UNITED STATES ARMY AVIATION CENTER OF EXCELLENCE

FORT RUCKER, ALABAMA

April 2009

STUDENT HANDOUT

TITLE: AH-64D AREA WEAPON SYSTEM

(LOT 11)

FILE NUMBER: 011-0921-5

Proponent For This Student Handout Is:

COMMANDER, 110TH AVIATION BRIGADE

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FOREIGN DISCLOSURE STATEMENT: (FD6) This product/publication has been reviewed by the product developers in coordination with the USAACE Foreign Disclosure Authority. This product is releasable to students from foreign countries who have purchased the AH-64D model, but the IETM is not releasable.

TERMINAL LEARNING OBJECTIVE:

NOTE: Inform students of the following Terminal Learning Objective requirements.

At the completion of this lesson, you (the student) will:

ACTION: Identify purpose, type, operations, location, function, procedures, ballistics, safety and inhibits of the Area Weapon System (AWS).

CONDITIONS: In a classroom environment, given an AH-64D Operator's Manual (TM 1-1520-251-10), the Aircrew Training Manual (TC 1-251), Helicopter Gunnery FM 3-04.140 (FM 1-140) and a student handout.

STANDARD: Identify the purpose, type, operations, location, function, procedures, ballistics, safety and inhibits of the AH-64D Area Weapon System (AWS) and receive a “Go” by answering 7 of 10 questions on scoreable unit 1 of criterion referenced test 011-1081 In Accordance With (IAW) the Student Evaluation Plan (SEP).

A. ENABLING LEARNING OBJECTIVE 1

After this lesson, you will:

ACTION: Identify the purpose and location of major components of the AH-64D Ammunition Handling System (AHS).

CONDITIONS: Given a written test without the use of student notes or references.

STANDARD: In accordance with TM 1-1520-251-10 and TC 1-251.

1. Learning Step/Activity 1

Identify the purpose and location of major components of the AH-64D Ammunition Handling System (AHS).

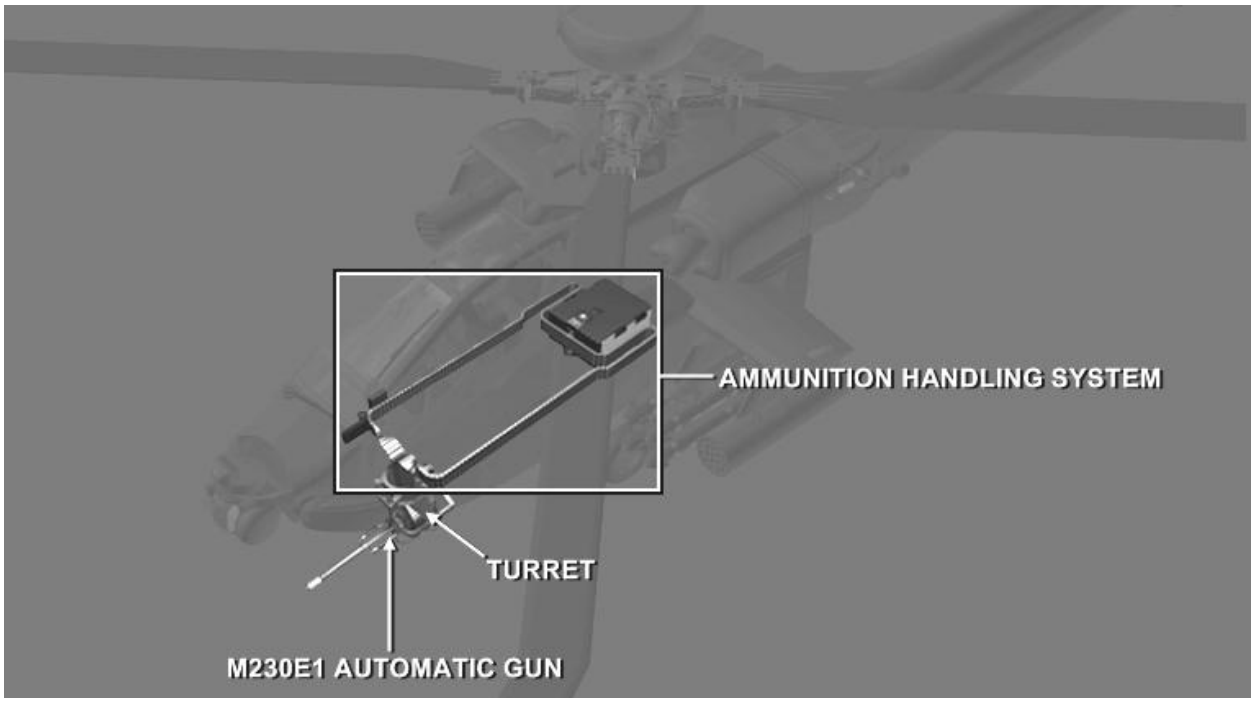

Figure 1. Area Weapon System (AWS)

a. The purpose of the AWS is to store, transport, aim, and fire 30 millimeter (mm) ammunition.

b. The three major subsystems of the AWS are as follows:

(1) Ammunition Handling System (AHS)

(2) Turret System

(3) M230E1 30mm Automatic Gun

c. The AHS transports, stores, and transfers a maximum of 1200 rounds of 30mm linkless ammunition for the AWS. The major components of the AHS are:

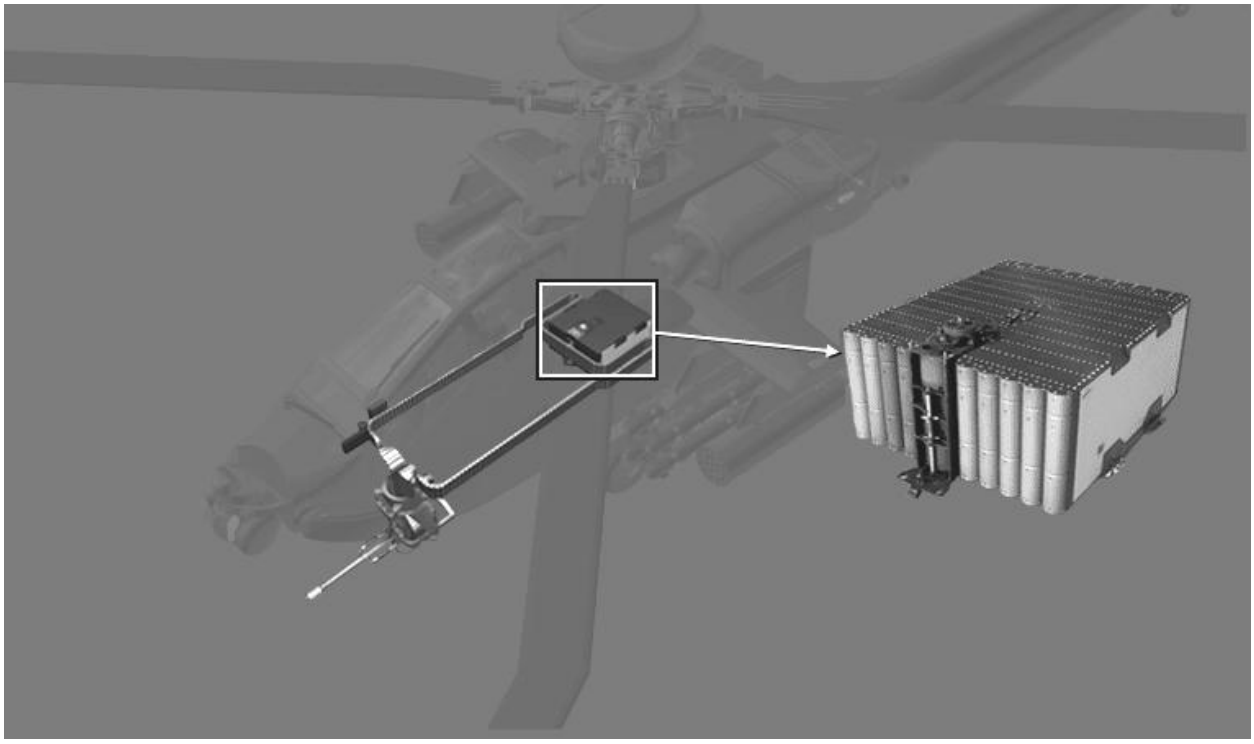

Figure 2. Ammunition Storage Magazine

(1) Ammunition storage magazine

(a) Purpose. Stores a maximum of 1110 rounds of ammunition in its upper and lower storage levels.

(b) Location. Ammunition bay in the center fuselage section between the forward and aft fuel cells.

(c) Description

1) The magazine is a mechanically driven aluminum container with an upper and lower storage level.

2) The only electrical components housed in the magazine are two last-round switches, one for each storage level, which indicates when the magazine is full.

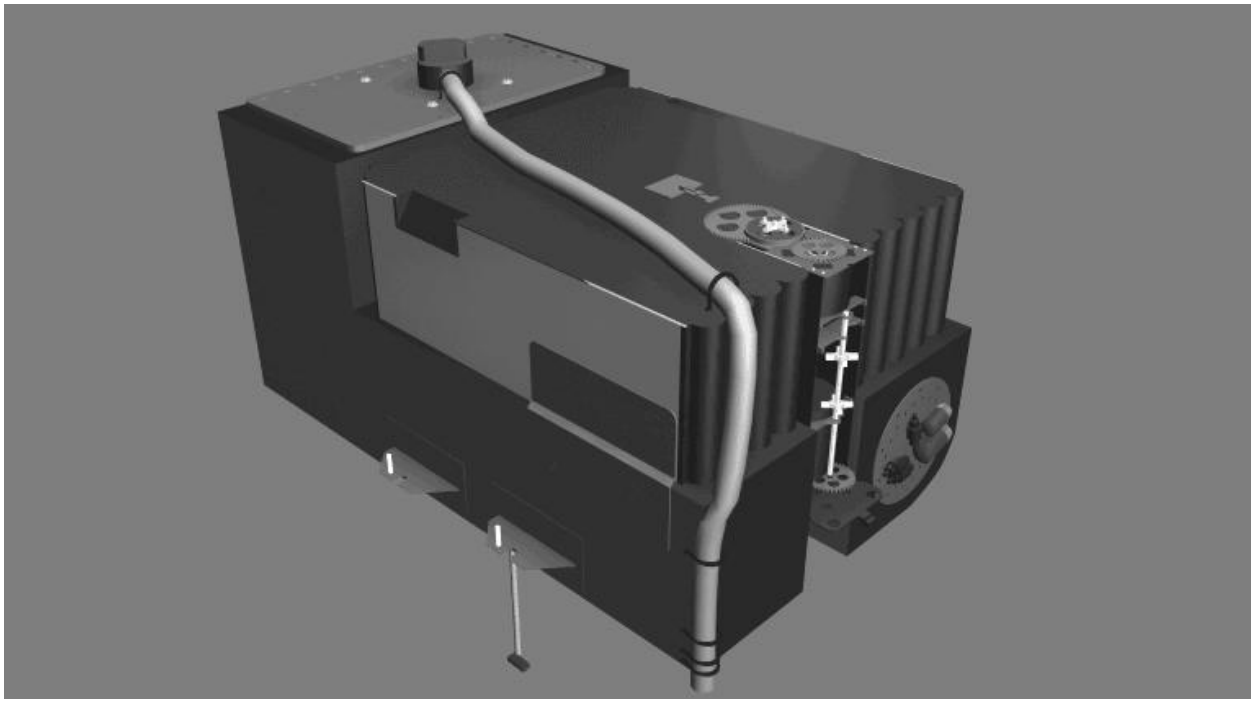

Figure 3. Internal Auxiliary Fuel System (IAFS) Combo-Pak

(2) The Internal Auxiliary Fuel System (IAFS)

(a) 100 gal tank has an integral ammunition storage magazine which stores approximately 242 rounds in the magazine and 58 rounds in the AHS allowing for approximately a 300 round capacity.

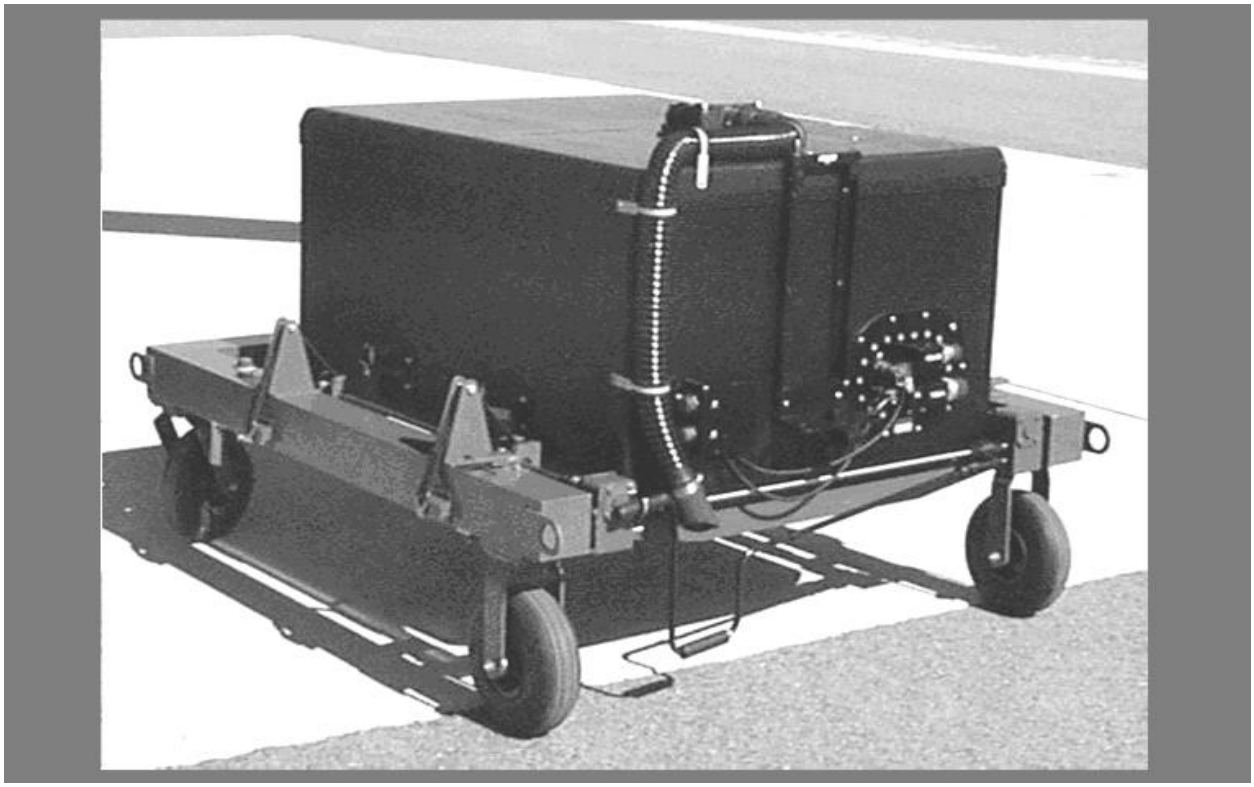

Figure 4. Internal Auxiliary Fuel System (IAFS) 130 gal. Tank

(b) 130 gal. tank does not incorporate a storage magazine.

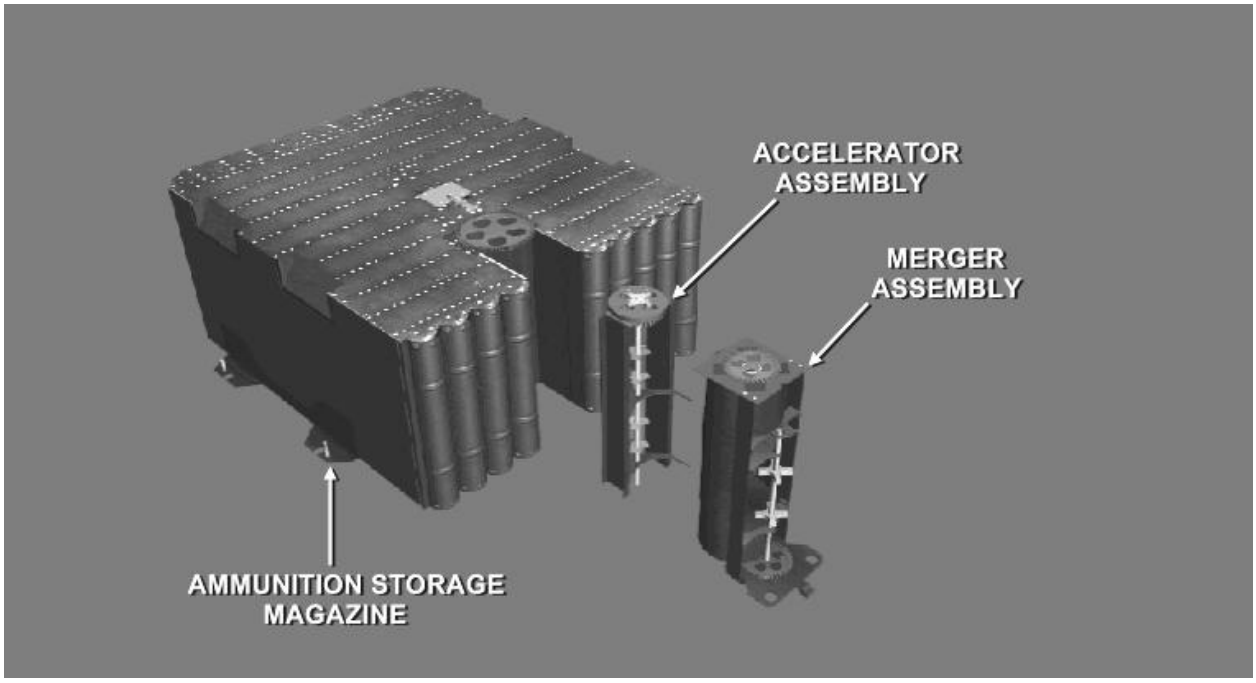

Figure 5. Accelerator-Merger Assembly

(c) The magazine incorporates the accelerator-merger assembly, which provides the means to transfer ammunition from the magazine's upper and lower storage areas into a single row of ammunition to be transferred onto the ammunition feed assembly.

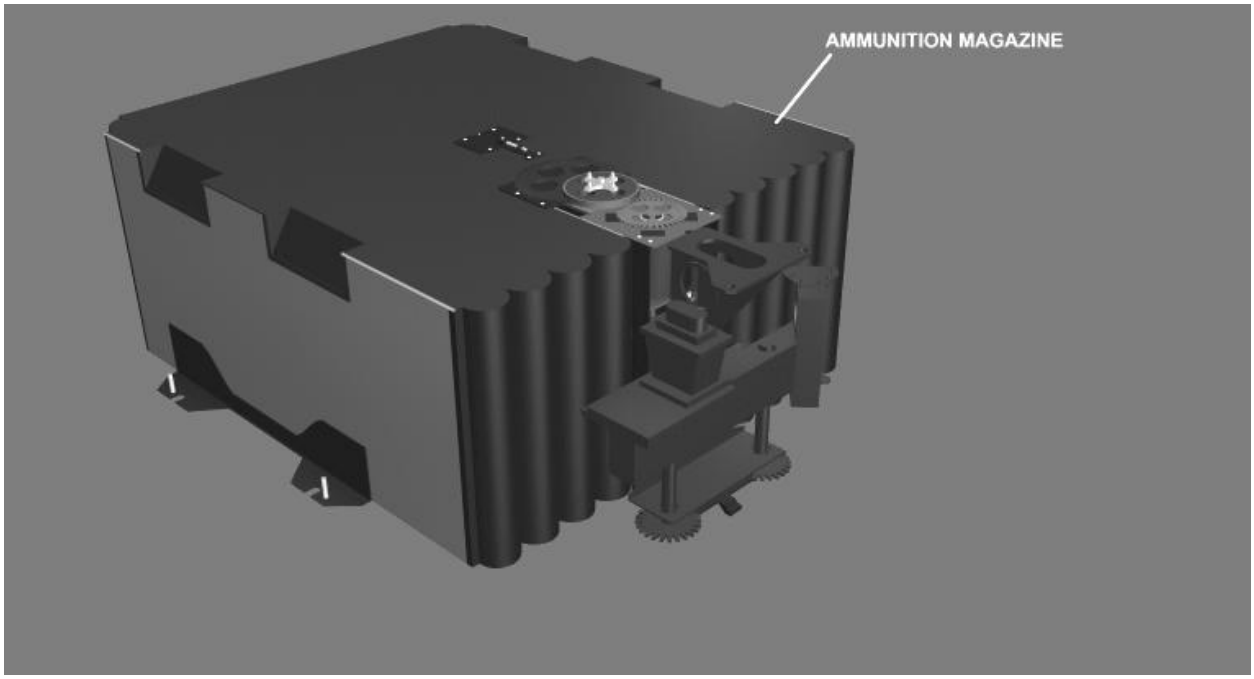

Figure 6. Accelerator-Merger Assembly–Video

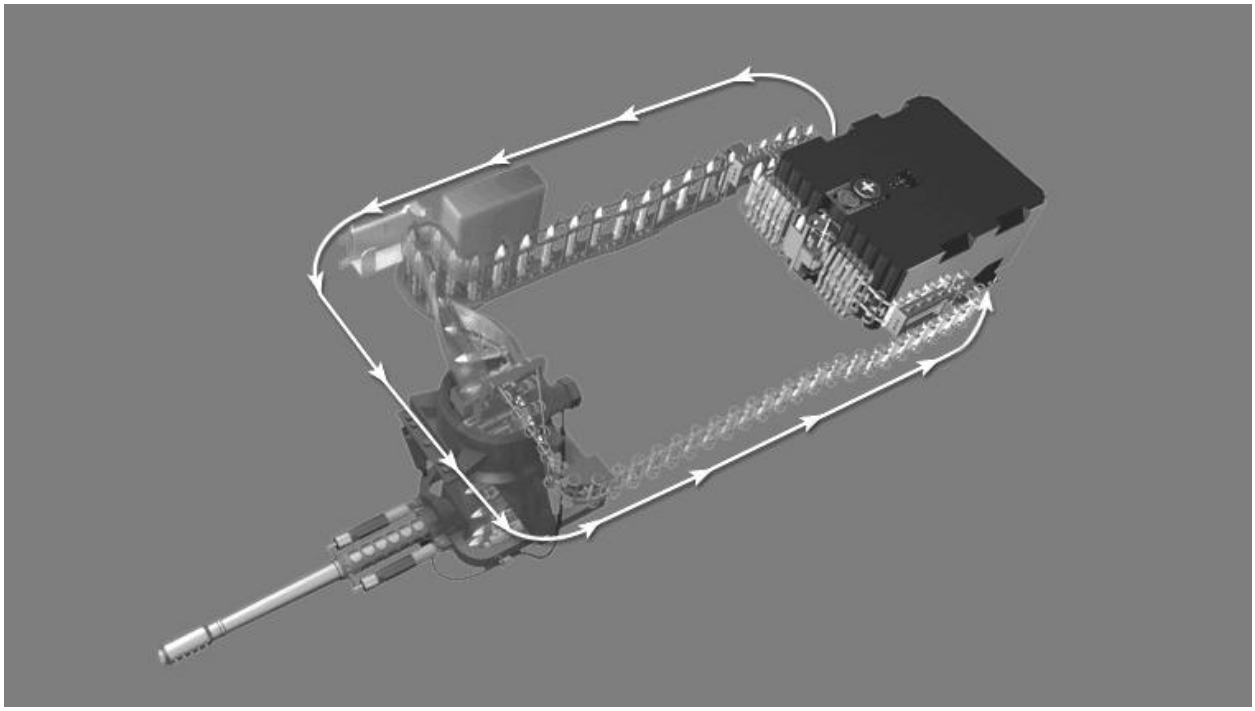

Figure 7. Ammunition Feed Assembly

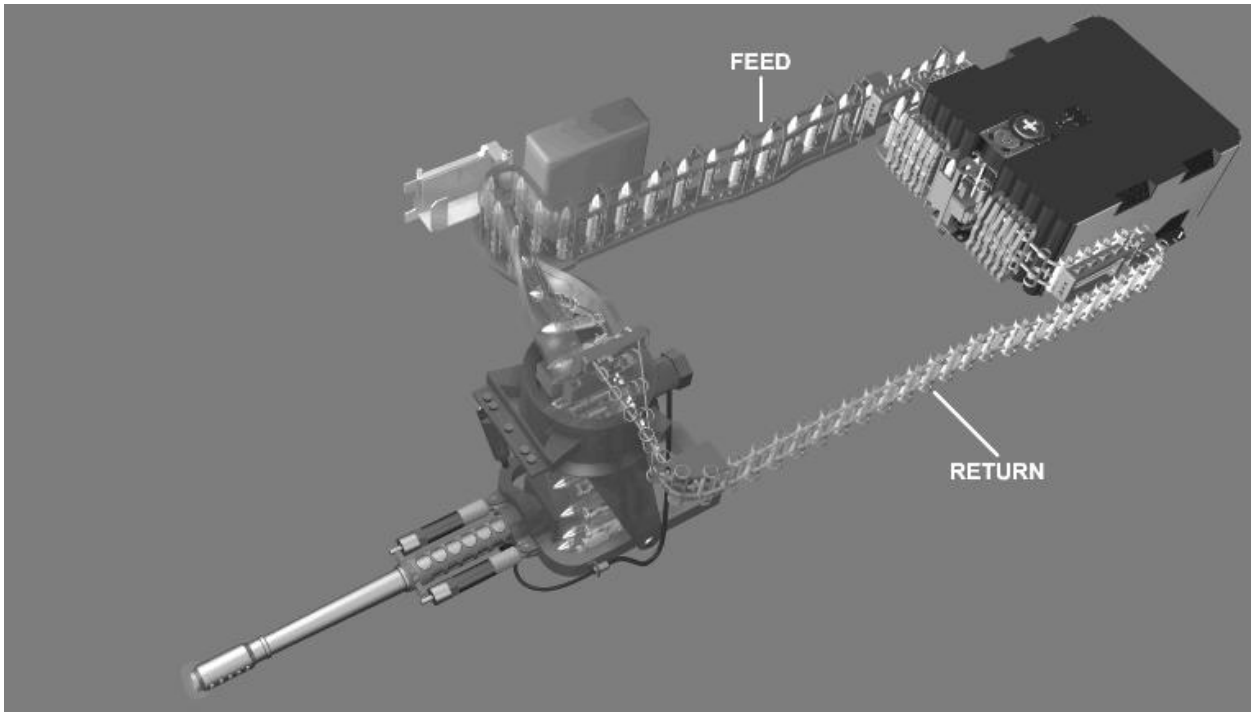

Figure 8. Ammunition Feed Assembly–Video

(3) The ammunition feed assembly transports and transfers 30mm ammunition to and from the gun. The components of the ammunition feed assembly are:

