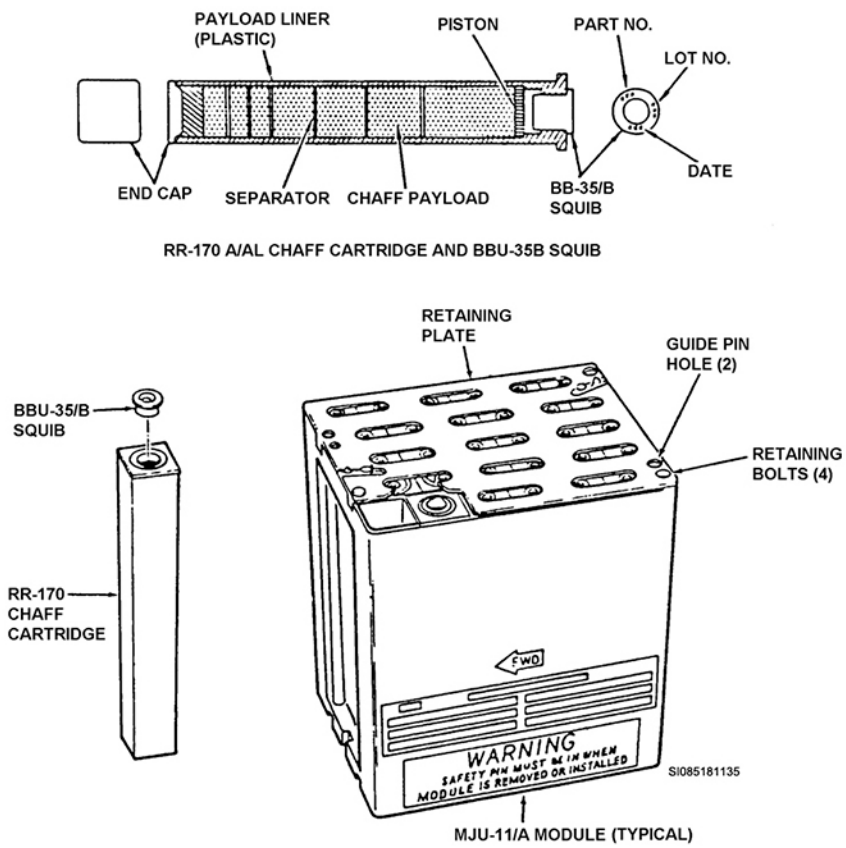



**Figure 3–14. RR–170 chaff cartridge and MJU–11/A magazine.**

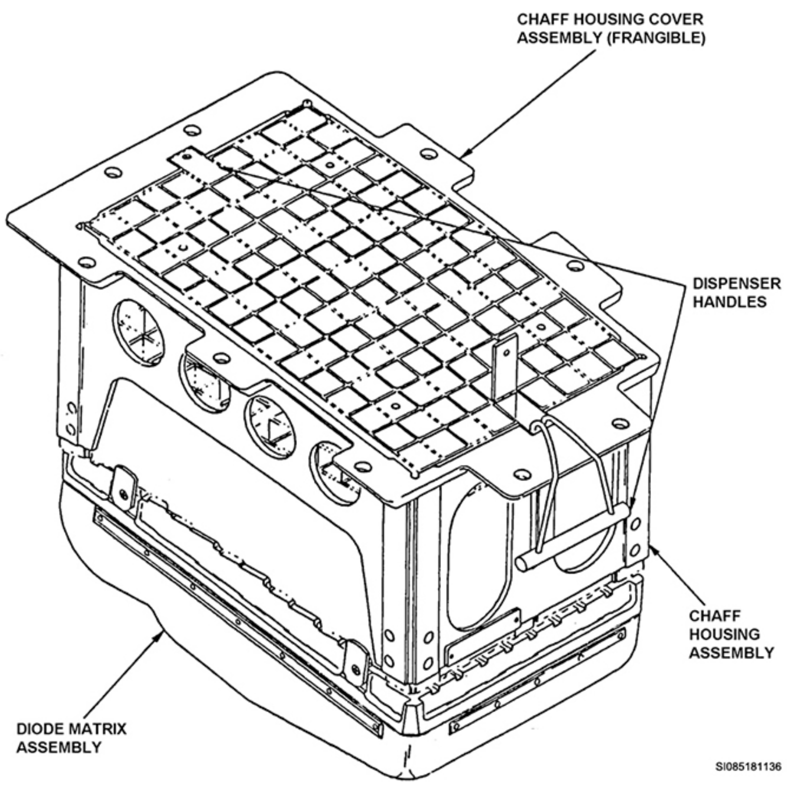



**Figure 3–15. B–1B aircraft chaff dispenser.**

### The RR–196/AL chaff cartridges

The ALE–52 countermeasures system used in the F–22 is compatible with the RR–196/AL bundled chaff countermeasure. The magazines used with the ALE–52 system are capable of carrying 18 RR–196/AL chaff bundles. The RR–196/AL chaff bundles consist of dual chaff payload contained in a single 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. The individual packages can be released independently. The effect is similar to having two individual chaff “sticks.”

