T.O. GR1F-16CJ-34-1-1

AVIONICS AND NONNUCLEAR WEAPONS DELIVERY FLIGHT MANUAL

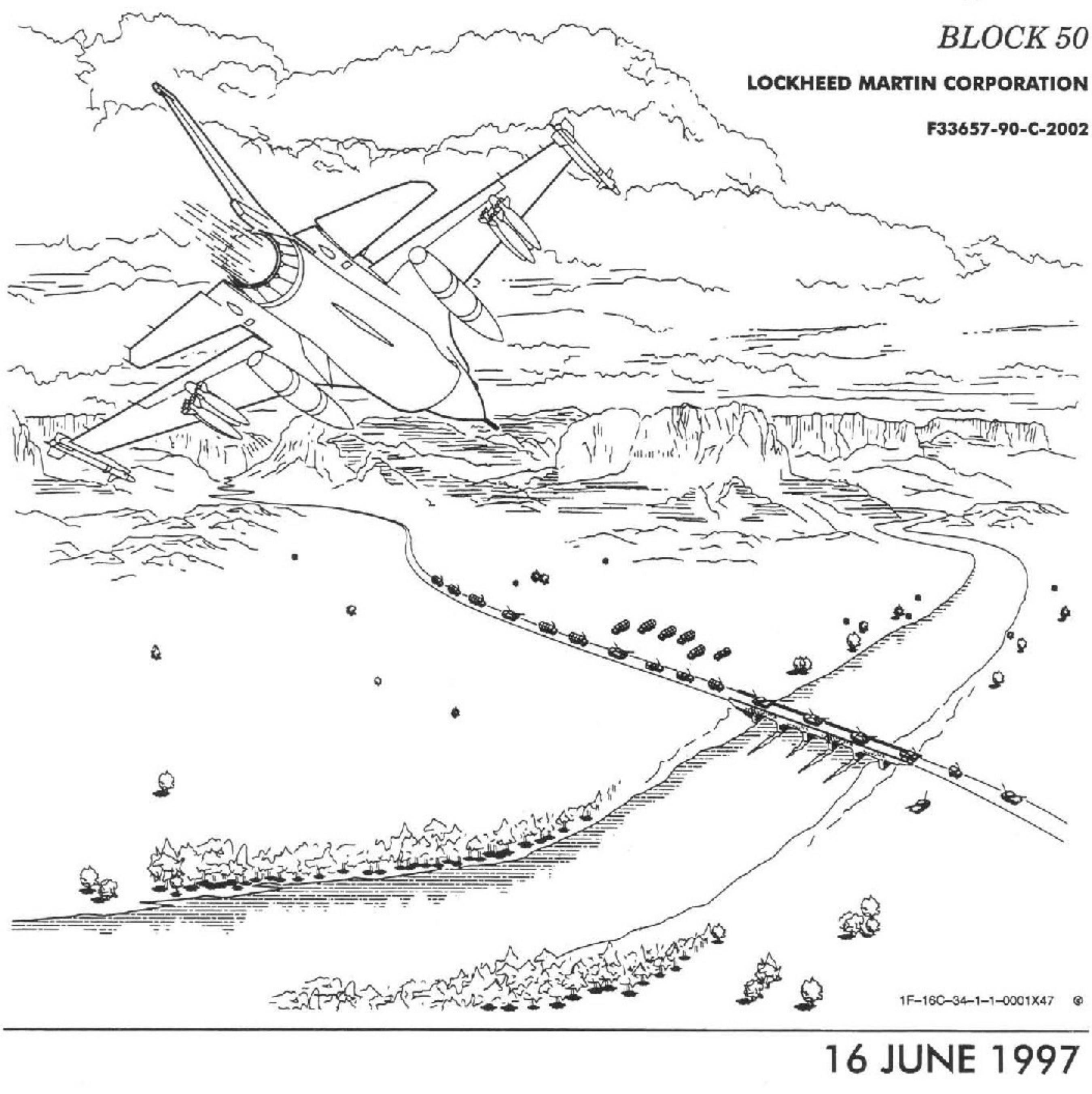
HAF SERIES AIRCRAFT

F-16C/D

BLOCK 50

LOCKHEED MARTIN CORPORATION

F33657-90-C-2002



1F-16C-34-1-1-0001X47

16 JUNE 1997

WEAPONS/FUZES/SUSPENSION SYSTEMS DESCRIPTION

This section contains descriptive information on weapons, fuzes, and suspension systems peculiar to the F-16 aircraft.

M61A1 20MM GUN SUBSYSTEM

The M61A1 20mm gun subsystem (figure 1-420) is internally mounted in the fuselage and left strake area of the aircraft. The subsystem consists of the M61A1 gun, a hydraulic drive system, and a linkless ammunition handling system. A gun purge system and an electrical control system are also provided.

M61A1 20MM GUN

The gun controller is the electronics unit which actually controls the firing of the gun. A voltage is applied to the gun breech providing fire voltage to the round while the trigger is depressed past the detent. At the end of a burst when the trigger is released, the gun clears itself. In the clearing operation, five to nine unfired rounds are cycled through the gun without firing pulses. These rounds are carried for the duration of the flight as spent rounds and cannot be used.

The SMS has a rounds remaining counting function which counts each firing pulse from the gun controller and subtracts these from the loaded number of rounds. In the clearing operation, however, there are no pulses or any way of determining the actual number of rounds cleared; therefore, the SMS assumes 7. Due to this fact, there can be a discrepancy between the rounds remaining on the MFD and the actual number of rounds left to be fired. This discrepancy can become larger with increasing number of clearings.

The rounds remaining feature is purely a pilot convenience and has no effect on the actual operation of the gun. The gun may still fire with no remaining rounds indicated on the MFD. When the last round actually passes through the gun, a last round switch closes and gun operation is shut down. At this time, SAF appears on the MFD in place of RDY with the present mode maintained. The rounds limit switch is in series with the last round switch. When the number of rounds fired equals the number set in the switch, gun operation is shut down.

The gun fires electrically primed 20mm ammunition at a rate of 6000 rounds per minute. The gun consists of a circular assembly of six single barrels, each with its own breech bolt. The assembly revolves during firing. During each revolution, a round is fed, chambered, fired, extracted, and ejected from each of the six barrels. Firing voltage is applied to the round when the barrel is rotated to the firing position. The system incorporates a rotor assembly that supports the six barrels and revolves within a stationary housing. The rotor assembly contains a bolt assembly for each barrel and is driven by the hydraulic drive system. During gun operation, ammunition is delivered to the gun transfer unit which removes the ammunition from the conveyor elements, feeds the rounds to the gun, and replaces the empty cases to the conveyor elements.

AMMUNITION HANDLING SYSTEM

The ammunition handling system stores the ammunition, delivers and feeds it to the gun, and returns the cases and rounds to the ammunition drum. The ammunition handling system is a 510-round capacity, double-ended, linkless-feed system. The ammunition storage drum consists of a stationary outer drum, a rotatable inner drum, and two covers. Ammunition rounds are stowed in rows in the outer drum. The inner drum is a double-lead helix which engages the noses of the rounds. As the inner drum is rotated, all rounds are driven by the helix to advance along the rows. The ammunition is extracted at one end cover by the exit unit mechanism for delivery to the gun. Empty cases and unfired rounds are received and stowed at the opposite end cover by the entrance unit mechanism during gunfiring. The entrance unit mechanism also receives the new rounds during the reloading process and distributes them into the rows of the outer drum. The loader-access unit is located in the right strake.

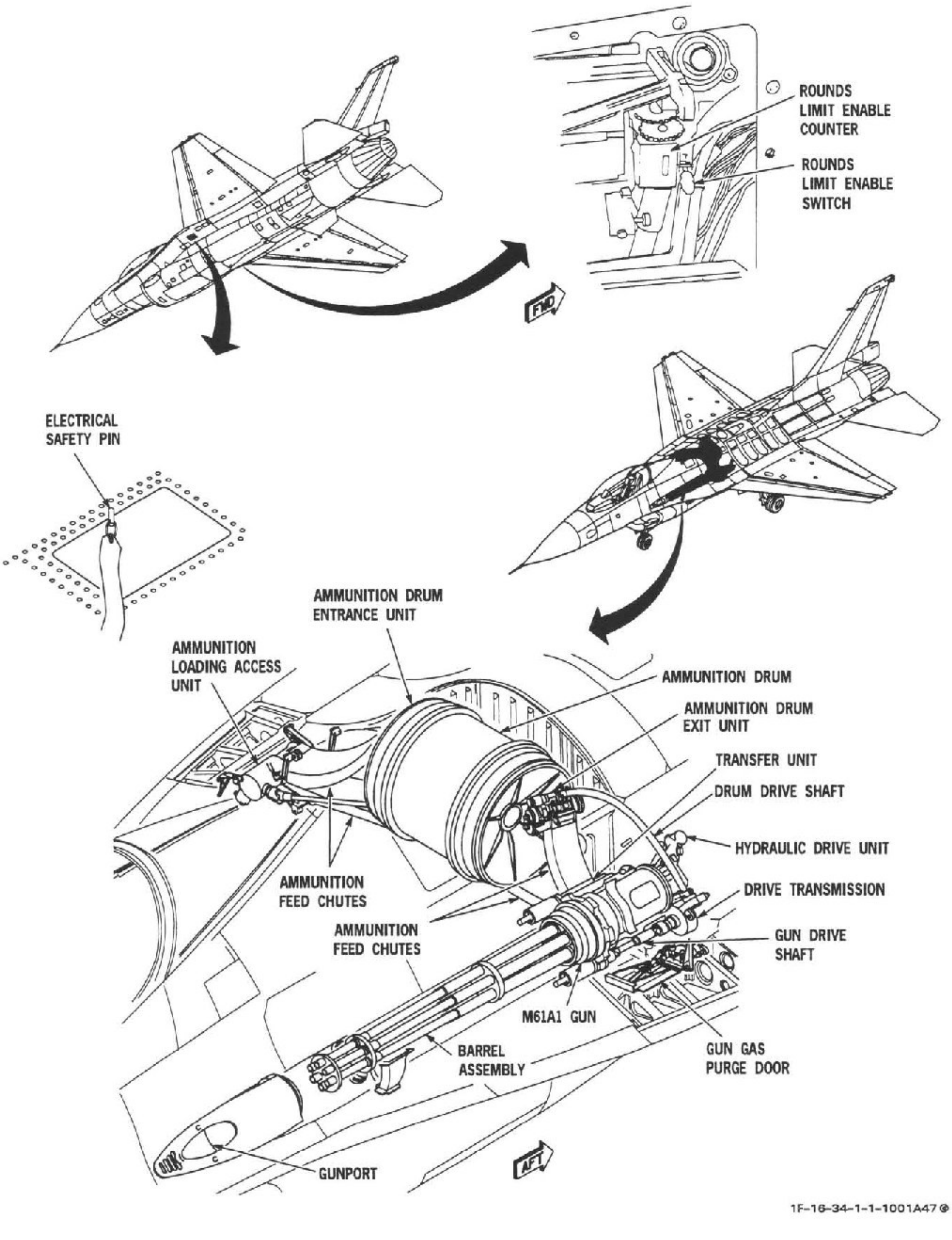


Figure 1-420. M61A1 20MM Gun Subsystem

Gun Gas Purge System

The gun gas purge system consists of a ram-air ventilation system and a hydraulically actuated gun gas purge door. The ram-air ventilation system provides air to ventilate the gun and ammunition compartments. Ram air is directed to the gun barrel trough through a flush inlet located on the lower surface of the left strake. Ram air is directed to the ammunition compartment and the gun breech area by a scoop-type inlet located on the lower surface of the right strake. The ventilation air is exhausted through a louvered vent located above the gun breech area in the left strake. When the gun is firing, purged air and gun gas are exhausted through the gun gas purge door located below the gun breech area in the left strake. Hydraulic pressure is applied to the purge door actuator when the gun trigger is depressed, causing the door to open. After the trigger is released, the door closes as the actuator bleeds off the residual hydraulic pressure.

Gun Electrical Control System

The control and indication of gun operation are accomplished electrically. A block diagram of the gun control system is shown in figure 1-421. Gunfiring is initiated by depressing the trigger switch (labeled CAMERA/GUN) past the detent located on the stick. Pressing the trigger to the first detent position initiates AVTR/CTVS operation. Depressing the trigger past the detent provides a 28 vdc signal to the gun controller. The gun controller provides a 28 vdc output to operate a solenoid valve which supplies hydraulic power to drive the gun and ammunition handling system. The gun controller also provides a firing voltage output (approximately 250 vdc) that provides the energy to fire each round of ammunition as it is processed through the gun. A visual presentation of gun configuration, mode, and rounds remaining is displayed on the MFD. Gunfiring can be set up by either selecting GUN on the MFD or by positioning the DOGFIGHT/missile override switch on the throttle to DOGFIGHT. A number of conditions must be satisfied before the gun is in a configuration to be fired. The gun control system interfaces with the SMS through the CIU and the MFD. An arm signal is supplied to the gun controller from the SMS when the following conditions are satisfied: (1) rounds of ammunition available (last

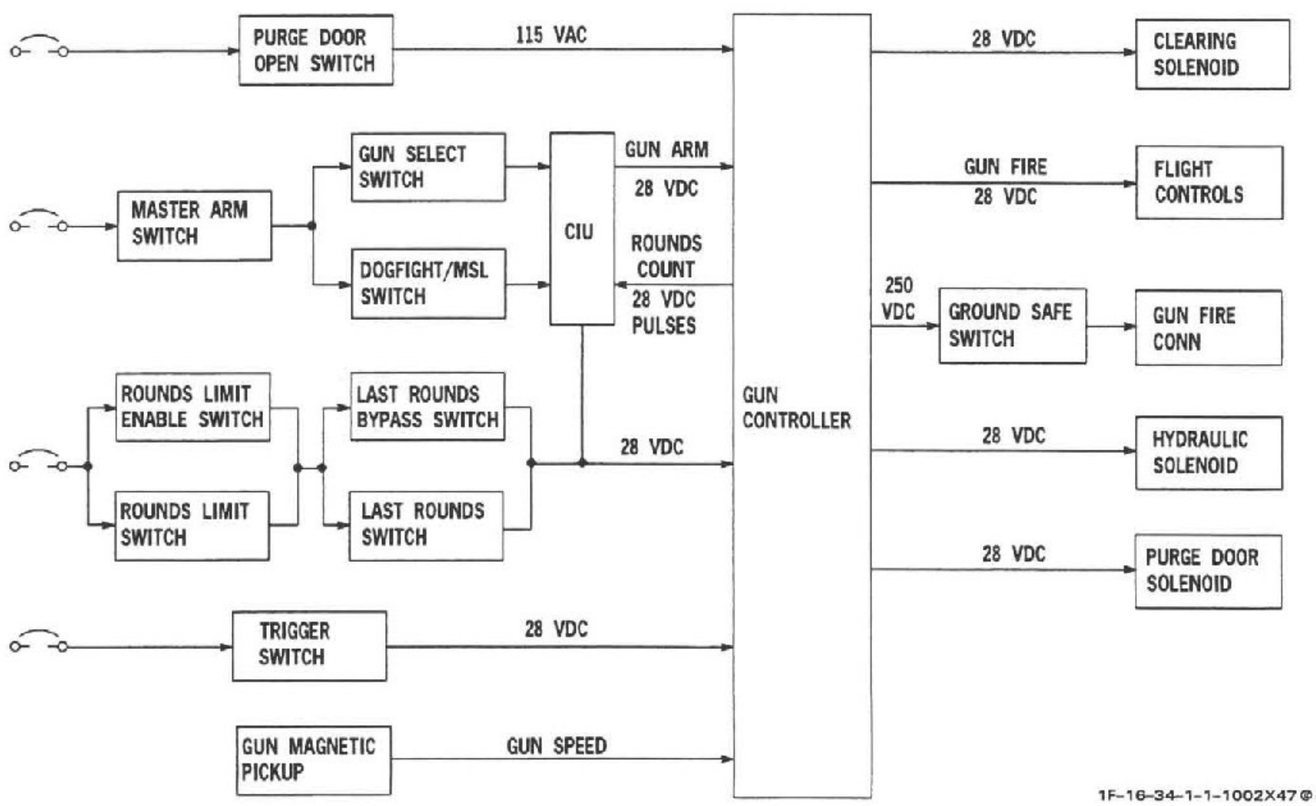


Figure 1-421. Gun Electrical Control System

rounds switch closed), (2) rounds limiter setabove 0 (zero) or rounds limiter enable switch in OFF position, (3) GUN selected on MFD or DOGFIGHT selected on throttle, (4) MASTER ARM switch positioned to MASTER ARM, (5) on F-16D aircraft, the aft cockpit ARMT CONSENT switch must be positioned to CONSENT (guarded) for the front cockpit firing operation to be accomplished. The final input is the 28 vdc signal initiated by the trigger switch. The purge door must be open to complete the 115 vac input circuit. Gun rotational speed information is supplied to the gun controller from a magnetic pickup in the gun drive mechanism. This information is used to initiate operation of the clearing solenoid when the gun rotation speed has decreased to approximately one-half speed. The clearing solenoid remains energized for 0.6 second after trigger release. Firing voltage and clearing solenoid power are applied until after gun motion ceases. This insures that all chambered rounds are fired and that the gun comes to rest in the cleared condition.

NOTE

The rounds limiter setting is the number of rounds that may be fired during a flight. This is not a burst limiter and is not resettable in the air. The rounds limiter enable switch allows rounds limiting in the ON position and prohibits the action in the OFF position.

20MM AMMUNITION

The components that make up a complete round are a brass cartridge case, an electric primer, propellant powder, and the projectile (figure 1-422). The firing process is initiated when an electrical pulse is applied to the primer. The resulting flame passes through a gas vent leading to the propellant chamber and ignites the propellant. As the propellant burns, it forms a gas which forces the projectile through the gun barrel.

The only significant difference between the five types of ammunition is in the projectile. Located at the rear of all projectiles is a band of soft metal that seats in the grooves of the gun barrel. The grooves in the barrel are twisted so that the projectile receives a rotating motion as it travels through and leaves the gun barrel. This rotation is induced to provide stability in flight. The soft band also serves to prevent the propelling gas from escaping past the projectile.

NOTE

The dummy ammunition color code may be either bronze or shades of gray or tan. The case will be steel or plastic. Dummy ammunition is used to check out the gun system.

20mm M55A1/A2 Target Practice Round (M220 TP Tracer Round)

The M55A1 target practice (TP) round (figure 1-422) is ball ammunition. The body of the projectile is made of steel. The projectile is hollow and does not contain a filler.

20mm M53 Armor-Piercing Incendiary Cartridge

The body of the M53 armor-piercing incendiary (API) projectile (figure 1-422) is composed of solid steel. The nose of the projectile is made of aluminum alloy, charged with an incendiary composition, and sealed with a closure disk. The projectile does not require a fuze, because it functions upon impact.

20mm M56A1 High Explosive Incendiary Round (XM242 HEI Tracer)

The M56 high explosive incendiary (HEI) round (figure 1-422) contains an HEI projectile. The round is used against aircraft and light material targets. The projectile explodes with an incendiary effect after penetrating the surface of the target. HEI projectiles require a fuze to complete the explosive train.

The fuze has a delay arming distance of 20 to 35 feet from the muzzle of the gun. Centrifugal force, created by the projectile spin, allows the detonator to align with the firing pin and the booster; the projectile is now armed. Upon impact, the projectile presses into its target, crushing the nose of the fuze and forcing the firing pin against the detonator. The booster, initiated by the detonator, causes the projectile to explode.

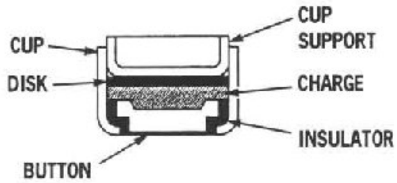
M55 TP (BALL)/M220 TP-T (TRACER)

CHARACTERISTICS

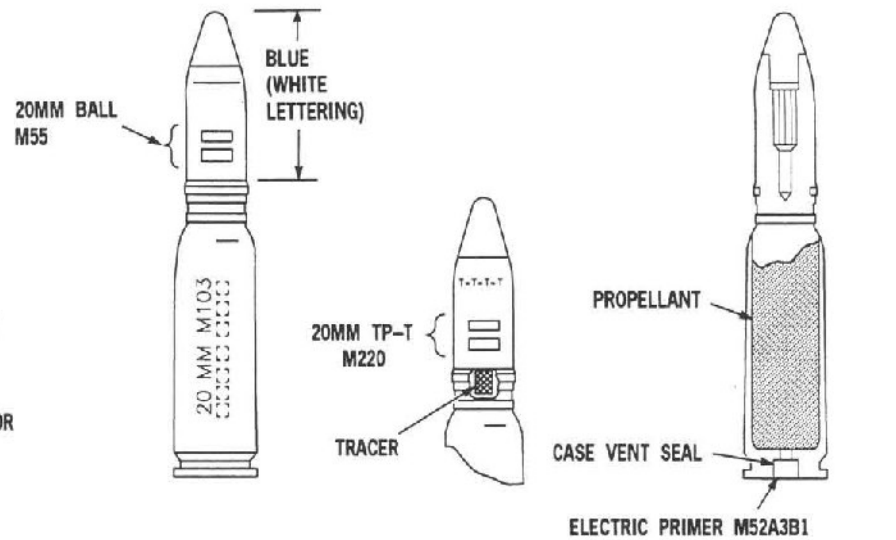
WEIGHT
- COMPLETE ROUND ________ 0.56 LB
- PROJECTILE ________ 0.22 LB

LENGTH
- COMPLETE ROUND ________ 6.62 IN.
- CARTRIDGE CASE ________ 4.02 IN.
- PROJECTILE ________ 2.98 IN.

DIAMETER, PROJECTILE ________ 0.79 IN.



ELECTRIC PRIMER M52A3B1
(ENLARGED)
(TYPICAL ALL THREE ROUNDS)



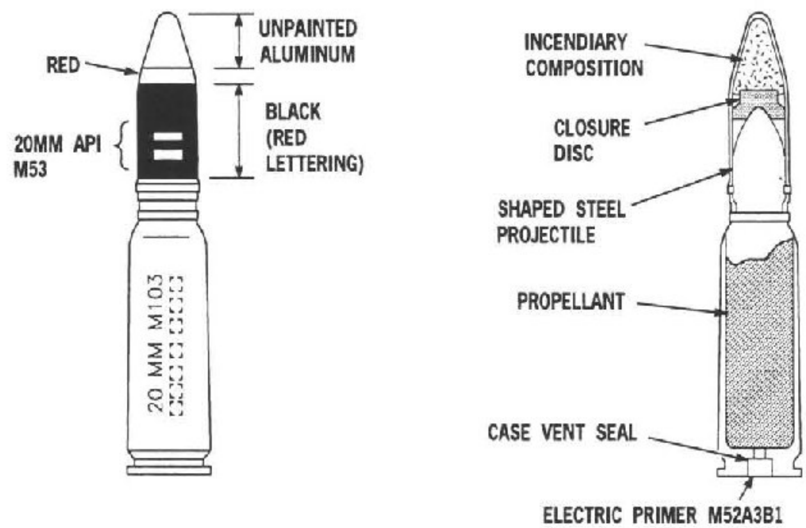
M53 API

CHARACTERISTICS

WEIGHT
- COMPLETE ROUND ________ 0.57 LB
- PROJECTILE ________ 0.22 LB

LENGTH
- COMPLETE ROUND ________ 6.62 IN.
- CARTRIDGE CASE ________ 4.02 IN.
- PROJECTILE ________ 2.98 IN.

DIAMETER, PROJECTILE ________ 0.79 IN.



M56 HEI/XM242 HEI-T (TRACER)

CHARACTERISTICS

WEIGHT
- COMPLETE ROUND ________ 0.56 LB
- PROJECTILE ________ 0.22 LB

LENGTH
- COMPLETE ROUND ________ 6.62 IN.
- CARTRIDGE CASE ________ 4.02 IN.
- PROJECTILE ________ 3.03 IN.

DIAMETER, PROJECTILE ________ 0.79 IN.

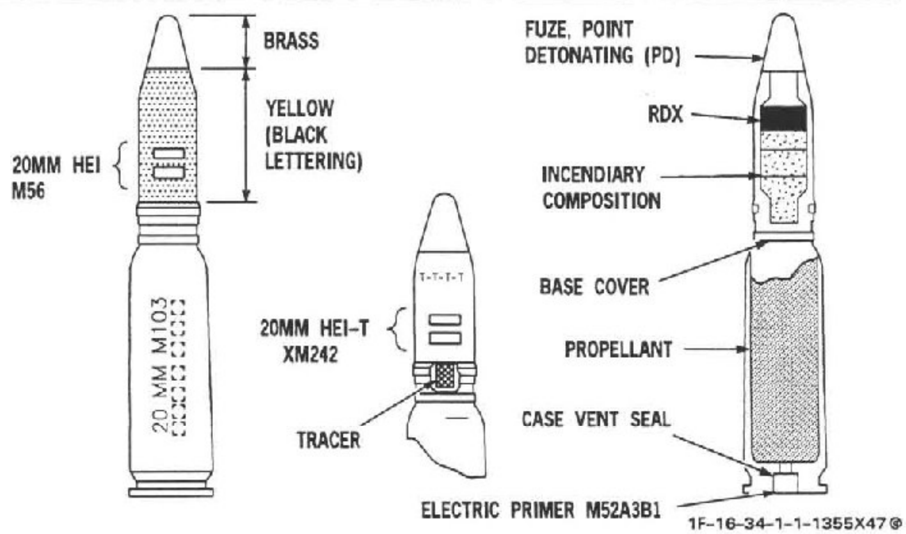


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Figure 1-422. 20mm Ammunition (M50 Series)

M505 PROJECTILE NOSE FUZE

The M505A2 and M505A3 (figure 1-423) fuzes are used in the 20mm M56 HE. The fuze has a point-detonating system that uses delay arming and detonator safety. The mechanical point-detonating feature consists of an aluminum windshield that crushes upon impact, shearing the firing pin flange and driving the pin into the detonator. The delay arming and detonator safety are accomplished by an out-of-line, unbalanced ball rotor. It is insensitive to light brush and rain but will detonate on 0.040-inch 2024 T aluminum. Upon firing, both acceleration and friction forces on the ball rotor and the C-ring prevent any detonator-in-line movement until muzzle exit. When acceleration decreases and projectile spin rate exceeds the required arm rate (49,800 rpm), the locking C-ring opens due to centrifugal force. The detonator cavity in the ball rotor is slightly cone shaped. This eccentrically balanced shape positions the mass of the ball rotor to align the detonator with the firing pin and booster charge. Arming is complete 30 to 65 feet in front of the aircraft.

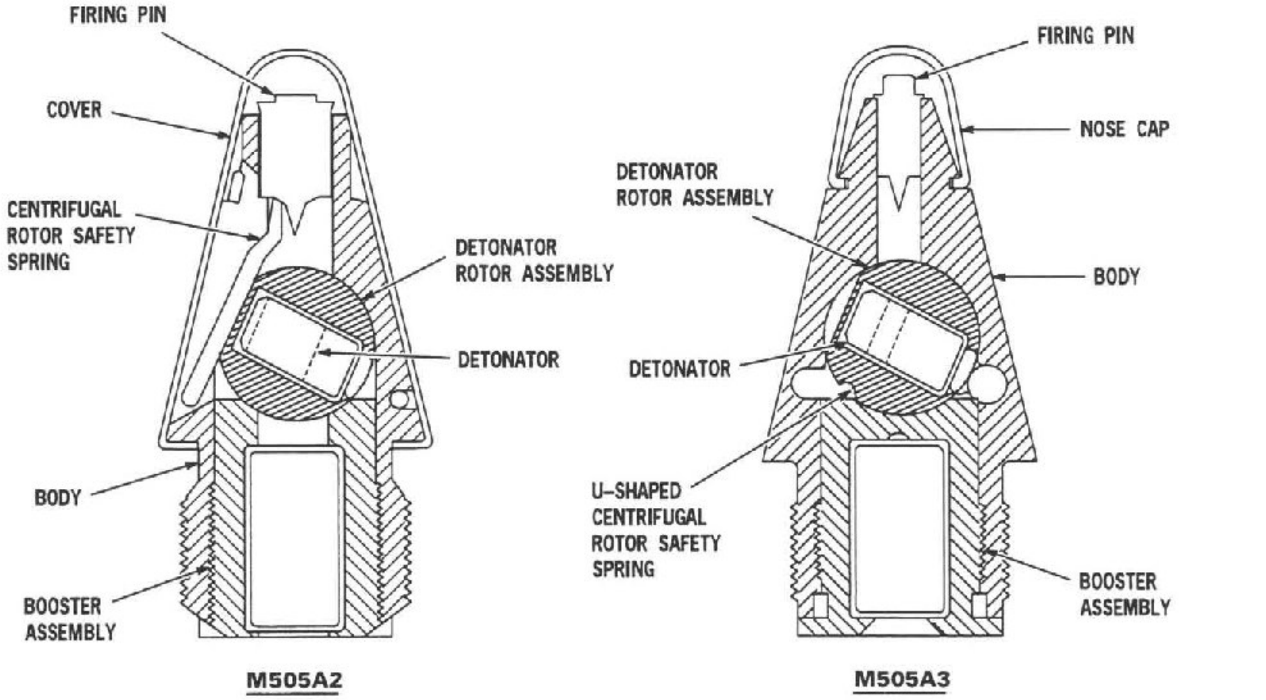


Figure 1-423. M505 Fuzes

PGU-28/B Semi-Armor-Piercing High-Explosive Incendiary (SAPHEI) Cartridge

The PGU-28/B (figure 1-424) projectile is an alternative to the M56 cartridge. The cartridge uses the same case, primer and a modified WC872 ball propellant designated WC867. The total cartridge length is the same as the M56, therefore no gun, ammunition handling or storage equipment interface problems exist.

The body of the PGU-28/B is machined from 15B27 steel bar stock and then hardened to improve performance against lightly armored targets such as APCs and armored helicopters. Two incendiary compounds, a high explosive, a zirconium pellet, a copper rotating band, an aluminum nose and a support disk complete the components used in the projectile. The type I nose incendiary is ignited by the mechanical shock of impact. The nose incendiary reaction ignites the type II body incendiary, which in turn, initiates the composition A-4 RDX high explosive. The burning of the pyrotechnic material produces a delay, allowing the projectile to penetrate the target before detonating. The high explosive reaction splinters the hardened steel body of the projectile and ignites the zirconium pellet providing a long, persistent spark for improved fire start capability. The support disk provides a mechanical support for the nose incendiary against the gravitational forces of acceleration and is instrumental in securing the aluminum nose to the body of the projectile. The sealant between the body and the nose provides the necessary environment protection for the energetic components.

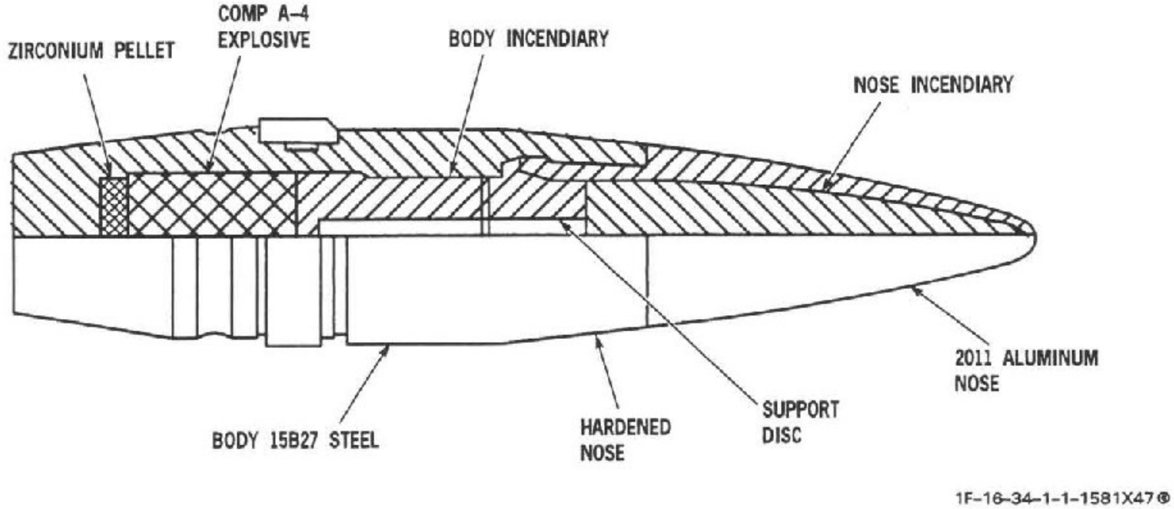


Figure 1-424. PGU-28/B SAPHEI Projectile

AIM-9 MISSILE

The AIM-9 missile (figure 1-428) is a supersonic air-to-air intercept missile. It is a passive missile that guides on infrared (IR) radiation generated by a target. Because no guidance is required after launch,the pilot may take evasive action immediately after the missile is launched. The AIM-9 missile consists of four external sections: guidance and control section (GCS), warhead, fuze, and missile body (rocket motor). The AIM-9 missile interfaces with the aircraft through the umbilical cable. The missile has three basic phases of operation; captive flight, launch, and free flight. Power is supplied from the launcher during captive flight. The power is switched to the missile contained thermal batteries during the launch phase and during free flight.

Missile Types

The AIM-9J/P missiles are designed for tail-aspect employment (the AIM-9P-4/5 have an all-aspect capability). The AIM-9L/M/S missiles are similar in appearance to the AIM-9J/P series missile but are more maneuverable and have an all-aspect capability, a more sensitive IR detector, and coolant gas for the detector. Configuration identification begins with the letter designation of the GCS and is then followed by a dash number. For further information, refer to T.O. GR1F-16CJ-34-1-1-1 (Secret).

Guidance and Control Section

The AIM-9 seeker receives IR energy emitted by a heat source and converts this energy into an electrical signal, which is used to navigate the missile. The IR detector is cooled to improve its sensitivity to IR energy. This cooling is done electrically in AIM-9J/P missiles and with cryogenic gas in AIM-9L/M/S missiles. An electrical signal is generated and sent to the GCS so that proper guidance to the target can be maintained. The GCS provides commands to keep the seeker looking directly at the target and to steer the missile via the fins. Fin movement is accomplished by connected servo pistons, which move up and down within their respective cylinders. The AIM-9 flies a proportional navigation course to the target.

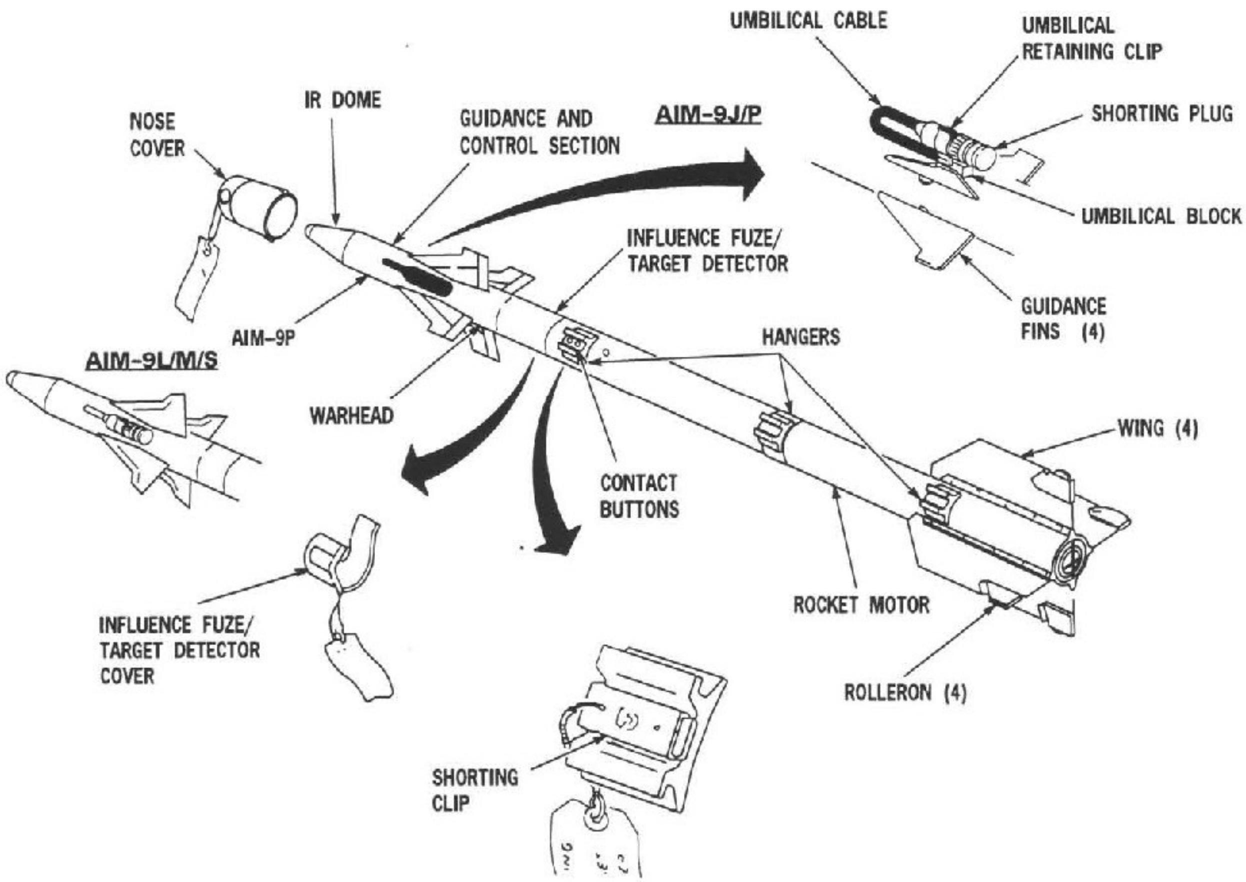
CAUTION

Chipping, cracking, and/or breaking of the infrared dome may occur if the missile is flown through rain or hail.

The AIM-9P4 GCS has significant improvements over earlier models in the seeker, electronics, and servo areas. The seeker optical system has been redesigned to accommodate a longer wavelength detector. A six-stage thermoelectric cooler is utilized to cool the new detector. The change of spectral operating region has resulted in an extended target detection range which improves the forward aspect engagement capability of the AIM-9P4 seeker as compared with previous AIM-9 GCS sections.

The AIM-9P5 GCS is a considerable improvement over existing versions of the AIM-9J/P GCS's. A new detector and multistage thermoelectric cooler provides extended target detection range and increased all aspect acquisition and tracking capabilities. Improvements in the signal processing provide more stable tracking even in the presence of cloud and terrain backgrounds. Additional pilot aids are incorporated to automatically uncage the seeker when the target enters the FOV, provide interface signals to enable display of the seeker pointing position on the aircraft HUD, and slave the seeker to a LOS commanded by the aircraft avionics. Additional electronic improvements have increased the missile kinematic capability, increased maneuverability and improved terminal accuracy, as well as significantly improving GCS reliability.

The AIM-9L/M/S GCS, WGU-4A/B, WGU-4D/B and WGU-4E/B have improved electronics to provide increased sensitivity and improved background rejection. Counter-countermeasures (CCM) is also provided. The GCS consists of three major assemblies; an IR seeker assembly for detecting the target, an electronic assembly for converting the detected target information to tracking and guidance command signals, and a hot gas servo assembly (consisting of a gas generator, manifold, pistons, rocker arms, electrical solenoids, and a thermal battery) where electrical guidance commands are converted to mechanical movement of the control fins. The GCS also contains an inertia switch and capacitor; if the missile strikes the target, the inertia switch actuates and discharges the capacitor which feeds a firing pulse to the safing and arming (S-A) device to initiate warhead detonation. The umbilical cable is part of the GCS but is sheared off at missile launch.



MODEL	MOTOR	FUZE	WEIGHT (POUNDS)	LENGTH (INCHES)	DIAMETER (INCHES)	WINGSPAN (INCHES)
J/P	MK 17	MK 303	165	120	5	22
J/P-1	MK 17	DSU-21/B	165	120	5	22
J/P-2	SR-116-HP-1	MK 303	178	120	5	22
J/P-3	SR-116-HP-1	DSU-21/B	178	120	5	22
P-4	SR-116-HR-1	DSU-21/B	178	120	5	22
P-5	SR-116-HP-1, SR-116-AJ-2	DSU-21/B	178	120	5	22
L	MK 36	DSU-15/B, A/B, B/B	191	113	5	25
M/S	MK-36	DSU-15B, A/B, B/B	190	115	5	25

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Figure 1-428. AIM-9 Missile (Typical)

The GCS WGU-4D/B is a modified version of GCS WGU-4A/B which provides improved guidance during a specific flare threat without degrading the original design. This GCS is identified by the marking 9M-7 painted on the GCS between the fins. The -7 represents a full-up-round tactical configuration.