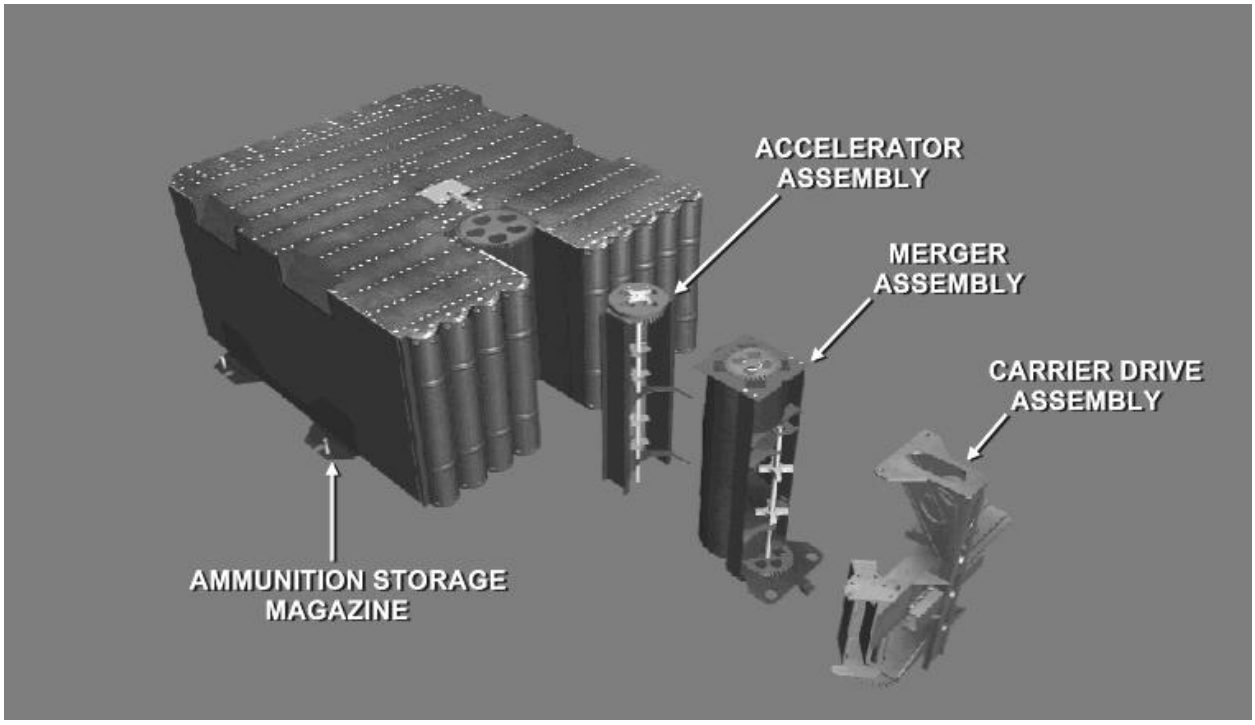

Figure 9. Carrier Drive Assembly

(4) Carrier drive assembly

(a) Purpose. Provides drive to the accelerator-merger and internal magazine components and places the rounds onto the carriers of the ammunition assembly conveyor during firing or downloading.

1) The carrier drive reverses its operation for uploading.

2) The carrier drive, on demand assists, the gun in driving the ammunition feed conveyor and is instrumental in regulating the tension of the conveyor assembly.

(b) Location. Mounted on the front of the magazine

(c) Description. The carrier drive is a bidirectional electro-hydraulic motor powered by the Utility Hydraulic System and controlled by the magazine controller.

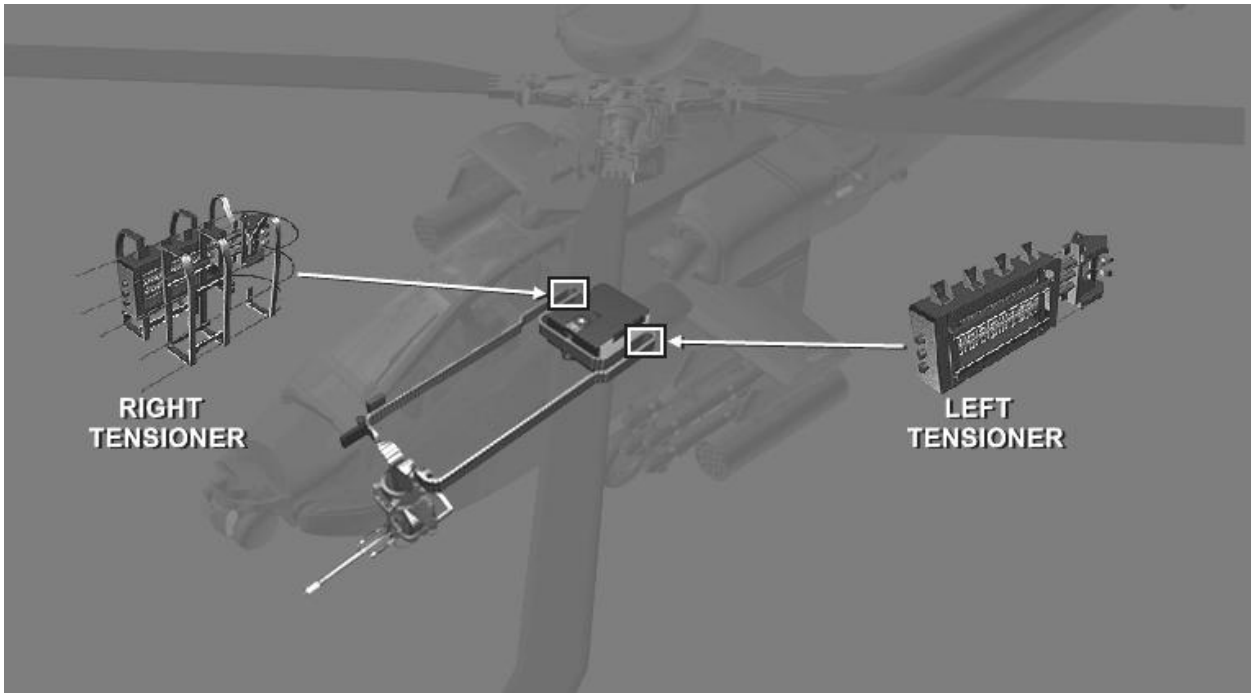

Figure 10. Chain Tensioners

(5) Chain tensioners

(a) Purpose. Keep the conveyor assembly stretched out with preload spring tension during firing, loading, and downloading modes. The tensioners provide conveyor assembly tension data to the magazine controller.

(b) Location. The tensioners are part of the feed assembly conveyor system and are mounted in the aft portion of each Extended Forward Avionics Bay (EFAB).

(6) Ammunition chutes and conveyor system

(a) Purpose. The ammunition chutes guide the conveyor assembly from the magazine to the gun and back to the magazine.

(b) Location and function

1) The feed chute guides the conveyor and ammunition from the magazine to the gun through the right EFAB. The feed chute provides storage for approximately 50 rounds between the magazine and side loader.

NOTE: When ammunition is loaded with the side loader, no ammunition is loaded between the side loader and the gun (space for approximately 40 rounds).

2) The transfer housing attaches to the gun receiver and transfers ammunition from the conveyor carriers to the index drive assembly of the gun receiver.

3) The return chute guides the conveyor assembly from the gun to the magazine through the left EFAB. Ammunition carriers of the conveyor assembly return to the magazine empty, because the spent cases are ejected overboard.

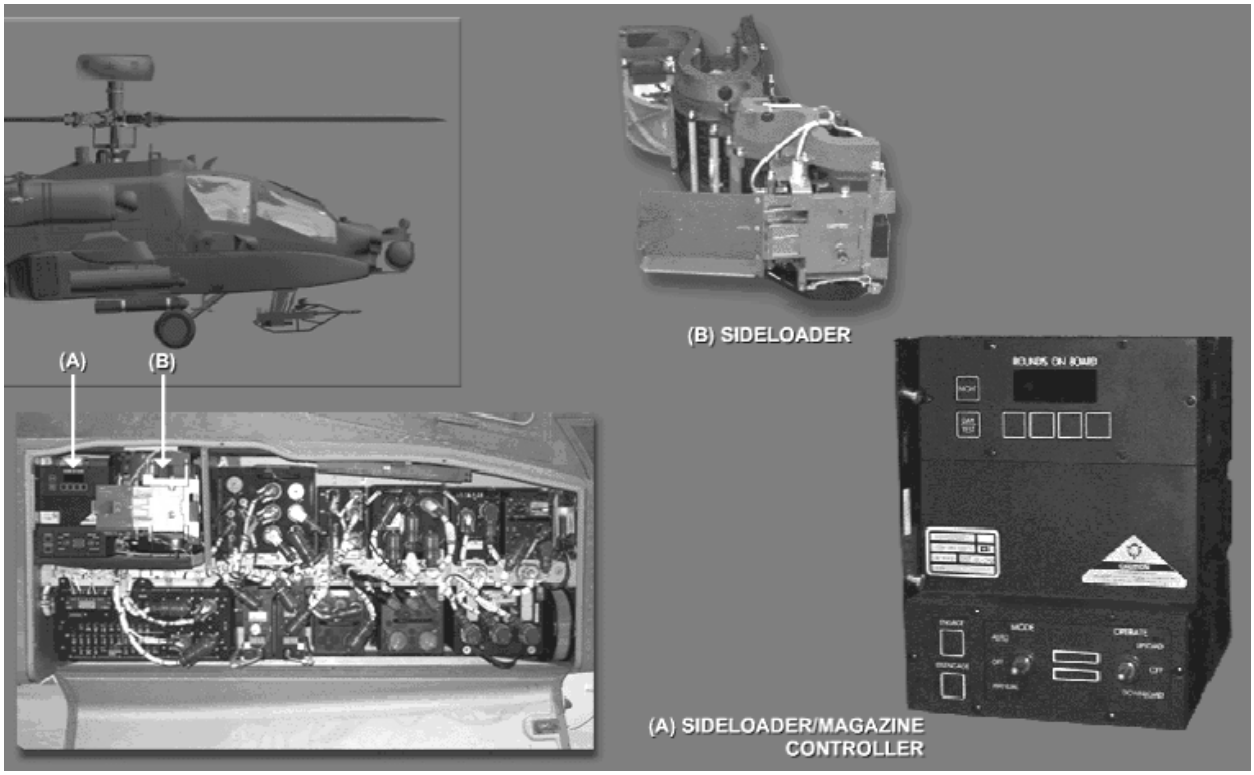

Figure 11. Side Loader/Magazine Controller

(7) Side Loader/Magazine Controller

(a) Purpose. Provides direct operator interface with the AWS Ammunition Handling System during uploading and downloading operations.

1) The side loader accomplishes the uploading and downloading of the AWS.

2) Ammunition can be loaded in bulk (individual rounds) or 11-round strips.

3) Linked ammunition cannot be used in the side loader.

4) The side loader is an electromechanical assembly.

5) The magazine controller counts rounds, controls the carrier drive assembly and the side loader loadhead. It also provides an interface between the turret control box, ammunition feed assembly tensioners, and the weapons processor.

(b) Location. The side loader/magazine controller is located in the right EFAB.

CHECK ON LEARNING

1. What is the capacity of the ammunition storage magazine?

ANSWER: _____

_____

2. The internal auxiliary fuel system (IAFS) incorporates a 100 gallon fuel tank and an ammunition storage magazine capable of holding approximately _____ rounds and _____ in the AHS allowing for approximately a 300 round capability.

ANSWER: _____

_____

3. What are the two ways ammunition can be loaded through the side loader?

ANSWER: _____

_____

4. When ammunition is loaded using the side loader, there is approximately _____ round space between the side loader and the gun.

ANSWER: _____

_____

Enabling Learning Objective 2

ACTION: Identify the type and purpose of the three types of ammunition used by the AWS.

CONDITIONS: Given a written test without the use of student notes or references.

STANDARD: In accordance with student handout materials, TM 1-1520-251-10, TC 1-251, and FM 3-04.140 (FM1-140).

2. Learning Step/Activity 1

Identify the type and purpose of the three types of ammunition used by the AWS

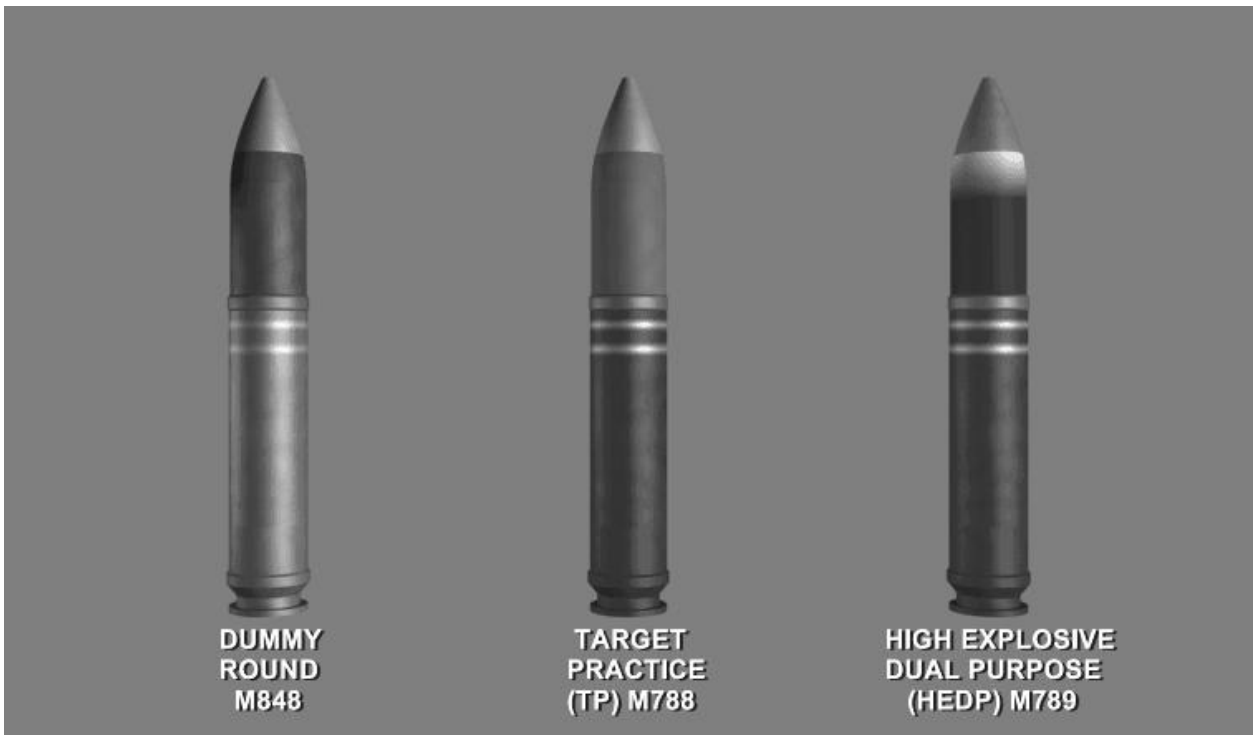

Figure 12. Three types of 30mm Ammunition

a. Types of ammunition

(1) Three types of 30mm ammunition are currently being used in the AWS:

(a) M848 dummy round

1) The M848 dummy round is used for functional checks of the weapon mechanism.

2) The round is an inert cartridge without propellant and the primer replaced with a threaded steel bolt.

3) The M848 is completely copper in color.

(b) M788 Target Practice (TP) round

1) The M788 TP round is an inert projectile without a fuze and is used for gunnery training in lieu of service ammunition.

2) The round serves no purpose other than for target impact or penetration.

3) The M788 has a blue projectile with a white stripe and lettering and an aluminum nosepiece.

(c) M789 High Explosive Dual Purpose (HEDP) round

1) The M789 HEDP round is a high explosive, dual-purpose service round with a point-detonating fuze.

2) The projectile of the round has a shaped charge liner for piercing in excess of 2 inches of Rolled Homogenous Armor (RHA) at 2500 meters and a fragmentation radius of 4 meters for soft targets.

3) The M789 has a black projectile with a yellow band below the fuze with yellow lettering.

NOTE: Armament Development Enfield (ADEN) (brass) and D'Etude Et Fabrication D'Armament (DEFA) (steel) can be used.

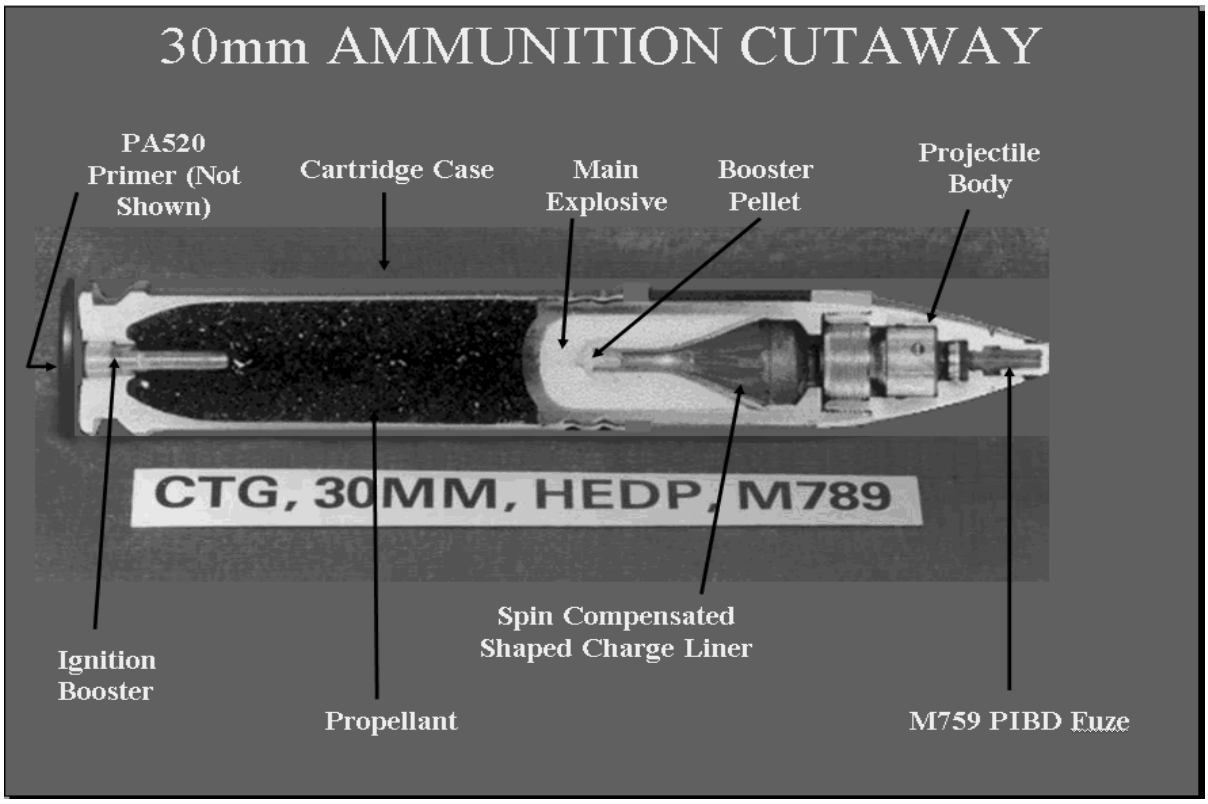

Figure 13. HEDP Cutaway

Approximate Time of Flight for 30 Millimeter Ammunition

(M789 Fired From Hover)

RANGE TO TARGET (METERS)	TIME OF FLIGHT (SECONDS)
500	0.7
1000	2.0
1500	3.7
2000	5.8
2500	8.6
3000	12.2

Figure 14. Approx. Time of Flight

CHECK ON LEARNING

1. What is the color of the projectile on the M789 High Explosive Dual Purpose (HEDP) round?

ANSWER: _____

_____

2. What is the fragmentation radius of the M789 HEDP round projectile?

ANSWER: _____

_____

3. The M789 (HEDP) can penetrate 2 inches of RHA at _____ meters.

ANSWER: _____

_____

4. What is the color of the M788 (TP) round?

ANSWER:_____

_____

B. ENABLING LEARNING OBJECTIVE 3

ACTION: Identify the purpose and location of major components of the AH-64D Gun Turret Assembly.

CONDITIONS: Given a written test without the use of student notes or references.

STANDARD: In accordance with TM 1-1520-251-10, and TC 1-251.

