CHAPTER 9

AIRCRAFT ORDNANCE

As an Airman, you might be assigned to the armament branch of an aircraft squadron, the weapons department of a naval air station, or an aircraft carrier. Regardless of where you are assigned, you will work around aircraft armament systems and various associated weapons. Aviation Ordnancemen (AOs) handle aircraft ordnance. They work with aircraft guns and pyrotechnics. They also maintain bombs, rockets, missiles, mines, and torpedoes. They maintain the aircraft weapons releasing and launching equipment necessary for disbursing such items. AOs are familiar with the safety precautions for working with such material. Personnel directly involved in ordnance handling must be qualified and/or certified according to the Navy’s current qualification/certification program. You may not be assigned in an area that requires direct contact with ordnance. You must still be familiar with the basic characteristics of ordnance and hazards peculiar to aircraft ordnance.

LEARNING OBJECTIVES

When you have completed this chapter, you will be able to do the following:

1. Describe common terms and definitions associated with aircraft ordnance.
2. State the method for identification and marking of ammunition.
3. Explain the purpose and types of aircraft bombs.
4. Identify the types, uses, and basic characteristics of air-launched guided missiles and guided missile launchers.
5. Identify the components of the M61A1 and M61A2 automatic gun and recognize the operating principles.
6. Define the purpose and use of hand-manipulated signaling devices.
7. Describe the types, uses, and basic characteristics of cartridges and cartridge-activated devices.
8. Identify the purpose and use of bomb racks.

TERMINOLOGY

AOs use special terminology on the job. To understand this chapter, you should know these terms. A few of the more common terms and definitions are as follows:

Ordnance

Military material (such as combat weapons of all kinds) with ammunition and equipment required for its use. Ordnance includes everything that makes up a ships or aircraft's armament. This includes guns, ammunition, and all equipment needed to control, operate, and support the weapons.

Propellant

The material that provides the energy for propelling a projectile, specifically an explosive charge for propelling a bullet, shell, or the like. It may also be a fuel, either solid or liquid, for propelling a rocket or missile.
Pyrotechnics
Ammunition containing compositions that produce illumination. Examples are colored lights or smoke for marking or signaling, or incendiary effects for smoke screens.

Ammunition
A device charged with explosives, propellants, pyrotechnics, initiating composition, or chemical materials.

Bomb-Type Ammunition
Bomb-type ammunition is characterized by a large high-explosive charge-to-weight ratio. Examples are aircraft bombs, mines, and warheads used in guided missiles and rockets. This ammunition has destructive blast effect at or near the target.

Cartridge-Activated Device (CAD)
Explosive loaded devices designed to provide the means of releasing or harnessing potential cartridge energy to initiate a function or a special-purpose action. Aircraft equipment, such as ejection seats, canopy ejection systems, aircraft bomb racks, and launchers, use CADs.

Chemical Ammunition
Chemical ammunition consists of a variety of items that depend upon a chemical filling for effect rather than upon explosives or shrapnel. An explosive or ignition element must activate this ammunition.

Inert Ordnance
Actual size ammunition items with working mechanisms used for training exercises but having no explosive materials.

Guided Missile
An unmanned vehicle designed as a weapon that travels above the surface of the earth. This vehicle follows a course or trajectory that is guided by an automatic or remotely controlled mechanism within the vehicle.

Incendiary
A chemical used to ignite combustible substances.

Practice/Training Ammunition
An ammunition item that looks and acts just like the service item. It may be a modification of a service (tactical) item or something designed specifically for practice. Used in training associated with all types of ordnance. Practice ammunition may either be expendable or recoverable, depending upon the device involved.

Service Ammunition
Ammunition for combat use. This ammunition is approved for service use. It contains explosives, pyrotechnics, or chemical agent filler. The propellant, if required, is of service or reduced charge weight. Service ammunition is also called tactical ammunition.
**Warhead**

The part of ammunition containing the materials intended to inflict damage. The explosives in warheads are called the payload.

**Airborne Stores**

Items that are NOT normally separated from the aircraft in flight. A partial list of these items includes tanks, pods, and non-expendable training weapons. Targets, racks, launchers, adapters, and detachable pylons are also included.

**High and Low Explosives**

There are two general classes of military explosives—high explosives and low explosives. Each is classified according to its rate of decomposition. High and low explosives may be further classified by their reaction, composition, or service use. However, only the two general classes, high and low, are covered in this chapter.

**High Explosives**

High explosives are usually products of organic substance nitration. They may contain nitrogen and inorganic substances or mixtures of both. A high explosive may be a pure compound or a mixture of several compounds. Additives, such as powdered metals, plasticizing oils, or waxes, provide desired stability and performance characteristics. A high explosive is characterized by extremely fast decomposition called detonation. A high explosive detonates almost instantaneously. The detonation is similar to a very rapid combustion or a rupture and rearrangement of the molecules themselves. In either case, gaseous and solid products are produced. The disruptive effect of the reaction makes some explosives valuable as a bursting charge. This bursting effect prevents its use in ammunition and gun systems because the gas pressures formed could burst the barrel of a weapon.

**Low Explosives**

Low explosives are mostly solid combustible materials that decompose rapidly but do not normally explode. This action is called deflagration. Upon ignition and decomposition, gas pressures develop to propel something in a definite direction. Ammunition, gun systems, and some missiles use this type of explosive. The rate of burning is an important characteristic, which depends on such factors as combustion gas pressure, grain size and form, and composition. Under certain conditions, low explosives may react in the same manner as high explosives and explode.

**AMMUNITION IDENTIFICATION**

Ammunition identification is an important part of ordnance handling and administration. Ammunition identification identifies the type of ammunition, class of explosive contained in the round, mark (Mk) and modification (Mod) numbers, lot numbers, and color codes representing the explosive hazards. Ammunition items are most readily identified by size, shape, and weight. Specific characteristics of these items are further identified by painting, marking, lettering, or combinations of these methods.

**Service Ammunition**

Ammunition intended for operational use is classified as service ammunition. The warhead contains explosives, pyrotechnics, or chemical agent filler. If required, the propellant is of service or reduced charge weight. Aircraft service ammunition is identified as either armament (kill stores) or ordnance (search stores).
Non-Service Ammunition

Ammunition used for training personnel in all aspects of a familiarization program is classified as non-service ammunition. This ammunition may be of service quality or may be specifically modified or loaded for practice ammunition inert training, inert dummy/drill, or exercise/recoverable ammunition.

Practice Ammunition

This is ammunition specifically designed or modified for use in exercises, practice, or operational training. Practice ammunition may be either expendable or recoverable. Practice ammunition is not inert and may contain all the explosive material normally contained in service ammunition. Practice ammunition may contain additional explosive material such as pyrotechnics, spotting charges, or flotation devices to assure destruction, location, or recovery.

Inert Ammunition

This is ammunition and components that contain no explosive material. Inert ammunition and components include:

- Ammunition and components with all explosive material removed and replaced with inert material
- Empty ammunition or components
- Ammunition or components that were manufactured with inert material in place of all explosive material

Drill Ammunition

This is inert ammunition which may have working mechanisms or cut-away sections and is used for training.

Painting

Painting (Table 9-1) is the application of the final body coating to ammunition, ammunition components, or ammunition containers by authorized activities. Usually, paint color identifies the use or explosive hazards of the ammunition; however, sometimes it has no meaning.
# Table 9-1 — Ammunition Color Codes

<table>
<thead>
<tr>
<th>COLOR</th>
<th>INTERPRETATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow</td>
<td>(1) Identifies high explosives (2) Indicates the presence of high explosives</td>
</tr>
<tr>
<td>Brown</td>
<td>(1) Identifies rocket motors and JATOs (2) Identifies low explosive items or components, or indicates the presence of a low explosive</td>
</tr>
<tr>
<td>*Gray</td>
<td>Identifies ammunition that contains irritant or toxic agents when used as an overall body color, except in underwater ordnance</td>
</tr>
<tr>
<td>Gray with Dark Red Band</td>
<td>Indicates the ammunition contains an irritant (riot control) agent</td>
</tr>
<tr>
<td>Gray with Dark Green Band</td>
<td>Identifies the ammunition contains a toxic agent other than binary agents</td>
</tr>
<tr>
<td>*Black</td>
<td>Identifies armor-defeating ammunition, except on underwater ordnance, dummy hand grenades, and when used for lettering or marking</td>
</tr>
<tr>
<td>Silver/Aluminum</td>
<td>Identifies countermeasure ammunition</td>
</tr>
<tr>
<td>Light Green</td>
<td>Identifies screening or marking smoke ammunition</td>
</tr>
<tr>
<td>Light Red</td>
<td>Identifies incendiary ammunition or indicates the presence of highly flammable material for producing damage by fire</td>
</tr>
<tr>
<td>*White</td>
<td>Identifies illuminating ammunition or ammunition producing a colored light; exceptions are underwater ordnance, guided missiles, dispensers, and rocket launchers, and when used for lettering or marking</td>
</tr>
<tr>
<td>Light Blue</td>
<td>Identifies ammunition used for practice</td>
</tr>
<tr>
<td>*Orange</td>
<td>Identifies ammunition used for tracking or recovery such as underwater mines and torpedoes</td>
</tr>
<tr>
<td>Bronze, Gold, and Brass</td>
<td>Identifies dummy/drift/inert ammunition not for firing, but only used for handling, loading, assembly and testing, training, and display; some dummy hand grenades may be painted black</td>
</tr>
</tbody>
</table>

**Nonsignificant Colors**

<table>
<thead>
<tr>
<th>COLOR</th>
<th>INTERPRETATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olive Drab</td>
<td>All ammunition items</td>
</tr>
<tr>
<td>Black</td>
<td>For lettering</td>
</tr>
<tr>
<td>White</td>
<td>(1) For lettering (2) For guide missiles, dispensers, and rocket launchers</td>
</tr>
</tbody>
</table>

*NOTE: The following colors, or when applied as stated, have NO identification color coding significance:
1. The colors gray, black, white, or green on underwater ordnance, such as mines and torpedoes, and the color white on guided missiles, dispensers, or rocket launchers
2. The colors black and white when used for lettering or special marking
3. Unpainted or natural color
4. Colors specifically applied to identify the color produced by smoke ammunition or pyrotechnics

## Marking

Marking is the application of colored spots, bands, or symbols on ammunition, ammunition components, or ammunition containers. Markings, by their color or shape, identify ammunition fillers or the presence of specific ammunition components.
AIRCRAFT BOMBS

Bombs must be manufactured to withstand reasonable heat and be insensitive to the shock of ordinary handling. They must also be capable of being dropped from an aircraft in a safe condition when in-flight emergencies occur.

Bomb detonation is controlled by the action of a fuze. A fuze is a device that causes the detonation of an explosive charge at the proper time after certain conditions are met. A bomb fuze is a mechanical or an electrical device. It has the sensitive explosive elements (the primer and detonator) and the necessary mechanical/electrical action to detonate the main burster charge. A mechanical action or an electrical impulse, which causes the detonator to explode, fires the primer. The primer-detonator explosion is relayed to the main charge by a booster charge. This completes the explosive train.

Aircraft Bomb Ammunition and Associated Components

Aircraft bombs are released over enemy targets to reduce and neutralize the enemy's war potential. This is done by destructive explosion, fire, nuclear reaction, and war gases. Aircraft bomb ammunition is used strategically to destroy installations, armament, and personnel; and tactically in direct support of land, sea, and air forces engaged in offensive or defensive operations.

For safety reasons, some bomb ammunition is shipped and stowed without the fuzes or arming assemblies and associated components installed. This ammunition must be assembled before use. Other types, such as cluster bomb units (CBUs), are shipped and stowed as complete assemblies, with fuzes or arming assemblies and associated components installed.

Bombs are designed to be carried either in the bomb bay of aircraft or externally under the wings or fuselage. The general characteristics and basic principles of operation of bomb ammunition and its associated components are described in this chapter. Bomb assembly procedures are discussed in Chapter 13 of this manual.

General-Purpose Bombs and Fin Assemblies

General-purpose (GP) bombs are used in most bombing operations. GP bombs have a slender body made of steel with a well in the nose section for a nose fuze, adapter booster, proximity sensor, or penetrator plug (ogive or MXU-735); a well in the aft section for a tail fuze; and wells centrally located on the top of the bomb body—two for suspension lugs and one for an arming safety switch Mk 122. Their cases (bomb bodies) are aerodynamically designed and relatively light, and approximately 45 percent of their weight is made of explosives. The GP bombs are compatible with proximity sensors, and mechanical and electronic fuzes. These GP bombs use either a conical or retarding fin, laser/GPS guidance airfoil fuzes. These GP bombs use either a conical or retarding fin, laser/GPS guidance airfoil kits, or underwater mine kits.

The GP bombs are olive drab or gray with stenciling on the side for identification. The size and weight of each bomb and other unique information is provided in the following paragraphs. Some of the bomb bodies have a thermal protective coat applied to the surface to extend the cook-off time (see Table 9-2). The nomenclature of the high-explosive filler in the bombs is stenciled on the bomb body, stamped on the base plug, and further identified by a yellow band around the nose. Thermally-protected bombs are identified by two yellow bands and the words THERMALLY PROTECTED in the identification legend. The lot number is stenciled on the forward end.
### Table 9-2 — MK 80/BLU 100 Series Cook-Off Times

<table>
<thead>
<tr>
<th>ITEM</th>
<th>ORDNANCE</th>
<th>FUZE/ADAPTER BOOSTER</th>
<th>AVERAGE REACTION TIME (Min. &amp; Sec.)</th>
<th>SHORTEST REACTION TIME</th>
<th>BOMB INITIATED REACTION</th>
<th>FUZE INITIATED REACTION (NOTE 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bomb H6 and PBXN 109 Filled</td>
<td>Mk 82, 83, 84 unprotected</td>
<td>All</td>
<td>3 + 30</td>
<td>2 + 30</td>
<td>Deflagration to explosion</td>
<td>Deflagration to detonation (after 5 minutes)</td>
</tr>
<tr>
<td></td>
<td>Mk 82 Mods (NOTE 2)/BLU-111 A/B BLU-126/B thermally protected</td>
<td>FMU-139</td>
<td>10 + 00</td>
<td>8 + 30</td>
<td>Deflagration</td>
<td>Deflagration to detonation (after 12 minutes)</td>
</tr>
<tr>
<td></td>
<td>No fuze</td>
<td></td>
<td>3 + 04</td>
<td>- -</td>
<td>- -</td>
<td>Deflagration to detonation (denotation may occur after 5 minutes)</td>
</tr>
<tr>
<td></td>
<td>Mk 83 Mods/ BLU-110 thermally protected</td>
<td>FMU-139</td>
<td>10 + 00</td>
<td>8 + 49</td>
<td>Deflagration</td>
<td>Deflagration to detonation (after 12 minutes)</td>
</tr>
<tr>
<td></td>
<td>Mk 84 Mods/ BLU-117 thermally protected</td>
<td>FMU-139</td>
<td>10 + 00</td>
<td>8 + 45</td>
<td>Deflagration</td>
<td>Deflagration to detonation (after 12 minutes)</td>
</tr>
<tr>
<td></td>
<td>BLU-109 A/B thermally protected PBXN-109</td>
<td>FMU-143</td>
<td>12 + 18</td>
<td>12 + 00</td>
<td>Deflagration</td>
<td>Deflagration</td>
</tr>
<tr>
<td></td>
<td>BLU-116A/B PBXN-109</td>
<td>FMU-143</td>
<td>14 + 15</td>
<td>11 + 58</td>
<td>Deflagration</td>
<td>Deflagration</td>
</tr>
</tbody>
</table>

**NOTES**

1. Fuze initiated reaction. Frequency of detonation reaction is small.
2. Chips in exterior coating and/or groove for retarding fin cut to bare steel do not change cook-off time.
The GP bombs currently in use are the GP Mk 80/BLU 100 (series). The specifications for the individual bombs are listed in Figure 9-1. The basic difference between the bombs listed is their size and weight. The following description of the Mk 80/BLU 100 (series) bomb is applicable to all bombs within the Mk 80/BLU 100 (series) unless otherwise noted.