The GCS WGU-4E/B is a modified version of GCS WGU-4D/B. The WGU-4E/B has expanded infrared countermeasures (IRCM) detection circuitry that improves the missile capability with respect to tactical IRCM deployment. This GCS is identified by the marking 9M-9 painted on the fuselage between the fins. The -9 represents a full-up-round tactical configuration.

Coolant Tank (AIM-9L/M/S)

The coolant pressure tank (figure 1-429), TMU-72/B or TMU-72A/B provides high pressure argon/nitrogen gas to the GCS refrigerated detector unit (RDU) for cooling as long as 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 the target. Either argon or nitrogen may be used as coolant. The coolant pressure tank is capable of storing 4.92 cubic feet (0.4 pound) of argon or nitrogen gas at a maximum pressure of 5000 pounds per square inch. A fully charged coolant tank will provide approximately 9.0 hours of continuous cooling when filled with argon gas and approximately 5.5 hours of continuous cooling when filled with nitrogen gas. Sustained cooling rates of both argon and nitrogen are less per hour than initial cool down rates. Coolant usage varies due to temperature, flight time and type of sortie. The cumulative effect of greater demand for argon during initial cool down and the number of cool down cycles have a large impact on bottle duration.

Influence Fuze (AIM-9P)

The AIM-9P, P2 missiles use an influence fuze to command detonation. The influence fuze is a dual channel passive IR device which senses energy from hot engine metal and is effective for tail aspect intercepts.

NOTE

The influence fuze can produce premature warhead detonation against targets in afterburner.

Fuze arming is delayed until safe separation requirements are met. Once armed, the fuze will function on either a direct hit or a proximity miss. In order for the proximity function to detonate the warhead, the target must fly within the effective radius of the target detector.

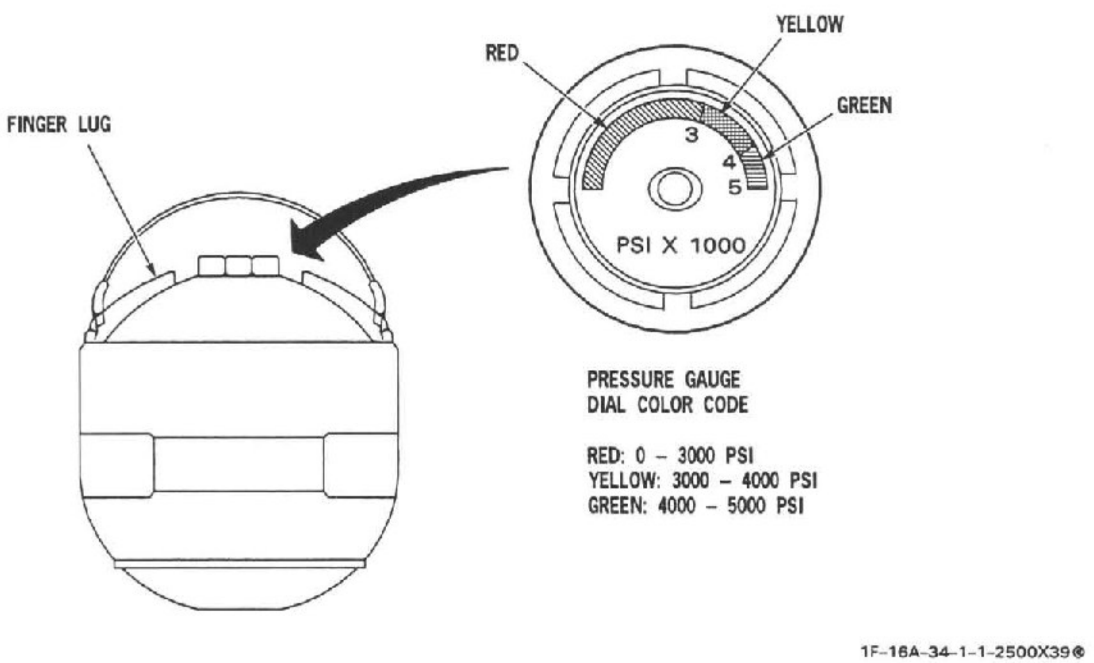


Figure 1-429. Coolant Pressure Tank (Accumulator) TMU-72/B or TMU-72A/B

Target Detector

The AIM-9P1, P3, P4, P5 missiles use an optical target detector to command detonation. The active optical target detector utilizes laser transmitters and silicon photo/diode receivers to detect a target in any aspect of intercept.

The AIM-9L/M/S missile uses the interchangeable DSU-15/B, DSU-15A/B or DSU-15B/B target detectors (TD) to command detonation. The major components of the narrow-beam, active optical system are the transmitter, receiver, signal processing logic, dc-to-dc converter, and a thermal battery. The four TD transmitters and four receivers are arranged in quadrants around the missile axis. Each transmitter and receiver pair make one quadrant. This arrangement provides 360-degree coverage around the missile axis. The transmitter and receiver assemblies are optically aligned and bonded into individual cavities in the electronics housing. The TD transmits pulsed IR energy through all four forward windows and the reflected IR energy is received by an IR detector through the four aft windows. When the reflected IR energy reaches a threshold level, the TD generates a firing pulse which is fed to the S-A device which, if armed, initiates warhead detonation. Variable threshold level and pulse logic techniques are used to prevent false firing due to the sun, clouds, or countermeasures.

Fuze arming is delayed until safe separation requirements are met. Once armed, the fuzes will function on either a direct hit or a proximity miss. In order for the proximity function to detonate the warhead, the target must fly within the effective radius of the target detector.

Safety-Arming Device

The safety-arming (S-A) device is an electro-mechanical device that causes initiation of the warhead. At launch, the S-A device launch-latch is electrically unlocked. Missile acceleration of at least 6g 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 influence fuze or TD initiates the S-A device explosive train; warhead booster ignition and warhead detonation follows.

Warhead

The WDU-17/B warhead is an annular blast fragmentation (ABF) warhead consisting of a case assembly, two booster plates, transfer tube assembly, high explosive, and fragmentation rods. The warhead weighs 20.8 pounds total including 7.0 pounds of PBXN-3 explosive, is 13.5 inches long, and 5.0 inches in diameter and is used on the AIM-9J/P missile. The S-A device explosive output is transferred through the the transfer tube assembly to the booster plates. The initiation is then transferred through the explosive-loaded channels of the booster plates to the booster pellets at each end of the warhead. Detonation of the booster pellets sets off the high explosive (PBXN-3) causing warhead detonation.

The AIM-9L/M/S warhead consists of a metal casing and a cellulose liner. The case itself provides the fragments, and the liner controls the breakup of the case to provide a more uniform size. The warheads yield a more concentrated and higher velocity fragment pattern than those used on earlier missiles.

Missile Body (Rocket Motor)

The aft section of the missile houses the rocket motor. There are two solid-propellant (MK 17 and SR-116-HP-1), all-boost rocket motors now used on the AIM-9J/P's. Three suspension hangers on the missile body enable loading on aircraft launcher rails. Four wing/rolleron panels are attached to the aft end of the missile body in a cruciform design. The wings provide airframe stabilization during flight. During captive flight, the rolleron assembly is held fixed to the wing. At launch, the rolleron assemblies are free to swivel back and forth. They act to gyroscopically provide roll stabilization to the missile. The four rollerons operating together keep inflight missile roll to less than one complete roll per 6 seconds.

The MK-36 rocket motor is used on AIM-9L/M/S missiles. The rocket motor is 70 inches long, weighs 99 pounds without wings, 123 pounds with wings, and has a propellant weight of 60 pounds. The rocket motor electrically and mechanically interfaces with the launcher. The mechanical interface is by means of a forward, center, and aft hanger. When the missile is loaded on the launcher, two striker points within the launcher are in contact with the two contact buttons on the forward hanger. When the firing circuit is activated, the firing voltage is sent through the aft contact button and fires the initiator on the S-A assembly. The initiator ignites the rocket motor propellant grain, thrust is developed, and the missile is launched.

MK36 MOD 7 (AIM-9L/M/S)

The Mod 7 rocket motor is a solid propellant, high thrust motor that comprises the aft end of the missile. The propellant is cast into the tube and case bonded to the tube wall. The propellant igniter train consists of a main charge, booster charge, and a MK 5 squib. The igniter is held in place by a nonpropulsive head closure that blows out upon accidental ignition, making the rocket motor nonpropulsive if the warhead is not attached. The Mod 7 motor also includes a radio interference filter on the front of the motor. The filter prevents stray rf energy from actuating the rocket motor igniter.

MK36 MOD 10 (AIM-9L/M/S)

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 rocket motor features a nonremovable safe-arm selector handle used to mechanically arm or safe the rocket motor on the ground.

MK36 MOD 11 (AIM-9L/M/S)

The Mod 11 rocket motor is a reduced smoke motor that is outwardly similar to the Mod 10. the primary difference between the motors is the type of propellant used. The propellant used is an organic hydroxyl-terminated polybutadiene (HTPB) for reducing smoke and abrasive properties of the exhaust plume. The rocket motor also incorporates an igniter with a charge that produces less smoke.

Wings

Four identical wings provide aerodynamic lift and stability during flight. The wings are attached to wing ribs located at the aft end of the rocket motor. Each wing has a rolleron assembly that provides pitch, yaw, and roll stabilization during free flight. The wing rolleron wheel is designed so the passing airstream causes it to spin at a very high speed, thus acting as a gyroscope to help stabilize the missile during flight. The entire rolleron assembly is held in line with the longitudinal axis of the missile during captive flight by a caging device. When the missile is fired, the rolleron is uncaged by acceleration and is free to move about the longitudinal axis throughout flight. An oil-filled damper at the forward end of the rolleron assembly is provided to smooth rolleron operation and prevent flutter.

Fins

Four identical fins, located on the GCS, provide a lift force on the missile body based on the seeker input signal from the seeker, missile velocity, and altitude. The fins are electrically controlled and pneumatically operated by a servo system located in the aft part of the GCS.

AIM-120B MISSILE

The AIM-120B (figure 1-430) is an all weather, beyond-visual-range, radar-guided, air-to-air missile with launch and leave capability. The missile guidance system has software reprogram capabilities and incorporates four guidance modes:

An active radar with home-on jam during any phase of flight.

Command update at long range plus active terminal.

Inertial plus active terminal if command update is not available.

Active terminal with no reliance on aircraft fire control systems at ranges within seeker acquisition range.

It is propelled by a solid fuel, reduced smoke rocket motor.

AIR-TO-GROUND MISSILES

AGM-65 MISSILE

The AGM-65 is a rocket-propelled air-to-ground missile. It is capable of launch-and-leave operations, relying on automatic self-guidance. Various modes of guidance are used in the AGM-65 series. There are four models: the electro-optical (EO) AGM-65A and B and the infrared (IR) AGM-65D and G. The aft sections, containing the thermal battery, rocket motor, warhead, and control-surface actuation system, are nearly identical in the AGM-65A, B, and D but different in the G. The AGM-65A, B, and D models use a shaped-charge warhead optimized for use against armored vehicles, bunkers, boats, radar vans, and small hard targets. The AGM-65G uses a larger kinetic energy penetrator and blast-fragment warhead that is effective against both unusually shaped targets such as hangars, bridges, and ships and against small point targets such as tanks and bunkers. The missile guidance sections have only minor differences within the EO models (AGM-65A and B) and within the IR models (AGM-65D and G) but have major differences between the EO and IR models. The training guided missile (TGM) is used to train aircrews in AGM-65 employment. The AGM-65A, B, and D models are carried on and launched from LAU-88A/A or LAU-117/A launchers. The AGM-65G is carried on and launched only from the LAU-117 due to missile weight constraints.

AGM-65A AND AGM-65B (EO) MISSILES

The AGM-65A and AGM-65B are TV-guided models. Both models contain a shaped-charge warhead and an EO, centroid-type tracker. Targets must be visually acquired and missile video acquisition must be accomplished prior to launch. Both models are guided autonomously, providing a launch-and-leave capability. The AGM-65B has an improved guidance unit and a magnified target image that allow target video acquisition and launch at greater standoff ranges; other portions of the B-model missile are the same as the AGM-65A. A typical AGM-65, associated launchers, and characteristics are shown in figure 1-456. The missile consists of two major sections: (1) a forward section containing the target seeker and missile guidance electronics and (2) an aft section containing the warhead, rocket motor, and flight control unit.

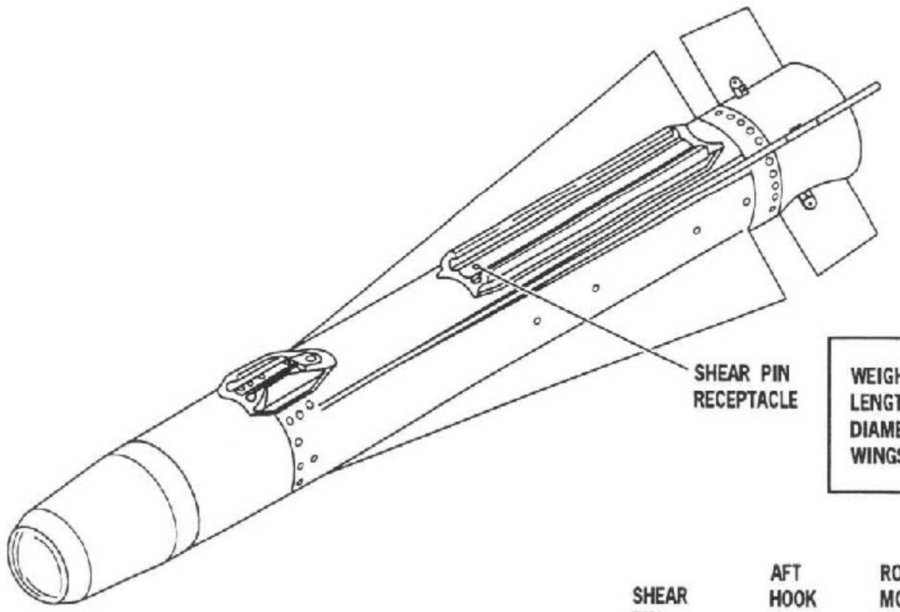
Forward Section

The nose of the missile has a clear, dome-shaped, glass window that is protected by a slightly opaque frangible glass dome cover. The dome cover is shattered as the missile is selected for launch. Immediately behind the window is a seeker unit composed of a vidicon (TV camera) surrounded by a ring-shaped gyro mounted on a two-axis gimbal structure. Figure 1-456 shows the camera gimbal limit, launch limit, and FOV of both the AGM-65A and AGM-65B. The seeker is positioned by pushrods connected from the gyro to two electrical torquer motors. Specific cockpit switch procedures can place the seeker/guidance unit in four modes: ready, align, slew, and track. In the ready mode, electrical power is supplied to spin the gyro and braking mechanisms on the torquer motors holding the seeker in a fixed position. When the missile is in the align mode, the brakes are relaxed and the seeker is held at the boresight position by electrical power applied to the torquer motors. In the slew mode, the seeker is positioned by left/right and up/down commands given to the two torquer motors from manual cockpit controls. When in the track mode, the torquer motors respond to commands from the target tracking portion of the guidance unit. The guidance unit electronics contain the circuits necessary to operate the seeker unit, track the target, and generate missile steering commands.

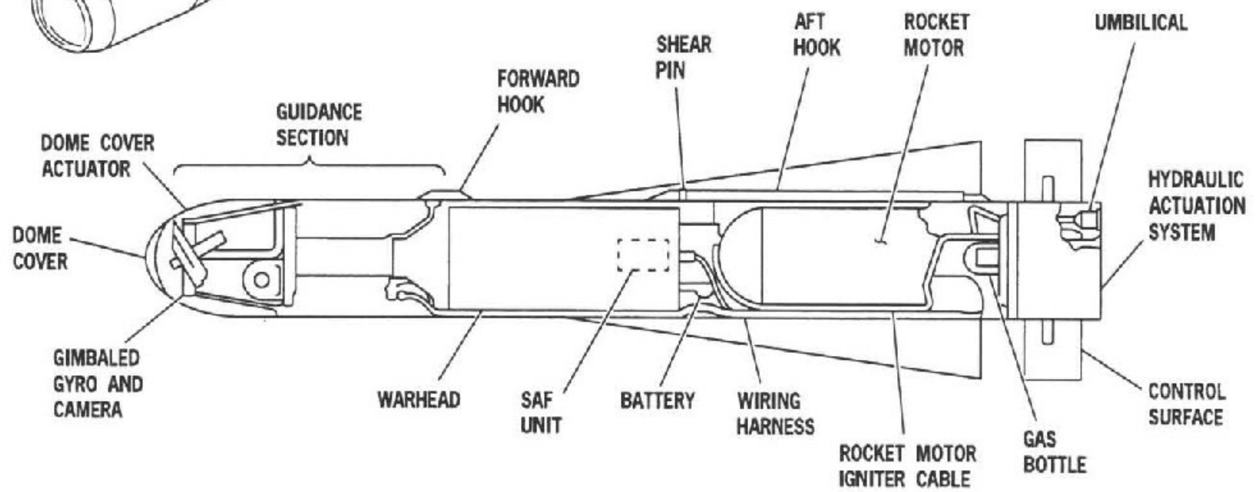
CAUTION

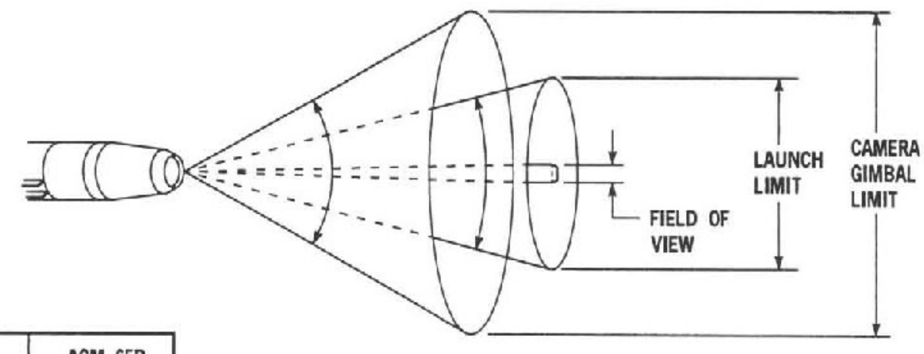
To prevent vidicon sunburns, do not point the AGM-65A or AGM-65B missile seeker head toward the sun while operating in the track mode.

The seeker optics and vidicon assembly are protected by an automatically operated sun shutter that closes when frontal light reaches harmful intensity. The shutter will remain closed until the seeker is directed away from the intense light source. During the tracking phase of missile operation, the sun shutter circuitry is deactivated and the shutter will remain open.



WEIGHT .... 464 POUNDS
LENGTH .... 8 FEET 2 INCHES
DIAMETER .... 12 INCHES
WINGSPAN .... 28 INCHES





PARAMETER	AGM–65A (DEG)	AGM–65B (DEG)
FIELD OF VIEW	5	2.5
LAUNCH LIMIT	30	20
SEEKER GIMBAL LIMIT	60	50

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Figure 1-456. AGM-65A and AGM-65B Missiles

Aft Section

Located behind the missile guidance unit is a 125-pound, conical, shaped-charge warhead designed to penetrate heavy armor or reinforced structures. Housed in the aft core of the warhead is a safe, arming, and fuzing (SAF) unit. As a missile encounters a designed acceleration/time envelope during launch, the SAF arms the warhead. Warhead detonation is initiated by a contact trigger in the nose of the missile or by a mechanical backup detonator in the SAF that functions when the missile encounters a longitudinal deceleration of at least 75g.

The missile is propelled by a 104-pound solid-propellant rocket motor. The boost-sustain-type motor consists of a case, liner, and blast tube. The boost phase produces approximately 10,000 pounds thrust and lasts approximately 0.5 second; the sustain phase produces approximately 2000 pounds thrust for approximately 3.5 seconds. After rocket motor burnout, the remainder of the missile flight is unpowered. Rocket motor ignition is accomplished through an igniter cable on the aft end of the missile. Before takeoff, the ground crew attaches the igniter cable to the receptacle on the launcher.

The missile uses aircraft electrical power until the missile has started to launch. When the launch command is received, the missile thermal battery is activated and reaches rated voltage in approximately 0.5 second. As the missile begins to travel forward along the launcher rail, the umbilical plug in the aft end of the missile separates from the launcher-mounted receptacle. At this point, the missile battery assumes the electrical load of the missile. The battery will continue to supply adequate power for a minimum of 105 seconds.

CAUTION

> Should too short a launch signal be provided, commonly referred to as a quick or short pickle, the battery may be activated and the rocket motor may fail to fire. In this case, the thermal battery will rapidly overheat internally and may fail to provide adequate voltage for successful guidance. A second launch of the missile should be attempted only if it can be done immediately on the same attack and safe launch parameters can be achieved.

The aft portion of the missile also contains the hydraulic actuation system (HAS), the flight control servomechanism that processes the steering signals from the autopilot into aerodynamic control of the missile. The HAS derives its mechanical power from a bottle of helium gas that provides pressure as the umbilical plug separates during launch. The gas pressure drives a hydraulic pump that feeds hydraulic fluid to actuating cylinders for the control surfaces. Flow of the hydraulic fluid is controlled by valves that respond proportionally to the signals from the guidance unit. Thus, control surface deflections are proportional to the amount of flightpath correction required.

Video Display

The AGM-65A seeker 5-degree FOV is presented on the cockpit video display as shown in figure 1-457. A set of crosshairs that span the entire display is also presented. The intersection of the crosshairs is open to represent the tracking gate,which has a minimum size of 1.8 mils (milliradians) high by 1.4 mils wide. The crosshair gap expands to accommodate the target size. A solid lock-on is achieved when the crosshairs become steady and centered on the target. Even with steady crosshairs, the smallest target dimension must fill at least one-half of the crosshair gap before attempting launch. Before missile launch, the seeker must be pointing within 15 degrees of the missile centerline in order to maintain successful track during transient forces encountered during launch.

The seeker of the AGM-65B has a 2.5-degree FOV and a 0.9-mil-high by 0.7-mil-wide tracking gate. A larger vidicon lens is used to double the size of the apparent target. The cockpit video display also presents a magnified image, and the symbology for the tracking gate is a rectangular arrangement of four small squares (background gates). A small crosshair, called a pointing cross, shows seeker position relative to the missile centerline. Before missile launch, the seeker must be aimed within 10 degrees of the missile centerline in order to maintain successful track during transient launch forces. The pointing cross flashes on and off to indicate when the 10-degree launch angle limit is exceeded. In addition, the pointing cross also flashes when the target size is too small to insure that lock-on will be maintained during launch.

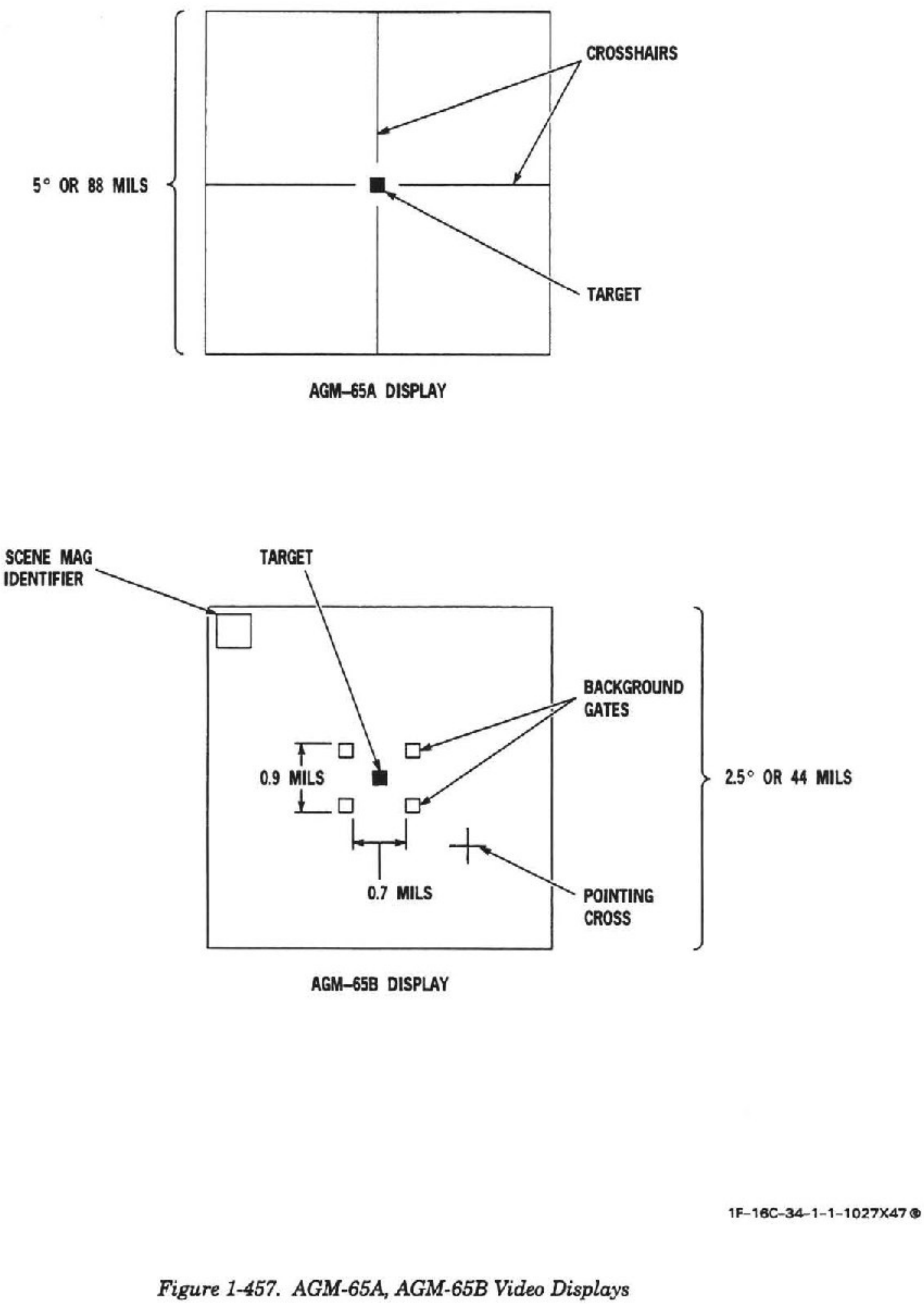


Figure 1-457. AGM-65A, AGM-65B Video Displays

NOTE

Target size is computed by the missile on the basis of area. In some cases, the target may present sufficient area to cause a steady pointing cross, yet have an apparent dimension that is too small to insure that lock-on is maintained. Before AGM-65B launch, the smallest target dimension must fill at least one-half of the gap between the four background gates.

Guidance

Light from the target scene enters through a window in the nose of the missile and is converted to an electrical charge pattern on a plate in the vidicon tube. The charge pattern varies in intensity corresponding to variations in brightness in the target scene. Electrical signals representing the target scene, along with electronically generated reference symbols, are sent to the cockpit display. The target scene signals are also sampled to determine brightness at particular points. Points inside the target area (defined by the opening at the intersection of crosshairs for the AGM-65A or the area bounded by the four background gates for the AGM-65B) are compared with points just outside the target area (background). In the automatic contrast mode, the guidance unit selects the contrast logic, light target on dark background or dark target on light background, based on the target-area/background-area relationship as referenced to an average brightness between the two areas. The average brightness level is established as the threshold between target and background at the time of the target lock-on.

NOTE

Due to the longer time required to obtain a lock-on, use of the automatic contrast mode is not recommended when target contrast can be visually determined.

Choice of target area as an area lighter or darker than the background normally is controlled by the setting of the contrast polarity switch in the cockpit. If white-on-black (W/B) contrast is selected, the target area is defined as an area lighter than the background. In this mode, the missile will not lock onto a dark target. The opposite is true if black-on-white (B/W) contrast is selected.

After lock-on, the target area and the background area are continually sampled to determine if the target is still in the center of the scene. If the target moves or if the missile LOS begins to drift off target, the seeker is slewed to realign it with the center of the target area. The resulting misalignment between the seeker and the missile line of flight is detected by the guidance unit, which sends correction signals to steer the missile back into alignment with the seeker.

After launch, the missile flies a humped course that is designed to allow the missile to achieve long range and maintain a higher terminal velocity. The missile function that produces this upward steering course is called g-bias. The effects of g-bias on missile flightpath are illustrated in figure 1-458. At lock-on, the missile determines the upward direction in relation to the wings of the aircraft, not the horizon. While a wings-level attitude is most desirable at lock-on, aircraft bank should not exceed 30 degrees at launch or vary more than 30 degrees from lock-on to launch; otherwise, g-bias programming will be less than optimum. The g-bias of the AGM-65A programs a nominal 3.5g pull in the upward direction until the missile detects a 20-degree angle between vidicon and missile axis. The AGM-65B has a nominal 4.5g pull until it reaches a 16-degree angle between vidicon and missile axis.

As the missile flies toward the target, the target grows in apparent size. This change is detected by the missile guidance unit, which continually redefines the target boundaries to adapt to the increasing target area. When the target fills 70 percent of the FOV, the AGM-65A and the AGM-65B guidance units stop increasing the defined target area and correction signals are held at a constant rate for the remainder of the flight. This is known as last rate memory and occurs during the last 0.25 to 0.50 second of flight for most armor-sized targets.

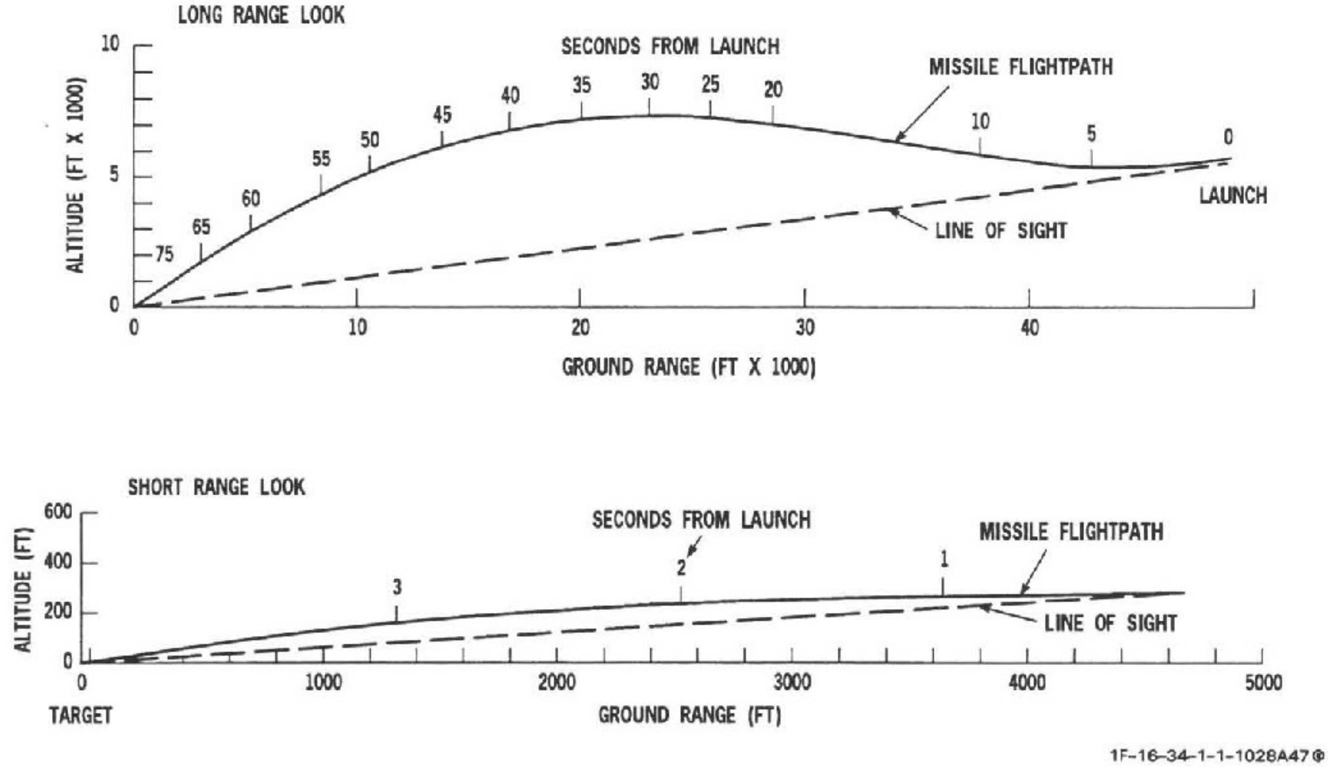


Figure 1-458. Effect of G-Bias on Missile Flightpath

WARNING

All AGM-65 (A or B) missiles shall have TCTO 511 complied with prior to firing. This TCTO requires the contact trigger in the missile to be disconnected. If it is not, there is a good chance the guidance control unit will malfunction and the missile will guide erroneously.

Minimum Launch Envelope (AGM-65)

In figure 1-459 (AGM-65A, B, and D), the envelopes for launch airspeeds of 300, 400, 500, and 600 KTAS provide boundaries that indicate the minimum ranges for missile launch. These boundaries will provide adequate time for system arming, safe escape, and ground clearance during recovery for a 4g pullout maneuver. Data are provided for launch dive angles of 10 to 60 degrees. The safe escape and ground clearance boundary lines assume a 4g pullup maneuver with a 4g acceleration attained 2.0 seconds after launch. For this type escape maneuver, the probability that the aircraft will encounter a fragment from its own missile detonation is less than 1 in 1000.

WARNING

Safe escape data are provided for AGM-65 fragmentation envelope only. Safe escape from secondary explosions of target munitions/stores is not considered.

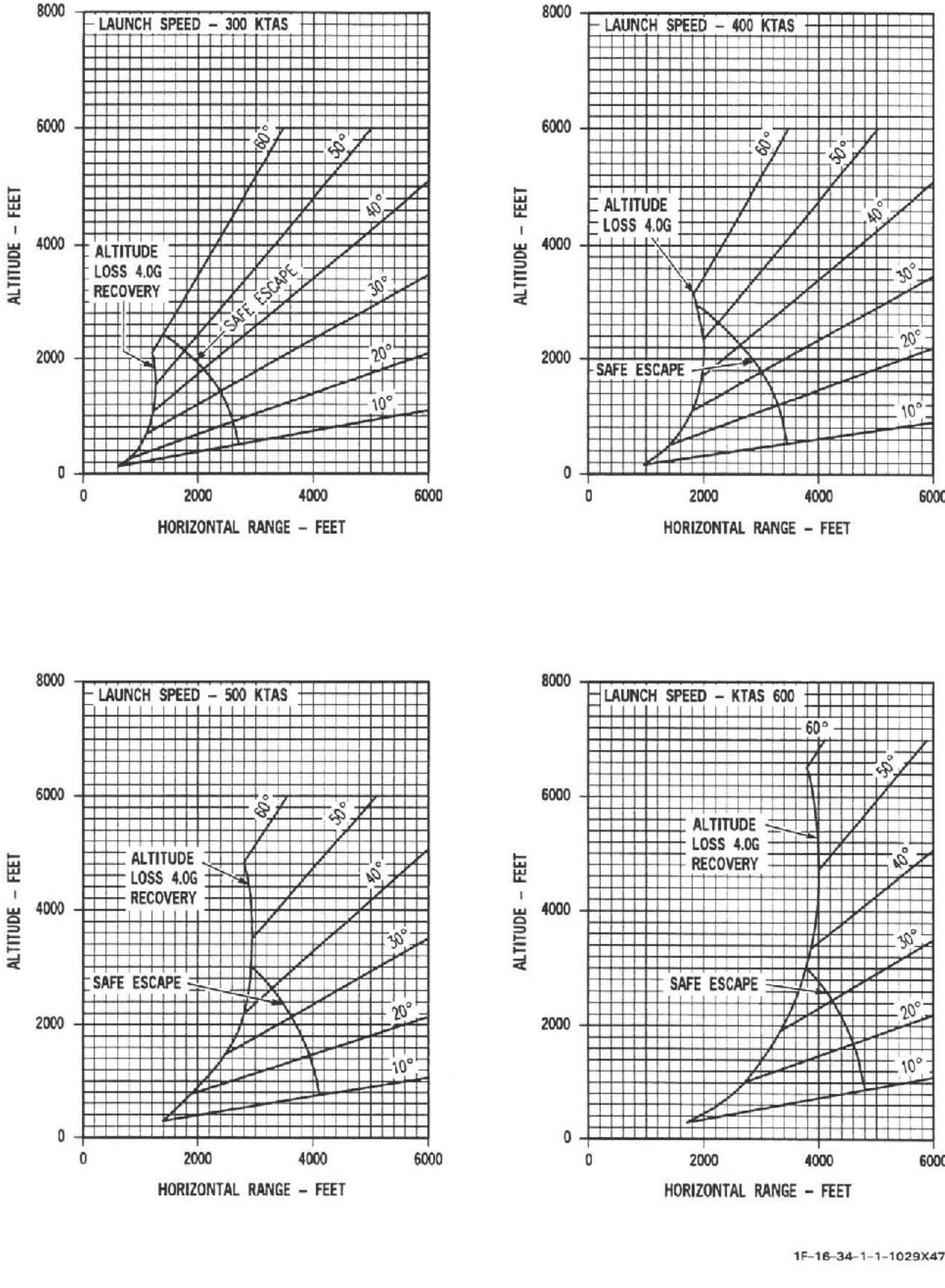


Figure 1-459. AGM-65A, B, and D Minimum Launch Envelope

Launch Envelopes (AGM-65A and AGM-65B)

Figure 1-460 shows missile launch limits in horizontal range versus launch altitude for three launch Mach numbers. The minimum launch range for any altitude determines the left boundary of the envelope; the maximum aerodynamic launch range and TOF determine the right boundaries. The maximum launch altitude is 33,000 feet. The minimum launch altitude is determined by line-of-sight (LOS) requirements.

For armor-sized targets, the AGM-65A and AGM-65B missile maximum launch range is a function of target size. For the AGM-65A, the displayed target image must be 1 mil in height and width to allow the missile tracking circuits to maintain target lock-on during launch transients. Therefore, for a target that has a 7-foot minimum dimension, the maximum launch range is 7000 feet for the AGM-65A missile. The AGM-65B missile incorporates a two-power magnification that allows launches against a displayed target image that is 0.5 mil high by 0.5 mil wide. The same 7-foot target can be attacked from a 14,000-foot slant range. Larger targets, such as buildings or ships, may be attacked out to the aerodynamic/battery limits as indicated in figure 1-460.

Climb After Launch (AGM-65A, AGM-65B, and AGM-65D)

After missile launch, the missile enters a climb. The missile climb angle above the launch angle varies with the launch parameters. A positive g-bias in the missile autopilot assures adequate altitude to reach the target from longer ranges and low dive angles. Missile lock-on is broken if the missile climbs into a cloud. Figures 1-461 through 1-463 are used to determine missile climb above missile launch point for a given horizontal launch range from target and launch altitude AGL.

AGM-65D AND AGM-65G (IR) MISSILES

The AGM-65D and AGM-65G missiles (figure 1-464) are separated into forward and aft sections. The aft section, containing the missile wings, warhead, rocket motor, and control-surface actuation system, is similar to the AGM-65A and B. An exception is that the AGM-65G uses a heavy-penetration warhead. The forward section is significantly different from EO models. The guidance unit uses an IR seeker that converts IR energy into electrical signals. The signals are then converted by a digital computer into a TV video image from which the aircrew is able to identify and lock onto objects within the seeker FOV. The AGM-65D utilizes a centroid mode of targeting similar to the AGM-65A and B. In addition to the centroid mode, the AGM-65G can also operate in a force correlate mode of operation for aimpoint selection of large targets or a ship-track mode optimized for ship targets. The digital computer also allows the missile to make logical decisions prior to, during, and after launch, decreasing aircrew workload and enhancing missile performance. A dual-FOV capability was added to provide selection of wide FOV (WFOV) for target acquisition and narrow (NFOV) for improved target identification and increased launch range. The IR seeker expands the missile launch environment to include night and degraded visual conditions.

