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Munitions Systems Journeyman

Volume 3. Precision-Guided Munitions

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Volume 3 of CDC 2W051B, *Munitions Systems Journeyman*, discusses precision-guided munitions and their test equipment. Unit 1 covers basic guided munitions principles and the theory of operation; including guidance, control, armament, and propulsion systems. It also covers laser guided bombs (LGBs) and electro-optically guided bombs (EOGBs). Unit 2 familiarizes you with air-to-ground and air-to-air missiles.

A glossary is included for your use.

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NOTE:

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

Page

Unit 1. Guided Munitions (Smart Bombs)

AS UNGUIDED MUNITIONS, rocket use goes back to A.D. 1232 when they were employed to repel the Mongolian besiegers of the city Pein--King (Peiping). Since then rockets have been used as weapons and machines of war, for amusement through their colorful aerial bursts, as life-saving equipment, and for communications or signals. The lack of suitable guidance and control systems may have accounted for the rocket's slow improvement over the years. Strangely enough, it was the airplane rather than the rocket that stimulated the development of guided munitions as we know them today.

In recent campaigns going back to the Persian Gulf War, guided munitions have been lauded for their precision and ability to strike targets deep in areas where we would not normally send in regular conventional munitions. As our precision-munitions technology increases, it allows the Air Force the ability to increase its global footprint on the enemy. Any military force that can destroy and/or break the will of an enemy to fight without suffering similar losses of its own is a force that can be victorious. Precision guided munitions (PGM) increase our odds of being that force.

1–1. Guided-Munitions Principles

Precision guided munitions, also known as "smart weapons," alter their trajectory in flight to seek or hone in on their targets. Unlike conventional unguided munitions, their accuracy does not diminish as range increases. This section discusses the latest PGMs in the Air Force inventory and the test equipment needed to support them. When equipped with a warhead, a missile or guided bomb is a devastating weapon. We classify guided missiles by target and launching positions, such as air-to-air or air-to-ground. Guided bombs are classified according to the guidance systems, such as laser-guided bomb (LGB), infrared, or electro-optically guided bombs. In order for you to understand the theory of how a PGM operates, you will have to be familiar with the four basic systems a PGM may use. The four basic systems that a PGM may use are guidance, control, armament, and propulsion. One point to keep in mind is that not all PGMs have all four of these systems. If a PGM has a propulsion system, we consider it a missile; if a PGM does not have a propulsion system, we call it a guided-bomb unit (GBU).

401. Guidance systems

The unique design of missiles and smart bombs allows them to be very accurate. Accuracy refers to the ability of the missile or smart bomb to reach the target with devastating results. A missile's course is controlled in several different ways. One of those ways is through the guidance system that they employ. A guidance system is the brain and is designed to determine the direction to the target and pick an interception path. After the system determines the error between its flight path and the target, the system produces steering commands to reduce the error. These steering commands tell the control system which way to move the control surfaces in order to put the PGM on the right course. We identify guidance systems by considering two factors—the tracking energy received by the guidance system sensors used to navigate toward the target area, and the origin of the tracking energy used. Different types of tracking energy include light energy, electro-optical, radar, and the global positioning system (GPS) with aided internal navigation system.

Light energy

Because of the varying frequencies of light, different types of light energy are used in our weapons systems. Infrared waves are in the frequency range just below visible light corresponding with radiated heat. Infrared waves can be generated by a kind of light emitting diode and are often used for remote controls for televisions. Military applications include heat-seeking air-to-air missiles that hone in on the infrared energy coming from the target, and imaging infrared that hones in on a computer memorized, television image of the target. Another light energy, laser, produces a beam of coherent (free from interference) highly directional and intense light. It can also produce other forms of consistent and highly directional energy that cannot be seen by the human eye; such as infrared or ultraviolet colored lasers.

Electro-optical

Electro-optical, also known as television guided, refers to a guidance system that uses a picture of a target that is produced by a television camera in the guidance system. This system allows the aircrew to fire the weapon and leave the target area while guiding the weapon to the target, just as if they were inside the weapon controlling its course. Electro-optical guidance has been so successful that it is used on air-to-ground missiles (AGM) and general purpose (GP) guided bombs.

Radar

Radar is nothing more than very high frequency radio waves. Radar is used as a method of detecting distant objects and determining their position, velocity, or other characteristics by analysis of the high frequency radio waves reflected from the target.

Global positioning system aided inertial navigation system

The global positioning system aided inertial navigation system (GAINS) uses pre-planned precision target location coordinates. The GAINS aligns the inertial navigation system (INS) with that of the aircraft while in captive flight. Once released from the aircraft, GAINS uses available satellites to further triangulate coordinates. A computer then makes optimum navigation solutions to guide the weapon to the target. The GAINS enables a weapon to navigate into the target area from a greater distance than other navigation systems. The GAINS provides all-weather capability and gives the pilot a greater standoff distance. Once the PGM is in close proximity, the primary guidance system (that is, infrared, electro-optical, and so forth) initiates and acquires the target finishing navigation to the objective.

Tracking energy origin refers to where the tracking energy originates. The three sources that produce the tracking energy used in the guidance systems of PGMs are active, passive, and semi-active.

Active

In an active guidance system, the weapon sends out the tracking energy, the tracking energy reflects off the target, and then the weapon follows or hones in on the reflected energy to the target. This allows for a “fire and forget” capability of that particular weapon.

Passive

In a passive guidance system, the target produces the tracking energy; the weapon merely follows or hones in on the energy that is being radiated or emitted by the target. This energy is commonly found in surface-to-air-missile-sites or radar installations.

Semi-active

Semi-active PGM hone in on energy reflected off a target produced by another outside source. What is meant by "another outside source"—is that the tracking energy originates from something other than the weapon or the target. Sources of tracking energy can come from the targeting aircraft, another aircraft, or hand-held devices used by ground forces.

402. Control systems

A control system is designed to do the actual steering of a PGM. It follows commands produced by the guidance system to steer the weapon. If the guidance system tells the control system to steer up, down, left, or right, the control system follows those commands to keep the weapon on the correct flight path. This is done with the help of at least two gyros, one that senses the munitions vertical axis and another that senses change from the horizontal axis. These gyros help control the roll, pitch or yaw of the munition. The guidance system communication and the use of gyros help in moving the wings, fins, or control surfaces, (name depends on the individual PGM) which respectively steer the PGM and keep it on course.

We sometimes refer to the control section of guided bombs as airfoil groups (AFG). AFGs are at the aft end of a GP bomb (also referred to as a warhead). Some AFGs consist of a forward adapter, four control fins, a folding wing assembly, and lanyards. The control fins which are attached to control actuators help maneuver the system in flight. The folding wing assembly provides lift and stability in flight. The lanyards provide the means of activating the weapon upon release from the aircraft. Later we will discuss other configurations of AFG with the specific guided bomb they support.

Control surfaces

There are two types of control surfaces on guided munitions—fixed and movable. Much like the feathers on an arrow or dart, the fixed control surfaces stabilize the weapon in flight. At the same time, the movable control surfaces steer the weapon to target. The movable surfaces are called wings, fins, canards or control surfaces depending on their position on the weapon in relation to the center of gravity. PGMs use either hydraulic, pneumatic, or electro-servo actuators to move the weapon body's control surfaces. If the control system is designed to expel pressurized fluid, air, or gases after it is used, we classify it as an open loop system. If the control system is designed to retain pressurized fluid, air, or gases within the weapon after it is used, we classify it as a closed loop system.

Hydraulic

A hydraulic control system uses pressurized fluid (oil) to move the control surfaces. This is similar to power steering in an automobile where hydraulic pumps provide power and pressure within the system.

Pneumatic

Relating to air or other gases, a pneumatic (gas) control system routes air pressure through a series of valves, manifolds, and other mechanical assemblies attached to the control surfaces. Some PGMs contain a tank that stores pneumatic pressure. This tank can be refilled when needed. Other PGMs use a small generator that will initiate with an explosive squib to produce its gas pressure.

Servo-actuators

Servo-actuators are electric motors that move the control surfaces when an electrical signal is received from the guidance section. Servo-actuators are powered by actuator batteries.

Types of navigation

Another important aspect of control systems is its navigation system. Navigation is the science, or art, of directing PGMs from one place to another. Navigation includes, more importantly, the method of determining a PGM's position, course, distance covered, and so forth, by using numerous geometric principles. All of this is done by our guidance systems. When we use the word navigation, we are merely referring to the way in which the PGM steers. Proportional navigation means that movement of the control surfaces is proportional to the error between the flight path of the weapon and the flight path to the target. If a weapon only needs to make a minor correction to the flight path, then the guidance commands to the control system are small. If the weapon needs to make a large turn to the target, then commands to the control surfaces are substantial. By contrast, a "bang-bang" control system does not use proportional movement. The "bang-bang" system either commands full movement of the control surfaces or no movement of the control surfaces based on the error between the line of flight of the weapon and the flight path to the target. As you might guess, the "bang-bang" control system has a more erratic flight path and is not as accurate as proportional navigation. Although proportional navigation can be found on the majority of our weapon systems, the "bang-bang" control system is used on some of the older PGMs.

403. Armament systems

The targets assigned to guided munitions are directly related to the size of the armament (warhead). Air-to-air missile warheads range in size from approximately 20 to 50 pounds of net explosive weight (NEW). Air-to-ground munition warheads range in size from 38 to over 1,000 pounds of NEW.

Guided missiles must move with high velocity to lessen the probability of interception and destruction by enemy countermeasures. Missiles must also intercept and destroy high-velocity enemy aircraft in flight. Let's look at the components that make up the armament system of guided munitions.

Fuzes

All air-to-air missile fuzes work in one of two ways: (1) upon impact or (2) proximity. The impact required can be a simple graze or a direct hit on the target. A proximity detonation occurs when the missile target detecting device determines the target is not getting closer but moving farther away. Typically all air-to-ground guided munition fuzes function either upon impact or after a predetermined amount of time. Some AGMs require the sudden acceleration associated with rocket motor (RM) ignition and departure from the firing aircraft before the fuze will arm. All fuzes that support this class of guided munitions require an electrical impulse before detonation occurs. The diversity of fuzes used with this class of munitions makes it difficult to outline; therefore, we provide further discussion later with each specific munition.

Warheads

A detonating missile scores a kill in one of two ways. Either the fragmentation of the missile case causes destruction of the target or the continuous rod construction (if applicable) of the warhead (fig. 1–1) causes the destruction of the target.

Warheads associated with air-to-ground guided munitions range in size. The use of one munition over another depends on the target and how well it is protected. Some warheads are propelled toward the target and others are guided gravity (freefall) bombs. The differing effects of the warhead are as diverse as the targets this class of munition is designed to destroy. Some warheads rely on a shaped charge effect, while others use fragmentation or mass blast effect to perform their task. The ability to place a 2,000 pound high explosive bomb exactly on target, while allowing the delivering aircraft to remain out of enemy reach, has proven beneficial.

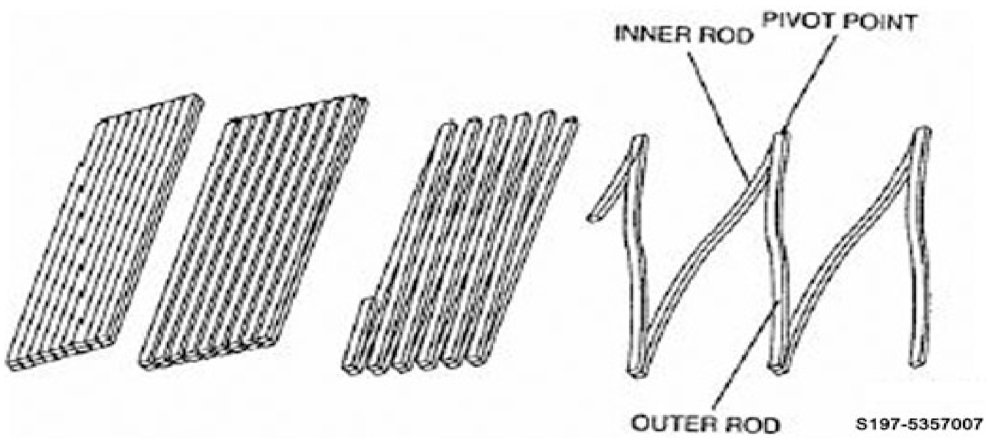

Figure 1–1. Continuous rod construction.

Safety and arming device

The safe and arm (S&A) device keeps the armament system in a safe condition while you are handling the weapon and while the weapon is on the carrying aircraft. After the weapon is launched from the aircraft and gets a safe distance away, the S&A device mechanically arms due to the gravitational force acceleration. The forward motion (acceleration) drives a mechanism which aligns the explosive components of the fuze to the ARM position. The newer electric S&A device arms when certain variables, including gravitational force acceleration, are met after launch from the aircraft. After these events occur, both mechanical and electric S&A devices wait until they receive an electrical signal from the fuzing device to arm.

404. Propulsion systems

A propulsion system provides thrust to propel the PGM to the target. When a PGM has a propulsion system, we call it a missile. The minimum components that make up a propulsion system consist of a rocket motor and an igniter.

Rocket motors

All the rocket motors used in our propulsion systems are one-piece, single-stage, solid-propellant. The shape of the propellant determines the type of burning action and the amount of thrust the RM provides. There are three types of RMs used in Air Force missiles: medium, dual, and high thrust.

Medium thrust

The medium thrust RM propellant has a round hole in its center. It provides a nearly neutral burning action, which gives the RM a constant amount of thrust (sustained speed) the entire time the propellant is burning.

Dual thrust

The dual thrust RM provides two distinct levels of thrust, an initial boost phase when the RM is first ignited, and then a sustained thrust phase after the boost phase. The shape of the propellant is what provides the two levels of thrust. The propellant has a star-shaped hole in its center. The star tips provide more propellant surface area, which provides more surface area to burn; thus, the RM provides extra thrust for the boost phase. After the RM burns for a short period, the star tips are consumed (burnt up). This leaves a round hole through the center of the propellant. When the dual thrust RM is left with a round hole, it burns the same as the medium thrust RM (sustained thrust).

High thrust

A high thrust RM is best described as a dual thrust that has a longer boost phase. It burns as fast as it can, for as long as it can. A high thrust RM travels with great velocity but sacrifices range or distance capabilities.

Rocket motor igniter

The RM igniter does exactly what its name implies—it ignites the RM. The RM igniter completes the low explosive train necessary to get the RM propellant burning. RM igniters usually have some type of S&A device incorporated into them to keep the propulsion system in a safe condition while you handle them. Live missiles must always have a ground wire attached to them to prevent static electricity from accidentally igniting their RMs.

Self-Test Questions

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

401. Guidance systems

1. What are the four types of tracking energy used in modern missiles?

2. Which guidance system is nothing more than very high frequency radio waves?

3. What are the three sources that produce the tracking energy used in the guidance systems of precision-guided munitions.

4. What guidance system allows for a “fire and forget” capability of that particular weapon?

5. In what guidance system does the target produce the tracking energy?

6. Which type of guidance system homes in on energy reflected off the target by another outside source?

402. Control systems

1. What is the control system designed to do?

2. What section of a guided bomb do we refer to as the AFG?

3. What are the two types of control surfaces on a guided munition and their purpose?

4. What are the three different mechanical forces that precision guided munitions use to move control surfaces?

5. What is the science or art of directing precision guided munitions from one place to another?

6. What is “*proportional navigation*”?

403. Armament systems

1. Impact and proximity describe the functioning of what part of an air-to-air missile?

2. What must take place for an air-to-ground missile to arm?

3. The fragmenting missile case is one way missiles score a kill. What is the other?

4. What is the purpose of the Safe and Arming device?

404. Propulsion systems

1. What are the minimum components of a propulsion system?

2. Air Force precision guided munitions rocket motors are constructed with what type propellant?

3. What are the three types of rocket motors used in Air Force missiles?

1–2. Laser Guided Bombs

We divide the guided bombs in use today into two similar but uniquely different groups, LGBs and electro-optical guided bombs. This section discusses the characteristics of these weapons and takes a look at the components used to assemble them.

405. Guided bomb unit–10 and –12 series

GBU–10 and GBU–12 munitions are LGB that consist of three major component groups which include: a general-purpose bomb or special-purpose bomb (warhead), a computer control group (CCG), and an AFG. The CCG guides the weapon to the target while the AFG provides lift and stability during flight. Use of the MK-82, MK-84, and bomb live unit (BLU)-109 for LGB warheads converts these “dumb” bombs from purely ballistic weapons to laser-guided weapons capable of very accurate and devastating strikes. During Operation Desert Storm, GBU–12s were employed by F–111s to destroy more than 200 tanks a night during the last few weeks of the war.

The difference between the two types of LGBs is the warhead and the AFG. The GBU–10 uses either the BLU–109 (fig. 1–2, view A) or the MK-84 warhead (fig. 1–2, view B) with the MXU–651 airfoil unit. However, the GBU–12 (fig. 1–2, view C) uses the MK-82 warhead with the MXU–650 airfoil unit. Likewise, both the GBU–10 and GBU–12 use either the miscellaneous armament unit (MAU)–169 series or the MAU–209 series for their CCG.

MAU-169 series computer control group

The CCG you see in figure 1–3 detects laser energy reflected from the target, processes the signals, and guides the weapon to the target. This CCG is powered by a thermal battery and consists of a detector, computer, and control section as described in the table below.

CCG Components	Description
Detector	Contains the circuitry that determines the direction to the target reflecting the laser energy. When the electronic circuitry senses the reflected energy on one or more quadrants of the detector surface, it causes the electronics to produce signals of varying strength, relative to the quadrant and amount of reflected energy received on the quadrant. The detector sends signals to the computer on four channels (A, B, C, or D) corresponding to the receiving quadrant.
Computer	Receives signals from the detector and converts each channel’s input into UP and DOWN and LEFT and RIGHT commands that operate solenoids in the control section.
Control section	Contains pneumatic-mechanical assemblies that respond to computer signals to guide the bomb. It mounts the bomb guidance fins (part of the airfoil group) on the fin control shafts, which protrude from the cylindrical housing. A gas generator in the control section ignites after the thermal battery ignites and provides gas pressure to power the steering solenoids.

Warheads

As we mentioned earlier, the GBU–10 uses either the MK–84 or BLU–109 bomb, while the GBU–12 uses the MK–82 bomb. As you may recall from the unit on GP bombs, the MK–84 and BLU–109 are 2,000 pound bombs, while the MK–82 is a 500 pound bomb.

Fuzes

The GBU–10, using the MK–84 or the GBU–12, using the MK–82 as the warhead, is capable of using the M905 mechanical tail fuze or the fuze munition unit (FMU)–81/B, FMU–139A/B (nose or tail installation), and the FMU–152A/B tail fuze. The GBU-10 using the BLU–109/B special-purpose penetrating bomb is capable of using the FMU–143/B and FMU–152A/B.

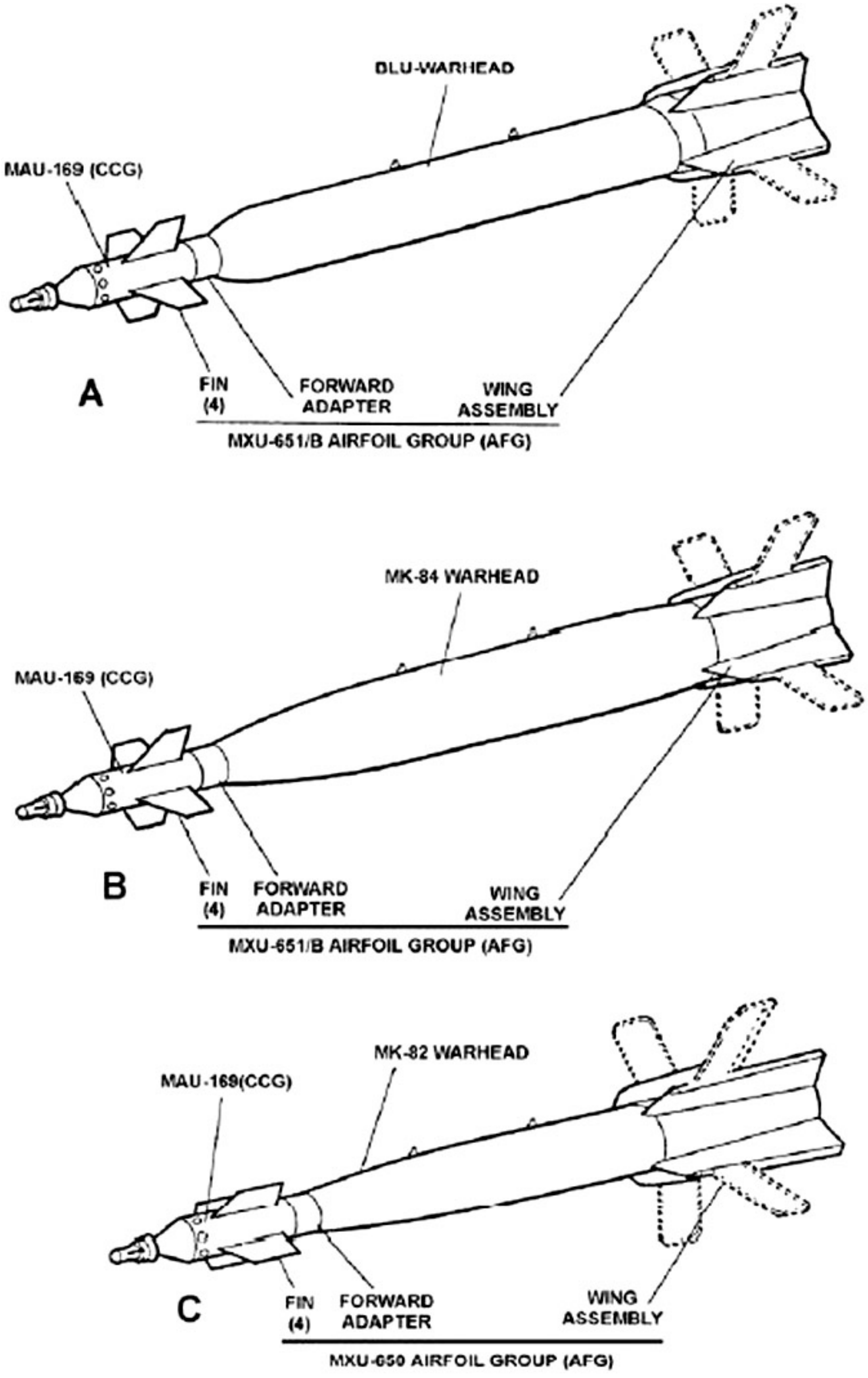

Figure 1–2. GBU-10 and GBU-12 (typical).

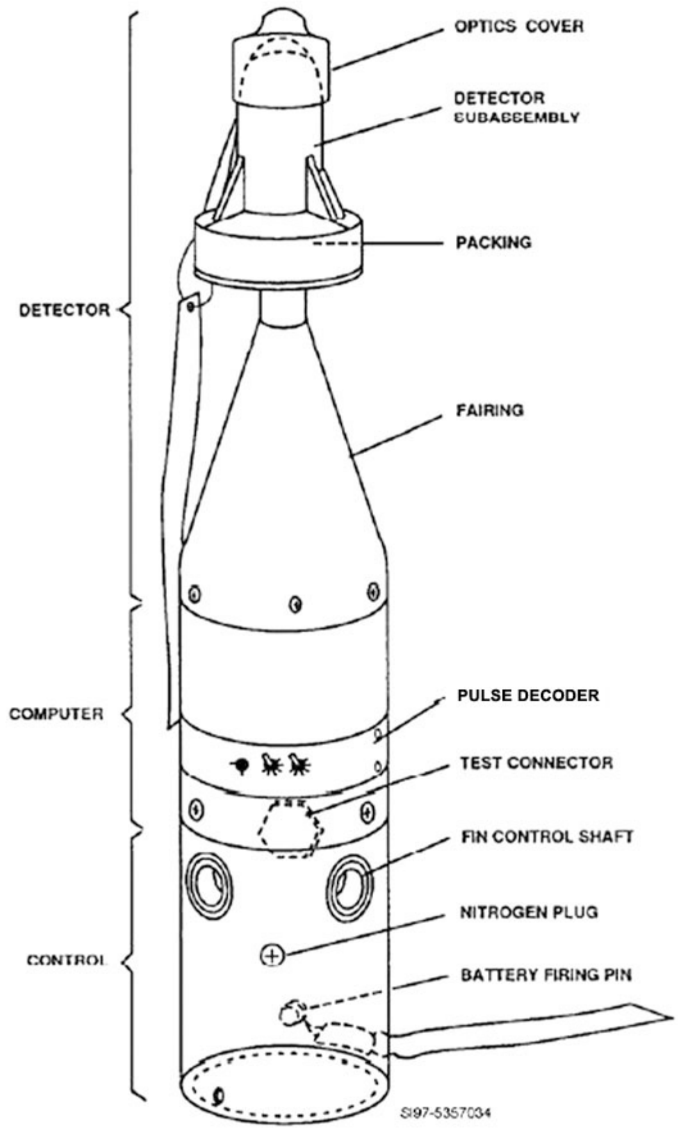

Figure 1–3. MAU-169 Computer Control Group (Typical).

MXU–650/B and MXU–651/B airfoil units

Airfoil units consist of a forward adapter assembly, four control fins, a folding wing assembly, and lanyards. The forward adapter assembly mounts the CCG to the warhead, and the four control fins snap into the control section of the CCG and maneuver the weapon in flight. The folding wing assembly mounts on the rear of the warhead and provides lift and stability during flight. Lanyards activate the weapon upon release from the aircraft. The major difference between the AFG of the MXU–650, shown in figure 1–4, and that of the MXU–651, is to accommodate the difference in size between the 500 and 2,000 pound bombs.

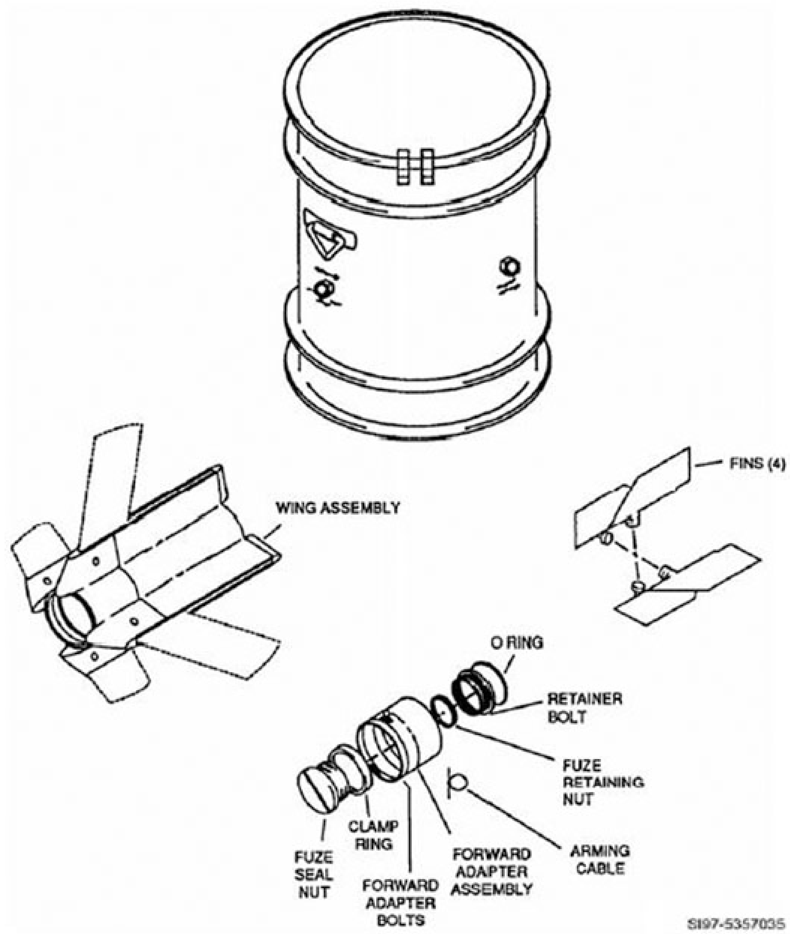

Figure 1–4. AFG MXU-650/B.

406. Guided bomb unit–-24 series

As you can see in figure 1–5, the GBU–24 low-level laser-guided bomb (LLLGB) has the same basic components as other GBUs, (a warhead, a guidance control unit [GCU], and an AFG), although its design is considerably different. Both the GBU–24/B and GBU–24A/B use either the weapon guidance unit (WGU)–12 or WGU–39 that attach to the nose of either a MK–84 or BLU–109 bomb body by a forward adapter assembly. The BSU-84/B airfoil group completes these LLLGB.

WGU–12/WGU–39 series guidance control unit

The purpose of the WGU–12 and WGU–39 is to provide autopilot control, target detection, and weapon guidance. Below are the three major subassemblies.

- A seeker platform assembly is a laser seeker that “looks” for the reflected laser light signal.
- A guidance electronic unit processes incoming error signals and turns them into steering commands for the control actuator assembly.
- A control actuator assembly which receives commands from the guidance electronic unit and steers the GBU.