Figure 9-1 — Specifications for GP bombs.
Shipping Configuration

The bomb body (Figure 9-2) is shipped with a plastic plug installed in the nose and tail fuze well to prevent damage to the internal threads and keep out moisture. The aft end of the bomb body has a metal shipping cap installed. Plastic lug caps are installed in the suspension lug wells, and a plastic plug is installed in the fuze-charging receptacle well. Some bombs contain a hoisting lug packaged in the tail fuze well.

![Figure 9-2 — Bomb Mk 80/BLU 100 (series) exploded view (shipping configuration).](image)

Bombs are shipped on metal pallets. The number of bombs loaded on each pallet depends on the bomb size. For example, six Mk 82/BLU 111 bombs can be shipped on a pallet, three Mk 83/BLU 110 bombs can be shipped on a pallet, and two Mk 84/BLU 117 bombs can be shipped on a pallet. Refer to *Airborne Weapons Packaging/Handling/Stowage*, NAVAIR 11-120A-1.1 or appropriate MIL-STD/WR for more information on shipping configurations.
**Fin Assemblies**

Fin assemblies, used with the Mk 80/BLU 100 (series) GP bombs, provide stability to the bomb. They cause the bomb to fall in a smooth, definite curve to the target, instead of tumbling through the air.

Two types of fins are described in this chapter—conical and retard/nonretard. The conical fin is used for the unretarded mode of delivery, and the retard/nonretard fin assembly can be used for either the unretarded or retarded mode of delivery.

**Conical Fin**

The typical BSU-33/conical fin assembly (Figure 9-3) is steel, conical in shape, and has four fins to provide stability. Access covers, attached by quick-release screws, are located on the sides of the fin body, providing access for dearming and inspections. There is a drilled or punched hole at the top and bottom of the forward end of the fin body. This hole is used to install an arming wire when the bomb is being configured for electric tail fuzing. The fin is attached to the aft end of the bomb, and is secured in place by tightening the fin setscrews into the V-groove of the bomb.

![MK 82/BLU 111/BDU-45/B Bomb (Typical)](image1)

![Conical Fin Assembly (MK 83/BLU 110)](image2)

![BSU-85 Air Inflatable Retarder (MK 83/BLU 110 Only)](image3)

![BSU-33 Fin Assembly (MK 82/BLU 111/BDU-45 Only)](image4)

*Figure 9-3 — Typical bomb conical fin assemblies.*
**Principles of Operation**

There are three modes of delivery available for the fin assembly. They are retarded, unretarded, and in-flight selection (pilot option) of either mode.

**Retarded Mode**

In the retarded mode of delivery, the fins open to retard or slow the weapon. Since the aircraft and the weapon are traveling at the same speed when the weapon is released, the weapon and the aircraft arrive at the target at the same time. During low-level bombing, the aircraft could be damaged by the blast; therefore, the retarded mode of delivery is used during low-level bombing to ensure the aircraft is clear.

**Unretarded Mode**

In the unretarded mode of delivery, the weapon is released from the aircraft and the fins remain in the closed position. The weapon free-falls to the target. In the unretarded mode of delivery (without pilot option), the cotter/safety pin installed in the fin release band is not removed or replaced with an arming wire.

However, the safety tag that reads REMOVE BEFORE FLIGHT is removed.

**BSU-85/B Air Inflatable Retarder**

The BSU-85/B bomb fin attaches to the Mk 83/BLU 110 GP bomb. It is an air-inflatable retarder designed for very low altitudes. It can be dropped in either high-drag (retarded) or low-drag (unretarded) mode. (Figure 9-4.) The BSU-85/B fin attaches to the bomb body by eight setscrews. It is a self-contained unit that consists of a stabilizer assembly (canister housing) with four fixed fins (X-shaped) and a lanyard assembly (Figure 9-5, Views A and B). The four

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**Figure 9-4** — Typical BSU-85/B air-inflatable retardable fin with high- and low-drag configurations.
fixed fins provide low-drag aerodynamic stability. The wedges installed on the trailing edges provide stabilizing spin during both low-drag and high-drag release. When stored in its original shipping/storage container, the bomb fin shelf life is 20 years.

Figure 9-5 — BSU-85/B air-inflatable retardable fin (top and rear view).
BSU-86/B Bomb Fin

The BSU-86/B bomb fin is used with GP bombs, Mk 82 Mods/BLU 111 (series), or the practice bomb BDU-45/B (Figure 9-6). The fin provides a retarded (high-drag) or unretarded (low-drag) bomb delivery capability for the aircraft. The BSU-86/B fin is attached to the Mk 82/BLU 111 or BDU-45/B bomb by eight setscrews. A 25-degree wedge is located at the tips of each fin to impart spin. The air stream drives the fin open rapidly, when the MAU-199/B spring arming wire (SAW) is activated. The spring load under each fin blade initiates fin opening.

Figure 9-6 — BSU-86/B fin with Mk 82 or BLU 111 bomb.
Guided Bomb Units (GBU)

GBU-10/12/16 GBU

GBU-10/12/16 GBUs (Figure 9-7) are Mk 80/BLU-110/111/117 (series) GP bombs modified to detect a target illuminated by a laser beam. The modification consists of a MAU-169 (series) MAU-209 (series) Computer Control Group (CCG) or WCU-10 (series) Control Section (CS) and MXU-650, -651, or -667 (series) Air Foil Group (AFG). The CCG and guidance fins are mounted on a forward adapter assembly and provide target detection and guidance. The wing assembly is mounted aft.

<table>
<thead>
<tr>
<th>Physical Characteristics</th>
<th>GBU-12/GBU-51/GBU-52</th>
<th>GBU-16</th>
<th>GBU-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>610 lb.</td>
<td>1100 lb.</td>
<td>2081 lb.</td>
</tr>
<tr>
<td>Dimensions:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>131 in.</td>
<td>145 in.</td>
<td>170 in.</td>
</tr>
<tr>
<td>Diameter</td>
<td>11 in.</td>
<td>14 in.</td>
<td>18 in.</td>
</tr>
<tr>
<td>Suspension Provisions</td>
<td>14 in.</td>
<td>14 in.</td>
<td>30 in.</td>
</tr>
</tbody>
</table>

Figure 9-7 — Typical GBU configuration.

The GBU-12F/B is a dual-mode weapon that incorporates Global Positioning System (GPS) guidance using the WGU-53/B vice the MAU-169, MAU-209 or WCU-10. Each AFG contains identical items; although they are different in physical size, they perform identical functions. A typical AFG is composed of a folding wing assembly, forward adapter assembly, guidance fins, and hardware required for assembly of laser-guided weapons.

9-14
The CCG mounts on the nose of the bomb body (this precludes the use of nose fuzing). The CCG detects a laser-illuminated target and provides weapon guidance signals to the moveable guidance fins (canards). The canards attach to the CCG and the forward adapter assembly. The canards react to the signals received from the CCG to direct the weapon to the target.

The wing assembly is mounted on the aft end of the bomb body. It adds necessary aerodynamic stability and lift for in-flight maneuvering. An electric tail fuze is installed in the tail of the bomb. Except for the glass nose of the CCG, all components are painted olive drab and the bomb body has standard GP markings.

**GBU-51/B and GBU-52/B Guided Bomb Units**

GBU-51/B and GBU-52/B GBUs are BLU-126/B LOCO bombs modified to detect a target illuminated by a laser beam. The GBU-51/B modification consists of a MAU-169 (series), MAU-209 (series) CCG or WCU-190 (series) Control Section and MXU-650 (series) AFG. The CCG and guidance fins are mounted on a forward adapter assembly and provide target detection and guidance. The wing assembly is mounted aft. The GBU-52/B is a dual-mode weapon that incorporates GPS guidance using the WGU-53/B vice the MAU-169, MAU-209 or WCU-10.

**GBU-24 (Series) Paveway III**

The GBU-24 (series) Paveway III (*Figure 9-8*) is a converted BLU-109A/B or BLU-116A/B 2000-pound-class bomb designated as a hard target penetrator (HTP). The associated components required for conversion are fuze, AFG, FZU generator, adapter group, and guidance control unit. The heavy-walled case of the bomb provides the capability to penetrate 4 to 6 feet of reinforced concrete. The BLU-109A/B has a thermal protective coating applied to the surface to extend the cook-off time. The BLU-109A/B must not be missing more than 20 square inches of thermal coating in a single area or more than 40 square inches total.

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*Figure 9-8 — GBU-24.*
Joint Direct Attack Munition (JDAM)/Laser JDAM (LJDAM) Series

JDAM GBUs (Figure 9-9) are Mk 82/83/84, BLU-109, or BLU-110/111/117/126 bombs modified with GPS guidance sets. The guidance sets for these weapons are functionally the same but not interchangeable because of the guidance software and physical interface with the warhead. Guidance set control fin actuators contain either electrically released motor “friction” brakes (designated KMU-XXX/B) or a fin lock device (designated KMU-XXXA/B) which unlock the tail control fins in flight. New production variants of the fin lock device guidance sets will be equipped with either Selective Availability Anti-Spoofing Module (SAASM) (designated KMU-XXXB/B) to provide capability of decoding new GPS cryptography. LJDAM adds a laser detector, DSU-38/B, to the GBU-38 (series) 500-pound weapons. When equipped with the DSU-38/B, the weapons are redesignated GBU-54 (series).

<table>
<thead>
<tr>
<th>Physical Characteristics</th>
<th>GBU-31(V) Series</th>
<th>GBU-31(V)4 Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>2085 lbs.</td>
<td>2162 lbs.</td>
</tr>
<tr>
<td>Dimensions:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>152.72 in.</td>
<td>148.60 in.</td>
</tr>
<tr>
<td>Diameter</td>
<td>25.32 in.</td>
<td>24.32 in.</td>
</tr>
<tr>
<td>Suspension Provisions</td>
<td>30 in.</td>
<td>30 in.</td>
</tr>
</tbody>
</table>

Figure 9-9 — JDAM/LJDAM.
Mines

The Mk 62 mine is a 500-pound weapon (Figure 9-10) and the Mk 63 mine is a 1000-pound weapon. Mk 62 and 63 mines are aircraft laid and can be utilized as land mines or may be laid in shallow to deep water as bottom mines. The component interchangeability feature of the mine permits defective components to be quickly and easily replaced without greatly affecting the operational readiness of the weapon. This concept also allows the Mk 62 and Mk 63 mines to be identical to their bomb counterpart in appearance, external configuration, weight, CG, ballistics, handling, and loading.

The Mk 62 mine consist of bomb body MK 82 or BLU 111, and the MK 63 mine consist of bomb body MK 83 or BLU110. A bomb/mine conversion kit, Mk 130 Mod 1, contains the Mk 32 arming device, Mk 59 booster, and the Mk 57 target detecting device (TDD) which requires an Mk 130 battery to be installed into the Mk 57 TDD. The bomb/mine conversion kit also has the necessary hardware (less battery and fin assembly) to convert a GP bomb to an air-laid mine.
The Mk 65 Mods mine (Figure 9-11) is a 2000-pound, aircraft-laid, all modular, influence-actuated bottom mine used against submarines and surface targets. PBXN-103 is used as the explosive payload. Through use of specific components, mine Mk 65 Mod 0, Mod 1, and Mod 3 can each be assembled in two Operational Assemblies (OAs). The Mk 65 mine consists of a Mk 65 mine case, a Mk 45 safety device arming group with an Mk 2 arming device, a Mk 57 target detecting device, and a Mk 7 tail assembly.

**Cluster Bomb Units (CBU)**

Cluster Bomb Units (CBUs) are weapons that dispense smaller weapons over a large area. The method of dispensing provides for release of the entire CBU which separates, by fuzing action, at a prescribed altitude. The smaller weapons are scattered when the CBU separates.
CBU-99B/B Antitank Bomb Cluster (Rockeye) and Dispenser Bomb SUU-76C/B

The antitank bomb cluster (Figure 9-12) is a free-fall, folding fin, airburst weapon. The bomb consists of an Mk 7 Mod 3 bomb dispenser loaded with Mk 118 Mod 0 antitank bombs and an Mk 339 mechanical time fuze or retrofitted with the FMU-140/B Dispenser Proximity Fuze (DPF) (Figure 9-17). The bomb cluster is delivered to operating activities completely assembled with 14-inch suspension lugs, arming wires, extractors, fuze, and a removable fuze protective cover installed. Fins are held in the folded position with a fin retaining band secured by an arming wire and a ground handling safety pin. When the ground handling safety pin and arming wire are removed, the spring-loaded fins open to a 34.2-inch span.

The Mk 20 Mod 6/7/11 weapons have a thermal protective coating to improve cook-off protection in the event of a fire. The Mk 20 Mod 7/11/12 weapons use a tether device to retain the nose fuze and fin release bands upon release.