Launch Range Determination (AGM-65D and AGM-65G)

The TV model is often limited in maximum launch slant range by target apparent size. The AGM-65D has the capability to lock onto and track tactical-size targets (tanks, BMP's, radar vans, etc.) at a slant range that exceeds the aerodynamic capability of the missile. The AGM-65G is primarily intended for use against larger targets, requiring considerable warhead penetration prior to detonation. However, the AGM-65G retains the small point-target capability of the AGM-65D. The good-lock algorithm does not consider target slant range as a parameter; therefore, the aircrew must insure the launch slant range falls within the aerodynamic range of the missile (AGM-65D launch range limits are shown in figure 1-465. AGM-65G launch range limits are shown in figure 1-466). The AGM-65G maximum launch range is about 3 to 5 percent shorter than that of the AGM-65D. This reduction in range is due primarily to the increased weight of the warhead.

Forward Section

The forward section is a hermetically sealed guidance unit consisting of an IR dome, IR seeker, electrical contact trigger, autopilot, and electronic assemblies including the digital computer. The dome cover will attenuate and distort IR energy and should be jettisoned prior to boresight or employment.

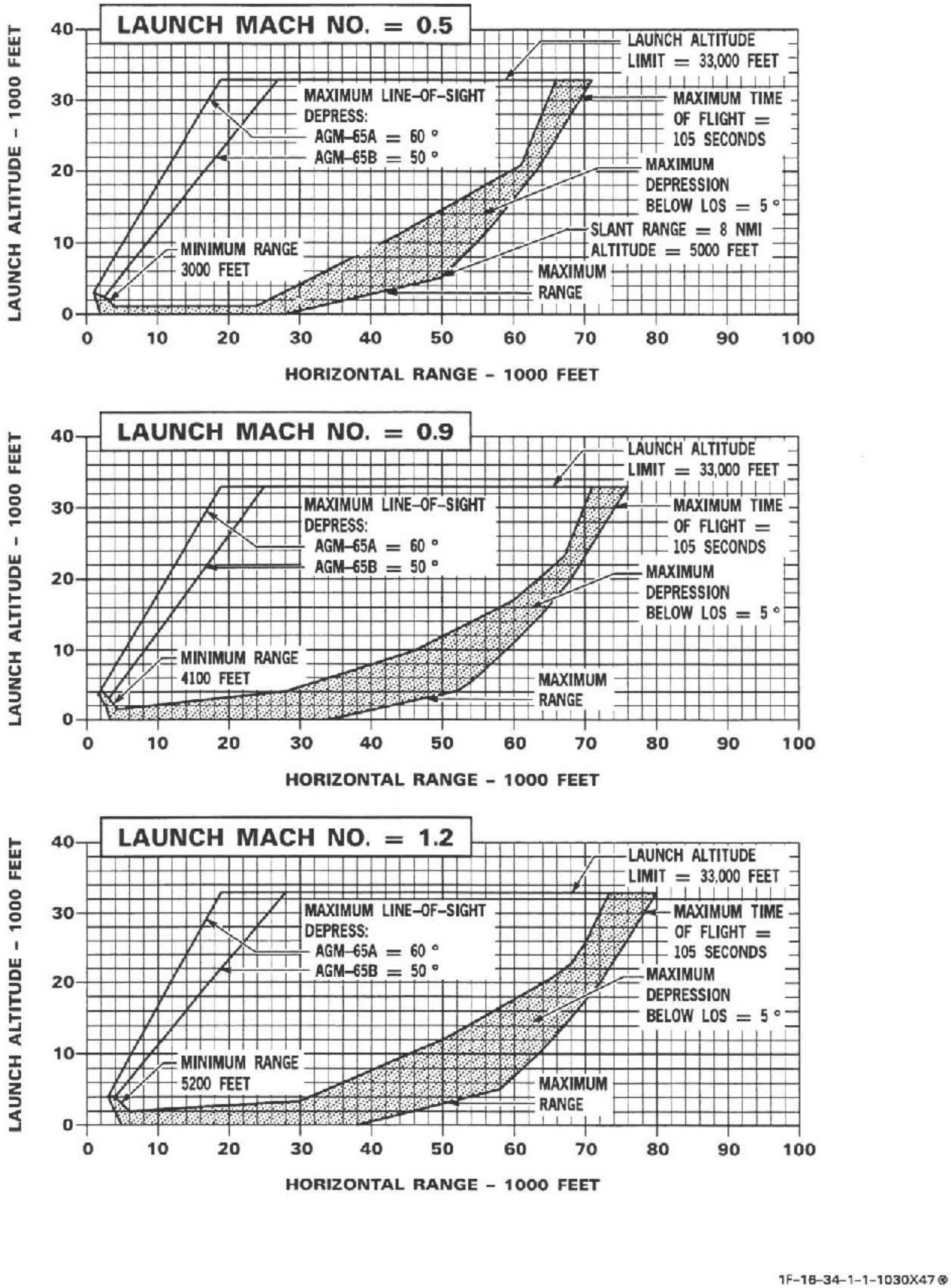
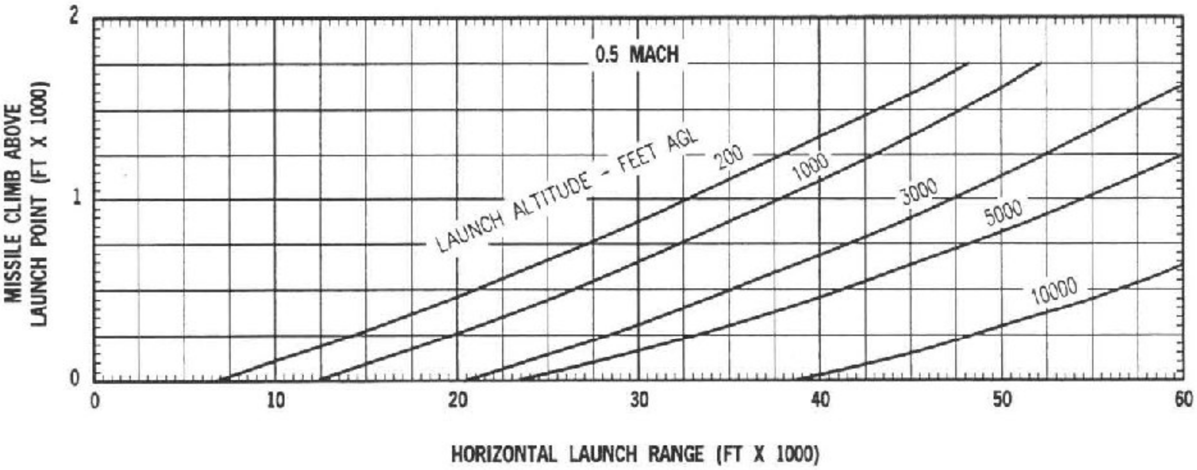


Figure 1-460. AGM-65A and AGM-65B Launch Envelopes



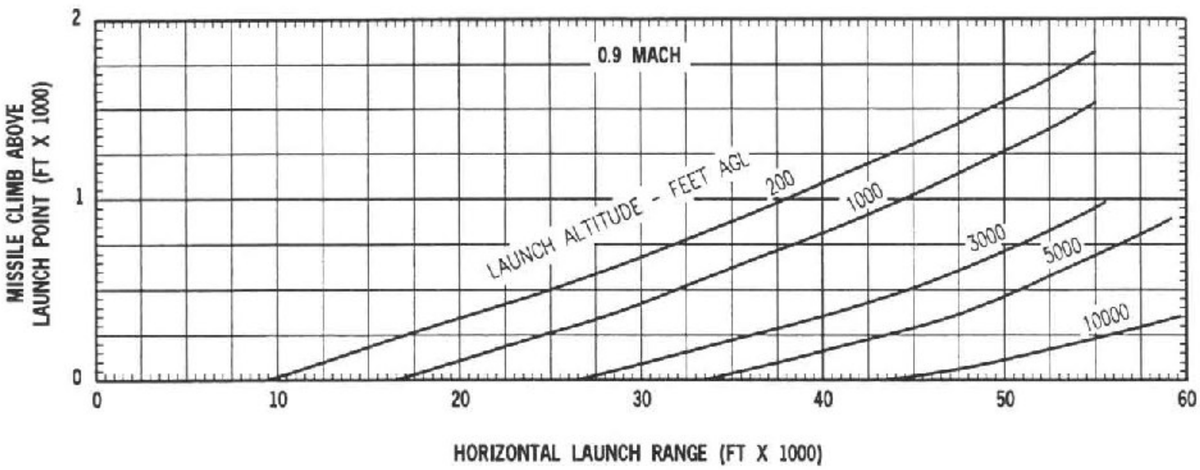


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Figure 1-461. AGM-65A Missile Climb After Launch

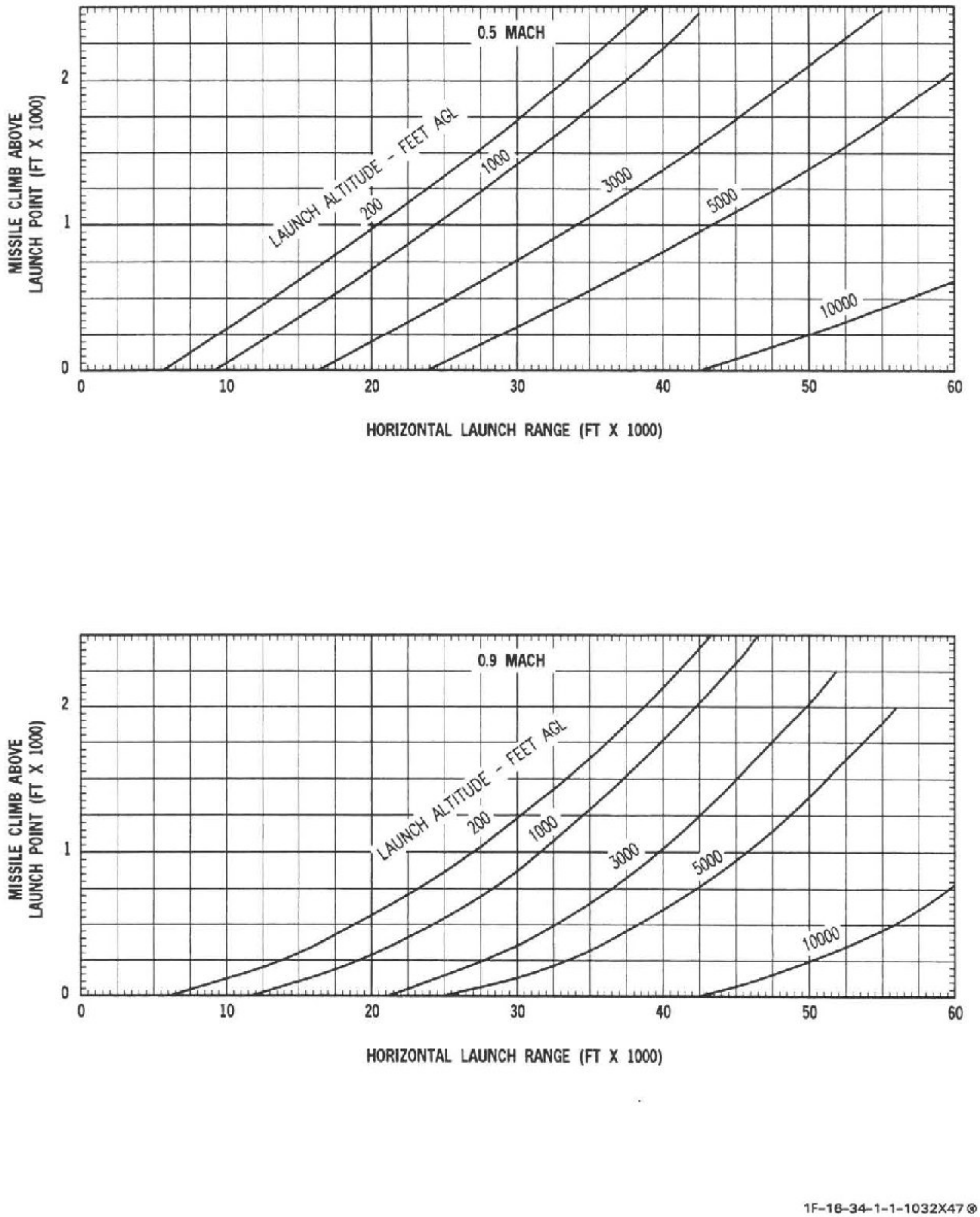

Figure 1-462. AGM-65B Missile Climb After Launch

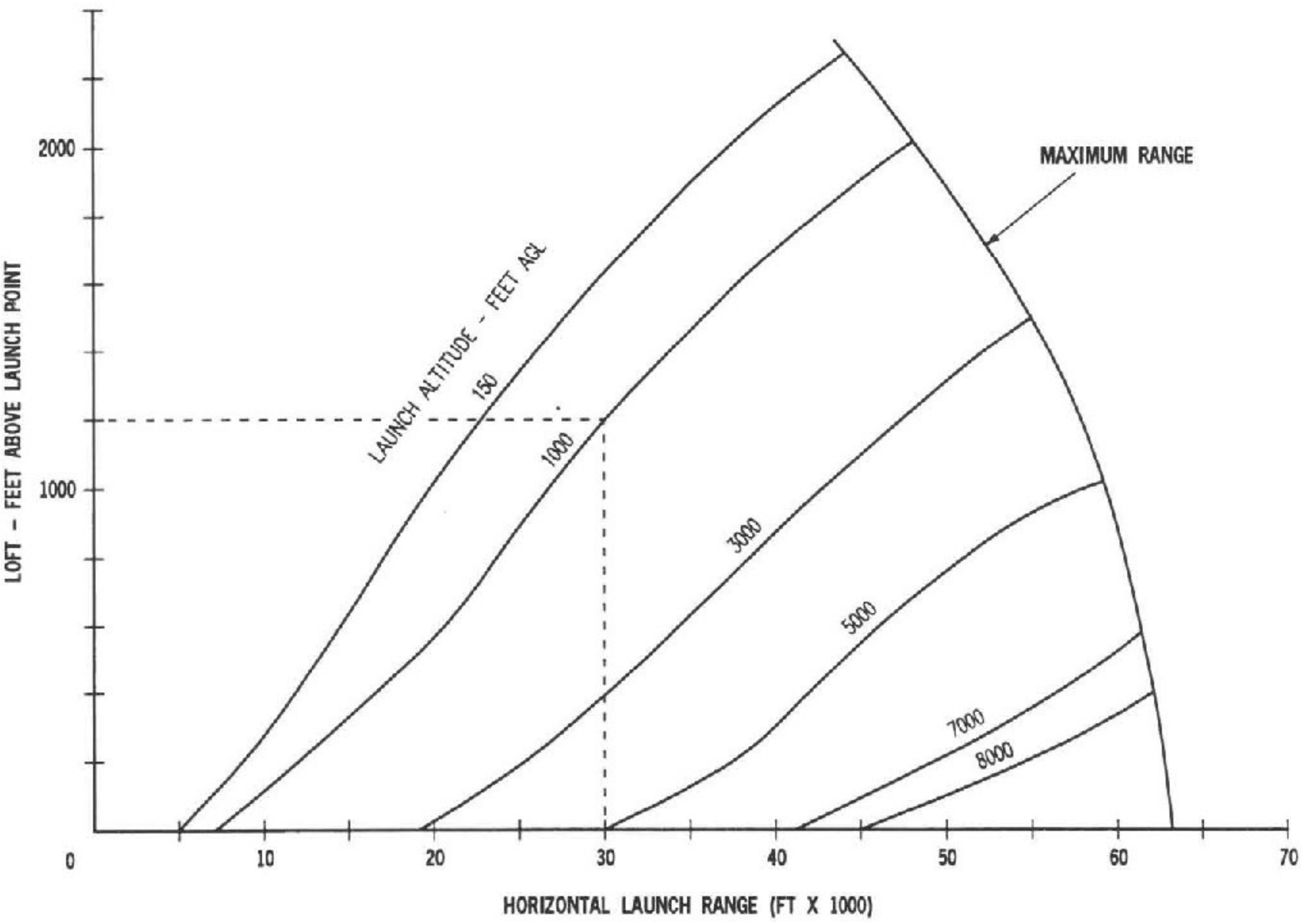

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Figure 1-463. AGM-65D Missile Climb After Launch

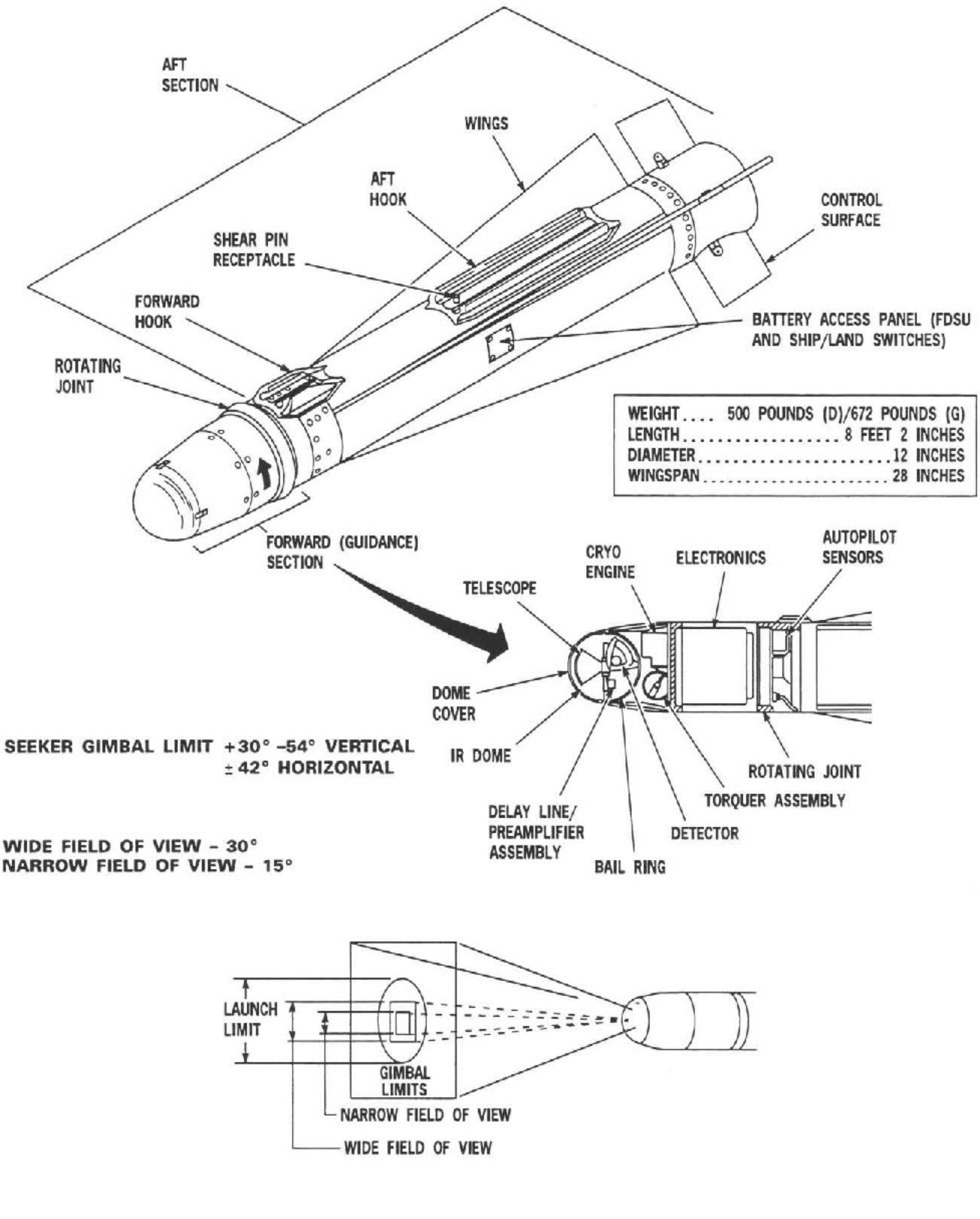

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Figure 1-464. AGM-65D and AGM-65G (IR) Missile

10 DEGREE POLAR OFFSET PERFORMANCE ENVELOPES

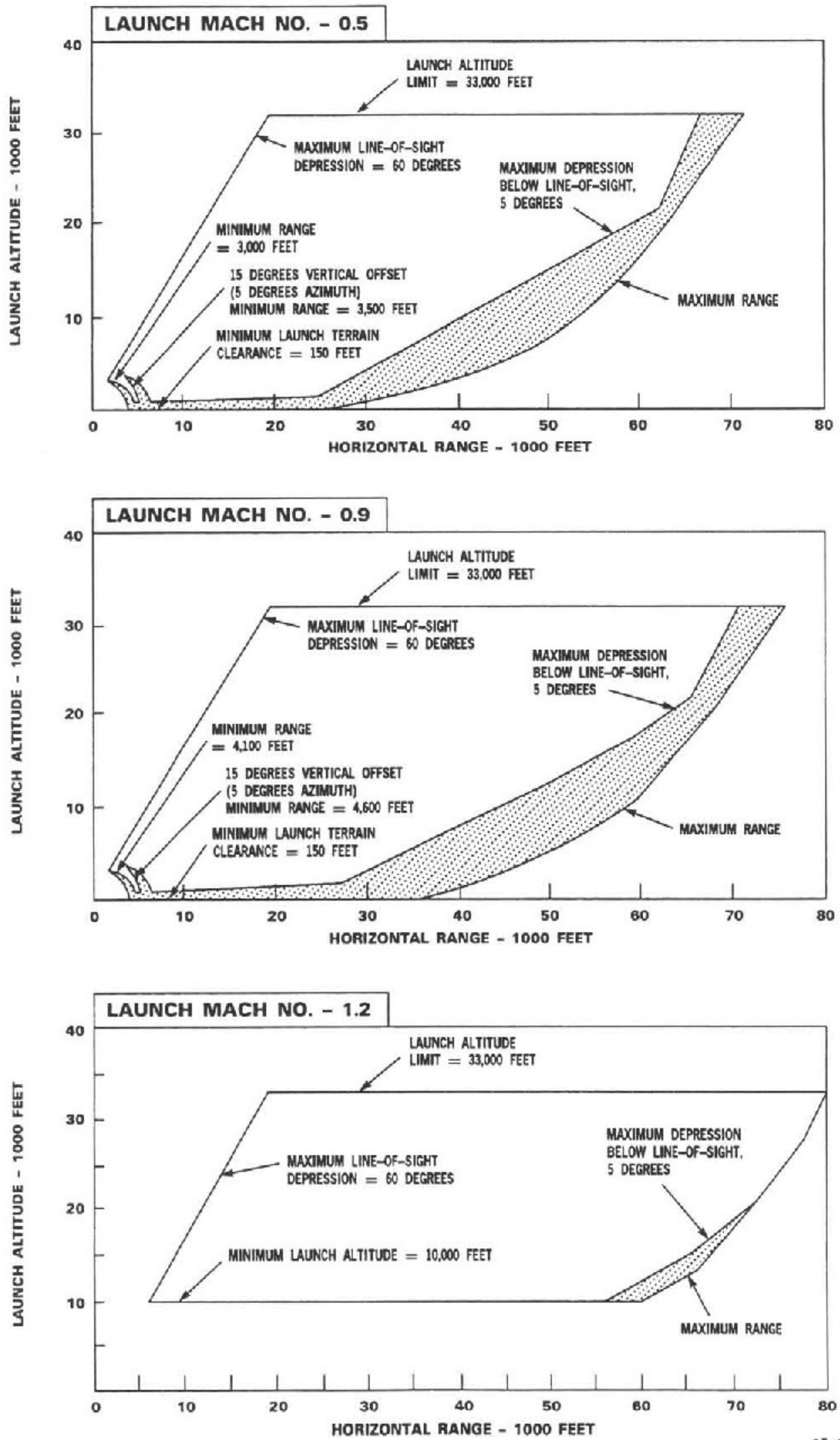

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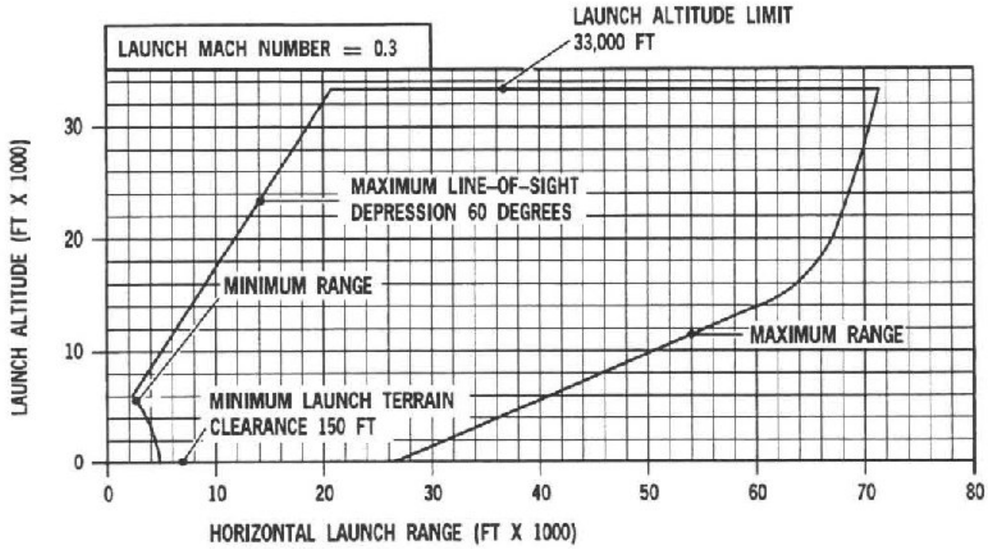
Figure 1-465. AGM-65D Missile Launch Envelope



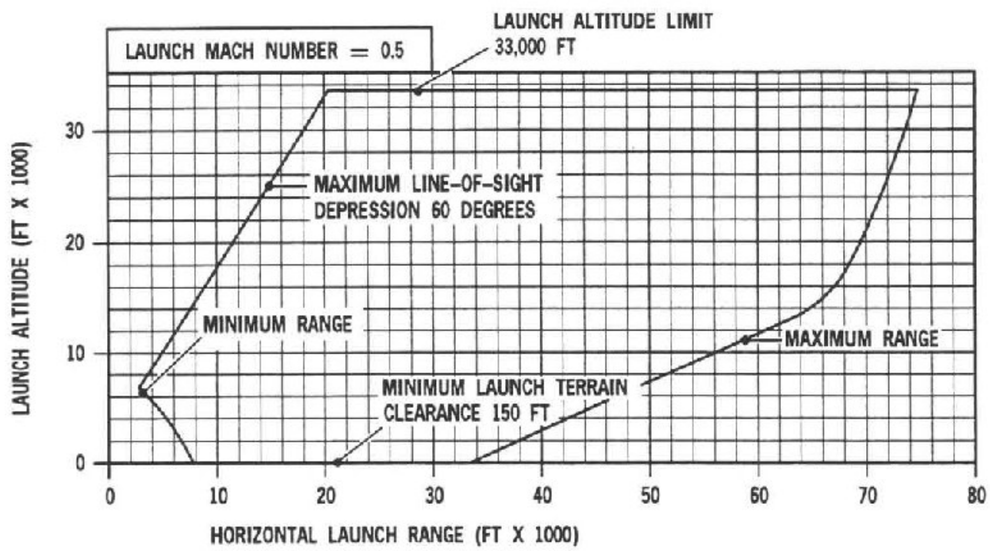


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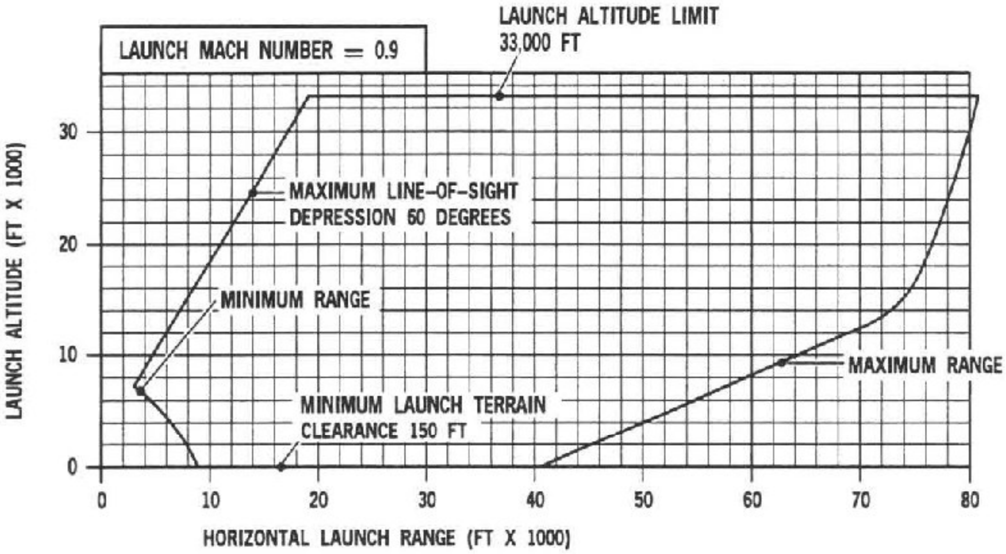
Figure 1-466. AGM-65G Performance Envelope (Sheet 1)



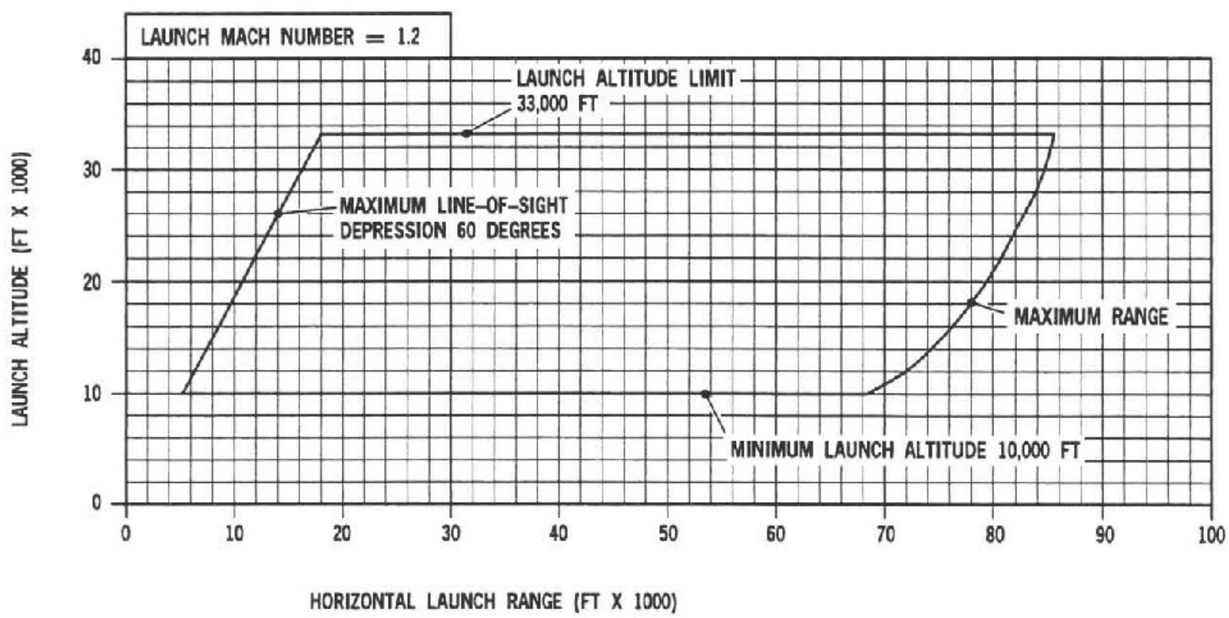


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Figure 1-466. AGM-65G Performance Envelope (Sheet 2)

The missile seeker is located immediately behind the guidance unit window. The seeker is gyrostabilized and free to move left and right 42 degrees, up 30 degrees, and down 54 degrees from the longitudinal axis of the missile. The seeker gyro requires a delay of 3 minutes after electrical power application to reach operating speed.

Missile electronics will inhibit missile activation until the seeker gyro has reached 90 percent of full operating speed.

IR energy from the target scene enters the seeker after passing through the guidance unit window (figure 1-464). The window is made of a special material that allows IR energy to pass through without distortion. As the IR energy enters the seeker, a set of telescope lenses focuses the IR scene on a folding mirror. The scene is reflected from the folding mirror through another series of lenses, which gives a dual-FOV capability. The scene is then reflected from a rotating scan mirror through a viewing lens that focuses the IR energy onto an array of IR detectors. The rotating scan mirrors break up the scene into a series of narrow bands. Each band is then further reduced to a series of electrical signals by the detector array. The signals are electronically manipulated and reconstructed into the TV image presented in the cockpit display. A special design feature of the scan mirrors produces an area of enhanced resolution in the center of the display. The super scan area allows the tracking of smaller targets at longer range.

The seeker is positioned by torquer motors that function in the same manner described for the EO Maverick. When the missile is in the ready mode, mechanical brakes in the torquer motors attempt to hold the seeker gyro at the boresight position. However, when the aircraft pulls positive g while maneuvering, the torquer motor brakes may slip and allow the seeker to slowly move to a gimbal limit. This slippage can cause unnecessary delays in the lock-on process. The seeker electrically aligns at the rate of 8 to 10 degrees per second; aircraft turn rates in excess of that will cause the seeker to lag behind the aircraft.

The forward section also contains the electronic circuits that operate the seeker unit, track the target, and generate missile steering commands. The autopilot combines these steering commands with gyro-sensed yaw, roll, pitch, and lateral acceleration rates. From this information, the autopilot computes course corrections to steer the missile on a collision path to the target.

Aft Section

The description of the AGM-65D IR Maverick missile aft section is the same as that for the AGM-65A and B missiles. The aft section of the AGM-65G differs in that it contains a larger warhead, a fuze delay select unit (FDSU) instead of a SAF, and a SHIP/LAND selection switch and uses a pneumatic actuation system (PAS) instead of a HAS for control surfaces actuation. The SHIP/LAND selection switch is used to select the ship-track mode of operation of the AGM-65G. The FDSU and SHIP/LAND switches are located behind the select switch access door on the aft section. The setting of these switches is a crew preflight function.

Video Display

The cockpit video image (figure 1-467) is composed of an IR scene video and electronically generated symbols consisting of crosshairs, a pointing cross, seeker depression angle markers, and four NFOV markers. The crosshairs are a set of horizontal and vertical lines extending through the center of the display. The intersection of the lines is gapped to delineate the tracking window, the area in which the tracker defines the boundaries of the target based on differences in IR radiation level. The adjustments of the tracker to accommodate the expanding apparent size of a target being approached produces a widening of the crosshair gap.

The displacement of the pointing cross from the center of the display shows the relative bearing between the LOS of the missile seeker and the longitudinal axis of the missile. Any portion of the pointing cross that is coincident with the tracking window is blanked so as not to interfere with target identification. The three seeker depression angle markers, at 5 degrees, 10 degrees, and 15 degrees, assist the aircrew in estimating the displacement of the pointing cross.

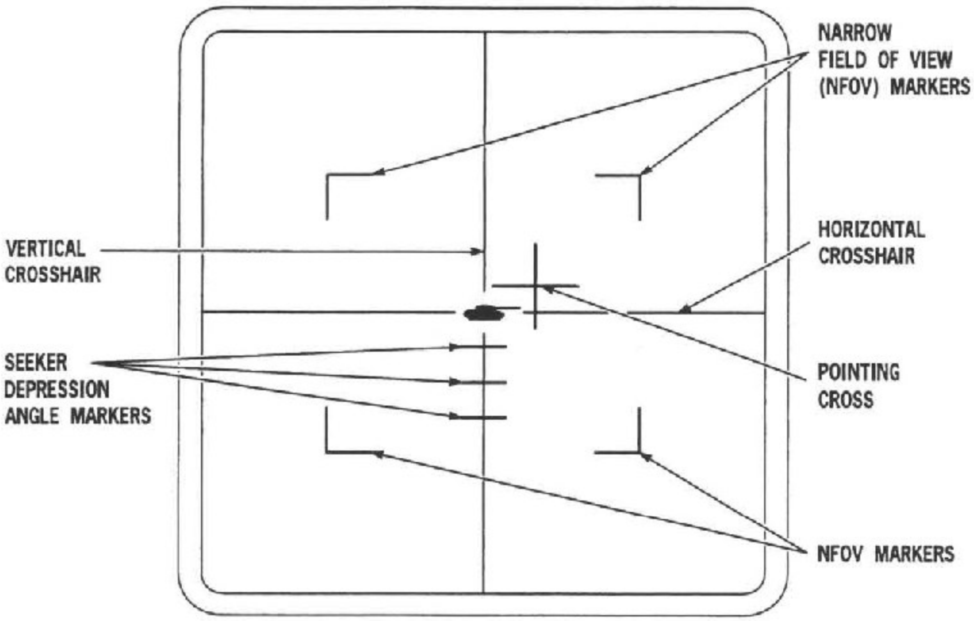


Figure 1-467. IR Video Display

When first activated by the uncage signal, the missile will display WFOV and the cockpit display will contain the four L-shaped NFOV markers. A second application of the uncage signal will select NFOV, and the portion of the video between the NFOV markers will fill the entire display. In NFOV, the four markers will not be present on the display.

NOTE

- NFOV provides a double magnification over WFOV and allows a certain increase in standoff capability. NFOV is useful in scene interpretation but severely inhibits target acquisition.
- If the missile is tracking a target in WFOV, activation of uncage will change the FOV but the lock-on will be broken and the seeker will return to memory boresight or commanded slave position. To regain lock-on rapidly when selecting NFOV, slew enable must be commanded before activating uncage. This will allow the seeker to remain fixed in angle and facilitate target reacquisition. The missile may be launched in either NFOV or WFOV.
- Air-to-ground weapons system evaluation program (WSEP) data show a significant increase in probability of hit for missiles launched in NFOV over missiles launched in WFOV. Advantages of NFOV are improved target identification and increased launch range. Missiles should be launched in NFOV whenever possible.

All display symbols may be displayed as either black or white. If W/B contrast is selected for tracking a target (white) that is warmer than its background (black), the display symbology will be white. Black symbols will be displayed for B/W contrast selection.

Guidance

The IR model does not use a hot spot tracker typically found in heat-seeking air-to-air missiles. It uses rotating scan mirrors and IR detectors to generate a video scene and uses the differences in IR energy levels (displayed as contrast) between the target and its background to define and track the target. The IR Maverick guidance unit differs from the EO version by the addition of a digital computer that processes the analog video signals. The computer then provides several programs that enhance missile employment. The computer uses a launch transient assist program that provides a memory of the target image should the tracking gate drift during the initial phase of flight. This program automatically begins to search and relock the seeker on the proper target. An event program prevents an abnormal tracking condition from pulling the tracker off the intended target. A motion program prevents the seeker from losing a lock on a moving target. A correlator track program provides guidance when the centroid tracking gate expands to approximately 75 percent of the FOV as the target is approached. The correlator track program uses data from the entire scene to guide missile to impact.

The AGM-65D has the capability to memorize a seeker boresight position within 6 degrees of the longitudinal axis of the missile. This feature allows the aircrew to correct for boresight errors that may occur during loading. In addition, for night use, it may be desirable to boresight the missile below the aircraft flightpath vector. Boresight memory can be set by adjusting aiming reference (gunsight) to the intended boresight position, placing the aiming reference over a visual target identifiable on the display, locking onto the target, selecting the auto position on the contrast polarity switch, depressing and releasing the TMS, and then placing the contrast polarity switch to either B/W or W/B. After accomplishing these steps, the seeker position will be stored in computer memory and will return to this position each time the missile is put in the align mode.

CAUTION

On LAU-88/A, A/A, boresight the missile in priority. Failure to retain the dome cover on nonpriority missiles may result in damage to the unprotected heads.

NOTE

Missiles loaded on a LAU-88/A or LAU-117/A must be boresighted individually. The missile cannot be boresighted with the dome cover in place.