### Decoys

As technological threats advance, our countermeasures need to keep pace so that the Air Force can achieve its missions. This was the case during the first Persian Gulf conflict and later in support of NATO efforts in the Balkans. New air defense technologies had appeared and the Air Force determined that it needed a new class of countermeasure to handle emerging threats.

#### *AN/ALE–50*

Have you heard an ambulance go by recently? As the ambulance approaches, the sound waves from its siren are compressed towards you, the observer. The intervals between waves diminish, which translates into an increase in frequency or pitch. As the ambulance passes you and starts traveling away, the sound waves are stretched relative to the observer, causing the siren's pitch to decrease (fig. 3–16). By the change in pitch of the siren, you can determine if the ambulance is coming nearer or speeding away. If you could measure the rate of change of pitch, you could also estimate the ambulance's speed. This phenomenon is called the “Doppler effect.”

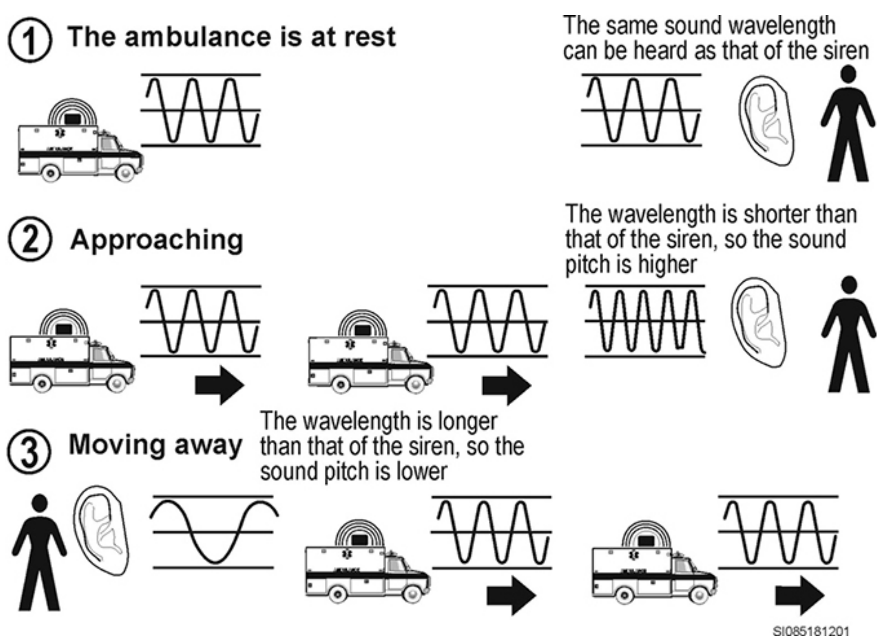



**Figure 3–16. Doppler effect.**

How do ambulances relate to aircraft countermeasures you might ask? In the 1990s, radar technology started incorporating the Doppler effect into a system known as *pulse Doppler radar*. These systems used rapid bursts of radar instead of continuous beams that had been used in earlier systems. By incorporating advanced computers into the radar systems it allows for the rapid analysis of the radar return signals. Therefore, it became much easier to pick out moving aircraft from stationary objects on the ground or the air, like chaff.

The deployment of pulse Doppler technology by our adversaries mandated a new type of electronic countermeasure that would present a moving target that would confuse the enemy systems. The end result of this developmental process was the AN/ALE–50 systems deployed on the F–16 and B–1 (fig. 3–17).

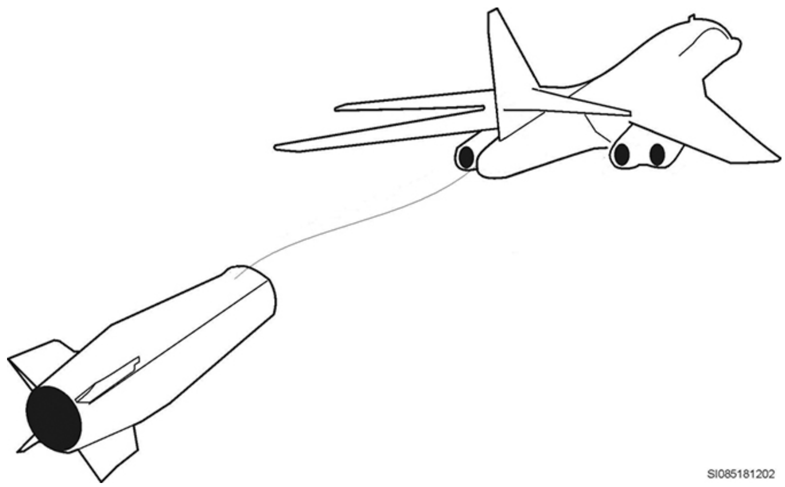



**Figure 3–17. ALE–50 operation.**

The AN/ALE–50 system consists of an Advanced Airborne Expendable Decoy (AAED) round, a launcher which holds the decoy round and launches it upon command, and a controller which contains the electronic circuitry that interfaces with each host platform (fig. 3–18). The decoy is a self-contained repeater that presents a more attractive target to an incoming missile and lures it away from the carrier aircraft. The complete decoy round consists of a canister, reel assembly, towline, and the expendable decoy, which is common to all platforms.