<table>
<thead>
<tr>
<th>Physical Characteristics</th>
<th>CBU-99B/B</th>
<th>SUU-76C/B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>490-505 lb.</td>
<td>230-310 lb. (with payload, PDU-5/B)</td>
</tr>
<tr>
<td>Dimensions:</td>
<td></td>
<td>143 lb. (empty)</td>
</tr>
<tr>
<td>Length</td>
<td></td>
<td>92.0 in.</td>
</tr>
<tr>
<td>Diameter</td>
<td></td>
<td>13.2 in.</td>
</tr>
<tr>
<td>Suspension Provisions</td>
<td></td>
<td>14.0 in.</td>
</tr>
</tbody>
</table>

Figure 9-12 — CBU-99B/B antitank bomb cluster.
CBU-99/B and CBU-100/B weapons retrofitted with AWC 422 will be redesignated CBU-99B/B and CBU-100B/B respectively. The dispenser bomb, SUU-76C/B, is configured as a CBU-100/B that has had the Mk 118 bomblets removed and has a payload sleeve and spacers installed. When the payload sleeve is filled with leaflets and inserted into the dispenser, the All-Up-Round (AUR) is redesignated PDU-5/B. Information on decanning, preparation for use, and recanning procedures are found in Airborne Weapons Assembly Manual Cluster Bombs Units, NAVAIR 11-140-9.

**SUU-76C/B (PDU-5/B) Dispenser Bomb**

The SUU-76C/B (PDU-5/B) dispenser bomb (Figure 9-13) is a free-fall, folding-fin, airburst, cluster-type dispenser. The dispenser consists of a SUU-76 bomb dispenser loaded with leaflet material and an Mk 339 mechanical time fuze. The SUU-76C/B (PDU-5/B) is delivered to operating activities completely assembled with 14-inch suspension lugs, arming wires, extractors, fuze, and a removable fuze protective cover. Fins are held in the folded position with a fin retaining band secured by an arming wire and a ground handling safety pin. When the ground handling safety pin and arming wire are removed, the spring loaded fins open to a 34.2 inch span. The leaflet dispenser contains an in-flight fuze option that requires the use of an option time wire and extractor, and has a fuze observation window for verifying settings and safety. The dispenser has fin and fuze tethers incorporated to retain release bands when the dispenser is released.

![Figure 9-13 — SUU-76C/B (PDU-5/B) dispenser bomb.](image-url)
Mk 118 Mods 0 and 1 Antitank Bomb

When the Mk 118 bomb (Figure 9-14) separates from the dispenser case, the base fuze-arming vane rotates and the fuze is armed. If the bomb strikes a hard target, such as concrete or armor, the electric detonator ignites the shaped-charge warhead immediately. If the bomb strikes a soft target, such as earth or a sandbag, the bomb penetrates the target until deceleration lets the inertia firing pin strike and initiate the stab detonator, causing warhead denotation.

CBU-78C/B Bomb Cluster (GATOR)

The CBU-78C/B bomb cluster (Figure 9-15) is an antipersonnel/antitank, free fall, folding fin, airburst weapon. The weapon consists of an SUU-58/B dispenser loaded with BLU-91/B and BLU-92/B mines, kit modification unit BRU-42/B, and a FMU-140A/B fuze. The weapon is delivered to operating activities completely assembled with 14-inch suspension lugs, arming wire extractors, and a

Figure 9-14 — Antitank bomblets MK118 Mod 0/Mod 1.

Figure 9-15 — CBU-78C/B bomb cluster (GATOR).
removable fuze cover installed. Fins are held in the folded position with a fin retaining band secured by an arming wire and a ground handling safety pin.

**SUU-58/B Subsonic Free-Fall Dispenser**

The SUU-58/B consists of a cargo section with a nose fairing assembly attached, a tail cone assembly, and fuze arming wires with extractors. There are two observation windows—one for viewing the safe/arm indicator and the other to observe the fuze time-setting dials. The cargo section houses the BLU-91/B and BLU-92/B mines. The tactical weapons have two yellow bands around the nose cone fairing.

**BLU-91/B and BLU-92/B Mines**

The target sensors are the primary difference between the two mines. The BLU-91/B uses an armor-piercing warhead and a magnetometer type of sensor; the BLU-92/B has a fragment type of warhead with trip wires as the primary target sensor.

**Practice Bombs**

Practice bombs are used to simulate the same ballistic properties of service bombs. Practice bombs are manufactured as either solid or cast-metal bodies. Since practice bombs contain no explosive filler, a practice bomb signal cartridge (smoke) can be used for visual observation of weapon-target impact. The primary purpose of practice bombs is safety when training new or inexperienced pilots and ground-handling crews. Other advantages of practice bombs include their low cost and an increase in available target locations.

Although not classified as practice bombs, the Mk 80 (series) inert-filled GP bombs are used for full-scale practice bombing. These bombs are physically the same as the Mk 80 (series) GP service bombs, but they do not contain explosive filler and are painted blue. These bombs provide full-scale training for assembly and loading crews and pilots.

The two general types of practice bombs are subcaliber or full-scale practice bombs. Subcaliber means that the practice bomb is much smaller in size and weight than the service bomb it simulates. Full-scale practice bombs are representative of service bombs in their size and weight.

**Subcaliber Practice Bombs**

There are two types of subcaliber practice bombs—the Mk 76 Mod 5 and BDU-48/B. The two types are used for practice and are quite different in design and appearance from each other.

**Mk 76 Mod 5**

The Mk 76 Mod 5 is a 25-pound, solid, metal-cast practice bomb (*Figure 9-16*). Its body is teardrop shaped and centrally bored to permit the insertion of a practice bomb signal cartridge. The after body, which covers the tail tube, is crimped to the bomb body and has welded-on tail fins. The bomb is designed with single-lug suspension, using the Mk 14 suspension lug.

*Figure 9-16 — Mk 76 Mod 5 practice bomb.*
The Mk 76 Mod 5 practice bomb is designed for impact firing only. It uses the Mk 1 firing pin assembly to initiate the practice bomb signal cartridge. The bomb signal and the firing pin assembly are held in the bomb by means of a cotter pin. The bomb is painted blue and the identification nomenclature is stenciled in white letters on the bomb body.

**BDU-48/B**

The BDU-48/B is a 10-pound practice bomb (Figure 9-17). It is a thin-cased cylindrical bomb used to simulate retarded weapon delivery. The bomb is composed of the bomb body, a retractable suspension lug, a firing assembly, and box-type conical fins. The firing device

**Full-Scale Practice Bombs**

Full-scale practice bombs have the same dimensions, weight factor, and configuration abilities as the service bombs they simulate. The bombs are filled with inert material to obtain the proper weight.

The full-scale practice bombs (Figure 9-18) currently in use are the Mk 80 (series) inert bombs and practice bomb BDU-45 (series). They include the Mk 82 inert, Mk 83 inert, and Mk 84 inert GP bombs. They can be configured with the same bomb components (fuzes, fins, lugs, and so forth) that are used to configure service bombs. However, if the use of fuzes is not desired, a Mk 89 Mod 0 bomb-
spotting charge adapter can be installed in the tail fuze well of the practice bomb to provide visual observation of weapon/target impact.

The Mk 80 (series) inert GP bombs are painted blue. The new Mk 80 (series) inert GP bombs have an olive-drab colored exterior and are thermally protected, but they can be distinguished from service bombs by a blue band around the nose and by the 1-inch letters INERT stenciled on the outside of the bomb body.

Laser Guided Training Round (LGTR)

The LGTR (Figure 9-19) provides a low cost training device permitting aircrews to realistically practice the employment of Paveway II LGTRs. The BDU-59 (series) duplicates the release envelope, terminal guidance, and closely matches the time of flight characteristics of the GBU-10/12/16.

The AUR LGTR has an aero-stabilized seeker to align the seeker to the LGTR velocity vector. The seeker can detect laser energy transmitted on one of twelve laser frequencies. A screwdriver-operated switch is provided to select one of the four to twelve prebriefed laser code settings. The LGTR is 4 inches in diameter and 75 inches long. The BDU-59 (series) has a weight of 89 pounds. The AUR shall not be disassembled for any maintenance inspection.

The guidance and control system uses pursuit navigation logic to null out the line-of-sight errors observed by the detector. Steering commands are provided to a pneumatic actuator driven by stored, compressed gas to deflect the canards.

The LGTR’s single Mk 14 suspension lug interfaces with the multiple-carriage bomb rack ejector unit’s aft hook. Two LGTR adapter brackets, PN 1784AS0827, must be used to secure the LGTR to the ejector unit. The LGTR adapter brackets are attached to the multiple-carriage bomb rack

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**Figure 9-19 — Laser guided training round (LGTR).**

<table>
<thead>
<tr>
<th>Laser Code Switch Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
</tbody>
</table>

**Figure 9-19 — Laser guided training round (LGTR) (Continued).**
ejector units forward and aft sway brace assemblies. The adapter brackets are sway-braced to secure the LGTR to the ejector unit.

**AIR-LAUNCHED GUIDED MISSILES AND GUIDED MISSILE LAUNCHERS**

Guided missiles are self-propelled objects. After launching, they automatically alter their direction of flight in response to signals received from outside sources. They usually carry high-explosive charges and are equipped with a means to explode them at or near a target. The majority of guided missiles used in the Navy are essentially rockets that are maneuvered while in flight.

**Air-Launched Guided Missiles**

The purpose of a guided missile is to reach and destroy or damage its target. The type of target involved influences the characteristics of the missile.

In general, a typical guided missile has a long, cylindrical shape, with an oval or a hemispherical shaped nose. It is fitted with a series of stabilizing or maneuvering fins, wings, or canards around its outer surface.

**Missile Classification**

Guided missiles are classified according to their range, speed, launch environment, mission, and vehicle type.

**Range**

Long-range guided missiles are usually capable of traveling a distance of at least 100 miles. Short-range guided missiles often do not exceed the range capabilities of long-range guns. The Navy has air-launched guided missiles that function within these ranges; they are medium-range or extended-range missiles.

**Speed**

The speed capability of guided missiles is expressed in Mach numbers. A Mach number is the ratio of the speed of an object to the speed of sound in the medium through which the object is moving. Under standard atmospheric conditions, sonic speed is about 766 miles per hour (Mach 1.0). Guided missiles are classified according to their speed as shown below:

- **Subsonic**—Up to Mach 0.8
- **Transonic**—Mach 0.8 to Mach 1.2
- **Supersonic**—Mach 1.2 to Mach 5.0
- **Hypersonic**—Above Mach 5.0

When considering the speed of an air-launched guided missile, the speed of the launching aircraft is added to the speed of the missile. For example, if a missile's speed is Mach 2.5 and the aircraft's speed, at the time of missile launch, is Mach 2.0, the missile's speed is Mach 4.5.

**Types of Guided Missiles**

Guided missiles are divided into two types—service missiles and nonservice missiles.

**Service Missiles**

These missiles are generally referred to as tactical missiles. Service missiles are fully operational and fully explosive loaded rounds, designed for service use in combat.
Nonservice Missiles

These include all types of missiles other than service or tactical. They are subdivided as captive air
training missiles (CATMs), dummy air training missiles (DATMs), special air training missiles
(NATMs), practice guided weapons (PGWs), and load drill trainer (LDT) missile.

Some practice and training missiles are used for actual launching. They contain live propulsion and
guidance systems with inert loaded warheads. They are fitted with pyrotechnic fuze indicator signals
and/or tracking flares that give a visual indication of missile/target impact. These missiles can also be
fitted with a telemetry-type warhead, which transmits electronic signals to a monitoring station. The
monitoring station displays the missile’s in-flight performance and missile/target hit. Some types of
exercise missiles contain explosive-destruct charges so the missiles destroy themselves in flight.
These explosive-destruct charges, when installed, are used as a safety measure so the missile does
not travel beyond the established target range.

Missile Designation—The Department of Defense established a missile and rocket designation
sequence. The basic designations (Table 9-3) of every guided missile are letters, which are in
sequence. The sequence indicates the following:

1. The environment from which the vehicle is launched
2. The primary mission of the missile
3. The type of vehicle

Examples of guided missile designators common to the Aviation Ordnanceman (AO) are as follows:

<table>
<thead>
<tr>
<th>Designator</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGM</td>
<td>Air-launched, surface-attack, guided missile</td>
</tr>
<tr>
<td>AIM</td>
<td>Air-launched, intercept-aerial, guided missile</td>
</tr>
<tr>
<td>ATM</td>
<td>Air-launched, training guided missile</td>
</tr>
<tr>
<td>RIM</td>
<td>Ship-launched, intercept-aerial, guided missile</td>
</tr>
</tbody>
</table>

A design number follows the basic designator. In turn, the number may be followed by consecutive
letters, which show a modification. For example, the designation of AGM-88C means the missile is an
air-launched (A), surface-attack (G), missile (M), eighty-eighty missile design (88), third modification
(C). In addition, most guided missiles are given popular names, such as Sparrow, Sidewinder, and
Harpoon. These names are retained regardless of subsequent modifications to the original missile.
Table 9-3 — Guided Missile and Rocket Designations

<table>
<thead>
<tr>
<th>FIRST LETTER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Air</td>
<td>Air launched</td>
</tr>
<tr>
<td>B Multiple</td>
<td>Capable of being launched from more than one environment</td>
</tr>
<tr>
<td>C Coffin</td>
<td>Stored horizontally or at less than a 45-degree angle in a protective enclosure and launched from the ground</td>
</tr>
<tr>
<td>F Individual</td>
<td>Carried and launched by one man</td>
</tr>
<tr>
<td>M Mobile</td>
<td>Launched from a ground vehicle or movable platform</td>
</tr>
<tr>
<td>P Soft Pad</td>
<td>Partially- or non-protected in storage and launched from the ground</td>
</tr>
<tr>
<td>U Underwater</td>
<td>Launched from a submarine or other underwater device</td>
</tr>
<tr>
<td>R Ship</td>
<td>Launched from a surface vessel, such as a ship or barge</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SECOND LETTER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>D Decoy</td>
<td>Vehicles designed or modified to confuse, deceive, or divert enemy defenses by simulating an attack vehicle</td>
</tr>
<tr>
<td>E Special Electronic</td>
<td>Vehicles designed or modified with electronics equipment or communications, countermeasures, and electronic relay missions</td>
</tr>
<tr>
<td>G Surface Attack</td>
<td>Vehicles designed to destroy enemy land or sea targets</td>
</tr>
<tr>
<td>I Intercept-Aerial</td>
<td>Vehicles designed to intercept aerial targets in defensive roles</td>
</tr>
<tr>
<td>Q Drone</td>
<td>Vehicles designed for target reconnaissance or surveillance</td>
</tr>
<tr>
<td>T Training</td>
<td>Vehicles designed to be modified for training purposes</td>
</tr>
<tr>
<td>U Underwater Attack</td>
<td>Vehicles designed to destroy enemy submarines or other underwater targets or to detonate underwater</td>
</tr>
<tr>
<td>W Weather</td>
<td>Vehicles designed to observe, record, or relay data pertaining to meteorological phenomena</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THIRD LETTER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>M Guided Missile</td>
<td>An unmanned, self-propelled vehicle with remote or internal trajectory guidance</td>
</tr>
<tr>
<td>R Rocket</td>
<td>A self-propelled vehicle whose flight trajectory cannot be altered after launch</td>
</tr>
<tr>
<td>N Probe</td>
<td>A non-orbital instrumented vehicle to monitor and transmit environmental information</td>
</tr>
</tbody>
</table>
Missile Identification

The external surfaces of all Navy guided missiles, except radome and antenna surfaces, are painted white or gray. The color white or gray has no identification color-coding significance when used on guided missiles.