A centroid tracker program tracks the centroid of the IR target in a manner similar to that of the tracker in the EO model. The tracker also uses an automatic gain control in conjunction with threshold levels to determine tracking gate size and position. An aided target acquisition program helps the tracker lock on when the target is not centered in the tracking gate. In the AGM-65G, the ATA initial gate is 45 pixels x 45 TV lines in size rather than 25 x 25 as in the AGM-65D. The object with the closest edge (not the centroid as in the AGM-65D) is selected as the target. This subtle difference allows the AGM-65G to lock onto large targets. A good-lock program indicates when a valid lock-on exists. As in the AGM-65B, a steady pointing cross on the TV display indicates a good lock and a flashing pointing cross indicates a high probability of break-lock at launch. The pointing cross is steady when the IR contrast between the target and background is sufficient, the target apparent size is large enough, and the relative bearing of the target is within the missile launch angle criteria. As mentioned earlier, the pilot must insure actual launch range is within the AGM-65D, G launch envelopes.

A synergistic track program enables the AGM-65G missile to combine the best qualities of centroid and correlation track to allow lock-on and tracking of unusually shaped targets. The two modes are horizontal for wide, short targets and vertical for tall, narrow targets. Synergistic track allows the tracker to maintain centroid track in the narrow dimension while the wide dimension is tracked by the correlator. During synergistic track, one pair of crosshairs will now extend toward the center of the field of view (FOV) and may overlay part of the target, while the other pair of crosshairs will continue to bound the target. This mode allows lock-on of targets that are normally unbounded in one direction or whose size exceeds the FOV. It is selected automatically by the missile.

Force Correlation Track (AGM-65G Missile Only)

Some large targets may not be suitable for attack by an AGM-65 operating in the centroid track mode. A specific aimpoint different from the centroid of the target may be the desired impact point (a certain building in an industrial complex, a specific span of a bridge, etc.). The AGM-65G has a feature that allows the tracker to be forced into the correlation track mode prior to launch to track a specific aimpoint. This action bypasses the centroid track circuitry. To force the missile into the correlation track mode, the AUTO position of the aircraft Contrast Select switch is used. UNCAGE and SLEW actions are performed normally. Prior to commanding TRACK (lock-on), selection of the AUTO position must be made. When TRACK is commanded, target tracking will be accomplished through the correlation tracker circuitry. When lock-on occurs, the crosshairs will close, creating solid crosshairs in both the horizontal and vertical axes on the aimpoint in the center of the display. The pointing cross will indicate when good-lock logic criteria have been met.

NOTE

Correlation track requires scene detail as would be found in large high value targets at employment slant range. Do not use force correlation on a good centroid target, such as a tank.

Target Acquisition

When a target is sighted visually, uncage the missile to activate missile video and align the seeker to boresight. Fly the aircraft to place the gun sight or head-up display (HUD) aiming reference on the target and use TMS to stabilize the seeker gyro. Observe the cockpit display and slew as necessary to center the target in the tracking gates. Release TMS to command lock-on. Even if the target is not quite centered in the tracking window, release of the TMS will activate the aided target acquisition program and effect target lock-on. (If a FOV change is desired or required, it should be accomplished prior to release of the TMS or subsequent rotation of the dual-FOV lenses will cause target break-lock.) Once lock-on is commanded, observe the cockpit display to insure the desired target is centered in the crosshairs and that the pointing cross is steady.

NOTE

- Because the pointing cross is initially steady prior to evaluation, allow approximately 1 second for the good-lock program to function before commanding launch.
- Aimpoint biasing associated with the AGM-65G ship-track mode is a missile function after launch. Target acquisition procedures using ship-track are identical to centroid land launches.

If the pointing cross remains steady for 1 second or longer, depress and hold the weapons release button to launch the missile. If the pointing cross is flashing, fly toward the pointing cross to center it in the display and change to NFOV if not already selected. Use the TMS to designate before commanding FOV change (uncage) to prevent the seeker from returning to the boresight or command and slaved position. Reaccomplish the lock-on and reevaluate the display. If the pointing cross is still flashing, continue to fly toward the target or select a different target. Insure the missile is launched within its maximum aerodynamic range. The aircraft must be properly wired, and the missile must be loaded on a LAU-117/A or a modified LAU-88/A launcher. With the missile in the align mode, locate the target with the active sensor and activate the slave switch. As this procedure is essentially a search for the target, leave the AGM-65D, -65G in WFOV and command slave. This missile seeker will slave to the same point as the selected sensor is pointing. The seeker will accept slaving signals from the selected sensor up to the slew limits of the missile. Selection may be made once the target appears on the cockpit display. If the target appears inside the NFOV markers, the uncage signal may be applied to change missile FOV. Lock-on and launch considerations are the same as those in visual target area procedures. As the slave signal may be some distance off boresight, the aircraft may have to be maneuvered to place the pointing cross within missile launch limits.

Flight Planning Data

After launch and after achieving safe separation distance, AGM-65 missiles enter a loft trajectory designed to increase the range of the missile. Depending on the launching aircraft altitude AGL and the range of the target, the altitude achieved by the missile may exceed the launch altitude by as much as 2300 feet. If launch occurs below a cloud ceiling, it is possible for the missile to enter the clouds and lose lock-on as a result. Figure 1-463 is a graphic representation of maximum loft trajectories for various launch altitudes. The g-bias profile has been modified to reduce missile altitude gain. This allows maximum range launches under lower cloud ceilings (figure 1-468). The missile will guide to and hit any target it locks onto and tracks with a steady pointing cross if the slant range is within aerodynamic limits.

LAUNCH ALTITUDE (AGL)	ALTITUDE GAIN
150 feet	950 feet
500 feet	750 feet
1,000 feet	150 feet

MACH 0.9 LAUNCH
MAXIMUM LAUNCH RANGE

Figure 1-468. AGM G-Bias Effect on Missile Altitude Gain

Fuze Delay Select Unit (FDSU) Switch and SHIP/LAND Selector Switch (AGM-65G)

Inside the select switch access door are two switches (figure 1-469) that are described in the following paragraphs.

FUZE DELAY SELECT UNIT (FDSU) SWITCH

The FDSU provides three selectable function delay times: INST (1.2 milliseconds), DLY 1 (14 milliseconds), and DLY 2 (30 milliseconds). The delay settings must be made during weapon preflight, as there is no cockpit selectability.

SHIP/LAND SELECTOR SWITCH

The AGM-65G provides algorithms for both land (LAND) and sea (SHIP) targets. Algorithms for the land mode are designed for smaller, point-size targets. The tracking gate for the LAND position, as indicated by the crosshairs, is square. Sea mode algorithms are designed for the larger, unusual shape of ship targets that conform to the requirements of aspect ratio limiting or synergistic tracking. The tracking gate for the SHIP mode is rectangular (width is twice the height). SHIP or LAND selection must be made during weapon preflight, as there is no cockpit selectability.

TGM-65 Training Guided Missile

The TGM-65 is a captive training device designed to train aircrews in the use of the AGM-65A, B, and D missiles.It provides realistic training in system operation, target acquisition, and tactics. The TGM can be configured as a TGM-65A, B, or D with or without a recorder. Because of the similarity of the operational and

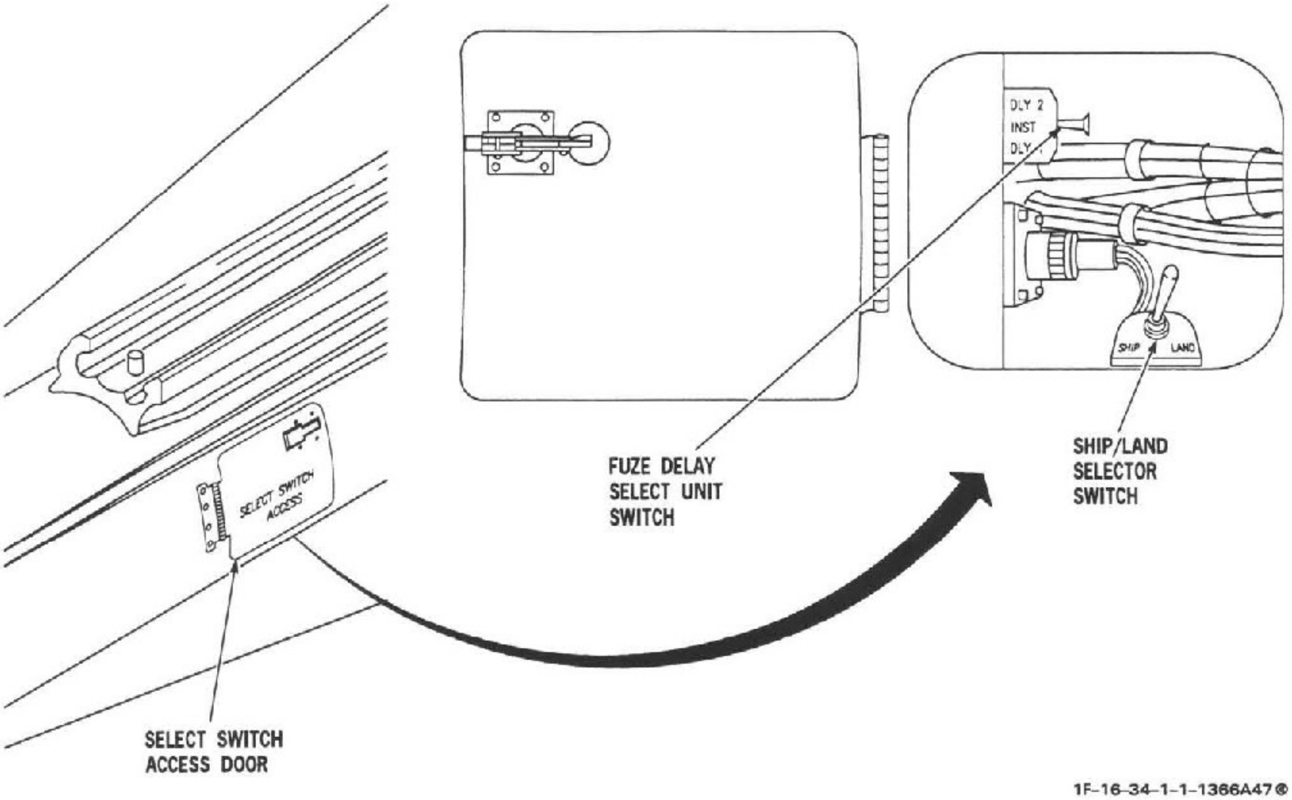


Figure 1-469. AGM-65G SHIP/LAND and FDSU Switches

training systems, only the differences will be discussed. In most respects, the TGM (figure 1-470) is physically identical to the live missile. The differences are the external control surfaces are not present, the warhead has been replaced by a signal processing unit, and the rocket motor and the hydraulic actuation system have been replaced by a film recorder, AVTR, and/or ballast. The TGM can be suspended from any LAU-88 or LAU-117 launcher. The TGM has no igniter cable. The TGM is completely inert because it contains no warhead, rocket motor, hydraulic actuation system, or battery. Electrical control is provided by the launcher electrical assembly. The inflight switch positions for the TGM are the same as for the live missile.

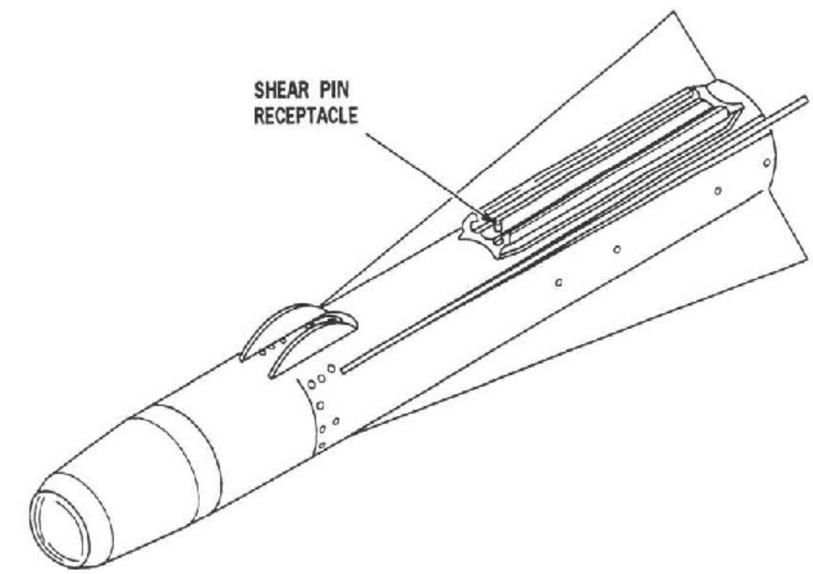
CAUTION

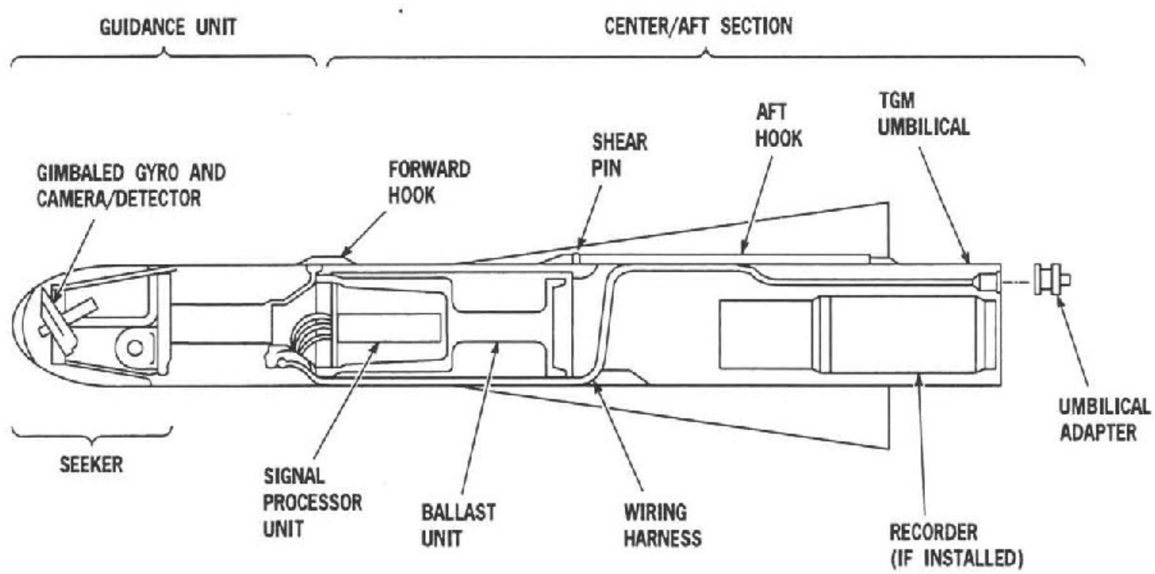
Improper switchology may result in the jettisoning of the TGM and associated suspension equipment.

NOTE

For the IR function, the training missile dome cover must be removed prior to flight.

The TGM provides the same cockpit control response as the operational AGM-65 missile except it does not launch. Launch is simulated by blanking the cockpit video display 1 second after depressing the pickle button. When the weapons release button is depressed to simulate launch, the TGM performs an orderly shutdown, which takes approximately 1 second.





LENGTH	8 FEET 2 INCHES
DIAMETER	12 INCHES
WINGSPAN	29 INCHES
SUSPENSION	LAU–88A/A OR LAU–117/A MISSILE LAUNCHER
WEIGHT (T–1)	464 POUNDS (APPROX) (445 WITHOUT RECORDER)
(T–8)	478 POUNDS (459 WITHOUT RECORDER)
RECORDING TIME	30 MINUTES AT 3.75 FRAMES PER SECOND (A/B) 15 MINUTES AT 7.5 FRAMES PER SECOND (A/B) 2 HOURS WITH VHS TAPE (D)

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Figure 1-470. TGM-65 Training Guided Missile

CAUTION

If the weapons release button is depressed for less than 0.5 second (quick pickle), the cockpit video display may blank but the seeker may still remain in the track mode. If this occurs, excessive heat buildup may cause damage to the TGM guidance unit. Deselecting the station after a pass with a TGM-65A or B will preclude this problem. In addition, in the A and B model TGM, the sun shutter circuitry will be disabled while in the track mode, causing vidicon damage should the seeker be pointed at the sun during pulloff.

When any TGM is carried on a LAU-117 launcher, the video does not blank with a quick pickle. Instead, the missile will be placed in the align mode by the launcher and the seeker will return to the boresight position. TGM quick pickle can be corrected by momentarily deselecting the TGM station when safety permits. This removes the seeker from the full-power mode (video blanks), applies the seeker mechanical brakes, and allows the TGM to reset by initiating an orderly shutdown.

The guidance unit functions only to enable acquisition, tracking, and designation of a target. The EO picture or IR picture is relayed to the cockpit video display. The TGM tracking window will expand to continue bounding the target as the aircraft closes on the target. This expansion will continue until the attack is terminated by a simulated launch, the guidance unit enters correlation track last rate memory, the tracker breaks lock during pulloff, or the missile is placed in the ready mode by deselection.

The AGM-65A, B requirement for 45 seconds between an aborted launch and subsequent missile callup does not apply to the TGM because the missile is not intended for flight; however, it is a habit pattern that should be developed.

TGM Recorders

TV RECORDERS

Some TGM's contain a camera (figure 1-470) that records TGM video on 16mm film for postflight evaluation. The full film magazine contains approximately 30 minutes of film at 3.75 frames per second and 15 minutes at 7.5 frames per second (better picture clarity). TGM's generate event markers (figure 1-471) to depict align, slew, track, and launch modes. Launch gimbal limits, missile polarity, and pass number markers are also depicted. Event markers are not presented on the cockpit video display.

IR RECORDERS

Some IR version TGM contain a video tape recorder utilizing a standard 1/2-inch VHS cassette. The recorder will operate anytime video is present on the cockpit display. To stop the recorder, it is necessary to either perform a simulated launch or momentarily deselect the loaded station (return TGM to ready mode). Available recording time exceeds guidance unit time limits and will provide recording capability for any normal mission. Event markers (figure 1-471) are recorded along the left edge of the film to aid in interpretation and assessment.

AGM-65/TGM-65 Operational Limitations

The AGM-65 missile will not be launched under conditions which exceed the following limits:

Launch speed – Maximum, Mach 1.2

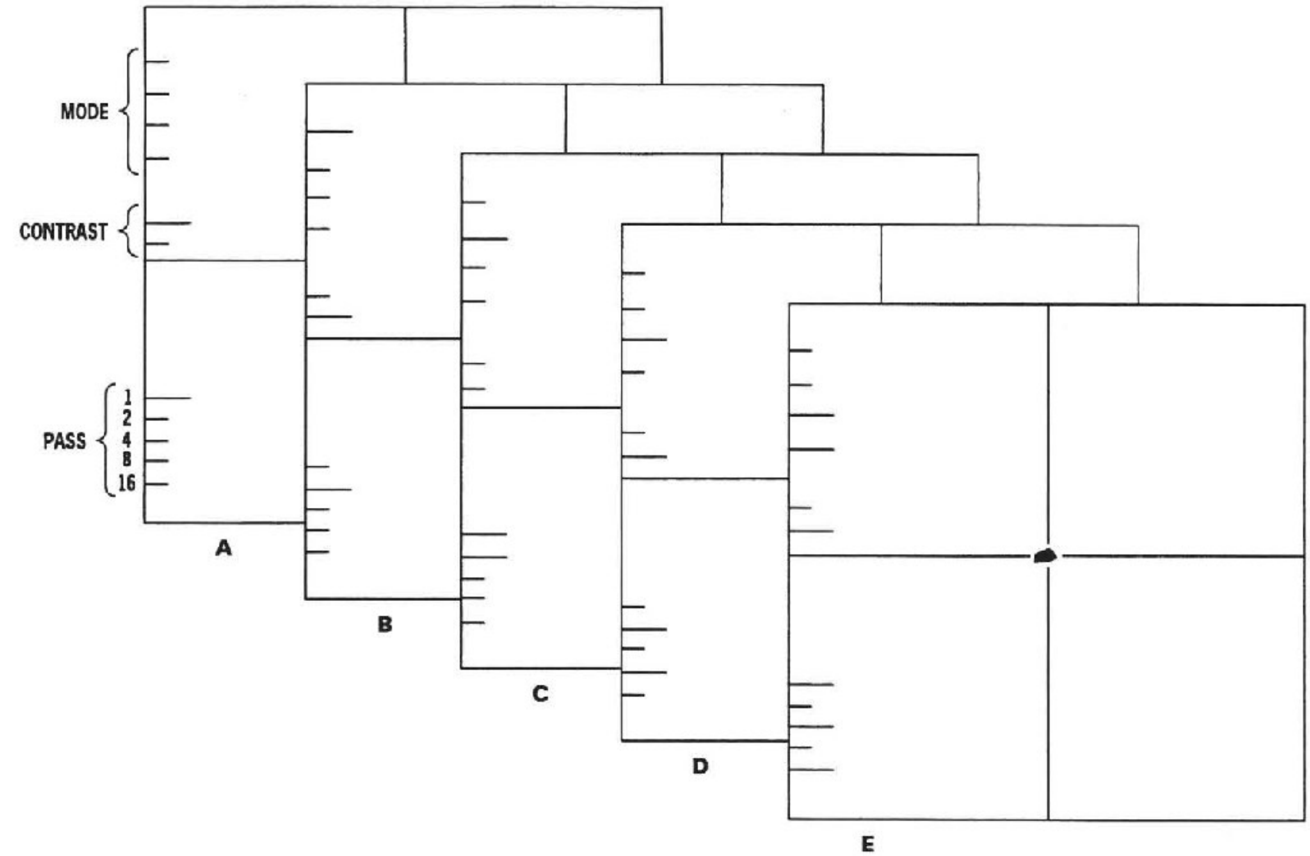
Maximum gimbal offset angle – AGM-65A, 15 degrees; AGM-65B, 10 degrees; AGM-65D/-65G, keyhole

Maximum dive angle – 60 degrees

Maximum bank angle: 30 degrees

Maximum roll rate: 30 degrees per second

Minimum/maximum load factor: +0.5g/+3.0g.



	EVENTS														
	A			B			C			D			E		
MODE	ALIGN			SLEW			TRACK			LAUNCH			LAUNCH (SEEKER ANGLE EXCEEDING LIMIT)		
CONTRAST	WHITE ON BLACK			BLACK ON WHITE			AUTO			BLACK ON WHITE			BLACK ON WHITE		
MARKER	LENGTH	VALUE	PASS	LENGTH	VALUE	PASS	LENGTH	VALUE	PASS	LENGTH	VALUE	PASS	LENGTH	VALUE	PASS
PASS 1	L	1		S	0		L	1		S	0		L	1	
2	S	0		L	2		L	2		L	2		S	0	
4	S	0	1	S	0	2	S	0	3	S	0	10	L	4	21
8	S	0		S	0		S	0		L	8		S	0	
16	S	0		S	0		S	0		S	0		L	16	

NOTE: LONG (L) OR SHORT (S).
LONG MARKERS ARE ASSIGNED THE CORRESPONDING NUMERICAL VALUE, SHORT MARKERS ARE ALWAYS ZERO VALUE.
THE PASS NUMBER IS DETERMINED BY SUMMING THE VALUES OF ALL FIVE PASS MARKERS.

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Figure 1-471. TGM-65 Recorder Event Markers

CAUTION

To avoid damage to the seeker head, do not fly through visible moisture (rain) at airspeeds greater than 350 KIAS or 0.53M (whichever is less).

AGM-65/TGM-65 Time Limitations

1. Allow 3 minutes gyro spin-up time before uncaging to prevent damage due to gyro tumble.
2. Power-On (Ready Mode).
   a. During ground checks – 15 minutes maximum (red).
   b. Cumulative per mission – 60 minutes maximum (includes 3 minutes gyro spin-up time).
      – 35 minutes maximum (sustained flight above 0.9 Mach)
3. Video-On (Full-Power Mode).
   a. Each attack – 3 minutes maximum (roll rate gyro – AGM-65A and B) (guidance unit heat damage – TGM-65A and B).
   b. Each attack – 30 minutes maximum (AGM-65D and AGM-65G).
   c. Cumulative per mission – 30 minutes maximum
      – 5 minutes maximum (sustained flight above 0.9 Mach).
4. Minimum time between attacks with the same AGM-65A or B is 45 seconds (roll rate gyro).
5. Ground operation will be limited to 15 minutes for TGM's to prevent heating problems.

NOTE

These missile operational time limits represent missile design capability. As a general rule, the missile may be operated for longer time periods if the image presented on the cockpit display is usable (AGM's).

AIR-TO-GROUND ROCKET EQUIPMENT

ROCKET LAUNCHERS

LAU-3/A, B/A, C/A, D/A Rocket Launcher

The LAU-3/A, B/A, C/A, D/A rocket launcher (figure 1-473) can carry and launch nineteen 2.75-inch folding-fin aircraft rockets (FFAR). The flight configuration consists of the loaded center-section assembly with a streamlined fairing installed and locked onto the front end. When the launcher is fired, the front fairing is shattered by rocket impact. The frangible fairing is made of treated paper and shatter readily after rocket impact.

The launcher center section is constructed of 19 paper tubes clustered together and is wrapped with a thin aluminum outer skin. Detent devices within the tubes restrain the rockets against normal flight loads and provide electrical contact to ignite the rockets. Contact fingers on the aft bulkhead provide a ground to complete the circuit through the rockets. Two receptacles on top of the center section provide the connection to the aircraft rocket-firing circuitry. The receptacles are wired in parallel; therefore, only one of them is connected to the aircraft. A shorting pin is inserted in the left side of the launcher as a ground safety device that is removed prior to flight. The intervalometer, located within the launcher, converts the aircraft firing voltage into a ripple-fire pulse with a 10-millisecond delay interval that will ripple-fire the rockets in pairs until the launcher is empty. The launcher should completely fire-out in approximately 0.1 second. TER switches must be positioned to ROCKET to provide the ripple-fire sequence.

WARNING

The CBU position would cause the high voltage to burn out the wire-type intervalometer at a rate that will produce a near salvo-fire effect, and the rockets will collide upon leaving the launcher.

NOTE

Several intervalometers are available for use with the LAU-3/A; some are reusable. A burnout-type unit supports the ripple-fire mode only. The reusable type supports both the ripple- and single-fire modes and includes a reset switch to select the firing modes. In a singles mode, two rockets are fired with each fire pulse.

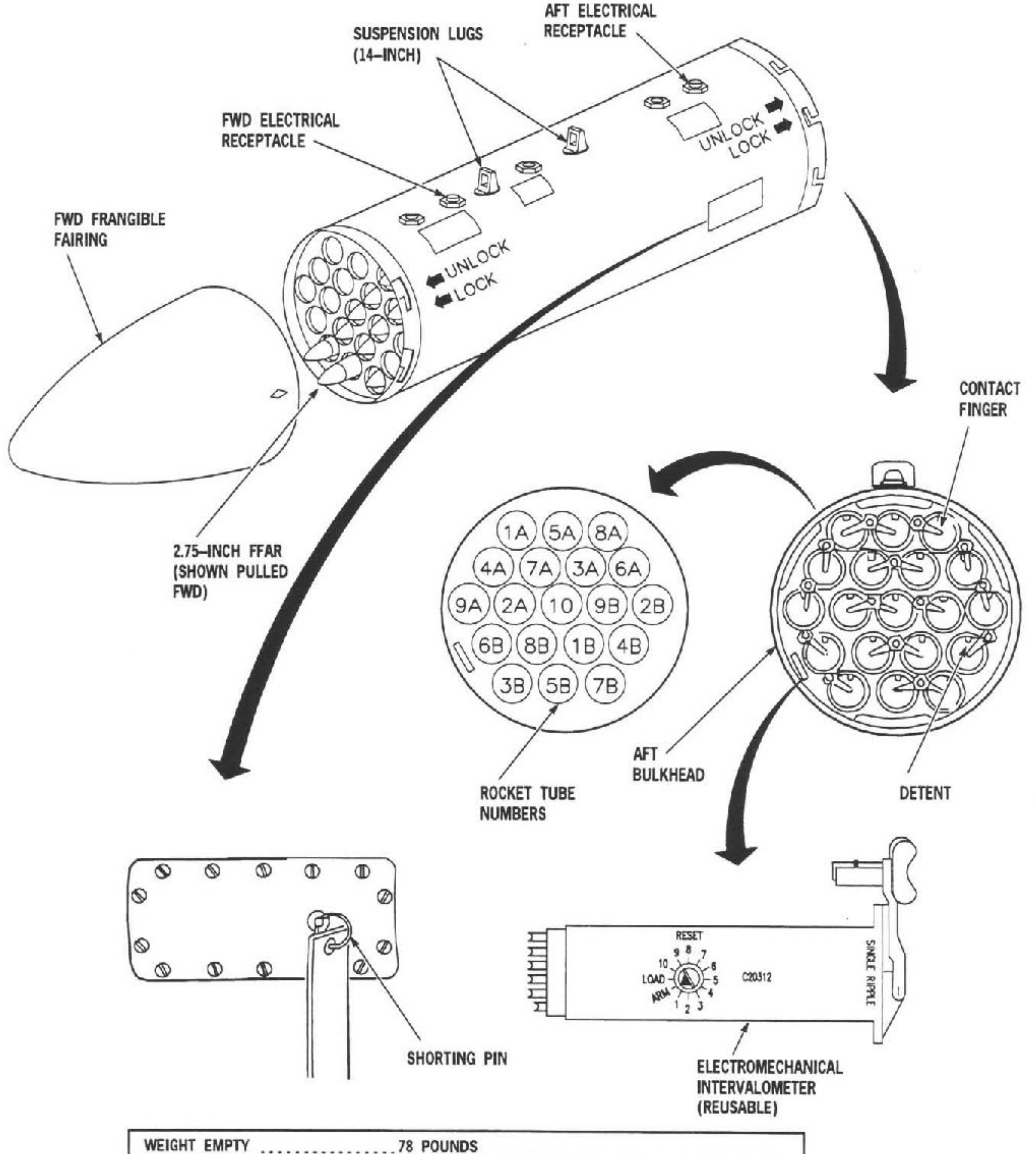
LAU-68A/A, B/A Rocket Launcher

The LAU-68A/A, B/A rocket launcher (figure 1-474) can carry and launch seven 2.75-inch FFAR's. The LAU-68A/A, B/A versions are basically the same as the LAU-3/A, only smaller. The descriptions of construction and operation of the LAU-3/A apply to the LAU-68A/A, B/A versions with the following exceptions:

1. The LAU-68A/A has a 26-pin electrical receptacle forward and a 5-pin electrical receptacle aft. The LAU-68B/A has a five-pin electrical receptacle forward and aft.
2. The launchers utilize a reusable electromechanical intervalometer to route the fire pulse to the different rocket tubes. A single/ripple switch and an intervalometer control, which must be positioned during aircraft loading, are located on the aft end of the launcher. With the single/ripple switch in single, one tube is fired with each fire pulse received by the launcher; with the switch in ripple, all tubes are fired in sequential order, with a 60-millisecond interval between tube firings. The intervalometer control has a load position for ground safety, an arm position, and firing positions 1 through 7.

NOTE

The interface of the LAU-68 intervalometer and ripple/pairs mode causes system anomalies. When the launcher is mounted on a TER-9/A, these anomalies may cause hung rockets. In this case, if a ripple mode is desired, select ripple on the LAU-68 single/ripple switch and use the aircraft single mode.



WEIGHT EMPTY	78 POUNDS
WEIGHT FULL	120 TO 534 POUNDS (VARIES WITH TYPE OF ROCKET)
LENGTH	87 INCHES
DIAMETER	16 INCHES

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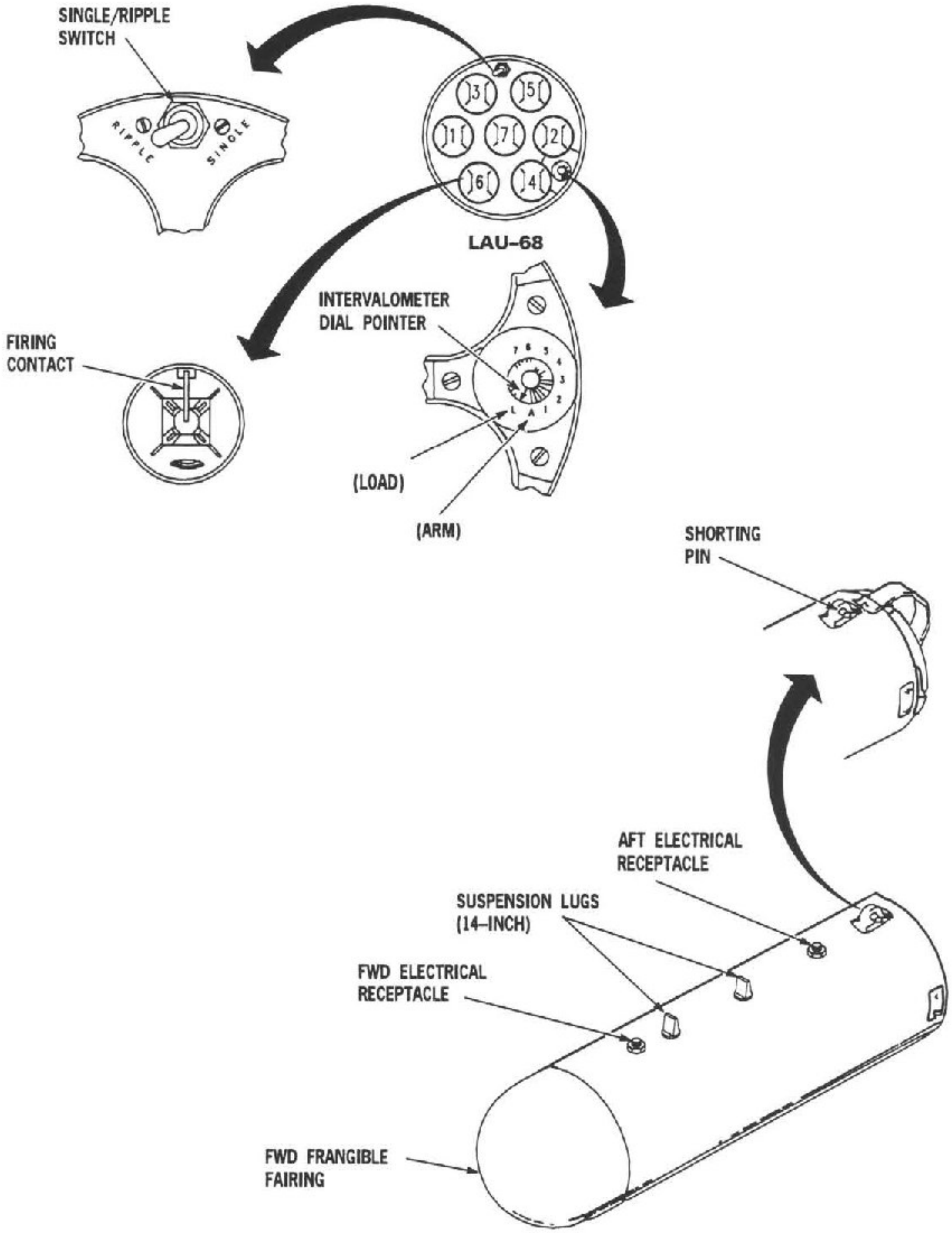
Figure 1-473. LAU-3/A, B/A, C/A, D/A Rocket Launcher



WEIGHT EMPTY......	67 POUNDS (WITH FAIRINGS)
WEIGHT LOADED....	193 TO 235 POUNDS (VARIES WITH TYPE OF ROCKET)
LENGTH...........	73 INCHES. (WITH FAIRINGS INSTALLED)
DIAMETER.........	10 INCHES.

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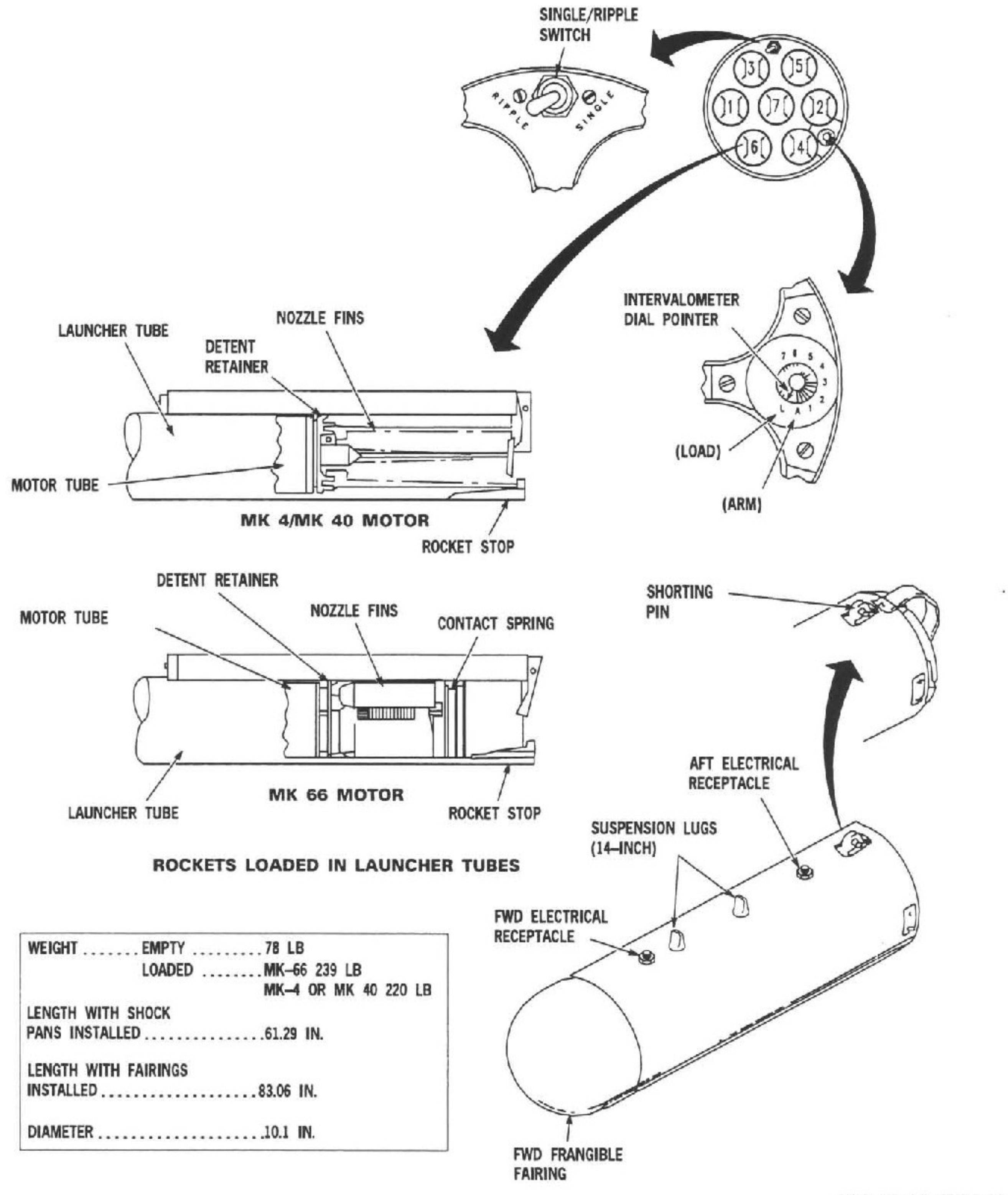
Figure 1-474. LAU-68A/A, B/A Rocket Launcher

LAU-131/A Rocket Launcher

The LAU-131/A (figure 1-475) has the capability to use both folding fin aircraft rockets (FFAR) and wrap-around fin aircraft rockets (WAFAR). The launcher consists of the center section with a streamlining fairing installed and locked onto the forward end. The front fairing is constructed so that upon rocket firing, the fairing shatters. Detents within the tubes restrain the rockets against normal flight loads and the contact spring (MK 66 motor)/contact arm (MK 4 and MK 40 motors) provide electrical contact to ignite the rockets. The rockets are grounded through the detent retainer to complete the electrical firing circuit. Two electrical receptacles are located on the top of the center section to receive power from the aircraft. The receptacles are wired in parallel. The firing of the seven rockets is controlled by an electromechanical intervalometer. The intervalometer will fire either one rocket in the single mode, or in ripple mode will fire each rocket with a 40-millisecond interval between pulses. The firing circuit of the launcher is safed by a shorting pin installed into the launcher side. The launcher is connected electrically to the aircraft armament system by a cable and is attached to the bomb rack by suspension lugs spaced 14 inches apart.