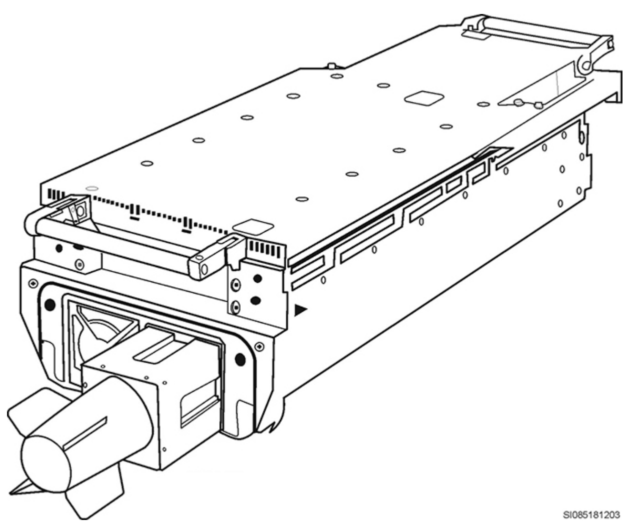



**Figure 3–18. ALE-50 round/launcher/controller.**

The AN/ALE–50A (V)1 is designed for the B–1B and is comprised of the Integrated Multi-Platform Launch Controller (IMPLC) and 1 x 4 dual compatible launcher (DCL). This version can carry four decoys and two complete systems can be mounted on the B–1B for a total of up to eight available decoys per aircraft. The AN/ALE–50 (V)2 is designed for the Block 25/30 F–16s and Block 40/50 F–16C/D and is comprised of the 1 x 2 launcher/controller that is installed into the 16S351-805 pylon and can only deploy the AAED. This version can carry two decoys and two systems can be mounted on the F–16 for a total of up to four decoys per aircraft.

### *ADM–160B Miniature Air Launched Decoy*

While being able to divert enemy missiles from our aircraft is a good thing, forcing the enemy to react to diversions is even better. Mission planners wanted the capability to saturate and confuse enemy air defenses without risking any of our aircraft. Launching free flight decoys allows us to saturate enemy air defenses with large volumes of targets simultaneously. This forces the enemy to divert its efforts to react to multiple threats (some real, some fake), diverting their air defense assets away from our aircraft. The platform that selected to undertake this mission is the ADM–160B Miniature Air Launched Decoy (MALD) shown in figure 3–19.

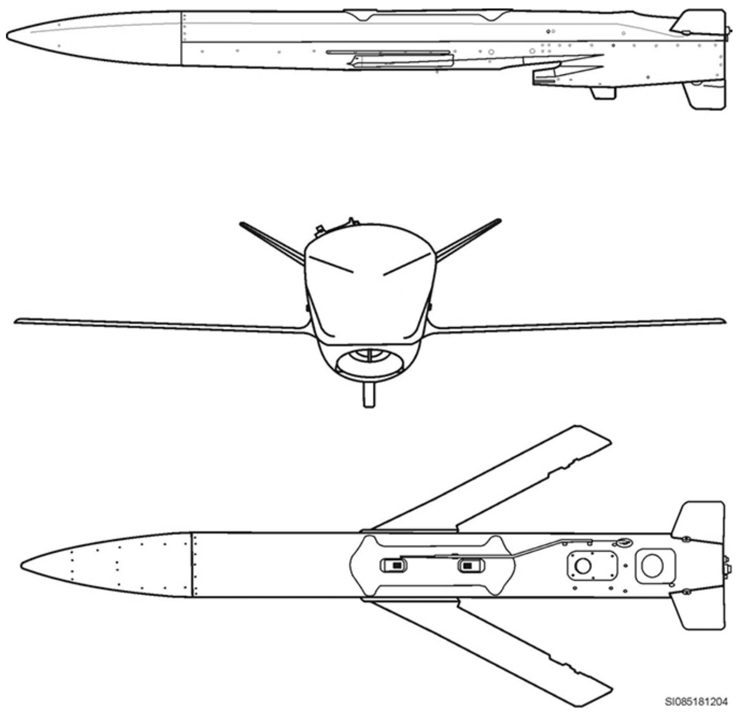



**Figure 3–19. ADM–160B MALD.**

The MALD is an air launched, preprogrammed, powered RF active vehicle used to deceive and saturate enemy integrated air defenses during strike aircraft operations. A computer within each vehicle can be preprogrammed with flight profile data before loading or the flight profile data can be uploaded by a MILSTD–1760 connector on the top of the drone at any time prior to launch. In either case the mission profile data provides flight management and controls of the vehicle through a series of planned maneuvers after launch (fig. 3–20). The MALD simulates a fighter/attack size aircraft.

The MALD is a 282 pound decoy munition using 14-inch lug spacing. It can be carried on the F–16 either singly on the MAU–12 bomb rack, or two can be carried on TER. The decoy can also be carried on the BA–52's heavy stores adapter beam (HSAB), with up to eight decoys per HSAB. Projects are currently underway to increase the carriage options for other aircraft in the inventory.