There are three significant color codes used on guided missiles and their components—yellow, brown, and blue. These color codes indicate the explosive hazard in the missile component. If components are painted blue on a practice missile and have a yellow or brown band painted on them, the component has an explosive component that does not have a comparable part in a service missile.

Each component of the missile, besides being color coded, is identifiable by lettering stenciled on the exterior surface of the component. The lettering on a component gives information such as the mark and mod, type and weight of explosive filler, loading activity symbol and date of loading, temperature range restrictions, and unit serial number.

Missile Components

Guided missiles are made up of a series of subassemblies (Figure 9-20 and Figure 9-21). The various subassemblies form one of the major sections used to operate a missile system, such as guidance, control, armament (warhead and fuzing), and propulsion. The major sections are carefully joined and connected to each other. They form the complete missile assembly. The arrangement of major sections in the missile assembly varies, depending on the missile type.
The guidance section is the brain of the missile. It directs its maneuvers and causes the maneuvers to be executed by the control section. The armament section carries the explosive charge of the missile, and the fuzing and firing system by which the charge is exploded. The propulsion section provides the force that propels the missile.

**Guidance and Control Section**

The complete missile guidance system includes the electronic sensing systems that initiate the guidance orders and the control system that carries them out. The elements for missile guidance and missile control can be housed in the same section of the missile, or they can be in separate sections. There are a number of basic guidance systems used in guided missiles. Homing-type, air-launched, guided missiles are currently used. They use radar or infrared homing systems.

A homing guidance system is one in which the missile seeks out the target, guided by some physical indication from the target itself. Radar reflections or thermal characteristics of targets are possible physical influences on which homing systems are based. Homing systems are classified as active, semiactive, and passive.

**Active**

In the active homing system, target illumination is supplied by a component carried in the missile, such as a radar transmitter. The radar signals (Figure 9-22) transmitted from the missile are reflected off the target back to the
receiver in the missile. These reflected signals give the missile information such as the target’s distance and speed. This information lets the guidance section compute the correct angle of attack to intercept the target. The control section that receives electronic commands from the guidance section controls the missile’s angle of attack. Mechanically manipulated wings, fins, or canard control surfaces are mounted externally on the body of the weapon. They are actuated by hydraulic, electric, or gas generator power, or combinations of these, to alter the missile’s course.

Semiactive
In the semiactive homing system (Figure 9-23), the missile gets its target illumination from an external source, such as a transmitter carried in the launching aircraft. The receiver in the missile receives the signals reflected off the target, computes the information, and sends electronic commands to the control section. The control section functions in the same manner as previously discussed.

Passive
In the passive homing system (Figure 9-24), the directing intelligence is received from the target. Examples of passive homing include homing on a source of infrared rays (such as the hot exhaust of jet aircraft) or radar signals (such as those transmitted by ground radar installations). Like active homing, passive homing is completely independent of the launching aircraft. The missile receiver receives signals generated by the target and then the missile control section functions in the same manner as previously discussed.

Armament Section
The armament system contains the payload (explosives), fuzing, safety and arming (S&A) devices, and target-detecting devices (TDDs).

Payload
The payload is the element or part of the missile that does what a particular missile is launched to do. The payload is usually the explosive charge, and is carried in the warhead of the missile. High-explosive warheads used in air-to-air guided missiles contain a rather small explosive charge, generally 10 to 18 pounds of H-6, HBX, or PBX high explosives. The payload contained in high-explosive warheads used in air-to-surface guided missiles varies widely, even within specific missile
types, depending on the specific mission. Large payloads, ranging up to 450 pounds, are common. Comp B and H-6 are typical explosives used in a payload.

Most exercise warheads used with guided missiles are pyrotechnic signaling devices. They signal fuze functioning by a brilliant flash, by smoke, or both. Exercise warheads frequently contain high explosives, which vary from live fuzes and boosters to self-destruct charges that can contain as much as 5 pounds of high explosive.

Fuzing

The fuzing and firing system is normally located in or next to the missile's warhead section. It includes those devices and arrangements that cause the missile's payload to function in proper relation to the target. The system consists of a fuze, S&A device, a TDD, or a combination of these devices.

There are two general types of fuzes used in guided missiles—proximity fuzes and contact fuzes. Acceleration forces upon missile launch arm both fuzes. Arming is usually delayed until the fuze is subjected to a given level of accelerating force for a specified amount of time. In the contact fuze, the force of impact closes a firing switch within the fuze to complete the firing circuit, detonating the warhead. Where proximity fuzing is used, the firing action is very similar to the action of proximity fuzes used with bombs and rockets.

S&A Devices

S&A devices are electromechanical explosive-control devices. They maintain the explosive train of a fuzing system in a safe (unaligned) condition until certain requirements of acceleration are met after the missile is fired.

TDD

TDDs are electronic detecting devices similar to the detecting systems in fuzes. They detect the presence of a target and determine the moment of firing. When subjected to the proper target influence as to both magnitude and change rate, the device sends an electrical impulse to trigger the firing systems. The firing systems then act to fire an associated S&A device to initiate detonation of the warhead.

Air-to-air guided missiles are normally fuzed for a proximity burst by using a TDD with an S&A device. In some cases, a contact fuze may be used as a backup. Air-to-surface guided missile fuzing consists of influence (proximity) and/or contact fuzes. Multifuzing is common in these missiles.

Propulsion Section

Guided missiles use some form of jet power for propulsion. There are two basic types of jet propulsion power plants used in missile propulsion systems—the atmospheric (air-breathing) jet and the thermal jet propulsion systems. The basic difference between the two systems is that the atmospheric jet engine depends on the atmosphere to supply the oxygen necessary to start and sustain burning of the fuel. The thermal jet engine operates independently of the atmosphere by starting and sustaining combustion with its own supply of oxygen contained within the missile.

Atmospheric Jet Propulsion System

There are three types of atmospheric jet propulsion systems—the turbojet, pulsejet, and ramjet engines. Of these three systems, only the turbojet engine is currently being used in Navy air-launched missiles. A typical turbojet engine includes an air intake, a mechanical compressor driven by a turbine, a combustion chamber, and an exhaust nozzle. The engine does not require boosting and can begin operation at zero acceleration.
Thermal Jet Propulsion System

Thermal jets include solid propellant, liquid propellant, and combined propellant systems.

The majority of air-launched guided missiles used by the Navy use the solid propellant rocket motor. They include the double base and multibase smokeless powder propellants as well as the composite mixtures. Grain configurations vary with the different missiles. Power characteristics and temperature limitations of the individual rocket motors also vary.

In some guided missiles, different thrust requirements exist during the boost phase as compared to those of the sustaining phase. The dual thrust rocket motor (DTRM) is a combined system that contains both of these elements in one motor. The DTRM contains a single propellant grain made of two types of solid propellant—boost and sustaining. The grain is configured so the propellant meeting the requirements for the boost phase burns at a faster rate than the propellant for the sustaining phase. After the boost phase propellant burns itself out, the sustaining propellant sustains the motor in flight over the designed burning time (range of the missile).

Service Guided Missiles

Missiles have been operational for several years. Still, research on missiles continuously produces changes in the missile field. The missiles discussed in this manual are presently operational.

Sparrow III Guided Missile

The AIM-7M/P missile (Figure 9-25) is a supersonic, air-to-air DTRM guided missile. It is designed to be rail- or ejection-launched from an interceptor aircraft. The missile’s tactical mission is to intercept and destroy enemy aircraft in all-weather environments. It is designed to be launched from the F/A-18 aircraft.

The AIM-7M/P missile is a semiactive missile. Missile guidance depends on radio frequency (RF) energy radiated by the launching aircraft and reflected by the target. Excluding the radome, the missile body has four sectional tubular shells that house the major functional components. The four major functional components are the target seeker, flight control, warhead, and rocket motor. The overall length of the missile is approximately 142 inches, and the diameter 8 inches. It weighs
approximately 502-510 pounds. The missile is issued to the fleet as an AUR. The only assembly required at fleet level is the installation of the wing and fin assemblies, which are shipped in separate shipping containers.

The radome is ceramic and forms the nosepiece of the missile. It does not obstruct RF energy. It covers the RF head assembly of the target seeker and provides protection against environmental damage.

The target seeker receives and interprets the radar energy reflected from the target. Then it produces signals that are sent to the flight control section to direct the missile to intercept the target or come within lethal range of it.

The flight control consists of the autopilot and the hydraulic group. These function to provide control signals and mechanical energy to move the external control surfaces that guide the missile toward the point of intercept, and to stabilize the missile in pitch, yaw, and roll.

The warhead is located between the target seeker and flight control section. The warhead is explosive-loaded, and it contains the fuze, fuze booster charge, and the S&A device. It is a continuous-rod or blast-fragment type of warhead. With a continuous-rod warhead, target kill is accomplished by collision of the continuous ring with the target. For a blast fragment-type warhead, thousands of fragments are propelled through the air, thereby killing the target. Detonation is triggered either by a fuze pulse from the target seeker at the nearest point of intercept or a fuze pulse from the flight control upon impact with the target.

The DTRM attaches to the aft end of the missile flight control section. It is equipped with a SAFE/ARM igniter assembly that is manually locked in either the SAFE or ARMED position. This switch can only be repositioned with an arming key. When in the SAFE position, the arming key cannot be removed. This switch prevents accidental firing of the motor. It should not be moved to the ARMED position until immediately before aircraft launch.

The control surfaces consist of four delta-shaped wing and fin assemblies. The wings and fins are designed for quick attachment and release without the use of tools. The wing assemblies attach to the flight control section, which controls their rotary motion to produce the desired pitch, yaw, and roll. The tail fin assemblies attach to fittings on the rear of the rocket motor and provide stability to the missile.

Another series of the Sparrow III guided missile is the RIM-7M and RIM-7P. These missiles are surface-to-air guided missiles. They are used in some ships in the NATO Sea Sparrow Missile System (NSSMS). As an AO, responsibility for these missiles is in the area of handling and stowage only.

**Harpoon/Standoff Land Attack Missile-Expanded Response (SLAM-ER) Guided Missile**

The Harpoon surface attack guided missile, AGM-84 series (AGM-84D Tactical) air-launched missile (*Figure 9-26*), is an all-weather antiship attack weapon. The Standoff Land Attack Missile-Expanded Response (SLAM-ER) (*Figure 9-26*), AGM-84H/K, is a standoff land attack missile.

The Harpoon can be delivered from the F/A-18 and P-3 aircraft. The SLAM-ER can be delivered from the F/A 18 aircraft.

Both missiles are AURs and require no assembly other than installation of the wing and control fin assemblies. The Harpoon missile consists of the guidance section, warhead section, sustainer section, control section, wings, and control fins. The missile is approximately 151 inches in length and weighs approximately 1,160 pounds.

The Harpoon missile has a low-level cruise trajectory with over-the-horizon range that makes it less susceptible to radar detection. It uses active guidance and has counter-countermeasure capability.
The guidance section contains the seeker, radar altimeter, midcourse guidance unit, and power supply.

A radome on the front of the guidance section provides the required aerodynamic shield to protect the internal components of the seeker. During ground handling, a radome protector cap protects the radome.

The warhead section contains a penetration blast-type of explosive, the guided missile fuze, fuze booster, and the pressure probe assembly. It also provides internal routing of the interconnecting cable from the guidance section to other parts of the missile.

The sustainer section contains the fuel tank and fuel supply system, missile battery, pyrotechnic relay panel, and the turbojet engine. Three BSU-42/B missile wings and one BSU-43/B missile wing are attached to the sustainer section by quick-attach clevis-type fittings. These wings are attached to the missile at the organizational level. They provide the aerodynamic lift required to sustain missile flight. They are made of a framed aluminum honeycomb construction and are nonfolding.
The control section contains four control actuators, which control the control fins. Four identical nonfolding missile control fins (BSU-44/B) provide directional control of the missile’s airframe proportional to the input signal received from the guidance section. The control fins are one-piece aluminum castings, and are attached to the control fin actuators by means of an integral torque-limiting, screw-type device.

The AGM-84 H/K SLAM-ER, an evolutionary upgrade to the combat-proven SLAM, is an air-launched, day/night, adverse weather, over-the-horizon, precision strike missile.

The SLAM-ER provides an effective, long range, precision-strike option for both preplanned and Target of Opportunity attack missions against land and maneuvering ship targets.

SLAM-ER characteristics include: a highly accurate, Global Positioning System (GPS)-aided guidance system; an imaging infrared seeker and two-way data link with the AWW-13 Advanced Data Link pod for Man-In-The-Loop (MITL) control; improved missile aerodynamics performance characteristics that allow both long range and flexible terminal attack profiles; an ordnance section with good penetrating power and lethality; a user-friendly interface for both MITL control and mission planning.

The missile is approximately 172 inches in length and weighs approximately 1,478 pounds. SLAM-ER has two wing fairings and four fin assemblies and is contained in the CNU-595/E container.

**Sidewinder Guided Missile**

The Sidewinder guided missiles, AIM-9M (series) (*Figure 9-27*), are supersonic, air-to-air weapons with passive infrared target detection, proportional navigation guidance, and torque-balance control systems. They are capable of being launched from the F/A-18 aircraft. The AIM-9M series missiles are issued to the fleet as AURs. The components of the ATM-9 (series) are identical to the AIM-9M (series) except that a training warhead is substituted for the tactical warhead. The AIM-9M (series) missile is used strictly for tactical purposes. The ATM-9 (series) missile is used for pilot training in target acquisition and missile firing.

![Figure 9-27 — AIM-9M series Sidewinder guided missile.](image)
The Sidewinder guided missile is approximately 113 inches in length, 5 inches in diameter, weighs approximately 190 pounds, and consists of five major components. These components are the guidance and control section, the target detector (TD) section, the S&A device, the warhead section, and the rocket motor section (Figure 9-28).

The guidance and control section consists of the following three major assemblies:

1. An infrared seeker assembly, which is used for detecting the target
2. An electronic assembly, which is used for converting detected target information to tracking and guidance command signals
3. A gas servo assembly (which consists of a gas generator, manifold, pistons, rocker arms, electrical solenoids, and thermal battery), where the electrical guidance commands are converted to mechanical movement of the control fins

Four BSU-32/B control fins are mounted on the guidance and control section to provide aerodynamic lift and course alterations to the missile during free flight. They are movable surfaces that are electrically controlled and pneumatically operated by the gas servo assembly. The missile’s umbilical cable is also attached to the guidance and control section. A shorting cap/dust cover must be installed on the umbilical connector at all times when the missile is not electrically connected to the LAU-7 launcher. The umbilical cable provides the necessary path for the exchange of electronic signals between the missile and aircraft before missile launch. It also provides a connection to the launcher-mounted cooling gas supply, which prevents the electronic components of the guidance and control section from becoming overheated during operation before missile launch.