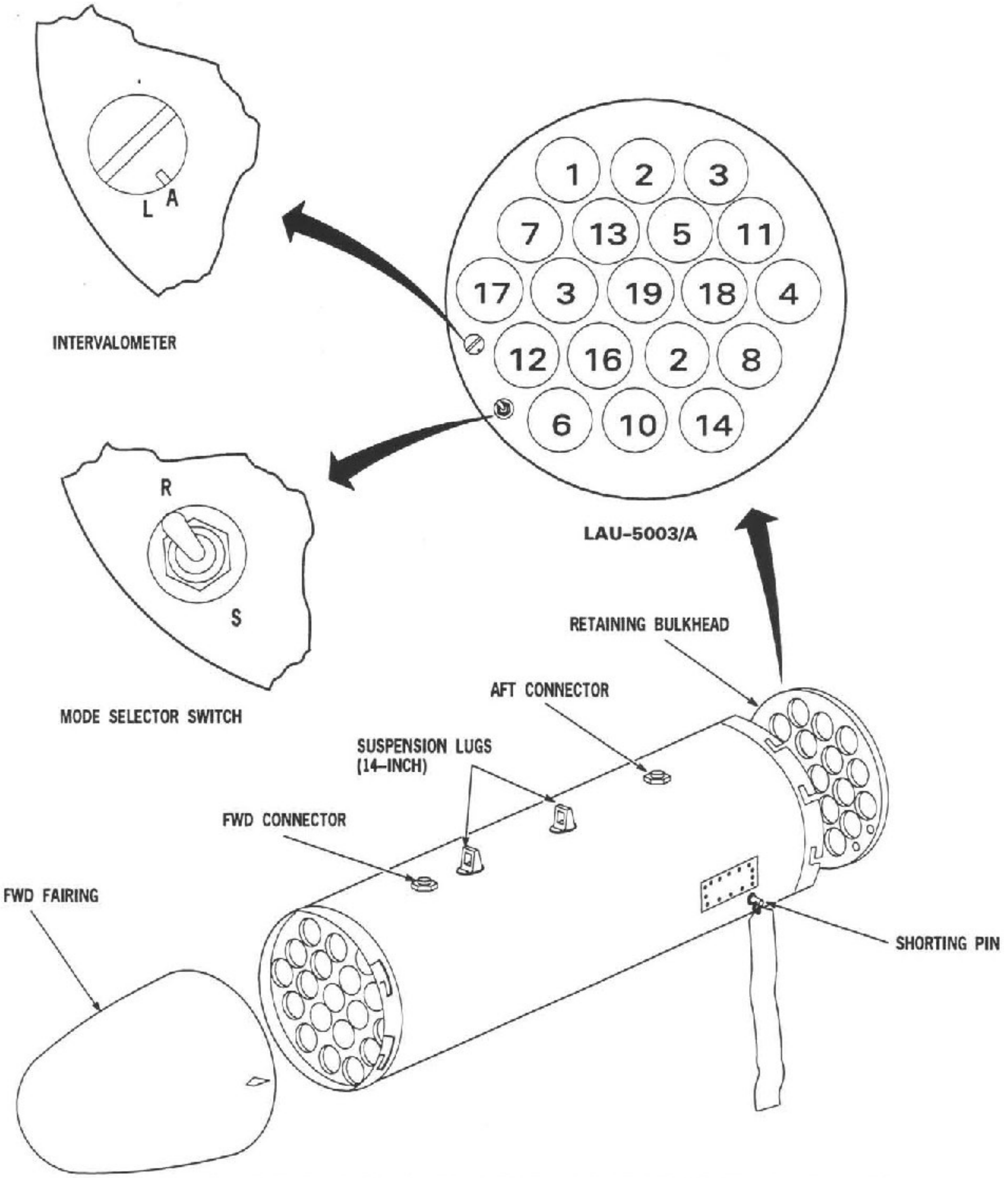
LAU-5003/A Rocket Launcher

The LAU-5003/A rocket launcher (figure 1-476) is used to launch the CRV7 rockets. The launcher is a cluster of 19 resin-impregnated paper tubes bonded together and enclosed in a thin aluminum outer skin. On the top of the launcher are two electrical connectors, wired in parallel, for connection to the aircraft armament circuitry. The shorting pin on the side of the launcher is used to safe the launcher firing circuit. On the aft bulkhead of the launcher is a single or ripple mode selector switch and the intervalometer. The mode switch must be positioned to the desired selection (single or ripple) prior to takeoff. In the ripple mode, the intervalometer will fire the rockets at 40-millisecond intervals. A detachable retaining bulkhead is secured to the aft bulkhead to secure the rockets in the tubes and provide the circuitry for the rocket ignition circuits. The frangible forward fairing shatters on rocket impact.



WEIGHT .... EMPTY	78 LB	
LOADED	MK–66 239 LB	
	MK–4 OR MK 40 220 LB	
LENGTH WITH SHOCK PANS INSTALLED	61.29 IN.	
LENGTH WITH FAIRINGS INSTALLED	83.06 IN.	
DIAMETER	10.1 IN.	

Figure 1-475. LAU-131/A Rocket Launcher



EMPTY WEIGHT	78 POUNDS (WITH FAIRINGS)
LOADED WEIGHT	497 TO 655 POUNDS (VARIES WITH TYPES OF ROCKET)
LENGTH	77 INCHES (WITH FAIRINGS)
DIAMETER	16 INCHES

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Figure 1-476. LAU-5003/A Rocket Launcher

2.75-INCH ROCKETS

The 2.75-inch rocket is an air-launched rocket used to deliver HE, high explosive antitank (HEAT), and white phosphorous (WP) warheads. Warheads are selected to best satisfy operational requirements. The 2.75-inch rocket also has a plaster-loaded inert TP warhead. A complete round consists of a rocket motor, warhead, and fuze.

2.75-Inch Folding Fin Aircraft Rocket (FFAR)

The 2.75-inch FFAR uses MK 4 and MK 40 rocket motors and is fired from LAU-3, LAU-68, LAU-131 series launchers and SUU-20 dispenser (figure 1-477). The motor tube is made of aluminum, weighs 11.4 pounds, and is 39.4 inches long. Both motors include an igniter, propellant grain, stabilizing rod, and nozzle and fin assembly.

The rocket is ignited by aircraft electrical power. When a firing impulse is applied to the igniter contact disk, electric current passes through the igniter circuit and ignites the squib, which ignites the main igniter charge. The salt-covered stabilizing rod prevents unstable burning and reduces flash and afterburning of the propellant grain.

Gas pressure from the burning igniter charge ruptures the igniter case, and burning particles of the igniter charge ignite the propellant charge. Burning propellant blows or burns away the nozzle seals and fin retainer and provides propulsion gases from the rocket. After the rocket leaves the launcher, gas pressure on a piston and crosshead in the nozzle and fin assembly forces the fins open. The opened fins stabilize the rocket in flight.

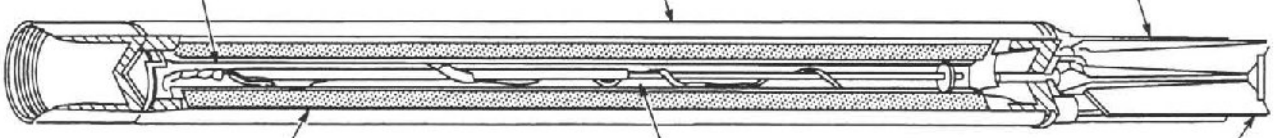
The MK 40 rocket motor uses scarfed nozzles that impart a spin to the rocket for additional stabilization while in flight. A rocket equipped with the MK 40 motor is designated a low spin FFAR. Figure 1-477 depicts a comparison between standard nozzles and scarfed nozzles.

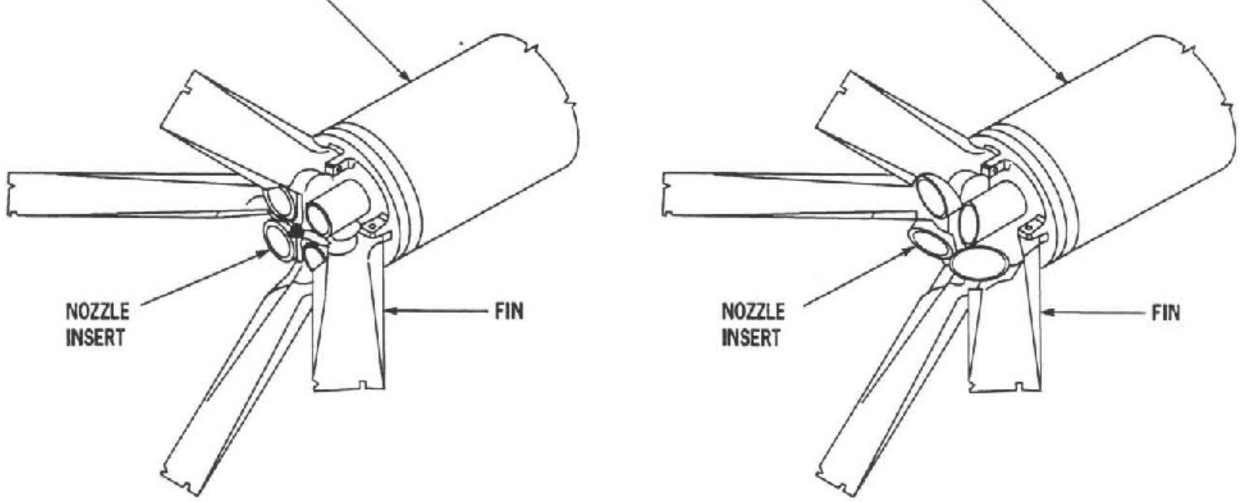
2.75-Inch Wrap-Around Fin Aircraft Rocket (WAFAR)

The 2.75-inch WAFAR consists of the MK 66 rocket motor and various combinations of warheads and fuzes. The MK 66 rocket motor is an improvement over previous MK 4 and MK 40 rocket motors in that it provides 36 percent increased thrust resulting in a 40 percent increase in range. The wrap-around fins provide increased stability in flight which increases accuracy both for fixed wing and rotary wing aircraft. It is compatible with the LAU-131 rocket launcher. The MK 66 rocket motor is 42 inches long and weighs 14 pounds. It consists of a motor tube, igniter, stabilizing rod assembly, charge support assembly, propellant grain, and nozzle-fin assembly (figure 1-478). The aluminum motor tube is threaded at one end to accept the warhead and grooved at the other end to provide the means for nozzle attachment. Spin is imparted to the rocket by the nozzle and flight stability is provided by the wrap-around fins which open and lock in place after the rocket exits the tube. Combustion is initiated by the igniter using current supplied by the launcher. The charge support assembly immobilizes the propellant grain to prevent gas circulation. The motor is propelled to the target by the forces resulting from combustion which are aided and stabilized by the stabilizing rod assembly. Rocket motor burn time is a nominal 1.1 seconds.

CRV7 Rocket

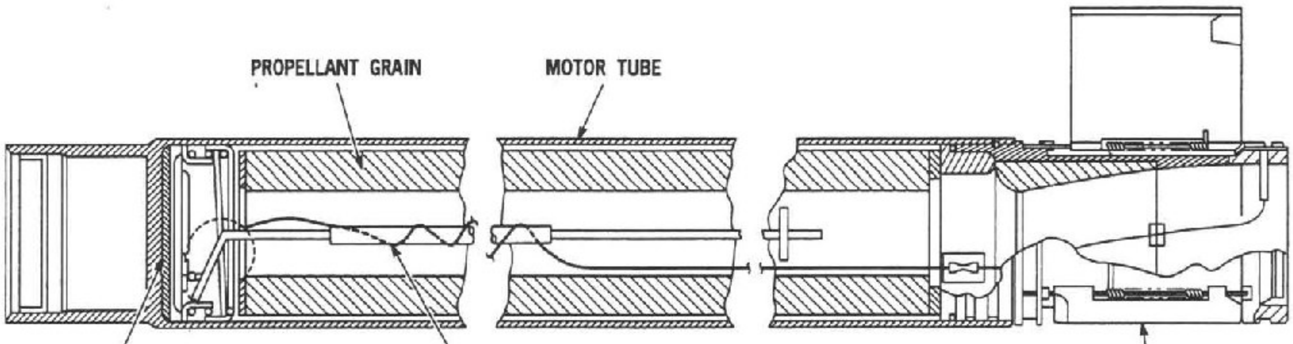
The Canadian CRV7 rocket (figure 1-479) is designed for air-to-ground use. The rocket consists of a C14 or C15 motor that is assembled in various combinations of warheads and fuzes to meet mission requirements. The wraparound fins are held in the closed position by a shearpin ring and three shearpins. When the rocket is loaded in the launcher, the shearpin ring is clamped between the aft bulkhead of the launcher and the detachable retaining bulkhead. This secures the rocket in the launcher. When the rocket is not loaded in a launcher, the ignition circuit is grounded to the rocket case by a shorting clip. The wraparound fins are fully deployed within 14 inches of exit from the launcher and quickly stabilize the rocket in flight. The rocket is fired from the LAU-5003/A launcher only.



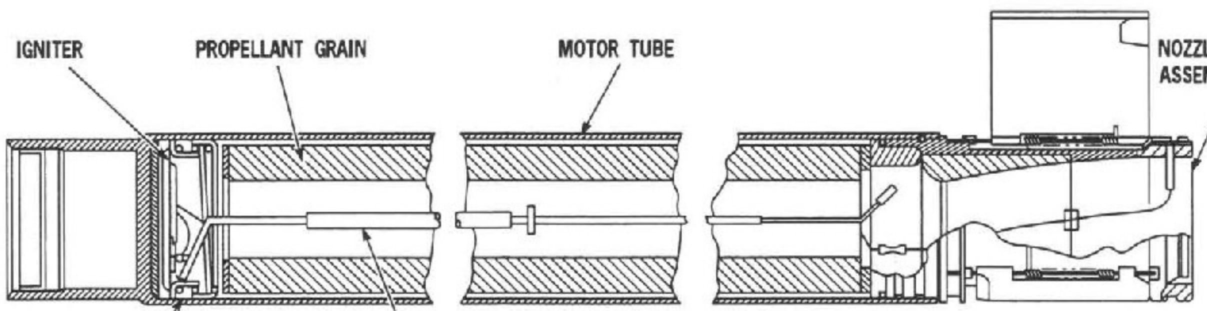


ROCKET WITH WARHEAD	LENGTH	DIAMETER (INCHES)	WEIGHT (POUNDS)	COLOR CODE
MK 1 (HE)	4 FEET	2.75	18	OD/YELLOW BAND
MK 5 (HEAT)	4 FEET	2.75	18	OD/YELLOW BAND
M151 (PMI)	4 FEET 5 INCHES	2.75	22	OD/YELLOW BAND
M156 (WP)	4 FEET 5 INCHES	2.75	22	GREEN/RED LETTERS

Figure 1-477. Folding-Fin Aircraft Rocket (FFAR), 2.75-Inch



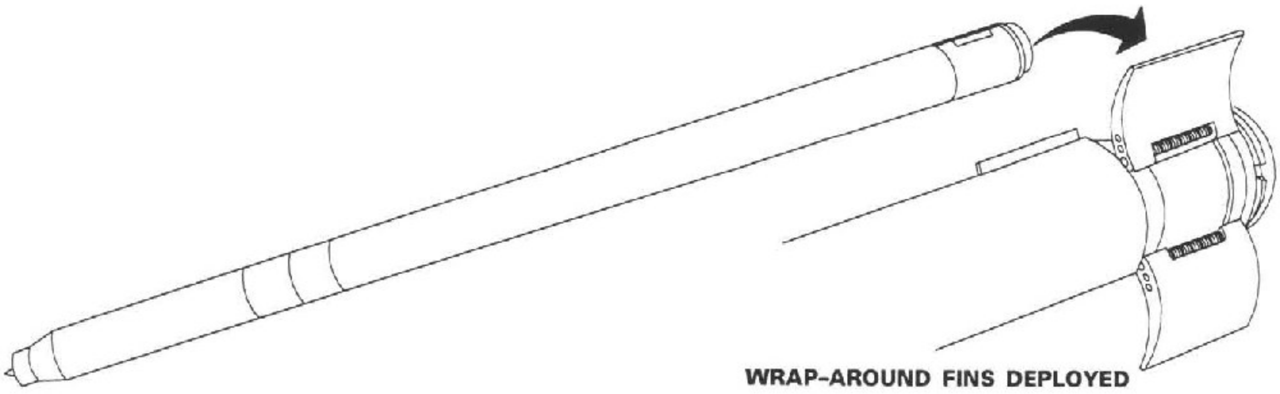
ROCKET MOTOR MK 66 MOD 1



ROCKET MOTOR MK 66 MOD 2

ROCKET WITH WARHEAD	LENGTH	DIAMETER (IN)	WEIGHT (LB)	COLOR CODE
MK 1 (HE)	4 FT 2 IN.	2.75	20	OD/YELLOW BAND
MK 5 (HEAT)	4 FT 2 IN.	2.75	20	OD/YELLOW BAND
M151 (PMI)	4 FT 7 IN.	2.75	24	OD/YELLOW BAND
M156 (WP)	4 FT 7 IN.	2.75	24	GREEN/WH LTRS

Figure 1-478. Wrap-Around Fin Aircraft Rocket (WAFAR), 2.75-Inch



ROCKET WITH WARHEAD	LENGTH	DIAMETER (INCHES)	WEIGHT (POUNDS)	COLOR CODE
MK 1 (HE)	4 FEET 5 INCHES	2.75	21	OD/YELLOW BAND
MK 5 (HEAT)	4 FEET 5 INCHES	2.75	21	OD/YELLOW BAND
MK151 (HE)	4 FEET 9 INCHES	2.75	24	OD/YELLOW BAND
MK156 (WP)	4 FEET 9 INCHES	2.75	24	GREEN/RED LETTERS

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Figure 1-479. CRV7 Rocket

2.75-INCH ROCKET WARHEADS

MK 1 Warhead (HE)

The MK 1 HE warhead (figure 1-480) has a steel case and an HE charge of 1.4 pounds of HBX-1 and uses the MK 176, MK 178, or M427 fuze. With the MK 178 fuze installed, the warhead weighs 6.5 pounds. The primary effects of the MK 1 warhead are blast and fragmentation.

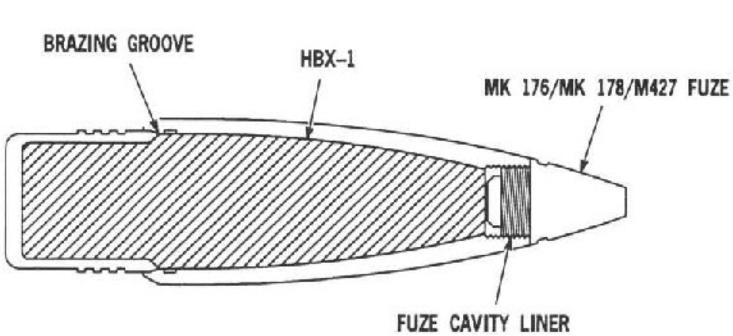
MK 5 Warhead (HEAT)

The MK 5 warhead (figure 1-480) is similar in external configuration to the MK 1 warhead. The filler is 0.92 pound of composition B in the form of a shaped charge. A booster pellet is located at the base of the shaped charge. With the MK 181 fuze installed, the warhead weighs 6.6 pounds. The warhead is intended for use against tanks and other armor.

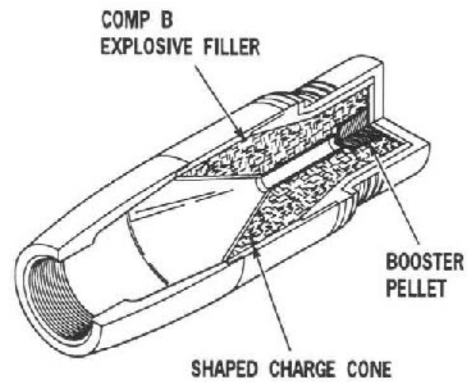
When the MK 5 warhead impacts and the fuze functions, a shaped-charge booster in the fuze projects a shock wave through the cone and flash tube of the warhead to the warhead booster pellet. The warhead booster pellet detonates and ignites the warhead shaped charge, which is designed to focus all the energy from the detonation into a narrow, high velocity jet. Pressures up to 25,000 psi are produced on the point of impact. Depth of penetration is a function of target density. Since all energy is directed forward, there is little appreciable lateral blast effect from the MK 5 warhead.

M151 Warhead (PMI)

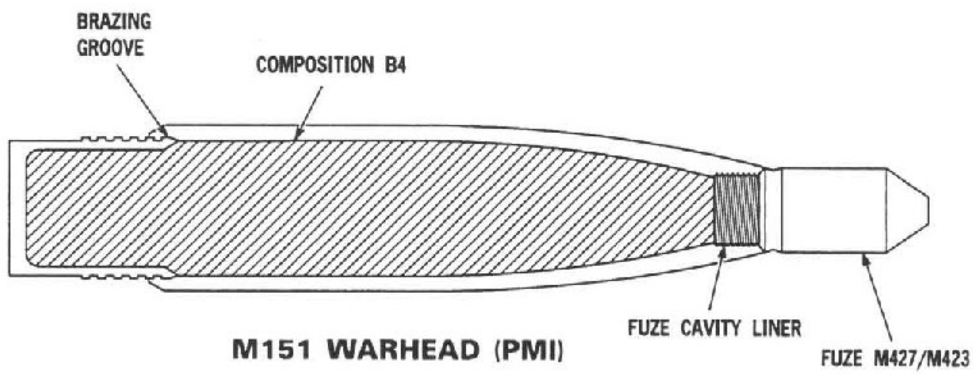
The M151 warhead (figure 1-480) has a pearlite malleable iron (PMI) case filled with 2.32 pounds of composition B4 and uses the M427/M423 fuze. With the M427/M423 installed, the warhead weighs 9.6 pounds. The primary effect of the M151 warhead is fragmentation.



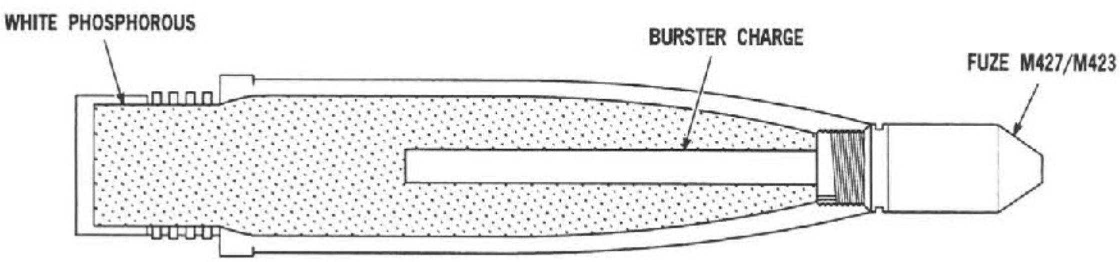
MK 1 WARHEAD (HE)



MK 5 WARHEAD (HEAT)



M151 WARHEAD (PMI)



M156 WARHEAD (WP)

Figure 1-480. Rocket Warheads, 2.75-Inch

M156 Warhead (WP)

The M156 (figure 1-480) is a target-marking white phosphorous (WP) warhead. The external appearance of the M156 is identical to that of the M151 HE warhead. Because of this similarity in appearance, markings must be carefully observed and maintained. With the M427 fuze installed, the warhead weighs 11 pounds and contains 0.125 pound of composition B4 and 2.3 pounds of WP.

When the warhead impacts and the fuze functions, the fuze booster initiates the warhead burster charge. The burst charge ruptures the warhead case and scatters the phosphorus, which ignites spontaneously to provide dense smoke. Incendiary effect is minor.

2.75-INCH ROCKET FUZES

M423/M427 Impact Rocket Warhead Fuze

The M423/M427 fuze is a super-quick-action impact fuze used on the M151 and M156 warheads. The fuze assembly consists of an inertial arming device, a mechanical firing mechanism, and an explosive train consisting of a primer, detonator, lead-in, and booster. The primer and booster are housed in an unbalanced arming rotor. In the unarmed condition, the rotor is locked in position so that the primer and detonator are out of line with the firing pin and booster. Fuzing elements are housed in a conical aluminum case. The fuze is graze sensitive with super-quick-action on impact and requires 20g's for approximately 1 second to arm. The M423 has a shorter arming time than the M427.

When the rocket is launched, inertial forces resulting from acceleration move a setback weight aft and free the arming rotor to turn. Sustained acceleration causes the unbalanced arming rotor to turn and lock in the armed position. The explosive train is in line and the primer is aligned with the firing pin. The firing pin is driven against the primer on impact. The primer functions and initiates the explosive train.

MK 181 Impact Rocket Warhead Fuze

The MK 181 fuze assembly is used with the MK 5 warhead and consists of an arming device, a firing mechanism, and a shaped-charge booster. The fuze contains an impact-sensitive primer and does not require a firing pin. Fuze arming is actuated by sustained rocket acceleration of approximately 20g's.

When the rocket is launched, inertial acceleration forces the rotor free. Sustained acceleration forces turn and lock the unbalanced rotor in the armed position. The explosive train is then in line. On impact, the primer functions and initiates the explosive train. The shaped-charge booster detonates and projects a shock wave against a booster pellet at the base of the warhead. The booster pellet then ignites the warhead shaped charge.

DISPENSER-TYPE MUNITIONS

Cluster bombs (figure 1-481) are dispensers loaded with submunitions and may remain attached to the aircraft or released as a freefall unit. Dispensers that remain attached to the aircraft dispense the submunitions by ejection through the bottom of the dispenser. Dispensers released as freefall units are designed as clamshells with two longitudinal sections (SUU-30) (figure 1-482). The clamshells blow apart at a predetermined time after release, or at a given altitude, and the submunitions inside are released. The submunitions (figure 1-483) are bomblets or mines designed for use against such targets as light material, personnel, or armor.

SUU-30H/B DISPENSER

The SUU-30H/B dispenser (figure 1-482) is a cylindrical metal container that is divided in half longitudinally. The upper half contains a strongback section that provides for forced ejection and sway bracing. The lugs are mounted on metal rods that extend through the dispenser and are attached to the lower half. The two halves are locked together by a nose locking cap at the forward end and by a baseplate bolted to the aft end. The nose locking cap consists of a lanyard tube, four shearpins, cap coupling, adapter, breech cap, and nose plug. A dual set of external arming wire guides is positioned along the top half of the dispenser to prevent excess arming wire vibration and to route the arming wire around the bomb rack ejector foot. Four cast-aluminum fins are attached at 90 degrees to the aft end of the dispenser and are canted 1.25 degrees to impart spin-stabilized flight. Additionally, a small drag plate is attached to the trailing edge of each fin to provide stability during separation from the aircraft.

When the dispenser is released from the aircraft, the arming wire/lanyard initiates the fuze arming and delay cycle. At fuze function, the fuze booster is ignited, blowing the fuze and nose locking cap forward and unlocking the forward end of the dispenser. Ram-air action on the dispenser forces the two halves apart, instantaneously dispensing the payload and causing the bomblets to spin-arm and self-dispense from the center of the trajectory at the point of release. The result is a doughnut-shaped void in the center of the pattern. Minimum delivery altitude for SUU-30-type CBU's is a function of bomblet arming plus SUU-30 fuzing requirements.

CBU-52B/B CLUSTER BOMB

The SUU-30H/B is loaded with 220 BLU-61A/B bomblets to create the CBU-52B/B. The BLU-61A/B (figure 1-484) is a spin-armed, self-dispersing fragmentation submunition that detonates upon impact. When the bomblet is released into the airstream, the bomblet flutes produce a high rate of spin. Spinning induces dispersion and initiates arming of the M129 fuze. Weights holding the rotor in the unarmed position are released by the centrifugal force caused by spinning. To arm, the hammer weights move back, releasing the firing pin from the rotor. The M129 fuze is sensitive to impact from any direction. Impact detonates the HE filler, which bursts the bomblet case and propels fragments at high velocity (approximately 5000 fps) in a radial direction. The case consists of three parts. A liner made of zirconium tin provides incendiary effects against flammable targets. A coined steel fragmenting case surrounds the liner, and the outer urethane plastic case surrounds the steel case. The aerodynamic flutes are molded into the plastic.

CBU-58/B CLUSTER BOMB

The SUU-30H/B is loaded with 650 BLU-63/B bomblets to create the CBU-58/B. The BLU-63/B (figure 1-484) is smaller in size, but similar in shape and function, to the BLU-61A/B used in the CBU-52B/B and uses the same M129 fuze. The average velocity is 4500 to 4900 fps. The main difference between the two submunitions is that the BLU-63/B has a scored steel fragmenting case that produces 260 fragments as opposed to the coined steel case of the BLU-61B/B.

CBU-58A/B CLUSTER BOMB

The SUU-30H/B is loaded with 650 BLU-63A/B bomblets to create the CBU-58A/B. The BLU-63A/B (figure 1-484) differs from the BLU-63/B bomblet in that the BLU-63A/B contains two 5-gram titanium pellets. The titanium is an incendiary used for additional capability against flammable targets. In all other respects it is identical to the BLU-63/B bomblet.

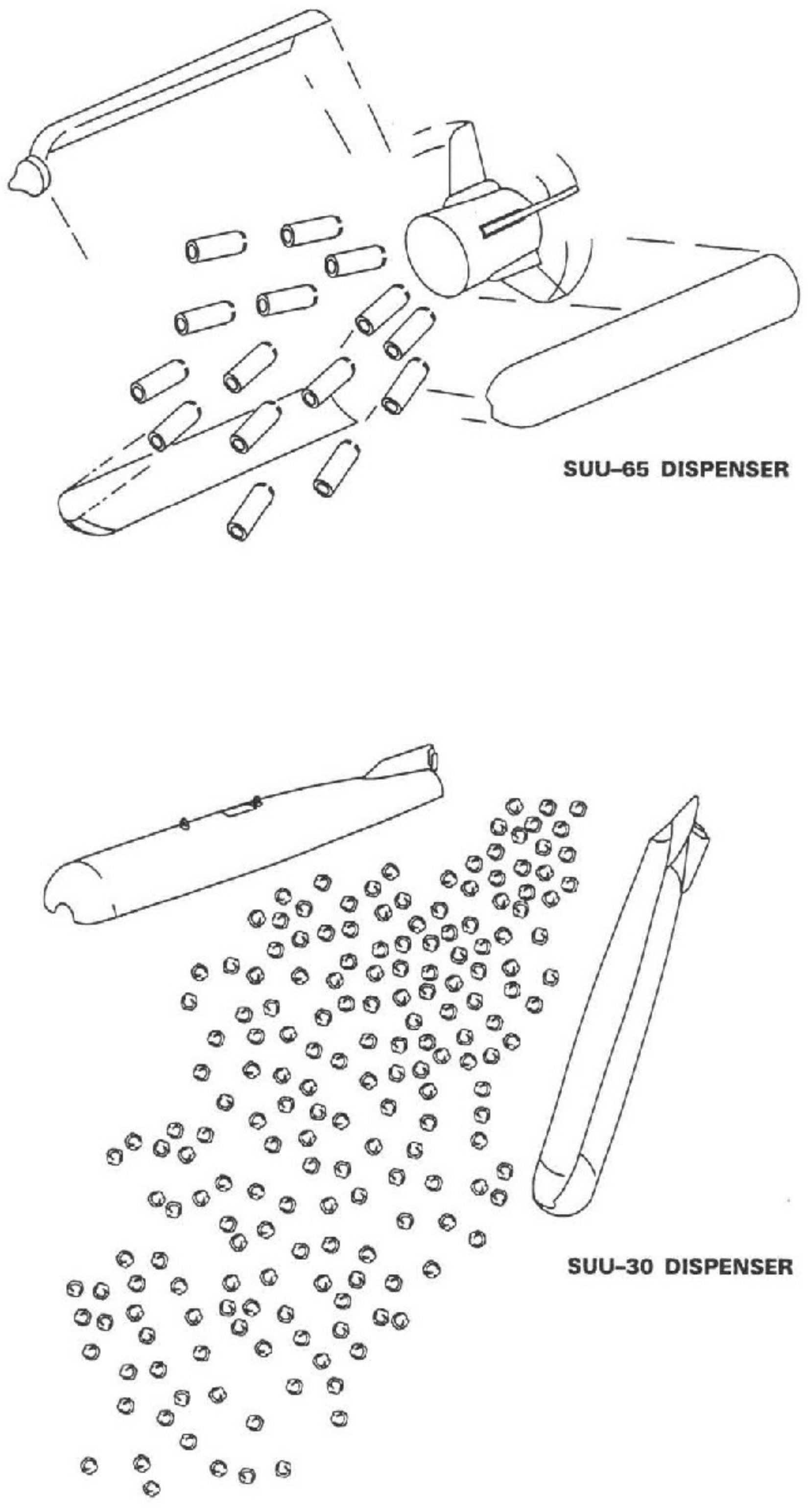


Figure 1-481. Cluster Bomb Dispensers

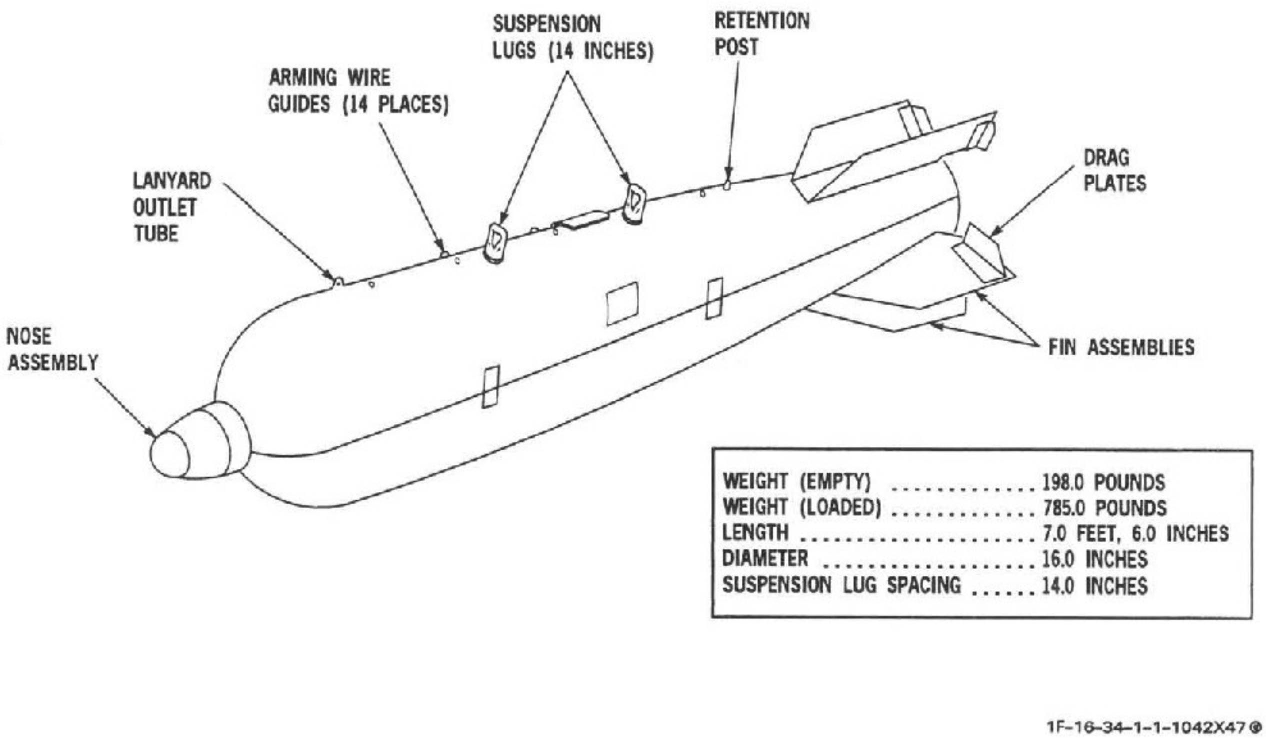
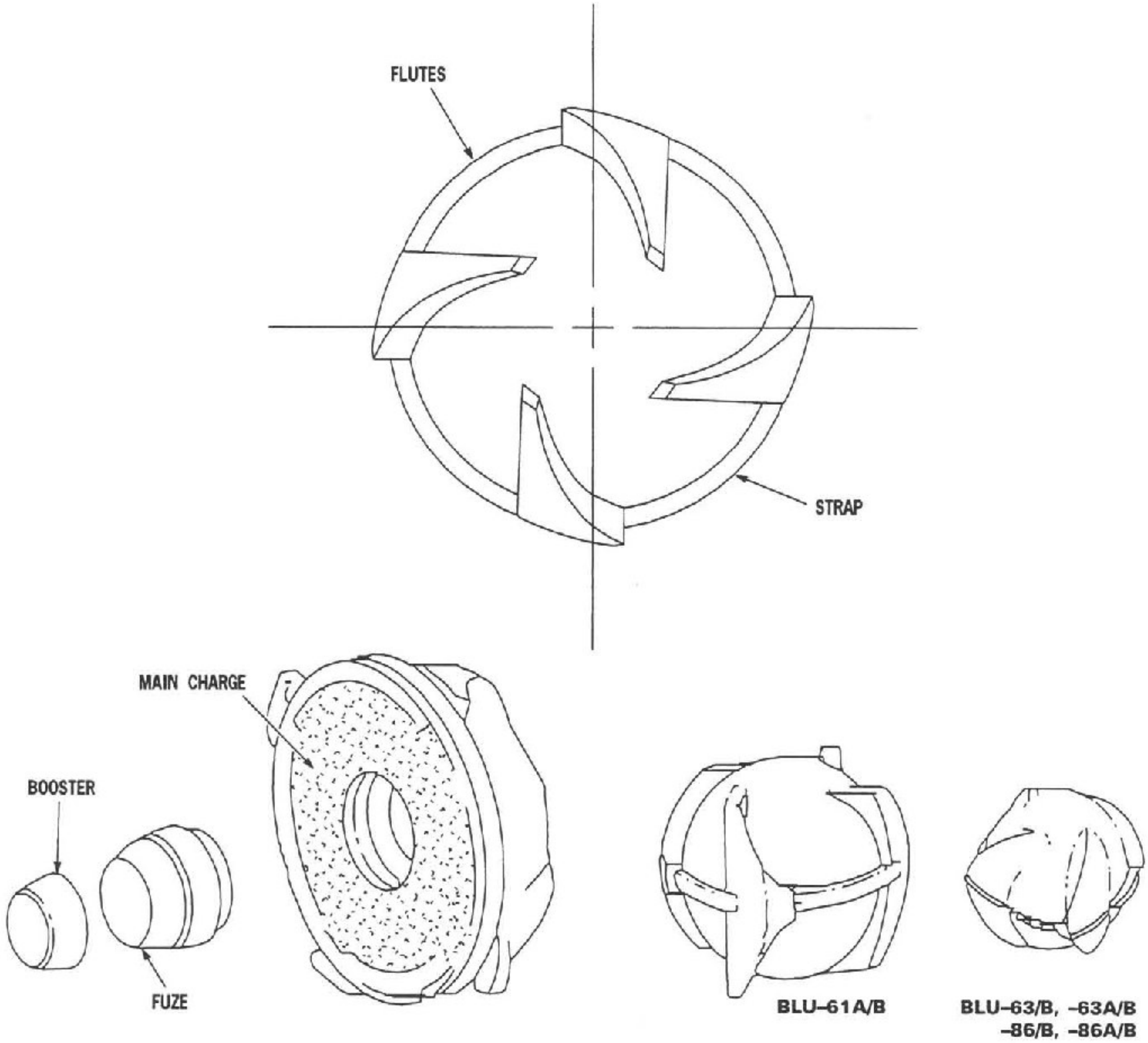


Figure 1-482. SUU-30H/B Dispenser

MUNITION	DISPENSER	SUBMUNITION	APPROXIMATE NUMBER OF BOMBLETS	TOTAL WEIGHT (LB)
CBU-52B/B	SUU-30H/B	BLU-61A/B	220	785
CBU-58/B	SUU-30H/B	BLU-63/B	650	810
CBU-58A/B	SUU-30H/B	BLU-63A/B	650	820
CBU-71/B	SUU-30H/B	BLU-86/B	650	810
CBU-71A/B	SUU-30H/B	BLU-86A/B	650	820
MK-20 (ROCKEYE)	MK 7	MK 118	247	490
BL-755	BL-755	BL-755	147	600
CBU-87/B	SUU-65/B	BLU-97/B	202	960

Figure 1-483. Cluster Bomb Chart



	BLU-61A/B	BLU-63/B, -63A/B BLU-86/B, -86A/B
DIAMETER	3.5 INCHES	2.94 INCHES
WEIGHT	2.7 POUNDS	0.93 POUND
EXPLOSIVE WEIGHT	0.65 POUND	0.25 POUND

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Figure 1-484. BLU Bomblets (Typical)

CBU-71/B CLUSTER BOMB

The SUU-30H/B is loaded with 650 BLU-86/B bomblets to create the CBU-71/B. The BLU-86/B (figure 1-484) differs from the BLU-63/B bomblet in that the BLU-86/B incorporates the M224 time-delay fuze, which detonates at random times after impact. In all other respects it is identical to the BLU-63/B.