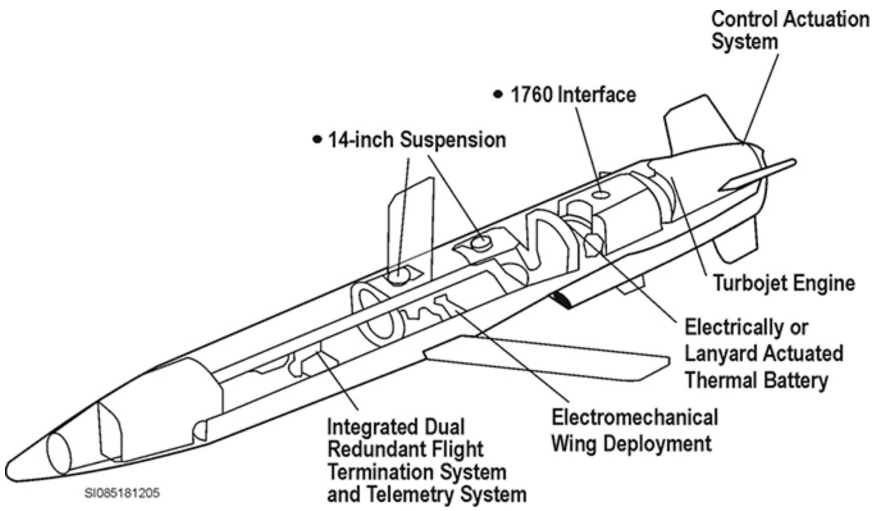



**Figure 3-20. ADM–160B MALD cutaway.**

## Self-Test Questions

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

### 218. Pyrotechnic ammunitions and munitions

1. What factors control the visibility of pyrotechnic ammunition?

2. List the classifications of pyrotechnic ammunition.

3. What two types of effects do signals have?

4. What does the pyrotechnic identification of colored bands signify?

5. What kinds of light do the parachute flares produce?

6. How much power and how long does the light usually last?

7. Why does the LUU–2/B flare not have a “safe” setting?

8. What should you do if you accidentally pull the timer knob of a LUU–2/B during handling?

9. How do you set the time delay on a LUU–2 A/B flare?

10. The MJU–7/B flare cartridge is used on which aircraft?

11. How many flare stations are found on the F–16 and F–15 aircraft?

12. What is the purpose of the M–206 flare?

13. On which aircraft can the M–206 flare and MJU–11 flare magazine be installed?

14. What flare cartridge is used on the B–1B aircraft?

15. What flare payloads are compatible with the ALE–52 dispenser system?

**219. Electronic countermeasures munitions**

1. What is the capacity of the MJU–11 chaff dispenser?

2. When carrying chaff and flares together, what positions of the B–1B chaff/flare station can chaff dispensers be loaded?

3. How many chaff dispensers are on the AC–130 gunship?

4. What three components comprise a complete AN/ALE–50 system?

5. What is the maximum number of AN/ALE–50 (V)2 decoys that can be carried by an F–16?

6. Which pylon on the F-16 can deploy the Advanced Airborne Expendable Decoy (AAED)?

7. What type of aircraft is simulated by the MALD?

8. Which two aircraft are currently capable of carrying the MALD?

## 3–3. Mines

Why do we as 2W1s need to study naval munitions? Our forces need to vary the types of munitions they use, in order meet our ever changing roles and missions. A different type of terrain (such as more ocean area) definitely dictates a munitions change. For these and other reasons, the Air Force has introduced the capability of using bomber aircraft to drop naval mines. A variety of mines may be loaded on the B-1B and B-52, but it isn't within the scope of this course to cover all of these, so our discussion will be limited to the most commonly used mines—the MK-62, -63, and -65.

### 220. Naval mines

We use many weapons to support other forces. Maritime mining operations are one of the tasks we share with the Navy. The main weapon system we use to complete this mission is the Quickstrike family of naval mines. In this lesson we will cover the weapons currently used in this family of mines.

#### MK–62 / MK–63 Quickstrike mines

The MK–62 (fig. 3–21) and MK–63 (fig. 3–22) mines are new generation weapons closely related to the old Destructor family of mines. They make use of the same variable influence-type target-detector systems. They are aircraft-laid bottom mines intended for use against submarines and surface targets. The primary difference between the two weapons is their warhead. The MK–62 mine uses the MK–82 500-pound GP bomb as a warhead while the MK-63 uses the larger MK–83 1,000-pound GP bomb. All mines have the capability of making arming-delay, sterilization, self-destruct, and other operational settings. The newest Quickstrike mines are programmable and modular, allowing them to be updated to keep abreast of emerging threat targets. All mine casings are painted gold.