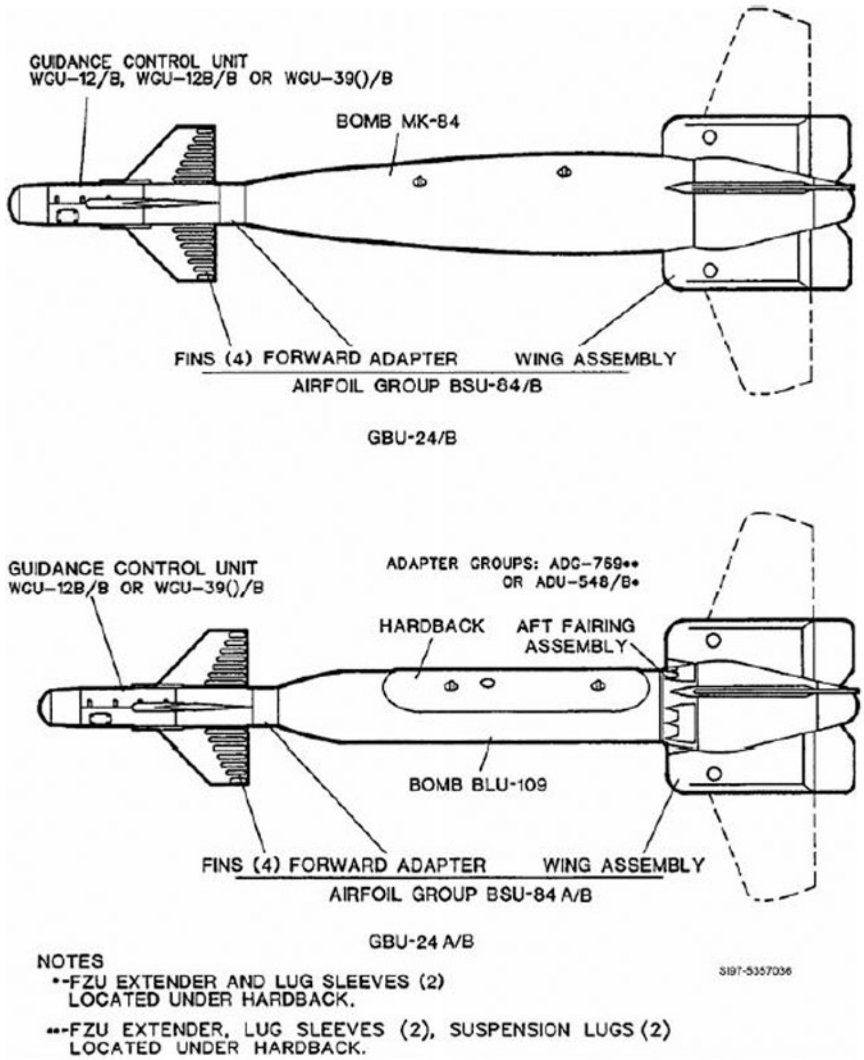

Figure 1–5. Low-level-laser-guided bomb.

Warhead

The GBU–24/B uses the MK–84 GP bomb, and the GBU–24A/B uses the BLU–109 special-purpose penetrating bomb, and the GBU–24H/B uses the BLU–118 thermoberic bomb.

Fuzes

The GBU–24/B uses either the FMU–81/B or the FMU–139A/B, while the GBU–24A/B, H/B uses the FMU–143/B, B/B, J/B, or the FMU–152A/B.

BSU–84 airfoil group

The BSU–84 airfoil group provides aerodynamic lift and stability during flight. Just like the MXU–650 and –651, this AFG is dangerous because accidental wing extension can cause serious injury. The BSU–84 AFG (fig. 1–6) consists of a forward adapter, four control fins, a folding wing assembly, and the lanyards. A forward adapter connects the GCU to the warhead. Control fins attach to the control actuator and maneuver the system in flight. A folding wing assembly provides lift and stability in flight. The lanyards activate the weapon upon release from the aircraft.

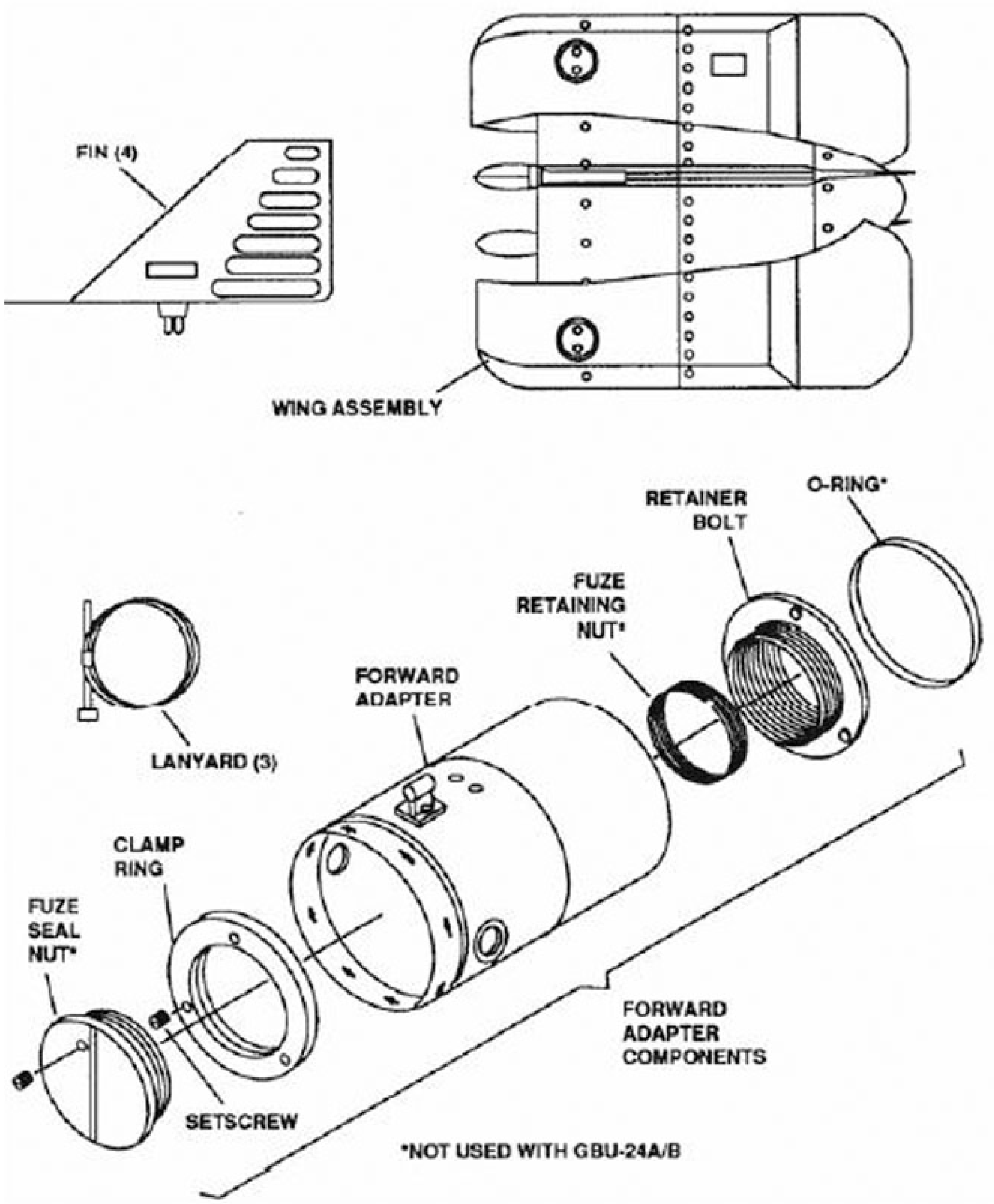

Figure 1–6. AFG BSU-84/B.

Adapter groups

The ADU–548/B adapter unit and the ADG–769 adapter group are used only on the GBU–24A/B. These kits consist of a hardback, two lug sleeves, two suspension lugs (ADG–769 only), aft faring assembly, and a fuze miscellaneous unit (FZU) extender. Functional testing of both AFGs are limited to deployment of the wing assemblies. A hydraulic wing actuator tool is used to deploy the wings and a hand-powered retracting tool is used to close the wings back to its original state. The BLU–109 special-purpose penetrator bomb is smaller in diameter than the MK–84 GP bomb. The hardback assembly and lug sleeves provide more distance between the bomb and bomb rack, while the aft fairing assembly provides an aerodynamic interface between the bomb and wing assembly. The FZU extender expands the bomb charging well conduit to the hardback assembly to facilitate proper fuze initiator installation.

407. Laser guided bomb test equipment

Computer control groups (CCG) have some fairly sophisticated test equipment to perform their functional checks. Information on CCGs for laser guided bombs can be found in technical orders (TO) 11K10–2–7, *Paveway II Laser Guided Bomb GBU–10 and GBU–12 Guided bomb Computer Control Groups* and TO 11K20–2–7, *Low-Level Laser-Guided Bombs GBU–24/B, GBU–24A/B, GBU–24H/B*. The TTU–373 and TTU–595 digital test sets are used for field testing all laser guided computer control groups/guidance control units you will come in contact with as a munitions specialist. We will briefly discuss these testers and special tools below.

Digital test set, TTU–373

The TTU–373 is an automated test set used for field testing laser-guided bombs CCGs and GCUs (fig. 1–7). The test set is primarily used to perform a functional check of the CCG or GCU before attaching it to the warhead.

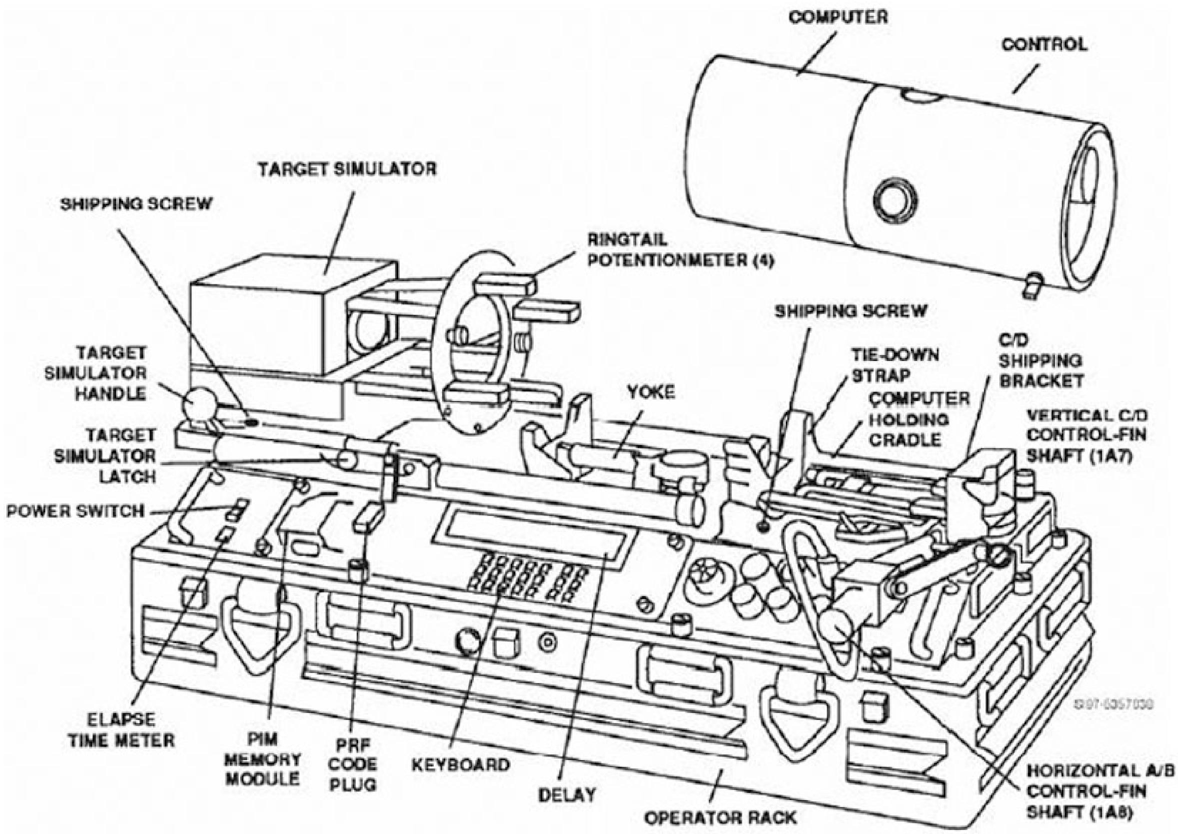

Figure 1–7. TTU-373A/E test set.

The TTU–373 operates in up to thirteen modes and is used as follows:

Six modes test and troubleshoot CCGs or GCUs.

Two modes test and troubleshoot the digital test set (DTS).

One mode isolates GCU/DTS problems.

Two modes input and display computer control group or computer guidance unit parameters.

One mode programs a pulse repetition frequency code plug.

One mode determines GCU mission configuration.

Select the modes of operation by entering command codes on the test set keyboard. This test set runs through the appropriate tests and gives you a pass or fail. The TTU–373 is housed in a shipping case with a removable cover. The cover provides a storage compartment for all cables and accessories. A compressor in the DTS supplies pneumatic power. Procedures for using all of the test equipment discussed are contained in work package (WP) 080 00 of T.O. 11K10-2-7 or WP 080 00 of TO 11K20-2-7.

Digital test set, TTU–595

The TTU–595 is our new test set designed to replace the aging TTU–373 and its old technology. The redesigned TTU–595 is much easier to operate, more ergonomic, and easier to maintain. Testing with the TTU–595 has been quoted as 80 percent faster than testing with its predecessor. Testing with the TTU–595 is a very simple process of connecting a few cables and minor interaction with the test set key pad.

WARNING: The TTU–595 directs invisible laser radiation through its cables and test heads. Operators must avoid direct exposure to the beam by *not* staring into the cables or test heads.

Special tools

As you might imagine, a weapon as complex as the LGB has quite a few special tools required for its maintenance. Among these are the torque wrench set and wrench adapter. They are used for installing the forward adapter. In addition to these tools, the bomb holding tool is used to hold the bomb body during torqueing because of the high foot-pound value needed. There is a wing actuator tool used for opening and closing the wings. A CCG maintenance stand and a wing assembly lifting bar are also available.

Self-Test Questions

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

405. Guided bomb unit–10 and –12 series

1. What are the three major component groups of a LGB?

2. What is the difference between the GBU–10 and the GBU–12?

3. Which CCG is used by the GBU–10 and GBU–12?

4. What does the computer control group do?

5. Which warheads are used by the GBU–10?

6. What warhead is used by the GBU–12?

406. Guided bomb unit–24 series

1. What are the functions of the WGU–12 and WGU–39 series GCU?

2. What fuzes are used in the GBU–24 series bombs?

3. What does the BSU–84 airfoil group provide for the LLLGB?

4. What is the function of the FZU extender when used with an airfoil adapter group for a GBU–24A/B?

407. Laser guided bomb test equipment

1. Which testers are used for field testing all laser guided computer control groups and guidance control units?

2. What is the TTU–373 digital test set primarily used for?

3. How many modes of operation does the TTU–373 have, and what do they do?

4. What hazard is present when the TTU–595 is in operation?

1–3. Global Positioning System Aided Inertial Navigation System

The GBU–31, –32, –38, –54 Joint Direct Attack Munitions (JDAM) and the GBU–39, 53 small diameter bombs (SDB) are some of the newest weapons in our inventory. The JDAM converts existing unguided free-fall GP and special purpose bombs into accurate, adverse weather "smart" munitions. The GBU–39 is a small, standoff precision glide weapon. These weapons, like all new weapons of today, use GPS to fix their position aided with INS. The benefit with using both systems together is INS may be calibrated by the GPS signals. The INS can also provide position and angle updates at a quicker rate than GPS. The two systems are complementary and are often employed together in our smart weapons.

408. Guided bomb unit–31, –32, –38, and –54

JDAMs are considered joint weapons because both the USAF and United States Navy (USN) employ them. The JDAM is built-up simply by installing guidance sets and fuzes to either a GP or special purpose bomb body. There are 28 GBU configurations we use in our arsenal, and the list is growing.

This includes 18 guidance sets in combination with eight warheads, fuzes, sensors and associated equipment. To go over each configuration would be time consuming, instead we will cover the major components and differences in the GBU-31, -32, -38, and the -54. This will give you a solid understanding of the JDAM. Let's start with an overview of the JDAM major components and then break down the similarities and differences of the JDAM guided bomb units.

Guidance set

The guidance set designation correlates as a kit munitions unit (KMU). The current guidance set designations are listed in the table below.

KMU-556/B	KMU-557B/B	KMU-559A/B
KMU-556A/B	KMU-557C/B	KMU-559B/B
KMU-556B/B	KMU-558/B	KMU-559C/B
KMU-556C/B	KMU-558A/B	KMU-572A/B
KMU-557/B	KMU-558B/B	KMU-572B/B
KMU-557A/B	KMU-558C/B	KMU-572C/B

The typical guidance set consists of a tail assembly, a set of aerosurfaces (strakes), and an umbilical cover; however, this varies dependent on the configuration (fig. 1–8). All KMU-series kits are functionally the same but are not interchangeable because guidance software and physical interfaces are peculiar to each warhead type used.

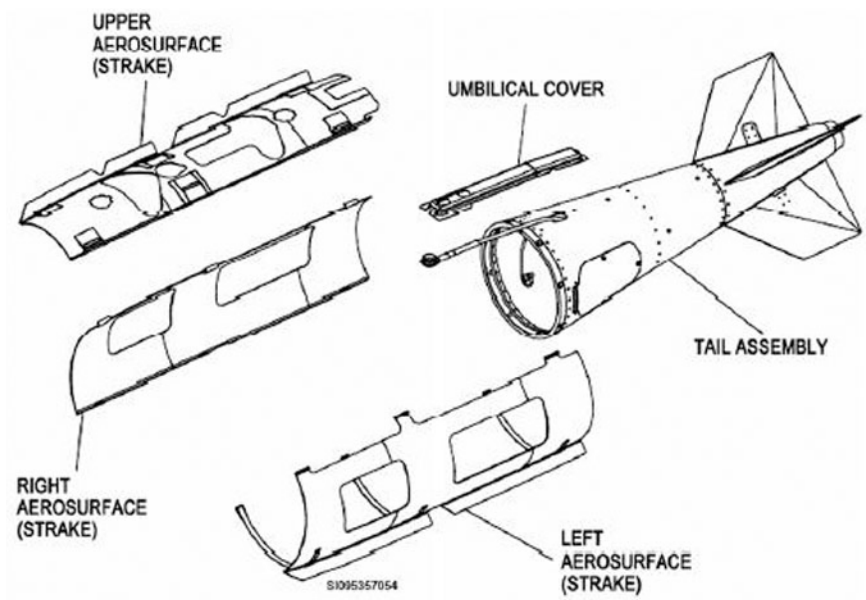

Figure 1–8. Typical guidance set (KMU kit).

Tail assembly

The tail assembly is essentially the major component of the KMU-series kit (fig. 1–9). The tail assembly provides electrical and electronic interfaces to the delivery aircraft, and guidance and control functions that guide the GBU to the target. The typical tail assembly consists of a tail fairing/structure, tail actuator subsystem, wire harness assembly, GCU, GPS antenna, three moveable control fins, and one fixed fin.

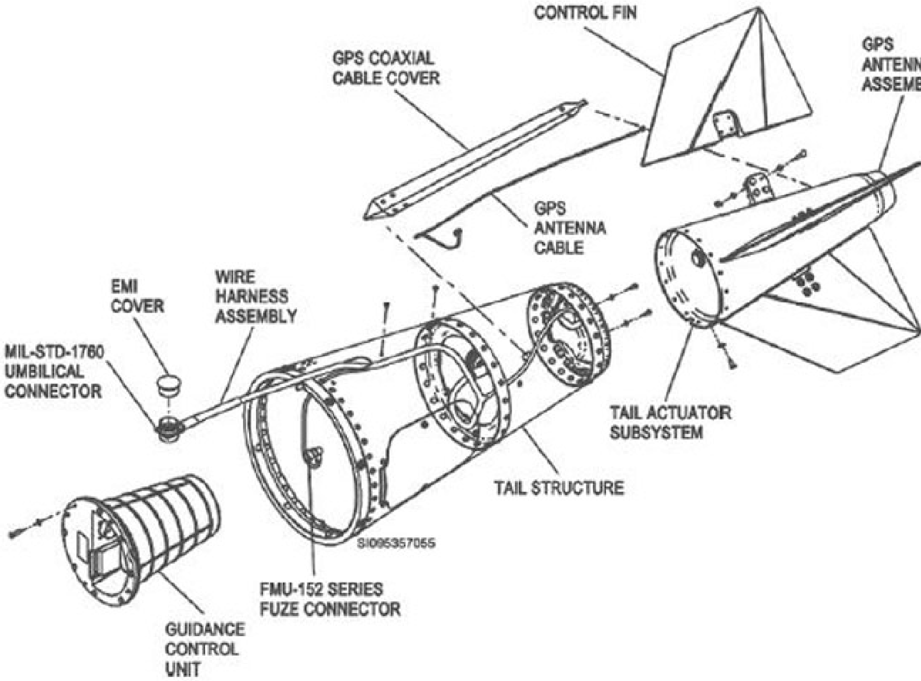

Figure 1–9. Typical KMU-series tail assembly.

Tail actuator subsystem

The tail actuator subsystem consists of the aft tail assembly structure, three electromechanical actuators to power three movable control fins, a lithium thermal battery and associated controlling electronics. The aft structure provides a mounting surface for a GPS antenna and mounting surfaces for control fins.

Wire harness assembly

The wire harness assembly consists of an umbilical connector, FMU–152 series fuze connector, GCU connectors, and a shielded wiring harness. A protective electro-magnetic interference cover is provided on the umbilical connector. The FMU–152 series fuze connector is connected to a stowage receptacle on the inside surface of the tail assembly structure when not in use.

Guidance control unit

The JDAM is guided by GPS and INS located in the KMU tail section. This system provides release and targeting flexibility for pilots, and optimizes the weapon's impact point. To accomplish this, mission plan data is loaded into aircraft computers prior to takeoff and that data is then downloaded into the JDAM GCU prior to weapon release.

Weapon release can be performed manually by the pilot, or automatically by aircraft onboard computers. Release options for the JDAM include dive, dive-toss, lateral toss, loft, or straight and level, within a release envelope that includes off-axis delivery options as well. An off-axis delivery is where the JDAM glides toward its intended target on a flight path that curves away from flight path of releasing aircraft. This allows the JDAM to reach a target without requiring the aircraft to directly overfly that target. The capability for off-axis attack provides increased aircraft and aircrew survivability. This feature makes the JDAM a true "fire and forget" weapon.

During free flight, the weapon acquires signals from several GPS satellites, providing it with navigational accuracy. At the same time, the JDAM employs its optimal guidance and autopilot features, which actuate control surfaces to maneuver the weapon toward its target and desired angle for greater target penetration. This guidance system provides the capability to hit a target within 13 meters (40 feet) from a distance of up to 15 miles.

Global positioning system antenna

The GPS antenna is located on aft end of the tail actuator subsystem. The antenna is connected to the GCU by a cable that runs along the exterior of the tail assembly.

Aerosurfaces

While all aerosurfaces are physically different dependent on the warhead to be used, all serve the same function. Aerosurfaces or "strakes" provide aerodynamic lift, maneuverability, and other needed flight characteristics. They typically consist of three formed steel "strakes" that are strapped around bomb body (warhead). Upper aerosurfaces are positioned over the suspension lugs. Right and left aerosurfaces attach to slots in upper aerosurface and are fastened around the bomb body.

Umbilical cover

The umbilical cover attaches to both the tail assembly and upper strake to ensure proper mating with aircraft, as well as protecting the wiring harness during weapon handling.

Warhead

There are currently eight bomb bodies used with the four GBUs. Some of these bomb bodies are used primarily by the US Navy so we will not discuss those JDAM version numbers. There are only five JDAM bomb bodies used by the USAF which include the MK–82, MK–83, MK–84, BLU–109, and the BLU–126.

Fuze

The final major component in the JDAM is the fuze. The only fuzes used with the JDAM are the FMU–139 series, FMU–143 series, or the FMU–152 series fuze depending on the configuration.

GBU–31 series version 1

The GBU–31(V)1 series uses a MK–84 2,000 pound GP warhead, the KMU–556 series guidance set, and either the FMU–139 series or FMU–152 series fuze (fig. 1–10). The GBU–31(V)1 has an optional configuration of using the DSU–33 sensor for proximity detonation. The guidance set consists of the typical tail assembly, a set of three aerosurfaces, and an umbilical cover. The GBU–31(V)1 series is employed only by the USAF.

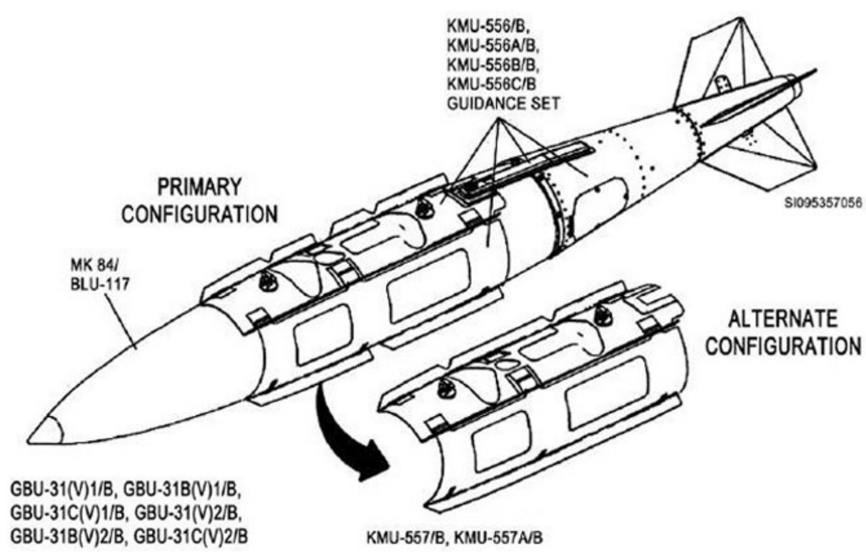

Figure 1–10. GBU–31 (V)1.

GBU–31 series version 3

The GBU–31(V)3 series uses a BLU–109 2,000 pound special purpose warhead, the KMU–557 series guidance set, and either the FMU–143 series or the FMU–152 series fuze (fig. 1–11). In addition to the typical guidance set components, these KMU kits include a hardback assembly and associated components instead of the upper strake to provide the necessary physical interface to the delivery aircraft. The GBU–31(V)3 series is employed only by the USAF.

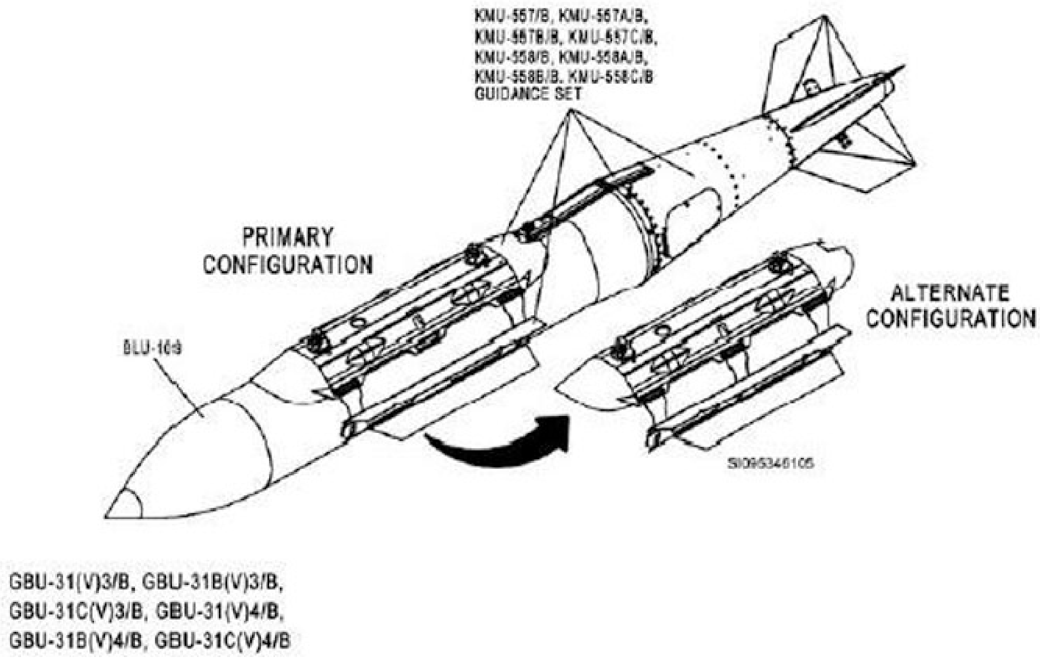

Figure 1–11. GBU-31 (V)3.

GBU–32 series version 1

This version of the JDAM uses a MK–83 1,000 pound GP warhead (fig. 1–12), the KMU–559 series guidance set, the FMU–139 series or FMU–152 series fuze. The GBU–32(V)1 has an optional configuration of using the DSU–33 proximity sensor that allows the JDAM to function as an airburst weapon. This GBU–32 version is employed only by the USAF.