CBU-71A/B CLUSTER BOMB

The SUU-30H/B is loaded with 650 BLU-86A/B bomblets to create the CBU-71A/B. The BLU-86A/B (figure 1-484) differs from the BLU-63A/B incendiary bomblet in that the BLU-86A/B incorporates the M224 time-delay fuze.

M224 RANDOM TIME DELAY FUZE

The M224 is a random time delay, spin-armed fuze that arms between 2400 and 3200 rpm. The fuze firing train consists of a detonator, lead charge of pressed RDX, and a spring-actuated firing pin released when the delay rotor reaches the necessary displacement. This rotor is timed by a variable-viscosity lubricant. The detonator is out of line until after arming.

WARNING

Avoid low altitude overflights of areas where time delayed munitions have been deployed.

SUU-65/B TACTICAL MUNITIONS DISPENSERS

The SUU-65/B tactical munitions dispenser (TMD) (figure 1-485) is a cluster munitions dispenser. The components in the SUU-65/B can be grouped into three main assemblies, body, tail, and nose, to include an integral timer fuze (figure 1-486).

The body is an aluminum cylinder that is welded to the forward bulkhead. This forms the main structure to which the remaining components are attached. The strongback is a single piece of aluminum attached to the underside of the cylinder and provides the strength and rigidity necessary for suspension and carriage. Two electrical harnesses are attached to the body: the fuze harness and body harness. The cutting network consists of a manifold and lead, three longitudinal strands of aluminum linear-shaped charges (ALSC), and a circumferential strand of ALSC at the aft bulkhead. Its function is to cut the dispenser body into three longitudinal pieces and separate the tail section. The aft bulkhead provides the primary structural support for the aft end of the body and acts as a seal for the cargo section.

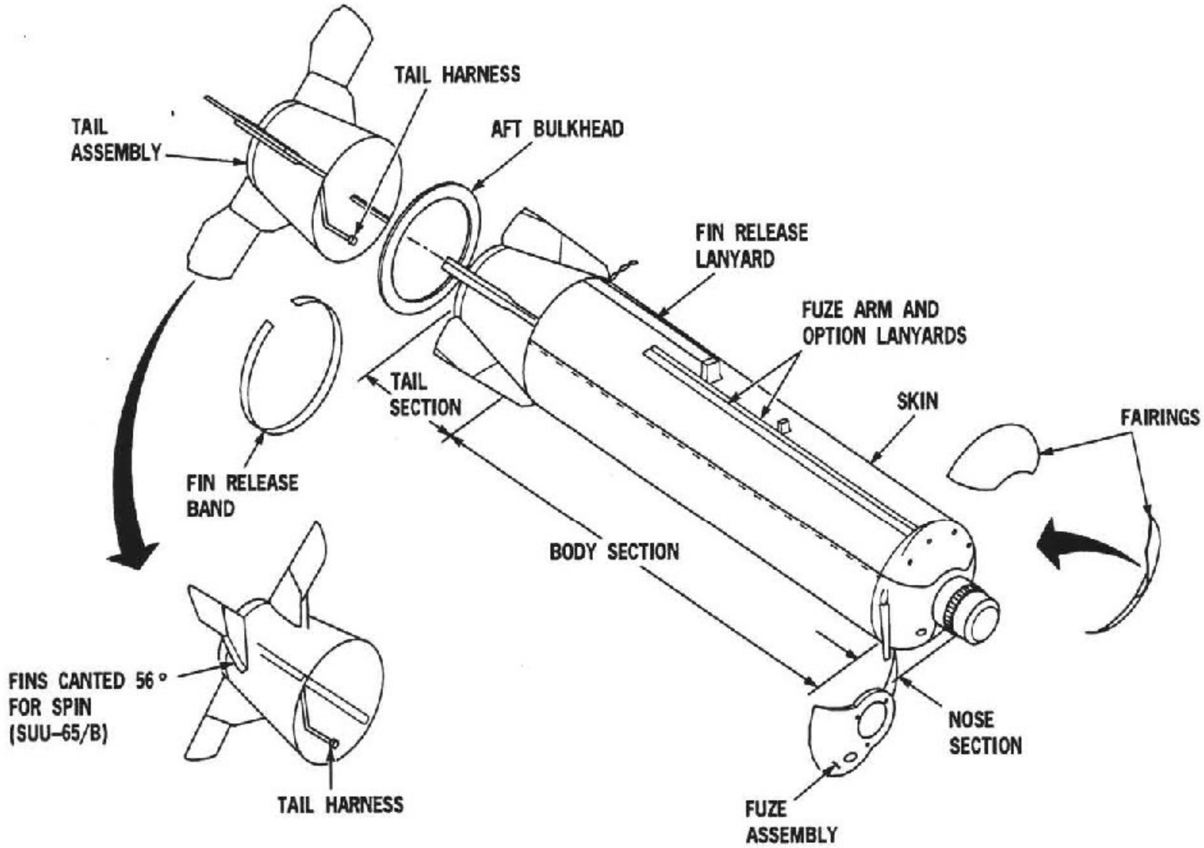
The lanyard system consists of three lanyards in two aluminum conduits and three lanyard extractors. The lanyard system is used to release the fin, initiate fuze arming, and select the fuze mode. The forward conduit carries the fuze arming and the fuze option lanyards, and the rear conduit carries the fin release lanyard. Each lanyard is secured at one end and connected to its particular function at the other end. The use of lanyard extractors with break links allows the lanyards to be retained by the dispenser after release.

The SUU-65/B has a modified tail section that imparts spin to the dispenser. The spin tail contains a fin cant mechanism and an explosive bolt and tail harness. The tail harness connects the body harness to the explosive bolt assembly. When the spin mode is selected, a signal is sent from the fuze through the body harness that detonates the explosive bolt. This allows the spring-loaded fin cant mechanism to rotate the fins to the fully canted position. The TMD will open when the preset spin rate is achieved. Six ground selectable spin rate settings ranging from 0 to 2500 rpm are available.

Sequence of Events

After release, the TMD falls away from the aircraft and pulls the fin lanyard, which releases the extendable fins. When the primary arming wire is pulled, the battery in the integral timer fuze starts the timer. When the preselected time has expired, the integral timer fuze detonates the explosive bolt. This allows the fin cant mechanism to rotate the fins 56 degrees.

The fin cant imparts spin on the TMD, and the integral timer fuze fires the ALSC when it senses the preselected spin rate. The ALSC cuts the TMD in three equal longitudinal pieces, dispensing the bomblets radially.



ARMING TIMER OPTIONS		
SETTING	SECONDS	TOLERANCE
M	0.63	+0.12
N	0.95	+0.14
O	1.28	+0.16
P	1.60	+0.18
R	1.92	+0.20
S	2.23	+0.25
T	2.55	+0.27
U	2.87	+0.31
V	3.19	+0.34
X	3.51	+0.37
Y	3.83	+0.40
Z	4.15	+0.44

SUU-65/B SPIN RATE OPTIONS		
SETTING	RPM	TOLERANCE
1	0	0*
2	500	±75
3	1000	±100
4	1500	±150
5	2000	±200
6	2500	±250

* ALLOWS FOR RPM OF 250.

CHARACTERISTICS	SUU-65/B CBU-87
WEIGHT	960 POUNDS
LENGTH	7 FEET 8 INCHES
DIAMETER	16 INCHES
SUSPENSION LUG SPACING	14 INCHES

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Figure 1-485. SUU-65/B Tactical Munition Dispensers

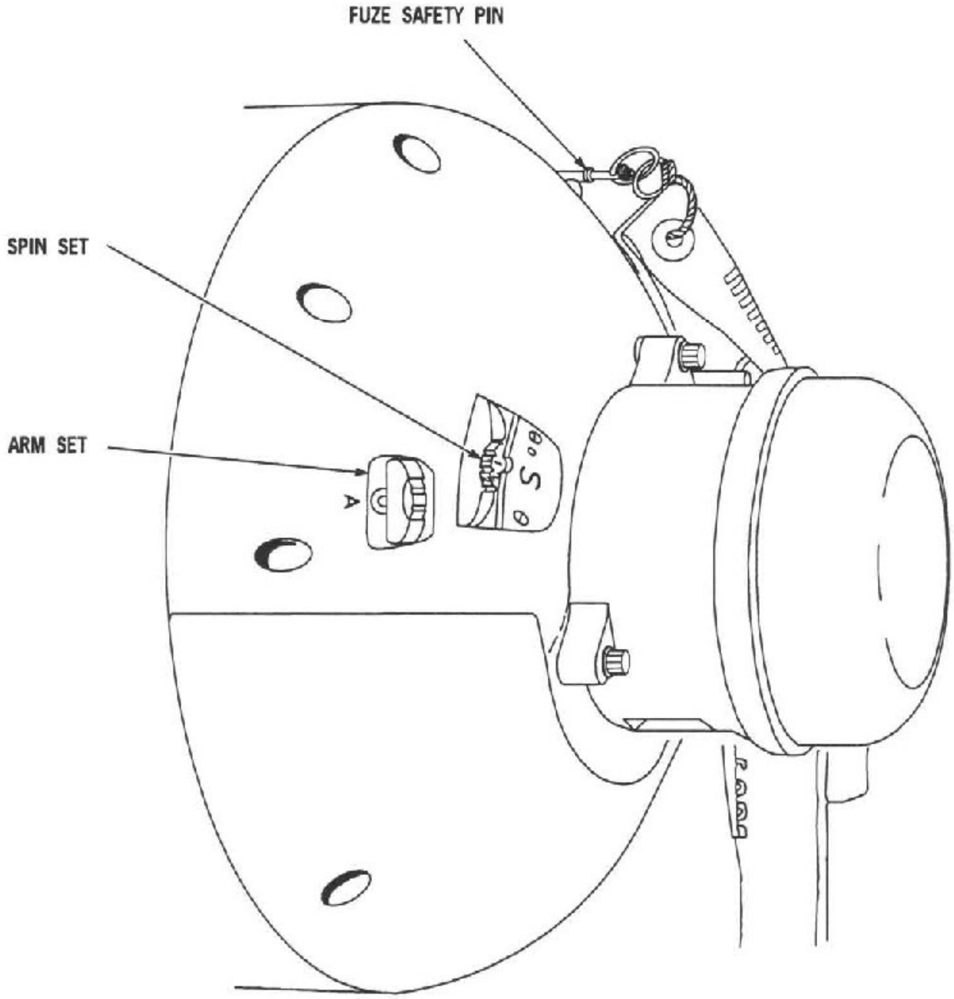


Figure 1-486. SUU-65/B Integral Timer

CBU-87/B, CLUSTER BOMB COMBINED EFFECTS MUNITIONS (CEM)

WARNING

- CBU-87/B cluster bombs have experienced numerous submunition airbursts immediately following submunition arming. These airbursts affect safe separation from submunition shaped charges during level deliveries when releasing multiple weapons in the timer mode. Refer to Section III for delivery restrictions.
- Timer setting M (0.63 second) is selectable but does not provide safe separation. Minimum timer setting is N (0.95 second).

The CBU-87/B combined effects munition (CEM) consists of a SUU-65/B and 202 BLU-97/B bomblets (figure 1-487). Of the six ground-selectable spin rates, only two are used with CEM: setting 3 (1000 rpm) and setting 5 (2000 rpm). The BLU-97/B case is made of scored steel designed to fragment into approximately 300 preformed 30-grain fragments for defeating light armor and personnel. It contains a forward-firing, shaped-charge liner for defeating armor and a zirconium ring for incendiary capability. An air inflatable decelerator (AID) or ram-air decelerator (RAD) that provides drag, orientation, and flight stability for the bomblet is held encased by a cap called a spyder.

When the BLU-97/B is released into the airstream from the SUU-65 dispenser and attains a minimum airspeed of 175 KCAS or greater, the airflow releases the spyder, which pulls the cup assembly rearward, exposing the AID/RAD to the airstream. As the AID/RAD is inflated by ram air, it orients and stabilizes the BLU-97/B for proper target impact by despinning the submunition and reducing the descent rate to approximately 125 fps. The AID/RAD transmits the air-induced loads to a shaft in the fuze that arms the submunition. 6.5g deceleration is required to arm the fuze. Total arming time after deployment requires approximately 1.0 second. Release of the spyder also allows a standoff tube to deploy forward. When the BLU-97/B impacts the target, the standoff tube is driven rearward to detonate the submunition. In the event the BLU-97/B impacts the target at an angle that does not drive back the standoff tube, a secondary omnidirectional piezoelectric firing system will detonate the submunition.

MK-20 MOD 3 AND MOD 4 (ROCKEYE II) CLUSTER BOMB

The MK-20 Rockeye (figure 1-488) is an anti-armor cluster bomb consisting of the MK 7 clamshell dispenser, MK 339 mechanical time fuze, and MK 118 bomblets. The weapon is produced, delivered, and loaded as a complete unit.

MK-20 Mod 3

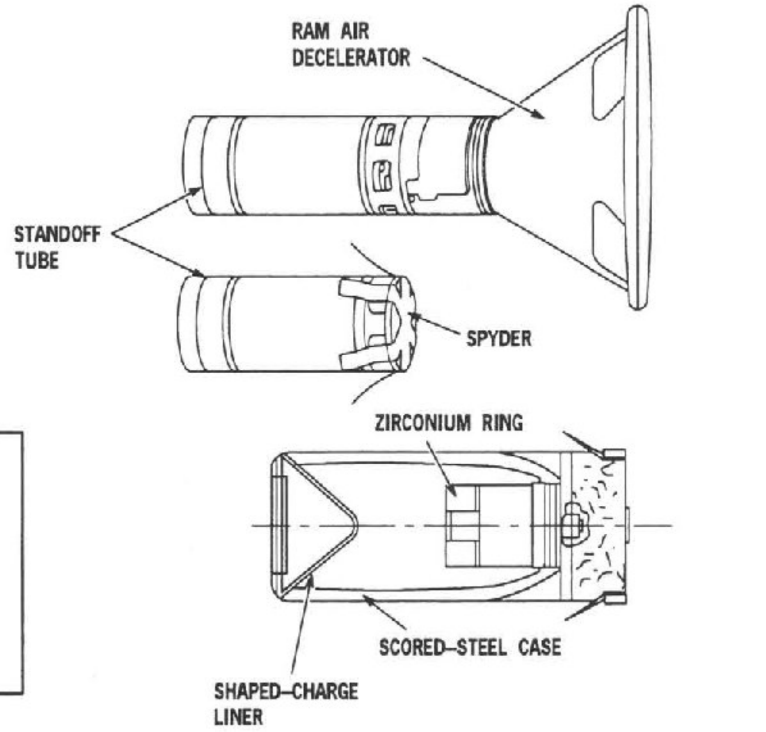
The MK 7 Mod 3 dispenser (figure 1-488) has a pilot option wire to allow the pilot to select, while airborne, either of the two fuze function times set on the MK 339 fuze. The conduit for the fuze wire is modified to allow routing of the pilot option wire to the tail solenoid.

MK-20 Mod 4

The MK 7 Mod 4 dispenser (figure 1-488) differs from the Mod 3 dispenser in that the Mod 4 dispenser section has two additional threaded lug wells to permit the center of balance to be shifted forward by repositioning the suspension lugs. In addition, the Mod 4 contains the MK 118 Mod 1, which arms in 0.5 second. The fin release wire and conduit are lengthened to permit attachment of the fin release extractors in two additional places.

NOTE

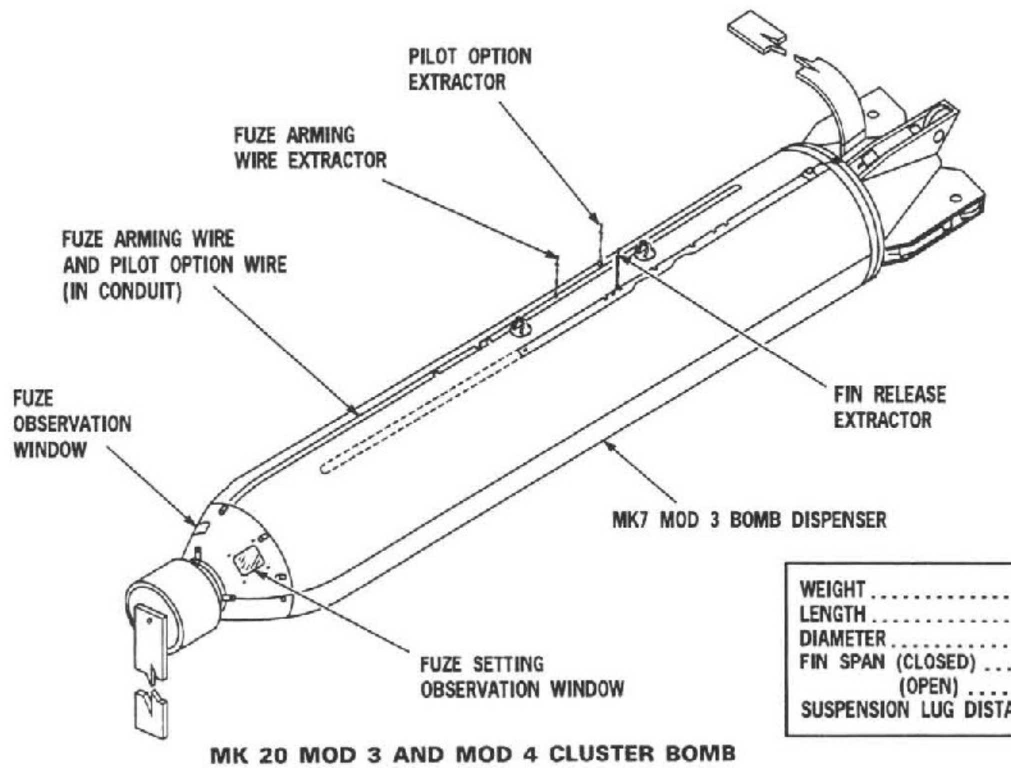
On both the Mod 3 and Mod 4 dispensers, selection of the nose arming option activates the primary time. Selection of nose/tail activates the option timer. Selection of tail only duds the bomb.



CHARACTERISTICS

DIAMETER	2 INCHES
WEIGHT, TOTAL	3 POUNDS
EXPLOSIVE	CYCLOTOL
WEIGHT	0.65 POUND
LENGTH	
STOWED	7 INCHES
DEPLOYED	10 INCHES

Figure 1-487. BLU-97 Bomblet (Typical)



NOTE

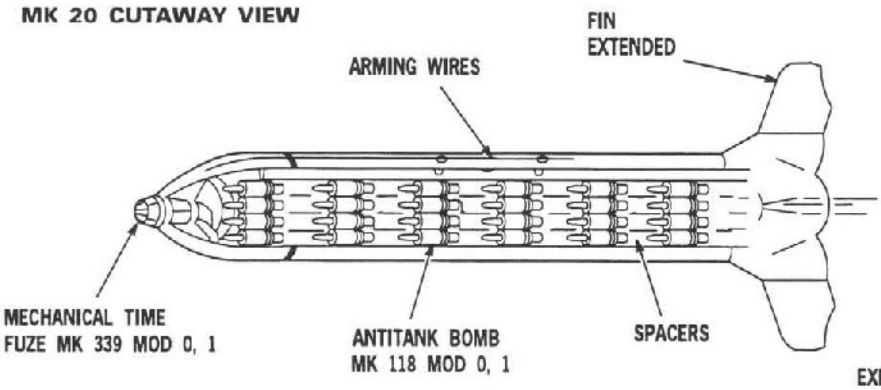
BROKEN LINES (-------) APPLY TO MK 7 MOD 4 DISPENSER

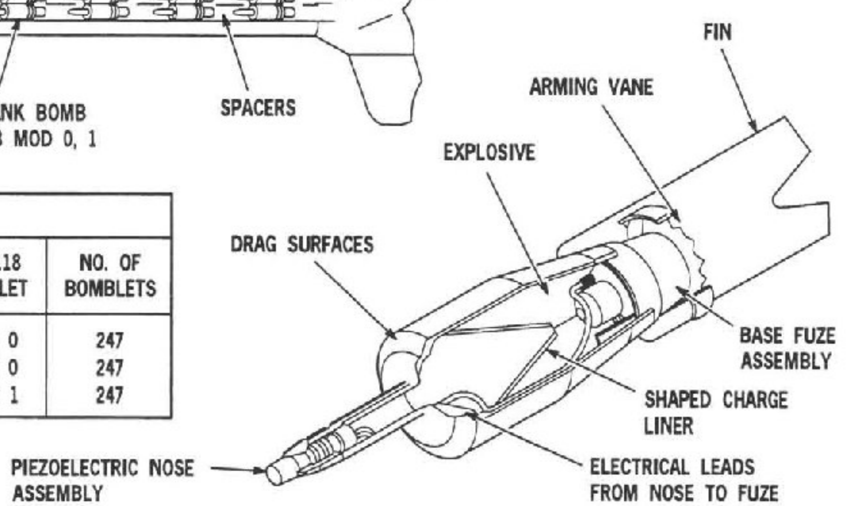
WEIGHT	490 POUNDS
LENGTH	7 FEET 6 INCHES
DIAMETER	13 INCHES
FIN SPAN (CLOSED)	17 INCHES
(OPEN)	35 INCHES
SUSPENSION LUG DISTANCE	14 INCHES

Figure 1-488. MK-20 Mod 3 and Mod 4 (Rockeye II) Cluster Bomb

MK 118 Mod 0 Bomblet

MK 118 Mod 0 antitank bomblet (figure 1-489) is used in the MK-20 Mod 3 Rockeye. The bomblet consists of three fixed plastic stabilizing fins, the body, and a fuzing system. The body consists of a strong alloy outer shell and standoff probe, a 0.4-pound explosive shaped charge of Octol, and a shaped-charge copper liner. The fuzing system consists of a piezoelectric nose assembly, a base fuze assembly, and an arming vane. Upon separation from the MK 7 dispenser, rotation of the arming vane initiates the arming cycle. The bomblet requires a speed of at least 200 knots to arm. It takes a total of 1.2 seconds to fully arm. Fuze detonation is initiated by either of two methods. Upon impact with a hard target, an electrical charge is extracted from the piezoelectric nose crystal and transferred through wiring to set off an electric detonation in the base fuze. Upon impact with soft targets, the base fuze firing pin fires a stab detonator that fires the electric detonator. The explosive charge functions the same whether initiated by the nose element or the base element. The shock waves of detonation within the shaped charge produce a high velocity gas jet and collapse the copper liner into a slug. When the gas jet strikes the target, pressures up to 250,000 psi are focused at the point of impact, allowing penetration of approximately 7.5 inches of armor. Little lateral blast or temperature effects are produced by the shaped charge; however, fragmentation effects from the outer shell are appreciable.





MK 20 COMPONENTS

MK 20 MOD	MK 7 DISPENSER	MK 339 FUZE	MK 118 BOMBLET	NO. OF BOMBLETS
2	MOD 2	MOD 0	MOD 0	247
3	MOD 3	MOD 0 OR 1	MOD 0	247
4	MOD 4	MOD 1	MOD 1	247

LENGTH	13 INCHES
DIAMETER	2 INCHES
WEIGHT	1 POUND

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Figure 1-489. MK 118 Bomblet

MK 118 Mod 1 Bomblet

The MK 118 Mod 1 bomblet differs from the MK 118 Mod 0 in that the MK 118 Mod 1 total arming time is reduced to 0.5 second. It is used in the MK-20 Mod 4 Rockeye. In all other respects, both bomblets are identical.

NOTE

In MK-20 Mod 3 and Mod 4 cluster bombs with lot numbers CRA-8ID-051-001 and subsequent, the piezoelectric nose assembly has been removed and the bomb relies on the base element for detonation for both hard and soft targets.

MK-20 Rockeye Delivery Considerations

Arming time for the total munition depends on the MK 339 fuze function time and the bomblet arming time. Minimum TOF is based on the MK 339 1.2 +0.1 seconds setting as depicted in figure 1-490.

	MK-20 MOD 3	MK-20 MOD 4
Dispenser (MK 339)	1.1 to 1.3 Seconds	1.1 to 1.3 Seconds
Bomblet (MK 118)	1.2 Seconds	0.5 Second
Total Arm Time	2.3 to 2.5 Seconds	1.6 to 1.8 Seconds

Figure 1-490. MK-20 Delivery Considerations

CAUTION

When the MK-20 Mod 4 is released, the aircraft may not be clear of the submunition fragment envelope at submunition fuze arming. Refer to SAFE SEPARATION (Section III).

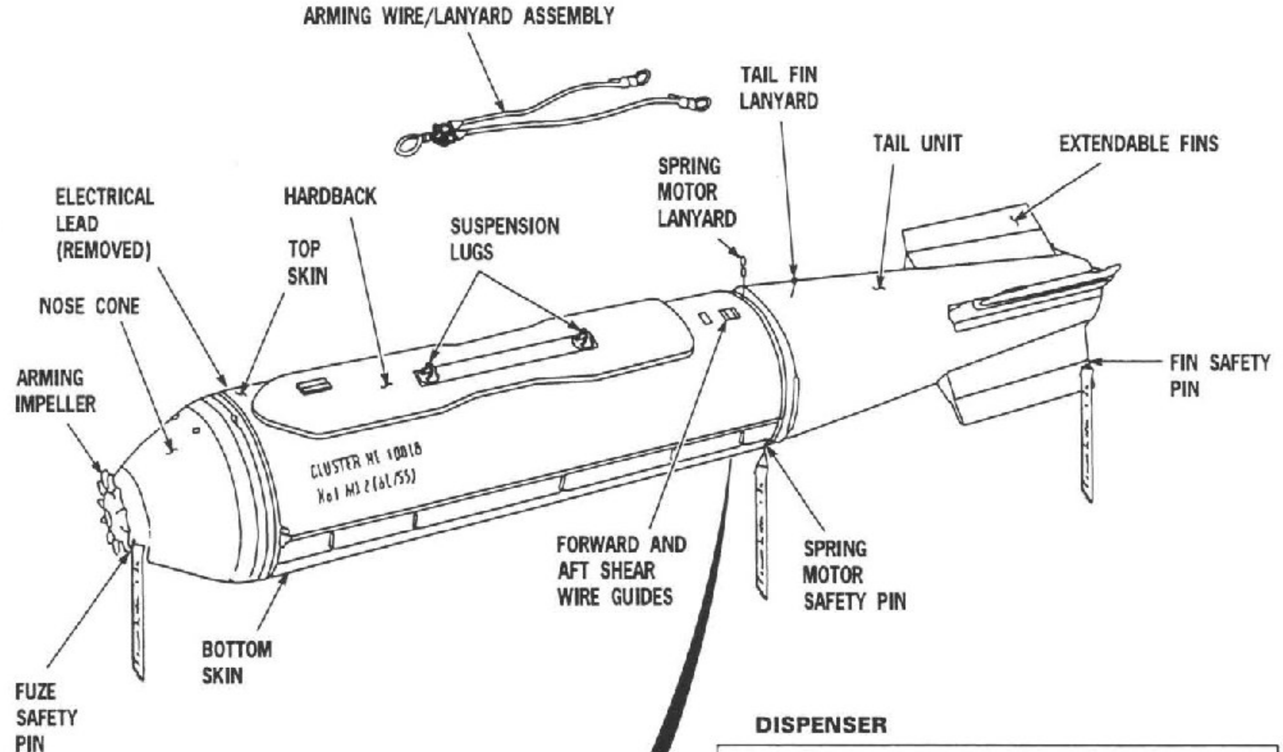
The MK-20 Rockeye is more efficiently used against area targets that require penetration to kill, although it can be employed against soft targets. Its probability of kill against any target is driven by impact angle and bomblet density. The recommended method to increase bomblet density is to make a multiple release. Bomblet impact patterns have no doughnut effect, and the bomblets are generally evenly spaced throughout an ellipse. These can be varied by dive angle, airspeed, and height of burst (HOB) (release altitude and fuze function time).

BL-755 CLUSTER BOMB AND BL-755 BOMBLET

The BL-755 (figure 1-491) is similar to the MK-20 Rockeye. It is composed of a bomb body, a nose fairing, and a tail unit. The bomb cluster contains 147 armor-piercing bomblets. The nose fairing contains the safety, arming, and functioning unit (SAFU), which is a factory-installed impeller-driven mechanical nose fuze. A minimum airspeed of 270 knots must be sensed for proper operation of the arming vane. The bomb body consists of two main bulkheads spanned by a suspension beam (hardback) and enclosed by an upper and lower skin that houses the armor-piercing bomblets. The tail unit consists of four spring-loaded extendable fins. Two arming wires/lanyards are used, one for the SAFU and one for the tail unit. Both lanyards are equipped with shear links. The arming wire/lanyard for the tail unit is secured to the bomb rack sway brace so that the fins will extend under any condition for safe separation of the bomb from the aircraft. The arming wire/lanyard for the SAFU and time delay unit is installed in the bomb rack tail arming solenoid. At bomb release, the tail fins extend, the lockpin is removed from the arming impeller, and the time delay starts. At a preset time, the primary cartridge fires to blow off the thin upper and lower skins. Then, a secondary cartridge fires and ejects the BL-755 bomblets outward from the dispenser in a controlled sequence. All components except the arming wire/lanyard are installed during manufacture to make a complete munition.

The BL-755 MK 2 has four fuze time settings.

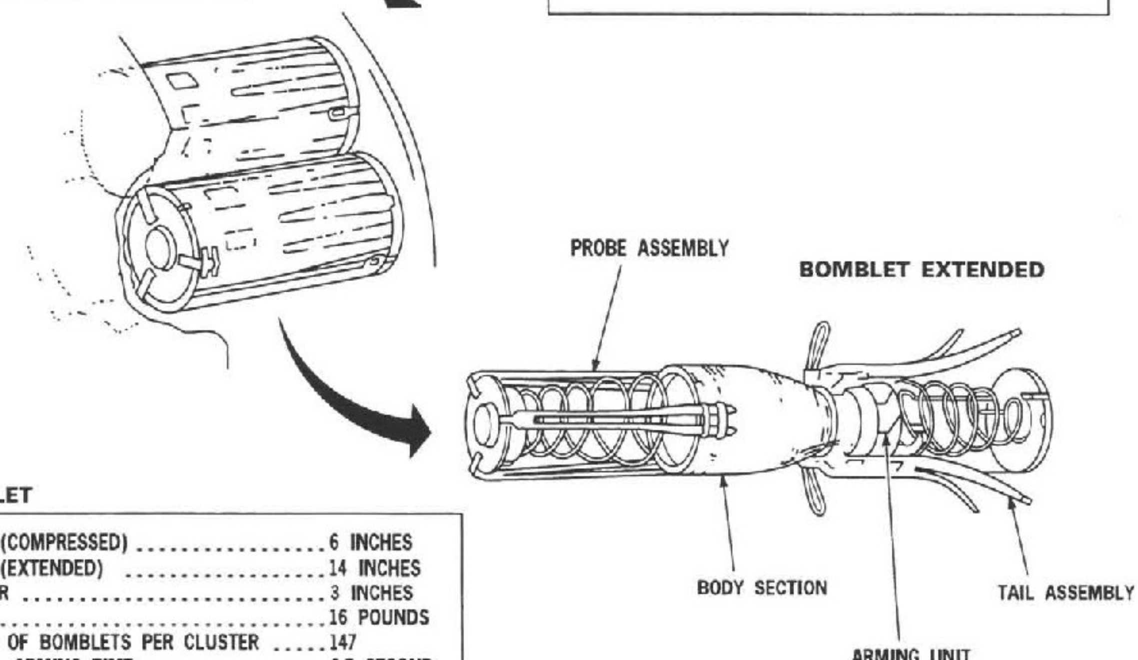
Setting	Fuze Function Time
E	0.68 second
F	0.80 second
G	0.94 second
H	1.13 seconds



DISPENSER

WEIGHT (LOADED)	600 POUNDS (APPROX)
LENGTH	8 FEET
DIAMETER	16 INCHES
FIN SPAN (OPEN)	28 INCHES
(CLOSED)	22 INCHES
SUSPENSION LUG DISTANCE	14 INCHES

BOMBLET COMPRESSED



BOMBLET

LENGTH (COMPRESSED)	6 INCHES
(EXTENDED)	14 INCHES
DIAMETER	3 INCHES
WEIGHT	16 POUNDS
NUMBER OF BOMBLETS PER CLUSTER	147
NOMINAL ARMING TIME	0.7 SECOND

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Figure 1-491. BL-755 Cluster Bomb and BL-755 Bomblet

The electrical detent, a primary safety feature, must be negated before flight. The desired time delay is set prior to takeoff by removal of the arming vane to gain access to the fuze time setting selection lever. Premature operation of the SAFU time is indicated by red in the arm/safe indicator on the face of the SAFU adjacent to the time selector mechanism.

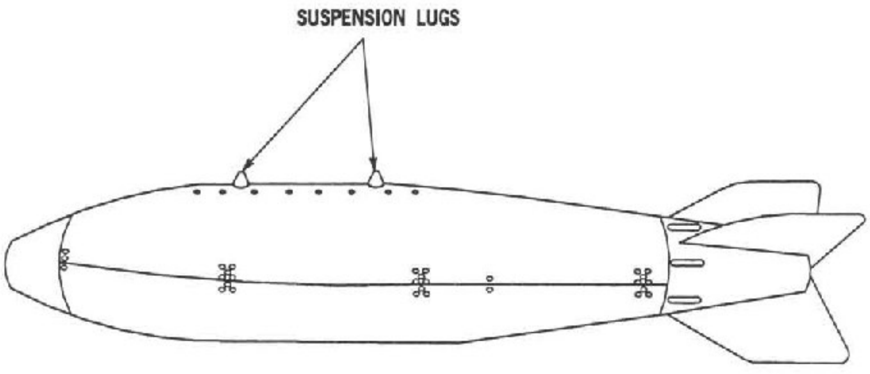
The BL-755 submunition is designed to be compressed when loaded in the bomb cluster by telescoping the probe and tail assemblies over the bomblet body. Upon ejection from the bomb cluster, the probe and tail extend and the arming cycle begins. The probe gives the bomblet the standoff distance required to achieve maximum effectiveness from the shaped charge. The BL-755 bomblet produces more fragmentation than does the MK 118 Rockeye bomblet.

M129E2 LEAFLET BOMB

The M129E2 leaflet bombs (figure 1-492) are designed for use in delivery and distribution of leaflet-type material. The bombs have a cylindrical body with an ogival nose and a tapered aft section. They are constructed of fiberglass. The bomb body is split longitudinally into two sections that are held together by four latches on each side. A steel reinforcing plate below the suspension lugs is added for forced ejection from the aircraft. The fuze well, which is located in the nose of the bomb body, will accommodate a mechanical time fuze designed for airburst operation. No provision is made for a tail fuze. The fin (M148) consists of an elongated fiberglass cone about 20 inches long and four streamlined blades assembled perpendicular to the cone.

Other components include an arming wire, an adapter-booster assembly, and a detonating cord (Primacord). The arming wire is threaded through the fuze safety device, thus keeping the fuze in a safe condition until release. The adapter-booster accommodates the fuze and retains the detonating cord in the proper position. The detonating cord is used to effect separation of the two bomb body sections.

Operation of the bomb occurs at a predetermined number of seconds after release. Functioning of the fuze causes the booster to ignite and detonate the 12-foot-long detonating cord. The detonating cord is inserted through the adapter-booster and longitudinally around the entire bomb. Detonation of the detonating cord separates the two body sections, detaches the fins, and allows the leaflets to be released and scattered. If the nose fuze fails to function, the bomb will disintegrate upon impact.



WEIGHT, EMPTY	92 POUNDS
WEIGHT, FULL	203 POUNDS (DEPENDS ON WEIGHT OF PAPER)
LENGTH	7 FEET 6 INCHES
DIAMETER	16 INCHES
FIN SPAN	22 INCHES
FIN ASSEMBLY	M148
SUSPENSION LUG SPACING	14 INCHES

Figure 1-492. M129E2 Leaflet Bomb

LANTIRN SYSTEM

The low altitude navigation and targeting infrared system for night (LANTIRN) is an imaging infrared system to provide tactical aircraft with a day/night under-the-weather attack capability. Carried left and right of the intake, LANTIRN is designed to employ a wide variety of conventional and precision-guided munitions at night using day-like tactics and deliveries.

LANTIRN consists of three main components: a wide angle conventional (WAC) HUD, navigation pod (NVP), and targeting pod (TGP).

NAVIGATION POD (NVP)

The NVP is fully integrated with the aircraft avionic system to provide navigation and target area acquisition information. It can also be used to deliver unguided, freefall ordnance with the FCC. The NVP (figure 1-535) has two main components: the forward-imaging navigation set (FINS) sensor and the Ku-band terrain following radar (TFR). Design parameters are detailed in figure 1-536.

The FINS, a WFOV FLIR system, provides the pilot with an IR image of the terrain and airspace in front of the aircraft. The FINS includes a look-into-turn mode which enables the pilot to look ahead of the turn while turning and a snap-look mode which provides enhanced left, right, up, and down viewing control while flying level or during turns. FINS functions include video polarity control, video gain and level adjustment options, and a gray scale capability for manual gain and level setting.

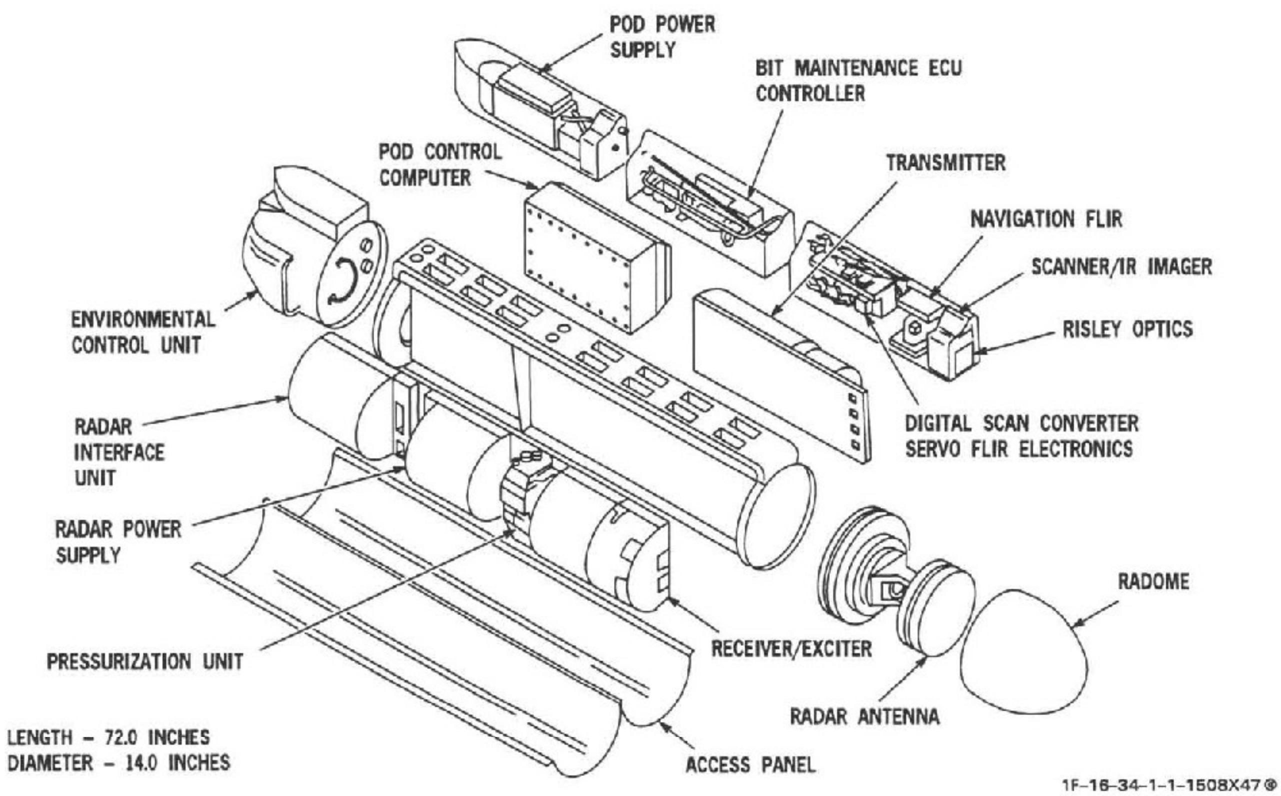


Figure 1-535. Navigation Pod LRU's

Dimensions	72.0 Inches Long 14.0 Inches Diameter
Weight	450 Pounds
Input Power	115 VOLTS, 400 Hz, 3-Phase, +28 VDC
Outputs	FLIR Video, TF Commands, Cautions And Warnings, Failure Discrete Signals
Inputs	FLIR and TFR Signals
Computer Interface	MIL-STD-1553B BUS
FLIR Sensor FOV	21 Degrees By 28 Degrees
FLIR Sensor FOR	77 Degrees By 84 Degrees
FLIR Sensor Digital Resolution	8 Bits
TFR Modes Of Operation	Normal, WX, LPI, VLC
Clearance Range	100 TO 1000 Feet
Look-into-turn Azimuth	30 Degrees (Max), 5.5 Degrees/Sec Turn (Max), 45 Degrees Bank Angle (Max)
Frequency	Ku-Band
Computer Master Processor	64K Word Memory, 615K Operations Per Second
Computer Slave Processor	32K Word Memory, 615k Operations Per Second
ECU Modes Of Operation	Heating, Neutral, Bypass Cooling, Vapor-cycle Cooling
ECU Flow Rate	2 Gallons Per Minute
ECU Fluid Temperature	85°F – Supply 113.4°F – Return
ECU Energy Absorption	1800 Watts

Figure 1-536. Navigation Pod Design Parameters

The NVP is moded such that the TFR and FINS are, in general, designed to be functionally independent of each other. However, the pilot depends on a cross-check of the information from both systems to perform night, low level, navigation tasks.