1. Learning Step/Activity 1

Identify the purpose and location of major components of the AH-64D Gun Turret Assembly

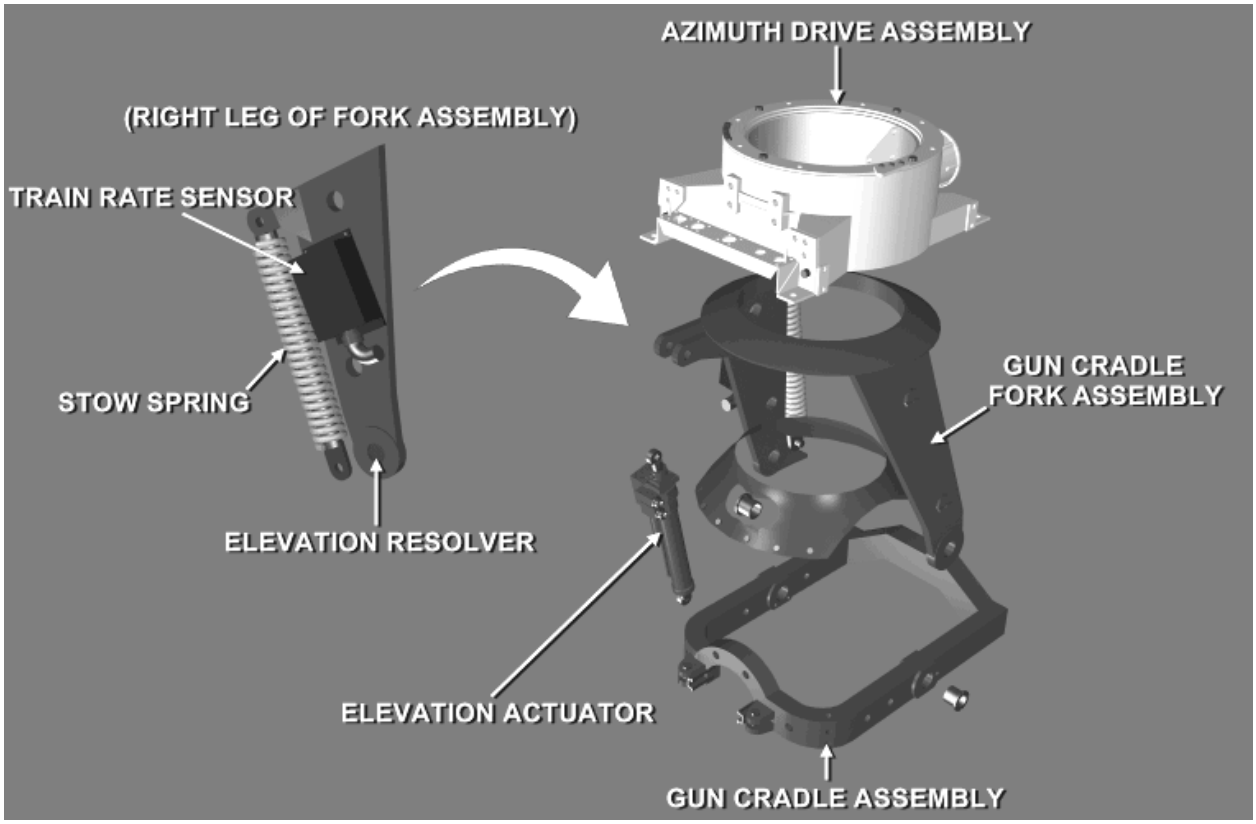

Figure 15. Gun Turret Assembly

a. Gun turret assembly

(1) Purpose. Provides a remotely controlled flexible mount for the M230E1 Gun

(2) Location. The turret assembly is located on the underside of the fuselage between the crewstations and is attached to the fuselage internally at four points.

(3) Description. The turret is an electro-hydraulic assembly utilizing hydraulic fluid from the Utility Hydraulic System at 3000 psi. The turret mounting structure is designed to absorb crash sequence energy by collapsing along rail guides into a tunnel in the fuselage between and below the crewstations. The major components of the turret assembly are as follows:

(a) Azimuth drive assembly

1) Provides the drive for azimuth positioning of the gun cradle fork assembly and the mounts for attaching the turret to the fuselage.

2) Forms the top portion of the turret assembly.

(b) Gun cradle fork assembly

1) Provides the mounting provisions for the gun cradle assembly, elevation actuator, stow spring, and train rate sensor.

2) Attached to a torque tube that is an internal component of the azimuth drive assembly.

(c) Train rate sensor

1) Provides turret azimuth displacement and acceleration feedback signals to the turret control box in all firing positions.

2) Mounted to the right leg of the gun cradle fork assembly.

(d) Gun cradle assembly

1) Provides mounting provision for the gun, gun recoil mechanisms, stow spring, elevation actuator, and elevation resolver.

2) Attached to the bottom of the fork assembly by two trunnion shafts.

(e) Elevation actuator

1) Extends and retracts to provide gun cradle elevation and depression movement.

2) Electro-hydraulic servoactuator is mounted between the gun cradle and fork assembly on the right side of the turret.

(f) Elevation resolver

1) Outputs feedback signals to the turret control box, which is used to determine the actual elevation position of the gun cradle assembly.

2) The resolver is an integral part of the trunnion shaft on the right leg of the fork assembly.

(g) Stow spring

1) Positions the gun cradle assembly to +11° elevation in the event of low utility hydraulic fluid, low hydraulic pressure, and/or electric power loss.

2) Prevents the gun from digging into the ground during landing or ground taxiing.

3) Mounted between the gun cradle and fork assembly on the right rear side of the turret.

b. The azimuth and elevation positioning limits of the turret assembly are determined by software and weapon systems firing combinations.

NOTE: Azimuth and elevation position limit figures are as viewed from the pilot/CPG stations. These limits are incorporated into the system to reduce gun feed stoppage**.**

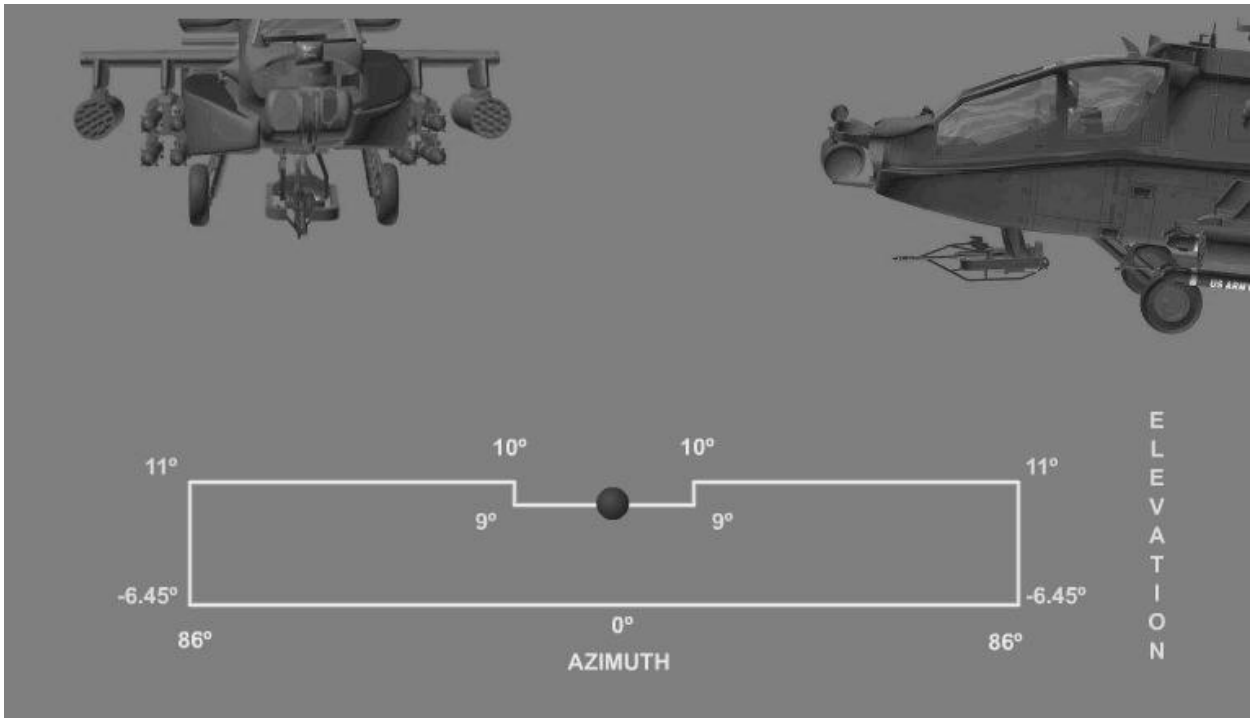

Figure 16. Gun Azimuth and Elevation Limits 1

(1) Azimuth and elevation limits for the gun turret assembly when the gun is actioned with the aircraft on the ground and with the Armament Panel, Ground Override (GND ORIDE) button ON.

(a) Azimuth. 86º left and right of aircraft centerline

(b) Elevation

1) +9º within 10º left and right of aircraft centerline

2) +11º from 10º left and right of aircraft centerline to 86º left and right

(c) Depression. –6.45º within 86º left and right of aircraft centerline

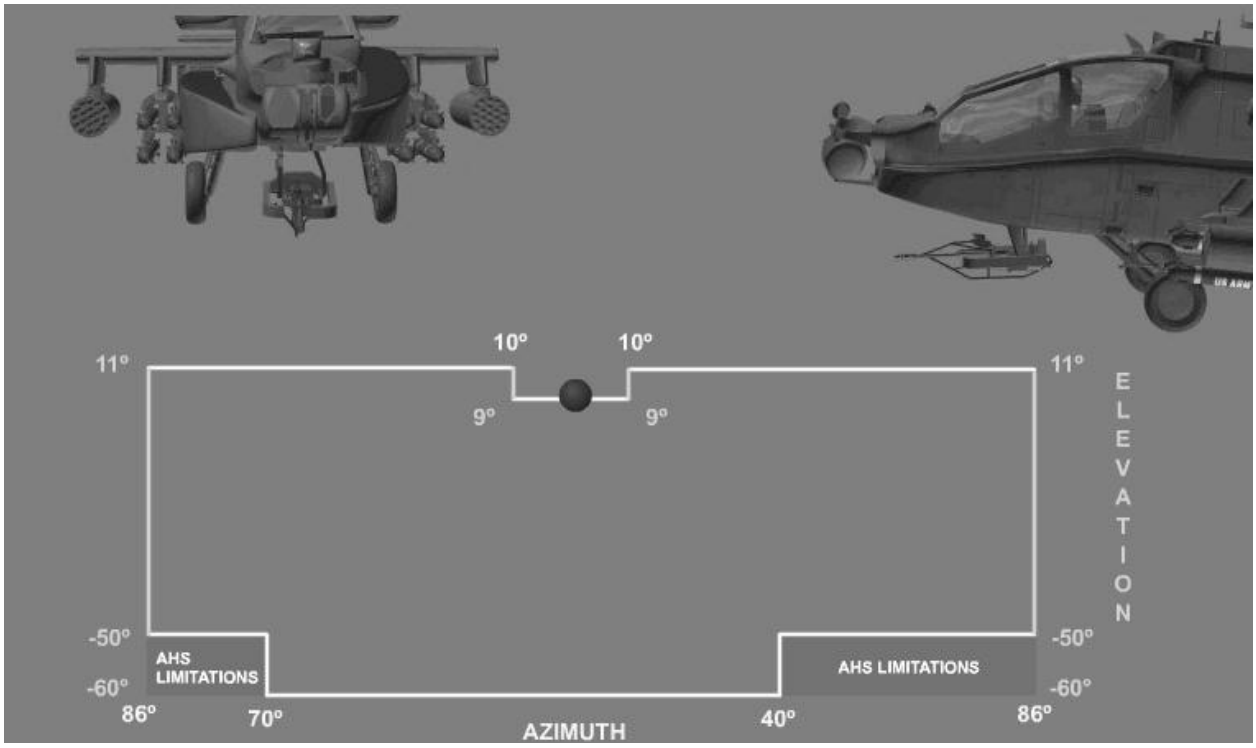

Figure 17. Gun Azimuth and Elevation Limits 2

(2) Azimuth and elevation limits for the gun turret assembly when the gun is actioned with the aircraft off the ground.

(a) Azimuth

1) 86º left and right of aircraft centerline above –50º depression

2) 70º left and 40º right of aircraft centerline between –50º and –60º depression

(b) Elevation

1) +9º within 10º left and right of aircraft centerline

2) +11º from 10º left and right of centerline to 86º left and right of aircraft centerline

(c) Depression

1) –50º between 86º left and right of aircraft centerline

2) –60º between 70º left and 40º right of aircraft centerline

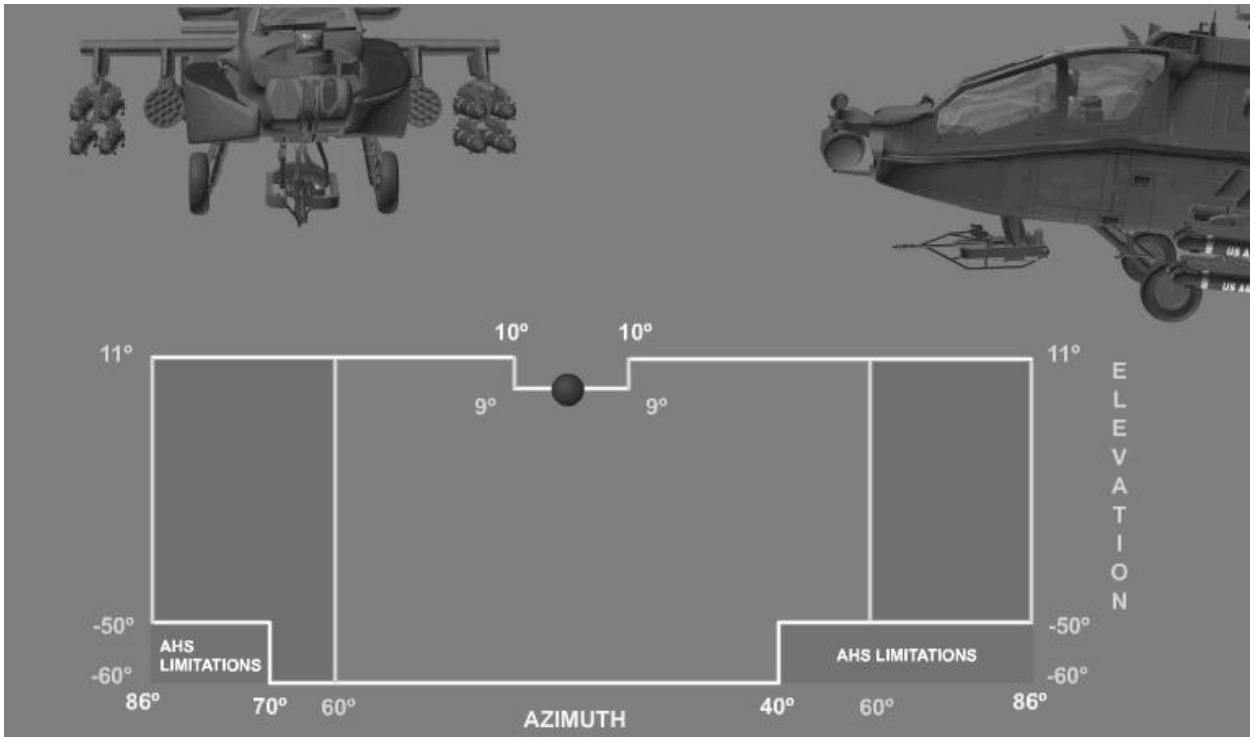

Figure 18. Gun Azimuth and Elevation Limits 3

(3) Azimuth and elevation limits for the gun turret assembly when the gun and rockets are simultaneously actioned with rockets loaded on the inboard pylons.

(a) Azimuth

1) 60º left of aircraft centerline and 60º right of aircraft centerline above -50º depression.

2) 40º right of aircraft centerline between –50º and –60º depression

(b) Elevation

1) +9º within 10º left and right of aircraft centerline

2) +11º from 10º left and right of centerline to 86º left and right of aircraft centerline

(c) Depression. –60º between 60º left of aircraft centerline and 40º right of aircraft centerline

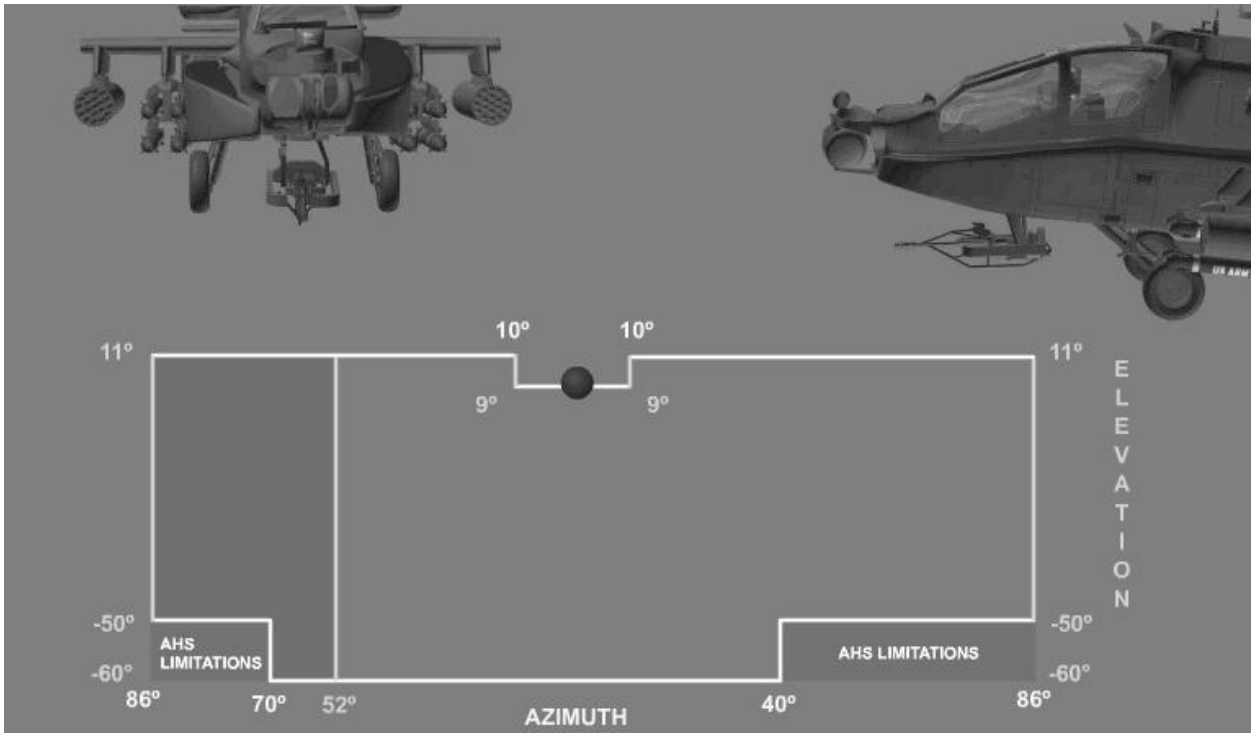

Figure 19. Gun Azimuth and Elevation Limits 4

(4) Azimuth and elevation limits for the gun turret assembly when the gun is actioned with the next-to-shoot missile on the inboard rail of the left inboard launcher.

(a) Azimuth

1) 86º left of aircraft centerline and 52º right of aircraft centerline above -50º depression

2) 70º left of aircraft centerline between –50º and –60º depression

3) 40º right of aircraft centerline between –50º and –60º

(b) Elevation

1) +9º within 10º left and right of aircraft centerline

2) +11º from 10º left and right of centerline to 86º left and right of aircraft centerline

(c) Depression

1) –50º between 70º and 86º left of aircraft centerline.

2) –50º between 40º and 52º right of aircraft centerline

3) –60º between 70º left of aircraft centerline and 40º right of aircraft centerline

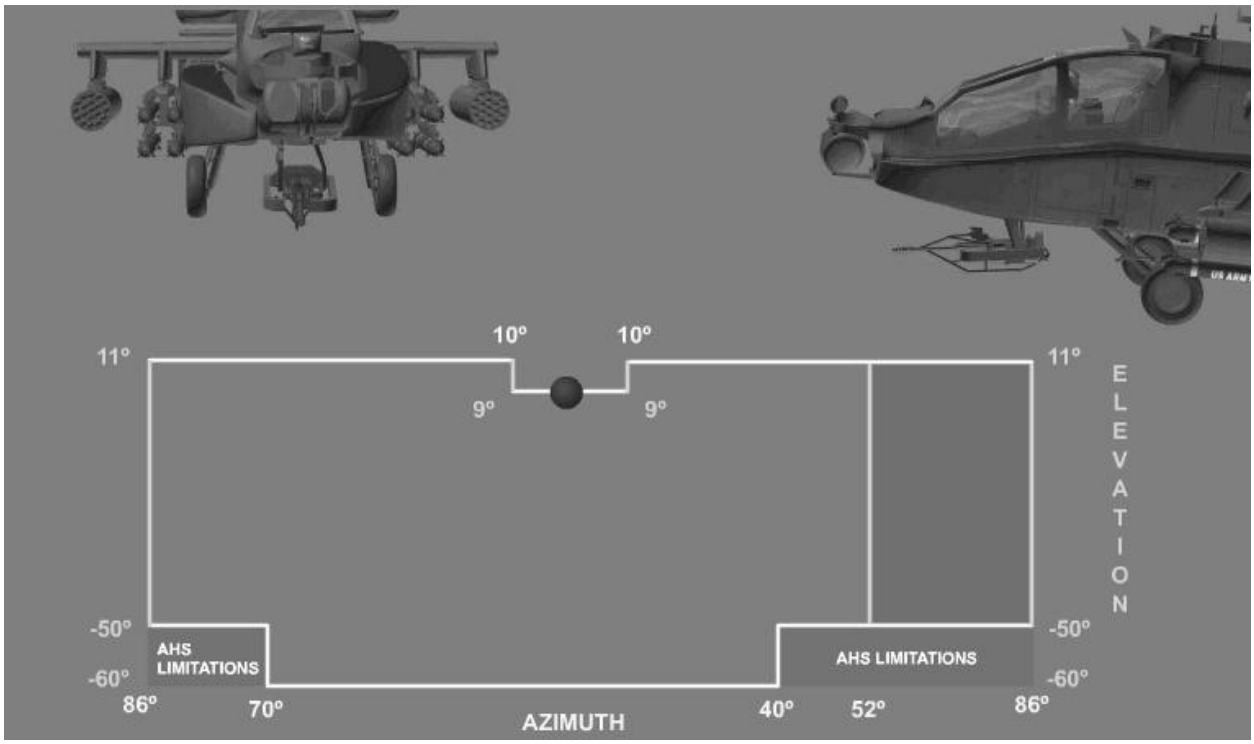

Figure 20. Gun Azimuth and Elevation Limits 5

(5) Azimuth and elevation limits for the gun turret assembly when the gun is actioned with the next-to-shoot missile on the inboard rail of the right inboard launcher.

(a) Azimuth

1) 52º left of aircraft centerline and 86º right of aircraft centerline above -50º depression

2) 52º left of aircraft centerline between –50º and –60º depression

3) 40º right of aircraft centerline between –50º and –60º

(b) Elevation

1) +9º within 10º left and right of aircraft centerline

2) +11º from 10º left and right of centerline to 86º left and right of aircraft centerline

(c) Depression

1) –60º between 52º left of aircraft centerline and 40º right of aircraft centerline.

2) –50º between 40º and 86º right of aircraft centerline

CHECK ON LEARNING

1. In the event of low hydraulic fluid or pressure and/or the loss of electrical power, the stow spring will position the gun cradle and gun to what position in elevation?

ANSWER: _____

_____

2. What are the Azimuth and Elevation limits of the gun turret assembly while on the ground with the GND ORIDE button selected ON?

ANSWER: _____

_____

C. ENABLING LEARNING OBJECTIVE 4

ACTION: Identify the purpose and location of major components of the AH-64D M230E1 30mm automatic gun.

CONDITIONS: Given a written test without the use of student notes or references.

STANDARD: In accordance with TM 1-1520-251-10, TC 1-251, FM 3-04.140 (FM 1-140).

1. Learning Step/Activity 1

Identify the purpose and location of major components of the AH-64D M230E1 30mm automatic gun.

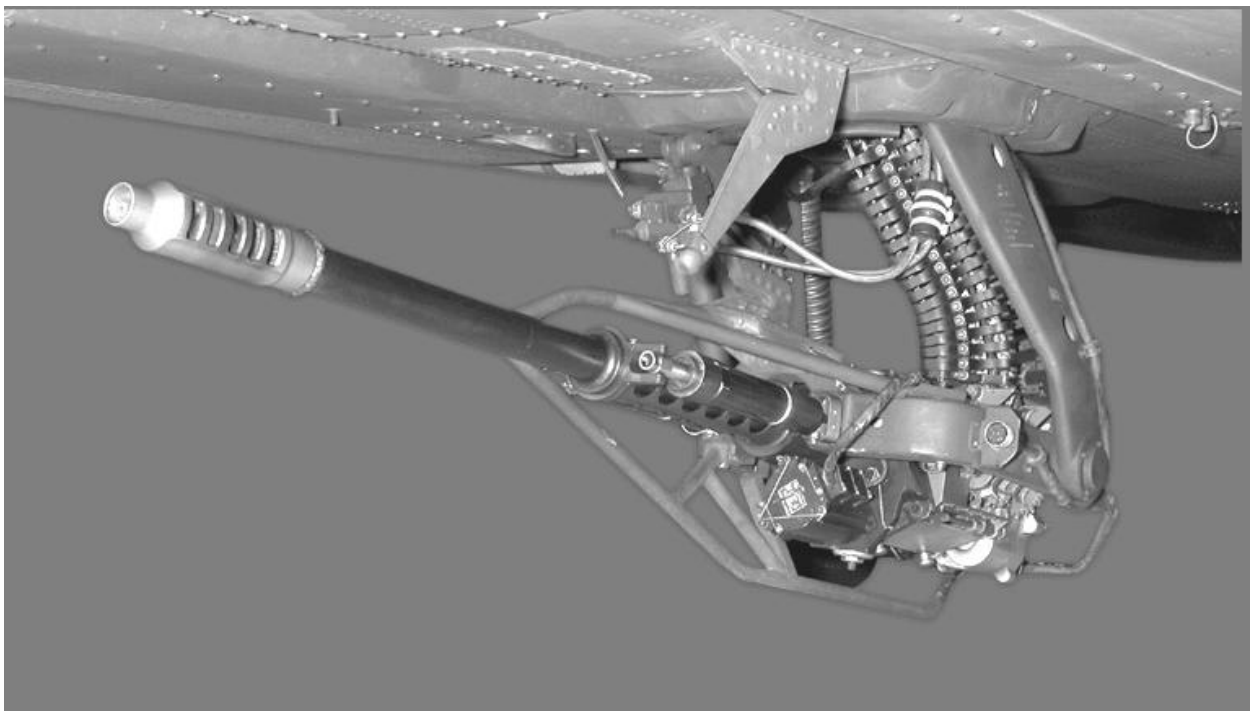

Figure 21. M230E1 30mm Automatic Gun.

a. M230E1 30mm automatic gun

(1) Purpose. The M230E1 30mm automatic gun was developed for use as an area weapon to neutralize or destroy light armor vehicles.