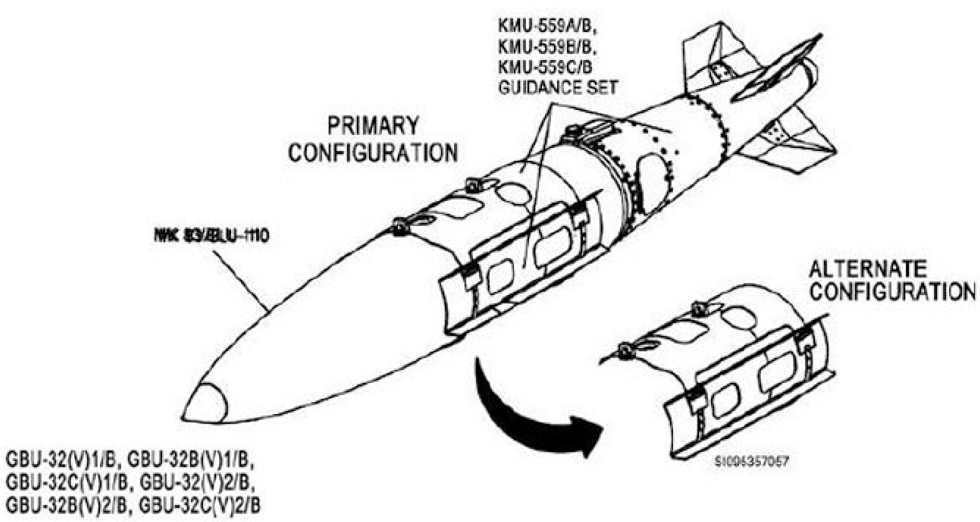

Figure 1–12. GBU-32 (V)1.

GBU–38 series version 1

The GBU–38 series is sometimes referred to as the "*baby*" JDAM (fig. 1–13). This smaller precision weapon further decreases the likelihood of collateral damage when warfighting has to target insurgents within heavily populated areas. The GBU-38(V)1 uses a MK-82 500 pound GP warhead, KMU–572 series guidance set, and the FMU–139 series or FMU–152 series fuze. The GBU–38(V)1 has an optional configuration of using the DSU–33 proximity sensor. The GBU–38 series has all the same hardware as the GBU–31 series, except smaller to accommodate the warhead size. This GBU–32 version is employed only by the USAF.

GBU–38 series version 4

The GBU–38(V)4 is employed by both the USAF and USN (fig. 1–13). The GBU–38(V)4 uses the BLU–126 500 pound Low-Collateral Damage Bomb warhead. The Low-Collateral Damage Bomb has a NEW of 27 pounds, which minimizes the possibility of collateral damage to close friendly or non-combatant forces. It also uses the FMU–152 fuze, KMU–72 series guidance set and the DSU–33 proximity sensor. The biggest difference between version 1 and version 4 is the warhead.

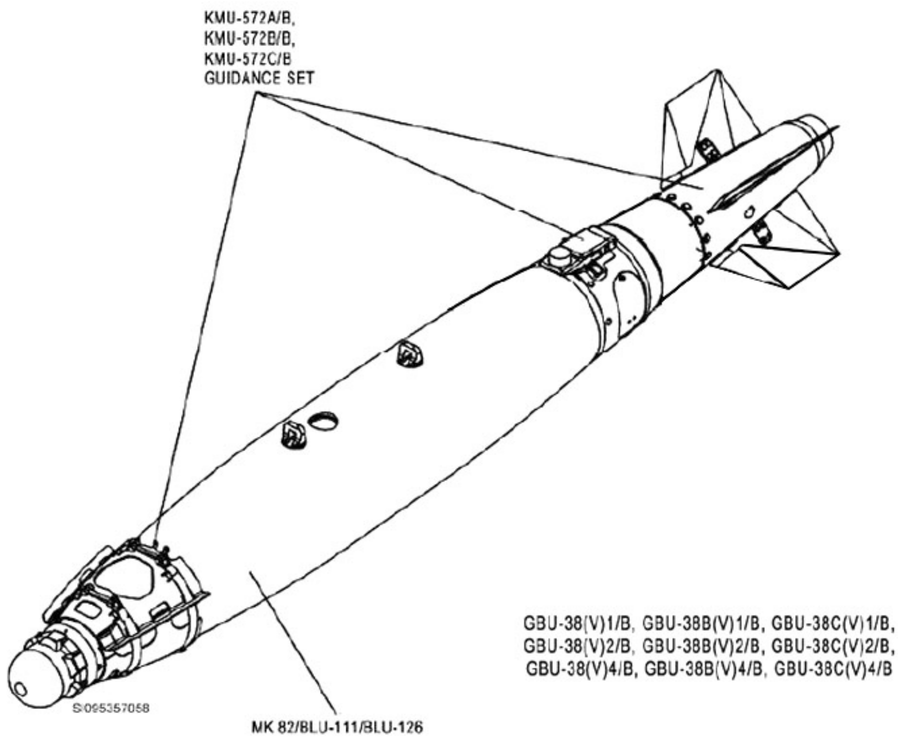

Figure 1–13. GBU–38 (V)1 and (V)4.

GBU–54 series version 1

The GBU–54(V)1 series is identical to the GBU–38(V)1 series except with the addition the DSU–38 laser illuminated target detector (see figs. 1–14 and 1–15). The DSU–38 adds a precision laser guidance set to the JDAM, giving it optional semi-active laser guidance in addition to its GPS/INS guidance. The sensor will continuously track a laser designated target illuminated by a laser spot and transmit data to the KMU–572 series guidance set. The DSU–38 is installed to the front of the JDAM via an externally mounted strap assembly which is included in the DSU–38 kit (fig. 1–16). Four stainless steel strap assemblies are fastened around the bomb body. The strake strap assembly replaces the aft aerosurface strap from the KMU–572 series aerosurface assembly. With the addition of the DSU–38, the JDAM takes on the new designation of laser joint direct attack munition (LJDAM). This GBU–54 version is employed only by the USAF.

GBU–54 series version 4

The GBU–54(V)4 series is identical to the GBU–38(V)4 series except with the addition of the DSU–38 laser illuminated target detector (fig. 1–14). With the addition of the DSU–38, the JDAM takes on the new designation of LJDAM. This GBU–54 version is employed by both the USAF and USN.

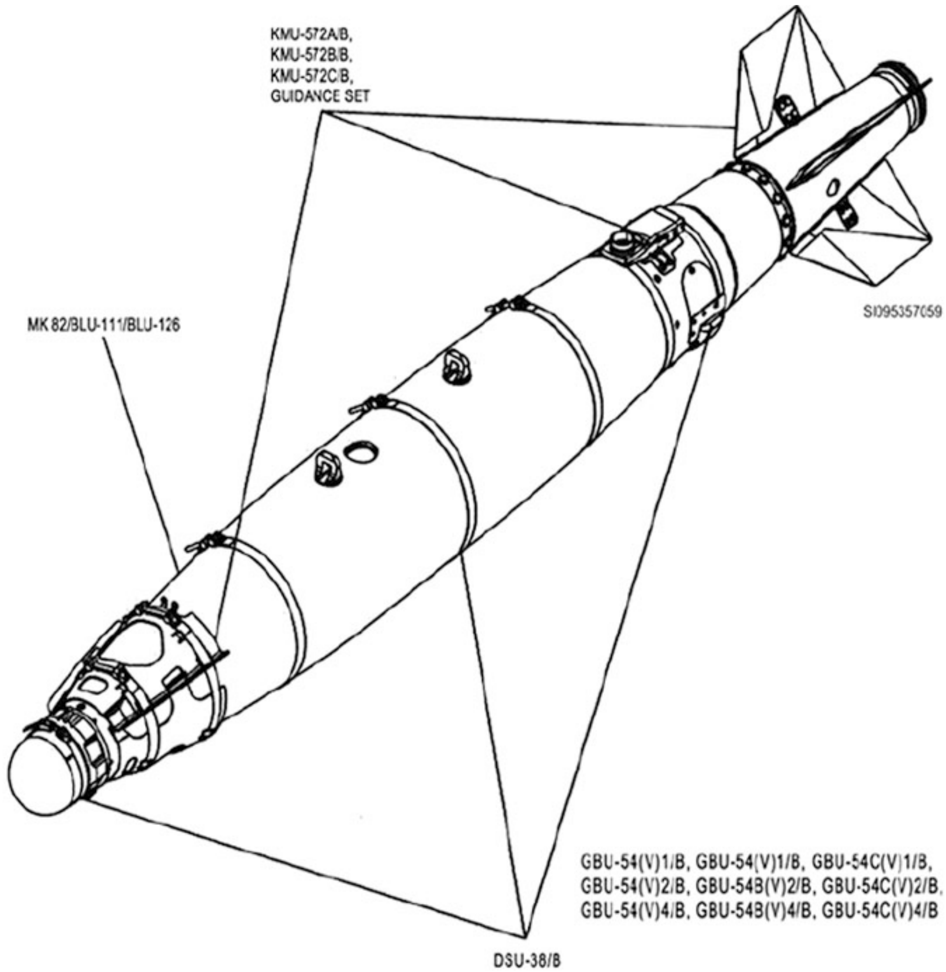

Figure 1–14. GBU–54 (V)1 and (V)4 series.

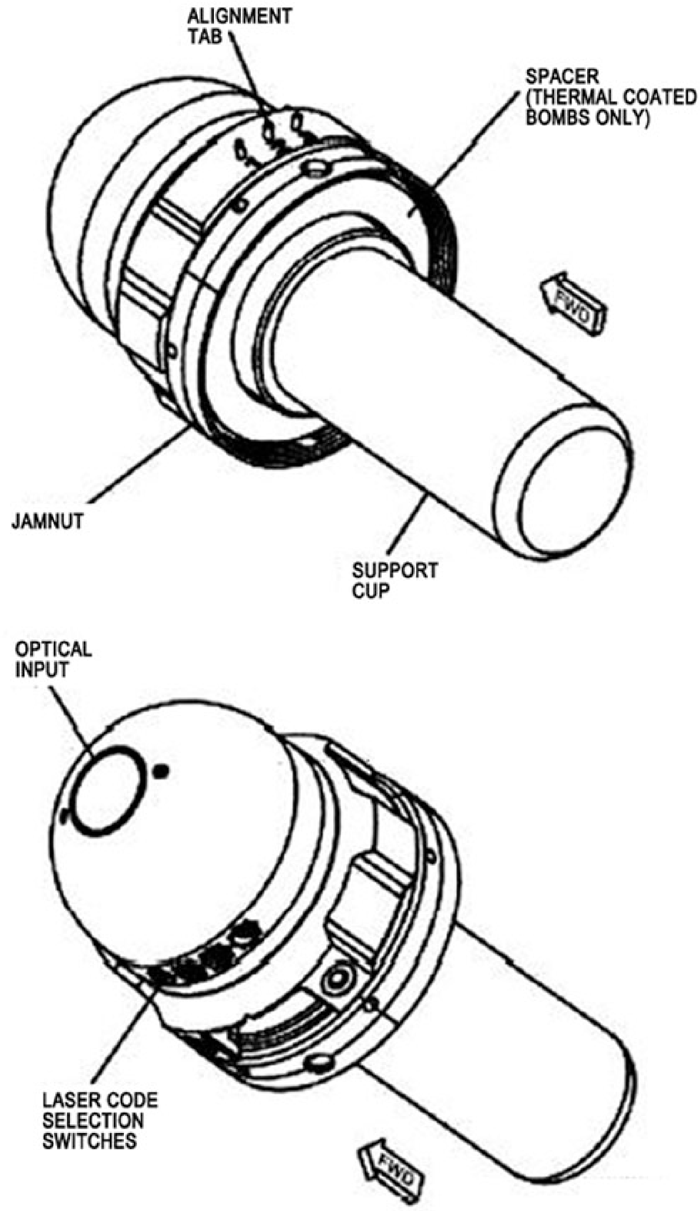

Figure 1–15. DSU–38 laser illuminated target detector.

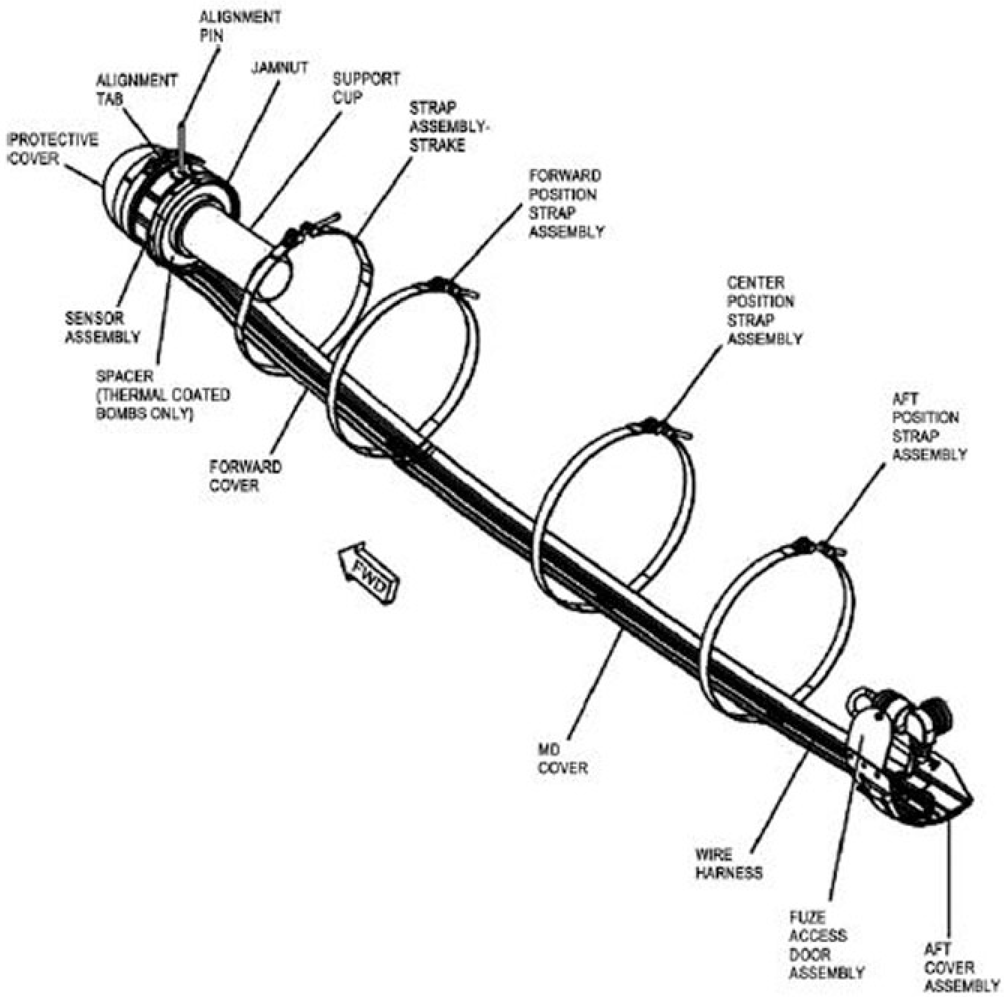

Figure 1–16. DSU–38 and included components.

409. Guided bomb unit –39 & –53 small diameter bomb

The small diameter bomb is designed to provide a small size precision, standoff air-to-ground weapon that can be delivered by both fighters and bombers. The small diameter bomb is a joint US Air Force and US Navy initiative that provides increased aircraft loadout/sorties, while leaving a smaller logistical footprint that results in less collateral damage.

GBU–39

The GBU–39 series SDB, shown in figure 1–17, is a 250-pound class weapon designed as a small autonomous air-to-ground, precision glide weapon able to strike targets in adverse weather from a standoff range of over 40 nautical miles. The GBU–39 SDB maneuverability and range are enhanced by diamond back wings attached to the main bomb body and control fins located on the tail actuation system. Currently, there are two variants of the GBU–39 series SDB. The GBU–39/B and GBU–39A/B variant are essentially the same. The main difference is in the construction of the warhead assembly and NEW.

Warhead

The warhead for the GBU–39/B is an advance penetrator that has a two-piece, welded, high strength steel casing. Besides the blast hazard, the GBU–39/B warhead has an added fragmentation capability and contains approximately 36 pounds NEW of Air Force explosive (AFX)–757.

The warhead outer casing for the GBU–39A/B is manufactured from a carbon fiber composite material instead of formed steel construction. The GBU–39A/B warhead assembly also uses a different high explosive material. It is filled with approximately 137 pounds NEW of a multi-phased blast explosive AFX 1209. With this unique warhead, the GBU–39A/B has earned the name *Focused Lethality Munition* (FLM). Another important component that makes up a SDM is the guidance unit which will be discussed below.

Figure 1–17. GBU–39 series small diameter bomb (wings extended).

Guidance unit

The guidance unit for the GBU–39 series SDB series is comprised of two sections located aft of the warhead and forward of the fins. The GBU–39 has an Advanced Anti-Jam Global Position System aided Inertial Navigation System that provides guidance to the coordinates of a stationary target. It provides accurate conventional strike capability from very low to very high altitudes. This system also enables both single-pass multiple-target engagements with individual GBU–39s and single-pass single-target engagements with multiple GBU–39s. The GBU–39 series SDB automatically begins its initialization process and aligns its INS when power is applied by the aircraft. Targeting data is downloaded to the GBU–39s from the cockpit by the air crew.

GBU–53

The GBU–53 small diameter bomb increment II (SDB II) is another 250-pound class weapon designed as a low collateral damage, network enabled, air-to-ground, precision glide bomb capable to strike targets in any weather from a standoff range over 40 nautical miles. The GBU–53 shown in figure 1–18 has many similarities of the GBU–39, but unlike the GBU–39 that is only successful against stationary targets, the GBU–53 incorporates a multi-mode seeker/data link for use against moving targets. Another difference from the GBU–39 is that the GBU–53 cannot be stored in the container unit (CNU)–659/E but instead will be stored in the CNU–660/E.

Figure 1–18. GBU–53 small diameter bomb (wings extended).

Warhead

The GBU–53 has a 22.5 pound multi-effects warhead, with PBX–N–109 explosive filler. The multi-effects this warhead produces are from its aluminized enhanced blast, scored fragmentation casing, and from a copper shaped charge. These characteristics enable the bomb to destroy armored targets, while at the same time, minimizing collateral damage.

Guidance unit

The fire and forget guidance unit for the GBU–53 is primarily a GPS/INS with weapon data link update capability. However, besides using the GPS/INS option, the multi-mode seeker also allows for millimeter-wave radar, imaging infrared, and semi-active laser targeting.

BRU–61 carriage system

The BRU–61 carriage system is designed to hold up to four miniature (GBU–39, GBU–53) bombs with independent release capability. The BRU–61 consists of a four-place rack with a self-contained, pneumatic charging and accumulator operating method (figs. 1–19 and 1–20). Four ejector assemblies hold the individual weapons and internal avionics. The carriage system controls the weapon power up sequence and passes targeting/alignment information through four weapon umbilical harnesses through a MIL–STD–1760 connector. The weapons can be released using the manual or automatic option. The automatic option utilizes the aircraft's computer system to calculate the release of the munitions when predetermined parameters are reached. In turn the BRU–61's carriage system control electronics (CSCE) processes the command signal from the aircraft and selects the appropriate munition for use based on the number and position available of the carriage system. Once the CSCE signals to eject the munition, a solenoid in the ejector unit unlocks the hooks. The ejector then releases the hooks from the munition, while compressed air is simultaneously forced into the ejector piston forcing the piston to extend. The combined weight of the munition and the force of the ejector pistons cause the munition to be released and ejected. As the munition is released, the ejector pistons extend, and the force of the ejector pistons causes the munition to be ejected away from the aircraft. The pitch valves, which are manually set before flight, vary the ejection force of each ejector piston. This controls the pitch of the munition as it is ejected away from the BRU–61/A.

The BRU–61 Carriage system is a warranted item and shall be limited to visual inspections. No periodic inspections are required. If the BRU–61 is containerized (CNU–660), then it will not be opened for an inspection unless the container is damaged. Special inspections may only be performed by direction of MAJCOM or Warner Robins Air Logistics Center for which specific instructions will be provided.

Testing of the BRU–61 can be done packaged or unpackaged using the AN/GYQ–79, also known as the Common Munitions BIT/Reprogramming Equipment (CMBRE). Ensure that you have the applicable Personal Computer Memory Card International Association and the TTU–598/E or ADU–890/E Guided Bomb Test Set as well. The munitions testing configuration of the CMBRE is used to initiate a built-in-test (BIT), perform an inquiry, perform maintenance operations, or to perform classified data erase on the BRU–61.

CNU–659/E container

CNU–659/E container is designed for all transportation environments including rail, truck, military air, and ship. The CNU–659/E is composed of a cover and base and designed for one GBU–39 series SDB. Once secured, the CNU–659/E becomes air tight. The container contains the breather valve, humidity indicator, desiccant port, and BIT access. An in-container BIT cable is provided to allow for in-container BIT testing. The desiccant port allows access to the in-container BIT cable. The base has fork lift pockets on each side. A removable GBU–39 series SDB cradle is located in the base. The cradle protects the GBU–39 SDB and provides interface with standard Air Force loading equipment. The cradle is required if we are to deliver a single weapon to the flight line. The GBU–39 series SDB cradle rests on foam inserts mounted to the container base which provide shock isolation during transport. The GBU–39 series SDB cradle has fork lift slots as well as a curved bottom for bomb lift truck interface.

CNU–660/E container

The CNU–660/E container has the same features as the CNU–659 container and is also designed for all transportation environments including rail, truck, military air, and ship. In addition, the CNU–660 is designed to hold four GBU series small diameter bombs or an empty BRU–61/A carriage. The container also contains a BIT cable to allow for in container testing of the BRU–61 and/or the attached small diameter bombs using the CMBRE.

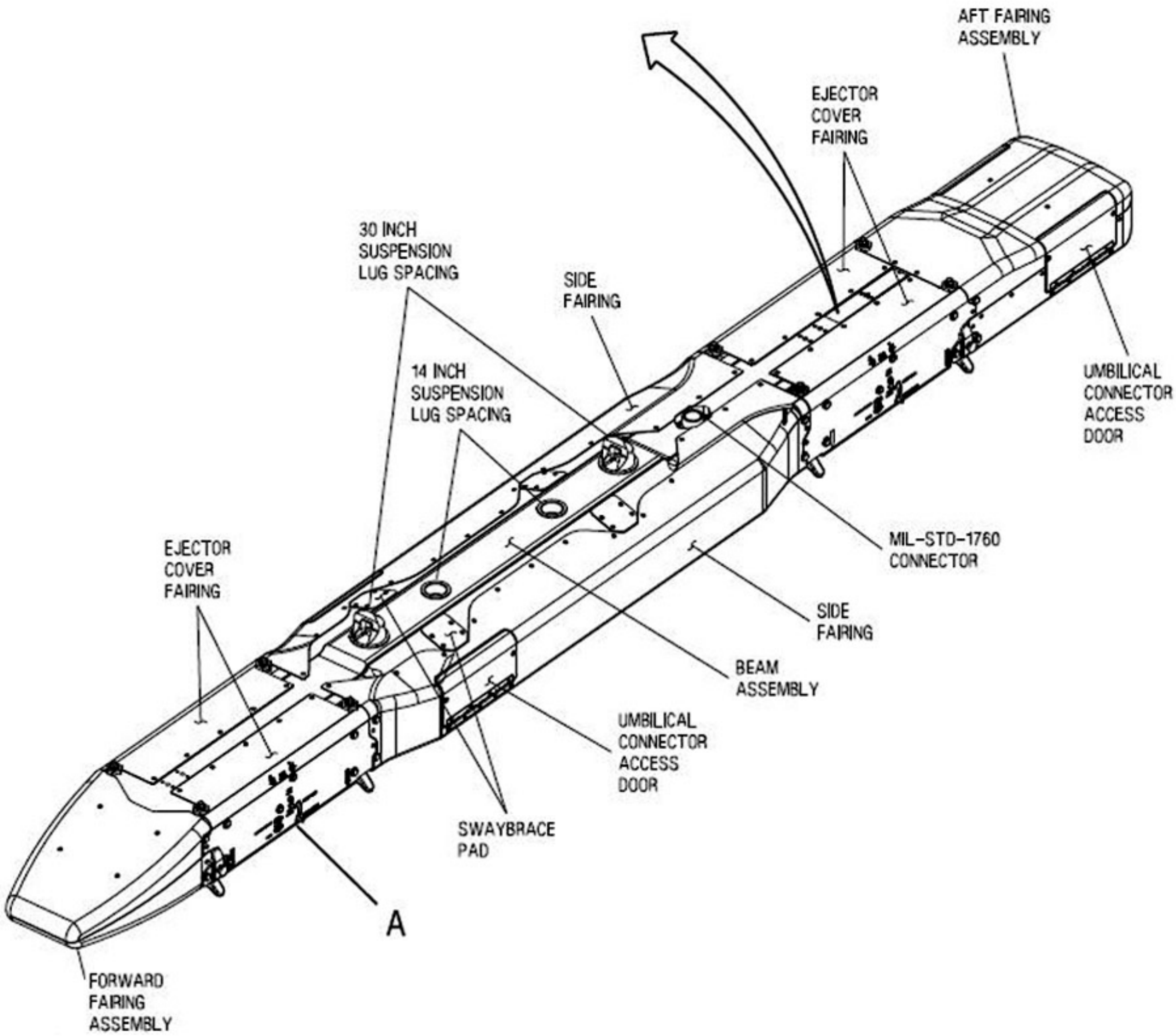

Figure 1–19. BRU–61 carriage (empty).

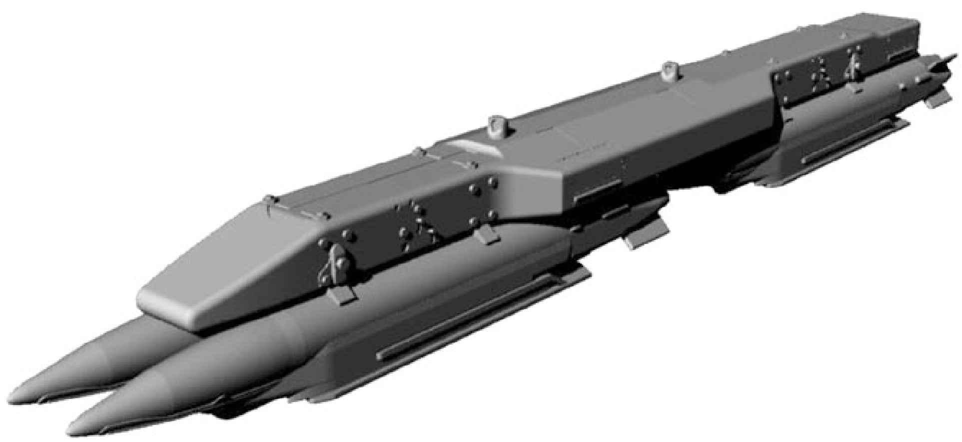

Figure 1–20. BRU–61 carriage pre-loaded with four GBU-39 series SDBs.

Inspecting and testing a GBU series small diameter bomb

Just like every other munition system, we have to inspect small diameter bombs to avoid obvious defects. We must also test the small diameter bombs to ensure they work as designed.

Inspecting

Like many of the newest weapon systems, the GBU–39 and GBU–53 series SDB requires only minimal inspections. We, as munitions systems specialists, are required to do very little with the SDB. We are not required to perform a periodic inspection. However, we must conduct the storage monitoring inspection every two years. A storage monitoring inspection simply requires us to check the humidity indicator to ensure the humidity level is acceptable inside the container.

We must perform a returned munitions inspection on items returned from custody/consumption accounts prior to return to base stock. Any GBU–39 series SDB returned in an unopened CNU–659/E container needs only an external visual inspection of the container. Likewise, a BRU–61/A and GBU–53 series SDB returned in unopened CNU–660/E containers need only an external visual inspection of the container. Visually inspect and conduct an initiated built-in test (IBIT) on uncontainerized GBU series SDBs or those in an open container.

Testing

Testing is just as important as inspecting, if not more so. It's the means we use to ensure the weapon will work properly when it is launched from the aircraft.

Weapon initiated built-in test

We can perform the weapon IBIT on up to four individual GBU–39 or GBU–53 series SDBs (packaged or unpackaged) simultaneously. We use the AN/GYQ–79 Common Munitions BIT/Reprogramming Equipment (CMBRE) to perform all the tests on the BRU–61 and/or the applicable small diameter bombs. To perform a weapon IBIT, the SDB munition application program, the personal computer memory card international association, and the maintenance log must be installed in the digital computer. The munition application program produces the digital computer menus for selecting the SDB operations. The SDB software suite consists of the files which determine if the GBU–39 series SDB reprogramming is required.

Carriage initiated built-in test

We perform carriage IBIT when zero to four GBU series SDBs are loaded on a BRU-61/A. We can perform carriage IBIT on packaged or unpackaged BRU–61/A. The carriage IBIT is almost identical to a weapon IBIT.

410. AN/GYQ–79 digital computer test set

We use the AN/GYQ–79 CMBRE to perform BIT and get systems and munitions status, to reprogram munitions operational flight programs, and to load mission planning and GPS crypto keys (fig. 1–21). The test set is capable of performing these tests on the AGM–158 Joint Air-to-Surface Standoff Missile (JASSM), GBU–31 JDAM, GBU–32 JDAM, GBU–38 JDAM, GBU–54 LJDAM, GBU–39 SDB, GBU–39 SDB FLM, ADM–160 Miniature Air Launched Decoy (MALD), AIM–9X Sidewinder, and many other weapons that are not studied in the CDCs. As you can see from the list of weapons the CMBRE can test, the CMBRE was designed in part to allow munition personnel to maintain one test set for maximum war fighter flexibility. Now we can test many weapons with a single test set as opposed to many decades ago when most weapons had their own unique systems. The CMBRE Plus is an upgraded configuration of the common CMBRE that will support the fielding of the next generation of weapons.

