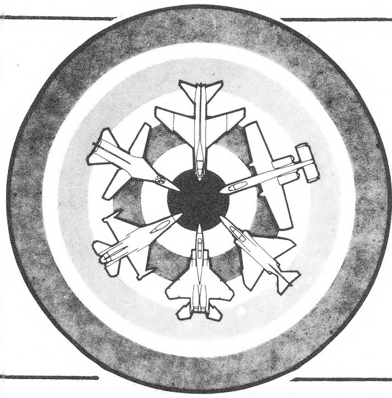

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FOREWORD

PURPOSE AND SCOPE

This manual is applicable to multiple aircraft and provides a single source for common descriptive and procedural information. Common is defined as information appropriate for more than one aircraft. Generally, the information is limited to standardized descriptions of common air-to-air and air-to-surface conventional munitions, fuzes, suspension equipment, safe escape data, mission planning, and weapons oriented avionics. When a conflict exists between the T.O.-1 Flight Manual and this technical manual, the flight manual will take precedence.

SUPPLEMENTS TO THIS MANUAL

This manual is intended to be used in conjunction with the aircraft unique Dash 34 volumes including T.O.-34-1, T.O.-34-1-1, T.O.-34-1-2, T.O.-34-1-1-1(C), and T.O.-34-1-2-1(C). These manuals provide descriptive and procedural data which are appropriate for a single aircraft.

SECTION I, AIR-TO-SURFACE MUNITIONS

Section I contains a description of the physical and functional characteristics of nonnuclear munition systems and controls, nonnuclear combat munitions, and nonnuclear training munitions and equipment.

SECTION II, FUZES

Section II contains a description of nonnuclear munition fuzes and associated fuze support equipment. The section includes physical and functional characteristics of the fuzes and fuze/munition compatibility data.

SECTION III, SPECIAL EQUIPMENT

Section III contains a description of special equipment necessary for mission support and/or weapon delivery, i.e., target acquisition devices, target illuminators, data link pods, resupply containers, special dispensers, etc. The information includes a physical and functional description of the equipment, its utility, and operation.

SECTION IV, AIR-TO-AIR MISSILES

This section contains a general discussion of air-to-air missile types, employment concepts, guidance and control groups, and warheads. The information includes a physical and functional description of each missile and its components.

SECTION V, SUSPENSION EQUIPMENT

This section contains a description of ejector racks, missile launchers, and practice bomb dispensers for both air-to-air and air-to-surface munitions. The information includes a physical and functional description of each system and its components.

SECTION VI, SAFE ESCAPE/SAFE SEPARATION

This section defines terms and standardizes the methods for determining minimum safe release altitude and minimum safe fuze arming time data for mission planning. The section also includes a description of methods for ensuring fragment deconfliction for flight attacks and sample problems for minimum safe fuze arming time.

SECTION VII, SUPPLEMENTARY DATA, ERROR ANALYSIS

This section contains data and methodologies necessary for accurate munition delivery and considers effects not normally included in ballistics and other delivery data, i.e., wind correction and release errors. The section also provides error analysis data for estimating miss distances attributable to errors in specific delivery parameters.

SECTION VIII, MISSION PLANNING

This section includes considerations which must be made in mission planning. The section describes the mission planning form and its preparation. Terms and methodologies are defined and sample problems are provided.

EXTERNAL STORES LIMITATIONS

The Flight Manual, T.O.-1, provides limitations for carriage, release, and jettison of certified stores. Only the stores listed in the Flight Manual are authorized, unless interim flight clearance is received from the appropriate aircraft system manager.

STORE CERTIFICATION

New nonnuclear munitions and external stores certification will be implemented as established in USAF PMDs for the SEEK EAGLE Program. Operating commands will generate these requirements by Statements of Operational Need (SON) in accordance with AFR 57-1.

FLIGHT CLEARANCE

Authorization for flight clearance will be requested through the appropriate aircraft system manager after any necessary testing and analysis acertains and verifies that an aircraft/store combination will not cause an unacceptable risk for a specific limited purpose such as DT&E, IOT&E, or FOT&E.

DEFINITION WORDS "SHALL," "WILL," "SHOULD," AND "MAY"

The words "shall' and "will" indicate a mandatory requirement. The word "should" indicates a nonmandatory desire or preferred method of accomplishment. The word "may" indicates an acceptable or suggested means of accomplishment.

WARNINGS, CAUTIONS, AND NOTES

The following definitions apply to Warnings, Cautions, and Notes found throughout the manual.

WARNING

Operating procedures, techniques, etc., which will result in personal injury or loss of life if not carefully followed.

CAUTION

Operating procedures, techniques, etc., which will result in damage to equipment if not carefully followed.

NOTE

An operating procedure, technique, etc., which is considered essential to emphasize.

YOUR RESPONSIBILITY — TO LET US KNOW

Every effort is made to keep this manual current. Review conferences with operating personnel and a constant review of accident and flight test reports assure inclusion of the latest data in the manual. We cannot correct an error unless we know of its existence. In this regard, it is essential that you do your part. Comments, corrections, and questions regarding this manual or any phase of the flight manual program are welcomed. These should be forwarded through your command channels on AF Form 847 to: HQ TAC/DOOW, Langley AFB, Virginia 23665-5000 with information copies to 3246 TESTW/TYD, Eglin AFB, Florida 32542-5000 and SA-ALC/MMUA, Kelly AFB, Texas 78241-5000.

GLOSSARY

ADVERSE YAW - A yaw opposite to the direction of turn, induced by rolling motion and aileron deflection.

AIMING POINT - The point on the ground used as a reference to determine bomb release.

AIRCRAFT AXIS - There are three axes, which are mutually perpendicular and have a common point of intersection:

1. Longitudinal axis: This axis is parallel to the fuselage reference line. Rotating the longitudinal axis will change the aircraft angle of attack (AOA) and/or pitch.

2. Vertical axis: This axis is perpendicular to the longitudinal axis. The aircraft rotates about this axis when yawing.

3. Lateral axis: This axis rotates about the longitudinal axis when the aircraft is rolled or banked.

AN - A prefix to denote use by Army, Air Force, and Navy.

ANGLE OF ATTACK (AOA) - The angle between the fuselage reference line and the relative wind.

ANGLE-OFF - The angular measurement between the longitudinal axis of two or more aircraft.

ANGLE OF GUNFIRE (AGF) - The angle between the gun bore line and the flightpath.

ANGLE OF INCIDENCE - A fixed angle between the wing chord line and the fuselage reference line.

ANGLE OF PITCH - The angle of the aircraft flightpath relative to a level plane.

BOMB STICK - The number of bombs released during a ripple delivery.

BOMB TRAIL - The distance the bomb trails behind the aircraft after release.

BOMB TRAJECTORY - The path of a bomb from release to impact.

BULLET DENSITY - The number of rounds passing through an area of 1 square foot per unit of time.

BULLET DISPERSION - Deviation of a bullet trajectory from the aiming point.

COCKPIT G - Acceleration forces on the aircraft as read from the g-meter.

CORRECTED SIGHT DEPRESSION - True sight depression corrected for a headwind or tailwind component.

DUD - A round or bomb that fails to explode.

EFFECTIVE SIGHT DEPRESSION - The depression from desired flightpath. Varies with release conditions. When preplanned parameters are met, effective depression equals required depression.

FIRE BOMB - An incendiary or napalm-filled bomb.

FIRE PULSE - An electrical impulse transmitted to fire/release stores.

FLIGHTPATH - The line or plane that describes the longitudinal motion of the aircraft.

FUSELAGE REFERENCE LINE (FRL) - A basic reference line through the fuselage parallel to the longitudinal axis of the aircraft.

GROUND RANGE - The horizontal distance from the point directly below the aircraft to the target.

GROUND TRACK - The actual line of movement of an aircraft over the ground.

GUN BORE LINE (GBL) - Extension of the initial bullet muzzle velocity.

HARMONIZATION - The adjustment (or boresighting) of the gun barrel so that, when the guns are fired at the most effective range, the pipper will be on the bullet impact point.

HEAD-UP DISPLAY (HUD) - An optical and electronic device that projects flight information into the pilot's forward field of view (FOV), and provides primary and standby weapon delivery capability.

INITIAL POINT (IP) - A point over which an aircraft begins an attack.

KNOTS CALIBRATED AIRSPEED (KCAS) - This is the indicated airspeed for installation error.

KNOTS INDICATED AIRSPEED (KIAS) - This airspeed is read directly from the airspeed indicator.

KNOTS TRUE AIRSPEED (KTAS) - This is the equivalent airspeed corected for atmospheric density.

LAUNCHER LINE (LL) - A line through a rocket launcher tube extended to infinity.

LINE OF DEPARTURE (LOD) - The path that a rocket follows after leaving the aircraft.

MIL - A milliradian which is 1/1000 of a radian (17.45 mil = 1 degree). One mil subtends approximately 1 foot at a 1,000-foot range.

MISSILE HANGFIRE - When a missile fails to launch after all normal procedures have been accomplished, and smoke or smoldering is observed. A potential launch is considered possible within the next 15 minutes.

MISSILE MISFIRE - When a missile fails to launch after all normal procedures have been accomplished, and no smoke or smoldering is observed within 3 minutes.

PARALLAX - The linear separation of the sight and weapons as they are installed in the aircraft.

PICKLE - The act of depressing the weapon release button.

PREDICTION ANGLE - Total lead angle required after calculations.

PYLON - A component attached to the aircraft to carry, arm, release, or jettison external stores.

RADIAL G - Cockpit g plus or minus the component of gravity.

REQUIRED SIGHT DEPRESSION - The amount of depression below the zero sight line (ZSL) necessary to accurately define bomb range.

RIP - Ripple - A release mode in which the quantity and interval of bombs may be selected.

SIGHTLINE (SL) - The base or zero line for all sight computations that has been corrected for parallax.

SIGHT SETTING - The value in mils to which the aiming reticle is depressed.

SLANT RANGE - Line-of-sight distance from the aircraft to the target.

STANDBY AIMING RETICLE - A backup display on the HUD, depressible over the same range as the primary.

TRAJECTORY - Flightpath from release to impact.

TRAJECTORY SHIFT - The angular shift of the bullet or rocket trajectory from bore line toward the flight path of the aircraft.

TRUE SIGHT DEPRESSION - A no-wind sight setting computed for preplanned flight conditions.

UPWINL AIMING POINT - Point upwind of the target used to determine bomb release.

VELOCITY VECTOR - A vector quantity denoting both magnitude and direction.

VIP - Visual identification point.

ZERO SIGHT LINE (ZSL) - The pipper line of sight when the optical sight is set on zero mil depression.

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ABBREVIATIONS

A

AB Afterburner
ACD Adapter Control Detector
ACMI Air Combat Maneuvering Instrumentation
ACP Armament Control Panel
ACS Armament Control System
ADI Attitude Director Indicator
ADL Armament Datum Line
AFG Air Foil Group
AFSC Air Force Systems Command
A/G Air-to-Ground
AGF Angle of Gunfire
AGL Above Ground Level
AGM Air-to-Ground Missile
AID Attached Inflatable Decelerator
AIM Air Intercept Missile
AIR Air Inflatable Retarder
AIS Aircraft Instrumentation Subsystem
AIU Aircraft Integration Unit
ALSC Aluminum Linear Shaped Charge
AOA Angle of Attack
AOD Aim of Distance
AOP Aim of Point
AP Armor-Piercing
API Armor-Piercing Incendiary
ATU Anemometer-Vane-Type-Unit
AVTR Airborne Video Tape Recorder
AZ Azimuth

B

BDU Bomb, Dummy Unit (practice munition)
BFD Battery Firing Device
BIT Built-In Test
BITE Built-In Test Equipment
BLU Bomb, Live Unit
BR Bomb Range
B/W Black on White (contrast)

C

CAS Close Air Support
CBU Cluster Bomb Unit
CCG Computer Control Group
CCS Control and Computation Subsystem
CEM Combined Effects Munition
CG Center of Gravity
CITS Centrally Integrated Test System
CRT Cathode-Ray Tube
CTVS Cockpit Television Sensor
CW Continuous Wave

D

DC Direct Current
DDS Display and Debriefing Subsystem
DEP Depression
DFP Depression from Flightpath
DL Data Link
DLCP Data Link Control Panel

E

E Net Error
ECCM Electronic Counter-Countermeasure
ECM Electronic Countermeasure
ECU Electronic Control Unit
EMI Electromagnetic Interference
EO Electro-Optical
EOB Electronic Order of Battle
EOD Explosive Ordnance Disposal
EWS Electronic Warfare Systems

F

FBL Fixed Bore Line
FFAR Folding Fin Aircraft Rocket
FGL Fixed Gun Line
FFOD Firefighting Operational Distance
FM Frequency Modulation
FMU Fuze, Munition Unit
FOV Field of View
fps Feet per Second

ABBREVIATIONS (Continued)

G

G	Gravity
GB	Guided Bomb
GBL	Gun Bore Line
GBU	Guided Bomb Unit
G&C	Guidance and Control
GHz	Gigahertz
GP	General-Purpose
G/VLLD	Ground or Vehicular Laser Locator Designator

H

HARS	Heading Attitude Reference System
HAS	Hydraulic Actuation System
HD	High Drag
HDGP	High-Drag, General-Purpose
HE	High Explosive
HEAP	High-Energy, Armor-Piercing
HEAT	High-Explosive, Antitank
HEI	High-Explosive, Incendiary
Hg	Mercury
HOB	Height of Burst
HUD	Head-Up Display
Hz	Hertz

I

IDS	Infrared Detecting Set
IF	Intermediate Frequency
IHC	Integrated Hand Control
INS	Inertial Navigation System
IP	Initial Point
IPP	Initial Pipper Placement
IR	Infrared

J

JMEM	Joint Munitions Effectiveness Manual

K

KCAS	Knots Calibrated Airspeed
kHz	Kilohertz
KTAS	Knots True Airspeed
km	Kilometer

L

LD	Low Drag
LDGP	Low-Drag, General-Purpose
LGB	Laser Guided Bomb
LL	Launcher Line
LOD	Line of Departure
LOS	Line of Sight
LRU	Line-Replaceable Unit
LSS	Laser Spot Seeker
LTD	Laser Target Designator
LTDSS	Laser Target Designator Scoring System
LUU	Illumination Unit

M

MAU	Miscellaneous Armament Unit
MCM	Manual Countermeasure
MER	Multiple Ejector Rack
mil	Milliradian
MK	Mark (Navy weapon designation)
MLV	Memory Loader Verifier
mm	Millimeter
MOD	Modification
MPS	Mission Planning Section
MRD	Missile Restraining Device
msec	Millisecond
MSL	Mean Sea Level

N

N	Nose
NFOV	Narrow Field of View
NM	Nautical Mile
NNMSB	Nonnuclear Munitions Safety Board
N/T	Nose and/or Tail

O

OAP	Offset Aiming Point

ABBREVIATIONS (Concluded)

P

PCO Power Changeover
PD Pulse Doppler
PIM Pulse Interval Modulation
PMI Pearlite Malleable Iron
PRF Pulse Repetition Frequency
PSA Phase-Scanned Array
PSI Pounds per Square Inch

R

RAT Ram Air Turbine
RF Radio Frequency
RGPO Range Gate Pulloff
RHAW Radar Homing and Warning
RKT Rocket
RPE Release Point Error
rpm Revolutions per Minute

S

SAF Safe, Arming, and Fuzing
SAFU Safety, Arming, and Functioning Unit
SL Sight Line
SMU Suspended Multilauncher Unit
SON Statement of Operational Need
SR Slant Range
SSLO Solid-State Local Oscillator
STS Search Track Set
SUU Suspension and Release Unit

T

T Tail
TAS True Airspeed
TDD Target Detecting Device
TE Trajectory Error
TER Triple Ejector Rack
TGM Training Guided Missile
TIS Tracking Instrumentation Subsystem
TISEO Target Identification System, Electro-Optical
TISL Target Identification Set, Laser (PAVE PENNY)
TMD Tactical Munitions Dispenser
TOF Time of Fall or Time of Flight
TP Target Practice
TPT Target Practice Tracer
TV Television

U

UHF Ultra-High Frequency

V

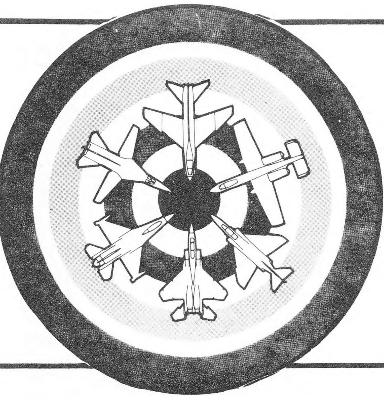
VIP Visual Identification Point

W

W/B White on Black (contrast)
WCU Weapon Control Unit
WD Warhead
W/D Weapon Delivery
WDL Weapon Data Link
WFOV Wide Field of View
WP White Phosphorous

Z

ZSL Zero Sight Line



SECTION I
AIR-TO-SURFACE MUNITIONS

CONTENTS

CONTENTS (CONTINUED)

CONTENTS (CONCLUDED)

BOMB-TYPE MUNITIONS

Bombs are generally categorized according to the ratio of explosive weight to total weight (FIGURE 1-1). Categories include general purpose (GP), demolition, fragmentation, and penetration. GP bombs can be used against a variety of targets. Since the body case is approximately one-half-inch thick, the casing creates a fragmentation effect at the moment of detonation. Also, since the explosive filler constitutes approximately 50 percent of the total weight, considerable damage from the blast effect can be expected at the target. In addition to these effects, a mining effect can be gained through the use of delayed-action fuzes. GP bombs can be made into a semiarmor piercing bomb by retaining the original nose closure plug and installing only a tail fuze. This configuration will penetrate medium hard targets. The bomb was given the designation GP because of its versatility.

GP BOMBS

The explosive weight equals approximately 50 percent of the total weight. These bombs normally weigh between 250 to 2,000 pounds and produce relatively good blast and fragmentation. Examples of this type are the MK 82 and 84 series bombs.

DEMOLITION BOMBS

The explosive weight equals approximately 65 to 80 percent of the total weight. These bombs have a relatively thin-walled casing to maximize blast effects while penetration and fragmentation effects are limited. An example of this type is the M118 demolition bomb.

FRAGMENTATION BOMBS

As the name implies, these bombs are intended to disperse and project high-velocity fragments. The fragments are the principle damage mechanism of the weapons, with blast effects being a secondary consideration. The charge to total weight ratio varies from 10 to 20 percent. No bomb presently in the inventory is primarily a fragmentation bomb although GP bombs do produce a relatively good fragmentation effect. CBU munitions are primarily fragmentation weapons.

PENETRATION BOMBS

These bombs are designed to penetrate and explode inside a hard target such as a concrete bunker. They are built with heavy cases and are aerodynamically designed to counter break-up. The explosive charge is approximately 25 to 30 percent of the total weight. The AGM-65 Maverick missile with its shaped charge penetrating warhead and the I-2000 are good examples of penetrating munitions.

BOMB EFFECTS

The destructive effect of a high-explosive bomb is due primarily to the detonation of the high-explosive filler. The chemical reaction which takes place upon initiation

EXPLOSIVES FILLER CHART

The following high explosives are the most commonly used and are arranged in relative order of decreasing sensitivity:

1. MERCURY FULMINATE: This is an initiating compound which is extremely sensitive to heat, friction, spark, flame, or shock. For all practical purposes, this compound has been replaced by lead azide.

2. LEAD AZIDE: This is an initiating compound used to detonate light explosives. It is sensitive to flame and impact. Lead azide is used in detonator assemblies in fuzes.

3. TETRYL: Tetryl is sufficiently insensitive when compressed to be used as a booster explosive. Tetryl is also used as a burster in chemical shells and bombs, in a 70:30 ratio with TNT.

4. RDX: This explosive is manufactured by the nitration of hexamethylenetetramine. Two types of RDX are used for military purposes. It is sometimes referred to as Hexogen. RDX is less sensitive to electric spark than are tetryl or TNT. It is suspected to be more sensitive to impact than tetryl, although limited tests indicate it approximately equals it in impact sensitivity. It is the second most powerful military explosive and is often used in small weapons.

5. EDNATOL: Ednatol is a mixture of Haleite (ethylene dinitramine) and TNT. It is less sensitive than tetryl but more sensitive than TNT.

6. CYCLOTOL: This is a mixture of 60 percent RDX and 40 percent TNT. It is sometimes called Composition B-2. Unlike Composition B, it does not contain any wax and is more sensitive than Composition B.

7. COMPOSITION B: This is a mixture of RDX, TNT, and beeswax or similar wax. It is less sensitive than tetryl but more sensitive than TNT.

8. TNT: Trinitrotoluene, commonly known as TNT, is one of the most stable of high explosives. It is relatively insensitive to blows or friction. Confined TNT, when detonated, explodes with violence. It is readily detonated by lead azide, mercury fulminate, and tetryl.

9. AMATOL: This is a mixture of ammonium nitrate and TNT. It has approximately the same general characteristics as TNT. Either a 50:50 or 80:20 mixture is used in bombs. The first figure in each ratio represents the percentage of ammonium nitrate in the mixture.

10. H-6: This explosive has the following composition: 45 percent RDX, 29.5 percent TNT, 21 percent aluminum, 4 percent D-2 wax, and 0.5 percent calcium chloride. It is used in the AGM-12B (MK 19 Mod 0) warhead.

11. TRITONAL: Tritonal is the name given to explosives containing TNT and aluminum, generally in the ratio of 80:20. Tritonal produces a greater blast effect than either TNT or Composition B.

12. EXPLOSIVE D: Of all the military explosives, this is the least sensitive to shock and friction. Therefore, it is used as a bursting charge in Armor-Piercing Bombs, which must pass through armor without exploding. Explosive D is also known as ammonium picrate.

FIGURE 1-1 (Continued)

13. PICRATOL: Picratol is a mixture containing 52 percent Explosive D and 48 percent TNT. It has the same resistance to shock as that of Explosive D. Picratol is used in some Semi-Armor-Piercing Bombs.

14. PENTOLITE: Pentolite is a mixture of PETN and TNT (50/50), usually in a melt cast formation. The impact sensitivity of Pentolite is about the same as TNT. It is used in bomb boosters, shape charges, and projectiles.

15. OCTOL: Octol is a mixture of TNT and HMX (25/75 or 30/70). Its sensitivity is about the same as HMX. It is a melt cast form. Its principle uses are in shape charges, high energy projectiles, and as bomb fillers.

16. HTA-3: This is a mixture of HMX/TNT/aluminum (49/29/22) and is a melt cast form with a sensitivity similar to Octol. Its principle uses are in high energy projectiles and bomb fillers.

17. HBX-1: This is a mixture of RDX/TNT/aluminum/D-2 wax/calcium chloride (40/38/17/5/.5). It is a melt cast. Its principle uses are in bomb fillers and high-explosive charges.

18. DESTEX: This is a mixture of TNT/aluminum/D-2 wax/carbon wax (74.7/18.7/4.7/1.9). It is used as filler in penetrating bombs and projectiles. It is less sensitive than Tritonal.

19. MINOL II: This is a compound of TNT, ammonium nitrate, and aluminum (40/32/28). It is an authorized alternate fill for Tritonal and has a similar sensitivity.

EXPLOSIVE	EXPLOSIVE FACTOR[a]				
	PENTOLITE BASE	TNT BASE	H-6 BASE	TRITONAL BASE	COMP B BASE
Comp B	1.02	1.13	0.87	0.92	1.00
Cyclotol D	1.09	1.21	0.93	0.98	1.07
Destex	1.11	1.23	0.95	1.00	1.09
H-6	1.17	1.30	1.00	1.05	1.15
HBX-1	1.08	1.20	0.92	0.97	1.06
HTA-3	1.10	1.22	0.94	0.99	1.08
Minol II	1.01	1.12	0.86	0.91	0.99
Octol	0.96	1.07	0.82	0.86	0.94
Pentolite	1.00	1.11	0.85	0.90	0.98
Picratol	0.83	0.92	0.71	0.75	0.81
TNT	0.90	1.00	0.77	0.81	0.88
Tritonal	1.11	1.23	0.95	1.00	1.09

[a] Weight of base explosive equivalent to one pound of the explosive. For example, one pound of H-6 explosive will provide blast pressure and impulse equal to 1.17 pounds of Pentolite. The above explosive factors apply to bare charges. They may vary for real cased charges.

FIGURE 1-1 (Concluded)

of the explosive train is the fundamental action required to attack and defeat a specified target. Generally, the explosive train is used to achieve one of three basic effects in the target area. These are blast, fragmentation, or cratering.

BLAST

The blast effect is caused by the tremendous overpressures generated by the detonation of a high explosive. Complete detonation of high explosives can generate pressures up to 700 tons per square inch and temperatures in the range of 3,000 to 4,500 °C prior to bomb case fragmentation. Approximately half of the total energy generated will be case fragmentation. Approximately half of the total energy generated will be used in swelling the bomb casing to 1.5 times its normal size prior to fragmenting and then imparting velocity to those fragments. The remainder of this energy is expended in compression of the air surrounding the bomb and is responsible for the blast effect. This effect is most desirable for attacking industrial complexes or habitable structures with the intention of blowing down walls, collapsing roofs, destroying or damaging machinery, etc. Blast is confined to relatively short distances in its effectiveness on personnel. The maximum distance is 110 feet at which the blast from a 2,000-pound bomb is considered effective against personnel. Blast is usually maximized by using a GP bomb with a fuzing system that will produce a surface burst with little or no confinement of the overpressures generated.

FRAGMENTATION

Fragments of a bomb case can achieve velocities comparable to those of a small-arms projectile (3,000 to 5,000 fps) and can cause great impact effects. Fragmentation is effective against troops, vehicles, aircraft, and other soft targets. The fragmentation generated from the detonation of a high-explosive bomb has greater effective range than blast, usually up to approximately 3,000 feet regardless of bomb size. The fragmentation effect can be maximized by using a bomb specifically designed for this effect, or by using a GP bomb with an airburst functioning fuze.

CRATERING

With conventional aircraft-delivered bombs, the cratering effect is normally achieved by using a GP bomb with a delayed fuzing system. This system allows bomb penetration before the explosion occurs and permits the formation of a larger crater as a result. This effect is most desirable in interdiction of supply routes and area denial operations. It also finds application in attacks on multiple-storied buildings. Rather than functioning the bomb instantaneously on impact with the roof of a building, the delayed fuzing will allow the bomb to penetrate and use the confinement of the building walls to increase the destructive effect of the bomb.

NOTE

Care must be exercised when employing GP bombs against hard targets. If the bomb impact angle is less than 40 degrees it will likely ricochet; if the velocity is too great, it will deflagrate (rapid burning). Both factors are interdependent. If exact combinations (angle/velocity) are required, consult your JMEM Weapon's Characteristic Manual.

GENERAL-PURPOSE BOMBS

GP bombs are all cylindrical in shape and are equipped with conical fins or retarders for external high-speed carriage. They are adapted for both nose and tail fuzes to insure reliability and to cause the desired effects, which may be blast, cratering, or fragmentation.

GP bombs in the current inventory are all similar in construction; therefore, the MK 82 bomb will be used as a typical example (FIGURE 1-2). The bomb body contains the high explosive, charging well, and suspension lugs. Other parts added to make a complete munition are adapter boosters, fin assembly, arming wires, and fuzes.

GP BOMB

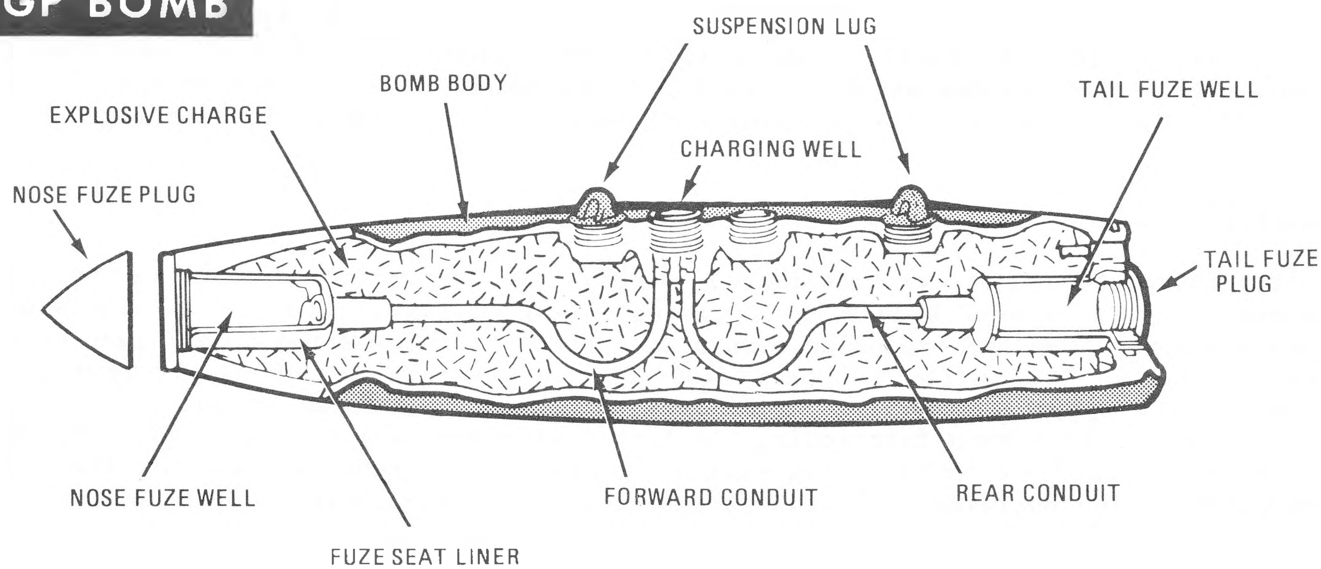


FIGURE 1-2

CHARGING WELL

GP bombs are constructed with a charging well connected to the nose and tail fuze wells. The charging well, located just aft of the forward suspension lug, is usually closed with a threaded plug that must be removed for installation of braided steel arming cables or lanyards used with the fuze, munition, and live unit (FMU) fuzes. The steel cables or lanyards are threaded through the conduits inside the bomb and extend out of the top of the charging well for attachment to the aircraft solenoids.

SUSPENSION LUGS

Bombs weighing less than 2,000 pounds are equipped with two-point 14-inch suspension lugs. The MK 84 and M118, which are in the 2,000-pound class and above, are equipped with two-point 30-inch suspension lugs.

ADAPTER BOOSTERS

Nose and tail adapter boosters (FIGURE 1-3) are required when mechanical fuzes are installed in bombs. The typical adapter consists of an adapter bushing and booster charge assembled in a cylindrical metal casing. The bushing has external threads for installation in the bomb fuze well and internal threads to accommodate the fuze. The body consists of a fuze seat liner, a booster charge of two perforated tetryl pellets, two felt spacer disks, and inert filler. The body is enclosed within a metal casing. A protector plug, in the form of a metal tube closed at one end, extends through the perforations in the booster charge and closes the casing at the booster end.

ADAPTER BOOSTER (TYPICAL)

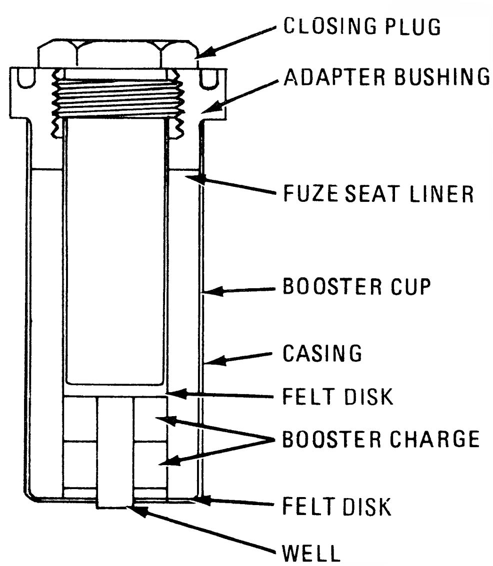


FIGURE 1-3

NOTE

There are various models of adapter-boosters and exact design will vary slightly.

CONICAL FIN ASSEMBLY

The purpose of the conical fin assembly is to help stabilize the bomb in flight. Fins are made of light metal and may be easily bent. Spot welds and other joints may be damaged. A bent fin may ruin the bomb's ballistic trajectory.

ARMING WIRE AND LANYARD

Arming wires and lanyards are installed on bomb-type munitions to allow the pilot to release an armed bomb or a safe bomb. Arming wires are used with mechanical fuzes and arming lanyards are used with FMU series fuzes. Arming wires and lanyards are rigged to provide the highest possible probability that the munition will arm as desired.

A typical arming wire/lanyard routing is shown in FIGURE 1-4. Prior to uploading the bomb on the suspension equipment, arming wires are attached to the bomb suspension lugs. One end of the nose arming wire is secured to the left side of the aft suspension lug. The other end is inserted through an arming wire swivel loop and then through the front suspension lug. The tail fuze arming wire is attached to the right side of the front suspension lug, inserted through a swivel loop, and then through the aft suspension lug. The bomb is now ready for uploading onto the appropriate suspension equipment. Once uploaded, the free ends of the arming wires are then attached or threaded through safety devices in the fuze, thus maintaining the fuze in a safe (unarmed) condition (FIGURE 1-5). A beryllium or copper Fahnstock clip is placed over the ends of the arming wires to prevent accidental slippage prior to release. The arming wire passes through the arming wire swivel loops. These are inserted into the proper arming solenoids (FIGURE 1-6).

ARMING WIRE/LANYARD ROUTING (TYPICAL)

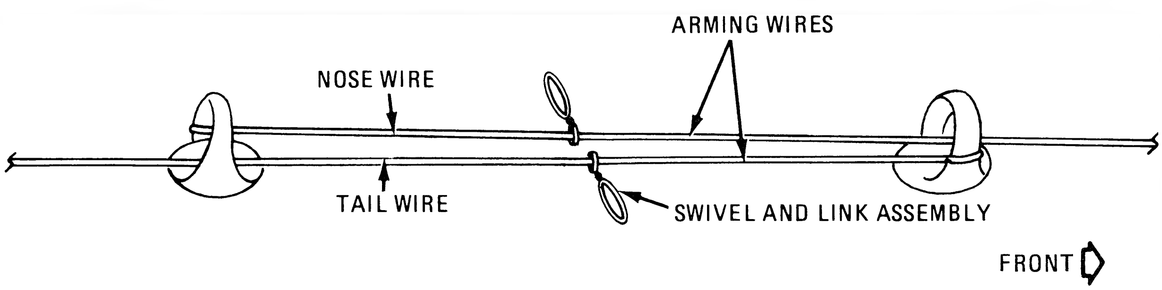


FIGURE 1-4

FMU SERIES FUZING

For example, on FMU-fuzed bombs the lanyard (FIGURE 1-7) cable is inserted through the internal conduit to the charging well. A swivel and link is then attached to the arming lanyard. The swivel is inserted into the appropriate solenoid.

RELEASE

If the weapon is released armed, the energized solenoid will hold the swivel and link assembly and cause the metal clips to be stripped off the arming wire, allowing it to pull from the fuze, which then arms. If the munition is configured with an

ARMING WIRE TO FUZE AND ATU-35 (TYPICAL)

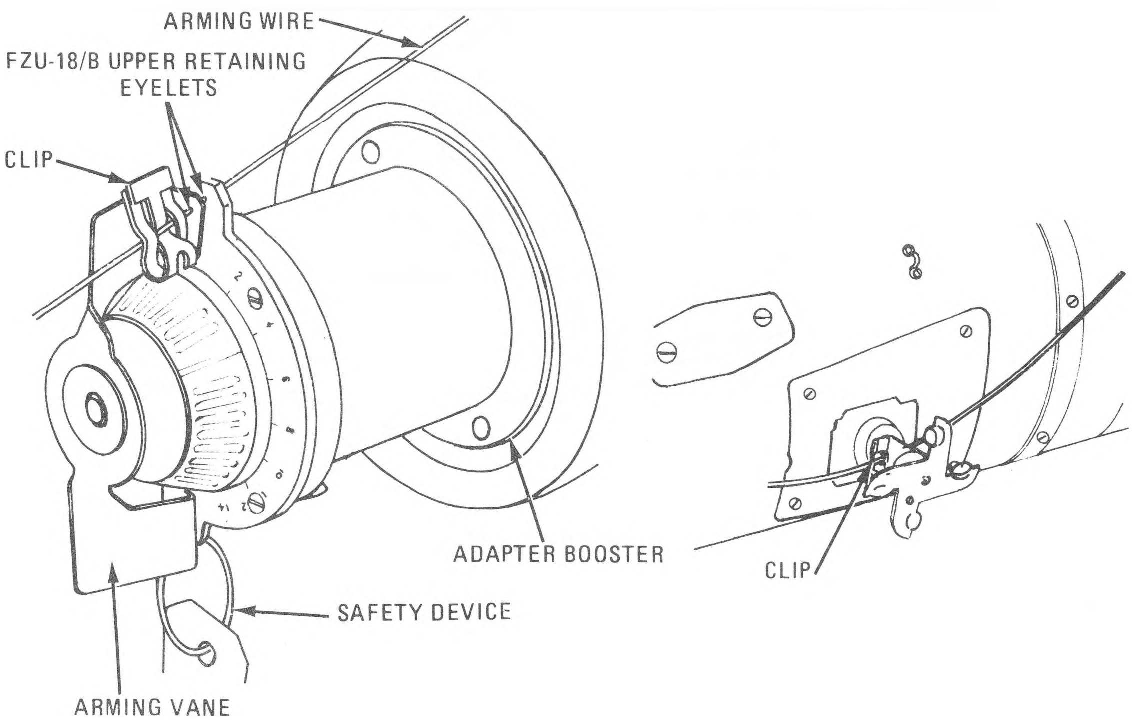


FIGURE 1-5

FMU-type fuze, the solenoid will normally hold the swivel and link assembly. This causes a sharp pull on the lanyard or cable which then activates the FMU fuze.

SAFE

If the bomb is released in the safe condition, the arming wire swivel loops are released from the pylon arming solenoids, the arming wires remain in the fuze safety devices, and the fuzes cannot arm. Without fuze operation, the bomb will usually be a dud. Low-order detonations may result from very high impact shock. A low-order detonation results when the high explosive is incompletely exploded. A high-order detonation results when all components of a high-explosive train decompose as planned. With an FMU-fuzed munition, the swivel loop is also released with the bomb and the fuze is not activated.

EXPLOSIVE FILLERS

The primary high-explosive filler used in the GP bombs is Tritonal, but there are a relatively small number of bombs in the inventory filled with H-6.

FMU ARMING WIRE ROUTING (TYPICAL)

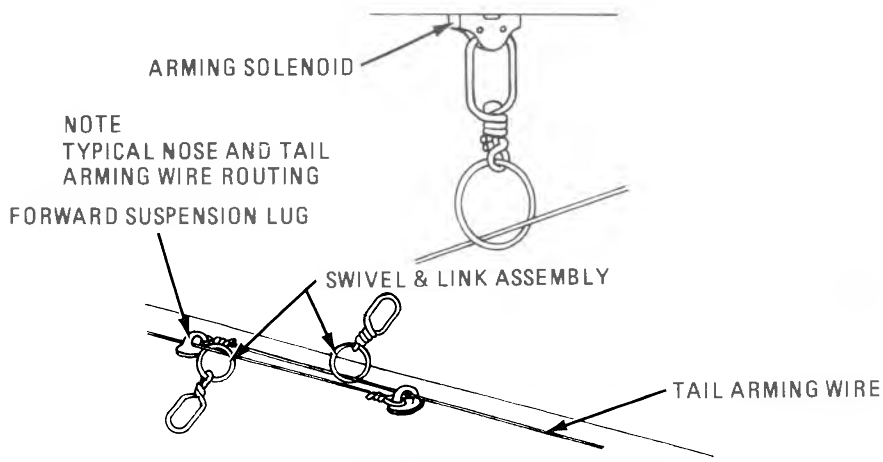


FIGURE 1-6

FMU SERIES FUZING

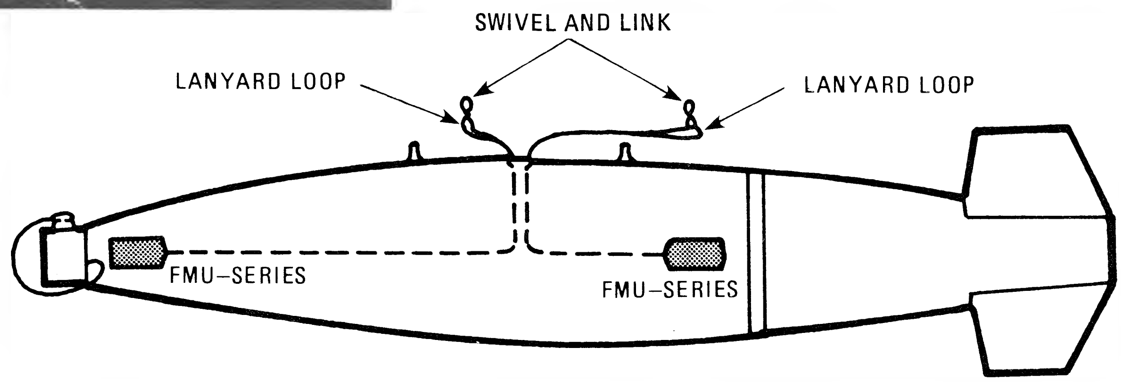


FIGURE 1-7

Tritonal is the name given to explosives containing trinitrotoluene (TNT) and aluminum, generally in the ratio of 80:20. H-6 has the following composition: 45 percent RDX, 29.5 percent TNT, 21 percent aluminum, 4 percent D-2 wax, and 0.5 percent calcuim chloride.

Knowledge of what type of explosive is used in bombs can be important. H-6 is more sensitive to impact than Tritonal. A test was conducted with MK 84 bombs fitted with inert fuzes to compare Tritonal and H-6 filled bombs. Seventy-five percent of the H-6 bombs exploded on impact (impact velocity 1,030 fps). The Tritonal-filled bombs all survived (1,040 fps). This has several important implications for employment of Tritonal and H-6 bombs.

Tritonal is much less impact sensitive than is H-6. Because of this, Tritonal-loaded GP bombs provide significantly improved penetration and survivability. A Tritonal bomb is preferable for a target requiring penetration.

WARNING

When a safe release is planned, the safe escape and fragment considerations must always be planned for, especially when releasing H-6 filled bombs, because they are more likely to detonate upon impact.

Some bombs will be marked Tritonal or H-6 somewhere on the bomb body. If the bomb is not marked, the type of explosive can be determined by requesting the information from explosive personnel or supply.

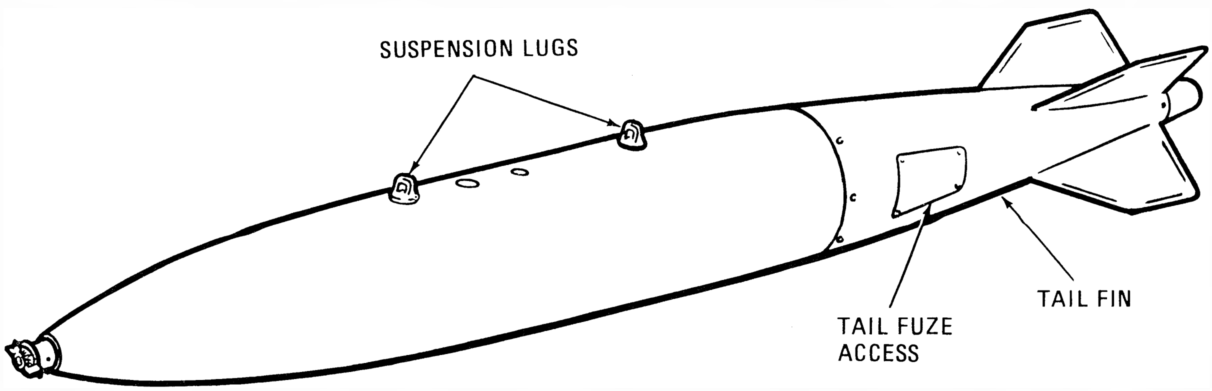
A Mod 2 version of the bomb has an exterior thermal protective coating, an improved interior lining, and a new base sealing compound to make it more resistant to cookoff in an open fire. The MK 82 Mod 2 can be recognized by a bumpy exterior surface and two yellow stripes around the bomb body.

MK 82 LD, MK 83 LD, MK 84 LDGP BOMBS

The MK 82 (500-pound class), MK 83 (1,000 pound class), and MK 84 (2,000-pound class) low-drag, general-purpose (LDGP) bombs are similar in construction and vary only in size and weight (FIGURE 1-8). The bombs have a streamlined cylindrical body with a tapered aft section to which a conical fin assembly is attached. The conical fin assembly will accept the ATU-35 series drive.

The MK 82 LD is equipped with the MK 82 conical-type fin or MAU-93/B conical fin. The total weight of the MK 82 is 531 pounds, and it contains 192 pounds of Tritonal high-explosive filler.

MK 82, MK 83, AND MK 84 GP BOMBS (TYPICAL)



CHARACTERISTICS

	MK 82	MK 83	MK 84
WEIGHT	531 LB	985 LB	1972 LB
LENGTH	7 FT 2 IN.	9 FT 11 IN.	12 FT 8 IN.
DIAMETER	11 IN.	14 IN.	18 IN.
FIN SPAN	15 IN.	20 IN.	25 IN.
FIN ASSEMBLY	MK 82 OR MAU-93/B	MK 83	MK 84
SUSPENSION LUG SPACING	14 IN.	14 IN.	30 IN.

FIGURE 1-8

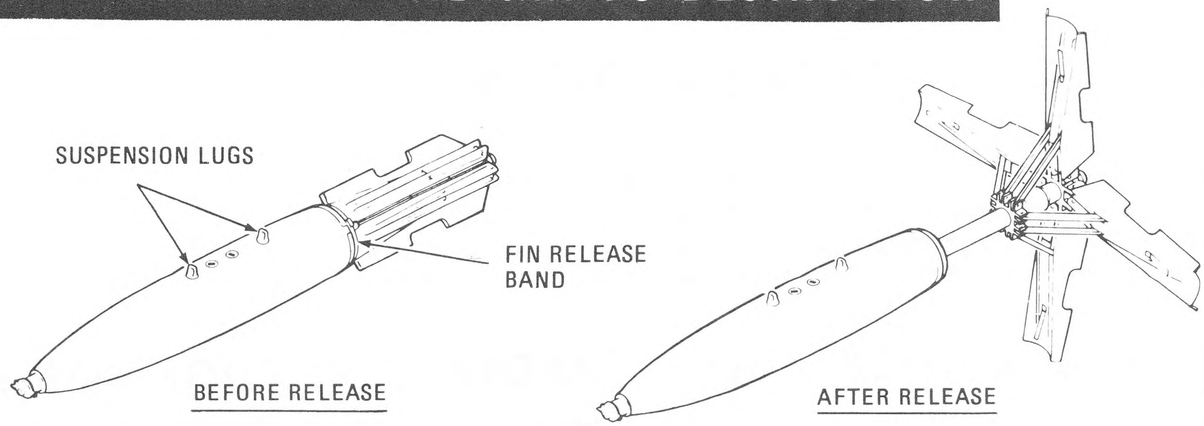
The MK 83 LD is equipped with the MK 83 conical-type fin or MAU-91 conical fin. The total weight of the MK 83 is 985 pounds, and it contains 416 pounds of Tritonal or H-6 high-explosive filler.

The MK 84 LD is equipped with the MK 84 conical-type fin. The total weight of the MK 84 is 1,972 pounds, and it contains 945 pounds of Tritonal or H-6 high-explosive filler.

MK 82 HDGP (SNAKEYE I) BOMB

The MK 82 (500-pound class) Snakeye I, a high-drag, general-purpose (HDGP) bomb (FIGURE 1-9), is a MK 82 GP bomb that is modified by attaching a MK 15 series retarding tail assembly. This configuration allows for low level releases and steeper impact angles. The four MK 15 retarding fins are linked to a sliding collar so all four fins must open at the same time. In the LD configuration, the retarder fins are held closed by a retaining band. The retaining band is under 40 pounds of tension provided by leaf springs under the retarder fins. After approximately 32 inches of fall from the aircraft, the fin release wire/lanyard is fully extracted from the weapon, releasing the retaining band. At this time the leaf springs force the retarder fins into the airstream. Airloads complete the opening of the fins, extending them approximately perpendicular to the airstream to provide maximum drag and stability.

MK 82 SNAKEYE AND MK 36 DESTRUCTOR



CHARACTERISTICS	MK 82 SNAKEYE	MK 36
WEIGHT	570 LB	572 LB
LENGTH	7 FT 6 IN.	7 FT 6 IN.
DIAMETER	11 IN.	11 IN.
FIN SPAN (BEFORE RELEASE)	15 IN.	15 IN.
FIN SPAN (AFTER RELEASE)	65 IN.	65 IN.
FIN ASSEMBLY	MK 15 SERIES	MK 15 SERIES
SUSPENSION LUG SPACING	14 IN.	14 IN.

FIGURE 1-9

The MK 82 Snakeye can be released in either the HD configuration (retarding fins open after release) or in the LD configuration (retarding fins remain closed). The release configuration is determined by arming wire/lanyard routing and may be cockpit selectable. Refer to the appropriate aircraft Dash 34 for detailed information concerning the required arming configuration for this capability.

WARNING

> If the cockpit selectable release option is used, the prescribed arming wire/lanyard routing must be utilized.

The MK 15 Mod 3A and Mod 4 tail assemblies are restricted to a maximum of 500 knots calibrated airspeed (KCAS). When released HD, the MK 15 Mod 3 is restricted to a maximum of 400 KCAS. HD deliveries (Mod 3A and Mod 4) below 450 KCAS may, and below 400 KCAS will, cause the fins to partially open. This results in the bomb impacting long.

HD deliveries above 5,000 feet above ground level (AGL) may, and above 10,000 feet AGL will, cause bomb impact errors up to hundreds of yards.

MK 36 (DESTRUCTOR) GP BOMB

The MK 36 (500-pound class) destructor is a MK 82 Snakeye I bomb fitted with a MK 75 arming kit which converts the bomb into a land or water mine (FIGURE 1-9). The weapon is deployed HD only. The MK 36 destructor uses MK 82 Snakeye I ballistic data. The MK 75 arming kit consists of a MK 32 arming device fitted into the nose of the bomb and a MK 42 firing device that fits in the tail fuze well.

MK 82 AIR INFLATABLE RETARDER (AIR) HDGP BOMB

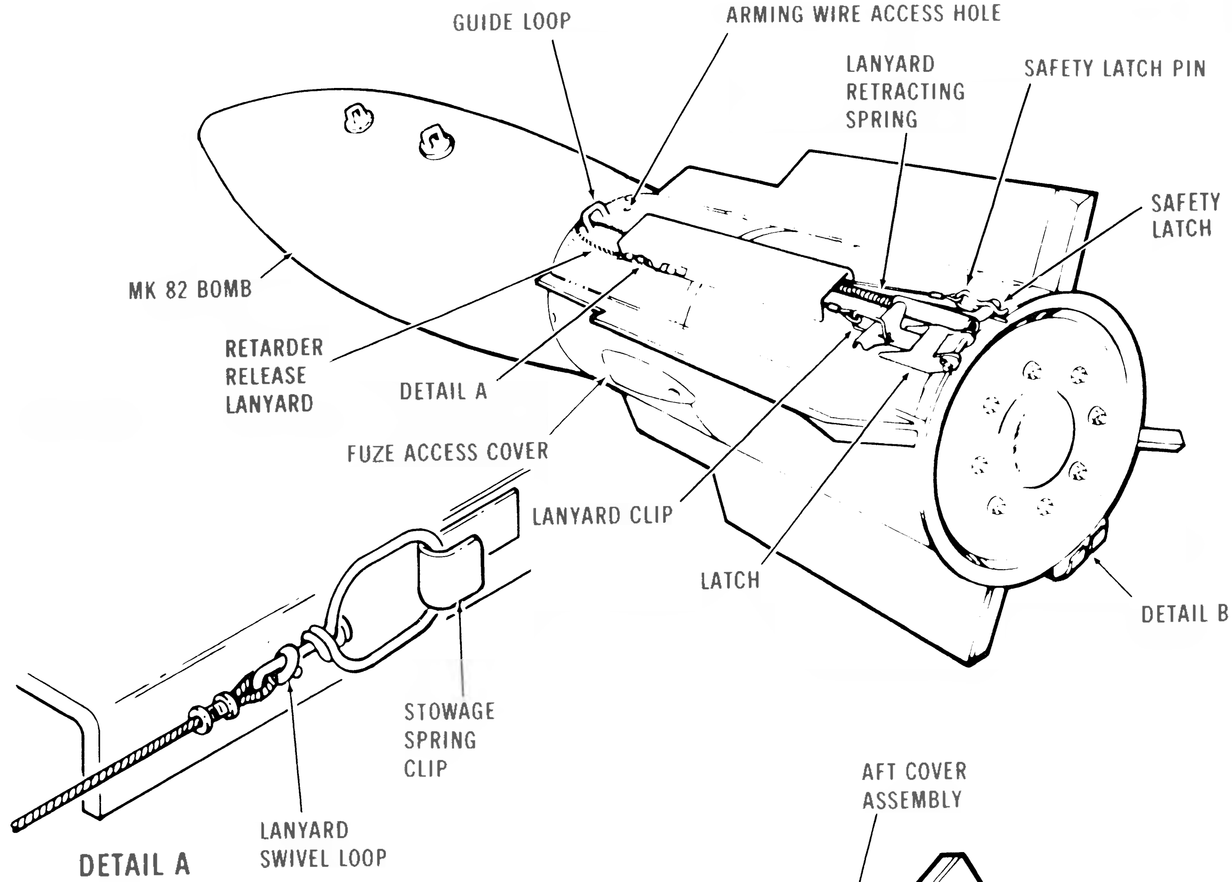
The MK 82 (500-pound class) AIR (FIGURE 1-10) is a MK 82 bomb that is modified by attaching a BSU-49/B AIR tail assembly. The AIR provides a high-speed, low-altitude delivery capability by use of bomb retardation. This increases bomb trail and reduces the danger of the aircraft being hit by weapon fragments. The probability of bomb ricochet is reduced by increased impact angles.

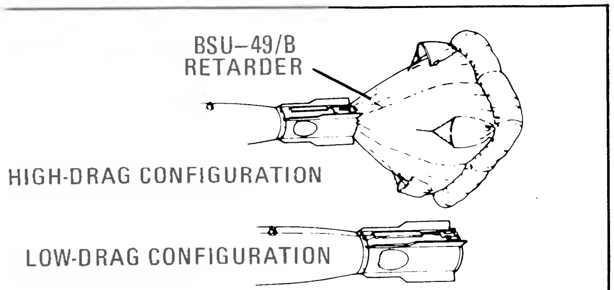
The BSU-49/B AIR tail assembly consists of a LD stabilizer canister unit, the ballute (combination of balloon and parachute), and the retarder release lanyard assembly. The stabilizer canister unit acts as a container for the ballute and provides aerodynamic stability during carriage and LD delivery. Four ballute attachment straps connect the ballute to an attachment plate near the center of the stablizer unit. The aft end of this stablizer assembly is held in place by a latch assembly until release. Forward of the attachment plate is a door for insertion of the ATU-35 series arming drive. The entire canister is connected to the bomb with an attachment ring. The ballute assembly is made from high strength, low-porosity nylon fabric and is approximately 8 inches in circumference at the point it enters the stabilizer canister. Ram air inflation is accomplished through four air inlet ports toward the aft end of the ballute.

The retarder release lanyard assembly, located between two fins along the top side of the stablizer canister, consists of a lanyard held in place by an adjustable retracting spring. The lanyard connects the arming solenoid to the latch assembly holding the baseplate onto the canister. As the bomb is ejected from the suspension rack, the lanyard pulls the safety latch pin, and the baseplate is forced into the airstream by compressed springs. Airloads continue to pull on the baseplate, withdrawing the ballute until airflow through the ram air inlets inflate it to full size. During this process, the lanyard cable pulls on the swivel and loop assembly, shearing it. The lanyard is retained by the bomb, preventing damage to the aircraft by the lanyard.

The MK 82 AIR release is cockpit selectable in either the HD configuration (ballute inflated) or in the LD configuration (ballute not inflated) provided arming wire/lanyard routing is accomplished during loading for these options. Refer to the appropriate aircraft Dash 34 for detailed information concerning the required arming configuration for this capability.

MK 82 AIR INFLATABLE RETARDER (AIR) HDGP BOMB





CHARACTERISTICS

WEIGHT	56 LB
LENGTH	26 IN.
FIN SPAN	15 IN.
COMBINED WEIGHT (MK 82/BSU-49/B)	550 LB
COMBINED LENGTH (MK 82/BSU-49/B)	7 FT 7 IN.
SUSPENSION LUG SPACING	14 IN.

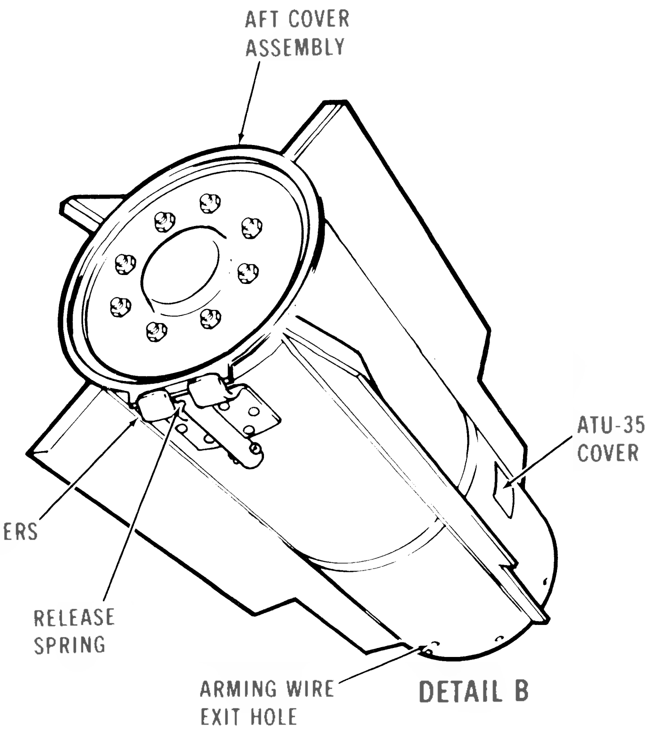


FIGURE 1-10

WARNING

If the cockpit selectable release option is used, the prescribed arming wire/lanyard routing must be utilized.

The BSU-49/B AIR assembly provides the capability to deliver HD MK 82s at airspeeds from 200 to 700 KCAS, depending on type of aircraft and fuzing. Refer to the appropriate aircraft Dash 34 tables for fuze arming. LD deliveries should be limited to a maximum of 600 KCAS as testing has found excessive dispersion caused by ballistic instability at delivery speeds above 600 KCAS.

MK 84 AIR INFLATABLE RETARDER (AIR) HDGP BOMB

The MK 84 (2,000-pound class) AIR (FIGURE 1-11) is a MK 84 bomb that is modified by attaching a BSU-50/B AIR tail assembly. The BSU-50/B assembly is similar to the BSU-49/B AIR assembly and consists of a LD stabilizer canister unit, a ballute, and the retarder release lanyard assembly. The BSU-50/B operation is identical to BSU-49/B operation. The release configuration is determined by arming wire/lanyard routing and may be cockpit selectable. Refer to the appropriate aircraft Dash 34 for detailed information concerning the required fuze arming configuration.

WARNING

If the cockpit selectable release option is used, the prescribed arming wire/lanyard routing must be utilized.

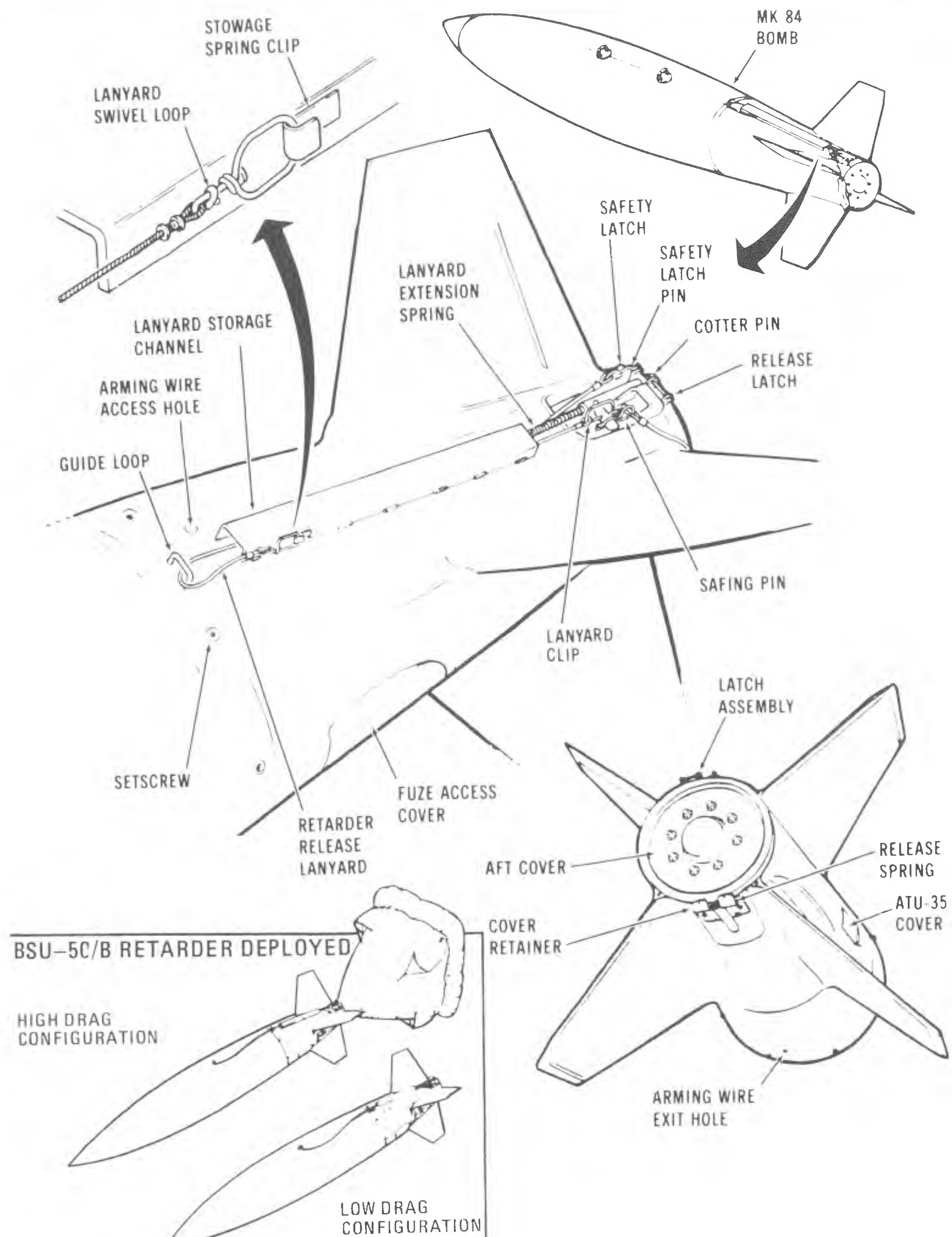
The BSU-50/B AIR assembly provides the capability to deliver the MK 84 at airspeeds to 700 KCAS. Decelerating forces to initiate fuze arming determine minimum release airspeeds. The minimum airspeeds are significantly higher than those required to arm the BSU-49/B. The BSU-50/B is only 12 percent larger than the BSU-49/B, but the MK 84 is four times heavier than the MK 82. This increase in weapon mass, coupled with a very small increase in ballute size, forces a higher delivery airspeed for proper g forces sensed by the fuze. Minimum release airspeeds for HD employment of the MK 84 AIR are:

1. FMU-54/B - 550 KCAS

2. FMU-54A/B - 550 KCAS

3. FMU-112/B - 460 KCAS.

MK 84 AIR INFLATABLE RETARDER (AIR) HDGP BOMB



CHARACTERISTICS

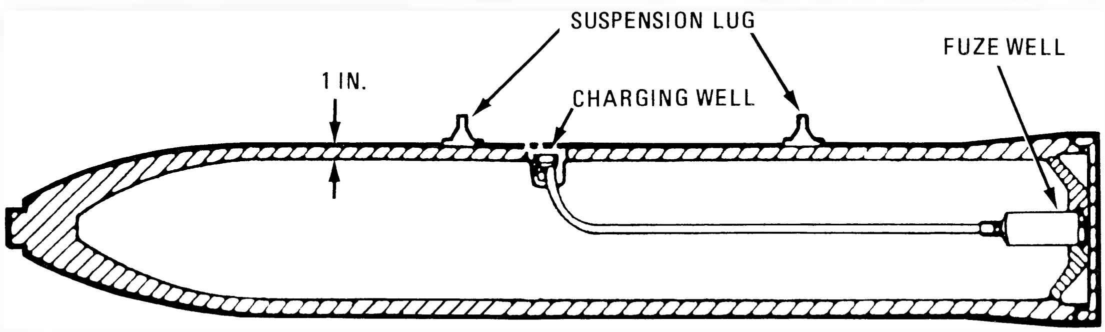
WEIGHT	97 LB
LENGTH	30 IN.
FIN SPAN	37 IN.
COMBINED WEIGHT (MK 84/BSU-50/B)	2020 LB
COMBINED LENGTH (MK 84/BSU-50/B)	11 FT
SUSPENSION LUG SPACING	30 IN.

FIGURE 1-11

BLU-109/B (I-2000/TARGET BUSTER) PENETRATOR BOMB

The BLU-109/B (I-2000/target buster) (2,000-pound class) Penetrator Bomb (FIGURE 1-12) is an improved GP bomb. Improvements include: no forward fuze well, use of high strength forged steel, increased bomb wall thickness, and a stronger tail fuze well baseplate assembly which is connected internally by conduit to the fuze well. The bomb body is flared on the rear to provide compatibility with the MK 84 tail assembly.

BLU-109/B (I-2000/TARGET BUSTER) PENETRATOR BOMB



CHARACTERISTICS

WEIGHT	1925 LB
LENGTH	8 FT 3 IN.
DIAMETER	14 IN.
FIN ASSEMBLY	MK 84 COMPATIBLE
SUSPENSION LUG SPACING	30 IN.

FIGURE 1-12

NOTE

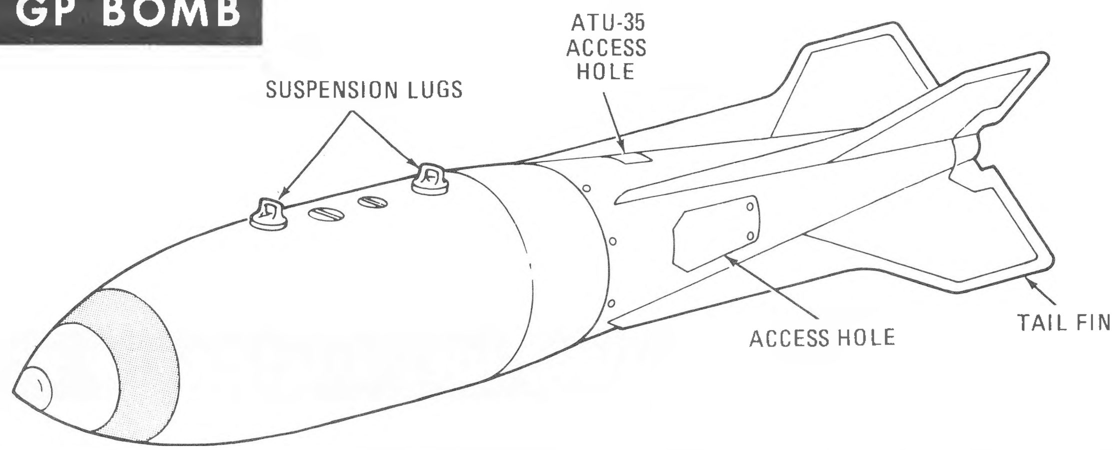
Impact angle and velocity are critical for proper weapon function. Refer to the appropriate aircraft Dash 34 ballistic tables.

The weapon contains 550 pounds of Tritonal explosive filler. An FMU-124A/B Mod 1 fuze (modified with a pyrotechnic delay) is installed in the tail fuze well of the bomb. The FZU-32B/B initiator is installed in the charging well of the bomb and provides electrical power to arm the fuze at release.

M117 GP BOMB

The M117 (750-pound class) LDGP bomb (FIGURE 1-13) has a cylindrical metal body with an ogival nose and a tapered aft section to which a MAU-103/B or MAU-103A/B fin assembly is attached. The MAU-103/B differs from the MAU-103A/B only in size and material. Both fin assemblies will accept the ATU-35 series drive. Bombs marked M117A1E1 or M117A3 contain 386 pounds of Tritonal explosive filler whereas those marked M117A1E2 contain 386 pounds of Minol II explosive filler.

M117 GP BOMB



CHARACTERISTICS

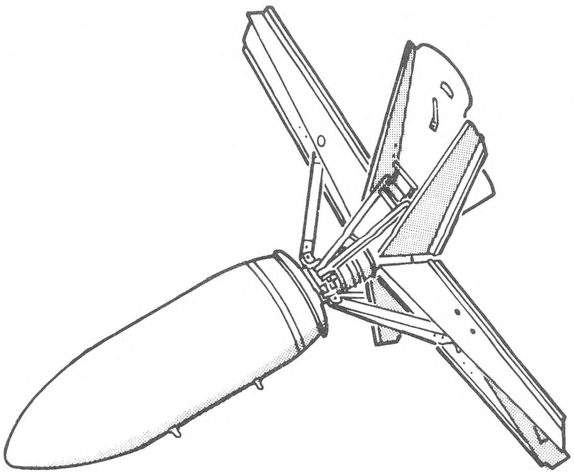
WEIGHT	823 LB
LENGTH	7 FT 6 IN.
DIAMETER	16 IN.
FIN SPAN	
MAU-103/B	19 IN.
MAU-103A/B	22 IN.
FIN ASSEMBLY	MAU-103/B OR MAU-103A/B
SUSPENSION LUG SPACING	14 IN.

FIGURE 1-13

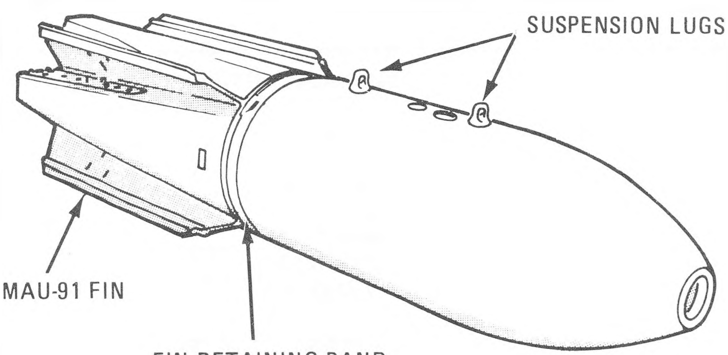
M117R (RETARDED) GP BOMB

The M117R (750-pound class) bomb (FIGURE 1-14) consists of an M117 bomb body with a MAU-91A/B or MAU-91B/B retarding tail assembly. The fin assembly replaces the conical fin and provides for a high- or low-drag employment. The HD or

M117R (RETARDED) GP BOMB



M117D (DESTRUCTOR) GP BOMB



CHARACTERISTICS

WEIGHT	857 LB
LENGTH	7 FT 7 IN.
DIAMETER	16 IN.
FIN SPAN (CLOSED)	22 IN.
FIN SPAN (OPEN)	6 FT 11 IN.
RETARDING ASSEMBLY	MAU-91A/B OR MAU-91B/B
SUSPENSION LUG SPACING	14 IN.

FIGURE 1-14

LD configuration is determined by arming wire/lanyard routing and may be cockpit selectable. Refer to the appropriate aircraft Dash 34 for detailed information concerning the required arming configuration for this capability.

WARNING

If the cockpit selectable release option is used, the prescribed arming wire/lanyard routing must be utilized.

The fin assembly consists of four extendable drag plates attached to the bomb body by a flange and support tube. In the LD configuration, the drag plates are held closed by a release band. In the HD configuration, the release band latch is pulled by the lanyard attached to the arming solenoid and allows the drag plates to deploy. The drag plates are snapped open by a leaf spring under each plate and by the airstream. The drag plates stop approximately perpendicular to the airstream to provide maximum drag area and stability.

M117D (DESTRUCTOR) GP BOMB

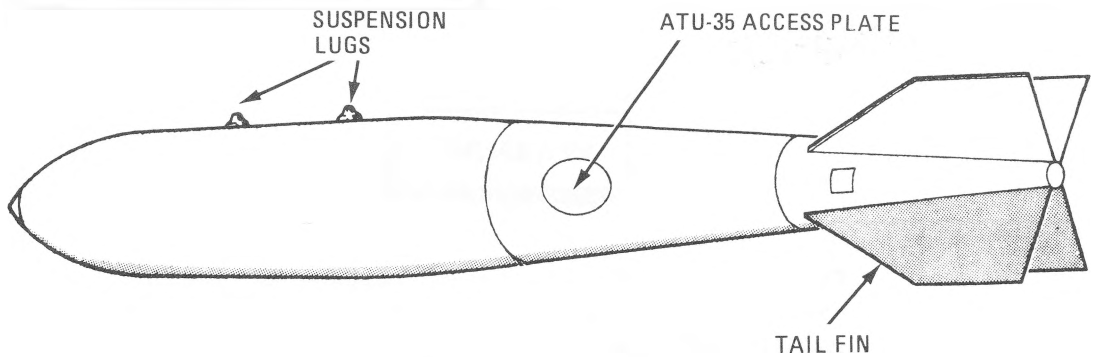
The M117D (750-pound class) destructor (FIGURE 1-14) differs from the M117R in one respect. The M117D is fuzed with components of the MK 75 arming kit (Refer to Section II.). The weapon is released HD only and is used for ground implant and shallow water mining operations. Ballistic data are the same for both M117R and M117D bombs.

M118 DEMOLITION BOMB

The M118 (3,000-pound class) LD demolition bomb (FIGURE 1-15) has a cylindrical metal body with an ogival nose and a tapered aft section to which an M132 conical fin assembly is attached. The demolition bombs are designed for higher blast effect than a GP bomb of comparable weight. Approximately 65 percent of the total bomb weight is an explosive charge of Tritonal. The case is relatively thin walled and as a result would not be a good penetrator. The M118E1 differs from the M118 in that threaded lug wells are provided to receive threaded suspension lugs. Both bombs contain 1,888 pounds of Tritonal filler.

The M132 conical fin assembly will accept the ATU-35 series drive (required for M905 tail fuze) by use of a modified access hole cover. This fin is used on the M118 bomb and is not compatible with the M118E1 bomb. The M132E1 conical fin is used on the M118E1 bomb and is not compatible with the M118 bomb. The fins are not interchangeable between bombs because of a difference in physical makeup. The bolt holes and attachment points vary between bombs and fins.

M118 DEMOLITION BOMB



CHARACTERISTICS

WEIGHT	3020 LB
LENGTH	15 FT 5 IN.
DIAMETER	24 IN.
FIN SPAN	37 IN.
SUSPENSION LUG SPACING	30 IN.

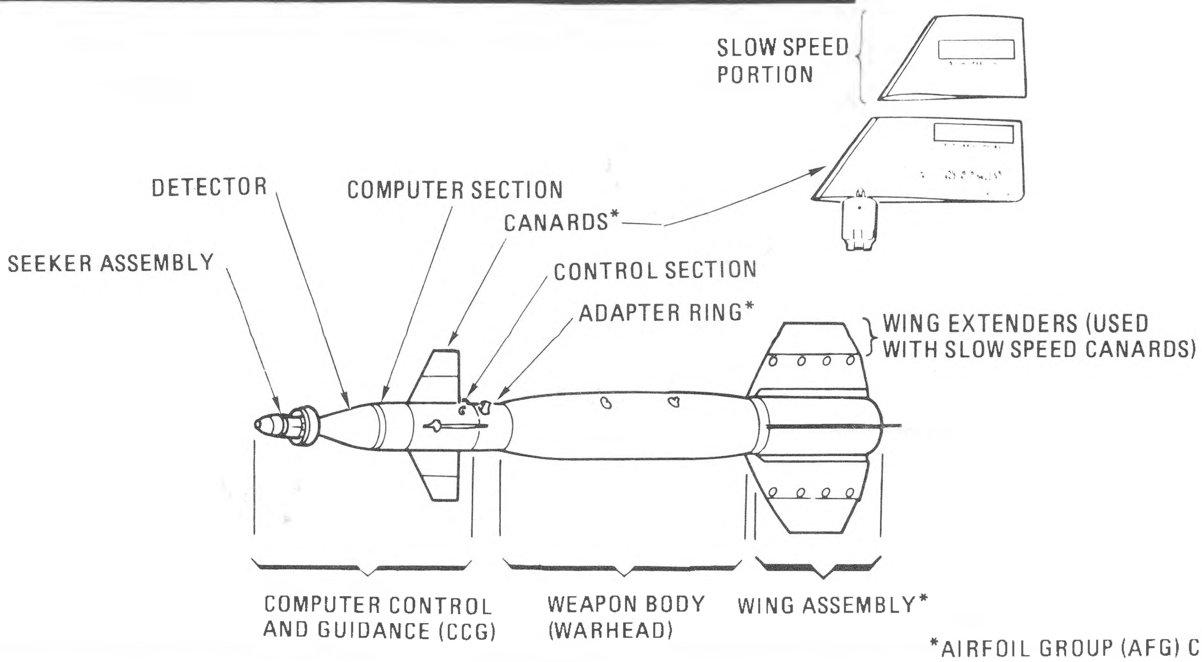
FIGURE 1-15

GBU-10 AND GBU-12 LASER-GUIDED BOMBS (LGB)

The GBU-10 and GBU-12 are GP bomb bodies (MK 84 and MK 82, respectively) equipped with electronic and mechanical assemblies that provide laser terminal guidance. A computer control group (CCG) with guidance canards is attached to the front of the warhead to provide steering commands. A wing assembly is attached to the aft end to provide lift. The LGB is a maneuverable free-fall weapon requiring no electronic interconnect to the aircraft. It has an internal semiactive guidance system that detects laser energy and guides the weapon to a target illuminated by an external laser source. The LGB samples the reflected laser energy from the target and corrects its trajectory as it glides. There are two generations of LGBs: Paveway I with fixed wings and Paveway II with folding wings (FIGURES 1-16 and 1-17, respectively).

Paveway I models are: GBU-10/B, A/B, and GBU-12/B, A/B. The airfoil group for these weapons can be either in the slow speed (big canards and wings) configuration or in the high speed (small canards and wings) configuration. The slow speed configuration is recommended for use by all aircraft as it outperforms the high speed configuration in all delivery regimes. In addition, the slow speed configuration provides low altitude, low angle, and loft/toss delivery capabilities which are not available with the high speed configuration.

PAVEWAY I LASER GUIDED BOMBS



GBU-10 CHARACTERISTICS

WEIGHT	2052 LB
LENGTH	14 FT
DIAMETER	18 IN
WINGSPAN	54 IN.
SUSPENSION LUG SPACING	30 IN.

GBU-12 CHARACTERISTICS

WEIGHT	600 LB
LENGTH	10 FT 6 IN.
DIAMETER	11 IN.
WINGSPAN	39 IN.
SUSPENSION LUG SPACING	14 IN.

COMPONENT REFERENCE CHART

ITEM	GBU-10/B	GBU-10A/B	GBU-10B/B	GBU-12/B	GBU-12A/B
WARHEAD	MK 84	MK 84	MK 84	MK 82	MK 82
GUIDANCE KIT	KMU-351A/B	KMU-351B/B	KMU-351C/B	KMU-388/B KMU-388A/B	KMU-388A/B
COMPUTER	MAU-157/B	MAU-157A/B	MAU-157B/B	MAU-157/B MAU-157A/B	MAU-157A/B
WING ASSEMBLY (COLOR)	MXU-600/B YELLOW	MXU-600A/B YELLOW (2)	MXU-600A/B YELLOW (2)	MXU-602/B ORANGE	MXU-602A/B ORANGE (3)
CANARDS					
HIGH SPEED	YELLOW	YELLOW	YELLOW	ORANGE	ORANGE
LOW SPEED		BROWN	BROWN	GREEN	GREEN

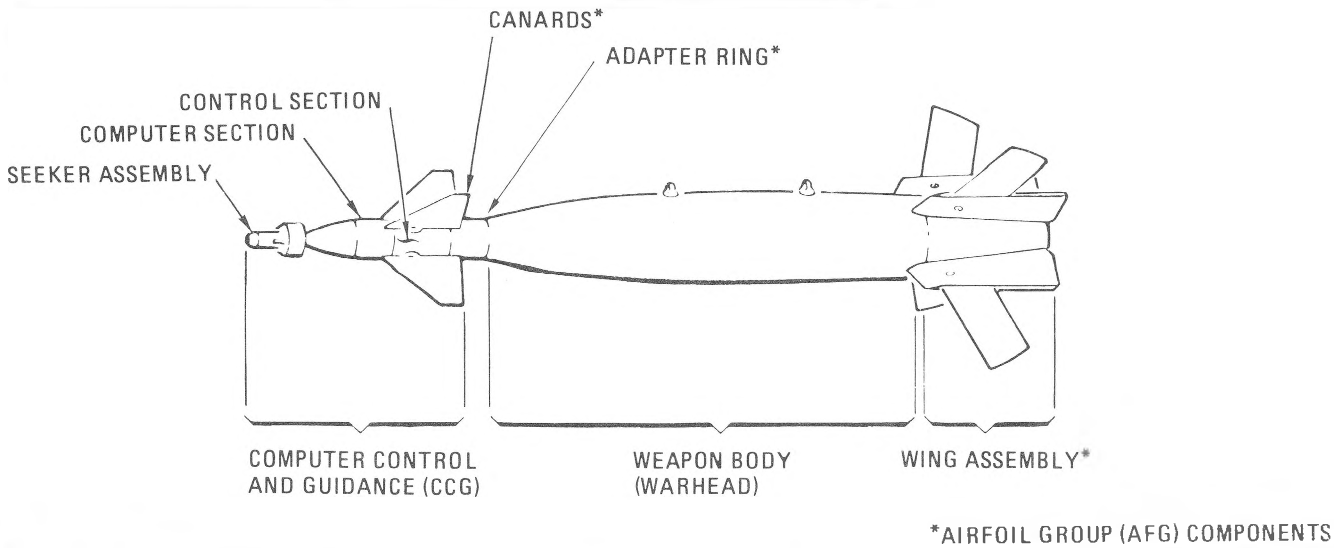
(1) EITHER THE GBU-12/B OR A/B CAN BE MADE A CONSTANT CODE BOMB BY THE ADDITION OF THE MAU-157B/B COMPUTER.

(2) LOW SPEED WING ASSEMBLY EXTENDERS ARE COLORED BROWN.

(3) LOW SPEED WING ASSEMBLY EXTENDERS ARE COLORED GREEN.

FIGURE 1-16

PAVEWAY II LASER GUIDED BOMBS



GBU-10 CHARACTERISTICS

WEIGHT 2081 LB
LENGTH 14 FT 2 IN.
DIAMETER 18 IN.
WINGSPAN 28/66 IN.
SUSPENSION LUG SPACING 30 IN.

GBU-12 CHARACTERISTICS

WEIGHT 610 LB
LENGTH 10 FT 11 IN.
DIAMETER 11 IN.
WINGSPAN 18/52 IN.
SUSPENSION LUG SPACING 14 IN.

COMPONENT REFERENCE CHART						
ITEM	GBU-10C/B	GBU-10D/B	GBU-10E/B	GBU-12B/B	GBU-12C/B	GBU-12D/B
WARHEAD	MK84	MK84	MK84	MK82	MK82	MK82
GUIDANCE KIT	KMU-351D/B	KMU-351E/B	KMU-351F/B	KMU-388C/B	KMU-388D/B	KMU-388E/B KMU-388F/B
COMPUTER	MAU-169/B	MAU-169A/B	MAU-169B/B MAU-169D/B	MAU-169/B	MAU-169A/B	MAU-169B/B MAU-169D/B
WING ASSEMBLY (COLOR)	MXU-651/B YELLOW	MXU-651/B YELLOW	MXU-651/B YELLOW	MXU-650/B ORANGE	MXU-650/B ORANGE	MXU-650/B ORANGE
CANARD COLOR	YELLOW	YELLOW	YELLOW	ORANGE	ORANGE	ORANGE

FIGURE 1-17

Paveway II models are: GBU-10C/B, D/B, E/B, and GBU-12B/B, C/B, D/B. These weapons are an improved version of the Paveway I series of weapons. The improvements consist of the following:

1. The detector optics and housing are made of injection-molded plastic instead of glass and metal to reduce weight and cost.

2. The detector field of view (FOV) is increased.

3. The detector sensitivity is increased.

4. The thermal battery delay after release is reduced.

5. The maximum canard deflection is increased.

6. Laser coding is provided.

7. Wings are folded for carriage.

LGB COMPONENTS

All LGB weapons consist of a CCG, warhead (bomb body with fuzes), and an airfoil group. The following description includes the differences between Paveway I and Paveway II weapons (FIGURES 1-16 and 1-17).

SEEKER HEAD

The seeker head (FIGURE 1-18) contains the detector assembly, optics, and electronic circuitry that determines the direction of the laser reflected energy and generates appropriate error correction signals. The seeker head, which is free to move in pitch and yaw, is always streamlined into the relative wind by a ringtailed stabilizer mounted around its circumference. Gimbal limits of the seeker head are +18 degrees for both Paveway I and II. The Paveway II instantaneous FOV is 30 percent greater than the Paveway I FOV.

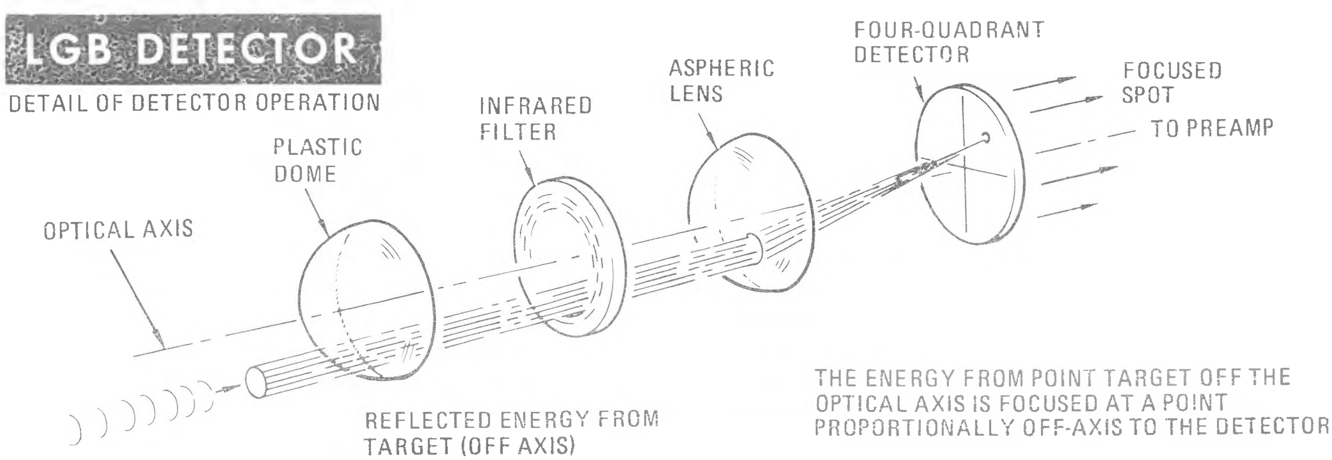


FIGURE 1-18

Instead of focusing the laser energy directly on the detector, the lens is moved closer to the detector which defocuses the spot. A filter allows only light of the desired laser wavelength to pass (FIGURE 1-18).

DETECTOR SUBASSEMBLY

A four-quadrant, light-sensitive disk produces a very small electrical signal when the laser spot hits it. The disk is mounted perpendicular to the axis of the seeker head. Since the seeker is stabilized into the relative wind, the location of the spot of light on the detector corresponds to the relative position of the target (FIGURE 1-18). If the spot of light falls in the upper right hand quadrant, the bomb electronics indicate the target is down and left, relative to its present flightpath.

BOMB GUIDANCE COMPUTER

The computer section contains circuitry that processes signals from the detector and transmits directional command signals to the appropriate pair(s) of canards. Other circuitry in the computer contains the guidance logic, and in the Paveway II has pulse repetition frequency (PRF) or pulse interval modulation (PIM) coding capabilities.

GUIDED BOMB CONTROL SECTION

The control assembly includes the thermal battery, gas generator, associated manifolds, valves, and pistons that actuate the canards. The thermal battery is activated by an external lanyard when the bomb is released. The thermal battery has a 70-second life in Paveway I and a 55-second life in Paveway II. After a 3-second delay (Paveway I) or 2-second delay (Paveway II except MAU-169D/B), an electrical pulse fires the gas generator. Gas from the generator is controlled through a manifold assembly with four cylinders. A solenoid for each cylinder is controlled by directional signals from the computer. Actuation of the solenoids permits gas to enter the corresponding cylinder and move the pistons that are mechanically connected to the canards.

NOTE

The current versions of the Paveway II, GBU-10E/B and GBU-12D/B, use the MAU-169D/B CCG. The CCG fires the gas generator after laser acquisition. This feature improves weapon ballistics for long-range loft/toss deliveries. However, this feature induces a 2.4- to 3.1-second delay in guidance after acquisition is declared. Therefore, to provide the 8 seconds of optimum guidance, a minimum time of fall or flight (TOF) of 11 seconds is recommended for weapons using the MAU-169D/B CCG.

GUIDANCE CANARDS

Guidance canards are attached to each quadrant of the control unit to change the flightpath of the weapon. Opposing canards always respond simultaneously (act in pairs) with 5.5-degree deflections (Paveway I), or 10.5-degree deflections (Paveway II), to generate up/down or left/right directional changes. The deflections are always full scale (bang, bang guidance). The bomb is not roll stabilized and may rotate randomly about its longitudinal axis. The guidance computer is able to function and cope with the slow roll rates generated. Paveway I canards snap into sockets on the control unit and lock into place. Paveway II canards are held in place with setscrews. (Refer to FIGURE 1-17 for various configurations.)

AIRFOIL GROUP COMPONENTS

The airfoil group consists of the adapter collar (which is bolted to the nose of the bomb for installation of the CCG), the canards, and the tail assembly. On Paveway I weapons, a fixed tail is bolted to the bomb and extenders are bolted to the wing to form a long winged bomb (slow speed configuration).

Paveway II weapons which have the folding wings have a tail assembly which contains four wings, each with a deployment spring. The wings are linked to a mechanism that ensures simultaneous movement. Wing deployment is activated at release by an external lanyard connected to a bomb rack sway brace. Upon release, shock absorbers restrict wing deployment for safe aircraft separation.

NOTE

The GBU-10A/B and GBU-12A/B Paveway I weapons are available in a high speed (short wing) version or in a slow speed (long wing) version which was developed for use on slower aircraft. Due to large control surfaces, the slow speed bomb has greater maneuverability and, therefore, a larger release envelope than the high speed version. There is no carriage or employment airspeed difference between the high speed and slow speed weapons. It is desirable to employ the long wing (slow speed) version when carriage allows because of the increased capabilities. Canards are packaged in the long wing version with a separation groove so the tip can be broken off to form the short wing. The tail assembly is packaged as a short wing version with extenders which must be bolted on to obtain the long wing. The short wing (high speed) bombs are capable of dive releases, but offer low probability of success from level or loft/toss releases because of the limited control surfaces area and maneuvering g available.

FLIGHTPATH CHARACTERISTICS

The flightpath (FIGURE 1-19) of the LGB is adjusted by the guidance and control section to meet the required impact criteria. However, the design of the system may result in some effects that can significantly degrade the performance of the weapon. The following explanation of the typical LGB flightpath discusses these effects on performance.

The LGB flightpath can be divided into three phases: ballistic, transition, and terminal guidance. The ballistic (unguided) phase, consists of the period of flight which lasts at least as long as the gas generator delay. The ballistic phase may last the entire flight, depending on the FOV and/or detector sensitivity constraints that restrict target acquisition and guided response.

During the ballistic phase, the weapon continues on the unguided trajectory established by the flightpath of the delivery aircraft at the moment of release. In the ballistic phase, the delivery attitude takes on additional importance. If released in a loft/toss mode (a positive climb angle), the weapon continues its climb, increasing in altitude but losing velocity. For level release, the weapon begins to lose velocity almost immediately and continues to decelerate until it has established a steep dive angle. Altitude permitting, it now ceases to lose velocity and slowly accelerates. If released in a high angle dive mode, the weapon normally accelerates from the moment of release to impact or until it reaches terminal velocity.

The change in weapon velocity during the ballistic flight can be critical. This is especially true if the velocity loss before acquisition is substantial. The maneuverability of the LGB is related to the weapon velocity during terminal guidance. Therefore, airspeed lost during the ballistic phase (and not recovered before acquisition) equates to a proportional loss of maneuverability during terminal guidance.

The transition phase begins at acquisition. The following conditions must be satisfied to accomplish acquisition:

1. The target must be within the detector FOV.

2. The reflected laser energy from the target must be of sufficient intensity to activate and maintain guidance circuits.

3. The gas grain generator delay must have expired and there must be sufficient gas pressure buildup to activate the canards.

At acquisition, there is usually a large error between the weapon velocity vector and the line of sight (LOS) to the target. In the transition phase, the weapon attempts to reduce this error by aligning the velocity vector with the LOS vector to the target. This phase usually takes from 0 to 3 seconds. During this period, the commands to the control surfaces are generally sustained for longer periods, causing additional energy loss.

The terminal guidance phase begins when the apparent guidance error is reduced and the weapon develops an oscillating pattern around the LOS. An oscillatory flightpath is produced because (1) the detector senses only the direction (not magnitude) of error, and (2) the canard deflections are always full scale.

LGB FLIGHTPATH

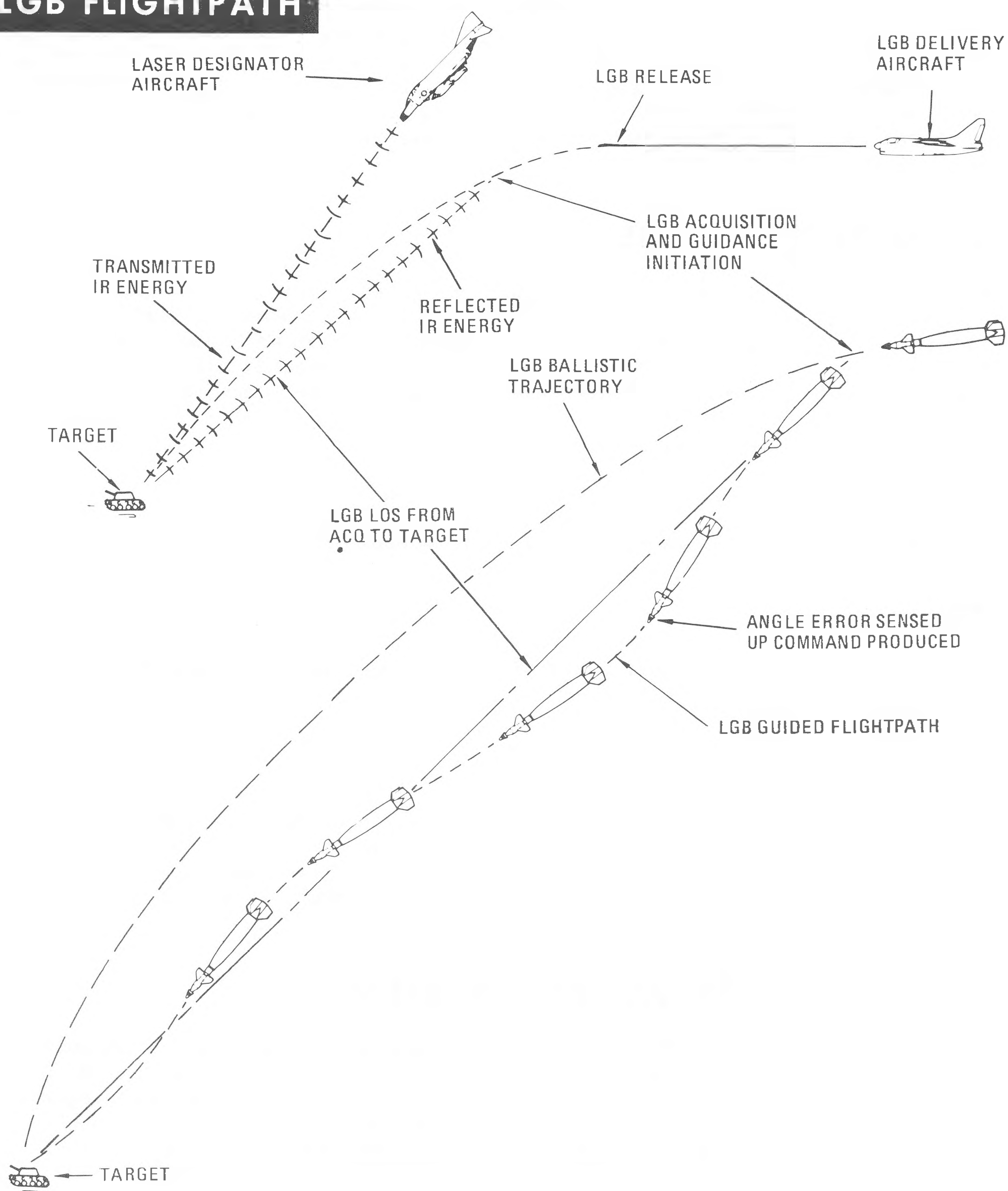


FIGURE 1-19

During terminal guidance, the LGB attempts to keep its velocity vector aligned with the instantaneous LOS. At the instant alignment occurs, the reflected laser energy centers on the detector and commands the canards to a trail position. At this time, the weapon flies ballistically with gravity biasing the velocity vector short of the target. Therefore, the reflected energy is moved from the detector center which generates an up command. In effect, the weapon's velocity vector tends to oscillate about a point short of the target which may cause the LGB flightpath to sag. The extent of this sag is dependent on the delivery angle and airspeed.