(2) Location. Mounted in the gun cradle of the turret assembly.

(3) Description. The M230E1 30mm automatic gun is a chain-driven, electrically fired, single-barrel, 30mm weapon.

(a) M230E1 30mm automatic gun characteristics:

1) Weight = 110 lb

2) Range (maximum ballistic solution) = 4200 m

3) Range (maximum effective) = 1500 to 1700 m

4) Rate of fire = 625 ±25 rpm (rounds per minute)

5) Time to rate = 0.2 seconds

6) Time to stop = 0.1 seconds

7) Clearing method = open bolt

8) Misfire = cycle through

9) Muzzle velocity = 2640 fps (feet per second)

10) Barrel life = 25,000 rounds

(b) M230E1 30mm automatic gun duty cycle

1) The purpose is to limit the amount of rounds fired in a specific time period to reduce heat damage to the barrel.

2) Failure to adhere to the published gun duty cycle may result in a catastrophic failure, loss of aircraft, injury or death.

3) The duty cycle is six 50-round bursts with 5 seconds between bursts, followed by a 10-minute cooling period.

4) Burst settings other than 50, the duty cycle can be generalized to mean that no more than 300 rounds are fired within 60 seconds before allowing the gun to cool for 10 minutes after which the cycle may be repeated.

5) If 300 or more rounds have been fired in the preceding ten minutes, and a stoppage occurs, personnel must remain clear of the aircraft for 30 minutes. Aircraft crewmembers should remain in the aircraft and continue positive gun control.

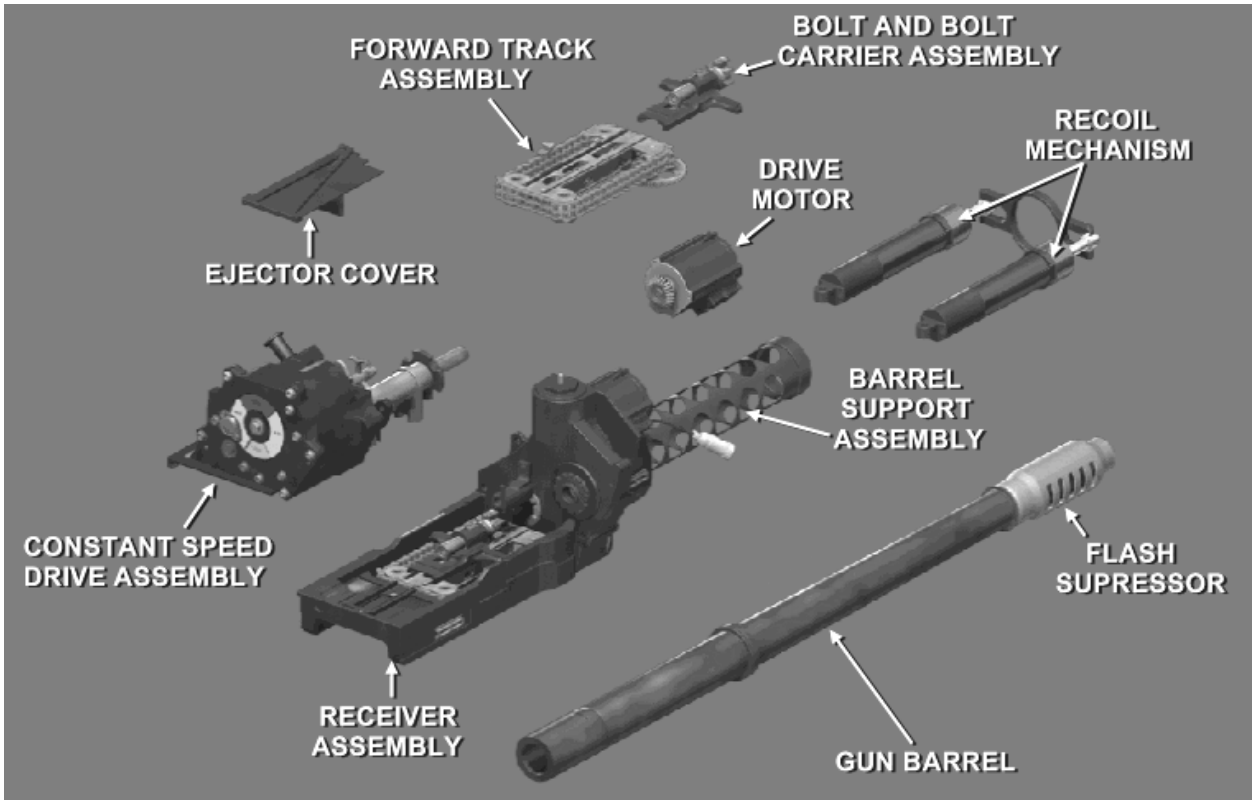

Figure 22. M230E1 30mm Automatic Gun Components (Exploded View)

(4) M230E1 30mm automatic gun major components

(a) Receiver assembly

1) Purpose. Provides attachment points and support for all gun components.

2) Location. Mounted to the gun cradle assembly.

3) Description. The receiver is made of aluminum and is the mounting point for the drive motor, barrel, barrel support, and index drive assembly.

(b) Constant speed drive assembly

1) Purpose. Ensures proper ammunition feed from the transfer housing of the feed assembly and in turn feeds the ammunition to the bolt face.

2) Location. Mounted on the bottom aft section of the receiver.

(c) Drive motor

1) Purpose. Provides primary drive to the index drive assembly and forward chain drive assembly.

a) The motor also drives the gun bolt assembly to the open-bolt position after firing using dynamic braking.

2) Location. Attached to the receiver at the left front, below the barrel support assembly.

3) Description. The drive motor is a 3 horsepower, 115 Vac, 3-phase, 400 Hz, electric motor that runs at a maximum 11,500 rpm.

(d) Forward track assembly

1) Purpose. Drives the bolt carrier assembly; a slider mounted on a link of one of the roller chains converts the rotational movement of the track assembly to the fore-and-aft movement of the bolt carrier.

2) Location. Mounted inside the receiver above the index drive assembly.

(e) Bolt and bolt carrier assembly

1) Purpose. Cycles the bolt aft to allow a round to feed into the receiver then cycles forward to ram the round into the barrel, locks the bolt, fires the round, unlocks the bolt, and cycles aft to extract the empty casing.

2) Location. Mounted to the forward track assembly.

(f) Gun barrel

1) Purpose. Provides the chamber for the round and imparts a clockwise spin on the projectile when fired.

2) Location. Secured to the front of the receiver by an integral barrel lug and a receiver T-shaped locking pin.

3) Description. The barrel weighs approximately 30 pounds and has a suppresser mounted to the forward end to reduce muzzle blast pressure and flash.

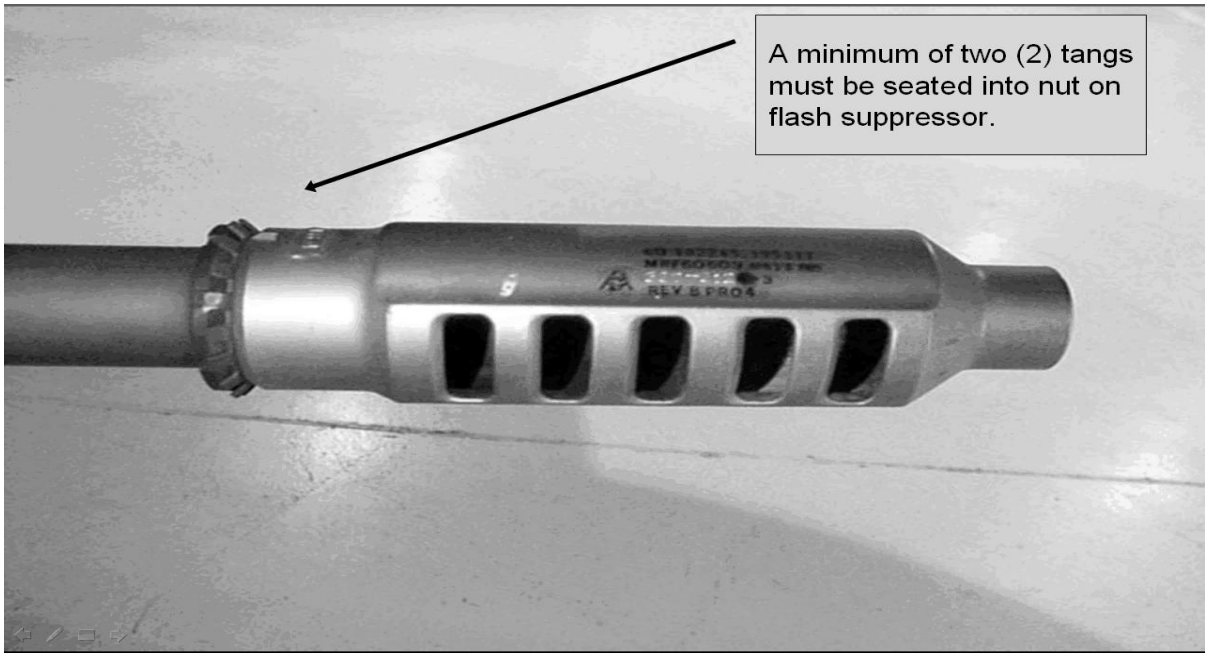

Figure 23. Flash Suppressor

(g) Barrel support assembly

1) Purpose. Supports the barrel at the midpoint and provides a mounting surface for the recoil mechanism clamps.

2) Location. Attached to the front of the receiver.

3) Description. Holes in the assembly provide cooling of the barrel.

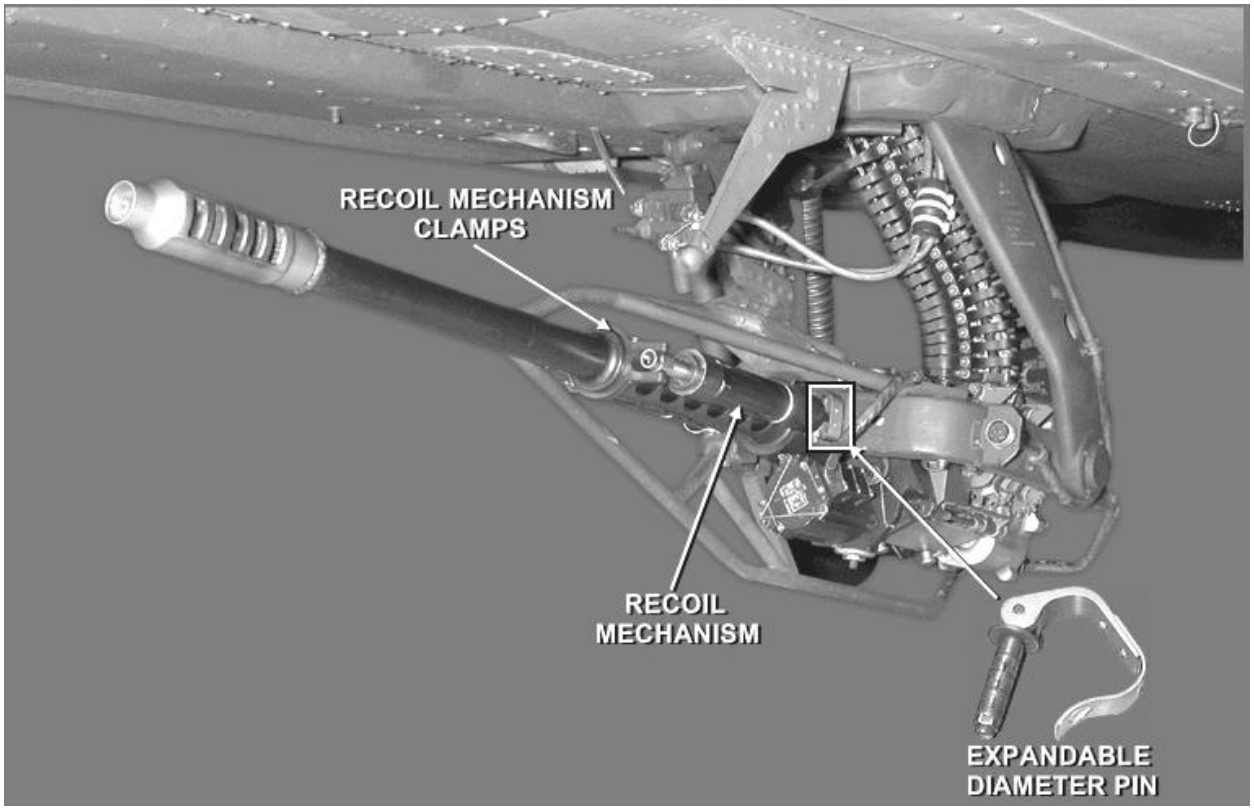

Figure 24. Recoil Mechanism and Clamp Assemblies

(h) Recoil mechanism and clamp assembly

1) Purpose. Retain the gun in the gun cradle and absorb the recoil force when the gun is fired.

2) Location. The recoil mechanism clamps secure the two recoil mechanisms to the forward end of the gun barrel support. Expandable diameter pins secure the aft end of each mechanism to the gun cradle assembly.

3) Description. Hydraulic filled cylinders that utilize spring compression and fluid displacement to absorb gun recoil.

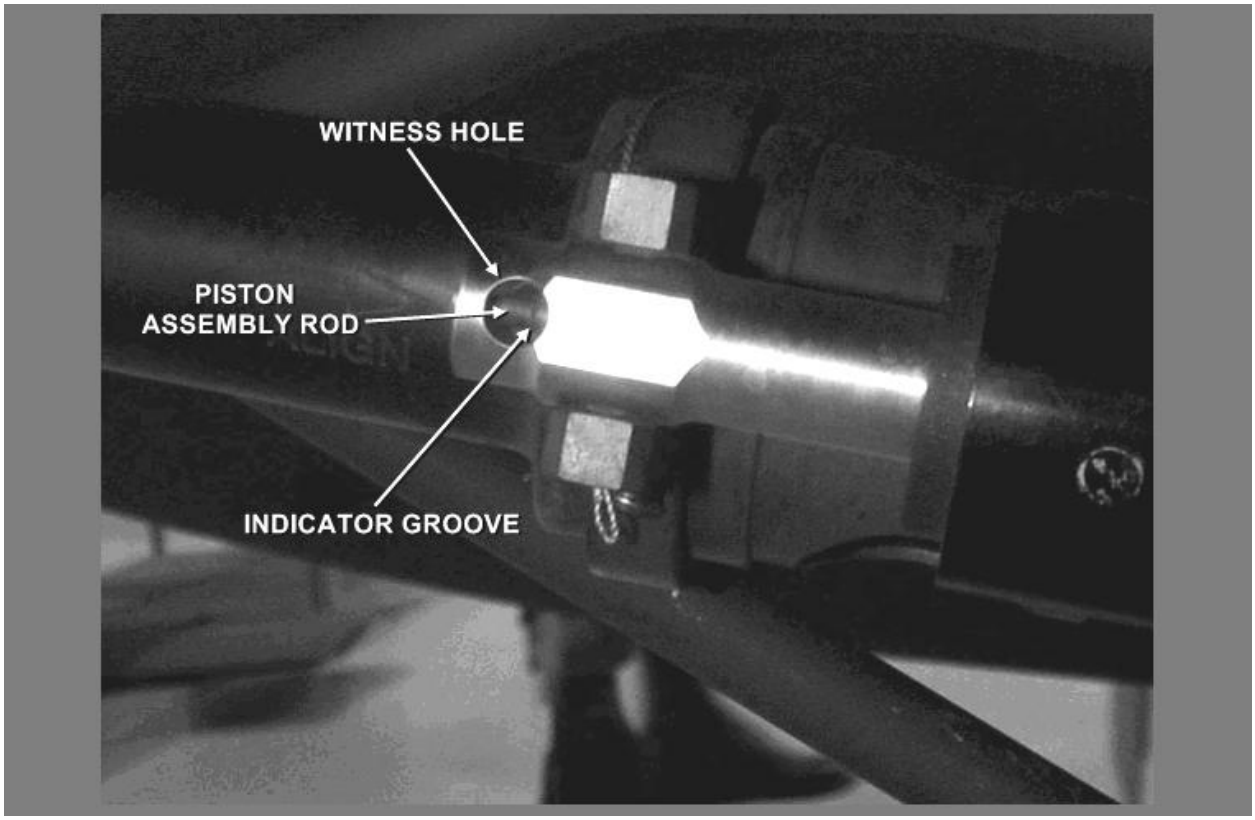

Figure 25. Recoil Mechanism Servicing

a) Proper servicing of the cylinders can be checked at the witness holes at the front of each cylinder.

b) The indicator groove on the piston assembly rod should be within the witness hole.

CHECK ON LEARNING

1. What is the maximum effective range of the M230E1 automatic gun?

ANSWER: _____

_____

2. What component drives the gun bolt assembly to the open-bolt position after firing using dynamic braking?

ANSWER: _____

_____

3. What is the maximum ballistic solution of the M230E1 automatic gun?

ANSWER: _____

_____

4. What is the cyclic rate of fire for the M230E1 automatic gun?

ANSWER: _____

_____

5. What is the gun duty cycle of the M230E1 automatic gun?

ANSWER: _____

_____

_____

_____

_____

D. ENABLING LEARNING OBJECTIVE 5

ACTION: Identify the location and function of the AH-64D AWS MIL-STD 1553B serial data Multiplexer (MUX) bus interface components.

CONDITIONS: Given a written test without the use of student notes or references.

STANDARD: In accordance with student handout materials, TM 1-1520-251-10, and TC 1-251.

1. Learning Step/Activity 1

Identify the location and function of the AH-64D AWS MIL-STD 1553B serial data Multiplexer (MUX) bus interface components.

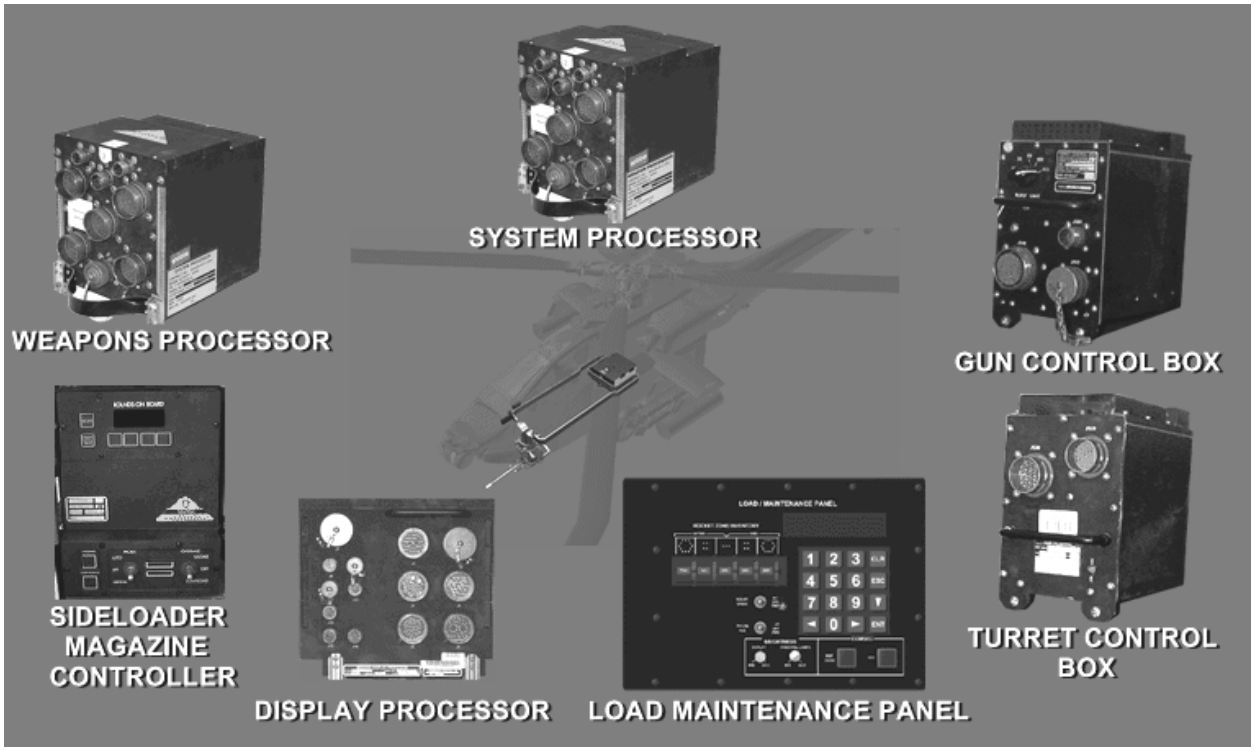

Figure 26. AWS MUX Interface Components

a. The integration of the AWS subsystems, their controls and displays, and crew interaction are performed by the MUX.

b. MUX interface components used to operate the AWS

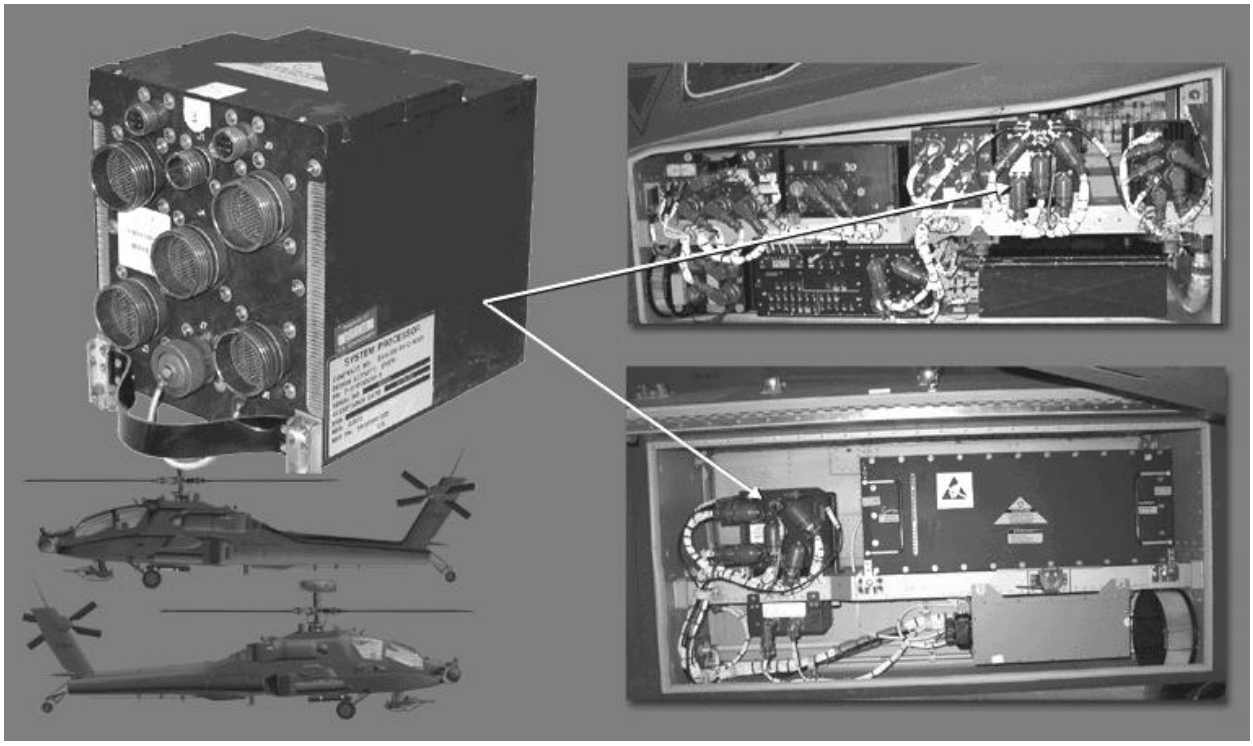

Figure 27. System Processors (SP)

(1) System Processor (SP)

(a) Purpose. The primary SP serves as the bus controller of MUX channels 1 and 2. It also controls the application of weapon primary and arm power based on the armament panel ARM/SAFE (A/S) and GROUND OVERRIDE (GND ORIDE) switch inputs, aircraft squat switch status, and arm power requests received from the Weapons Processor (WP).