Figure 9-28 — AIM-9M (series) Sidewinder guided missile (exploded view).
Sidewinder AIM-9X (Series) Guided Missile

The AIM-9X (series) Sidewinder (hereinafter referred to as AIM-9X) is a supersonic, air-to-air, short-range guided missile, capable of both offensive and defensive counter-air missions in day/night operations (Figure 9-29). This launch-and-leave, air combat missile features passive infrared (IR) guidance to detect, intercept, and destroy enemy aircraft.

Figure 9-29 — AIM-9X (series) Sidewinder guided missile.
Principles of Operation

The AIM-9X is launched from an aircraft after target detection to home in on IR emissions, and intercept and destroy enemy aircraft. The missile interfaces with the aircraft through the missile launcher using an umbilical cable, a mid-body buffer connector, and three missile hangers. The AIM-9X incorporates a dual umbilical design (i.e. a modified AIM-9 “forward” umbilical cable and the AIM-9/120 “mid-body” umbilical). Using combinations of the missile’s forward and mid-body umbilicals, AIM-9X has two distinct interface configurations: digital and analog.

The digital interface configuration is invoked when the missile detects an active digital (i.e. MIL-STD-1553) interface at either the forward or mid-body umbilical aircraft/missile interface.

The analog interface configuration is invoked in the absence of a digital interface at either the forward and mid-body umbilical aircraft/missile interfaces.

Advanced Medium Range Air-to-Air Missile (AMRAAM)

The AIM-120 (series) AMRAAM is an all-weather missile (Figure 9-30). The F/A-18 aircraft currently carries the missile. The AIM-120 (series) is an AUR that consists of a guidance section, armament section, propulsion section, and control section. The overall length of the missile is approximately 144 inches with a diameter of 7 inches. The AIM-120A/B/C/C-4 weighs approximately 348 pounds and the AIM-120C-5/C-6/C-7/D weighs approximately 356 pounds. The wing span of the AIM-120A/B is 21 inches and the wing span for the AIM-120C/C-4/C-5/C-6/C-7/D is 19 inches. The missile is issued to the fleet as an AUR. The only assembly required at fleet level is the installation of the wing and fin assemblies.

![Image](image.png)

**Figure 9-30 — AIM-120 AMRAAM guided missile.**

The guidance section consist of a radome, seeker components, electronics unit, inertial reference unit, target detection device, batteries, power converter, and related harnesses and hardware.

The armament section includes a WDU-33/B fragmenting warhead, Mk 44 booster, and an FZU-49/B safe-and-arm fuze (SAF).

The propulsion section consists of a dual-thrust, solid propellant, low-smoke rocket motor, a blast tube and exit cone, and an arm/fire device (AFD).
The control section includes four independently-controlled electromechanical actuators, four thermal batteries, a data link assembly, and associated hardware. Gas pressure-operated mechanical locks during ground handling and captive carry lock the control surfaces in position. During launch, a pyrotechnic gas generator creates enough gas pressure to unlock the control surfaces.

**Maverick Missile**

The AGM-65 (series) Maverick missile (*Figure 9-31*) is a precision-guided, high-velocity, low visibility standoff weapon possessing extreme accuracy and a high probability of target destruction. It is designed as a highly accurate, reliable, low maintenance air-to-ground hardened target weapon compatible with a variety of airborne platforms in the U.S. Navy and U.S. Marine Corps inventories.

![Figure 9-31 — AGM-65 (series) Maverick missile.](image)

The Maverick is primarily utilized on fixed-wing aircraft for fixed hardened targets. The system is intended to be easy to load, launch, and maintain utilizing common launchers, ordnance support equipment, and electronic systems interfaces currently used by U.S. Navy and U.S. Marine Corps war fighters.

**High-Speed Anti-Radiation Missile (HARM)**

The AGM-88 (series) high-speed anti-radiation missile (HARM) (*Figure 9-32*) is used for defense suppression and similar operations.

The HARM is a supersonic, air-to-ground, rail-launched guided missile. Guidance is provided through reception of signals emitted from ground-based threat radar. It has the capability of discriminating a single target from a number of emitters in the environment.

The C version has an improved guidance section which incorporates improved tactical software and an electronically reprogrammable memory. The missile has four major sections: guidance, control, warhead, and rocket motor.
The HARM missile, in conjunction with the launching aircraft's avionics, detects, identifies, and locates enemy radar, displays threat information, and computes target parameters. The HARM missile is 10 inches in diameter, 194 inches long, and weighs 780 pounds. The missile operates in three basic modes: (1) self-protect (which attacks targets that pose immediate threat to the aircraft), (2) target of opportunity (which attacks discrete targets important to the tactical situation), and (3) prebrief (missile programmed to the vicinity of known or expected targets, and to attack when lock-on is achieved). Launch aircraft for the HARM are the EA-6B and F/A-18.

**Hellfire Missile**

The AGM-114 (series) Hellfire missile (*Figure 9-33*) is an antiarmor terminal homing weapon that uses a variety of warhead configurations, including shaped charge, blast fragmentation, and

*Note: The AGM-114K-2A has an external blast fragmentation sleeve located on the forward end of the warhead section.*
thermobaric, to defeat individual hard point targets with minimal exposure to enemy fire by the
delivery platform. It is designed as a precision-guided, high-velocity, low-visibility standoff weapon
possessing extreme accuracy and a high probability of target destruction. It is highly accurate,
reliable, low maintenance air-to-ground antiarmor weapon compatible with a variety of airborne
platforms in the U.S. Navy and U.S. Marine Corps inventory.

Hellfire missiles provide accurate fire on targets acquired and designated by ground observers or the
airborne laser target designator. The Hellfire is primarily used on helicopters against tanks, other
armored vehicles, and hardened fixed targets. The system is intended to be easy to load, launch, and
maintain utilizing common launchers, ordnance support equipment, and electronic systems interfaces
currently used by Army and Navy war fighters.

All versions of Hellfire missiles in the U.S. Navy and U.S. Marine Corps inventory are carried on the
M-272/M-299 guided missile launcher and can be launched from the AH-1W, AH-1Z, and H-60 Series
helicopter, and the MQ-1B, MQ-1C, and MQ-9 Series Unmanned Air Vehicles. The Hellfire missiles
may be launched in day or night operation in three launch modes and in four different firing modes.

The AGM-114 (series) Hellfire missile is composed of five unique sections or groups: the laser seeker assembly, the guidance section, the control section, the warhead section, and the propulsion section (Figure 9-38).

The laser seeker acquires and tracks targets designated with laser energy by using the energy reflected
from the target. The laser seeker section is packaged in two separate units—the seeker head assembly and an electronics assembly. The seeker head assembly consists of a gyro-optics assembly, dome, potted coil assembly, and the interface board, which attaches to the back of the gyro support. The gyro-optics assembly is an inertial-stabilized, spinning-mass, gimbaled detector assembly made up of three subassemblies: the rotor, gimbal, and the sensor. The dome is made of injection molded optical grade polycarbonate. A purging operation is performed to remove any moisture within the seeker head by replacing the air that is present with dry nitrogen under positive pressure. All AGM-114 (series) Hellfire missiles utilize an equivalent or similar seekers.

**Joint Stand-off Weapon (JSOW) AGM-154 (series)**

The JSOW (Figure 9-34) is a family of low-cost, air-to-ground weapons which employ a GPS-aided inertial guidance system and a kinematically efficient airframe. The JSOW has an inherent range capability that satisfies the stand-off requirements of the U.S. Navy, U.S. Air Force, and U.S. Marine Corps for attacking interdiction targets from outside enemy point defenses during day, night, and adverse weather conditions. The JSOW is intended for use on a wide range of aircraft, including the F-18C/D and the F-18E/F.

There are currently two configurations of the JSOW vehicle: AGM-154A and AGM-154C. All weapon variants are inexpensive, unpowered, and survivable. For payload delivery, they are carried aloft by a host of aircraft and launched to the target area from a Stand-off Outside Point Defense (SOPD).

The JSOW baseline AGM-154A is an air-launched, surface attack weapon that provides an intermediate stand off attack capability against a wide variety of less-than-value land and sea targets. It is an expendable air-to-ground weapon that can successfully accomplish pre-launch, launch, mid-course, and terminal flight phases of a surface attack mission. The baseline weapon body structure is composed of a main air vehicle assembly and payload assemblies.

The main air vehicle assembly is used in all JSOW configurations. Sub-assemblies of the air vehicle assembly are used in all JSOW configurations.
Tube-Launched, Optically Tracked, Wire-Guided (TOW) Missile

The BGM-71E-5B TOW 2A missile (Figure 9-35) is a precision wire-guided, high-velocity, short-range antitank/antiarmor and bunker weapon. It is designed as a tube-launched, optically tracked, wire-guided (TOW) missile integrated on the AH-1W (series) platforms. The TOW force deployment on vehicles and man-portable launchers.

The TOW system is intended to be easy to load, launch, and maintain utilizing common ordnance support equipment and electronic system interfaces currently used by U.S. Navy and U.S. Marine Corps war fighters.
The TOW missile can be fired from tube launchers installed on vehicles, helicopters, or from a tripod on the ground. The operator identifies a target using the launcher's telescopic sight, and then fires the missile. A very short duration (0.05 second) rocket motor ejects the missile from the tube, and the mid-body stabilization fins and the control fins on the tail flip out. After a safe distance is reached, the solid-fuel main boost motor is ignited, and accelerates the missile to a speed of about Mach 0.9. The motor exhausts are on the side because the tail is used to spool out the guidance wire. After launch, the operator simply has to keep the cross-hairs of his sight pointing at the target, and the guidance system will automatically transmit corrective commands to the system through the wire. The TOW is controlled in flight by its four gas-operated movable tail fins.

**Griffin Missile**

The Griffin missile *(Figure 9-36)* is a small, light, precision-guided, small-yield weapon used for light fortified structures and soft targets. It is designed as a highly accurate and reliable air-to-ground weapon with low maintenance requirements. It is currently compatible with the U.S. Marine Corps Harvest Hawk weaponization kit, with future integration being planned for U.S. Navy and U.S. Marine Corps UAV and rotary wing platforms.

The Griffin is primarily utilized on the C-130 Harvest Hawk platform for light fortified structures, stationary or moving vehicles, or as an anti-personnel round.

The system is intended to be easy to load, launch, and maintain utilizing common support equipment and electronic systems interfaces currently used U.S. Navy and U.S. Marine Corps war fighters.

There are currently two tactical variants of the Griffin planned for the U.S. Navy and U.S. Marine Corps. The major difference between these two variants will be the launch mode of the weapon. Fixed wing platforms, like the Harvest Hawk, will utilize a rear launching variant of the Griffin missile, while most rotary and UAV platforms will utilize a forward launching variant. Regardless of launch type, the Griffin will utilize GPS guidance after launch to track toward the designated target area. After reaching the target area, the Griffin missile will maneuver to acquire the laser designator from the remote ground-based designator unit. The Semi-Active Laser will then perform terminal guidance of the missile to the target.

The Griffin missile has three cockpit selectable fuzing options for controlled lethality and minimizing collateral damage.
These fuzing modes are height of burst, point detonation, and 5 millisecond delay fuzing. These fuzing options, along with Laser PRF codes and BIT testing via the Battle Management System, allow for real-time flexibility and assessment for the war fighter.

**AN/AWW-13 Advanced Data Link**

The AN/AWW-13 advanced data-link pod (*Figure 9-37*) is the communications link between the pilot and the weapon. The pod is suspended from a standard configured bomb rack. It can be jettisoned in an emergency. The pod contains the necessary electronics to allow the pilot to receive the transmitted video from the weapon and to transmit the command signals to the weapon. The AN/AWW-13 advanced data link allows the operator to select an aimpoint for weapon impact, and provides available link between munition seekers and humans. This link generally requires electro-optical/infrared acquisition in clear weather.

![AN/AWW-13 Advanced Data Link](image)

*Figure 9-37 — AN/AWW-9/13 advanced data-link pod.*

The AWW-13 pod transmits these RF signals to the missile under flight to allow slewing and designation of the track point of the missile. The missile data-link transmitter sends the seeker scene back to the AWW-13 data link pod on the controlling aircraft. The AWW13 pod then relays this scene up to the cockpit video display.

In addition, the pod contains a video tape recorder (VTR) that records the video transmitted by the weapon all the way to impact on the target. This allows low-cost weapon performance monitoring, which can be played back for mission evaluation or for training purposes.

The weapon system may be used in one- or two-aircraft operations. In a single aircraft operation, the aircraft carries both the weapon and the pod, and the aircraft perform both launch and control functions. In the two-aircraft operation, one aircraft carries the weapon and a second aircraft carries the pod. In this operation, both the launch aircraft and the pod aircraft receive a video picture of the target area from the weapon. After weapon launch, the pod aircraft monitors the flight of the weapon and can update the weapon aim point all the way to impact.
Guided Missile Launchers

Guided missile launchers provide the mechanical and electrical means of suspending and air-launching a guided missile from an aircraft. The physical, mechanical, and functional requirements vary for each particular missile-to-aircraft configuration. There are specific missile-to-launcher applications (Table 9-4) and a brief description of each type of missile launcher is discussed in the following paragraphs.

| LAU-7/A-6 | AIM-9 SIDEWINDER/AGM-122 SIDEARM | RAIL | F/A-18 |
| LAU-7B/A | AIM-9 SIDEWINDER/AGM-122 SIDEARM | RAIL | F/A-18 |
| LAU-7/A-7 | AIM-9 SIDEWINDER/AGM-122 SIDEARM | RAIL | EA-6B, F/A-18 |
| LAU-B/A | AIM-9 SIDEWINDER/AGM-122 SIDEARM | RAIL | F/A-18 |
| LAU-7C/A | AIM-9 SIDEWINDER/AGM-122 SIDEARM | RAIL | AV-8B, AH-1W, AH-1Z |
| LAU-7D/A | AIM-9 SIDEWINDER/AGM-122 SIDEARM | RAIL | F/A-18 |
| LAU-7E/A | AIM-9 SIDEWINDER/AGM-122 SIDEARM | RAIL | F/A-18 |
| LAU-7F/A | AIM-9 SIDEWINDER/AGM-122 SIDEARM | RAIL | F/A-18 |
| LAU-115C/A | AIM-7 SPARROW, AIM-9 SIDEWINDER, AIM-120 AMRAAM | RAIL | F/A-18 |
| LAU-115D/A | AIM-7 SPARROW, AIM-9 SIDEWINDER, AIM-120 AMRAAM | RAIL | F/A-18 |
| LAU-116/A | AIM-7 SPARROW | EJECTOR | F/A-18 |
| LAU-116A/A | AIM-7 SPARROW, AIM-120 AMRAAM | EJECTOR | F/A-18 |
| LAU-116B/A | AIM-7 SPARROW, AIM-120 AMRAAM | EJECTOR | F/A-18 |
| LAU-117(V)2/A | AGM-65 MAVERICK | RAIL | AV-8, F/A-18, P-3 |
| LAU-118(V)1/A | AGM-88 HARM | RAIL | EA-6B, F/A-18 |
| LAU-127D/A | AIM-9 SIDEWINDER, AIM-120 AMRAAM | RAIL | F/A-18 |
| LAU-127E/A | AIM-9 SIDEWINDER, AIM-120 AMRAAM | RAIL | F/A-18 |
| LAU-127F/A | AIM-9 SIDEWINDER, AIM-120 AMRAAM | RAIL | F/A-18 |
| M272 | AGM-114 HELLFIRE | RAIL | AH-1 |
| M279 | AGM-114 HELLFIRE | RAIL | AH-1 |
| M299 | AGM-114 HELLFIRE | RAIL | AH-1, HH-60, SH-60, MH-60 |
| TOW | BGM-71A (TOW) MISSILE | TUBE | AH-1 |
LAU-7 (Series) Guided Missile Launcher

The LAU-7 (series) guided missile launcher (*Figure 9-38*) is a reusable launcher that provides a complete launching system for use with the AIM-9 Sidewinder and AGM-122 SIDEARM missiles.