The CMBRE is composed of three boxes (refer to fig. 1–21 as we discuss the boxes):

- Box 1 – Contains the test adapter unit.
- Box 2 – Contains the controller unit.
- Box 3 – Contains the accessory kit.

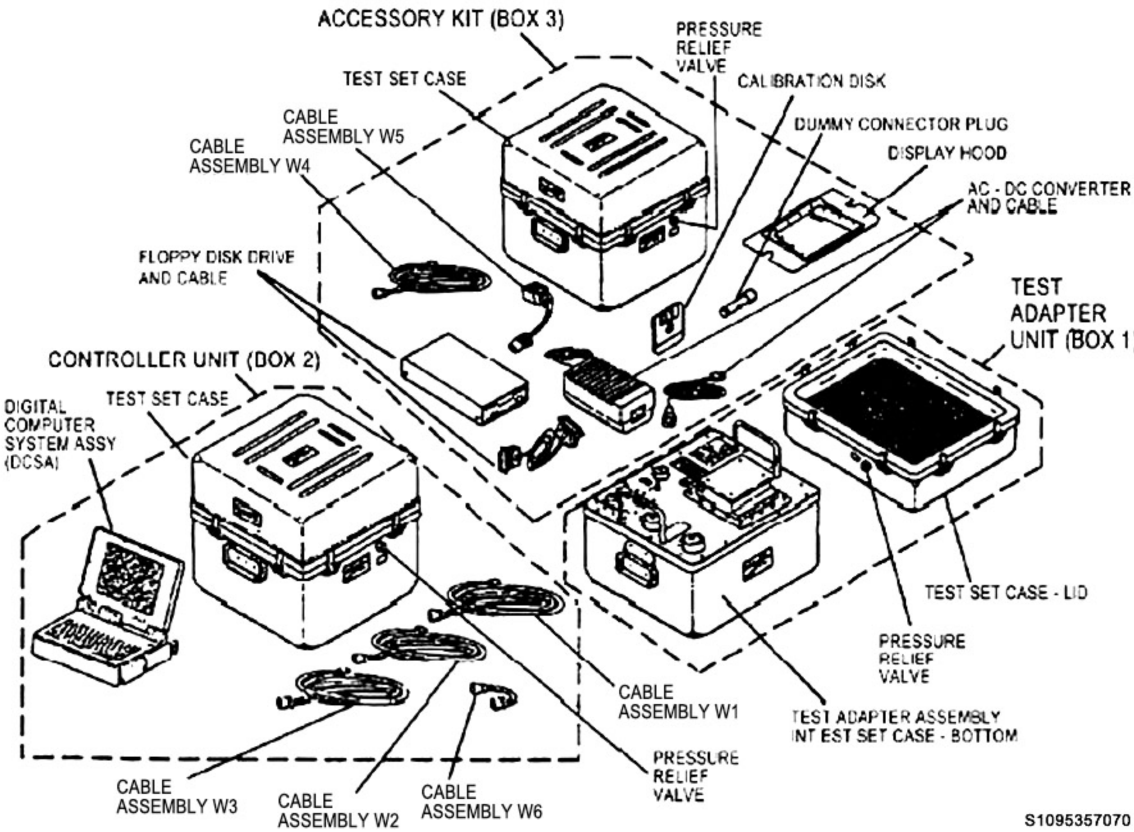

Figure 1–21. AN/GYQ–79 digital test set.

Test adapter unit (Box 1)

The test adapter unit (TAU) provides the electrical resources for munitions power, addressing, and discrete input/output (I/O) between the digital computer system assembly (DCSA) and the munitions being tested (fig. 1–22).

The TAU is used to initiate BIT and get systems and munitions status, to reprogram munitions operational flight programs, and to load mission planning and GPS crypto keys. It operates from 115 volts, alternating current (VAC), 3-phase (4-wire), and 400 hertz (Hz) power sources. The TAU supplies 13 volts, direct current (VDC) power to the DCSA (laptop computer from box 2) and 28 VDC to the munitions interface. The TAU is comprised of an electronic control panel, power supply, processor circuit card assembly, and power monitor circuit card assembly.

Electronic control panel

The electronic control panel provides the power indicators and control and I/O interfaces to the controller (J2) and the munitions interface (J3).

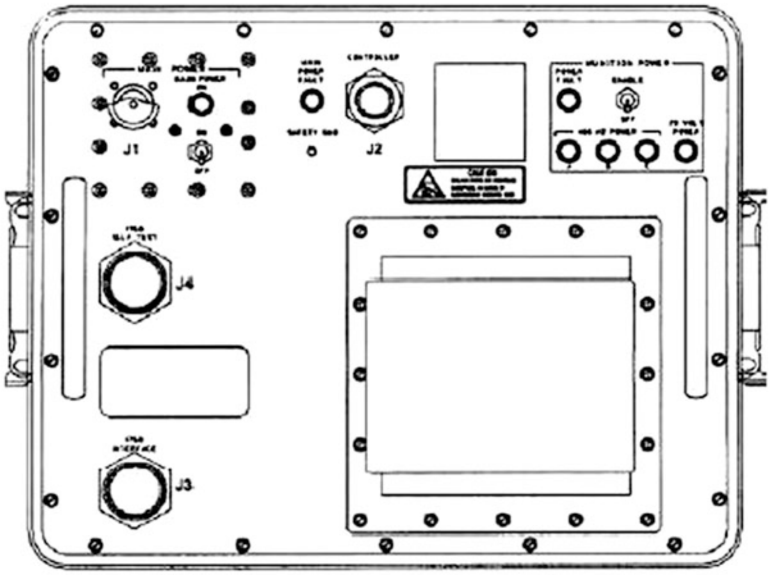

Figure 1–22. Test adapter unit.

Power supply

The power supply (PS1) provides regulated DC power to the TAU CCAs at ±13 VDC, controller unit at 13 VDC and to munitions under test at 28 VDC. The power supply contains a cooling fan that automatically activates when unit internal temperature reaches 131ºF.

Processor circuit card assembly (A1)

The processor CCA receives commands from the controller unit via cable W2 and performs commanded action to initialize or control one of the TAU resources. The processor CCA operates on an independent microcontroller, separate from the DCSA microprocessor.

Power monitor circuit card assembly (A3)

The power monitor CCA monitors the frequency, phase, and amplitude of the alternating current (AC) input power. Out-of-tolerance conditions always result in the removal of power to the munitions or unit under test.

Controller unit (Box 2)

The controller unit consists of the DCSA, electrical power cable assembly W1, controller interface cable assembly W2, 1760 interface cable assembly W3, and the munitions adapter cable assembly W6. The DCSA is a self-contained, ruggedized computer that is International Business Machines (IBM) compatible (fig. 1–23). The computer receives its power from the TAU via cable assembly W2 unless it is being used as a stand-alone personal computer. In this case, the DCSA receives its input power via the alternating current-direct current (AC-DC) converter. The computer provides system central control, communications, access to the munitions application program memory, and interfaces to external resources.

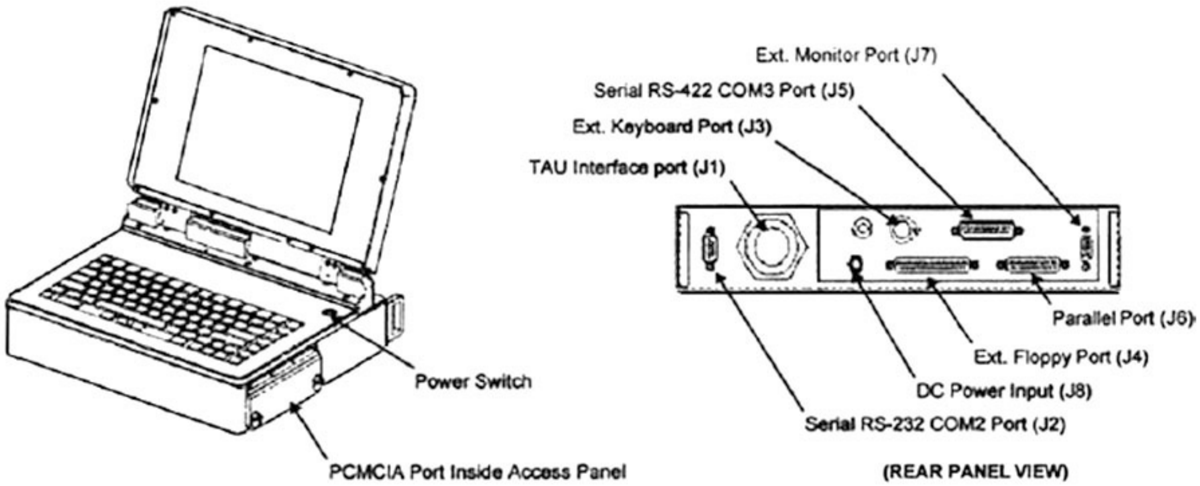

Figure 1–23. Digital computer system assembly.

Accessory kit (Box 3)

The accessory kit is a test set case we use for storage and transporting components that are not required for normal system operation. The table below shows the standard content of the accessory kit and interface cable assembly:

Component	Description
Power extension cable assembly (W4)	W4 is a 75-foot extension power cord that allows the AN/GYQ-79 to be used 100 feet from a power source.
Power adapter cable assembly (W5)	The W5 is a two-foot power adapter cable that connects W1 to a power cart.
AC-DC converter	The AC-DC converter converts 60 Hz, 115 VAC or 50 Hz, 220 VAC for input power for the DCSA when being used as a stand-alone personal computer.
Disk drive unit and interface cable assembly	The disk drive unit is a 3.5-inch floppy disk drive that interfaces with the DCSA via the floppy disk drive cable. This cable must be used only in an office environment.
Calibration disk (USAF only)	The calibration disk is a 3.5-inch floppy disk used to perform a calibration check once every 59 months. Calibration is not required for Navy use.
Dummy connector plug	The dummy connector plug is used to troubleshoot communication errors between the TAU and the DCSA.
Computer hood	The computer hood is used to improve readability of the DCSA display during outdoor, bright sunlight conditions.
ADU-891 Adapter Unit Computer Test Set	The ADU–891 is a test set used in conjunction with the AN/GYQ–79 to support BIT testing of the AIM–120 and AIM–9X missiles (discussed later). It allows for a successful interface between the CMBRE and these missiles.

Self-Test Questions

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

408. Guided bomb unit–31,–32,–38, and–54

1. Why are JDAMs considered joint weapons?

2. How many guided-bomb unit configurations are there for the JDAM?

3. What peculiar differences of KMU-series kits prevent them from being interchangeable?

4. What are the components of a typical tail assembly?

5. Where are the global positioning system antennas located on the joint direct attack munitions?

6. What is the purpose of the aerosurfaces on the joint direct attack munitions?

7. Which joint direct attack munition is used exclusively by the USAF and utilizes *only* the MK–84 general-purpose warhead?

8. Which joint direct attack munition is used by both the United States Air Force and the United States Navy, and utilizes the BLU–126, 500 pound warhead designed for low-collateral damage?

409. Guided bomb unit–39 &–53 small diameter bomb

1. Describe the design and capability of the GBU–39 series weapon.

2. What type warhead does the GBU–39/B small diameter bomb use?

3. What type of guidance does the GBU–39 series small diameter bomb use?

4. What three characteristics of the GBU–53 warhead are responsible for producing its explosive effects?

5. The BRU–61 carriage systems consist of how many ejector assemblies for holding weapons?

6. Special inspections of a BRU–61 carriage system are only to be performed when given direction by whom?

7. Which container is designed to store four small diameter bombs or an empty BRU–61 carriage?

8. What inspection *is not* required on the small diameter bomb?

410. AN/GYQ–79 digital computer test set

1. What munitions are tested with the AN/GYQ 79 digital computer test set?

2. Which test set component do we use to initiate a BIT and get systems and munitions status, reprogram munitions operational flight programs, and also load mission planning and GPS crypto keys?

3. Which AN/GYQ–79 box contains the DCSA that provides central system control?

4. Which test set can be found in the accessory kit (box 3), and can be used in conjunction with the AN/GYQ–79 to support BIT testing of the AIM–120 and AIM–9X missiles?

Answers to Self-Test Questions

401

1. (1) Light energy.
   (2) Electro-optical.
   (3) Radar.
   (4) GPS.

2. Radar.
3. (1) Active.
   (2) Passive.
   (3) Semi-active.
4. Active.
5. Passive.
6. Semi-active.

402

1. Actual steering of a PGM.
2. Control section.
3. Fixed and movable. The fixed surfaces stabilize the weapon in flight, and the movable surfaces steer the weapon.
4. (1) Hydraulic.
   (2) Pneumatic.
   (3) Servo-actuators.
5. Navigation.
6. Movement of the control surfaces is proportional to the error between the flight path of the weapon and the flight path to the target.

403

1. Fuze.
2. Sudden acceleration associated with RM ignition and departure from the firing aircraft.
3. Continuous rod construction of the warhead.
4. Keeps the armament system in a safe condition while we are handling the weapon and while the weapon is on the carrying aircraft.

404

1. The RM and the RM igniter.
2. Single-stage, solid-propellant.
3. (1) Medium thrust.
   (2) Dual thrust.
   (3) High thrust.

405

1. (1) The CCG.
   (2) Bomb (warhead).
   (3) AFG.
2. The warhead and AFG.
3. MAU–169 series or the MAU–209 series CCG.
4. Detects laser energy reflected from the target, processes the signals, and guides the weapon to the target.
5. MK84 and BLU–109.
6. MK82.

406

1. Autopilot control, target detection, and weapon guidance.
2. (1) FMU–81/B.
   (2) FMU–139A/B.
   (3) FMU–143/B, B/B or J/B.

(4) FMU–152A/B.

3. Aerodynamic lift and stability during flight.
4. Expands the bomb charging well conduit to the hardback assembly to facilitate proper fuze initiator installation.

407

1. Digital test set, TTU–373, and TTU–595.
2. Performs a functional check of the CCG or the GCU.
3. Thirteen modes—six modes to test and troubleshoot CCGs or GCUs; two modes to test and troubleshoot the DTS; one mode to isolate GCU/DTS problems; two modes to input and display computer control group or computer guidance unit parameters; one mode to program a pulse repetition frequency code plug, and one mode to determine GCU mission configuration.
4. Invisible laser radiation is directed through the TTU–595's cables and test heads. Operators must avoid staring into the cables or test heads.

408

1. Both the USAF and USN employ them.
2. 28.
3. The guidance software and physical interfaces are peculiar to each warhead.
4. (1) Tail fairing/structure.
   (2) Tail actuator subsystem.
   (3) Wire harness assembly.
   (4) Guidance control unit.
   (5) GPS antenna.
   (6) Three moveable control fins and one fixed fin.
5. The aft end of the tail actuator subsystem.
6. Provide aerodynamic lift, maneuverability, and other needed flight characteristics.
7. The GBU–31 (V)1.
8. The GBU–38 (V)4.

409

1. It is a small autonomous air-to-ground, precision glide weapon able to strike targets in adverse weather from a standoff range of over 40 nautical miles.
2. Advanced penetrator.
3. Advanced Anti-Jam Global Position System aided Inertial Navigation System.
4. (1) Aluminized enhanced blast.
   (2) Score fragmentation casing.
   (3) Copper shaped charge.
5. Four.
6. MAJCOM or Warner Robins Air Logistics Center.
7. The CNU–660/E container.
8. Periodic inspection.

410

1. (1) AGM–158 JASSM.
   (2) GBU–31 JDAM.
   (3) GBU–32 JDAM.
   (4) GBU–38 JDAM.

(5) GBU–54 LJDAM.
(6) GBU–39 SDB.
(7) GBU–39 SDB FLM.
(8) ADM–160 MALD.
(9) AIM–9X Sidewinder.

2. Test adapter unit.
3. Controller unit (Box 2).
4. ADU–891.

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

Unit Review Exercises

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

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

1. (401) What system is actually the brain of precision-guided munitions (PGM)?
   a. Control.
   b. Guidance.
   c. Armament
   d. Propulsion.

2. (401) Which type of guidance system is also known as television guided?
   a. Electro-optical.
   b. Light energy.
   c. Inertial.
   d. Radar.

3. (401) Which type of guidance system is nothing more than very high frequency radio waves?
   a. Electro-optical.
   b. Light energy.
   c. Inertial.
   d. Radar.

4. (401) Which guidance system does the weapon send out the tracking energy?
   a. Active.
   b. Passive.
   c. Semi-active.
   d. Semi-passive.

5. (401) Which type of precision-guided munition (PGM) hones in on energy reflected off the target by another source?
   a. Active.
   b. Passive.
   c. Semi-active.
   d. Semi-passive.

6. (402) The purpose of the fixed control surfaces used on guided munitions is to
   a. provide ballast in flight.
   b. stabilize the weapon in flight.
   c. steer the weapon to the target.
   d. provide aerodynamics in flight.

7. (402) To move their control surfaces, precision guided munitions (PGM) use either hydraulic, pneumatic, or
   a. electro-servo actuators.
   b. electronic circuits.
   c. pressurized fluid.
   d. proportional.

8. (402) An aspect of the control system that can make minor or large corrections relative to the flight path of the target is said to have
   a. a “bang-bang” control system.
   b. a closed-loop control system.
   c. proportional navigation.
   d. directional navigation.

9. (403) The air-to-air missile proximity fuze detonation occurs when
   a. a predetermined amount of time elapses.
   b. the missile senses the target getting closer.
   c. the missile senses the target moving farther away.
   d. the missile comes into direct contact with the target.

10. (403) Before an air-to-ground guided munition will detonate, the fuze requires
   a. a full battery.
   b. an electrical impulse.
   c. a confirmation signal from the pilot.
   d. a safe predetermined distance from the launching aircraft.

11. (404) What *minimum* components make up a propulsion system?
   a. Rocket fuel and nozzle.
   b. Rocket motor and nozzle.
   c. Rocket fuel and an igniter.
   d. Rocket motor and an igniter.

12. (404) Which type of rocket motor propellant is used in our air-to-air missiles?
   a. Gas grain.
   b. Granular.
   c. Liquid.
   d. Solid.

13. (404) Live missiles *must* always have a ground wire attached to them to prevent static electricity from
   a. damaging the internal circuits.
   b. igniting the rocket motor.
   c. damaging the missile.
   d. arming the fuze.

14. (405) The MAU–169 series computer control group (CCG) consists of a detector,
   a. computer unit, and warhead section.
   b. computer, and control section.
   c. igniter, and computer control section.
   d. control section, and warhead.

15. (405) Which guided-bomb unit (GBU) laser guided bomb (LGB) uses a 2,000 pound bomb body?
   a. GBU–10.
   b. GBU–12.
   c. GBU–39.
   d. GBU–54.

16. (405) What airfoil group (AFG) component mounts the computer control group (CCG) to the warhead?
    a. Forward adapter assembly.
    b. Folding wing assembly.
    c. Control section.
    d. Control fins.

17. (406) What purpose does the WGU–12/WGU–39 series guidance control unit (GCU) seeker platform assembly serve?
    a. Holds the GCU seeker.
    b. Connects the GCU to the warhead.
    c. Looks for the reflected laser light signal.
    d. Send signals to the computer group which determines the direction to target.

18. (406) What subassembly of the WGU–12/WGU–39 series guidance control unit (GCU) processes incoming error signals and turns them into steering commands?
    a. Guidance electronic unit.
    b. Control actuator.
    c. Seeker platform.
    d. Computer.

19. (406) The purpose of the BSU–84 airfoil group (AFG) is to
    a. provide aerodynamic lift and stability during flight.
    b. create smooth and stable flight while in glide mode.
    c. provide steering commands for the control surfaces.
    d. steer the bomb and provides aerodynamic lift.

20. (406) The purpose of the aft faring assembly used on the GBU–24A/B is to
    a. provide an aerodynamic interface between the bomb and wing assembly.
    b. extend the bomb charging well conduit to the hardback assembly.
    c. provide more distance between the bomb and bomb rack.
    d. provide the aerodynamic lift and stability during flight.

21. (407) Which hazard is present when operating the digital test set, TTU–595?
    a. High pressure pneumatics.
    b. Invisible laser radiation.
    c. Equipment weight.
    d. High voltage.

22. (407) The wing actuator tool is used to perform which maintenance task?
    a. Install the forward adapter.
    b. Install and remove the wing.
    c. Deploy the wing in flight.
    d. Open and close the wings.

23. (408) The typical Joint Direct Attack Munition (JDAM) tail assembly consists of a tail fairing/structure, tail actuator subsystem, wire harness assembly, guidance control unit,
    a. global positioning system antenna, two moveable control fins, and two fixed fins.
    b. global positioning system antenna, three moveable control fins, and one fixed fin.
    c. three moveable control fins, and one fixed fin.
    d. and control fins.

24. (408) Which statement is *not* a benefit of off-axis delivery of the Joint Direct Attack Munition (JDAM)?
    a. Allows the JDAM to reach a target without requiring the aircraft to directly overfly that target.
    b. Allows the JDAM true “fire and forget” weapon capability.
    c. Provides increased aircraft and aircrew survivability.
    d. Provides increased weapons range.

25. (408) Which Joint Direct Attack Munition (JDAM) guidance set components provide lift and maneuverability?
    a. Tail assemblies.
    b. Aerosurfaces.
    c. Wings.
    d. Fins.

26. (408) Which guided-bomb unit (GBU) uses a 2,000 pound warhead?
    a. GBU–31.
    b. GBU–32.
    c. GBU–38.
    d. GBU–54.

27. (408) Which guided-bomb unit (GBU) decreases the likelihood of collateral damage within populated areas?
    a. GBU–24.
    b. GBU–31.
    c. GBU–32.
    d. GBU–38.

28. (408) Which joint direct attack munition (JDAM) employed by the USAF uses the BLU–126 Low-Collateral Damage Bomb for its warhead?
    a. GBU–38(V)1.
    b. GBU–38(V)4.
    c. GBU–54(V)1.
    d. GBU–54(V)4.

29. (408) Which guided-bomb unit (GBU) adds an optional precision laser guidance set in addition to its GPS/INS guidance system?
    a. GBU–31.
    b. GBU–32.
    c. GBU–38.
    d. GBU–54.

30. (409) The GBU–39A/B small diameter bomb is has a unique multi-phased explosive that has earned it what name?
    a. The Focused Lethality Munition (FLM).
    b. The Joint Direct Attack Munition (JDAM).
    c. The Low-Collateral Damage Bomb (LoCo).
    d. The Anti-Jam Global Position Bomb (AJGPB).

31. (409) The guidance unit for the GBU–39 is made up of two sections that are located where on the bomb body?
    a. At the nose and in front of the warhead.
    b. One section is at the nose; the other is at the rear.
    c. To the rear of the warhead and forward of the fins.
    d. Both sections are located toward the rear end of the bomb.

32. (409) How does the GBU–53 differ from the GBU–39 small diameter bomb?
    a. Can be used by the BRU–61 carriage system.
    b. Can be used against moving targets.
    c. Can strike targets over 40 miles.
    d. Can glide to target.

33. (409) What class warhead does the GBU–53 small diameter bomb use?
    a. A special-purpose penetrator warhead.
    b. An advance penetrator warhead.
    c. A general-purpose warhead.
    d. A multi-effects warhead.

34. (409) Name two target tracking options of the GBU–53's multi-mode seeker.
    a. Laser illuminated target detector and electro-optical.
    b. Imaging infrared and semi-active laser targeting.
    c. Millimeter-wave radar and manual release.
    d. Electro-optical and millimeter-wave radar.

35. (409) The BRU–61 carriage system is a warranted item and shall be limited to what type of inspection?
    a. Visual.
    b. Special.
    c. Annual.
    d. Periodic.

36. (409) Which container is designed to hold one GBU–39 series small diameter bomb?
    a. CNU–317/E.
    b. CNU–534/E.
    c. CNU–659/E.
    d. CNU–650/E.

37. (409) What does the CNU–660/E contain that allows for in container testing of the BRU–61 carriage system?
    a. A personal computer memory card (PCMC).
    b. A small diameter bomb (SDB) cradle.
    c. A MIL-STD–203 connector cable.
    d. A built-in-test (BIT) cable.

38. (409) Up to how many small diameter bombs (GBU–39 or GBU–53) can the weapon initiated built-in-test (IBIT) simultaneously perform with use of the common munitions built-in test/reprogramming equipment (CMBRE)?
    a. One.
    b. Two.
    c. Three.
    d. Four.

39. (410) The common munitions built-in test/reprogramming equipment (CMBRE) is composed of three boxes that contain the
    a. digital computer system assembly, controller unit, and interface cable assembly.
    b. digital computer system assembly, controller unit, and accessory kit.
    c. test adapter unit, controller unit, and interface cable assembly.
    d. test adapter unit, controller unit, and accessory kit.

40. (410) Which common munitions built-in test/reprogramming equipment (CMBRE) component initiates the built-in test (BIT) and gets systems and munitions status, reprograms munitions operational flight programs (OFP), and loads mission planning and global position system (GPS) crypto keys?
    a. Digital computer system assembly.
    b. Controller box unit.
    c. Test adapter unit.
    d. Accessory kit.

41. (410) What component of the common munitions built-in test/reprogramming equipment (CMBRE) is considered the ruggedized computer?
    a. The ADU–891 adapter unit computer test set.
    b. Digital computer system assembly (DCSA).
    c. Test adapter unit (TAU).
    d. The IBM tough book.

42. (410) The ADU–891, Adapter Group Computer Test Set, is used in conjunction with what test set?
    a. AN/GYQ–79.
    b. TTU–373.
    c. WGU–12.
    d. TS–4044.

Please read the unit menu for unit 2 and continue ➔

Unit 2. Missiles

IN TIME OF WAR, the Air Force has many different targets of concern—from the enemy aircraft in the air to the tanks and troops on the ground. No weapon in our inventory is more accurate or cost effective than our missiles. During Operation Desert Storm, our missile precision capabilities allowed us to use one $70,000 Maverick missile to destroy a $1.5 million T–72 tank. Whether it's an incoming tank unit or fighter aircraft in our air space, we have the missiles to combat any situation. This unit discusses both air-to-air and AGM.

2–1. Air-to-Ground Missiles

Guided bombs destroy selected targets with greater precision than is possible with standard conventional gravity bombs or dumb bombs as we know them. A good example of the use of guided bombs comes from the war in Vietnam. During that war, the North Vietnamese covered many of their key bridges with a wire mesh that was invisible from the air. When our bombers dropped ordinary GP bombs on those bridges, the bombs were deflected away from the bridge by the mesh or detonated above it, thus minimizing damage. Once this wire mesh was detected, a way to penetrate it had to be developed. The answer was to develop guided bombs that could be targeted at the portions of the bridges that were either unprotected or especially vulnerable. To do this, the electro-optically guided bomb (EOGB) was developed. It was the first of our guided bombs and is the direct ancestor to the GBU and LGB in use today. Also in this class of munition, you will find missiles that were developed to perform a specific tactical mission. For example, the AGM–65 is specifically used to destroy tanks, and the AGM–88 is for use against enemy radar sites. The AGM–114 (Hellfire) is a weapon system used on the Predator and Reaper Remotely Piloted Aircraft (RPA). This class of munition has been used in many hot spots around the world, to include Iraq and Afghanistan, against high-value targets. In this section we look at the AGM–65, AGM–88, and the AGM–114.

411. Air-to-ground missile–65 (Maverick) missile series and test equipment

The Air Force accepted the first AGM–65A Maverick in August 1972 and took delivery of the first AGM–65D in October 1983, with initial operational capability in February 1986. Delivery of operational AGM–65G missiles took place in 1989. AGM–65 missiles were employed by F–16s and A–10s in 1991 to attack armored targets in the Persian Gulf during Operation Desert Storm. Mavericks played a large part in the destruction of Iraq's significant military force.

Missile description

The AGM–65 Maverick is a tactical, air-to-surface guided missile designed for close air support, interdiction, and defense suppression mission (fig. 2–1). It provides standoff capability and high probability of strike against a wide range of tactical targets, including armored vehicles, air defenses, ships, transportation, equipment, and fuel storage facilities.