OPTIMUM GUIDANCE TIME

Release tables for LGBs are generated with consideration for the gas generator safe separation delay, and provide for 5 seconds of guidance. However, field experience has shown that an optimum guidance time of 8 seconds provides a much greater probability of success. Thus, release parameters should be selected that provide optimum guidance time. The minimum TOFs to ensure optimum guidance time are:

Paveway I (all).......................11 seconds

Paveway II (early versions)...........10 seconds

Paveway II (GBU-10E/B, GBU-12D/B)......11 seconds

FUZES

Fuzing options available for LGBs are depicted in the fuze/bomb compatibility chart, Section II.

CODING

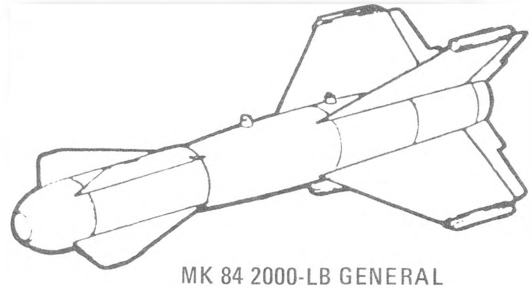
Coding has two purposes: (1) to meet the requirement for target identification in a multilaser environment and (2) to provide effective operation in the presence of enemy countermeasures. As a result, two code formats have been developed for use: PRF and PIM. Refer to classified supplements of aircraft Technical Orders (T.O.) for amplification.

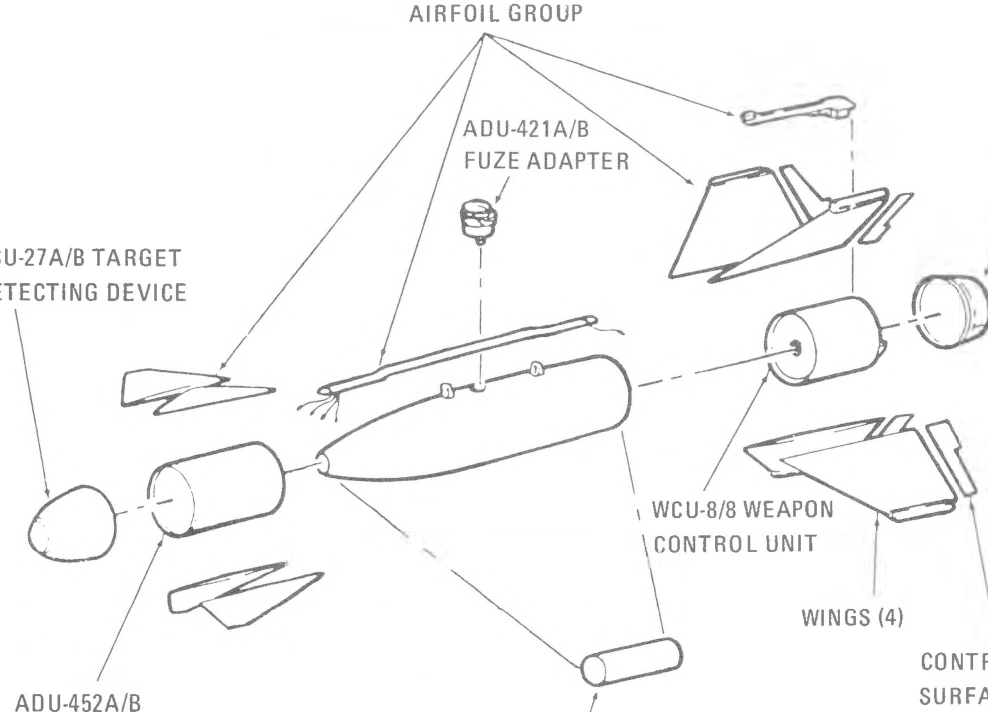
GBU-15 DATA LINK WEAPON SYSTEM

The GBU-15(V)1/B (FIGURE 1-20) provides the capability for accurate standoff TV (automatic/manual) guided delivery of the MK 84 bomb at increased ranges. Effective standoff range is increased because it is not necessary to acquire the target area before release; the target area and specific aiming point can be located after release during weapon flight by observing the video transmitted from the weapon. The weapon midcourse flightpath may be adjusted either automatically or manually. Likewise, terminal guidance may be closed-loop automatic tracking with aiming point updating, or if desired, the weapon may be manually steered to impact.

The weapon may be remotely controlled before and after release by means of the AN/AXQ-14 data link (DL) system. Major components of the DL system are the DL pod, the cockpit data link control panel (DLCP), and the weapon data link (WDL) installed on the weapon.

GBU-15(V)1/B GUIDED BOMB





CHARACTERISTICS

TOTAL WEIGHT	2515 LB
LENGTH	13 FT
WINGSPAN	4 FT 11 IN.
STRAKE SPAN	29 IN.
DIAMETER	
TARGET DETECTING DEVICE	15 IN.
WARHEAD	18 IN.
CONTROL UNIT	16 IN.
SUSPENSION LUG SPACING	30 IN.

FIGURE 1-20

The DL system provides simultaneous transmission and reception of command signals and video information between the command aircraft and the weapon. Video data from the weapon are transmitted by the WDL to the DL pod on the command aircraft for front and rear cockpit display. Command signals for control of the weapon are transmitted to the WDL by the DL pod, which is controlled by the weapon system operator (WSO) through the DLCP.

Inflight remote control (primary indirect attack mode) of the GBU-15 is provided by the RT-1210/AXQ-14 DL pod. The indirect attack mode provides operational flexibility in both the release and guidance envelopes. This is made possible by the video/command DL between the delivery aircraft or a standoff control aircraft and the weapon.

In the indirect attack mode (See FIGURES 1-21 and 1-22.) the DL pod receives video from the weapon and, under control of the WSO, transmits command signals to effect weapon control. The WDL accepts and processes these commands and transmits the weapon video to the controlling aircraft to form the basis for operator decisions and commands. Weapon video is generated in the Target Detecting Device (TDD) in the nose of the weapon.

The GBU-15 may be released in a backup, direct mode (without DL) as well as in the primary indirect attack mode. The direct attack option is useful for targets of opportunity. It is also useful as a backup mode in the event of a malfunction in the DL subsystem (control panel, DL pod, or WDL). The weapon may be released from low or high altitudes, but is always released in terminal mode without DL control.

The direct attack weapon is locked onto the target before release. After target acquisition and lock-on, the weapon is released from the aircraft in the terminal mode. The target detecting and control unit components generate the required signals (yaw, pitch, and roll attitude) for the weapon to maintain or correct the designated heading to target impact.

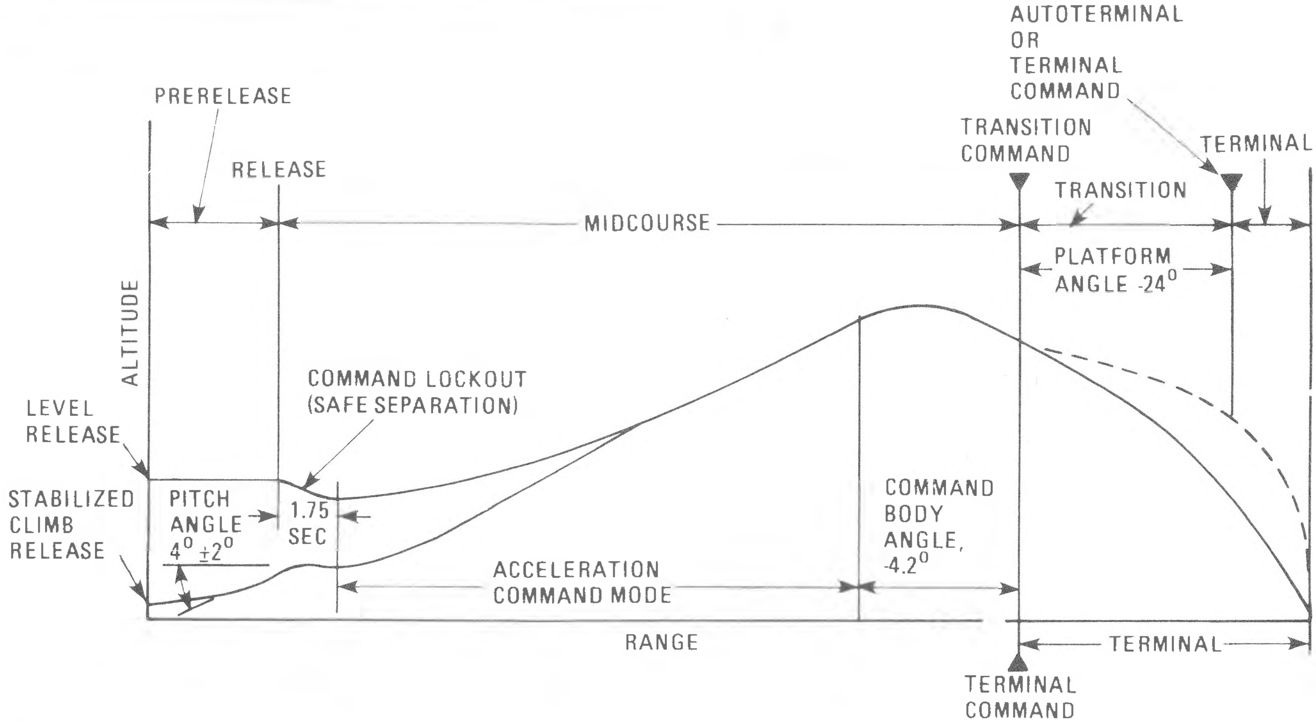
DSU-27A/B TARGET DETECTING DEVICE

The TDD (FIGURE 1-20) contains the optical dome, TV camera (seeker), stabilized platform, logic, video processor, automatic tracker, weapon mode switch, and power supply. The camera provides the scene sensing functions for target acquisition, manual and automatic tracking and weapon steering. In the captive and midcourse modes of operation, the seeker can automatically track a target or can be manually positioned up to ±30 degrees in azimuth and elevation from the weapon longitudinal axis. LOS rate signals from the TDD generate steering signals to the automatic pilot.

ADU-452A/B GUIDANCE ADAPTER

The guidance section adapter provides the mechanical interface between the TDD and warhead nose. It has attachment points for the strake and conduit assemblies. An opening in the right side provides an entry point for the conduit electrical wire harness. The wire harness connects the control unit to the TDD. An access door located on the right side allows weapon assembly operations, nose fuze inspection for safe/armed condition, fuze arming lanyard connection/inspection, and selection of the TDD weapon mode switch position.

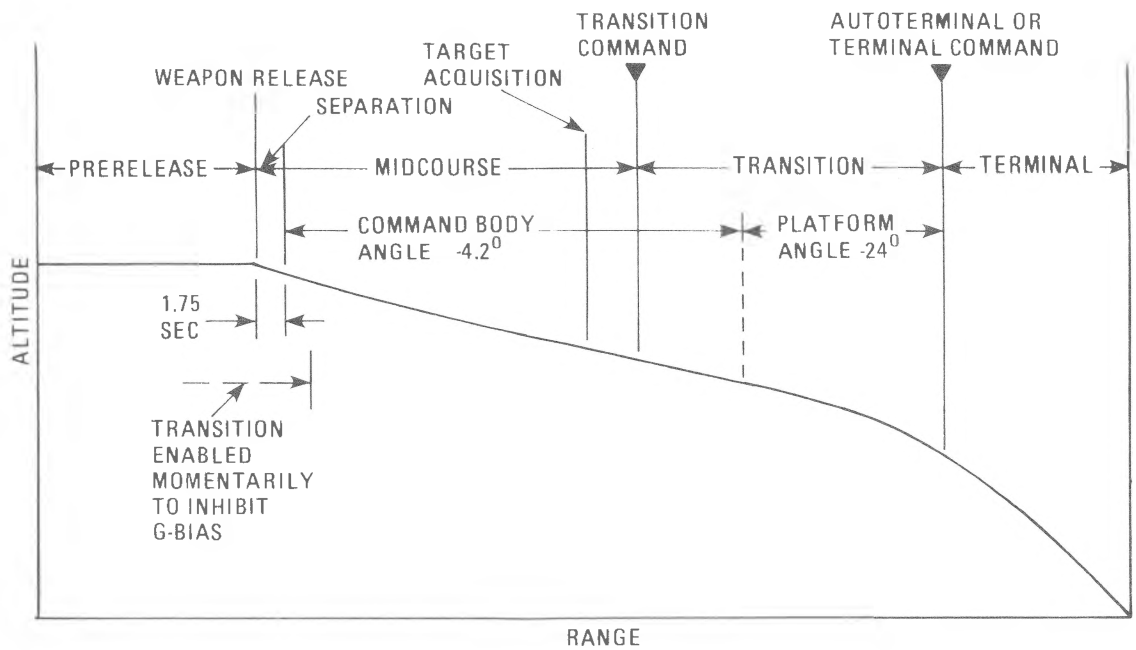
LOW ALTITUDE INDIRECT ATTACK



	PRERELEASE	MIDCOURSE	TRANSITION	TERMINAL	WEAPON FLIGHT CONTROL
		● HEADING COMMANDS	● SEEKER STEERING	● SEEKER STEERING	YAW
		● ACCELERATION (G-BIAS) ● ATTITUDE	● -24° PITCH PLATFORM ANGLE LIMIT ● ATTITUDE	● SEEKER STEERING	PITCH
AIRCREW ACTIONS	● SET UP WEAPON FOR RELEASE ● SET UP DATA LINK POD ● ACQUIRE AND IDENTIFY TARGET OR TARGET AREA IF VISIBLE ● SELECT EO	● RELEASE WEAPON ● EXECUTE TURN ● TRACK TARGET OR TARGET AREA ● SLEW (PLATFORM) ● FREE GYRO ● AUTO TRACK ● ADJUST WEAPON HEADING ● ARM FUZE (OPTIONAL)	● FLY PREPLANNED EGRESS ● SELECT TRANSITION ● TRACK TARGET ● SLEW(GATE) ● AUTO TRACK ● ARM FUZE (OPTIONAL)	● FLY PREPLANNED EGRESS ● SELECT TERMINAL OR ALLOW AUTOTERMINAL ACTIVATION ● TRACK TARGET ● SLEW/UPDATE ● RELOCK WEAPON OR ● STEER TO IMPACT ● AUTOMATIC FUZE ARM IF NOT DONE PREVIOUSLY	

FIGURE 1-21

HIGH ALTITUDE INDIRECT ATTACK



	PRERELEASE	MIDCOURSE	TRANSITION	TERMINAL	WEAPON FLIGHT CONTROL
		● HEADING COMMANDS	● SEEKER STEERING	● SEEKER STEERING	YAW
		● ATTITUDE	● -24° PITCH PLATFORM ANGLE LIMIT ● ATTITUDE	● SEEKER STEERING	PITCH
AIRCREW ACTIONS	● SET UP WEAPON FOR RELEASE ● SET UP DATA LINK POD ● ACQUIRE AND IDENTIFY TARGET OR TARGET AREA ● SELECT TRANSITION	● RELEASE WEAPON ● EXECUTE TURN ● DESELECT TRANSITION (SELECT EO 3 SEC AFTER RELEASE) ● TRACK TARGET OR TARGET AREA ● SLEW (PLATFORM) ● FREE GYRO ● AUTO TRACK ● ADJUST WEAPON HEADING ● ARM FUZE (OPTIONAL)	● FLY PREPLANNED EGRESS ● SELECT TRANSITION ● TRACK TARGET ● SLEW(GATE) ● AUTO TRACK ● ARM FUZE (OPTIONAL)	● FLY PREPLANNED EGRESS ● SELECT TERMINAL OR ALLOW AUTOTERMINAL ACTIVATION ● TRACK TARGET ● SLEW/UPDATE ● RELOCK WEAPON ● OR MANUALLY STEER TO IMPACT ● AUTOMATIC FUZE ARM IF NOT DONE PREVIOUSLY	

FIGURE 1-22

MXU-724/B AIRFOIL GROUP

This group consists of the four cruciform configured forward strakes, wings, and control surfaces. The strakes are attached to the guidance adapter, and the wings and control surfaces are attached to the control unit. The control surfaces are linked to the wings and the control unit pneumatic actuation system. Signals from the TDD to the automatic pilot drive the control unit actuator output shafts, which in turn, cause control surface movement and provide aerodynamic control of the weapon. The conduit and umbilical assembly are also components of the airfoil group. The conduit provides the electrical interface between the TDD and control unit. It attaches to the right side (looking forward) of the weapon. The umbilical assembly, located on the top center line of the control unit, provides the electrical interface between the aircraft and the weapon. The umbilical connector mates with the aircraft pylon wiring harness.

WCU-8/B WEAPON CONTROL UNIT

The weapon control unit (WCU) is attached to the aft end of the warhead and contains subcomponents that process data received from the DSU-27A/B TDD and Receiver-Transmitter Group, to provide control of the weapon during flight. The WCU is attached to the aft end of the warhead and consists of the body assembly, pneumatic actuation system, two accelerometers, inverter/converter, wire harness assembly, two gyroscopes, automatic pilot, and battery. The body section provides attachment points for the wings, control surfaces, umbilical assembly, and conduit assembly. The wire harness assembly provides the electrical interface between components in the control unit, WDL, conduit assembly, and umbilical located on the top centerline. A safety pin protects against inadvertent activation of the electrical squib systems (pneumatic actuator and battery) during ground handling. When activated by the pickle signal, the pneumatic actuation system supplies the energy to position the control surfaces. An access door located on the left side allows weapon assembly operations, tail fuze inspection for safe/armed conditions, arming lanyard connection and inspection, and inspection of the battery fault indicators.

OA-8921/AXQ-14 WEAPON DATA LINK

The WDL is attached to the aft end of the control unit. It simultaneously transmits video from the TDD to the control aircraft DL pod and receives commands from the control aircraft DL pod to the weapon. The video transmitter radiates low power video at station select and automatically switches to a high power video when the weapon ready mode is initiated. The radio frequency channel must be selected prior to flight with the channel select switch on the back cover. Multiple tactical channels and one training channel are available.

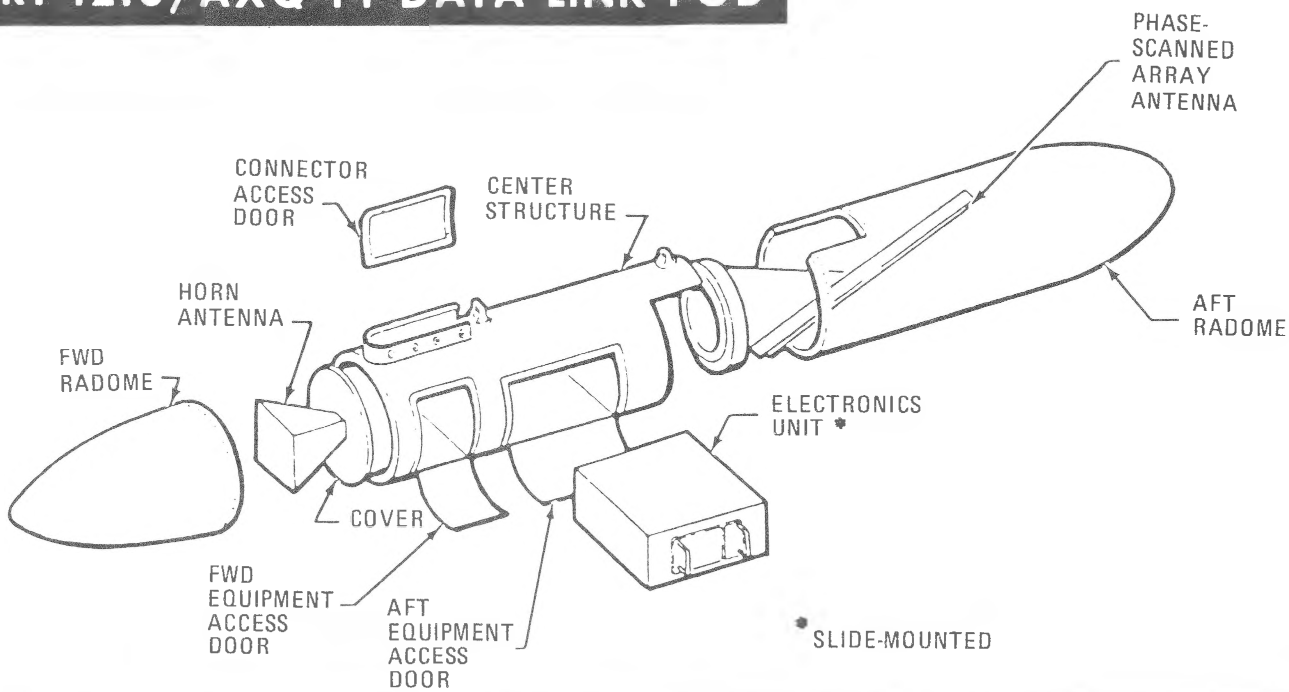
GBU-15(V)(T-1)/B TRAINING BOMB

The GBU-15(T-1)/B training bomb is a captive weapon used to train aircrews in the delivery of the GBU-15. It is identical in appearance to the GBU-15(V)1/B bomb and uses the same modules with the exception of the WCU. The WCU-6(T-1)/B training control unit contains a modified automatic pilot which prevents normal weapon release, and it uses a power supply unit instead of a battery to supply weapon voltages. The control surfaces of this training bomb are locked in place to permit safe separation in the event of jettison.

RT-1210/AXQ-14 DATA LINK POD

The DL pod (FIGURE 1-23) is an aerodynamically shaped body suspended from the bomb rack on the centerline station. It is not jettisonable.

RT-1210/AXQ-14 DATA LINK POD



CHARACTERISTICS

WEIGHT	435 LB
LENGTH	10 FT 10 IN.
DIAMETER	20 IN.
SUSPENSION LUG SPACING	30 IN.

FIGURE 1-23

Commands to the DL pod are converted into weapon guidance and control (G&C) signals by the pod and then transmitted to the WDL for weapon control. Simultaneously, the pod receives weapon video for display in the command aircraft. The pod also uses one of two selectable antennas for transmission/reception: a rear Phase-Scanned Array (PSA) antenna for use in the aft and side sectors of the command aircraft or a front horn antenna for forward sector coverage. To minimize enemy detection of pod radiation, the pod transmits only when a discrete command is issued and stops 2 seconds after the command is terminated. However, pressing and holding the action switch on the Integrated Hand Control (IHC) causes the command transmitter to continuously transmit until 2 seconds after the action switch is released. Thus, holding the action switch pressed unnecessarily defeats the silent unless keyed transmitter mode.

The DL pod has two transmitting power levels, low for prerelease checkout and high for weapon control during free flight. The power levels are determined by controls on the DLCP.

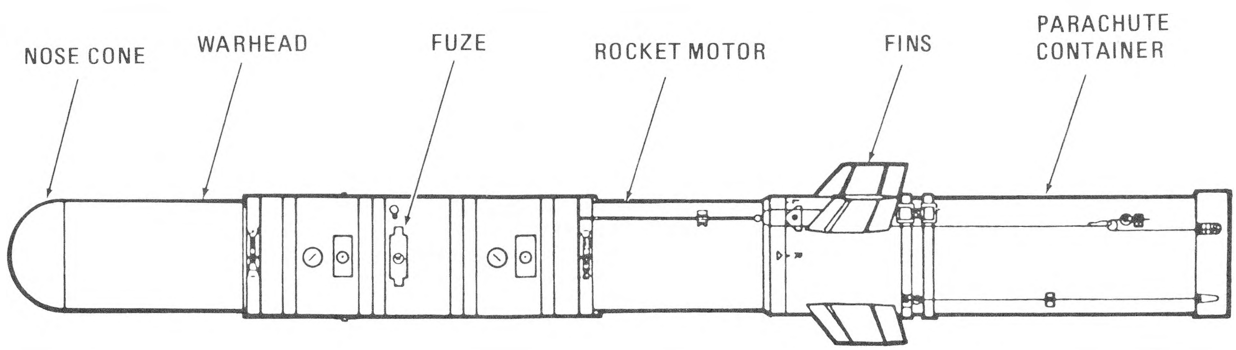
BLU-107/B (DURANDAL) PENETRATOR BOMB

The BLU-107/B (Durandal) (FIGURE 1-24) is a demolition bomb designed for low altitude release, to penetrate thick unreinforced concrete, and to create large craters that cause buckling of airfield surfaces. The weapon design incorporates a two-stage parachute retardation system that allows for low altitude delivery while providing safe separation. Penetration velocity is achieved by rocket-boosted kinetic energy. It is designed for level delivery at 250 feet AGL and for release speeds up to 620 KCAS.

The Durandal has three main sections: the parachute, rocket motor, and the warhead.

The parachute section is a cylindrical metal casing which contains two folded parachutes and is attached to the rocket motor section by the separation frame. The rear cover of the casing acts as the extractor for the 21.5-square-foot surface area brake chute. The brake chute is attached to the rear frame by a swivel shackle. The swivel shackles are used to prevent parachute malfunction caused by rotation. The R1500 pyrotechnic delay is a timing delay between brake chute and main chute deployment and is housed in the separation frame.

BLU-107/B (DURANDAL) PENETRATOR BOMB



CHARACTERISTICS

WEIGHT	450 LB
LENGTH	8 FT 2 IN.
DIAMETER	9 IN.
FIN SPAN	16 IN.
FIN ASSEMBLY	BLU-107
SUSPENSION LUG SPACING	14 IN.

FIGURE 1-24

The rocket motor and sequencer are surrounded by a skirt and four stabilizer fins. The sequencer contains a bobweight and senses deceleration caused by the parachute system and the R350 pyrotechnic delay. The delay, a nominal 300 milliseconds (ms), provides the time required to sense proper deceleration of the bomb and provides the required delay between main chute deployment and firing of the R2500 pyrotechnic delay. This delay between the sequencer and rocket motor provides a nominal 1,700 ms delay between deceleration verification and rocket motor initiator firing.

The warhead contains 33 pounds of TNT-base explosive surrounded by a cylindrical metal casing and capped with an aerodynamic nose. The nose cap covers a cutting surface which prevents ricochets. The warhead fuze, which is connected to the sequencer, protrudes through the rear of the warhead.

The post-release sequence is depicted in FIGURE 1-25. At weapon release, the bomb rack solenoid extracts the arming wire. During extraction the arming wire locks the brake chute shackle to the rear frame of the parachute container and the main chute

DURANDAL RELEASE SEQUENCE

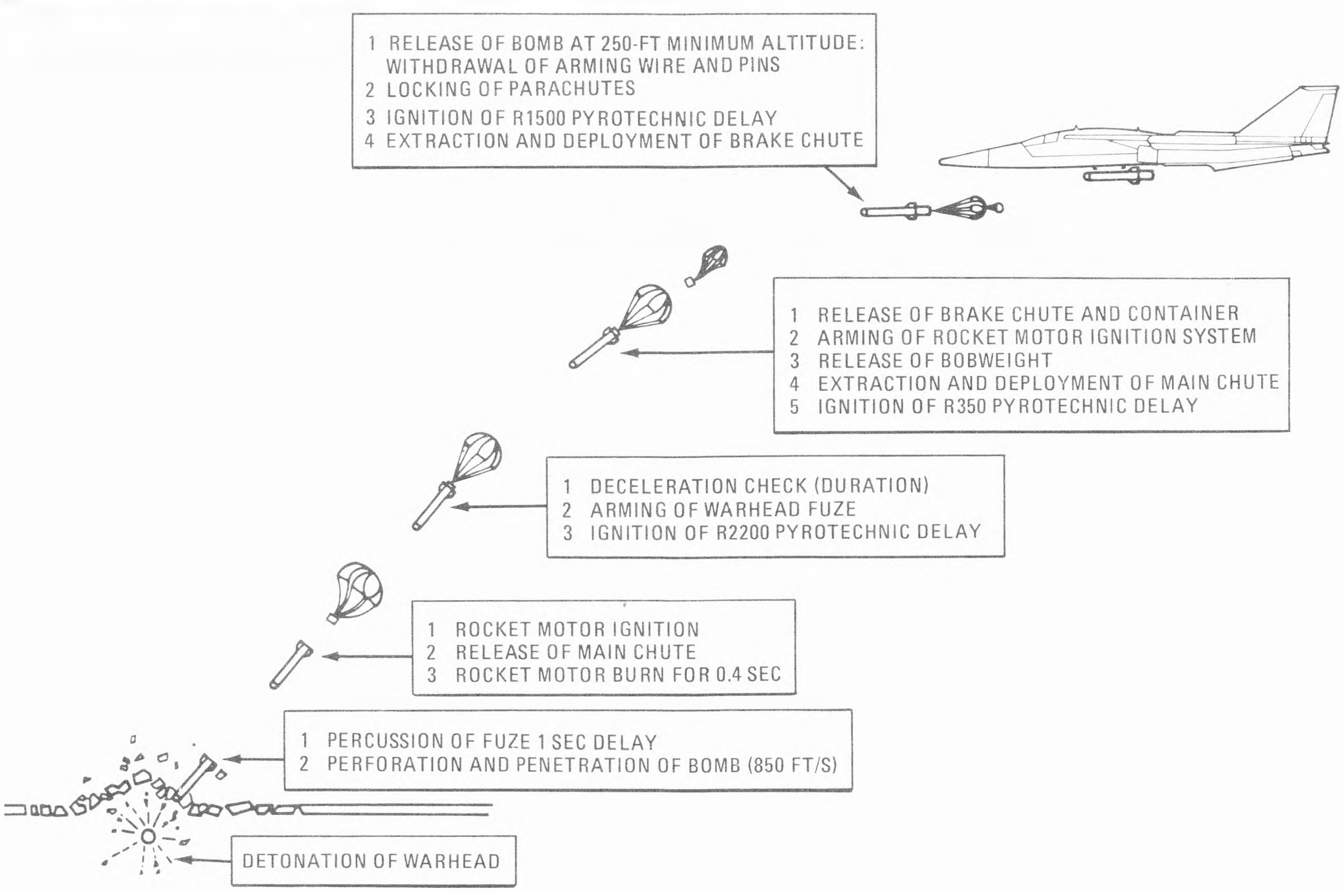


FIGURE 1-25

shackle to the separation frame. The rear parachute cover is released into the free airstream and pulls out the brake chute. Simultaneously, the R1500 delay is initiated. Following the delay, the parachute container and brake chute are jettisoned and the main chute is deployed. During this sequence, the rocket motor ignition system is armed, the sequencer bobweight is released, and the R350 delay (300 ms) is initiated. If the bobweight senses an 8-g deceleration for the duration of the R350 delay, the bomb functional sequence continues (The warhead fuze arms, and the R2500 delay fires.). If the proper deceleration is not felt, the functional sequence is stopped. This delay provides proper separation between the aircraft and the bomb at fuze arming and, in conjunction with the bobweight, provides a safety factor by not allowing the bomb to arm if the chute fails. The R2500 delay (1,700 ms) allows the bomb to attain the desired angle of incidence (35 degrees or greater) before the main chute is jettisoned. Following the R2500 delay, the rocket motor initiator ignites the rocket motor and the separation frame and main chute are jettisoned. The rocket motor burns for 0.45 second. Upon impact with the target, a 1-second warhead detonator delay is actuated, allowing the warhead sufficient time to penetrate several feet below the target surface prior to detonation.

AGM-65 MAVERICK MISSILE

The Maverick is a rocket propelled air-to-ground missile that uses a shaped charge optimized for use against armored vehicles, bunkers, boats, radar vans, and small, hard targets. The Maverick is capable of launch-and-leave operations, relying on automatic self-guidance. Various modes of guidance exist in the Maverick missile series. The Air Force has procured three models, the Electro-Optical (EO) AGM-65A and B, and the Infrared (IR) AGM-65D. The A/A37A Training Guided Missile (TGM) is used for training in AGM-65 employment. The aft section, containing the power supply, rocket motor, warhead, and hydraulic actuation system, is common to the AGM-65A, B, and D. The missile guidance sections, however, are different, with minor changes between the AGM-65A and B, and a major variation in the AGM-65D. All Maverick missiles are carried and launched from the LAU-88 or LAU-117 launcher described in Section V.

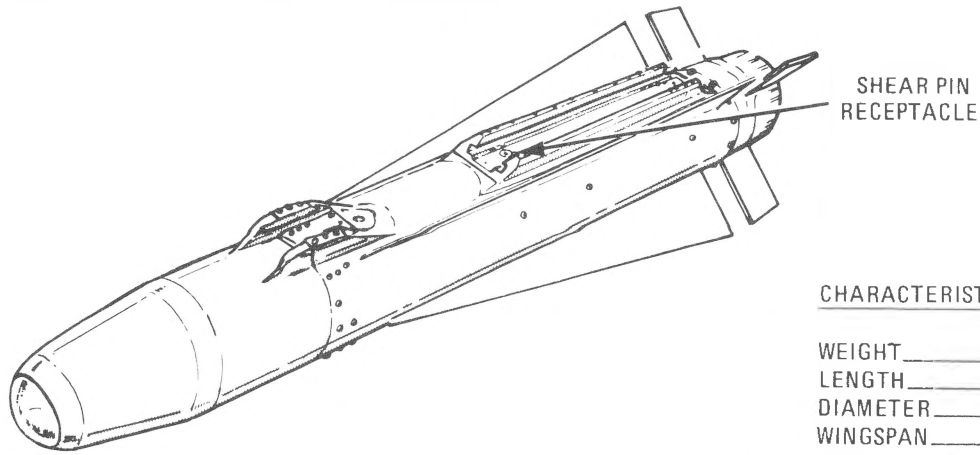
AGM-65A AND AGM-65B (EO) MAVERICK MISSILES

The AGM-65A and AGM-65B are TV-guided models of the Maverick air-to-surface missile family. 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 which allows 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 statistics are shown in FIGURE 1-26. 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

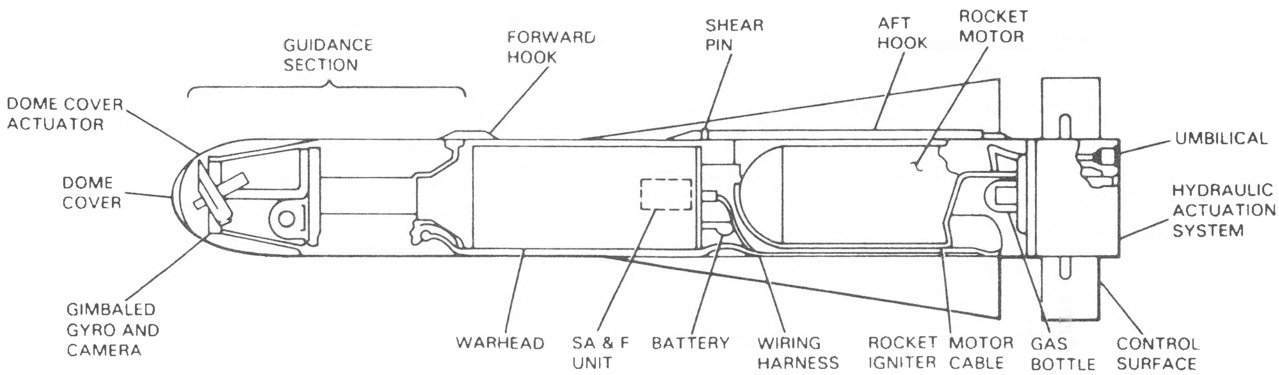
The nose of the missile has a clear, dome-shaped, glass window that is protected by a slightly opaque, frangible glass dome cover. The dome cover is shattered as the

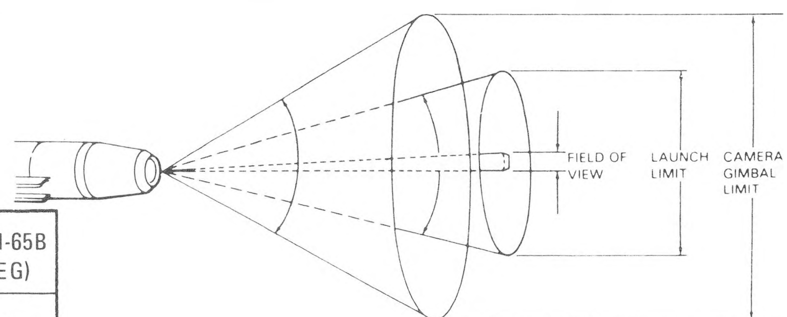
AGM-65A, -65B MISSILES



CHARACTERISTICS

WEIGHT	464 LB
LENGTH	8 FT 2 IN.
DIAMETER	12 IN.
WINGSPAN	28 IN.





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

FIGURE 1-26

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 1-26 shows the gimbal limit, launch limit, and FOV of both the AGM-65A and AGM-65B. The seeker is positioned by push rods 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 hold 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

- The AGM-65 (A or B) missile must not be maintained in the ready mode in excess of 60 minutes on any single mission. Since 3 minutes are necessary for the gyro to reach rated speed, the missile can only be operated an additional 57 minutes.
- The AGM-65 (A or B) missile must not be maintained in a full power mode (align, slew, or track) in excess of 3 minutes on any single attack if the missile is intended to be launched on that attack.
- 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.

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.

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 which functions when the missile encounters a lateral deceleration of at least 75 g.

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 2,000 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.

NOTE

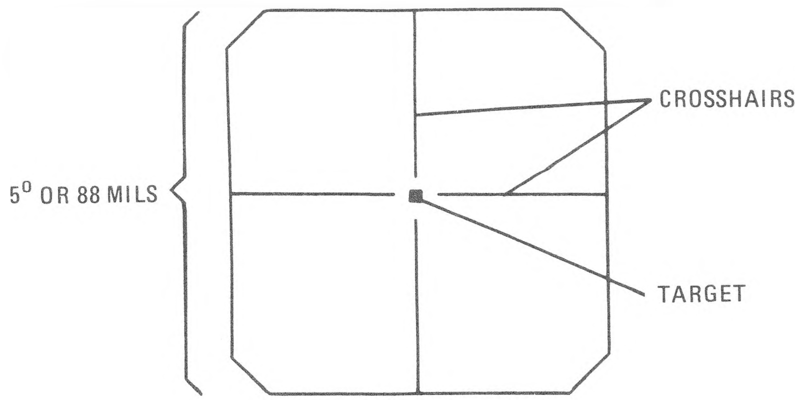
Should too short a launch signal be provided, commonly referred to as a quick or short pickle, the battery may be activated and the rocket motor fail to fire. In this case, the thermal battery will rapidly overheat and may fail to provide adequate voltage for successful guidance. A second launch of the 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 servo mechanism which processes the steering signals from the guidance unit 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 which feeds hydraulic fluid to actuating cylinders for the control surfaces. Flow of the hydraulic fluid is controlled by valves which respond proportionally to the signals from the guidance unit. Thus, control surface deflections are proportional to the amount of flightpath correction required.

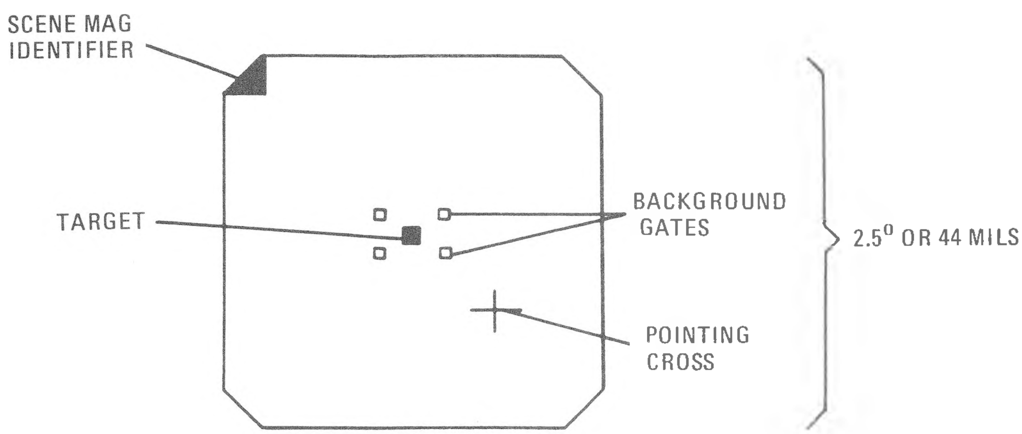
VIDEO DISPLAY

The AGM-65A seeker 5-degree FOV is presented on the cockpit video display as shown in FIGURE 1-27. 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

AGM-65A, -65B VIDEO DISPLAY



AGM-65A DISPLAY



AGM-65B DISPLAY

FIGURE 1-27

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 ensure that lock-on will be maintained during launch. A scene magnification identifier is located in the upper left corner of the video to indicate Maverick video versus F-4 Target Identification System Electro-Optical (TISEO) video is present.

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 ensure 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

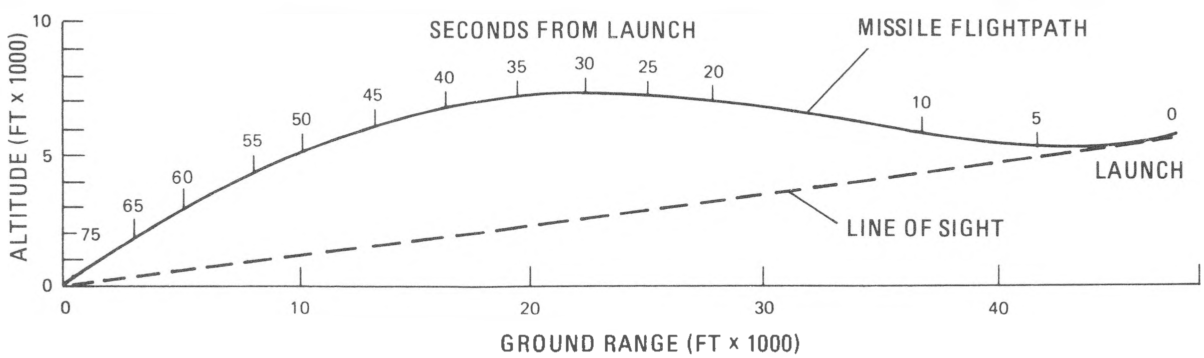
Due to the longer time required to obtain a lock-on, use of the automatic contrast mode is not recommended when target contrast can be visually determined.

Choice of target area as an area lighter or darker than the background is normally 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 the 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 which is designed to allow the missile to achieve long range and maintain a higher terminal velocity. The missile function which produces this upward steering course is called g-bias. The effects of g-bias on missile flightpath are illustrated in FIGURE 1-28. 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 3.5-g pull in the upward direction until the missile detects a 20-degree look-down angle. The AGM-65B has a nominal 4.5-g pull until it reaches a 16-degree look-down angle.

EFFECT OF G BIAS ON MISSILE FLIGHTPATH



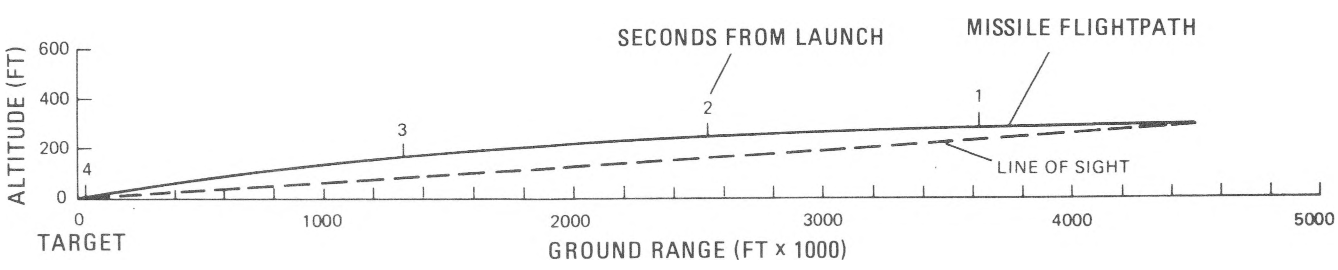


FIGURE 1-28

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 size fills a large portion of the FOV, 62.5 percent for the AGM-65A and 70 percent for the AGM-65B, the guidance unit stops 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.

AGM-65 OPERATIONAL LIMITATIONS

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

1. Launch speed: Maximum, mach 1.2.
2. Maximum gimbal offset angle: AGM-65A--15 degrees; AGM-65B--10 degrees.
3. Maximum dive angle: 60 degrees.
4. Maximum bank angle: 30 degrees.
5. Maximum roll rate: 30 degrees per second.
6. Minimum/maximum load factor: +0.5 g/+3.0 g.

AGM-65D (IR) MAVERICK MISSILE

The AGM-65D missile (FIGURE 1-29) is separated into forward and aft sections. The aft section containing the missile wings, warhead, SAF unit, rocket motor, and hydraulic activation system is identical to the AGM-65A and B. The forward section is significantly different from EO Mavericks. The AGM-65D 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 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 search 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.

FORWARD SECTION

The forward section is a hermetically sealed guidance unit consisting of an IR dome, IR seeker, electrical contact trigger, autopilot, and electronics assemblies including the digital computer. The entire forward section may be rotated on the missile body to orient the seeker head when the missile is mounted on a shoulder rail of the LAU-88 launcher. The guidance unit window in the nose of the missile is protected by a glass dome cover identical to that used on the EO Maverick. The purpose of the cover is to protect the second and third missiles in the launch sequence from the rocket motor exhaust of the first missile. The dome cover must be shattered prior to employing the AGM-65D because the material in the cover will attenuate and distort the IR energy.

AGM-65D (IR) MISSILE

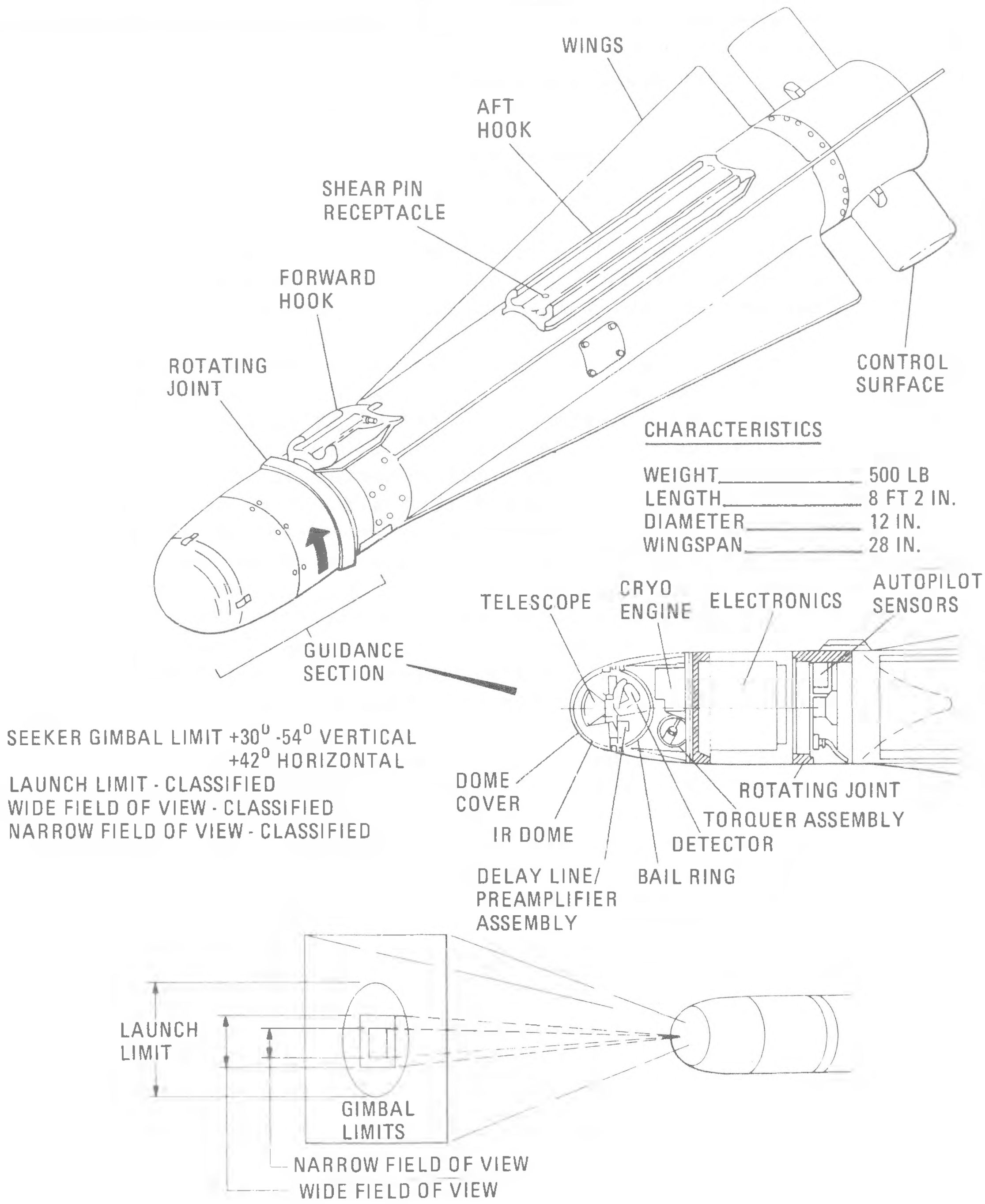


FIGURE 1-29

The missile seeker is located immediately behind the guidance unit window. The seeker is gyro-stabilized and free to move left and right 42 degrees, up 30 degrees, and down 42 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 should inhibit missile activation until the seeker gyro has reached 90 percent of full operating speed.

CAUTION

A minimum of 3 minutes must be allowed beween seeker gyro electrical power application and any attempt to uncage the seeker.

IR energy from the target scene enters the seeker after passing through the guidance unit window (FIGURE 1-29). The window contains a special material which allows IR energy to pass through it 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 give a dual FOV capability. The scene is then reflected from a rotating scan mirror, through a viewing lens which 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 on 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 which 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.

CAUTION

- The AGM-65D missile must not be maintained in the ready mode in excess of 60 minutes on any single mission. Because 3 minutes are necessary for the gyro to reach rated speed, the missile can only be operated an additional 57 minutes.

- The AGM-65D missile must not be maintained in full-power mode (align, slew, or track) in excess of 3 minutes on any single attack if the missile is intended to be launched on that attack.

The forward section also contains the electronic circuits which 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.

VIDEO DISPLAY

The AGM-65D cockpit video image (FIGURE 1-30) 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

AGM-65D (IR) VIDEO DISPLAY

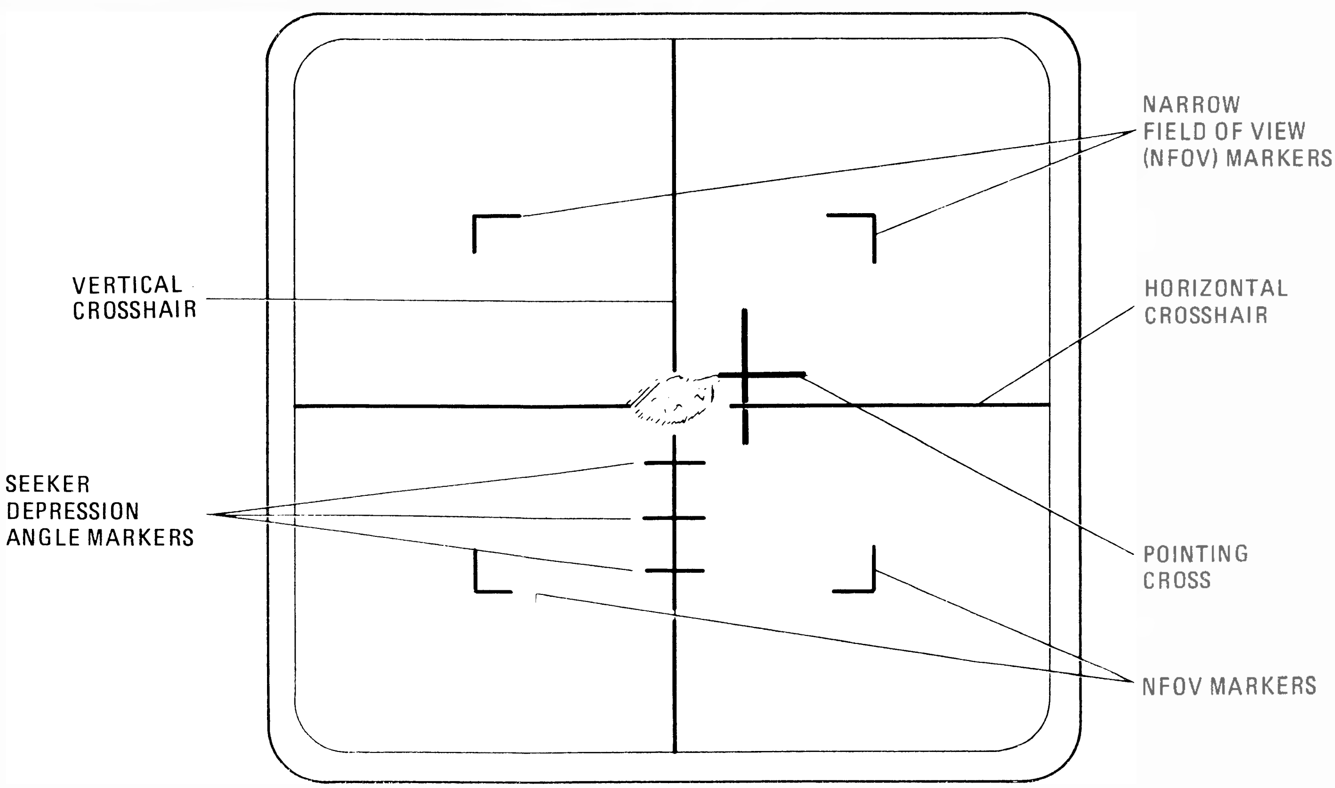


FIGURE 1-30

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.

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

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 slave mode. 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.

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 Maverick does not use a hot spot tracker typically found in heat seeking air-to-air missiles. The AGM-65D uses rotating scan mirrors and IR detectors to generate a video scene and uses the differences in temperature (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 which processes the analog video signals. The computer then provides several programs which enhance missile employment. The computer uses a launch transient assist program which 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 70 percent of the FOV as the target is approached. The correlator track program uses memorized data to establish directions and rates of motion which are then used to compute terminal steering commands.

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 which 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 slew enable button, 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.

NOTE

Missiles loaded on a LAU-88/A or LAU-117/A must each be boresighted individually.

A centroid tracker program tracks the centroid of the IR target in a manner similar to that of the tracker in the EO Maverick. 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. 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.

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 gunsight or head-up display (HUD) aiming reference on the target, and depress the slew enable button to stabilize the seeker gyro. Observe the cockpit display, and verify that the correct target is centered in the tracking window. Release the slew enable button to command lock-on. Even if the target is not quite centered in the tracking window, release of the slew enable button 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 slew enable button, or subsequent rotation of the dual FOV lenses will cause target break-lock.) Once lock-on is commanded, observe the cockpit display to ensure the desired target is centered in the crosshairs and that the pointing cross is steady. Because the pointing cross is initially steady prior to evaluation, allow approximately 1 second for the good lock program to function before commanding launch. 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. Depress and hold the slew enable button before commanding FOV change (uncage) to prevent the seeker from returning to the boresight 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. The aircrew must ensure that the missile is launched within its maximum aerodynamic range. Aircraft sensors such as PAVE TACK, AN/ARN-101, and AN/APR-38 may be used to slave the IR Maverick FOV to the target. 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 Maverick 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 within 30 degrees of the missile longitudinal axis. Contrast 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.

A/A37A TRAINING GUIDED MISSILE (TGM-65)

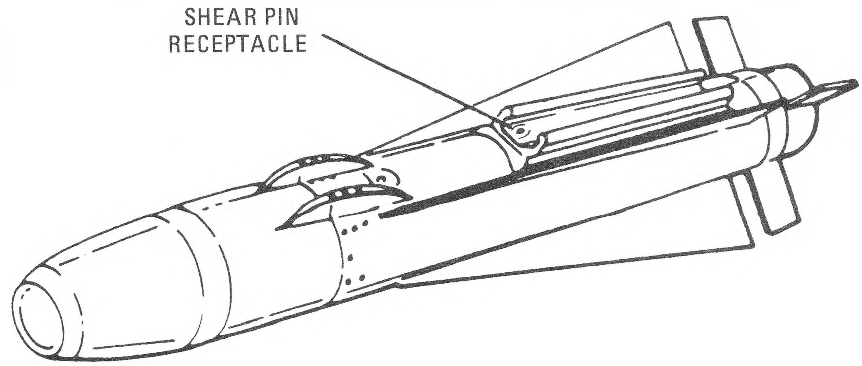
The Maverick TGM is a captive training device designed to train aircrews in the use of the AGM-65A, B, and D missiles. It provides realistic training in systems operation, target acquisition, and tactics. The TGM can be configured as a TGM-65A, B, or D, with or without a recorder. Because of the similarity of the operational and training systems, only the differences will be discussed. In most respects the TGM (FIGURE 1-31) 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 and/or ballast. The TGM can be suspended from any LAU-88/A or LAU-117A 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.

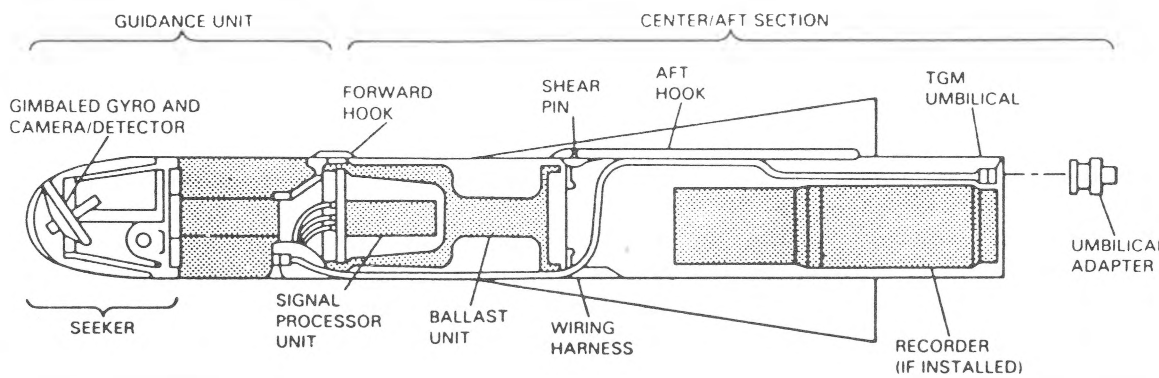
The TGM is a modular training device made up of any one of four guidance units mated to any one of two center/aft sections. The T3 and T4 guidance units provide the same cockpit display as does the AGM-65A. The T5 guidance unit simulates the AGM-65B, and the T8 guidance unit provides the AGM-65D IR display. These guidance units differ from their respective tactical missile guidance units in external markings, lack of autopilot, and lack of dome cover. The T7 center/aft section is equipped with the film recorder, but the T6 center/aft section has ballast in place of the recorder. The inflight switch positions are the same for the TGM as for the live missile.

CAUTION

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

A/A37A TRAINING GUIDED MISSILE (TGM-65)





CHARACTERISTICS

LENGTH	8 FT 2 IN.
DIAMETER	12 IN.
WINGSPAN	29 IN.
SUSPENSION	LAU-88 OR LAU-117 MISSILE LAUNCHER
WEIGHT (A/B)	464 LB (APPROX) (445 WITHOUT RECORDER)
(D)	478 LB (459 WITHOUT RECORDER)
RECORDING TIME	30 MINUTES AT 3.75 FRAMES PER SECOND 15 MINUTES AT 7.5 FRAMES PER SECOND

FIGURE 1-31

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 shut-down, which takes approximately 1 second.

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, causing vidicon damage should the seeker be pointed at the sun during target pulloff.

When a TGM with an IR guidance unit 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 last rate memory, the tracker breaks lock during pulloff, or the missile is placed in the ready mode by deselection.

TGM TIME LIMITATIONS

Do not operate the TGM in excess of 40 minutes in the ready mode or in excess of 30 minutes in the full-power mode (video present). The 30-minute full-power limitation is cumulative video time during the mission.

CAUTION

- Three minutes are required for gyro spin-up, to prevent damage due to gyro tumble, prior to uncaging the seeker head.
- Three minutes of constant video on a single pass is maximum allowable time to prevent heat damage to the guidance unit.
- Do not operate the TGM in excess of 15 minutes on the ground to prevent heating problems.

The AGM-65 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.

TGM RECORDER

TGMs with a T7 center/aft section contain a camera (FIGURE 1-31) which 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). TGMs generate event markers (FIGURE 1-32) 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.

AGM-45 SHRIKE MISSILE

The AGM-45 (FIGURE 1-33) is an antiradiation air-to-surface missile designed for the destruction of ground- or sea-based radar systems. Twelve versions were produced and each version has a preset frequency coverage that is set at missile buildup, and once set is not field changeable. The frequency range of a particular Shrike version is denoted by a suffix number to the AGM-45 designation.

Electronic order of battle (EOB) is gathered by the WILD WEASEL aircraft using its on-board equipment. The emitters are targeted, switches are set and when launch parameters are met, the missile is fired.

After leaving the aircraft, the Shrike continually senses the radar emissions and generates command signals to home-in on the targeted radar.

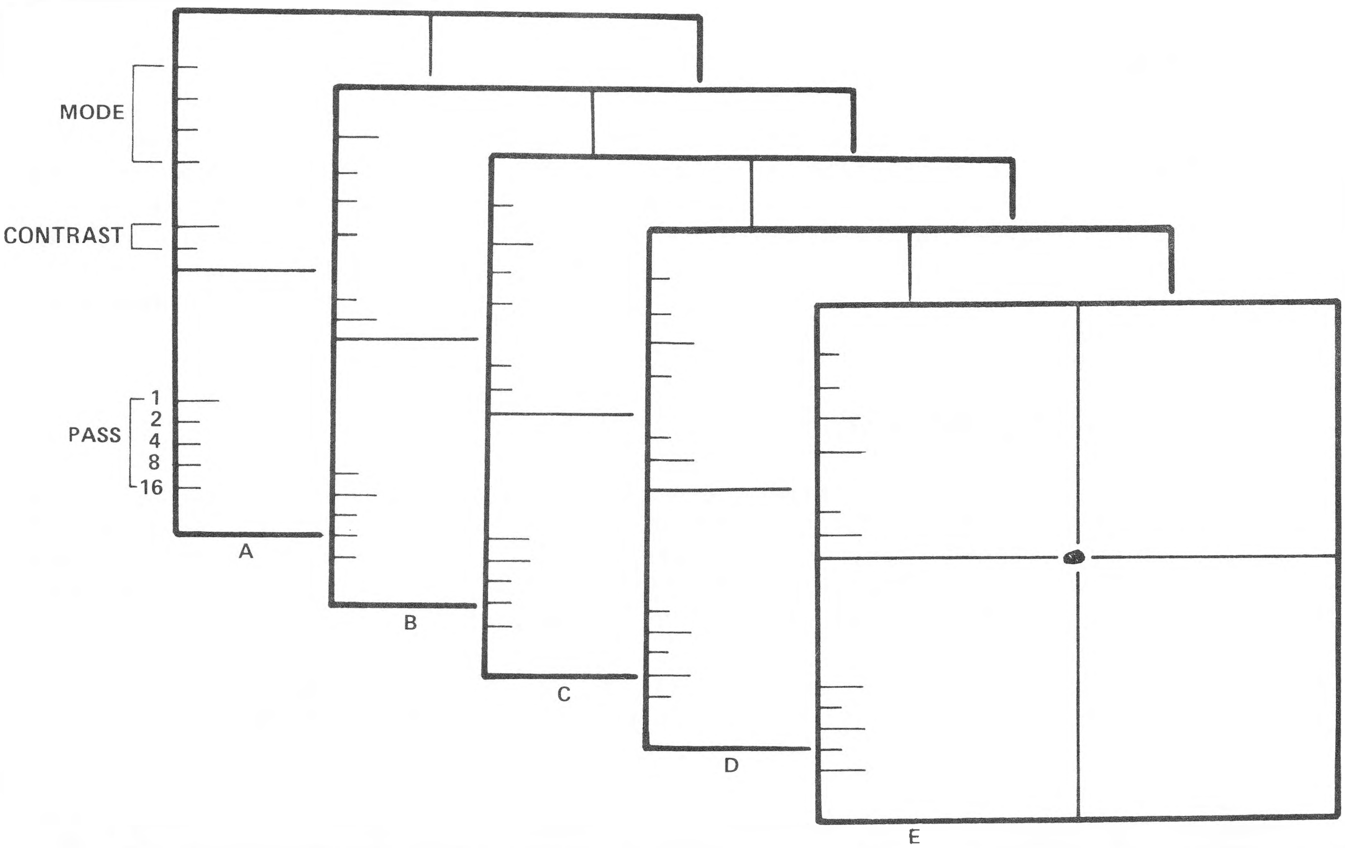
In the final phase, a proximity fuze sets off a high explosive fragmentation warhead which is designed to destroy or damage radar components.

MC-1 GAS BOMB

The MC-1 (FIGURE 1-34) is a nonpersistent gas bomb designed by modifying the M117 GP bomb. The MC-1 has a cylindrical metal body with an ogival nose and a tapered aft section to which a fin assembly is attached. The basic structural material of the bomb is steel. The bomb body is filled with 24 gallons (220 pounds) of chemical agent. The filler tube is permanently welded shut at the time filling is accomplished. The bomb is designed for use with both a nose fuze and a tail fuze. A hollow burster tube runs through the center of the bomb and connects the nose and tail cavities. Fuze wells are installed at both ends of the tube to accommodate nose and tail fuzes. Prior to loading, an M32 burster charge containing an explosive is installed in the tube.

Other components used are arming wires and adapter-boosters. The arming wires are threaded through safety devices in the fuze, thus maintaining the fuze in a safe (unarmed) condition until release. The adapter-boosters serve to accommodate the fuze bodies and to contain a booster charge which ensures proper operation of the burster charge. The MC-1 gas bomb uses mechanical fuzes (nose and tail) in the same manner as GP bombs do. When the bomb impacts, the fuzes function, causing the

EVENT MARKERS

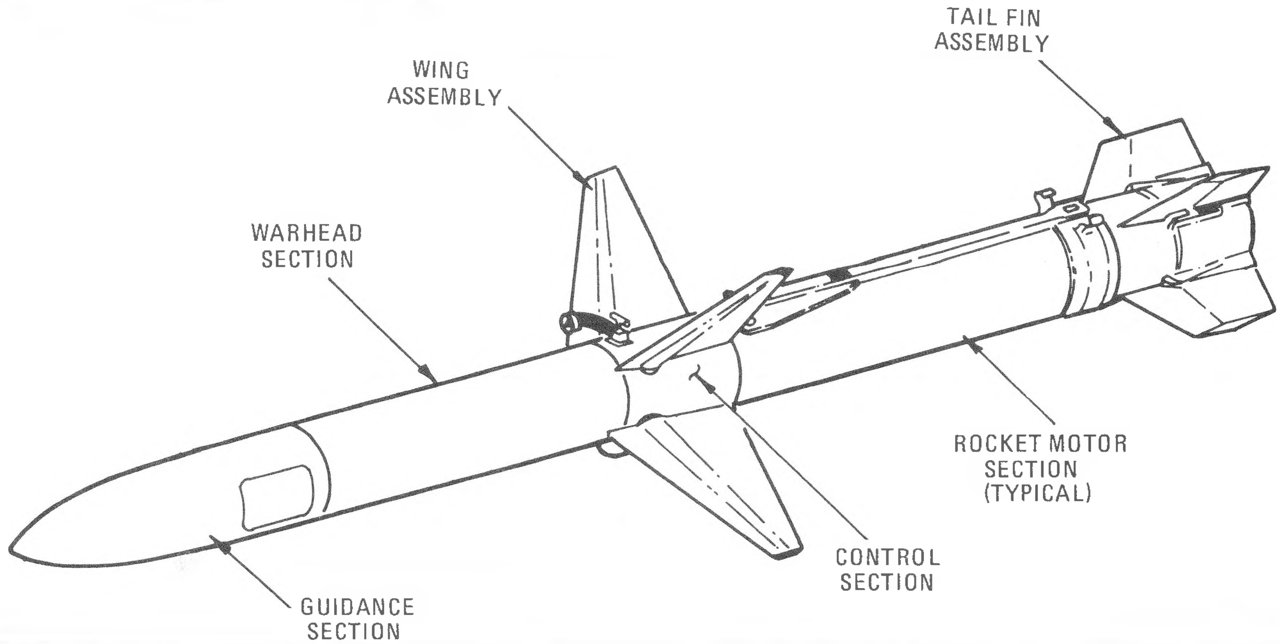


	EVENTS														
	A			B			C			D			E		
MODE	ALIGN			SLEW			TRACK			LAUNCH			LAUNCH (SEEKER ANGLE EXCEEDING LIMIT)		
CONTRAST	WHITE ON BLACK			BLACK ON WHITE			AUTO			BLACK ON WHITE			BLACK ON WHITE		
MARKER	LENGTH	VALUE	PASS	LENGTH	VALUE	PASS	LENGTH	VALUE	PASS	LENGTH	VALUE	PASS	LENGTH	VALUE	PASS
PASS 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.

FIGURE 1–32

AGM-45 MISSILE



CHARACTERISTICS

WEIGHT	395 LB
LENGTH	10 FT
DIAMETER	8 IN.
WINGSPAN	3 FT

FIGURE 1-33

burster to detonate. The detonation of the burster ruptures the bomb body and disperses the chemical agent, forming tiny droplets of liquid which quickly evaporate to a gas.

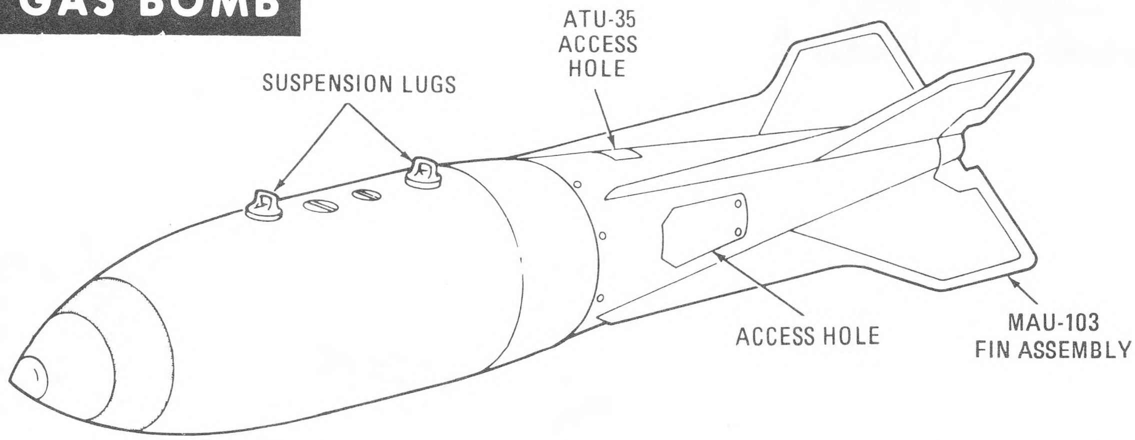
The MAU-103 fins used on the MC-1 gas bomb are conical, LD assemblies consisting of an elongated cone and four identical streamlined fins assembled perpendicular to the cone. All fin assemblies used on the MC-1 gas bombs will accept the ATU-35 series drive.

BLU-27 FIRE BOMBS

The BLU-27 series fire bombs (FIGURE 1-35) are incendiary munitions that are factory loaded with Napalm B incendigel mix, a slightly toxic, highly viscous fluid. The BLU-27 fire bombs are designed to break on impact, dispersing the burning napalm against such targets as dug-in troops, parked aircraft, supply installations, combustible materials, and land convoys.

The base structure of the bomb body is aluminum, with a reinforced area along the top center section to provide for suspension, sway-bracing, and forced ejection from

MC-1 GAS BOMB



CHARACTERISTICS

WEIGHT	725 LB
LENGTH	7 FT 6 IN.
DIAMETER	16 IN.
FIN SPAN	
MAU-103/B	19 IN.
MAU-103A/B	22 IN.
SUSPENSION LUG SPACING	14 IN.

FIGURE 1-34

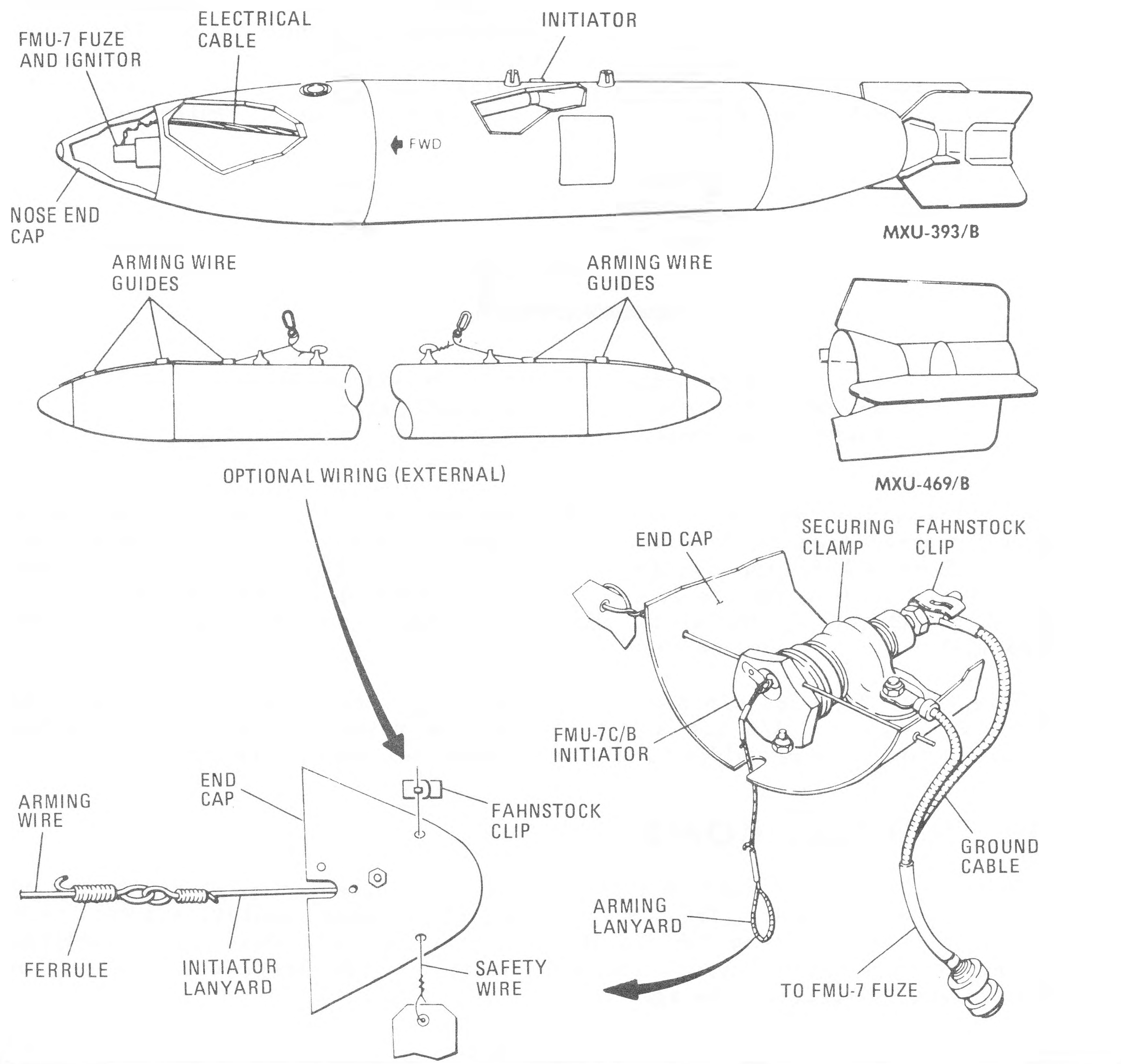
the aircraft. The ends are cone-shaped with a filler hole and cap in the forward end. On the aft end, a tail end cap or a fin assembly may be used. The fin assembly is either the MXU-469/B or MXU-393/B, which are interchangeable and produce the same trajectory.

The BLU-27 series fire bomb is fuzed with the FMU-7 series fuze. This consists of an FMU-7 impact detonating fuze installed in an AN-M23A1 igniter in both the fore and aft bulkhead receptacles. They are connected via internally routed electrical cables to an FMU-7 thermal battery initiator installed in the initiator well between the two suspension lugs.

WARNING

The white phosphorus in the igniter liquifies at 111 °F and may leak through filter plug if exposed to high temperature. Leaking igniters can be determined by the presence of smoke and/or flame or by the presence of white material on the igniter. If any of these conditions are observed, notify EOD personnel immediately.

BLU-27



CHARACTERISTICS

WEIGHT	870 LB (UNFINNED)
LENGTH	10 FT 10 IN. (UNFINNED)
DIAMETER	19 IN. (UNFINNED)
FIN WEIGHT	15 LB
FIN LENGTH	17 IN.
FIN DIAMETER	24 IN.
SUSPENSION LUG DISTANCE	14 IN.
FUZE	FMU-7 SERIES

FIGURE 1-35

The AN-M23A1 igniter is issued separately from the BLU-27B/B. The igniter body is in the form of a short cylinder rounded at one end with an internally threaded fuze well on the rounded end. The other end of the igniter is flat and threaded externally for installation in the BLU-27B/B. The flat end also contains a filler plug, which is used during manufacture. The igniter is installed in the BLU-27B/B after it is loaded on the aircraft. The igniter contains 1.20 pounds of white phosphorus, which is initiated by the fuze detonation and which in turn, ignites the bomb filler.

WARNING

Do not fly through fire bomb smoke within 20 seconds of burst, as a compressor stall or flameout may occur.

Operation of the arming sequence starts when the weapon is released and the arming lanyard is extracted from the initiator. This permits a firing pin to fire a thermal battery contained in the initiator and to electrically arm the fuze. Upon impact, the tank ruptures and the fuze(s) function, bursting the igniter, which contains white phosphorous. The white phosphorus causes immediate ignition of the splattered fuel from the ruptured tank.

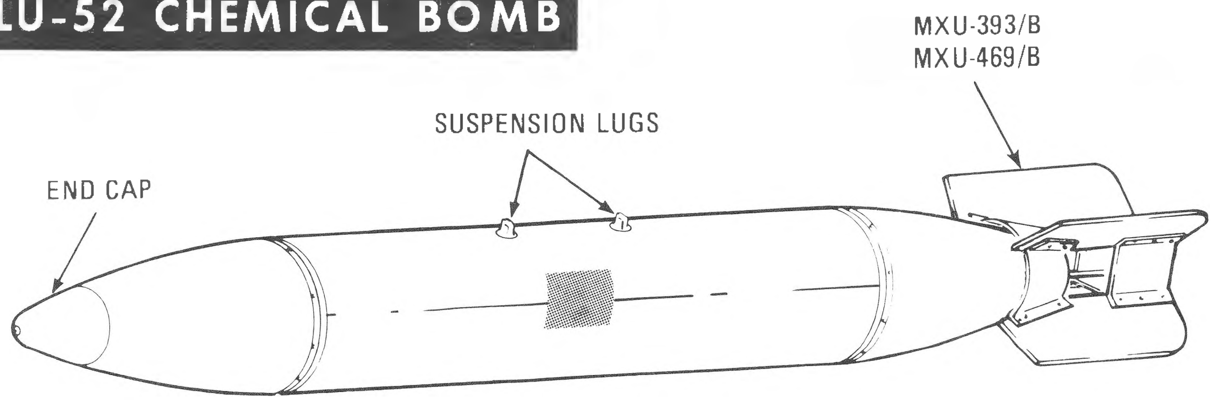
The BLU-27/B, A/B, B/B, and C/B are similar in design and construction. The only external differences are A/B has a 3-inch red band painted on each end, B/B has larger external arming wire guides, and C/B has threaded suspension lugs.

BLU-52 CHEMICAL BOMB

The BLU-52/B and BLU-52A/B chemical bombs (FIGURE 1-36) are tanks (BLU-1C/B) filled with an incapacitating agent. The bomb body consists of nose, center, and tail sections. Reinforced areas along the top of the center section provide for suspension sway-bracing, and forced ejection from the aircraft. The tanks are designed to break upon impact, dispersing the agent.

The nose section is fitted with an aerodynamic fairing, and the tail section with an MXU-393/B or MXU-469/B fin. The BLU-52/B is filled with CS-1 chemical agent, and the BLU-52A/B is filled with CS-2 chemical agent. Both CS-1 and CS-2 are white micropulverized powders that are highly irritating to the eyes, skin, and respiratory system.

BLU-52 CHEMICAL BOMB



CHARACTERISTICS

WEIGHT	350 LB
LENGTH	12 FT 4 IN.
DIAMETER	19 IN.
SUSPENSION LUG SPACING	14 IN.
FIN ASSEMBLY	MXU-393/B OR MXU-469/B

FIGURE 1-36

WARNING

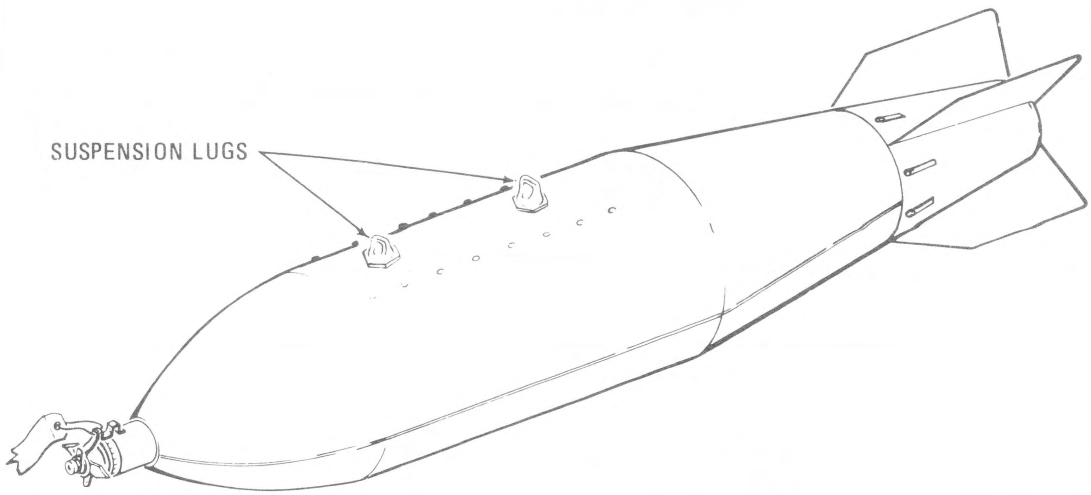
In case of a suspected leak or emergency involving the bomb, immediately evacuate to an upwind area. Notify appropriate EOD personnel immediately.

Approximately 250 pounds of chemical agent are used. The total weight of the bomb may vary with packing density and/or degree of humidity. This bomb does not use a fuze or initiator.

M129E1 AND E2 LEAFLET BOMBS AND MJU-1 CHAFF BOMB

The M129E1 and E2 (FIGURE 1-37) are leaflet bombs designed for use in delivery and distribution of leaflet type material. When these bomb bodies are filled with chaff, they are called MJU-1 chaff bombs. The bomb has a cylindrical body with an ogival nose and a tapered aft section. It is constructed of fiberglass and has an external configuration similar to the M117 GP bomb. The bomb body is split longitudinally into two sections which are held together by four latches on each side. A steel reinforcing plate below the suspension lugs is added for forced ejection from

M129E1 AND E2 LEAFLET BOMBS AND MJU-1 CHAFF BOMB



CHARACTERISTICS

WEIGHT, EMPTY	92 LB
WEIGHT, FULL	203 LB (DEPENDS ON WEIGHT OF PAPER)
LENGTH	7 FT 6 IN.
DIAMETER	16 IN.
FIN SPAN	22 IN.
FIN ASSEMBLY	M148
SUSPENSION LUG SPACING	14 IN.

FIGURE 1-37

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. Tail fuzes are not used or provided for in the M129E1, E2 bombs. 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.

CLUSTER BOMBS AND DISPENSERS

Cluster bombs (FIGURE 1-38) are dispensers loaded with submunitions and may remain attached to the aircraft or released as a free-fall unit. Dispensers that remain attached to the aircraft dispense the submunition by ejection to the rear or by ejection through the bottom of the dispenser. Dispensers that are released as free-fall units are designed as clamshells with either two longitudinal sections (SUU-30) or three longitudinal sections (SUU-64/65) (See FIGURE 1-38.). The clamshells blow apart at a predetermined time after release, or at a given altitude, and the submunitions inside are released. The submunitions (FIGURE 1-39) are bomblets or mines designed for use against such targets as light material, personnel, or armor.

SUU-13 DISPENSERS

SUU-13/A

The SUU-13/A dispenser (FIGURE 1-40) is an externally mounted pod containing a 40-tube assembly that dispenses downward various types of submunitions. The dispenser is a rectangular shape with a curved hardback section. Some models of the SUU-13/A have aerodynamic aft fairings and some models have a flat (bobtail) aft fairing. A removable pallet is attached by internal wrenching bolts to the bottom of the dispenser to prevent inadvertent release of the payload and to protect the dispenser. The pallet is removed prior to flight. On the SUU-13B/A and C/A dispensers, the intervalometer safety pin must be removed prior to removal of the pallet and replaced after the removal. Each of the tubes contains devices for retaining the bombs in the dispenser and a cartridge assembly used to eject them. The weapon release system supplies power to fire an electrically primed cartridge of one tube assembly and activates a stepping mechanism controlled by the intervalometer as set prior to flight. The available intervalometer settings are 0.1, 0.2, 0.3, 0.4, and 0.5 second. The release signal must be continuously applied to the SUU-13/A timing circuit for a time duration (3.9 to 19.5 seconds) which may be determined by multiplying the selected intervalometer setting by bomb releases (n) minus one (39). For example, n-1(39) x 0.2 (intervalometer setting) = 7.8 seconds.

SUU-13A/A

The SUU-13A/A dispenser differs from the SUU-13/A dispenser in the following respects: the SUU-13A/A removable pallet is attached with quick-release fasteners in lieu of internal wrenching bolts and the intervalometer settings are 0.05, 0.1, 0.2, 0.3, and 0.4 second. The SUU-13A/A has flat (bobtail) aft fairings.

SUU-13B/A

The SUU-13B/A dispenser differs from the SUU-13A/A dispenser in the following respect: the intervalometer safety pin must be removed prior to the removal of the pallet and replaced after its removal. The dispenser has been modified to accept this new safety pallet.

SUU-13C/A

The SUU-13C/A dispenser differs from the SUU-13B/A in the following respect: the intervalometer settings for the SUU-13C/A are 0.025, 0.05, 0.1, 0.2, and 0.3 second.

CLUSTER BOMBS AND DISPENSERS

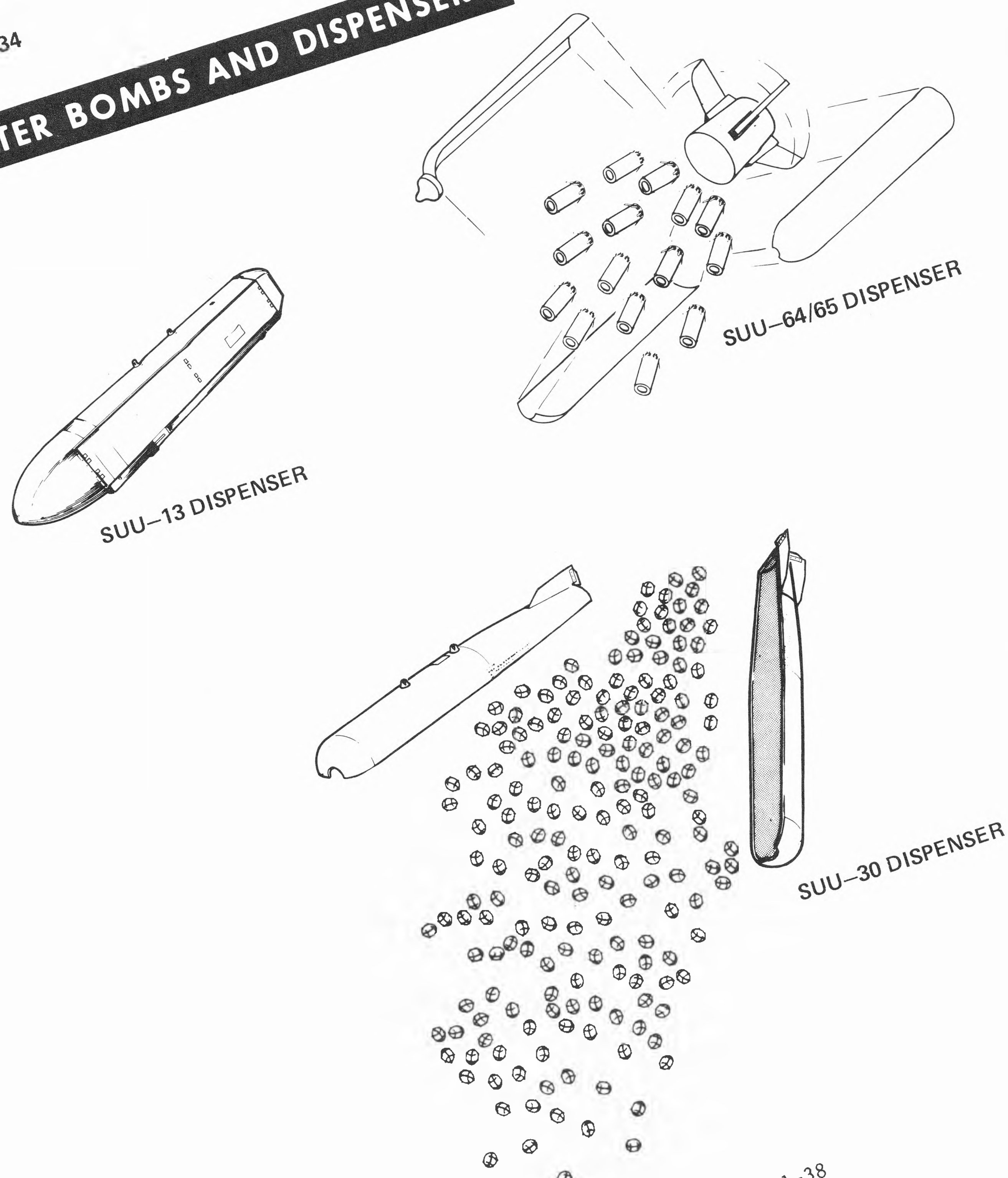


FIGURE 1-38

CLUSTER BOMB CHART

MUNITION	DISPENSER	SUBMUNITION	APPROXIMATE NUMBER OF BOMBLETS	TOTAL WEIGHT (LB)
CBU-30/A	SUU-13/A	BLU-39/B23	1280	385
CBU-38/A	SUU-13A/A	BLU-49/B	40	820
CBU-38A/A	SUU-13B/A	BLU-49A/B	40	822
CBU-38B/A	SUU-13C/A	BLU-49A/B	40	806
CBU-38C/A	SUU-13C/A	BLU-49B/B	40	806
CBU-24B/B	SUU-30B/B	BLU-26/B	665	832
CBU-49B/B	SUU-30B/B	BLU-59/B	665	832
CBU-52B/B	SUU-30H/B	BLU-61A/B	217	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	500
BL-755	BL-755	BL-755	147	600
CBU-87	SUU-64	BLU-97/B	202	950
CBU-89 (GATOR)	SUU-65	BLU-91/B	72	680
		BLU-92/B	22	

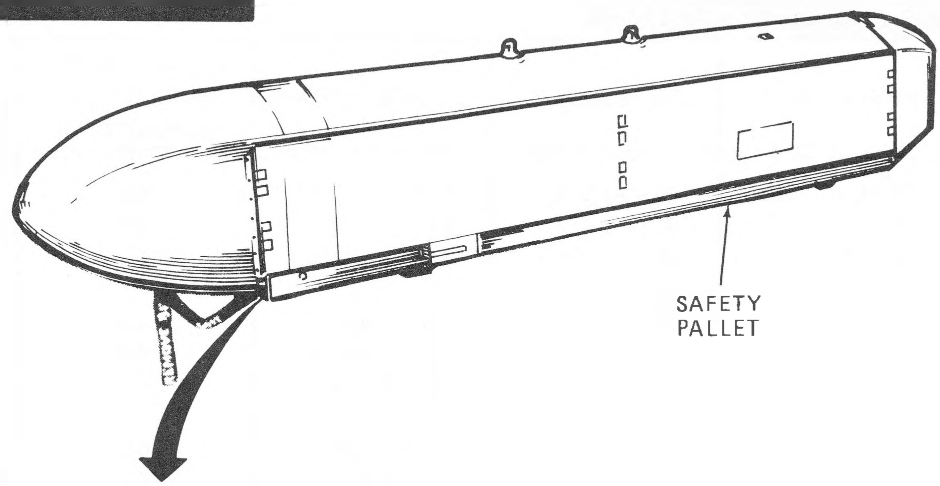
FIGURE 1-39

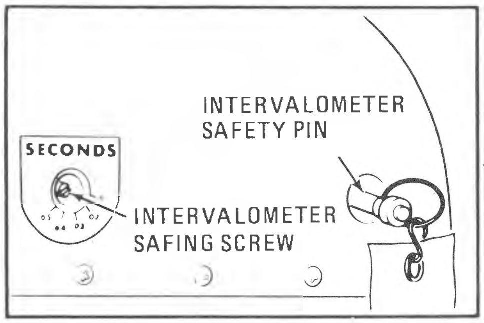
CBU-30/A CLUSTER BOMB AND BLU-39/B23 CS BOMBLET

The CBU-30 cluster bomb comprises the SUU-13/A dispenser with the 40 vertical tubes loaded with CDU-12/B bomb cluster canisters(FIGURE 1-41). Each bomb cluster canister contains 32 BLU-39/B23 antipersonnel chemical bomblets.

The canister is retained in the dispenser tube by four screws, which are sheared when the canister is ejected by the tube impulse ejection cartridge. The downward ejection velocity of the canister from the dispenser is approximately 90 fps. FIGURE 1-40 depicts a typical SUU-13/A tube assembly with a CDU-12/B canister installed. Each canister contains a delay assembly and an expulsion tube. When the tube assembly cartridge is fired, the hot gases created are vented to the canister delay assembly while creating sufficient pressure on the canister to shear the tube's four canister retaining screws. After 0.3 to 0.5 second, the delay assembly ignites black powder contained in the canister expulsion tube and ignites the fuze igniter of each BLU-39 bomblet. The burning black powder in the canister expulsion tube forces the bomblets through the thin fiberglass walls of the canister. The bomblet will start to dispense CS smoke 5 to 6 seconds after it is released from the bomb package. The CS will be dispensed from each bomblet for approximately 10 to 15 seconds causing the bomblet, after impact on a cleared surface, to skitter about due to the violent expulsion of the CS from an orifice in the end of the bomblet.