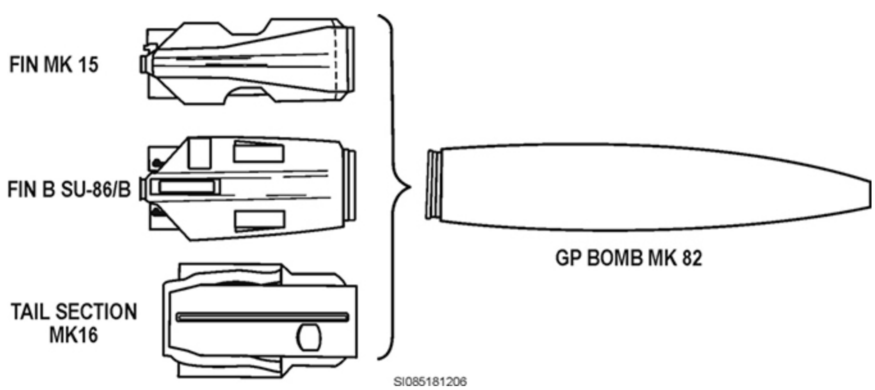



**Figure 3–21. MK-62 Quickstrike mine.**

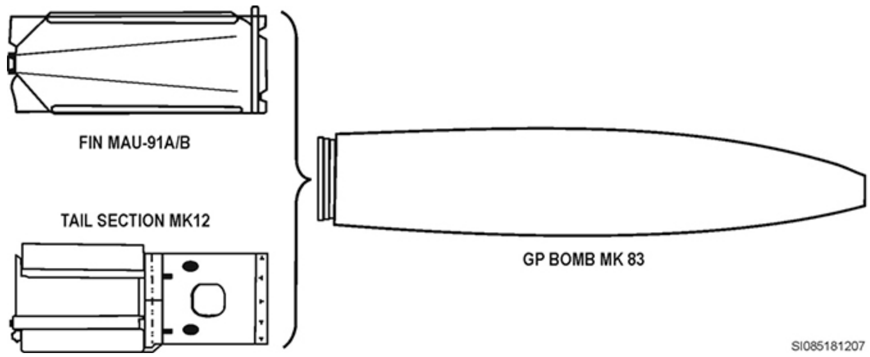



Figure 3–22. Mk-63 Quickstrike mine.

## MK–65 Quickstrike mine

MK–65 (fig. 3–23) is a 2,000-pound weapon, employing a distinctively different, new concept, thin-walled, mine-type case, as opposed to the thick-walled bomb-type case of the MK–62/–63. Older Quickstrike versions (MK–62 and MK–63) were converted streamlined bombs of the 500-pound and 1000-pound sizes. Other differences in the MK–65 include a special arming device, a nose fairing, and a tail section adaptable to adding a parachute option. The B–52H is the only aircraft in the Air Force inventory that is capable of carrying the MK–65. As always, you should be extremely careful and *do not* pull the parachute pack opening control unit arming wire from the control unit after you remove the safety device (safety pin and safety screw). The parachute will eject with enough force to injure nearby personnel. Since the nose fairing is retractable, never insert your fingers in the nose fairing access holes; you could be seriously injured if the fairing were inadvertently released. Never roll this mine when removing it from a trailer; you could damage the mine or its components.

The MK 7 Mod 1 tail section deploys a parachute after separation from the aircraft to provide retarded delivery. The TDD is installed in the aft fuze well of the MK–65 case. The MK–65 is 21 inches in diameter, and 128 inches long.

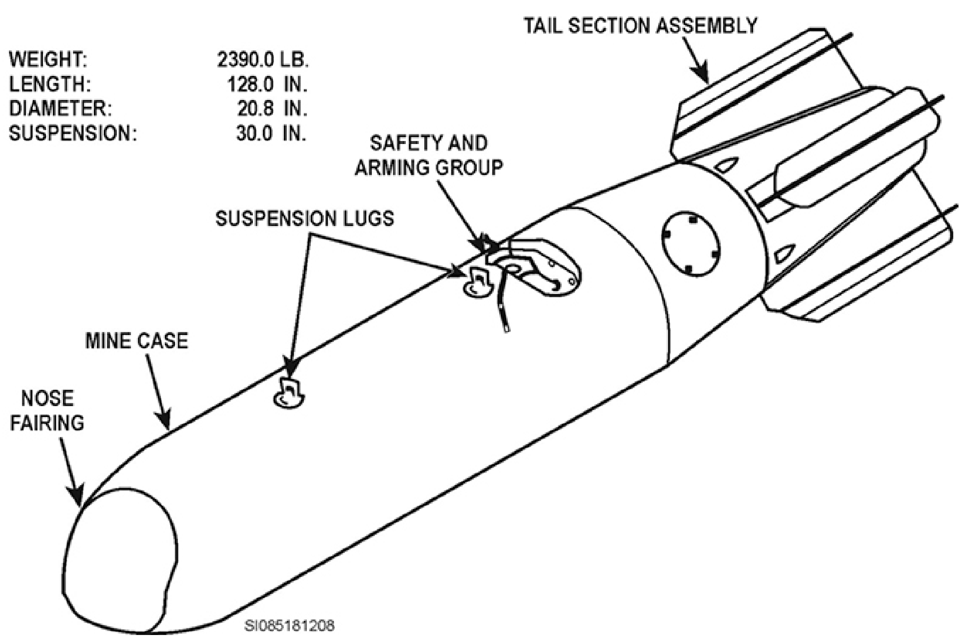



Figure 3–23. MK–65 Quickstrike mine.

### Naval mine loading

We said the MK–65 mines are loaded on the B–52, but we didn't say where and how they're loaded. The mines may be loaded internally or externally. Internally they're loaded on the cluster bomb rack (CBR), four mines per rack, in either the front or rear bays or both. A *maximum internal mine load* consists of eight stores. Externally the B–52 can carry a total of 10 mines. They're loaded on the HSAB at the forward, center, and aft shoulder stations, five per beam (2-1-2), one beam installed on each side of the aircraft. The B–52 can carry a total of 45 MK–62 mines, 27 on cluster racks internally, and 18 on the wing stations with heavy stores adapter beam (HSAB), externally. Only 18 MK–63 mines can be carried by the B–52 and all are stored externally on the HSAB.