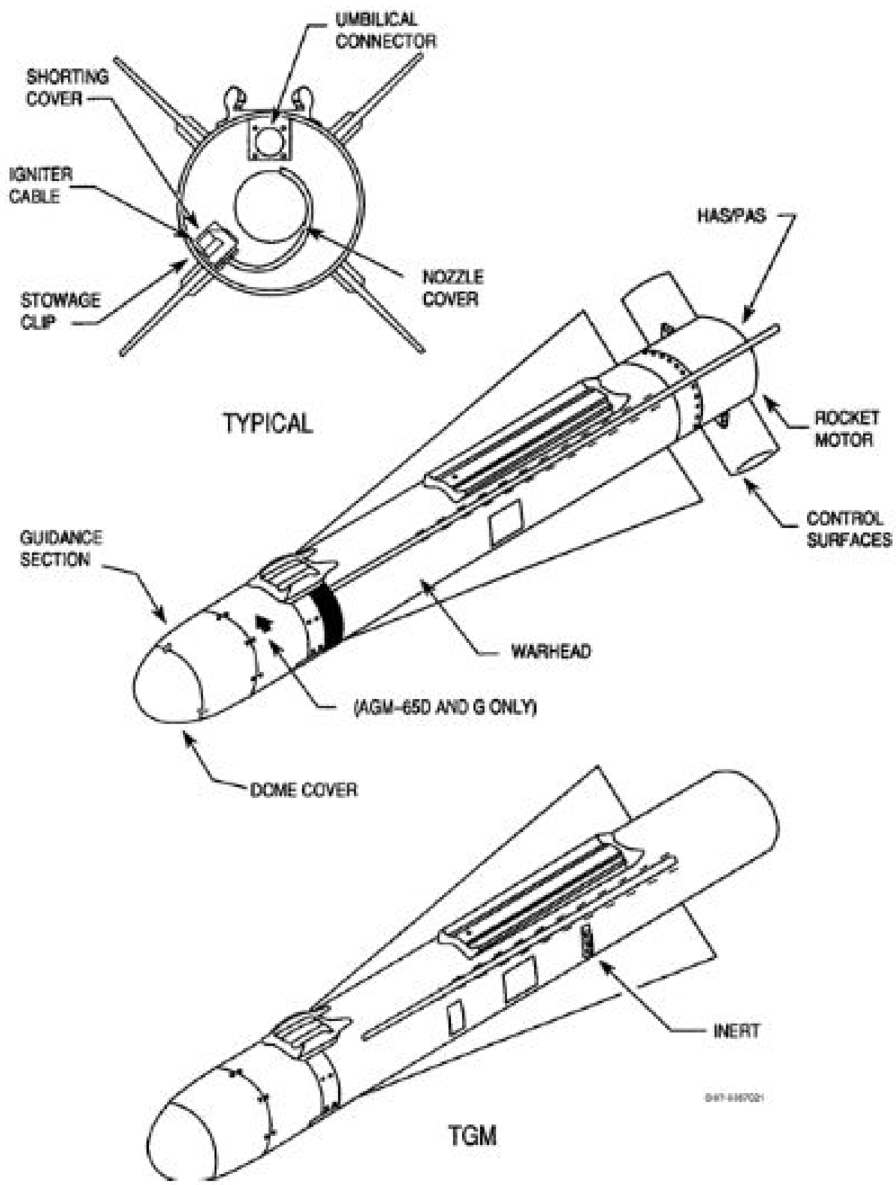

Figure 2–1. AGM–65 missile (typical).

The Maverick has a cylindrical body and either a rounded glass nose for electro-optical imaging or a zinc sulfide nose for imaging infrared. It has long-chord delta wings and tail control surfaces mounted close to the trailing edge of the wing of the aircraft that is using it. The warhead is in the missile's center section. A cone-shaped warhead, one of two types carried by the Maverick, is fired by a contact fuze in the nose. The other type of warhead is a delayed-fuze penetrator—a heavyweight warhead that penetrates the target with its kinetic energy before detonating. The propulsion system for both types is a solid rocket motor behind the warhead.

The A–10, F–15E, and F–16 aircraft carry Mavericks. These aircraft are equipped to carry as many as six Mavericks (usually in three round, under-wing clusters), which provide the pilot an option to engage several targets during one mission. The missile also has "launch-and-leave" capability that enables a pilot to fire it and immediately take evasive action or attack another target as the missile guides itself to the target. Mavericks can be launched from high altitudes to tree-top level and can hit targets ranging from a distance of a few thousand feet to 13 nautical miles at medium altitude. Currently, the Air Force employs the AGM–65B, –65D, –65E, –65G, –65H, and –65K.

AGM–65A & AGM–65B

Maverick A and B models have an electro-optical television guidance system. After the protective dome cover is automatically removed from the nose of the missile and its video circuitry activated, the scene viewed by the guidance system appears on a cockpit television screen. The pilot selects the target, centers the cross hairs on it, locks on, and then launches the missile. The missile guides itself to the designated target. The AGM–65B is identical in weight, dimensions, and external characteristics to the AGM–65A except that the AGM–65B seeker magnifies the target scene. This capability provides the AGM–65B with a greater acquisition range than the AGM–65A. Both models utilize a 125-pound shaped-charge warhead.

AGM-65D

The Maverick D has an imaging infrared guidance system that is similar to an electro-optical television guidance system, except that infrared video overcomes the daylight-only and adverse weather limitations that the Maverick A and B systems have. The infrared Maverick D tracks the heat differences between the target and the background environment and provides the pilot a pictorial display of the target during most conditions including darkness and hazy or inclement weather. The AGM–65D Maverick is also equipped with a shaped-charge warhead.

AGM–65E

The Maverick E is the only version that has a laser-guided seeker section. Also, unlike the A, B, D, and H models, the AGM–65E utilizes a heavyweight 300-pound penetrator warhead. This variant is used against fortified ground installations, armored vehicles, and surface combatants during close air support missions. Used in conjunction with ground or airborne laser designators, the missile seeker searches a sector seven miles across and over 10 miles ahead.

AGM–65G

The Maverick G model essentially has the same guidance system as the D, with some software modifications to track larger targets. Another difference from the Maverick D is that the Maverick G utilizes a heavyweight 300 pound penetrator warhead. The AGM-65G launches only from the Launch Adapter Unit (LAU)–117, single missile launcher.

AGM–65H & AGM–65K

The Maverick H and K models both utilize an optical charged coupled device guidance system, which is an upgrade of the electro-optical television guidance system used by the Maverick A and B models. The new guidance system camera provides improved haze penetration, increased target contrast, and longer range target identification. The major difference between the two models is that the AGM–65H uses the (lightweight) shaped-charge warhead, while the AGM–65K uses the (heavyweight) penetrator warhead.

Training guided missile

The training guided missile has the same aerodynamic configuration as the AGM–65, except the training guided missile has no control surfaces (fig. 2–1). A film recorder or ballast installs in place of the rocket motor and the hydraulic actuation system. A ballast unit simulates the weight of the warhead and safety, arming, and fuzing (SAF) units. A signal processor installs on the forward end of the ballast unit. The A/A37A–T1 provides aircrew training in AGM–65A procedures, and the A/A37A–T8 and A/A37A–T10 provide aircrew training in AGM–65D procedures. The difference between the A/A37A–T1, A/A37A–T8, and A/A37A–T10 is the T8 and T10 have AGM–65D guidance and control sections.

Missile sections

Now let's discuss the missile sections of the Maverick. Refer to figure 2–2 while we discuss each section of the Maverick.

Forward section

The forward section of the missile is the guidance unit (GU). This unit includes the outside skin that forms the nose section of the missile, a transparent optical window, and the missile forward bulkhead on which the seeker gimbal mounts. The GU provides the means for tracking the target. After launch, the guidance section directs the missile control surfaces to steer the missile to impact with the target.

Before launch the guidance unit receives mode control and seeker position signals from the launcher. The weapon may also be "slaved" to other acquisition aids, such as the low-altitude navigation and targeting infrared for night targeting pod. The pilot electronically moves the TV camera of the seeker to find a specific target. When the pilot has a target centered in the tracking window on his or her video monitor, the pilot sets the GU in the automatic tracking mode.

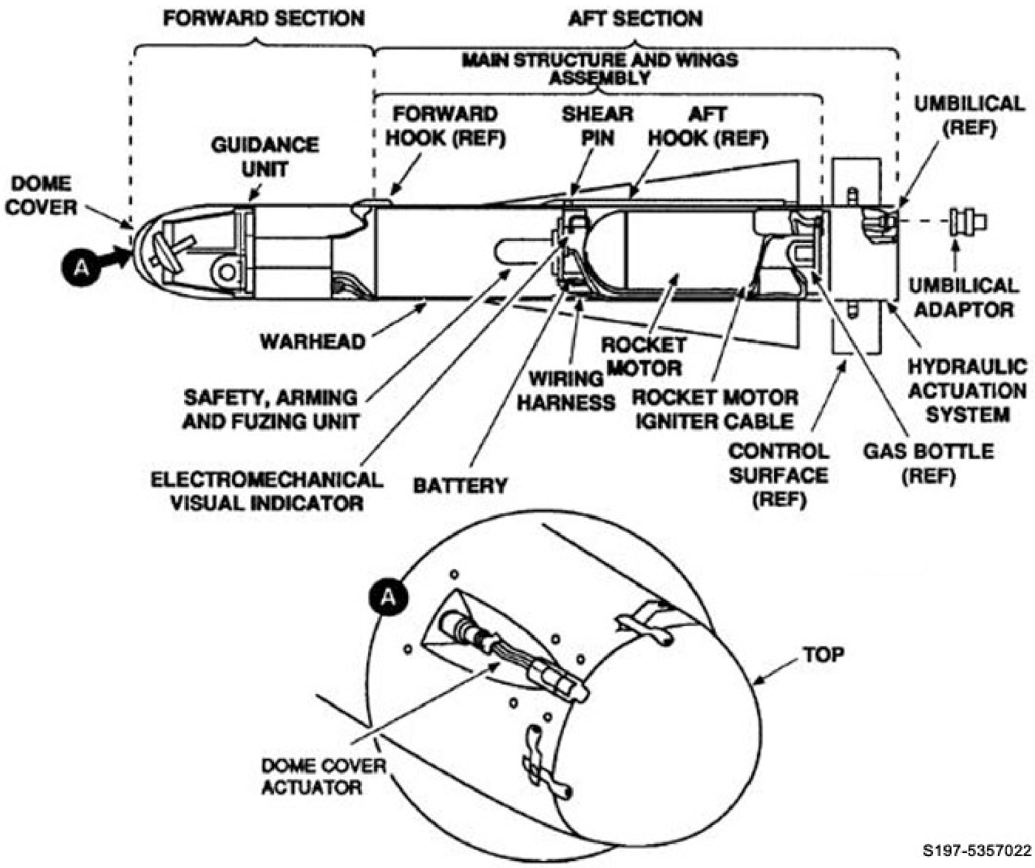

Figure 2–2. AGM-65 missile subsections.

The seeker unit consists of a TV camera, lens assembly, and sun shutter. A dome cover protects the GU window from scratches, external environment, and rough handling.

The GU window is polished and has an anti-reflective coating on each of its spherical surfaces. The dome cover actuator consists of a piston actuated by an explosive cartridge. When the pilot selects a missile, an electrical signal triggers the explosive cartridge, which drives the piston approximately four-tenths ($^{4}/_{10}$) of an inch. The outer end of the piston strikes the edge of the tempered glass dome cover hard enough to shatter the dome cover.

The sun shutter control is mounted below the lens and the vidicon assemblies. A photodiode senses the sunlight if the camera is pointed toward the sun. If the photodiode is exposed to direct sunlight, its output closes the sun shutter and prevents the vidicon camera from being damaged. When the missile is pointed away from the sun, the sun shutter opens. The sun shutter does not open until after the missile is selected. After the missile begins tracking, the sun shutter remains open. If the missile is deselected, the sun shutter closes.

Aft section

The aft section contains the warhead, SAF, RM, battery, and hydraulic actuation system (HAS). You learned about the RM in the previous unit. Now, we will discuss the battery and HAS and then discuss the warhead and SAF under armament.

Battery

A squib activates the thermal battery during the launch sequence. This battery consists of two power sections connected in parallel, each incorporating 14 pellet cells. It supplies two outputs: –30 volts and +30 volts. On the near side of the battery, looking through the missile hatch, there is a color spot (indicator). This spot allows you to tell if the battery has been fired. If the battery has not been fired, the spot is pink. If it has been fired, the spot is black. The battery output duration is sufficient to power the missile during missile flight until impact occurs.

Hydraulic actuation system

The HAS consists of the hydraulic power supply and the servo-actuators for moving the four control surfaces. Pressure is provided to the hydraulic power supply from a pneumatic subassembly, which is activated during launch. The pneumatic subassembly is a separable bolt-on assembly consisting of a high-pressure helium gas reservoir, an electro-explosive device, and a pressure regulator with an inlet filter. Pressure of the gas reservoir is approximately 7,450 pound per square inch (psi) at 70 degrees.

The HAS is initially pressurized and is made operational by the release of high-pressure gas when an electro-explosive device breaks off a metal cap at the end of the reservoir. Helium gas passes through a pressure regulator at 500 pounds per square inch gage (psig) and is directed to the hydraulic power supply. The hydraulic power supply consists of the pump, accumulator, and reservoir.

AGM–65 armament components

The warhead and the SAF are parts of the aft section of the missile. This armament system consists of the warhead, SAF, and contact sensor. Let’s look at each of these separately.

Warhead

The AGM–65A/B/D/H uses the 125 pound cone-shaped warhead. The shape of the warhead causes a thin jet of extremely high-temperature plasma to form in front of the warhead. This allows maximum explosive penetration into hardened ground targets. The warhead is initiated by the SAF unit, which is threaded into the aft end of the warhead. The AGM–65E/G/K uses the 300-pound delayed fuze penetrator, heavyweight warhead. This is a fragmentation warhead which achieves lethality through dense steel fragments moving at high velocity.

Safe, arming and fuze unit

The SAF is cylindrical in shape with a threaded shoulder for installation into the warhead. A booster unit attaches to the front end of the SAF. Electrical connections are made through a single connector in the aft end of the unit.

The SAF keeps the missile in a safe condition until it is supplied with arming power during the prelaunch sequence and after launch acceleration is experienced. After a time delay to allow for safe separation of the missile from the launching aircraft, the SAF attains an armed condition. On impact with the target, the detonators fire to initiate the booster, which detonates the warhead.

This SAF provides two ways of detonating the warhead. The primary means is by the contact sensor located in the forward section of the missile, just aft of the optical window. The secondary means is by a backup mechanical method.

There is a window on the side of the SAF that indicates a safe (S) or armed (A) condition. This window is only visible when the SAF is removed from the warhead.

Contact sensor

When the missile impacts the target, the contact sensor (due to crushing the missile) closes the electrical firing circuit of the SAF. In the event the primary system fails to work, a backup mechanical device built into the SAF operates by high deceleration forces to fire a percussion detonator.

AGM–65 rocket motor

Unlike most missiles, the AGM–65 RM is not a separate, removable item. The motor is a part of the aft section of the missile and consists of an aluminum alloy motor case containing a polysulphide/ammonia perchlorate solid propellant. The igniter is a flash-powder pellet-type and contains two squibs wired in parallel that are located in the head end of the motor case. The igniter cable tapes to the outside and ends in a self-shorting connector at the aft end of the motor. A nozzle and blast tube assembly threads onto the aft end of the motor case and the joint is sealed with an O-ring. To protect the motor from dirt and humidity, the nozzle contains a closure seal.

When the squibs receive a firing signal from the launcher, the ignition sequence begins. At this instant the squibs fire and ignite the flash-powder pellets, which ignite the solid propellant grain. Combustion gases expand through the nozzle at high velocity producing the thrust. Two levels of thrust are achieved due to the geometry of the propellant grain. During the boost phase, the star tips, which present a large surface area for burning, are consumed. Once the star tips burn, a much smaller surface area is available to burn, thus providing a lower sustained thrust.

AGM–65 test equipment

We use Maverick missile test equipment to perform preflight go/no-go and missile launcher, guidance, center aft section, and training missile checkout. We use the test equipment most often in the storage and maintenance shop; however, we can use it on the flight line/aircraft shelter.

AN/DSM–129 test set

The AN/DSM–129 projects an optical image into the guidance section of the AGM–65A/B/H missile to simulate a target during the operational readiness test of the missile. This is done by observation of the quality of the target image displayed on the television display of the DSM–99 (or DSM–100 during cluster checkout).

The DSM–129 (fig. 2–3) is made up of a test set assembly, test adapter, test set case, four interconnecting cables, six nickel cadmium batteries, and three support legs. The AN/DSM–129 can be used in an AC mode or in a battery DC mode of operation. In the AC mode, the test set receives operating DC voltages from the control panel assembly in the case. In the DC mode, the test set operates off its own batteries.

The AN/DSM–129 generates a target image that is focused on the vidicon tube by a lens in the missile guidance section and is processed by the missile into a TV display on the DSM–99 or DSM–100. The quality of the target image shown on the TV screen indicates to you if the optical-mechanical circuits in the missile are in a go or no-go condition. When you place the motion switch (S2) on the control panel to ON, the target begins to move. By watching the TV display on the DSM–99 or DSM–100 after you energize the lock-on function on either test set, you can determine the tracking capability of the missile.

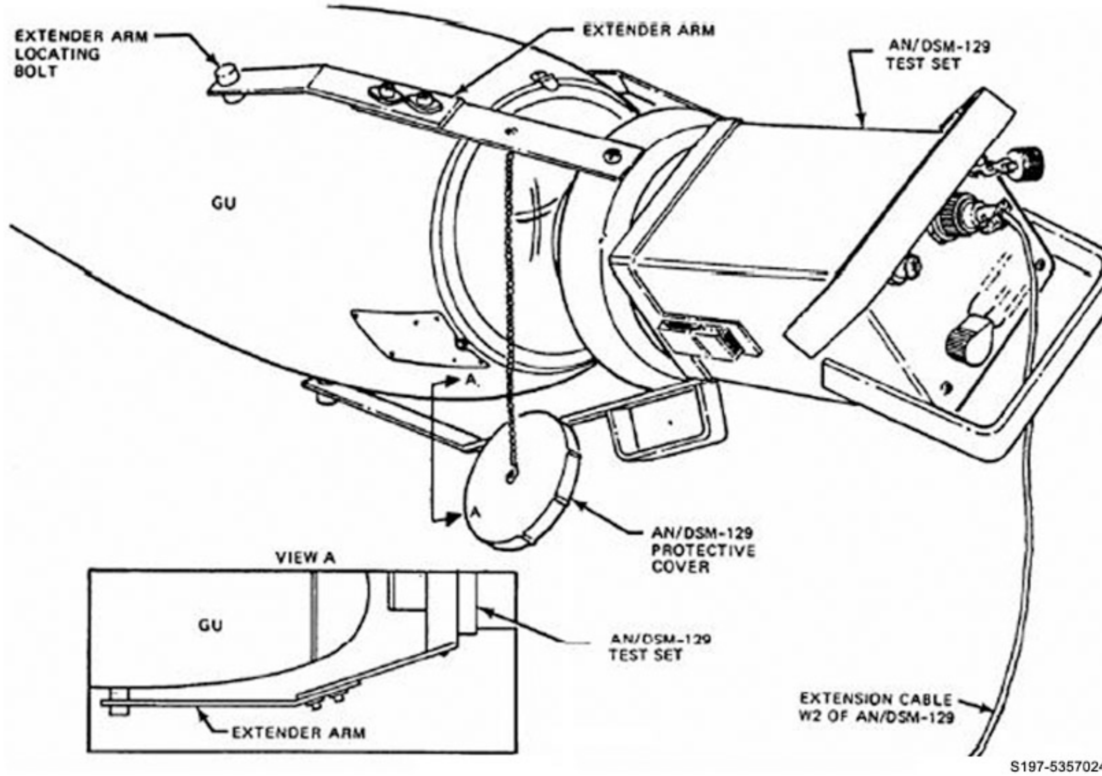

Figure 2–3. AN/DSM–129 test set installation.

AN/DSM–157 guided missile test set

The AN/DSM–157 is a microprocessor-based, stored-program tester that tests the missiles and/or clusters when they are removed from the aircraft (fig. 2–4). You use it to test and fault-isolate various elements of the Maverick's system.

Interface cabling connects the test set to the missile or cluster. Test instructions and test setup information are presented to the operator by an 80-character display. The data format is designed as a prompting display that permits test progression to be done by answering a series of questions with simple yes or no responses. Performance evaluations of the unit under test are displayed with the appropriate maintenance action if required.

NOTE: You can use the AN/DSM–157 in place of the DSM–99 and DSM–100.

SM–787/DSM infrared target simulator

The infrared target simulator provides simulated targets for checkout of the AGM–65D, 65G, 65K, maintenance trainers, and guidance and control sections (fig. 2–5).

The target simulator collimator assembly attaches to the unit under test by means of a mounting adapter. Use the collimator unit to project simulated targets on the guidance window of the unit under test. Power is provided by a cable connected either to the maintenance building or by the AN/DSM–157. Target motion is performed by moving the collimator unit inside the outer shell of the collimator assembly.

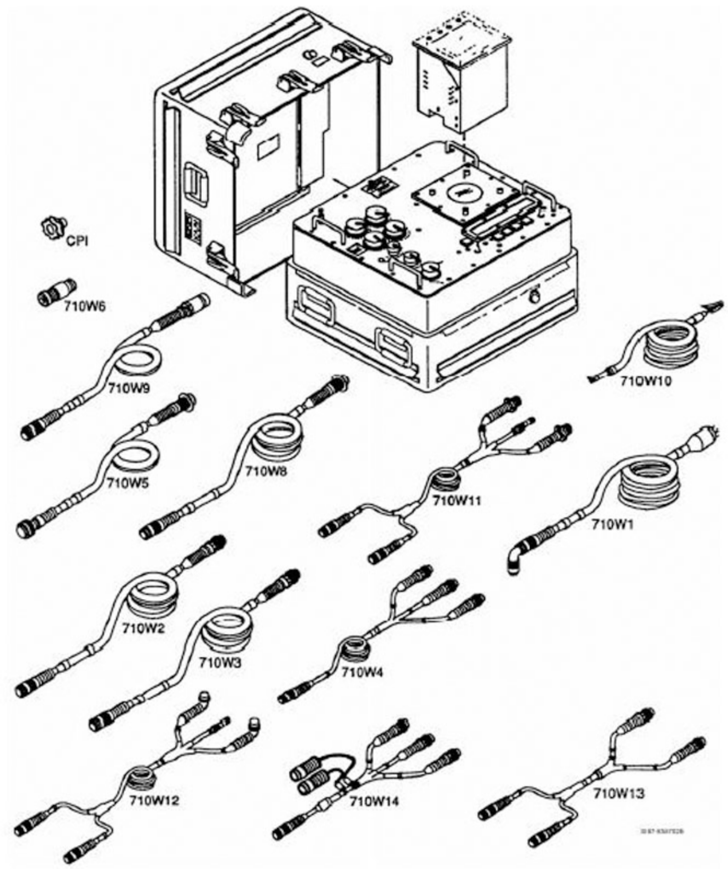

Figure 2–4. AN/DSM–157 guided missile test set.

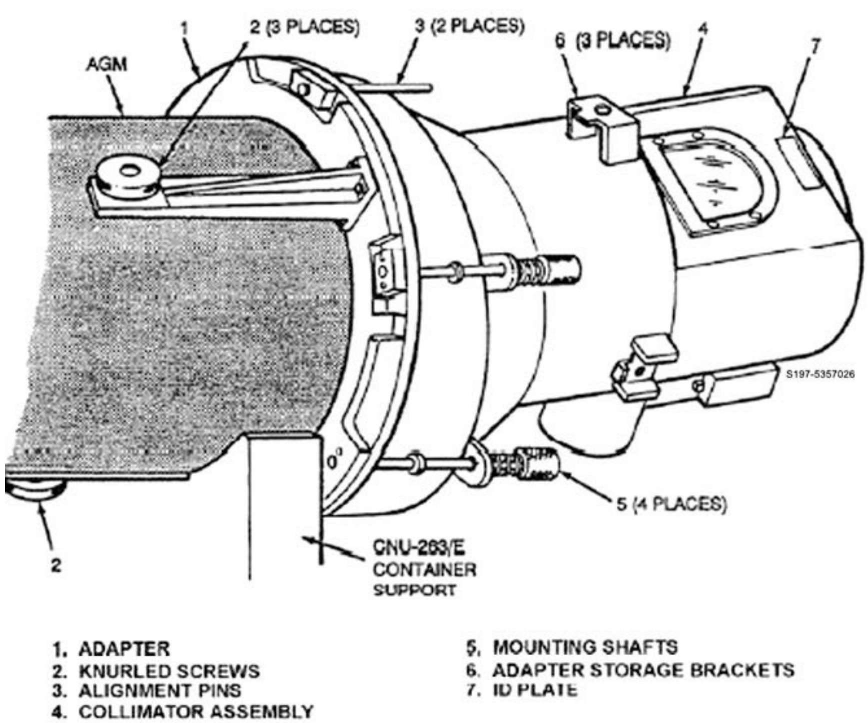

Figure 2–5. SM-787/DSM test set installation.

412. Air-to-ground missile–88 high-speed anti-radiation missile series and test equipment

The AGM-88 high-speed anti-radiation missile (HARM) is an air-to-surface tactical missile capable of detecting, acquiring, displaying, and selecting a transmitting radar installation (fig. 2–6). It then goes to the target and damages it to the extent that the radar is inoperable. The AGM–88 can detect, attack, and destroy a target with minimum aircrew input. The proportional guidance system that homes in on enemy radar emissions has a fixed antenna and seeker head in the missile nose. A smokeless, solid-propellant, dual-thrust RM propels the missile. The F–16 has the capability to employ the AGM–88 and is the only aircraft in the current inventory to use the AGM–88. The AGM-88B and AGM–88C consist of four sections–guidance, control, warhead, and RM (fig. 2–7). You complete operational and self-tests using the AN/GSM–396 test set.

Guidance section

The guidance section is a passive broadband radio frequency (RF) tracker that detects signals with high/low band antennas. The guidance section counters the expected threats of high pulse densities, wide frequency agility, complex pulse patterns, and multiple engagement radars. The signals are processed by a central processing unit, RF, and video circuits. These circuits generate signals to control the missile in flight. An internal elapsed time indicator records the length of time the all-up-round (AUR) operates.

Control section

The control section provides the electrical interface between the aircraft and missile through the umbilical cable. This section also contains the mechanical interface to drive the wings, which provide in-flight control of the missile. Four wings attach to the control section for steering and four fins attach to the RM to provide stability.

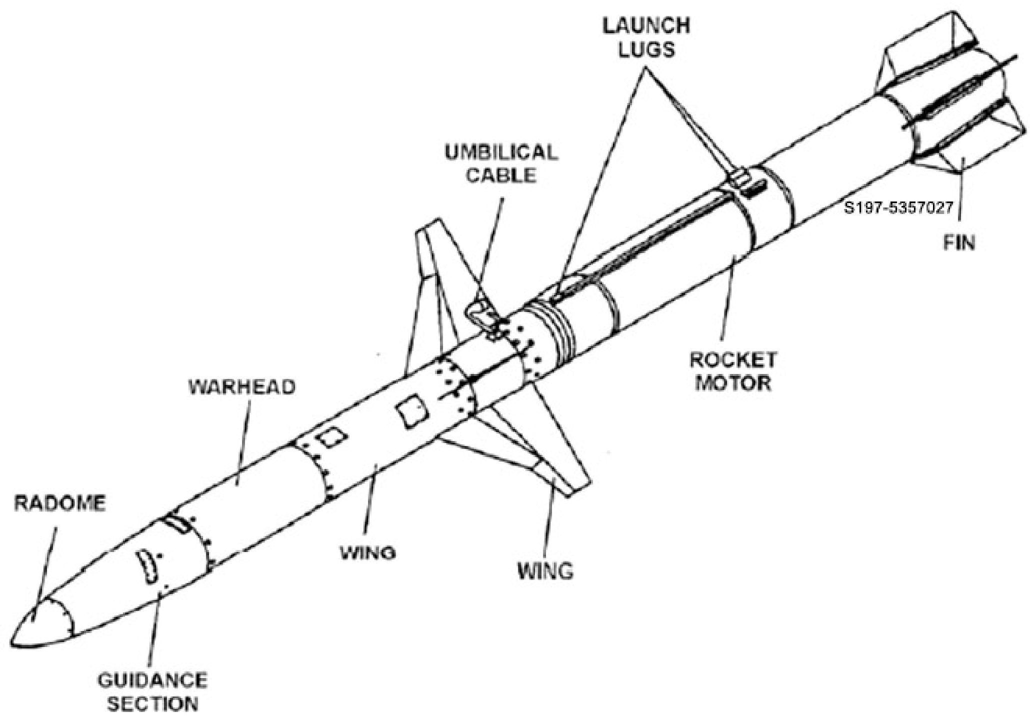

Figure 2–6. Typical AGM-88 HARM.