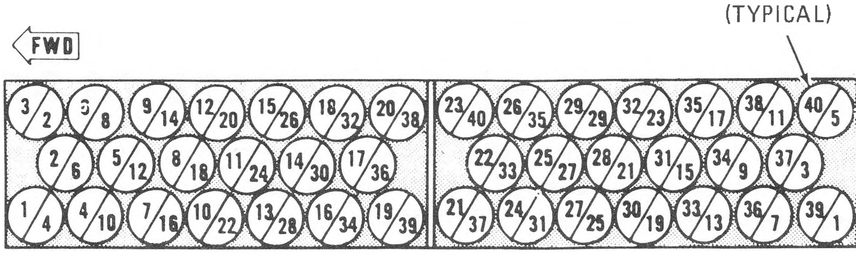
SUU-13 DISPENSERS





SUU-13 DISPENSER CHECK

ITEM	CBU-30/A	CBU-38/A	CBU-38A/A	CBU-38B/A	CBU-38C/A
DISPENSER	SUU-13/A	SUU-13A/A	SUU-13B/A	SUU-13C/A	SUU-13C/A
WEIGHT	385 LB	820 LB	822 LB	806 LB	806 LB
BOMBLET	BLU-39/B23	BLU-49/B	BLU-49A/B	BLU-49A/B	BLU-49B/B



BOTTOM VIEW

CHARACTERISTICS

EMPTY WEIGHT	157 LB
WIDTH/HEIGHT	15 X 14 IN.
LENGTH W/REAR FAIRING	8 FT 5 IN.
LENGTH W/O REAR FAIRING	7 FT 9 IN.
LENGTH W/BOBTAIL FAIRING	7 FT 6 IN.
NUMBER OF TUBES	40
SUSPENSION LUG SPACING	14 IN.

FIGURE 1-40

NOTE

The bomblet will start to dispense CS smoke 5 to 6 seconds after release. Release conditions that provide a time of flight of less than 6 seconds should be selected.

CBU-38 CLUSTER BOMB

The CBU-38 cluster bomb is made up of the SUU-13 dispenser and BLU-49 series bomblets (FIGURE 1-42). A single BLU-49 antimaterial high-explosive (HE) bomblet (FIGURE 1-43) is carried in each of the SUU-13A/A dispenser's 40 ejection tubes to make up the CBU-38/A. The bomblets are ejected downward from the dispenser at approximately 62 fps. Ejection forces imparted by the dispenser tube ejection cartridges shear six pins which hold the bomblet in the tube.

WARNING

If all submunitions cannot be confirmed dispensed, the SUU-13 should be jettisoned prior to landing the aircraft to prevent aircraft/runway damage caused by hung submunitions which may fall out on landing.

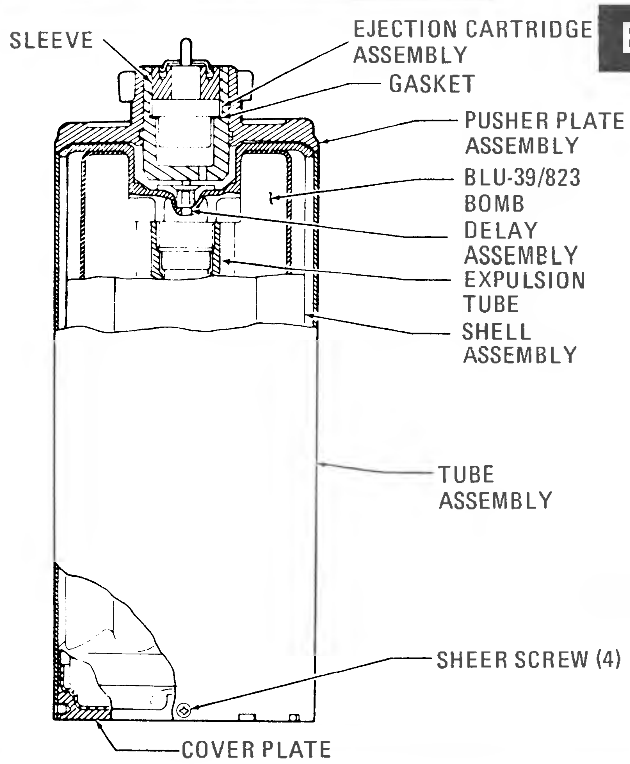
NOTE

Release conditions must be selected which provide a BLU-49A/B or BLU-49B/B bomblet a time of flight greater than 3.5 seconds to assure adequate time for the fuze to arm prior to impact. A minimum dispensing airspeed of 400 KTAS is recommended for the CBU-38A/A, CBU-38B/A, or CBU-38C/A to ensure safe delivery at minimum altitudes.

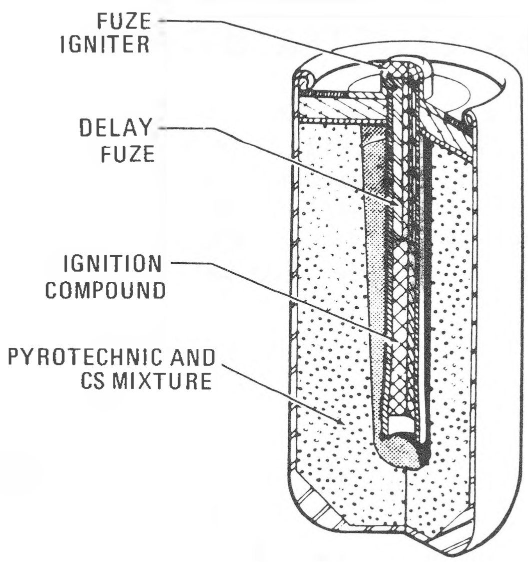
BLU-49/B BOMBLET

As the bomblet emerges from the tube, three wind tabs within the bomblet tail assembly force the stabilizer ringtail into the extended position. Extension of the ringtail actuates the fuze system. The bomblet is armed in 5.5±1 seconds and detonates on impact.

CDU-12/B CANISTER



BLU-39/B23 CS BOMBLET



CHARACTERISTICS

	CDU-12/B	BLU-39/B23 CS
WEIGHT	10 LB	0.13 LB
LENGTH	10 IN.	2 IN.
DIAMETER	5 IN.	1 IN.

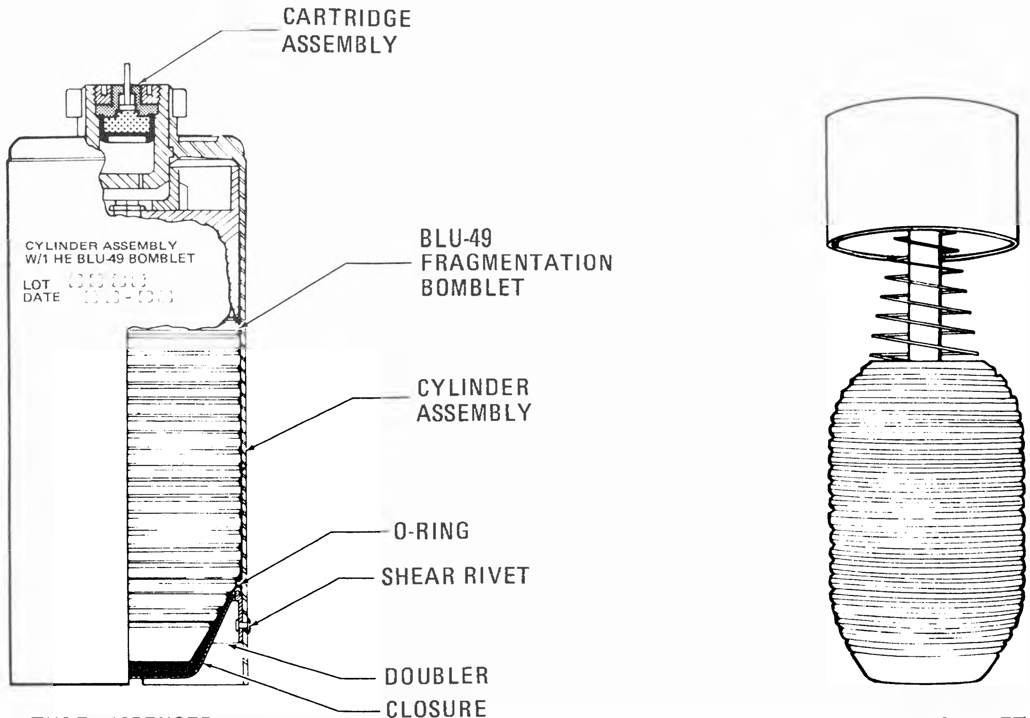
FIGURE 1-41

CBU-38 SERIES MUNITIONS CONFIGURATION AND WEIGHT CHART

MUNITION	DISPENSER	BOMBLET	WEIGHT (LB)
CBU-38/A	SUU-13A/A	BLU-49/B	820
CBU-38A/A	SUU-13B/A	BLU-49A/B	822
CBU-38B/A	SUU-13C/A	BLU-49A/B	806
CBU-38C/A	SUU-13C/A	BLU-49B/B	806

FIGURE 1-42

BLU-49 BOMBLET



TUBE DISPENSER

BLU-49 BOMBLET

CHARACTERISTICS

TUBE DISPENSER	
WEIGHT	13 LB
LENGTH	10 IN.
DIAMETER	5 IN.

BLU-49 BOMBLET	
WEIGHT	13 LB
LENGTH	
IN CANISTER	10 IN.
RINGTAIL EXTENDED	14 IN.
DIAMETER	5 IN.

FIGURE 1-43

BLU-49A/B BOMBLET

The single difference between the BLU-49A/B and the BLU-49/B is the fuzing. The arming time for the BLU-49A/B was reduced to a minimum of 2.25 seconds and a maximum of 3.50 seconds. The BLU-49A/B has a safety device that prevents the bomblet from arming when it senses an impact greater than 25 g after the ringtail has been extended and before the arming time (2.25 to 3.50 seconds) is reached.

If the bomblet must penetrate jungle canopy, the resultant deceleration should not be sufficient to cause the inertial weights to fire the detonator. The bomblet then will penetrate and explode following impact with the ground. Upon water or mud impact (which does not provide sufficient deceleration to fire the detonator by the action of the inertial weights), another means is provided to fire the detonator.

Openings in the face of the fuze will allow the fluid media to enter and push a piston against the firing pin. The firing pin then fires the detonator and ignites the explosive train.

BLU-49B/B BOMBLET

The BLU-49B/B contains slightly more explosive material (including a small incendiary component) than the BLU-49A/B and has a slightly longer body. In all other respects they are the same.

SUU-30 DISPENSERS

SUU-30B/B DISPENSER

The SUU-30B/B (FIGURE 1-44) is a cylindrical metal dispenser 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 base plate bolted to the aft end. The nose locking cap consists of a lanyard tube, four shear pins, 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 fin tab is attached to the outer 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 altitudes for SUU-30 type CBUs are a function of bomblet arming plus SUU-30 fuzing requirements.

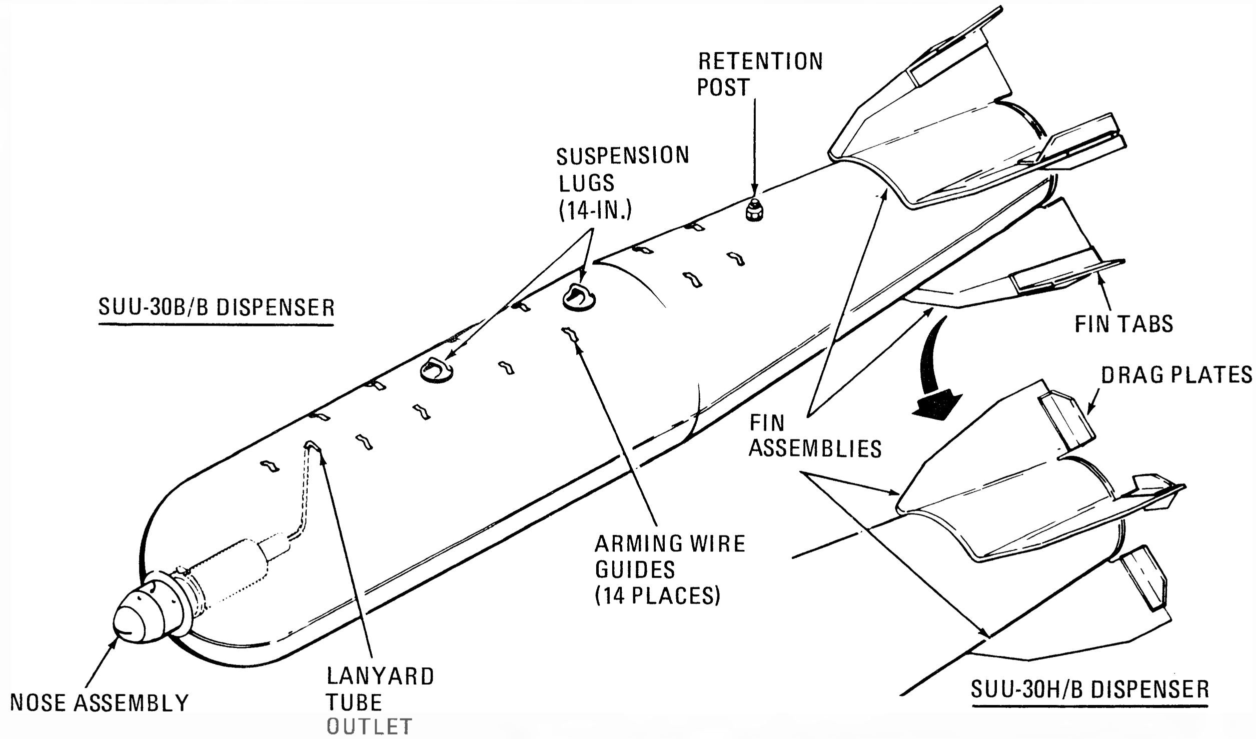
SUU-30H/B DISPENSER

The SUU-30H/B dispenser fin tabs are located on the trailing edges of the fins and are called drag plates. In other respects it is the same as the SUU-30B/B dispenser.

CBU-24B/B CLUSTER BOMB

The SUU-30B/B is loaded with 665 BLU-26 bomblets to create the CBU-24B/B. The BLU-26 bomblet (FIGURE 1-45) is a spin-armed, self-dispensing 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 M219 fuze. Weights holding the rotor in the

SUU-30B/B, H/B DISPENSERS



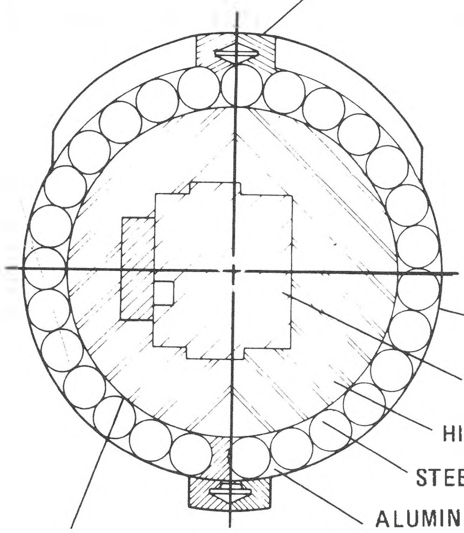
CLUSTER BOMB	DISPENSER	BOMBLETS		TOTAL WEIGHT
CBU-	SUU-	BLU-	QUANTITY	(LB)
24B/B 49B/B	30B/B	26/B 59/B	670	822
52B/B	30H/B	61A/B	217	785
58/B 58A/B 71/B 71A/B		63/B 63A/B 86/B 86A/B	650	818

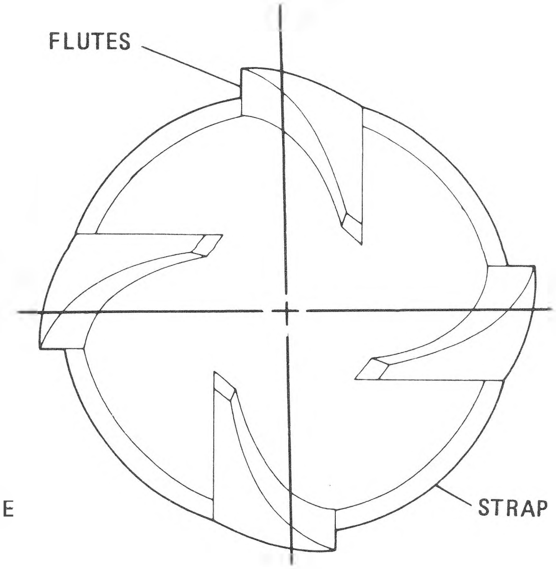
CHARACTERISTICS

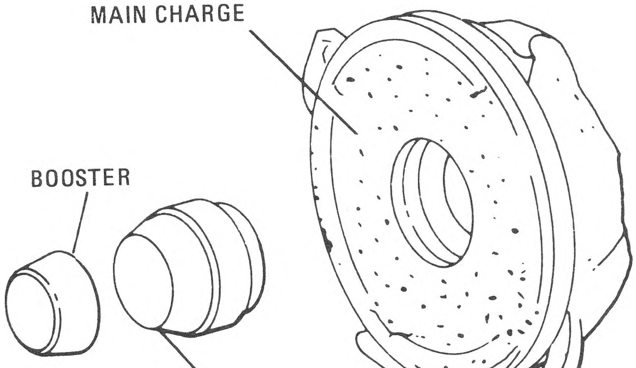
LENGTH — 7 FT 6 IN.
DIAMETER — 16 IN.
WEIGHT
(EMPTY) — 198 LB
(LOADED) — 735 - 832 LB
SUSPENSION LUG SPACING — 14 IN.

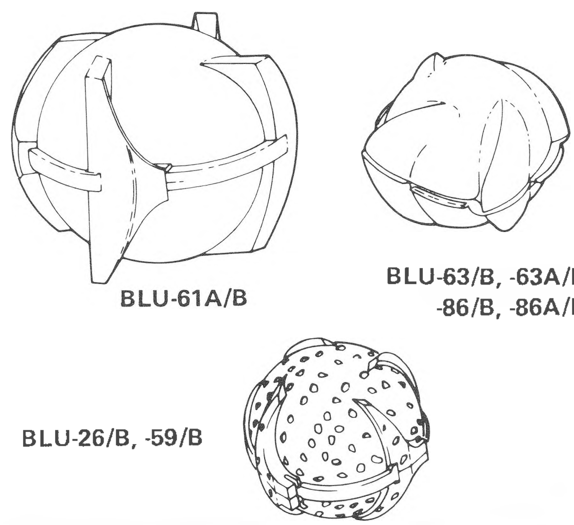
FIGURE 1-44

BLU BOMBLET (TYPICAL)









CHARACTERISTICS

	BLU-61A/B	BLU-26/B BLU-59/B	BLU-63/B, -63A/B BLU-86/B, -86A/B
DIAMETER	3.5 IN.	2.38 IN.	2.94 IN.
WEIGHT	2.7 LB	0.93 LB	0.93 LB
EXPLOSIVE WEIGHT	0.65 LB	0.182 LB	0.25 LB

FIGURE 1-45

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 M219 fuze is sensitive to impact from any direction. Impact detonates the HE filler that bursts the bomblet case and propels steel balls at high velocity (approximately 4,000 fps) in a radial direction.

CBU-49B/B CLUSTER BOMB

The SUU-30B/B is loaded with 665 BLU-59/B bomblets to create the CBU-49B/B. The BLU-59/B differs from the BLU-26/B bomblet used in the CBU-24B/B in that the BLU-59/B is equipped with an M224 time delay fuze that causes the bomblets to detonate randomly after impact (FIGURE 1-45). In all other respects it is identical to the BLU-26/B bomblet.

M224 RANDOM TIME DELAY FUZE

The M224 is a random time delay, spin-armed fuze that arms between 2,400 and 3,200 rpm. It is used to detonate the BLU-59/B and BLU-86/B, A/B bomblets which fill the SUU-30B/B and SUU-30H/B, respectively. 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.

CBU-52B/B CLUSTER BOMB

The SUU-30H/B is loaded with 217 BLU-61A/B bomblets to create the CBU-52B/B. The BLU-61A/B is similar in shape and function to the BLU-26/B bomblet used in the CBU-24 and uses the same M219 fuze. The BLU-61A/B is approximately 50 percent larger, however, which produces heavier fragments with improved penetration capability. Average fragment velocity is 5,000 fps. 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 in the plastic.

CBU-58/B CLUSTER BOMB

The SUU-30H/B is loaded with 650 BLU-63/B bomblets to make the CBU-58/B. The BLU-63/B is similar in size, shape, and function to the BLU-26/B used in the CBU-24 and uses the same M219 fuze. The average fragment velocity is 4,500 to 4,900 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 steel ball/cast aluminum case of the BLU-26/B.

CBU-58A/B CLUSTER BOMB

The SUU-30H/B is loaded with 650 BLU-63A/B bomblets to make the CBU-58A/B. The BLU-63A/B 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.

CBU-71/B CLUSTER BOMB

The SUU-30H/B is loaded with 650 BLU-86/B bomblets to make the CBU-71/B. The BLU-86/B differs from the BLU-63/B bomblet (FIGURE 1-45) 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 make the CBU-71A/B. The BLU-86A/B differs from the BLU-63A/B incendiary bomblet (FIGURE 1-45) in that the BLU-86A/B incorporates the M224 time delay fuze, which detonates at random times after impact. In all other respects it is identical to the BLU-63A/B.

WARNING

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

SUU-64/B, -65/B TACTICAL MUNITIONS DISPENSERS

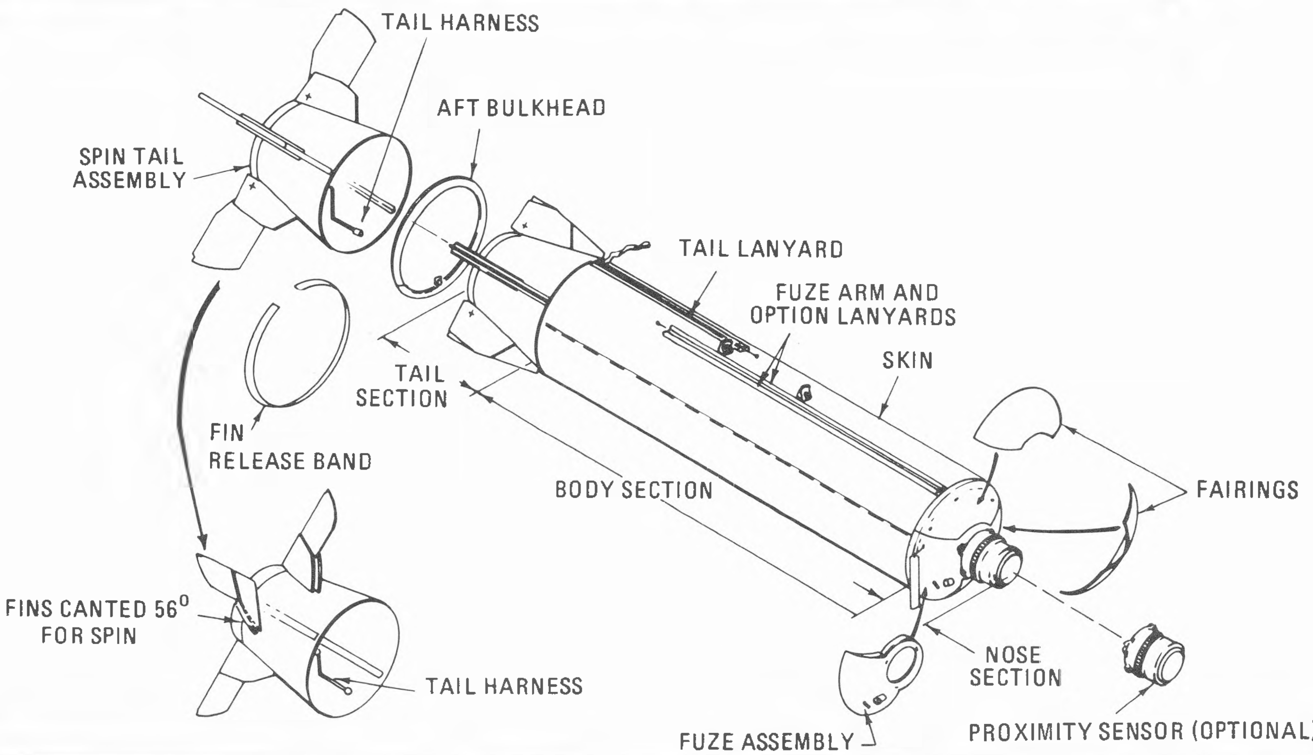
The Tactical Munitions Dispenser (TMD) (FIGURE 1-46) is a cluster munitions dispenser. The TMD is made in two major versions designated the SUU-64/B and SUU-65/B. The major difference between the two versions is the tail sections. The SUU-64/B has a nonspin tail section, and the SUU-65/B has a fin cant mechanism to provide aerodynamic spinning of the dispenser and to enhance submunition dispersion.

SUU-64/B

The components in the SUU-64/B can be grouped into three main assemblies: body, tail, and nose (FIGURE 1-46).

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 inside 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 the body harness. The fuze harness connects the fuze to the proximity sensor and to the body harness. The cutting network consists of a manifold and a lead, three longitudinal strands of

SUU-64/B, -65/B TACTICAL MUNITIONS DISPENSER



CHARACTERISTICS

	SUU-64/B	SUU-65/B
WEIGHT		
EMPTY	195 LB	215 LB
LOADED	651 LB	950 LB
LENGTH	7 FT 8 IN.	7 FT 8 IN.
DIAMETER	16 IN.	16 IN.
SUSPENSION LUG SPACING	14 IN.	14 IN.

FIGURE 1-46

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 fins, 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 tied off 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 extractor has two break links. The lower break link is attached to the conduit and will break with a pull of 54 to 79 pounds. It is used to assure that the extractor will be pulled free of the solenoid jaws without pulling the lanyard when the arming solenoid is not energized. The upper break link breaks under a pull of 108 to 140 pounds. When the dispenser is released with the arming solenoid energized, the extractor becomes taut and breaks the lower break link. This allows the extractor to pull the lanyard until it engages its stop and the upper link breaks. The lanyard and extractor remain with the dispenser, and only the loop remains attached to the ejector rack. Fuze option is determined by the arming solenoid selection. The tail solenoid is used to pull the fuze arming lanyard, and the nose solenoid is used to pull the fuze option lanyard. The fin release lanyard is tied off on the ejector rack sway brace and is always pulled regardless of arming solenoid selection.

The tail section is attached to the aft bulkhead and has four extendable fins which are held in the retracted position by a fin release band. When the fin release lanyard is pulled, the fins are extended in unison by four pairs of springs and a gang pulley assembly. The fins are then locked in the extended position.

The nose section is attached to the forward bulkhead and consists of two fairing sections which form the aerodynamic profile of the nose, an optional proximity sensor, and a fuze.

SUU-65/B

The SUU-65/B is a SUU-64/B with a modified tail section that imparts spin to the dispenser.

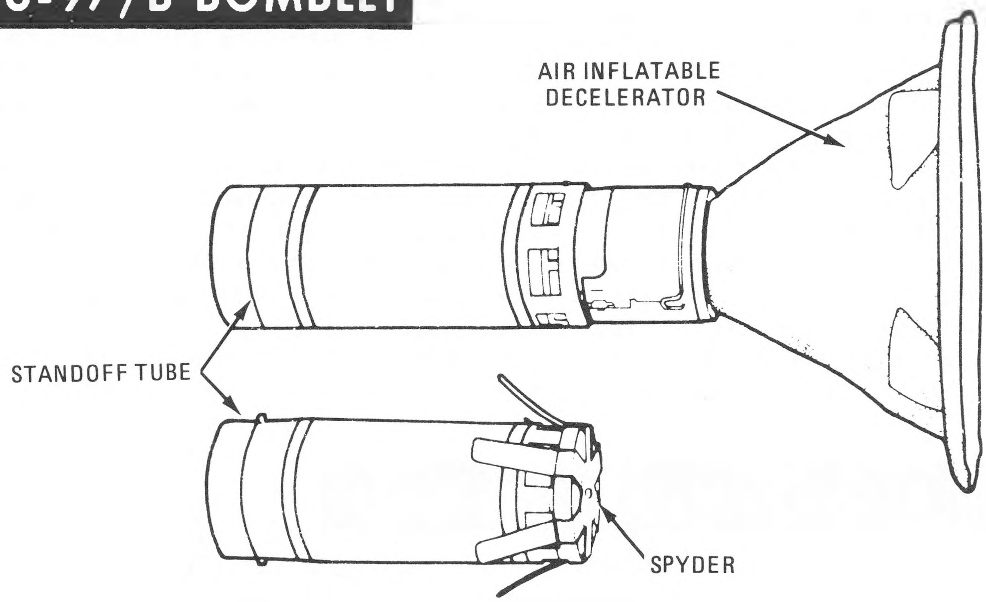
The spin tail differs from the nonspin tail in that it contains a fin cant mechanism and an explosive bolt and tail harness. The tail harness connects the body harness to the explosive bolt assembly. When the spin mode is selected, a signal is sent from the fuze through the body harness which detonates the explosive bolt. This allows the spring-loaded fin cant mechanism to rotate the fins to the fully canted position.

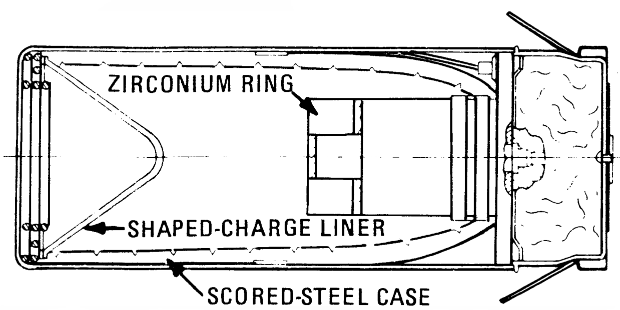
CBU-87 CLUSTER BOMB (COMBINED EFFECTS MUNITIONS)

The Combined Effects Munition (CEM) is a SUU-65/B containing BLU-97/B (FIGURE 1-47) bomblets. 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) 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 cap which pulls the cup assembly rearward, exposing the AID to the airstream. As the AID 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 transmits the air-induced loads to a shaft in the fuze which arms

BLU-97/B BOMBLET





CHARACTERISTICS

DIAMETER	2 IN.
WEIGHT, TOTAL	3 LB
EXPLOSIVE	CYCLOTOL
WEIGHT	0.65 LB
LENGTH	
STOWED	7 IN.
DEPLOYED	10 IN.

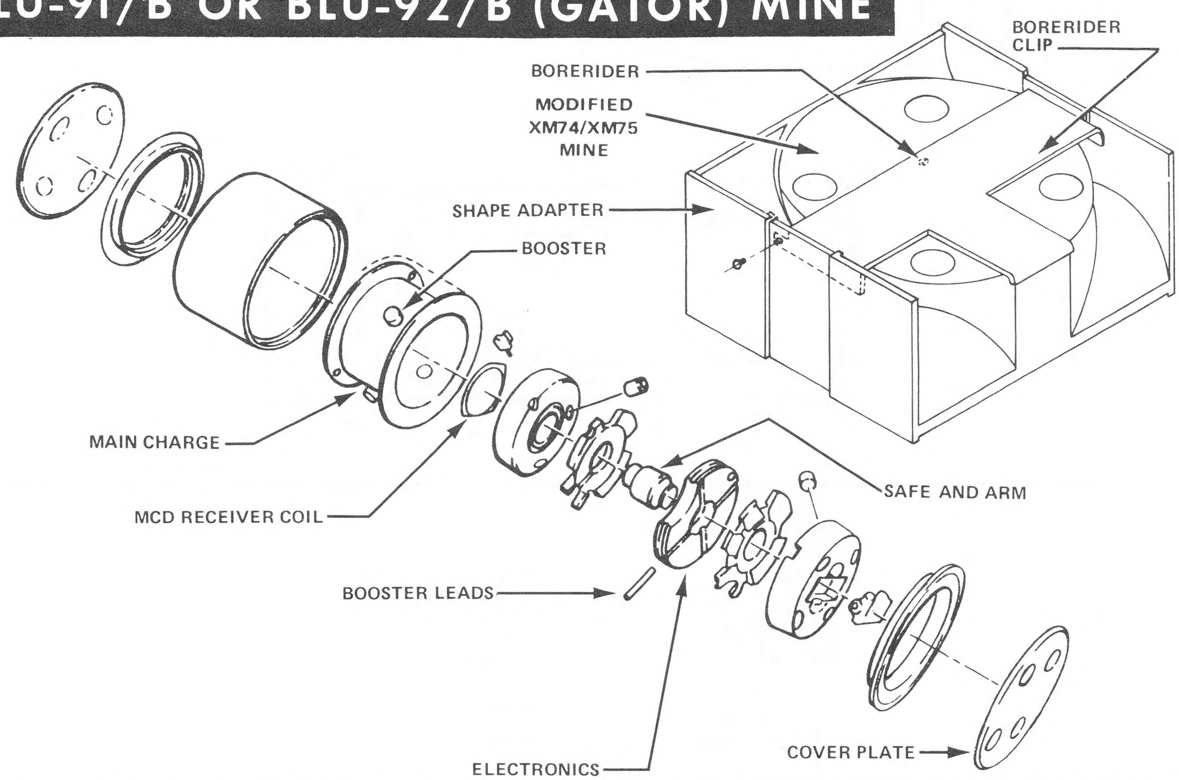
FIGURE 1-47

the submunition. Release of the cap 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 other than straight on, a secondary firing system will detonate the submunition.

CBU-89 CLUSTER BOMB (GATOR)

The CBU-89 is made up of a SUU-64/B dispenser containing BLU-91/B and BLU-92/B submunitions (FIGURE 1-48). The BLU-91/B antitank mine is a delayed-action, target-sensing submunition. The BLU-91/B consists of a safe and arming device, a clearing charge, a bidirectional shaped-charge warhead, a magnetic sensor, and electronic components. All components are contained in a compact plastic aeroballistic shape adapter. Mine arming begins when the SUU-64 dispenser opens and is completed shortly after ground impact. Self-contained batteries keep the BLU-91/B armed until detonation. Detonation occurs when the magnetic sensor detects a target or the mine is disturbed. If no target is detected before the preset self-destruct time is reached, the mine detonates at the expiration of the preset time period. If the battery voltage drops below a specified level, the mine will detonate. The BLU-91/B is effective against tanks and armored vehicles.

BLU-91/B OR BLU-92/B (GATOR) MINE



CHARACTERISTICS

	BLU-91/B	BLU-92/B
WEIGHT	4 LB	4 LB
LENGTH	6 IN.	6 IN.
WIDTH	5 IN.	5 IN.
HEIGHT	3 IN.	3 IN.
EXPLOSIVE	RDX	COMP B
WEIGHT	1.3 LB	0.905 LB

FIGURE 1-48

The BLU-92/B antipersonnel mine closely resembles the BLU-91/B in appearance and function. The BLU-92/B bursts on the ground; its fragmenting case warhead is triggered by tripwires. The BLU-92/B contains eight tripwires and tripwire sensors, four per face. Maximum tripwire deployment length is 40 feet. The four upward-facing tripwires deploy at mine arming. Mine arming is otherwise similar to the BLU-91/B arming process. Detonation occurs when a target actuates the tripwires or when the mine is disturbed. BLU-92/B self-destruct processes are the same as for the BLU-91/B.

MK 20 MOD 2,3, AND 4 (ROCKEYE II) CLUSTER BOMB

The MK 20 Rockeye (FIGURE 1-49) is an antiarmor cluster bomb consisting of the MK 7 clamshell dispenser, MK 339 mechanical fuze, and MK 118 bomblets. The weapon is produced, delivered, and loaded as a complete unit.

MK 7 MOD 2 DISPENSER

The MK 7 Mod 2 bomb dispenser consists of a nose fairing, cargo section, and tail section. The nose fairing contains an upper and lower nose fairing assembly, and houses the MK 339 mechanical time fuze. The upper nose fairing has two observation windows. One is for viewing the safe/arm indicator and the other is to view the fuze time setting dials. Two access holes are provided in the lower fairing for changing fuze time settings. During ground handling, a fuze cover is installed over the fuze impeller and fuze safety pin.

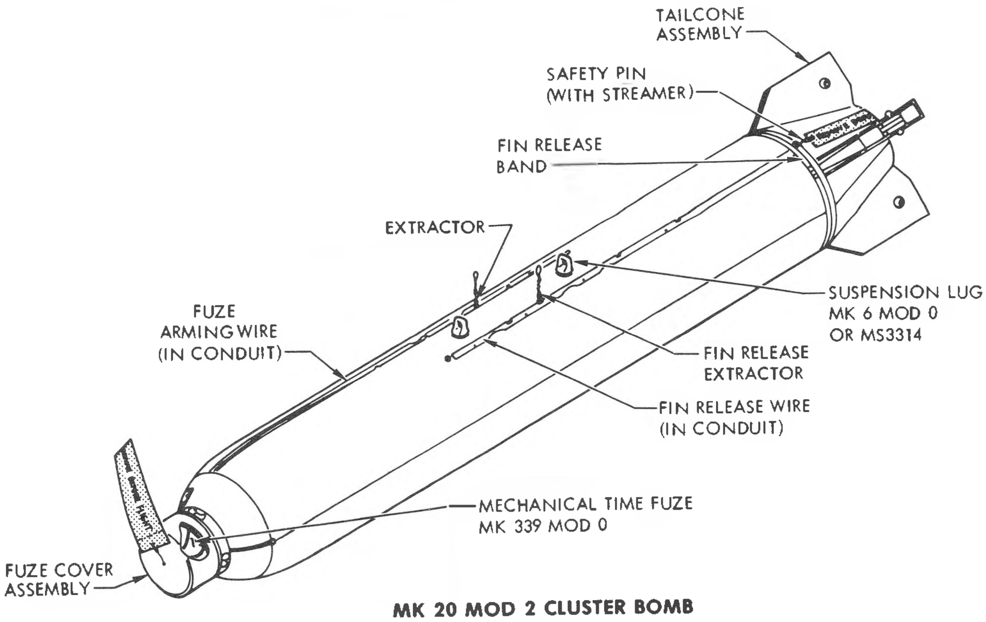
The cargo section is made of aluminum. It is thick at the top for suspension purposes, but thins to 0.125 inch for the cargo walls. It houses 247 MK 118 antitank bomblets which are secured and protected by plastic spacers. A linear charge is secured to both inner walls of the cargo section. This charge is used to cut the dispenser in half longitudinally when the MK 339 fuze functions after release. This allows the MK 118 bomblets to spread in a free-fall trajectory.

The tail section consists of a conical body equipped with four foldable spring-loaded fins. Until release, these fins are held in the folded position by a fin release band which, in turn, is held closed by a fin release wire, and a fin safety pin. Two conduits are provided along the top of the dispenser, one for the fin release wire, which is tied off to a rear sway brace, when loaded, and one for the MK 339 arming wire.

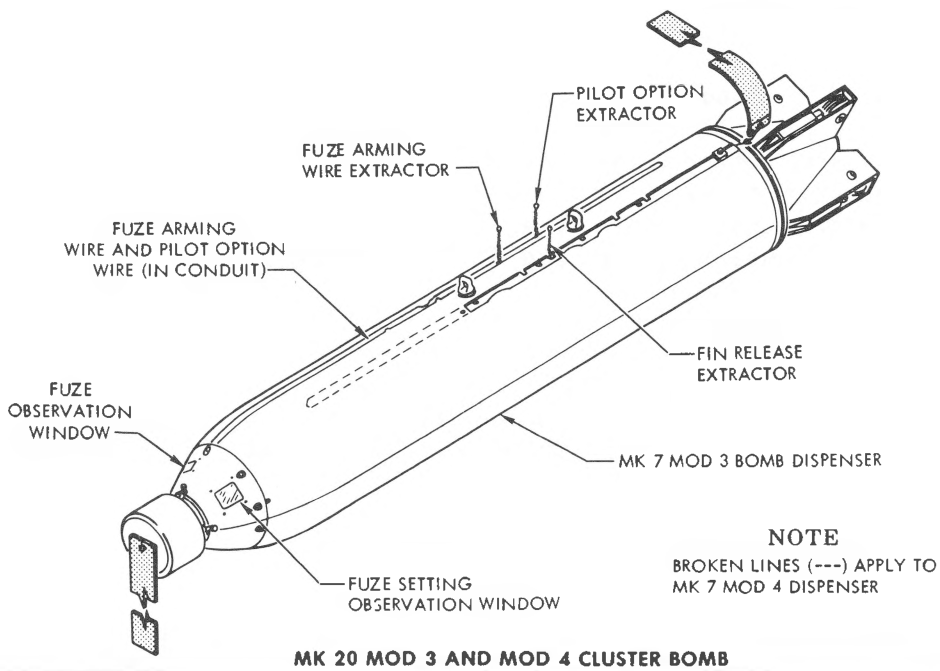
NOTE

In the MK 20 Mod 2 bomb cluster, the MK 339 option wire is removed and the option pin is extended. The consequences are that the option time will be utilized. To avoid confusion when employing MK 20 Mod 2 put both primary and option timer on the same setting.

MK 20 MOD 2,3, AND 4 (ROCKEYE II) CLUSTER BOMB



MK 20 MOD 2 CLUSTER BOMB



NOTE

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

MK 20 MOD 3 AND MOD 4 CLUSTER BOMB

CHARACTERISTICS

WEIGHT	500 LB.
LENGTH	7 FT 6 IN.
DIAMETER	13 IN.
FIN SPAN	
CLOSED	17 IN.
OPEN	35 IN.
SUSPENSION LUG SPACING	14 IN.

FIGURE 1-49

MK 7 MOD 3 DISPENSER (MK 20 MOD 3)

The MK 7 Mod 3 dispenser differs from the MK 7 Mod 2 dispenser in that on the Mod 3 a pilot option wire is added 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 7 MOD 4 DISPENSER (MK 20 MOD 4)

The MK 7 Mod 4 dispenser differs from the MK 7 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 MK 7 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 fin release extractors in two additional places.

MK 339 MECHANICAL TIME FUZE

A discussion of the MK 339 mechanical time fuze used with the MK 7, Mod 2, Mod 3, and Mod 4 dispensers can be found in Section II, Nonnuclear Weapons Fuzes.

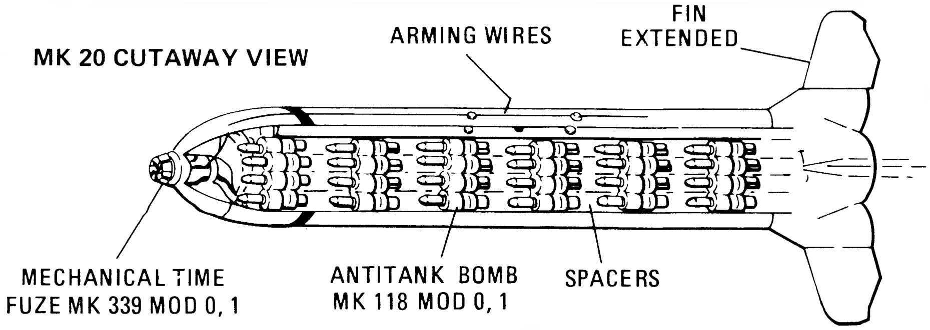
MK 118 MOD 0 BOMBLET

MK 118 MOD 0 antitank bomblet (FIGURE 1-50) is used in the MK 20 Mod 2 and 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 Octal, 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 at least 200 knots to arm. It takes a total of 1.2 seconds to fully arm. Fuze detonation is initited 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, which 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.

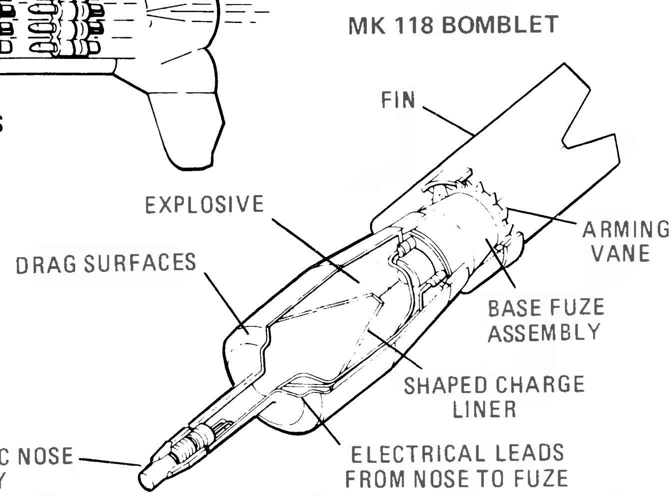
MK 118 MOD 1 BOMBLET

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.

MK 20 ROCKEYE II, MK 118 BOMBLET



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



CHARACTERISTICS

LENGTH ________ 13 IN.
DIAMETER ________ 2 IN.
WEIGHT ________ 1 LB

FIGURE 1-50

NOTE

In current MK 118 Mod 0 and Mod 1 bomblets, 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 1-51.

DELIVERY CONSIDERATIONS

	MK 20 MOD 2 and 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 1-51

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 appropriate safe separation data.

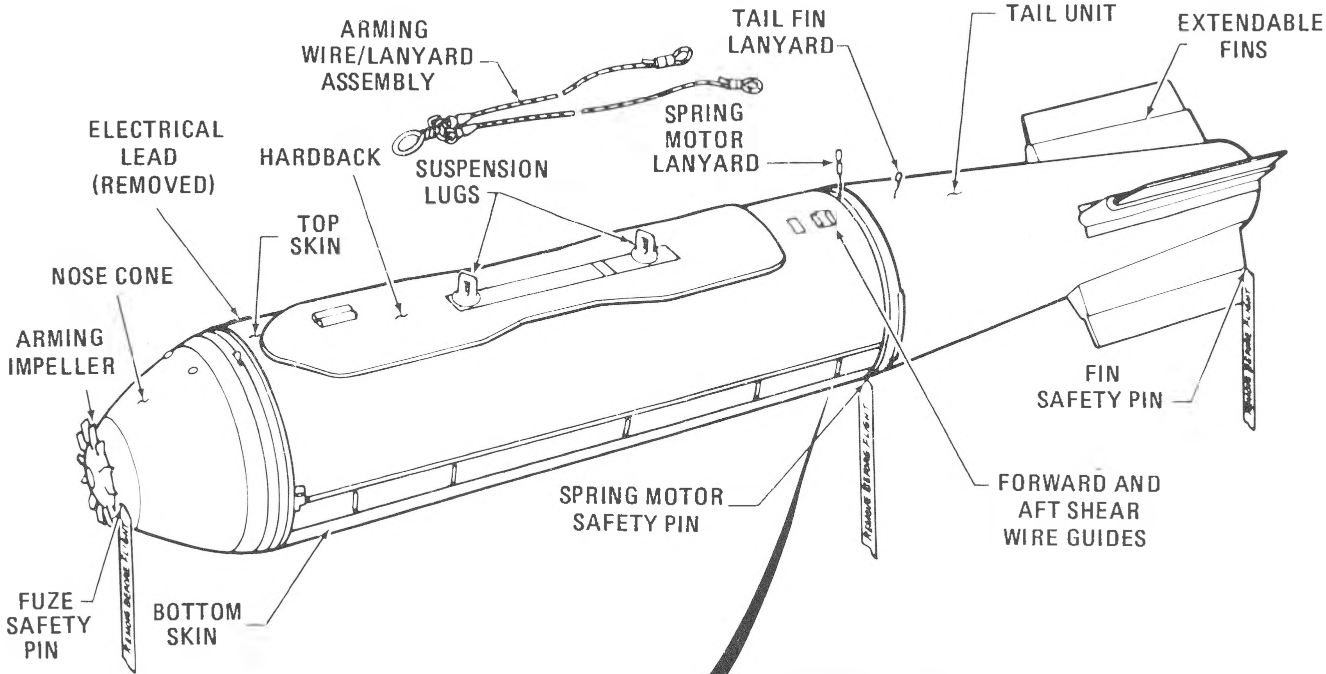
The MK 20 Rockeye is more efficiently used against area targets that require penetration to kill, although it can be employed against soft targets. Its probability of kill against any target is driven by impact angle and bomblet density. The recommended method to increase bomblet density is to make a multiple release. Bomblet impact patterns have no doughnut effect, and the bomblets are generally evenly spaced throughout an elipse. 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 cluster bomb (FIGURE 1-52) has not received safety certification by the USAF Nonnuclear Munitions Safety Board (NNMSB). The munition is certified only for the contingency rearming of USAF aircraft at allied bases with BL-755 munitions from their inventories. The electrical detent, a primary safety feature, must be negated before flight. The remaining safety features, which prevent dispenser functioning and submunition dispersal while carried on the aircraft, do not meet USAF design safety criteria.

The BL-755 is a British munition (similar to the MK 20 Rockeye) 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

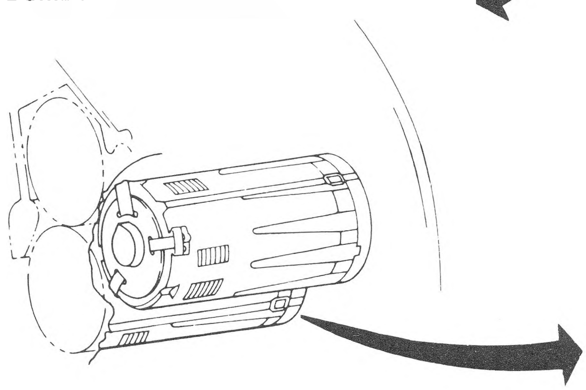
BL-755 CLUSTER BOMB



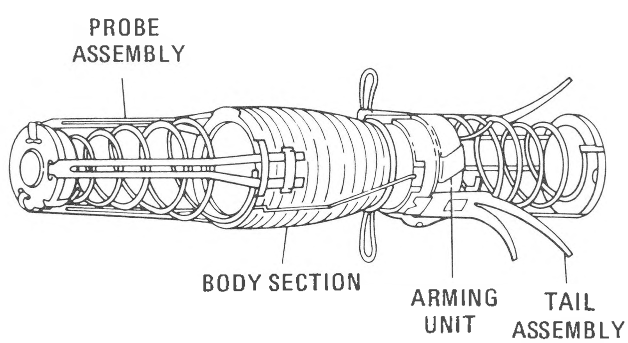
DISPENSER CHARACTERISTICS

WEIGHT (LOADED)	600 LB (APPROX)
LENGTH	8 FT
DIAMETER	16 IN.
FIN SPAN (OPEN)	28 IN.
(CLOSED)	22 IN.
SUSPENSION LUG DISTANCE	14 IN.

BOMBLET COMPRESSED



BOMBLET EXTENDED



BOMBLET CHARACTERISTICS

LENGTH (COMPRESSED)	6 IN.
(EXTENDED)	14 IN.
DIAMETER	3 IN.
WEIGHT	16 LB
NUMBER OF BOMBLETS PER CLUSTER	147
NOMINAL ARMING TIME	0.7 SEC

FIGURE 1-52

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/lanyards are installed during manufacture to make a complete munition.

The MK 1 was built for British use and has four fuze time settings.

SETTING	FUZE FUNCTION TIME
A	1.13 seconds
B	1.38 seconds
C	1.64 seconds
D	2.00 seconds

The MK 2 was built for German use and has a longer hardback than the MK 1. The 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

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.

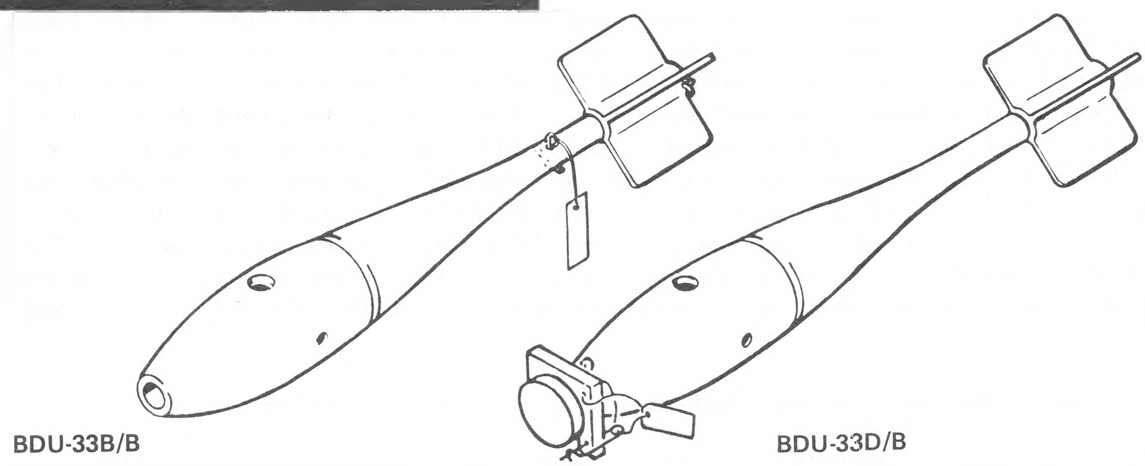
The BL-755 submunition is designed to be compressed when loaded in the bomb cluster by telescoping the probe and tail assemblies over the bomblet body. Upon ejection from the bomb cluster, the probe and tail extend and the arming cycle begins. The probe gives the bomblet the standoff distance required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

PRACTICE BOMBS

BDU-33

The BDU-33 is a 24-pound practice bomb (FIGURE 1-53), designed for pilot training in weapons delivery techniques. The teardrop-shaped body is cast metal with a

BDU-33 PRACTICE BOMB



CHARACTERISTICS

WEIGHT	24 LB
LENGTH	23 IN.
DIAMETER	4 IN.

FIGURE 1-53

cavity running lengthwise through the center. A conical fin is attached to the bomb body and has a hollow tube that serves as an extension of the bomb signal cavity. A single-suspension lug is installed.

BDU-33B/B

From nose to tail, the signal cavity of an assembled BDU-33B/B bomb contains an MK 1 Mod 0 firing pin assembly, MK 4 Mod 3 or MK 4 Mod 4 signal cartridge, inertia tube, and cotter pin. The BDU-33B/B also has a safety (cotter) pin installed between the signal cartridge and the firing pin assembly. Once the safety pin is removed, it cannot be reinstalled in the bomb until the bomb is disassembled. Impact of the bomb drives the signal cartridge, aided by the inertia tube, against the firing pin assembly and detonates the cartridge. The cartridge expels smoke and a flash from the tail of the bomb, permitting visual observation of bombing accuracy. Instead of the signal cartridge, a CXU-2/B (titanimun tetrachloride) spotting charge can be used in the bomb. The safety clip on the CXU-2/B can be reinstalled without disassembly.

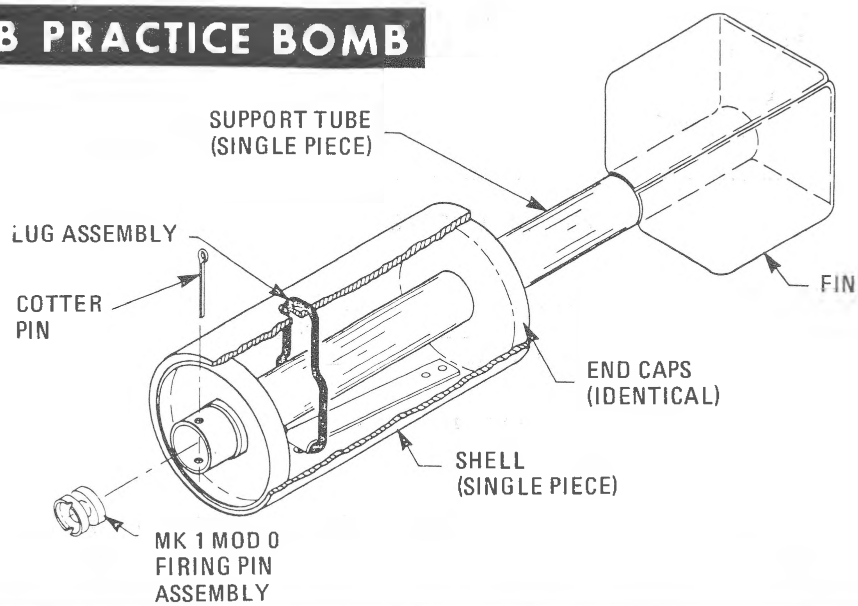
BDU-33D/B

The BDU-33D/B differs from the BDU-33B/B in that the BDU-33D/B spotting charge has been relocated from the tail to the nose of the bomb. The spotting charge relocation results in a new firing pin on the nose of the bomb which utilizes a safety block to prevent the firing pin from being moved during handling operations. The safety block is held in place by a cotter pin or a safety pin. The safety block may be reinstalled after removal without disassembling the bomb.

BDU-48/B

The BDU-48/B is a practice bomb designed to simulate the ballistics of the MK 82 (retarded) (FIGURE 1-54). It is similar to the MK 106 practice bomb and is compatible with MER/TER and SUU-20/SUU-21 dispensers.

BDU-48/B PRACTICE BOMB



CHARACTERISTICS

WEIGHT	10 LB
LENGTH	19 IN.
DIAMETER	4 IN.

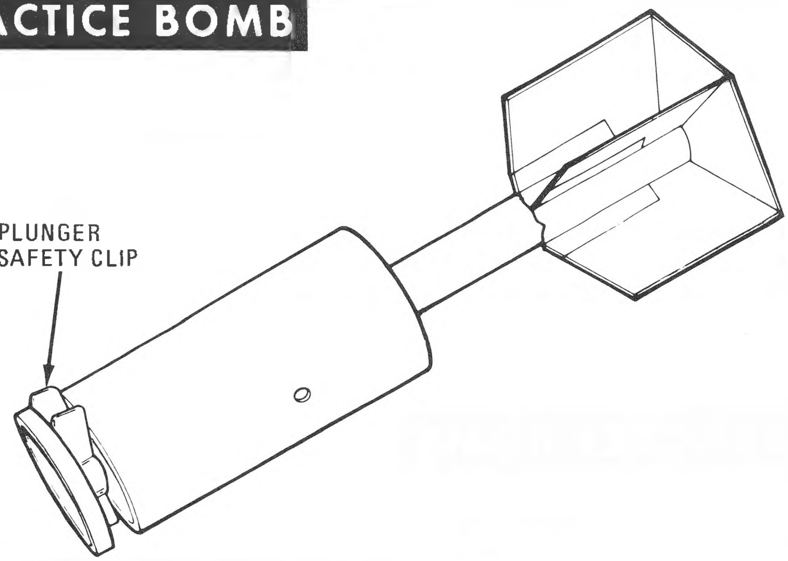
FIGURE 1-54

MK 106

The MK 106 (FIGURE 1-55) is a thin-skinned practice bomb designed for aircrew training in retarded weapons delivery techniques. The bomb consists of an outer cylinder, an inner cylinder (sleeve), a firing device, a signal cartridge, and a box fin assembly. The box fin assembly consists of four metal vanes welded to the aft end of the inner sleeve. On the MK 106 Mod 4, the firing device has been changed to a flat circular nose plate the same diameter as the outer cylinder.

The MK 4 Mod 3 or Mod 4 signal cartridge is installed in the sleeve with the primer toward the bomb nose. The firing device is installed and secured in the bomb nose.

MK 106 PRACTICE BOMB



CHARACTERISTICS

WEIGHT	5 LB
LENGTH	19 IN.
DIAMETER	4 IN.

FIGURE 1-55

Impact of the bomb after release causes the spring-loaded firing device to collapse, detonating the signal cartridge. Smoke from the cartridge permits visual observation of bomb accuracy.

NOTE

The ballistics for practice weapons differ sufficiently to require a separate set of bombing tables, one set for the SUU-20 and one set for the SUU-21 bomb dispensers.

MK 4 MOD 3 AND MK 4 MOD 4 SIGNAL CARTRIDGE

The MK 4 Mod 3 signal cartridge closely resembles a 10-gauge shotgun shell. The cartridge has an aluminum case with a commercial shotgun primer. The case is filled with an expelling charge of smokeless powder and a marker load of stabilized red phosphorus.

The MK 4 Mod 4 signal cartridge differs from the MK 4 Mod 3 in that in the Mod 4 the red phosphorus has been replaced by colored (red) powder due to fire hazards encountered when phosphorus is used. In all other respects the signal cartridges are identical.

20MM AMMUNITION

The components that make up a complete round are: a brass cartridge case, an electric primer, propellant powder, and the projectile (See FIGURE 1-56.). The projectile is fired 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 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 grey or tan. The case will be steel or plastic. Dummy ammunition is used to check out the gun system.

M55A1/A2 TARGET PRACTICE ROUND (M220 TP TRACER ROUND)

The M55A1 and M55A2 target practice (TP) round is ball ammunition. The body of the projectile is made of steel. The projectile is hollow and does not contain a filler.

M53 ARMOR-PIERCING INCENDIARY ROUND

The body of the M53 armor-piercing incendiary (API) projectile 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.

M56 HIGH-EXPLOSIVE INCENDIARY ROUND (XM242 HEI TRACER)

The M56 high-explosive incendiary (HEI) round (FIGURE 1-56) 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.

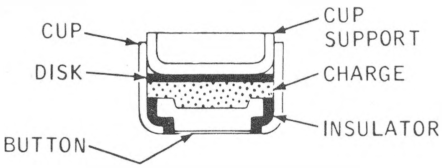
The fuze has a delay arming distance of 20 to 35 feet from the muzzle of the gun. Centrifugal force, created by the projectile spin, allows the detonator to align with the firing pin and the booster; the projectile is now armed. Upon impact, the projectile presses into its target, crushing the nose of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

20MM AMMUNITION

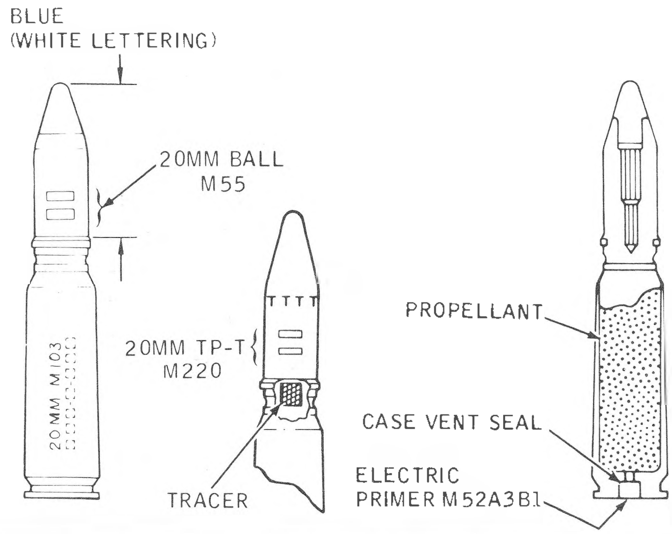
M55 TP (BALL)/M220 TP-T (TRACER)

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.



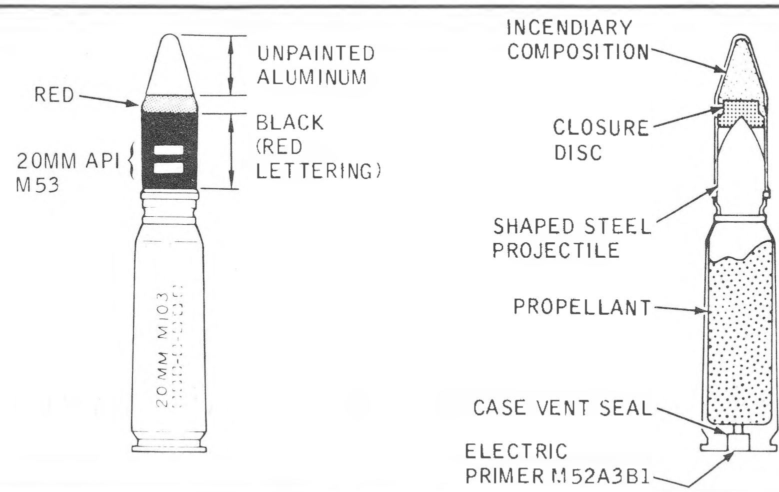
ELECTRIC PRIMER M52A3B1
(ENLARGED)
(TYPICAL ALL THREE ROUNDS)



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.

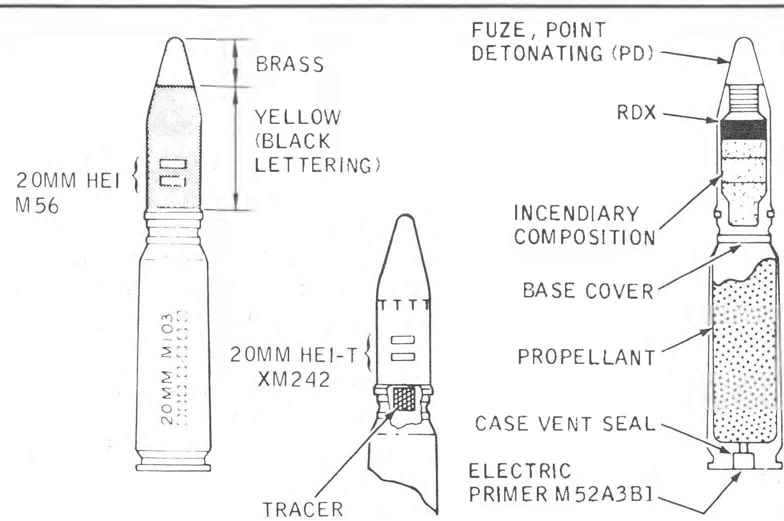


FIGURE 1-56

30MM AMMUNITION

The PGU-13/B 30mm round (FIGURE 1-57) has been developed specifically for the GAU-8/A weapon and ammunition handling system and can be used in the GPU-5 pod. It includes TP, HEI, and API rounds. Common to all rounds is a lightweight percussion primed cartridge case.

The aluminum cartridge case contains an M-36 A1E1 primer, flash tube assembly, and a single or double base propellant. The WECOM-30 tube, FFFG black powder, and disk comprise the flash tube assembly.

The functional/operational sequence of this cartridge is as follows: The firing pin strikes the primer, the primer is ignited by being crushed between the cap and anvil, and the flame from the primer mix shoots through the flash hole and ignites the black powder in the flash tube. Flame from the black powder ignites the propellant, and high-pressure gases from the burning propellant drive the projectile out the rifled barrel. The rifling spin stabilizes the projectiles via the plastic rotating bands. The TP round has an inert projectile assembly. The HEI projectile consists of a fragmenting steel body, a modified M505 nose fuze, and an HE incendiary mix. The API projectile contains a depleted uranium penetrator, a non-discarding aluminum carrier, and a nose cap.

M505 PROJECTILE NOSE FUZE

The M505A2 or M505A3 (FIGURE 1-58) fuze is used in the 20mm M56 HE and the 30mm PGU-13/B HE projectiles. 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. The firing pin cannot initiate the detonator, nor can the detonator initiate the booster, until the fuze reaches a spin rate of 70,000 rpm when the ball-rotor is released from its retaining C-clamp and precessed into the proper orientation. Although a minimum arming distance of 15 meters is desired, the fuze will arm between 3 and 10 meters. It is insensitive to light brush and rain but will detonate on 0.040 inch 2024T aluminum.

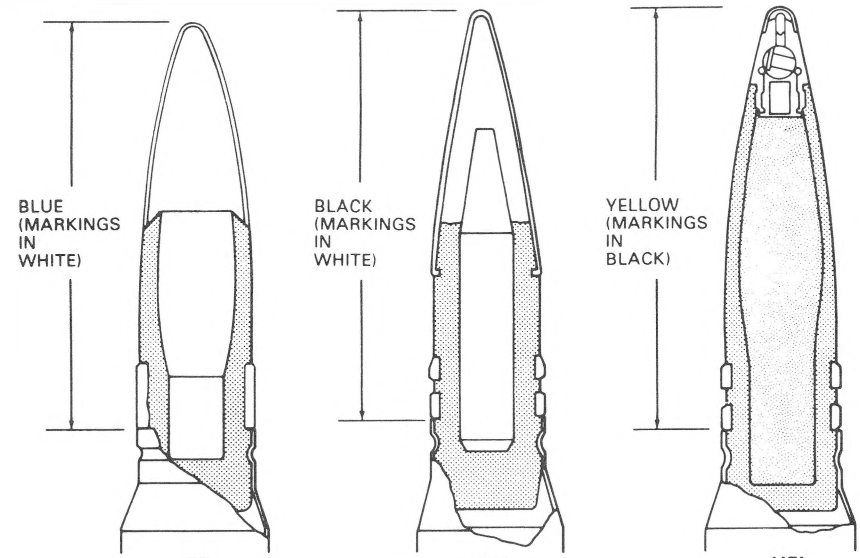
2.75-INCH FOLDING FIN AIRCRAFT ROCKET (FFAR)

The 2.75-inch FFAR (FIGURE 1-59) is an air-launched rocket used to deliver HE, high-explosive antitank (HEAT), flechette, and white phosphorous (WP) warheads. Warheads are selected to best satisfy operational requirements. The 2.75-inch FFAR also has a plaster-loaded inert head for TP. A complete rocket and round consists of a motor, warhead, and fuze. The 2.75-inch FFAR is fired from LAU-68 series launchers.

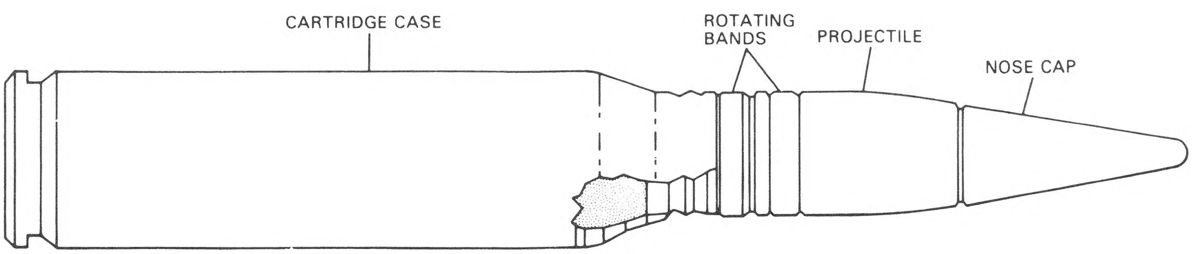
2.75-INCH ROCKET MOTOR

The 2.75-inch FFAR uses MK 4 and MK 40 rocket motors (FIGURE 1-60). 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.

30MM AMMUNITION



	TP	API	HEI
MUZZLE VELOCITY (FPS)	3400	3300	3440



TYPICAL

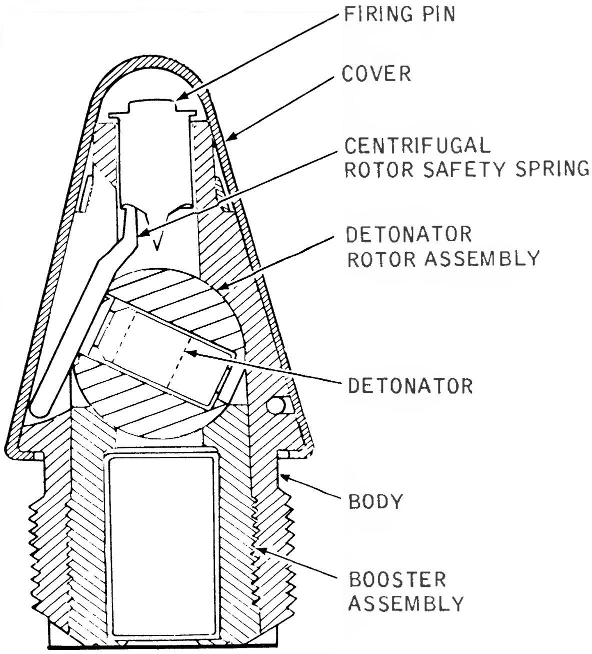
CHARACTERISTICS

	TP	API	HEI
WEIGHT, COMPLETE ROUND	1.50 LB	1.60 LB	1.50 LB
WEIGHT, PROJECTILE	0.84 LB	0.97 LB	0.82 LB
WEIGHT, CARTRIDGE CASE (AFTER FIRING)	0.34 LB	0.34 LB	0.34 LB
LENGTH, COMPLETE ROUND	11.4 IN.	11.4 IN.	11.4 IN.
LENGTH, CARTRIDGE CASE	6.8 IN.	6.8 IN.	6.8 IN.
LENGTH, PROJECTILE	5.6 IN.	5.6 IN.	5.6 IN.
DIAMETER, PROJECTILE	1.2 IN.	1.2 IN.	1.2 IN.

NOTE: DUMMY COLOR CODE MAY BE EITHER BRONZE OR SHADES OF GREY OR TAN

FIGURE 1-57

M505 SERIES FUZES



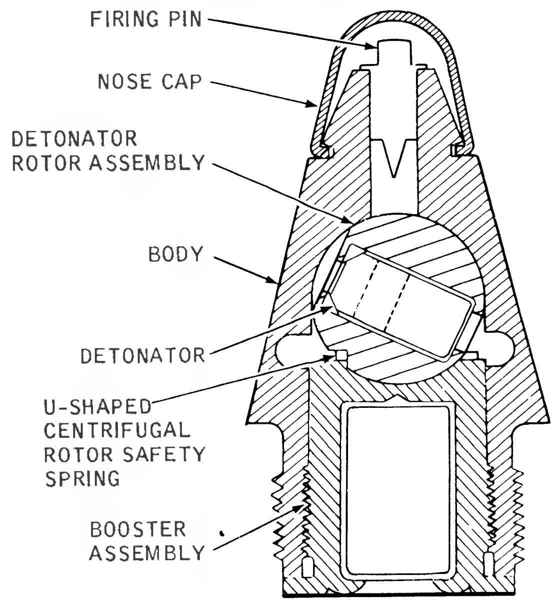


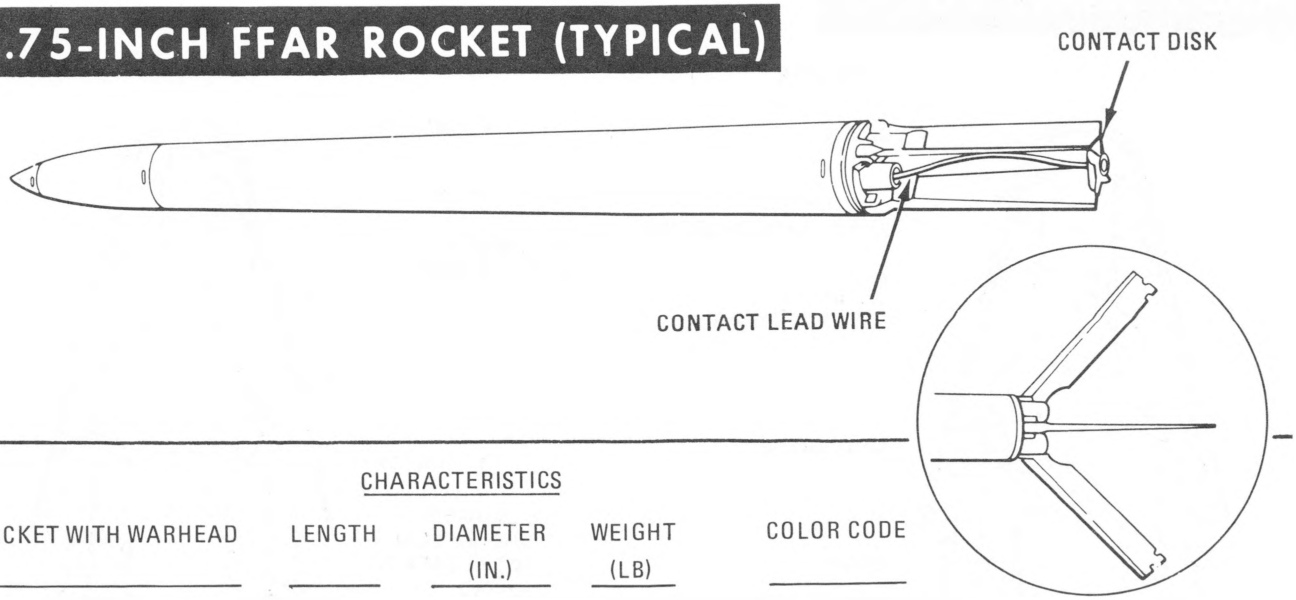
FIGURE 1-58

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 after-burning 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 1-60 depicts a comparison between standard nozzles and scarfed nozzles.

2.75-INCH FFAR ROCKET (TYPICAL)



CHARACTERISTICS

ROCKET WITH WARHEAD	LENGTH	DIAMETER (IN.)	WEIGHT (LB)	COLOR CODE
MK 1 (HE)	4 FT	2.75	18	OD/YELLOW BAND
MK 5 (HEAT)	4 FT	2.75	18	OD/YELLOW BAND
MK 61 (TP)	4 FT	2.75	18	BLUE/WHITE LETTERS
M151 (PMI)	4 FT 5 IN.	2.75	22	OD/YELLOW BAND
M156 (WP)	4 FT 5 IN.	2.75	22	GREEN/RED LETTERS
WTU-1/B (TP)	4 FT 5 IN.	2.75	22	BLUE/WHITE LETTERS
WDU-4A/A (FLECHETTE)	4 FT 6 IN.	2.75	22	OD/YELLOW BAND
WDU-13A (FLECHETTE)	4 FT 6 IN.	2.75	22	OD/YELLOW BAND

FIGURE 1-59

2.75-INCH ROCKET WARHEADS

MK 1 WARHEAD (HE)

The MK 1 HE warhead (FIGURE 1-61) has a steel case and an HE charge of 1.4 pounds of HBX-1, and uses the MK 176 or MK 178 fuze. With the MK 178 fuze installed, the warhead weighs 6.5 pounds. The primary effect of the MK 1 warhead is fragmentation.

MK 5 WARHEAD (HEAT)

The MK 5 warhead (FIGURE 1-61) 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 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

2.75-INCH ROCKET MOTOR (TYPICAL)

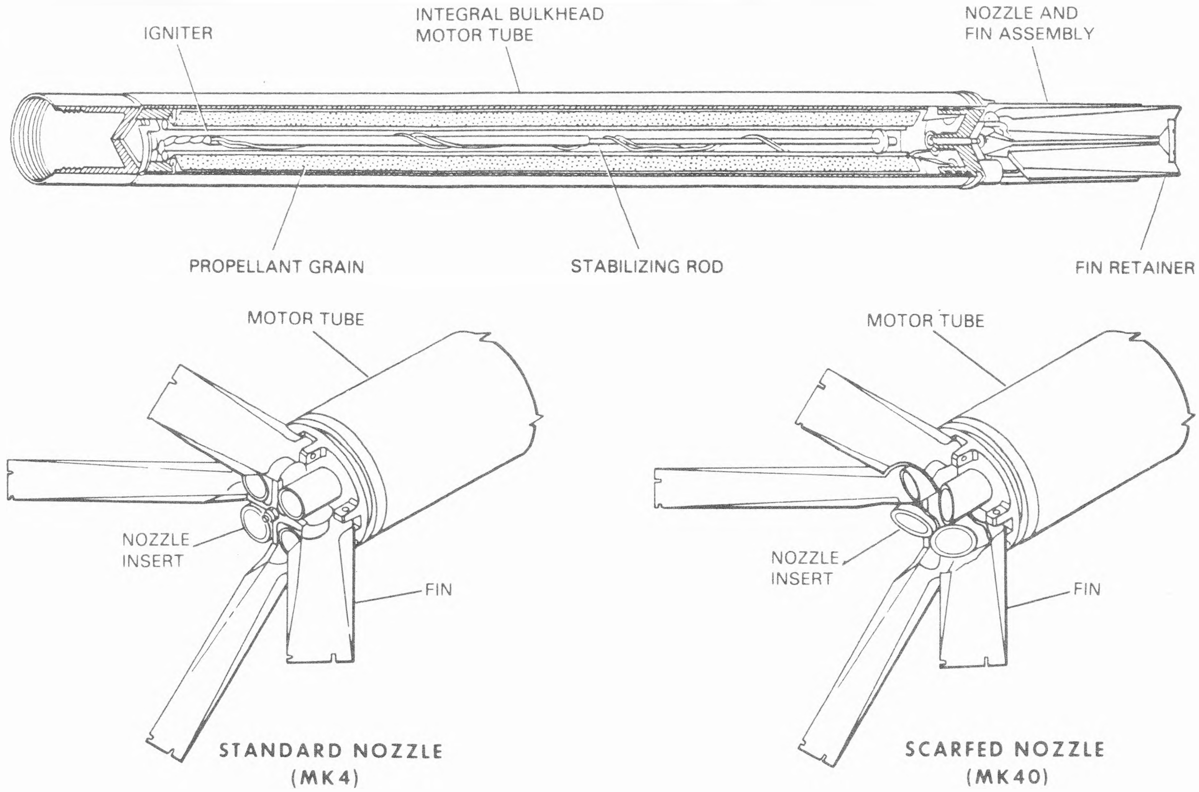


FIGURE 1-60

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.

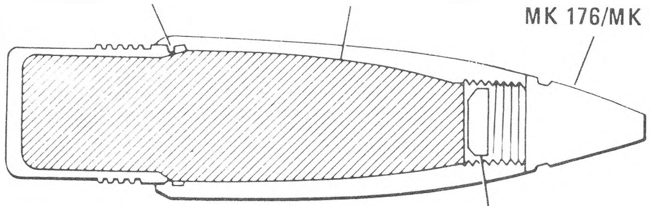
M151 WARHEAD (PMI)

The M151 warhead (FIGURE 1-61) has a pearlite malleable iron (PMI) case filled with 2.32 pounds of Composition B4 and uses the M427 fuze. With the M427 installed, the warhead weighs 9.6 pounds. The primary effect of the M151 warhead is fragmentation.

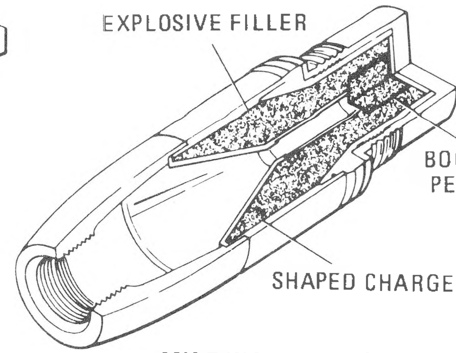
M156 WARHEAD (WP)

The M156 (FIGURE 1-61) is a target-marking 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 10.75 pounds, and contains 0.125 pound of Composition B4 and 2.3 pounds of WP.

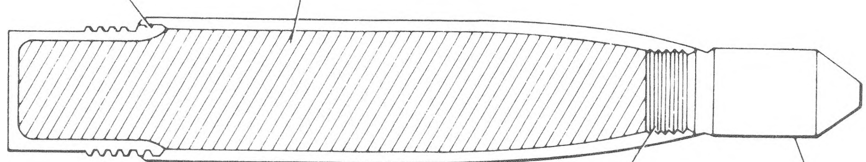
2.75-INCH WARHEADS



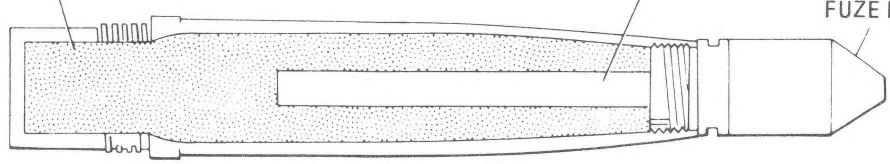
MK 1 WARHEAD (HE)



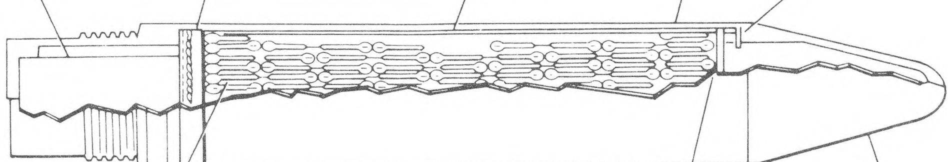
MK 5 WARHEAD (HEAT)



M151 WARHEAD (PMI)



M156 WARHEAD (WP)



WDU-4 A/A AND WDU-13/A WARHEADS (FLECHETTE)

FIGURE 1-61

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.

WDU-4A/A AND WDU-13/A WARHEADS (FLECHETTE)

The WDU-4A/A antipersonnel flechette warhead (FIGURE 1-61) weighs 9.1 pounds and contains 5.5 grams of explosive. The warhead contains 2,200 20-grain flechettes. The WDU-13/A warhead differs from the WDU-4A/A warhead in that the WDU-13/A has approximately 720 60-grain flechettes. Both warheads have a base fuze, ejecting charge, piston, an aerodynamic nose cone, and contain a red dye marker to provide visual identification of warhead functioning.

The fuze is installed during assembly and is an integral part of the warhead. At launch, acceleration forces arm the fuze. At 1.6 seconds after launch, an airburst, initiated by deceleration forces, allows the spring-loaded firing pin to ignite the ejecting charge. The ejecting charge generates gas pressure against the pusher plate, which transmits the pressure through the flechettes to the shear pins on the nose cone. The shear pins break, the nose cone is ejected, and the flechettes follow the nose cone. The flechettes are packed alternating fore and aft. Aerodynamic force causes the tail-forward flechettes to tumble and streamline after ejection. This weather vaning causes dispersion.

Slant range at launch is the critical factor in determining slant range at warhead function. Slant range at function must be known to determine dispersion and weapon effectiveness. Refer to aircraft ballistic tables to determine optimum launch conditions.

MK 61 WARHEAD (TP)

The MK 61 TP warhead has an inert, solid iron head and simulates the ballistic characteristics of the MK 1 warhead. It has the same appearance as the MK 1 warhead. The MK 61 weighs 6.5 pounds.

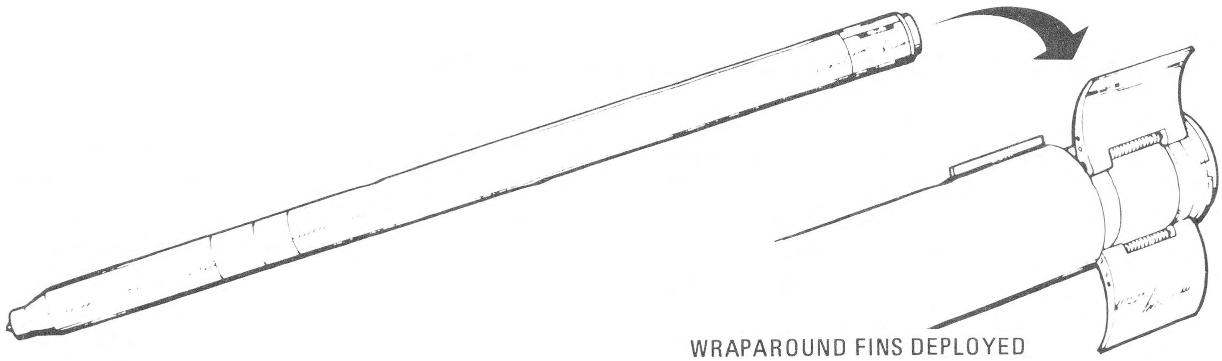
WTU-1/B WARHEAD (TP)

WTU-1/B TP warhead is an inert, one-piece cast warhead that simulates the ballistic characteristics of the M151 warhead. The WTU-1/B weighs 9.4 pounds.

CRV7 ROCKET

The CRV7 rocket (FIGURE 1-62) is designed for air-to-ground use. The rocket consists of a C14 motor which is assembled in various combinations of heads 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.

CRV7 ROCKET



CHARACTERISTICS

ROCKET WITH WARHEAD	LENGTH	DIAMETER (IN.)	WEIGHT (LB)	COLOR CODE
MK 1 (HE)	4 FT 5 IN.	2.75	21	OD/YELLOW BAND
MK 5 (HEAT)	4 FT 5 IN.	2.75	21	OD/YELLOW BAND
MK 61 (TP)	4 FT 5 IN.	2.75	21	BLUE/WHITE LETTERS
M151 (HE)	4 FT 9 IN.	2.75	24	OD/YELLOW BAND
M156 (WP)	4 FT 9 IN.	2.75	24	GREEN/RED LETTERS
WTU-1/B (TP)	4 FT 9 IN.	2.75	24	BLUE/WHITE LETTERS
WDU-4A/A (20 GR FLECHETTE)	4 FT 11 IN.	2.75	24	OD/YELLOW BAND
WDU-13/A (60 GR FLECHETTE)	4 FT 11 IN.	2.75	24	OD/YELLOW BAND

FIGURE 1-62

CM151 TRAINING ROCKET

The CM151 training rocket consists of a CRV7 rocket with a WTU-1/B warhead. Both of these components are described in this section.

2.75-INCH ROCKET FUZES

MK 176 AND MK 178 IMPACT ROCKET WARHEAD FUZES

The MK 176 and MK 178 impact fuzes are used with the MK 1 warhead. The fuzes have cone-shaped steel bodies that enclose an arming mechanism, a firing mechanism, and an explosive train. The explosive train consists of a primer, detonator, booster, and in the MK 176 a 3-millisecond delay. In the unarmed condition, the arming mechanism is positioned and locked so that the primer delay element and detonator are out of alignment with the firing pin and booster lead-in. The fuze is armed by sustained acceleration. Once armed, the fuze remains armed until detonation.

When the rocket is launched, inertial forces resulting from acceleration cause the setback weights to move aft and free the rotor to turn. Sustained acceleration turns and locks the unbalanced rotor in the armed position and aligns the explosive train under the firing pin. On impact, the firing pin is driven against the primer, and the exploding primer initiates the explosive train.

The MK 178 differs from the MK 176, in that the MK 178 delay element between the primer and the detonator has been removed and replaced by a flash tube to reduce fuze function time.

M427 IMPACT ROCKET WARHEAD FUZE

The M427 fuze is a superquick 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 superquick action on impact, and requires 20 g for approximately 1 second to arm.

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 20 g.

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.

WDU-4A/A AND WDU-13/A FUZE

The fuze used in the WDU-4A/A and WDU-13/A is an integral part of the warhead.

The fuzing element consists of an acceleration-actuated arming mechanism, a deceleration-actuation spring-loaded firing mechanism, a percussion primer, and an explosive charge. The primer is housed in an unbalanced arming rotor. In the unarmed condition, the rotor is locked in a position so that the primer is out of alignment with the firing mechanism and explosive charge. A pusher plate is installed between the explosive charge and the payload.

When the rocket is fired, inertial acceleration forces free the fuze arming rotor. The unbalanced rotor turns to the armed position and is locked in place. The primer is in line with the firing mechanism, and the fuzing mechanism is armed. At deceleration through 11 g the firing pin strikes the primer. The primer initiates the explosive charge behind the pusher plate of the warhead. Pressure resulting from the exploding charge shears the warhead nose retaining pin and the flechettes are expelled.

SECTION II
FUZES

CONTENTS

FUZES

GENERAL DESCRIPTION

Only aircrew-selectable, internal fuzes will be presented in this section. A fuze is a device used to initiate bomb detonation at a predetermined time and under the desired circumstances. Since targets are usually selected in advance of a mission and the structure of the target indicates the type of fuzing that would produce the best results, it is imperative that the correct fuzing system be installed in the weapon. Additionally, many weapons can accommodate a large variety of fuzes that can drastically change the weapon effects. Aircrews must be familiar with the classification and operation of fuzes to effectively plan the mode of delivery and ensure safe escape.

FUZE CLASSIFICATION

Fuzes for nonnuclear weapons are located in the nose or tail (FIGURE 2-1) of the munition or in both the nose and tail. The distinction between nose and tail fuzes is important because of the differences in sensitivity on impact and because of the directional effect on fragmentation. The nose fuze (used in bombs, rockets, projectiles, and some guided missiles) is frequently a fuze that functions on impact. The tail fuze may be an inertia fuze initiated by the deceleration of the bomb on impact. A properly adjusted fuze can be sensitive enough to be initiated by impact with the lightest roofing material. As mentioned previously, the location of the fuze affects the direction in which fragments are projected. A nose fuze tends to deflect sidewall fragments away from the nose of the bomb, whereas a tail fuze tends to deflect them away from the tail. If your target were troops in the open and you wanted maximum fragmentation effect, it would be desirable to have bombs that had been fuzed with a nose fuze. This would result in more fragmentation deflection

FUZE CLASSIFICATION

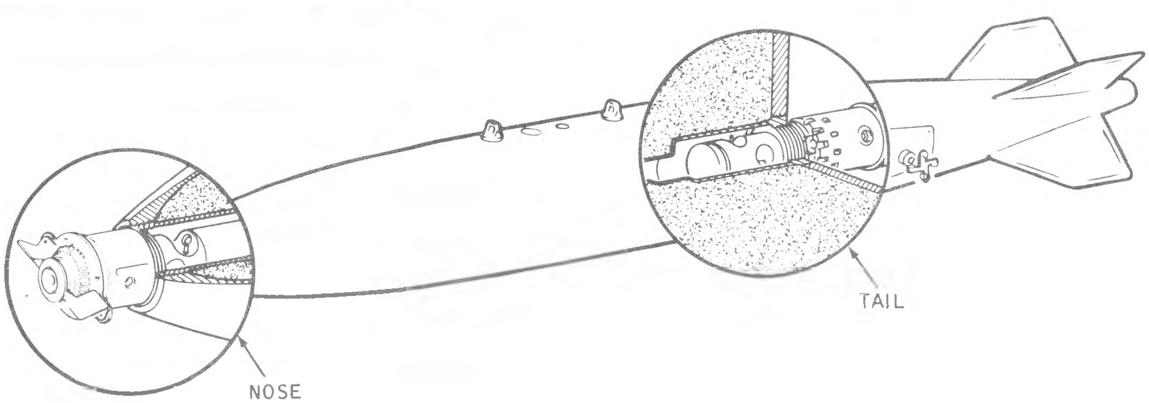


FIGURE 2-1

above ground level (AGL) - where your target is. The addition of a tail fuze may also be appropriate in this situation to increase overall munition detonation reliability.

METHODS OF ARMING

Fuzes are armed in one or a combination of the following four methods:

1. Vane - The arming vane is a small propeller rotated after weapon release by airflow as the bomb falls. When the vane rotates the required number of times, the fuze is armed.

2. Pin - The arming pin is ejected or withdrawn by spring action when the bomb is released. The ejection of the pin releases the arming mechanism and allows the fuze to arm.

3. Inertia - Abrupt changes in the velocity of the falling bomb arm the fuze by deploying fins or ballutes.

4. Electric - The fuze is armed by a thermal battery that is activated at bomb release by the extraction of the arming lanyard.

ARMING TIME INTERVAL

Direct arming fuzes are armed immediately when the arming pin is ejected or when the arming vane has rotated the required number of revolutions. Delay arming fuzes have an arming pin or vane that initiates a time delay mechanism that arms the fuze after a predetermined time lapse.

METHODS OF FUNCTIONING

A fuze functions by one of the following methods (FIGURE 2-2):

1. Impact - This type of fuze is designed to function upon impact or after a delay. The time delay (if any) is measured from the instant of impact.

2. Proximity - The proximity fuze is a miniature doppler radar set. The fuze transmits radar waves that are reflected back to the fuze by the target. When the lag time between transmission and reception reaches a set value, the fuze functions. The lag time between transmission and reception is precomputed and translated into selectable burst height values in altitude above the target. Burst height values vary among different fuzes.

3. Time - In a time fuze, the delay is initiated at bomb release from the aircraft and not at the instant of impact. The time element is obtained by a mechanical or electrical device.

4. Hydrostatic - This type of fuze is employed in depth bombs for underwater demolition work. The fuze operates on the principle of a bellows or diaphragm that

FUZE FUNCTION

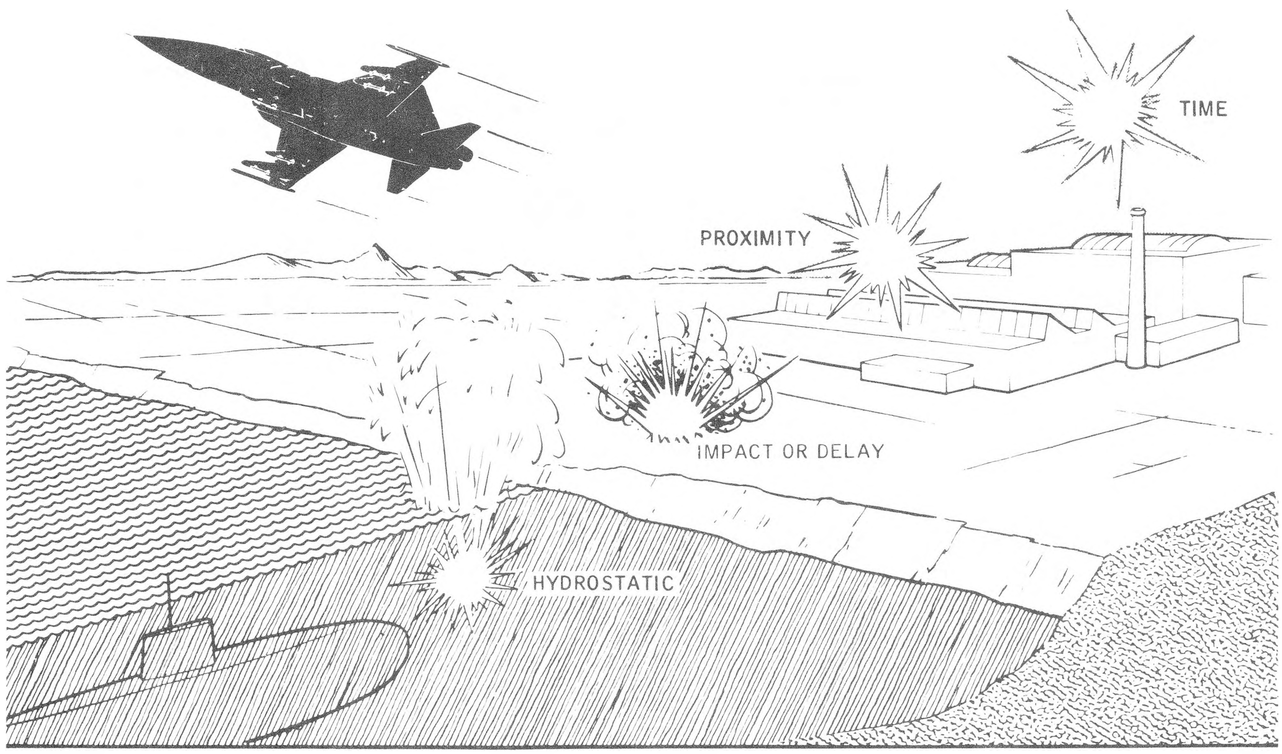


FIGURE 2-2

expands with an increase in water pressure as the bomb sinks to counteract the force exerted by a spring. When the spring force is overcome, the firing pin is released and driven against the primer by spring action.