While the B–1B and B–2 are capable of carrying mines as well, they are limited to the MK-62 model only. The B–1B is capable of carrying a *maximum* total of 84 MK–62 mines internally on the conventional bomb module, while the B–2 can carry 20 mines on each installed smart bomb rack assembly (SBRA).

## Self-Test Questions

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

### 220. Naval mines

1. What type of munition are the MK–62 and MK–63?

2. What munition is used as the warhead for the MK–63?

3. What aircraft is capable of deploying the MK–65?

4. Why must you never roll the MK–65 when removing it from the trailer?

## Answers to Self-Test Questions

### 216

1. Cartridge case, primer, propellant, rotating band, projectile (bullet), and flash tube assembly.
2. (1) It's the receptacle in which the primer, propellant and projectile are assembled.
   (2) It's a waterproof container for the primer and propellant.
   (3) It expands in and seals the weapon's barrel, keeping gas from escaping to the rear when the cartridge is fired.
3. Extracting grove.
4. Electrically or by percussion.
5. Electrically–20 mm. Percussion–7.62 mm, .50 caliber, 25 mm, 30 mm, 40 mm and 105 mm.
6. It creates the gas pressure required to push the projectile from the barrel of the weapon and to the target.
7. It makes the projectile rotate during movement, and it keeps propellant gases from escaping past the projectile when it is fired.

8. API.
9. It means that small particles may self-ignite when exposed to the friction and heat of a munitions strike.
10. There are none.
11. Dummy rounds may be complete one-piece rounds or normal rounds with the primer removed; either type must have the word INERT stenciled on them.
12. TP and TPT.
13. A ring of red or orange Ts stenciled around the projectile body.
14. Never.
15. Prolonged exposure to heat will affect the ballistics of ammunition.

**217**

1. Explosive and non-explosive (dummy) cartridges.
2. They're used to create gas pressure to eject or cause the release of stores from an aircraft during flight.
3. Normally electrically initiated and case grounded.
4. Electrically, impact, and heat.
5. Reduces the amount of gas pressure produced and consequently affects the munitions release or ejection process.
6. Shelf life and service life.
7. The length of time an impulse cartridge can stay in storage under prescribed packaging and storage requirements.
8. The length of time an item can stay in actual service (use).
9. (1). By placing a strip of pressure sensitive self-adhesive tape (no more than 3/8 inch wide and 0.002 inch thick) around the cartridge. This tape must not overlap and must not be placed within 3/8 of the cartridge base. The service life must be written on the tape indelible ink.
   (2) By scribing markings on the cartridge case with permanent ink, a metal scribe, or other sharp pointed instrument.
   (3) By placing markings on the cartridge closure disc with indelible ink.
10. Because touching the electrode of the cartridge could cause inadvertent ignition.
11. Loosening of the closure disc.
12. If it's only used in a breech with a spring-loaded firing pin, an impulse cartridge may be used an unlimited number of times during its service life.
13. Unserviceable.

**218**

1. Candlepower, frequency, color, weather, and light.
2. Illuminants (photoflash cartridges and flares), signals, combination signaling and illuminating items, and simulators.
3. Light and smoke.
4. The color of the signal produced.
5. White or yellowish light in the visual range or infra red illumination.
6. Usually ranges from 60,000 candlepower for 1 minute to 2,000,000 candlepower for 5 minutes or longer.
7. Because it can't function until two lanyard release systems have been actuated.
8. Forcibly hold the timer and release mechanism by hand on the flare housing to prevent ejection. When the timer completes its cycle, tape the mechanism to the flare housing, and mark the flare for disposal.
9. Rotate the timer knob to the desired setting from 500 to 11,000 feet.
10. A–10, F–15, and F–16.
11. 4; 4.
12. It simulates aircraft engine heat to decoy enemy IR missiles.
13. A–10.

14. MJU–23/B flare cartridge.
15. The MJU–10/B, MJU–39/B, MJU–40/B, and the MJU–7 A/B.

## 219

1. 30 (1 X 1 X 8 inch) RR–170/180 chaff cartridges.
2. 1, 2, 3, and 4.
3. 20.
4. The AN/ALE–50 consists of an AAED round, a launcher which holds the decoy round and launches it upon command, and a controller which contains the electronic circuitry that interfaces with each host platform.
5. 4.
6. Installed into the 16S351–805.
7. A fighter/attack size aircraft.
8. The F–16 and the B–52.

## 220

1. Aircraft-laid bottom mines for use against submarines and surface targets.
2. The MK-83 1,000-pound GP bomb.
3. The B–52H.
4. You could damage the mine or its 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).**

74. (216) Which ammunition round component expands in and seals the barrel's chamber to keep gas from escaping to the rear when the cartridge is fired?
    a. Cartridge case.
    b. Rotating band.
    c. Flash tube.
    d. Projectile.