**LAU-7 Series**

*Figure 9-38 — LAU-7 (series) guided missile launcher.*
The launcher (Figure 9-39) has four major assemblies—the housing assembly, mechanism assembly, power supply, and nitrogen receiver assembly or Pure Air Generating System (PAGS).

**Figure 9-39—LAU-7 (series) guided missile launcher (exploded view).**

**Housing Assembly**

The housing assembly is the main structural member of the launcher. It is an extruded, machined-aluminum member that provides structural rigidity to the launcher and includes provisions for mounting all other assemblies. It also includes provisions for mounting the launcher to the aircraft.

**Forward Fairing Assembly**

The forward fairing assembly is an aluminum casting that mounts to the forward end of the outer housing to provide an aerodynamic nose to the front of the launcher. It has two doors that are spring loaded that provide access to the umbilical hook support assembly. The LAU-7F/A removes the spring-loaded doors.
**Umbilical Hook Support Assembly**

The umbilical hook support assembly mounts to the forward housing rails and, during missile loading, is connected to the missile umbilical shear block. At missile launch, the mechanism snaps up, retracting the sheared end of the umbilical cable into the launcher to prevent interference with the missile hangers.

**Fin Retainer Assemblies**

Two fin retainer assemblies are mounted to the forward end of the housing assembly beneath the forward fairing assembly. The fin retainer snaps over the missile fins to prevent movement during captive flight.

**Aft Fairing Assembly**

The aft snubber mount fitting assembly, aft snubber assembly, and aft fairing latch are assembled together as a group and mounted to the aft end of the housing assembly. When the aft fairing latch assembly is in the open position, you can access the nitrogen receiver assembly or the PAGS. It also releases the aft snubbers to allow missile loading. When in the closed position, it allows the snubbers to spring over the aft missile hanger, locking it in place.

**Mechanism Assembly**

The mechanism assembly is an electro-mechanical device that holds the missile for takeoffs and landings and releases the missile for launching. It mounts in the center of the housing assembly forward of the nitrogen receiver assembly or PAGS.

**Power Supply**

One power supply is available for use in the launcher. The power supply is a self-contained single-phase unit with connectors on each end. The aft connector links the power supply and the mechanism assembly. The forward connector provides the connection to the missile's umbilical cable.

**Nitrogen Receiver Assembly**

The nitrogen receiver assembly stores the high-pressure nitrogen (3,200 psi) used to cool the missile’s IR detector in the guidance system. The nitrogen receiver assembly mounts in the aft section of the launcher subassembly and screws into the aft end of the mechanism assembly. All nitrogen receiver assemblies contain a charging valve (for refilling), a relief valve, and a pressure indicator mounted in the aft end of the cylinder. The pressure indicator is color coded to ensure correct readings.

**Pure Air Generating System (PAGS)**

The PAGS is a modular constructed unit which mounts into the aft fairing of the launcher subassembly. The PAGS compresses and filters ambient air to generate high-pressure pure air used to cool the missile IR detector in the guidance system. The PAGS connects to the PAGS interface harness assembly.

Two configurations of the PAGS exist; HiPPAG and M-PACT. Both configurations are completely interchangeable; however, slight variations exist between the two.
LAU-115 (Series) Guided Missile Launcher

The LAU-115 (series) guided missile launcher (Figure 9-40) is a reusable launcher. It completes the F/A-18 aircraft suspension and launching system for the AIM-7 (series) Sparrow, AIM-9 (series) Sidewinder, and AIM-120 (series) AMRAAM missiles.

Figure 9-40 — LAU-115 (series) guided missile launcher.
LAU-116 (Series) Guided Missile Launcher

The LAU-116 (series) guided missile launcher (Figure 9-41) is a reusable launcher of the F/A-18 aircraft suspension and launching system for the AIM-7 (series) Sparrow and AIM-120 (series) AMRAAM missiles. The launchers are mounted internally in the fuselage structure. They are self-contained, gas-operated mechanisms, capable of suspending and ejecting the AIM-7 (series) Sparrow and AIM-120 (series) AMRAAM missiles.

Figure 9-41—LAU-116 (series) guided missile launcher.
LAU-117(V) 2/A Guided Missile Launcher

The LAU-117(V)2/A guided missile launcher (Figure 9-42) is a reusable launcher that completes the F/A-18, AV-8, and P-3 aircraft suspension and launching system for the Maverick AGM-65 air-to-ground missile.

LAU-118(V) 1/A Guided Missile Launcher

The LAU-118(V)1/A guided missile launcher (Figure 9-43) is a reusable launcher that completes the F/A-18 and EA6B aircraft suspension and launching system for the HARM AGM-88 air-to-ground guided missile.
The launcher consists of the launcher housing, forward and aft fairing assemblies, forward and aft launcher tracks, suspension lugs, and internal electrical components. The LAU-118 is suspended from the BRU-32 bomb rack on the inboard and outboard pylons. An electrically-operated retention mechanism prevents inadvertent loss of the missile.

**LAU-127 (Series) Guided Missile Launcher**

The LAU-127 series guided missile launcher (Figure 9-44) is designed to carry and launch the AIM-9 Sidewinder and AIM-120 AMRAAM missiles.

![LAU-127 Series Diagram](image)

**Figure 9-44**—LAU-127 (series) guided missile launcher.
Figure 9-45 — Hellfire (series) guided missile launcher.
Hellfire (Series) Guided Missile Launcher

The Hellfire (series) guided missile launcher (Figure 9-45) is designed to carry and launch the AGM-114 (series) Hellfire missiles. The M272 launcher provides a stable structure capable of carrying and launching one to four AGM-114 (series) Hellfire Surface Attack Guided Missiles. The M279 launcher provides a stable structure capable of carrying and launching one or two AGM-114 series Hellfire Surface Attack Guided Missiles. The M299 launcher adds the capability to fire one to four MIL-STD-1760 capable AGM-114 (series) Hellfire Surface Attack Guided Missiles.

The launcher is attached to the aircraft by a bomb-rack-equipped pylon on an aircraft weapons station. The launcher is suspended from the bomb rack by two hooks that engage the suspension lugs on the top of the launcher hardback. Sway braces on the bomb rack are adjusted against the launcher hardback to prevent lateral movement of the launcher.

The aircraft wiring harness provides the electrical connection from the aircraft to the launcher. This cable runs from the aircraft pylon to the umbilical connector on the top of the Electronic Command Signal Programmer (ECSP) and is part of the aircraft wiring harness. The electrical connection to the missile is provided via the ECSP or LEA to the launcher rail wiring harnesses. When the missile is loaded onto the launcher rail, the missile umbilical connectors engage the launcher umbilical connectors.

The missile is restrained in this position by the launcher holdback release mechanism. The holdback release mechanism is overcome during the launch sequence by missile thrust, allowing the missile to move forward and separate from the launcher. The launcher umbilical connector assemblies are protected by the launcher umbilical connector doors, which are automatically pushed open by the missile just prior to connector engagement. During launch, the launcher umbilical connector doors close, protecting the launcher umbilical connectors from the rocket motor blast.

TOW Missile Launcher

The TOW Missile Launcher (TML) (Figure 9-46) supports two BGM-71A (TOW) missiles and provides electrical interface with the TOW Missile System (TMS).

The TML electrically isolates the TOW missiles from the TMS until the gunner’s weapon action bar is closed. Then the TML provides the correct interface between the TMS and the missiles to be launched.

When the gunner’s weapon action bar is closed and the program is running, the Remote Armament Control (RAC) assembly relays energize and close the signal paths between the TMS and the missile. Also, the RAC assembly shear pin engages the missile and determines whether the missile is
in a low or high shear condition. Low shear is ready to withstand the vibration and jolts of transportation.

The missile is launched into the field of view of an infrared receiver, and wire-transmitted command signals from the TMS; guidance and command functional group steer the missile along the telescopic sight unit’s line-of-sight. After launch, the TML returns to its stow (+4 degrees) position.

**ADU-299 (Series) Missile Launcher Adapter**

The ADU-299 series missile launcher adapter (*Figure 9-47*) is used to adapt the LAU-7 missile launcher, providing Sidewinder missile capabilities.

Mechanical attachment of the adapter to the ejector rack is provided by two suspension lugs on 30-inch centers. Mechanical attachment of the adapter to the LAU-7 launcher is provided by two swivel nuts positioned on 30-inch centers to mate with the launcher bolts. When the launcher and adapters are electrically connected and mechanically mated, an adapter harness from the wing pylon to the aft end of the adapter supplies electrical power.

**AIRCRAFT GUNS**

Gun systems installed in high-speed aircraft must meet demanding performance requirements and provide firepower. The General Electric M61A1 and M61A2 20-mm automatic gun system, installed in the F/A-18 aircraft, along with the GAU-21, GAU-16, GAU-17 and M240D machine guns, meet these requirements.

**M61A1 and M61A2 Automatic Gun**

The M61A1 or M61A2 (M61A1/2) (*Figure 9-48*) is a six-barrel, rotary-action, automatic gun based on the machine-gun design of Richard J. Gatling. The gun consists of a revolving cluster of barrels. Each barrel is fired once per revolution. The M61A1/2 automatic gun is hydraulically driven, electrically controlled, and can fire M50 and PGU-series ammunition at 4,000 to 6,000 rounds per minute. As installed in Navy aircraft, the gun has a pilot-selectable firing rate of either 4,000 (GUN LOW) or
6,000 (GUN HIGH) rounds per minute. It is designed for either air-to-ground or air-to-air gunnery missions.

Ammunition is supplied to the M61A1/2 gun by an ammunition handling and storage system that functions within a specific aircraft. The system uses an endless conveyor that transports 20-milimeter ammunition from the ammunition drum to the gun. The conveyor then returns the expended cases and unfired rounds to the ammunition drum.

Although the physical location of components varies between different aircraft gun installations, the function and description of the components are essentially the same. The primary parts of the gun are the barrels, housing assembly, and rotor assembly. The following paragraphs contain a description of each gun component and an explanation of how each component works. Figure 9-49 shows an exploded view of the gun components and locations.

**Gun Components**

The primary parts of the gun are described in the following paragraphs.

**Muzzle Clamp Assembly**

The muzzle clamp assembly is positioned at the outer end of the barrels. It restrains individual barrel movement during firing. It is positioned against the flange on the barrels and secured by the pressure of the self-locking nut assembly against the opposite side of the shoulders.

**Mid-Barrel Clamp Assembly**

The mid-barrel clamp assembly is positioned near the center of the barrels. The clamp tabs are engaged in the slots of the stop shoulders on the barrels. This clamp should be secured in this position by rotating the locating disk to the locked position. The direction of rotation of the gun and barrel hue prevents the clamp from unlocking. As an additional safety measure, a cotter pin should be inserted through the locking disk.

![Figure 9-49 — M61A1 gun components and locations.](image-url)
Barrels
The M61A1/2 automatic gun has six rifled barrels. The stub rotor attached to the rotor body supports them. The three rows of interrupted locking lugs on the barrel engage similar interrupted locking lugs in the rotor to secure the barrel. There are three knurled bands near the center of the barrels. These bands provide a gripping surface for easy installation and removal of the barrels from the rotor.

Recoil Adapters
The recoil adapters are mounted on the bearing retainer and provide the front mounting for the gun. The adapters reduce the amount of recoil and counter-recoil forces transmitted to the supporting structure when the weapon is fired.

Firing Contact Assembly
The firing contact assembly is mounted to the housing so that the connector is outside the housing, and the spring-loaded cam is inside the assembly. The contact assembly provides the necessary path for the current to enter the housing and reach the breech-bolt assembly. This path goes through the connector to the conductor, to the insulated insert in the contact cam assembly, and then to the breech-bolt assembly.

Clearing Solenoid Assembly
The clearing solenoid assembly is mounted near the back of the gun housing. It is linked to and controls the movement of the clearing sector assembly.

Clearing Sector Assembly
The clearing sector assembly is linked to and controlled by the clearing solenoid assembly. When the solenoid is activated, the sector arm diverts the bolt assemblies into the clearing cam path.

Guide Bar
The guide bar is located on the gun housing. It guides the rounds into and out of the extractor lip that is located on each of the six breech-bolt assemblies.

Breech-Bolt Assembly
The breech-bolt assembly picks up a round as it enters the gun, transports it to the firing chamber, locks it into the firing position, transmits the firing voltage to the primer of the round, and returns the empty case to the guide bar, where it is cammed out of the gun. An extractor lip on the front of each bolt assembly engages the rim of a round throughout these actions.

There are six breech-bolt assemblies in the gun. Guide slots or grooves on the side of the bolt body permit it to slide on the rotor tracks. The bolt roller shaft determines the position of the bolt as it follows the main cam path or the clearing cam path in the housing.

Rotor Assembly
The rotor assembly is a major unit of the M61A1/2 gun. The front section or stub rotor supports the six barrels. The main body of the rotor assembly contains the rotor tracks, rotor drive gear, and the locking lugs to lock the barrels in place.

The rotor tracks support the breech-bolt assemblies and provide a guide for the forward and backward movement of the bolt. There are six sets of rotor tracks attached to the ribs along the rotor body. Each set contains a front, center, and rear removable track. The removable track lets you install or remove a bolt assembly for servicing or replacement.
The front support for the rotor assembly consists of a double row of ball bearings. The rear is supported by needle bearings located inside the rotor body. The end plate provides the inner race for the needle bearings, and it also provides for the gun's rear support.