EXPLOSIVE TRAIN

The explosive train (FIGURE 2-3) controls the detonation of the bomb. The train is a sequence of explosions in which a small quantity of very sensitive explosive sets off a large quantity of much less sensitive explosive.

The type of explosive used in bombs must be relatively insensitive to shock and heat to provide a reasonable degree of safety in storing, shipping, and handling. It must also permit the bomb to penetrate a resistant target such as armor plate, earth, or concrete before exploding. Conversely, the type of explosive used in fuzes must be very sensitive, so that it will explode when impacted by the firing pin. Such an explosive is not safe to handle except in minute quantities and, therefore, is strongly compressed into a metal capsule called a detonator that is built into the fuze. The explosion of a detonator is not of sufficient strength to detonate the insensitive main charge explosive. A small quantity of explosive more

FUZE EXPLOSIVE TRAIN

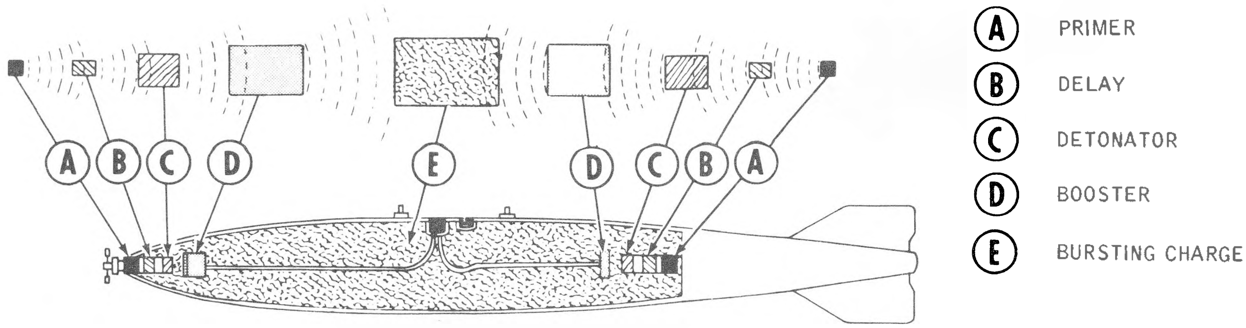


FIGURE 2-3

sensitive than the main charge is placed next to the detonator. This element is called the booster. The booster is sufficiently sensitive for the shock of the boosted explosion to detonate the bursting charge (main charge) of the bomb. Such an arrangement of elements is basic to all explosive ammunition.

The explosive train sequence in both nose and tail fuzes may be an instantaneous or a delayed action sequence. The instantaneous sequence begins immediately upon weapon impact when the firing pin is driven into the detonator. The blast from the detonator explodes the booster, which relays and amplifies the blast, causing the main charge to explode. A delayed action train allows bomb penetration of a target. The delay action requires two additional components, a primer and a delay element, which are placed ahead of the detonator, booster, and main charge. The action is started as a detonation but is converted into a delaying flame by the delay element.

SAFETY FEATURES

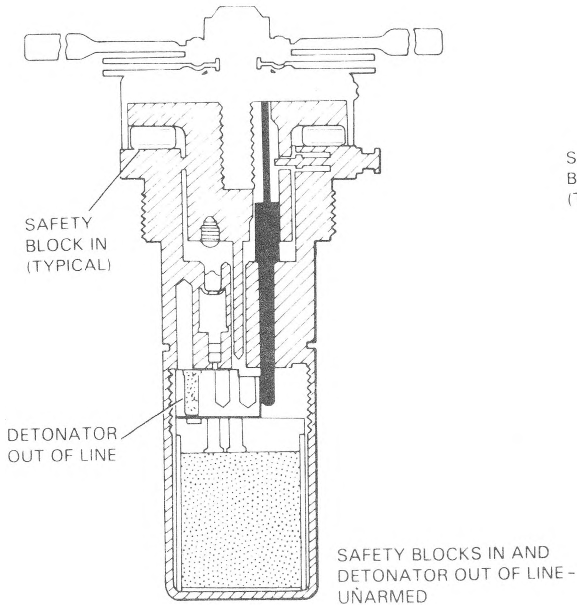
For safety reasons, a bomb must be incapable of explosion through fuze action before it is clear of the aircraft. Fuzes are constructed in such a manner that they should not function while unarmed. To prevent premature or accidental functioning of a fuze, a safety feature is incorporated during manufacture. Common safety features in fuzes are detonator-out-of-line, arming stem-safe, safety block-safe, and electrically safe.

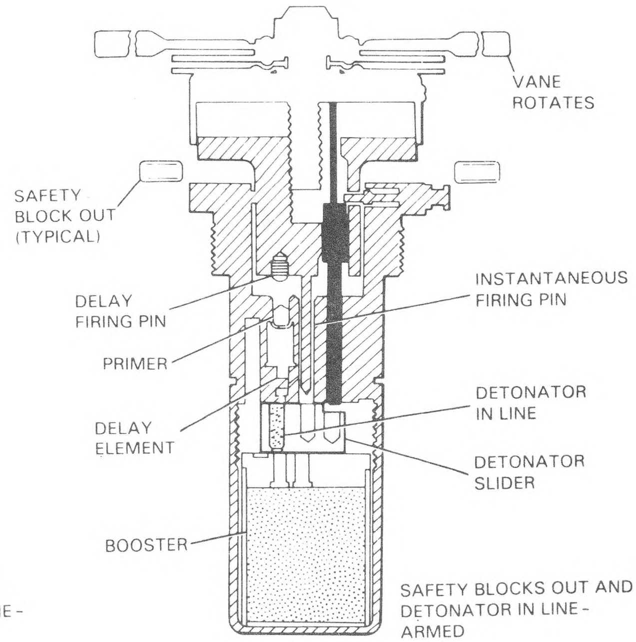
DETONATOR OUT OF LINE

A detonator-out-of-line arrangement (FIGURE 2-4) in a fuze holds one of the explosive train elements out of alignment with the other elements. For example, the detonator may be held out of line with the firing pin until the fuze is armed.

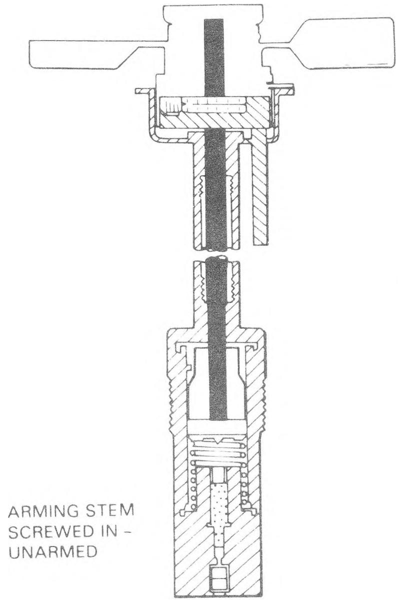
FUZE SAFETY FEATURES

SAFETY BLOCK – SAFE AND DETONATOR OUT OF LINE





ARMING STEM – SAFE



NOTE:

AS VANE ROTATES, REDUCTION GEARS WITHDRAW ARMING STEM FROM PLUNGER, FREEING IT. UPON IMPACT, PLUNGER COMPRESSES ANTICREEP SPRING AND FIRES PRIMER DETONATOR

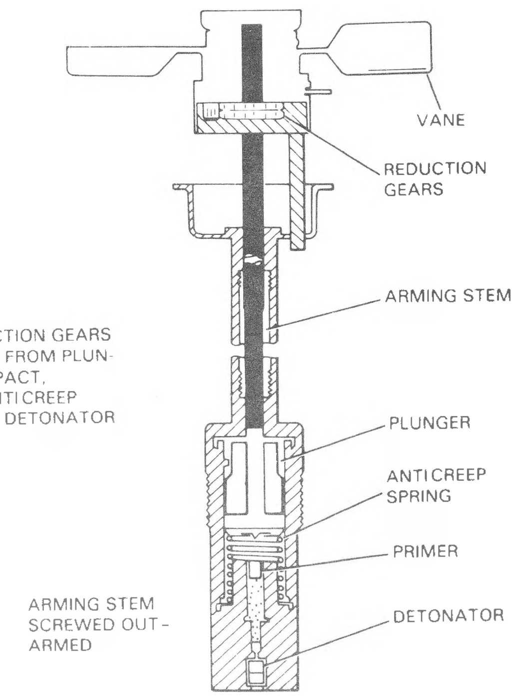


FIGURE 2-4

ARMING STEM-SAFE

A safety feature found in some tail fuzes is an arming stem (FIGURE 2-4), which is screwed into the firing pin plunger. The detonator in this type of fuze is located immediately beneath the firing pin. Vane rotation during arming unscrews the arming stem from the firing pin plunger, thus freeing the plunger; an anticreep spring prevents premature movement of the plunger and firing pin, caused by velocity changes of the bomb during free-fall.

SAFETY BLOCK-SAFE

This safety feature, commonly found in nose fuzes (FIGURE 2-4), is a block between the striker and the fuze body, which prevents the firing pin from contacting the primer or detonator. The arming vane drives a gear train which permits the safety block to be ejected after a definite interval.

ELECTRICALLY SAFE

The firing contacts of an electrical fuze are kept out of alignment until the fuze has been armed. Additional features may be used to electrically prevent the fuze from arming unless the proper release conditions have been fulfilled. Usually the electrical contacts are brought in line. This safing principle resembles the detonator-out-of-line principle.

FMU-54 TAIL FUZES

There are two versions of the FMU-54, the FMU-54/B and the FMU-54A/B. The differences are the arming delay times and compatibility with the MK 43 target detecting device (TDD). Refer to the Fuze/Bomb Compatibility Chart (FIGURE 2-40) for details.

FMU-54/B TAIL FUZE

The FMU-54/B tail fuze (FIGURE 2-5) is a mechanically operated retardation sensing device. Arming time delays are from 0.75 to 3.50 seconds in 0.25-second increments. The fuze is used in the MK 82 Snakeye (SE) I, MK 82 air-inflatable retarder (AIR), MK 84 AIR, and M117R. The fuze is not visible when installed. The fuze is approximately 2 inches in diameter, 6 inches long, and weighs 3 pounds. Refer to the Fuze/Bomb Compatibility Chart (FIGURE 2-40) for specific details.

ARMING AND OPERATING SEQUENCE

When the bomb is released the lanyard is pulled, allowing the fuze to operate. The release of the retardation device causes a rapid deceleration of the bomb, initiating the fuze arming cycle. If the retardation device malfunctions, the fuze should not arm. The retardation sensor ensures a sufficient force of 3.5 ±0.5 g for 0.6 second before releasing the arming timer. If at any time retardation is lost during this 0.6 second, the fuze does not arm. If the bomb impacts before the fuze is armed, the fuze should not function.

FMU-54/B TAIL FUZE

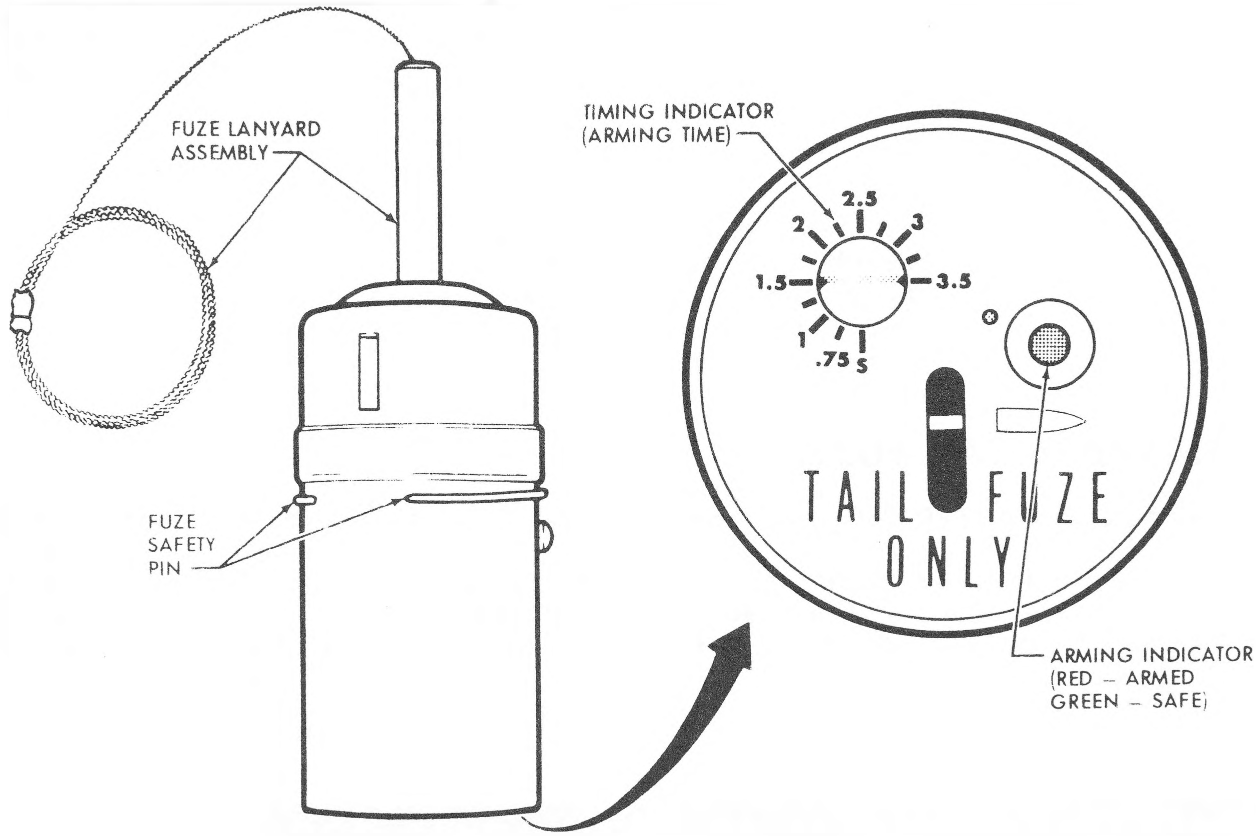


FIGURE 2-5

SAFETY FEATURES

The fuze requires a 0.6-second, sustained-g loading in the front-to-rear direction in order to arm. An initiated fuze can be subjected to repeated impacts from the front but will not arm unless the impacts are 0.6 second or longer. Detonator-out-of-line safety mechanism is used on the FMU-54/B. If the retarder has not caused the fuze to arm, the fail-safe g weight will function upon impact and prevent arming.

WARNING

If the retardation device fails during opening, the retardation should be insufficient to arm the fuze. BSU-49 failure (flagger) may result in an armed munition.

OPERATING LIMITATIONS

In order to achieve the required retardation force for arming, the minimum release airspeed is 330 knots calibrated airspeed (KCAS) for MK 82 AIR, 350 KCAS for MK 82 Snakeye, 550 KCAS for MK 84 AIR, and 175 KCAS for M117 when used with the FMU-54/B fuze. These are minimum airspeeds; bombs will not detonate if released slower.

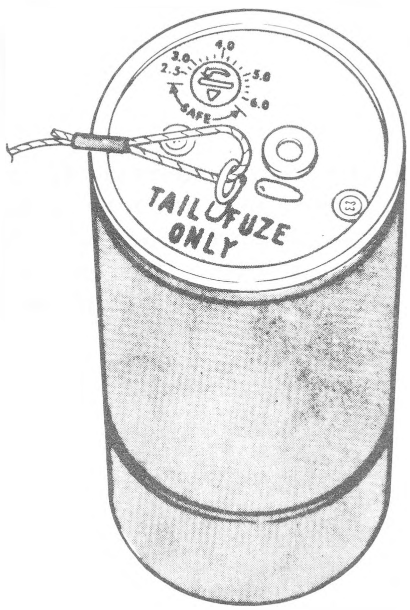
NOTE

> The fuze type and arming delay setting should be recorded on the side of the bomb or on a red warning tag attached to the bomb. This should be checked during preflight of the munition.

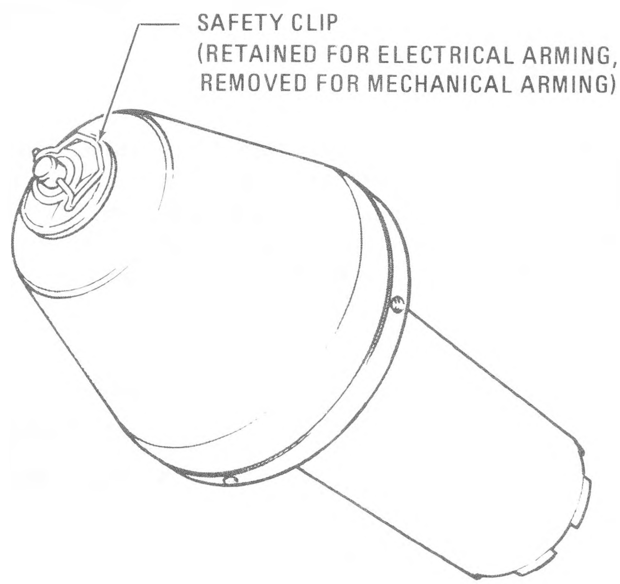
FMU-54A/B TAIL FUZE

The FMU-54A/B (FIGURE 2-6) is a modified version of the FMU-54/B with selectable arming time delays of 2.5 to 6.0 seconds in 0.25-second intervals. The MK 43 TDD can be used with the FMU-54A/B. The FMU-54A/B used alone behaves in the same manner as the FMU-54/B; when used with the MK 43 TDD, it becomes a proximity fuze. The TDD electrically activates the fuze at a set function altitude above the ground. Refer to the Fuze/Bomb Compatibility Chart (FIGURE 2-40) for specific details.

FMU-54A/B TAIL FUZE AND MK 43 TDD



FMU-54A/B TAIL FUZE



MK 43 TDD

FIGURE 2-6

ARMING AND OPERATING SEQUENCE

During an armed release, the FMU-54A/B functions as follows:

1. When the cord assembly attached to the arming solenoid stretches to its elastic limit, the swivel fails and initiates the fuze arming cycle.

2. The lanyard assembly is activated, releasing the retarder.

3. When the retarder opens, an arming wire is withdrawn from the striker rod in the MK 43 TDD.

4. If the FMU-54A/B fuze is used alone or if the MK 43 TDD fails to function, the spring-loaded firing pin initiates the detonator at impact.

SAFETY FEATURES

Safety features and operational limitations are the same as those for the FMU-54/B in addition to the following:

1. A cable assembly safing pin provides ground safety. The cable assembly permits removal of the safing pin through the aft end of the retarded fin prior to aircraft launch.

2. The FMU-54A/B is armed if the red band on the cord assembly is visible in the charging well after installation in the bomb.

MK 43 TARGET DETECTING DEVICE

The MK 43 TDD (FIGURE 2-6) is an electronic proximity sensor that provides an electrical signal to detonate the FMU-54A/B fuze. The TDD fits into the nose fuze well of the MK 82 Snakeye I. The TDD contains no explosive components. The nominal function height for the MK 43 is 16 feet.

The MK 43 TDD consists of a cylindrical metal body with a dark green plastic nose cone attached to the forward end. The battery initiating striker rod protrudes from the nose cone. The spring-loaded striker rod is held in place by a safety clip. A receptacle for an electrical connection is located at the rear of the cylindrical body. The TDD is initiated by withdrawal of the arming wire from the striker rod. This occurs when the high-drag (HD) device is deployed shortly after release. The spring-loaded striker rod ignites the thermal battery through an electric pyrotechnic match. The thermal battery reaches operating voltage in approximately 2 seconds. The target signal amplifier output is fed to the radio frequency (RF) oscillator detector where pulsed RF energy is radiated outward in a lobal pattern. As the bomb approaches the target, the interaction between the emitted and reflected RF energy causes a doppler signal to the oscillator detector. This signal is then applied to the target signal amplifier to be amplified sufficiently to trigger the firing circuit. Energy is then applied to the electric detonator, which detonates the bomb.

M904 NOSE FUZE

The M904 (FIGURE 2-7) is a mechanical impact nose fuze used in general purpose (GP) bombs. It is 9 inches long and 2 inches in diameter at the fuze threads. The fuze uses an arming vane to arm. Arming delay times for the M904E1 are 4, 6, 8, 12, or 20 seconds with a tolerance of ±20 percent. For the M904E2 and M904E3 arming, delay times range from 2 to 18 seconds in 2-second increments with a tolerance of ±10 percent. For arming times below 6 seconds, a stop screw must be removed. Arming time is independent of release airspeed. Set arm time is measured by the nose vane, mechanical governor and constant-speed rotating gear train. Refer to the Fuze/Bomb Compatibility Chart (FIGURE 2-40) for details.

M904 NOSE FUZE

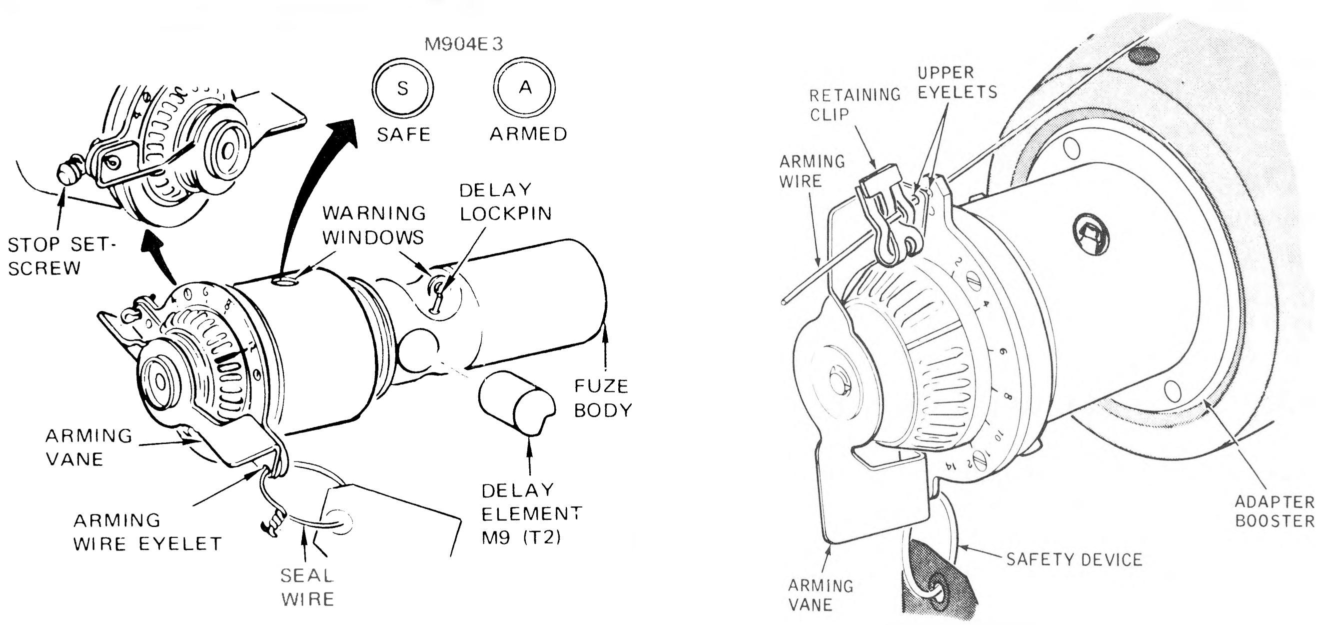


FIGURE 2-7

ARMING AND OPERATING SEQUENCE

Arming begins when the arming wire is withdrawn from the vane and the vane spins in the airstream (operating range is 150 to 600 knots). Thirty revolutions equal 1 second of arming time. After the selected arming time has expired, the spring-loaded rotor is permitted to rotate and align the detonator with the rest of the explosive train. The rotor is locked in position, and the fuze is fuly armed. When the bomb impacts, the fuze nose assembly moves rearward, causing the firing pin to strike the detonator, which initiates the explosive train. Required impact forces are approximately 250 g. Function delay times are provided by inserting a delay element in the cavity beyond the firing pin. The delay increments are instantaneous; 0.010, 0.025, 0.05, 0.10, and 0.25 second.

SAFETY FEATURES

The fuze includes a rotor containing the detonator which is locked out of line with the rest of the explosive train until air arming is completed,

The delay element cavity acts as an interrupter to the explosive train when the delay element is not installed.

Fuze arm/safe indications are visible in two windows; one located above the booster (not visible when installed), the other on the fuze body. On the M904E1 and M904E2, any red indicates the fuze is armed. On the M904E3, a black A on a red background indicates the fuze is armed.

M1 AND M1A1 FUZE EXTENDERS

The fuze extension devices (FIGURE 2-8), sometimes called daisy cutters, are physically compatible with the T45 nose adapter booster and any bomb which will accept the M904E1, M904E2, and M904E3 nose fuzes. The T45 is a bushing (with an explosive booster charge) which is threated on the outside for assembly to the bomb, and on the inside for assembly to the fuze. The T45 is required to adapt the 2-inch thread size of the M904 nose fuze to the large diameter bomb wells. The M1 and M1A1 fuze extenders are authorized for use with MK 82 low-drag, general-purpose (LDGP) and MK 84 LDGP bombs. The M904 is the only fuze recommended for use with the extenders. Fuze extenders are available in 18- , 24-, and 36-inch lengths. An aluminum arming wire guide tube is attached to the fuze extender, to prevent arming wire slip or breakage. The M1 is filled with cast tetrytol, and the M1A1 is filled with Comp B.

M1 AND M1A1 FUZE EXTENDERS

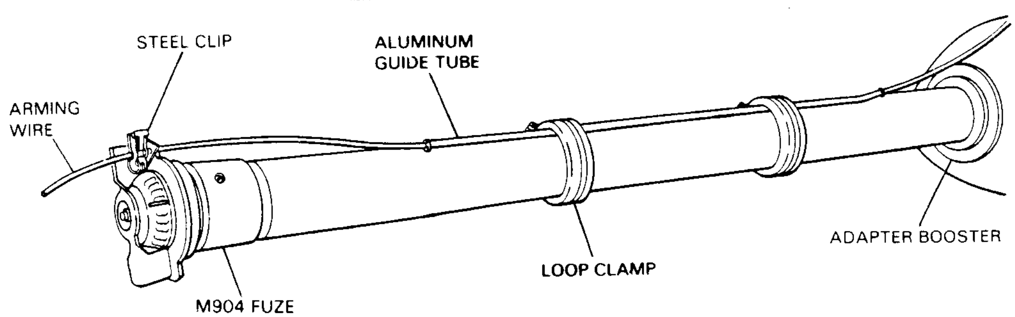


FIGURE 2-8

WARNING

When attempting a safe release/jettison, there is an increased probability of low-order detonation because of the explosive contained in the fuze extender.

NOTE

- Existing LDGP bombing tables, fuze arming data, and safe escape data should be used for bombs on which the fuze extenders are used.
- Fuze extenders allow detonation of the bomb before bomb impact with the ground, resulting in increased blast and fragmentation effects. Use only instantaneous function times with extenders.

M905 TAIL FUZE

The M905 (FIGURE 2-9) is a mechanical impact tail fuze used with M147 or T46 adapter boosters in general-purpose (GP) bombs. It is 6 inches long and 2 inches in diameter at the thread. The M147 or T46 tail adapter booster is used to permit installation of the M905 tail fuze to the larger wells of GP bombs. The arming is effected by an ATU-35 arming device assembly through a flexible shaft. Arming time is independent of release airspeed and is accomplished by the arming drive assembly, flexible shaft, mechanical governor, and constant-speed rotating gear train. The desired arming time is set on a calibrated dial with selective delay times of 4, 6, 8, 12, 16, and 20 seconds; tolerance is +20 percent. Impact detonation delay times are provided by inserting a delay element in the cavity just beyond the firing pin. The delay elements are available in the following delay increments: instantaneous; 0.01, 0.025, 0.05,0.10, and 0.25 second. Refer to the Fuze/Bomb Compatibility Chart (FIGURE 2-40) for details.

ARMING AND OPERATING SEQUENCE

Fuze arming starts when the arming wire is withdrawn from the vane tab of the arming drive assembly. This action permits the vane tab to rotate the inner parts of the fuze (operating range of the fuze is 150 to 600 knots). After the selected arming time has expired, the firing pin is free to move in the direction of flight upon sufficient deceleration of the fuze. An anticreep spring prevents premature movement of the firing pin attributed to velocity changes of the bomb during free fall. At approximately the same time the firing pin arms, the rotor containing the detonator is released so it may rotate by spring action, bringing the detonator in line

M905 TAIL FUZE

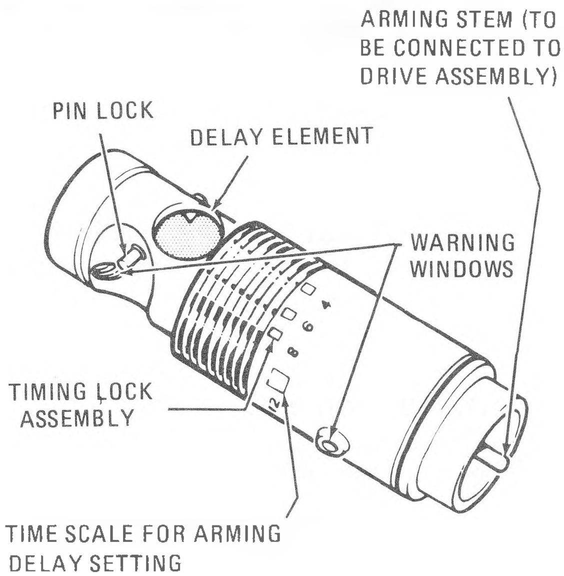


FIGURE 2-9

with the rest of the explosive train. When the detent locks the rotor in the armed position, the fuze is armed. When the bomb impacts, the inertia generated by the impact causes the firing pin assembly to move forward and strike the primer in the delay element, initiating the explosive train. Required impact forces are approximately 250 g.

SAFETY FEATURES

Safety features include a rotor containing the detonator, which is locked out of line with the rest of the explosive train until air arming is complete, and two warning windows. One window is located in the fuze body, and one is just above the booster. If the fuze is armed, the warning in the body shows a red flag. The fuze is not visible when installed.

ATU-35 FUZE DRIVE ASSEMBLY

The ATU-35A/B or B/B (FIGURE 2-10) arming drive assembly is used to provide the rotational force required to arm the M905 tail fuze. The drive assembly consists of a blade anemometer, housing, mounting plate, restraining pin that prevents inflight chatter, and safing pin. The ATU-35B/B differs from the A/B, in that the dimensions of the restraining pin have been changed.

ATU-35 DRIVE ASSEMBLY

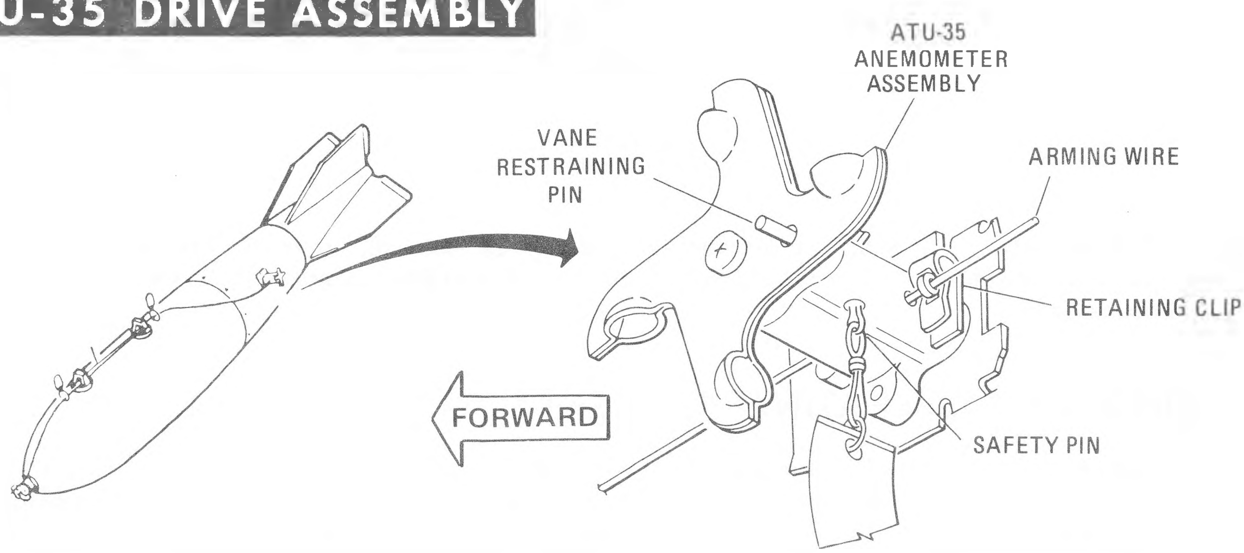


FIGURE 2-10

If the safety pin is inadvertently pulled before the arming wire is installed, the vane restraining pin will retract, and reinstallation of the safety pin or arming wire will not be possible. The ATU-35 drive assembly is a direct drive, and the output speed is transmitted to the fuze through a MAU-86/B flexible drive shaft and MAU-87/B governed coupler. The arming time is independent of release airspeed, because the spring-loaded centrifugal governor reduces high revolutions to a constant speed of 1,800±100 revolutions per minute.

M907 NOSE FUZE

The M907 mechanical time fuze (FIGURE 2-11) is used for airburst functioning of the SUU-30 series dispensers. It is 5.48 inches long, 2.5 inches in diameter, and

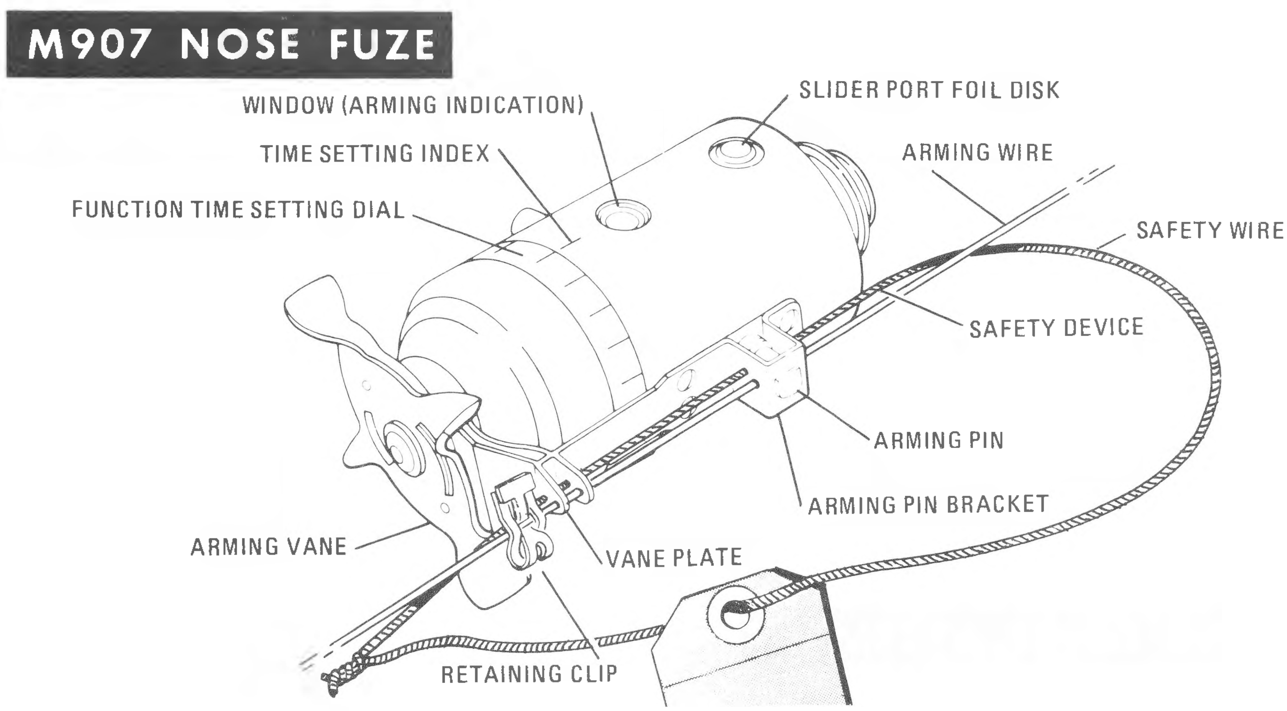


FIGURE 2-11

weighs 2.2 pounds. Arming is accomplished by an arming vane. The arming time is independent of release airspeed. Refer to the Fuze/Bomb Compatibility Chart (FIGURE 2-40) for details.

ARMING AND OPERATING SEQUENCE

The arming wire is pulled when the munition is released from the aircraft, allowing the vane to rotate and the arming pin to be ejected from the fuze. The arming vane drives a constant-speed rotating gear train and timing disk. As the disk rotates, the slot once occupied by the arming pin will align with the arming stem, allowing the primer to slide into line with the firing pin and booster, arming the fuze. When function time is greater than 10 seconds, the arming time is automatically set at one-half the function time. For function times less than 10 seconds but not the minimum, arming time is at least one-half the function time. For the minimum selection of 4-second function time, arming time is 1.5 seconds after release. Delivery airspeeds encompass a range of 100 to 600 knots true airspeed (KTAS). However, the fuze is more reliable at speeds above 175 KTAS.

Normal airburst function occurs as the timing disk continues to rotate. The arming slot will trigger a disengagement lever, which releases the spring-loaded firing pin. The firing pin strikes the primer, firing the fuze.

The function time is set on a calibrated dial on the fuze body. Function times may be set from 4 to 92 seconds at 0.5-second increments. When the function time is set below 45 seconds, a tolerance of 1 second exists. At settings above 45 seconds, the tolerance is 1.5 seconds. If impact occurs before expiration of set function time, the fuze will detonate.

NOTE

The M907 is not consistently reliable. Use only if no other SUU-30 fuze is available.

SAFETY FEATURES

Safety features include a slider detonator block containing the detonator that is locked out of line with the rest of the explosive train until arming time is complete. An arming pin prevents functioning of the timing mechanism and locks the firing pin in position, blocking movement of the slider detonator block. The arming pin is spring-ejected when the arming wire is pulled during weapons release. The fuze has two visible safety indicators: (1) the aluminum foil disk in the fuze body indicates the fuze is safe if the disk is intact and the brass slider assembly is not visible; (2) a warning window forward of the foil disk indicates the fuze is safe when the head of the arming stem is positioned under the arming disk.

AN-M147A1, M909, AND FMU-107/B NOSE FUZES

The AN-M147A1 and the FMU-107/B (FIGURE 2-12) are mechanical time fuzes used to open the M129 leaflet bomb and are the same fuze except for the difference in functional delays. Arming delay of both fuzes is 4.5 seconds. The functioning delay settings for the AN-M147A1 fuze are from 5 to 92 seconds. The functioning delay settings for the FMU-107/B fuze are from 13 to 92 seconds. All three fuzes use a combination of vane and pin for arming. The M909 mechanical time fuze is used only to open the M129. The M909 is the same as the M907 and will not be discussed here. Refer to the Fuze/Bomb Compatibility Chart (FIGURE 2-40) for details.

ARMING AND OPERATING SEQUENCE

The bomb is released from the aircraft, extracting the arming wire from the arming vane, allowing it to rotate in the airstream. The arming pin is forced out of the

AN-M147A1 AND FMU-107/B NOSE FUZE

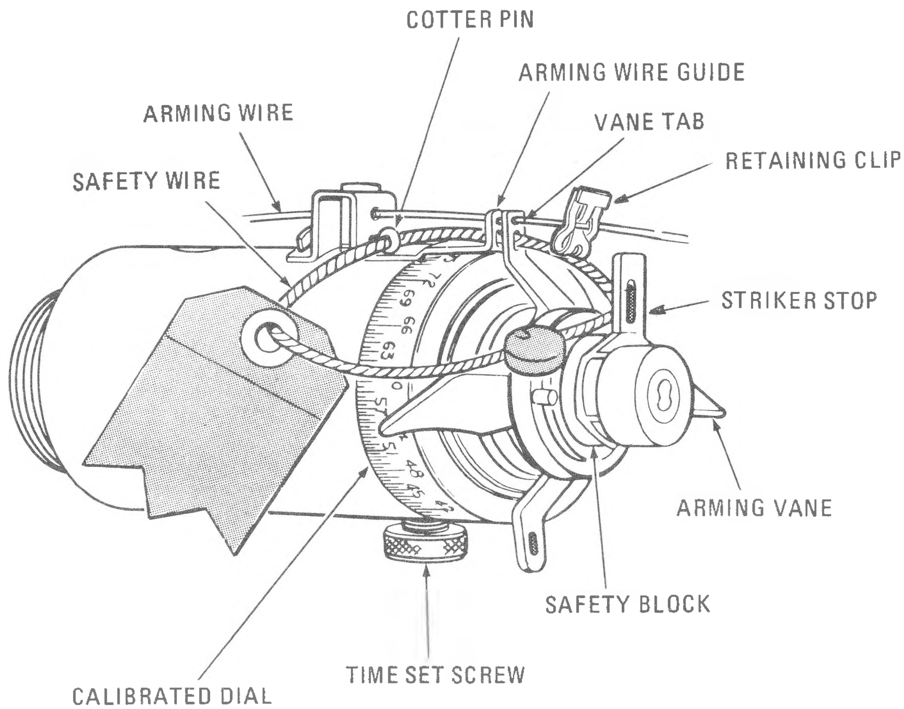


FIGURE 2-12

fuze by a spring, leaving the clockwork mechanism to operate. The clock turns the disk at a uniform rate until the timing disk lever drops into the notch and releases the firing lever and firing pin.

The time is set by rotating the head of the fuze to locate the timing disk lever at such a distance from the arming pin as will give the time desired. A thumbscrew is provided to lock the head in position after the setting is made. The time settings are engraved around the base of the head. Upon completion of the preset time interval, a small detonator charge is moved into position under the firing pin. The firing pin is propelled into the detonator by a spring. The detonator, in turn, detonates the booster lead, which detonates the explosive cord to separate the two halves of the bomb body.

SAFETY FEATURES

A sealed safety wire, with attached instruction tag, is threaded through a vane stop strap, the arming wire guide, the striker stop, and the eye of the cotter pin which secures the arming pin. This wire locks the mechanical arming system.

A safety block, located between the striker and vane, prevents the firing pin from being driven inward prematurely. Evidence of arming is indicated by the absence of a safety block, by complete or partial ejection of an arming pin, and by failure of the trigger mechanism to support the striker clear of the safety block.

MK 339 NOSE FUZE

The MK 339 is a mechanical timed airburst nose fuze used in the MK 20 Rockeye II and SUU-30 dispensers. There are two fuze variations, Mod 0 and Mod 1. Refer to the Fuze/Bomb Compatibility Chart (FIGURE 2-40) for details.

MK 339 MOD O

The MK 339 Mod 0 nose fuze (FIGURE 2-13) has a fixed arming time of 1.1±0.1 second, which starts when the primary time wire is removed from the fuze at weapon release. Two independent arming events must occur:

1. A clamping and sealing band is removed from the fuze impeller, allowing the impeller to spin in the airstream. The minimum airspeed for arming is 224 KCAS.

2. The arming timer will self-start. At 1.1 seconds, the timer arming pin will disengage from a slider, allowing the slider to move to the armed position (provided the centrifugal clutch has functioned). At 1.2 seconds, the timer safe mechanism will place the fuze firing mechanism in the firing mode.

At expiration of the preset time (primary/option) the fuze will function. A MK 43 Mod 1 detonator is the only explosive contained in the fuze. This initiates the linear-shaped charge in the MK 20, which cuts the dispenser in half.

The fuze has two selectable function times, primary and option, with a setting range of 1.2 to 50 seconds in 0.1-second increments for each function time. The function timers are accurate to within ±0.1 second time settings from 1.2 to 10.0 seconds, and 1 percent of all settings above 10.0 seconds. Any setting within the above range may be selected. The fuze settings are preset at the time of manufacture to 1.2 seconds for primary and 4.0 seconds for option.

NOTE

A fuze function timer, set at 0.9 second or below, will function as if set at 50 seconds. For settings from 1.0 to 1.2 seconds, it functions at 1.2 seconds and not before. This is a design safety feature to prevent early fuze functioning when released.

Function times used by the fuze are determined by the position of the fuze option pin. The option pin is normally held depressed by the option wire, which is installed at the time of manufacture. With the option wire installed and the option pin depressed, the fuze will function at the expiration of the selected primary time. When the option wire is pulled, allowing the option pin to extend, the fuze will function at the expiration of the selected option time. Once the option wire has been removed, it cannot be reinstalled and the fuze is committed to the option time setting.

CAUTION

The times set on the fuze must be carefully checked by maintenance personnel and aircrew. A timer setting that appears to be 1.2 seconds might possibly be 12.0 seconds and could easily be overlooked (FIGURE 2-13).

NOTE

The primary time is the first time read when viewed from the front. The option time is the second time showing when viewed from front to back (FIGURE 2-13).

When installed in the MK 20 Mods 3 and 4, the MK 339 fuze is configured with an option wire, allowing use of either the primary or the option time setting as the mission requires. The aircrew selects the time to be used by pulling or not pulling the option wire at weapon release.

NOTE

Selection of the option mode only will result in a dud.

The option wire is secured in the ejector rack rear solenoid. The fuze arming wire secures both the impeller and the primary starting pin until the wire is withdrawn at release. The fuze arming wire is secured in the forward rack solenoid. For the Mod 3 and 4 munitions, the mechanical fuzing switch is positioned to get either the primary or the option function.

Nose-Arms munitions and selects primary time

Tail-Duds munition

N/T-Arms munition and selects option time.

SAFETY FEATURES

The fuze arming wire passes through a timer starting pin and impeller sealing band release stud. With the arming wire installed, the timer starting pin prevents timer rundown, and the sealing band prevents impeller (arming value) rotation. The fuze incorporates a safe/arm indicator that is visible through a window in the upper half of the Rockeye nose fairing. The indicator is a clear plastic bubble that extends from the case of the fuze (FIGURE 2-14). When the fuze is armed, an indicator pin with a black tip or a red flat surface extends from the fuze into the bubble. On

MK 339 MOD O NOSE FUZE

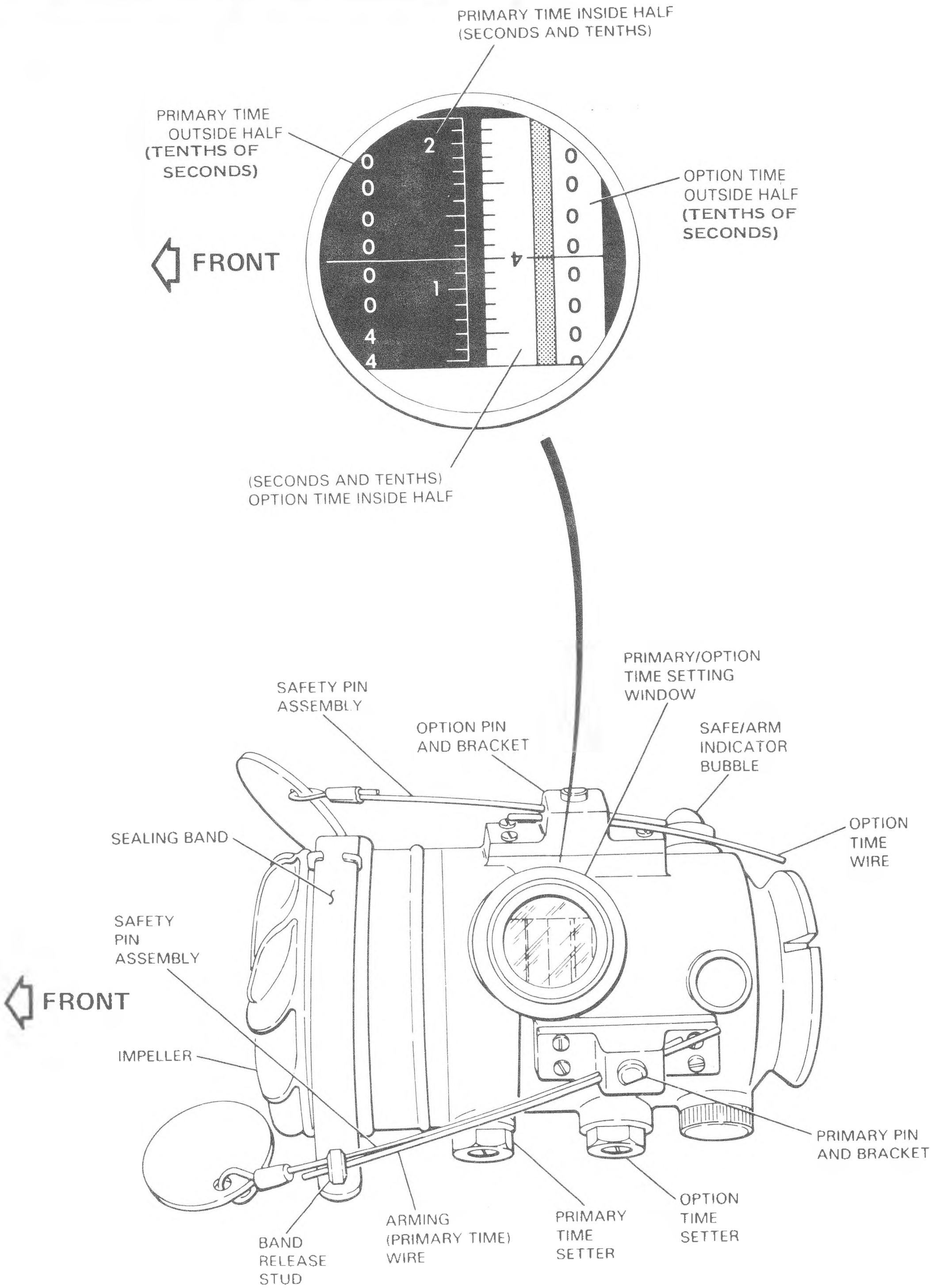


FIGURE 2-13

later models of Mod 0 and all the Mod 1 models of the fuze, the base of the bubble is covered by a green foil disk. When the fuze is safe, the bubble is empty and, on later models, the green foil is visible and intact.

MK 339 MOD 1

The Mod 339 Mod 1 differs from the MK 339 Mod 0 as follows: the function delay for both the primary and the option mode can be set from the 1.2 to 100.0 seconds. A function mode indicator, which indicates the fuze has been shifted from primary to option mode, is visible in the time setting observation window. Selection of the option mode only will result in a dud. A safety clip has been added to increase pull force because of the design of the Mod 1 fuze option spring pin.

FMU-7 FUZES AND INITIATORS

The FMU-7 fuzes and initiators (FIGURE 2-15) are used in conjunction with the AN-M23A1 igniter in the BLU-27 fire bomb. The fuze functions instantaneously on impact at any angle and can be used as a nose or a tail fuze. The fuze is electrically armed by the FMU-7 initiator assembly installed between the munition suspension lugs, or by external arming wires. The initiator assembly consists of a spring-loaded firing pin, a 1.5-volt battery, and electric cabling that connects the initiator to the fuzes. In the fire bomb, the fuze is installed in the AN-M23A1 igniter and forms part of the fuzing network consisting of an arming lanyard, initiator, and electric cabling. Refer to the Fuze/Bomb Compatibility Chart (FIGURE 2-40) for details.

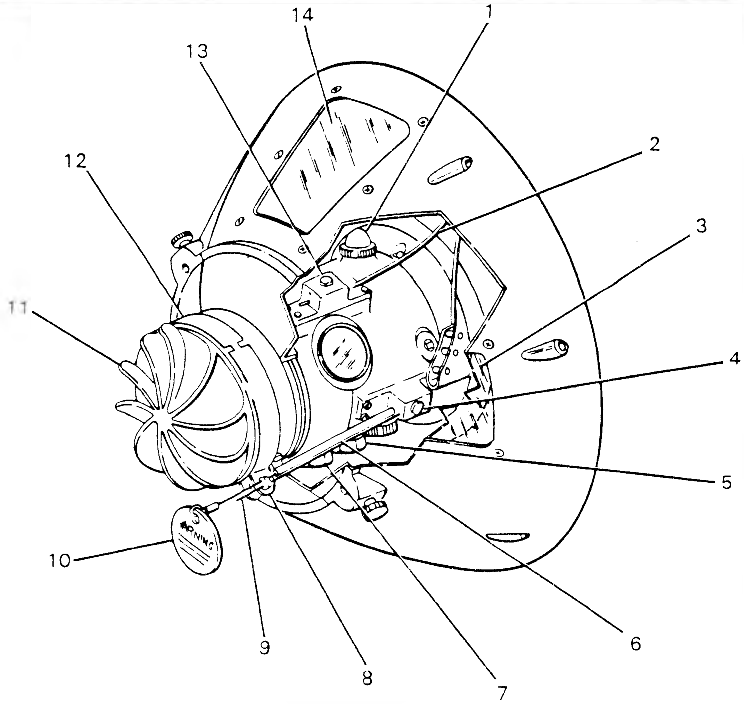
ARMING AND OPERATING SEQUENCE

Arming begins when the arming lanyard, which is connected from the initiator assembly to the bomb rack solenoid, pulls the initiator cap and is retained by the arming solenoid. As a result, a spring-loaded firing pin is released, forcing it against the primer and activating the thermal battery. The output of the thermal battery rises to a 1.5-volt pulse. The pulse is passed through the electric cabling in the fire bomb to a bellows motor in the fuze. The bellows motor withdraws the arming pin, which frees the firing pin. The fuze is armed. The time from firing of the thermal battery to completion of fuze arming is 0.5 to 1.1 seconds for the FMU-7/B and 0.3 to 0.9 second for the FMU-7A/B, B/B, and C/B fuzes. The FMU-7/B fuze will have a pin protruding from the center of the fuze head when armed.

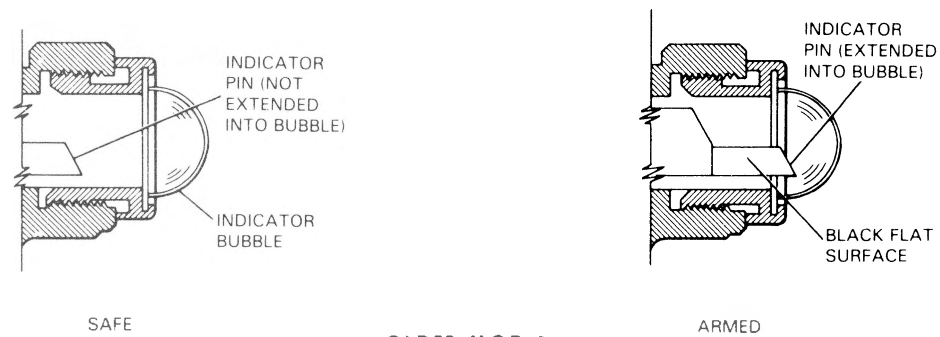
AN-M23A1 IGNITER

The AN-M23A1 igniter is cylindrical and rounded at one end. A fuze well in the rounded end is designed to receive the FMU-7/B, A/B, or C/B bomb fuzes. The body of the igniter is filled with 1.2 pounds of white phosphorus (WP). When the fuze impacts a target, the fuze functions and the booster in the fuze detonates, bursting the igniter and scattering the WP filling. The phosphorus ignites spontaneously upon exposure to the air and ignites the scattered filling of the bomb. Safety features are of the arming stem-safe principle.

MK 339 NOSE FUZE INSTALLED ON MK 20 ROCKEYE



1. FUZE SAFE/ARM INDICATOR BUBBLE
2. PILOT OPTION WIRE (IF INSTALLED)
3. FUZE SETTING OBSERVATION WINDOW
4. TIMER STARTING PIN
5. OPTION TIME SETTER
6. SAFETY WIRE GUIDE TUBE
7. PRIMARY TIME SETTER
8. BAND RELEASE STUD
9. ARMING WIRE
10. SAFETY TAG AND WARNING WIRE
11. IMPELLER
12. SEALING BAND
13. OPTION PIN
14. SAFE/ARM INDICATOR OBSERVATION WINDOW



OLDER MOD 0

NEWER MOD 0 AND MOD 1
SAFE/ARM INDICATOR BUBBLE

FIGURE 2-14

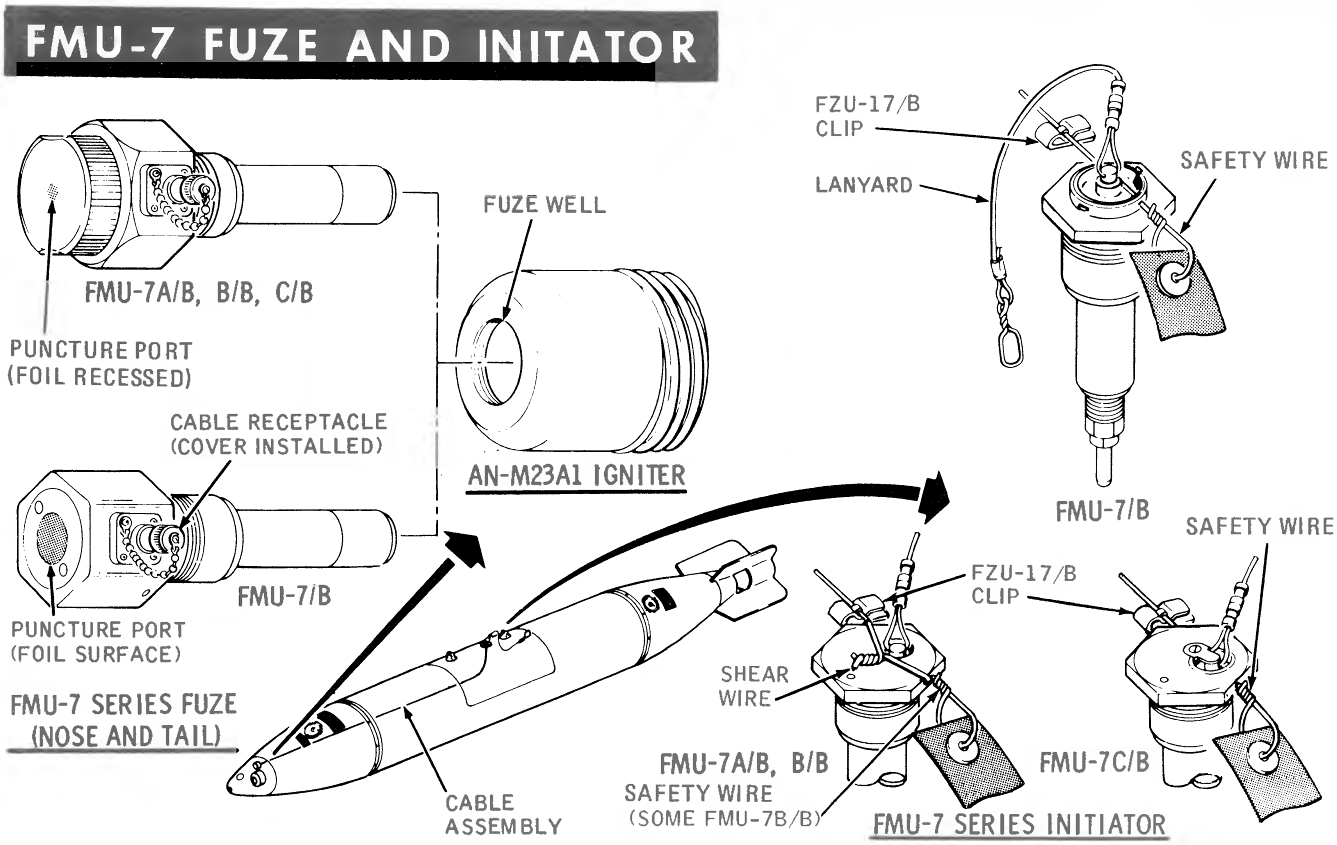


FIGURE 2-15

FMU-26 FUZES

There are two variations of FMU-26 (FIGURE 2-16) electric fuzes. The fuzes are powered by an internal thermal battery. Both are used in SUU-30 dispensers for air-burst opening. The FMU-26B/B is a nose or tail fuze and is also used in GP bombs. The FMU-26A/B is a nose fuze only and is only used with SUU-30 dispensers. Both fuzes use the FZU-1/B booster. Only the FMU-26B/B uses the FZU-2/B booster. Neither fuze is visible during preflight. Refer to the Fuze/Bomb Compatibility Chart (FIGURE 2-40) for details.

FMU-26A/B NOSE FUZE

ARMING AND OPERATING SEQUENCE

The FMU-26A/B electric fuze opens SUU-30 dispensers. It is 6.4 inches long, 2.87 inches in diameter, and weighs 3 pounds. The thermal battery is initiated by a battery-firing device (BFD) which runs from the fuze well through a swivel and link and is secured to the dispenser. During loading, the swivel and link is installed in the bomb rack arming solenoid. When a dispenser containing an FMU-26A/B fuze is released, the bomb rack arming solenoid holds the swivel and link that remains with

FMU-26A/B AND FMU-26B/B FUZES

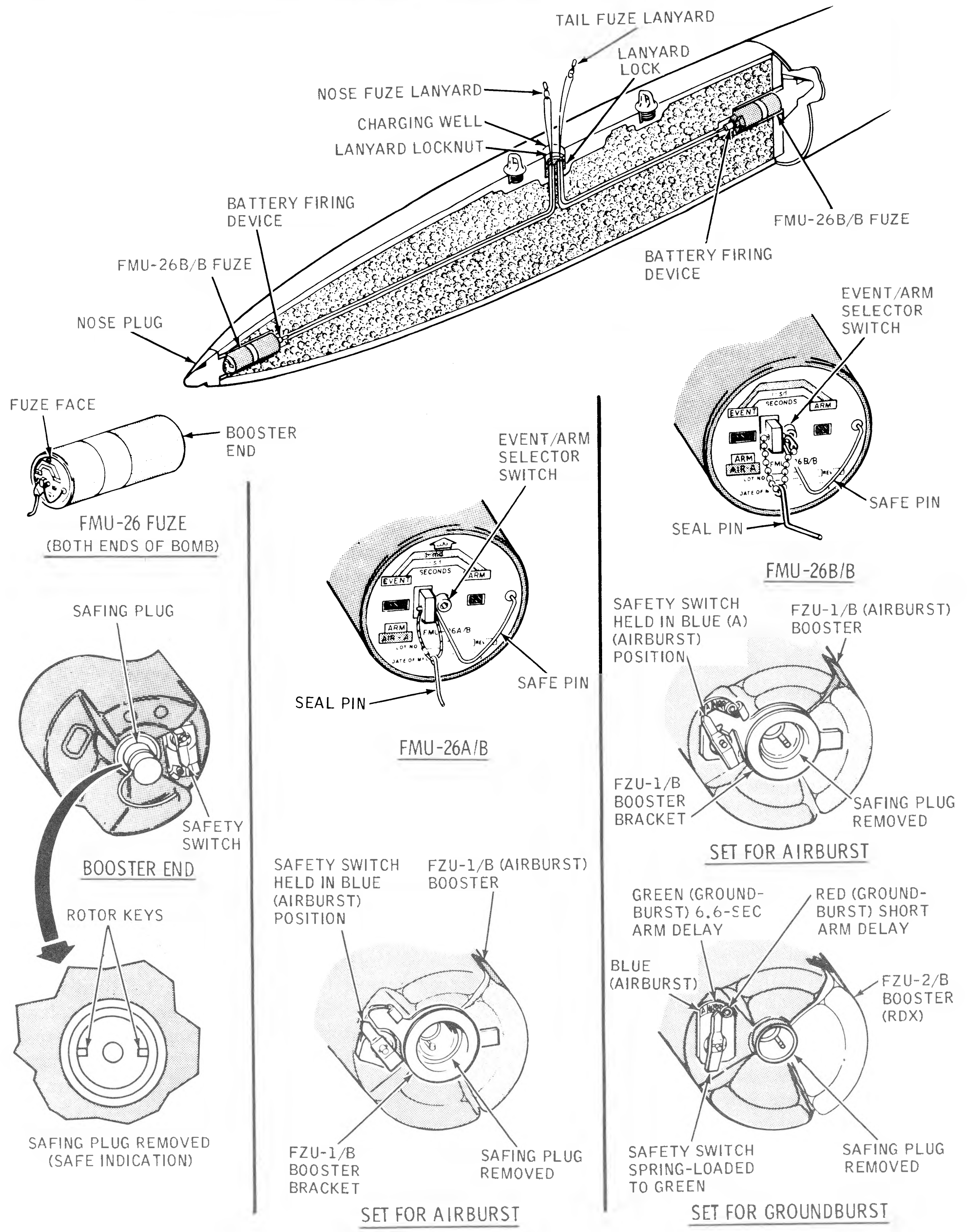


FIGURE 2-16

the bomb rack as the BFD is withdrawn through the swivel and link. The BFD remains attached to the dispenser. This action cocks and releases the firing pin, which initiates the thermal battery in the fuze. The fuze timing circuitry provides an arming signal at the preset arming time. This arming signal is used to rotate the detonator from the out-of-line position to the in-line or firing position. The fuze timing circuitry then provides the firing signal at the preset time for airburst function.

NOTE

The fuze was designed to perform the following functions: airburst, impact short delay, and impact medium delay (FIGURE 2-17). The FMU-26A/B is certified for airburst (BLUE) only in the SUU-30 munition. The fuze was never certified for the impact short delay mode (RED) because of an early burst problem. The impact medium delay (GREEN) was not certified because of its nonsettable, extremely short safe arm time (1 second).

FMU-26A/B AND FMU-26B/B MODES

MODE	ARMING TIME	FINAL EVENT TIME	EVENT TOLERANCE
Airburst 1	Selectable	Selectable	
FMU-26A/B, B/B	1.9 to 99.9 sec in 0.5-sec increments	occurs 0.1 sec after arming	±3 sec
Impact 2	Selectable	Selectable	
Short-delay FMU-26B/B only	2.0 to 20.0 sec in 2.0-sec increments	Nondelay; 0.010, 0.020, 0.050, 0.100, or 0.250 sec	±10% or ±0.002 sec, sec, whichever is greater

FIGURE 2-17

The function and arm times are displayed in the windows on the face of the fuze. The safing pin locks the fuze rotor in the out-of-line position until after the fuze is installed in the bomb. Before flight, the safing pin is removed from the fuze and replaced with the seal pin. The seal pin prevents entry of moisture into the fuze. The aft end of the fuze has a pie-shaped section to accept a booster. A 5-gram M5 propellant booster, the FZU-1/B, is secured to the fuze by a metal bracket. The bracket is also used to activate the airburst mode.

SAFETY FEATURES

The aft end of the fuze has a safe plug and a safety switch. The safe plug is in the fuze only during shipping and handling and is removed prior to installation of the fuze into the dispenser. The BFD is installed in the cavity vacated by the safe plug.

The safety switch must be on the BLUE position for the A/B fuze and can only be selected when the FZU-1/B is installed. The FZU-1/B booster has a metal bracket that holds the spring-loaded safety switch in BLUE. When the FZU-1/B booster and its bracket are removed, the safety switch will spring to GREEN. The airburst mode is inoperative when the safety switch is not in BLUE. If the fuze selector switch is set in the airburst mode, but the safety switch is not set in BLUE, the fuze will not detonate airburst, but will detonate at impact.

FMU-26B/B NOSE OR TAIL FUZE

ARMING AND OPERATING SEQUENCE

The FMU-26B/B electric fuze is used as a nose or tail fuze and provides airburst for SUU-30 dispensers and impact-initiated burst for GP bombs. It is 6.5 inches long, 3 inches in diameter, and weighs 3 pounds. It is compatible with bombs that have internal plumbing and the standard 3-inch fuze wells (nose and tail).

Upon release, the bomb rack arming solenoid holds the swivel and link as the arming lanyard is withdrawn. The arming lanyard remains attached to the bomb by the lanyard lock. This action cocks and releases the firing pin, which initiates the thermal battery in the fuze. The thermal battery provides the electrical power for fuze operations. The fuze timing circuitry provides an arming signal at the preset arming time. This arming signal is used to arm the fuze, that is, to rotate the detonator from the out-of-line position to the firing position. The fuze timing circuitry then provides the firing signal at impact or the preset time for airburst function. The function and arm times are displayed in the windows on the face of the fuze. The arm and function delays are the same as those for the FMU-26A/B.

The safing pin locks the fuze rotor in the out-of-line position until after the fuze is installed in the bomb. Before flight, the safing pin is removed from the fuze and replaced with the seal pin. The seal pin prevents entry of moisture into the fuze.

The aft end of the fuze has a pie-shaped section to accept a booster. The FMU-26B/B uses the FZU-1/B to open the SUU-30 dispenser. The FZU-2/B is used with the FMU-26B/B in high-explosive bombs.

SAFETY FEATURES

The fuze safety switch has three positions: RED, GREEN, and BLUE. GREEN keeps the firing circuit to the detonator disabled for approximately 6.6 seconds after bomb release. RED (no delay) bypasses the 6.6-second delay. The safety switch should be kept in GREEN for all short-delay settings except when operational delivery conditions are such that the time from bomb release to impact will be less than 6.6 seconds.

NOTE

The impact medium delay is not certified, and attempting any medium delay (GREEN) will cause the fuze to dud.

For release conditions where the bomb time of fall is less than 6.6 seconds, the safety switch must be set to RED to ensure the fuze is armed at impact. BLUE can be selected only when the FZU-1/B (airburst) booster is installed. The FZU-1/B booster has a metal bracket that holds the spring-loaded safety switch in BLUE. If the fuze selector is set to airburst mode, but the safety switch is not set to BLUE, the fuze will not function as an airburst but will detonate on impact. When used in high-explosive bombs, nose installation permits easier access for inspection and permits changes of arming and function times.

WARNING

Whether the fuze safety switch is set to RED, GREEN, or BLUE, the minimum release altitude for safe escape must be observed.

NOTE

- If the FMU-26/B is used in the nose of a laser-guided bomb (LGB), the fuze well will be covered by the guidance kit.
- The arming time tolerance for the FMU-26/B short delay mode (FIGURE 2-17) is ±0.30 second. With this mode, the minimum allowable bomb time of flight (to prevent duds) will be the arming delay setting plus 0.30 second.
- The fuze contains a safing device which makes the fuze dud if impact occurs prior to arming.

FMU-72/B LONG-DELAY FUZE

The FMU-72/B (FIGURE 2-18) is a long-delay impact fuze used to detonate MK 82/84 GP bombs up to 36 hours after impact. It is electrically armed and can be used as a nose or tail fuze. It is 7 inches long, 3 inches in diameter, and weighs 3.5 pounds. The settings must be made prior to installing the fuze in the fuze well. If a change in a setting is required after installing the fuze, it must be removed from the bomb to make the change. Refer to the Fuze/Bomb Compatibility Chart (FIGURE 2-40) for details.

FMU-72/B LONG-DELAY FUZE

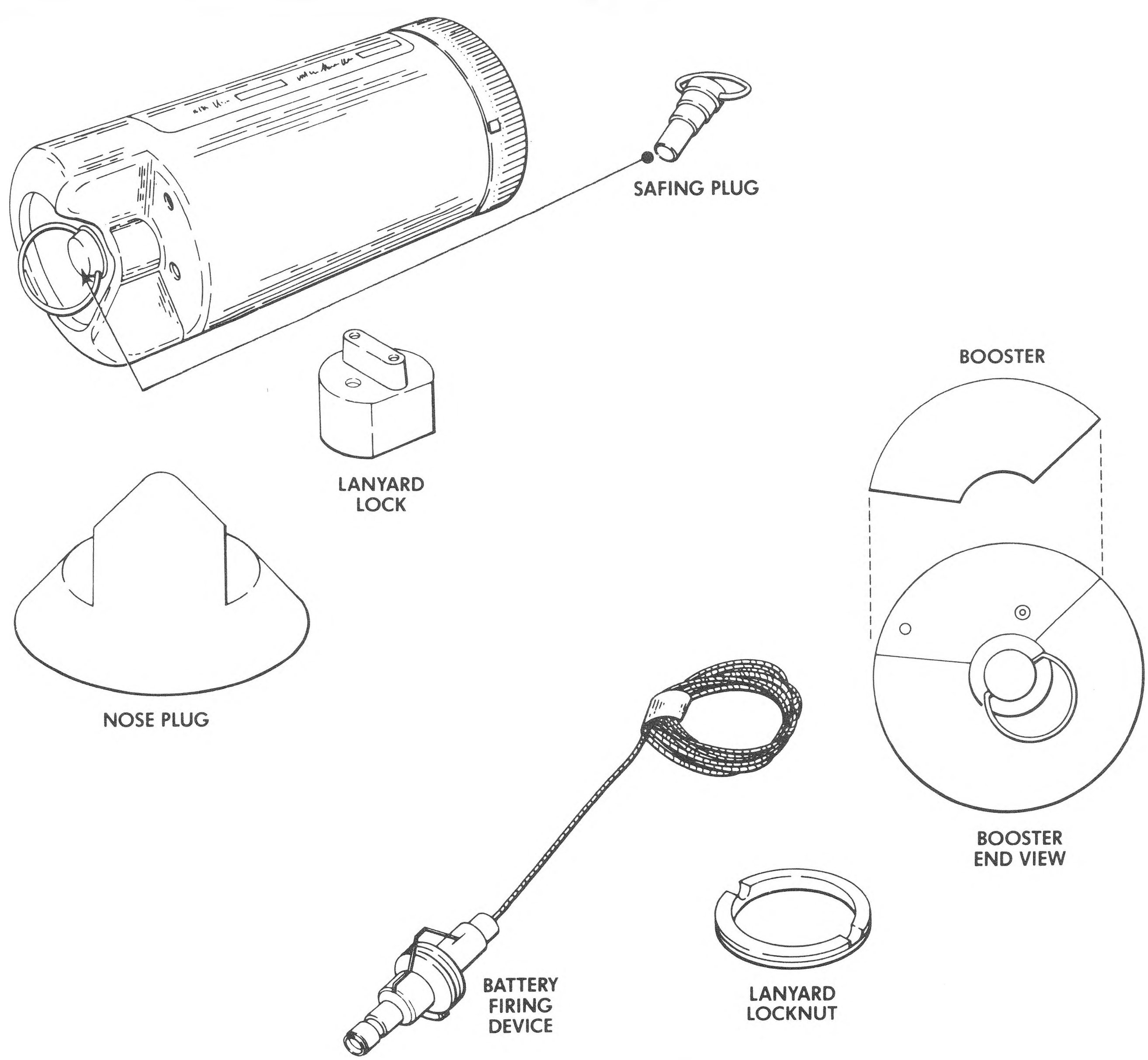


FIGURE 2-18

NOTE

The fuze settings are not visible for inspection. The fuze type and arming delay setting should be recorded on the side of the bomb or on a red warning tag attached to the bomb. This should be checked during preflight of the aircraft.

ARMING AND OPERATING SEQUENCE

The swivel and link assembly held by the arming solenoid pulls the lanyard and stays with the aircraft. This pull (greater than 36 pounds) cocks and releases the firing pin, which initiates the liquid ammonia battery in the fuze. The battery provides electrical power for fuze operation. The arming circuitry provides a fuzed delay for the signal for arming. The arming signal is used to arm the fuze; that is, rotate the detonator from the out-of-line position to the in-line or firing position. To assure that the detonator does not fire at arming, it is grounded until impact occurs, and the power source that fires the detonator is not charged until 33 ±10 seconds after impact. The fuze timing and counting circuitry provide the firing or final function time at the set function time after impact. The arming time and selectable function times are as follows:

Arming time: Fixed at 6.0 (+1.5, -1.0) seconds

Function times:

20-minute increments - 20 minutes-5 hours
1-hour increments - 5-16 hours
2-hour increments - 16-30 hours
3-hour increments - 30-36 hours
Function delay tolerance is +12 percent

If for any reason, the fuze is disturbed or rotated prior to function time, an anti-disturbance switch will send a signal to the fire output circuit, causing it to fire the detonator and initiate the explosive train. Activation time of the anti-disturbance feature is 33 ±10 seconds after impact because of the power source charging delay.

WARNING

When the FMU-72/B is used in GP bombs, select minimum release altitudes that will provide safe escape from bomb fragments for instantaneous or contact bursts. This is required to protect the aircraft and aircrew in the event of a premature bomb detonation at initial impact.

SAFETY FEATURES

The fuze contains a safing switch that duds the fuze if impact occurs prior to arming.

Deliveries should be planned to prevent bomb impact in the proximity of previously dropped bombs after their antidisturbance activation time has lapsed.

To prevent sympathetic detonation, bombs should be delivered so the distance between individual bombs at impact is in excess of 75 feet. If sympathetic detonation is desired, the spacing between individual bombs should be 30 feet or less.

To ensure adequate time for the FMU-72/B fuze to arm prior to impact, the last munition to leave the aircraft must have a minimum time of flight (TOF) of 7.5 seconds.

The FMU-72/B is used more effectively in the tail fuze well. This location provides a higher success ratio in functioning at the preset function time.

FMU-81/B SHORT-DELAY FUZE

The FMU-81/B (FIGURE 2-19) is an electrically armed, short-delay impact fuze intended for use with GBU-10 and GBU-12 LGBs, but it can be installed in any GP bomb. It is 11 inches long, 3 inches in diameter, and weighs 4 pounds. Refer to the Fuze/Bomb Compatibility Chart (FIGURE 2-40) for details.

The FMU-81/B consists of three major assemblies: fuze, FZU-2/B fuze booster, firing lanyard adjuster (MAU-162/A), and lanyard assembly. An auxiliary booster clip is provided as an accessory for guided bomb (GB) applications. Contained within the fuze body are a battery, a safing and arming mechanism, and an electronics assembly. The nose contains two thumbwheel setting knobs, one for arming delay and one for impact delay, held in place by a fuze nose plug and connected to selector switches in the electronics assembly by two mating shafts. A seal plug and safety clip with warning tag complete the unit. The BFD is integral to the recessed end of the fuze body. It contains a firing pin held in restraint by a shear wire until initiated by a pull from the lanyard. The lanyard assembly is a braided steel cable connected to the BFD by a ball and shank.

The fuze booster is shaped to fit the contour of the fuze booster cavity and is snapped into position under the booster clip.

The firing lanyard adjuster (MAU-162/A) consists of a lanyard tie-off block, a pull ring, and a shear wire.

The auxiliary booster clip is a spring-steel holder that holds three supplementary boosters in place around the BFD when the fuze is used in a GB.

ARMING AND OPERATING SEQUENCE

Any of nine arming-delay settings (4, 5, 6, 7, 8, 10, 12, 14, or 20 seconds, with a tolerance of 5 percent) or a SAFE setting can be selected by means of the thumbwheel knob of the arming-delay selector switch. The tolerance on the arming

FMU-81/B SHORT-DELAY FUZE

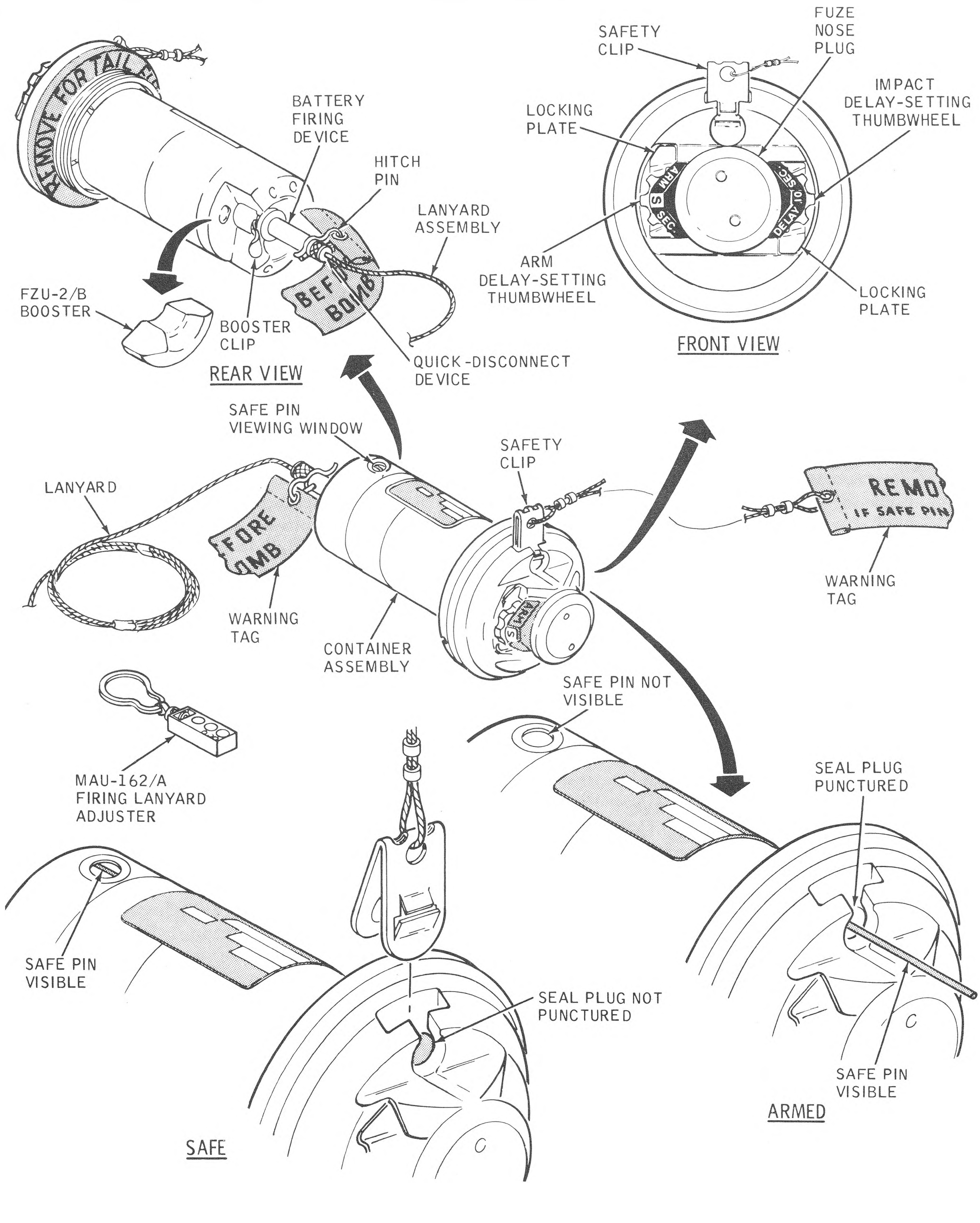


FIGURE 2-19

delay time is 5 percent of the selected setting. The arming delay settings may be made before or after installation of the fuze in the bomb. Any of six impact delay settings (0.0, 0.01, 0.02, 0.05, 0.10, or 0.25 second) can be selected by means of the thumbwheel setting knob of the impact-delay selector switch. The impact-delay settings may be made before or after installation of the fuze in the bomb.

Upon bomb release, a lanyard pull of 20 pounds or more shears a pin in the BFD and releases the BFD firing pin. The firing pin initiates a primer cap which, in turn, initiates the battery. The battery produces the 11 volts necessary to operate the timing and control circuitry in the fuze. At approximately 3/4 of the set arm time, the enable bellows motor is activated, removing the safing pin block on the safe and arm mechanism. At the set arm time, the arming bellows motor moves the detonator to the fire position. On impact, the fuze functions after elapse of the preset impact delay.

SAFETY FEATURES

A SAFE position on the arming delay setting thumbwheel renders the arming circuit inoperative. Locking plates behind the arming delay and impact delay setting thumbwheels prevent accidental movement of the thumbwheels during ground-handling of the fuze. A safing pin reveals potentially armed conditions of the fuze by visibly protruding through a seal plug on the fuze nose. The safing pin holds the rotor out of line until the pin is driven through the plug by the arm-enable bellows.

A safety clip on the fuze nose prevents the safing pin from releasing the rotor until the safety clip is manually removed during installation in a bomb. If the BFD is accidentally initiated during handling, the safing pin permanently locks the safety clip in place to reveal a defective fuze condition to the munition handler. A hitch pin prevents actuation of the BFD until manually removed during bomb installation.

The safe and arm mechanism provides out-of-line safety until the rotor is freed by movement of the safing pin, and is propelled in line by an arming bellows after BFD installation. If an impact of greater than 250 g should occur prior to arming, the safing switch and/or the detonator enable switch will function and prevent the fuze from arming. If an arming signal is generated prior to removal of the safing pin, the rotor will attempt to rotate and will deform a locking tang that permanently locks the rotor out of line. The safe and arm mechanism also prevents battery voltage from reaching the event circuitry before mechanical arming occurs.

The arm-enable circuitry prevents premature actuation of the arm-enable bellows by means of a resistor-capacitor combination that limits the enable-bellows charging current until the preset timing circuit releases a voltage pulse and triggers the capacitor to discharge into the bellows.

FMU-112 FUZE

The FMU-112/B (FIGURE 2-20) can be used as a nose or tail fuze in high- and low-drag GP bombs. The fuzing system consists of the FMU-112/B fuze and the FZU-37A/B turbine generator power supply/initiator. An electrical cable assembly is routed from the fuze internally to an FZU-37A/B located in the charging well between the lugs.

FMU-112/B SYSTEM

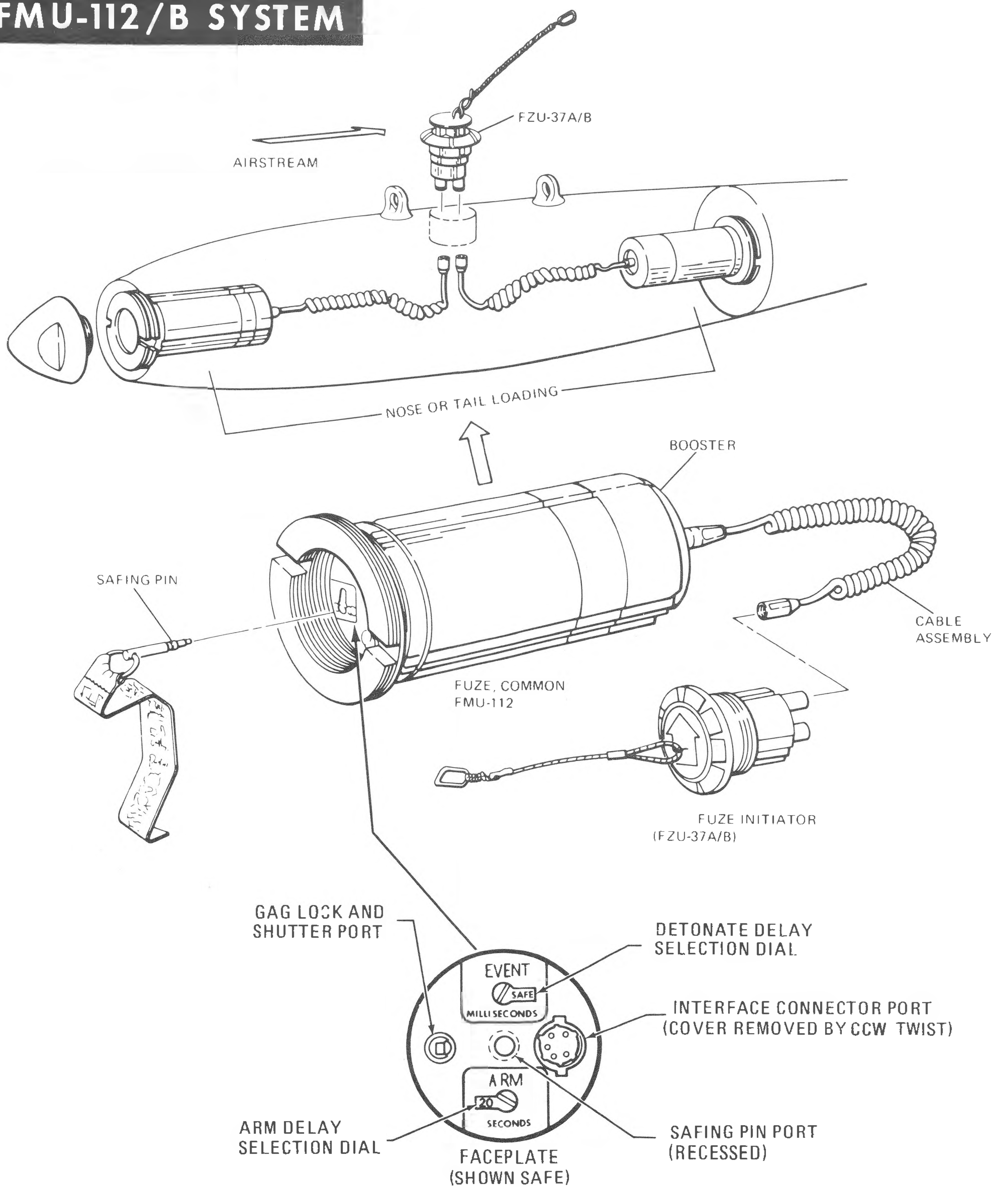


FIGURE 2–20

The FZU-37A/B is a mechanically actuated air turbine which generates electrical power from the slipstream of the bomb. Refer to the Fuze/Bomb Compatibility Chart (FIGURE 2-40) for details.

ARMING AND OPERATING SEQUENCE

The FMU-112/B is capable of both low-drag and high-drag arming, with the high-drag arming mode taking priority if retardation is detected by drogue sensors. When a high-drag weapon release is sensed by the fuze, all ground-set arming times are automatically reduced to 2.6 seconds, unless the special arm time of 6/4 seconds is selected. The special 6/4 setting provides a 6.0-second low-drag arm time, which is automatically shortened to 4.0 seconds when a valid high-drag release is sensed. This provides a greater safety margin for slower releases, where 2.6 seconds does not provide safe separation. Ground-selectable impact functional delay times are instantaneous; 0.005, 0.010, 0.025, 0.050, 0.1, and 0.2 second ±5 percent.

FUZE ARMING (LOW DRAG)

The fuze has eight ground-selectable low-drag arm times of 4, 5, 6, 7, 10, 14, 20, or 6/4 seconds. The low-drag arming cycle begins 0.3 second after weapon release, when the FZU-37A/B initiator reaches a sufficient power level (FIGURE 2-21). This power initiates both a nonelectric timer and an electric timer. The remaining power is stored in a capacitor. The fuze uses the detonator out-of-line principle with the nonelectric timer, removing a lock from the rotor 2.0 seconds after release. If valid free-flight (i.e., nonretarded flight) is sensed, the electric timer uses the power stored in the capacitor to remove a second lock at the expiration of the set arming time, or at 6 seconds if the special 6/4 setting is used. At this time, the detonator is electrically rotated into the firing position, and the fuze is armed. The fuze is electrically detonated, either instantaneous or delay, after sustaining 40 to 80 g deceleration.

FUZE ARMING (HIGH DRAG)

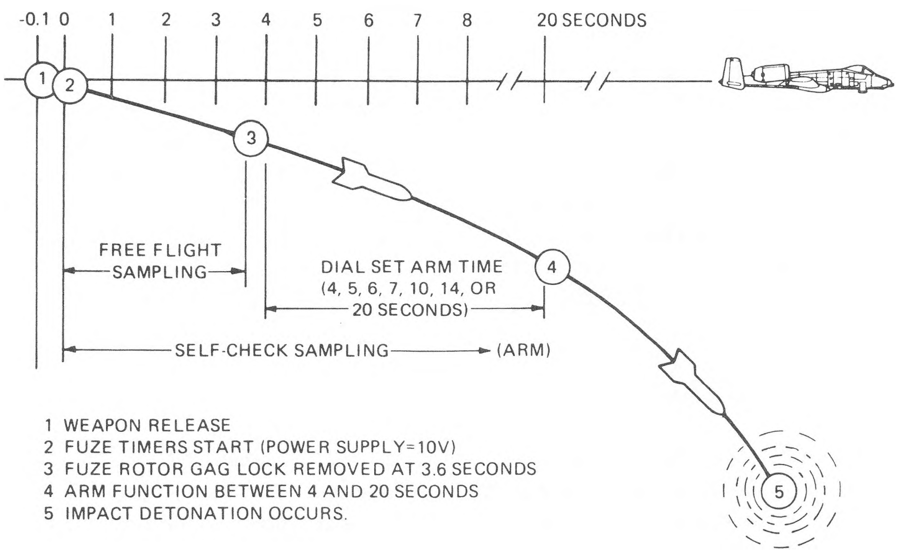
The FMU-112/B fuze arms in the high-drag mode if 3.0 g deceleration is sustained (FIGURE 2-21). The FZU-37A/B requires a 0.1 second to initiate power. As in low drag, the nonelectric timer is initiated and removes its lock from the rotor 2.0 seconds after release. The retardation of the ballute or fins actuates a bidirectional, axial g switch that overrides any low-drag timer setting. After 2.5 seconds, the second electrically actuated lock is removed by power stored in the capacitor, arming the fuze by 2.6 seconds. If the special 6/4 setting is used, however, high-drag arming is delayed until 4.0 seconds.

SAFETY FEATURES

The FMU-112/B fuze incorporates both mechanical and electrical safety features. Proper fuze initiation, timing, and high-drag profile, as well as proper sequencing of unlock, arming, and impact are monitored. Out-of-tolerance or improperly sequenced events will cause the fuze to be a dud.

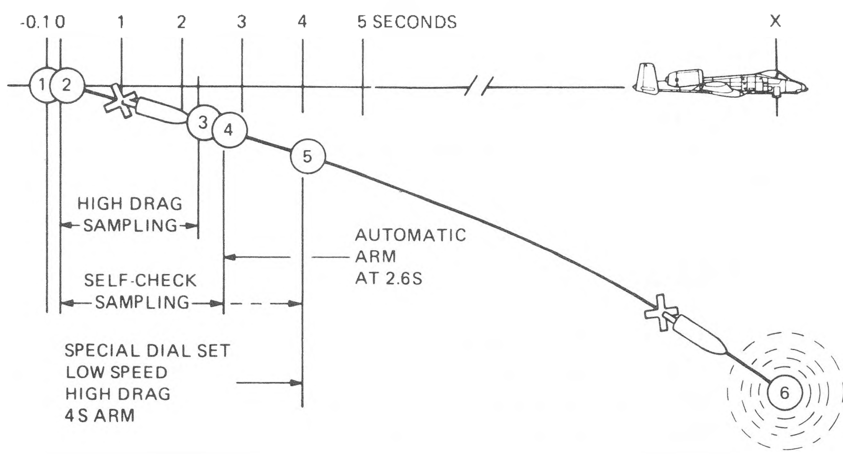
FMU-112/B ARMING

LOW DRAG RELEASE



1 WEAPON RELEASE
2 FUZE TIMERS START (POWER SUPPLY=10V)
3 FUZE ROTOR GAG LOCK REMOVED AT 3.6 SECONDS
4 ARM FUNCTION BETWEEN 4 AND 20 SECONDS
5 IMPACT DETONATION OCCURS.

HIGH DRAG RELEASE



1 WEAPON RELEASE
2 FUZE TIMER
3 DUAL DECELERATION DETECTION CAUSES GAG LOCK REMOVAL
4 AUTO HIGH DRAG ARM AT 2.6 SECONDS OCCURS FOR ANY DIAL SETTING OF 4, 5, 6, 7, 10, 14, OR 20 SECONDS
5 AUTO HIGH DRAG ARM AT 4 SECONDS OCCURS FOR SPECIAL 6/4 DIAL SETTING
6 IMPACT DETONATION OCCURS.