75. (216) Which ammunition component actually starts the chain reaction to fire the round?
    a. Cap.
    b. Squib.
    c. Primer.
    d. Flash tube.

76. (216) What does the term *pyrophoric* mean?
    a. The munition is highly reactive with air and may self-ignite if placed in contact with it.
    b. The munition is highly reactive with water and may self-ignite if placed in contact with it.
    c. Small particles may self-ignite when exposed to the friction and heat of a munitions strike.
    d. The munition is sensitive to water pressure and uses the pressure exerted on it to detonate the warhead.

77. (216) Which precautions *must* you take to prevent exposure to harmful radiation when working around unfired munitions containing depleted uranium?
    a. You must wear protective gloves.
    b. You must wear a dosimeter to detect harmful radiation exposure.
    c. You must be tested annually to determine if you have been over exposed to radiation.
    d. There are *no* additional protective measures required beyond those standards for all munitions.

78. (216) A normal round with the primer and propellant charge *removed* is called a
    a. tracer round.
    b. dummy round.
    c. target practice round.
    d. high-pressure test round.

79. (216) What distinguishes 20mm high explosive incendiary with tracer (HEIT) rounds from high explosive incendiary (HEI) rounds?
    a. Red ring painted around the projectile.
    b. Red ring painted around the cartridge case.
    c. Ring of red Ts stenciled around the projectile.
    d. Ring of red Ts stenciled around the cartridge case.

80. (216) Which type of projectile has a hollow body?
    a. High explosive incendiary with tracer (HEIT).
    b. Armor piercing tracer (API).
    c. High explosive (HE).
    d. Target practice (TP).

81. (216) You *must* be extremely careful when handling linked ammo to keep from
    a. getting dirty.
    b. breaking the links.
    c. getting cut or pinched.
    d. damaging the container.

82. (216) Ammunition should *neve*r be needlessly subjected to sunlight because
    a. prolonged exposure to heat will affect its ballistics.
    b. the sun's ultra violet rays will degrade plastic rotating bands.
    c. prolonged exposure to heat will degrade the propellant charge.
    d. the sun's ultra violet rays will degrade the adhesive attaching the rounds primer to the case.

83. (217) What are the two basic types of impulse cartridges?
    a. Service and drill.
    b. Inert and dummy.
    c. Explosive and non-explosive.
    d. Expendable and non-expendable.

84. (217) Which of these impulse cartridges is *not* case grounded?
    a. ARD–863.
    b. ARD–446.
    c. BBU–63/B.
    d. BBU–863/B.

85. (217) Which impulse cartridge component *normally* provides a ground for the electrical firing circuit?
    a. Case.
    b. Primer.
    c. Electrode.
    d. Separation disc.

86. (217) What do you use to place scribe markings on the closure disc of an impulse cartridge?
    a. A sharp-pointed instrument.
    b. Dry erase ink marker.
    c. Indelible ink marker.
    d. Metal scribe.

87. (217) How many insertion markings constitute the end of service life for impulse cartridges that are used in breeches with spring-loaded firing pins?
    a. 5.
    b. 10.
    c. 15.
    d. No limit.

88. (218) Which action do you take if the timer knob of a LUU–2/B flare is accidentally pulled during ground handling and the timer cycle starts?
    a. Evacuate at least 400 feet and call explosive ordinance disposal personnel.
    b. Evacuate at least 4000 feet and call explosive ordinance disposal personnel.
    c. Submerge the flare in a 5 gallon water container and call explosive ordinance disposal personnel.
    d. Forcibly hold the time-and-release mechanism on the flare housing to prevent ejection of the timer and release mechanism; then tape the mechanism on the flare housing and mark it for disposal once the timer completes its cycle.

89. (218) On the LUU–2A/B flare what limits timer travel between safe and 500 feet?
   a. Two pegs.
   b. Switch.
   c. Clip.
   d. Pin.

90. (218) A F–15 and F–16 aircraft uses which type of flare magazines?
   a. MJU–12.
   b. MJU–7/B.
   c. MJU–10/B.
   d. MJU–23/B.

91. (218) What aircraft uses the MJU–17 flare magazines?
   a. F–15.
   b. F–22.
   c. F–15 and F–16.
   d. F–15, F–16, and F–22.

92. (218) How many flare magazines can be loaded on the F–22?
   a. 4.
   b. 6.
   c. 8.
   d. 16.

93. (218) The F–22 countermeasure stations are located just
   a. aft of the main weapons bays.
   b. aft of the left and right intakes.
   c. aft of the left and right side weapons bays.
   d. forward of the left and right engine exhaust nozzles.

94. (219) How many RR196/AL chaff bundles may be loaded in the ALE–52 magazines used in the F–22?
   a. 15.
   b. 18.
   c. 24.
   d. 30.

95. (219) AN/ALE–50 decoys can be deployed by the
   a. F–22 only.
   b. F–16 and the B–1.
   c. F–15 and the F–16.
   d. F–15, the F–16, and the F–22.

96. (219) How many AN/ALE–50 decoys can the B–1 carry?
   a. 4.
   b. 6.
   c. 8.
   d. 12.

97. (219) The heavy stores adapter beam can carry how many ADM–160B Miniature Air Launched Decoys (MALD)?
   a. 4.
   b. 6.
   c. 8.
   d. 12.