The rotor assembly is driven by an external hydraulic drive. Drive is applied through a shaft and drive assembly. The drive assembly is bolted to the gun housing but is not a component of the gun.

Rear Housing Assembly and Associated Parts

The rear housing assembly is a major unit of the gun. It consists of an upper section and a lower section assembled as one unit. The rear housing assembly provides the main cam path that controls the movement of the breech-bolt assemblies. The elliptical (oval) shape of the main cam path causes the forward and backward movement of the bolt assemblies. The clearing-cam path is circular and located at the rear of the housing. It provides a path for the bolt assemblies during the gun's clearing cycle. The housing cover, when in the closed position, forms a part of the clearing cam path. The housing cover may be removed to install or remove the bolt assembly.

The locking and unlocking cams are part of the housing assembly. The gun-indexing pin (timing pin) is located on the housing. It is used to time the gun when it is mated with the ammunition handling system, or when you perform loading/unloading procedures.

Lubricator Assembly

A lubricator assembly is attached externally to the gun housing assembly. It is used to lubricate the bolt assemblies during gun operation. During gun acceleration/deceleration and when the gun is firing, an inertia-actuated pump located within the lubricator assembly pumps the lubricant through a metal tube to the gun housing assembly. The lubricator can be refilled when performing normal maintenance procedures.

HAND-MANIPULATED SIGNALING DEVICES

Hand-manipulated devices are used for various signaling purposes, such as identification, recognition, warning, and distress.

Pyrotechnics

Pyrotechnics are items that produce their effect by burning, and are consumed in the process. Pyrotechnics, as used in the military, are items that produce a bright light for illumination or colored lights or smoke for signaling.

All Navy pyrotechnic devices contain combustible chemicals. When ignited, these chemicals generate a flame, flash, infrared radiation, smoke, sound display, or combinations of these effects for many purposes. Some of these effects are visual and audible signaling, area and target illumination, reference point marking, indication of practice weapon impact or fuze action, tracking, decoying, simulating, and smoke-screen generation.

Dye-marking devices are pyrotechnics and screening devices, even though their display is not the product of combustion. They are classed as pyrotechnic or screening devices because their end purposes are quite similar to those of the true pyrotechnic. Dye-marking devices are used to establish reference points on the surface of the water. In some cases, the dye is spread on the surface by explosive means.

Pyrotechnics generally function by means of an ignition train, similar to the explosive train of high-explosive ammunition.

For further information on pyrotechnics, you should refer to Pyrotechnic, Screening, Marking, and Countermeasure Devices, NAVSEA SW050-AB-MMA-010/NAVAIR 11-15-7.
Pyrotechnic Pistols

Pyrotechnic pistols, Mk 1 Mod 0 (Figure 9-50) and AN-M8 (Figure 9-51) are breech-loaded, double-action, single-shot devices. The barrel is hinged to the frame and held in position by a breech block or latch pin. All are fired by pulling a pistol-type trigger.

These devices are capable of firing various types of marine signaling devices. Refer to Table 9-5.

Figure 9-51 — Pyrotechnic pistol, Mk 1 Mod 0.

Figure 9-50 — Pyrotechnic pistol, AN-M8.

Table 9-5 — Pyrotechnic Pistols and Projectors

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DEVICES LAUNCHED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mk 1 Mod 0 Pyrotechnic Pistol</td>
<td>Mk 2 Marine Smoke Signal</td>
</tr>
<tr>
<td></td>
<td>Mk 1 Marine Illumination Signal</td>
</tr>
<tr>
<td>AN-M8 Pyrotechnic Pistol</td>
<td>Mk 1 Marine Illumination Signal</td>
</tr>
<tr>
<td></td>
<td>Mk 2 Marine Smoke Signal</td>
</tr>
<tr>
<td></td>
<td>Mk 50 Decoy Flare</td>
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<tr>
<td></td>
<td>AN-M37A2 through AN-M45A2 Aircraft Illumination Signal</td>
</tr>
<tr>
<td></td>
<td>AN-Mk 1 Marine Location Marker</td>
</tr>
<tr>
<td></td>
<td>M11 Aircraft Illumination Signal</td>
</tr>
<tr>
<td>Mk 31 Mod 0 Surface Signal Projector</td>
<td>Mk 80 Hand-Fired Signal</td>
</tr>
<tr>
<td></td>
<td>Mk 110 Hand-Fired Signal</td>
</tr>
</tbody>
</table>
Mk 124 Mod 0 Marine Smoke and Illumination

The Mk 124 Mod 0 signal is intended to be used for either day or night signaling, as appropriate, by personnel on land or sea. The signal is a one-handed operable device, intended for rescue use. Its light weight (237 grams) and small size permit it to be carried in life vests or flight suit pockets and on life rafts. This signal, (Figure 9-52), consists of an aluminum case approximately 5.376 inches long and 1.638 inches in diameter; each end is provided with a protective cap.

![Figure 9-52 —Mk 124 Mod 0 marine smoke and illumination signal.](image)

The case has two raised beads around its circumference on the flare (night) end. These circumferential beads positively identify the flare end, by the sense of touch, for nighttime use. A label adhered to the outer surface of the case further identifies the smoke (day) and flare (night) ends and provides precise instructions for use. The case contains four sub-assemblies: smoke candle, smoke igniter, flare candle, and flare igniter. The igniter is one-hand operable and consists of an arming lever that must be extended before functioning and a mechanism that cocks (and then releases) the firing pin.

For proper functioning of the Mk 124, the lever must be extended to the armed position and then depressed to cock and release the firing pin. This action allows the striker on the firing pin to hit the primer which ignites the flare candle (night) or the smoke candle (day) depending on the display desired. The signal emits an orange smoke or red flare for approximately 20 seconds.

MK 79 MODs 0 and 2 Illumination Signal Kit

The Mk 79 Mods 0 and 2 signal kit (Figure 9-53) consists of an Mk 31 Mod 0 Surface Signal Projector, a plastic bandoleer that holds seven Mk 80 Mod 0 signals, and an instruction sheet. A 48-inch long cord is attached to the bandoleer and signal projector. The Mk 79 Mod 2 kit contains Mk 80 Mod 2 signals.

The Mk 80 Mod 0 Hand-Fired Signal consists of an aluminum case approximately 2.25 inches long and 0.50 of an inch in diameter. The case contains a percussion primer on one end and a steel end cap on the other end. The primer end of the case is threaded for attachment to the Mk 31 Mod 0 projector. The signal contains 3.0 grams of red pyrotechnic flare composition, 1.0 gram of black powder ignition composition, and 250 milligrams of black powder expellant charge. The Mk 80 Mod 2 signal is similar to the Mod 0 design. The Mod 2 design incorporates an expellant charge disc...
assembly and replaces the black powder ignition charge with 1.0 gram of red lead/silicon ignition mixture.

In an emergency or during rescue operations, downed aircrew personnel use the distress signaling device kit. Because it is small and lightweight, personnel can carry it in pockets of flight suits or in life rafts. The projector aims and fires the signals. Each signal contains a single red star. On activation, this star is propelled upward to a height of between 250 and 650 feet. The star burns for a minimum of 4.5 seconds.

Figure 9-53 — Mk 79 Mod 0 and 2 illumination signal kit.
To operate the device, the projector firing pin is cocked by moving the trigger screw to the bottom of the vertical slot, and slipped to the right so it catches at the top of the angular slot. After cocking the firing pin, a signal is removed from the bandoleer and the projector is mated with the signal. The projector is rotated clockwise until the signal is seated, and held overhead while pointed at a slight angle away from the body. While the projector is firmly gripped, the signal is then fired by slipping the trigger screw to the left, out of the safety slot, and into the firing slot.

**MK 108 MOD 1 Illumination Signal Kit**

The Mk 108 Mod 1 illumination signal kit is intended to be used as a signaling device. The kit is small and light in weight so that it can be carried in the pocket of a flight suit or on a raft. The signals in this kit produce a single green star display at a minimum altitude of 250 feet for a minimum time of 4.5 seconds.

This kit consists of one Mk 31 Mod 0 Surface Signal Projector, a plastic bandoleer holding seven Mk 110 Mod 1 Hand-Fired Signals, and an instruction sheet. A 48-inch long cord is attached to the bandoleer and signal projector.

The Mk 110 Mod 1 Hand-Fired Signal consists of an aluminum case approximately 2.25 inches long and 0.50 of an inch in diameter. The case contains a percussion primer on one end and a steel end cap on the other end. The primer end of the case is threaded for attachment to the Mk 31 Mod 0 projector. The signal contains 3.0 grams of green pyrotechnic flare composition, 1.0 gram of red lead/silicon ignition composition, and 250 milligrams of black powder expellant charge.

**Handling and Safety Precautions**

Pyrotechnic ammunition is one of the most widely used types of ammunition in naval aviation. Pyrotechnics of one type or another are carried in almost every Navy aircraft, including unarmed transport and training aircraft.

All pyrotechnic and screening devices, while designed and tested to be safe under normal conditions, are subject to accidental ignition. A general rule for the handling of pyrotechnic devices is as follows:

<table>
<thead>
<tr>
<th>NOTE</th>
</tr>
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<tbody>
<tr>
<td>You should be constantly aware that pyrotechnics contain chemical components that are intended to burn with intense heat, and you should act accordingly.</td>
</tr>
</tbody>
</table>

Pyrotechnic and screening devices are normally equipped with some type of safety pin, lock, or tape that is designed to prevent accidental activation of the initiation mechanism. Do NOT tamper with such equipment. Do NOT strike, bend, or otherwise remove the safety equipment until just before the device is launched. Any devices that show signs of damage to the safety features are considered unserviceable; carefully put them to one side and promptly dispose of them according to current directives.

If a pyrotechnic device should accidentally ignite, it will result in a fire hazard. In a confined area, the gases generated by this combustion could present a serious toxic hazard. Signaling charges that contain propellant charges, designed to propel the pyrotechnic candle into the air, create an extremely dangerous missile hazard.

Pyrotechnic compositions characteristically contain their own oxidants; therefore, they do not depend on atmospheric oxygen for combustion. For this reason, exclusion of air, by whatever means, from a pyrotechnic fire is usually ineffective. Many pyrotechnic mixtures, particularly illuminating flare compositions, burn with intense heat (up to 4500 °F). Normally, extinguishers are not useful in this kind of fire.
Carbon dioxide extinguishers, in addition to being ineffective, are potential sources of danger because they tend to produce oxygen, which supports the combustion. Foam-type extinguishers are equally ineffective because they work on the exclusion-of-air principle.

<table>
<thead>
<tr>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water, in flooding quantities and at low pressure, should be used to cool the surrounding area and to prevent the spread of the fire. Properly controlled and directed, water is the best fire-extinguishing agent for aircraft parachute flares burning in the open.</td>
</tr>
</tbody>
</table>

Pyrotechnic hazards are frequently increased by such factors as age, improper storage conditions, rough handling, moisture penetration, excessive temperatures, damage to shipping containers, and other mishaps that cause the devices to become unserviceable. In most cases, immediate danger does not exist. Unserviceable pyrotechnic and screening devices on ships at sea are put to one side for normal return to an appropriate shore station for disposition according to the instructions and regulations contained in NAVSEA OP 5, Volume 1.

Conditions may develop that demand emergency disposal of potentially hazardous devices. In such cases, disposition is the responsibility of the commanding officer. Under NO circumstances, other than an extreme emergency, should ammunition, explosives, or other related hazardous materials be dumped at sea by a Navy vessel, aircraft, or activity without prior approval of the Chief of Naval Operations (CNO). If, in the commanding officer's best judgment, immediate disposition is necessary to protect lives and property, the commanding officer should order such disposition by the most appropriate means available. In all cases, the commanding officer must notify Naval Sea Systems Command, at the earliest practical time, of the facts and circumstances.

**CARTRIDGES AND CARTRIDGE-ACTUATED DEVICES (CADs)**

With the advent of the high-performance jet aircraft, aviation relies more and more on CADs. CADs are small explosive-filled cartridges used to fire other explosives or release mechanisms. CADs provide high reliability and easy maintenance. The cartridges undergo rigid quality control throughout design and manufacture. Their actual performance is dependable only when they have been properly handled and installed. In a personnel escape system, the CAD must work perfectly the first time.

Malfunction of a device or failure to fire when needed usually results in injury or death to the pilot and/or crew members. Escape operations performed by cartridges and CADs are canopy removal, seat ejection, streaming of ejection seat drogue chutes, and parachute opening. It is not possible to discuss all the cartridges and CADs in this TRAMAN. Therefore, a few representative cartridge systems are briefly discussed.
**Personnel Escape Device Cartridges**

High-speed aircraft have many designs, special control features, and space limitations. As a result, a sequence of emergency operations must be carried out before it is possible for pilot and/or crew members to escape. CADs allow several operations to be performed concurrently (at the same time), or in rapid sequence, to ensure personnel escape. Personnel in the AME rating usually install cartridges and CADs used in personnel escape systems. The impulse cartridge (Figure 9-54 slide 1) contains an electric primer, a booster, and a main charge. When the cartridge is fired, gas pressure moves a piston and unlocking linkage, freeing and/or ejecting the store from the rack.

**Impulse and Delay Cartridges**

Impulse cartridges are used as power sources in aircraft stores release and ejection systems. The cartridges provide a force to free or eject a store away from the aircraft or to operate other devices.

**CCU-45/B Impulse Cartridge**

The CCU-45/B impulse cartridge (Figure 9-54 slide 2) is used primarily for release and ejection of stores from an aircraft in flight.

**Mk 19 Mod 0 Impulse Cartridge**

The Mk 19 Mod 0 impulse cartridge (Figure 9-54 slide 3) is a backup cartridge. It is normally used for the emergency jettison/release of stores loaded on an aircraft during flight. This cartridge is fired after an attempt has been made to fire the primary cartridges.

**Miscellaneous Cartridges**

Miscellaneous cartridges include cable cutters, explosive bolts, and fire extinguishers. The Mk 97 Mod 0 impulse cartridge (Figure 9-54 slide 4) is used as a power source to actuate a helicopter cable cutter to cut a chain/cable in an emergency. The Mk 1 Mod 3 impulse cartridge (Figure 9-60 slide 5) is used primarily to actuate a refueling hose guillotine in an emergency. In the event of fire, the aircraft fire extinguisher cartridges start the release of fire-extinguishing agents into the area surrounding an aircraft engine.