FIGURE 2-21

The fuze uses the basic detonator out-of-line principle. The nonelectric timer acts as an independent lock, and the electric lock maintains the detonator out of line even during safe jettison release and impact. If the retardation device failure occurs during opening, retardation is insufficient to arm the fuze.

WARNING

BSU-49 failure (flagger) may result in an armed fuze.

All fuze operating power is cut and the detonator will not fire if any of the following occur:

1. Impact occurs before arming
2. Electrical unlock occurs before 2.0 seconds
3. Loss of high-drag retardation occurs prior to 2.0 second after retardation begins
4. Sensing logic issues a command during the first 2.0 seconds
5. The two timers do not agree.
6. The detonator arms before electrical lock occurs.

OPERATING LIMITATIONS

Minimum delivery airspeed for low-drag bombs and MK 82 AIR is 250 KCAS. Minimum delivery airspeed for MK 82 Snakeye is 275 KCAS.

The fuze firing capacitor requires 0.2 seconds to charge. This delay, along with the 0.1-second FZU-37A/B initiator delay, constitutes a total inherent delay of 0.3 second for the FMU-112.

FMU-124 IMPACT FUZE

The FMU-124/B impact fuze (FIGURE 2-22) is used for fuzing the nose and tail of GBU-15 bombs. Fuze arming is accomplished by both mechanical and electrical means. The fuze is housed in a cylinder 8 inches long and 3 inches in diameter. The front of the fuze is equipped with a safety release assembly, an electrical connector to accept operating power and electrical signals, and a screwdriver-adjustable selector switch to select arming and functional delay times. A retractile cable connects to the rear of the fuze. The cable is terminated in a connector that mates with an

FMU-124A/B IMPACT BOMB FUZE

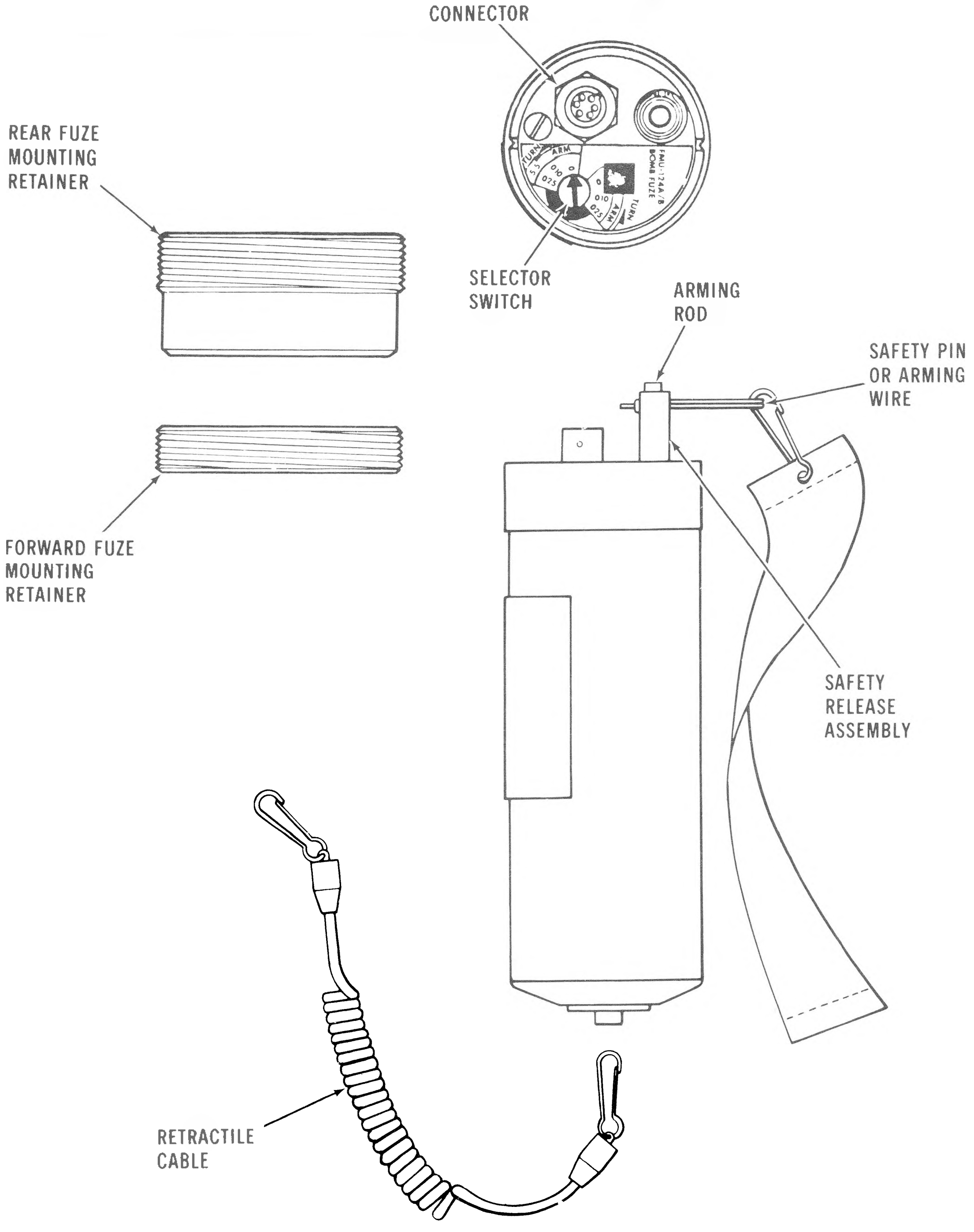


FIGURE 2-22

ADU-421A/B adapter mounted in the charging well of the bomb. The adaptor provides the means of electrically connecting the nose and tail fuzes. Refer to the Fuze/Bomb Compatibility Chart (FIGURE 2-40) for details.

ARMING AND OPERATING SEQUENCE

The FMU-124A/B fuze has selectable arming delay times of 5.5 or 12 seconds. Functional delays are 0, 0.01, or 0.025 second. Upon bomb release from the aircraft, the arming wire is extracted from the arming rod, and a mechanical timer starts a timing cycle of approximately 5 seconds during which an arming power isolation switch is closed and a blocking gag rod is removed from the rotor. Upon receipt of electrical power (arm command from the aircraft) firing capacitors are charged, which activates dual electronic timer switches having selectable delays of either 5.5 or 12 seconds. Upon delay expiration, both timer switches close, and a bellows motor actuator rotates the rotor. The rotor then latches in the arm position, mechanically aligning the fuze explosive train, completing the arming cycle. The fuze is capable of airburst functioning upon application of an electrical detonation signal, but it is not used in this manner in the GBU-15 bomb. Impact results in instantaneous detonation or 10- or 25-millisecond delayed detonation, as selected on the fuze.

SAFETY FEATURES

The fuze safety release assembly is held in the safe position by a safety pin with a warning flag attached. The safety pin and warning flag are replaced by an arming wire when installed in the bomb. Arming can occur only if the arming rod is extended and electrical power is applied.

ADU-421A/B FUZE ADAPTER

The ADU-421A/B fuze adapter (FIGURE 2-23) is installed in the charging well of the GBU-15 bomb and provides interconnection for the nose and tail fuzes of the bomb. It is cylindrical in shape and contains two electrical connectors side by side in the base. The adapter is fastened into the charging well by means of a retaining ring.

FMU-56 NOSE FUZES

The FMU-56B/B and FMU-56D/B fuzes (FIGURE 2-24) are self-powered doppler radar proximity nose fuzes used to open SUU-30 dispensers. They have 10 arming time settings and 10 height of burst (HOB) settings (FIGURE 2-25) for above ground fuze functioning. Additionally, the FMU-56 fuze has provisions for selecting an electronic countermeasures (ECM) mode. Refer to the Fuze/Bomb Compatibility Chart (FIGURE 2-40) for details.

ADU-421A/B FUZE ADAPTER

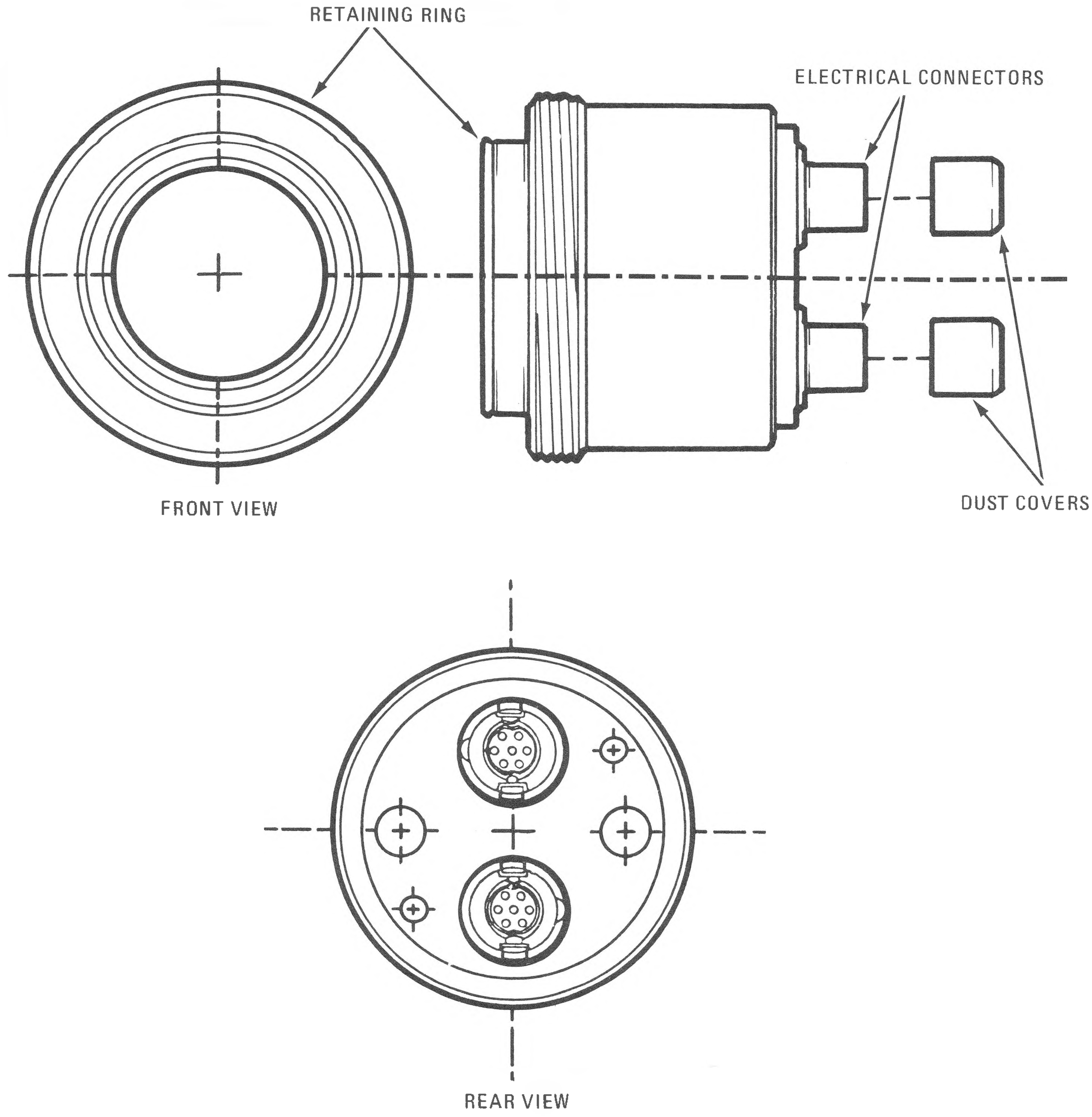


FIGURE 2-23

FMU-56B/B AND FMU-56D/B FUZES

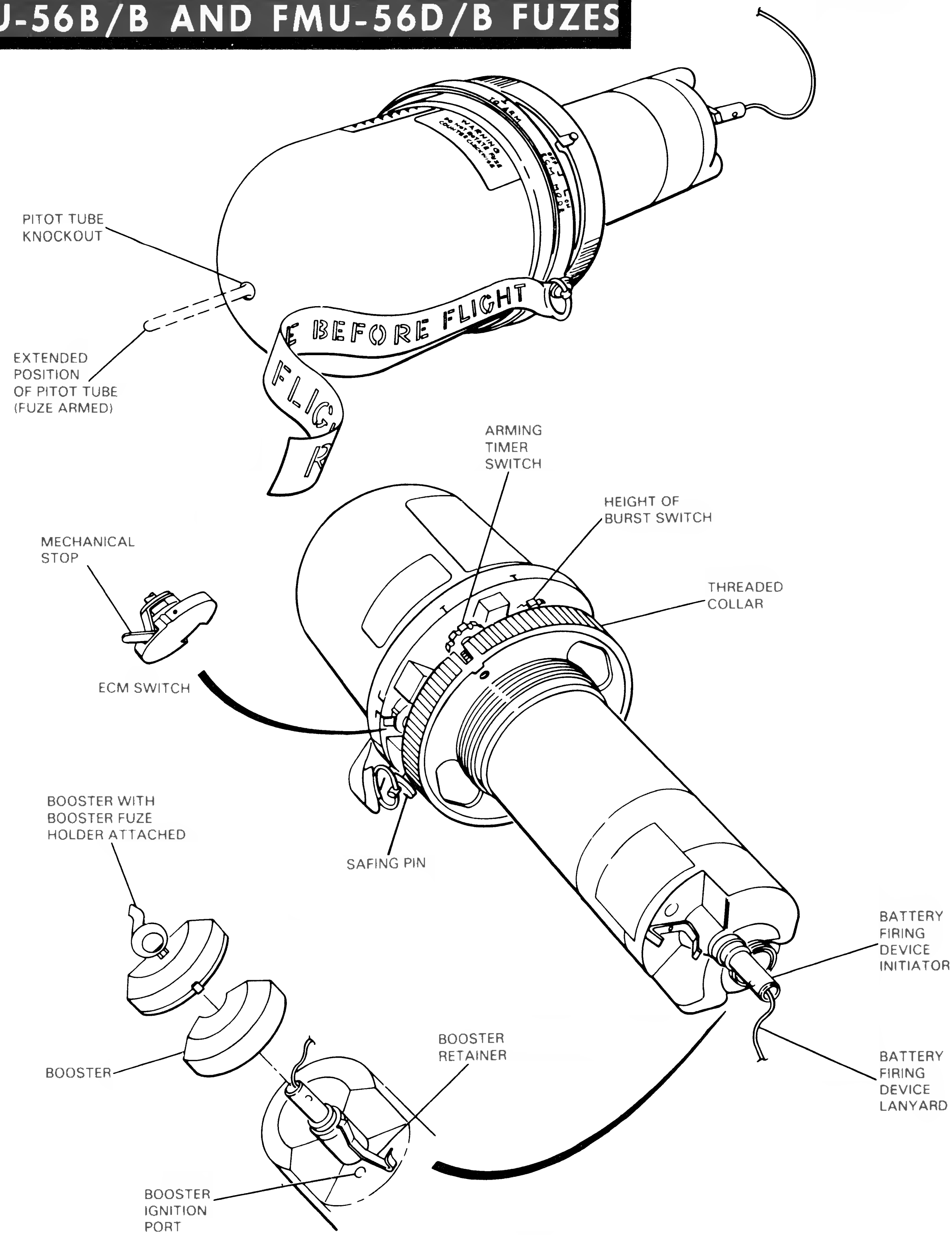


FIGURE 2–24

FMU-56B/B, D/B SELECTABLE ARMING TIMES AND HOB

ARMING		HEIGHT OF BURST	
SWITCH POSITION	ARMING TIME[a] (SEC)	SWITCH POSITION	HOB (FT)
X	SAFE	A	250
3	3	B	500
4	4	C	800
5	5	D	1100
6	6	E	1500
7	7	F	1800
8	8	G	2000
9	9	H	2200
10	10	J	2500
18	18	K	3000

[a] Tolerance ±10 percent or ±0.5 second, whichever is greater

FIGURE 2-25

FMU-56B/B NOSE FUZE

ARMING AND OPERATING SEQUENCE

When the CBU is released from the aircraft, the swivel and link assembly pulls the lanyard, activating the BFD. The initiator firing pin strikes the battery primer and activates the battery; this applies power to the fuze circuitry and starts the arming timer.

The FMU-56B/B has a two-step arming timer. First, a pitot tube is extended from the radome to activate the velocity sensor system. The velocity sensor must sense an airflow of at least 150 knots. At the end of the second step, the fuze will arm if the velocity sensor switch is closed. When the CBU reaches the preset height of burst (HOB), the detonator fires through the booster ignition port of the housing, setting off the booster. Ignition of the booster opens the CBU.

The FMU-56B/B outer gate is HOB plus 120 feet; its middle gate is HOB plus 60 feet. Arming must occur prior to reaching the outer gate. It must sense 200 feet per second (fps) downward vertical velocity (minimum) as it passes through both range gates and the HOB. If the fuze does not sense passing through the outer gate and the middle gate after fuze arming and prior to HOB, the fuze will not function.

ECM MODE OF OPERATION

The ECM mode is incorporated into the FMU-56B/B and D/B fuzes to provide a backup function 2.0 ±0.5 seconds after expiration of the safe arming time. This mode provides fuze function if the fuze sees an electromagnetic environment sufficient to mask the radar return. The electronic countermeasures (ECM) mode switch is set during manufacture in the ECM ON position and is restrained in that position by a spring lever. The safe arming time tolerance is the same for all FMU-56 fuzes (10 percent of the preset value or 0.5 second, whichever is greater). For mission-planning purposes, the safe arming time plus ECM tolerances should be considered cumulative. For example:

Safe arming time of 3.0 ±0.5 seconds plus
ECM backup of 2.0 ±0.5 seconds equals
Function time of 5.0 ±1.0 seconds

In this case, if the fuze senses an ECM environment, it would be expected to function between 4.0 and 6.0 seconds after release. In this type environment, fuze function approximating the desired time/altitude might be obtained if the fuze safe arming time were set at a value approximately 2 seconds less than the TOF from release to function. For example, if TOF from release to HOB were 10 seconds (obtained from ballistic tables), a safe arming time of 8 seconds might be selected in an ECM environment as follows:

Arm time - 8.0 ±0.5
ECM backup - 2.0 ±0.5
Function - 10.0 ±1.0

In this situation, if the fuze were jammed, you would expect it to function at any time from 9 to 11 seconds. This would be near your planned HOB. TOF to HOB for planned parameters would be 10 seconds.

SAFETY FEATURES

Both the FMU-56B/B and the FMU-56D/B possess the safety features described in the following paragraphs.

The safing pin operates a switch that disables the arming timer by disconnecting the timer from the battery and shorting the arm pulse output. Should the battery be initiated while the safing pin is installed, the fuze will not arm.

When the SECONDS-TO-ARM switch is set to SAFE, the arming timer will not run, and the safing and arming device will not receive an arm signal; it will remain in SAFE.

When the velocity of air sensed by the pitot boom is less than 150 knots, the switch will remain open, breaking the arm circuit to the safing and arming device.

When installed in the fuze subassembly, the uninitiated BFD locks the safing and arming rotor in SAFE. The safing and arming rotor is an out-of-line safety device. The detonator is seated in the rotor.

Should the fuze impact the ground prior to expiration of the preset arm time, the impact switch will prevent the fuze from arming.

When the pitot tube in the radome is extended, the fuze may be armed. The extended pitot tube is an indication that the battery may have been ignited. When it is retracted the fuze is safe. The BFD of the fuze contains a safety indicator (two holes) located on the rear of the BFD. If tabs protrude through these two holes, the fuze has been initiated and is a dud.

OPERATIONAL LIMITATIONS

Simultaneous release of more than one CBU with FMU-56 fuzes is not recommended. Spatial separation is required in order that the fuze radar does not confuse other fuze radar signals with its own. Radar interference from other fuzes could cause the fuze to malfunction. An increased dud rate must be expected if more than four FMU-56B/B fuzed munitions are ripple released on one pass. Refer to appropriate aircraft Dash 34 to determine minimum release altitudes and minimum release interval settings which provide adequate munition separation distance for ripple release.

NOTE

If different HOB settings are used, the first munition should be set to the lowest HOB to preclude subsequent dispensers falling through the dispensed munitions.

FMU-56D/B NOSE FUZE

ARMING AND OPERATING SEQUENCE

The FMU-56D/B has an integrated circuit timer which contains digital logic circuits that extend a pitot tube 0.5 second before arming. Extension of the pitot tube activates a velocity-sensing system. The timer logic circuits require the velocity sensor be open before the pitot tube is extended and closed within 0.5 seconds prior to arming, or it will not arm. The FMU-56D/B must be armed prior to reaching the preset HOB, and it must sense a minimum of 200 fps downward vertical velocity as it passes through the range gates and the HOB. The fuze must sense passing through the outer gate (HOB plus 500 feet) and the middle gate (HOB plus 250 feet) after 3.7 seconds and prior to the HOB. Because of a receding target (i.e., the release aircraft), the range gate logic prevents the fuze from functioning. The fuze will sense and remember the range gates, if they occur after 3.7 seconds and prior to or after arming time, because the fuze radar is operational at 3.7 seconds, regardless of the set arming time. If all other criteria are satisfied and the munition passes through both range gates and the HOB before arming, the munition will function immediately upon expiration of the arming time, Ripple releases of up to 12 FMU-56D/B fuzed munitions may be accomplished. However, if more than six munitions are rippled on one pass, an increased dud rate must be expected. For all FMU-56D/B ripple releases, the munitions must attain a spatial separation of 20 feet when HOB is 2,200 feet or lower, 24 feet when HOB is 2,500 feet, and 38 feet when HOB is 3,000 feet. Refer to appropriate Aircraft Dash 34 to determine minimum release altitude and minimum release interval settings which provide adequate munition separation distance for ripple release.

NOTE

If different HOBs are used, the first munition released should be set to the lowest HOB. An FMU-56D/B fuzed cluster munition will be a dud if, during flight, the munition is flown in medium rain at 550 KCAS in excess of 8 minutes, or at 450 KCAS in excess of 30 minutes. Under these flight conditions, radome erosion will cause the pitot tube to sense a pressure differential which is premature in the FMU-56D/B arming sequence; this will cause the fuze to be a dud.

Operational limits, safety features, and ECM mode of operation for the FMU-56D/B are the same as those for the FMU-56B/B.

FMU-110/B PROXIMITY NOSE FUZE

The FMU-110/B (FIGURE 2-26) is an electrical proximity, airburst (doppler radar ranging) fuze powered by an internal battery. It is used as a nose fuze to open SUU-30 series CBU munitions. An ECM mode can be selected. The FMU-110/B has 10 arming-time settings and 10 HOB settings (FIGURE 2-27). Refer to the Fuze/Bomb Compatibility Chart (FIGURE 2-40) for details.

FMU-110/B PROXIMITY NOSE FUZE

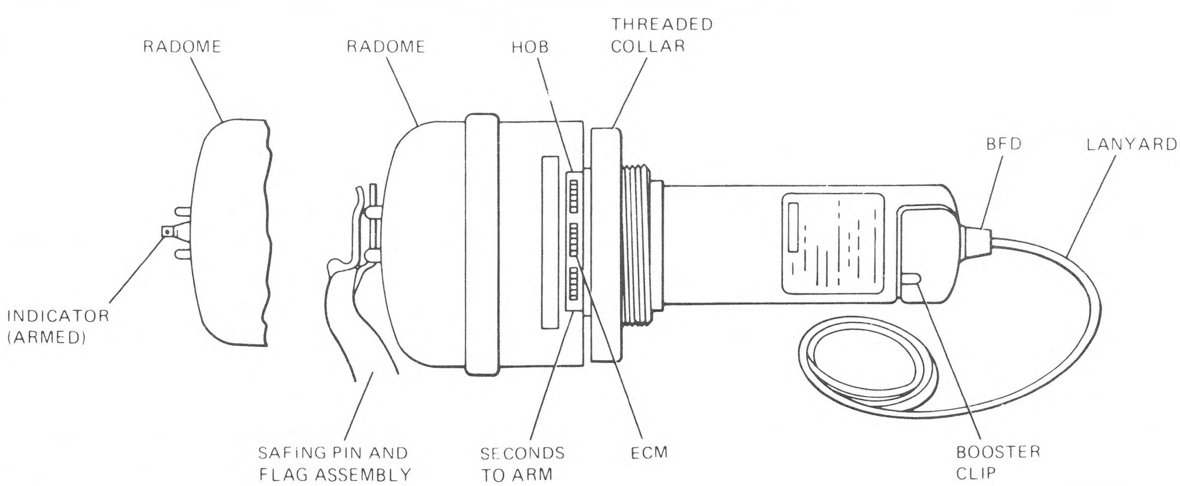


FIGURE 2-26

FMU-110/B SELECTABLE ARMING TIMES AND HOB

ARMING		HEIGHT OF BURST	
SWITCH POSITION	ARMING TIME (SEC)	SWITCH POSITION	HOB (FT)
X	SAFE	A	300
3	3	B	500
4	4	C	700
5	5	D	900
6	6	E	1200
7	7	F	1500
8	8	G	1800
9	9	H	2200
10	10	J	2600
18	18	K	3000

FIGURE 2-27

The fuze subassembly contains the doppler ranging radar, battery, and safing and arming device. The fuze subassembly safing pin must be removed before flight. A booster fuze (FZU-1/B) is attached to the rear of the fuze assembly. Detonation of the booster causes the nose cap of the CBU to separate. The BFD is integral to the fuze and consists of a steel initiator, a retaining clip, and a steel lanyard. The lanyard is routed through the CBU lanyard tube.

ARMING AND OPERATING SEQUENCE

Upon release of the munition from the aircraft, a 15-pound lanyard pull removes one lock on the safing and arming rotor, and the BFD initiator strikes the battery primer, igniting the battery. Voltage from the battery provides power for the electronic circuitry. The fuze contains an arming time that starts on battery ignition. The timer runs for the preselected time set on the arming timer switch, unless it is in the X position. In the X position, the timer will not run and the fuze will not arm. The arming timer deploys a pop-out arm indicator rod and removes a locking rod from the safe and arm device 0.5 second prior to expiration of set arming time. The pop-out arm indicator rod ejects a protective cap from the nose of the fuze; this exposes a port on a velocity sensor. The air velocity sensor samples the airstream, and the contacts of the velocity switch close if an airflow greater than 120 KCAS is detected. When the contacts close, an impulse cartridge is fired, rotating the safing and arming rotor to the armed position.

When energized, the radar circuitry of the fuze is continually checking the height of the CBU above the ground and the vertical component of its velocity with respect to the ground. Height above the ground is measured by determining the time required for the radar pulse to reach the ground and return to the fuze. The closing velocity of the CBU is determined from the amount of doppler shift in the returned signal with respect to the internal reference oscillator in the fuze. When the height above the ground, as measured by the fuze, is the same as the preset height of burst, and the closing velocity of the munition is greater than a predetermined minimum value, the fuze functions to open the dispenser and disperse the payload.

The criteria that must be met for the FMU-110/B to function normally at the preset HOB are:

1. The fuze must be armed prior to reaching the HOB

2. The fuze must sense 100 fps downward vertical velocity as it passes through the HOB.

The arming time tolerance for the FMU-110/B fuze is 10 percent of the select value or 0.5 second, whichever is greater. During mission planning where FMU-110/B fuzed munitions are involved, the munition TOF from release to function altitude must be greater than the arming timer setting plus the tolerance. This procedure must be carefully observed. If the munition passes through the selected function height prior to the expiration of the preset arming time, the fuze function is uncertain and a dud round may result. To assure adequate time for all fuze functional requirements to be met, the fuze should be fully armed no less than 2 seconds prior to the preset HOB.

All radar proximity sensing begins after 2.7 seconds, regardless of the arming time setting. If the munition passes through the HOB after 2.7 seconds but before the fuze arms, the fuze will function immediately after the arming time expires (assuming all other functioning criteria have been met). If the munition passes through a HOB of 1,500 feet before the radar is operational (after 2.7 seconds), the fuze will function at the backup HOB of 700 ±50 feet after arming. If the fuze sees a slant range that corresponds to the vertical HOB, it will function. For example, if the fuze is 100 feet below its HOB when the radar is operational (at 2.7 seconds), it may not see a true vertical HOB of 1,500 feet, but it may see slant range that equates to 1,500 feet. If the fuze does not see a slant range of 1,500 feet, it will function at the alternate HOB.

The FMU-110/B incorporates an alternate HOB feature that allows a proximity function at a secondary HOB other than the ground-selectable HOB. This alternate HOB is internal to the fuze and is preset by the manufacturer at 700 ±50 feet. If the fuze is armed and has not functioned prior to 700 ±50 feet, it should function at that altitude. Even though the fuze may function at 700 feet, it is very doubtful that the dispenser will have time to open and that all the bomblets fully arm; the envelope is very small for a 700-foot HOB. At slow delivery airspeeds, dud bomblets can be expected.

For proper operation of the FMU-110/B fuzes in ripple releases of up to 12 cluster munitions, the munitions must attain a spatial separation of 20 feet within the HOB range for HOBs of 2,200 feet and below. Refer to appropriate Aircraft Dash 34 to determine minimum release altitude and minimum release interval settings which provide adequate munition separation distance for ripple release.

ECM MODE

An ECM mode of operation is incorporated into the FMU-110/B fuze to provide a backup function after expiration of the arming time. This feature provides an optional fuze function if the fuze sees an electromagnetic environment sufficient to mask the radar return. The ECM mode of operation is selectable at the antenna support collar by placing the ECM switch to ON. Selection of OFF precludes the fuze function (a dud fuze) in the presence of an electromagnetic environment sufficient to mask a radar return. ON allows the fuze to function in an electromagnetic environment. If the FMU-110/B senses an ECM environment, the fuze should be expected to function approximately 2 seconds after expiration of the arming time. If an ECM environment is expected, the arming timer should be set to approximately 2 seconds less than time from release to HOB. This will give the munition its best chance to function at or near the planned HOB.

SAFETY FEATURES

Before the FMU-110/B will arm, the following sequence of events must occur:

1. The safing pin must be removed

2. The battery must be ignited by pulling the arming lanyard

3. The arming timer switch must be set to a position other than X

4. Airflow sensed by the velocity sensor ports at the expiration of safe separation time must exceed 120 KCAS. Test data indicate fuze arming range is 120 to 184 KCAS.

When a safing pin is installed in the front of the fuze, the safing pin locks the safing and arming rotor in SAFE. If the battery is ignited while the safing pin is installed and the arming timer switch is in a setting other than SAFE, the safing pin will physically block removal of a mechanical lock on the safing and arming rotor. When the arming timer switch is set to SAFE, the safe separation timer will not run, and the safing and arming device will not receive an arm signal and will remain in SAFE. When the velocity of air sensed at the velocity sensor ports is less than 120 KCAS, the switch will remain open, breaking the arm circuit to the safing and arming device. The FMU-110/B fuze has a visual arm indicator. With the safing pin installed and the SECONDS TO ARM switch in the X position, the fuze is unarmed.

FMU-113/B PROXIMITY NOSE FUZE

The FMU-113/B nose fuze (FIGURE 2-28) is a low-altitude, radar proximity fuze used in GP bombs. It is 13.75 inches long, 5.6 inches in diameter, and weighs 8 pounds. A FZU-2 booster is required to be installed on the fuze prior to installation in the bomb. The fuze has a safe/arm indicator that can be viewed after installation in the bomb. The fuze is mechanically armed and has ground-selectable arming time settings of 5, 6, 7, 8, 9, 10, and 18 seconds, as well as a SAFE position. Initiation of the fuze is accomplished by a bungee lanyard pulled at release. The fuze has no stored arming energy; power for sensor operation is obtained from an air-turbine-

FMU-113/B PROXIMITY NOSE FUZE

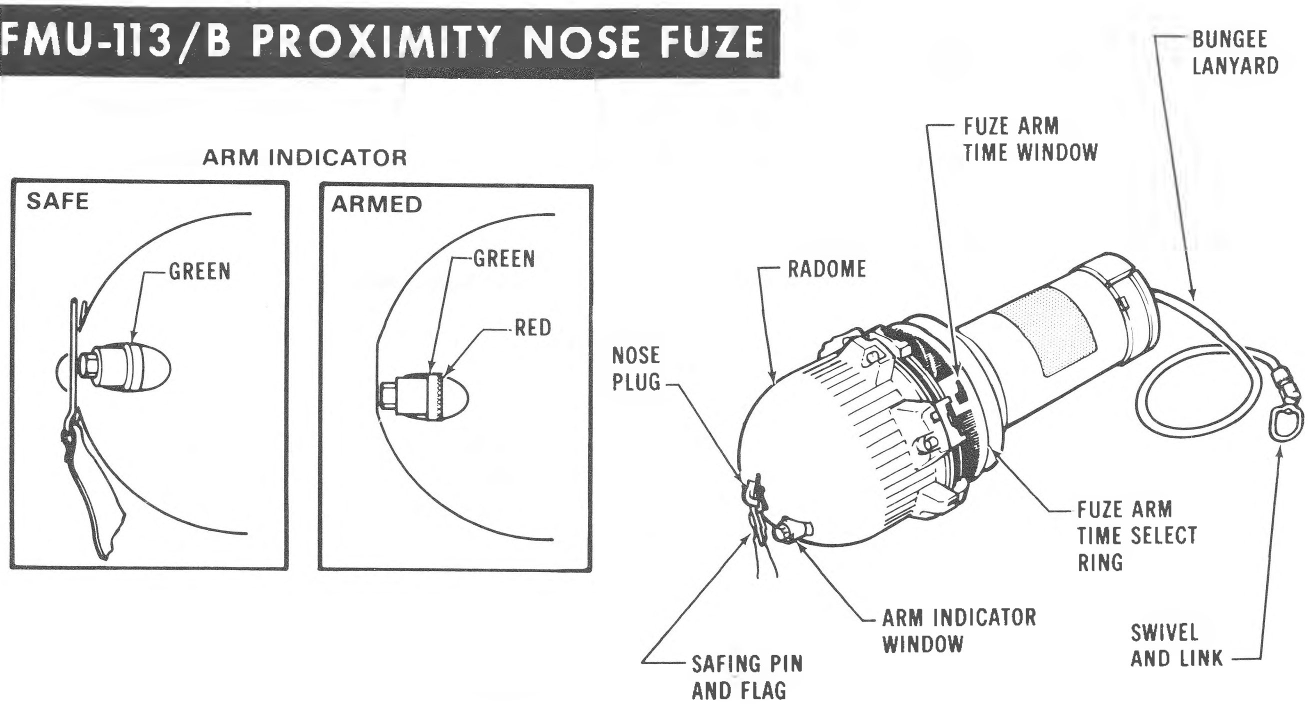


FIGURE 2-28

powered alternator. The sensor portion of the fuze is designed to provide a 0- to 25-foot (15-foot nominal) HOB. The fuze has an impact burst backup feature. Refer to the Fuze/Bomb Compatibility Chart (FIGURE 2-40) for details.

ARMING AND OPERATING SEQUENCE

The fuze contains a velocity threshold device that must be overcome at munition release (FIGURE 2-29) for fuze operation. The munition must be released at 250 KCAS or greater to assure proper fuze operation.

The flight time of the munition must allow for the vertical velocity of the munition to exceed 200 fps and also for the arming time, including the inherent 0.5-second delay in fuze operation, to expire. The munition flight time must be greater than the sum of the arming time setting, plus the 10 percent tolerance, plus 0.5 second. If sufficient flight time is not allowed, the munition may be a dud (if impact occurs before expiration of arm time), or it may function on impact (if impact occurs after expiration of arm time but prior to expiration of the fixed delay).

SAFETY FEATURES

If for any reason the fuze arms and fails to fire, the arm indicator rod will indicate RED through the arm indicator window.

FLIGHT DELIVERY

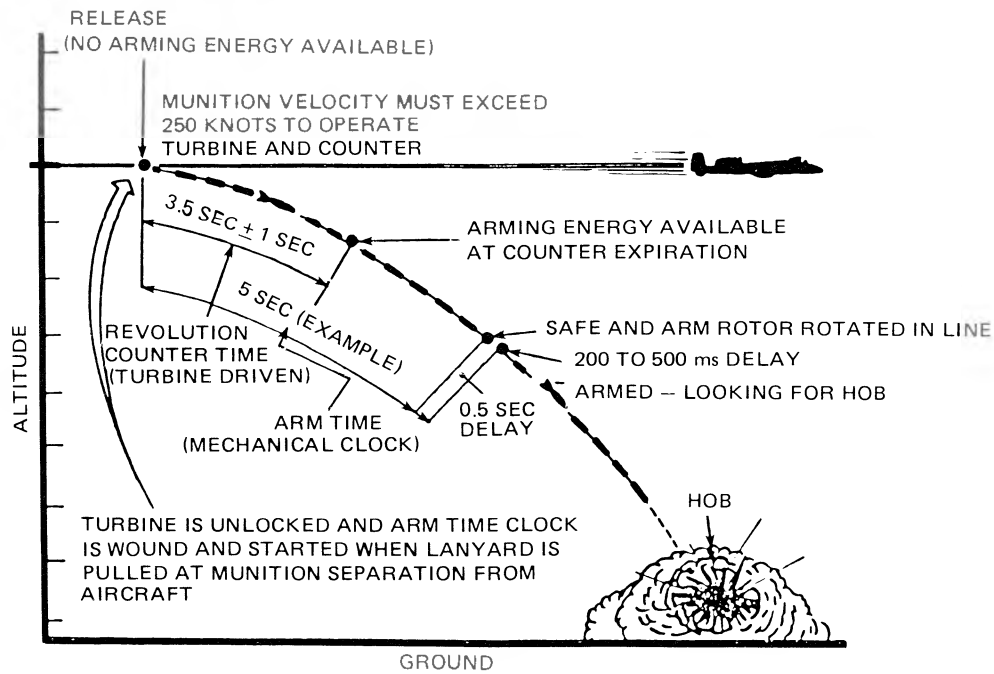


FIGURE 2-29

WARNING

Any RED or RED/GREEN showing in the window indicates an armed fuze. Only GREEN showing (no RED) indicates an unarmed fuze. Explosive ordnance disposal (EOD) personnel should be notified immediately of any armed fuze.

MK 75 ARMING KIT

The MK 75 arming kits are mated to MK 82 Snakeye I bombs to form the MK 36 destructor (FIGURE 2-30) and they also fuze the M117 destructor. The arming kit consists of the MK 32 arming device in the nose fuze well, a MK 42 firing mechanism in the tail fuze well, a MK 59 booster, and a MK 95 battery.

MK 75 ARMING KIT (TYPICAL)

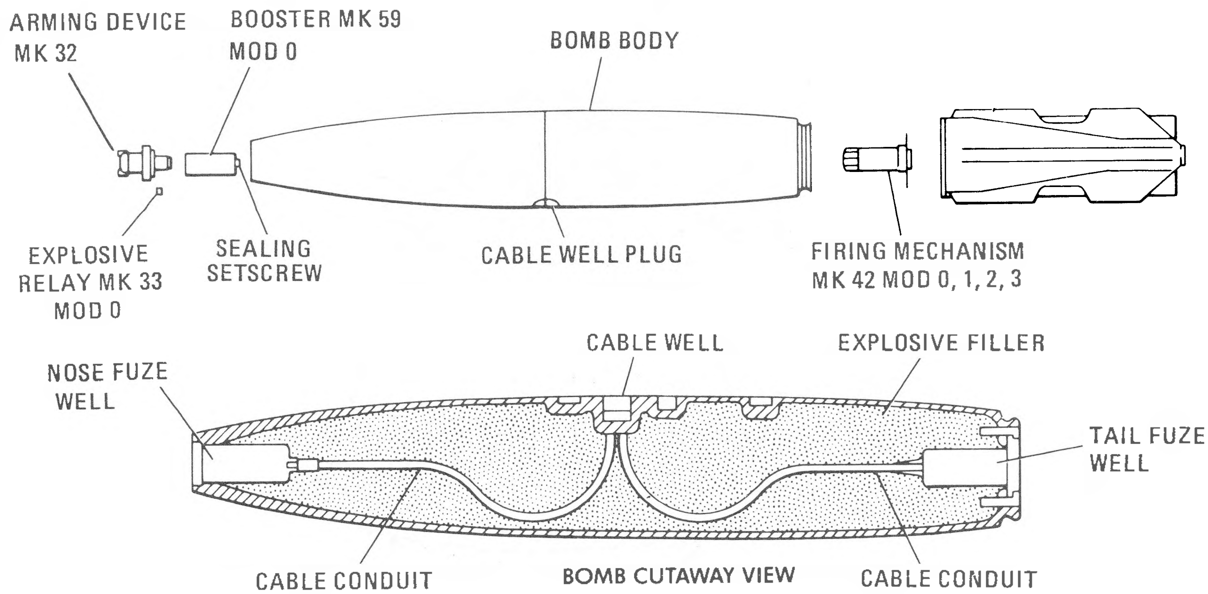


FIGURE 2-30

NOTE

Ballistic data are the same for both the MK 82 Snakeye I and the MK 36 destructor bombs. Ballistic data are the same for both the M117R and the M117D.

MK 32 MOD 1 ARMING DEVICE

The MK 32 Mod 1 arming device (FIGURE 2-31) is a mechanical time-delay device that requires both an airstream (vane arming) and an impact (g sensing) in order to arm. The device provides a fixed delay of 2.16 seconds from the time the last arming wire is withdrawn until enabling of the impact mode. Function delay is controlled by the MK 33 Mod 0 delay system. The actual recorded fuze setting shoud be checked against the briefed setting. Arming wires and lanyards should be checked for proper routing, security, and clip installation.

MK 32 MOD 1 ARMING DEVICE

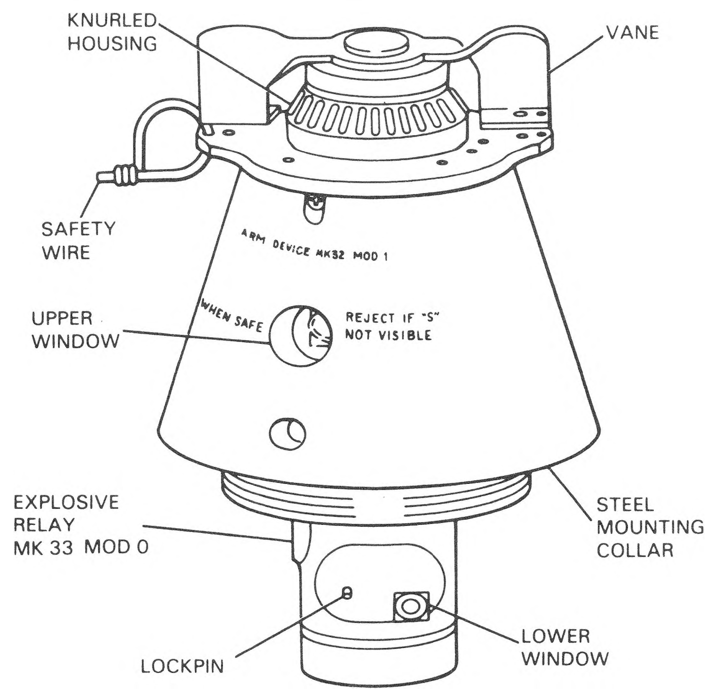


FIGURE 2-31

MK 59 BOOSTER

The MK 59 booster is an explosive device installed in the nose fuze well of the bomb; it explosively links the arming device to the main charge of the bomb.

The MK 59 booster contains three different explosive elements, a MK 70 Mod 0 electric detonator, an explosive lead, and the main charge. The electric detonator is located in the keyway on the side of the well and is electrically connected to the firing mechanism through the bomb M72 cable assembly. The explosive relay of the arming device aligns with the detonator when the arming device is mated with the booster. The explosive lead is located at the base of the well next to the main charge of the booster.

The booster is electrically initiated and functions upon receiving an electrical signal mechanism from the firing mechanism. The signal fires the MK 70 electric detonator in the side of the well. The detonator, in turn, fires the explosive relay. The explosive relay is inserted into the arming device during mine buildup. There is an explosive element in the relay. This explodes and detonates the fixed element that sets off the detonator in the rotor of the arming device. The detonator in the rotor will fire the explosive lead at the base of the well in the booster. The explosive lead sets off the booster main charge which then detonates the main charge of the destructor. If the arming device is not armed, the detonator in the rotor of the arming device will not fire because of its out-of-line condition. Thus, the booster fulfills two explosive functions: it initiates explosive train of the destructor, and it sets off the main charge of the destructor.

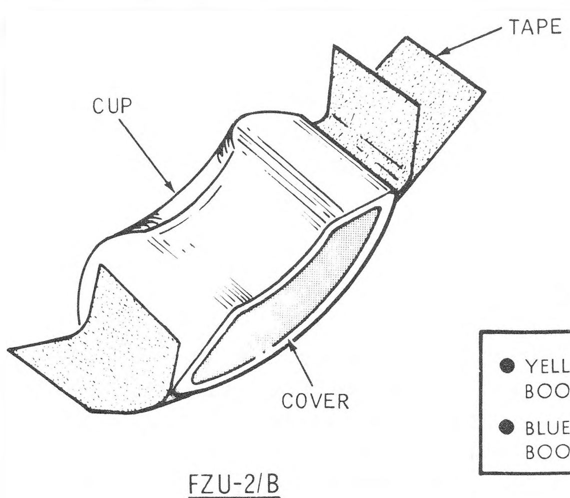
MK 42 FIRING MECHANISM

The MK 42 firing mechanism is initially activated by the opening of the fins (high drag) or by an arming wire being withdrawn (low drag). Either action pulls the pop-out pin, enabling the device. The MK 42, at a selectable time after impact, is sensitive to electromagnetic interference (EMI). The explosive train of the destructor mine is activated when the MK 42 sends an electric signal to the MK 59 booster. Refer to appropriate Aircraft Dash 34 for employment information and related fuzing data.

FZU-1/B FUZE BOOSTER

The FZU-1/B airburst booster (FIGURE 2-32) contains 5 grams of M5 propellant in a metal container topped by a foam filler. The booster is attached to the rear of the fuze subassembly. The booster may have two configurations, with or without an attached holding clip. When initiated by the fuze detonator, the booster propels the fuze which acts in piston-like fashion to open the dispenser.

FZU-1/B AND FZU-2/B FUZE BOOSTERS



Note

- YELLOW BODY IS LIVE BOOSTER
- BLUE BODY IS DUMMY BOOSTER

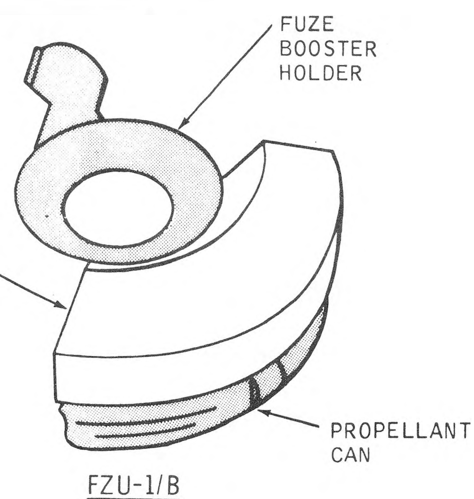


FIGURE 2-32

FZU-2/B FUZE BOOSTER

The FZU-2/B high-explosive booster (FIGURE 2-32) contains RDX explosives. When initiated by the fuze detonator, the booster detonates the bomb. It is used with FMU fuzes installed in GP bombs. It is shaped to fit in a cutout position over the detonator flash hole in the rear of the fuze. When the fuze detonates, the explosion penetrates the seal over the detonator flash hole and explodes the booster to assure the explosion of the bomb filler.

FZU-37A/B INITIATOR

The FZU-37A/B fuze initiator (FIGURE 2-33) is an air-driven turbine power supply that is used with the FMU-112/B. The initiator is installed in the bomb charging well and provides electrical power and interconnection between the fuzes. When the bomb is dropped and the lanyard pulled (exposing the turbine to the airstream), the initiator provides electrical power to the fuzes. A minimum airstream velocity of 200 KCAS is required to start, and a minimum of 140 KCAS is required to sustain turbine generator operation.

FZU-39/B PROXIMITY SENSOR

The FZU-39/B (FIGURE 2-34) is a proximity sensor used on the SUU-64/B (CBU-89/B) and SUU-65/B (CBU-87/B). When activated, the FZU-39/B transmits an omnidirectional signal which it uses to measure the vertical height above ground level. When the measured height above the ground equals the preset function altitude, the sensor sends a fire pulse to the integral fuze, opening the SUU-64 dispenser (FIGURE 2-35). When the preset SUU-65/B function altitude is reached, the FZU-39/B sends a signal for fin cant, causing the dispenser to spin. Upon reaching the selected spin rate setting, the SUU-65/B opens. The pilot has the option of changing from time function to proximity function by arming both the nose and the tail solenoids.

BATTERY FIRING DEVICE

The BFD (FIGURE 2-36) initiates the battery of electrical fuzes upon armed release of the munition. The BFD consists of a machined steel initiator, retaining clip, and lanyard. It replaces the fuze safing plug after the fuze is installed in the munition.

MAU-162 FIRING LANYARD ADJUSTER

The MAU-162A and B/A firing lanyard adjuster (FIGURE 2-37) is used with the FMU-81/B and permits adjustment of the fuze lanyard to variable lengths for attachment to the aircraft bomb rack solenoid. The tie-off block contains three small holes through which the fuze lanyard is threaded to adjust lanyard length. The MAU-162 consists of a lanyard tie-block, pull ring, and shear wire. The shear wire is designed to break, between 80 and 120 pound of pull, leaving the lanyard and tie-block with the munition.

FZU-37A/B FUZE INITIATOR

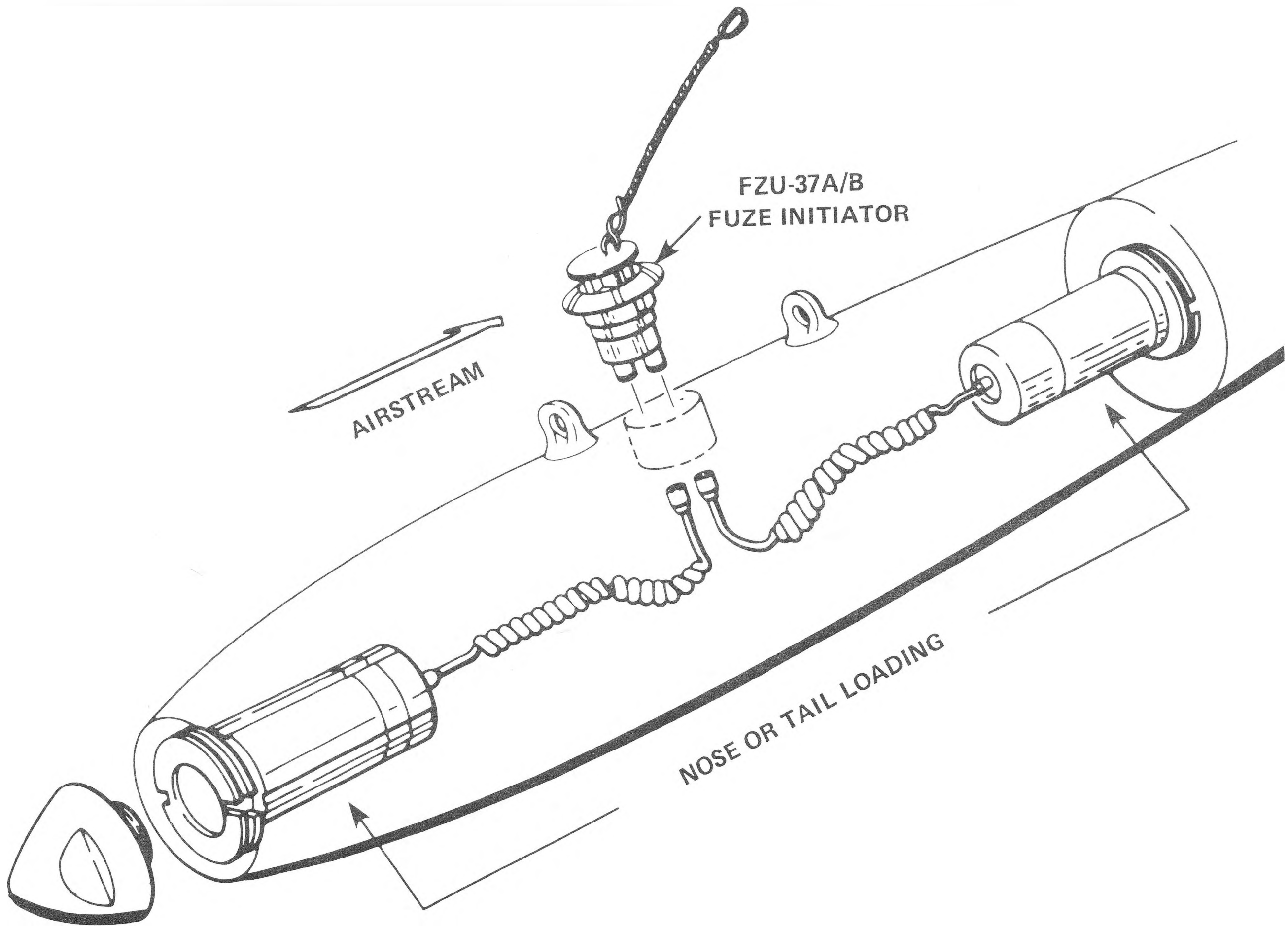


FIGURE 2–33

FZU-39/B PROXIMITY SENSOR

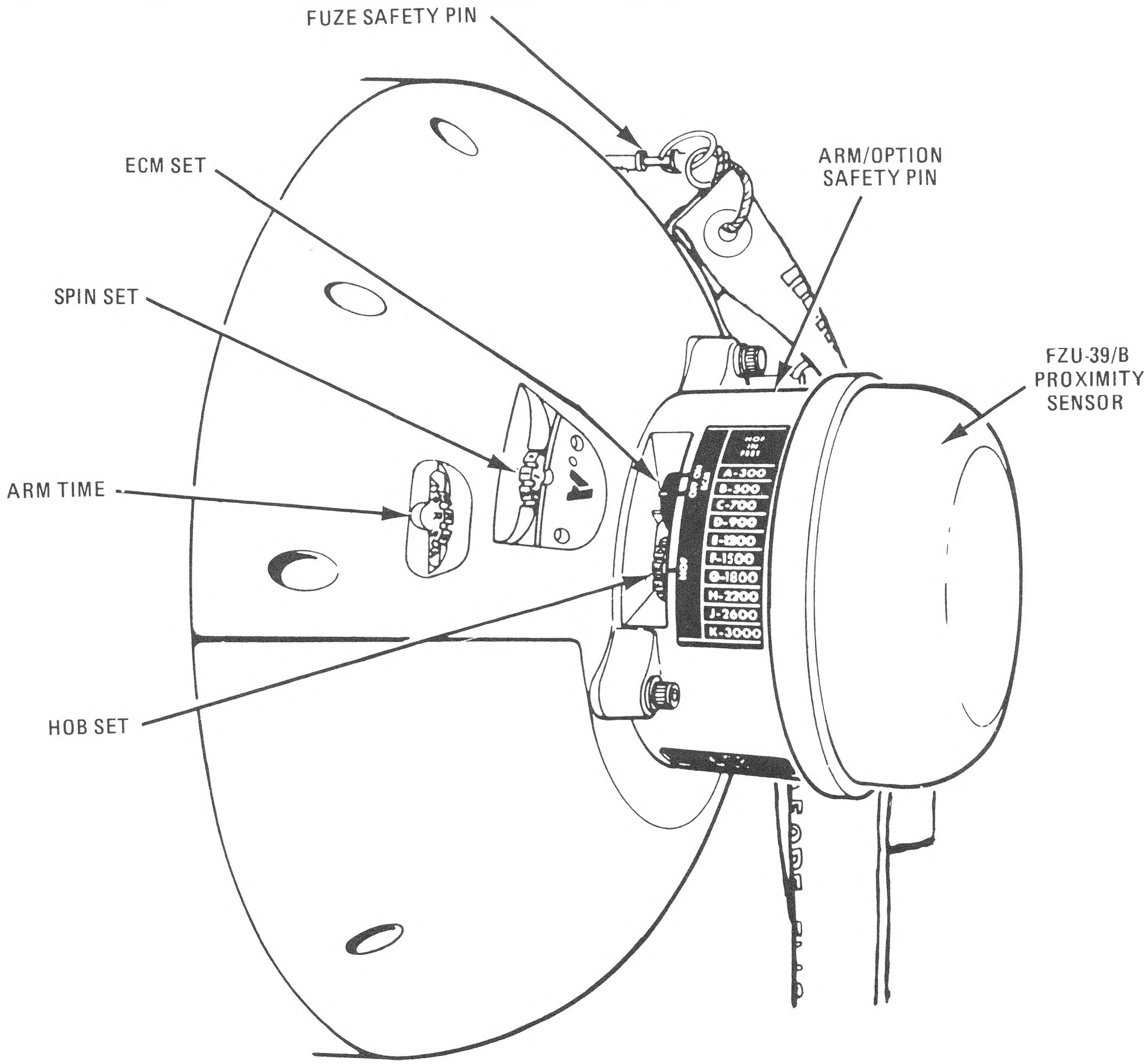


FIGURE 2-34

FZU-39/B SELECTABLE ARMING TIME, HOB, AND SPIN RATE

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

HOB OPTIONS		
SETTING	HOB (FT)	TOLERANCE
A	300	±50
B	500	±50
C	700	±50
D	900	±75
E	1200	±75
F	1500	±75
G	1800	±100
H	2200	±100
J	2600	±100
K	3000	±100

SPIN RATE OPTIONS	
SETTING	RPM
1	0
2	500
3	1000
4	1500
5	2000
6	2500

FIGURE 2-35

BATTERY FIRING DEVICE

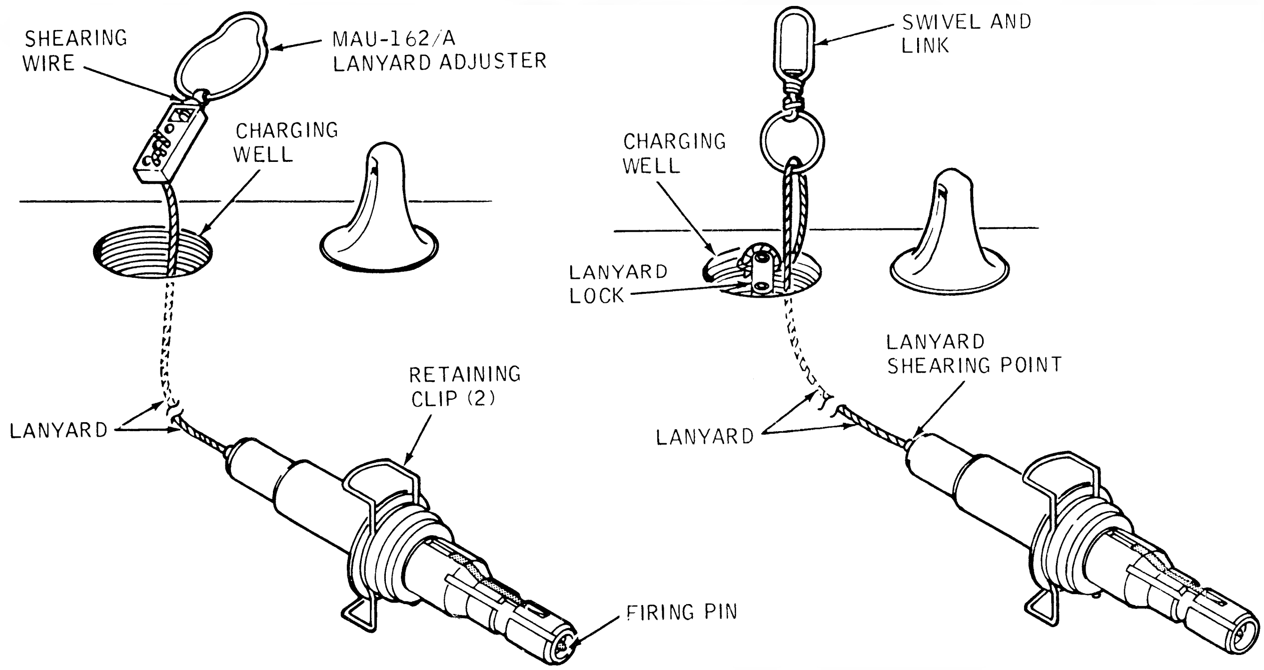


FIGURE 2-36

MAU-162 FIRING LANYARD ADJUSTER

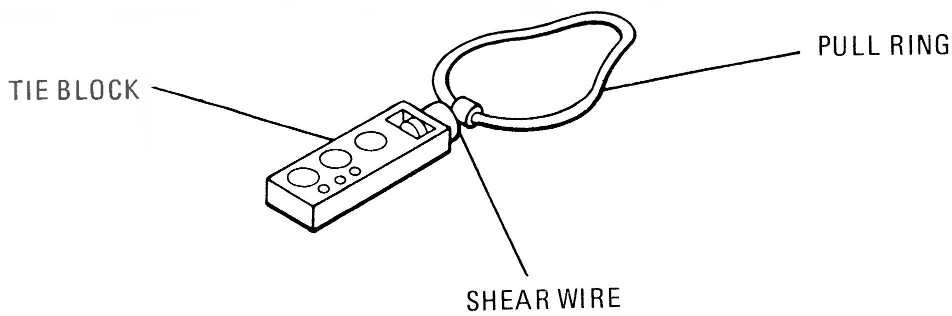


FIGURE 2-37

SWIVEL AND LINK ASSEMBLY

The swivel and link (FIGURE 2-38) is a double-loop assembly that provides the mechanical link between the fuze arming wire/lanyard and the bomb arming solenoid on the aircraft bomb racks.

SWIVEL AND LINK

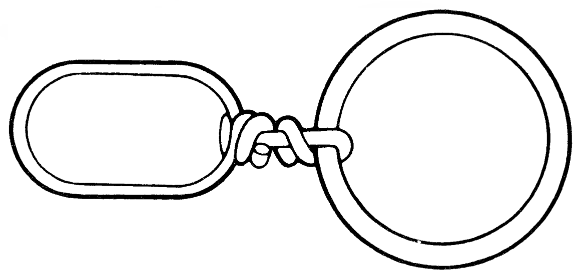


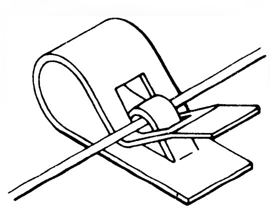
FIGURE 2-38

RETAINING CLIPS

The FZU-17/B (brass Fahnstock) and FZU-18/B (copper beryllium) (FIGURE 2-39) retaining arming wire safety clips are stamped and formed from flat metal. They provide a gripping force through spring tension, to prevent inadvertent extraction of arming wires. The FZU-18/B has a minimum stripping force of 15 pounds, and the FZU-17/B has a stripping force of 2 to 8 pounds.

RETAINING CLIPS

FZU-17/B (FAHNSTOCK)



FZU-18/B (BERYLLIUM)

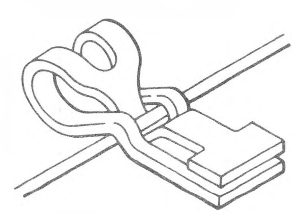


FIGURE 2-39

FUZE/BOMB COMPATIBILITY

<table>
<tr><th>FUZE</th><th>TYPE
(N-NOSE
T-TAIL)</th><th>MUNITION</th><th>SELECTABLE
ARM TIMES</th><th>ARM TIME
TOLERANCE/
INHERENT
DELAY[a]</th><th>FUNCTIONAL
DELAY</th></tr>
<tr><td>FMU-7/B
FMU-7A/B
FMU-7B/B
FMU-7C/B</td><td>N, T</td><td>BLU-1
BLU-27</td><td>0.8 sec
0.6 sec
0.6 sec
0.6 sec</td><td>±0.3 sec</td><td>Instantaneous</td></tr>
<tr><td>FMU-26A/B
FMU-26B/B</td><td>N</td><td>CBU-24
CBU-49
CBU-52
CBU-58
CBU-71</td><td>1.9 to 99.9 sec in 0.5-sec incr</td><td>±0.3 sec</td><td>Airburst, 0.1 sec after arming</td></tr>
<tr><td>FMU-26B/B</td><td>N, T</td><td>MK 82
MK 83
MK 84
M117
M118
GBU-10
GBU-12</td><td>2.0 to 20.0 sec in 2.0-sec incr</td><td>± 0.3 sec</td><td>Impact, selectable 0,0.01,0.02, 0.05,0.10,and 0.25 sec (greater of 10% or 0.002 sec)</td></tr>
<tr><td>FMU-54/B</td><td rowspan="2">T</td><td rowspan="2">MK 82 SE
MK 82 AIR
MK 84 AIR
M117R</td><td>0.75 to 3.5 sec in 0.25-sec incr</td><td rowspan="3">±10%
Inherent delay (sec)
KTAS delay</td><td rowspan="2">Instantaneous only</td></tr>
<tr><td>FMU-54A/B</td><td>2.5 to 6.0 sec in 0.25-sec incr</td></tr>
<tr><td>FMU-54A/B with MK 43 TDD</td><td>T
N</td><td>MK 82 SE</td><td>2.5 to 6.0 sec in 0.25-sec incr</td><td>Instantaneous at 16 ft AGL</td></tr>
<tr><td>FMU-56B/B
FMU-56D/B</td><td>N</td><td>CBU-24
CBU-49
CBU-52
CBU-58
CBU-71</td><td>3,4,5,6,7, 8,9,10, and 18 sec</td><td>Greater of 10% or 0.5 sec</td><td>Airburst, selectable 250,500,800, 1100,1500,1800, 2000,2200,2500, and 3000 ft AGL</td></tr>
<tr><td colspan="6">[a] Used to determine vertical drop for fuze arming when arm times are selected which do not appear in safe escape/safe separation charts.</td></tr>
</table>

FIGURE 2-40 (Sheet 1 of 4)

RELEASE AS MIN/MAX	METHOD OF FUNCTION	METHOD OF ARMING	ACCESSORIES	SAFE SEPARATION
	Impact	Electric	AN-M23A1 igniter	No
	Time	Electric	A/B:FZU-1/B B/B:FZU-1/B	No
	Time	Electric	B/B:FZU-2/B	No
MK 82 SE: Min 330 KCAS MK 82 AIR: min 330 KCAS MK 84 AIR: min 550 KCAS M117 min 175 KCAS	Impact	Inertia		No
				No
	Proximity (impact backup)	Inertia	MK 43 TDD	Yes
All CBU min 150 KCAS (munition velocity)	Proximity	Electric	FZU-1/B	No

FIGURE 2-40 (Sheet 1 of 4 continued)

FUZE	TYPE (N-NOSE T-TAIL)	MUNITION	SELECTABLE ARM TIMES	ARM TIME TOLERANCE/ INHERENT DELAY[a]	FUNCTIONAL DELAY
FMU-72/B	N, T	MK 82 MK 83 MK 84	6.0 sec	+1.5 to -1.0 sec	Selectable 20-min incr from 20 min to 5 hr; 1-hr incr from 5 to 16 hr; 2-hr incr from 16 to 30 hr; 3-hr incr from 30 to 36 hr
FMU-81/B	N, T	GBU-10 GBU-12	4,5,6,7,8, 10,12,14, and 20 sec	±5%	Selectable 0,0.01,0.02, 0.05,0.10, and 0.25 sec
FMU-107	N	M129	4.5 sec	Not specified	Selectable 13 to 92 sec
M909			See M907		See M907
AN-M147A1			4.5 sec		Selectable 5 to 92 sec 0.5-sec incr
FMU-110/B	N	CBU-24 CBU-49 CBU-52 CBU-58 CBU-71	3,4,5,6,7,8, 9,10, and 18 sec and SAFE	Greater of ±10% or ±0.5 sec	Airburst, selectable 300,500,700, 900,1200,1500, 1800,2200,2600, and 3,000 ft AGL
FMU-112/B	N, T	MK 82 MK 82 SE MK 82 AIR MK 84 MK 84 AIR GBU-10 GBU-12	Unretarded: 4,5,6,7,10,14 and 20 sec or 6 sec if 6/4 selected Retarded: 2.6 sec or 4 if 6/4 selected	±5% Inherent delay: 0.3 sec	Selectable 0, 0.005,0.01 0.025,0.05,0.10 and 0.2 sec

[a] Used to determine vertical drop for fuze arming when arm times are selected which do not appear in safe escape/safe separation charts.

FIGURE 2-40 (Sheet 2 of 4)

RELEASE AS MIN/MAX	METHOD OF FUNCTION	METHOD OF ARMING	ACCESSORIES	SAFE SEPARATION
	Impact	Electric		No
Min 100 KTAS Max 600 KTAS	Impact	Electric	FZU-2/B MAU-162	No
	Time	Vane		No
Min 120 to 184 KCAS (municicn velocity)	Proximity	Electric	FZU-1/B	No
Min 200 KCAS	Impact	Electric	FZU-37A/B	No

FIGURE 2-40 (Sheet 2 of 4 continued)

FUZE	TYPE (N-NOSE T-TAIL)	MUNITION	SELECTABLE ARM TIMES	ARM TIME TOLERANCE/ INHERENT DELAY[a]	FUNCTIONAL DELAY
FMU-113/B	N	MK 82 MK 84 M117	5,6,7,8,9, 10, and 18 sec	±10% Inherent delay: 0.5 sec	0 to 25 ft AGL (15 ft AGL nominal)
FMU-124/B	N, T	GBU-15	5.5 or 12 sec	Not specified	Selectable 0,0.01,0.025 sec
MK 339 MOD 0	N	MK 20 SUU-30	1.1 sec	±0.1 sec	Selectable 1.2 to 50 sec in 0.1-sec incr
MOD 1					Selectable 1.2 to 100 sec in 0.1 sec incr
M904E1	N	MK 82 LD MK 82 SE MK 82 AIR MK 84 MK 84 AIR MK 83 M117 M118 MC-1	4,6,8,12,16, and 20 sec	±20% Inherent delay for all M904 fuzes (high drag only) SE: 0.3 sec AIR: delay is airspeed-dependent	Selectable 0,0.01,0.025, 0.05,0.1, and 0.25 sec
M904E2			2 to 18 sec in 2.0-sec incr	±10%	
M904E3					

[a] Used to determine vertical drop for fuze arming when arm times are selected which do not appear in safe escape/safe separation charts.

FIGURE 2-40 (Sheet 3 of 4)

RELEASE AS MIN/MAX	METHOD OF FUNCTION	METHOD OF ARMING	ACCESSORIES	SAFE SEPARATION
Min 250 KCAS	Proximity (impact backup)	Air turbine powered alternator	FZU-2/B	Yes
	Impact	Electric	ADU-421A/B	No
Min 224 KCAS	Time	Vane		No
Min 150 KCAS/ Max 600 KCAS	Impact	Vane	M148/T45 booster M1 and M1A1 extender	No

FIGURE 2-40 (Sheet 3 of 4 continued)

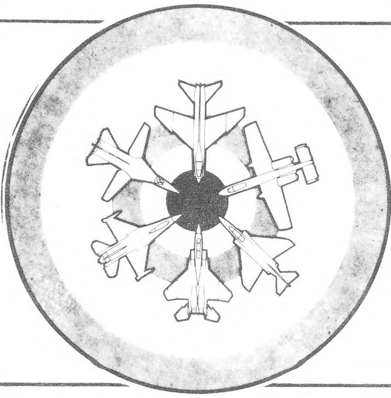
FUZE	TYPE (N-NOSE T-TAIL)	MUNITION	SELECTABLE ARM TIMES	ARM TIME TOLERANCE/ INHERENT DELAY[a]	FUNCTIONAL DELAY
M905	T	MK 82 LD MK 82 AIR MK 84 LD MK 84 AIR MK 83 M117 M118 MC-1 GBU-10 GBU-12	4,6,8,12,16, and 20 sec	±20%	Selectable 0,0.01,0.025 0.025,0.1, and 0.25 sec
M907	N	CBU-24 CBU-49 CBU-52 CBU-58 CBU-71	1/2 of function delay when greater than 4 sec; 1.5 sec for 4-sec function delay		Selectable 4 to 92 sec in 0.5-sec incr

[a] Used to determine vertical drop for fuze arming when arm times are selected which do not appear in safe escape/safe separation charts.

FIGURE 2-40 (Sheet 4 of 4)

RELEASE AS MIN/MAX	METHOD OF FUNCTION	METHOD OF ARMING	ACCESSORIES	SAFE SEPARATION
Min 150 KCAS/ Max 600 KCAS	Impact	Vane	M148/T45 booster ATU-35 w/MAU-86/B and MAU-87/B	No
Min 100 KCAS/ max 600 KCAS (decreased reliability below 175 KCAS)	Time	Vane		No

FIGURE 2-40 (Sheet 4 of 4 concluded)



SECTION III
SPECIAL EQUIPMENT

CONTENTS

CONTENTS (CONCLUDED)

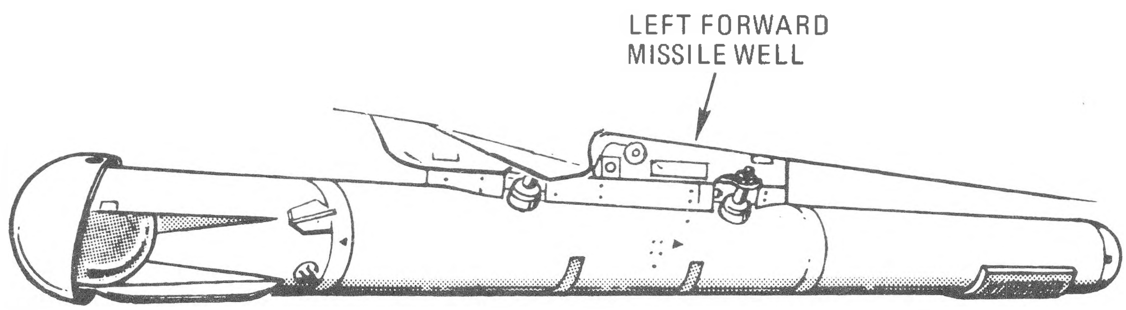
AN/AVQ-23A/B PAVE SPIKE POD

NOTE

This information is provided for aircrews of non-PAVE SPIKE aircraft.

The PAVE SPIKE pod (FIGURE 3-1) is an electro-optical laser designator pod used with selected F-4D and F-4E aircraft. It provides laser illumination and continuous, accurate, angular position and range to selected day-visual targets. The pod may be used to designate for a parent-released [laser-guided bomb (LGB)] or to buddy-lase for a non-PAVE SPIKE aircraft. In addition, the PAVE SPIKE may be used to improve conventional bomb delivery accuracy or to enhance navigation updates on visual check-point.

AN/AVQ-23A/B PAVE SPIKE POD



CHARACTERISTICS

WEIGHT	422 LB
LENGTH	12 FT
DIAMETER	10 IN.

Figure 3-1

The PAVE SPIKE may be operated independently, or it can be completely integrated with the aircraft's weapon release computer set, thereby taking advantage of radar target acquisition, offset target acquisition, automatically computed weapon release, and target memory. When integrated with the aircraft, the system is the AN/ASQ-153(V)-3 Target Designator System.

Basic integrated operation of the Target Designator System consists of the following:

1. Acquiring a selected target, using visual or radar-aided cueing

2. Identifing the target on the cockpit television (TV) display and initiating track and laser ranging, to provide accurate target position information for weapon release and laser illumination for LGB guidance

3. Using the attack steering commands for more accurate release of the weapon

4. Continuously tracking the target during the escape maneuver to provide laser designation of the target until bomb impact.

The PAVE SPIKE pod is carried in the left forward AIM-7 missile well of the F-4D or F-4E aircraft. It contains a laser transmitter, a TV camera, an optical system, a beam-pointing and stabilization system, an environmental control system, and a laser coding system.

POD STRUCTURE

The nose of the pod has a glass dome which is protected by a visor when the pod is stowed. The visor is rotated upward, under the aircraft surface when the pod is in use. The visor protects the dome during supersonic flight and flight through rain. The visor contains a heater to minimize icing in the window area. The pod nose compartment is pressurized with nitrogen and contains a heat exchanger to control humidity and temperature. A plunger-type indicator provides preflight inspection of the nitrogen pressure.

The pod nose section is connected to, and rolls with, the sensor assembly. The sensor assembly is covered by an inner shell. The inner shell is mounted on bearings within the outer shell and driven by a roll drive motor. The outer shell supports the forward mounting lug.

The pod middle section contains the umbilical plugs, the mounting lugs, and access doors to the electrical and cooling connections. The pod aft section outer shell covers the laser power supply and the electronics assembly, and it can be removed with the pod mounted on the aircraft. A surface heat exchanger is attached to the outside surface of the aft shell. An aft end cap provides access to the phase-change, material-status indicator (an environmental sensor), the elapsed time meter, the laser pulse counter, and various hydraulic connectors.

LASER SYSTEM

The laser system includes a laser transmitter, a laser receiver, and the laser coder control unit.

The laser transmitter produces a narrow beam of pulsed laser energy. The beam is used for LGB guidance. The pulses are also used to measure slant range. The laser pulses are produced in the transmitter by a xenon flash-lamp which serves as the pump source for the laser rod.

The laser receiver detects each laser pulse reflected from the target and sends an amplified signal to the range circuits in the laser control electronics. The range circuits provide accurate range to the last target detected in the range window. The laser-derived slant range is compared with a computer slant range derived from aircraft system inputs. The laser range is rejected if it appears invalid. Laser transmitter cooling is accomplished by circulating a coolant (flurocarbon mixture) through cavities around the flash-lamp and laser rod. The heat generated by the laser transmitter is passed to a heat exchanger in the pod nose section.

TV CAMERA SYSTEM

The TV image presented on the scope is held relatively constant over a wide range of light levels. The stabilization and beam pointing system keeps the view stabilized during aircraft buffet.

OPTICAL SYSTEM

The optical system (FIGURE 3-2) couples the laser transmitter, laser receiver, TV camera, TV field-of-view (FOV) selection, TV reticle, and line-of-sight (LOS) beam-pointing and stabilization. The TV LOS and laser LOS are boresighted together and pointed by using a gyro-stabilized gimbaled mirror.

LOS coverage and gimbal limits are shown in FIGURE 3-3. The LOS limits are reduced further by obscuration caused by aircraft stores.

AN/AVQ-23A/B PAVE SPIKE OPTICAL SYSTEM

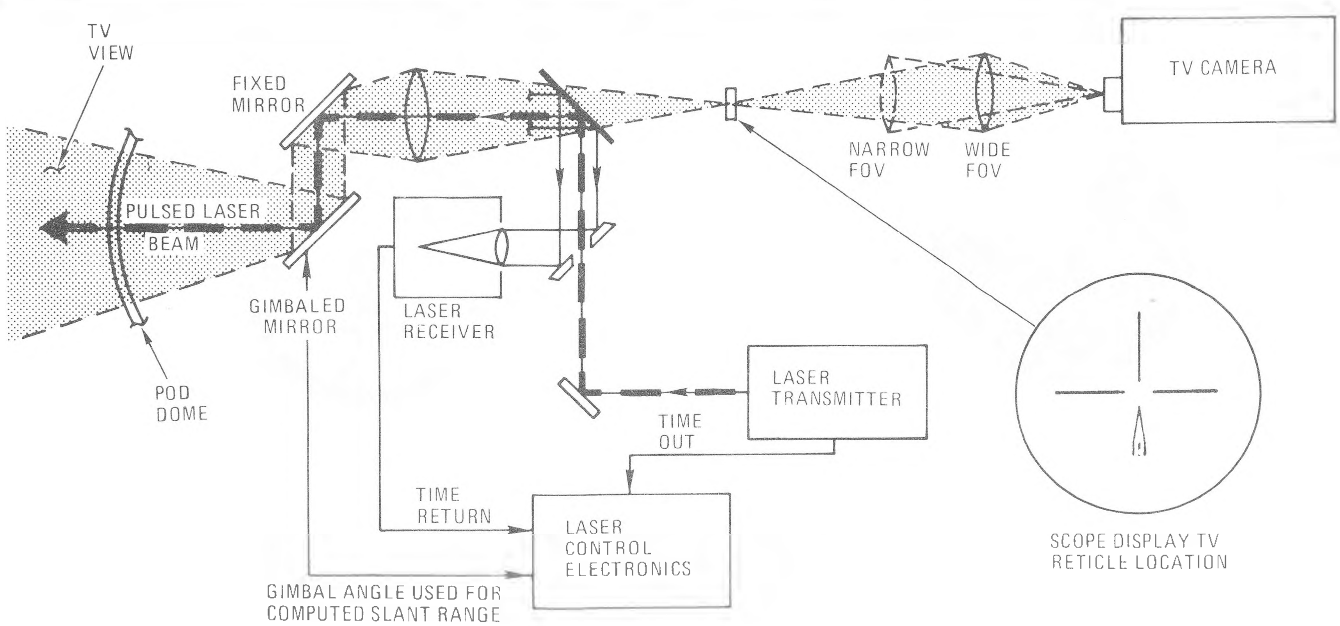
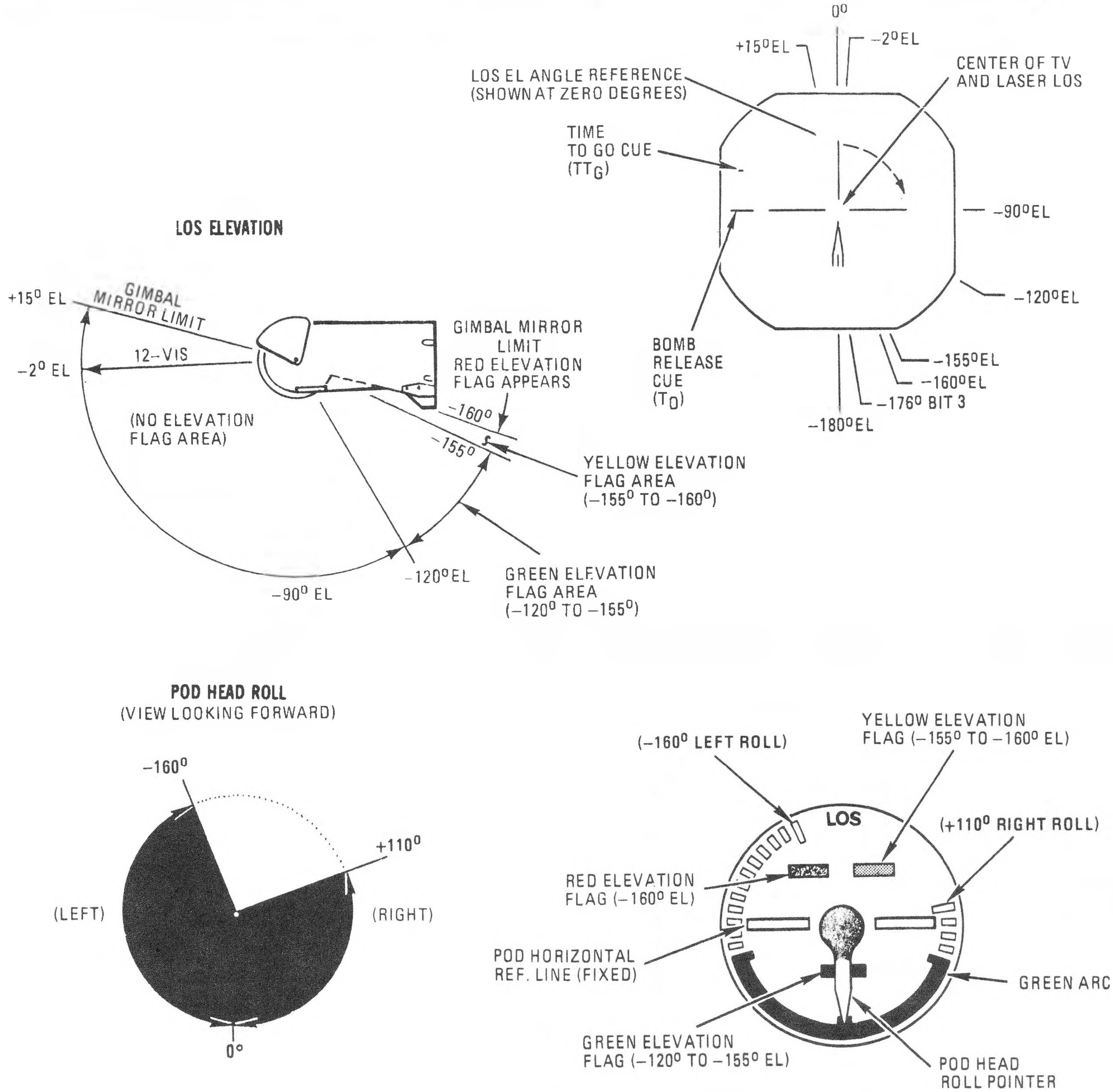


Figure 3-2

AN/AVQ-23A/B PAVE SPIKE LOS/GIMBAL LIMITS



NOTE

WHEN GREEN ELEVATION FLAG IS UP, POD HEAD ROLL POINTER MUST BE IN GREEN ARC.

FIGURE 3–3

STABILIZATION AND BEAM POINTING SYSTEM

Inputs to the stabilization and beam-pointing system are obtained from the aircraft inertial navigation system (INS), the weapons release computer set, and the antenna hand control. During acquisition mode, the system receives LOS positioning commands. During track mode, the system receives rate commands. The rate commands induced by antenna hand control movements permit continuous tracking of a target.

AN/AVQ-26 PAVE TACK POD

NOTE

This information is provided for aircrews of non-PAVE TACK aircraft.

The PAVE TACK pod (FIGURE 3-4) is an imaging infrared (IR), day and night, laser designator pod used with the F-111F and AN/ARN-101 equipped F-4E and RF-4C aircraft. It provides a 24-hour, adverse weather delivery system. Capabilities include navigation updating, enhanced target recognition, precise target tracking, and target position definition for precision weapon delivery. The pod may be used to designate for a parent-released LGB or to buddy-lase for a non-PAVE TACK aircraft.

The pod contains an IR detecting set (IDS) which provides high-resolution, thermal imaging. The IDS senses the radiated IR energy and converts it into a video signal which in turn provides a TV display in the cockpit.

The PAVE TACK pod assembly (FIGURE 3-5) is composed of two major sections: (1) a rotating head section and (2) a fixed-base section. The head section contains a turret with an optical bench which supports the mirror control assembly, the AN/AAQ-9 IDS, the AN/AVQ-25 laser rangefinder/target designator, and the optical assembly. The turret has a pod window assembly which includes an IR filter for transmission of the IDS wavelengths and two glass windows for the laser transmit and receive beams. The turret rotates about the pitch axis of the head section to follow the target LOS in pitch, while the entire head section rotates about the longitudinal axis of the pod (in roll), allowing the sensor-window assembly to follow the target LOS throughout the full lower hemisphere.

The base section, mounted to the aircraft via the pod adapter, houses the necessary electronics and power supplies to operate the pod. The base structure consists of a thin shell with major bulkheads and frames to carry the pod loads and support line-replaceable units (LRU). The LRUs are readily accessible for service and maintenance through structural access doors. Space has also been allocated in the base section for installation of a video tracker and a video recorder at a later date. The forward portion of the nose section is an aerodynamic fairing.

The base section contains the following LRUs:

1. Digital computer

2. Signal generator

3. Target designator pod control

4. Electronic control amplifier

5. Power supply

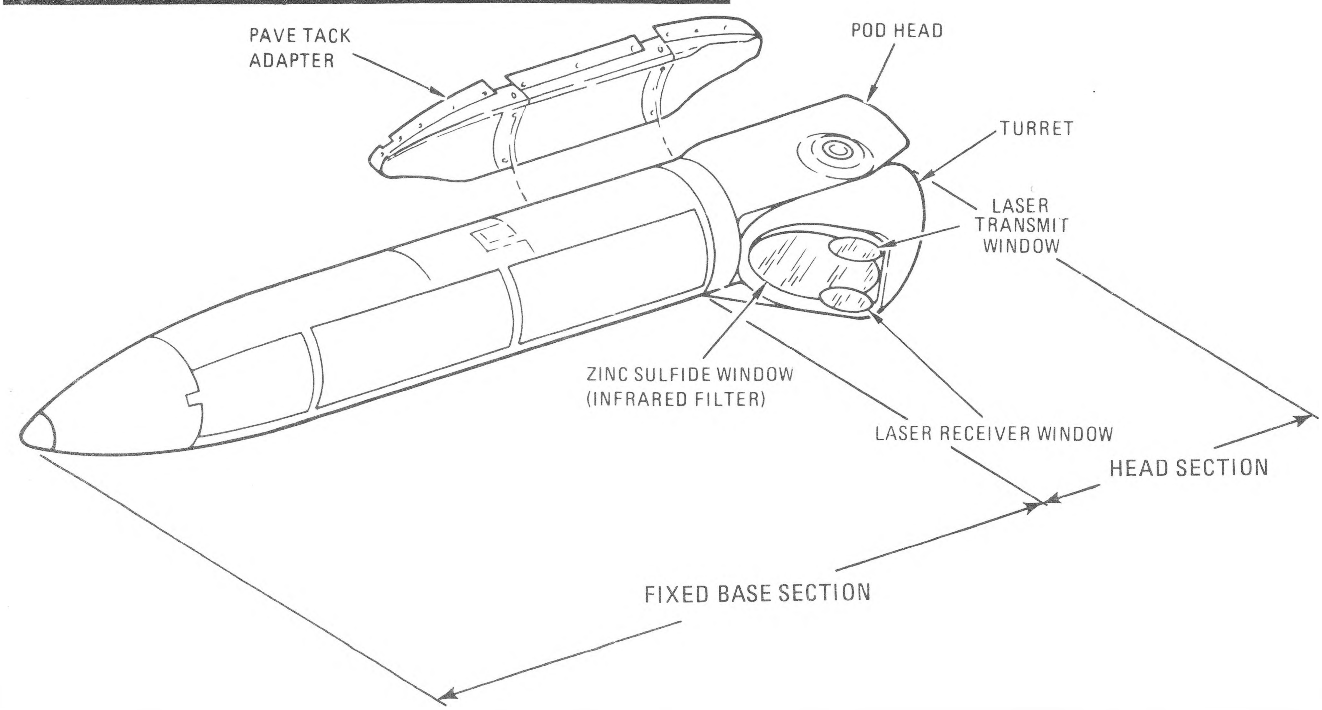
6. Laser power supply

7. IDS power supply

8. Power distribution panel

9. Environmental control unit.

AN/AVQ-26 PAVE TACK POD



CHARACTERISTICS

LENGTH	163 IN.
DIAMETER	20 IN.
WEIGHT: PAVE TACK POD	1277 LB
POD ADAPTER	70 LB

FIGURE 3-4

PAVE TACK POD ASSEMBLY

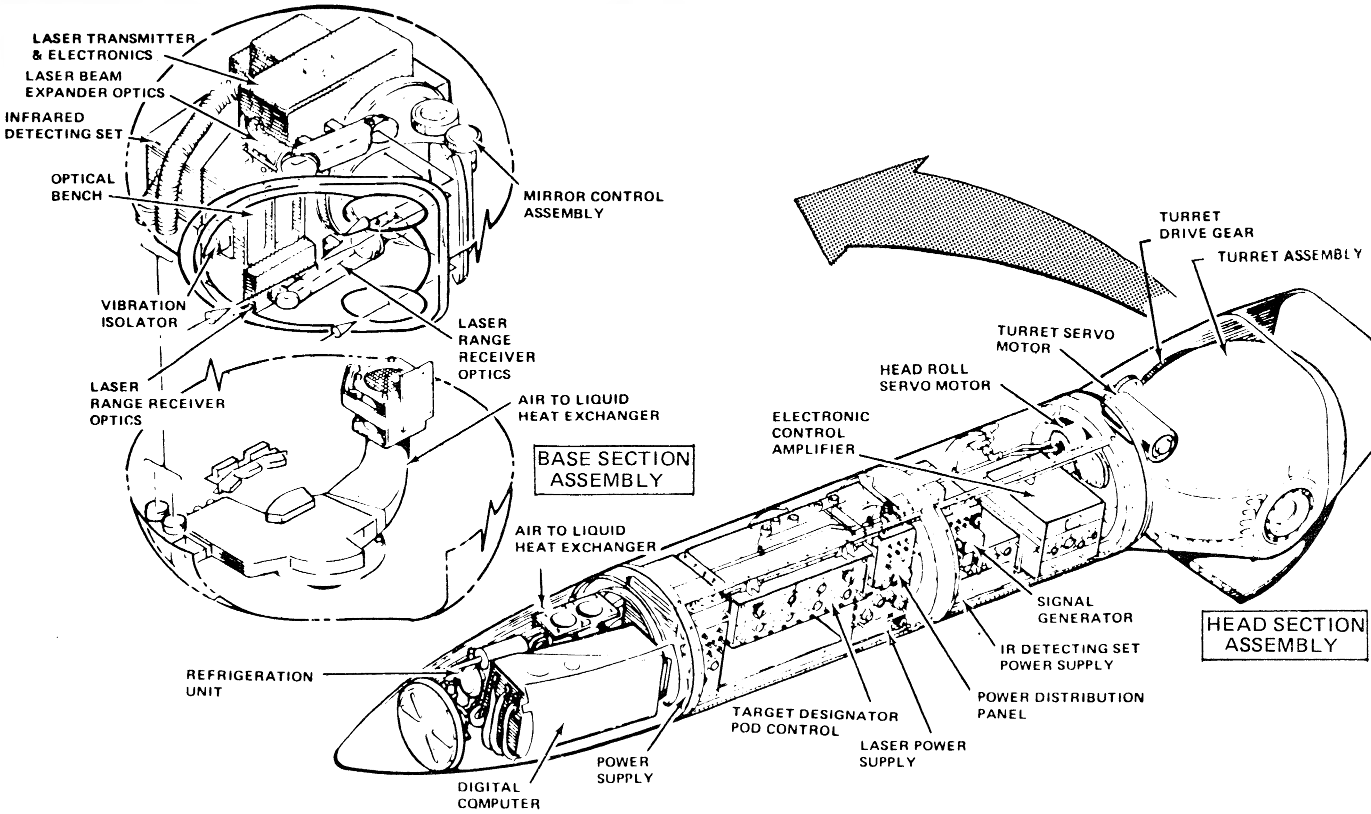


Figure 3-5

The head section consists of two assemblies: a fixed transition assembly, which is joined to the base section, and a rotating turret assembly.

The transition assembly contains the head roll servo gear train which drives a ring gear to produce roll motions of the head. Roll motion is provided through a bearing set located at the interface with the rotating head. This head structure extends aft and carries the pitch turret on a bearing axis aligned perpendicular to the head roll axis. A pitch servo and gear train drives a pitch gear located on the perimeter of the turret.

The turret assembly, which includes the entire PAVE TACK optical system, is ball-shaped with a flat surface formed by the pod window assembly. The turret has removable sections which allow installation and removal of internal equipment. An optical bench is mounted within the turret, and all electro-optical components are supported by this bench which, in turn, is mounted on an isolation system to attenuate input turret shock and vibration environments.

The head section assembly consists of a designator head section which supports the turret section, plus a strut assembly, a pitch and roll drive assembly, and head fairings. The primary function of the head section is to provide precision pointing and stabilization over the entire lower hemisphere coverage region. Hence, it contains the necessary windows, gimbals, optics, sensors, and electronic elements which must rotate with respect to the pod base section. The major elements within this assembly are as follows:

1. Turret assembly
2. Mirror control assembly
3. Infrared detecting set
4. Laser rangefinder/target designator (optics/electronics)
5. Head structure and cabling.

The laser rangefinder/target designator produces a narrow beam of pulsed laser energy. The beam makes an invisible spot on the target to which the laser guided bombs home. The laser receiver detects each laser pulse reflected from the target and determines slant range. The laser is compatible with present laser coding systems.

AN/AA-35(V)(1) TARGET IDENTIFICATION SET, LASER(TISL) OR PAVE PENNY

NOTE

This information is provided for aircrews of non-PAVE PENNY aircraft.