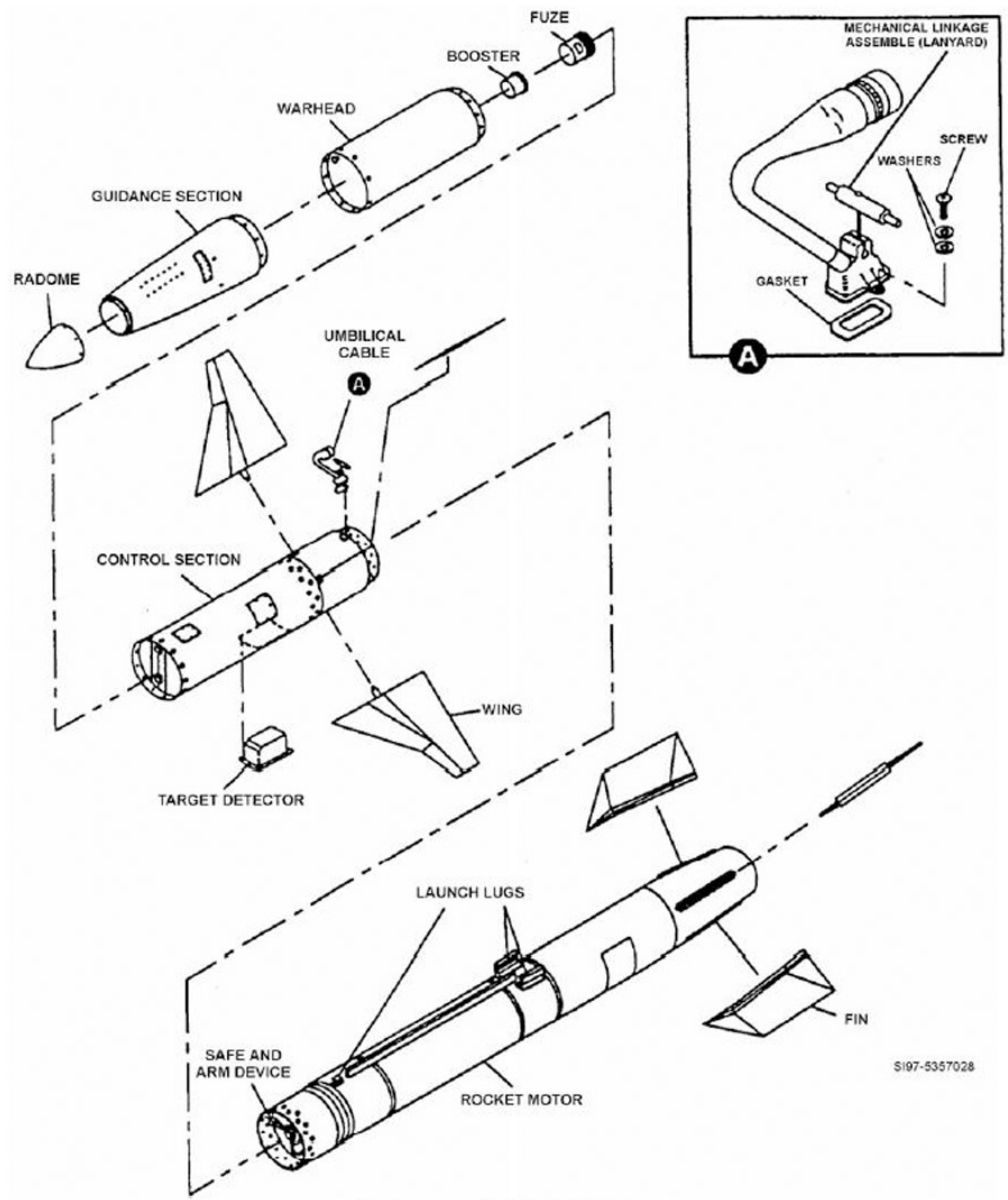

Figure 2–7. HARM components.

Warhead

The warhead section is a structural member of the missile airframe and is located between the guidance and control sections. The warhead section contains a main explosive charge, booster, fuze, and a wiring harness that electrically connects the warhead with the guidance and control sections using manually mated connectors. The warhead casing is made of stainless steel and contains a NEW of approximately 42 pounds of PBXN–107 explosive.

Warhead fuze

The warhead fuze performs two major functions. It contains an accelerometer that prevents arming until the missile experiences launching acceleration. After arming, the fuze detonates the warhead when it receives a signal from the target detector (TD) located in the control section. If it does not receive a signal from the target detector, it detonates on impact.

Rocket motor

The RM electrically and mechanically connects the aft end to the control section. This motor consists of the solid propellant, igniter, S&A switch, and connector. Two fire squibs that are located in the igniter, supply enough energy to initiate combustion of the motor propellant. The squibs are fired by 15-VDC supplied through the control section carrier board from the battery when the fire control logic section causes the proper relays to close. Located on the RM, the S&A switch helps prevent an inadvertent launch of the missile. The RM squib lines are “out of line” and grounded when the switch is in the SAFE position. The switch is manually set to ARM prior to launch by use of a mechanical key.

The RM connector provides an electrical feedback line to the control section for BIT to verify proper mating of the RM connector. Launcher lugs on top of the motor support the full weight of the missile and interface with the launcher. The effective range of the AGM–88 is approximately 30 miles.

AN/GSM–396 guided missile-launcher test set

The AN/GSM–396 guided missile-launcher test set (GM-LTS) is used to test all configurations of the AGM-88, with the exception of the Dummy Air Training Missile (DATM)-88 that cannot be tested (fig. 2–8). We use the GM-LTS to perform the all-function test, missile BIT, missile gyro exercise test, and the umbilical cable test.

All-function test

We perform the all-function test on repaired AURs, missile failing in-flight BIT, AURs failing inspection, and as part of the 10 percent annual inspection of assigned missile inventory. In addition to testing AURs, we can also test a short round. A short round consists of an assembled guidance section, control section, and inert warhead with an RM short round test plug attached to the control section.

The all-function test includes missile BIT power supply, communication, ground support equipment, gyro drift, false alarm rate, aileron, and RF source tests. The following table gives a description of each test:

ALL FUNCTION TEST	DESCRIPTION
Missile BIT power supply test	This test verifies integrity of missile captive flight power supplies.
Missile communication test	This test verifies the GM-LTS can communicate with the missile’s internal computer.
Missile ground support equipment test	This test performs a collection of two cable tests and verifies functions in both the guidance and control section.
Gyro drift test	This test verifies the drift rates for missile pitch, yaw, and roll gyros are within specified limits.
Missile false alarm rate test	This test measures the seeker’s internal noise level. Noise level affects sensitivity.
Missile aileron test	This test performs tests of the missile’s ailerons subsystem.
RF source test	This test confirms the missile can detect an RF signal similar to enemy radar.

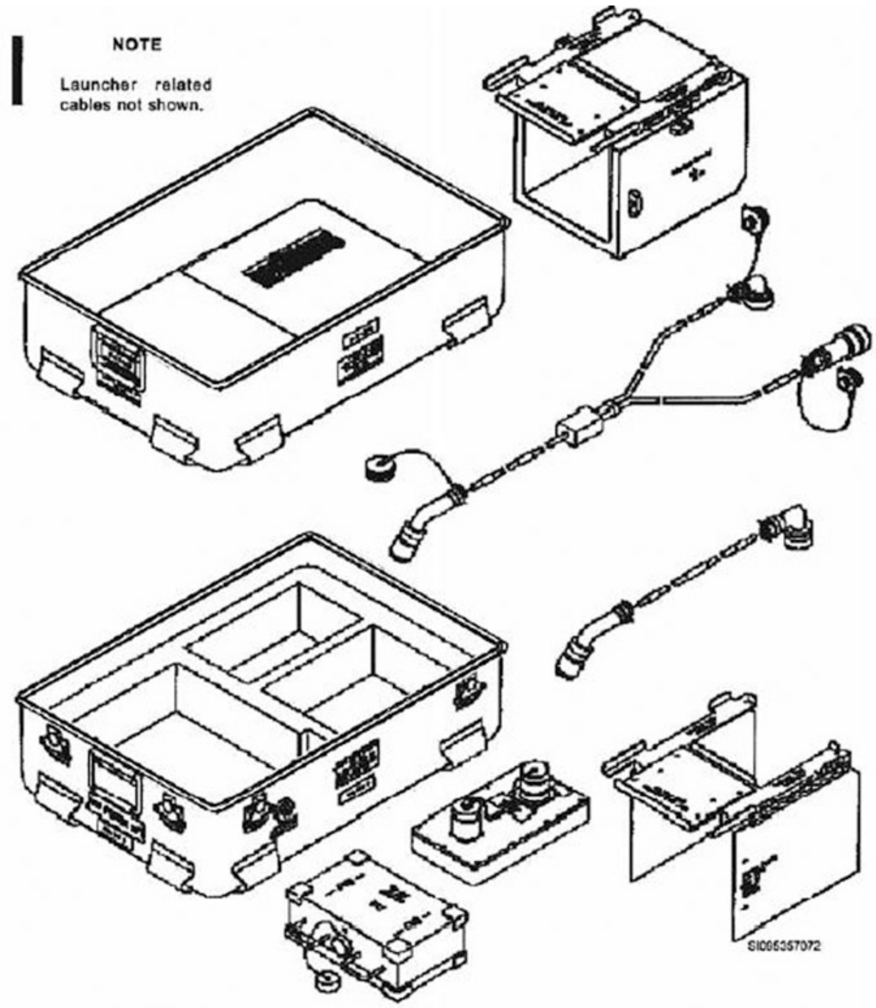

Figure 2–8. AN/GSM–396 guided missile-launcher test set.

Missile built-in test

The missile BIT is an optional test used by the operator when trying to confirm the results of an aircraft missile BIT test. Missile BIT includes performing a missile power supply test, monitoring safety circuits, performing a missile communication test, and running missile BIT. The purpose of the missile BIT is to verify that the HARM seeker and control sections are operational.

Missile gyro exercise test

We perform this test when we are reconfiguring a captive air training missile (CATM) to a tactical missile or whenever we suspect control section gyro failure. It is not part of the all-function test. The purpose of the missile gyro exercise test is to verify that the missile pitch, yaw, and roll gyros can detect physical missile movement.

Umbilical cable test

This test performs a serviceability test on the HARM umbilical cable with it removed from the control section.

413. Air-to-ground missile–114 (Hellfire) missile series

The AGM–114 Heliborne, Laser, Fire and Forget (Hellfire) modular missile system was designed in the 1970s as a multi-mission anti-armor and precision attack weapon that would be effective against tanks, bunkers, and structures. The requirement included the attack of both stationary and moving vehicle targets. Since the introduction of the Hellfire family of missiles many decades ago, the missile has gone through numerous variants. We will center our discussion of this missile on the most recent variants employed by the USAF on the RPA delivery platform.

Missile description

The AGM–114 Hellfire missile system is a rocket-propelled, laser-guided weapon designed to defeat individual hard point targets well forward of friendly ground-maneuver elements. The AGM–114 Hellfire missile uses a semi-active laser. A digital communication link provides targeting data to the missile and enables it to inertial navigate, acquire, and destroy targets from various lateral offset angles. The AGM–114 missile is considered an AUR, which requires no maintenance other than normal routine surveillance and cleaning. The missile includes BIT for evaluation of missile condition.

The missile is launched from the USAF Predator MQ–1B and Reaper MQ–9 RPAs. In 2001, the Hellfire was successfully fired from a Predator in flight tests at Nellis Air Force Base, Nevada. In 2002, the first Hellfire was fired in combat from a Predator RPA destroying a terrorist vehicle. Since that time, the Hellfire delivery platform is constantly being perfected. The Reaper MQ–9 RPA has the capacity to carry four AGM–114 Hellfire missiles on a single sortie in addition to a combination of GBU-12s and GBU-38s previously discussed.

Missile variants

Current variants that support the USAF RPA platform are the AGM–114K, –114K-2, –114K–2A, –114P–2, –114P–2A, –114P–2B, –114M–6, and the –114N–6. All the variants are similar with the major difference in the warhead.

- AGM–114K and –114P series use a dual shaped charge warhead with approximately 14 pounds NEW of LX–14 or PBXN–9 explosive filler.
- AGM–114M series use a blast fragmentation warhead with approximately five pounds NEW of PBXN–109 explosive filler.
- AGM–114N series use a thermobaric warhead with approximately five pounds NEW of PBXN–112 and four pounds of pressed aluminum powder. As you may recall, a thermobaric explosive is more lethal in confined spaces than high explosives.

Missile sections

The AGM–114 series Hellfire Missile System is comprised of four major components: the guidance section, the warhead section, the propulsion section, and the control section. Refer to figure 2–9 while we describe each section of the AGM–114 series Hellfire missile.

Guidance section

The guidance section of the AGM–114 consists of the guidance unit, strakes, umbilical connector housing, forward launch shoe, and dome assembly.

Guidance unit

The guidance unit contains the laser seeker and includes all the area forward of the strakes. It uses a semi-active laser to acquire and track targets using reflected laser energy.

Strakes

The strakes of the AGM–114 Hellfire missile are part of the guidance section housing that provide the necessary stability during flight.

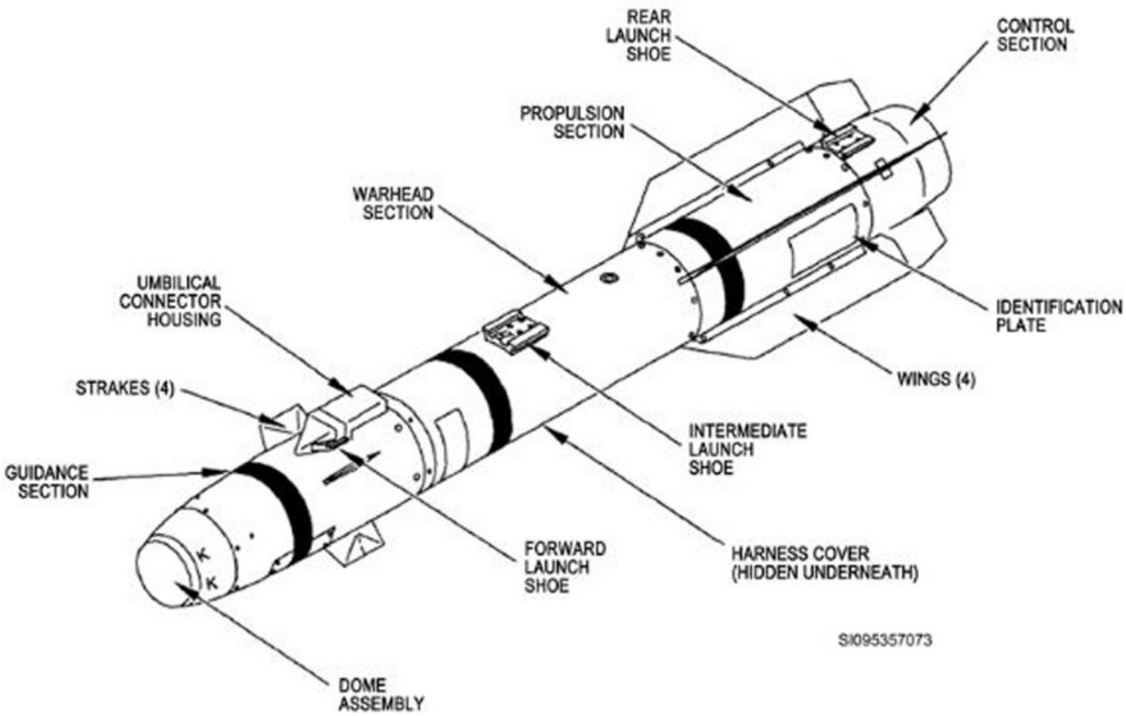

Figure 2–9. AGM–114 series tactical missile.

Umbilical connector housing

The umbilical connector housing is part of the guidance section which holds the wiring harness that provides electrical interface between the missile and launcher.

Forward launch shoe

Part of the guidance section housing, it supports the forward end of the missile while on the launcher rail.

Dome assembly

The dome assembly is located on front of the guidance section and provides the environmental protection for the guidance section while allowing reflected laser energy to enter.

Warhead section

The warhead of the AGM–114 contains the main warhead and the intermediate launch shoe.

Main warhead

The warhead is located between the guidance section and propulsion section. There are three variants of the AGM–114 series for the remotely piloted aircraft that we use. The type of warheads for USAF use include: dual shaped charge, blast fragmentation, and thermobaric. The main warhead is dependent on the variant/model as mentioned above.

Intermediate launch shoe

The intermediate launch shoe supports and locks the center of the missile on the launcher rail. It is located on top of the warhead section.

Propulsion section

The propulsion section is located between the warhead and the control section. The propulsion section consists of the rocket motor and wings.

Rocket motor

The rocket motor is a single grain solid propellant and generates the thrust necessary to separate missiles from the launcher rail and propel missiles to the target.

Wings

The wings of the AGM–114 Hellfire are a part of the propulsion section that provides stability during flight.

Control section

The control section is located on the rear of the missile. It consists of the steering and pneumatic controls necessary to control the Hellfire during flight. On top of the control section is the Rear Launch Shoe. The Rear Launch Shoe supports the aft end of the missile on the launcher rail.

Missile container

The AGM–114 series Hellfire missile is stored in the CNU–317 container (fig. 2–10). The CNU–317 container provides protection for one AGM-114 series missile during transportation and storage. The AGM–114 series missile weighs approximately 100 pounds; two people must be used when handling the AGM–114 outside the container. A *loaded* CNU–317 container weighs 185 to 190 pounds and requires four people when handling.

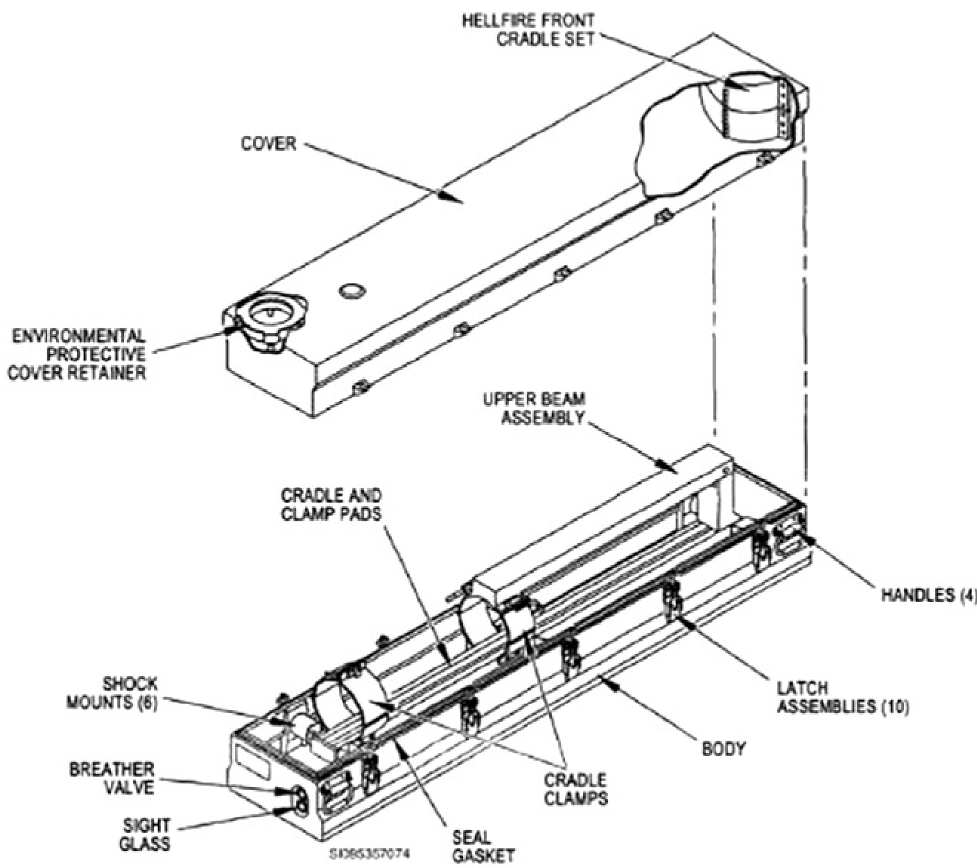

Figure 2–10. CNU–317 container.

414. Air-to-ground missile–158 joint air-to-surface standoff missile

The AGM–158 JASSM is another weapon that is recent to our inventory. It is a liquid fueled weapon providing standoff attack capability. The AGM–158 is launched from outside the enemy area defenses to strike critical, high value, heavily defended hard targets.

The JASSM is a joint Air Force and Navy project (fig. 2–11). Basically, it is a precision 2,000-pound cruise missile, factory fueled with 40 gallons of JP–10 fuel. The missile fuselage has a pointed nose, a trapezoidal shape, and an overall length of 168 inches and a wingspan of 120 inches. It can be used on the F–16, B–52, B–1, and B–2 aircraft. Once released from the aircraft, the weapon navigates autonomously by three-dimensional waypoints. At a specified distance from the target, the missile descends to an altitude above ground level that will allow the best angle for the target selected. This angle is dependent on the type of target and the hardness. The infrared seeker is used during the terminal dive if impact precision is required to minimize damage to surrounding structures.

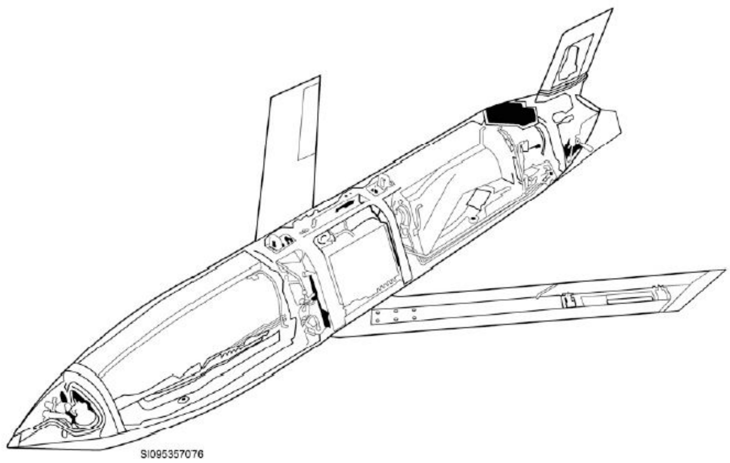

Figure 2–11. AGM–158 joint air-to-surface standoff missile.

Guidance system

Mission data is downloaded to the missile prior to or during flight. Mission plans include the release envelope, target coordinates, and weapon terminal parameters. The AGM–158 is guided by a tightly coupled GPS aided INS. An infrared seeker can be optionally used to provide a precision targeting capability.

The AGM–158 is designed to operate under adverse weather conditions. If weather conditions prevent the seeker from acquiring the target, the system will guide to the target using the GPS/INS and target coordinates it received via mission planning. During the terminal trajectory, the missile transmits position and final status; this data can be used to quantify the probability of missile impact on the target and to make recommendations for re-attack.

Warhead

The AGM–158 uses the WDU–42/B 1,000 pound class warhead with AFX–757 fill and FMU–156/B fuze.

Container

The missile is stored and shipped in a reusable CNU–614/E container (fig. 2–12). Overall weight of the container is approximately 1,120 pounds with the container cover being approximately 575 pounds and the container base being approximately 545 pounds. The container has an access port for conducting an in-container IBIT using the AN/GYQ–79 series digital computer set.

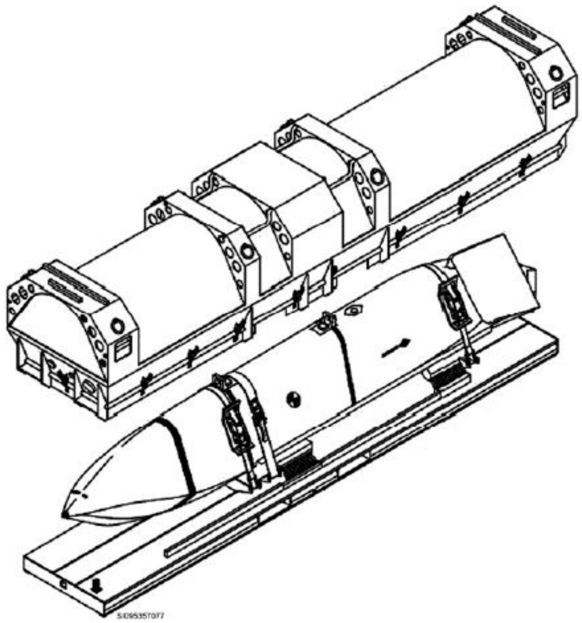

Figure 2–12. CNU-614/E container.

Self-Test Questions

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

411. Air-to-ground missile-65 (Maverick) missile series and test equipment

1. Against what type of targets do we use the AGM–65?

2. What is the difference between the AGM–65A and B?

3. Which launcher do we use to launch the AGM–65G?

4. What is the purpose of the photodiode in the seeker unit?

5. What type of warhead does the AGM–65 use?

6. What is the function of the AN/DSM–129 test set?

7. Which target simulator provides simulated targets for testing the AGM–65D?

412. Air-to-ground missile-88 high-speed anti-radiation missile series and test equipment

1. What are the four sections of the AGM–88 (HARM)?

2. Which type of guidance system does the AGM–88 (HARM) use?

3. What are the four components that make up the AGM–88 (HARM) warhead?

4. What are the two major functions of the warhead fuze?

5. Which test set do we use to test all configurations of the AGM–88 (HARM)?

6. Match each test in column B with its applicable function in column A. Items in column B may be used only once.

Column A	Column B
____ (1) This test performs a serviceability test on the HARM umbilical cable with it removed from the control section.	a. All-function test.
____ (2) This test is performed on repaired AURs, missile failing in-flight BIG, AURs failing inspection, and as part of the 10 percent annual inspection of assigned missile inventory.	b. Missile BIT test.
____ (3) This test is performed when reconfiguring a CATM to a tactical missile or whenever control section gyro failure is suspected.	c. Missile gyro exercise test.
____ (4) An optional test used by the operator when trying to confirm the results of an aircraft missile BIT test.	d. Umbilical cable test.

413. Air-to-ground missile-114 (Hellfire) missile series

1. Hellfire missiles were designed to be effective against what kind of targets?

2. What type of warhead does the AGM–114N series use?

3. What are the four major sections of the AGM–114?

4. What does the AGM–114 use to acquire and track targets?

5. Match each AGM–114 Hellfire component in column A with its correct section in column B. Items in column B may be used once, more than once, or not at all.

Column A	*Column B*
____ (1) Strakes.	a. Guidance section.
____ (2) Rocket motor.	b. Warhead section.
____ (3) Intermediate launch shoe.	c. Propulsion section.
____ (4) Dome assembly.	d. Control section.
____ (5) Wings	
____ (6) Forward launch shoe.	

6. How many people are required to lift a *loaded* CNU-317 container?

414. Air-to-ground missile-158 Joint air-to-surface standoff missile

1. What are the characteristics of the AGM–158?

2. What on the AGM–158 is used if impact precision is required to minimize damage to surrounding structures?

3. What type of warhead does the AGM–158 use?

4. What container is used to store the AGM–158?

2–2. Air-to-Air Missiles

One of the first considerations a force commander must be concerned with is control of the airspace. There is no better way to explain this doctrine than to review the execution of the initial air battles that took place during Operation Desert Storm. Control of the air assures the friendly use of the environment while denying its use to the enemy. Air intercept missiles used in the offensive role to control the air environment are called “offensive counterair.” Conversely, air intercept missiles used to protect other combat forces from air attack are known as “defensive counterair.” The missiles in this section are used for both types of air operations.

415. Air intercept missile–9 (Sidewinder) missile series and test equipment

The Air intercept missile–9 (AIM–9) is one of the most influential and widely used missiles in history. This slim air-to-air missile was developed by a very small team of experts at the Naval Weapons Center, China Lake, California. The AIM–9 missile has been around since the early 1950s and has been redesigned over a dozen times. The Sidewinder is one of the oldest air-to-air missiles we have due to its being the least expensive and most successful missiles in the entire US weapons inventory.

The AIM–9 is a “fire-and-forget” infrared sensing missile. Fire and forget means that after the missile is launched, the launch aircraft has nothing more to do with it. Earlier versions of the AIM–9 required a direct shot at the exhaust end of a fleeing aircraft to score a hit. The newer versions launch from virtually any angle and track the heat from the airframe as well as the exhaust.

AIM-9M components

The difference between one variant and another comes from the components from which they are assembled. Also virtually every component in the AIM–9, whether it is a RM, GU, or warhead, comes in more than one version and is often interchangeable. The Navy “Mark-and-Mod” system identifies most missile components. Because our discussion is oriented towards the AIM–9 series and not particular variants, we don’t refer to the different variants of each component very often. AIM–9M missiles consist of five major components (fig. 2–13):

- Guidance control section (GCS).
- TD.
- S&A device.
- Warhead.
- RM.

Four fin assemblies attach to the GCS and four wing assemblies attach to the RM. An umbilical cable and the forward hanger aft contact button electrically connect the missile to the aircraft when the missile is attached to the aircraft launcher.

Guidance control section

The GCS is the foremost section of the missile (fig. 2–13). The GCS has improved electronics to provide increased sensitivity and improved background rejection. Counter-countermeasures are also provided. AIM–9M target acquisition is indicated by an audible tone on the aircraft’s intercommunication system. Target tracking is indicated by an increase in volume of this tone when the tracker is uncaged (allowed to search for the target). The missile can be launched during target acquisition or target tracking.

TMU–72/B coolant pressure tank (accumulator)

The coolant pressure tank is installed in the GCS (fig. 2–14). The coolant pressure tank provides high pressure argon/nitrogen gas to the GCS refrigerated detector unit for cooling the missile sensors while the missile is attached to the aircraft. Once the missile leaves the aircraft, power is lost to the coolant valve and the tank is no longer used. A small reservoir in the GCS supplies coolant for approximately one minute while the missile is in flight. This is ample time for the missile to reach its target. The coolant pressure tank has a capacity of 4.92 cubic feet of argon gas (or nitrogen) at a maximum pressure of 5,100 ±100 psig. A fully charged coolant tank provides approximately nine hours of continuous cooling when filled with argon gas, and approximately 5.5 hours of continuous cooling when filled with nitrogen gas. Obviously argon gas is the preferred coolant, but nitrogen gas works.

Umbilical cable

Located on the guidance control section (GCS), the umbilical cable provides the electrical connection between the GCS and the aircraft (fig. 2–13). During launch, the cable is sheared off and remains with the aircraft.