(b) Location. SP No. 1 is located in the forward portion of the left EFAB, and SP No. 2 is located in the aft portion of the right EFAB.

(c) Description. The SPs are redundant.

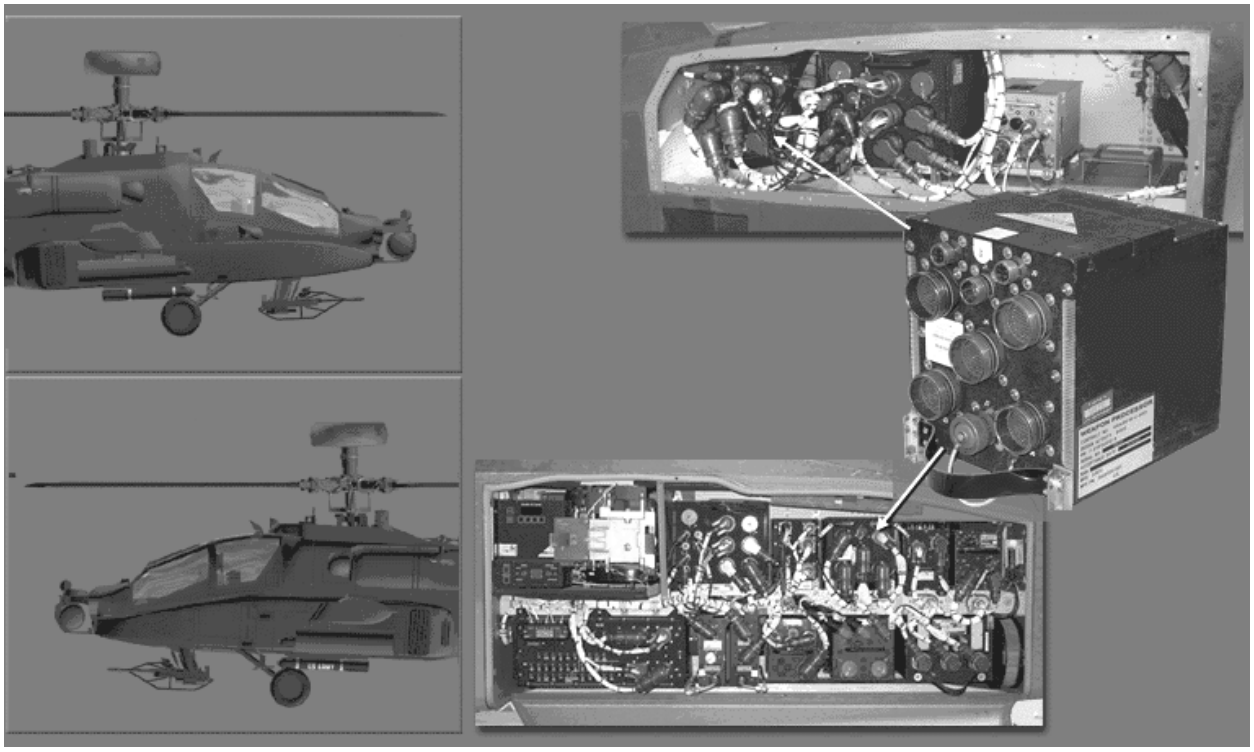

Figure 28. Weapons Processors (WP)

(2) Weapons Processors (WP)

(a) Purpose. The primary WP serves as bus controller on MUX channel 3.

1) The WP provides primary control and management of the AWS and digital data flow to and from the SP.

2) The WP performs gun cueing, gunfire control, munitions inventory, AWS Built-In-Test (BIT) functions, and constraints processing for weapon performance and safety inhibits.

3) The WP also performs the ballistic processing for the AWS.

a) The fire control equations used by the WP compensate for gravity, wind effects, range, and air density and temperature.

b) These equations are based on data from the Embedded Global Positioning Inertial Navigation System (EGI), Air Data System (ADS), and selected sight and range source.

4) Supplementary ballistic processing by the WP significantly enhances AWS accuracy.

a) The Target State Estimator (TSE) is a seven-state Kalman filter that utilizes aircraft rates and velocities from the EGIs, the Target Acquisition and Designation Sight (TADS) Line of Sight (LOS) vector, TADS angular velocity, pre-processed laser range from the laser range

validator, and TADS Tactical Electronic Display And Control (TEDAC) thumb force controller inputs to derive actual target velocities.

b) The target predictor derives lead compensation offsets based on target velocities from the TSE and munitions time of flight. The TSE is bypassed if the Fire Control Radar (FCR) is used as the LOS.

c) The Laser Range Validator (LRV) processes raw laser range data from the TADS and corroborates the range profile prior to its use by the TSE or fire control algorithms.

d) The wind filter derives actual surface wind values using longitudinal and lateral wind data from the ADS in conjunction with aircraft velocities.

e) Boresight compensation algorithms apply correctors measured using the Captive Boresight Harmonization Kit (CBHK). This compensation addresses errors introduced by mechanical misalignment of weapon and sight stations to the armament data.

f) Fuselage bending compensation applies correction to the pointing solution to address structural deformation between the sight and weapon stations under varying G-load conditions.

g) Gun turret bending compensation is applied to the pointing errors associated with sustained recoil. The compensation value is dependent upon gun angle and is applied after the first round is fired.

h) Parallax compensation is applied to the pointing solution to address physical offsets between sights and weapons stations.

i) Moment arm compensation is employed to translate velocities sensed by the EGIs to weapon, sight, and ADS moment arms.

j) Reversionary processing is employed when data used in ballistic calculations is deemed invalid. The EGIs and ADS pass detailed data validity status to the WP.

(b) Location. WP No. 1 is located in the center section of the left EFAB, and WP No. 2 is in the forward portion of the right EFAB.

(c) Description. The WPs are redundant.

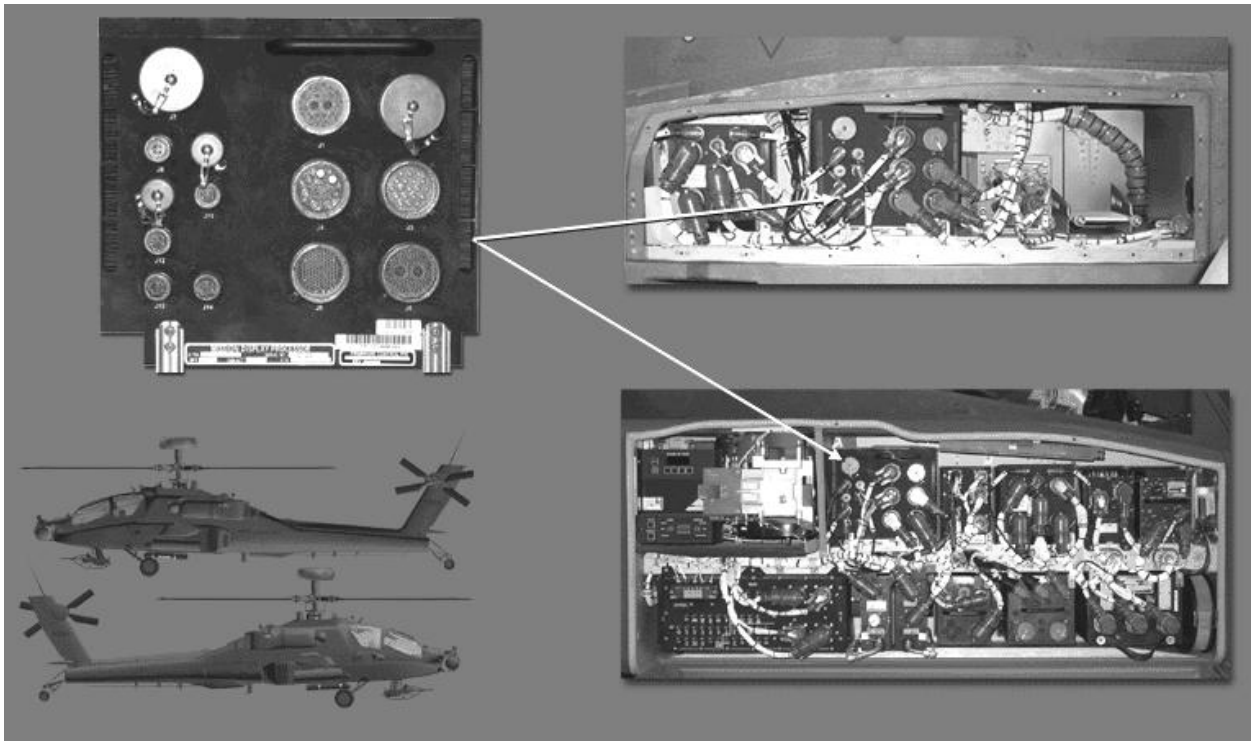

Figure 29. Display Processors (DP)

(3) Display Processor (DP)

(a) Purpose. The DPs process and distribute symbology and video to the crewstation, Multipurpose Displays (MPDs), TEDAC, and Integrated Helmet And Display Sight System (IHADSS). The DPs also process data to and from the keyboard units, MPD bezel buttons, and cursor controllers.

(b) Location. DP No. 1 is located in the midsection of the left EFAB, and DP No. 2 is located in the forward portion of the right EFAB.

(c) Description

1) The DPs are not completely redundant; both DPs must be functional to operate the four MPDs independently.

2) If one DP fails, the remaining functional DP will support the operation of two MPD formats at each crewstation.

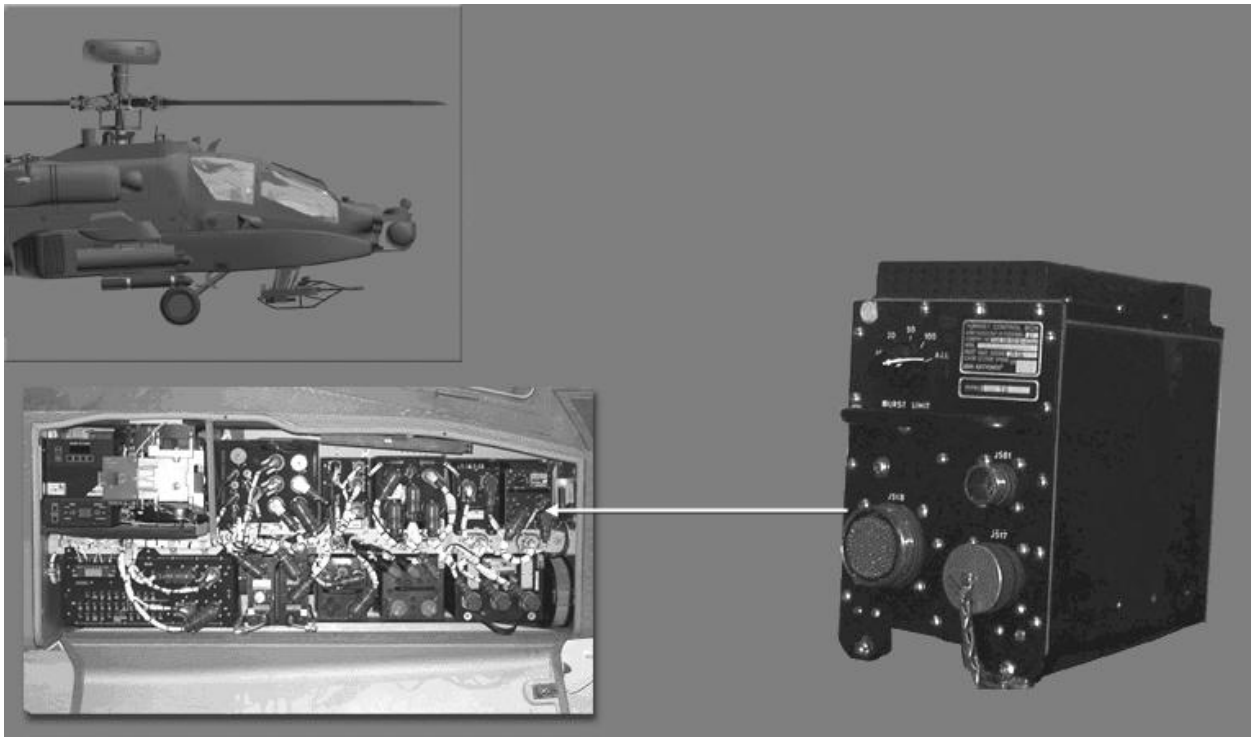

Figure 30. Turret Control Box (TCB)

(4) Turret Control Box (TCB)

(a) Purpose. The TCB serves as the gun turret assembly controller.

(b) Function

1) Outputs arming and firing signals from the SP to the gun control box.

2) Outputs turret positioning commands from the WP to the turret azimuth drive and the elevation actuator.

3) Processes bolt position status from the gun control box to derive rounds decrement during firing.

(c) Location. The TCB is located in the right EFAB.

(d) Description. The TCB is specific to the AWS and is not a redundant processor.

1) A BURST LIMIT switch is located on the TCB. The switch establishes the maximum number of rounds that may be fired with each trigger pull.

2) The selections are 10, 20, 50, 100, and ALL.

NOTE: Ensure the BURST LIMIT switch on the TCB is in the ALL position. If the BURST LIMIT switch is less than the MPD WPN page burst limit selection, the gun will fire the number of rounds selected on the TCB, then fail. Recycling AWS power on the WPN UTIL page will clear this failure until the next trigger pull.

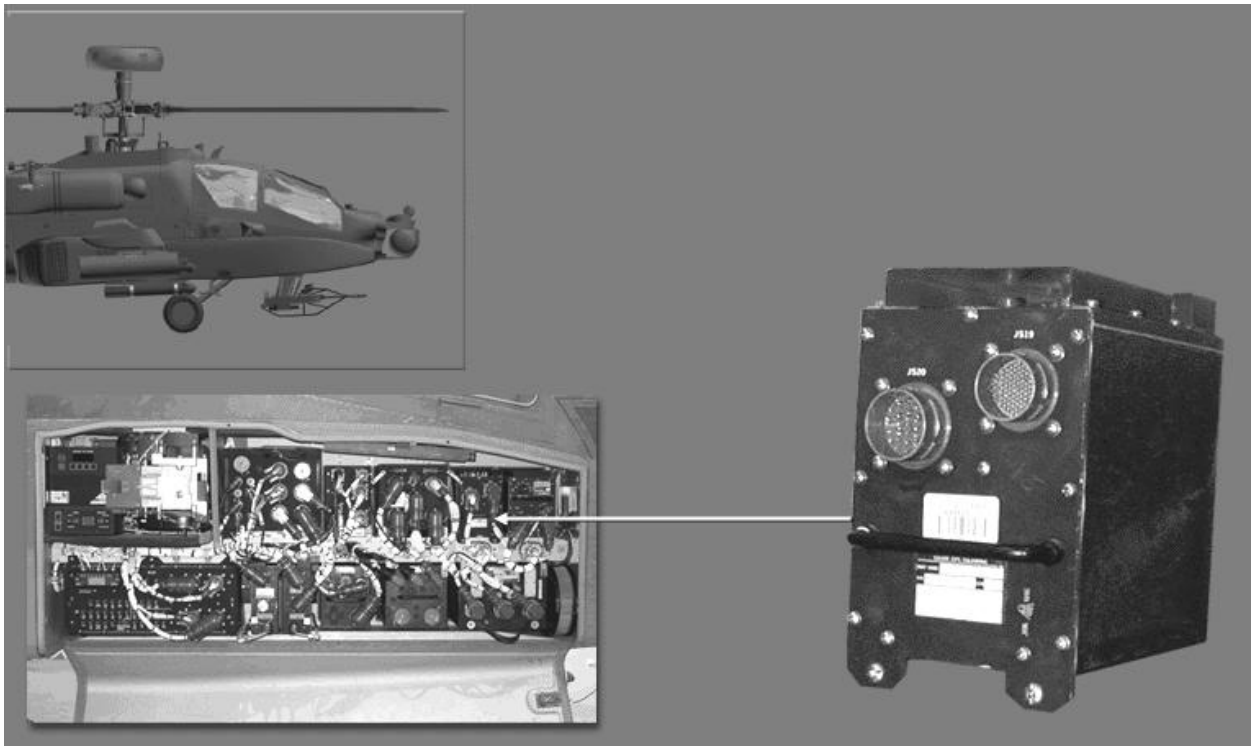

Figure 31. Gun Control Box (GCB)

(5) Gun Control Box (GCB)

(a) Purpose. The GCB provides power to the gun drive motor to cycle the gun during a firing sequence and provides the electrical pulses to fire the ammunition.

(b) Function (trigger release)

1) When the fire signal is removed (trigger released), the GCB stops voltage to the gun firing circuits.

2) Then the GCB terminates gun cycling by removing 3-phase AC power, rectifying one phase of the switched 115 Vac power to 28 Vdc, and applying it to the gun drive motor creating dynamic braking. The bolt stops in the open-bolt position, optimizing safety.

(c) Location. The GCB is located in the forward portion of the right EFAB.

(d) Description. The GCB is specific to the AWS and is not a redundant processor.

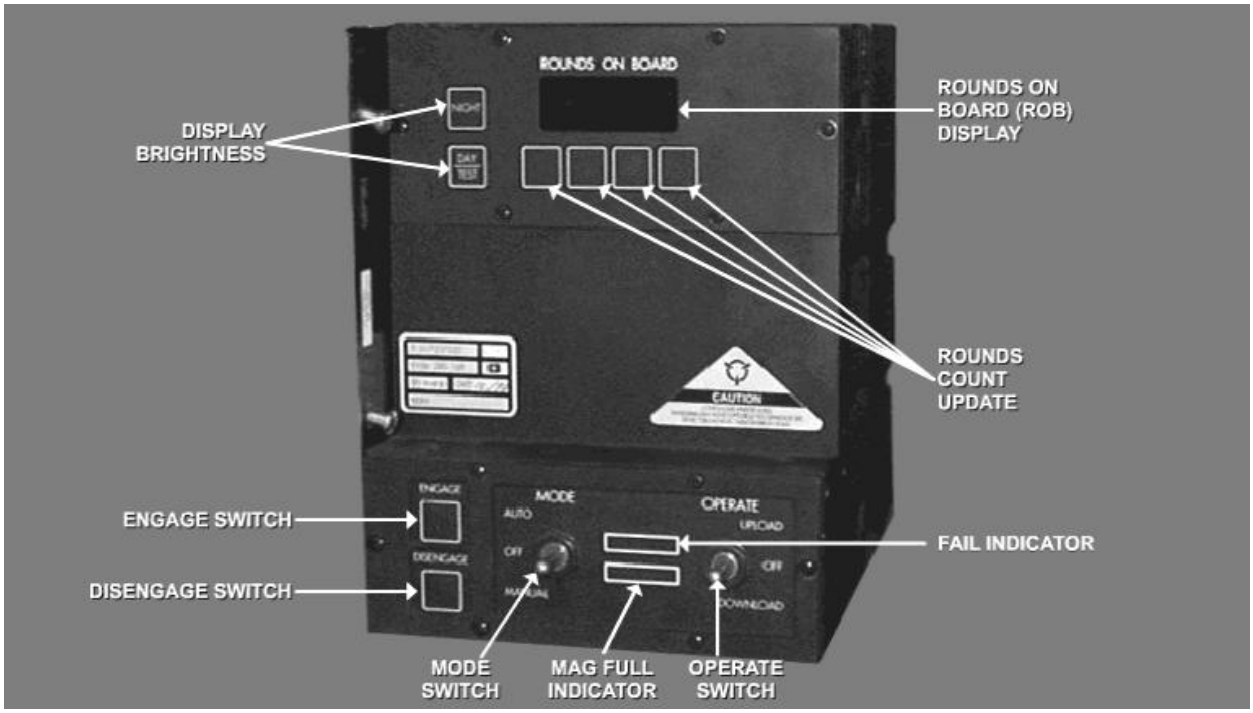

Figure 32. Side Loader/Magazine Controller (S/MC)

(6) Side Loader/Magazine Controller (S/MC)

(a) Purpose. The S/MC provides the interface link between the TCB, carrier drive, left and right tensioners, side loader, and weapons processors.

(b) Function

1) The magazine controller monitors the tensioners for unequal tension during uploading, downloading, and firing and will increase or decrease carrier drive motor speed to equalize the tension on the ammunition feed conveyor assembly.

2) The magazine controller stops the carrier drive motor when firing is ceased.

3) The magazine controller also provides dynamic rounds-count information to the WP for munitions inventory. Rounds count is obtained from the side loader loadhead during up/downloading and from the TCB during gun firing.

(c) Operation. The S/MC operational interface is grouped into five functional areas

1) Lighting functions

The lighting function provides illumination of the displays for day and night operations. The night mode has five different intensities . A momentary press of the DAY/TEST button provides maximum display lighting intensity for direct sunlight. Pressing and holding the DAY/TEST button for longer than 3 seconds will initiate

a lamp test routine to confirm all lighting circuits are functional.

2) Rounds count management

   a) The rounds on board display provides rounds count and fail code information. Fail codes will override rounds count.

   b) The four rounds-count update buttons are used to manually edit displayed numeric values of rounds count. This data is not displayed in the AWS GUN icon. This must be entered via the LOAD / MAINTENANCE PANEL (LMP) or LOAD page.

3) Loader switching. Provides for the automatic set-up and shutdown of loading operations.

4) Mode switch. The magnetically latched MODE switch selects either the Automatic (AUTO) or the MANUAL mode of operation. In the OFF position, all other switches are inactive.

5) Operate switch

   a) The magnetically latched OPERATE switch selects the direction of operation, either UPLOAD or DOWNLOAD.

   b) Normal mode of operation:

      1 MODE switch AUTO.

      2 Latch the OPERATE switch in the UPLOAD position.

      3 Load switch ENGAGE.

      4 Feed rounds strips onto loading tray.

   c) The Magazine Full (MAG FULL) indicator will illuminate when the magazine is full.