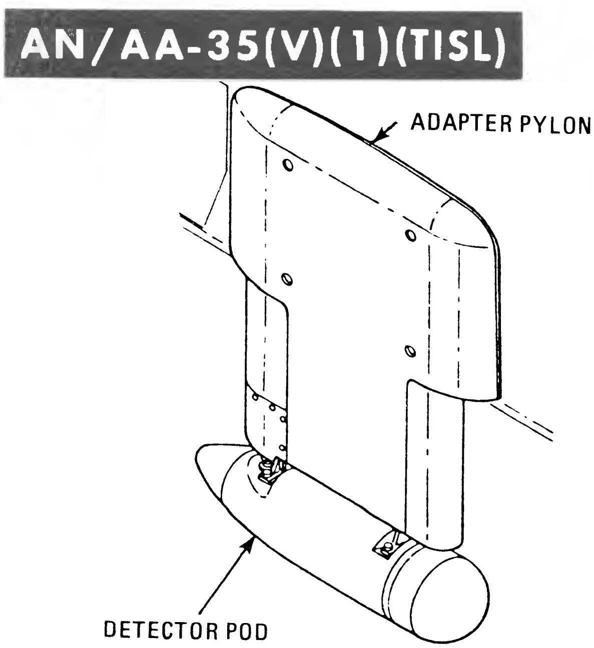


FIGURE 3-6

The TISL (PAVE PENNY) is a forward-looking laser seeker and tracker system. The system consists of a laser illumination detector pod, adapter control detector (ACD), and control panel. The detector pod is attached to an adapter pylon and weighs 32 pounds (FIGURE 3-6). The TISL system function is to search for coded laser energy reflected from a target illuminated by a coded laser designator, to lock on and track, and to provide a target location indicator to the aircraft avionics systems. The target location indicator is presented on the head-up display (HUD) and/or the attitude director indicator (ADI).

AN/PAQ-1 LASER TARGET DESIGNATOR (LTD)

The LTD (FIGURE 3-7) is a snub-nosed, rifle-like laser designator weighing approximately 16 pounds. It is used by a forward observer to designate targets. The laser energy can be used to designate for LGBs or to illuminate the target for PAVE PENNY equipped aircraft. (See FIGURE 3-10 for system parameters.)

AN/PAQ-1 LTD

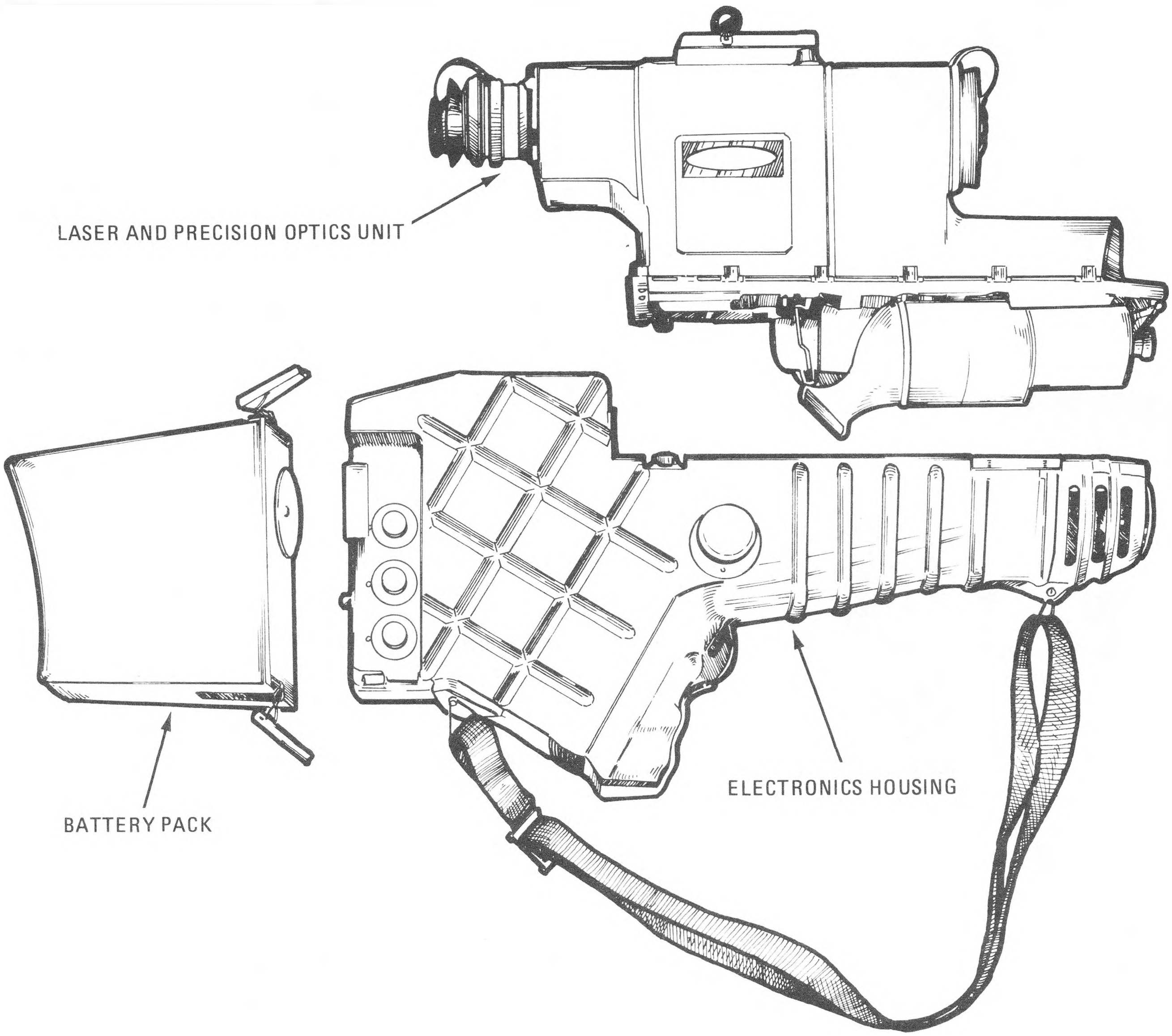


FIGURE 3-7

NOTE

Continuous operation is limited to 1 minute to prevent overheating of the LTD battery.

AN/PAQ-3 MULE

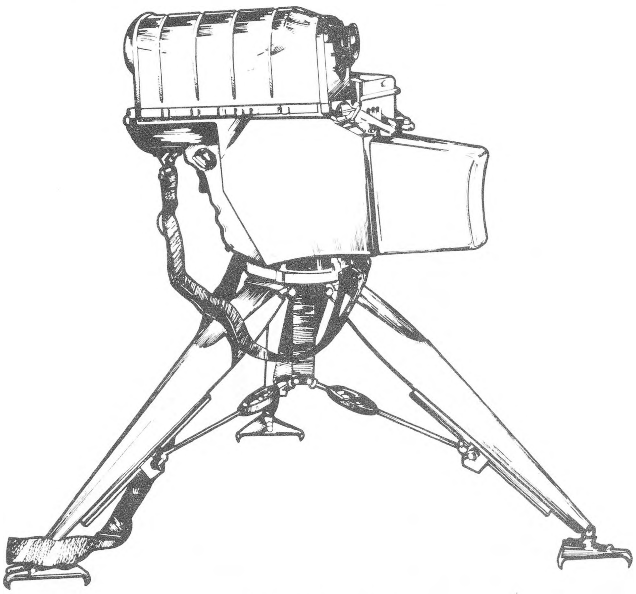


FIGURE 3-8

G/VLLD

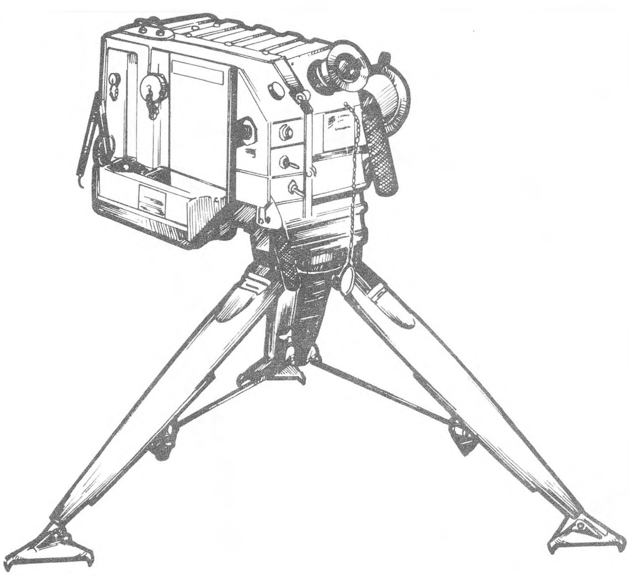


FIGURE 3-9

AN/PAQ-3 MODULAR UNIVERSAL LASER EQUIPMENT (MULE)

The MULE (FIGURE 3-8) laser designator/rangefinder is a precision target locator for conventional artillery. It furnishes range, azimuth, and elevation data on moving and stationary targets. It can be used by forward observers to designate the target. The laser energy can be used to designate for LGBs or to illuminate the target for PAVE PENNY equipped aircraft. With an AN/TAS-4 night sight added, the system can operate under reduced visibility conditions. The MULE weighs 38.5 pounds. (See FIGURE 3-10 for system parameters.)

GROUND OR VEHICULAR LASER LOCATOR DESIGNATOR (G/VLLD)

The G/VLLD (FIGURE 3-9) is a precision target locator and detector. It furnishes range, elevation, and azimuth of moving and stationary targets. Laser energy can be used to designate for LGBs or to illuminate the target for PAVE PENNY equipped aircraft. It may be used by forward observers or mounted on vehicles and, with the attachment of an AN/TAS-4 night sight, it is operational under reduced visibility conditions. The unit and tripod assembly weigh 61 pounds. See FIGURE 3-10 for system parameters.

A/A 37U-15 TOW TARGET SYSTEM

The A/A 37U-15 tow target system (FIGURE 3-11) consists of a tow reel pod, a tow reel, a boom and launcher for installing the TDU-10/B, and facilities for incorporating a parachute recovery system for the target. The tow system has the

LTD, MULE, G/VLLD SYSTEM PARAMETERS

DESIGNATION AND RANGEFINDING	LTD	MULE	G/VLLD
Designation range - Stationary target (NM) (km)	(2.7) (5)	(3.8) (7)	(4.9) (9)
Designation range - Moving target (NM) (km)	(1.9) (3.5)	(2.7) (5)	(3.5) (6.5)
Minimum target size (meters per kilometers of range). Size = 2 x range x tan (B/2)	0.50	0.25	0.13
Standard target size (meters)	2.3 by 2.3	2.3 by 2.2	2.3 by 2.3
Beam divergence, B, maximum (microradians)	500	250	130
MISCELLANEOUS			
Setup time (minutes)	0	<3	<5
CODING			
Type	PRF	PRF	PRF
Limits (pulses/second)	9 to 20	9 to 20	9 to 20
OPERATOR MANNING			
Transportation (No. of personnel)	1	2	2
Operation (No. of personnel)	1	1	1
TRANSMITTER PERFORMANCE			
Laser type	Neodymium (YAG)	Neodymium (YAG)	Neodymium (YAG)
Wavelength	1.06	1.06	1.06
Pulse width (nanoseconds)	10 to 30	15 to 25	15 to 25
Emitted energy (millijoules)	>80	>80	>100
Pulse repetition frequency - Nominal (pulses/second)	10 to 20	10 to 20	10 to 20
Beam divergence (microradians)	500	250	130
Diameter of output beam (inches)	2	3	4

FIGURE 3-10

following capabilities: target launch, cable reel-out, tow, and cable cut. Normal aircraft conventional weapon controls are used for these functions.

BOOM AND LAUNCHER

The boom and launcher, attached to the side of the adapter, provide mounting facilities for the tow target. The boom and launcher hold the target until launch. A nose guide channel holds the nose of the target and keeps the target stable during flight.

PARACHUTE RECOVERY SYSTEM

A parachute recovery system may be used to recover the tow target. The parachute and canister are attached to the aft end of the pod by cloth tape. The cable is attached to the parachute canister which, in turn, is attached to a 15-foot nylon rope. The rope is attached to a bridle loop cable on the tow target. When cut, the falling cable drags behind the target, causing the parachute canister to tumble 180 degrees. The canister reversal allows the wind pressure to move aerodynamically operated levers which release the canister lid. The lid acts as a drogue and deploys the recovery parachute.

TOW REEL

The tow reel, mounted in the center section of the tow reel pod, is a one-way reel capable of carrying approximately 2,300 feet of 11/64-inch cable or 5,000 feet of 1/8-inch cable. Cable reel-out speed is controlled by a self-energized inertial brake acting on the one-way wheel drum. The brake is operated by a centrifugal force built up in flyweights on the drum. A duct admits ram air through the nose of the pod to cool the tow reel braking unit.

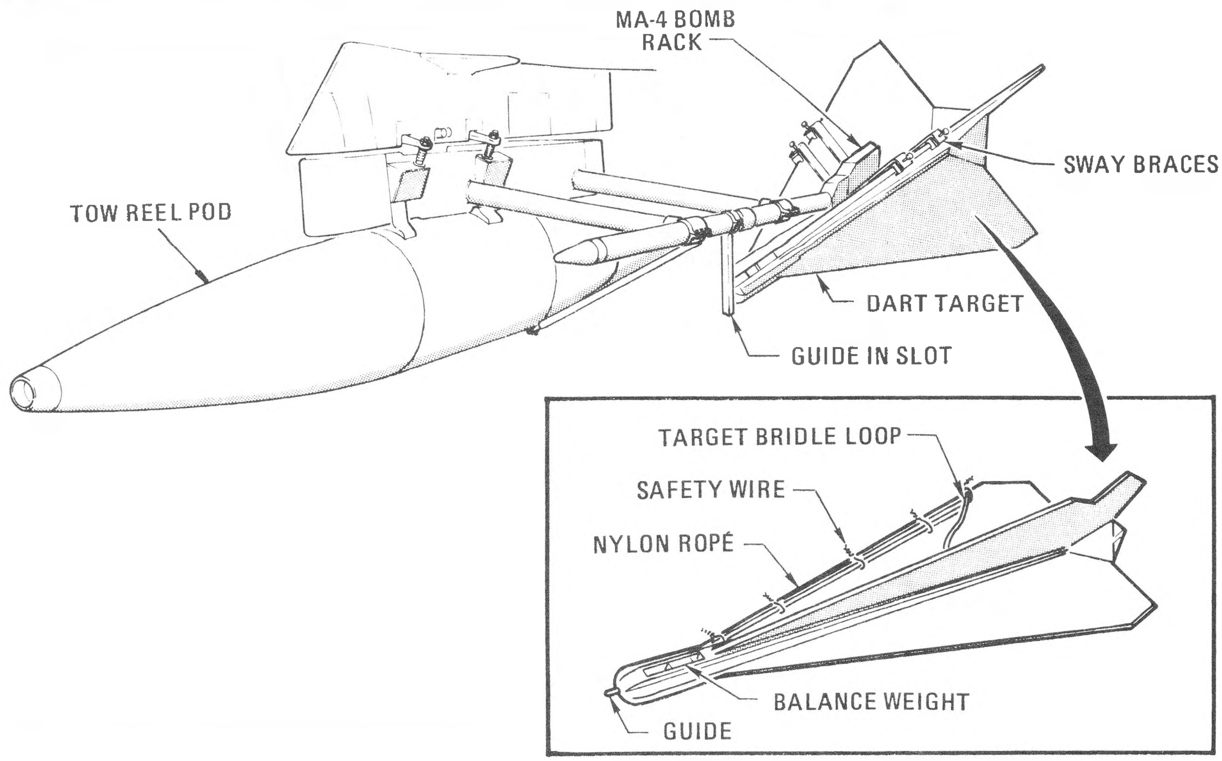
TOW TARGET OPERATION

The weapon release button is used to launch the target and to cut the tow cable. When required enabling is accomplished, the target is launched and the cable is completely reeled out by pressing the weapon release button once. When the mission is complete, the tow cable is cut by pressing the weapon release button a second time. The first time the weapon release button is pressed, a rotary solenoid releases the target. When the weapon release button is released, the rotary solenoid shifts a transfer switch to the cutter circuits. The cable cutter is operated by an explosive squib. An emergency cutting circuit is available.

TDU-10/B TARGET (DART)

The TDU-10/B target (FIGURE 3-11) consists of four fins, or wings, mounted together to form a dart-like shape. A bridle cable loop and a 15-foot nylon rope form a leader assembly between the tow cable and the target. The bridle loop is attached to the target, and the nylon rope attaches to the reel cable and the bridle loop. The rope provides a dampening effect for the target during launch. While the target

A/A 37U-15 TOW TARGET SYSTEM



TDU–10/B TARGET (DART)

CHARACTERISTICS

WEIGHT:	
COMPLETE SYSTEM (2300 FT OF 11/64 IN. CABLE AND TDU-10/B INSTALLED)	845 LB
EMPTY POD AND ADAPTER ONLY	521 LB
CABLE	153 LB
TDU-10/B	171 LB
LENGTH:	
BOOM AND LAUNCHER	11 FT
TDU-10/B	16 FT
TDU-10/B WINGSPAN	5 FT

FIGURE 3-11

is stowed, the slack in the bridle cable and nylon rope is lockwired and taped to the target fins. This prevents the cable and rope from whipping during flight and causing damage to the target. When the target is launched, the lockwire and tape pull loose.

A/A 37U-33 AERIAL GUNNERY TARGET SYSTEM (AGTS)

The AGTS is a recoverable, aerial gunnery tow target, equipped with a real-time acoustical scorer. The target can be towed at airspeeds up to 500 KCAS (or 0.9 mach), altitudes up to 35,000 feet, and acceleration forces up to 5 g. The target system has two major subassemblies (FIGURE 3-12):

1. AN/RMK-33/A 37U-33 Tow Set, aerial target

2. AN/TDK-36/A 37U-33 Target Set, aerial towed.

A receiver antenna and receiver are in the tow set. All other components are in the target set. Operation of the target system includes deployment, scoring, and release.

TARGET DEPLOYMENT

As the target falls from the aircraft, the tow cable is extracted from the tow set. When the tow cable reaches full length, it forces the tow arm forward. This causes power to be supplied to the transmitter and allows deployment of the tetraplane. Target deployment is limited to an airspeed of 220 to 250 knots calibrated airspeed (KCAS), 1,000 to 25,000 feet altitude, and level flight. Deployment normally is accomplished in 15 seconds. Target deployment is recommended at an altitude of 18,000 feet or below to reduce deployment shock on the tow cable.

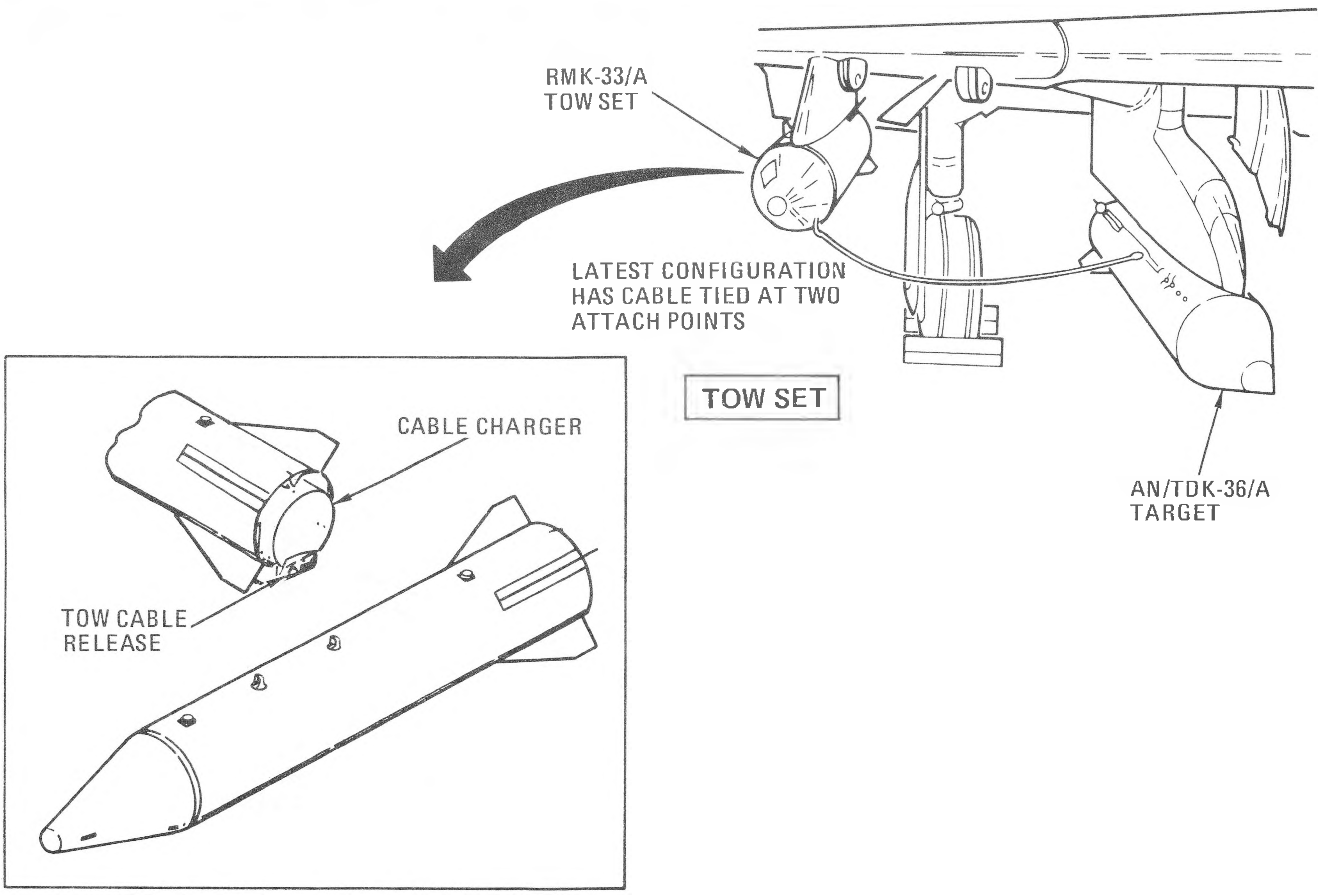
SCORING

Real-time scoring of rounds fired at the target is achieved through acoustical scoring. A microphone housed in the nose of the target senses the shock wave of a passing projectile. The acoustical scoring system is capable of accurately scoring 20mm projectiles passing through two spherical zones, 2 meters forward of the nose of the microphone (FIGURE 3-12). Two sets of scoring zones are selectable. One has an inner radius of 2 meters and an outer radius of 3 meters. The other (only available at 20,000 feet and below) has an inner radius of 3 meters and an outer radius of 5 meters. The magnitude of the acoustical disturbance is a function of air density; therefore, the scoring altitude must be manually set in the control panel.

CABLE RELEASE

Recommended cable release conditions are 800 to 1,000 feet AGL at an airspeed of 220 to 250 KCAS in level flight. A special wire bundle between the tow set and the pylon is used. There is a backup system for the nose and for the tail arm circuitry, but it will activate both cable releases in the event of dual carriage. An electric motor opens the hook to release the cable in less than 3 seconds. Therefore, the bomb button should be held pressed for 3 seconds, for cable release.

A/A 37U-33 AERIAL GUNNERY TARGET SYSTEM (AGTS)



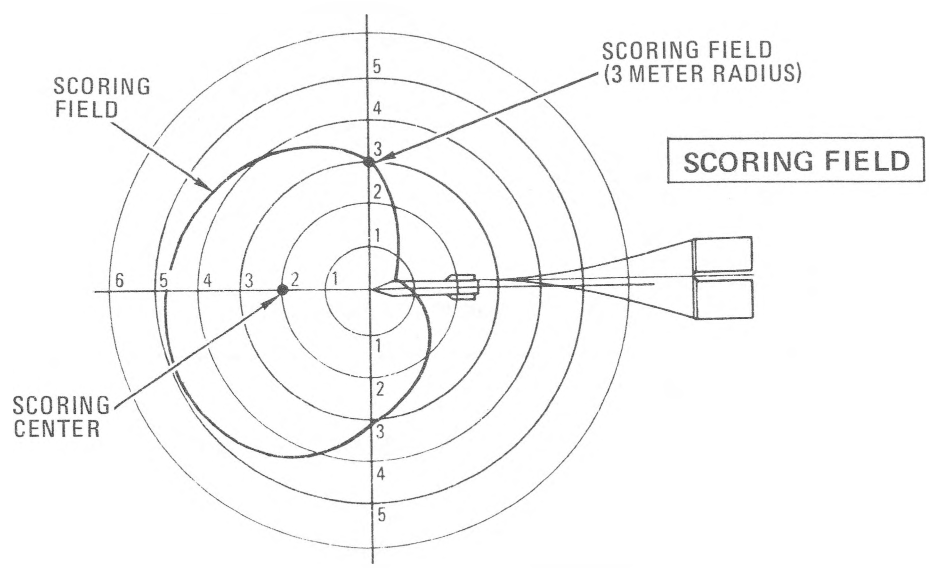
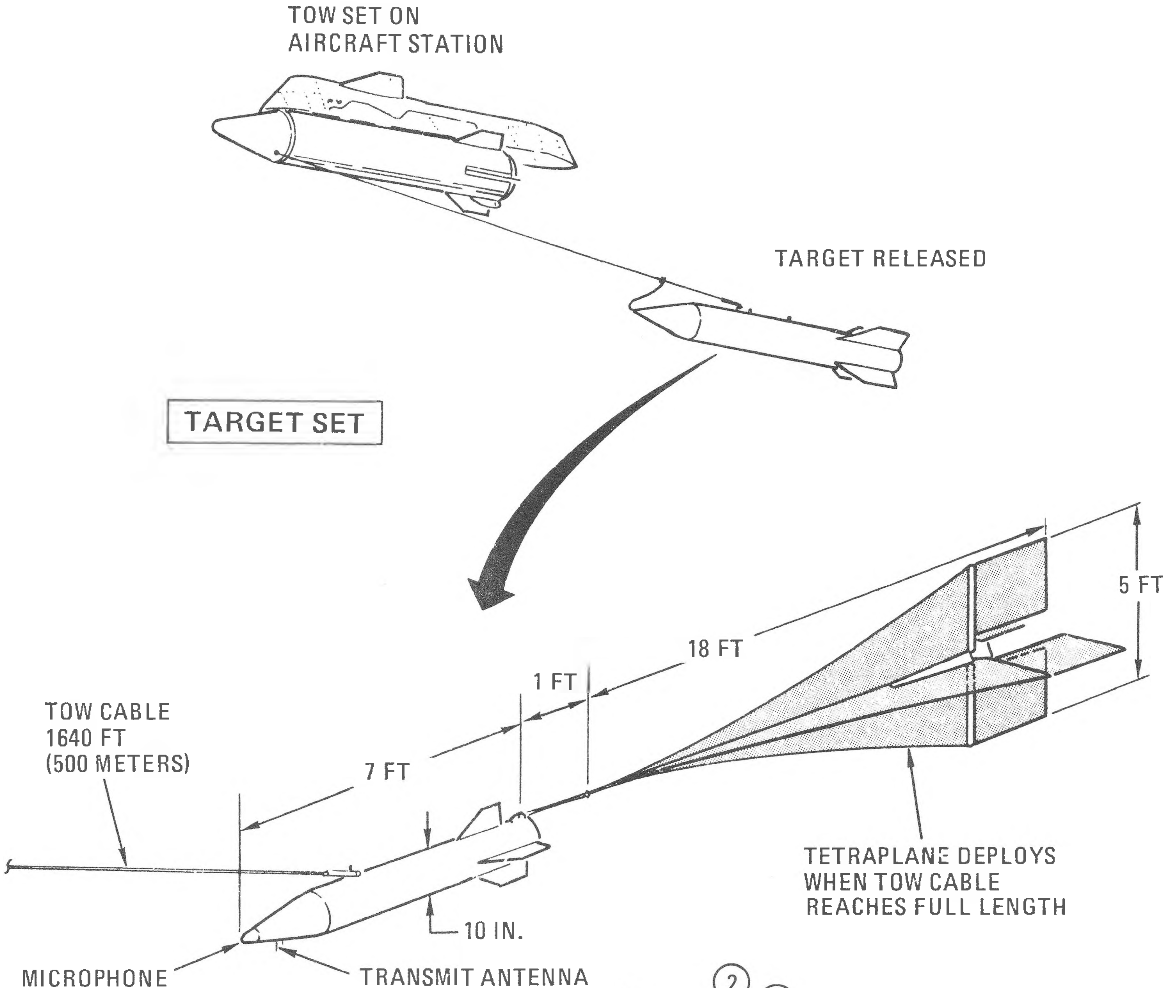
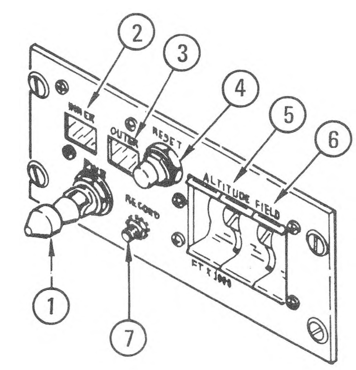


FIGURE 3-12 (Continued)





1. POWER SELECTOR
2. INNER SCORING WINDOW
3. OUTER SCORING WINDOW (Total inner and outer zone hits.)
4. RESET BUTTON
5. ALTITUDE SELECT
6. FIELD SELECT
7. RECORDER RECEPTACLE

GUNNERY TARGET CONTROL PANEL

CHARACTERISTICS

	RMK-33/A	TDK-36
WEIGHT	357 LB	107 LB
LENGTH	8 FT	7 FT
DIAMETER	14 IN.	10 IN.
SUSPENSION LUG SPACING	14 IN.	14 IN.

FIGURE 3-12 (Concluded)

RMK-33/A AERIAL TARGET TOW SET

The RMK-33/A tow set is 14 inches in diameter, approximately 8 feet long, and weighs 357 pounds fully loaded (FIGURE 3-12). Although not normally released during flight, it can be jettisoned in emergencies. Carriage of the RMK-33/A does not cause any adverse flight characteristics. No special procedures are required for takeoff, but pretakeoff asymmetric trim is required.

The tow cable contained in a cable charger. The cable charger is a cylindrical container that slips into the rear of the tow set and locks into place. The tow cable is a nylon rope 1,640 feet (500 meters) long.

TDK-36/A TOWED AERIAL TARGET SET

The TDK-36/A target set (FIGURE 3-12) has an aluminum body with replaceable nose cone and fins. The target has a tow arm for the tow cable attach point and 14-inch suspension lugs. The target is 10.2 inches in diameter and weighs 107 pounds. The tow cable is routed forward along the surface of the tow set, locally secured to the front with breakaway cord, and then attached to the tow arm of the target.

MICROPHONE

The microphone is housed in a protective target head. A protective cover separates from the nose during target deployment.

TETRAPLANE

The tetraplane is used for visual aid. The primary material of the tetraplane is nylon mesh with a folding crossarm structure and metallic radar reflector.

GUNNERY TARGET CONTROL PANEL

The control panel (FIGURE 3-12) includes a switch for turning the power (PWR) on, a receptacle for plugging in a recorder, a reset button, and dials for selecting altitude and scoring zones. After turn-on, the altitude and scoring zones are selected by rotating the knob marked FIELD to either position 1 for 2-meter inner and 3-meter outer scoring field, or position 2 for a 3-meter inner and 5-meter outer scoring field.

The digital readout on the inner and outer windows provide a cumulative count of hits recorded. The inner scoring window displays the number of projectiles passing through the inner firing zone. The outer scoring window displays total inner and outer zone hit count. The RESET button causes the display to show 88 in each window (to check display lights) and then returns the display count to zero.

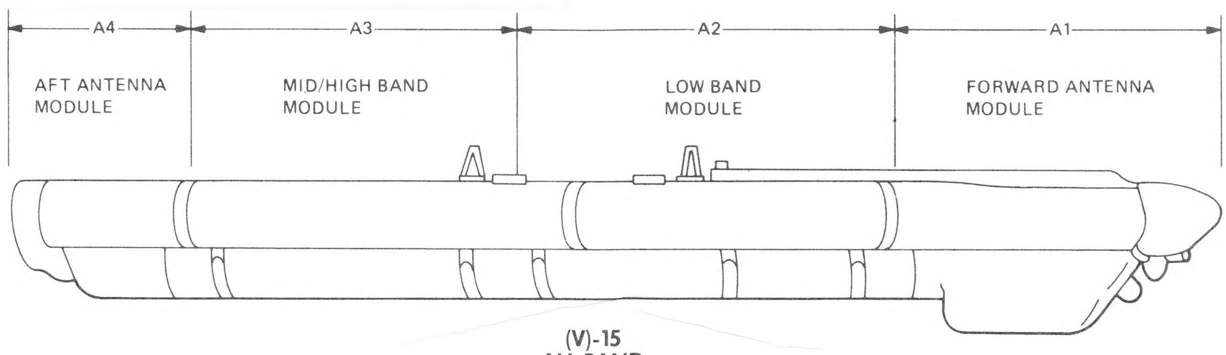
The scoring windows also display incorrect setting information. If the 3-5 zone is selected with an altitude above 20,000 feet set, the inner and outer display windows show EE, indicating an imcompatible scoring setup has been selected. In addition, the scoring display will flash whenever signal strength has been lost from the transmitter. The scoring function remains active, and scoring will continue immediately if signal strength returns. Flashing can be stopped by pressing the reset button.

AN/ALQ-119(V) ECM POD

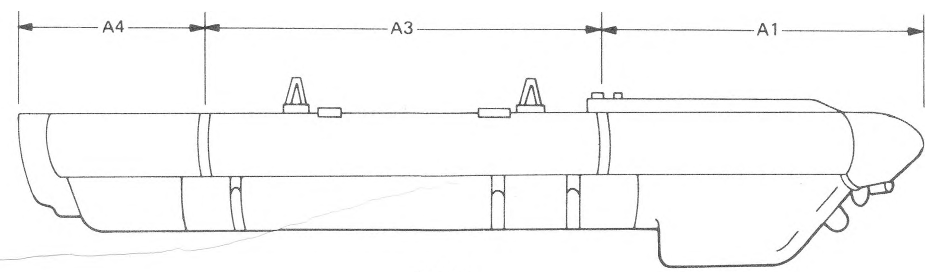
The AN/ALQ-119(V) ECM pod is of modular construction, with each module self-contained in an integral pod shell and gondola. The pod is carried externally and is currently available in two versions, the AN/ALQ-119(V)-15 and AN/ALQ-119(V)-17. The AN/ALQ-119(V)-15 pod contains low band and mid/high band modules (FIGURE 3-12). The AN/ALQ-119(V)-17 pod contains the mid/high band module only (FIGURE 3-13).

The AN/ALQ-119 has a closed-loop, circulating-liquid cooling system.

AN/ALQ-119(V) ECM POD



(V)-15
ALL BAND



(V)-17
MID AND HIGH BAND

CHARACTERISTICS

	(V)-15	(V)-17
WEIGHT	576 LB	406 LB
LENGTH	11 FT 11 IN.	9 FT 7 IN.
WIDTH	12 IN.	12 IN.
HEIGHT	21 IN.	21 IN.
SUSPENSION LUGS	30 IN.	30 IN.

FIGURE 3-13

WARNING

The AN/ALQ-119 ECM pod should not be operated on the ground when ground personnel are within 6 feet of the pod.

CAUTION

The AN/ALQ-119 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.

CONTROL INDICATORS

The AN/ALQ-119 pod can be controlled by the C-9492A, C-6631, C-6175, or the C-7854 control indicators. The C-6175 is the nomenclature given to two miniature C-6631 indicators, and the C-7854 is a modified C-6631. The operation of the C-6175 and C-7854 control indicators is identical to that of the C-6631. The control indicators are used to turn the system on, enable (activate) preset groups of techniques, and display system status. The C-9492A control, being more versatile than the C-6631, can mix techniques from preset groups and also provide a more detailed status display.

C-6631 CONTROL PANEL

The AN/ALQ-119 can be programmed for three different combinations of jamming techniques that are selectable in flight by the XMIT-1, XMIT-2, and BOTH positions on the C-6631 control indicator (see FIGURE 3-14). C-6631 control and fault indications are explained in the following paragraphs.

1. Operate Knob. This knob selects the mode of operation as follows:

   a. OFF - The AN/ALQ-119 pod is off.

   b. STBY - Puts the AN/ALQ-119 pod in standby status. STBY 1 and STBY 2 lamps illuminate after a 200-second warmup delay.

   c. XMIT-1 - The AN/ALQ-119 pod transmits a preselected jamming program; generally an all-repeater program. XMIT-1 lamp illuminates. STBY 1 lamp is off. STBY 2 lamp illumnates.

C-6631/ALQ-119 CONTROL PANEL

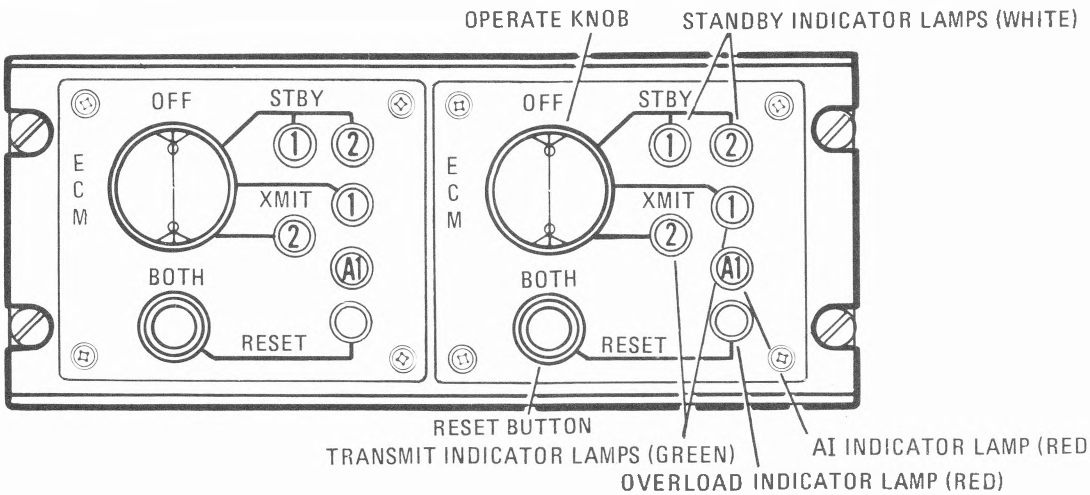


FIGURE 3-14

d. XMIT-2 - The AN/ALQ-119 pod transmits a second preselected jamming program. The XMIT-2 lamp illuminates and the STBY 2 lamp is off. STBY 1 lamp illuminates.

e. BOTH - The AN/ALQ-119 pod transmits a third preselected jamming program. XMIT-1 and XMIT-2 lamps illuminate. STBY 1 and STBY 2 lamps are off.

2. RESET Button. When depressed, reset places AN/ALQ-119 into standby mode until the button is released. It is used for a look-through period to have an unobstructed look at the radar warning system or to clear temporary pod malfunctions. If fault remains, recycle the pod to OFF and immediately back to operate. If the fault still remains, turn the pod OFF for 30 seconds, then back to STBY. When the pod completes a 3-minute warmup, turn the pod back to operate. If the malfunction fails to clear, as indicated by fault lights, the equipment should be turned OFF.

3. STBY 1 Lamp. This is a white lamp that illuminates (after a 200-second warmup delay) when the operate switch is set to STBY. The light goes off when the operate switch is set to XMIT-1 or both. The light illuminates when XMIT-2 is selected, indicating that the XMIT-1 circuits are in standby.

4. STBY 2 Lamp. This is a white lamp that illuminates (after a 200-second warmup delay) when the operate switch is set to STBY. The light goes off when the operate switch is set to XMIT-2 or BOTH. The light illuminates when XMIT-1 is selected, indicating that XMIT-2 circuits are in standby.

5. XMIT-1 Lamp. This is a green lamp that illuminates when the operate switch is set to XMIT-1 or BOTH. The STBY 1 lamp is off.

6. XMIT-2 Lamp. This is a green lamp that illuminates when the operate switch is set to XMIT-2 or both. The STBY 2 lamp is off.

7. Flashing XMIT-1 or XMIT-2 Lamp. When a XMIT-1 or XMIT-2 light flashes at a 1-Hz rate, high-band faults are indicated.

8. Overload Lamp. This red lamp flashing at a 1-Hz rate indicates low-band fault.

9. AI Lamp. This red lamp flashing at a 1-Hz rate indicates midband fault.

C-9492A CONTROL PANEL

The C-9492A control panel is designed to control an AN/ALQ-119 pod, or to control an AN/ALQ-119 pod with reduced flexibility and one or two analog control-type systems that would normally be controlled by a C-6631 (e.g., AN/ALE-38 chaff pod). The front panel of the C-9492A contains eight pushbutton switches and two toggle switches to control the AN/ALQ-119 pod (see FIGURE 3-15). C-9492A control and fault indications are explained in the following paragraphs.

C-9492A/ALQ-119 CONTROL PANEL

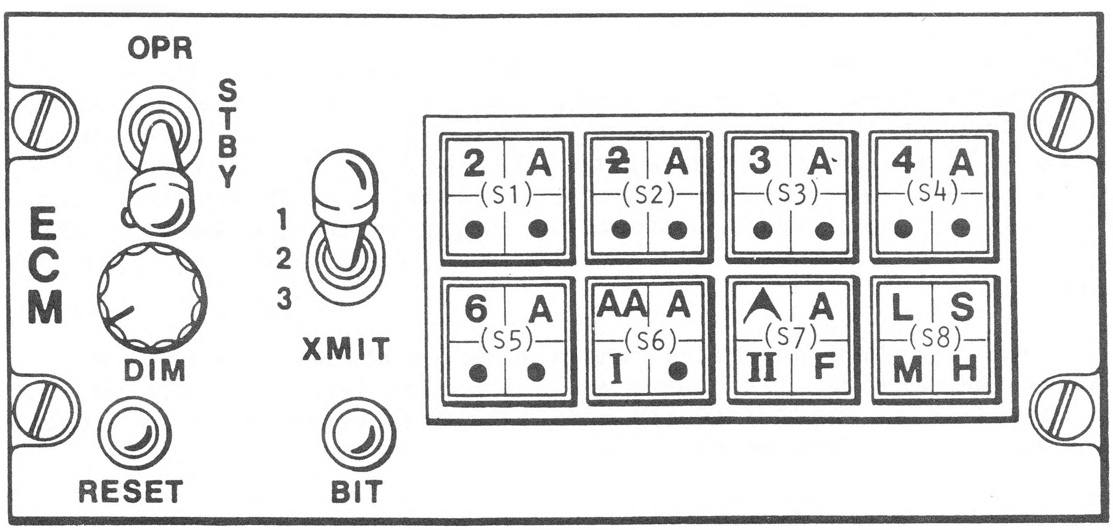


FIGURE 3-15

1. 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 AN/ALQ-119 pod. The STBY position puts the AN/ALQ-119 in standby status and/or initiates a 3-minute warmup period. After warmup, the "S" in 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. Pushbuttons will come on to indicate that OPR has been selected.

2. 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 2 operation. Additional jamming functions are available by depressing pushbuttons. Position 3 places the system in mode 3 operation.

3. Pushbuttons. The S1 through S7 buttons are push-to-engage and push-to-release. Each button has an alphanumeric symbol in the upper right quadrant. All other dots and symbols are nonfunctional. The alphanumeric symbols will come on when the power switch is in OPR and the AN/ALQ-119 is operational. These symbols will not come on if the appropriate fault lights are lit. The "A" symbol comes on to indicate the button is depressed. The S8 button provides an alternate jamming program in XMIT-1. It has no effect in XMIT-2 or XMIT-3. The "S" comes on to indicate the AN/ALQ-119 is in standby. The "L," "M," and "H" symbols come on to indicate faults in the low, medium, and high bands. The "L" will remain on after warmup when the AN/ALQ-119(V)-17 pod is loaded.

4. DIM control. The DIM control adjusts the intensity of the lights inside the eight pushbutton switches. Edge lighting is controlled by the console lights rheostat.

5. RESET button. When depressed, the RESET button places the AN/ALQ-119 into standby mode until the button is released. It is used for a look-through period to have an unobstructed look at the radar warning system or to clear temporary pod malfunctions. If the fault remains, recycle pod to OFF and immediately back to OPR. If the fault still remains, turn the pod OFF for 30 seconds, then back to STBY. When the pod completes a 3-minute warmup, turn the pod back to OPR. If the malfunction fails to clear as indicated by fault lights, the equipment should be turned off.

6. BIT button. When depressed, the BIT button allows a built-in-test of about 80 percent of the C-9492A. It causes all pushbutton lights to come on, but has no effect on operation of the AN/ALQ-119 pod. The BIT button can be activated at any position of the power switch except OFF.

AN/ALQ-119 POD PREFLIGHT SYSTEM CHECK

The AN/ALQ-119 pod preflight system check can be accomplished any time after power is applied to the aircraft. Since maintenance personnel do not activate the pod once it is loaded on the aircraft, this check will provide aircrew confidence and ensure that all the programs set into the pod are activated and thus self-tested by the fault detect and system monitor capability of the C-9492A control indicator. Refer to appropriate aircraft Dash 34 for preflight system checks.

AN/ALQ-131(V) ECM POD

GENERAL DESCRIPTION

The AN/ALQ-131(V) (FIGURE 3-16) is an advanced electronic countermeasures (ECM) pod design. It provides an aircrew-activated, computer-controlled ECM pod with improved jamming performance, growth potential, and maintainability. The AN/ALQ-131 is modularly constructed for multiple band capability and ease of maintenance. FIGURE 3-16 illustrates the system's modularity and reconfiguration capability.

Cooling for the AN/ALQ-131 is provided by an I-beam (hardback) structure that houses a Freon-to-ram air cooling system. The I-beam structure is composed of individual sections that correspond in length to the equipment canisters. The modular canisters housing the AN/ALQ-131 electronic components are mounted to both sides and the bottom of the I-beam hardback and are easily removable for maintenance.

Operation of the AN/ALQ-131 is controlled by a digital computer in the pod. The data that define the pod's jamming techniques are specified on a punched tape called the Blue Tape. A Blue Tape selected for a particular mission can be loaded into the portable memory loader verifier (MLV) at the field shop. The MLV can then be used to program the AN/ALQ-131 while the pod is installed on the mission aircraft. After loading the pod's computer memory with the new Blue Tape data, the MLV verifies that the Blue Tape data have been correctly loaded. Flight line reprogramming can be accomplished on one pod in approximately 15 minutes.

SYSTEM OPERATION

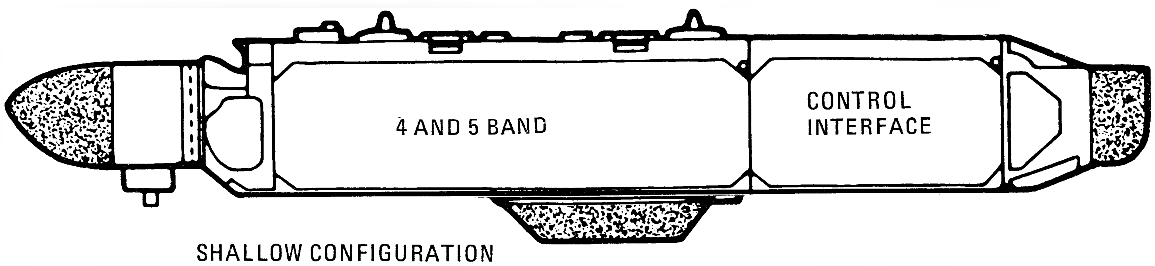
CONTROL PANEL-GENERAL

Cockpit control of the AN/ALQ-131 is achieved using the C-9492B or the C-6631 control panel (FIGURES 3-17 and 3-18). The C-9492B provides the most flexibility for the operation of the AN/ALQ-131. Either control panel controls pod operation and has the following common characteristics:

1. Power Switch. The power switch is a three-position, psitive-locking toggle switch. In the OFF position, all power is removed from the control panel and AN/ALQ-131 pod. The STBY position places AN/ALQ-131 into standby and/or initiates a 3-minute pod warmup. During warmup, "F" lights will be on under buttons 4 and 5, and a "LO" light will be on the ALT button. After warmup, "F" lights should go out and "S" lights come on, indicating bands 4 and 5 are ready to transmit. "S" lights on buttons 1, 2, and 3 will never come on, indicating bands 1, 2, and 3 are not in the "shallow" pod. The OPR position enables the pod to transmit jamming programs. Program selection is determined by the XMIT switch and/or pushbuttons.

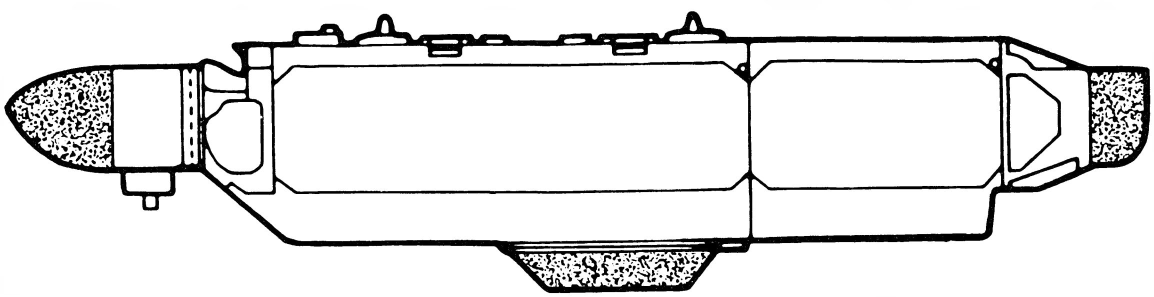
2. XMIT Switch. The XMIT switch is a three-position toggle switch with positive-locking in each of its three positions. This switch functions when the power switch is in OPR.

AN/ALQ-131(V) ECM PODS



SHALLOW CONFIGURATION
(LOW DRAG)
(BANDS 4 AND 5)

DEEP CONFIGURATION
(BANDS 3, 4, AND 5)



CHARACTERISTICS

WEIGHT ______ 535 LB
LENGTH ______ 9 FT 3 IN.
HEIGHT ______ 14 IN.
SUSPENSION LUG SPACING

FIGURE 3-16

C-9492B/ALQ-131 CONTROL PANEL

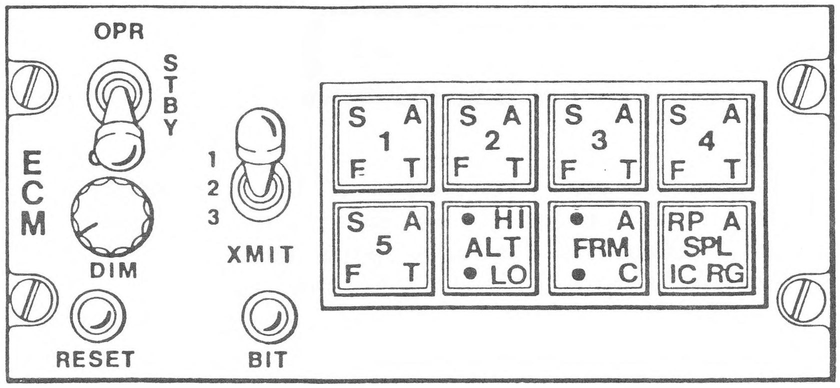


FIGURE 3-17

a. Position 1 places the system in the XMIT-1 mode of operation and activates a set of preset jamming techniques. Buttons 1 through 5 disable. If pushed in, "A" lights will not come on. "T" lights on buttons 3, 4, or 5, or any combination, could come on, indicating bands 4 and/or 5 are in a transmit condition.

b. Position 2 places the system in the XMIT-2 mode of operation and activates a second set of preset jamming techniques. Button operation and light indications are the same as those for XMIT-1.

c. Position 3 places the system in the XMIT-3 mode and requires one or more of the pushbuttons 1 through 5 to be depressed. When so selected, a preset jamming technique can be activated. In XMIT-3, when any button (1 through 5) is depressed, the "A" light will come on, indicating only that it is selected. Any time band 4 or 5 is activated in the jamming program, the "T" light in the respective button will come on whether the button has been depressed or not.

3. RESET Button. When depressed, the RESET button momentarily changes pod status from operate to standby. Pod malfunctions and faults discovered by continuous centrally integrated test system (CITS) may be corrected, but faults discovered by interruptive CITS will not be corrected. The appropriate "F" light will go out if the fault is cleared.

C-9492A CONTROL PANEL

BIT Button

The BIT button is depressed and held for 3 seconds. When depressed, the system runs an interruptive CITS and an in-depth self-test of each pod function. If depressed when the power switch is set to STBY, high voltage is not applied to the bands and energy is not radiated from the pod. If depressed with the power switch in OPR, a test is conducted on the high voltage applied to the bands and power is radiated from the pod antenna.

WARNING

Do not perform BIT check on the ground in OPR, unless required by maintenance personnel. Ensure all ground personnel are well clear of aircraft before initiating test.

This CITS test requires 30 seconds to perform, and jamming is interrupted during this period. The "C" light under the FRM button will come on during the test, indicating CITS is in progress. A lamp test on the control indicator is also performed.

NOTE

Crew activation of interruptive CITS should be routinely accomplished twice during each mission, regardless of fault indications, to provide an interruptive CITS history for use by maintenance technicians. Recommend CITS be performed near the beginning and the end of each mission.

Numbered Pushbuttons

The numbered (1 through 5) pushbuttons operate only with the XMIT-3 mode of operation and are inoperative in XMIT-1 and XMIT-2. XMIT-3 with none of the buttons depressed will place the pod in standby (silent mode). Depressing any button, 1 through 5, in the XMIT-3 mode will direct the pod onboard computer to initiate new jamming techniques in the appropriate bands and channels as specified in each Blue Tape. If more than one button is depressed on the control panel (for example, buttons 1 and 4), a hybrid jamming program will be initiated in the pod. This new program will be composed of jamming techniques associated with the highest priority threats identified in the Blue Tape for both buttons 1 and 4. In general, multiple buttons should not be depressed unless the Blue Tape loaded in the pod has been expressly designed for this purpose.

NOTE

Premission briefings should define when XMIT-3 multiple button mode is required.

Formation and Special Buttons

Formation (FRM) and special (SPL) buttons have unique priority characteristics. Depressing the FRM button will override all other transmit modes, i.e., XMIT-1 and XMIT-2. For example, XMIT-3 with button 1 and FRM depressed will result in only the set of jamming techniques specified for the FRM button. SPL also has override capabilities and overrides all modes, i.e., XMIT-1 and XMIT-2, or XMIT-3 with any button depressed including FRM. In other words, if the pod is in operate, depressing SPL will set the SPL jamming techniques specified on the Blue Tape for SPL, regardless of the mode switch position.

Altitude Button

The altitude (ALT) button is active in any operational mode and permits crew selection of two altitudes modes. Depressing the ALT button activates the high mode and illuminates the HI symbol; releasing the button illuminates the LO symbol. The ALT button position controls two pod functions: the pod's fore and/or aft transmit antenna tilt angle and the priority of jam techniques associated with each threat. The specific antenna tilt angles and threat priorities are specified on each Blue Tape.

Pushbutton Symbology

Each pushbutton on the C-9492B control panel has from one to four symbols that illuminate under the following conditions:

1. Symbol "A" indicates that the affected pushbutton has been depressed. The "A" has no direct connection with transmitting in a particular band.

2. Symbol "S" indicates that the band reflected by the button number is in standby mode; i.e., an illuminated "S" on button 4 indicates that band 4 in the pod is in standby. An "S" symbol should be expected when the pod has timed in and is in STBY in XMIT 3 with no buttons pressed, or if the Blue Tape requires no jamming output in the band indicated by the illuminated button.

3. Symbol "T" indicates that the band reflected by the button number is transmitting; i.e., an illuminated "T" on button 3 indicates that band 3 is transmitting.

4. Symbol "F" indicates that a fault has been discovered in the indicated band by CITS. Aircrew reaction: When an "F" light illuminates as a result of continuous CITS, the crewmember should immediately depress the RESET button for 1 to 5 seconds and release. If the fault remains, two options exist. If a 30-second interruption in jamming can be tolerated, the BIT button should be depressed to initiate

interruptive CITS, which would store the fault in pod memory. The second option is to try an alternate jamming mode. Turning the pod off and back to operate is not recommended, because the "F" light may go out but the fault may remain.

Symbol "HI-LO" is displayed only on the ALT button and, as discussed previously, it indicates that the high- or low-altitude mode has been selected. LO will be displayed until the power switch is placed in the OPR position.

Symbol "C" is present only on the FRM button. The "C" light illuminates when the BIT button has been depressed by the crewmember and remains illuminated while interruptive CITS is in progress.

NOTE

> Jamming transmission is interrupted while the "C" light is illuminated. The interruptive CITS program requires approximately 30 seconds for completion.

Symbol "RP" and "RG" are present only on the SPL button and, if illuminated, indicate that the receiver-processor or the ram air turbine generator has failed. "RP" and "RG" have no functions in current AN/ALQ-131 pods.

Symbol "IC" (interface control) on the SPL button indicates that the pod computer or the computer memory has failed. Aircrew reaction: (1) Do not change jamming mode and/or button; (2) do not initiate interruptive CITS; and (3) do not depress the reset button until all mission requirements have been met. Rationale: If the pod is set up and operating properly prior to the computer fault, there is a good possibility that the pod will remain in an acceptable configuration if it is not directed to change by the faulted computer. When mission requirements have been met, BIT is depressed to record CITS data and attempt to clear the fault.

C-6631 CONTROL PANEL

The AN/ALQ-131 pod can be controlled with the C-6631 control indicator (FIGURE 3-18). XMIT-1 and XMIT-2 operate identically to the XMIT-1 and XMIT-2 of the C-9492B. The C-6631 BOTH position will select the jamming mode programmed under the SPL button of the C-9492B. Only one altitude mode is available when using the C-6631. This is programmed in the aircraft tape (part of the Blue Tape) and can be programmed for high or low altitude.

Light Indications

STBY 1 and STBY 2 will come on after the 3-minute time-in. During this period, the overload lamp will be illuminated. This will go out when the 3-minute time-in is complete. When XMIT-1 is selected, the XMIT-1 lamp will illuminate, and the STBY 1 lamp will go out. XMIT-2 operation is identical. When both is selected, the

C-6631/ALQ-131 CONTROL PANEL

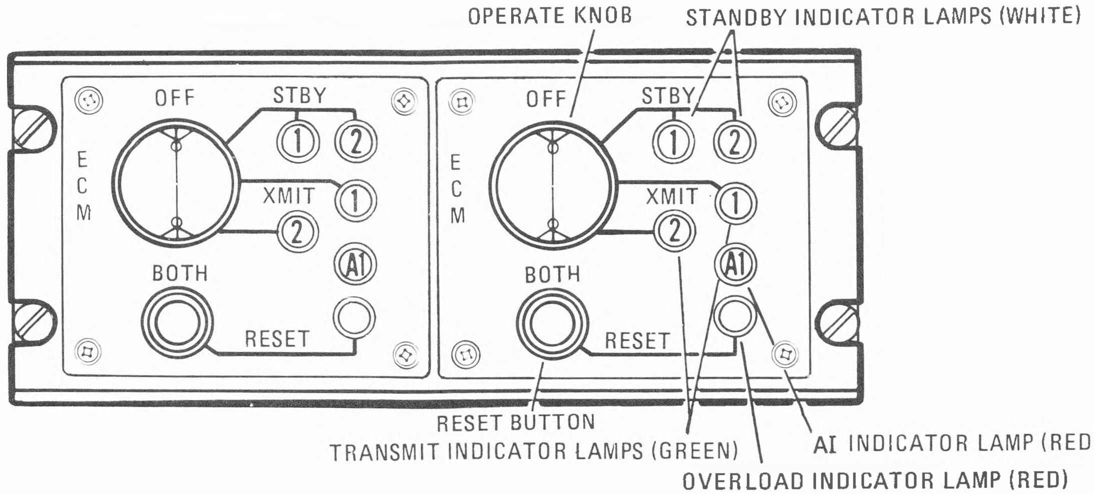


FIGURE 3-18

XMIT-1 and XMIT 2 lamps will be illuminated, and the STBY 1 and STBY 2 lamps will go out. Band 3-4-5 and interface control (IC) fault will illuminate the overload lamp and Band 1-2, "RP", "RG", and "IC" faults will illuminate the airborne intercept (AI) lamp.

Interruptive CITS

The STBY interruptive CITS will be conducted each time the control indicator is switched from OFF to STBY. An operate (XMIT) interruptive CITS will be conducted once when the pod has gone through a time-in sequence and is placed in a XMIT mode. Operate CITS will not be conducted again until the system is turned off for more than 10 seconds and timed-in again.

Fault Summary

A fault in Band 3, 4, or 5 will be displayed by the overload lamp. "IC" faults will be displayed by both the overload lamp and the "AI" light. Band 1-2 and "RP-RG" faults will be displayed by the AI light.

Antenna Modules

The forward and aft transmit antenna modules each contain a Band 3, 4, and 5 transmit antenna. The receive antenna module located on the bottom pod contains six receiver antennas: two for each band, one pointed forward, and the other pointed aft. Refer to appropriate classified aircraft Dash 34 for antenna coverage.

Transition Module

The transition module section provides the mechanical and aerodynamic transition from the forward radome to the canister housing. The transition module contains the air inlet for ram air, the electromagnetic interference (EMI) filters, and the power relays.

Interface and Control (IC) Module

The IC module provides control of system modes of operation and performs the major system management functions. The IC module has the capability to activate and control Band 3, 4, and 5 transmitter jamming techniques. It generates the various jamming waveforms required for the operation of each band and serves as a communications center for all critical data flow between modules, with a special interface provided for the control panel.

AN/ALQ-131 JAMMING TECHNIQUES

The basic ECM techniques available can be grouped into three general categories: noise, repeater, and transponder. Each of the bands in the AN/ALQ-131 offers the operator some combination of two or three of these categories.

NOISE

Jammer transmission is independent of the reception of a radio frequency (RF) signal from the threat environment. The jamming signal originates from a noise generator within the jammer equipment. The resulting signal, which may or may not have deception modulation impressed upon it, is transmitted at rated power.

REPEATER

Jammer transmission is initiated by the reception of an RF signal from the threat environment. In general, the received signal is amplified (at constant gain), has amplitude and/or frequency modulation impressed upon it, and is subsequently retransmitted to the threat environment. The amplitude modulation provides angle deception, and the frequency modulation provides velocity deception.

TRANSPONDER

Jammer transmission is initiated by the reception of an RF signal from the threat environment. In general, the received signal is stretched and amplified in a keyed-oscillator RF memory circuit within the jammer, and deception modulation is impressed. The stretched pulse is used to implement range gate pull-off (RGPO) techniques. Subsequent transmission of the modulated signal is accomplished at or near saturated power.

GUN PODS

SUU-16/A 20MM GUN POD

The SUU-16/A gun pod (FIGURE 3-19) contains the M61A1 20mm gun, a ram air turbine (RAT) drive assembly, an ammunition feed assembly, an electrical control package, and the ammunition drum. The M61A1 gun has six rotating barrels. Each barrel fires once per revolution to fire a total of 6,000 rounds per minute (100 rounds per second) when the gun is rotating at 1,000 revolutions per minute (rpm). The muzzle velocity is 3,380 feet per second (fps). The M61A1 gun fires electrically primed, steel-case, 20mm ammunition, M50 series. The gun pod has an ammunitiom capacity of 1,200 rounds, of which approximately 50 to 70 rounds are unusable.

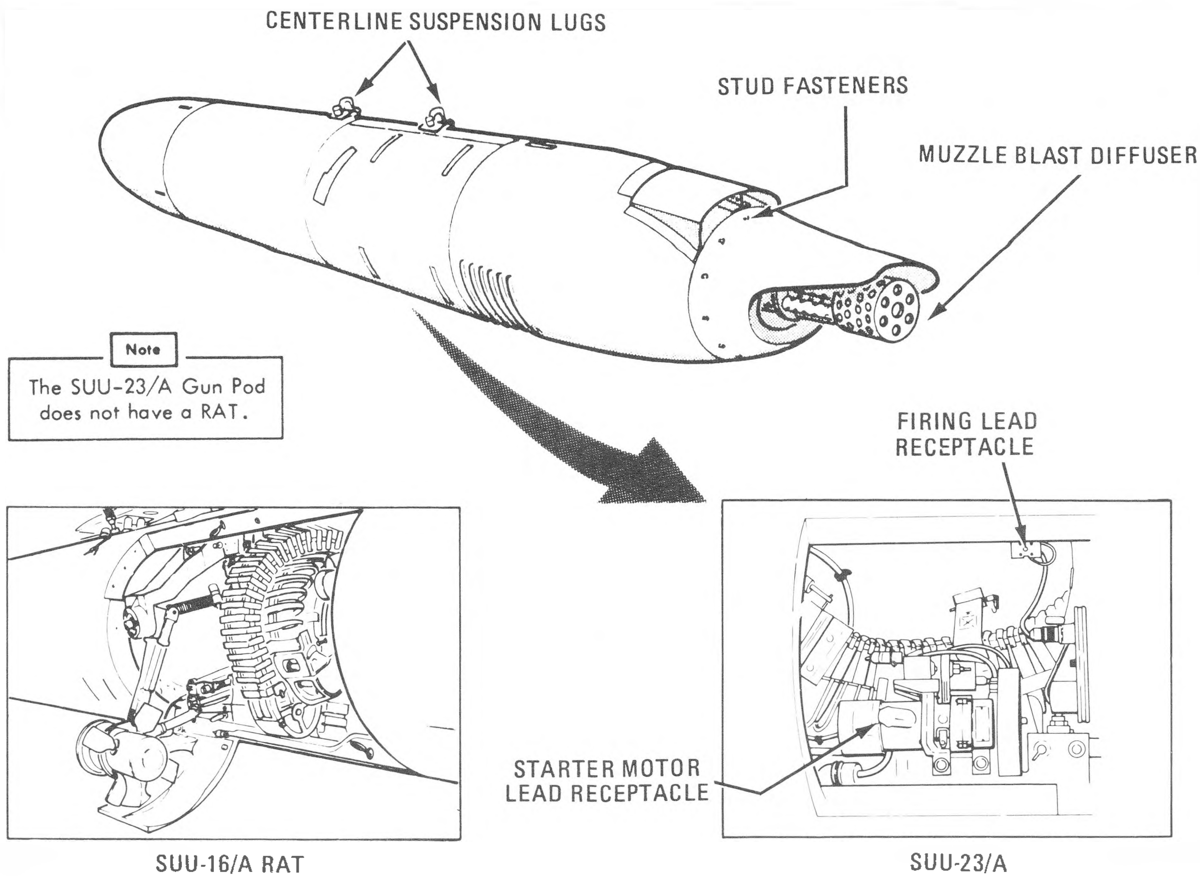
CAUTION

- The usable ammunition in the pod can be completely fired out with a single burst, or fired in short bursts; however, to reduce possible gun damage and prolong gun life, a single burst should not exceed 3 seconds.
- Firing bursts in the autoclear mode with less than a 2-second interval will cause extensive damage to the gun.

The gun has two operating modes: autoclear and nonclear. The purpose of the autoclear mode is to remove live rounds from the firing position at the completion of each burst. The purpose of the nonclear mode is to preclude the ejection of live rounds from the gun and to provide immediate gun-firing when the trigger is pulled.

The RAT is extended into the airstream when electrical power is applied to the gun pod. Electrical power is received from the aircraft, converted within the gun pod, and used to fire the cartridge and operate the clutch/brake actuator solenoid. Mechanical power to rotate the gun is received from the RAT; therefore, the RAT directly controls the rate of fire. The RAT rotates at a constant speed to provide mechanical power to drive the gun and the ammunition feed system. The speed of the RAT is maintained at 12,000±600 rpm by a mechanical governor. Any change in rpm will cause the governor to change the turbine blade pitch accordingly, to maintain a constant speed. A minimum airspeed of 330 KCAS is required to drive the system at a steady rate of 12,000 rpm. The gun can fire at lower than 330 KCAS; however, the rate of fire will diminish. The clutch assembly transmits the power developed by the RAT to the ammunition feed system and the gun. When the trigger is actuated, a drive clutch is engaged by a solenoid to place a gear train in action which reduces the 12,000 rpm to rotate the gun at 1,000 rpm, which causes 6,000 rounds a minute to be fired from the gun.

SUU-16/A AND SUU-23/A 20MM GUN PODS



CHARACTERISTICS

	SUU-16/A	SUU-23/A
WEIGHT, LOADED	1693 LB	1722 LB
WEIGHT, 50 - 70 ROUNDS REMAINING	1043 LB	1072 LB
LENGTH	17 FT 4 IN.	
DIAMETER	22 IN.	
AMMO CAPACITY	1200 ROUNDS (50 TO 70 ROUNDS UNUSABLE)	
SUSPENSION LUG SPACING	30 IN.	

M61A1 20MM GUN

NUMBER OF GUN BARRELS	6
RATE OF FIRE (6 BARRELS)	6000 ROUNDS PER MIN
MAX RECOMMENDED BURST TIME	3 SEC
AMMO	20MM - M56E2 (HEI) 20MM - M53 (API) 20MM - M55A2 (TP)
HARMONIZATION RANGE	2250 FT

FIGURE 3-19

During a nonfiring condition, the RAT freewheels while the gun and feed system are held fixed by the brake band. When the fire command is given, a solenoid engages the clutch band against a drum and releases the brake band to allow the RAT to drive the system. The ammunition drum stores the major portion of the ammunition.

During firing operation, the ammunition drum discharges the ammunition into an endless conveyor unit which picks up each cartridge and delivers it to the gun. The cartridges are placed into the gun where a cam-operated, sliding-bolt assembly picks up the cartridge and carries it forward and locks it in the breech (or firing position). The cartridge is fired as it passes an electrical contact, and the empty case is extracted as the gun rotates toward the lower left side. The empty case (or a dud cartridge) is extracted from the breech and ejected from the lower left side of the pod by the case ejector with sufficient velocity to clear the aircraft.

At the end of each burst, in the autoclear mode, an automatic clearing function is initiated which prevents the bolts from carrying the cartridges forward into their breech position during gun deceleration.

As the gun decelerates to approximately 3,750 shots per minute, the bolts are automatically cleared to the rear of the gun out of the breech position. Firing voltage remains to fire out the rounds that enter the breech prior to initiation of the clearing action. With the bolts out of the breech, air is permitted to pass through the gun barrel to aid gun-cooling.

Firing voltage is on the firing pin when the trigger is pulled and remains on the firing pin for 1 second after the trigger is released. When operating in the nonclear mode, the gun starts firing immediately when the trigger switch is pulled. When operating in the autoclear mode, the gun starts firing after it has rotated one-third revolution to position a cartridge in contact with the electrical firing pin; the time required for this operation may be considered instantaneous. The time required for the gun to obtain maximum firing rate is approximately 0.4 second for both operating modes.

The gun stops rotating between 0.2 to 0.6 second after the trigger is released, depending on the adjustment of the clutch and brake assembly, regardless of the operating mode. For the autoclear mode, the gun stops firing when the clearing action is initiated. The clearing action begins when the gun has decelerated to approximately 3,750 rounds per minute; approximately four to six rounds will be fired during this period. Approximately four to six live rounds will be ejected overboard before the gun stops rotating. For the nonclear mode, the gun stops rotating; approximately 8 to 12 rounds will be fired during this period.

To fire successive bursts in autoclear mode, the gun must first stop rotating and then accelerate for one-third revolution; 2 seconds should be allowed between trigger release and next trigger pull. When operating in the nonclear mode, the gun starts firing when the trigger is pulled, regardless of the gun rotating speed. The gun should be operated in the nonclear mode when it is desirable to fire short bursts with a minimum of time delay between trigger-pull and first-shot. The bolts remain in the firing cycle when the gun is operated in the nonclear mode, to clear the gun of live rounds. A live round remaining in the breech after a long burst in the nonclear mode could cook off if the gun is hot. This will not cause the gun to malfunction. When a gun malfunction occurs, the cause will most often be the jamming of the feed system. Another type of malfunction that might occur is the jamming of the bolt assembly operation in the autoclear mode; the nonclear mode is not susceptible to this type of malfunction.

Complete fire-out of all ammunition is not possible; approximately 50 rounds must remain in the feed system to maintain control of the flexible feed chute. A last-round switch in the ammunition drum stops the feed system before the last round in the ammunition drum reaches the feed system. Firing voltage is removed by the last-round switch as if the trigger switch were released, and the autoclear clearing action is initiated regardless of the mode selected; all cartridges are removed from the breech.

The M61A1 gun can develop 3,800 pounds of reverse thrust when firing at its maximum rate. For short bursts of less than 1 second, the reverse thrust of the guns will cause negligible movement of the pipper and, consequently, the shot pattern. The pilot should anticipate the effect of reverse thrust and aim at the top of the target or to the side of the target.

SUU-23/A 20MM GUN POD

The SUU-23/A gun pod (FIGURE 3-19) is similar to the SUU-16/A gun pod, except it contains the GAU-4 20mm gun and does not have a RAT drive system. Instead, it has an internal electric inertia start motor which accelerates the gun. With the gun selected, the inertial start motor begins to develop operating speed when the gun is armed. For gun pod systems with a prestart capability, a prestart cable is provided which starts the SUU-23/A inertia motor. Prestarting of the inertia motor eliminates the 20- to 30-second delay in firing.

CAUTION

To avoid inertia motor burnout, avoid selecting this mode during ground operations or any operations not directly involving the gun pod.

When the trigger is squeezed, the inertia motor accelerates the gun to 5,400 shots per minute. At 5,400 shots per minute, the motor disengages and a gas drive system extracts gun gas from four of the six barrels to further accelerate the gun to the maximum firing rate of 6,000 shots per minute. The maximum gun firing rate is obtained 0.2 to 0.4 second after the trigger is pulled.

The gas drive system sustains the driving rate of the gun and linkless feed system. The electric inertia start motor disengages but continues to run. If a malfunction occurs (such as misfire of four or more consecutive rounds), or if the driving rate falls below 900 rpm (5,400 shots per minute), the electric inertia start motor engages to achieve firing rate, and again disengages. All data pertaining to the SUU-16/A gun pod are applicable to the SUU-23/A gun pod except when noted.

BURST LIMITER

Some gun pods may be modified to include a burst limiter. The burst limiter can be set by armament crew personnel when it is desired to limit the number of rounds to be fired during one flight. The burst limiter has two controls; a burst limiter setting knob and a burst limiter switch.

Burst Limiter Setting Knob

The burst limiter setting knob can be set from 50 to 250 rounds, in units of 5 rounds. The actual setting indicated by the posisiton of the V-notch in the knob, may vary by three rounds, i.e., if 150 rounds is set, the limiter may be set on either 147 or 153.

Burst Limiter Switch

The burst limiter switch has two positions; limit and no limit. With the limit position selected, the trigger circuit is interrupted when the set number of rounds has been fired. The gun stops firing and cannot be fired again during flight. Therefore, the gun pod must be operated in the autoclear mode when the burst limiter is used. If the gun pod is operated in the nonclear mode the burst limiter stops gun firing in the nonclear mode, and the gun breech cannot be cleared of live rounds prior to landing.

WARNING

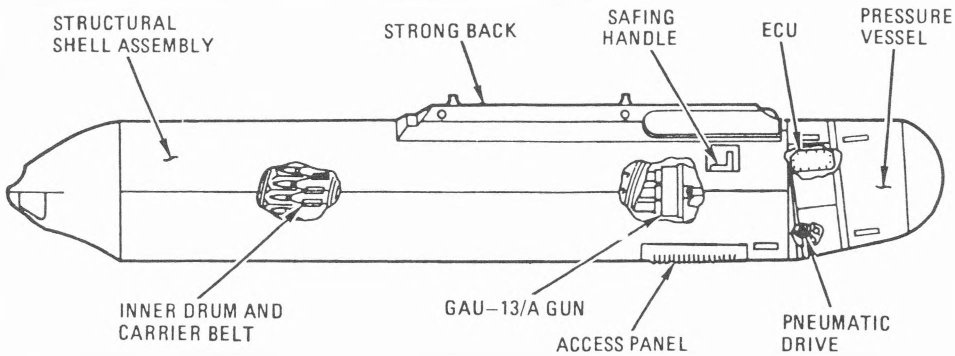
When the burst limiter is used, the gun pod must be operated in the autoclear mode to ensure that the gun is cleared of live rounds in the breech prior to landing.

When the no limit position is selected, the burst limiter is removed from the gun circuit; the gun pod then may be operated in either mode, nonclear or autoclear.

GPU-5/A 30MM GUN POD

The GPU-5/A gun pod (FIGURE 3-20) contains a GAU-13/A, 30mm, pneumatically driven, four-barrel Gatling-type gun; a closed-loop ammunition feed and storage system; an electronic control unit (ECU); and a precharged pressure vessel. The gun pod is suspended from the bomb rack and can be jettisoned.

GPU-5/A 30MM GUN POD



CHARACTERISTICS

GUN	GAU-13/A
LENGTH	14 FT 2 IN.
DIAMETER	28 IN.
SUSPENSION LUG SPACING	30 IN.
WEIGHT, EMPTY	1273 LB
WEIGHT, LOADED	1865 LB
AMMO CAPACITY	353 ROUNDS
FIRING RATE	2400 SHOTS/MIN
MUZZLE VELOCITY	3200 FPS

Figure 3-20

The aircraft gun fire circuit for the SUU-23 gun pod is used for the GPU-5/A gun pod. After each burst, the gun reverses direction of rotation to clear the gun of unfired rounds. The unfired rounds are returned to the feed system for use during the next trigger pull. Empty cases are retained in the gun pod.

WARNING

There is no cockpit indication that the gun is cleared of live rounds.

The gun pod has one fire rate (40 shots per second) and two selectable firing modes on the pod: combat and training. In combat mode, the gun can be fired out in one burst (353 rounds). In the training mode, the total number of rounds fired in a single burst is limited to 30, and the total rounds fired during a single flight is limited to 117.

Three types of ammunition are available: target practice (TP), armor-piercing incendiary (API), and high-explosive incendiary (HEI). All cartridges are percussion-primed. For a description of projectile functions, see 30mm Ammunition (Section I).

SUU-25C/A AND E/A FLARE DISPENSERS

The SUU-25 series flares dispensers (FIGURE 3-21) are capable of dispensing eight LUU-2 or MJU-3 series flares, or eight LUU-1/B, LUU-5/B, or LUU-6/B markers. The flare dispenser is designed to be returned and used for more than one mission. There is only one difference in the SUU-25E/A and the SUU-25C/A flare dispensers; the SUU-25E/A forward shear pins (retaining link) are visible and accessible from outside the dispenser. This allows visual confirmation that the forward flares are secure.

The dispenser is a tubular body of all-metal construction, consisting of four tubes clustered and enclosed by an outer skin with a bulkhead at each end. Located at the top center of the dispenser are two electrical receptacles for connection with the aircraft electrical system.

Flares/markers are loaded against a compression cushion and are retained by eight shear pins, four located in the forward section and four in the aft end. Each of the four tubes has two breech assemblies loaded with impulse cartridges. One breech is routed to a chamber between the forward and aft flares. The aft flare is dispensed first by cartridge gases creating a temporary compression chamber between the flares. Single flare dispensing is controlled through the dispenser intervalometer, which causes one flare to be dispensed with each release pulse. However, if the aft munition fails its launching sequence, the forward munition firing sequence will purge the tube, launching both munitions together. On the right side of the dispenser, in the center section, is a jack in which a shorting pin can be inserted on the right side of the dispenser to interrupt the electrical circuit between the two electrical receptacles and the breeches. This pin electrically safes the dispenser. Located in the center, on each side of the dispenser, is an access door with a notch at the top and bottom to allow the forward retaining link shear blocks to extend outside the dispenser (FIGURE 3-21). The retaining link assembly is designed with a slot in which to insert a shear pin that secures the forward munition within the dispenser tube. Information as to type of munitions loaded, fuze settings, and date loaded is written on the side of the dispenser. The area around the lugs is reinforced with a strongback to permit sway-bracing and forced ejection.

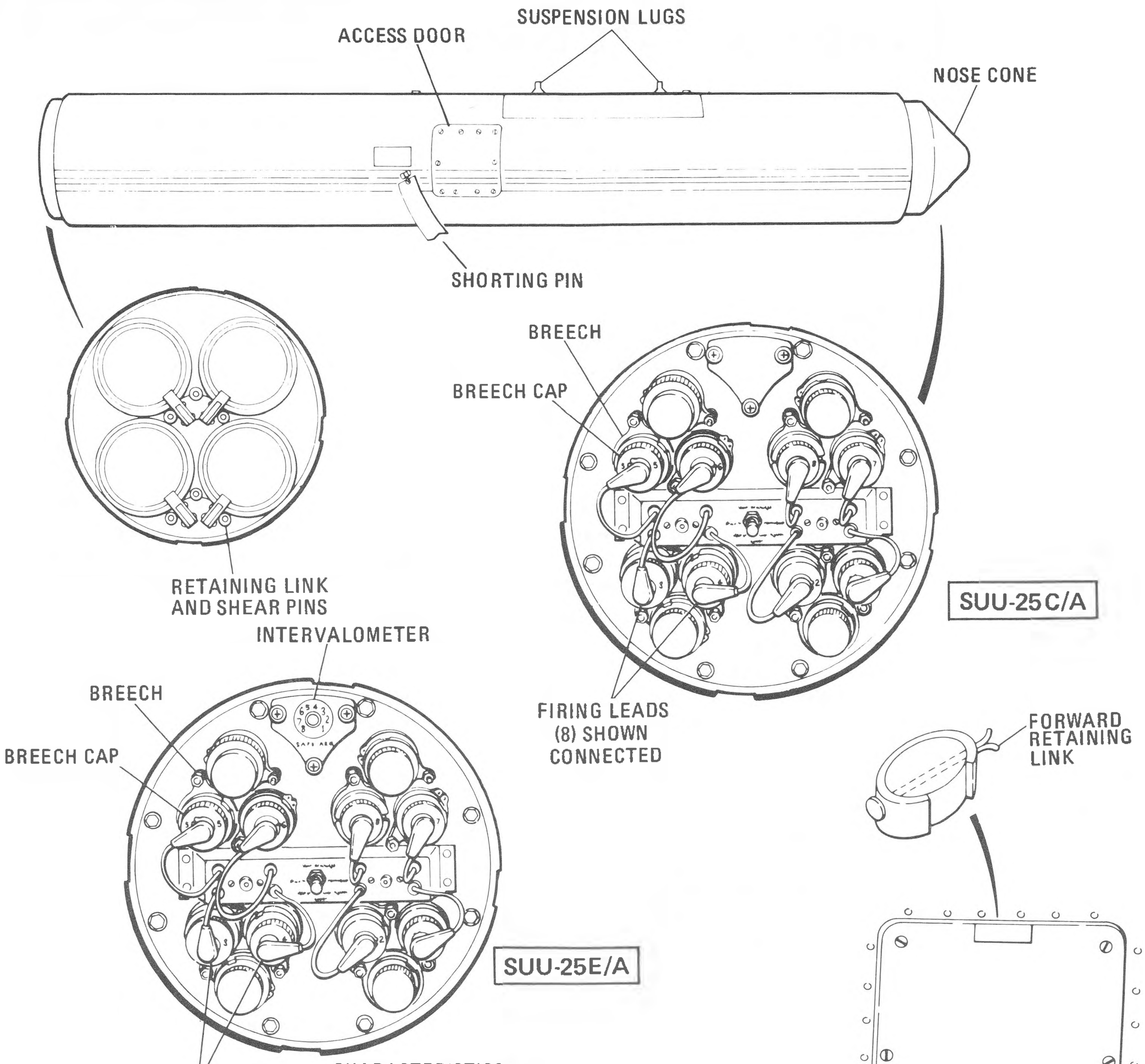
To confirm the SUU-25C/A dispenser is loaded with munitions, the aft end of each tube should be checked for the bottom end of a munition with a sealing cap ring.

To confirm the SUU-25E/A dispenser is loaded with munitions, the aft end of each tube should be checked for the bottom end of a munition with a sealing cap ring. A manually set/remotely controlled intervalometer and breeches are located at the forward bulkhead.

LUU-1/B, 5/B, 6/B TARGET MARKER FLARES

The LUU-1/B, 5/B, 6/B target marker flares (FIGURE 3-22) are designed to burn for 30 minutes on the ground, providing a colored flame. It is intended that the color be

SUU-25C/A AND E/A FLARE DISPENSERS



CHARACTERISTICS

WEIGHT, EMPTY	260 LB
WEIGHT, LOADED	500 LB (APPROX)
LENGTH	8 FT
DIAMETER	14 IN.
TUBE DIAMETER	5 IN.
SUSPENSION LUG SPACING	14 IN.

FIGURE 3-21

distinguisable in the presence of burning illumination flares. The LUU-1/B burns with a red flame, the LUU-5/B burns green, the LUU-6/B burns maroon. The candle burning surface is on the end connected with the parachute to reduce chances of snuffing out the flame on ground impact. A steel suspension cable links the parachute and the wooden suspension block located on the bottom of the candle. The suspension cable passes through a 2.75-inch-diameter protective core in the center of the candle, and extends 6.0 feet from the top of the candle to a point where the cable is connected to eight 6-foot shroud lines. The parachute for the target maker flare uses two 7.5- by 2-foot panels sewn together in the form of a plus (+) sign. The parachute is designed to provide a 30-fps rate of descent and to snag in the top of heavy foliage, making it useful in jungle areas. After flare ignition, the flare has a rate of descent of approximately 15.0 fps.

A 5- to 30-second delay ejection fuze and a 10- to 30-second delay ignition fuze are used for target marker flares.

When the marker is loaded in the SUU-25 dispenser, the arming lanyard extension is removed, and a KMU-361 adapter kit is installed on the marker. An adapter arming lanyard and the marker arming lanyard are both attached to the marker safety pin keyring. Ejection of the marker from the dispenser pulls the adapter free of the marker, which in turn pulls the marker safety pin and the marker arming lanyard, arming the ejection fuze.

NOTE

During mission planning, a release altitude, an ejection fuze setting, and an ignition fuze setting that assure flare ignition prior to ground impact must be selected.

The ejection and ignition fuzes must be set before loading. Upon release, the pull on the lanyard ignites the ejection fuze. At the conclusion of the ejection fuze delay, an ejection charge expels the candle and deploys the parachute. The ejection charge also ignites the ignition fuze delay element. The candle is ignited at the expiration of the ignition fuze delay.

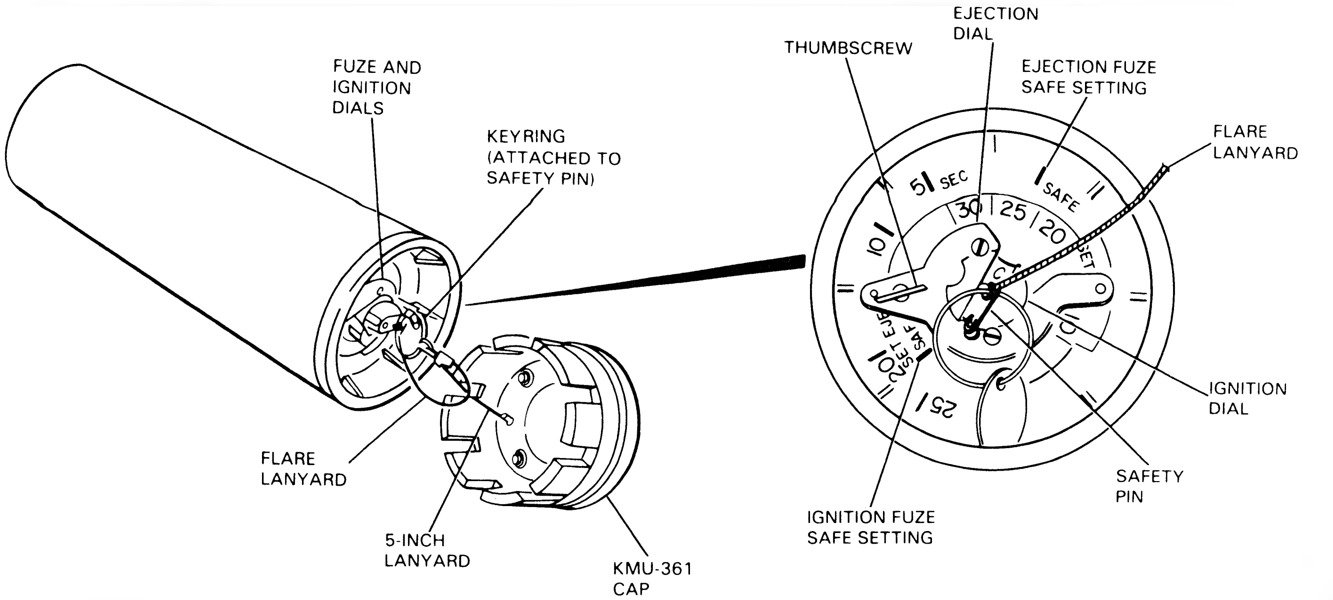
LUU-2/B FLARE

The LUU-2/B flare (FIGURE 3-23) is a pyrotechnic illuminating device with a burn time of approximately 5 minutes. The flare burns at an average of 2 million candle-power.

The desired free-fall distance in feet (delay time) must be set into the timer before loading. The available settings into the timer are 500, 1,500, 3,000, 4,000, 5,000, 6,500, 7,500, and 8,500 feet.

The timer knob is removed as the flare is ejected from the aircraft, which starts the timer. After the selected delay time, The release mechanism is tripped, allowing the timer and cover to be ejected from the flare case by a spring. As the

LUU-1/B, 5/B, 6/B TARGET MARKER FLARES



CHARACTERISTICS

WEIGHT	26 LB
LENGTH	36 IN.
DIAMETER	4.87 IN.

FIGURE 3-22

timer is ejected, it pulls the parachute with it. Deployment of the main parachute produces a shock force on the support cables through the ignition lanyard to rotate a bellcrank in the ignition system, shearing a safety pin and cocking and releasing a firing pin. The firing pin strikes and initiates a primer, which ignites boron pellets. The boron pellets ignite a wafer of propellant, which ignites the flare candle. Pressure buildup on flare ignition blows out pressure relief plugs in the igniter housing, after which the flare case burns through and the ignition housing falls free.

The flare burns for approximately 5 minutes. The average rate of descent of the flare after parachute deployment is 8.0 fps, and the flare descends approximately 2,500 feet during the 5-minute burn time.

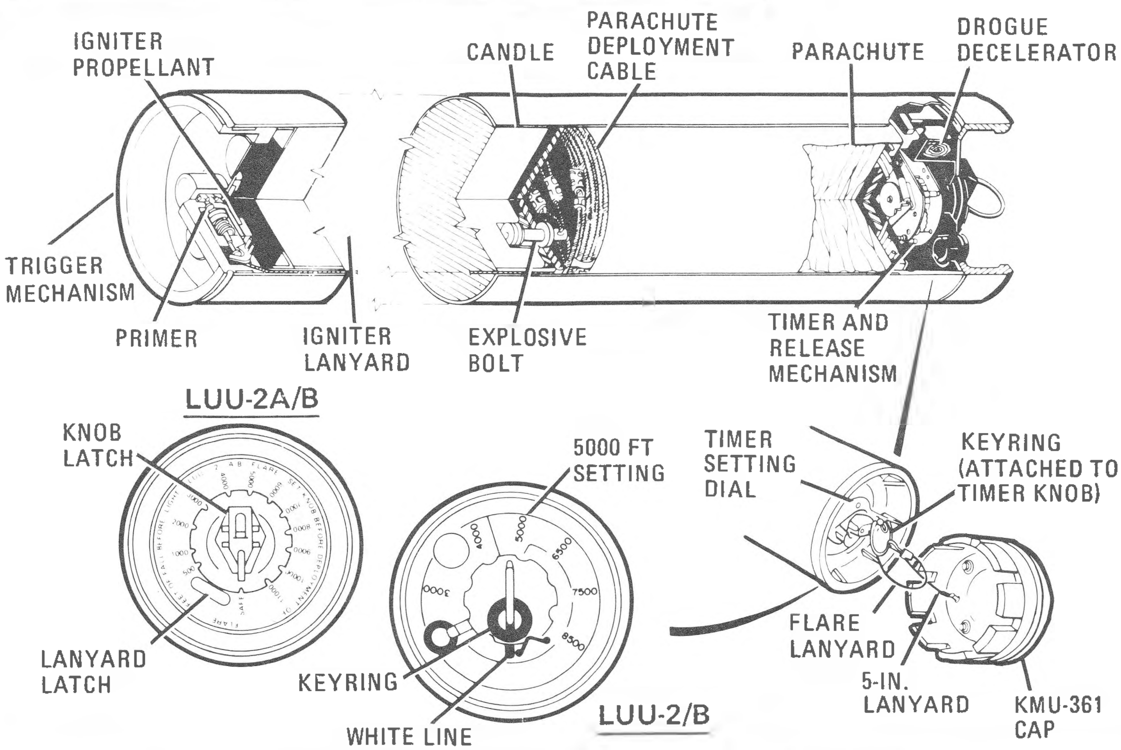
NOTE

At 5,000 feet density altitude, the flare descends approximately 11.5 fps and falls approximately 3,500 feet during the 5-minute burn time.

The pyrotechnic candle consumes the flare housing. This reduces the flare weight, which allows the flare to hover during the last 2 minutes of burn time. At candle burnout an explosive bolt is initiated; this releases one parachute support cable, causing the parachute to collapse.

When the flare is installed in the SUU-25 dispensers, a KMU-361 adapter kit (FIGURE 3-23) is installed on the flare. A 6-inch lanyard is attached from the adapter kit to the flare timer knob key ring. Ejection of the flare from the dispenser pulls the adapter free of the flare; this, in turn, pulls the flare timer knob from the flare.

LUU-2/B AND LUU-2A/B FLARE



CHARACTERISTICS

WEIGHT ____ 29 LB
LENGTH ____ 3 FT
DIAMETER ____ 5 IN.

FIGURE 3-23

LUU-2A/B FLARE

The LUU-2A/B incorporates an improved timer for higher reliability and increased flexibility. This is the only respect in which it differs from the LUU-2/B. The feet-of-fall settings for the LUU-2A/B are 500, 1,000, 2,000, 3,000, 4,000, 5,000, 6,000, 7,000, 8,000, 9,000, 10,000, and 11,000.

FLARE DISPENSING

The flare delivery aircraft approaches the target in level flight at the preplanned release altitude. The flare profile and parameters are illustrated in FIGURE 3-24.

Release airspeed is not a critical parameter. Release altitude is critical only when it is desirable to have flare burnout above the ground. The flare-dispensing table (FIGURE 3-24) provides the minimum release altitude above ground level (AGL) that will provide flare burnout at impact. The desired burnout altitude AGL must be added to the minimum release altitude AGL to determine the actual release altitude AGL. The flare-dispensing table also provides the horizontal distance traveled and the vertical drop of the flare prior to ignition. The flare ejection fuze delay time and the flare ignition fuze delay time are set according to the mission requirements and the data on the flare-dispensing table. To properly position the flare at ignition; rangewind effect and crosswind offset (feet) may be determined by multiplying the rangewind or crosswind component (knots) times 1.7 times the sum of the ejection and ignition fuze delay settings.

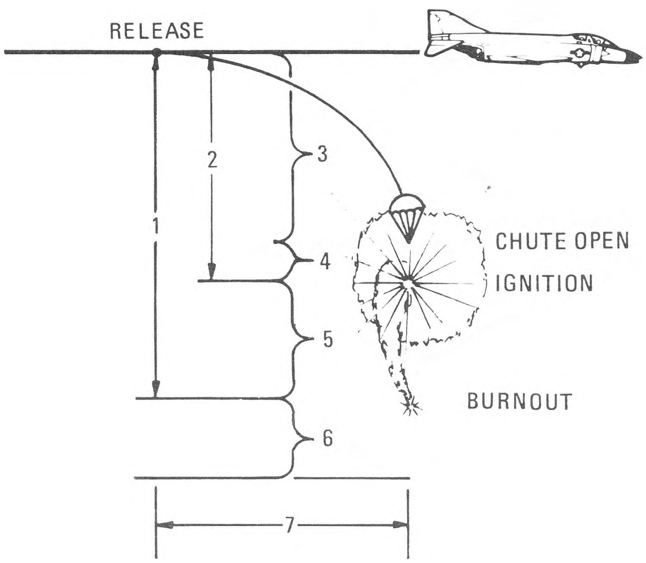
AIR COMBAT MANEUVERING INSTRUMENTATION (ACMI) SYSTEM

The ACMI system uses the combination of distance measuring equipment, airborne sensors, and inertial-measuring equipment to provide real-time measurement of position and attitude of aircraft instrumentation subsystem (AIS) equipped aircraft to ground station. The ACMI system provides a capability for (1) training and maneuvering, (2) recognizing weapons envelopes, and (3) weapon system employment evaluation. The ACMI system consists of instrumentation that allows radio communications and presents real-time graphic and alphanumeric displays of aircraft and weapon status data. This ACMI presentation can also be recorded and reviewed later for mission debrief. Computer simulations of missiles are used for training in achieving weapon firing envelopes. The ACMI system is organized into four subsystems: the tracking instrumentation subsystem (TIS), the AIS, the control and computation subsystem (CCS), and the display and debriefing subsystem (DDS). The AIS is the only airborne subsystem in the ACMI system and the only subsystem described here.