The TFR features include terrain following, obstacle warning, and limited in-the-weather flying. The set clearance plane (SCP) settings between 200 and 1000 feet AGL are available in the normal mode. In addition to normal operation of the TFR, other modes are available for specific operating conditions. These modes are weather (WX), low probability of intercept (LPI), and very low clearance (VLC).

FINS Subsystem

The FINS generates a 21 by 28 degree gray scale video image of the IR emissions from terrain, targets, and obstacles in the aircraft flightpath. The FINS imagery is presented as a 1:1 image on the HUD, which provides the pilot with a night window for daylight-type operations at night. IR images on the HUD are the same relative size and position as the pilot would see in daylight. Fly-to cues and other symbology are derived from the TFR data and presented on the HUD.

FLIR Scene Conversion to HUD Video Image

All materials above absolute zero temperature emit varying amounts of IR energy at all times. The FINS detects emitted IR energy and processes it to create an image of the FOV under observation. This image is a 1:1 version of the observed area in varying gray shades depending on variations in the IR emissions of the observed scene. The FLIR sensor can be slewed to change the center of the FOV and thus increase the field of regard (FOR). Focusing is done automatically to adjust for temperature differences in the optical path.

FLIR Line-of-Sight (LOS) Options

The FLIR LOS options are incorporated in the FINS to increase the pilot's situational awareness. The options are normal LOS, snap-look (left, right, up, and down), and look-into-turn (LIT). These options increase the total FOR. The FOV remains the same for each LOS.

The pilot's normal LOS is shown in figures 1-537 and 1-538. The HUD depicts an area within the pilot's LOS about a point depressed 7.5 degrees from the aircraft zero vertical and horizontal axes. The image represents the LOS 14 degrees to the left, 14 degrees to the right, 10.5 degrees upward, and 10.5 degrees downward.

The snap-look option is initiated manually by the pilot to move the FLIR sensor LOS from directly in front of the aircraft (14 degrees WAR HUD/10 degrees WAC HUD) either side of the zero axis (figures 1-539 and 1-540) to 25 degrees (WAR HUD)/17 degrees (WAC HUD) beyond the outside limit on either side and 9 degrees above and below the normal frontal view. A total of 3 degrees on either side and 12 degrees (WAR HUD)/6 degrees (WAC HUD) on top or bottom of the outer edge of the frontal view is retained in the snap-look view to give the pilot a point of reference (figure 1-541). The total FOR for snap-look is 78 degrees (WAR HUD)/54 degrees (WAC HUD) in azimuth and 39 degrees (WAR HUD)/33 degrees (WAC HUD) in elevation.

The snap-look function only moves the FINS LOS; it does not affect the scan pattern of the TFR. Snap-look is not automatic when performing maneuvers or banking. If a bank maneuver is initiated without selecting snap-look, the HUD image remains in the normal FOV 14 degrees on either side of the aircraft zero axis throughout the maneuver.

The LIT function (figure 1-541) is automatic when a bank maneuver has exceeded 5 degrees provided the LIT function is enabled by the pilot. The LIT is enabled by holding the DMS in the up position. If snap-look is selected and a bank maneuver exceeding 5 degrees is initiated, the system remains in snap-look. Snap-look has precedence over the LIT mode. However, if the aircraft is in a bank maneuver and the cursor is released, the FINS returns to a LIT condition.

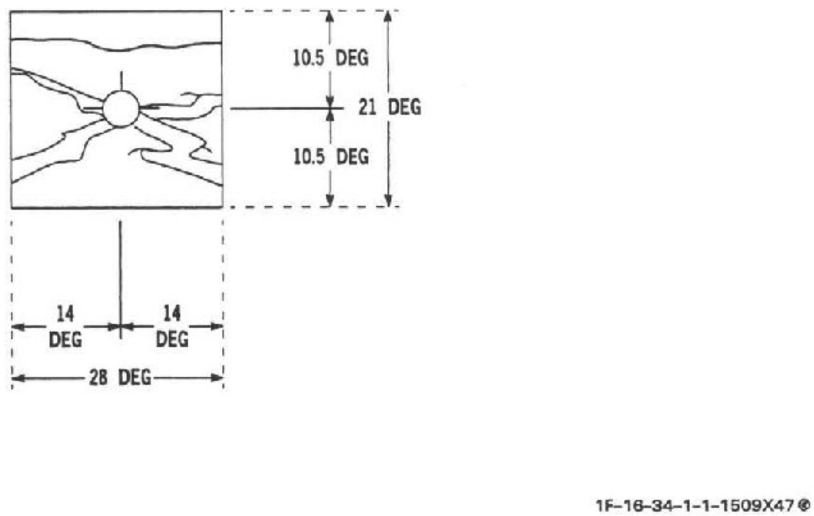


Figure 1-537. WAR HUD Image for Normal Operations

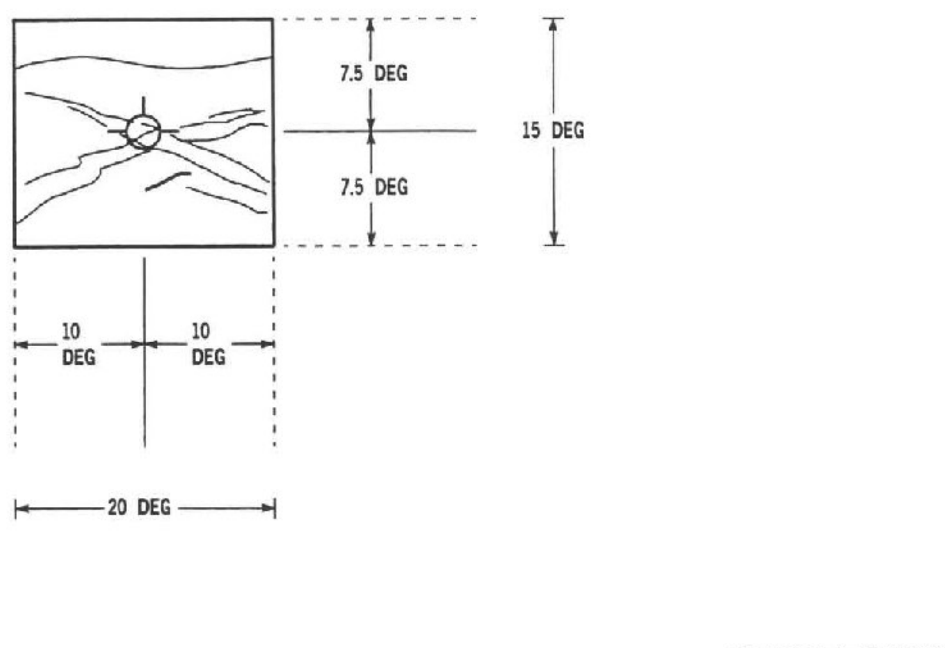
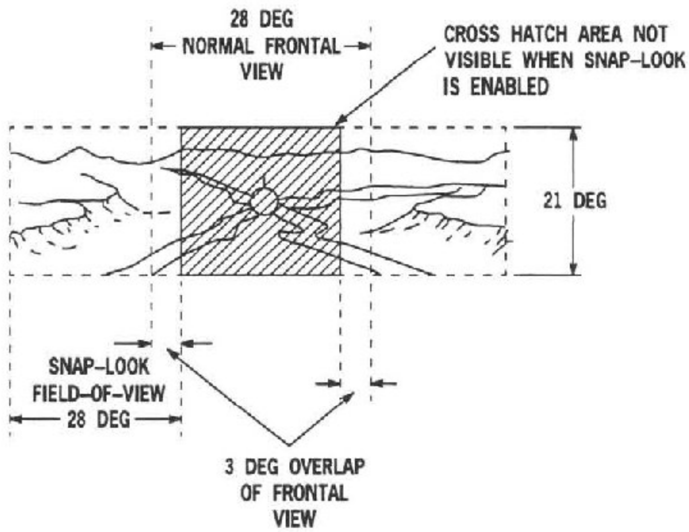


Figure 1-538. WAC HUD Image for Normal Operations



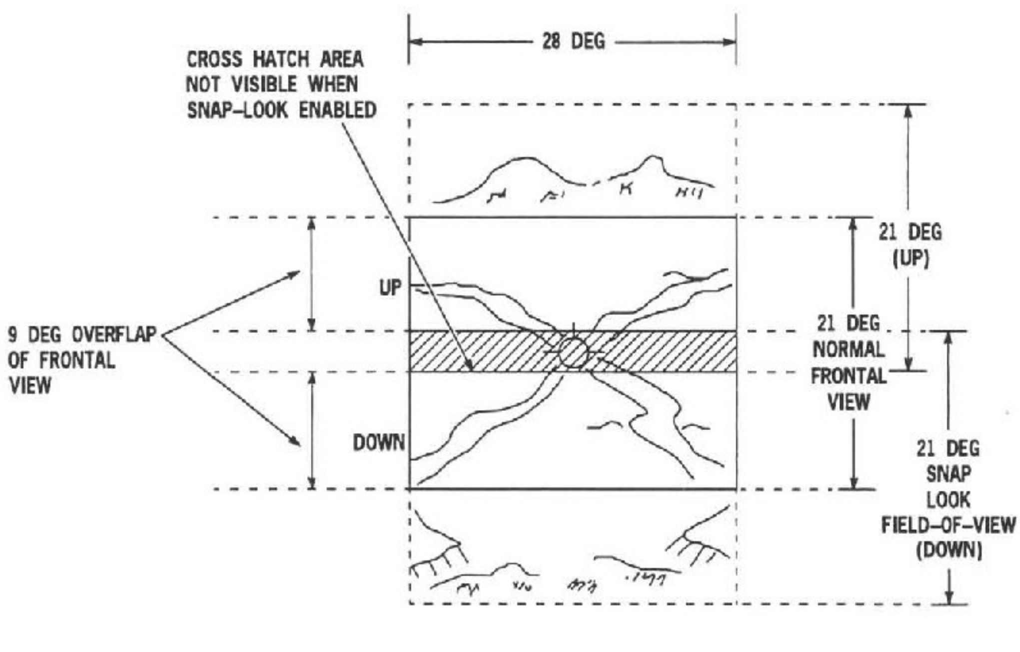


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Figure 1-539. WAR HUD Snap-Look

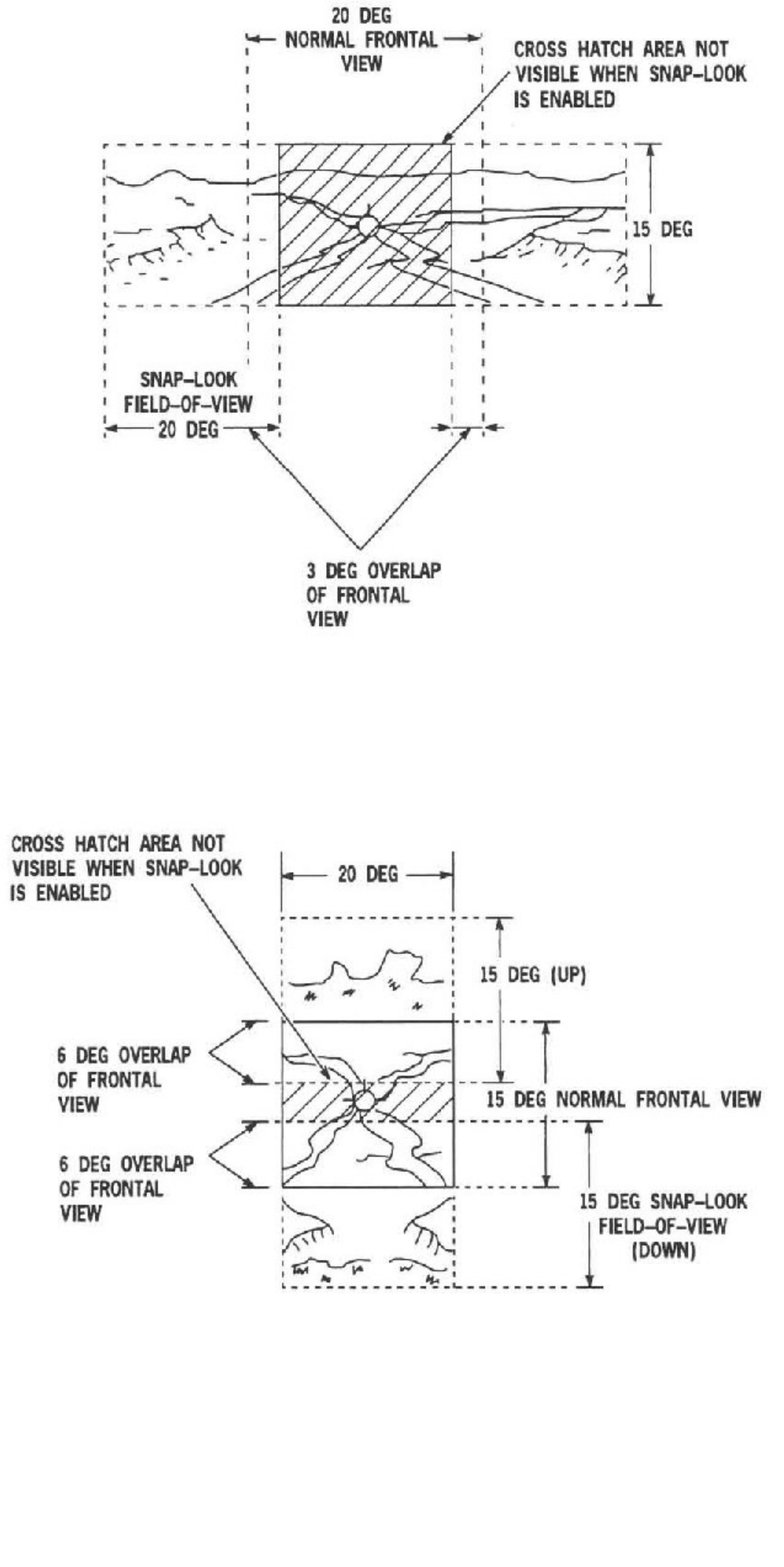
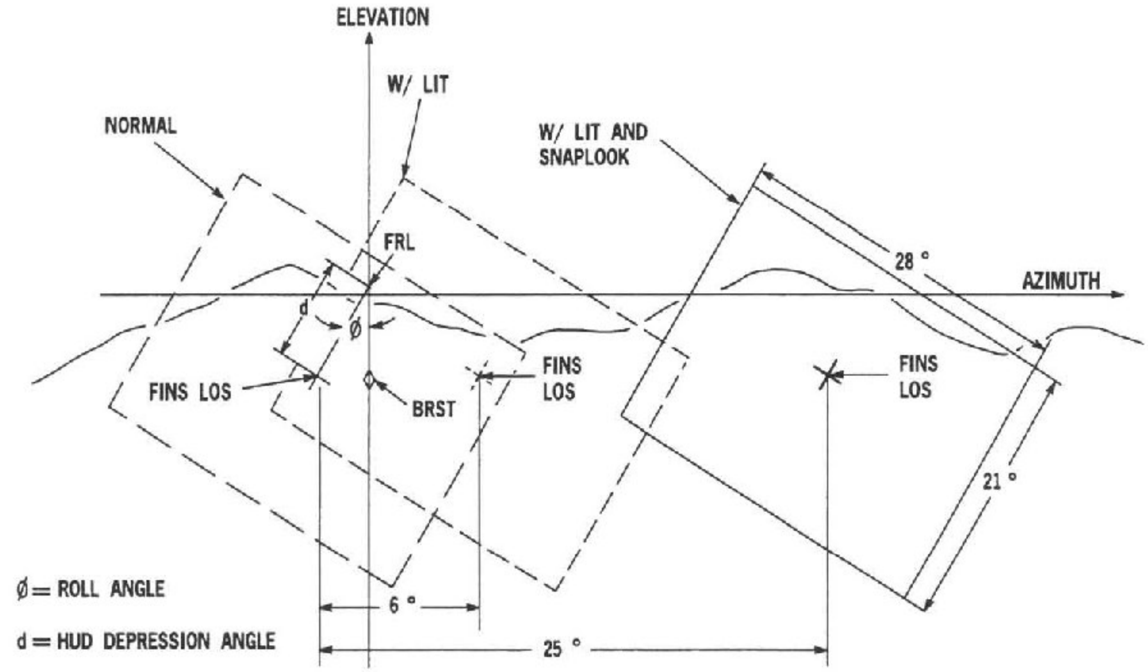
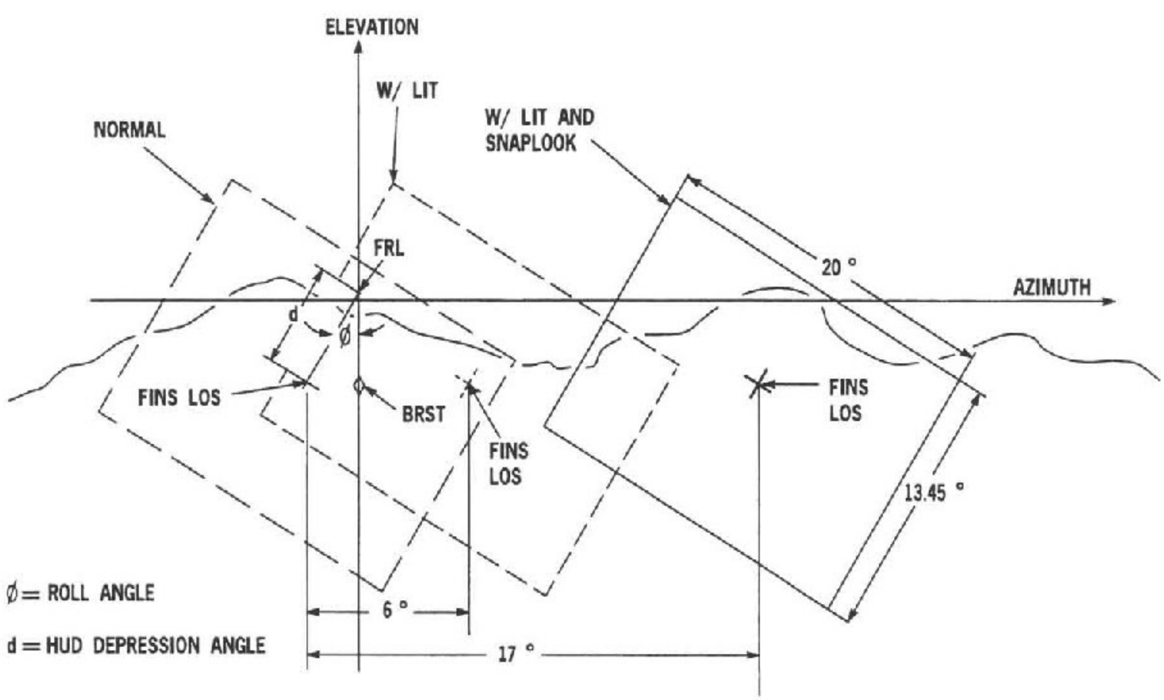


Figure 1-540. WAC HUD Snap-Look



WAR HUD



WAC HUD

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Figure 1-541. FINS Field-of-View With Look-Into-Turn and Snap-Look

During LIT, the pilot is presented a velocity vector and an additional pseudo-velocity vector on the HUD. The velocity vector and pseudo-velocity vector indicate the actual direction of aircraft flight in relation to the FLIR image. The pseudo-velocity vector remains at the display center, and the arrow points to the direction of turn (flightpath) of the aircraft. If bank angles are high, the velocity vector leaves the HUD in the opposite direction of the bank.

The LIT and the snap-look functions are roll stabilized and pitch dependent. If a roll maneuver is performed during LIT or snap-look, the HUD scene remains horizontally stabilized with little variance in reference point. If the aircraft pitch moves up or down, the HUD scene follows.

TERRAIN FOLLOWING RADAR (TFR)

The TFR function of the NVP is performed by a gimballed Ku-band radar. The TFR, in conjunction with the NVP computer, INU, and CARA, collect and process data used to generate TF cues which are overlaid on the FINS video image on the HUD.

The TFR is located in the lower half of the NVP. It provides an incremental g-command required to clear the terrain at selectable SCP's (100, 200, 300, 400, 500, and 1000 feet) from 330 to 540 knots groundspeed. These commands are displayed by a vertically moving TF box on the HUD. By keeping the FPM inside the TF box, the aircraft altitude is maintained at the SCP.

TFR Operating Modes

The TFR has selectable operating modes as shown on figure 1-542. The normal mode is designed to provide the best possible performance over a wide range of requirements, including average clearance and peak performance. The WX mode uses circular polarization and reductions in receiver sensitivity, processing range, and antenna upscan to minimize the interference of false returns from rain and clouds. The LPI mode uses reductions in radiated power and antenna scanning to minimize detection by enemy defenses. The VLC mode allows operation down to a 100-foot SCP. If rough terrain is encountered, the SCP automatically reverts to 200 feet. Additionally, VLC has a fast scan rate to provide more detection opportunities for small obstacles. Only limited turning flight is allowed.

Once the NVP has been set in the desired mode and is operating, no further control functions are required unless an operating mode change is desired. In manual TFR, the aircraft is flown in accordance with the TF box and flight director cues. The TF box in relation to the FPM directs the altitude to stay in the selected terrain-masking altitude window. The TF box moves up or down as approaching terrain elevation changes, cueing the pilot to gain or reduce altitude. If the aircraft descends below 75 percent of the set terrain following SCP, the pilot is notified by a flashing LO-TF warning on the HUD. In automatic TF, the aircraft autopilot responds to the TF steering commands to maintain the desired SCP.

Cautions and Warnings

The TFR provides many cautions and warnings to maximize pilot safety. Due to antenna scan limitations, valid g-commands can only be made within certain limits of aircraft roll, dive, turn rate, and turn acceleration. When these limits are exceeded, the message LIMIT appears on the HUD and flashes. If the limits are exceeded for too long, the HUD TF box blanks. When the TFR fails for any reason, the TF box disappears, a flashing WARN appears on the HUD, WARNING – WARNING is heard through the headset, and the TF FAIL warning light on the left glareshield is illuminated. The LO-TF advisory is activated whenever the RA drops below 75 percent of the SCP. PULL UP – PULL UP is heard whenever terrain is close enough that the TFR commands over its 2.1g limit to clear it at the SCP. The obstacle warning function looks at the command bar information and compares the terrain height above the aircraft to a computed value based on present aircraft parameters. If the terrain height exceeds this value, PULL UP – PULL UP is heard, indicating that an immediate pullup of at least 3.0g's is required to safely clear the obstacle. The TERRAIN caution uses the same logic as the obstacle warning. In this case, the caution occurs if the terrain height to one or both sides of the aircraft exceeds the computed value. The caution displays TERRAIN with arrows pointing in the appropriate direction on the HUD and indicates that turning in that direction might exceed the g-constraints of the TFR.

MODE	CHARACTERISTICS
NORMAL	Highest Accuracy Terrain Following Performance Turning Flight Capability Provided Limited Auto-ECCM Capability
WX	Terrain Following Performance In Rainfall Up To 10 mm/hr Turning Flight Capability Provided
LPI	Terrain Following Radiation Minimized By Spatially And Temporally Controlled Transmitter Emission Turning Flight Not Allowed
VLC	For Use On Prebriefed Routes Over Water Or Smooth Terrain 100-foot SCP Limited Turning Capability

Figure 1-542. TFR Mode Descriptions

TARGETING POD (TGP)

The TGP (figure 1-543) provides the capability to acquire targets at sufficient slant range to cue, lock-on, and fire AGM-65D/G's and designate stationary targets for the delivery of laser-guided bombs. The TGP also enhances unguided conventional weapons delivery capabilities. TGP functions included FLIR imaging, laser designation and ranging, accurate pointing and target tracking, missile boresight correlation, and AGM-65D/G hand-off for subsequent manual launch. Design characteristics of the TGP are listed in figure 1-544.

Target acquisition FLIR (TAF) provides imagery in a 1.7 by 1.7 degree NFOV image area and a 6 by 6 degree WFOV image area that can be viewed on the MFD. The TAF imagery is routed to the MBC and to the target tracker electronics for weapon control processing.

The optical system is inertially stabilized by positioning the IR optics to view a target area or to track a designated target. The IR optics are mounted on pitch and yaw gimbals in the gimbal shroud assembly (forward portion of the nose section). The TAF is mounted in an inner roll assembly (aft portion of the nose section) which corrects for IR scene rotation caused by the motion in the stabilization system. This allows the IR image on the MFD to always appear right side up. The whole nose section is rotated or rolled to maintain track on a target while the TAF assembly is derolled to preserve proper orientation of the IR image.

TARGET ACQUISITION FLIR (TAF)

The TAF FLIR subsystem provides real-time IR imagery which allows the detection of targets by sensing their natural long wavelength IR emissions. The TAF includes the following major components: FLIR scanner, focus control, 180-channel detector, scan and interface printed wiring board, SCM, and the Stirling split-cycle cooler.

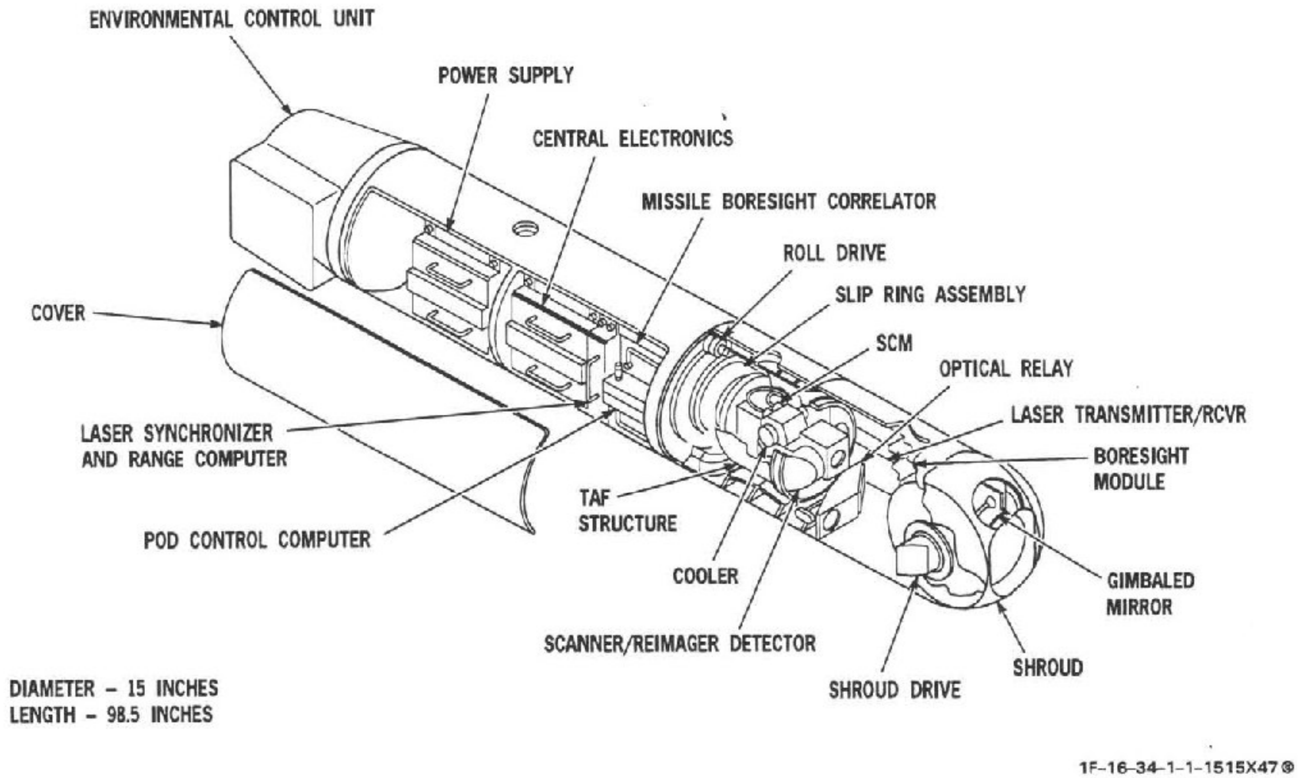


Figure 1-543. Targeting Pod

Dimensions	98.5 Inches Long 15.0 Inches Diameter
Weight	530 Pounds
Input Power	115 Volts, 400 Hz, 3-phase, 4-wire +28 vdc
Outputs	IR Image Reformatted To RS-170 Video, Target Position Data, Failure Discrete Signals
Inputs	Missile Status Information, Aircraft Commands And Data
Computer Interface	MIL-STD-1553B BUS
FLIR Sensor NFOV	1.7 Degrees By 1.7 Degrees
FLIR Sensor WFOV	6 Degrees By 6 Degrees

Figure 1-544. Targeting Pod Design Parameters (Sheet 1)

IMAGE TRACKER MODES OF OPERATION	POINT, AREA, RATE
Laser Designator/Ranger Missile Boresight Correlator	1.06 Or 1.54 Microns
Computer Master Processor	64K Word Memory, 615k Operations Per Second
Computer Slave Processor	32K Word Memory, 615k Operations Per Second

Figure 1-544. Targeting Pod Design Parameters (Sheet 2)

The TAF sensor and optics are located within the nose section of the TGP. The aperture is 8 inches in diameter. The nose section is connected to the remainder of the pod electronics through an electrical slipring assembly which allows continuous rotation of the forward nose section. The gimballed shroud assembly, located in the front portion of the nose section, contains the FLIR and laser window assembly. The FLIR optics provide IR imagery in 1.7 by 1.7 degree and 6.0 by 6.0 degree FOV's. These FOV's are aircrew selectable and are designated as NFOV for the 1.7 by 1.7 degree image and WFOV for the 6.0 by 6.0 degree image. The TAF imagery is routed to the MBC and the image tracker electronics for weapon control processing.

The TAF image scan is moved up or down by rotating the gimbal shroud assembly. The TGP provides NFOV or WFOV TAF imagery at any point upward until the aircraft is masked to −150 degrees in relation to the aircraft boresight plane. The TGP FLIR azimuth capability is achieved by rotating the nose section in the opposite azimuth direction desired and pitching the shroud assembly down. This gives an azimuth coverage of 150 degrees in either direction. However, not all the azimuth FOV is usable, due to aircraft masking.

The TAF imagery is horizon stabilized, regardless of the attitude of the aircraft, except while missile boresight correlation is attempted or while in the A-A mode. When correlation is attempted, the FLIR deroll capability is disabled and the real-world attitude of the image is presented to the MBC for comparison to the rolled video from the AGM-65 missile. Horizon stabilization is accomplished by the inner and outer roll assemblies. The inner and outer roll assemblies roll the nose section equipment support assembly and deroll the FLIR assembly to preserve proper orientation of the FLIR image. This insures that the pilot sees right-side-up target video while attempting to manually slew AGM-65's or verify targets.

IMAGE TRACKER

The image tracker is physically located within the CEU and consists of the software (applicable printed circuit card assemblies) required to track and engage a primary target. The tracker processes the video signals from the reformatter to detect and follow a stationary or moving target. It provides the capability to track and engage a target selected during the manual mode of operation.

The point tracker and target correlator are subsystems of the image tracker that acquire and track targets positioned within the sensor FOV.

The image tracker can track either a single point target selected by the aircrew or a defined target area scene. Tracker default logic is POINT track to AREA track to RATES track (scene stabilization based on aircraft INU inputs).

LASER DESIGNATOR/RANGER

The laser designator/ranger is designed to provide the pilot with accurate range data to update the aircraft position and to designate targets for precision delivery of LGB's. The laser contains a Raman cell modification to enable frequency switching from 1.06 to 1.54 microns. The 1.06-micron position is the full-power mode required for combat operations and actual LGB deliveries. The 1.54-micron mode of operation is an eye-safe, reduced-power mode of operation intended for training use. It enables the aircrew to employ the laser (at reduced range) both on and off range for fix update, weapons ranging, and practice (unguided) LGB's in peacetime training. Frequency selection is accomplished through a pod-mounted mechanical switch during preflight. It cannot be changed from the cockpit.

MISSILE BORESIGHT CORRELATOR (MBC)

The MBC receives FLIR digital video data, both real-time and field-delayed, from the CEU reformatter function and analog video data from the AGM-65D/G. Following digitization of AGM-65 video, it is compared to the reformatter data and correlation confidence index.

The TGP AGM-65 controller assumes control of the missile(s) by monitoring aircraft and missile status and issuing commands to the missile(s). The AGM-65 controller designates a missile as primary and, if a second launcher was active, designates one of its missiles as secondary. The missiles are then commanded to the slave mode to follow the TAF LOS via slave commands until POINT track is established.

The handoff sequence progressively reduces error between the TAF LOS and the missile LOS until the missile gated tracker acquires the designated target. When the LOS error is 1.25 mr or less, the missile is commanded to track the target. Following verification checks of the target tracks, the TGP issues a handoff-complete signal to the aircraft.

By using the MBC function of the TGP, the aircrew can designate two separate targets to two separate AGM-65's (one from each launcher) and achieve sequential lock-ons prior to either launch. After both missiles are locked-on, they can be ripple fired with a minimum time interval.

SUSPENSION SYSTEMS

GENERAL

The weapon suspension subsystem consists of missile launchers and adapters, wing and centerline pylons with bomb ejector racks, bomb rack units, guided missile launchers, and the various umbilical cables required for interface with the aircraft wiring system. Nine external store stations provide carriage and release of a multiplicity of weapons and configurations for mission flexibility.

AIM-9 MISSILE LAUNCHER AND ADAPTER

The 16S210 launcher (figure 1-545) provides suspension and release capability for AIM-9 missiles. The missile launchers may be installed at stations 1, 2, 3, 7, 8, and 9. The launchers at stations 1 and 9 attach directly to wingtip hardpoints, while launchers at stations 2, 3, 7, and 8 are installed on adapters that attach to hardpoints on the wing lower surfaces. Each launcher contains its own power supply and remote interface unit (MRIU). The power supply provides control voltages necessary to prearm and launch the AIM-9 missile, and the missile interface unit provides the interface with the central interface unit and the SMS.

WING PYLONS

Wing pylons (figure 1-546) may be suspended from stations 3, 4, 6, and 7. Each pylon is equipped with a bomb ejector rack and weapon remote interface unit (RIU). Multiple combinations of ejector racks, launchers, and weapons can be suspended from the MAU-12C/A bomb ejector rack. Umbilical harnesses are used to interface with various racks or launchers. The wing armament pylons attach directly to hardpoints on the wing lower surface. Provisions are included for making discrete electrical connections in the wing lower surface. These connections provide the discrete interface wiring between aircraft and pylon electrical components.

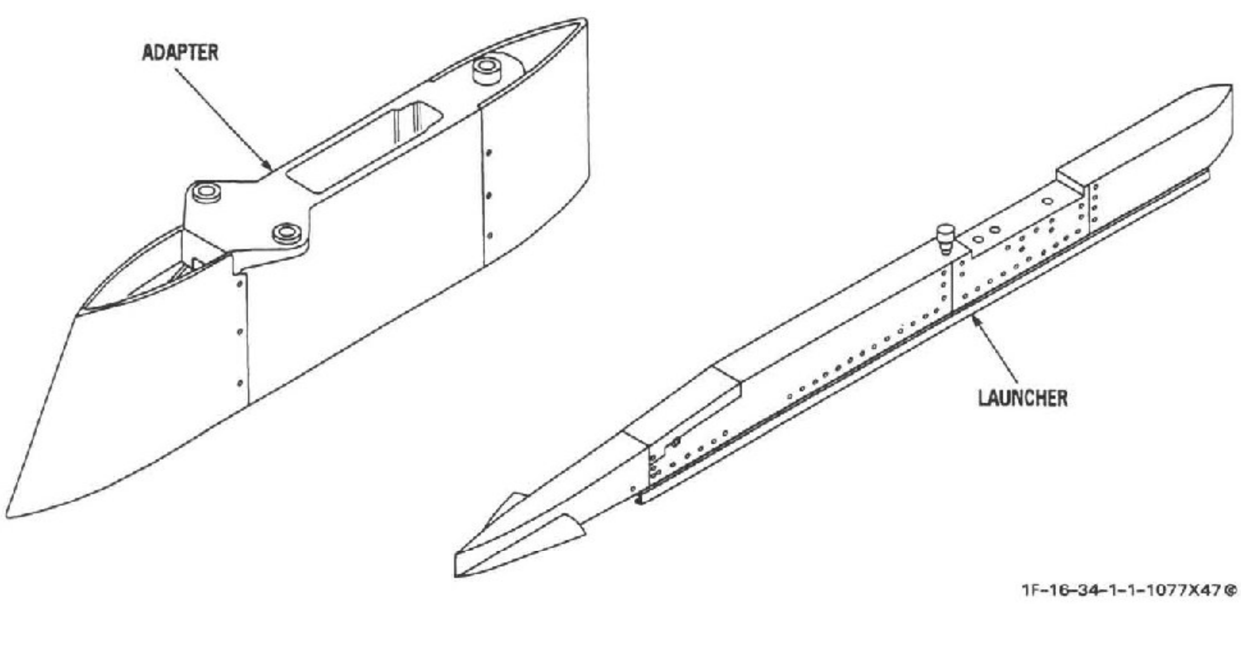


Figure 1-545. AIM-9 Missile Launcher and Adapter

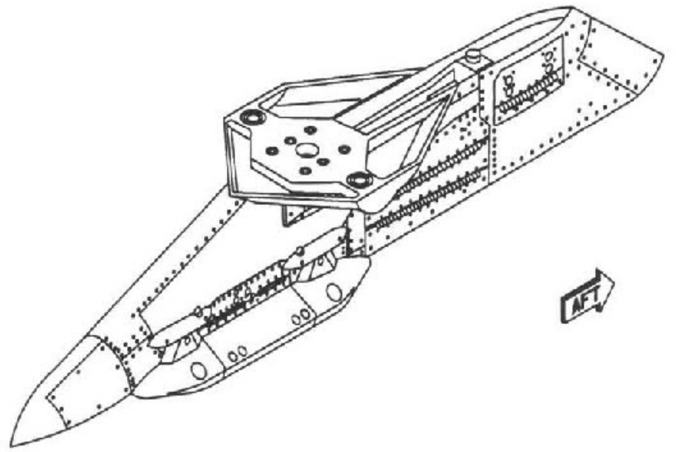


Figure 1-546. Wing Pylon

CENTERLINE PYLON

The centerline pylon (figure 1-547) is attached at station 5 located on the lower centerline of the fuselage between the main landing gear doors. The pylon consists of the pylon body, MAU-12C/A bomb rack, attaching electrical wiring, and a remote interface unit (RIU). The pylon electrical harness is routed through the pylon nose fairing to a receptacle in the main landing gear wheel well. All rack orifices, cartridges, inspection holes, and safety provisions are accessible without removing any of the pylon covers.