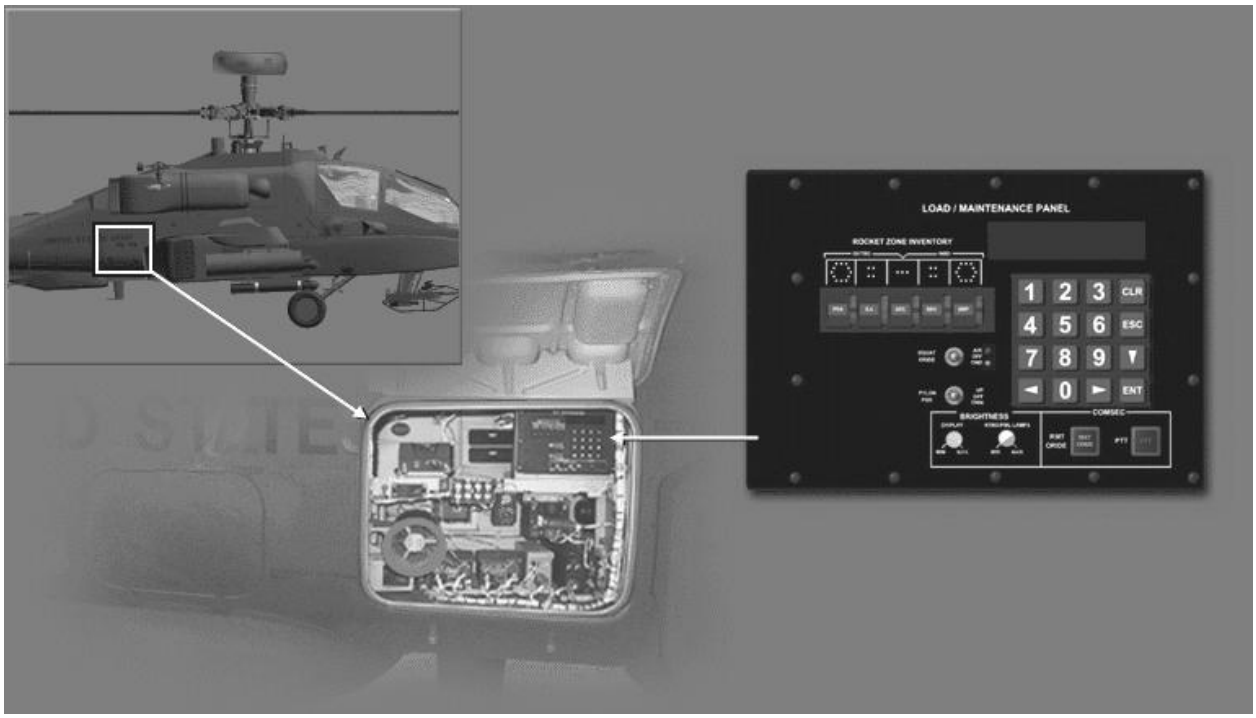

Figure 33. LOAD / MAINTENANCE PANEL (LMP)

(7) LOAD / MAINTENANCE PANEL (LMP)

(a) Purpose. The LMP provides the ground crew with the capability to manually enter and display AWS ammunition load data.

(b) Function

1) Interfaces with the crew MPDs through the SP and WP, providing the initial rounds count at aircraft power-up.

2) If no inputs are made on the LMP, the rounds count initialized at aircraft power-up will be the last rounds count at aircraft shutdown.

(c) Location. The LMP is located on the top shelf of the aft avionics compartment.

(d) Description. The LMP is a multifunctional panel that also interfaces with systems other then the AWS. Specific load functions are accessed through the LMP keyboard, referencing the menu display.

CAUTION:

The LMP incorporates a SQUAT ORIDE switch. There is no indication in the cockpit when the SQUAT ORIDE switch is in the AIR position. If the switch is placed in the AIR position while the aircraft is on the squat switch (wheels on the ground), the ground safety limits for gun depression are overridden and, if actioned, the gun could be driven into the ground.

CHECK ON LEARNING

1. What processor provides constraints processing for weapon performance and safety inhibits?

ANSWER: _____

_____

2. What processes the bolt position status data from the Gun Control Box (GCB) to derive rounds decrement during firing?

ANSWER: _____

_____

E. ENABLING LEARNING OBJECTIVE 6

ACTION: Identify the purpose, location and function of the controls and displays of the AH-64D AWS.

CONDITIONS: Given a written test without the use of student notes or references.

STANDARD: In accordance with TM 1-1520-251-10, and TC 1-251.

1. Learning Step/Activity 1

Identify the purpose, location and function of the controls and displays of the AH-64D AWS.

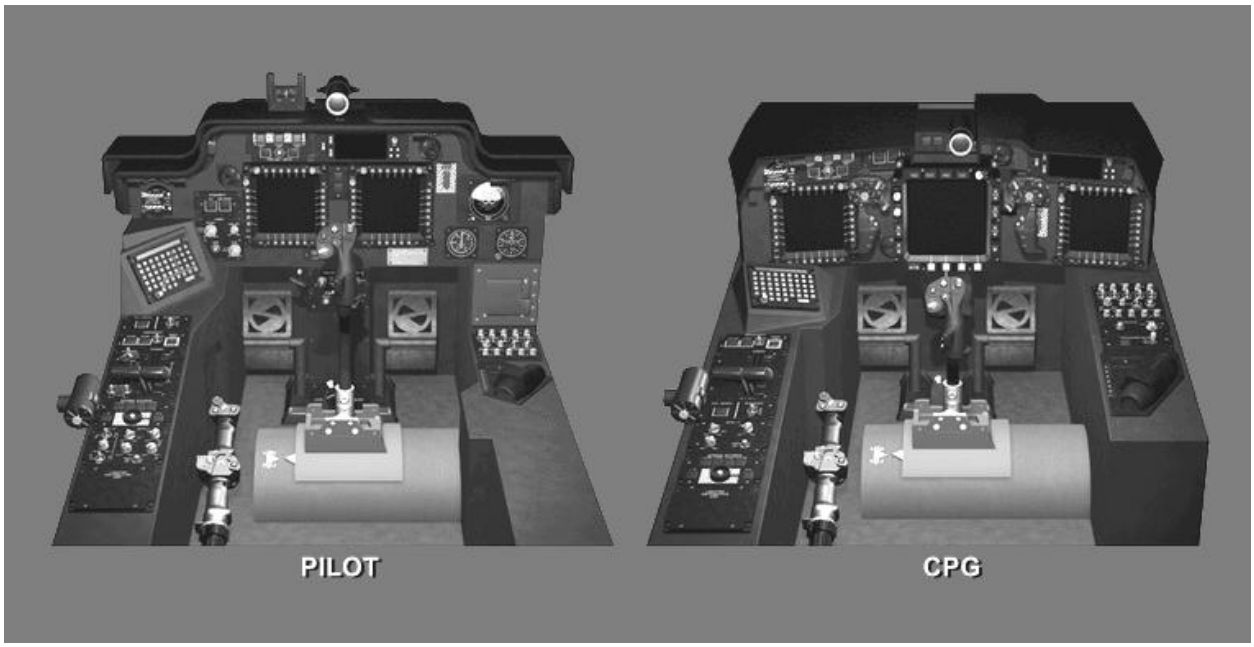

Figure 34. Crewstations

a. Crewstation design provides a logical means for the crew to quickly select, control, mode, and fire the AWS. To increase mission effectiveness and reduce crew workload, various controls, information displays, and MPD pages are used.

b. Controls common to all weapon systems are as follows.

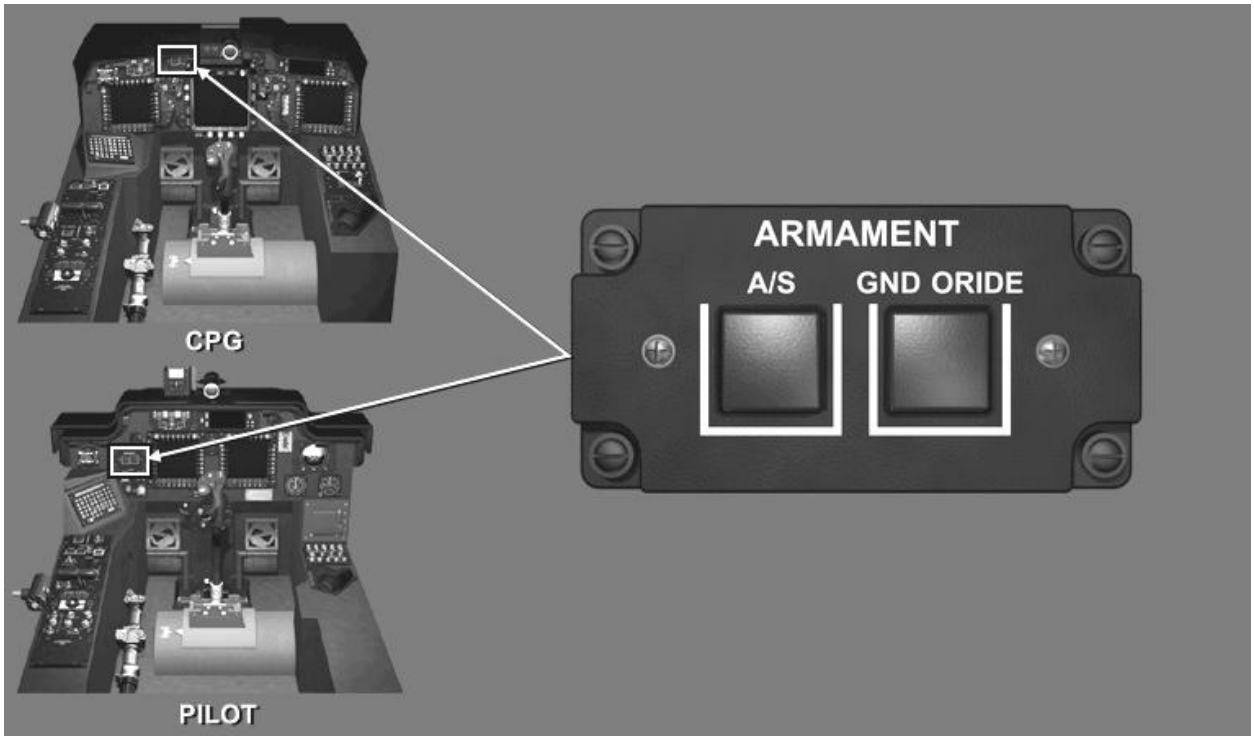

Figure 35. ARMAMENT Panel

(1) ARMAMENT panel

(a) Purpose. The ARMAMENT panel is used to select the aircraft ARM/SAFE (A/S) status.

(b) Location. There is an ARMAMENT panel in each crewstation.

(c) Description. The panel has two push buttons, an A/S button and a Ground Override (GND ORIDE) button.

1) The SAFE position illuminates in green and enables all weapons related switches except the triggers. The aircraft initializes in the SAFE mode on power-up.

2) The ARM position illuminates in yellow and enables all trigger functions. Pressing the A/S button will alternately ARM and SAFE the Weapon System when the aircraft is in the air.

3) The GND ORIDE button ON position illuminates in green and overrides aircraft squat switch inhibits to allow arming of the Weapon System when the aircraft is on the ground.

4) ARMAMENT panel selections are aircraft common. A selected status will be displayed in both crewstations.

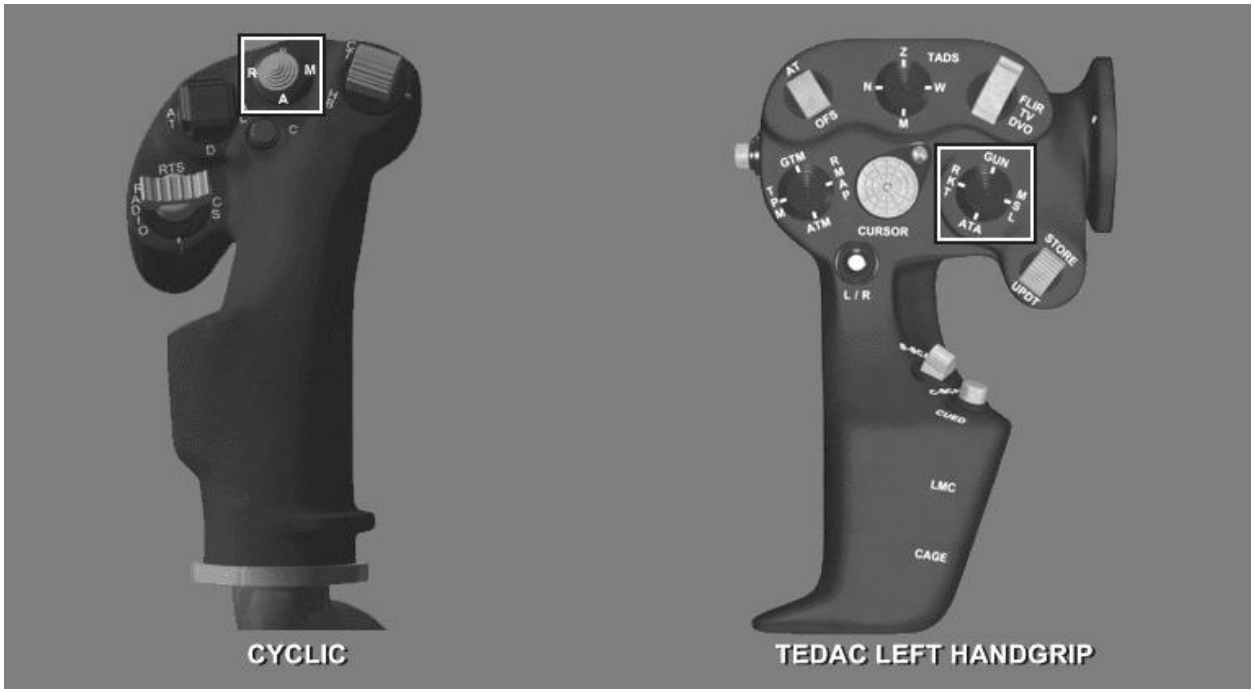

Figure 36. Weapon Action Switches (WAS)

(2) Weapon Action Switch (WAS)

(a) Purpose. The WAS are used to select (action) a weapon system for operation from a specific crewstation.

(b) Location. WAS is located on both cyclics and on the TEDAC Left Handgrip (LHG).

(c) Description

1) The WAS is a five-position spring-loaded switch with the AWS position designated by a G on the cyclic WAS and GUN on the TEDAC LHG WAS.

2) The gun is selected, from any crewstation, at the 12 o'clock position of the WAS.

(d) Function. Placing the WAS momentarily to the desired position actions the weapon. Placing the WAS to the selected weapon again will deselect the weapon system. Actioning any other weapon position will deselect the current weapon and action the newly selected weapon.

1) The WAS used in the CPG station must be associated with the intended trigger.

a) If the weapon is actioned on the cyclic, the cyclic trigger must be used.

b) If the weapon is actioned on the TEDAC LHG, the trigger on the TEDAC LHG must be used.

2) The last crewmember to action the AWS will have control.

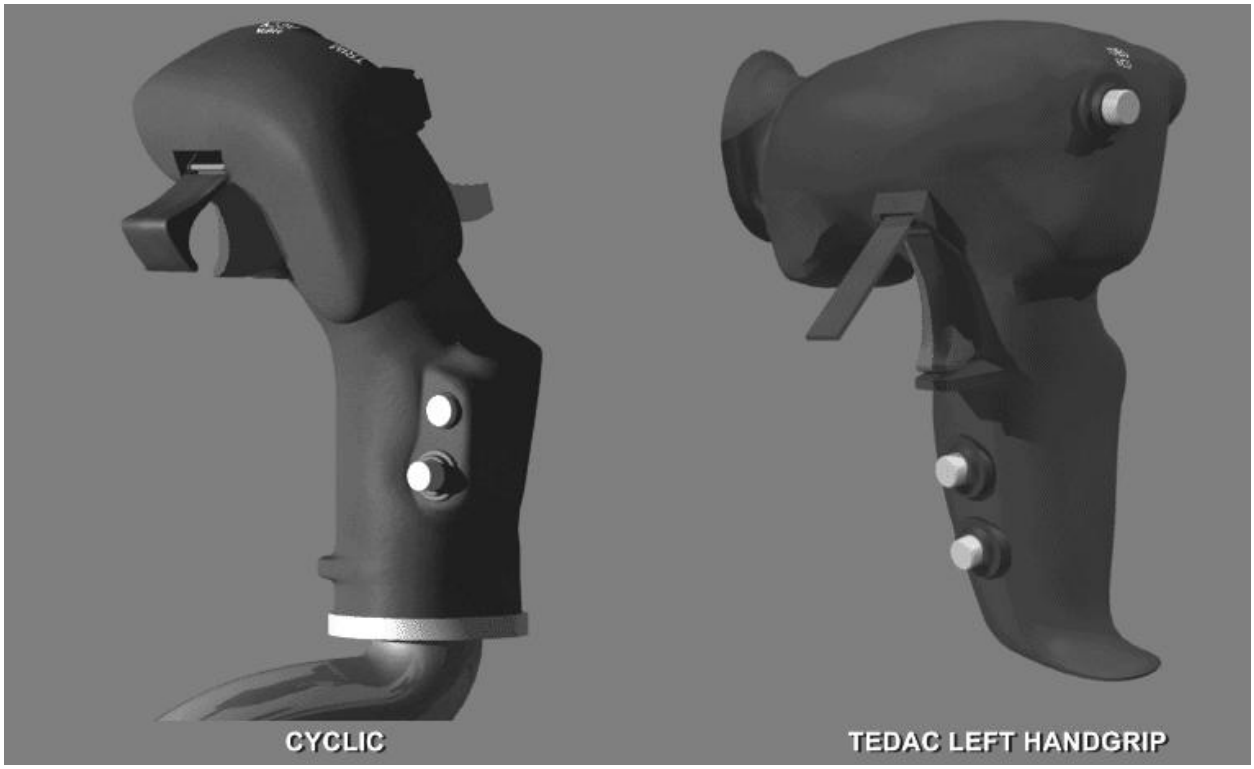

Figure 37. Weapons Triggers

(3) Weapons triggers

(a) Purpose. The weapons triggers are used to fire the selected weapon system.

(b) Location. The weapons triggers are located on both cyclics and on the TEDAC LHG.

(c) Description. The weapons triggers are two-position switches that are protected from accidental weapons firing by a cover which must be raised to gain access to the trigger.

(d) Function. The weapons triggers are active in a crewstation only when the ARM/SAFE switch is armed and a weapon has been actioned by that crewmember. Each trigger has two detents.

1) Pressing the trigger to the first detent will fire a weapon if no inhibits exist.

2) Pressing the trigger to the second detent will override weapon system performance inhibits and fire the weapon.

NOTE: Safety inhibits can never be overridden.

c. Information displays

(1) High Action Display (HAD)

(a) Purpose. The HAD provides weapons and sight employment information independently by crewstation.

(b) Location. The HAD is located at the bottom of the weapons and flight symbology formats.

(c) Description. The HAD is divided into eight status fields. Status fields specific to the operation of the AWS are the weapon control, weapon status, and weapon inhibit fields.

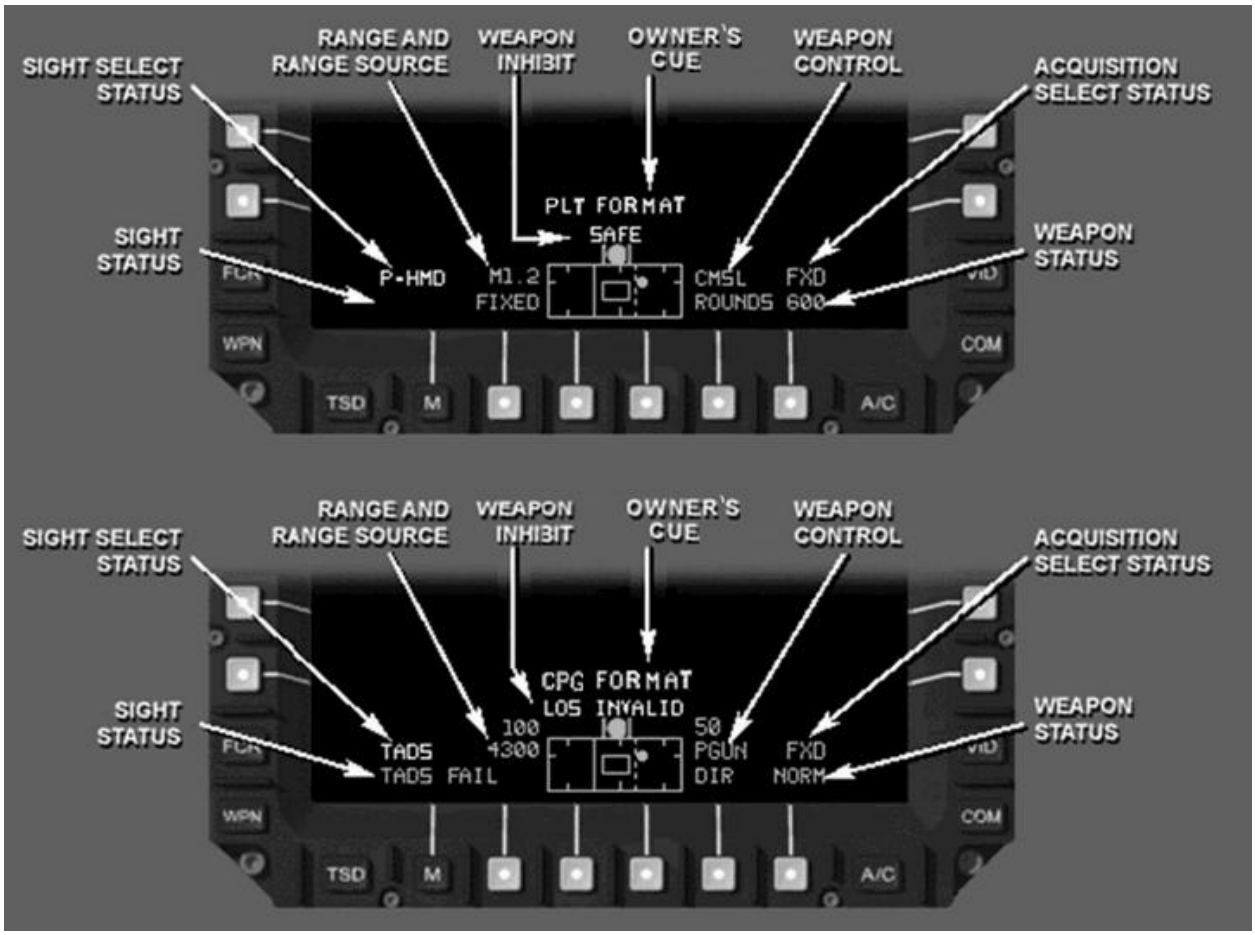

Figure 38. Pilot Actioned Gun

(d) Function

1) Normal operation

a) When the AWS is actioned in one crewstation that crewstation HAD will indicate the rounds inventory in the weapon status field. The opposite crewstation weapon status field will be blank if they do not have a weapon selected or will reflect their selected weapon status.

b) The weapon control status field of the crewstation that actioned the AWS will be blank if the other crewmember has not selected a weapon, or will reflect the other crewmember selected weapon. The opposite crewstation weapon control status field will indicate the crewmember who has control of the AWS.

c) The weapon inhibit status field will display SAFE when the AWS is actioned with the ARMAMENT panel in a SAFE status.

2) Safety and/or performance limits exceeded

a) The weapon inhibit status field provides an indication of safety or performance inhibits based on the selected weapon.

b) AWS safety and performance messages are:

1 Azimuth Limit (AZ LIMIT)

2 Elevation Limit (EL LIMIT)

3 Out of Coincidence (COINCIDENCE)

4 Line of Sight Invalid (LOS INVALID)

5 Alternate Launch (ALT Launch)

NOTE: In a degraded mode during single DP operation, the OWNER CUE, located above the weapons inhibit status field, will read “PLT FORMAT” or “CPG FORMAT.”

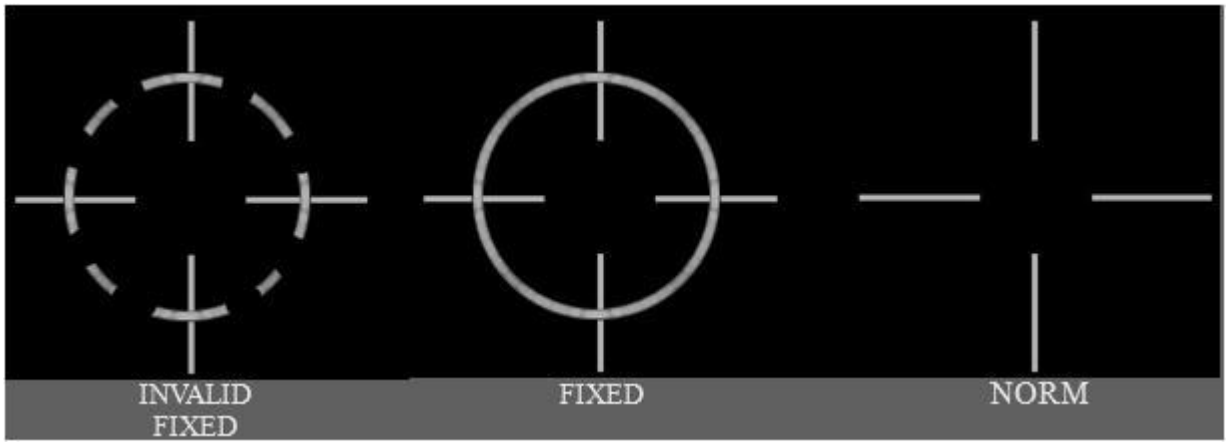

Figure 39. AWS Reticles

(2) AWS reticles

(a) Purpose. Unique AWS reticles are presented on the flight and weapon symbology formats to indicate weapon aiming points and status information.