NOTE

Aircrews should provide the ACMI operator with AIS pod number and aircraft station number prior to flight.

LUU-2A/B FLARE PROFILE



1 MINIMUM RELEASE ALTITUDE AGL REQUIRED TO PROVIDE FLARE BURNOUT.

2 VERTICAL DROP PRIOR TO FLARE IGNITION.

3 EJECTION FUZE DELAY TIME.

4 IGNITION FUZE DELAY TIME.

5 FLARE BURNING TIME.

6 DESIRED FLARE BURNOUT HEIGHT AGL.

7 HORIZONTAL FLARE TRAVEL PRIOR TO IGNITION.

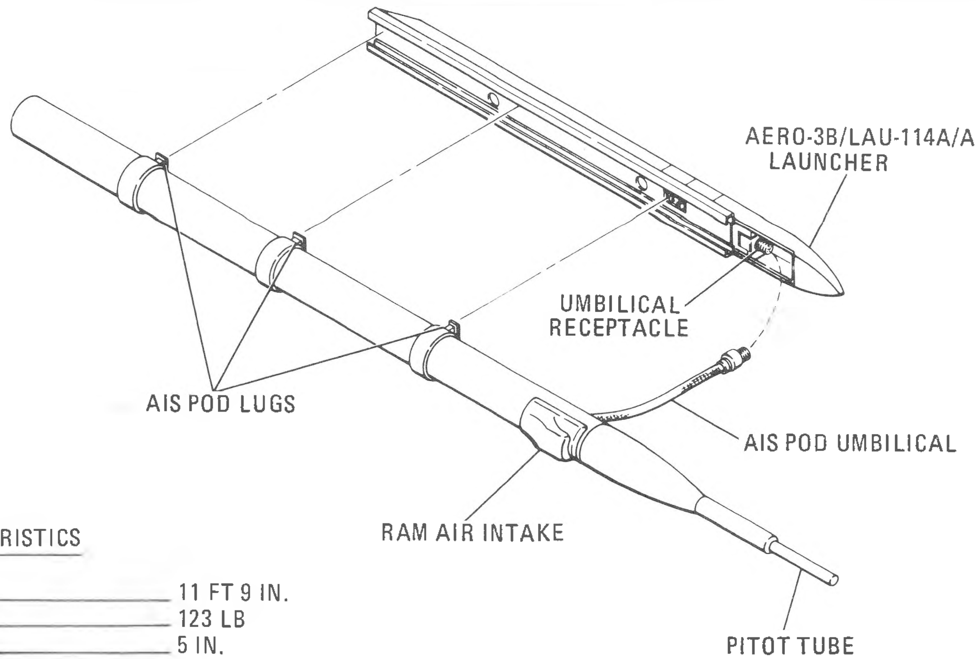
FIGURE 3-24

AIRCRAFT INSTRUMENTATION SUBSYSTEM (AIS)

The AIS pod (FIGURE 3-25) is carried on all flights utilizing the ACMI system. It consists of an AIM-9 missile shell which contains a transponder, a digital interface unit, an inertial reference unit, an air data sensor unit, and a digital data link receiver and transmitter. These units measure flight data which are transmitted to the TIS for computation of space positioning of all pod-carrying aircraft on the ACMI range.

The AIS pod operates from standard aircraft power available from various launchers. It receives electrical power any time that electrical power is on the aircraft. No specific pod switches are utilized to operate the AIS pod. In addition to transmitting flight parameters to the ground, fire control system information is monitored by the pod to reflect proper fire control switchology and transmit fire signals to the ACMI computer.

AIS POD WITH AERO-3B/LAU-114A/A LAUNCHER



CHARACTERISTICS

LENGTH	11 FT 9 IN.
WEIGHT	123 LB
DIAMETER	5 IN.

FIGURE 3-25

Each ground-to-air and air-to-ground transmission consists of a digital data message and ranging tones. The AIS pod receives an uplink ranging and data message from one of the ground stations designated as the interrogator and returns a downlink ranging and data message which all ground stations may receive. The downlink data message contains aircraft attitude, velocity, and pressure data, and missile firing data. The uplink data message contains attitude and velocity corrections for updating the inertial reference unit data processor and pod identification.

Attitude and velocity corrections are derived in the CCS real-time filter based on the tracking data from the TIS combined with attitude, velocity, and barometric data downlinked from the AIS pod. These corrections are used to update the inertial reference unit platform state, forming a closed loop between AIS, TIS, and CCS.

Current variants (FIGURE 3-26) include the T-11, T-13, T-17, and T-20. The T-11 utilizes a modular component design which requires a ram air intake for cooling. The T-13, and subsequent variants, reduced pod weight 30 pounds by converting to a five black box line-replacable unit (LRU) concept. The T-17 was developed to provide AIS pod interface with aircraft electronic warfare systems (EWS). Other features include a self-contained radar altimeter and ultra-high frequency (UHF) uplink. The separate UHF uplink permits ACMI operators to uplink 1 of 12 prerecorded voice messages to the aircrew via the AIS pod at the press of a button. The T-20 is the same as the T-17 pod except it does not have the UHF uplink and radar altimeter features.

AIS POD VARIANTS

AIR FORCE NOMENCLATURE	VENDOR NOMENCLATURE	UNIQUE FEATURE
AN/ASQ T-11	P3	Modular maintenance, ram air cooling
AN/ASQ T-13	P4	Five LRU concept, no cooling scoop
AN/ASQ T-17	P4A	EWS interface radar, alt, UHF uplink
AN/ASQ T-20	P4AX	EWS interface

FIGURE 3-26

CTU-2/A RESUPPLY CONTAINER

The CTU-2/A is a parachute retarded container used to deliver combat supplies to ground forces (FIGURE 3-27). The container may be loaded with any equipment up to a maximum weight of 500 pounds, provided the equipment can be loaded to maintain the container center of gravity (CG) within allowable limits.

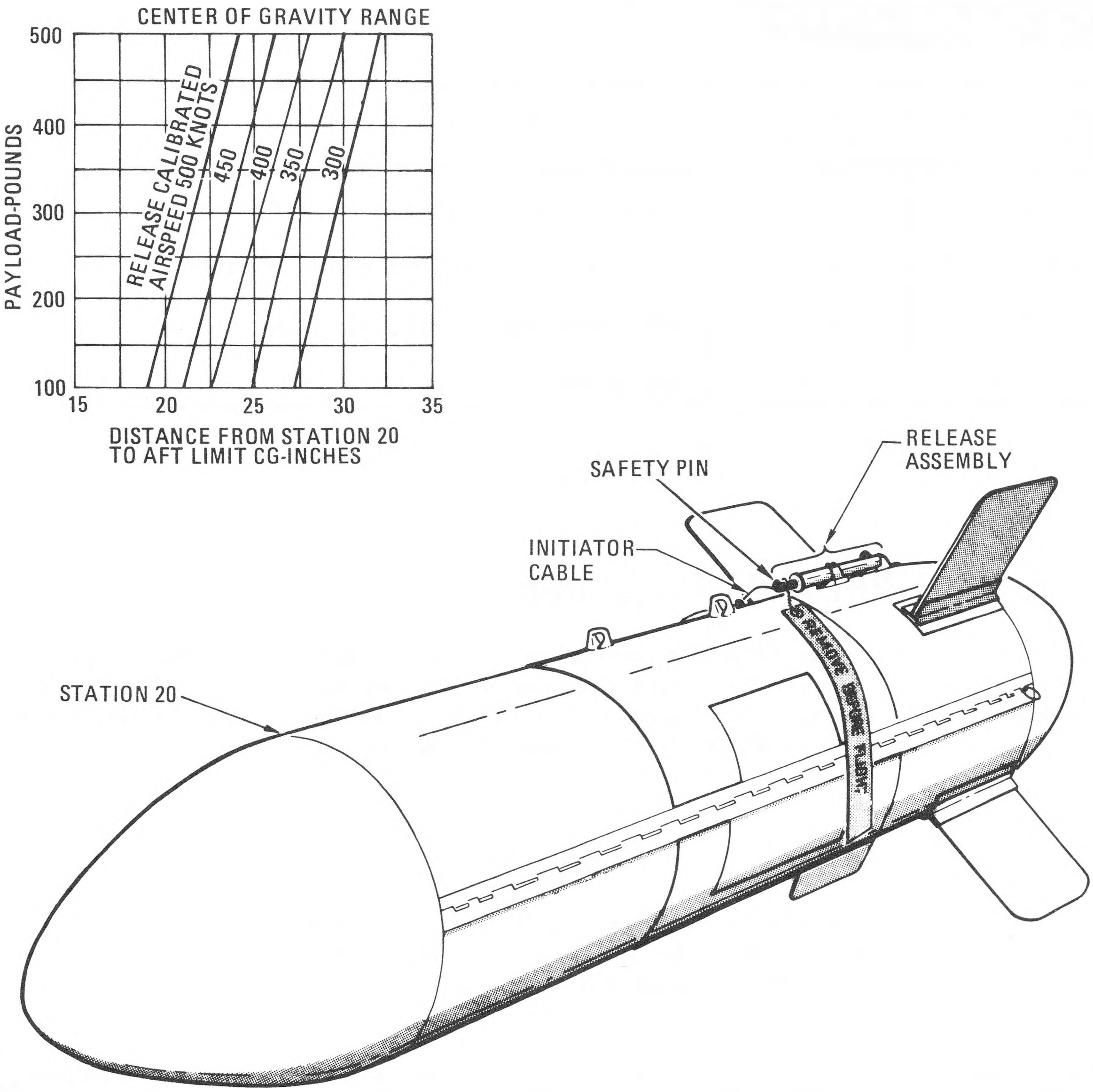
NOTE

The parachute system limits the delivery speed to 450 KCAS maximum and the delivery altitude to 300 feet AGL minimum.

The CTU-2/A consists of three basic assemblies: the fin stabilized container, an XM5 cartridge-actuated parachute release assembly, and the parachute assembly. At release, the initiator cable attached to the bomb rack causes detonation of the cartridge-actuated release assembly. After a 0.3-second delay, the release assembly ejects the tail cone and deploys the pilot parachute. The pilot parachute, in turn, deploys the main parachute to a reefed diameter of 36 inches. Explosive cutters then part a reefing line and initiate blossoming to full diameter. Container descent is controlled to an impact velocity of approximately 30 fps and at a nearly vertical impact angle.

At release, the aerodynamic stability of the loaded container is specifically dependent on maintaining the loaded container CG within specified limits. The appropriate

CTU-2/A RESUPPLY CONTAINER



CHARACTERISTICS

WEIGHT, EMPTY	213 LB
MAX CONTAINER LOAD	500 LB
LENGTH	8 FT 10 IN.
DIAMETER	21 IN.
SUSPENSION LUG SPACING	14 IN.

FIGURE 3-27

authority must therefore verify that the weight and CG locations are within allowable limits as a function of the planned payload and release airspeed. A plot is provided so that the aircrew may establish the CG required for a stable separation.

The chart in FIGURE 3-27 is provided to establish a CTU-2/A CG limit in order to verify container stability at release. The chart locates the most aft allowable CG position as a function of container payload weight and release calibrated airspeed (CAS). The measurement is expressed as the distance between the leading edge of the gravity center section (station 20) and the most aft CG. The allowable CG therefore includes any point forward of the aft limit. The allowable CG is obtained from the chart in the following manner: (1) locate the planned payload weight on the chart, (2) project to the planned release CAS and then down to arrive at the aft limit; the actual CG must be forward of this point.

CAUTION

If the actual CG is aft of the chart measurement, then the release speed and/or payload weight must be adjusted to establish an acceptable CG position. Failure to observe the required CG limits can result in unstable separation characteristics.

MXU-648/A CARGO POD

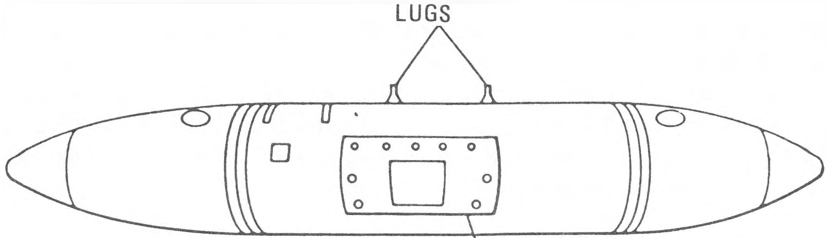
The MXU-648/A cargo pod (FIGURE 3-28) is a modified BLU-1 or BLU-27 firebomb shell. It is an aluminum canister consisting of tapered nose and tail sections, and a center section with a hinged access door. The cargo pod has a reinforced strongback for sway-bracing. Empty pod weight varies from 98 to 125 pounds, depending on type of BLU canister used in the modification. The pod is nonjettisonable, and a maximum of 300 pounds can be carried.

AN/DSQ-34 LASER TARGET DESIGNATOR SCORING SYSTEM (LTDSS)

The LTDSS (FIGURE 3-29) is a portable, battery-operated, laser scoring system. The system can be used as an aid in laser designation training or as an operational check of laser designator equipment. The system registers laser pulses striking the unit or a nearby target through an electromechanical counter; it transmits an audible tone of a UHF frequency as the laser pulses are registered. The system may be operated by ground range personnel for scoring, or left unattended when only a tone is required.

The LTDSS consists of a remote control and a pulse detector. The remote control assembly contains a transceiver radio, two electromechanical counters, radio control switches, and associated wiring. The pulse detector assembly consists of a photographic lens, light filter, light detector diode, and a pulse amplifier. A

MXU-648/A CARGO POD



CHARACTERISTICS

WEIGHT, EMPTY	98 - 125 LB
LENGTH	10 FT 10 IN.
DIAMETER	19 IN.
SUSPENSION LUG SPACING	14 IN.

FIGURE 3-28

rechargable 28-volt nickel-cadium battery pack is mounted in the bottom of the system container. The LTDSS weighs approximately 75 pounds.

WARNING

Under no circumstances should magnifying devices (binoculars, monoculars, etc.) be used to view the laser designating aircraft or the target area during periods of laser designation. Laser light can cause permanent and irreversible damage to eyesight.

AN/DSQ-T34 LASER TARGET DESIGNATOR SCORING SYSTEM

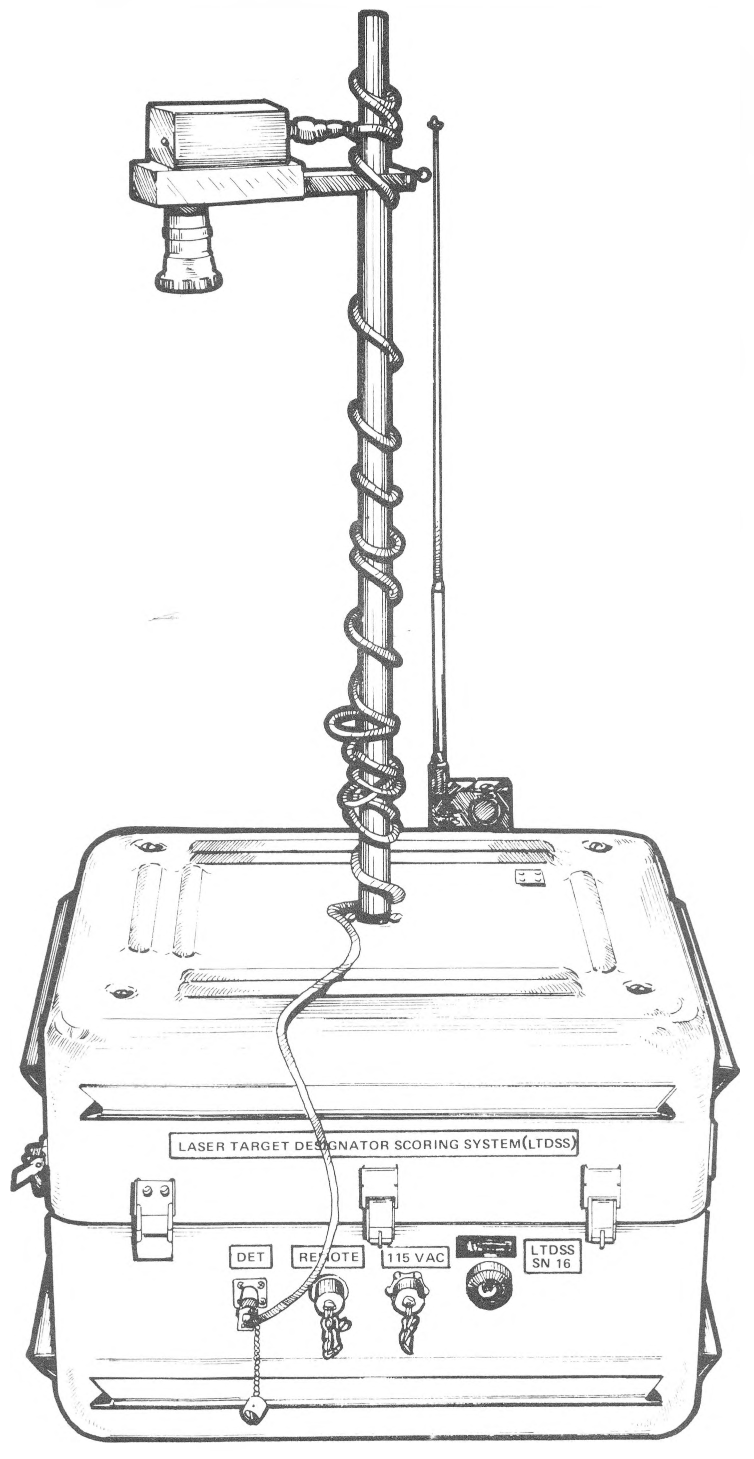
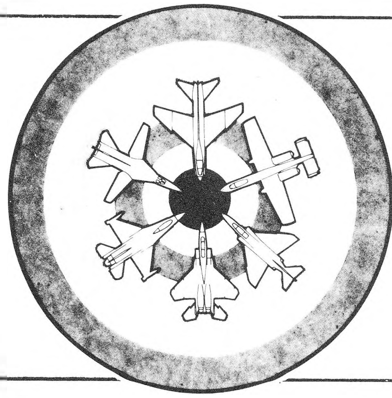


FIGURE 3-29



SECTION IV

AIR-TO-AIR MISSILES

CONTENTS

MISSILE TYPES

A missile may be either guided or unguided (FIGURE 4-1). Unguided missiles follow the natural laws of motion to establish a ballistic trajectory. Guided missiles may either home to the target, or follow on a nonhoming course. Nonhoming guided missiles are either inertially guided or preprogrammed. Homing missiles may be active, semiactive, or passive.

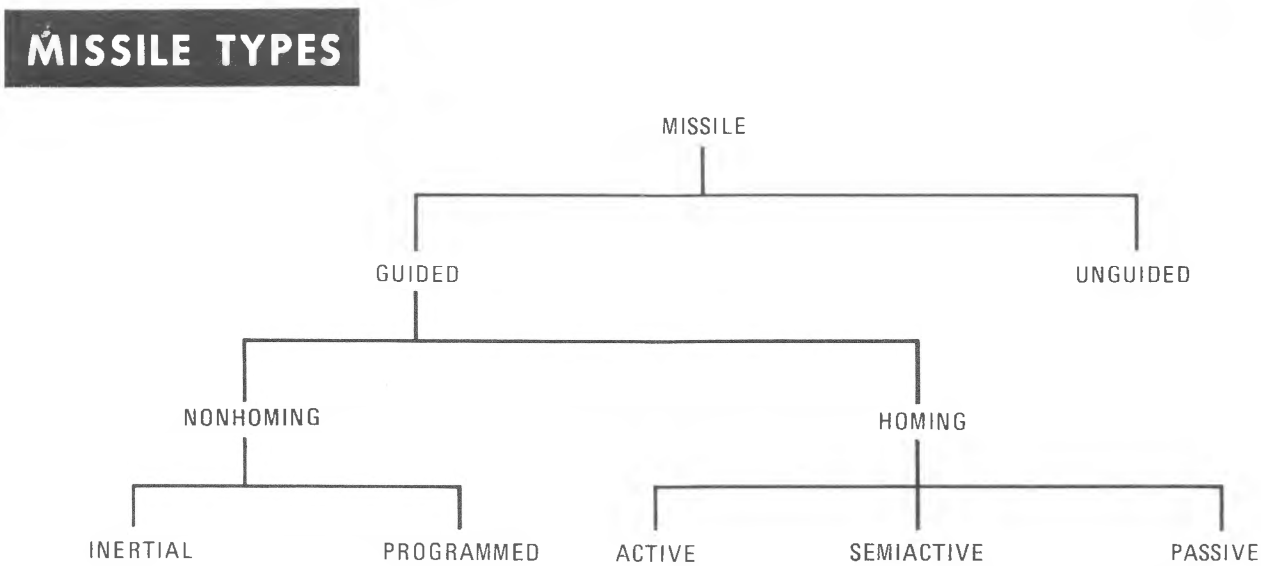


FIGURE 4-1

An active missile carries the radiation source on board the missile. Radiation from the missile is emitted, strikes the target, and is reflected back to the missile. The missile then is self-guided on this reflected radiation.

A passive missile uses radiation originated by the target or by some source not a part of the overall weapon system. Typically, this radiation is in the infrared (IR) region (Sidewinder) or the visible region (EO Maverick), but may also occur in the microwave region (Shrike).

A semiactive missile has a combination of active and passive characteristics. A source of radiation is part of the system but is not carried in the missile. The source (usually at the launch point) radiates energy to the target, from which the energy is reflected back to the missile. The missile senses the reflected radiation and homes to it.

TYPES OF GUIDANCE

Guidance is the means by which a missile steers to, or is steered to, a target (FIGURE 4-2). This definition included ballistic missiles, in which gravity and other forces of nature determine where the missile will go. This is generally referred to as ballistic guidance. All gunnery involves ballistics. For ballistic missiles, the guidance occurs before launch in the form of prelaunch attempts to reduce aiming errors.

HOMING TECHNIQUES

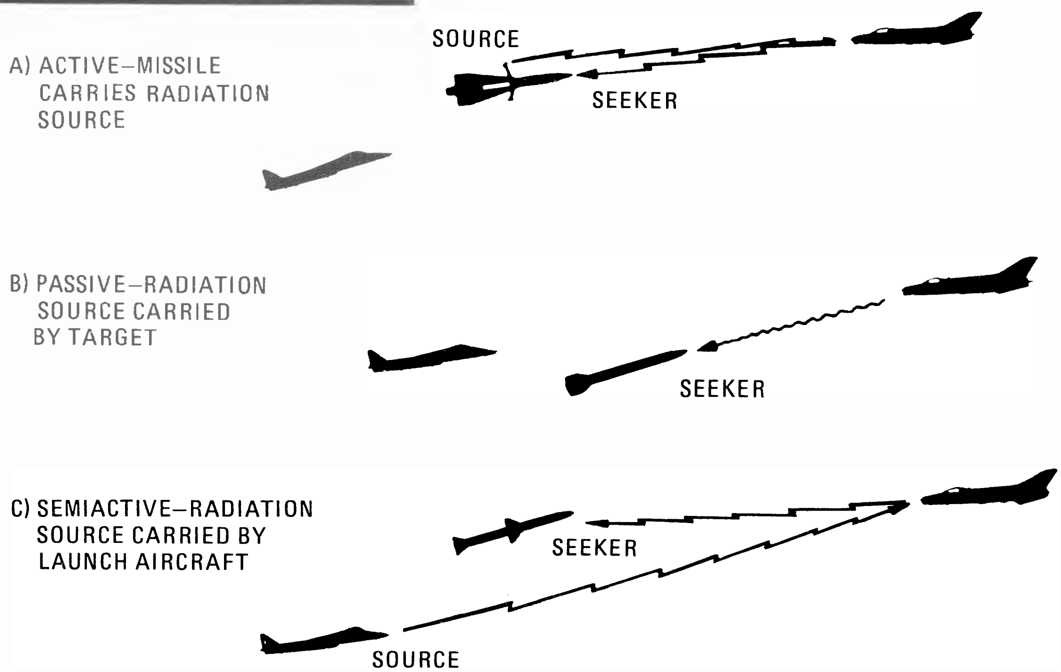


FIGURE 4-2

For guided missiles the guidance occurs after launch. By guiding after launch, the effect of prelaunch aiming errors can be minimized. As a result, the primary purpose of postlaunch guidance is to reduce prelaunch requirements. Postlaunch guidance can be done in a number of ways (FIGURE 4-3). Some of the prominent types of guidance are discussed in the following paragraphs.

LEAD PURSUIT

The launch aircraft directs its velocity vector at an angle from the target so that missiles or projectiles launched from any point on the course will impact on the target if within the range of the weapon. Note lead pursuit is flown by the launch aircraft in conjunction with the missile trajectory.

DEVIATED PURSUIT

The missile tracks the target and produces guidance commands to establish a fixed lead angle (λ). When the fixed lead angle is zero, deviated pursuit becomes pure pursuit. No current missile is designed to fly deviated pursuit; however, random errors and unwanted bias lines often result in a deviated pursuit course. Also, quite often the launch aircraft flies a deviated pursuit course.

TYPES OF GUIDANCE

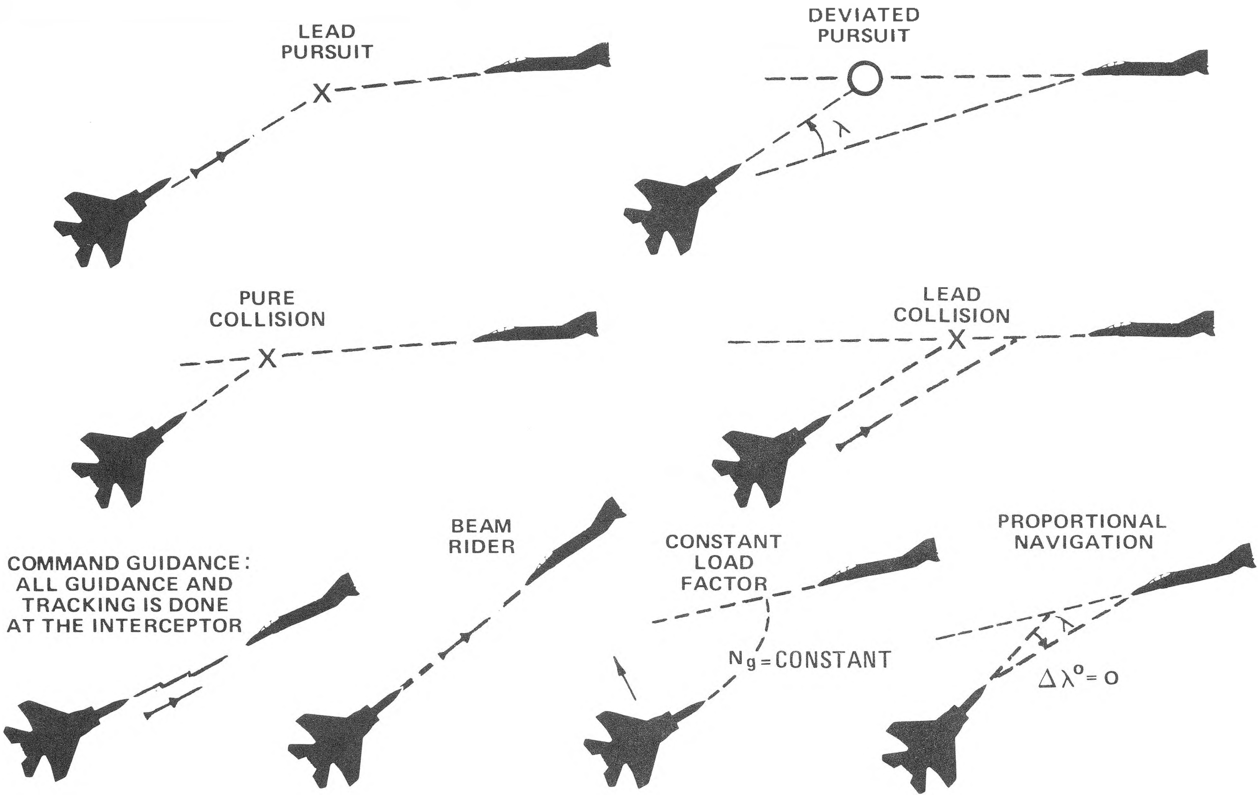


FIGURE 4-3

PURE COLLISION

Pure collision is a straight line course flown by a launch aircraft or weapon such that it will collide with the target.

LEAD COLLISION

Lead collision is a straight line course flown by a launch aircraft such that it will achieve a single given firing position. The time of flight (TOF) of the weapon is a constant.

COMMAND GUIDANCE

The launch aircraft tracks the target with one radar and tracks the missile with a second radar. A computer on the launch aircraft determines if the missile is on the proper trajectory to intercept the target. If it is not, steering commands are generated by the computer and transmitted to the missile.

BEAM RIDER

The launch aircraft tracks the target with a V-shaped beam. The missile flies at the bottom of the V. If the missile moves out of the bottom of the V, sensing circuits in the missile cause the missile to return to the correct position. As long as the launch aircraft continues to track the target, and the missile continues to ride the radar beam, the missile will intercept the target.

CONSTANT LOAD FACTOR

This is a course flown by a launch aircraft or missile so that a constant g load factor on the aircraft/missile will result in collision with the target. No missiles presently fly constant load factors. Normal acceleration is constant in this course.

PROPORTIONAL NAVIGATION

This is a course flown such that the lead angle is changed at a rate proportional to the angular rate ($\Delta\lambda$) of the line of sight (LOS) to the target.

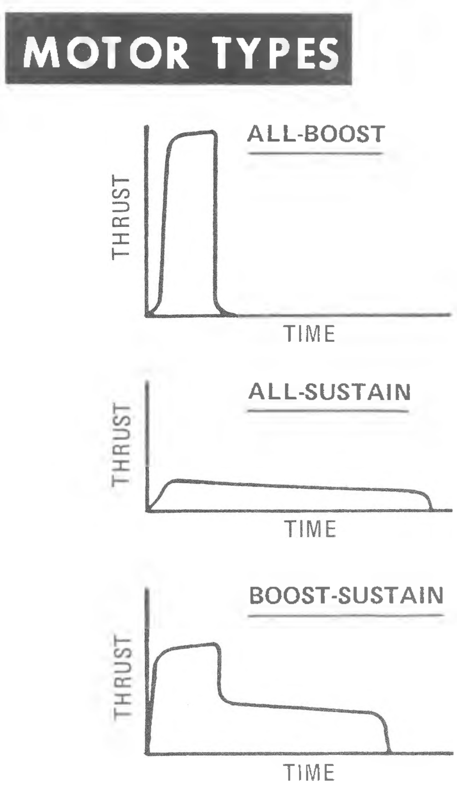


FIGURE 4-4

MOTOR TYPES

There are three basic air-to-air missile motor types: all-boost, all-sustain, and boost-sustain (FIGURE 4-4).

ALL-BOOST

An all-boost motor typically will make the missile accelerate rapidly, causing a high peak velocity. The short TOF for a given range causes high missile drag and high aerodynamic heating. This motor type is adequate for rear hemisphere, tail chase encounters.

ALL-SUSTAIN

The all-sustain motor produces slow missile acceleration, resulting in less aerodynamic drag and longer flight time, for a given range. Because the motor burns for a long period of time, the motor can be used to overcome gravity in a look-up engagement, and to provide sufficient velocity for maneuvering at high altitude. This type of motor is suitable for head-on engagements, or in look-up engagements to high altitude.

BOOST-SUSTAIN

The boost-sustain motor represents an attempt to combine the best features of the all-boost and the all-sustain motors. The boost-sustain motor is designed so that the sustain phase of propulsion will maintain the velocity achieved at the end of boost.

AIM-7 SPARROW MISSILE

DESCRIPTION

The AIM-7 is a supersonic, air-to-air guided missile designed for ejection launch. The missile can intercept and destroy targets in adverse weather conditions. The AIM-7 is a semiactive missile which is guided on either continuous wave (CW) or pulse doppler (PD) radio frequency (RF) energy radiated by the launching aircraft and reflected by the target. The missile is guided, controlled, and detonated by the target seeker and flight control sections. The warhead is of continuous-rod design which expands upon detonation of its explosive charge to produce target destruction. The solid propellant rocket motor provides the thrust (all-boost, AIM-7E3 and boost-sustain, AIM-7F/M).

AIR FRAME

Four major sections comprise the AIM-7 Sparrow missile (FIGURE 4-5): the guidance section (radome and target seeker); the control section (autopilot and wings); the warhead; and the rocket motor. The sections of the missile are coupled together and locked into position by screws. Four delta-shaped wings are plugged into the wing hub sockets. Four tail fins are attached to the rocket dovetail pad. A wiring harness provides the electrical connection between the target seeker and control section, and a waveguide provides an RF connection from the rear antenna to the target seeker. The missile is attached to the launcher by a set of hooks on the rocket motor and one lug on the flight control section. An umbilical cable and a rocket motor fire connector provide an electrical interface between missile and launcher. A safe and arming device on the rocket motor permits manual arming of the motor after installation.

GUIDANCE SECTION

RADOME

The radome forms the nosepiece of the missile and covers the seeker head assembly. It forms an important part of the external contour of the missile and is a vital link in the electromagnetic path of RF energy reflected from the target to the missile front antenna. The AIM-7F/M has an ogive shape which provides optimum balance between aerodynamic drag and electromagnetic requirements. The ogive shape is flaired into a cylindrical aft section, allowing for antenna size and eliminating RF interference at antenna gimbal limit angles.

AIM-7 SPARROW MISSILE-GENERAL OPERATIONS

RADOME

- SHIELDS RF HEAD AND TARGET SEEKER FROM THE ENVIRONMENT.
- OGIVE SHAPE SATISFIES BOTH ELECTROMAGNETIC AND AERODYNAMIC REQUIREMENTS.
- ALLOWS RECEIPT OF TARGET RETURN REFLECTED ENERGY WITH A MINIMUM OF BORESIGHT ERROR.

TARGET SEEKER

- DETECTS, LOCKS-ON, AND TRACKS TARGET
- AFTER TARGET LOCK-ON, SUPPLIES GUIDANCE SIGNALS TO FLIGHT CONTROL FOR CONVERSION TO WING MOTION.

WARHEAD

- WARHEAD IS DETONATED BY FUZING PULSE GENERATED BY EITHER THE CONTACT OR PROXIMITY RADAR FUZING CIRCUITS.
- WHEN DETONATED, HIGH EXPLOSIVE IN THE WARHEAD EXPANDS THE ROD BUNDLE INTO A RING.
- TARGET KILL OCCURS BY COLLISION OF THE RING WITH THE TARGET.

WARHEAD S & A DEVICE

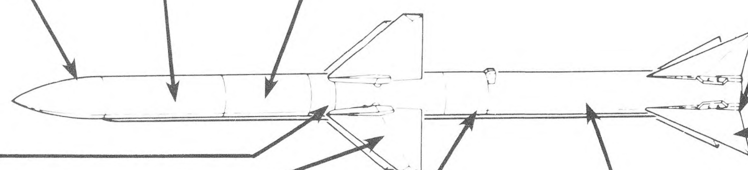
- WARHEAD S & A DEVICE ARMS THE WARHEAD WHEN THE MISSILE HAS ACCELERATED TO A SAFE DISTANCE FROM THE AIRCRAFT.

REAR ANTENNA

- RECEIVES REAR SIGNAL FROM LAUNCH AIRCRAFT AND APPLIES IT TO TARGET SEEKER.

FLIGHT CONTROL
(AUTOPILOT AND WING-HUB)

- ALL CONTROL OF THE MISSILE DURING FLIGHT PROVIDED BY THE FLIGHT CONTROL SECTION.
- CONTAINS CIRCUITS THAT CONTROL THE ROLL, PITCH, AND YAW ATTITUDES OF THE MISSILE.
- AUTOPILOT PROCESSES GUIDANCE SIGNALS FROM THE TARGET SEEKER AND PROVIDES ELECTRICAL IMPULSES TO THE WING-HUB.
- WING-HUB ELECTROHYDRAULIC VALVES CONTROL WING HYDRAULIC SERVO SYSTEM WHICH DEFLECTS THE WINGS.



TAIL FINS

- FOUR DELTA-SHAPED TAIL FINS STABILIZE THE MISSILE DURING FLIGHT.

WINGS

- WHEN DEFLECTED BY THE ACTION OF THE WING-HUB, THE FOUR WINGS PROVIDE MISSILE FLIGHT PATH CONTROL IN PITCH, ROLL, AND YAW PLANES.

ROCKET MOTOR

- WHEN IGNITED AT LAUNCH THE BOOST-SUSTAIN MOTOR ACCELERATES MISSILE TO SPEED AND MAINTAINS THRUST DURING SUSTAIN PHASE OF MOTOR BURNING.

ROCKET MOTOR IGNITER
AND S & A DEVICE

- MOTOR IGNITER IGNITES MOTOR PROPELLANT WHEN THE MISSILE IS LAUNCHED.
- S & A DEVICE PERMITS ARMING OF IGNITER PRIOR TO AIRCRAFT TAKE-OFF TO ENSURE SAFE GROUND HANDLING OF MISSILE.

ELECTRICAL POWER

- A QUICK-ACTIVATE BATTERY SUPPLIES ALL MISSILE ELECTRICAL POWER AFTER LAUNCH.

WAVEGUIDE

- FEEDS REAR SIGNAL RF TO TARGET SEEKER.

HYDRAULIC POWER

- HYDRAULIC ACCUMULATOR LOCATED IN THE WING-HUB SUPPLIES HYDRAULIC POWER FOR HUB (WINGS).
- CONTROL POWER UNIT LOCATED IN TARGET SEEKER SUPPLIES HYDRAULIC POWER FOR HEAD (ANTENNA).

FIGURE 4-5

TARGET SEEKER

The AIM-7 Sparrow target seeker receives and compares the radar energy acquired directly from the target illuminator on the launch aircraft and radar energy reflected by the target. The guidance system uses range rate, angle, and angle rate information to produce guidance signals for the autopilot. The target seeker consists of electronic modules packaged around the hydraulic system for the missile antenna gimbals. The antenna gimbal system provides antenna pitch and yaw motion about the missile body axis.

CONTROL SECTION

The control section consists of the autopilot and the hydraulic control group. The functions of the control section are to process angular error information and provide wing control signals to guide the missile and to stabilize the missile in pitch, yaw, and roll. The launching aircraft supplies the control section with attitude control voltages (English bias), which provide the missile with course correction commands used during the boost portion of the missile flight. The launching aircraft supplies a roll command signal which aids the missile in establishing a normal postlaunch flight attitude (umbilical up). The wing hub assembly consists of the steel midsection shell and the internal hub block. The hub block acts as a structural stiffener and functions as a foundation and support for the components required for wing operation. The assembly mounts contain the hydraulic accumulator, the valve manifold, wing servo valves, wing locks, four sets of double linear actuators, and wing socket assemblies. All four wings are actuated in pitch and yaw, while two of the wings also control roll rate. A maximum of ±22 degrees of rotary motion is available in each wing. Before activation, wing motion is restrained by spring-loaded locks to ±0.25 degree deflection. The hydraulic control group reacts to the signals from the autopilot to control the flightpath of the missile. The accumulator supplies the hydraulic power necessary to move the wings as required by the flight command signals from the autopilot.

WARHEAD SECTION

WARHEAD

The continuous-rod bundle is made up of pairs of 3/16-inch-square cross-sections of steel rods which are assembled in two interconnecting layers. The effective length of each inner and outer rod is approximately 8 inches. Each rod in the outer layer is welded at its forward end to the forward end of the adjacent rod in the inner layer. The welded points are the pivot points for the outer and inner layers. The resulting continuous construction is similar to an expansion bracelet, and can extend into a zig-zag hoop. The rods are tightly pressed together in the assembled condition.

SAFE AND ARM DEVICE

The safe and arm device is mounted at the forward end of the central axis of the warhead. The basic function of the safe and arm device is to maintain the warhead in an unarmed condition until the missile has intentionally been launched and has traveled a safe distance from the launching aircraft. After the missile reaches a safe distance, the safe and arm device arms the warhead so that upon receipt of a firing pulse from the guidance section, the warhead will be detonated.

ROCKET MOTOR SECTION

ROCKET MOTOR

The AIM-7 rocket motors are solid propellant motors providing thrust (all-boost, AIM-7E3 and boost-sustain, AIM-7F/M) for the missile. The motor is attached to the aft end of the missile warhead (AIM-7E3) or the control section (AIM-7F/M) and consists of three major subassemblies: a case propellant grain, a safe and arm igniter assembly, and a nozzle weather seal assembly. The motor case consists of a cylindrical tube section with an integral forward dome and an aft boattail section. The boattail incorporates four fin support brackets (dovetails) and an antenna mount.

SAFE AND ARM IGNITER ASSEMBLY

The safe and arm igniter assembly is a manually operated mechanism that can be locked in either the safe or armed position. The initiator gases are contained within the free volume of the device when the safe and arm igniter assembly is in the safe position. The safe and arm igniter assembly is attached to the rocket motor case and requires a separate arming tool to actuate the mechanism. A red streamer is attached to the handle of the arming tool to visually indicate that the igniter is in the safe position. The arming tool is removed after the igniter is armed. The igniter contains a main charge and a booster charge. When the rocket motor ignition is commanded, the gases exhaust through the perforated aft end of the case. The booster charge is ignited with redundant single-bridgewires by electric heating.

REAR ANTENNA ASSEMBLY

The rear antenna is a structural waveguide used to receive the RF energy emitted by the launching aircraft and conduct it to the target seeker. On the AIM-7F/M, the rear antenna waveguide is constructed in two sections.

MISSILE OPERATION

Homing guidance is accomplished by the semiactive radar target seeker which is compatible with either PD or CW illumination (AIM-7E3 is CW only). The seeker antenna receives the target-reflected energy which is then processed to obtain speed, range, and directional information, using the doppler principle. The AIM-7 Sparrow achieves velocity tracking by comparing target-reflected energy received through the front antenna with a reference signal received through the rear antenna. The comparison yields a doppler or difference signal which is proportional to the missile-to-target closing velocity. Because the missile must be able to accept a wide range of closing velocities, a tracking speedgate is used to search over the frequency range containing targets of interest. Range information is extracted from the ranging frequency modulation (FM) on the illuminator's transmitted signal. The ranging signal is present on the target-reflected energy but is time delayed with respect to the ranging signal received at the missile rear antenna. Comparison of the front signals and rear signals yields a doppler which is frequency modulated at the ranging frequency with a peak deviation proportional to range. This information is extracted in the range comparator to arm the fuze at the proper distance from intercept and to switch to an internal FM to retain a speedgate lock as the range diminishes to zero. Directional information for the missile in flight is obtained by conically scanning the antenna beam. Conical scanning of the received energy results in amplitude modulation whenever an error exists between the antenna to target LOS and the antenna boresight axis. Errors are detected, filtered, and fed to the front antenna as tracking commands and to the autopilot as guidance commands. Conical scanning is only initiated at a speedgate lock so that the full antenna gain is available for target acquisition. The primary function of the autopilot is to convert LOS rate into actual missile lateral acceleration. Basically, the autopilot consists of three tight acceleration feedback loops using rate gyros for the proper pitch, yaw, and roll damping. Autopilot gain switching is incorporated into the missile to optimize flight performance under varying conditions. This switching is automatically accomplished by a command from the fire control computer and is a function of interceptor altitude and target altitude.

AIM-7E3 SPARROW MISSILE

The AIM-7E3 Sparrow missile (FIGURE 4-6) is the oldest operational version of the AIM-7 missiles. The target seeker and flight control sections are connected together with the warhead between the control section and the rocket motor. The missile internal power is generated by a gas grain generator. The rear antenna is a one-piece waveguide which connects to the rear of the control section. The rocket motor is all-boost only. Homing guidance is accomplished by the semiactive target seeker which is compatible with CW illumination only.

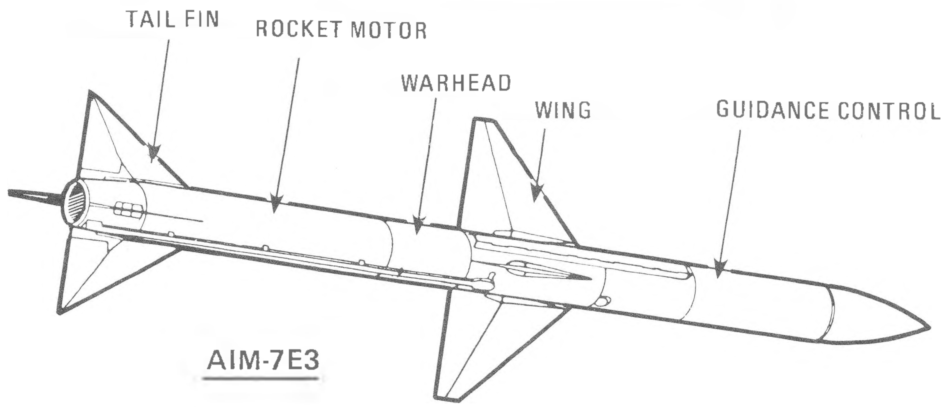
AIM-7F SPARROW MISSILE

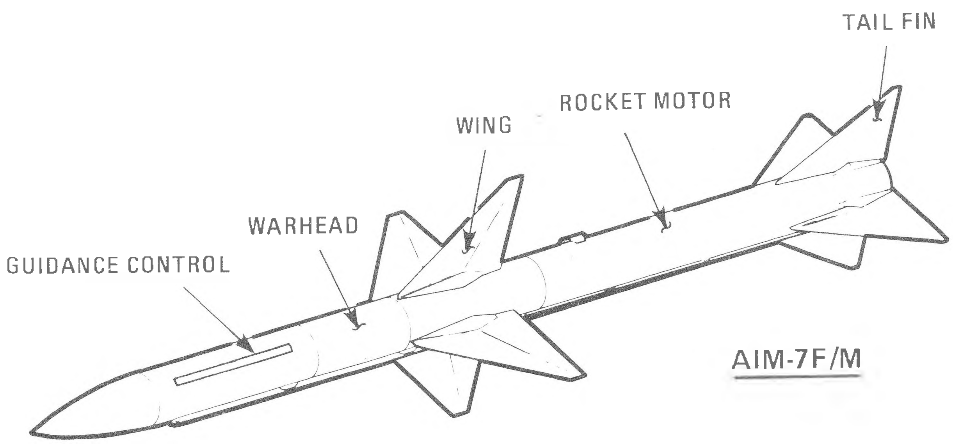
The AIM-7F Sparrow missile (FIGURE 4-6) is a larger version of the AIM-7 missiles. The warhead is larger and is placed between the target seeker section and the flight control section. The gas grain generator used in the AIM-7E3 version was replaced by a battery. The rear antenna is constructed in two sections. The forward section connects to the internal microwave circuitry in the guidance section. The forward section also serves as a cover for the tunnel connecting cable which provides electrical connection between the guidance and control section. The rear antenna aft section is joined to the forward section at the forward rocket motor joint. It has a boost-sustain rocket motor designed to maintain the velocity achieved at the end of the boost. Homing guidance is accomplished by the semiactive radar target seeker which is compatible with either PD or CW illumination.

AIM-7M SPARROW MISSILE

In most respects, the AIM-7M Sparrow missile is like the AIM-7F. The primary difference is an increased electronic countermeasure (ECM) and electronic counter-countermeasure (ECCM) capability.

AIM-7 SPARROW FAMILY DIFFERENCES





CHARACTERISTICS

	AIM-7E3	AIM-7F	AIM-7M
LENGTH	12 FT 1 IN.	12 FT	12 FT
DIAMETER	8 IN.	8 IN.	8 IN.
WINGSPAN	40 IN.	40 IN.	40 IN.
TAIL SPAN	32 IN.	32 IN.	32 IN.
WEIGHT	425 LB	510 LB	510 LB
ROCKET MOTOR	BOOST	BOOST-SUSTAIN	BOOST-SUSTAIN
GUIDANCE	CW	CW/PD	CW/PD
ANTENNA GIMBAL	55 DEG	55 DEG	60 DEG

FIGURE 4-6

AIM-7 EXERCISE WARHEAD

The exercise warhead is used for training and practice and can be used in place of the tactical warhead. The weight and size of the exercise warhead are similar to those of the tactical warhead. The exercise warhead has two signal types which upon firing emit a brilliant flash, permitting observation of the moment of simulated warhead detonation. The exercise heads use the same safe and arm devices employed in the tactical warhead.

AIM-7 TELEMETRY SET

A telemetry set may be used in place of the tactical warhead to transmit missile flight data to telemetry receiving stations. The telemetry data provide information necessary for the detailed analyses and evaluation of missile performance. The telemetry sets and the missiles they are used with consist of the following:

1. AN/DKT-30(V)1, (V)2 telemetry sets are used with AIM-7E3 missiles.

2. AN/DKT-37A(V) telemetry set is used with the AIM-7F missile.

The telemetry sets are of two types, full pack and video pack. The full pack consists of a telemetry unit installed in a duplicate warhead shell. The unit monitors approximately 30 missile functions, and transmits radar receiver functions, missile attitude, and autopilot instructions. The video pack is installed in a duplicate warhead shell and monitors missile speedgate, doppler, and fuzing. Closing velocity, lock-time, and miss distance are obtained from the transmitted data. For training flights where neither warhead nor telemetry is required, an exercise warhead shell is used, which approximates the warhead in weight and size.

AIM-9 SIDEWINDER MISSILE

The AIM-9 Sidewinder missile (FIGURE 4-7) is a supersonic air-to-air intercept missile. The missile consists of four external sections: guidance and control (G&C), warhead, influence fuze, and rocket motor. The missile has an IR radiation seeker in the G&C unit which controls the missile guidance and provides a tone in the pilot's headset. The aural tone indicates that the seeker head is operating and is used to monitor target detection and tracking. The IR system is a passive means of detection. Because the missile does not require guidance from the launching aircraft, the pilot may take evasive action immediately after the missile is launched. The missile warhead is detonated on contact or by an influence fuze when the target is within effective radius of the warhead.

Three suspension hangers attached to the motor enable loading on launcher rails. Four stabilizing wings are attached in the X-configuration at the rear of the rocket motor. Each wing contains a rolleron device which effectively opposes the roll rate of the missile during flight. An umbilical cable on the G&C and two contacts mounted in the forward hanger provide the electrical connection to the aircraft missile firing circuitry. The umbilical cable is attached to a connector which is sheared when the missile is launched.

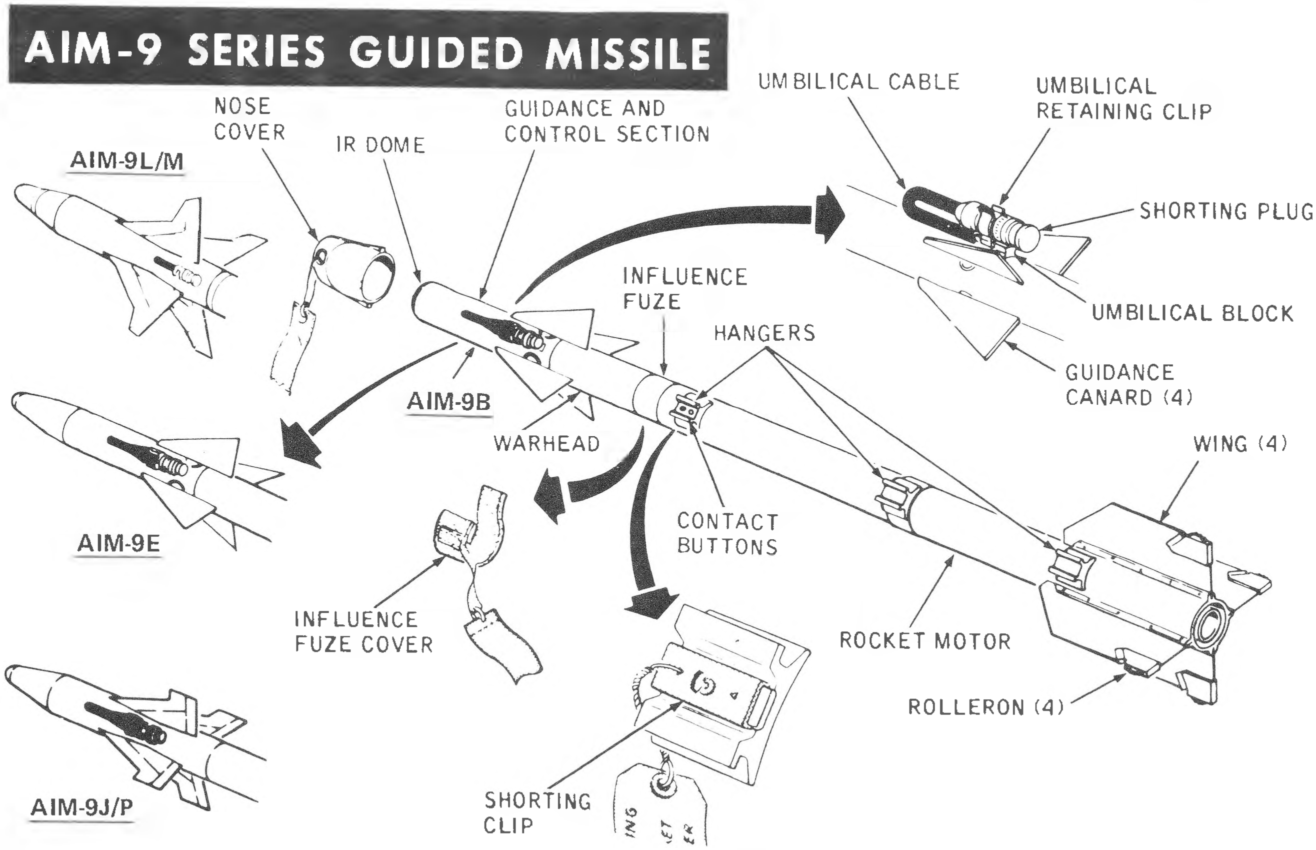


FIGURE 4-7

Various combinations of rocket motors and influence fuzes, with a given G&C unit, are available (FIGURE 4-8). Configuration identification begins with the letter designation of the G&C unit and is then followed by a dash number.

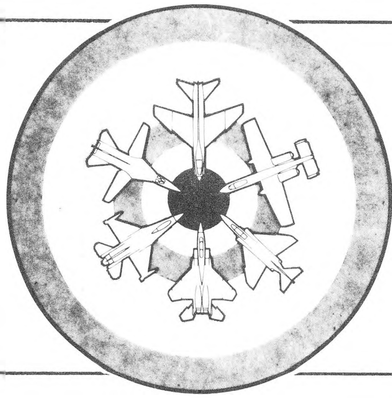
The difference between the AIM-9B, E, J, and P models, other than the physical characteristics, is in the G&C units. The AIM-9L/M missile (FIGURE 4-8) is similar to the other AIM-9 missiles but has an active optical target detector, is more maneuverable, has an all-aspect capability, has a more sensitive IR sensor, and has coolant gas for the IR detector. The coolant is provided by a small replaceable tank mounted within the G&C unit.

AIM-9 MODEL CONFIGURATIONS/CHARACTERISTICS

MODEL	MOTOR	FUZE	WEIGHT (LB)	LENGTH (IN.)	DIAMETER (IN.)	WINGSPAN (IN.)
B	MK 17	MK 303	167	112	5	22
B-1	MK 17	DSU-21/B[a]	167	112	5	22
B-2	SR-116-HP-1	MK 303	180	112	5	22
B-3	SR-116-HP-1	DSU-21/B[a]	180	112	5	22
E	MK 17	MK 303	171	118	5	22
E-1	MK 17	DSU-21/B[a]	171	118	5	22
E-2	SR-116-HP-1	MK 303	184	118	5	22
E-3	SR-116-HP-1	DSU-21/B[a]	184	118	5	22
J/P	MK 17	MK 303	165	120	5	22
J-1/P-1	MK 17	DSU-21/B[a]	165	120	5	22
J-2/P-2	SR-116-HP-1	MK 303	178	120	5	22
J-3/P-3	SR-116-HP-1	DSU-21/B[a]	178	120	5	22
L	MK 36	DSU-15/B, A/B[b]	191	113	5	25
M	MK 36	DSU-15/B, A/B[b]	233	115	5	25

[a] DSU-21/B target detector for the AIM-9B, E, J, P.
[b] DSU-15/B, A/B target detector for the AIM-9L/M.

FIGURE 4-8



SECTION V

SUSPENSION EQUIPMENT

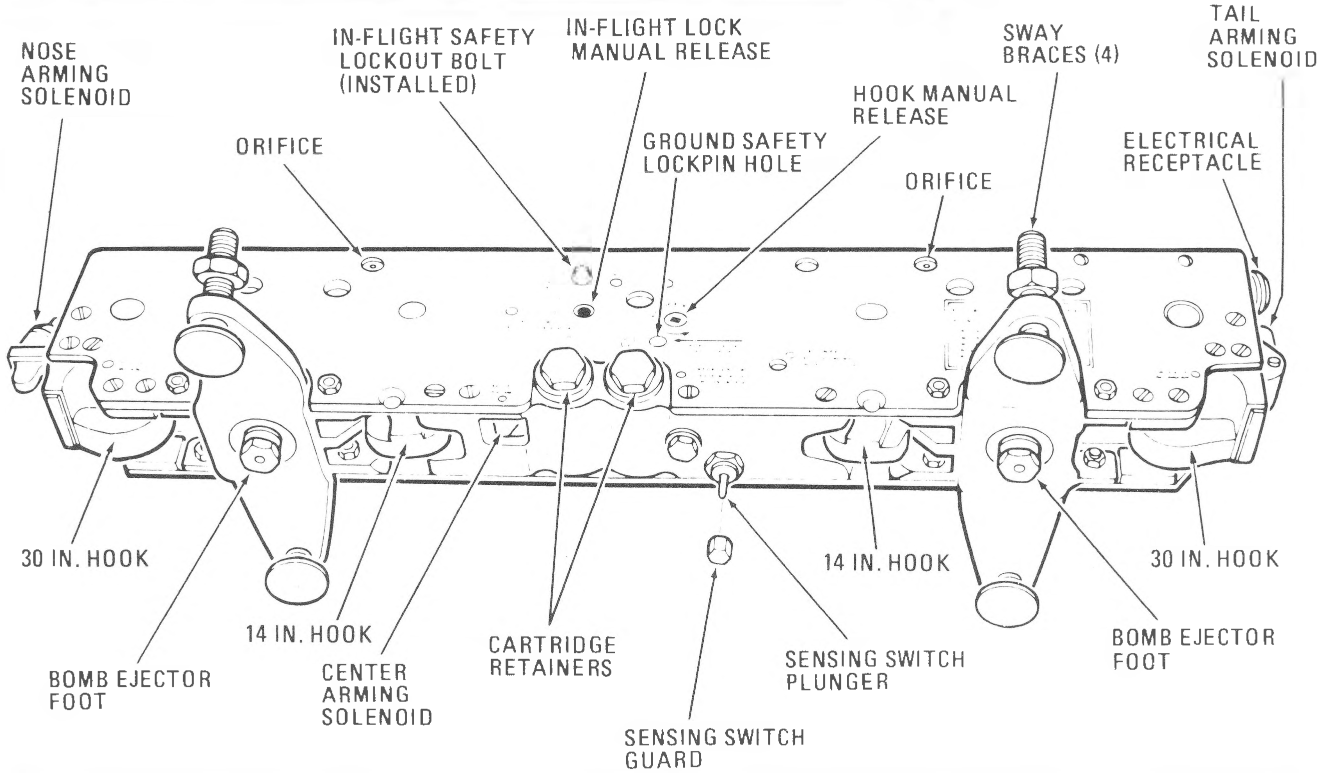
CONTENTS

BOMB AND EQUIPMENT RACKS

MAU-12B/A, C/A, D/A BOMB EJECTOR RACK

The MAU-12B/A, C/A, D/A bomb ejector rack (FIGURE 5-1) is a universal bomb rack installed in 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 up to a combined weight of 5,000 pounds and 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 which is positively locked in position by a latch mechanism of over-center bellcrank design.

MAU-12 BOMB EJECTOR RACK (TYPICAL)



CHARACTERISTICS

WEIGHT	75 LB
LENGTH	2 FT 8 IN.
WIDTH	3 IN.
HEIGHT	6 IN.
SUSPENSION HOOK SPACING	14 AND 30 IN.

FIGURE 5-1

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 solenoid and the tail arming option will arm only the aft solenoid (except A-7 aircraft). 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 in-flight safety lock (FIGURE 5-2). The ground safety pin is installed to prevent accidental firing of the cartridges when the aircraft is on the ground.

The in-flight safety lock is used to prevent operation of the pivot arm without appropriate nuclear consent switch settings. When configured for use with conventional munitions, an in-flight safety lockout bolt must be installed or no release will occur. This bolt is not streamered. The MAU-12C/A is completely interchangeable with the MAU-12B/A bomb rack. Essentially, MAU-12C/A is a strengthened MAU-12B/A with steel, instead of aluminum, side plates. The MAU-12D/A is the same as the MAU-12C/A.

MAU-40/A BOMB EJECTOR RACK

The MAU-40/A (FIGURE 5-3) is a universal bomb rack that is essentially a MAU-12C/A, D/A except it does not contain the safety wiring and in-flight safety lock required for nuclear munitions. All other descriptive items and operation for the MAU-40/A are the same as for the MAU-12C/A, D/A.

MAU-50/A BOMB EJECTOR RACK

The MAU-50/A (FIGURE 5-4) rack is shorter than the MAU-12C/A, D/A, and can carry only stores having 14-inch suspension lug spacing, weighing up to 2,000 pounds, and having a diameter between 9 and 30 inches. The MAU-50/A does not contain the safety wiring and in-flight safety lock required for nuclear munitions. All other details, descriptions of components, and operations are the same as those for the MAU-12C/A, D/A.

TER-9, 9/A TRIPLE EJECTOR RACK (TER)

The TER-9, 9/A (FIGURE 5-5) 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 1,000 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 (FIGURE 5-5) has provisions for suspension, sway-bracing, sensing, electromechanical arming, and

MAU-12 BOMB RACK OPERATIONAL SCHEMATIC

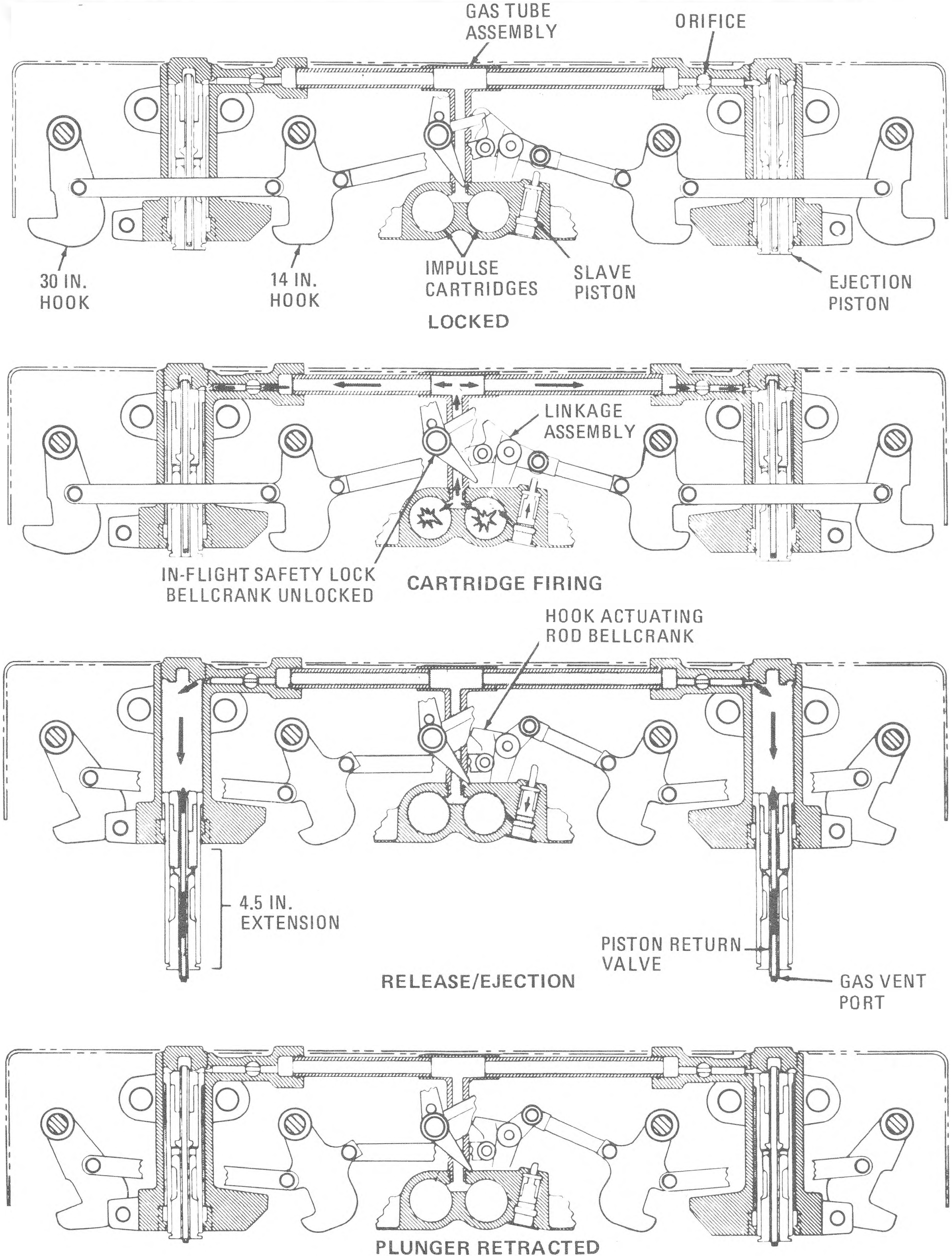
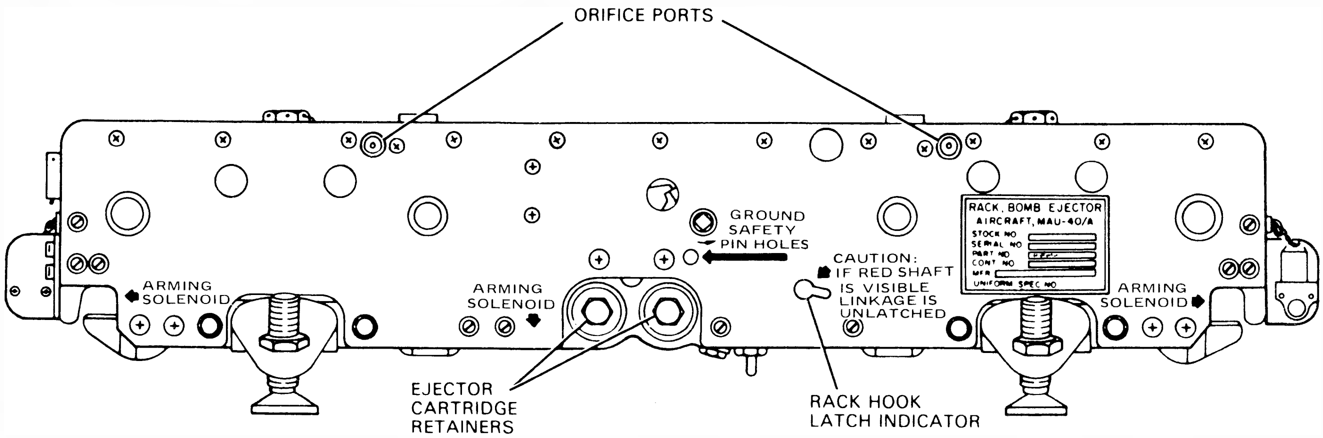


FIGURE 5-2

MAU-40/A BOMB EJECTOR RACK



CHARACTERISTICS

WEIGHT	65 LB
LENGTH	32 IN.
WIDTH	3 IN.
HEIGHT	6 IN.
SUSPENSION HOOK SPACING	14 AND 30 IN.

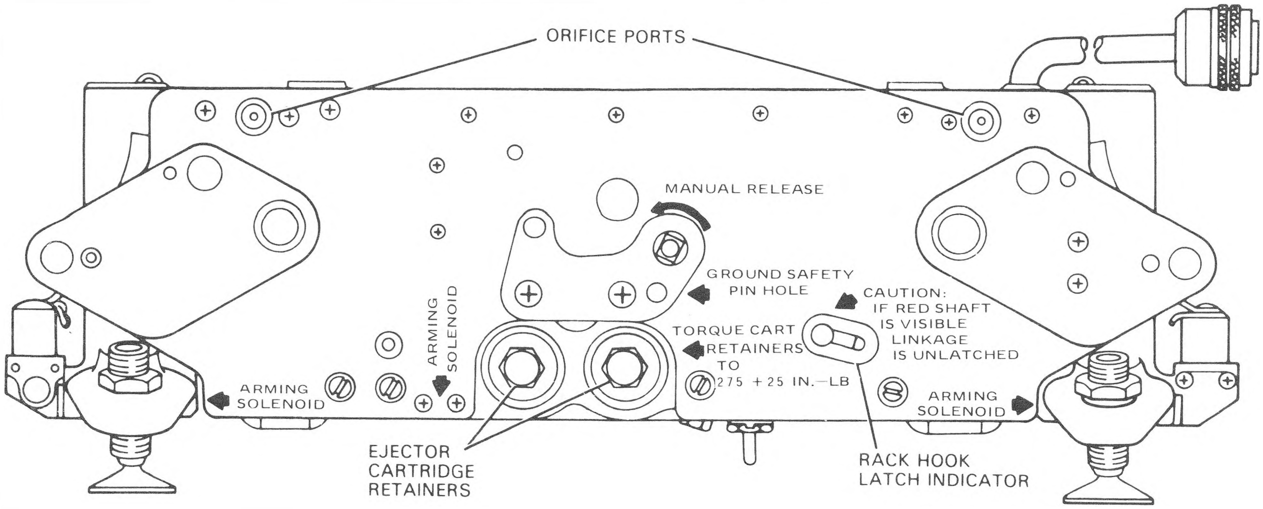
FIGURE 5-3

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 front of the unit which is electrically fired through an umbilical cable.

A control panel (FIGURE 5-5) at the aft end of the TER has a CBU/rocket switch, an electrical safety pin receptacle, and a manual stepper switch. The CBU/rocket switch should be in the rocket position for firing from SUU-25 series flare dispensers only. All other weapons are released in the CBU position. The electrical safety pin is used for ground safing and when inserted in the receptacle 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.

MAU-50/A BOMB EJECTOR RACK



CHARACTERISTICS

WEIGHT	45 LB
LENGTH	23 IN.
WIDTH	3 IN.
HEIGHT	6 IN.
SUSPENSION HOOK SPACING	14 IN.

FIGURE 5-4

The TER-9/A functions differ from the TER-9 as follows:

1. Only the loaded TER-9/A stations receive a release pulse regardless of the nose/tail arm switch position.

2. The TER-9/A is automatically homed to the first loaded station in sequence each time power is applied to the aircraft.

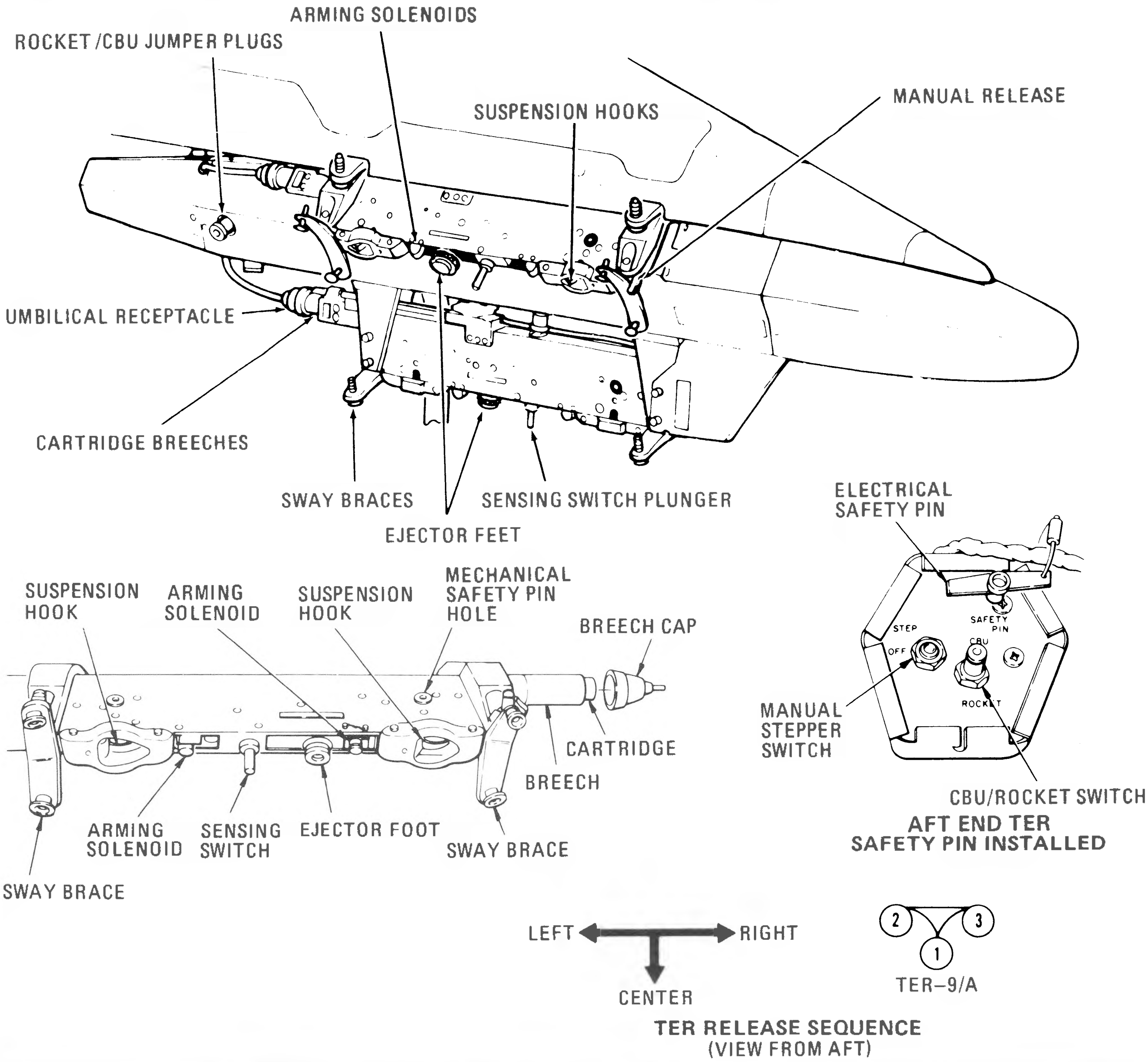
3. The step switch on the TER-9/A is used for ground checkout operation.

A hung munition may sometimes be released by re-homing the TER to the first loaded station. (See the appropriate aircraft Dash 34 for re-homing procedures.)

Arming is accomplished through cockpit setting for either nose, tail, or both to select the two arming solenoids. These solenoids provide arming wire/lanyard swivel loop retention for fuze arming in the same manner as does the MAU rack.

Ground safety is provided by an electrical safety pin in the aft plate, one mechanical safety pin in each loaded ejector unit, and the MAU rack mechanical safety pin. If a single ejector unit safety pin is not removed, a hung munition will occur, but the next munition in the release sequence will be released.

TER-9, 9/A TRIPLE EJECTOR RACK (TER)



CHARACTERISTICS

WEIGHT	95 LB
LENGTH	5 FT 7 IN.
WIDTH	15 IN.
SUSPENSION HOOK SPACING	14 IN.
SUSPENSION LUG SPACING	30 IN.

FIGURE 5-5

MER-10, 10/A, 10/N MULTIPLE EJECTOR RACK (MER)

The MER-10, 10/A, 10/N (FIGURE 5-6) is an auxiliary suspension rack used to increase the number of munitions the aircraft pylon (with MAU racks installed) can carry. A MER can carry and sequentially eject up to six stores weighing up to 1,000 pounds each and 16 inches in diameter. The MER is mounted to the pylon using 30-inch suspension lugs which can be adjusted either in an aft or a forward position to maintain the CG and loads within design limits. All details and descriptions of components and circuitry discussed for the TER-9, 9/A (including differences between the two models) apply to the MER-10, 10/A. The MER-10 operates exactly as the MER-10/A does. The only change is the configuration of the firing leads to the cartridges. The firing leads are more accessible for maintenance, inspection, and repair. The MER release sequence is rear center, front center, rear left, front left, rear right, and front right.

AIR-TO-AIR MISSILE LAUNCHERS

AERO-3B, LAU-105 MISSILE LAUNCHER

The AERO-3B missile launcher (FIGURE 5-7) is used to carry and fire AIM-9 Sidewinder missiles. The LAU-105 is an AERO-3B launcher that has been modified to allow carriage of the AIM-9L/M missile.

The AERO-3B/LAU-105 provides launching rails for the missiles and secures them during takeoff, flight, and landing. Major components are a power supply, a detent and snubber assembly, and a rail assembly. The power supply, located in the center of the launcher, provides power for the AIM-9 missile during captive flight as well as power for firing. The detent and snubber assembly consists of three functional units. A detent extending through the rail restrains the missile in vertical and lateral directions and provides two contact points for the missile motor firing pulse. When the rocket motor ignites, the thrust overrides the detent spring and allows the missile to travel forward along the launcher rails.

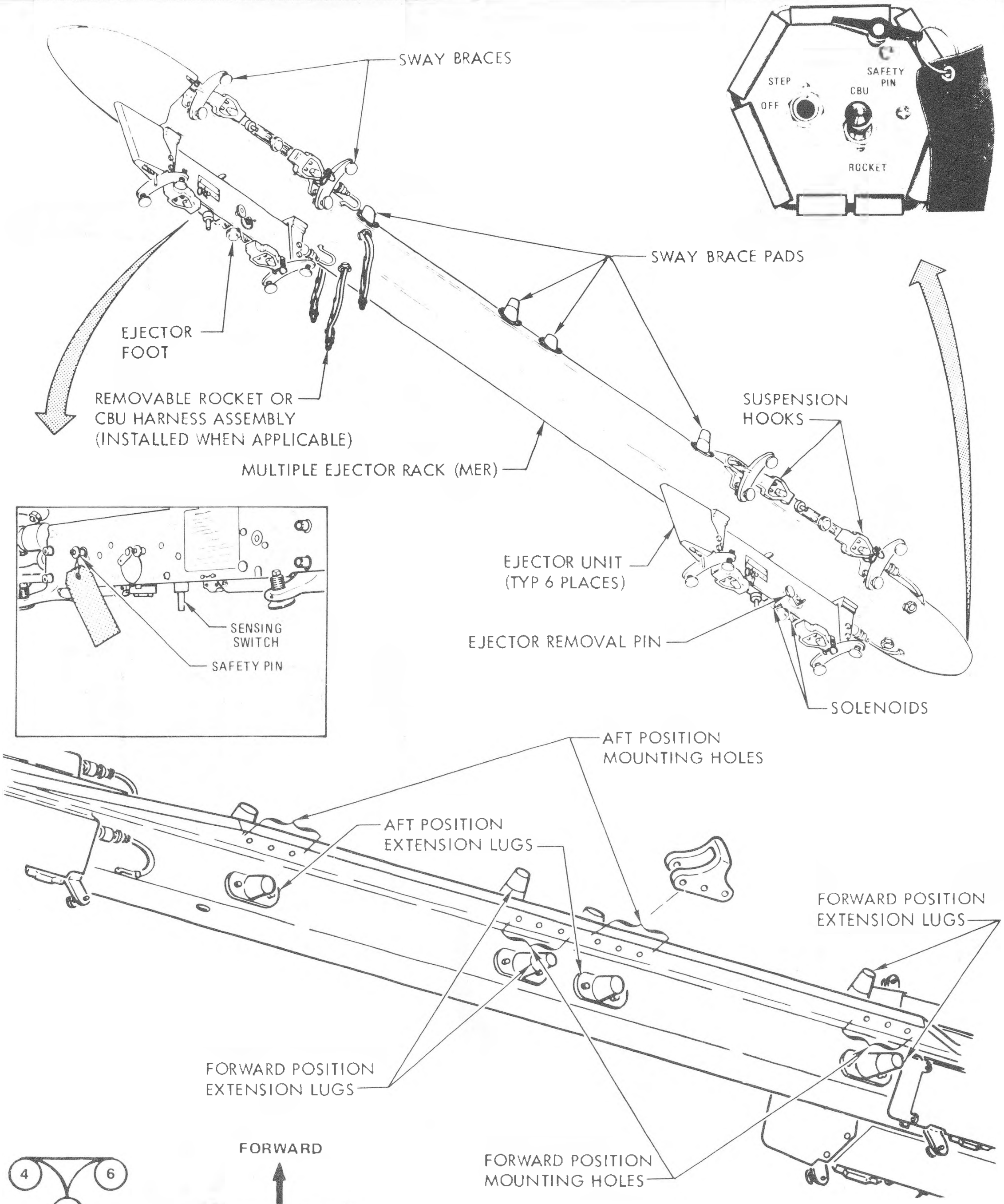
Snubber cams extending through slots in the rail engage the forward and aft missile hangers to prevent movement of the missile until it is fired. Upon missile firing, guides provide for the locking of the forward cams to clear the rail for passage of the missile hangers.

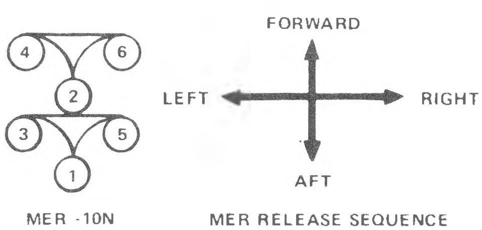
The launcher may be fitted with a streamered safety pin inserted into the top of the launcher forward fairing. The safety pin must be removed before flight. If inserted, the pin will prevent accidental firing of the missile motor while on the ground, but it will not prevent inadvertent firing of the gas grain generator in the guidance and control unit.

LAU-34/A MISSILE LAUNCHER

This assembly (FIGURE 5-8) must be used to carry and launch the AGM-45 missile. The launcher contains the electrical circuits and relays which are responsible for the dispersal of missile pre-heat, pre-arm, and missile launch voltage. The launcher also contains a cartridge-fired jettison gun assembly. When the jettison system is activated, expanding gas from the detonated cartridge operates the assembly and

MER-10, 10/A, 10/N MULTIPLE EJECTOR RACK (MER)



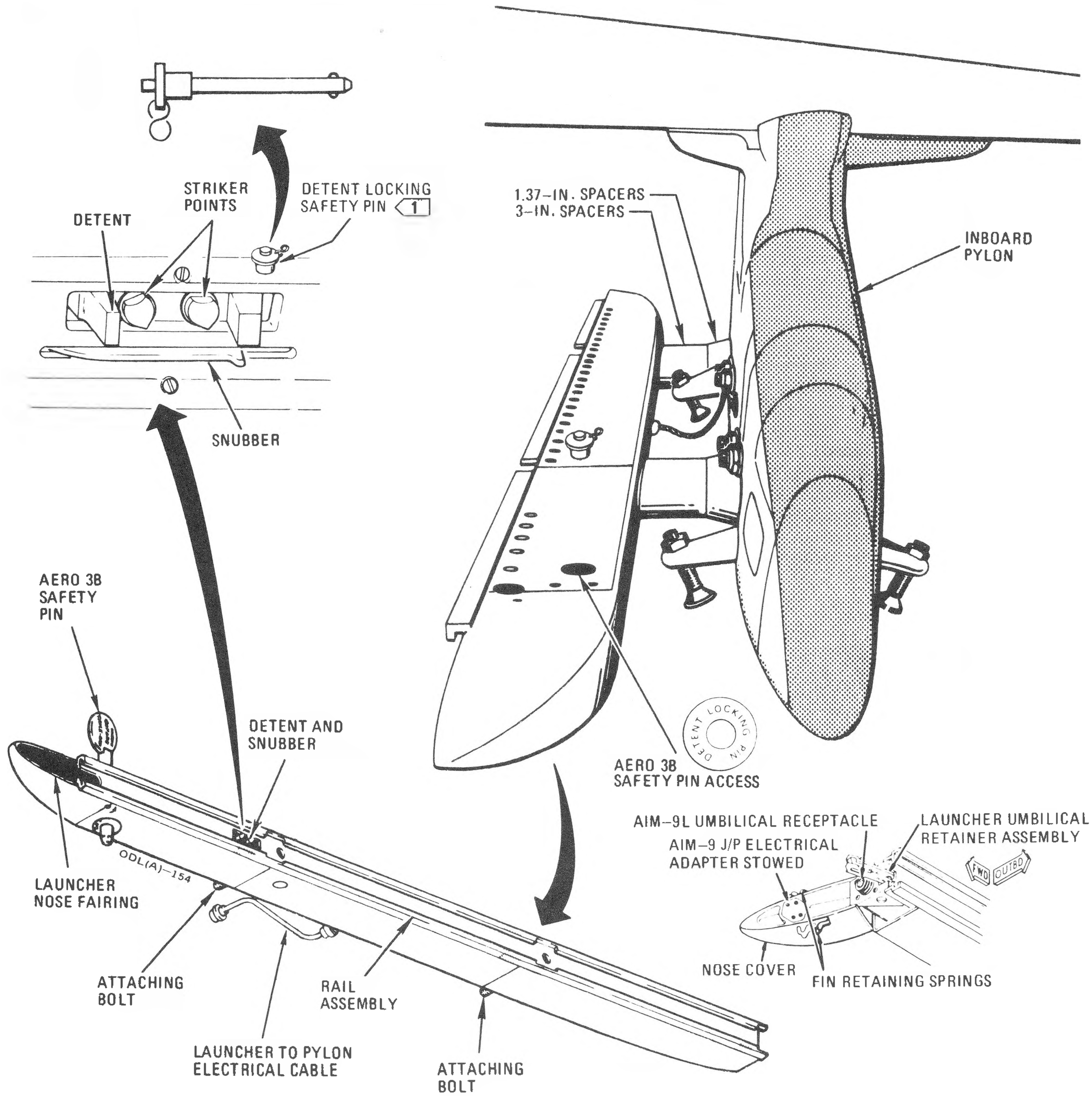


CHARACTERISTICS

WEIGHT	220 LB
LENGTH	13 FT
WIDTH	15 IN.
HEIGHT	16 IN.
SUSPENSION LUG SPACING	30 IN.
SUSPENSION HOOK SPACING	14 IN.

FIGURE 5-6

AERO-3B, LAU-105 MISSILE LAUNCHER



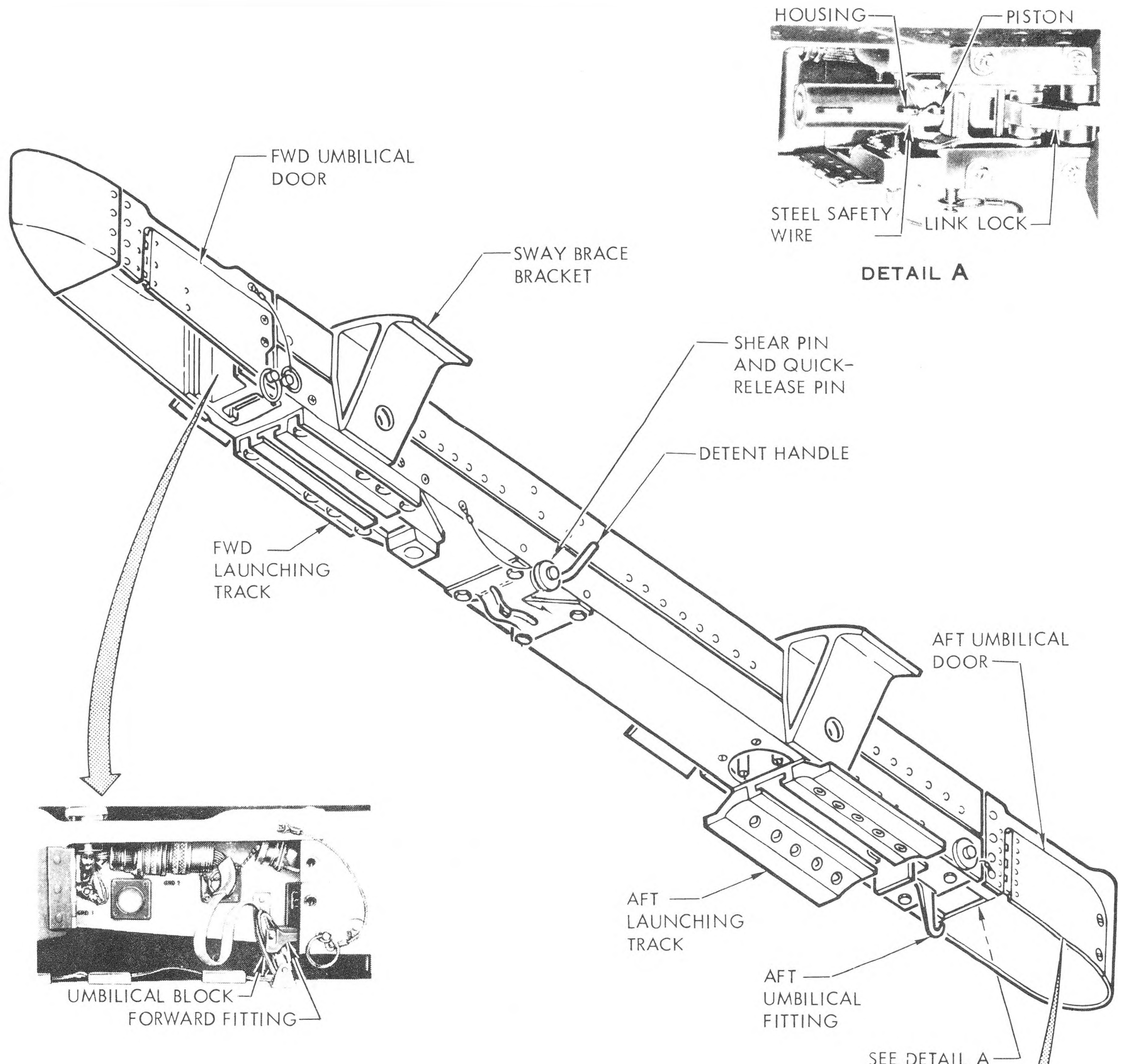
CHARACTERISTICS

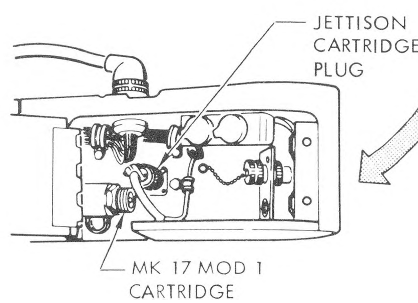
WEIGHT	49 LB
LENGTH	7 FT 3 IN.
WIDTH	3 IN.
HEIGHT	5 IN.

1 AFTER TO 11L1–3–15–515, THE SAFETY PIN REMAINS INSTALLED DURING FLIGHT. IT RESTRAINS REARWARD MOVEMENT OF THE MISSILE DURING FLIGHT.

FIGURE 5–7

LAU-34/A MISSILE LAUNCHER





CHARACTERISTICS

WEIGHT	85 LB
LENGTH	6 FT 3 IN.
WIDTH	4 IN.
HEIGHT	5 IN.

FIGURE 5-8

slides the missile rearward, free of the launcher rails. Impulse cartridges are not installed in MAU-12 breeches of stations configured with the LAU-34/A launcher. This weapon system will function with or without the installation of the MAU-12 in-flight safety lockout pin.

LAU-114A/A MISSILE LAUNCHER

The LAU-114A/A (FIGURE 5-9) missile launchers are basically the same as AERO-3B launchers. However, the LAU-114A/A contains an umbilical receptacle underneath the forward fairing for directly connecting AIM-9L/M missile umbilical cables.

AIM-9L/M missile umbilical cables are connected directly to the launcher umbilical receptacle underneath the forward fairing. If an AIM-9J/P missile is loaded on the launcher, an electrical adapter plug is connected in series with the umbilical cable and receptacle. When AIM-9L/M missiles are loaded, the adapter is stowed in the forward fairing housing.

The LAU-114A/A is also equipped with the fin retainer springs for use with the AIM-9L/M only. The fin retainer springs snap over the trailing edge of each pair of missile fins to prevent fin flutter during captive flight. The fin retainer springs automatically disengage when the missile is launched.

SUSPENDED MULTILAUNCHER UNIT (SMU)

The SMU is a machined aluminum block designed to adapt two modified AERO-3B or two LAU-114 launchers to 14-inch suspension. The SMU consists of the aluminum block with covers and fairings, suspension lugs, electrical components, and a ground safety/captive switch.

AIR-TO-GROUND MISSILE/ROCKET LAUNCHERS

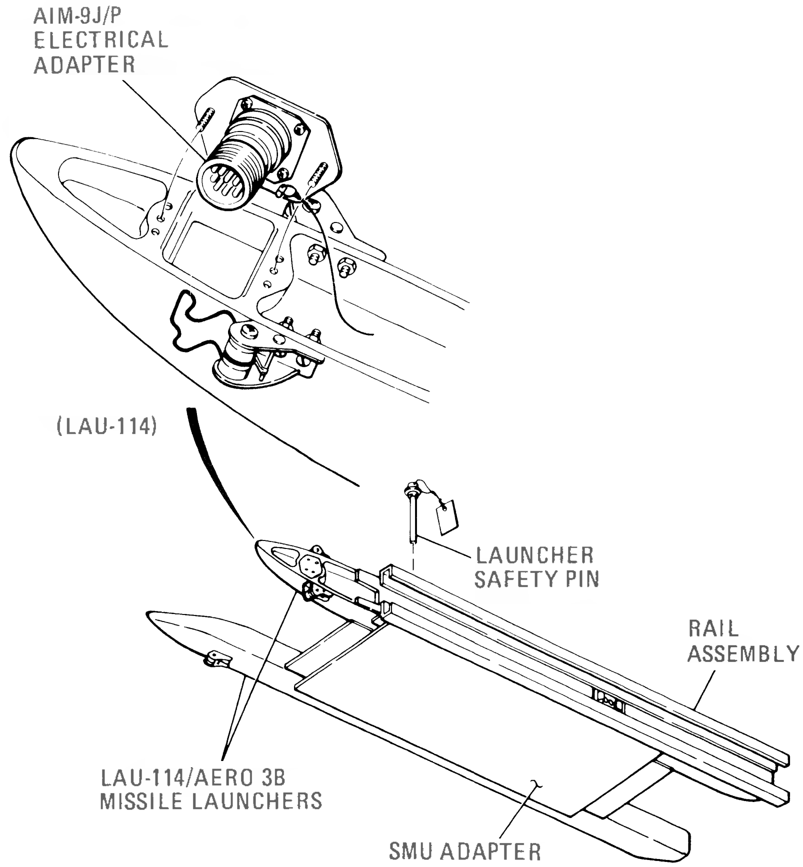
LAU-88/A MISSILE LAUNCHER

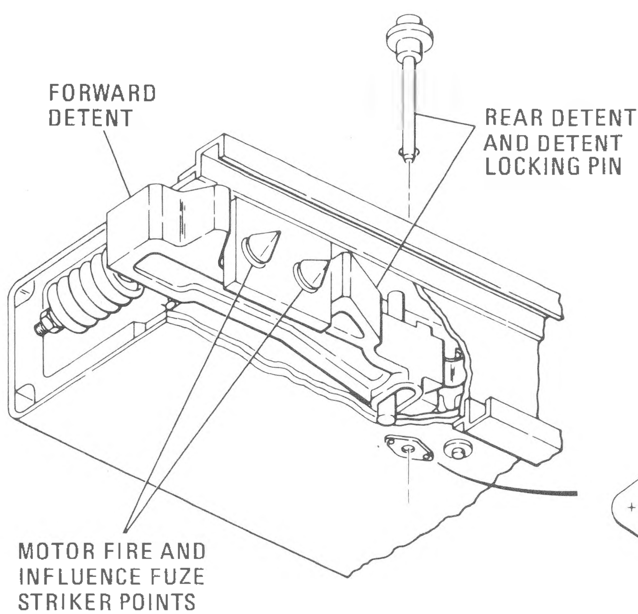
The LAU-88/A launcher (FIGURE 5-10) is designed to carry, control, and launch up to three AGM-65 missiles. The TGM-65 training missile can also be carried and controlled on the LAU-88/A. The launcher consists of three track-rail assemblies attached to a central structure which contains the electronic 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.