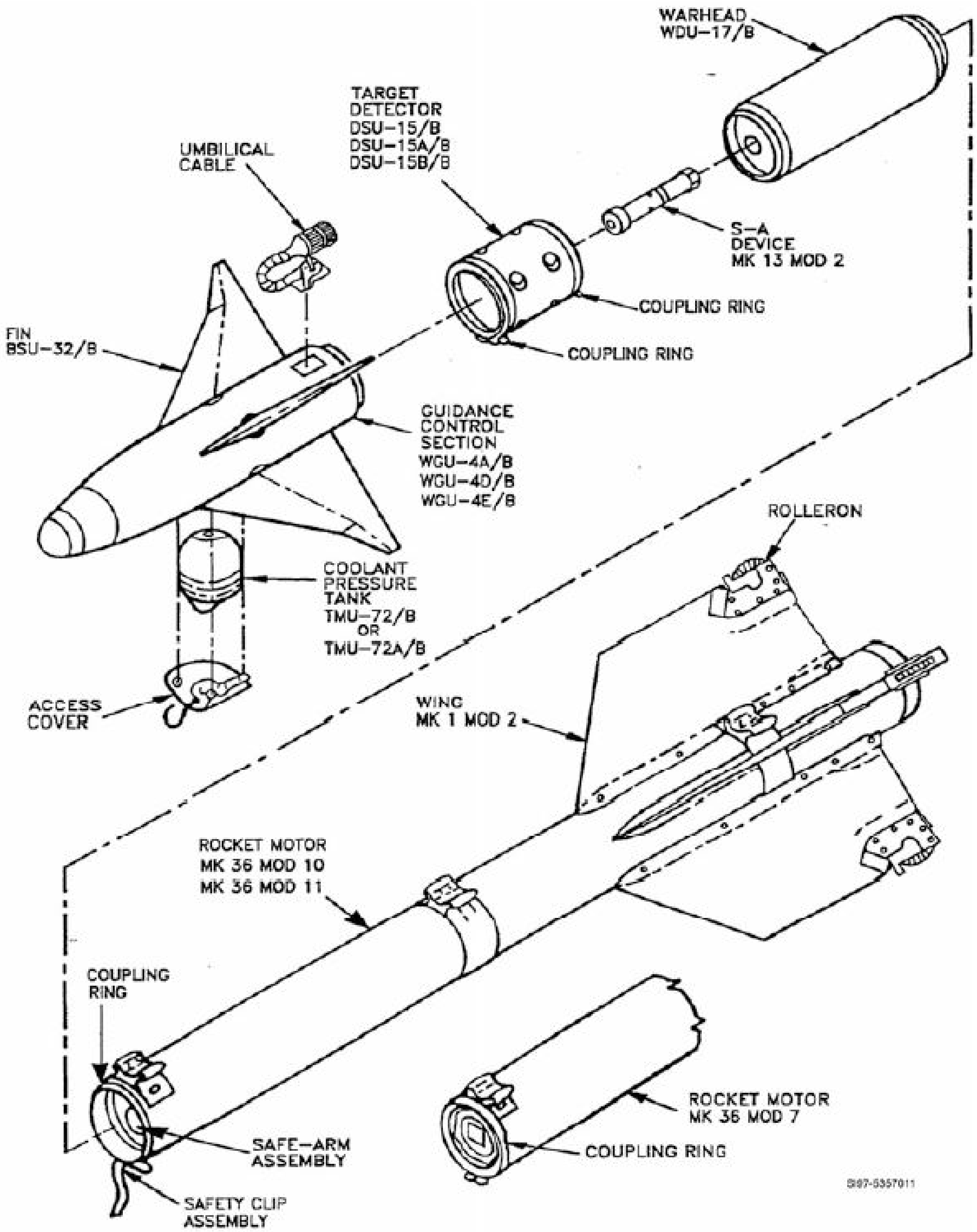

Figure 2–13. AIM–9M guided missile, exploded view.

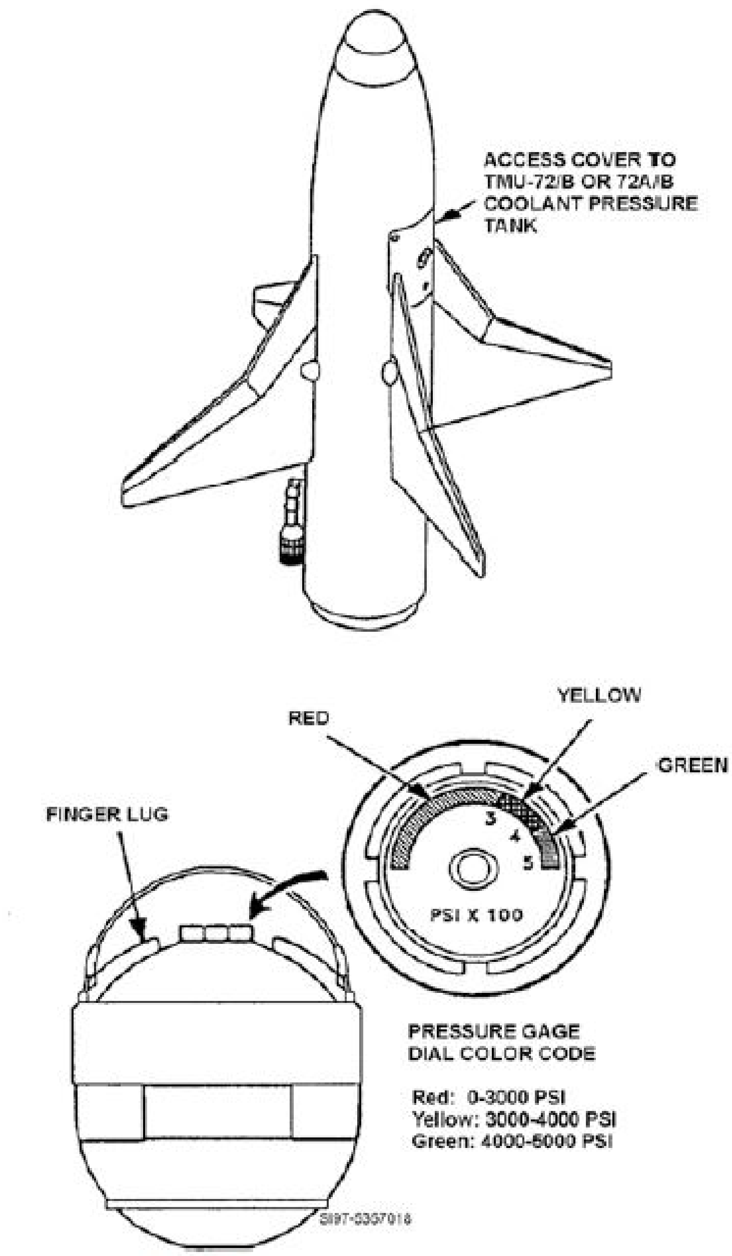

Figure 2–14. TMU-72/B coolant pressure tank and location.

Fins

Four identical fins attach to the outside of the GCS and provide the steering force for the missile while it is in free flight. The fins are electrically controlled and pneumatically operated by a servo system located in the aft part of the GCS.

Inertia switch and capacitor

The guidance control section also contains an inertia switch and capacitor. If target detector fails and the missile strikes the target, the inertia switch actuates and discharges the capacitor, which feeds a firing pulse to the S&A device to initiate warhead detonation. The small explosive charge inside this section is a class 1.1 explosive.

Target detector

The purpose of the TD is to detect the presence of a target at distances out to maximum effective range of the missile warhead and generate an electrical firing signal so that the S&A explosive train and warhead are detonated at a point where kill probability average is maximized (fig. 2–13). The TD transmits pulsed infrared energy through the four forward windows and the reflected energy is received by an infrared detector through the aft four windows. The four TD transmitters and four receivers are arranged in quadrants around the missile axis (middle position). Each transmitter and receiver pair makes one quadrant. This arrangement provides 360-degree coverage around the missile axis.

Safety and arming device

The S&A device is an electromechanical device that causes initiation of the warhead (fig. 2–13). The device is attached to the aft end of the TD and slid into the warhead cavity. The device contains a small 1.1 explosive to initiate the explosive train. The S&A has two windows: one for viewing the condition of the safe-arm indicator and one for viewing the condition of the launch-latch. If the device safe-arm indicator windows have a “silver A” (bare metal) on a red field visible, or if no letter is visible, the device is armed. If any red area is visible in the launch-latch window, the launch latch is not properly engaged and the device is unsafe. At launch, the S&A device launch latch is electrically unlocked. Missile acceleration of at least a six gravitational force causes a setback weight to move into the enabled position. Continued acceleration causes eccentrically weighted rotors to rotate. When the rotors have traveled through their full movement, the explosive train is complete. On target intercept, an electrical signal from the TD initiates the S&A device explosive train—igniting the warhead booster and detonation follows.

Warhead

The warhead is an annular blast fragmentation warhead (fig. 2–13). This means that when the warhead is detonated, fragments fly in all directions (360 degrees) to affect an aircraft kill. The AIM-9M uses the WDU–17/B warhead. The explosive filler is 7.9 pounds of PBXN–3, while the warhead is detonated by the S&A device.

Rocket motor

The AIM–9M uses the MK36 series rocket motors (fig. 2–15, A, B). The Mod 7 rocket motor is a solid propellant, high thrust motor that comprises the aft end of the missile. Cast into the tube and bonded to the tube wall, the propellant igniter train consists of a main charge, booster charge, and MK5 squib. The igniter is held in place by a non-propulsive head closure that blows out at a low pressure if the motor should ignite with no warhead attached. This motor differs from the Mods 10 and 11 because of the installation of a radio interference filter on the front end of the rocket motor, which was replaced by a S&A selector handle on the Mods 10 and 11. The radio interference filter prevents stray RF energy from actuating the rocket motor igniter. The Mod 10 rocket motor contains the same grain propellant as the Mod 7 but uses an igniter that mechanically interrupts the explosive ignition train in the event of accidental squib ignition. The Mod 11 is a reduced smoke motor outwardly similar to the MK36 Mod 10. The primary difference between the motors is the type of propellant used. The effective firing range of the AIM-9M missile is between two to eleven miles depending on the model.

Safe-arm selector

The rocket motor features a non-removable safe-arm selector handle that’s used to mechanically ARM or SAFE the rocket motor on the ground. The rocket motor has a non-propulsive head closure that blows out if a warhead is not connected; ensuring the rocket motor does not become propulsive.

Hangers

The rocket motor connects electrically and mechanically to the aircraft. The mechanical interface (connection) is the forward, center, and aft hangers positioned along the upper portion of the rocket motor. In addition, the forward hanger accommodates two contact buttons. The rear contact button is the electrical interface between the rocket motor and the launcher/aircraft and is used to initiate the electric charge needed to fire the igniter. Because of the severe electrical hazard, this section must be grounded during maintenance handling.

Wings

Four identical wings provide aerodynamic lift and stability during flight (fig. 2–15, C). The wings attach to wing ribs at the aft end of the R/M. Each wing has a rolleron assembly that provides pitch, yaw, and roll stabilization during free flight (fig. 2–16). An oil-filled damper is located at the forward end of the rolleron assembly to smooth rolleron operation and prevent flutter. When the missile is launched, the forward momentum uncages the rolleron wheel. The passing air stream causes the rollerons to spin at high speed, causing them to act as a gyroscope to help stabilize and reduce missile roll during flight.

Principles of operation

The AIM–9 interfaces with the aircraft through an umbilical cable and has three basic phases of operation: captive flight, launch phase, and free flight. During each of these phases, power is supplied:

1. From the launcher power supply during captive flight.
2. To the missile-contained thermal batteries during the launch phase.
3. By the thermal batteries during free flight.

Captive flight phase

During captive flight, the missile is powered by the launcher power supply via the GCS umbilical cable. Aircraft power is available when the engines are started. When a combat engagement is expected, the pilot sets the S&A switch on the aircraft missile control panel to ARM, which enables the missile firing circuits.

Targets are acquired with the missile bore sighted to the aircraft axis. This means that when the plane points at a target, the missile also points at the target. When the missile acquires the target, an interlock is uncaged and the seeker begins tracking the target. The seeker continues to track the target and the missile is ready to launch.

Target acquisition is indicated by an audible tone on the aircraft intercommunication system. Target tracking is indicated by a chirping tone when the tracker is uncaged. The pilot launches the missile during target acquisition or target tracking.

Launch sequence

The pilot initiates the launch sequence. When the pilot initiates the launch sequence, a firing voltage is applied through the launcher causing the GCS thermal battery squib and the servo gas grain generator squib to ignite. Then the thermal battery applies power to the contact fuze (inertia switch). When the battery reaches 21 volts, the GCS begins to operate on internal power. This battery also provides a launch latch voltage to enable the S&A device to arm. When the S&A device sense sufficient motion to be well clear of the launch aircraft, it arms.

If the seeker is not already tracking, a signal is applied to uncage the seeker tracker and enable target tracking. A servo enabled signal delays the servos from maneuvering the missile immediately after launch to prevent striking the launch aircraft. With the first motion of the missile during launch, the umbilical separates and initiates a servo signal.

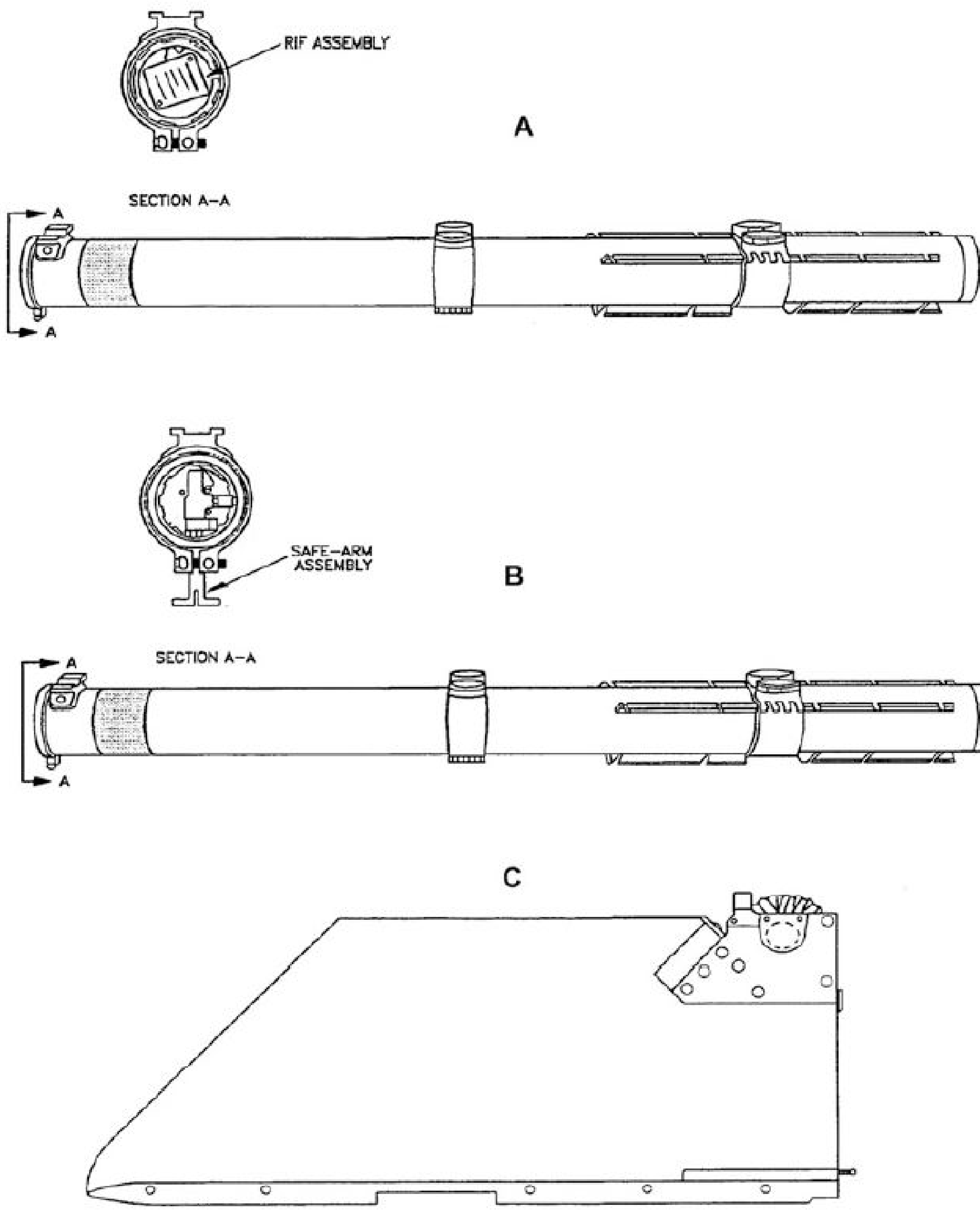

Figure 2–15. AIM–9 rocket motors and wing assembly.

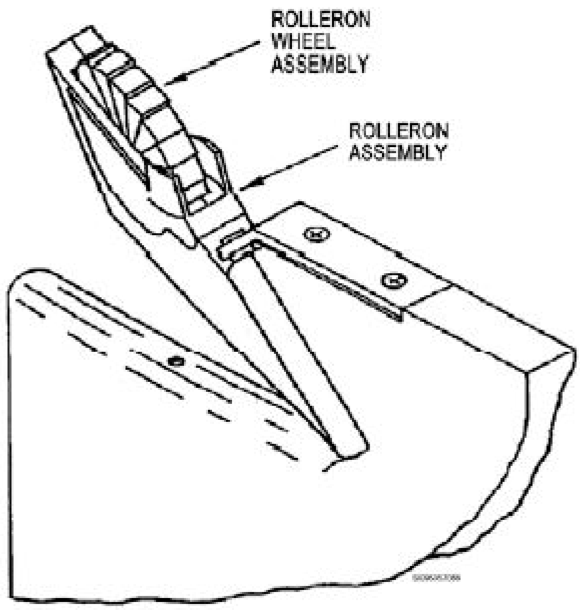

Figure 2–16. AIM–9 rolleron assembly.

Free flight

During free flight, the control system activates and makes the course corrections required to intercept the target. The missile flies a straight line as long as the line of sight remains constant.

TS-4044/D test set

As with all intricate pieces of machinery, AIM–9 missiles have their own special test equipment. Tactical missiles have many different types of component holding fixtures and assembly stands. For more information on special tools for the AIM–9, consult technical order (TO) 21M-AIM-9M-2, *Missile (Sidewinder)* and TO 33D9-1-432, *AIM–9 Missile Field Support Tools and Equipment (AGE).*

The test set we use at the field maintenance level to determine the serviceability of the AIM-9M GCSs is the TS-4044/D (fig. 2–17). The TS-4044/D is made up of seven major components that are either mounted or stored in the case:

- Control panel assembly.
- Pneumatic control panel assembly.
- Infrared target simulator.
- Target drive mechanism.
- Multi-voltage power supply.
- Torque measurement assembly.
- Forward and aft support assemblies.

The test set produces the necessary infrared and electronic signals to evaluate a go/no-go condition on the AN/DSQ–29, WGU–4A/B, and the WGU–4D/B. During guidance system testing, an infrared source produces targets under precise temperature and aperture control. This permits testing of the GCS seeker slaving, automatic gain control response, dark cell noise, audio and seeker tracking, and counter-countermeasures characteristics. Total time required for setting up the test set and mounting, testing, and removing a GCS is approximately 25 minutes. Additional information is found in TO 33D9-54-67-31, *Test Set, Guidance Control Section TS-4044B/D.*

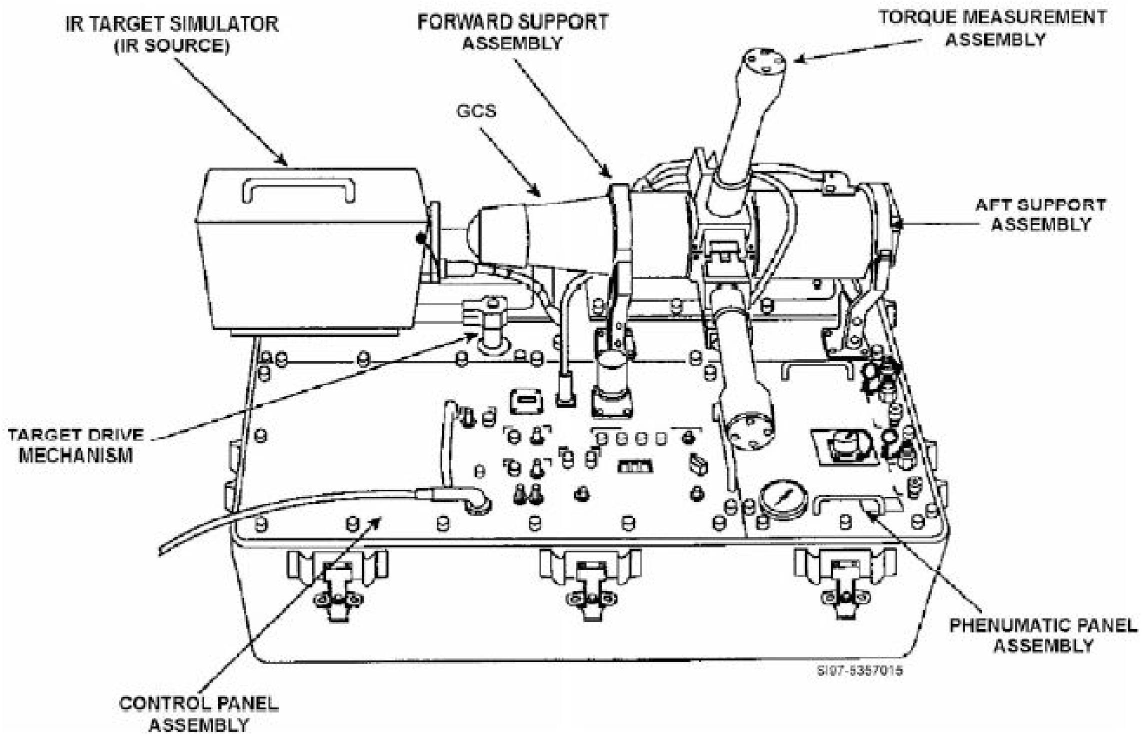

Figure 2–17. TS-4044/D test set major components.

GCU–30/E, coolant recharging unit

As we previously discussed, argon or nitrogen super cools the sensors in the guidance control unit (GCU), which provides all-weather, day and night use of the AIM–9 missile. Either argon gas or nitrogen gas works as a coolant; however, the argon gas is the preferred coolant. You store argon gas in a TMU–72A/B coolant pressure tank. From time to time you must refill this pressure tank; do this using a coolant recharging unit.

The GCU–30/E coolant recharging unit is a portable gas pressurization unit capable of filling one bottle at a time (fig. 2–18). It consists of four major assemblies: control panel assembly, chassis assembly, gas booster assembly, and case assembly. The following table provides a brief view of the major assemblies.

Assembly	Explanation
Control panel assembly	Provides a means to mount controls and indicators required to operate the recharging unit. Removal of the front cover permits access to the control panel.
Chassis assembly	Provides a mount for the internal low pressure air and argon gas components. An extra charging probe mounts on the mounting bracket assembly.
Gas booster assembly	Major component of the high pressure argon system. Incoming argon gas is boosted to 5100 ± 100 psig.
Case assembly	Is a pressure-molded, fiberglass container. Removable front and rear covers with gaskets provide environmental protection. The rear cover has a pressure relief valve to equalize internal pressure to ambient. The front cover is also used as a storage compartment for the argon and air supply hoses, the automotive air coupling, and the pouch assembly. The pouch assembly contains two reducers and one adapter that may be used to connect a portable air compressor to provide an alternate air drive pressure when needed. Four handles are provided on the case for handling.

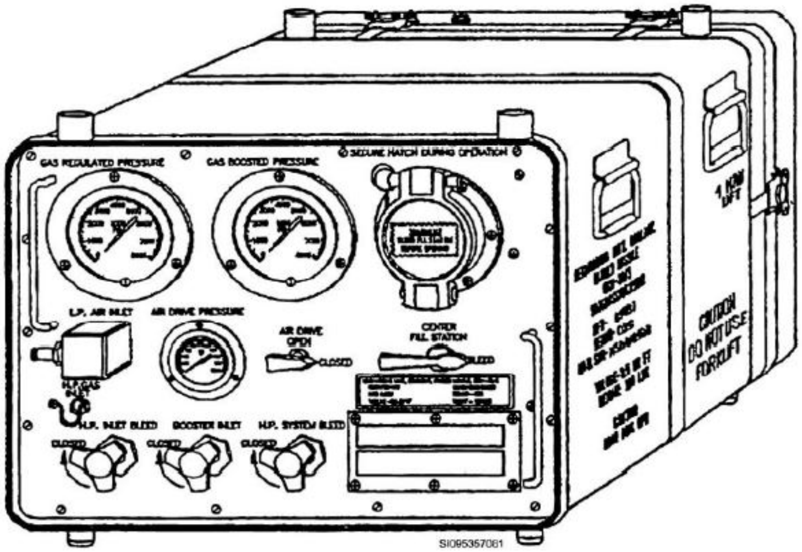

Figure 2–18. GCU–30/E coolant recharging unit.

AIM–9X next generation sidewinder components

The AIM–9X is a supersonic, air-to-air guided missile which employs a passive infrared target acquisition system (fig. 2–19). This system can be employed in the near beyond visual range and within visual range arenas. It also has proportional navigational guidance, a closed-loop position servo fin actuator unit (FAU), and an active optical target detector (AOTD). A solid-propellant R/M propels the missile and incorporates a manual safe-arm selector assembly.

The AIM-9X is composed of six unique components: GU, AOTD, electronic safe-arm device (ESAD), armament, propulsion, and control.

Guidance unit

As we stated above, the AIM-9X employs a passive infrared GU that provides tracking, guidance and control signals. It consists of three subassemblies: (1) infrared sensor unit assembly, (2) electronics unit, and (3) a center section.

Sensor unit assembly

The sensor unit assembly is in the GU at the nose of the missile (fig. 2–19). The sensor unit assembly senses target infrared radiation and generates the electrical signals necessary to track the target. The entire sensor unit assembly is kept small to allow for the small profile low-drag window design, while retaining the capability for high off-bore sight viewing angles.

Electronic unit

The electronic unit is located in the forward part of the GU, just aft of the sensor unit assembly. The primary function of the electronic unit is to process the signals received from the sensor unit assembly, and output corresponding signals to the FAU, which provides the necessary fin movement to guide the missile to the target. The electronic unit is the controller for the missile, performing all critical functions required to carry out the missile's mission.

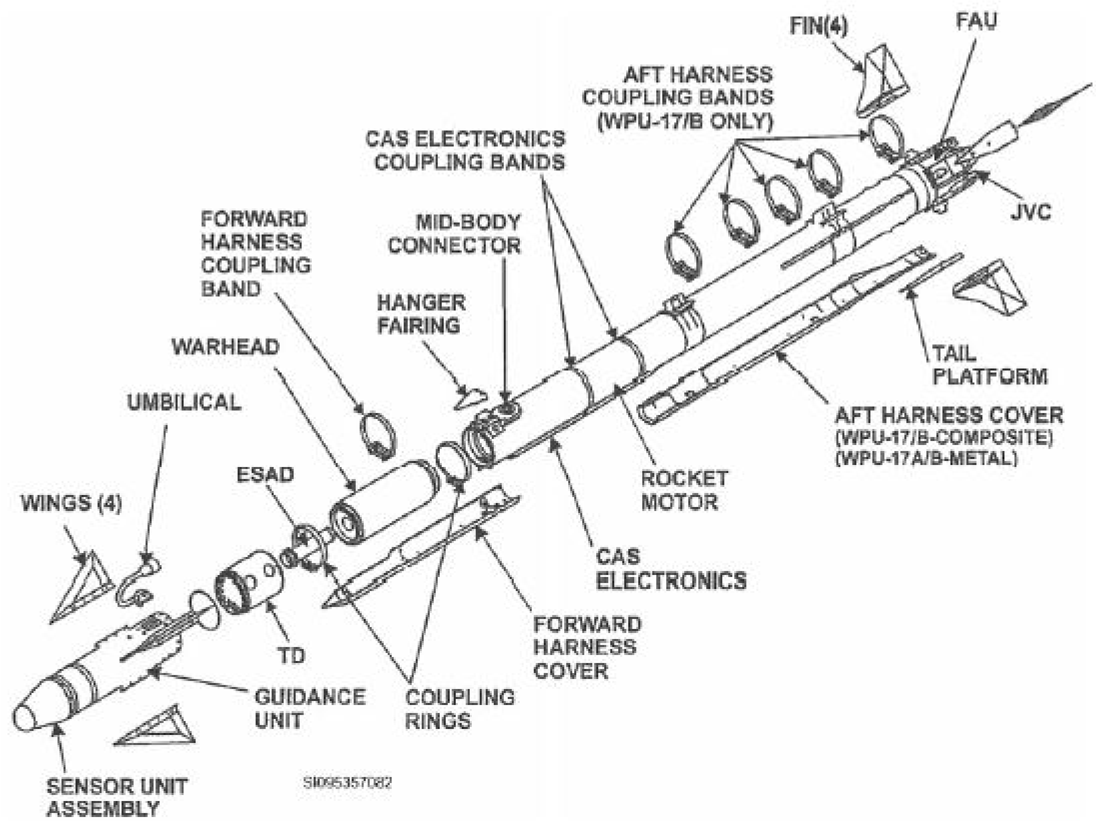

Figure 2–19. AIM–9X guided missile, exploded view.