(b) Description. There are two specific reticles used by the AWS.

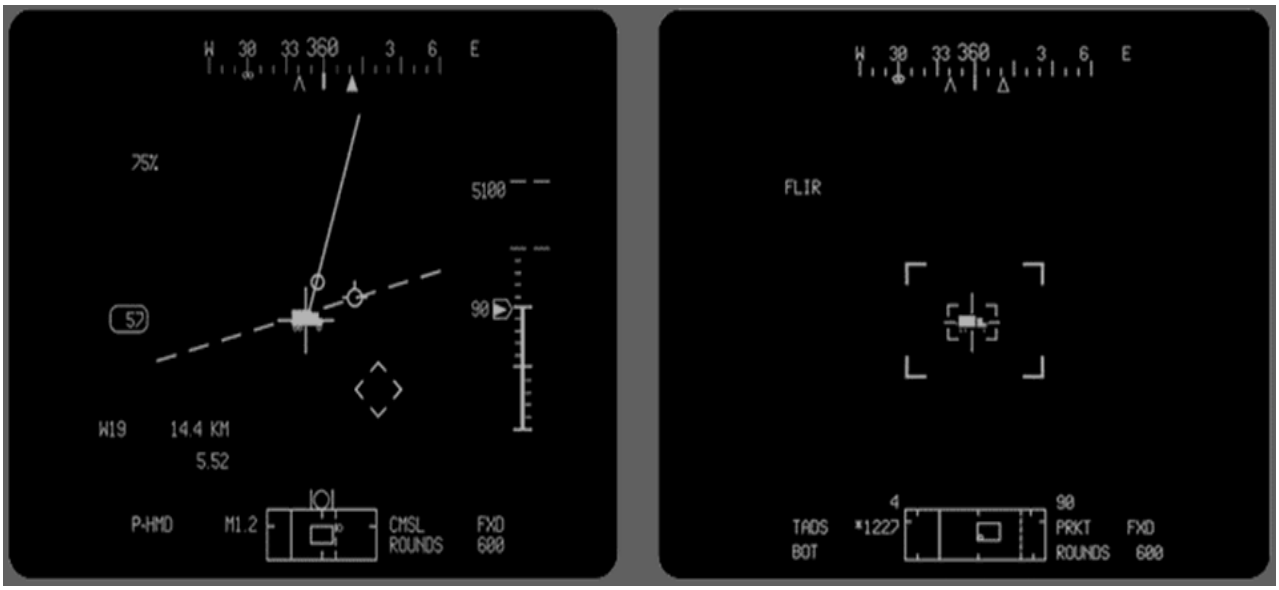

Figure 40. LOS Reticle

1) LOS reticle

   a) The LOS reticle represents the line of sight of the selected sight and is used to aim the gun during the NORM mode of operation.

   b) The reticle is a bold crosshair that is always present in the center of the flight and weapon symbology formats.

   c) The reticle will flash when the gun is selected and the gun system has failed.

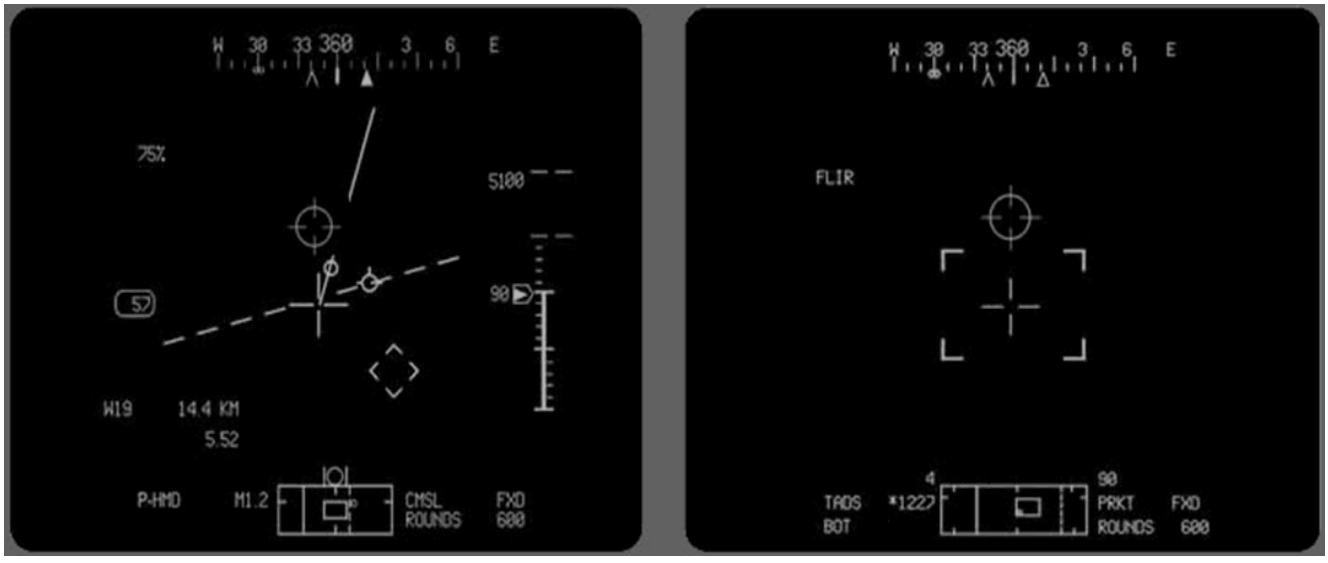

Figure 41. Fixed Gun Aiming Reticle.

2) Fixed gun aiming reticle

a) When fixed gun is selected, an LOS reticle, with a circle, is displayed representing the Continually Computed Impact Point (CCIP) or gun-target line.

b) The CCIP is used as an aiming reference by the person flying the aircraft. It indicates the direction to move the aircraft to adjust the gun target line to the target.

c) The reticle remains oriented in the symbology field to the centerline of the aircraft (0° azimuth) and represents a computed impact point for a selected range.

d) When fixed gun mode is in use, and the CCIP symbol is driven past the screen limit (if applicable), the CCIP symbol will reflect an invalid fixed gun reticle and no longer reflects rounds impact point.

e) With fixed gun mode in use, if TADS LOS and the TADS LOS is invalid, or other than WFOV FLIR is selected (CCIP symbols scaled for 1:1 only), the CCIP symbols shall reflect an invalid fixed gun reticle.

f) Modified gun firing inhibits permit firing of the AWS in fixed mode with an invalid IHADSS LOS.

g) Implementing the invalid IHADSS LOS as a performance inhibit in fixed gun mode requires the operator to override the inhibit via the weapon trigger second detent.

(3) MPD

(a) Purpose. The MPD is the means by which the crew interacts with the AWS.

(b) Location. There are two MPDs on each crewstation instrument panel.

(c) AWS-specific MPD pages.

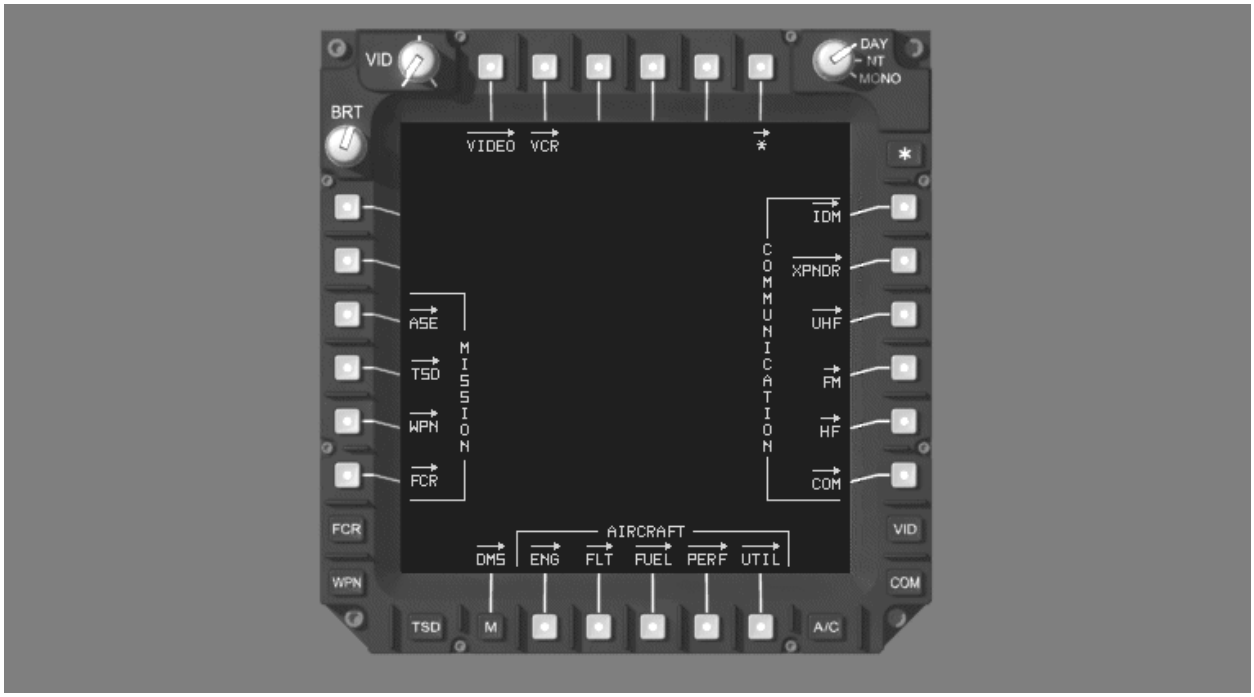

Figure 42. Data Management System (DMS) Menu Page

1) Access to the top-level WPN page can be accomplished two ways.

   a) Pressing the Weapon (WPN) Fixed Action Button (FAB).

   b) From the DMS Menu page, press the WPN Variable Action Button (VAB) button (L5) in the MISSION button group.

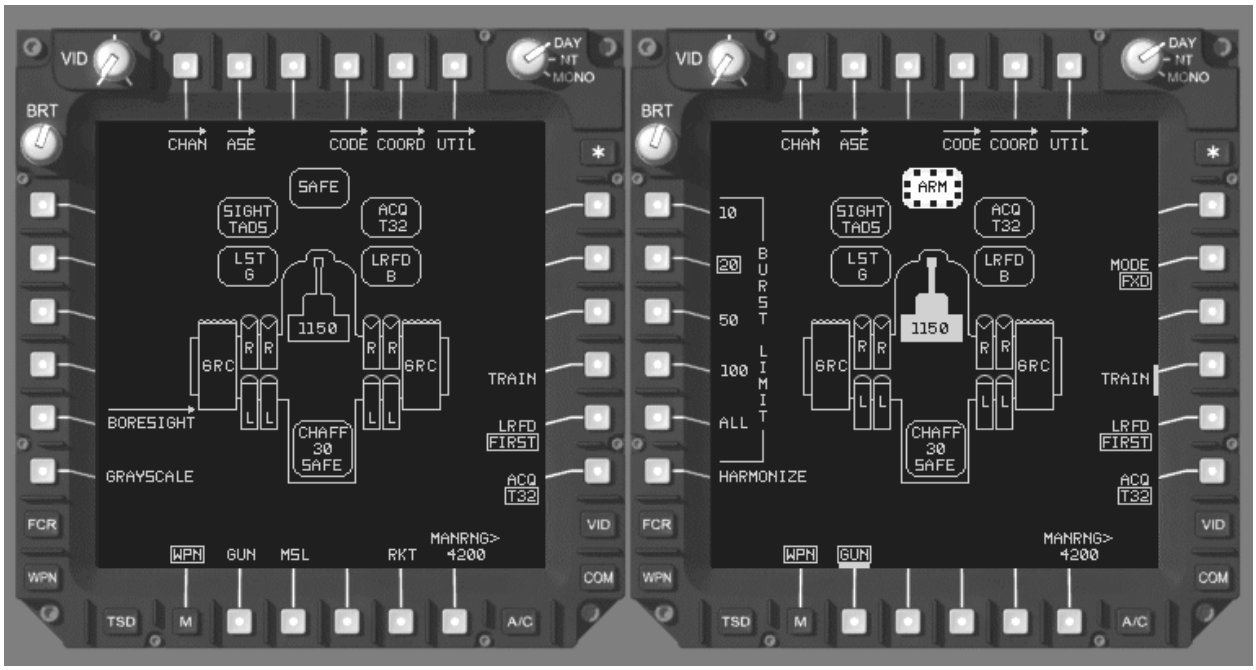

Figure 43. Weapon (WPN) Page

2) The WPN page contains various sight and weapons status windows, icons, and control selections. All are designed to reduce crew workload and enhance situational awareness.

a) GUN button (B2)

1 Selecting the GUN button causes the GUN label to become boxed and the gun icon to become inverse video.

2 AWS control groups BURST LIMIT, MODE, and HARMONIZE (CPG crewstation only) become available around the display edge.

3 The GUN button will be boxed and barriered, and no other weapon switches will be available when the AWS is actioned.

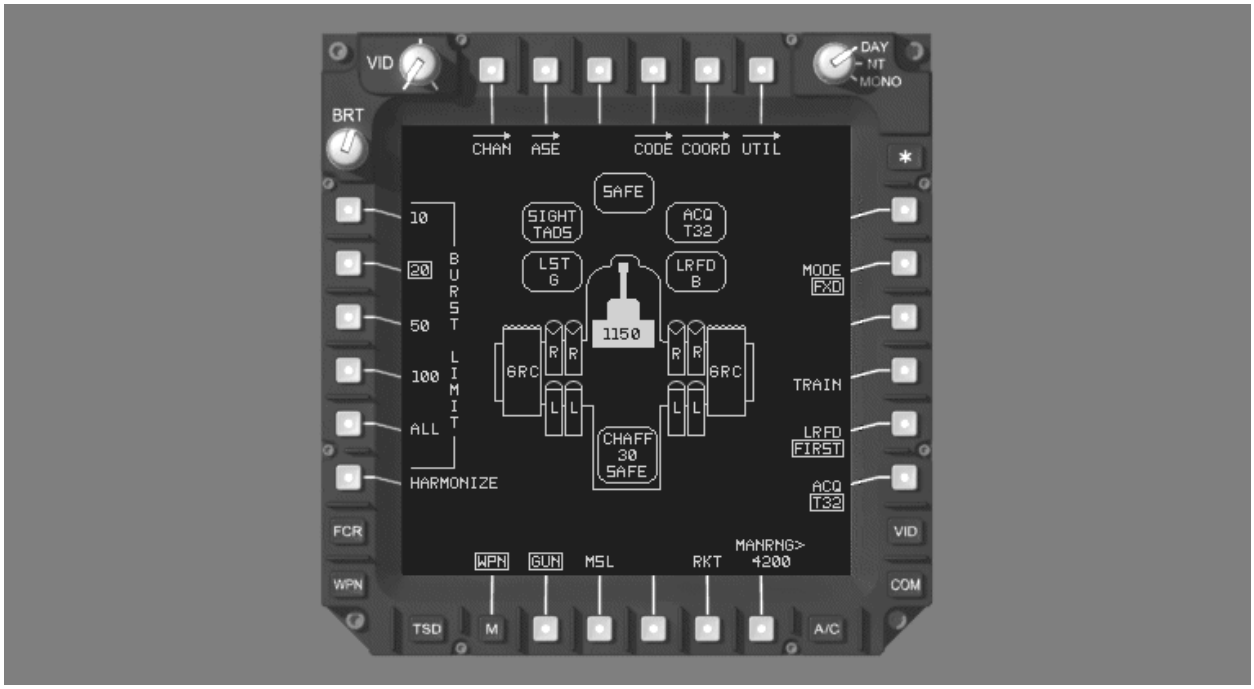

Figure 44. WPN Page, GUN Format

b) Gun icon

1 The rounds counter is displayed on the gun icon. The rounds count will decrease to reflect the number of rounds remaining as the gun is fired.

2 When all rounds have been fired, the gun icon will display 0.

3 If the AWS is detected to be in a failed state, the rounds counter will be replaced by a FAIL indicator displayed in yellow.

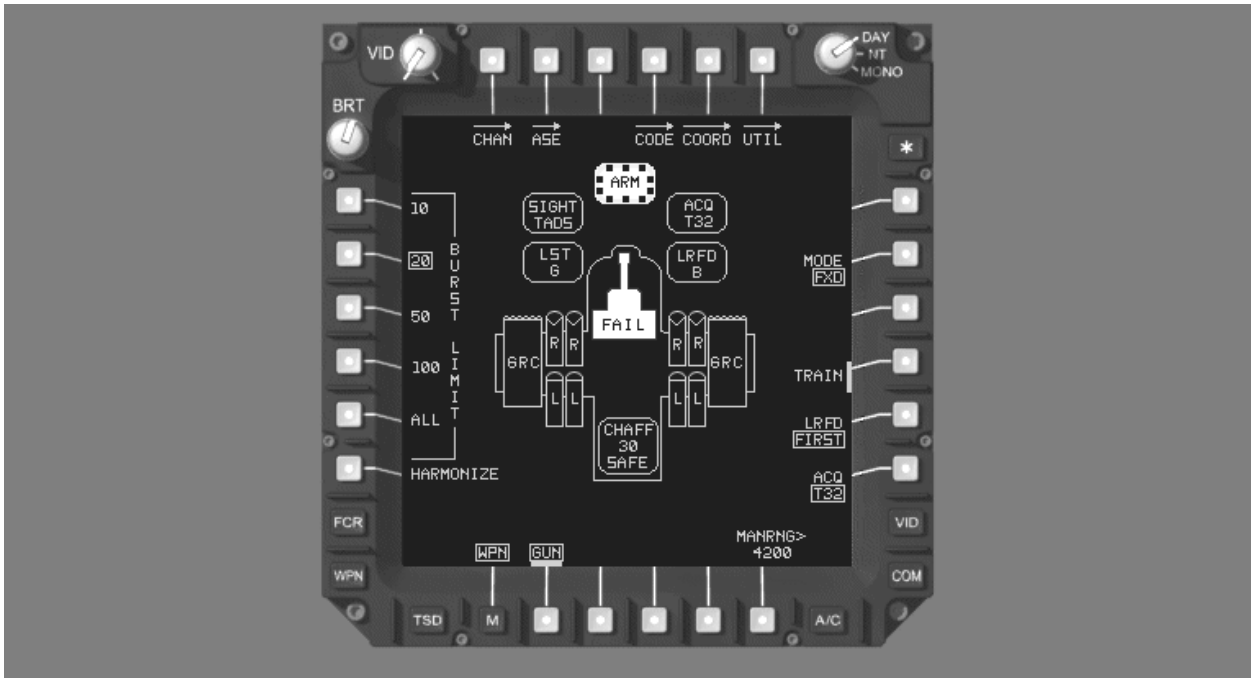

Figure 45. Gun Fail

c) The gun MODE button (R1) is used to select the operational modes normal or fixed for the AWS. The MODE selection is independent in each crewstation.

1 The Normal (NORM) mode allows the gun to follow the selected sight. The MODE defaults to NORM during aircraft power-up, unless a different setting is input via the Data Transfer Card (DTC).

2 The Fixed (FXD) mode fixes the gun to 0° azimuth and +0.87° elevation.

d) The BURST LIMIT button group (L1 through L5) defines the number of rounds to be fired with each trigger pull.

1 The BURST LIMIT selection is independent in each crewstation.

2 The burst selections are 10, 20, 50, 100 and ALL.

3 The BURST LIMIT defaults during aircraft power-up to 20 unless a different setting is input via the DTC.

e) The HARMONIZE button (L6) is used to select and perform the gun dynamic harmonization procedure. This procedure is available only to the CPG.

1 Gun harmonization develops correctors that the WP uses to correct mechanical

boresight errors when the gun is being fired in the normal mode.

2 Dynamic harmonization does not adjust or change the original CBHK values stored by the WP.

3 The dynamic harmonization correctors are stored separately in the non-volatile memory of the WP.

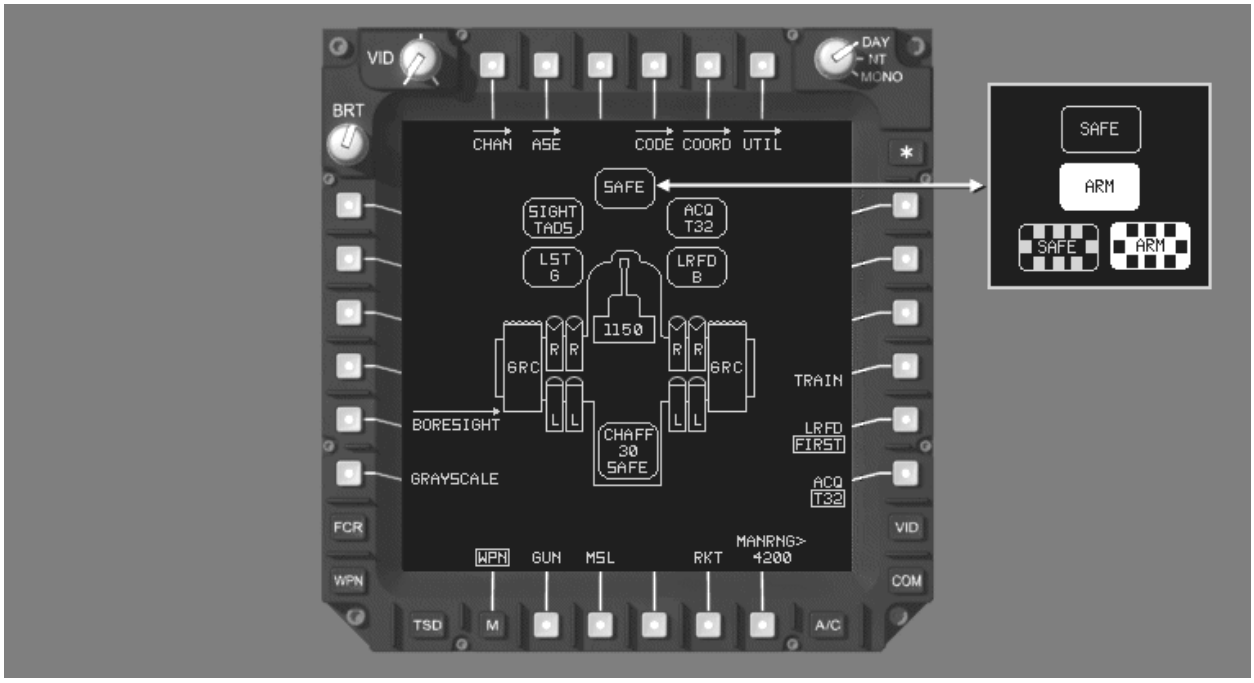

Figure 46. WPN Page Status Window

f) The ARM/SAFE status window indicates SAFE status in green and ARM status in an inverse yellow video.

1 The ARM/SAFE status window is aircraft common.

2 When a weapon is actioned, the ARM/SAFE status window border will have a “checkerboard” pattern applied in the crewstation where the weapon was actioned.