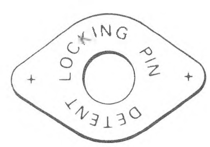
The missiles are restrained on the rails by a shear pin, installed midway on each rack, and by two bumpers at the rear of each rail. Between these two bumpers, a retractable electrical umbilical connector is rotated forward and connected to the missile after it is loaded.

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

LAU-114A/A MISSILE LAUNCHER





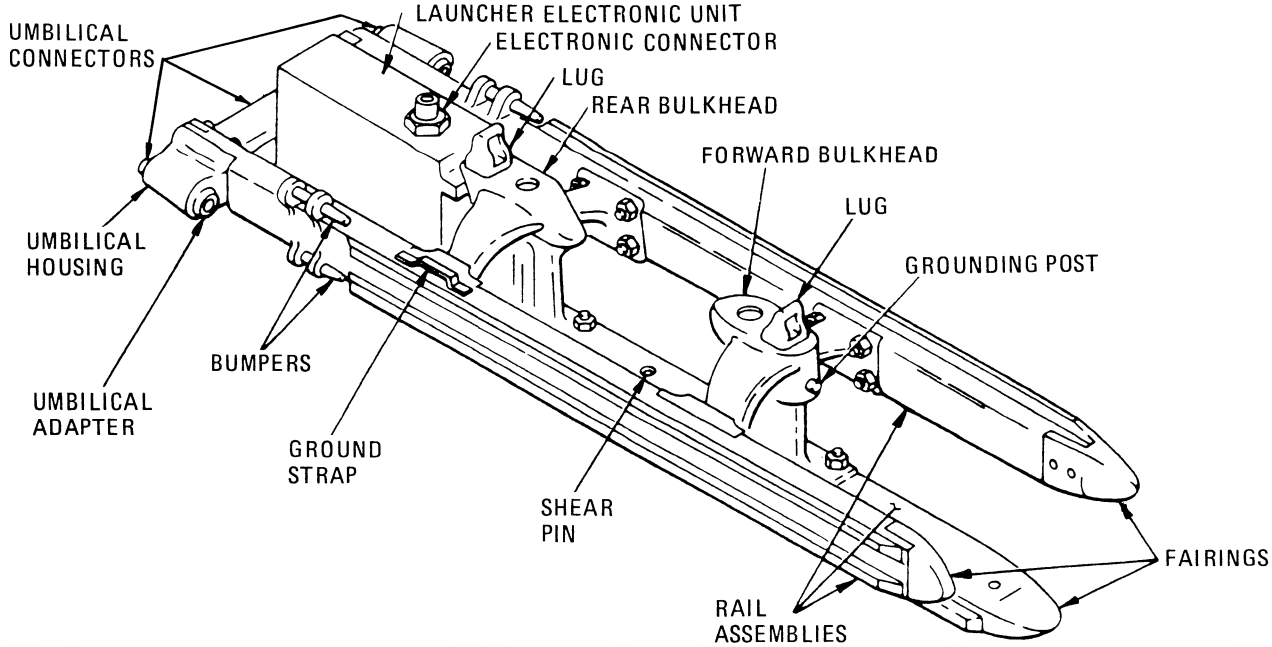


CHARACTERISTICS

WEIGHT	55 LB
LENGTH	7 FT 9 IN.
WIDTH	3 IN.
HEIGHT	5 IN.

FIGURE 5-9

LAU-88/A MISSILE LAUNCHER



CHARACTERISTICS

WEIGHT	465 LB
LENGTH	7 FT 9 IN.
WIDTH	27 IN.
HEIGHT	18 IN.
SUSPENSION LUG SPACING	30 IN.

FIGURE 5-10

Aircraft control systems will not automatically sequence between different stations after a missile launch to alternate launching from different stations. The appropriate aircraft Dash 34 manual must be consulted for missile sequencing if LAU-88/As are loaded on more than one station.

NOTE

Due to high initial electrical power requirements of the AGM-65D, only two missiles can be loaded on a LAU-88/A.

LAU-117/A MISSILE LAUNCHER

The LAU-117/A missile launcher (FIGURE 5-11) provides AGM-45 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.

Restraint of an installed missile is accomplished by use of a mechanical pin inserted into the missile holdback pin bushing. The mechanical pin is designed to be forced back (retracted) mechanically whenever the missile motor thrust exceeds 2,500 pounds.

WARNING

If USAF is not visible in the notch of the missile restraining device (MRD) cover plate, the MRD may be in the Navy position. With the MRD in the Navy position on USAF aircraft, the rocket motor will fire at launch command, but the missile will not leave the launcher rail, even at maximum rocket motor thrust.

NOTE

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

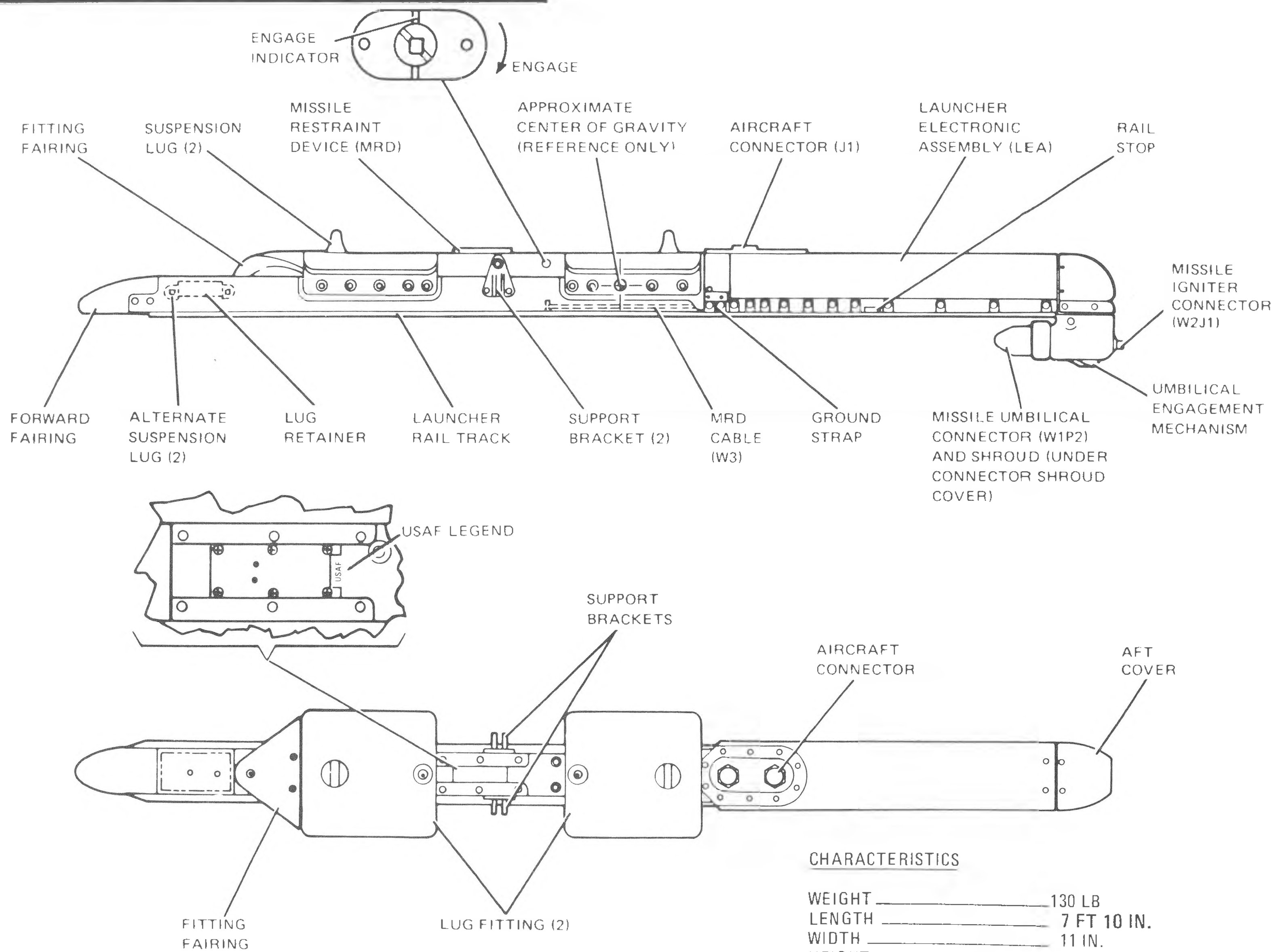
The launcher electronics assembly provides an electrical interface between the aircraft and the missile. The umbilical cable connector, which is housed in the umbilical engagement mechanism assembly, interfaces the electrical signals from the aircraft and launcher circuits to the missile. Interface is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

LAU-3/A, A/A, B/A, -60A ROCKET LAUNCHER

The LAU-3/A, A/A, B/A, -60A rocket launcher (FIGURE 5-12) can carry and launch nineteen 2.75-inch folding fin aircraft rockets (FFAR). The flight configuration consists of the loaded center-section assembly with streamlined fairings installed and locked onto the ends. When the launcher is fired, the front fairing is shattered by rocket impact, and the tip of the rear fairing is shattered by rocket blast. The frangible fairings are made of treated paper and shatter readily after rocket impact and blast.

Approximately 11 inches of the base of the rear fairing will remain on the adapter to channel rocket debris away from the undersurface of the wing.

LAU-117/A MISSILE LAUNCHER

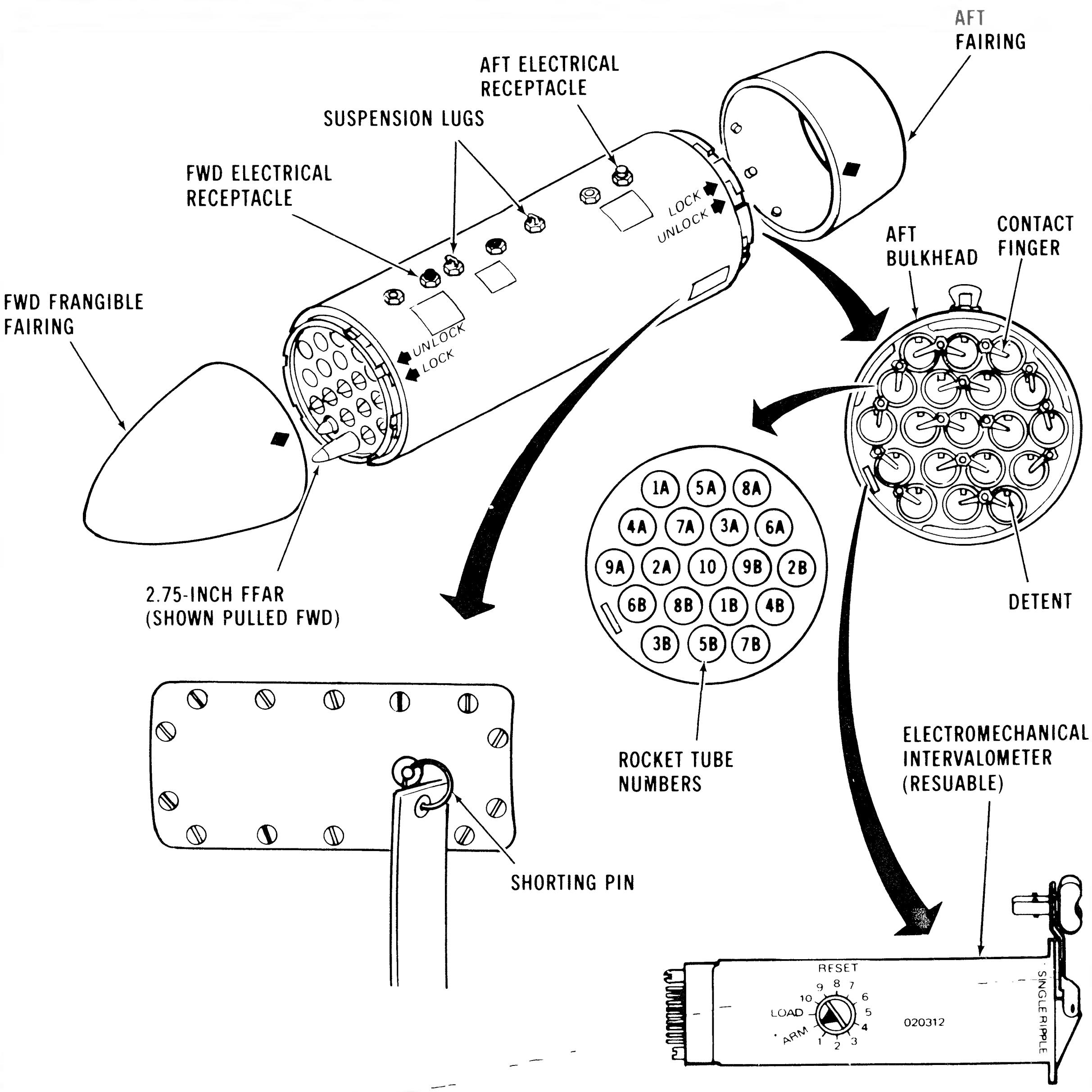


CHARACTERISTICS

WEIGHT	130 LB
LENGTH	7 FT 10 IN.
WIDTH	11 IN.
HEIGHT	11 IN.
SUSPENSION LUG SPACING	14 OR 30 IN.

FIGURE 5-11

LAU-3/A, A/A, B/A, -60A ROCKET LAUNCHER



CHARACTERISTICS

WEIGHT	
EMPTY	78 LB
LOADED	420 TO 534 LB (VARIES WITH TYPE OF ROCKET)
LENGTH	7 FT 5 IN.
DIAMETER	16 IN.
SUSPENSION LUG SPACING	14 IN.

FIGURE 5-12

CAUTION

Not using the rear fairing may damage the wing during firing.

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 LAU-3/A, A/A, B/A launcher as a ground safety device which is removed prior to flight. The LAU-60/A contains a breaker switch on the top of the launcher behind the aft electrical receptacle. Electrical power for the rocket ignition system supplied to the launcher is 28 volts direct current (dc). The intervalometer, located within the launcher, converts the aircraft firing voltage into a ripple-fire pulse with a 10-millisecond delay interval which will ripple-fire the rockets in pairs until the launcher is empty. The launcher should completely fire-out in approximately 0.1 second. MER and TER switches must be positioned on 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.

Certain aircraft have limitations and possible warning notes which apply to LAU-3/A launchers. Refer to the appropriate aircraft Dash 34 manual for this information.

NOTE

Several intervalometers are available for use with the LAU-3/A; some are reusable. A burn-out 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 5-13) can carry and launch seven 2.75-inch FFARs. 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 5-pin electrical receptacle forward and aft.

2. The tail fairings of the LAU-68A/A, B/A versions are constructed of metal and shaped like a funnel, with a hole on the aft end. During rocket launching, the tail fairing functions to channel rocket debris away from the underside of the aircraft wing.

CAUTION

Not using the rear fairing may damage the wing during firing.

3. 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

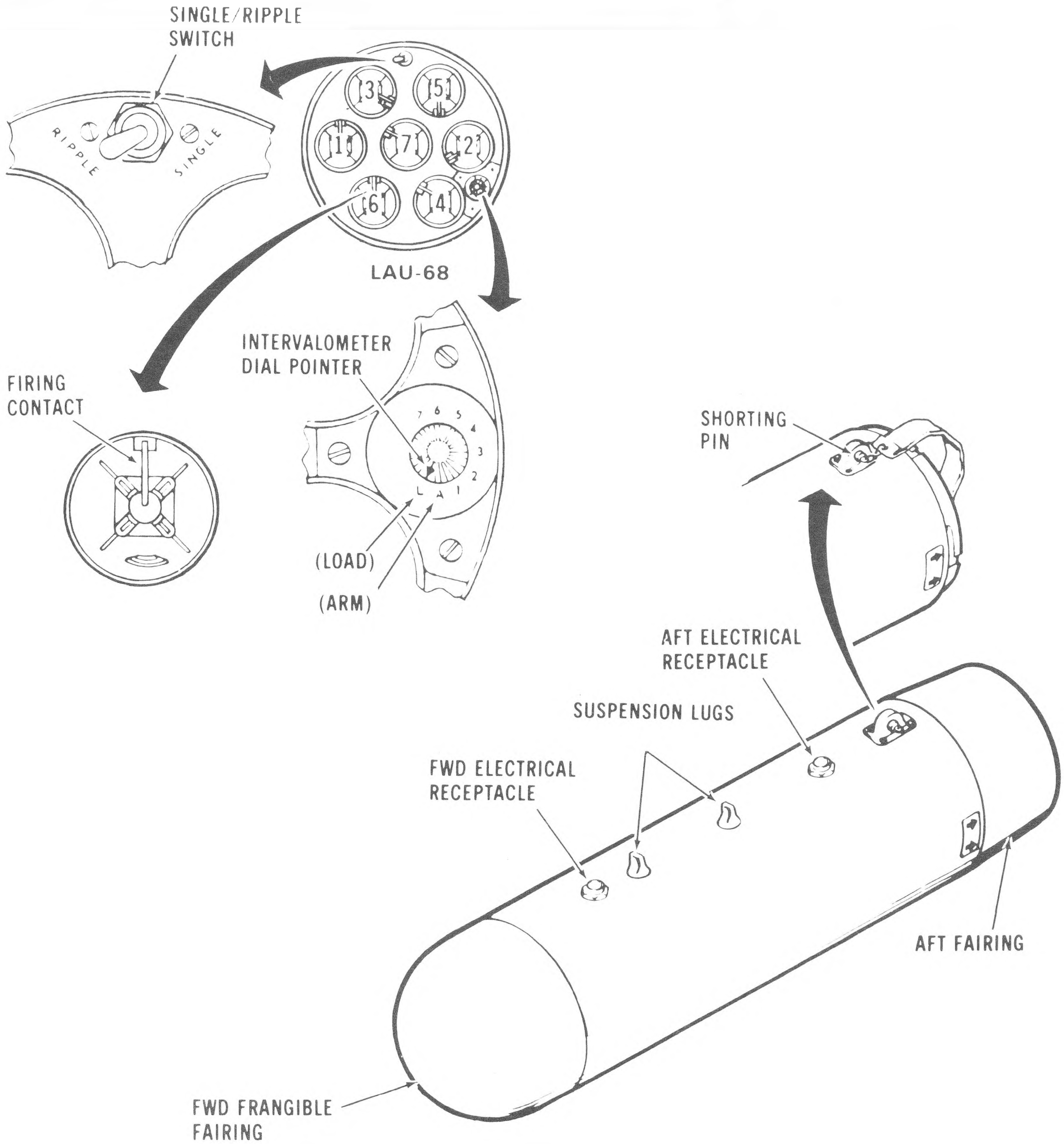
The interface of the LAU-68 intervalometer and ripple/pairs mode causes system anomalies. When the launcher is mounted on a TER-9/A, these anomalies may cause hung rockets. In this case, if a ripple mode is desired, select ripple on the LAU-68 single/ripple switch and use the aircraft single mode.

4. Certain aircraft have limitations and possible warning notes which apply to LAU-68/A launchers. Refer to the appropriate aircraft Dash 34 for this information.

LAU-5003/A ROCKET LAUNCHER

The LAU-5003/A rocket launcher (FIGURE 5-14) is used to launch the CRV7 rockets. The launcher is a cluster of 19 resin-impregnated paper tubes bonded together and

LAU-68A/A, B/A ROCKET LAUNCHER

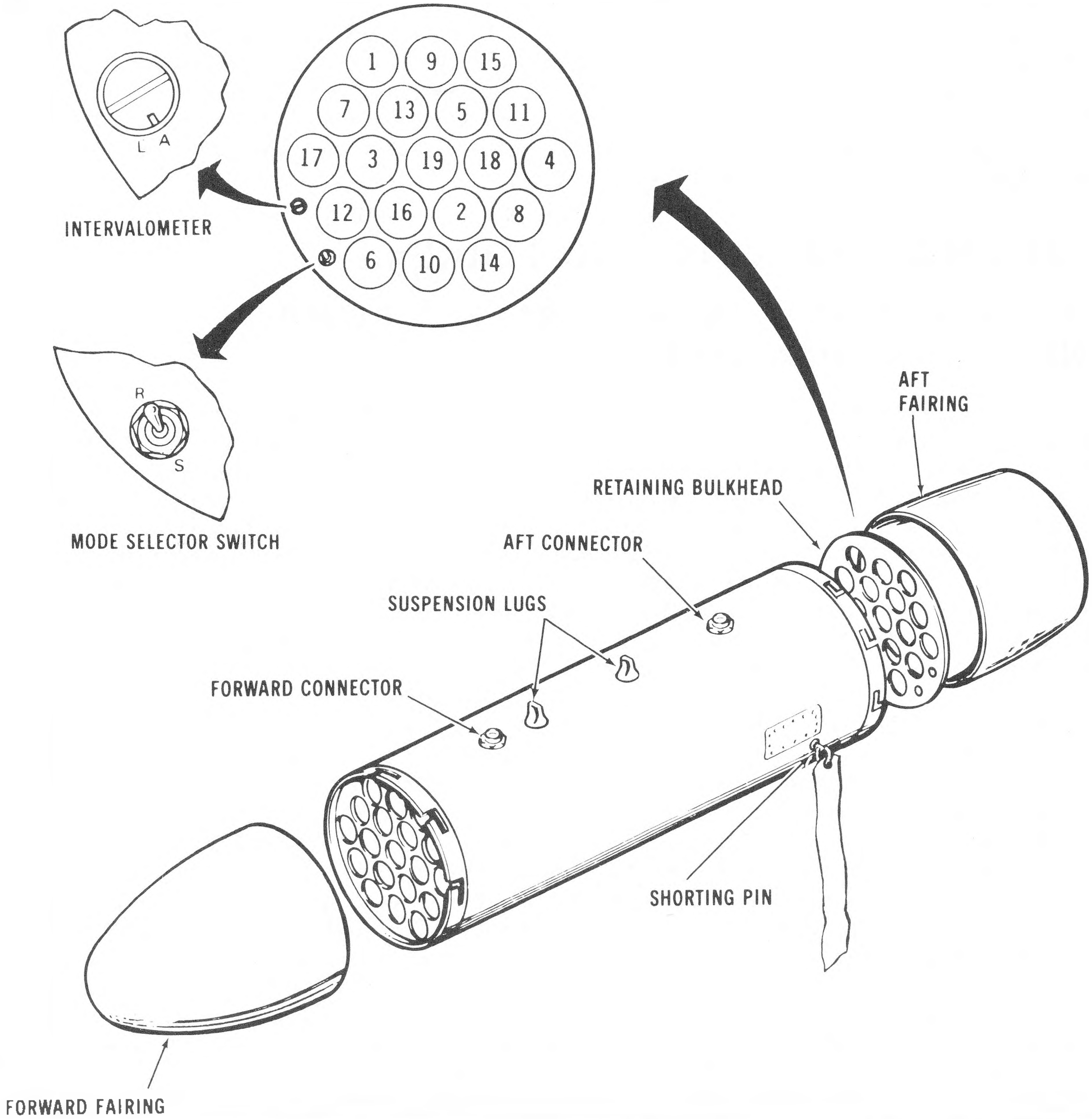


CHARACTERISTICS

WEIGHT	
EMPTY	67 LB (WITH FAIRINGS)
LOADED	193 TO 235 LB (VARIES WITH TYPE OF ROCKET)
LENGTH	6 FT 1 IN. (WITH FAIRINGS)
DIAMETER	10 IN.
SUSPENSION LUG SPACING	14 IN.

FIGURE 5-13

LAU-5003/A ROCKET LAUNCHER



CHARACTERISTICS

WEIGHT
- EMPTY .... 78 LB
- LOADED .... 497 TO 655 LB (VARIES WITH TYPE OF ROCKET)

LENGTH .... 6 FT 5 IN. (WITH FAIRINGS)
DIAMETER .... 16 IN.
SUSPENSION LUG SPACING .... 14 IN.

FIGURE 5-14

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. The open end aluminum aft fairing directs debris away from the aircraft.

TRAINING WEAPONS AND EQUIPMENT

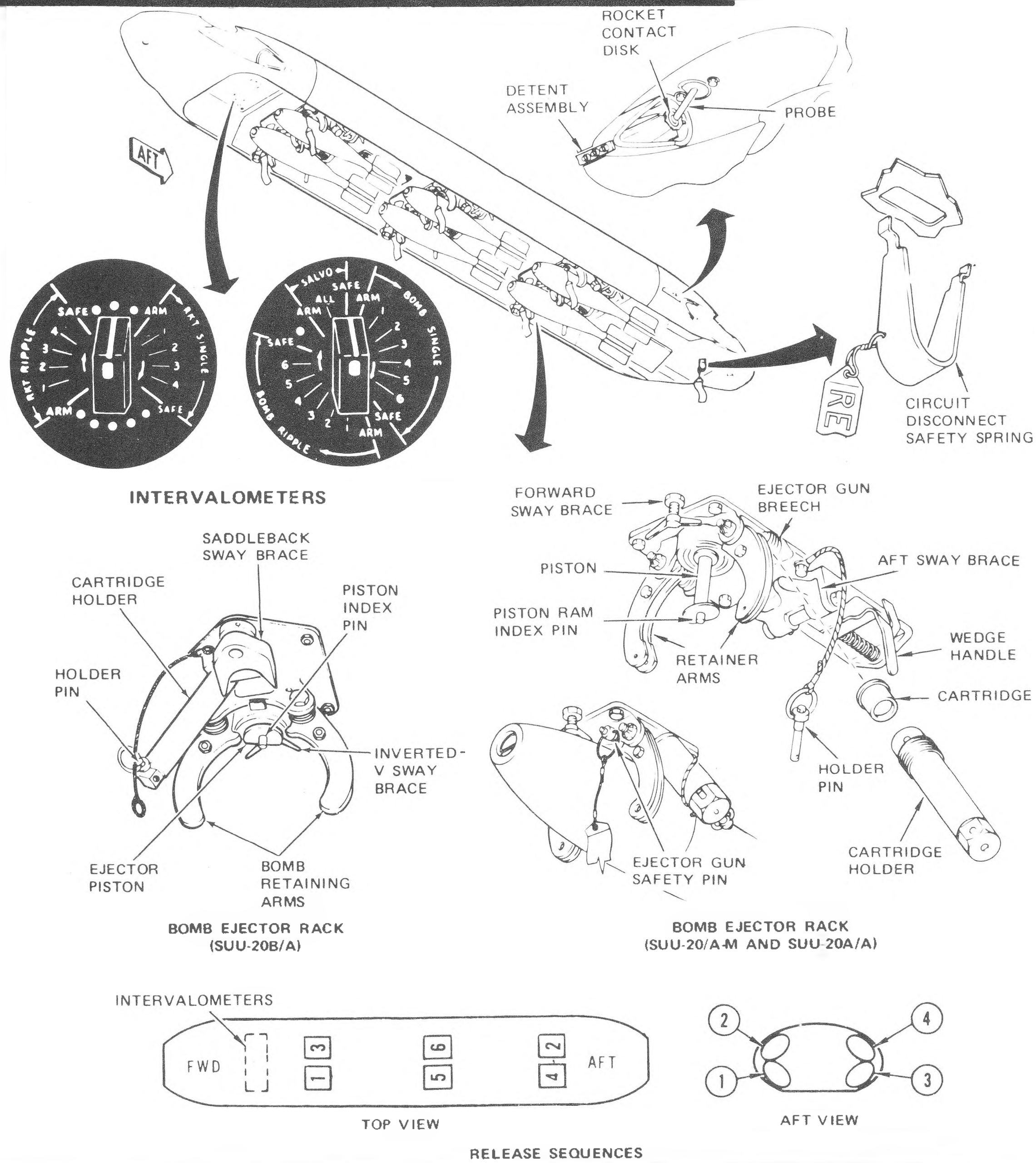
SUU-20/A, A/M, A/A, B/A PRACTICE BOMB AND ROCKET DISPENSER

The SUU-20 dispenser (FIGURE 5-15) is an aerodynamically shaped container which carries practice bombs and/or rockets for weapons delivery training. The SUU-20 can carry up to six practice bombs and four 2.75-inch diameter rockets. The structure of the dispenser consists of two cast aluminum end caps and a heavy gauge aluminum weldment center section. The center section is recessed on the underside to accommodate the bombs; the rocket tubes are located in the upper section, two on each side. The dispenser incorporates a stiffener beam hardback along the top surface for lug attachment and has modified bomb sway braces. The modified sway braces provide a positive bomb-lock condition by insertion of a safety pin through the inspection slot of the ejector gun housing.

The bombs are held in place by individual ejector racks and are stabilized by sway braces. The bombs are retained in the rack by ice-tong clamps and ejected by a piston and rod assembly that operates within a breech housing. The assembly is driven by gas from an electrically fired ejector cartridge. The four 84-inch rocket launch tubes of the dispenser provide initial flight stability, since the rockets must travel from the aft end of the tubes during launch. The rockets are fired by an electrical pulse supplied to each rocket through a spring-loaded plunger mounted in the aft end of each rocket tube. Inadvertent release of bombs or firing of rockets during ground operation is prevented by a streamered safety spring inserted near the lower aft end of the dispenser. The safety spring actuates a switch which safes the dispenser electrical circuits. In addition, each bomb is saftied by a bomb retainer lock which is hooked to one retention arm, closed around the bomb, and secured with a streamered safety pin to the other retainer arm. All streamered pins (a maximum of seven) must be removed before flight. The bomb rack ejector cartridge breeches (six) are removable and are usually installed when the cartridges are installed. When the breeches and cartridges have been installed in the dispenser, a cartridge retainer pin will be inserted in the lower portion of each breech. These pins remain in place during flight.

A rocket-firing intervalometer and a bomb-release intervalometer (FIGURE 5-15) are located in the lower portion of the SUU-20 dispenser just forward of bomb dispenser stations 1 and 3. FIGURE 5-15 shows two similar dispenser intervalometers. The rocket intervalometer is forward of the number 1 station while the bomb intervalometer is forward of the number 3 station. The only difference in the two intervalometers is the number of stepping positions for the ripple and single modes of

SUU-20/A, A/M, A/A, B/A PRACTICE BOMB AND ROCKET DISPENSER



CHARACTERISTICS

WEIGHT	
EMPTY	320 LB
LOADED	554 LB
LENGTH	10 FT 2 IN.
WIDTH	19 IN.
SUSPENSION LUG SPACING	14 IN.

FIGURE 5-15

operation. These positions conform to the number of bomb and rocket positions; 6 and 4 respectively. The power required for dispenser operation is furnished by the weapon selection and the master arm switches. When the master arm switch is in the ARM position, the pickle button sends a signal to the aircraft intervalometer. Proper cockpit weapon select knob energizes a relay within the SUU-20 dispenser-carrying station. This is accomplished by directing the firing pulses through this relay to the appropriate dispenser intervalometer. The dispenser relay completes the circuit to either the bomb or rocket intervalometer. Each bomb or rocket intervalometer has three mode positions of operation: SINGLE, RIPPLE, and SALVO (SALVO: SUU-20A/M only). Each mode has an ARM and a SAFE position. When positioned to ARM, the intervalometer will automatically step then fire through the selected mode sequence during release operations. Intervalometer modes of operation must be selected prior to flight. Each intervalometer will be selected prior to flight. Each intervalometer will be in a SAFE position during preflight operations. The appropriate mode arm position will be selected immediately prior to flight. The intervalometers are constructed so that rotation of the mode selector must be in a clockwise direction. It may be necessary to rotate the selector through an arm release sequence in order to reach the desired arm position.

NOTE

The bomb firing intervalometer must be set to ARM on the empty station prior to the desired loaded station. If the intervalometer is set on a loaded station with the intent of dropping the next bomb in the sequence, a double release may occur.

Operation of the SUU-20 bomb or rocket dispenser intervalometer in the SINGLE mode allows the release of one practice bomb or the launch of one rocket at a time. The SUU-20 intervalometer requires approximately 50 to 75 milliseconds to step from one station to the next. Operation of the SUU-20 intervalometer in the RIPPLE mode allows release of a series of bombs or rockets at a fixed 100-millisecond interval.

NOTE

A weapon release switch must be held depressed for the duration of the SUU-20 ripple release sequence which is approximately 0.5 second.

The SALVO mode of dispenser intervalometer operation releases all dispenser bombs or rockets simultaneously. In addition to the SINGLE, RIPPLE, and SALVO modes of the SUU-20, the aircraft intervalometer may also be used for bomb releases. In release of nonnuclear practice bombs, the cockpit selections of step single, step pairs, step all, ripple single, ripple pairs, or ripple salvo are available using the respective release option switch on the weapons control panel. In SUU-20 practice rocket release, these selections are also available with the exception of step or ripple pairs. If the SUU-20 intervalometer is set for RIPPLE mode, an aircraft step release option switch must be selected. If a ripple release option is selected, the aircraft and dispenser intervalometer will not be synchronized and skipped releases will probably result.

NOTE

The SUU-20 intervalometer(s) must be positioned to BOMB SINGLE when using the aircraft intervalometer.

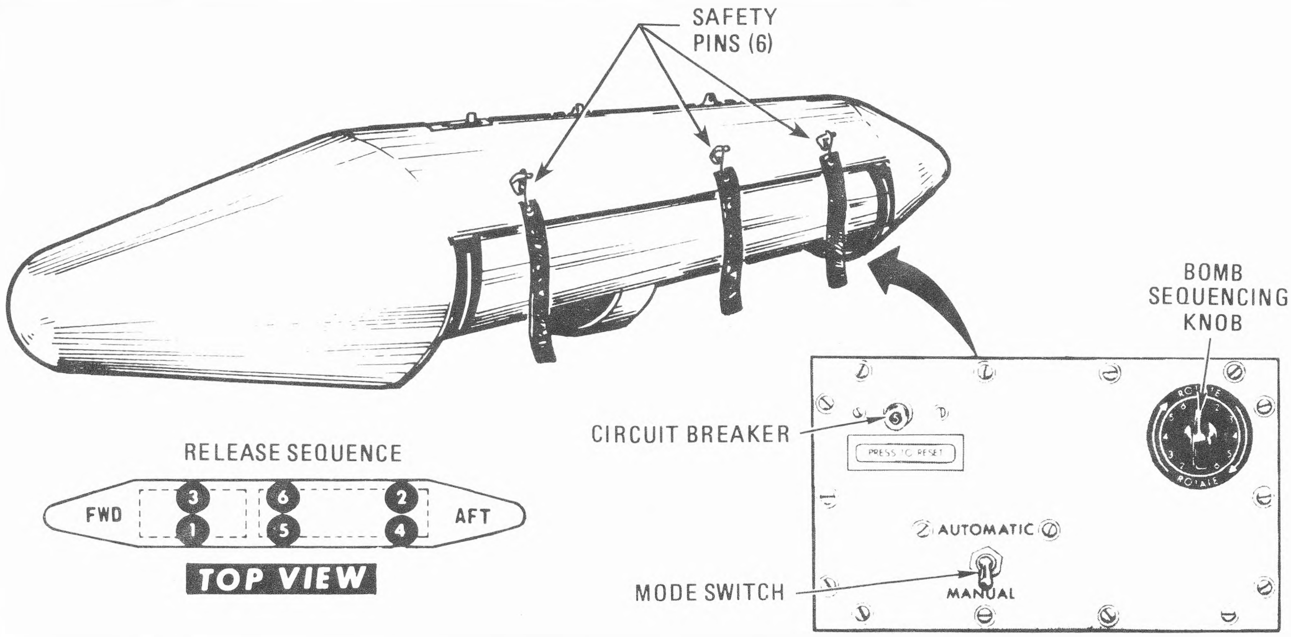
The SUU-20 dispenser may be jettisoned, when necessary, by either the external stores jettison switch or by selective jettison procedures. Refer to the appropriate aircraft Dash 34 manual for detailed procedures.

SUU-21/A PRACTICE BOMB DISPENSER

The SUU-21/A practice bomb dispenser (FIGURE 5-16) contains six spring-loaded ejector mechanisms permitting up to six practice bomb releases. The SUU-21A has electrically operated conformal doors which are opened for weapon delivery. The act of loading a practice bomb forces the ejector plunger upward, compressing a spring until toggle arms snap into a cocked position around the bomb, securing it to the ejector. As the ejector operates (cocking or releasing), an indicator pin extends from the side of the dispenser near the ejector being loaded and then retracts within the dispenser contour. A red flagged stop guard is inserted into a slot over the indicator pin hole to prevent release of a bomb-loaded ejector. The guards must be removed prior to flight.

The relay box, located in the aft bay of the dispenser, contains circuits that control door operations and the sequence of practice bomb releases. The circuit breaker guards power to the door actuator motor in the dispenser and must be closed (pushed in) prior to flight. The relay box also contains a two-position switch with AUTOMATIC and MANUAL positions. The switch determines if the doors close automatically or remain open after each release. The rotary selector switch on the relay box can be manually positioned to any of the ejector positions prior to takeoff and the switch will automatically step to the next position after each release.

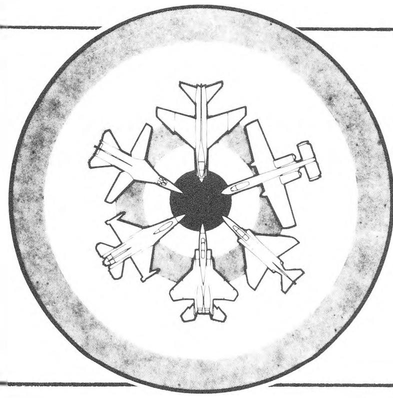
SUU-21/A PRACTICE BOMB DISPENSER



CHARACTERISTICS

WEIGHT, EMPTY	470 LB
LENGTH	13 FT
DIAMETER	17 IN.
SUSPENSION LUG SPACING	14 IN.

FIGURE 5-16



SECTION VI

SAFE ESCAPE/SAFE SEPARATION

CONTENTS

SAFE ESCAPE/SAFE SEPARATION

This section is designed to standardize terminology and methods of calculation for safe escape/safe separation. Specific values for planning are aircraft-unique and are found in appropriate aircraft Dash 34s.

WARNING

Mission planning must include consideration of safe escape requirements, safe separation requirements for proximity-fuzed GP bombs, vertical drop required for fuze arming, and altitude lost during dive recovery. The highest applicable altitude/time must be used.

The release altitude derived for the mission planning form must include consideration of safe escape, safe separation, vertical drop required for fuze arming, and altitude lost during dive recovery. The highest applicable altitude/time must be used. Safe escape is the minimum release altitude that will provide the delivery aircraft acceptable protection for weapon fragmentation. For all munitions, except cluster bomb units (CBU) and flagging air-inflatable retarders (AIR), safe escape is based on normal functioning of the munitions, with detonation at ground impact. For the CBU, safe escape is based on failure of the canister to open and detonation of the intact cluster at ground impact. Flagging AIR (MK 82/84) data are for the AIR which fails to fully inflate. Safe separation corresponds to the minimum detonation time after release which will provide the delivery aircraft acceptable protection from early weapon detonation (airburst). Safe separation requirements must be met when employing proximity-fuzed general-purpose (GP) munitions. Safe separation is not required for impact-fuzed GP bombs, because there is small likelihood of premature detonation at fuze arming.

WARNING

When MK 82 Snakeye I, MK 82 AIR, or MK 84 AIR are configured for inflight high- or low-drag selectability, the minimum M904 nose fuze arm delay setting is 6 seconds, and the minimum FMU-54 tail fuze arm delay setting is 2.5 seconds. These minimum settings do not apply if the high-drag bomb release altitude exceeds the low-drag bomb safe escape minimum release altitude.

The Safe Escape/Safe Separation Charts (appropriate aircraft Dash 34) include two sets of data which must be considered during mission planning to ensure safe escape/safe separation criteria are satisfied. These data are as follows:

1. Time of Fall (Seconds). This is the minimum time from release at which the weapon can detonate and satisfy the safe separation criteria. It equates to the weapon time of fall from minimum safe release altitude for low-altitude delivery.

2. Minimum Release Altitude for Safe Escape (Feet). This altitude represents the minimum altitude for release of a particular munition to ensure criteria for safe escape are satisfied.

Safe escape/safe separation data consider all weapon fragments except an extreme few. Lug/hardback components of bombs are an exception to published safe escape/safe separation tables, in that they can travel higher and farther than normal bomb case fragments. Fragments from the lug/hardback area are not normally included in the computer model. Since most bombs are spin-stabilized, the probability of the lug/hardback area fragments being aimed at the delivery aircraft is very small. Also, weapons occasionally produce fragments not normally anticipated, which may fly further than predicted. However, the frequency of these events causes them to be treated as anomalies, and they are also not included in the computer model. The behavior of the lug/hardback area fragments and the anomalies are not included in the model, because they cannot be accurately predicted. It is operationally accepted that the probability of being hit by these fragments is less than 1 in

The fragmentation model is redistributed in the computer solution to account for weapon impact velocity. Also, the predicted impact angle is rotated 10 degrees to account for possible flightpath disturbance and/or slight changes in the fragmentation pattern attributed to nose versus tail fuzing.

SAFE ESCAPE

The safe escape data provided are used in mission planning to determine the minimum release altitude that will provide the delivery aircraft acceptable protection from weapon fragmentation. These data are determined through a complex computer analysis of weapon fragmentation envelopes relative to the specified delivery profile and specific escape maneuver of the delivery aircraft. The data represent a probability of being hit that is less than or equal to 1 chance in 1,000 ($\leq$0.001).

WARNING

The safe escape data are provided only for single or pairs release and level ripple/train deliveries followed by a level, constant-speed, no-turn escape maneuver. For ripple/train deliveries, when initiation of the escape maneuver is delayed by the duration of the ripple release, the minimum release altitude must be increased to provide safe escape from the first weapon detonation as follows:

For dive ripple/train deliveries, the release altitude must be increased such that the last weapon is released at or above the minimum release altitude. Add the altitude lost during the ripple/train release to the data provided in the Safe Escape/Safe Separation Chart to determine the increased minimum release altitude.

For level ripple/train deliveries followed by either a level turn or pullup escape maneuver, increase the minimum release altitude by adding the ripple/train release time (N-1 times the release interval) to the listed time of fall. Use this increased time of fall to find the increased minimum release altitude in the ballistic tables or in the Minimum Release Altitude for Fuze Arming Chart. Since ballistic data are not provided for intact CBU munitions, the increased minimum release altitude can be estimated by using MK 82 low-drag, general-purpose (LDGP) data.

NOTE

- The safe escape information presented is based upon a probability of less than or equal to one chance in a thousand (≤ 0.001) that the delivery aircraft will be hit by fragments when delivering a single bomb at the minimum altitude for fragment clearance.
- Safe escape data are provided for target density altitudes of 0 and 5,000 feet. For density altitudes between 0 and 5,000 feet, a reasonable approximation may be obtained by linear interpolation. For target density altitudes above 5,000 feet, a reasonable approximation may be obtained by extrapolation. Extrapolation is not recommended for target density altitudes above 10,000 feet.

SAFE SEPARATION

Safe separation requirements must be met when employing proximity-fuzed GP bombs. Safe separation is not required for impact-fuzed GP bombs. Safe separation differs from safe escape (ground burst) in that it provides the delivery aircraft protection from early weapon detonation (airburst). Therefore, safe separation requirements are met by using a minimum fuze arming time that provides sufficient aircraft-to-weapon separation prior to the fuze arming. The separation time required is the time of fall listed for the minimum release altitude for safe escape.

WARNING

- When determining the minimum fuze arming time for safe separation, the negative fuze arming tolerance and fuze inherent delays must be included to ensure that the earliest possible arming time meets or exceeds the safe separation time required.

- The safe separation data are provided only for single or pairs release and level ripple/train deliveries followed by a level, constant-speed, no-turn escape maneuver. For ripple/train deliveries, when initiation of the escape maneuver is delayed by the duration of the ripple release, the minimum safe fuze arming time must be increased to provide safe separation from the first weapon as follows:

  The new minimum fuze arming time is determined by adding the ripple/train release time (N-1 times the release interval) to the time of fall shown for the desired airspeed and escape maneuver.

NOTE

- The safe separation information presented is based upon a probability of less than or equal to one chance in a thousand (≤ 0.001) that the delivery aircraft will encounter fragments when delivering a single bomb at the minimum altitude for fragment clearance.

- Safe separation data are provided for target density altitudes of 0 and 5,000 feet. For density altitudes between 0 and 5,000 feet, a reasonable approximation may be obtained by linear interpolation. For target density altitudes above 5,000 feet, a reasonable approximation may be obtained by extrapolation. Extrapolation is not recommended for target density altitudes above 10,000 feet.

SAFE ESCAPE MANEUVERS

The safe escape data are provided for specific safe escape maneuver profiles in the appropriate aircraft Dash 34s.

WARNING

Safe escape data are not provided for all maneuver/weapon combinations. When planning weapon deliveries at minimum release conditions, nominal deviations from planned conditions may result in a significant increase in the risk of self-damage. Therefore, the aircrew must observe the appropriate delivery parameters, minimum release alti-tudes, and recovery maneuvers required for safe escape.

EXPLANATION OF SAFE ESCAPE/SAFE SEPARATION CHARTS

These charts provide safe escape/safe separation and vertical drop data required for fuze arming for various weapons/fuze combinations, delivery parameters, and escape maneuvers. Use the proper chart for mission plannning. The charts are located in appropriate aircraft Dash 34.

The Safe Escape/Safe Separation Charts include three sets of data that must be considered during mission planning to ensure safe escape/safe separation for munition detonation and vertical drop to ensure fuze arming. These factors are defined as follows:

1. Time of Fall (Seconds). This is the minimum time from release at which the weapon can detonate and satisfy the safe separation criteria. It equates to the weapon time of fall from minimum safe release altitude for low-altitude delivery. For GP bombs with proximity fuzes, when arming time must be considered, the time of fall is also the safe separation minimum fuze arming time.

2. Minimum Release Altitude for Safe Escape (Feet). This altitude represents the minimum altitude for release of a particular munition to ensure criteria for safe escape are satisfied.

WARNING

For ripple/train deliveries where initiation of the escape maneuver is delayed by the duration of the ripple/train release, the minimum release altitude must be increased to provide safe escape from the first weapon detonation. If safe separation is required, the safe fuze arming time must also be increased.

NOTE

Specific guidance for ripple/train deliveries is provided for each aircraft Safe Escape and Fuze Arming Chart.

3. Vertical Drop for Fuze Arming (Feet). These data include all delays that affect fuze arming (wiring, retardation device opening time, fuze inherent delays, and the positive tolerances on arming time. Vertical drop for fuze arming requirements must be used in mission planning; this applies to both impact- and proximity-fuzed weapons.

WARNING

Mission planning must include consideration of safe escape requirements, safe separation requirements for proximity-fuzed GP bombs, vertical drop required for fuze arming, and altitude lost during dive recovery. The highest applicable altitude/time must be used.

MINIMUM RELEASE ALTITUDE FOR FUZE ARMING

These charts are provided to supplement the Vertical Drop for Fuze Arming Data provided in the Safe Escape Charts and are provided in the appropriate Dash 34.

If an arm time is selected for which data are not available in the Safe Escape Charts, the user must determine the required release altitude using the Minimum Release Altitude for Fuze Arming Charts provided in the appropriate aircraft Dash 34. First, inherent fuze delays and the positive arm time tolerance must be added to the selected arm time to determine the required time of fall. Inherent delays for specific fuzes are provided in the Fuze/Bomb Compatibility Chart in Section II. Next, enter the Minimum Release Altitude for Fuze Arming Charts at that TOF to determine the release altitude to insure fuze arming. Example: Safe separation time and altitude required for fuze arming:

Aircraft	A-10
Weapon	MK 82 LDGP
Fuze	FMU-113/B (inherent delay 0.5 sec)
Release mode	Ripple
Number of weapons	6
Ripple interval	0.24 sec (240 msec)
Release angle	-15 deg
Release velocity	300 KTAS
Escape maneuver	4-g/2-sec, wings-level (in-plane) pullup
Density altitude	5000 ft

Because the FMU-113/B is a proximity fuze, safe separation must be considered. Enter the Safe Escape/Safe Separation Chart (A-10 used in this example) to find the required safe separation time (presented as Time of Fall). For this example, the value is 4.78 seconds.

However, because this is a ripple release, the required time of fall value must be increased by the ripple release time. In this case, N-1 equals 5, and the release interval is 240 msec (0.24 sec). For this ripple release, the time of fall required is:

$$4.78 + (5 \times 0.24) = 4.78 + 1.2 = 5.98 \text{ sec}$$

A 5-second arm time selection would result in the fuze potentially arming at exactly 5.0 seconds when the negative fuze tolerance (-0.5 second) and the inherent delay (0.5 second) are considered. Therefore, a 5-second fuze setting will not satisfy safe separation criteria. A 6-second fuze setting (5.90-second possible arm time) will also not satisfy safe separation criteria. The 7-second setting allows fuze arming as early as 6.80 seconds (7.0 - 0.7 + 0.5). Since 6.80 seconds is greater than 5.98 seconds, safe separation criteria are satisfied.

In this case, 7 seconds is not listed in the Safe Escape/Safe Separation Chart. Therefore, to determine this release altitude, enter the Minimum Release Altitude for Fuze Arming Charts (appropriate aircraft Dash 34) with 8.2 (7.0 + 0.7 + 0.5) seconds. For the A-10 aircraft, this value is 2,740 feet. The FMU-113/B is used to detonate a bomb at 15 feet AGL (nominal). To ensure fuze arming above this altitude, the last bomb must be released at or above 2,755 feet AGL.

FRAGMENT DECONFLICTION FOR FORMATION FLIGHTS

WARNING

During simultaneous formation deliveries, the wingman must consider safe escape from both his own and his leader's munitions.

MAXIMUM BOMB/ROCKET FRAGMENT TRAVEL CHART

MUNITION	IMPACT ANGLE (DEGREES)	ALTITUDE (FEET)		HORIZONTAL RANGE (FEET)		TIME OF FLIGHT (SECONDS)	
		SEA LEVEL	5000 FEET	SEA LEVEL	5000 FEET	SEA LEVEL	5000 FEET
MAXIMUM BOMB FRAGMENT TRAVEL							
MK 82 ALL TYPES		2050	2325	2310	2625	24.0	25.5
MK 84 ALL TYPES		2750	3100	3100	3350	30.0	31.2
CBU (INTACT CLUSTER) ALL TYPES		1380	1575	1645	1850	19.4	20.6
BLU-26/B (CBU-24/B) BLU-59 (CBU-49/B)		960	1085	1160	1310	16.3	17.3
BLU-61A/B (CBU-52/B)		665	755	775	880	14.2	15.0
BLU-63/B, A/B (CBU-58/B) BLU-86/B, A/B (CBU-71/B, A/B)		430	490	490	560	11.6	12.3
MK 20 ROCKEYE (INTACT CLUSTER)		1380	1575	1645	1850	19.4	20.6
MK 118 (MK 20)		695	790	800	915	14.7	15.5
MAXIMUM ROCKET FRAGMENT TRAVEL							
MK 1	5	1030	1170	1430	1630	17.1	18.1
	10	1015	1150	1425	1630	16.9	17.9
	20	985	1110	1425	1620	16.5	17.5
	30	930	1045	1410	1610	16.0	17.0
MK 5	5	1190	1360	1620	1850	18.5	19.5
	10	1175	1340	1620	1845	18.3	19.4
	20	1140	1300	1615	1840	18.0	19.1
	30	1110	1265	1600	1825	17.7	18.8
M151	5	1010	1145	1335	1515	17.1	18.2
	10	1000	1135	1330	1515	17.0	18.1
	20	990	1110	1325	1510	16.9	17.8
	30	965	1085	1300	1500	16.6	17.6

FIGURE 6-1

MAXIMUM BOMB FRAGMENT TRAVEL

A Maximum Bomb Fragment Travel Chart is provided in FIGURE 6-1. These date must be used to determine fragment deconfliction between multiple aircraft attacks. The envelopes present the maximum altitude and maximum horizontal range anticipated for the worst-case fragment of the bomb case, and the time from detonation until all bomb case fragments have settled to the ground. Data are provided for sea level and 5,000 feet target density altitudes. Interpolation between sea level and 5,000 feet and extrapolation up to 10,000 feet are permissible.

NOTE

Maximum fragment travel envelopes consider all except an extreme few of the weapon fragments. Lug/hardback components of bombs are an exception, in that they can travel higher and farther than bomb case fragments. However, their behavior cannot be accurately predicted, and it is operationally accepted that the probability of being hit by these fragments is less than one in 1,000.

FRAGMENT DECONFLICTION

For all weapons employment involving simultaneous or sequential deliveries on the same target or on separate targets in the same area, flights must ensure that either time, altitude, or horizontal fragment deconfliction is achieved.

Time Deconfliction

Time separation between aircraft deliveries must be equal to or greater than the time the preceding weapon's fragments are in the air, plus the delivery time of fall of the preceding munition. For example, 30 seconds spacing is the minimum time between aircraft using MK 82 deliveries at sea level with a bomb TOF of 6 seconds (24 seconds fragment TOF +6 seconds bomb TOF = 30 seconds). See FIGURE 6-1.

Altitude Deconfliction

Following aircraft must recover above the maximum altitude for the fragment envelope for the preceding attacker's munition. For example, a 3,100-foot minimum altitude is required for a MK 84 delivery at a 5,000-foot target density altitude. See FIGURE 6-1.

Horizontal Deconfliction

Following aircraft must remain outside the maximum horizontal range of the fragment envelope for the preceding attacker's munition. For example (FIGURE 6-1), 2,310 feet lateral separation provides deconfliction from a MK 82 at sea level. For CBU munitions, the horizontal deconfliction (FIGURE 6-1 and FIGURE 6-2) must be equal to or greater than the larger of the following:

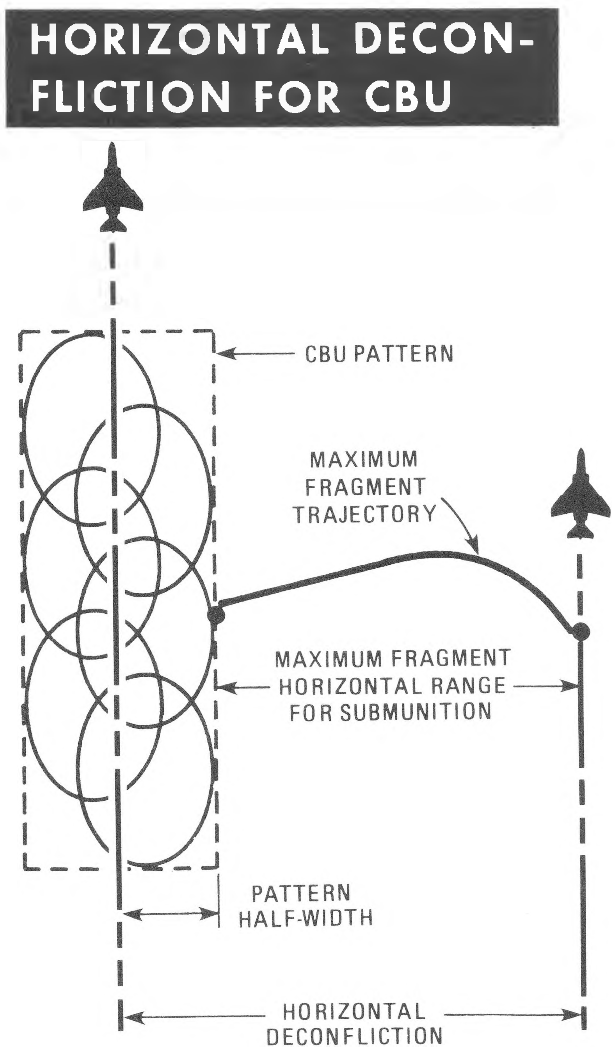


FIGURE 6-2

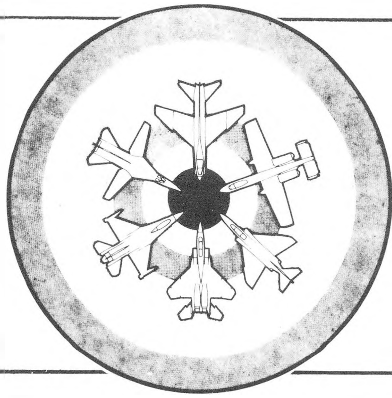
1. Maximum horizontal range of fragment envelope for the intact cluster

2. Sum of CBU pattern half-width/radius and maximum horizontal range of the fragment envelope for the submunition. Single dispenser pattern data may be found in JMEM document TH61A1-3-2.

For simultaneous formation deliveries on the same target or area, when time, altitude, or horizontal deconfliction will not be achieved, the wingmen must be in close (fingertip) or line-abreast formation and level with to higher than the leader. In this type of delivery, fragment protection is provided by the safe escape minimum release altitude.

WARNING

The wingmen must not drop back to any type of route or trail position during formation deliveries; the probability of being hit by fragments will be significantly increased.



SECTION VII
SUPPLEMENTARY DATA, ERROR ANALYSIS

CONTENTS

WEAPON DELIVERY

ARMAMENT REFERENCE LINES

The various reference lines used in this manual are illustrated in FIGURE 7-1.

BOMBING GEOMETRY

In dive deliveries, the bomb is released manually from a fixed dive angle; approach to the target is at a preplanned airspeed and altitude. After release, the bomb is accelerated downward by gravity and slowed by aerodynamic drag. These factors cause the bomb to travel along a curved path and to impact the ground some distance short of the intersection of the aircraft's extended flightpath and the ground.

The geometry of a manual dive bombing problem is illustrated in FIGURES 7-2 through 7-4. The ballistic tables for free-fall munitions contained in the appropriate aircraft Dash 34 give sight depression from flightpath (DFP) in mils. DFP is predicated on four factors: gravity, drag, ejection forces that provide aircraft/bomb separation, and parallax.

Gravity, drag, and ejection forces are used for a given dive angle, altitude, and airspeed. Using trigonometry, the DFP can be calculated with bomb range, release altitude, and dive angle.

NOTE

Level bombing is a specific case of dive bombing where the dive angle is zero. Therefore, by using a dive angle equal to zero, this discussion applies equally to dive and level bombing.

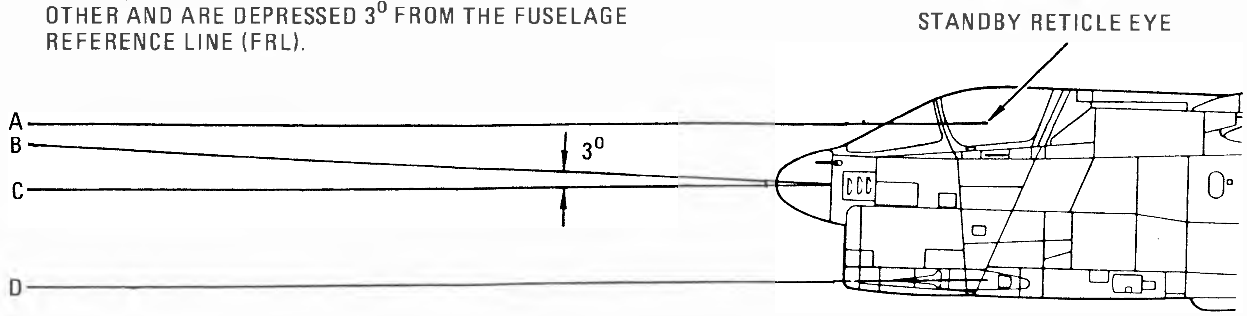
The following parameters are defined:

- r - Denotes parameters at weapon release
- Y_r - Release altitude, feet above ground level (AGL)
- BR - Bomb range, feet
- θ - Dive angle, degrees (measured below horizontal)
- ϕ_r - DFP at release
- S_r - Slant range from release point to target, feet
- α_r - Zero sight line angle of attack (AOA) at release

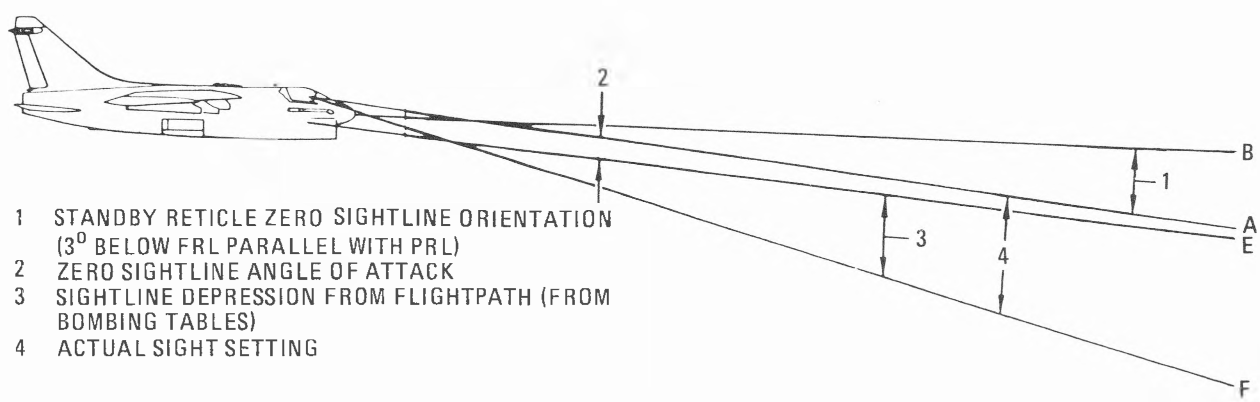
REFERENCE LINES

NOTE:
WING AND FUSELAGE PYLONS, STANDBY RETICLE ZSL, RADAR, AND GUN BORE LINES ARE ALL PARALLEL TO EACH OTHER AND ARE DEPRESSED 3° FROM THE FUSELAGE REFERENCE LINE (FRL).

A-7

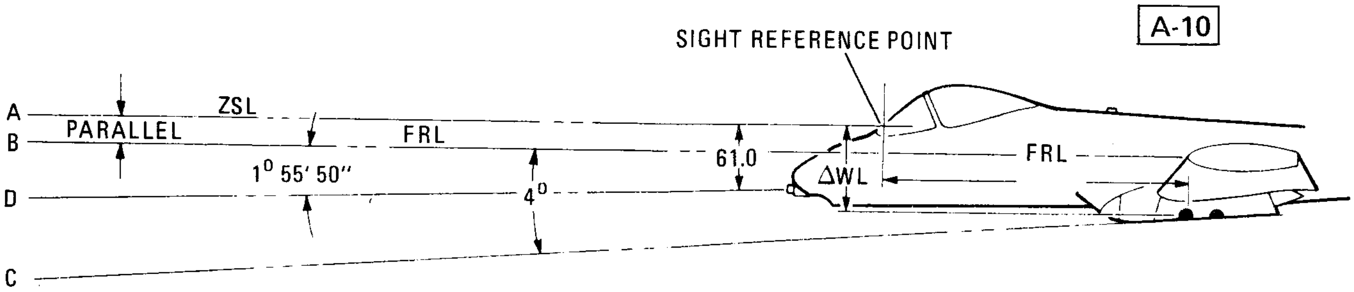


A STANDBY RETICLE ZERO SIGHTLINE (ZSL)
B FUSELAGE REFERENCE LINE (FRL)
C FUSELAGE AND WING PYLON LINE, RADAR LINE
D GUN BORE LINE
E FLIGHTPATH
F DEPRESSED SIGHTLINE

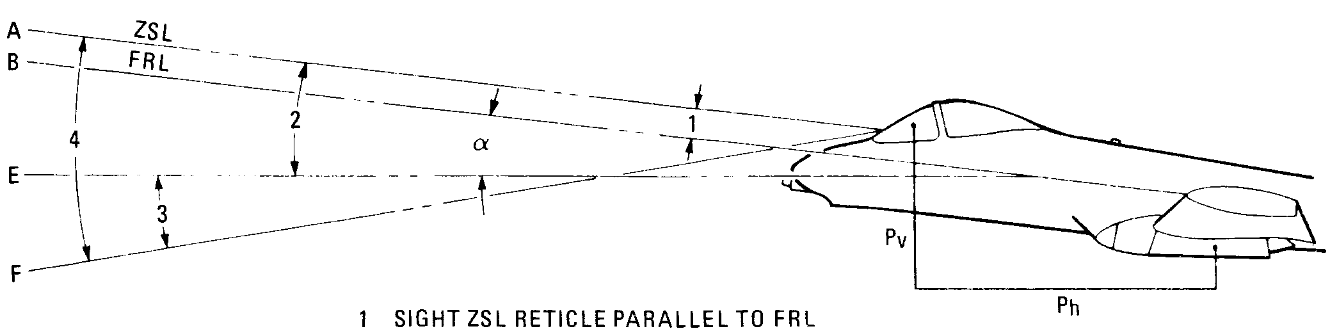


1 STANDBY RETICLE ZERO SIGHTLINE ORIENTATION (3° BELOW FRL PARALLEL WITH PRL)
2 ZERO SIGHTLINE ANGLE OF ATTACK
3 SIGHTLINE DEPRESSION FROM FLIGHTPATH (FROM BOMBING TABLES)
4 ACTUAL SIGHT SETTING

FIGURE 7-1 (Sheet 1 of 4)



A ZERO SIGHTLINE (ZRL)
B FUZELAGE REFERENCE LINE (FRL)
C LAUNCHER LINE
D GUN BORE LINE
E FLIGHTPATH (VELOCITY VECTOR)
F DEPRESSED SIGHTLINE

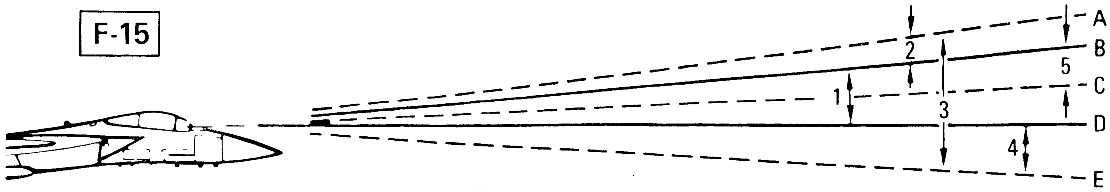


1 SIGHT ZSL RETICLE PARALLEL TO FRL
2 ANGLE OF ATTACK (α)
3 SIGHTLINE DEPRESSION FROM FLIGHTPATH (DFP) (OBTAIN FROM WEAPON DELIVERY TABLES FOR BOMBS, STORES, AND GUN)
4 ACTUAL SIGHT SETTING

NOTES:
- ZERO SIGHTLINE (ZSL) IS PARALLEL TO FUSELAGE REFERENCE LINE (FRL)
- EFFECTIVE GUN BORE LINE IS BELOW FRL (1° 55′ 50″)
- BASED UPON GUN AND INSTALLATION ANGLE ϕ (2°06′ 39″) BELOW FRL FUSELAGE AND WIRE PYLON LINE 4° BELOW FRL
- GUN PARALLAX ERROR (61.0 INCHES)

FIGURE 7-1 (Sheet 2 of 4)

F-15



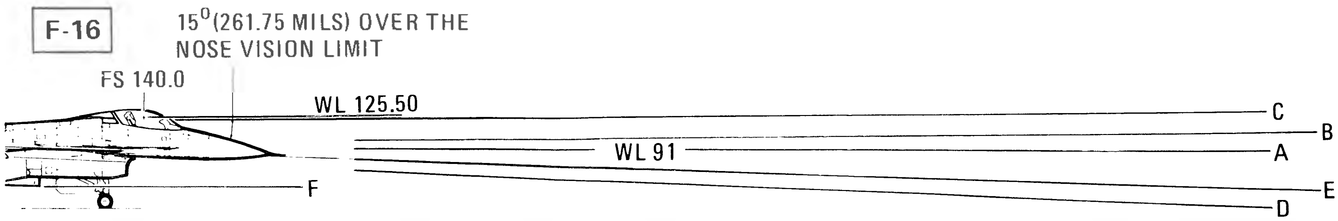
REFERENCE LINES

A GUN CROSS LINE, ZERO SIGHTLINE
B WATER LINE (WL), FUSELAGE REFERENCE LINE, RADAR BORESIGHT LINE
C AIM-9 MISSILE BORESIGHT LINE
D AIRCRAFT FLIGHTPATH
E DEPRESSED PIPPER SIGHTLINE

ANGLES

1 ANGLE OF ATTACK
2 GUN CROSS ELEVATION ANGLE (2^0 or 35 MILS ABOVE WL)
3 PIPPER DEPRESSION ANGLE FROM ZERO SIGHTLINE
4 PIPPER DEPRESSION ANGLE FROM FLIGHTPATH
5 AIM-9 WEAPON DEPRESSION ANGLE (0.5^0 OR 9 MILS)

F-16



0^0 REFERENCE LINES (PARALLEL TO FRL)
A A/C LONGITUDINAL AXIS, FRL, WING CHORD, RADAR ZERO REFERENCE LINE
B GUN BORE LINE
C HUD ZERO SIGHTLINE, HUD MINIMUM ERROR BORESIGHT

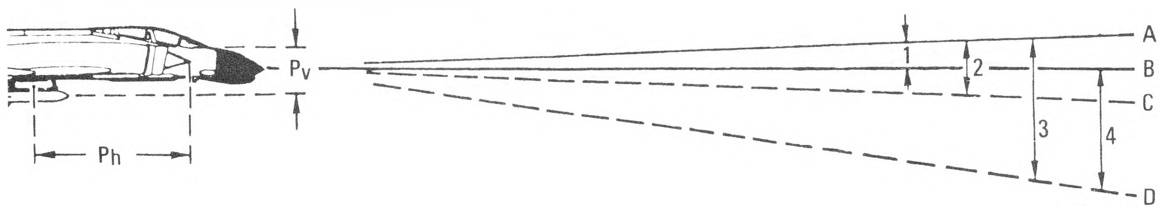
3^0 (52.35 MILS) REFERENCE LINES (3^0 DOWN FROM FRL)
D WING PYLONS
E AIM-9 MISSILES

1.72^0 (30.01 MILS) REFERENCE LINE (1.72^0 DOWN FROM FRL)
F CENTERLINE PYLON (STATION 5)

NOTE
HUD SIGHTLINE AND GUN BORE LINE DO NOT INTERSECT

FIGURE 7-1 (Sheet 3 of 4)

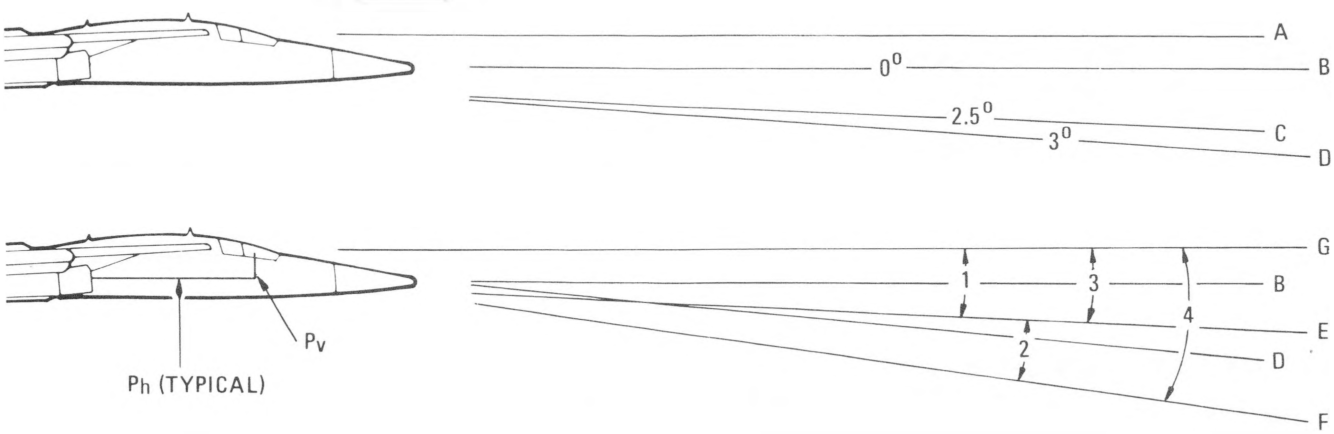
F-4



REFERENCE LINES
A FUSELAGE REFERENCE LINE (FRL); PIPPER SIGHTLINE AT ZERO MILS DEPRESSION
B AIRCRAFT FLIGHTPATH
C RADAR ANTENNA BORESIGHT (BST) LINE
D DEPRESSED PIPPER SIGHTLINE

ANGLES
1 ANGLES OF ATTACK
2 2^0 (35 MILS) BELOW FRL
3 SIGHT DEPRESSION FROM ZERO SIGHTLINE, OR FROM FRL (ACTUAL SIGHT SETTING)
4 SIGHT DEPRESSION FROM FLIGHTPATH (DFP)

F-111



A WING CHORD LINE
B FUSELAGE REFERENCE LINE (FRL)
C GUN BORE LINE
D LAUNCHER LINE, CAGED SIGHTLINE
E FLIGHTPATH (VELOCITY VECTOR) (TYPICAL)
F DEPRESSED SIGHTLINE (TYPICAL)
G ZERO SIGHTLINE (ZSL)

1 ANGLE OF ATTACK
2 SIGHT DEPRESSION FROM FLIGHTPATH (DFP)
3 ZERO SIGHTLINE ANGLE OF ATTACK
4 ACTUAL SIGHT SETTING

FIGURE 7-1 (Sheet 4 of 4)

RELEASE GEOMETRY

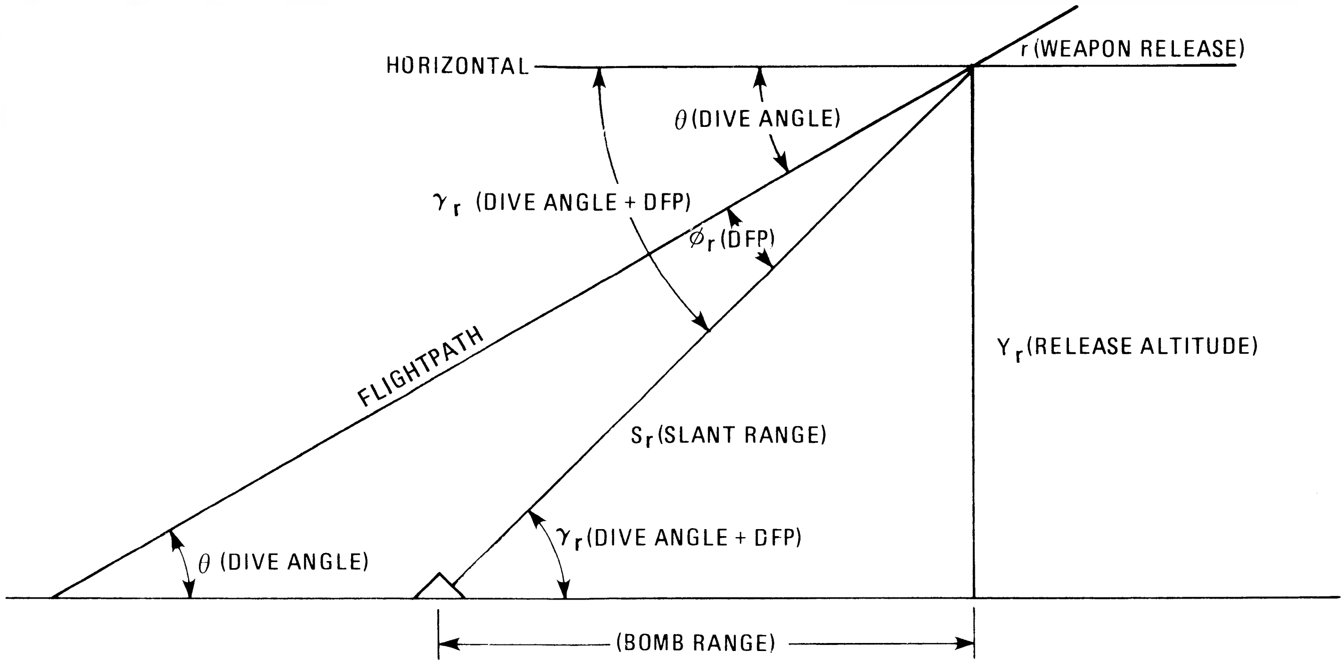


FIGURE 7–2

TOTAL DEPRESSION

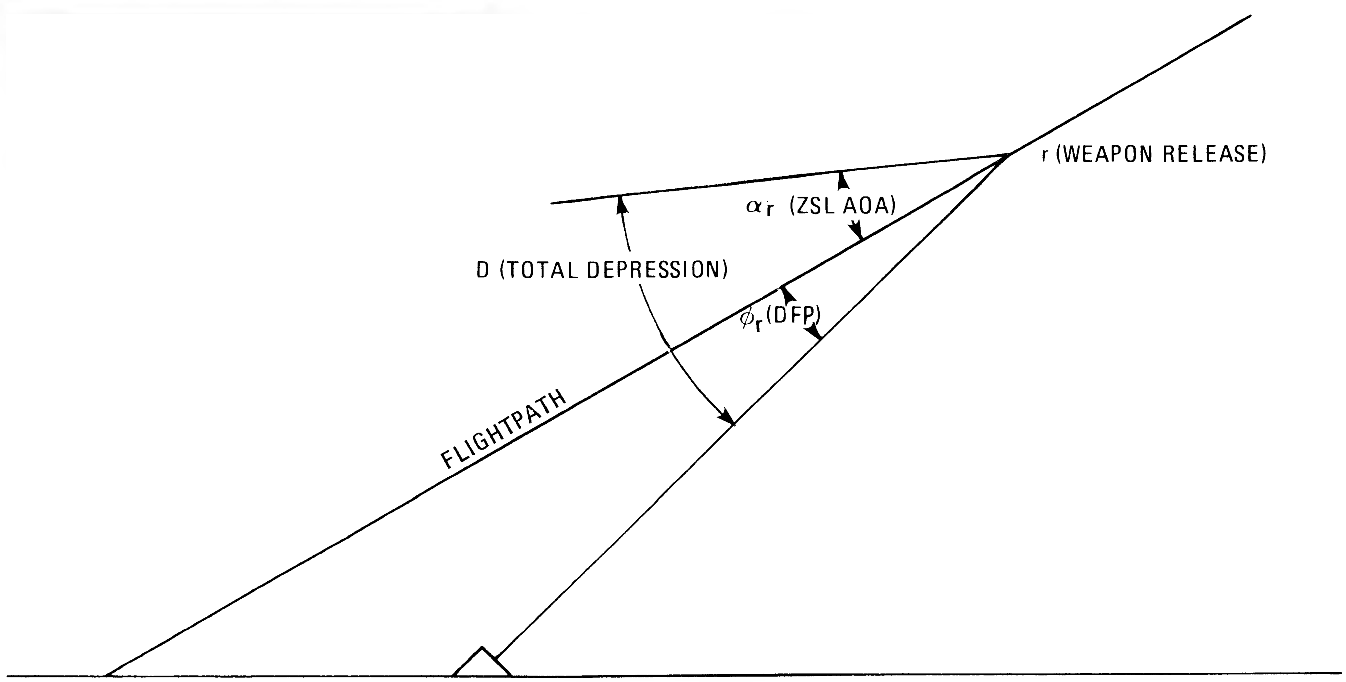


FIGURE 7–3

ROLLOUT GEOMETRY

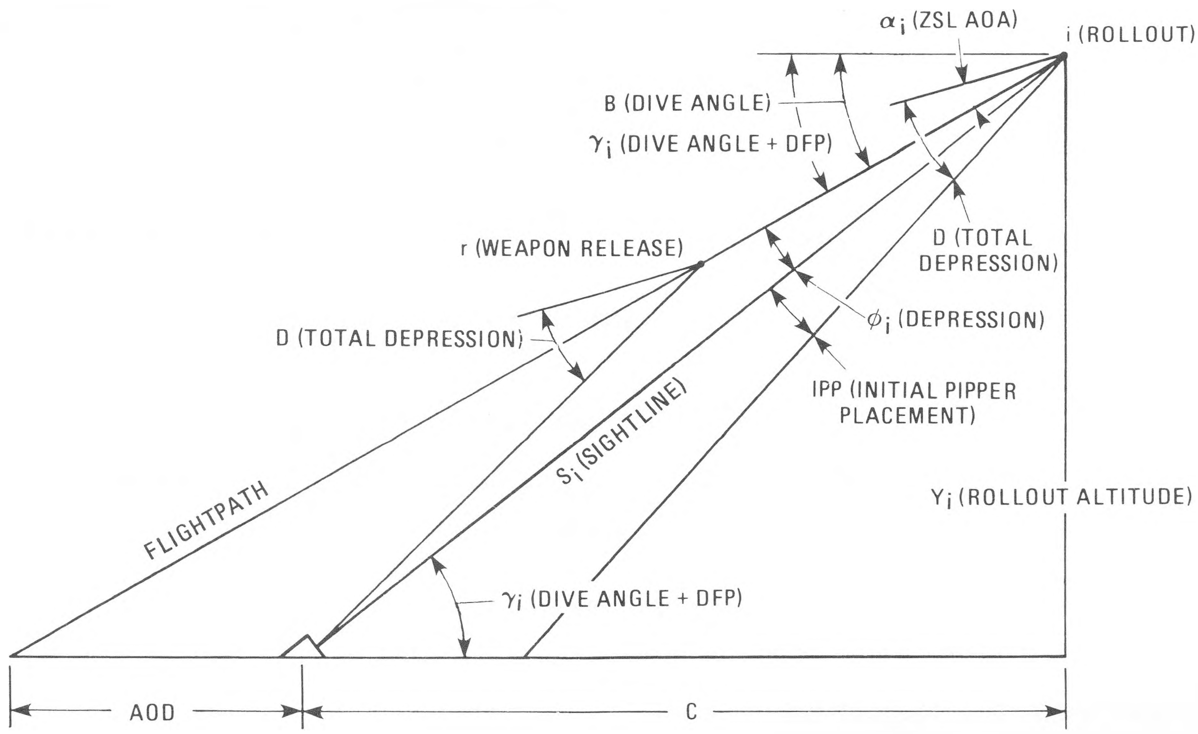


FIGURE 7-4

D – Total depression set in the HUD/sight for weapon release

i – Denotes initial parameters (rollout)

AOD – Aim off-distance, feet

Y_i – Rollout altitude, feet

IPP – Initial pipper placement, mils

α_i – Zero sight line (ZSL) AOA at rollout

ϕ_i – Depression from flightpath at rollout

S – Sight line from the pilot's eye to target, at rollout

C – Horizontal range from target at rollout

Using these parameters, DFP at release (ϕ_r) is calculated as follows:

The angle γ_r is the sum of dive angle and DFP.

Therefore

$$\phi_r = \gamma_r - \theta$$

The tangent of γ_r equals Y_r divided by BR.

$$\tan \gamma_r = \frac{Y_r}{BR}$$

and

$$\left[\phi_r = \tan^{-1}\left(\frac{Y_r}{BR}\right) - \theta\right]$$

This yields a DFP predicted on gravity, drag, and ejection force. Parallax is caused by the distance from the bomb to the pilot's eye, and will cause a small change in DFP. For any dive angle, the horizontal (P_h) and vertical (P_v) components of parallax can be found in FIGURE 7-5.

Release altitude corrected for parallax (Y_p) is:

$$Y_p = Y_r + (P_v, \text{ FIGURE 7-5})$$

Bomb range corrected for parallax (BR_p) is:

$$BR_p = BR - (P_H, \text{ FIGURE 7-5})$$

Therefore, DFP (expressed in mils) predicted on gravity, drag, ejection forces, and parallax is:

$$DFP\ (\phi_r) = 17.45 \left[\tan^{-1}\left(\frac{Y_p}{BR_p}\right) - \theta\right]$$

For a given release altitude (Y_r), dive angle (θ) and knots true airspeed (KTAS), BR, SR, and θ_r are given in the appropriate aircraft Dash 34 ballistics tables. DFP is not the total sight setting. The aircraft has some AOA that must be considered when calculating total sight depression. In dive bombing, the zero sight line (sight angle when zero mils is set into the HUD/sight is used as a reference. The zero sight line angle of attack (ZSL AOA) is given in Section VIII as a function of release KCAS, aircraft gross weight, and dive angle.

The total depression (or sight setting) is the sum of DFP and ZSL AOA at release:

$$D = \phi_r + \alpha_r$$

HORIZONTAL/VERTICAL PARALLAX CORRECTIONS

DIVE ANGLE (DEG)	A-7	A-10	F-4	F-15	F-16	F-111
HORIZONTAL PARALLAX CORRECTIONS (P_h, FEET)						
0	15.4	17.5	18	21	17.3	30
5	15.6	18.0	18.5	21.4	17.6	30.2
10	15.6	18.3	18.9	21.6	17.7	30.2
15	15.5	18.5	19.2	21.6	17.7	30.0
20	15.3	18.5	19.3	21.4	17.6	29.6
25	15.0	18.4	19.3	21.1	17.3	28.9
30	14.6	18.2	19.1	20.7	16.9	28.0
35	14.0	17.8	18.8	20.1	16.4	26.9
40	13.4	17.3	18.3	19.3	15.7	25.6
45	12.7	16.6	17.7	18.4	14.9	24.0
50	11.8	15.8	16.9	17.3	14.0	22.3
55	10.9	15.0	16.1	16.1	13.0	20.5
60	9.9	13.9	15.1	14.8	11.9	18.5
VERTICAL PARALLAX CORRECTIONS (P_v, FEET)						
0	2.5	6.0	7.0	5.0	3.8	4.0
5	1.1	4.5	5.4	3.2	2.3	1.4
10	-0.2	2.9	3.8	1.3	0.7	-1.3
15	-1.6	1.3	2.1	-0.1	-0.8	-3.9
20	-2.9	-0.3	0.4	-2.5	-2.3	-6.5
25	-4.2	-2.0	-1.3	-4.3	-3.9	-9.1
30	-5.5	-3.6	-2.9	-6.2	-5.4	-11.5
35	-6.8	-5.1	-4.6	-7.9	-6.8	-13.9
40	-8.0	-6.7	-6.2	-9.7	-8.2	-16.2
45	-9.1	-8.1	-7.8	-11.3	-9.5	-18.4
50	-10.2	-9.6	-9.3	-12.9	-10.8	-20.4
55	-11.2	-10.9	-10.7	-14.3	-12.0	-22.3
60	-12.1	-12.2	-12.1	-15.7	-13.1	-24.0

FIGURE 7-5

For the planned combination of dive angle, altitude, and airspeed, this sight setting will define the proper release point. Any variation in any parameter will nullify this relationship, and the sight setting will be in error (it will not define the proper bomb range).

Several other relationships exist that are useful in solving the dive bombing problem.

The AOD is the distance from the target to the point where the theoretical extension of the aircraft flightpath intersects the ground. This point is called AOP and is useful in solving the dive bombing problem. In order to arrive at the proper point in space, as defined by the sight setting, the aircraft must be flown along the flightpath ending at the AOP, as depicted in FIGURE 7-4. If the AOP can be visualized on the ground, the aircraft can be flown toward the AOP with the proper dive angle to intercept the preplanned flightpath. Normally the AOP is difficult to visualize; therefore, another method must be used to point the aircraft fightpath toward the AOP.

The aircraft flightpath can be pointed toward the AOP using the geometric relationships depicted in FIGURE 7-4. If rollout is achieved at the preplanned point and the pipper is positioned the proper distance short of the target at rollout, the flightpath will necessarily be the proper distance (AOD) past the target. This IPP is measured in mils short of the target, and can be computed as follows:

$$IPP = D - \alpha_i - \phi_i$$

The ZSL AOA at rollout is given in Section VIII as a function of rollout KCAS, gross weight, and dive angle.

Just as ϕ_r subtends the AOD at release altitude (FIGURE 7-2), ϕ_i subtends the AOD at rollout altitude and is computed in the same manner as ϕ_r.

$$\phi_i = \tan^{-1}\left(\frac{Y_i}{C}\right) - \theta$$

$$IPP = D - \alpha_i - \phi_i$$

NOTE

Parallax applies to rollout conditions similar to release conditions. However, it is a very small correction and is essentially zero.

AOD and rollout DFP (ϕ_i) can also be determined using the aim off-distance charts in Section VIII.

ERROR ANALYSIS

BOMBS

Variations in delivery parameters change the bomb trajectory and affect the accuracy of the sight setting. If the bomb is released from the preplanned bomb range, but planned delivery parameters are not attained, the bomb will miss the target. This miss distance is called trajectory error (TE).

The sight setting is computed using the planned bomb range, altitude, dive angle, and airspeed. Any change in these parameters will change the required DFP and/or ZSL AOA and, therefore, the sight setting. If preplanned delivery parameters are not attained and the bomb is released using the precomputed sight setting (pipper on the target), the bomb will miss the target. This miss distance is called release point error (RPE).

The miss distance caused by the combination of trajectory error and release point error is called net error (E). Release point and trajectory errors can be either compounding or compensating. Net error therefore is the algebraic sum of RPE and TE.

E = RPE + TE

NOTE

> Net error is always in the direction of RPE. (When RPE and TE are compensating errors, RPE is always larger. In instances where TE is larger than RPE, the two are compounding errors.)

ERRORS AFFECTING ORDNANCE IMPACT

The effect of varying each delivery parameter can be examined independently. In each case, only the parameter listed will be varied; all other parameters are constant. The pipper is always on the target.

To understand the specifics of TE and RPE, the two phenomena can be thought of as discussed in the following paragraphs.

TRAJECTORY ERROR

The product of a rate and a time equals a distance (distance = rate x time). In bombing, rate is horizontal velocity, time is the time of fall, and distance is bomb range. Therefore, the bomb range depends on the horizontal velocity at release and the time of fall of the weapon. Any change in a delivery parameter that will change the time of flight (TOF) or the horizontal velocity at release will change the bomb range. If horizontal velocity and/or TOF are increased, the bomb range will increase; and, if the bomb is released from the preplanned bomb range, a long TE will result. The opposite is true of decreased velocity or TOF.

RELEASE POINT ERROR

The preplanned sight setting provides the proper sight depression from the planned flightpath, based on planned release conditions. Variations in release parameters will cause an incorrect sight depression from the planned flightpath. The actual depression from the planned flightpath is called effective depression. Effective depression determines the actual range from the target at release. With an increased effective depression, the pipper will arrive on target later than required. This late sight-picture will cause a long RPE. Conversely, decreased effective depression will cause an early sight-picture and a short RPE (FIGURE 7-6 and 7-7).

RELEASE ALTITUDE ERROR

Ordnance release at an altitude higher than planned will impact short of the target (FIGURE 7-8). The increased altitude causes an early sight-picture that produces an RPE short of the target. The higher release altitude will increase the TOF and bomb range, and cause a TE that tends to be long. In this case RPE and TE are compensating but RPE is greater, resulting in a net error short of the target. The opposite is true of ordnance released lower than planned. A late sight-picture causes a long RPE, and the decreased bomb range tends toward a short TE. Net error, because of the dominance of RPE, is long. The fallacy of releasing low (pressing) becomes immediately apparent, as the ordnance will overshoot the target, and the aircraft will be further exposed to the bomb blast and fragmentation envelope.

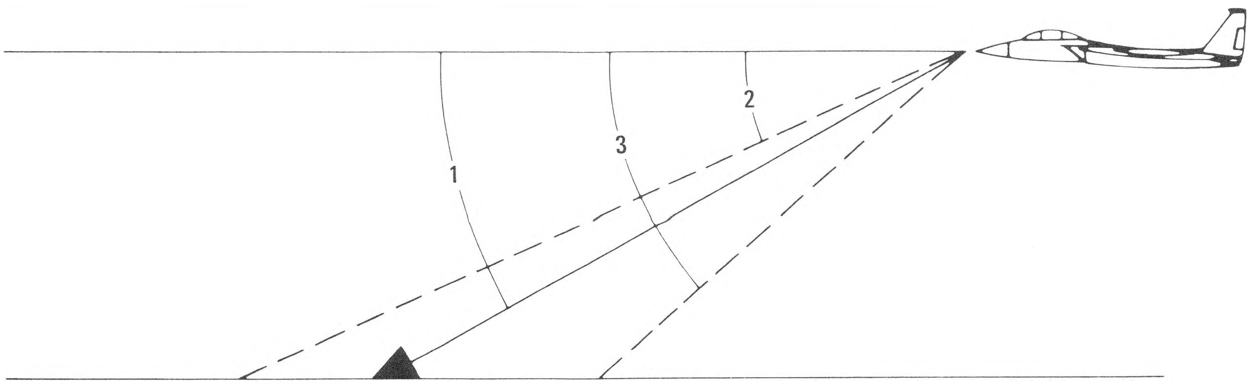
DIVE ANGLE ERROR

Ordnance released at a dive angle shallower than planned will impact short of the target (FIGURE 7-9). The decreased dive angle causes an early sight-picture that produces a short RPE. The decreased downward velocity at release will increase TOF, and the increased bomb range will cause a TE that tends to be long. Again RPE and TE are compensating, with RPE being greater and net error short of the target. A steeper than planned dive angle results in a late sight-picture and long RPE. The increased downward velocity at release will decrease TOF, decrease bomb range, and cause a TE that tends to be short. Again RPE and TE are compensating, with RPE being greater and net error long of target.

AIRSPEED ERROR

Ordnance released at an airspeed slower than planned will impact short of the target (FIGURE 7-10). As airspeed is decreased AOA must be increased to maintain the same flightpath. As angle of attack is increased, the effective sight depression below flightpath is reduced, causing an early sight-picture. As in other cases, an early sight-picture produces a short RPE. The lower release airspeed will reduce horizontal velocity and bomb range, producing a short TE. RPE and TE are compounding errors in this case, and net error is necessarily short of the target. Increased airspeed will reduce AOA, increase effective sight depression, cause a late sight-picture, and result in a long RPE. The bomb range will be increased, resulting in a long TE. Again RPE and TE are compounding errors, resulting in a long net error.

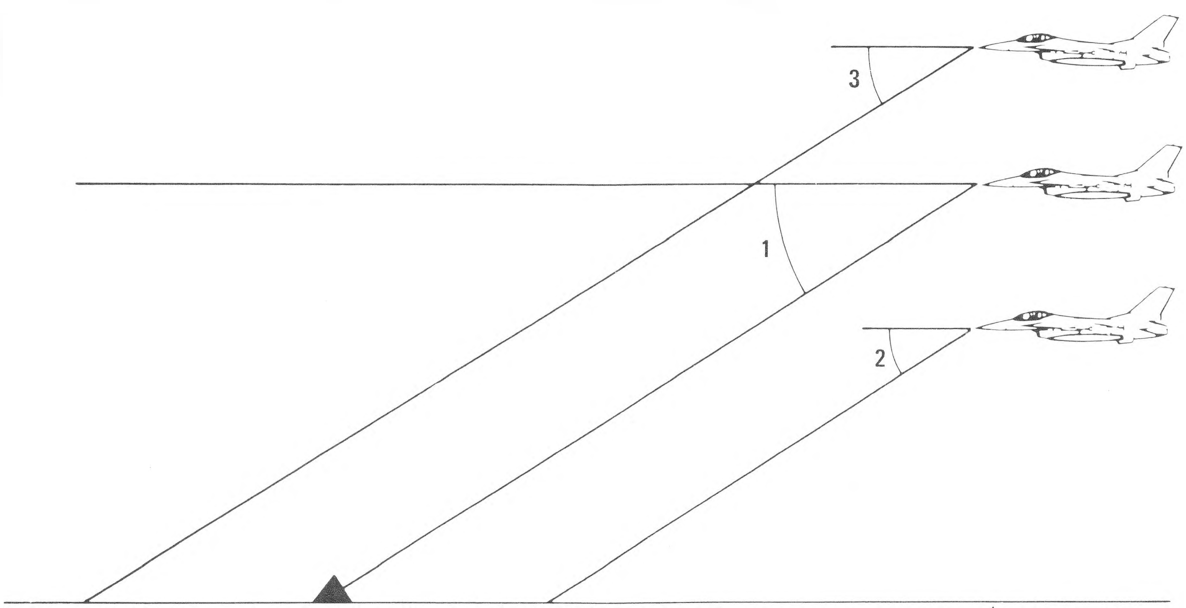
RELEASE POINT ERROR (AIRSPEED/DIVE ANGLE)



1 SIGHT DEPRESSION WITH PLANNED PARAMETERS.
2 DECREASED EFFECTIVE DEPRESSION DUE TO DECREASED AIRSPEED OR DIVE ANGLE.
3 INCREASED EFFECTIVE DEPRESSION DUE TO INCREASED AIRSPEED OR DIVE ANGLE.

FIGURE 7-6

RELEASE POINT ERROR (ALTITUDE)



1 SIGHT PICTURE WITH PLANNED PARAMETERS.
2 EARLY SIGHT PICTURE DUE TO REDUCED RELEASE ALTITUDE.
3 LATE SIGHT PICTURE DUE TO INCREASED RELEASE ALTITUDE.

FIGURE 7-7