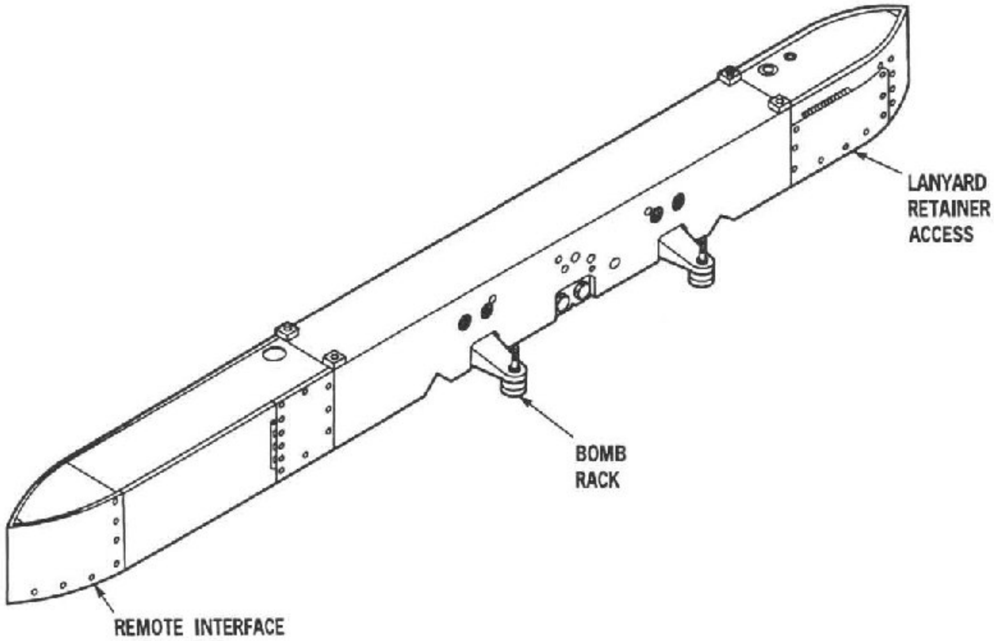


Figure 1-547. Centerline Pylon

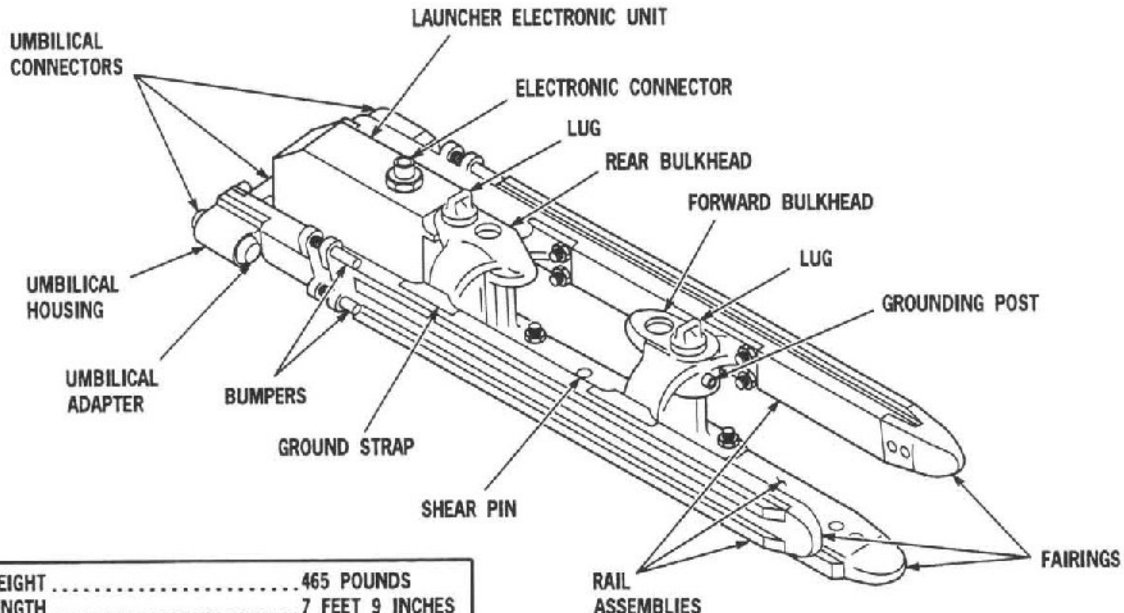
LAU-88/A MISSILE LAUNCHER

The LAU-88/A launcher (figure 1-548) is designed to carry, control, and launch up to three AGM-65 missiles. The TGM-65 training missile can also be carried and controlled on the LAU-88/A. The launcher consists of three track-rail assemblies attached to a central structure that contains the electronic unit. The order of release and the station empty signals come from the electronic unit mounted behind the rear bulkhead. All control and switching circuits for the launcher and missiles are also contained in the electronic unit.

The missiles are restrained on the rails by a shearpin, installed midway on each rack, and by two bumpers at the rear of each rail. Between these two bumpers, a retractable electrical umbilical connector is rotated forward and connected to the missile after it is loaded.

At missile launch, the rocket motor thrust exceeds the shearpin strength, allowing the missile to leave the rail. Launch sequence is outboard, center, and inboard.

Aircraft control systems will not automatically sequence between different stations after a missile launch to alternate launching from different stations.



WEIGHT	465 POUNDS
LENGTH	7 FEET 9 INCHES
WIDTH	27 INCHES
HEIGHT	18 INCHES
SUSPENSION LUG SPACING	30 INCHES

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Figure 1-548. LAU-88/A and LAU-88A/A Missile Launcher

LAU-88A/A MISSILE LAUNCHER

The LAU-88A/A launcher (figure 1-548) is identical to the LAU-88/A except for an improved launcher electronic unit (LEU). The LAU-88A/A LEU provides:

Rapid Fire Capability. At uncage, the priority missile and the next missile in the selection sequence, called the nonpriority missile, are activated. If both missiles are AGM-65D IR Mavericks, the nonpriority missile can be slaved to the priority missile. After launch, the nonpriority missile dome cover is jettisoned and next missile in sequence becomes the nonpriority missile.

Slave Capability. The LEU provides capability to slave the AGM-65D Maverick to a preselected aircraft target acquisition aid.

Separate Boresight Memory Setting. The LAU-88A/A LEU retains the missile boresight setting. Once the first missile is boresighted, the launcher provides the same boresight correction to all missiles on the LAU-88A/A.

Assured Launch Capability. The LAU-88A/A maintains the launch pulse after the weapon release button is released (eliminating quick pickles).

Field-of-View Changes. The LAU-88A/A allows FOV changes without MASTER ARM switch – MASTER ARM (dome cover power).

LAU-117/A MISSILE LAUNCHER

The LAU-117/A missile launcher (figure 1-549) provides AGM-65 carriage control and launch of a single AGM-65 missile. The launcher is equipped with two removable lug fittings that provide bomb rack sway brace pads and ejector fittings. The lug fittings may be adjusted for 14 or 30-inch suspension spacing.

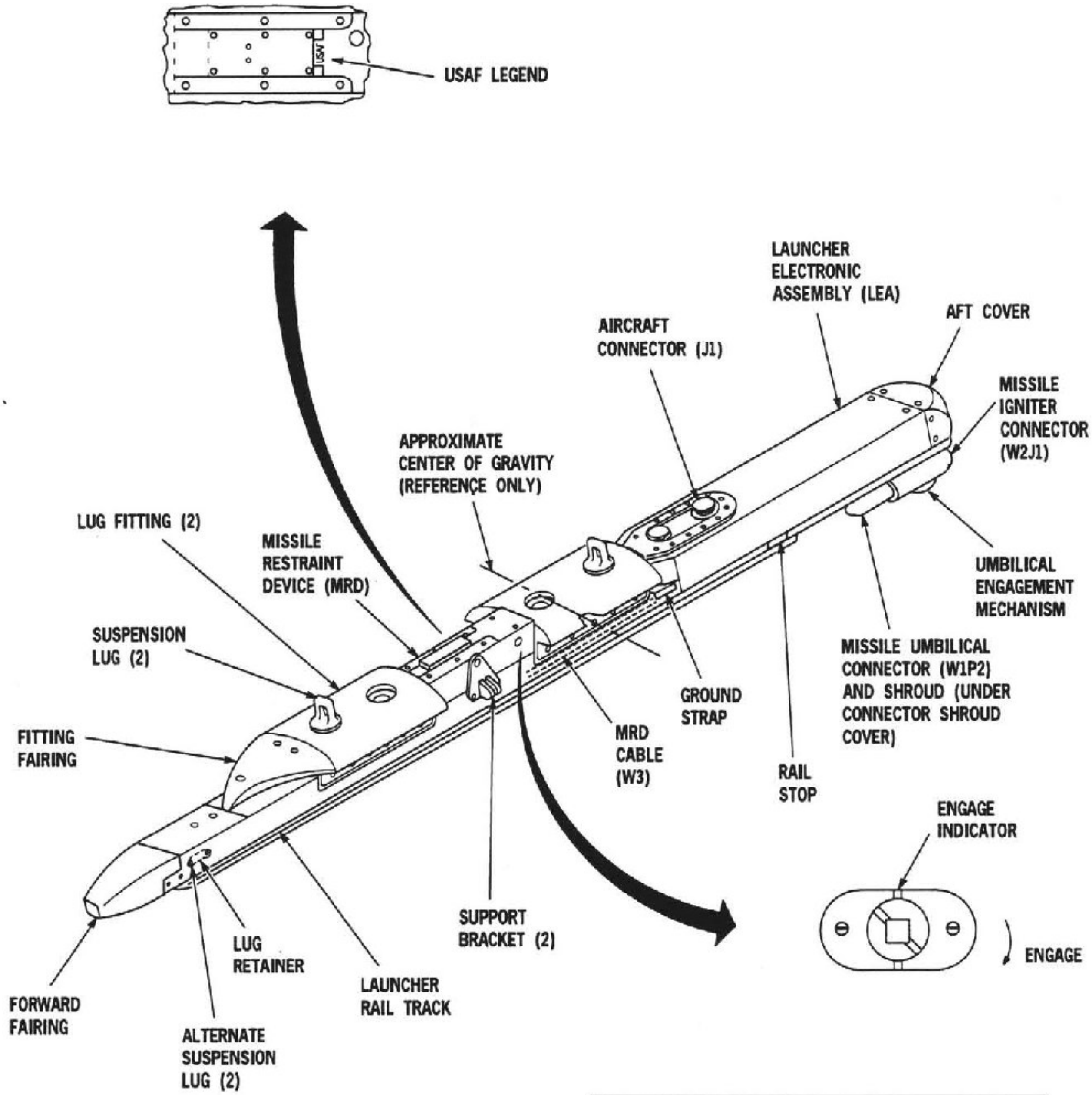
The missile restraint device (MRD), used to retain the missile on the rail, can be set in two positions, USAF or USN. The MRD position can be verified by reading the lettering displayed through a notch in the MRD cover on the top of the launcher (figure 1-549). In the USAF position, the MRD is mechanically unlocked, allowing the MRD pin to retract out of the missile upon application of a forward force of 2500-3000 pounds (the Maverick rocket motor provides a nominal 10,000 pounds of thrust).

During forward deceleration of greater than 2.1g's, an inertia weight pivots forward and mechanically locks the MRD to prevent pin retraction and missile movement during an arrested landing. In the USN position, the MRD is mechanically locked until an electrical signal is applied. This electrical signal removes the mechanical lock, allowing the MRD pin to retract out of the missile upon application of a forward force of 2500-3000 pounds as in the USAF position. If the LAU-117/A is carried on an F-16 in the USN position, the electrical signal that removes the mechanical lock is always present and sudden decelerations, such as barrier engagements, may cause the MRD pin to retract and result in missile movement.

NOTE

> AGM-65 missiles cannot be jettisoned from LAU-117 launchers. The LAU-117 launcher can be jettisoned when carted.

The launcher electronic assembly provides an electrical interface between the aircraft and the missile. The umbilical cable connector, which is housed in the umbilical engagement mechanism assembly, interfaces the electrical signals from the aircraft and launcher circuits to the missile. Interface is accomplished during missile installation on the launcher.



WEIGHT	130 POUNDS
LENGTH	7 FEET 10 INCHES
WIDTH	11 INCHES
HEIGHT	11 INCHES
SUSPENSION LUG SPACING	14 OR 30 INCHES

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Figure 1-549. LAU-117/A Missile Launcher

LAU-118(V)4/A MISSILE LAUNCHER

The LAU-118(V)4/A launcher (figure 1-550) provides a launcher capability (carriage and delivery) for the AGM-88 missile. The launcher is mounted on armament pylons by lugs spaced 30 inches apart. The missile is attached to the rail by two suspension assemblies and held in place by a detent pin. Missile launch occurs after the rocket motor thrust has reached the required level to override the detent pin.

LAU-129/A MISSILE LAUNCHER

The LAU-129/A (figure 1-551) modular rail launcher (MRL) provides suspension and release capabilities for the AIM-9 missiles. The LAU-129/A contains a mechanical forward detent mechanism, held down by spring tension and mechanically locked down by a solenoid-actuated inflight operable lock. The LAU-129/A can be installed on the same stations as the 16S210. The LAU-129/A also includes its own power supply and remote interface unit.

MAU-12C/A BOMB EJECTOR RACK

The MAU-12C/A bomb ejector rack (figures 1-552 and 1-553) is a universal bomb rack installed on pylons. The bomb rack has electrically fired impulse cartridges and a gas-operated mechanism. It will carry and forcibly eject suspension equipment and/or munitions with diameters from 9.0 to 30.5 inches. The rack contains three electromechanical arming solenoids, two gas-operated bomb ejector feet, four adjustable sway braces, and two sets of suspension hooks (one set spaced 14 inches apart, and one set spaced 30 inches apart). Both sets of hooks are connected by a common linkage system that is positively locked in position by a latch mechanism of overcenter bellcrank design.

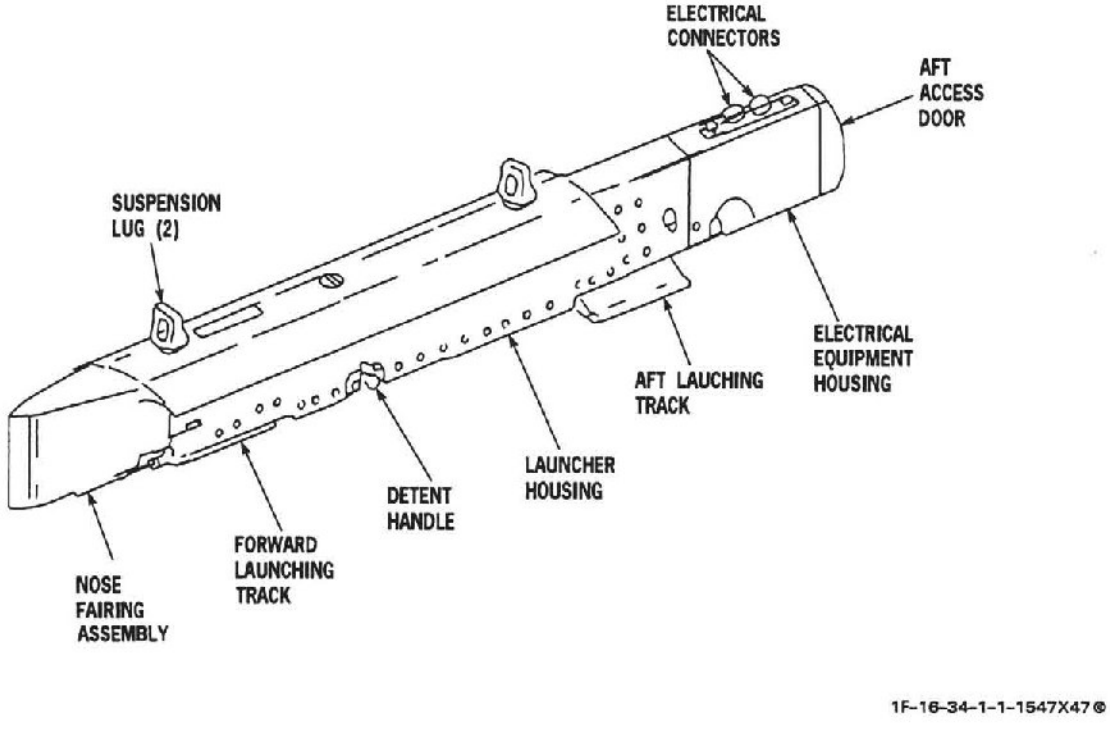

Figure 1-550. LAU-118(V)4/A Missile Launcher

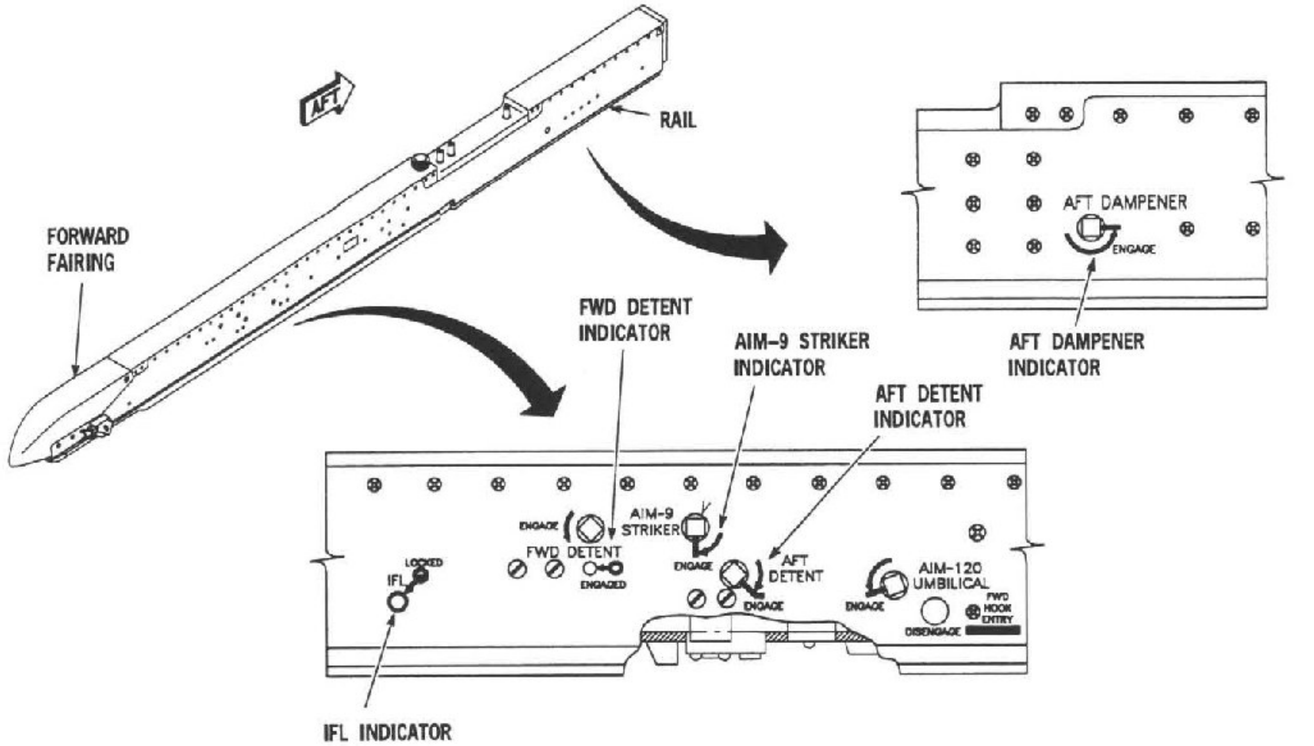

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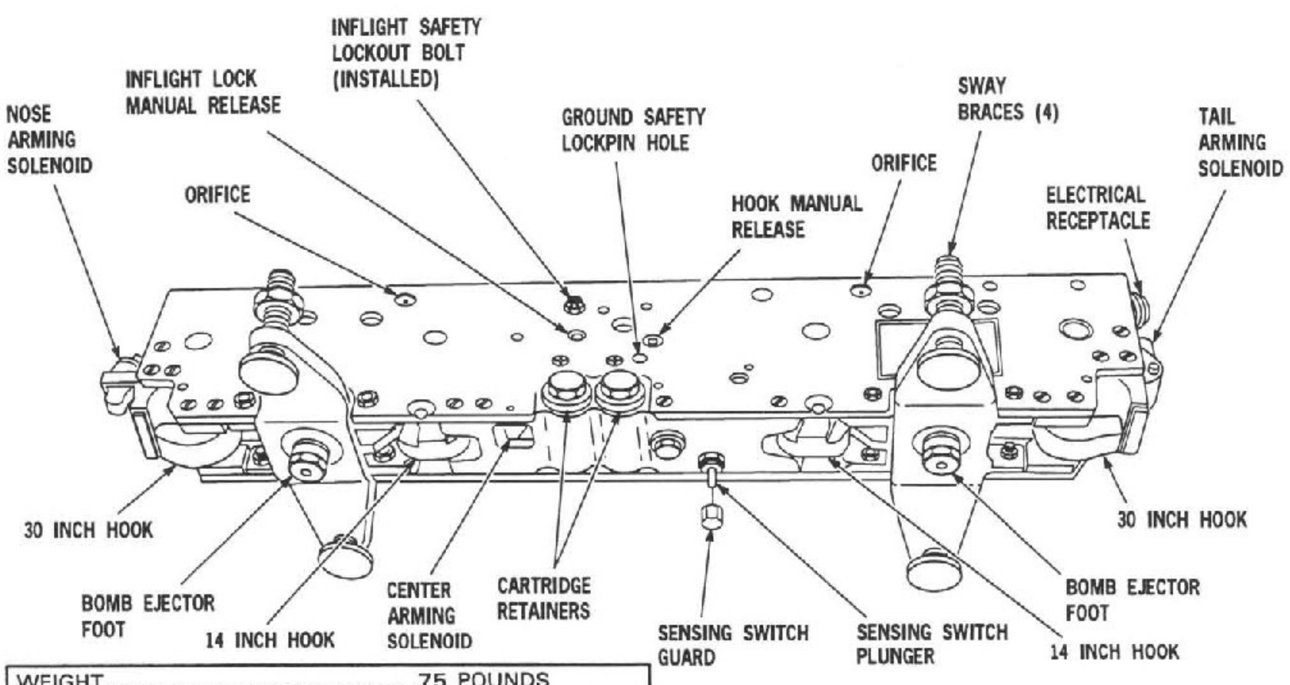
Figure 1-551. LAU-129/A Launcher



WEIGHT	75 POUNDS
LENGTH	2 FEET 8 INCHES
WIDTH	3 INCHES
HEIGHT	6 INCHES
SUSPENSION HOOK SPACING	14 AND 30 INCHES

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Figure 1-552. MAU-12 Bomb Ejector Rack

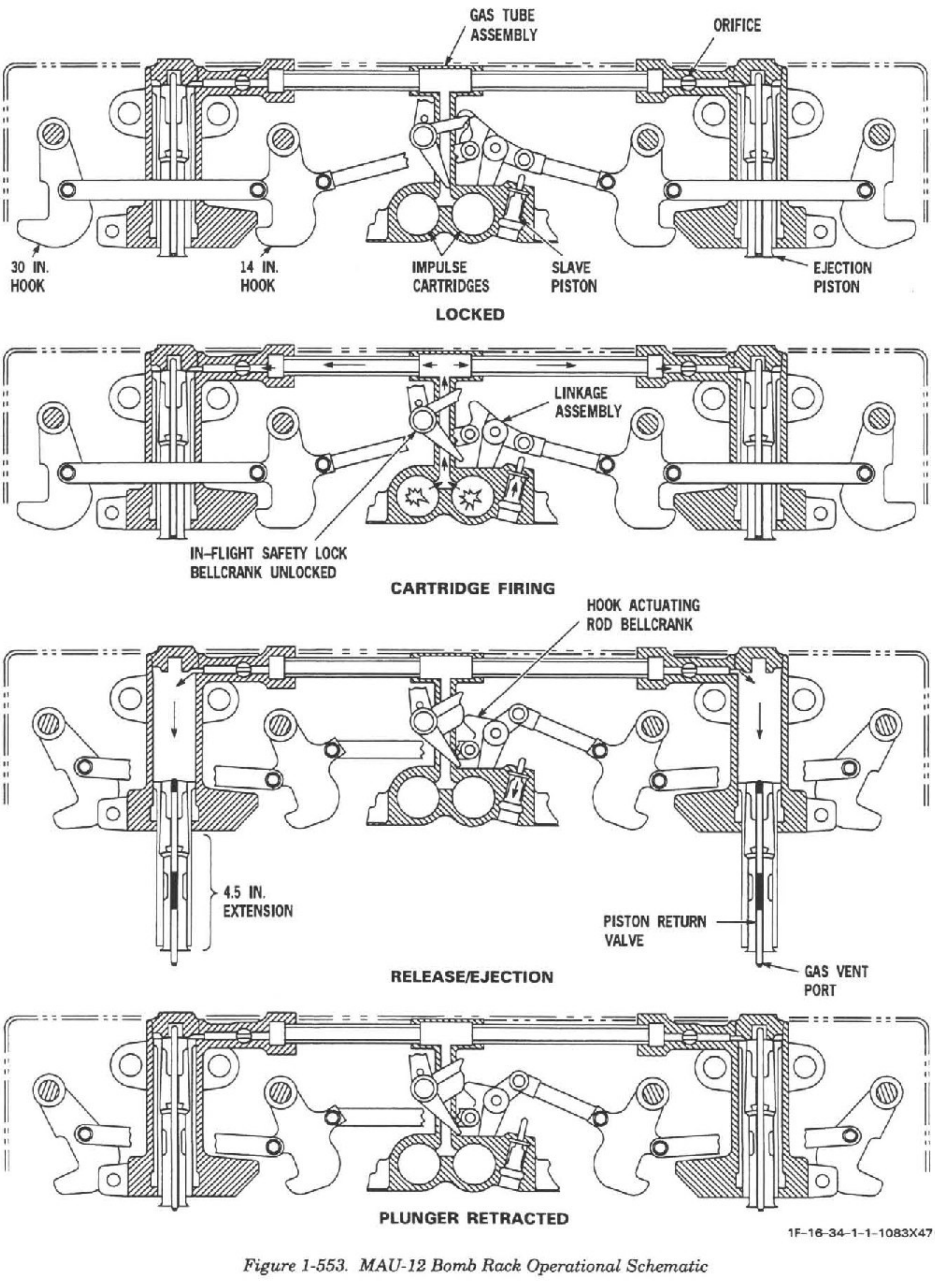


Figure 1-553. MAU-12 Bomb Rack Operational Schematic

The arming solenoids, when armed by cockpit switch selection, retain the munition arming wire/lanyard swivel loops upon munitions release. The nose arming option will arm the forward and center solenoids, and the tail arming option will arm only the aft solenoid. With nose/tail arming option, all three solenoids will be armed. To remove the munition swivel-and-link assembly from the arming solenoids requires 10 to 14 pounds of force when the solenoid is in the safe position and 150 pounds of force when it is in the armed (energized) position.

Two ejection pistons are equipped with orifices to vary the ejection force of each piston and allow compensation for various bomb centers of gravity (CG). The release mechanism and ejection pistons are operated by gas pressure from the electrically fired cartridges with dual electrical circuits. In the event one cartridge misfires electrically, it will be fired by the hot gases from the ignited cartridge traveling through the interconnecting port within the dual-cartridge breech. The rack has provisions for a ground safety pin and an inflight safety lock (figure 1-552). The ground safety pin is installed to prevent accidental ordnance release in case cartridges fire when the aircraft is on the ground.

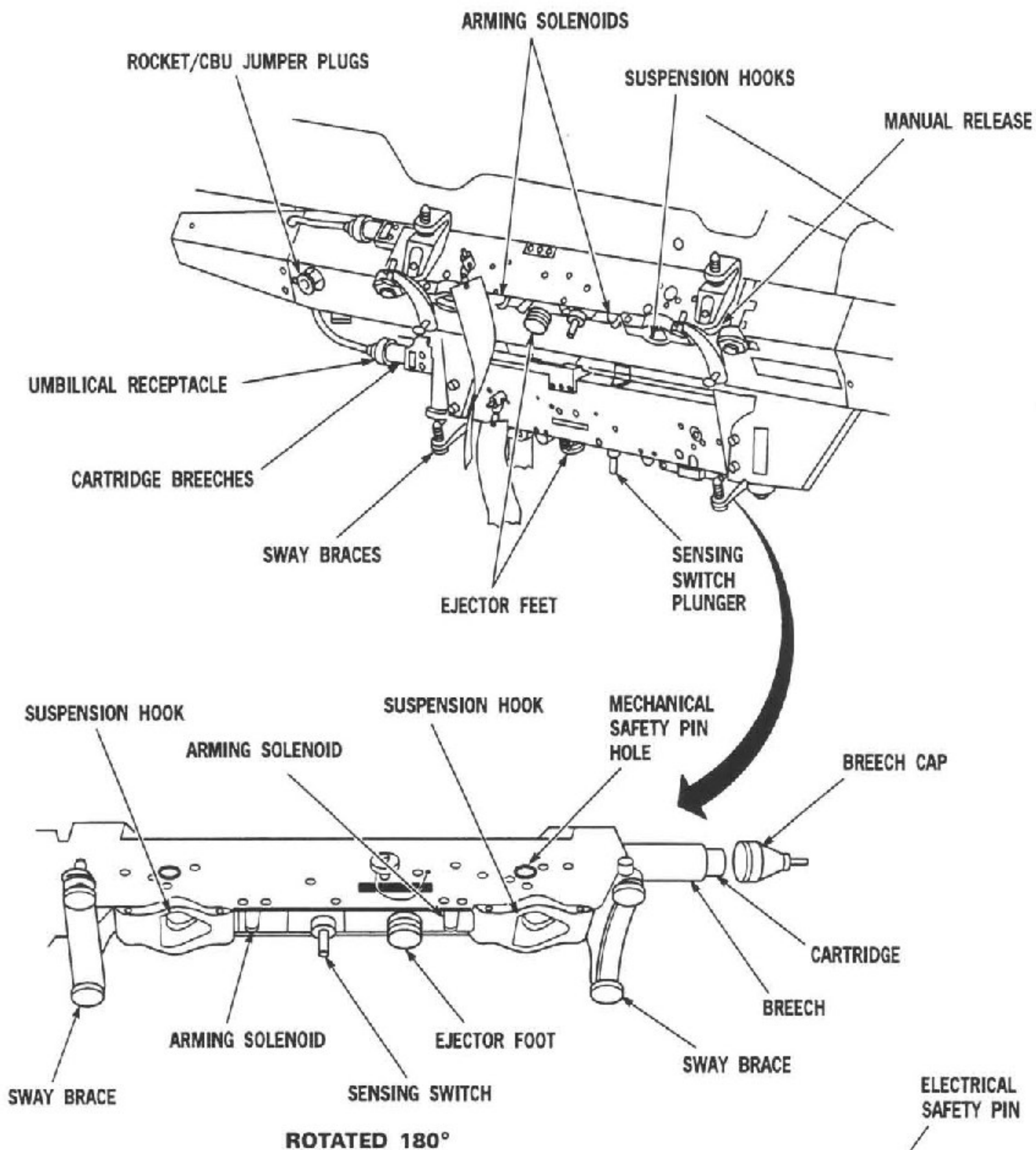
The inflight safety lockout bolt must be installed or no release will occur through the munitions circuitry. This bolt is not streamered.

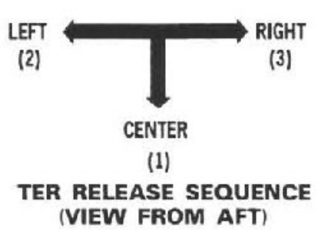
TER-9/A TRIPLE EJECTOR RACK (TER)

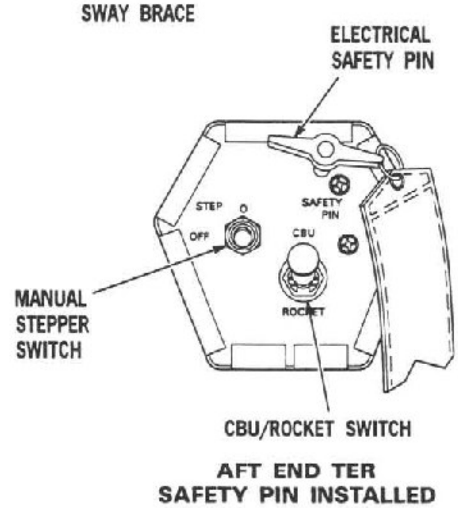
The TER-9/A (figure 1-554) is an auxiliary suspension rack used to increase the number of munitions aircraft pylons (with MAU racks installed) can carry. A TER can carry and sequentially eject up to three stores weighing up to 1000 pounds each and 16 inches in diameter. The rack consists of a structural unit (strongback) with three ejector units and associated wiring. Each ejector unit has provisions for suspension, sway bracing, sensing, electromechanical arming, and munition ejection to operate functionally the same as a MAU rack. The TER strongback attaches to a pylon with 30-inch spaced lugs and provides 14-inch suspension hook spacing on the ejector units. Each ejector unit has a gas-operated ejector foot to forcibly eject the munition. The gas is supplied by a cartridge installed in the rear of the unit that is electrically fired through an umbilical cable.

A control panel at the aft end of the TER has a CBU/ROCKET switch, an electrical safety pin receptacle, and a manual stepper switch. All weapons are released in the CBU position. The electrical safety pin is used for ground safing, and when inserted in the receptacle it interrupts the electrical circuit. The manual stepper switch is used only during maintenance.

Store release/ejection is accomplished sequentially by fire-and-step logic. Each pulse fires one station (ejector unit) and causes the stepper switch to select the next station in firing order and wait for the next fire-and-step pulse. Firing order for the TER is centerline, left, and right station. Within this order, circuitry in the rack assemblies automatically skips unloaded stations; therefore, every fire-and-step signal will fire a loaded store.







WEIGHT	95 POUNDS
LENGTH	5 FEET 7 INCHES
WIDTH	15 INCHES
SUSPENSION HOOK SPACING	14 INCHES
SUSPENSION LUG SPACING	30 INCHES

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Figure 1-554. TER-9/A Ejector Rack

MISCELLANEOUS STORES

QRC80-01(V) ECM POD

The QRC80-01(V) ECM pod (figure 1-555) are of modular construction, with each module self-contained in an integral pod shell and gondola. The pods are carried externally and are currently available in two versions, the QRC80-01(V)-3 or QRC80-01(V)-4. The QRC80-01(V)-3 pod contain low band and mid/high band modules. The QRC80-01(V)-4 pod contains the mid/high band module only.

The QRC80-01 have a closed-loop, circulating-liquid cooling system. For additional information on the QRC80-01 ECM pod, refer to T.O. GR1F-16CJ-34-1-1-1 (Secret).

WARNING

The QRC80-01 ECM pod should not be operated on the ground when ground personnel are within 6 feet of the pod.

CAUTION

The QRC80-01 ECM pod should not be operated on the ground in any transmit position in excess of 10 minutes in any 1 hour without a cooling unit connected and operating.

NOTE

ECM pod activation in some modes can degrade radar warning system.

Control Indicators

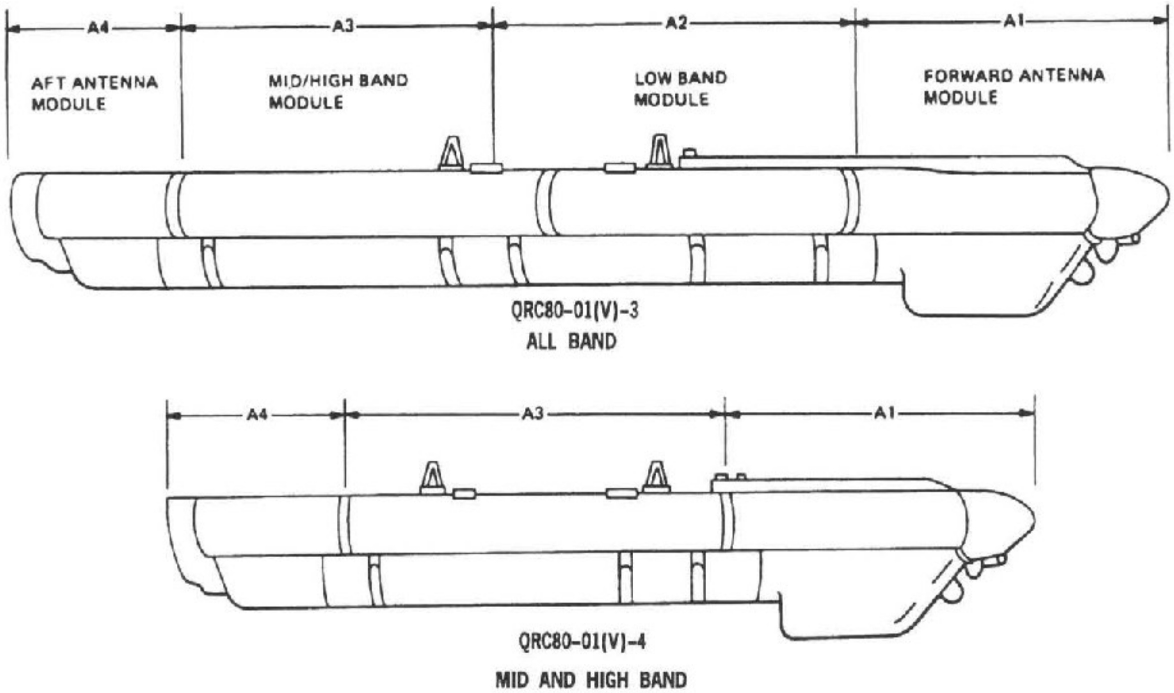
The QRC80-01 pod can be controlled by the C-9492B control indicators. The control indicator is used to turn the system on, enable (activate) preset groups of techniques, and display system status. The C-9492B control can mix techniques from preset groups and also provide a detailed status display.

Control Panel (C-9492B)

The C-9492B control panel is designed to control a QRC80-01 pod. The front panel of the C-9492B contains eight pushbutton switches and two toggle switches to control the QRC80-01 pod (figure 1-556). C-9492B control and fault indications are explained in the following paragraphs.

POWER SWITCH. The power switch is a three-position, positive-locking toggle switch. In the OFF position, all power is removed from the control panel and the QRC80-01 pod. The STBY position puts the QRC80-01 in standby status and/or initiates a 200-second warmup period. After warmup, the S on button S8 should come on to indicate the system is ready for operation. The OPR position allows all control indicator circuits to operate and the pod to transmit jamming programs. The selection of jamming programs is determined by the XMIT toggle switch and/or the eight pushbuttons, S1 through S8. The symbols in the upper left quadrant of the pushbuttons will come on to indicate that OPR has been selected.

XMIT SWITCH. The XMIT switch is a three-position toggle switch with positive locking for each of its three positions. It functions when the power switch is in OPR. Position 1 places the system in mode 1 operation. Additional jamming functions are available by depressing pushbuttons. Position 2 places the system in mode 4 operation. Additional jamming functions are available by depressing pushbuttons. Position 3 places the system in mode 7 operation.



	QRC80-01(V)-3	QRC80-01(V)-4
WEIGHT	645 POUNDS	435 POUNDS
LENGTH	13 FEET 6 INCHES	9 FEET 6 INCHES
WIDTH	12 INCHES	12 INCHES
HEIGHT	21 INCHES	21 INCHES
SUSPENSION LUGS	30 INCHES	30 INCHES

Figure 1-555. QRC 80-01 ECM Pods

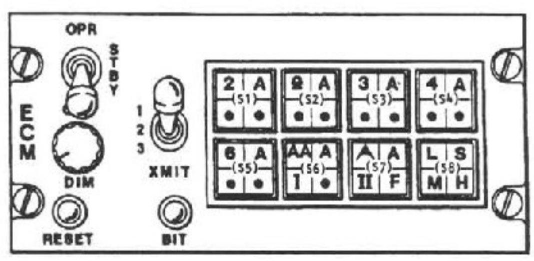


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Figure 1-556. C9492B ECM Pod Control Panel