98. (220) Which naval mine uses the MK 82 GP bomb as its warhead?
    a. MK 52.
    b. MK 62.
    c. MK 63.
    d. MK 65.

99. (220) All naval mine casings are painted
    a. blue.
    b. gold.
    c. green.
    d. brown.

100. (220) Which aircraft is capable of deploying the MK 65 Quickstrike mine?
    a. F–15E only.
    b. B–52H only.
    c. F–15E and F–16.
    d. B–1, B–2, and B–52.

# Glossary Abbreviations and Acronyms

| | |
|---|---|
| **AAED** | advanced airborne expendable decoy |
| **ABF** | annular blast fragmentation |
| **AFD** | arm/fire device |
| **AFLC** | Air Force Logistics Center |
| **AGM** | air-to-ground missile |
| **AIM** | air intercept missile |
| **AIR** | air-inflatable retarder |
| **AJ** | anti jam |
| **ALCM** | air launched cruise missile |
| **ALE** | airborne countermeausres ejecton/release |
| **AMRAAM** | advanced medium range air to air missile |
| **AOTD** | active optical target detector |
| **API** | armor piercing incendiary |
| **APT** | armor piercing tracer |
| **ATM** | air training missile |
| **ATU** | Anemometer Vane Type Assembly |
| **AUP** | Advanced Unitary Penetrator |
| **BDU** | bomb dummy unit |
| **BFD** | battery-firing device |
| **BLU** | bomb live unit |
| **BRU** | bomb ejector rack unit |
| **BSU** | bomb stabilization unit |
| **CALCM** | conventional air launched cruise missile |
| **CBR** | cluster bomb rack |
| **CBU** | cluster bomb unit |
| **CDC** | career development course |
| **CEM** | combined effects munition |
| **CSRL** | common strategic rotary launcher |
| **DCL** | dual compatible launcher |
| **DODIC** | Department of Defense identification code |

| | |
|---|---|
| **DU** | depleted uranium |
| **ECM** | electronic counter measure |
| **ECS** | environmental control system |
| **ECU** | electrical conversion unit |
| **EFP** | explosively formed projectile |
| **EGBU** | enhanced guided bomb unit |
| **EO** | electro optical |
| **EOD** | explosive ordinance disposal |
| **ESAD** | safety and arming device |
| **FAU** | fin actuation unit |
| **FMU** | fuze munition unit |
| **FZU** | fuze related unit |
| **G & C** | guidance and control |
| **GBU** | guided bomb unit |
| **GCU** | guidance control unit |
| **GP** | general purpose |
| **GPS** | global positioning system |
| **HARM** | high-speed, anti-radiation missile |
| **HAS** | hydraulic actuation system |
| **HE** | high explosive |
| **HEI** | high-explosive incendiary |
| **HEIT** | high-explosive incendiary tracer |
| **HOF** | height of function |
| **HSAB** | heavy stores adapter beam |
| **IMPLC** | integrated multi-platform launce controller |
| **INS** | inertial navigation system |
| **IR** | infrared |
| **IRU** | inertial reference unit |
| **JASSM** | Joint Air-to-Surface Standoff Missile |
| **JDAM** | Joint Direct Attack Munition |
| **JHMCS** | joint helmet mounted cueing system |
| **JSOW** | joint standoff weapon |
| **JVC** | jet vein control |
| **KCAS** | knots, calibrated air speed |
| **KE** | kinetic energy |

| | |
|---|---|
| **KEP** | kinetic energy penetrator |
| **KMU** | kit munitions unit |
| **LAU** | launcher adapter unit |
| **LGB** | laser guided bomb |
| **MALD** | miniature air launched decoy |
| **MAU** | Miscellaneous Armament Unit |
| **MILSTD** | military standard |
| **MK** | supply code K (munitions) (pronounced mark) |
| **MRD** | missile restraint device |
| **NATO** | North Atlantic Treaty Organization |
| **NIR** | near infrared |
| **NSN** | National Stock Number |
| **PAL** | permissive action link |
| **PAS** | pneumatic actuation system |
| **QTDD** | quad/target detection device |
| **RDX** | Cyclotrimethylenetrinitramine |
| **rpm** | revolutions per minute |
| **S and A** | safe and-arm |
| **SAF** | safe/arm fuze when used in relation to AIM-120; safe/arm fuzing when used in relation to AGM-65 |
| **SBRA** | smart bomb rack adapter |
| **SASSM** | selective availability anti-spoofing module |
| **SDB** | small diameter bomb |
| **SFW** | sensor fuzed weapon |
| **SUU** | suspension utility unit |
| **TA** | time-to-arm |
| **TB** | time-to-burst |
| **TD** | target detector |
| **TDD** | target detecting device |
| **TER** | triple ejector racks |
| **TO** | technical order |
| **TP** | target practice |
| **TP-T** | target practice tracer |
| **USAF** | United States Air Force |
| **UXO** | unexploded ordinance |
| **VDC** | volts, direct current |

| | |
|---|---|
| **WCMD** | Wind Corrected Munitions Dispenser |
| **WDU** | warhead unit |
| **WP** | white phosphorus |

# Student Notes

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