Center section

The center section of the GU contains the cryo-engine and contact fuze device. The cryo-engine is an electrically driven regenerator that takes the place of the AIM–9M TMU–72 coolant pressure tank and performs nearly the same function. It is located in the center section of the GU and runs the entire time the missile is powered up. The advantages over the previous Sidewinders are the elimination of the coolant pressure tank and reduction of coolant contamination that would otherwise degrade performance or create failure. The contact fuze device is an impact sensing inertia switch mounted in the center section of the GU. The contact fuze device sends a detonation signal to the ESAD to provide warhead triggering in the event of a direct hit on the target. The AIM–9X uses the same umbilical without the nitrogen line as the AIM–9M and is left on the launcher at the time of separation.

Active optical target detector

The active optical target detector (AOTD) is a narrow beam, active optical, proximity fuze system (fig. 2–19). It transmits pulsed energy through four forward windows; this energy is reflected through four aft windows. The purpose of the AOTD is to detect the presence of targets at distances out of maximum effective range of the missile warhead and generate an electrical firing signal so that the ESAD explosive train and warhead are detonated at a point where *average-kill-probability* is maximized. The four AOTD transmitters and four receivers are arranged in quadrants around the missile axis (middle position). Each transmitter and receiver pair makes one quadrant. This arrangement provides 360-degree coverage around the missile axis.

Electronic safe-arm device

The electronic safe-arm device (ESAD) is an in-line explosive train, electronic-actuated firing device used on the AIM–9X (fig. 2–19). ESAD arming occurs only after the ESAD receives an irreversible commit to launch signal, experiences the appropriate launch environment, and reaches a minimum separation distance. The ESAD is purely electronic. When the appropriate environmental sensing has detected acceleration of the missile, the ESAD arms and prepares for warhead detonation. This device contains a small amount of high explosive to start the explosive train.

Armament section

The AIM–9X employs an explosive-loaded, end-initiated, annular blast, titanium rod fragmentation type warhead (fig. 2–19). The new ESAD fits into the hollow cavity of the warhead and arms the missile at a safe distance from the launch aircraft. It detonates upon receipt of the explosive output from the ESAD.

Propulsion section

The AIM–9X uses a high thrust RM which consists of three subassemblies: (1) arm-fire device (AFD), (2) hangers, and (3) mid-body umbilical and buffer connector.

Arm-fire device

The AFD is a manual safety device that prevents the inadvertent firing of the RM. The device is switched to the arm position on the flight line by the ground crew prior to flight. It is the same selector that is used presently on AIM–9M, although the handle is modified to allow for the new harness cover. The new handle is called the safe-arm selector handle. The handle is a “PLUS” or cross design with four extensions. This design provides a visual confirmation of the arm/safe condition of the rocket motor. Three of the extensions are painted black and the fourth is painted white. The safe or armed condition is indicated by the position of the white extension in relation to the ARM/SAFE indication on the R/M harness cover decal.

Hangers

Slightly “taller” hangers for AIM–9X replace the hangers on the AIM–9M RM. These taller hangers provide additional separation between the missile and the launcher. This separation is needed to provide adequate clearance for the AIM–9X on most of the newly designed launcher configurations. The middle and aft hanger mountings are unchanged from the AIM–9M configuration, while an integrated forward hanger/mid-body umbilical assembly replaces the AIM–9M forward hanger.

Mid-body umbilical connector

The mid-body umbilical connector adds a mid-body interface for the aircraft launcher (fig. 2–19). This connection provides the missile digital communications for modern aircraft like the F-22.

Control section

The control section on the AIM–9X is broken into three subassemblies: (1) fin actuator unit (FAU), (2) control actuation system, and (3) jet vane control.

Fin actuator unit

The FAU provides the AIM–9X flight control and connects to the aft end of the RM (fig. 2–19). The FAU is a thrust vector control system, consisting of four movable aerodynamic tailfins. Electro-servo actuators position the control surfaces and are powered by independent batteries. Tail fins, mounted to the control surfaces steer the AIM–9X in flight.

Control actuation system

The control actuation system is the electronics unit which receives error signals from the guidance section and produces steering signals (fig. 2–19). These steering signals are then sent to the FAU.

Jet vane control

The jet vanes are in the exhaust section of the missile, aft of the RM. Each jet vane is slaved to the associated tail fin on the same side of the missile. Prior to launch, spring loaded pistons lock the tail fins and jet vanes from moving. They are mechanically linked through a shaft to the control fins and provide additional steering capability by redirecting the exhaust gases. The AIM–9X uses the same AN/GYQ–79 (CMBRE) test set we described earlier to perform its BIT test.

416. Air intercept missile–120 advanced medium range air-to-air missile

The AIM–120 is a supersonic homing missile equipped with active radar target detection and on-board inertial navigation guidance. It is 144 inches in length, seven inches in diameter, 329 ± six pounds, and has a total wing span of 25 inches. It also has an all-weather, beyond-visual-range capability. The advanced medium range air-to-air missile (AMRAAM) is compatible with the F–15, F–16, and F–22 aircraft. It incorporates active radar with an inertial reference unit and microcomputer system, which makes the missile less dependent on the fire-control system of the aircraft. Once the missile closes on a target, its active radar guides it to intercept. This enables the pilot to aim and fire several missiles simultaneously at multiple targets and then perform evasive maneuvers while the missiles guide themselves to their targets. The AMRAAM is combat tested, scoring two kills during Operation Southern Watch and one kill in Bosnia.

AIM–120 missile components

The AMRAAM is a launch-and-leave missile, meaning the delivery aircraft can aim at a target, launch the missile, and break from the area (fig. 2–20). This not only provides added safety for the delivery aircraft but also frees the delivery aircraft to search for another target. The major sections of the AIM–120 are the guidance section, warhead section, propulsion section, and control section.

Radome

The radome is not considered a section of the missile but does warrant discussion. The radome forms the nose of the missile and covers the antenna group of the guidance section. The radome is made of glass-ceramic or ceramic material bonded to a metal sleeve. When handling the missile, it is extremely important that all measures are taken to prevent fingerprints, dirt, and grease from getting on the radome that could interfere with the antenna group.

Guidance section

The guidance section includes the hardware and software necessary to perform the functions of acquisition and tracking, navigation, data link processing, and section secondary power. The guidance section provides midcourse guidance and control, target acquisition, terminal guidance and control, and target encounter timing for warhead detonation. The guidance section uses semi-active/active radar guidance. Thermal batteries are used to power the electronics in the guidance section in flight. It uses semi-active radar guidance immediately after launch, which lasts only a few seconds. During this time, the guidance section is verifying that it is tracking and locked on to the correct target. The missile then switches to active radar to guide itself to the target.

The guidance section is also equipped with a target detecting device, which is used for proximity detonation. As the missile gets near its target, this device will sense it and send a signal to the warhead to detonate. The four target detecting device antennas are mounted under the skin in the aft portion of the guidance section.

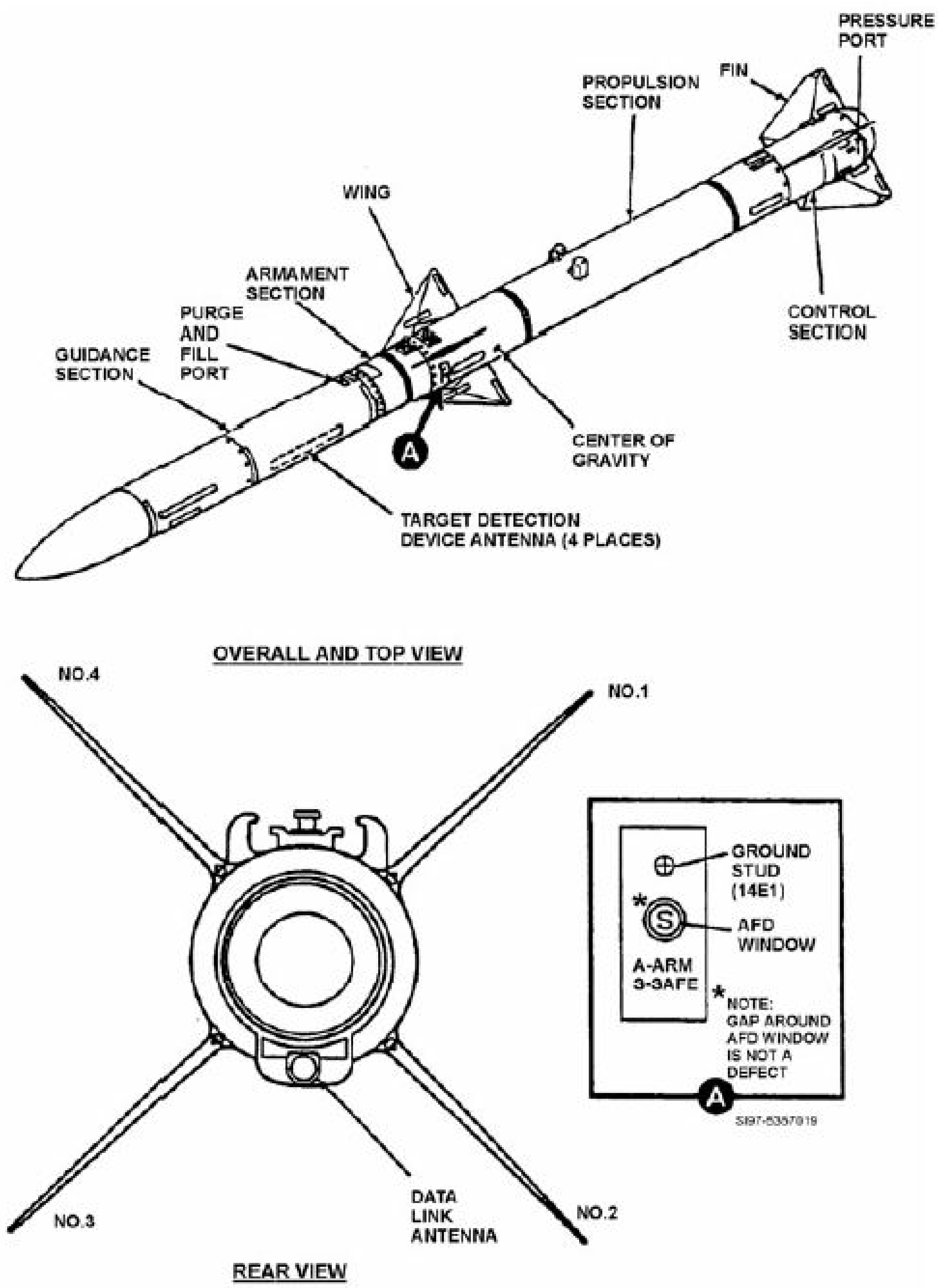

Figure 2–20. AIM–120 missile (typical).

Warhead section

The warhead section of an AIM–120 includes a warhead assembly and a MK44 MOD 1 booster threaded onto a SAF device. The warhead is situated between the guidance section (forward) and the propulsion section (aft). The missile forward attachment point (launching shoe/suspension lug) mounts on the warhead's top aft end. Extending over the entire length of the warhead and propulsion sections, the harness cover attaches to the bottom. The primary kill mechanisms of the warhead are fragments. The warhead is also coated with an epoxy coating beneath the missile's top coat of paint.

This epoxy coating acts as a thermal barrier during flight. The warhead contains 15 pounds of the explosive PBX–108.

The SAF device is attached to the warhead and does just like the name implies. It keeps the warhead in a safe position during handling, arms it during launch, and provides fuzing to detonate the warhead. In the safe position, the electrical leads are out of alignment with the detonators. To arm the SAF three things must occur: (1) upon launch a setback weight unlocks, (2) a minimum acceleration must be met, (3) after a minimum time has elapsed, the electrical leads will rotate into alignment with the detonators. This action completes the electrical circuit. At this time, the SAF is waiting for a signal to detonate from either a signal in the guidance section upon impact or from a signal from the target detecting device during proximity detonation.

Propulsion section

The propulsion section has three components, RM, arm-fire device, and thermally initiated venting system. The RM is dual thrust and configured so it will burn in a boost-sustain mode. Boost-sustain means the rocket motor will burn very fast and hot to get the missile up to speed. Once up to speed, the RM will burn slower to sustain the speed. This increases the range of the missile.

Arm-fire device

The arm-fire device (AFD) is an electromechanical device that provides protection against accidental RM ignition during ground handling and captive flight. Arming of the device occurs during the launch cycle. A signal is sent to the AFD when power is applied to the missile to start the launch sequence. If the signal is stopped, the device returns to the safe mode. On the forward section of the RM, there is an AFD window, which displays the condition of the AFD. Ensure the AFD window shows a safe condition at all times. When viewed through the window, “S” should be visible. If the AFD shows an armed condition (“A” on red background), stop all work, evacuate area, and notify explosive ordnance disposal (EOD) personnel.

Thermally initiated venting system

The thermally initiated venting system prevents the RM from becoming propulsive. The system consists of an external thermal cord which, when ignited triggers a linear shaped charge, weakening the RM case. This sequence allows the RM to vent if ignited. A thermally initiated venting system indicator is on the harness cover. The thermally initiated venting system has two positions: Enable or Disable. The indicator should be in the “Enable” position for the thermally initiated venting system to function properly. In the “Disabled” condition, the linear shaped charge is mechanically out of line from detonation.

Umbilical receptacle

On the forward section of the RM, there is an umbilical receptacle which allows for a buffer connector to be installed, which electrically connects the missile with the aircraft.

Wings

The wings located on the forward end of the RM provide stability during flight.

Control section

The three components of the control section are the electronics unit, electro-servo actuators/batteries, and fins.

Electronics unit

The control section electronics receives three signals (pitch, yaw, and roll) from the guidance section. It converts these signals into four control signals for driving the electro-servo actuators. It also controls the amount of current delivered to the electro-servo actuators.

Electro-servo actuators and batteries

The actuator batteries provide control section primary power and consist of four identical cylindrical thermal batteries. Each battery provides a nominal 135-volt output at an average 1-ampere load. Electro-servo actuators position the missile fins in response to control signals received from the control electronics.

Fins

The fins are attached to the control section and move to steer the weapon in flight.

TS-4108/G test set

Also known as the missile bit test set, the TS-4108/G is one of the simplest test sets you'll ever use (fig. 2–21). It provides a go/no-go test capability that takes approximately three seconds to check out the missile. Pre-use procedures include a self-test and connecting the test set and missile to a common ground. This is critical since damage to the test set or the missile can occur if not connected to a common ground. Verify the missile is safe by looking for a white "S" on a green background in the AFD. Remove the umbilical cap and be sure the umbilical is clean, free from foreign matter, and not damaged. Connect the missile to the test set. If the missile is serviceable, the pass lamp lights in approximately three seconds.

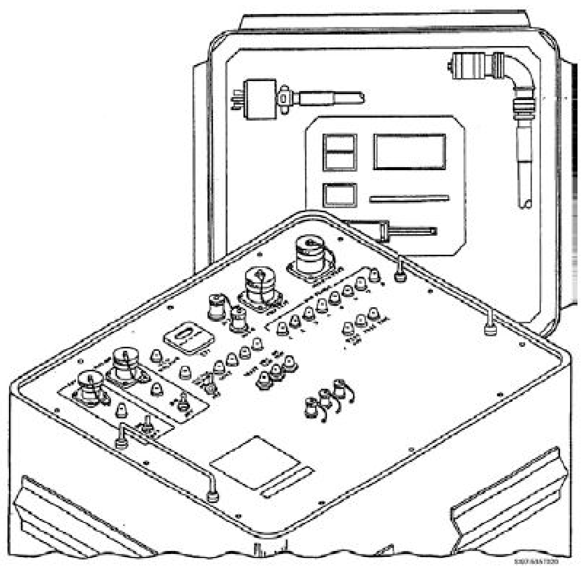

Figure 2–21. TS-4108/G test set.

Should the missile be unserviceable, the test set has degraded mode assessment (DMA) lamps that indicate what is wrong with the missile. If a blinking DMA 8 status lamp illuminates, this means a commit to launch. Do not disconnect the test set. Instead, switch the 115-volt 400-hz circuit breaker off, evacuate the area and notify EOD personnel. Test results are documented in the tactical missile record system. You can find a more detailed description of the missile check out in TO 21M-AIM120-2, *AIM-120 Missile System.*

Self-Test Questions

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

415. Air intercept missile–9 (Sidewinder) missile series and test equipment

1. What are the five major components of an AIM–9M?

2. What gas is used to cool the sensors in the AIM–9M Guidance Control Unit?

3. Explain the functions of the inertia switch and capacitor on the AIM–9M?

4. What hazard/class explosive does the S&A device on an AIM–9M use to initiate the explosive train?

5. What is the effective range of the AIM–9M missile?

6. What is the purpose of the TS–4044/D missile test set used at the field maintenance level?

7. What are the four major assemblies of the GCU–30/E?

8. What are the six unique components of an AIM–9X?

9. What eliminates the coolant pressure tank and coolant contamination?

10. When does the ESAD arming occur?

416. Air intercept missile–120 advanced medium range air-to-air missile

1. What are the four major sections of the AIM–120 missile?

2. What is the primary kill mechanism of the AIM–120 missile warhead?

3. How many pounds and what type of explosive does the AIM–120 missile warhead contain?

4. What three actions must take place to arm the SAF device?

5. Which test set performs a go/no-go test on the AIM–120 missile?

6. What does a blinking DMA 8 status lamp on the AIM–120 missile bit test set indicate?

Answers to Self-Test Questions

411

1. Armored vehicles, air defenses, ships, transportation equipment, and fuel storage facilities.
2. The AGM–65A missile is a television guided missile. The AGM–65B is the same except that the seeker magnifies the target scene. This capability provides the AGM–65B with a greater acquisition range.
3. The LAU–117, single missile launcher.
4. The photodiode senses the sunlight if the camera is pointed toward the sun. If the photodiode is exposed to direct sunlight, its output closes the sun shutter and prevents the vidicon camera from being damaged.
5. The AGM–65A/B/D/H uses a 125 pound cone-shaped warhead; AGM–65G/K uses a 300 pound delayed fuze penetrator, heavyweight warhead.
6. The AN/DSM–129 projects an optical image into the guidance section of the AGM–65 to test the operational readiness of the missile.
7. The SM–787/DSM infrared target simulator.

412

1. (1) Guidance.
   (2) Control.
   (3) Warhead.
   (4) RM.
2. Passive broadband RF tracker.
3. (1) Main explosive charge.
   (2) Booster.
   (3) Fuze.
   (4) Wiring harness.
4. (1) It prevents the warhead arming until the missile experiences launching acceleration.
   (2) After arming, the fuze detonates the warhead when it receives a signal from the target detector.
5. AN/GSM–396 guided missile-launcher test set (GM-LTS).
6. (1) d.
   (2) a.
   (3) c.
   (4) b.

413

1. Tanks, bunkers, and structures.
2. Thermobaric.
3. (1) Guidance.
   (2) Warhead.
   (3) Propulsion.
   (4) Control.
4. Semi-active laser using reflected laser energy.
5. (1) a.
   (2) c.
   (3) b.
   (4) a.
   (5) c.
   (6) a.
6. Four.

414

1. Precision 2,000 pound cruise missile, factory fueled with 40 gallons of JP–10 fuel.
2. Infrared seeker.
3. WDU–42/B 1000 pound class warhead with AFX–757 fill and FMU–156/B fuze.
4. CNU–614/E.

415

1. (1) Guidance control section.
   (2) Target detector.
   (3) Safety-arming device.
   (4) Warhead.
   (5) Rocket motor.
2. Argon or nitrogen gas.
3. If target detector fails and the missile strikes the target, the inertia switch actuates and discharges the capacitor, which feeds a firing pulse to the safety and arming device to initiate warhead detonation.
4. 1.1.
5. Two to eleven miles.
6. To determine serviceability of the AIM–9M GCSs.
7. (1) Control panel assembly.
   (2) Chassis assembly.
   (3) Gas booster assembly.
   (4) Case assembly.
8. (1) GU.
   (2) AOTD.
   (3) ESAD.
   (4) Armament.
   (5) Propulsion.
   (6) Control.
9. Cryo-engine.

10. Only after the ESAD receives an irreversible commit to launch signal, experiences the appropriate launch environment, and reaches a minimum separation distance.

416

1. (1) Guidance.
   (2) Warhead.
   (3) Propulsion.
   (4) Control.
2. Fragments.
3. 15 pounds of PBX-108.
4. (1) Set back weight unlocks.
   (2) Minimum acceleration must be met.
   (3) After a minimum time has elapsed, the electrical leads will rotate into alignment with the detonators.
5. TS-4108/G.
6. A commit to launch.

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

Unit Review Exercises

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

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

43. (411) What additional capability does the scene magnification upgrade provide to the air-to-ground missile (AGM)–65B?
    a. Increased lock on and tracking of the missile to the target.
    b. Wider view of the battlefield to the pilot.
    c. Fire-and-forget capability.
    d. Greater acquisition range.

44. (411) What component is installed on the training guided missile (TGM)–65 in place of the rocket motor and hydraulic actuation system?
    a. Film recorder or ballast.
    b. Missile ballast only.
    c. Film recorder only.
    d. Laser designator.

45. (411) What component is housed in the forward section of the air-to-ground missile (AGM)–65?
    a. Control section.
    b. Computer unit.
    c. Guidance unit.
    d. Warhead.

46. (411) Which air-to-ground missile (AGM)–65 series does *not* use the 125 pound cone-shaped warhead?
    a. A.
    b. B.
    c. D.
    d. E.

47. (411) The purpose of the AN/DSM–129 missile test set is to
    a. provide a power source for checkout of the missile control surfaces.
    b. provide an operational checkout of the entire missile and missile launchers.
    c. project an optical image into the guidance section of the missile to simulate the operational readiness test of the missile.
    d. provide the interface needed between missile and the computer that determines the operational readiness test of the missile.

48. (411) You can use the AN/DSM–157 test set in place of the
    a. DSM–99 and DSM–100.
    b. AN/DSM–129 only.
    c. DSM–100 only.
    d. DSM–99 only.

49. (412) What type of target is the air-to-ground missile (AGM)–88 designed to target?
    a. Reinforced concrete bunker.
    b. Headquarters building.
    c. Flightline runway.
    d. Radar installation.

50. (412) The guidance section of an air-to-ground missile (AGM)–88 uses a passive
    a. mixer radio frequency (RF) tracker.
    b. short-wave RF tracker.
    c. broadband RF tracker.
    d. low-band RF tracker.

51. (412) What number of miles is the effective range of the air-to-ground missile (AGM)–88?
    a. 11.
    b. 28.
    c. 30.
    d. 62.

52. (413) Which USAF delivery platforms are used to launch the air-to-ground missile (AGM)–114 Hellfire?
    a. Predator and Reaper remotely piloted aircraft (RAF).
    b. U–2 and RQ–4 reconnaissance aircraft.
    c. B–1B and B–2A bomber aircraft.
    d. F–15 and F–16 fighter aircraft.

53. (413) Which air-to-ground missile (AGM)–114 variant uses a thermobaric warhead?
    a. AGM–114K.
    b. AGM–114M.
    c. AGM–114N.
    d. AGM–114P.

54. (413) Which air-to-ground missile (AGM)–114 component is *not* part of the guidance section?
    a. Umbilical connector housing.
    b. Forward launch shoe.
    c. Dome assembly.
    d. Wings.

55. (413) How many personnel are required to handle an air-to-ground missile (AGM)–114 outside the container?
    a. One.
    b. Two.
    c. Three.
    d. Four.

56. (414) What is the air-to-ground missile (AGM)–158 fueled with?
    a. 10 gallons of JP 10.
    b. 40 gallons of JP–10.
    c. 10 gallons of JP–8.
    d. 40 gallons of JP–8.

57. (414) What warhead class is used on the air-to-ground missile (AGM)–158?
    a. WDU–42/B 1,000 pound.
    b. WDU–40/B 750 pound.
    c. WDU–32/B 500 pound.
    d. WDU–30/B 250 pound.

58. (415) The air intercept missile (AIM)–9L/M is comprised of the guidance control section (GCS), target detector (TD), warhead,
    a. safe and arm device (S&A), and rocket motor (RM).
    b. flight control section, and RM.
    c. wing assembly, and RM.
    d. radome, and RM.

59. (415) What is the maximum pressure capacity for a TMU–72/B argon coolant tank?
    a. 5,000 ± 100 pounds per square inch gage (psig).
    b. 5,100 ± 100 psig.
    c. 5,200 ± 100 psig.
    d. 5,300 ± 100 psig.

60. (415) Depending on the model, the effective range in miles of the air intercept missile (AIM)–9M missile is between
    a. 2 to 8.
    b. 2 to 9.
    c. 2 to 10.
    d. 2 to 11.

61. (415) Which coolant recharge unit is portable and capable of filling one bottle at a time?
    a. AN/DSM–129.
    b. AN/GYQ–79.
    c. TS–4044/D.
    d. GCU–30/E.

62. (415) What type of missile guidance system does the air intercept missile (AIM)–9X use?
    a. Semi-active continuous wave doppler.
    b. Passive infrared.
    c. Active infrared.
    d. Passive radar.

63. (415) What does the air intercept missile (AIM)–9X use to digitally communicate with aircraft like the F–22?
    a. An electronic safety-arming device.
    b. A mid-body umbilical connector.
    c. An analog umbilical connector.
    d. Contact buttons.

64. (415) What component provides the air intercept missile (AIM)–9X flight control?
    a. Control actuation system.
    b. Fin actuator unit (FAU).
    c. Jet vane control (JVC).
    d. Contact fuze device.

65. (416) Within the guidance section of the air intercept missile (AIM)–120, what allows the functions of acquisition and tracking, navigation, data link processing, and section secondary power?
    a. Hardware and software.
    b. Improved electronics.
    c. Thermal batteries.
    d. Active radar.

66. (416) What mechanism is the primary kill of the air intercept missile (AIM)–120 warhead?
    a. Advanced annular rod construction.
    b. Continuous rod construction.
    c. Fragments.
    d. Blast.

67. (416) How many pounds of explosive does the air intercept missile (AIM)–120 warhead contain?
    a. 10.
    b. 15.
    c. 30.
    d. 45.

68. (416) What component prevents the air intercept missile (AIM)–120 rocket motor from becoming propulsive?
    a. Thermally initiated venting system.
    b. Electronic-actuated firing device.
    c. Umbilical receptacle.
    d. Arm-fire device.

69. (416) What three signals of the air intercept missile (AIM)–120 control section electronics are received from the guidance section?
    a. Pitch, azimuth, and horizontal.
    b. Horizontal, vertical, and roll.
    c. Azimuth, roll, and yaw.
    d. Pitch, yaw, and roll.

70. (416) What missile test set used to verify serviceability of an air intercept missile (AIM)–120?
    a. AN/DSM–157.
    b. AN/DSM–99.
    c. TS–4108/G.
    d. TS–4044/D.

Glossary of Abbreviations and Acronyms

AC	alternating current
ADG	adapter group
ADU	adapter unit
AFD	arm-fire device
AFG	airfoil groups
AFX	Air Force explosive
AGM	air-to-ground missile
AIM	air intercept missile
AMRAAM	advanced medium range air-to-air missile
AOTD	active optical target detector
AUR	all-up-round
BIT	built-in test
BLU	bomb live unit
CATM	captive air training missile
CCA	circuit card assembly
CCG	computer control group
CMBRE	commons munitions built-in test/reprogramming equipment
CNU	container unit
DATM	dummy air training missile
DC	direct current
DCSA	digital computer system assembly
DMA	degraded mode assessment
DTS	digital test set
EOD	explosive ordnance disposal
EOGB	electro-optically guided bomb
ESAD	electronic safe-arm device
FAU	fin actuator unit
FLM	focused lethality munition
FMU	fuze munition unit
FZU	fuze miscellaneous unit
GAINS	global positioning system-aided internal navigation system
GBU	guided-bomb unit

GCS	guidance control section
GCU	guidance control unit
GM-LTS	guided missile-launcher test set
GP	general purpose
GPS	global positioning system
GU	guidance unit
HARM	high-speed anti-radiation missile
HAS	hydraulic actuation system
Hz	hertz
I/O	input/output
IBIT	initiated built-in test
IBM	International Business Machine
INS	inertial navigation system
JASSM	Joint Air-to-Surface Standoff Missile
JDAM	Joint Direct Attack Munition
KMU	kit munitions unit
LAU	launch adapter unit
LGB	laser-guided bomb
LJDAM	laser joint direct attack munition
LLLGB	low-level laser-guided bomb
MALD	miniature air launched decoy
MAU	miscellaneous armament unit
NEW	net explosive weight
PGM	precision-guided munition
PS	power supply
psi	pound per square inch
psig	pounds per square inch gage
RF	radio frequency
RM	rocket motor
RPA	remotely piloted aircraft
S&A	safe and arm
SAF	safety, arming, and fuzing
SDB	small diameter bomb
SDB II	small diameter domb increment II

TAU	test adapter unit
TD	target detector
TO	technical order
USN	United States Navy
VAC	volts, alternating current
VDC	volts, direct current
WGU	weapon guidance unit
WP	work package

Student Notes

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