**BOMB RACKS**

The Navy uses complex suspension, arming, and releasing devices in combat aircraft and weapons. The high speed and performance of potential targets and our own aircraft require the electronic operation of suspension, arming, and releasing equipment.
The equipment covered in this chapter is part of the aircraft search or kill stores systems. Generally, these devices operate electrically and are controlled by aircraft electrical circuits. A circuit-closing device actuates them manually by a hand switch or automatically in the system.

Aircraft bombs, torpedoes, mines, and other stores are suspended internally or externally from the aircraft by bomb racks. Bomb racks carry, arm, and release stores.

**Aero 1A/1B Adapter Assembly**

The Aero 1A (Forward)/1B (Aft) adapter assemblies (*Figure 9-55*) are used on the forward and aft ends of the BRU-14/A or BRU-15/A bomb racks which enable them to load and carry weapons/stores that have suspension lugs spaced 30 inches apart and weigh up to 2,000 pounds.

The Aero 1A/1B adapter linkage attaches to the bomb rack. The movement of the Aero 1A/1B adapter suspension hooks corresponds to the movement of the bomb rack suspension hooks. More information on the Aero 1A/1B adapter assembly can be found in *Bomb Rack Adapter Assembly Aero 1A/1B*, NAVAIR 11-5E-17.

*Figure 9-55 — Aero 1A/1B bomb rack adapter assembly.*
**BRU-12/A, BRU-12A/A Bomb Rack**

The BRU-12/A and BRU-12A/A bomb racks (*Figure 9-56*) are designed for fixed mounting in a bomb bay of the P-3 aircraft and can be used to carry, arm, and release a weapon/store weighing up to 1,450 pounds, and having two hooks, spaced 14 inches apart.

Two solenoid actuated arming units at the bottom of the rack provide mechanical arming for the nose and tail of a weapon/store. These units are electrically actuated to arm a weapons/store as it is dropped. If the arming units are not electrically actuated, the weapon/store will drop unarmed. A Linear Electro-mechanical Actuator (LEMA) provides electrical release of a weapon/store. No in-flight manual release mechanism is provided. A BRU-12/A bomb rack with improved positive arming latch installation creates a BRU-12A/A.

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*Figure 9-56 — BRU-12/A, BRU-12A/A aircraft bomb rack.*
**BRU-14/A Bomb Rack**

The BRU-14/A bomb rack (Figure 9-57) provides suspension and release of conventional and special weapons/stores up to 2,200 pounds with 14-inch suspensions. At times, Aero 1A/1B adapter assemblies are used to increase the bomb rack to 30-inch suspension capacity. It may be installed in the bomb bay of the P-3C aircraft and in the weapon pylon of the H-60 aircraft.

Sway braces are bolted to the rack frame. Installation of an in-flight operable bomb rack lock (IFOBRL) allows remote locking and unlocking of the rack when electrical power is applied to the aircraft.

The BRU-14/A bomb rack has an auxiliary unlock assembly. It releases the IFOBRL if it fails to function in the normal release mode. The auxiliary unlock assembly is a CAD that provides a mounting point for the aft end of the IFOBRL. When actuated, the unlock assembly releases the IFOBRL and allows it to move forward. This frees the sear link from restraint and lets the rack linkage function normally.

The BRU-14A bomb rack has a secondary release assembly. It initiates hook release if the LEMA fails to function. The secondary release assembly is a CAD that consists of a housing, piston, and release slider assembly mounted on the top of the bomb rack frame. When actuated, the secondary release moves the sear link forward to release the bomb rack. The BRU-14/A does not have remote manual-release capabilities.

![Figure 9-57 — BRU-14/A aircraft bomb rack (left-hand configuration).](image-url)
**BRU-15/A Bomb Rack**

The BRU-15/A bomb rack (*Figure 9-58*) is installed on the wing stations of the P-3 aircraft. It is used with the aircraft wing store launcher assembly, which is modified to launch a Harpoon missile. Aero 1A/1B adapter assemblies can be attached to increase the bomb rack to 30-inch suspension capacity.

The BRU-15/A bomb rack is a modification of the BRU-14/A bomb rack. The IFOBRL mechanism and associated auxiliary unlock device are not included.

There is a safety mechanism to positively lock the release mechanism of the bomb rack when a safety pin is installed.

There is a cable-actuated manual release mechanism that operates the primary release linkage through an added manual release cable and lever.

**Bomb Ejector Racks**

When in flight, today's high-speed fighter and attack aircraft create a vacuum under the fuselage and wings. If a weapon/store is released from the bomb rack, this vacuum can prevent the weapon/store from entering the airstream and falling to the target. If this happens, the weapon/store may physically contact the aircraft structure, causing serious damage to or loss of the aircraft.

Bomb ejector racks are different from bomb racks. Bomb ejector racks use electrically fired impulse cartridges to eject the weapon/store free of the bomb racks. Bomb ejector racks eject the weapon/store from the bomb rack with sufficient force to overcome vacuum buildup and ensure a safe weapon/store-launching environment.

**BRU-32 (Series) Ejector Unit Rack Assembly**

The BRU-32 (series) ejector unit rack assembly (*Figure 9-59*) is a non-jettisonable single carriage rack used for carrying weapons or other external stores on the F/A-18 aircraft. The bomb rack is attached to the aircraft by four bolts and electrically connected to the aircraft weapons system.

The BRU-32A/A can carry weapons/stores of between 10 and 28 inches in diameter weighing up to 2,600 pounds, while the BRU-32B/A can carry weapons/stores of the same diameter weighing up to
4,200 pounds. There are two pairs of suspension hooks, 14 and 30 inches apart on the longitudinal centerline of the ejector unit rack.

The BRU-32 (series) is used to suspend single stores, BRU-33/A vertical ejector racks (VER), BRU-33A/A canted vertical ejector rack (CVER), BRU-55/A ejector rack, and LAU-115/A, LAU-117/A, and LAU-118/A missile launchers by using a 14-inch suspension hook.

The BRU-32 (series) bomb ejector rack has safety interlock and two sway brace assemblies with self-adjusting wedges. The safety interlock mechanically prevents the accidental opening of the suspension hooks. It is also used to lock and unlock the suspension hooks during loading operations. Automatic sway bracing is controlled by the opening and closing of the suspension hooks.

Figure 9-59 — BRU-32 (series) bomb ejector rack.
Sensing switches are incorporated within the rack to indicate to the aircraft weapon system that a store is loaded. The primary ejection uses two cartridges to generate the required gas pressure for rack operations. If the primary ejection fails, the auxiliary release unit provides emergency release. The auxiliary release unit uses one cartridge that opens the hooks only. Nose and tail arming solenoids are used with mechanical fuzing. The Mk 39 electric fuzeing receptacle is used for electric fuzing. The bomb rack is interchangeable with the centerline or the inboard and outboard pylons.

**BRU-33 (Series) Vertical Ejector Rack Assembly**

The BRU-33/A vertical ejector rack assembly (VER) (Figure 9-60) and BRU-33A/A canted vertical ejector rack (CVER) are suspended by the BRU-32 (series) bomb ejector rack. They are used to carry two external stores weighing up to 1,000 pounds each, 10 to 16 inches in diameter, by using 14-inch suspension hooks. The VER/CVER feature a special safety interlock and self-adjusting wedges. The safety interlock is electrically controlled by the aircraft and mechanically prevents accidental opening of the suspension hooks.

![Figure 9-60 — BRU-33/A bomb ejector rack.](image)

Sensing switches are incorporated to indicate to the store management system (SMS) that a store is loaded. The rack has provisions for mechanical and electric fuzing. The ejection unit uses two cartridges to generate the required gas pressure for rack operations.
BRU-55 (Series) Aircraft Bomb Ejector Rack

The BRU-55 (Figure 9-61) allows carriage of two smart weapons (up to 1,000-pound class) on a single aircraft station. BRU-55 weapons currently consist of JSOWs, and 1,000-pound JDAMs.

The BRU-55 uses the MIL-STD-1760 interface (Aircraft-to-Rack and Rack-to-Weapons). BRU-55 aircraft currently consist of the F/A-18. The BRU-55 is 70 inches long, 29 inches wide, and weighs between 228 and 236 pounds. Its aircraft interface is 30-inch lugs and single 1760 umbilical. Its weapons interface is 14-inch lugs and one 1760 umbilical each. The BRU-55 is equipped with two weapon umbilical-retaining brackets to prevent damage to the weapon umbilical upon release.

Figure 9-61 — BRU-55 aircraft bomb ejector rack.
Improved Multiple Ejector Rack (IMER) BRU-41/A and Improved Triple Ejector Rack (ITER) BRU-42/A

The BRU-41/A (Figure 9-62) and the BRU-42/A (Figure 9-63) operate and function basically the same way. There are four major subassemblies—the structural adapter assembly, the electronic control unit, the cable assembly, and the ejector unit. The electronic control unit and the ejector unit are the same for both the BRU-41/A and the BRU-42/A.
End of Chapter 9
Aircraft Ordnance

Review Questions

9-1. What is the name for ammunition containing compositions that produce illumination?

A. Cartridge activated device (CAD)
B. Propellant
C. Pyrotechnics
D. Warhead

9-2. What is the name for the part of ammunition containing the materials intended to inflict damage?

A. Cartridge activated device (CAD)
B. Propellant
C. Pyrotechnics
D. Warhead

9-3. Which of the following is an unmanned vehicle designed as a weapon that travels above the surface of the earth?

A. Airborne stores
B. Guided missile
C. Incendiary
D. Warhead

9-4. What type of ammunition is intended for operational use?

A. Inert
B. Practice
C. Non-service
D. Service

9-5. What type of ammunition is specifically designed or modified for use in exercises?

A. Inert
B. Practice
C. Non-service
D. Service

9-6. What type of ammunition and components contain no explosive material?

A. Inert
B. Practice
C. Non-service
D. Service
9-7. What type of ammunition is used for training personnel in all aspects of a familiarization program?
A. Inert
B. Practice
C. Non-service
D. Service

9-8. What type of ordnance is painted yellow?
A. Armor-defeating
B. Marking
C. High explosive
D. Toxic

9-9. What type of ordnance is painted grey with a dark green band?
A. Armor-defeating
B. Marking
C. High explosive
D. Toxic

9-10. What type of ordnance is painted light blue?
A. Illuminating
B. Irritant
C. Low explosive
D. Practice

9-11. What is the average reaction time of an MK 82 unprotected?
A. \(3 + 30\)
B. \(10 + 00\)
C. \(12 + 18\)
D. \(14 + 15\)

9-12. What is the shortest reaction time of a BLU-117 thermally protected?
A. \(3 + 30\)
B. \(10 + 00\)
C. \(12 + 18\)
D. \(14 + 15\)

9-13. Which of the following types of bomb is used in most bombing operations?
A. General-purpose (GP) bombs
B. Special purpose bombs
C. Cluster bombs (CBU)
D. Low-collateral damage bomb (LOCO)
9-14. A bomb body is shipped with a plastic plug installed in the nose and tail fuze wells to prevent what occurrence?

A. The explosive filler from spilling out  
B. Static charge build-up  
C. Accidental arming  
D. Damage to the internal threads from moisture entering the fuze wells

9-15. When shipping bombs, what type of pallet is used?

A. Metal  
B. Nylon  
C. Plastic  
D. Wood

9-16. How do laser-guided bombs detect a target?

A. Laser beam illumination  
B. Remote guidance  
C. Laser-guided bombs do not detect targets  
D. Programmed target data

9-17. Long-range missiles are usually capable of traveling what minimum number of miles?

A. 100 miles  
B. 200 miles  
C. 300 miles  
D. 400 miles

9-18. Speeds from Mach 0.8 to Mach 1.2 are referred to by what term?

A. Subsonic  
B. Transonic  
C. Supersonic  
D. Hypersonic

9-19. Speeds above Mach 5.0 are referred to by what term?

A. Subsonic  
B. Transonic  
C. Supersonic  
D. Hypersonic

9-20. A service missile is usually referred to as which of the following types of missile?

A. A practice missile  
B. A tactical missile  
C. A dummy missile  
D. A training missile
9-21. Which of the following guided missile launchers is a complete launching system used with AIM-9M (series) missiles?

A. LAU-7  
B. LAU-115  
C. LAU-116  
D. LAU-118

9-22. What launchers are capable of launching the AIM-9X?

A. LAU-7 and LAU-118  
B. LAU-7 and LAU-127  
C. LAU-115 and LAU-117  
D. LAU-117 and LAU-118

9-23. All versions of Hellfire missiles in the Navy and Marine Corps inventory are carried on what type of guided missile launcher?

A. LAU-117 and LAU-118  
B. LAU-118 and LAU-127  
C. M-272/M-299  
D. All the answers are correct

9-24. How is an M61A1/A2 automatic gun (1) driven and (2) controlled?

A. (1) Electrically (2) pneumatically  
B. (1) Hydraulically (2) electrically  
C. (1) Electrically (2) electrically  
D. (1) Hydraulically (2) pneumatically

9-25. At what prescribed rate can an M61A1/A2 gun fire M50 series ammunition?

A. 2,000 to 6,000 rpm  
B. 2,000 to 4,000 rpm  
C. 4,000 to 6,000 rpm  
D. 4,000 to 7,200 rpm

9-26. What components are the primary parts of an M61A1/A2 automatic gun?

A. Barrels, housing assembly, and muzzle clamp assembly  
B. Housing assembly, muzzle clamp assembly, and clearing sector assembly  
C. Barrels, rotor assembly, and housing assembly  
D. Muzzle clamp assembly, rotor assembly, and barrels

9-27. A hand-manipulated signaling device is used for all EXCEPT which of the following signaling purposes?

A. Identification  
B. Countermeasure  
C. Warning  
D. Distress

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9-28. When fired, the star ejected from an Mk 80 Mod 0 signal burns for what minimum amount of time?

A. 4.5 seconds  
B. 10.5 seconds  
C. 4.5 minutes  
D. 10.5 minutes

9-29. When an Mk 25 Mod 2 marker is in the water, what liquid serves as an electrolyte to produce a current in the battery?

A. Fresh water  
B. Oil  
C. Seawater  
D. Acid

9-30. What type of CAD is used primarily for release and ejection of stores from an aircraft?

A. CCU-44/C  
B. CCU-45/B  
C. Mk 19 Mod 0  
D. Mk 97 Mod 0

9-31. What type of CAD is used as a power source to actuate a helicopter cable cutter?

A. CCU-44/C  
B. CCU-45/B  
C. Mk 19 Mod 0  
D. Mk 97 Mod 0

9-32. What type of bomb rack is designed for fixed mounting in a bomb bay of a P-3 aircraft and can be used to carry, arm, and release a weapon?

A. BRU-11  
B. BRU-12  
C. BRU-14  
D. BRU-32

9-33. What type of bomb rack allows carriage of two smart weapons (up to 1,000-pound class) on a single aircraft station?

A. BRU-12  
B. BRU-14  
C. BRU-55  
D. BRU-65
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