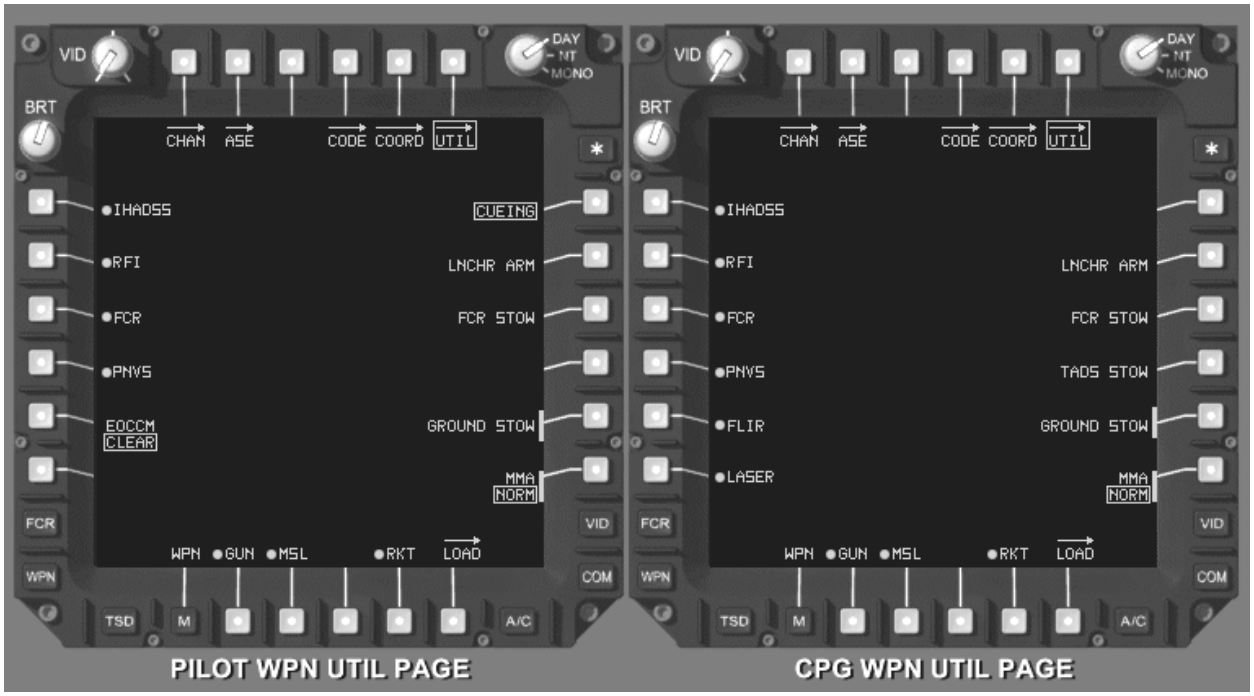

Figure 47. Pilot and CPG WPN UTIL Pages

3) WPN UTIL page

a) To access the WPN UTIL page, select the UTIL button (T6) on the WPN page.

b) The WPN UTIL page is unique to each crewstation, although some functions are aircraft common.

NOTE: Components displayed on the utility page are ruled by “Management by Exception”: If the component is not installed, it will not be displayed, for example. FCR, RFI, and so forth.

c) The AWS can be enabled from either crewstation on the WPN UTIL page by selecting the GUN button (B2).

d) The weapons LOAD page also can be accessed from either crewstation from the WPN UTIL page by selecting the LOAD button (B6).

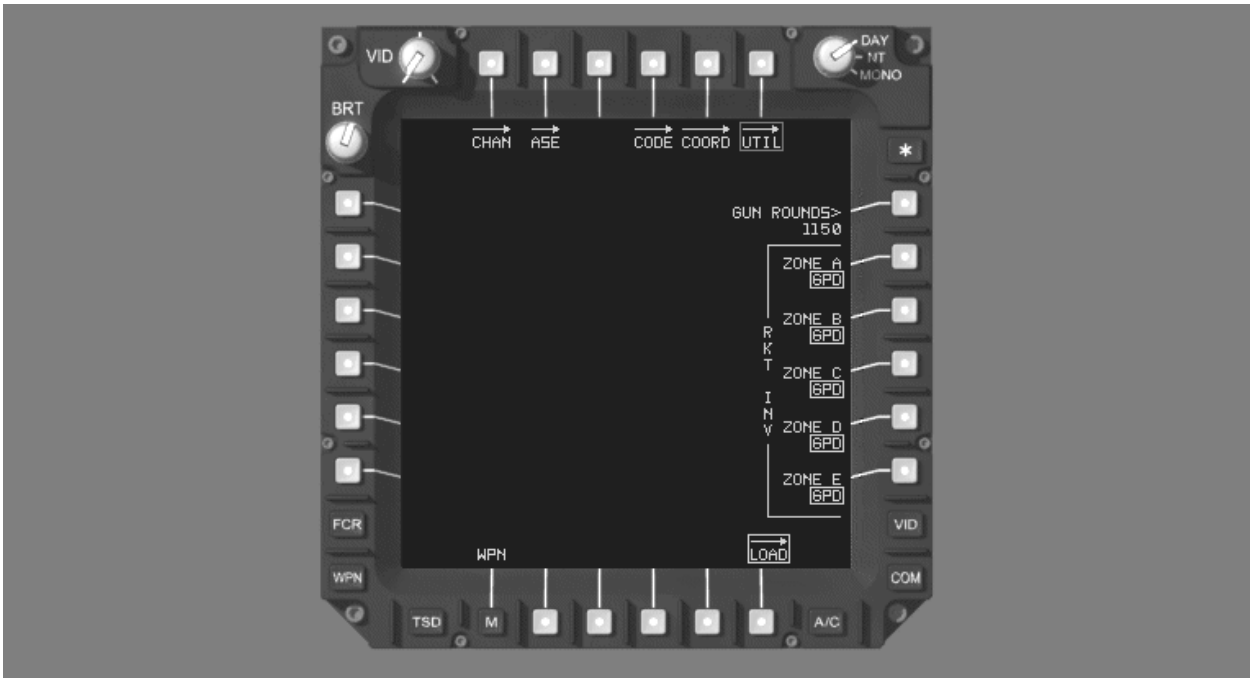

Figure 48. WPN UTIL LOAD Page

4) WPN UTIL LOAD page

a) The WPN UTIL LOAD page is used to access the controls required to manually correct the ammunition inventory data loaded at the LMP if it is incorrect.

b) The GUN ROUNDS> button (R1) is used to manually enter the number of rounds loaded. The range value entry will be from 0 to 1200 rounds in 1-round increments.

5) DMS Utility page. The DMS Utility page provides a capability for the crew to edit the gun CBHK correctors if they are found to be incorrect.

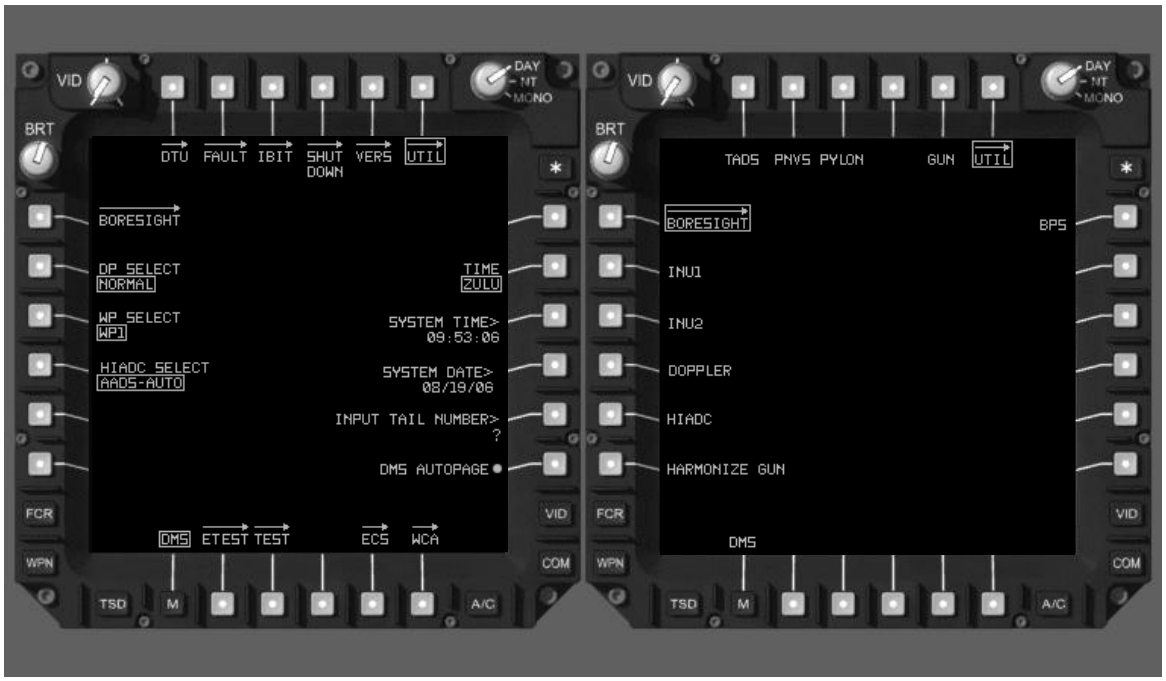

Figure 49. DMS and DMS UTIL Pages.

a) The DMS Utility page can be accessed through the DMS page UTIL button (T6).

b) The Gun CBHK correctors can be checked by selecting the BORESIGHT button (L1) on the DMS Utility page, then selecting the GUN button (T5).

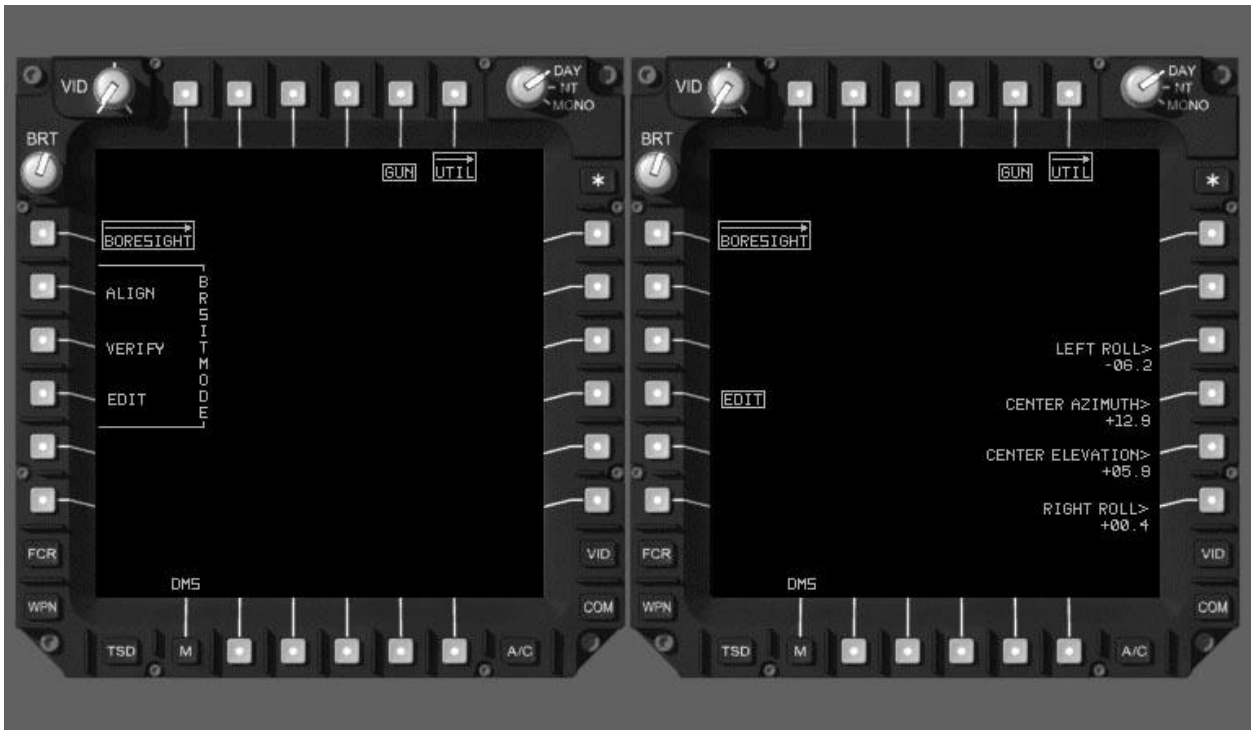

Figure 50. GUN Boresight Correctors.

c) Selecting the GUN button (T5) will bring up the Boresight Mode (BRSIT MODE) group (L2–L4).

d) Selecting the EDIT button (L4) will bring up the GUN BORESIGHT correctors.

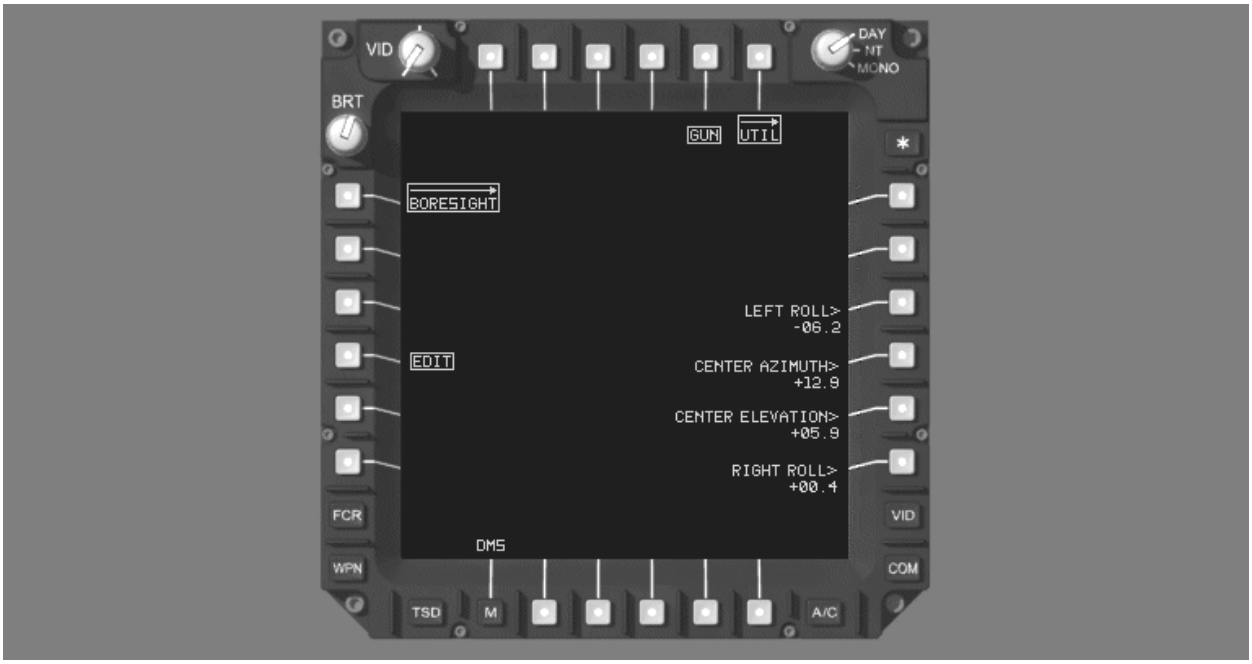

Figure 51. EDIT Boresight Mode Page.

e) After comparing the displayed correctors with the correctors in the aircraft logbook, incorrect boresight correctors may be changed by the crew.

CHECK ON LEARNING

1. You are in the pilot crewstation and the CPG actions the GUN; what indication will you see in your High Action Display (HAD) and in what status field(s)?

ANSWER: _____

_____

2. Which crewstation can conduct the GUN DYNAMIC HARMONIZATION?

ANSWER: _____

_____

3. You are in the CPG crewstation, and you action the GUN; will the checkerboard pattern be applied to the pilot WPN page ARM/SAFE status window?

ANSWER: _____

_____

4. The fixed mode places the gun _____ degrees in azimuth and _____ degrees in elevation.

ANSWER: _____

_____

ENABLING LEARNING OBJECTIVE 7

ACTION: Identify operational procedures of the AWS.

CONDITIONS: Given a written test without the use of student notes or references.

STANDARD: In accordance with TM 1-1520-251-10 and TC 1-251.

1. Learning Step/Activity 1

Identify operational procedures of the AWS

a. AWS operational procedures

NOTE: During normal operation, many of the AWS functions/selections may be pre-selected by use of the Aviation Mission Planning System (AMPS) and uploaded to the aircraft via DTC.

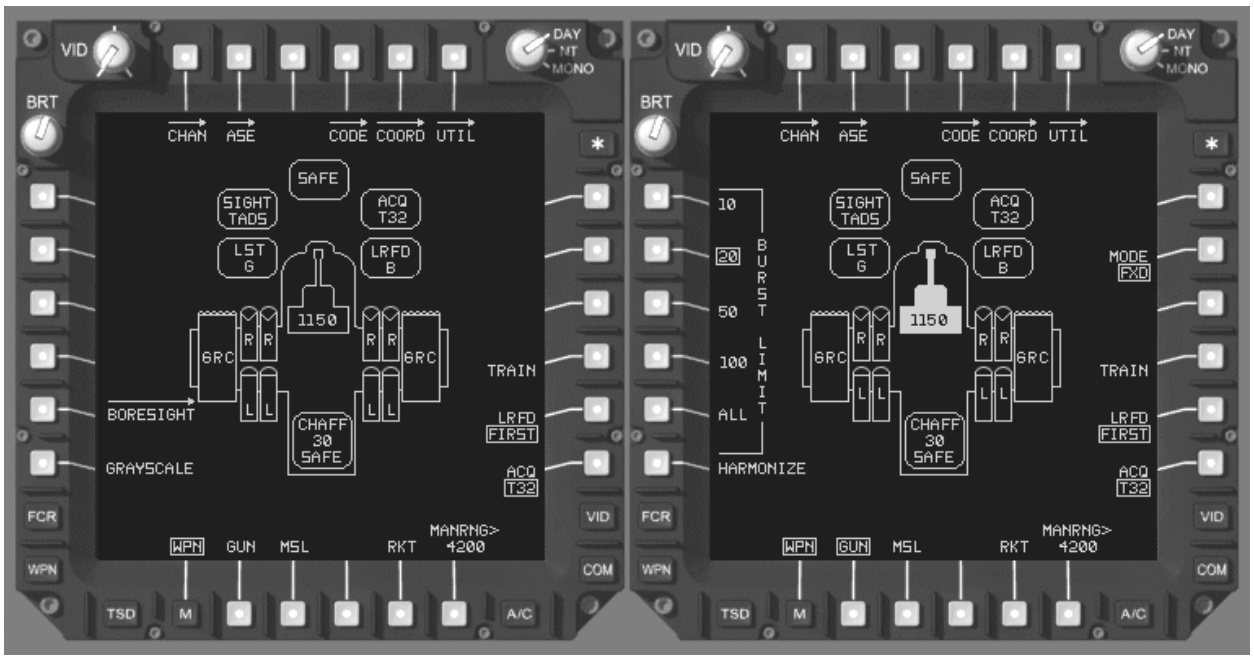

Figure 52. Selecting the WPN Page GUN format

(1) Prepare the AWS for operation by selecting the GUN format button (B2) on the WPN page.

(2) Validate DTC upload or select and set as desired, in each crewstation, the following options:

(a) GUN MODE button (R1)

(b) BURST LIMIT button group (L1-L5)

(c) Rounds count in the GUN icon

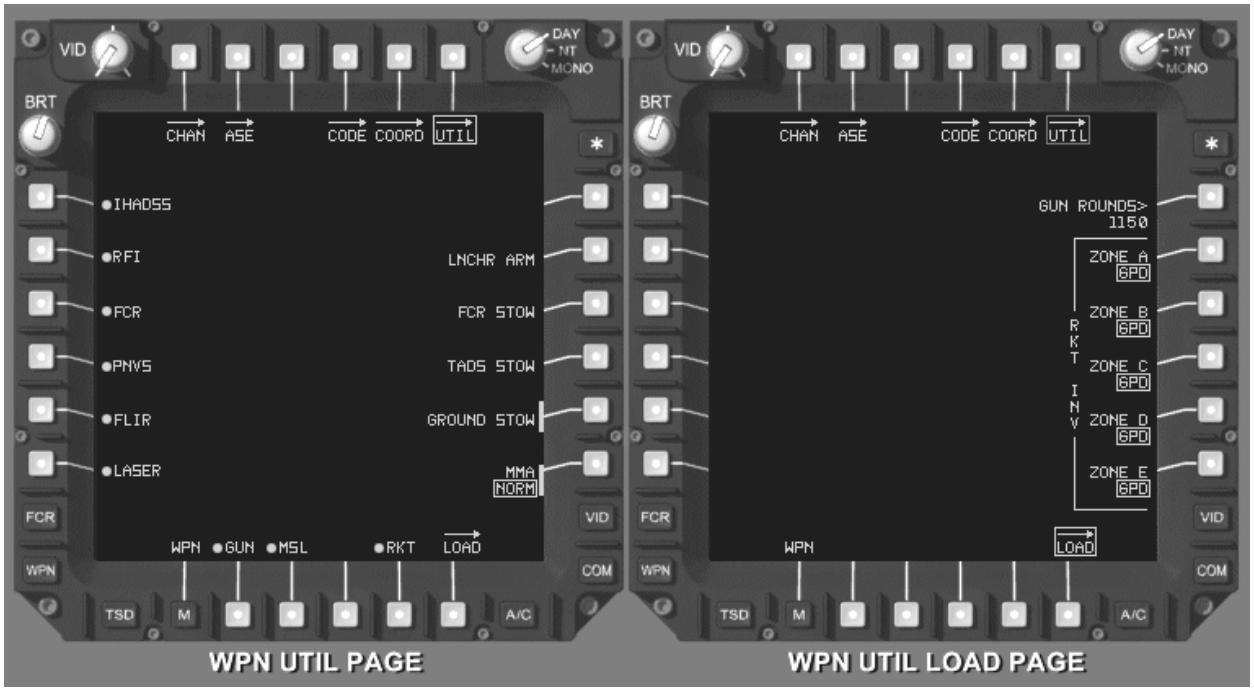

Figure 53. WPN UTIL and WPN UTIL LOAD Pages

1) If rounds count is incorrect select the WPN UTIL LOAD page by selecting the UTIL button (T6) on the WPN page then select the LOAD button (B6) on the UTIL page.

2) Selecting the GUN ROUNDS > button (R1) on the LOAD page will activate the Keyboard Unit (KU). Type in the correct amount of rounds and ENTER.

3) Changing the rounds count in one crewstation will change the rounds count for the aircraft.

(3) Select a sight.

(a) Sights available to the pilot

1) Helmet Mounted Display (HMD)

2) FCR

(b) Sights available to the CPG

1) HMD

2) TADS

3) FCR

(c) FCR sight selection is based on the last-to-select logic.

NOTE: For the TADS to be used as a sight, the CPG must place the NVS MODE switch on the left console to the OFF position.

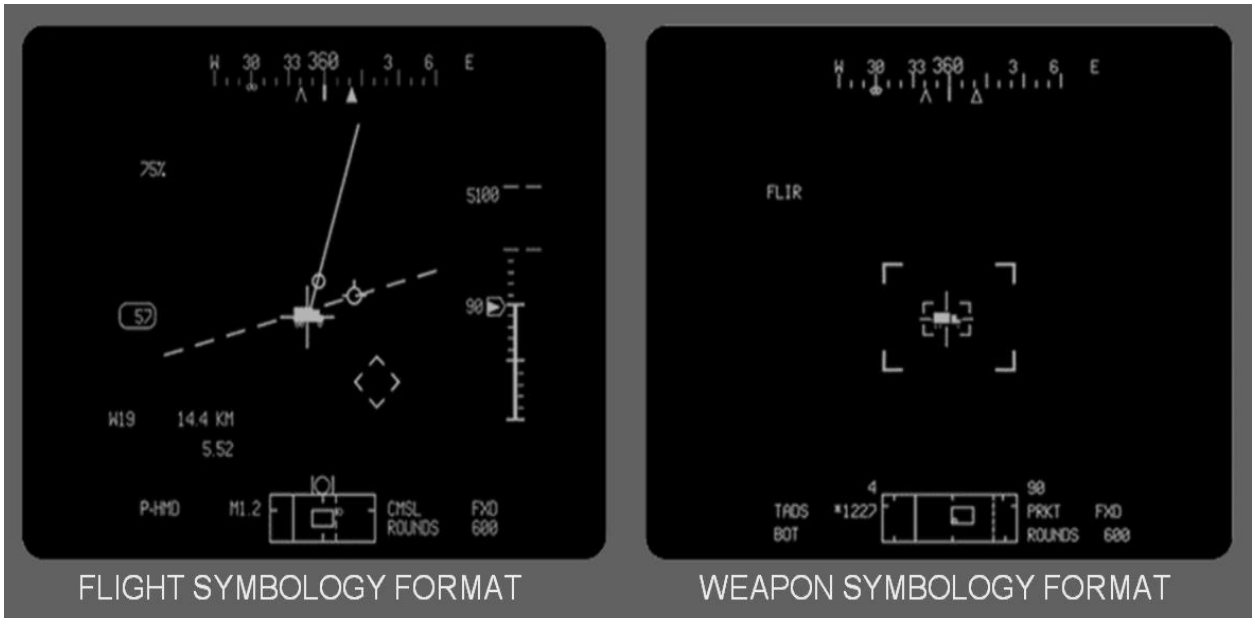

Figure 54. Confirmation of Selected Sight (HAD)

(d) Crewmembers can confirm their selected sight in the sight select status field of their appropriate high action displays.

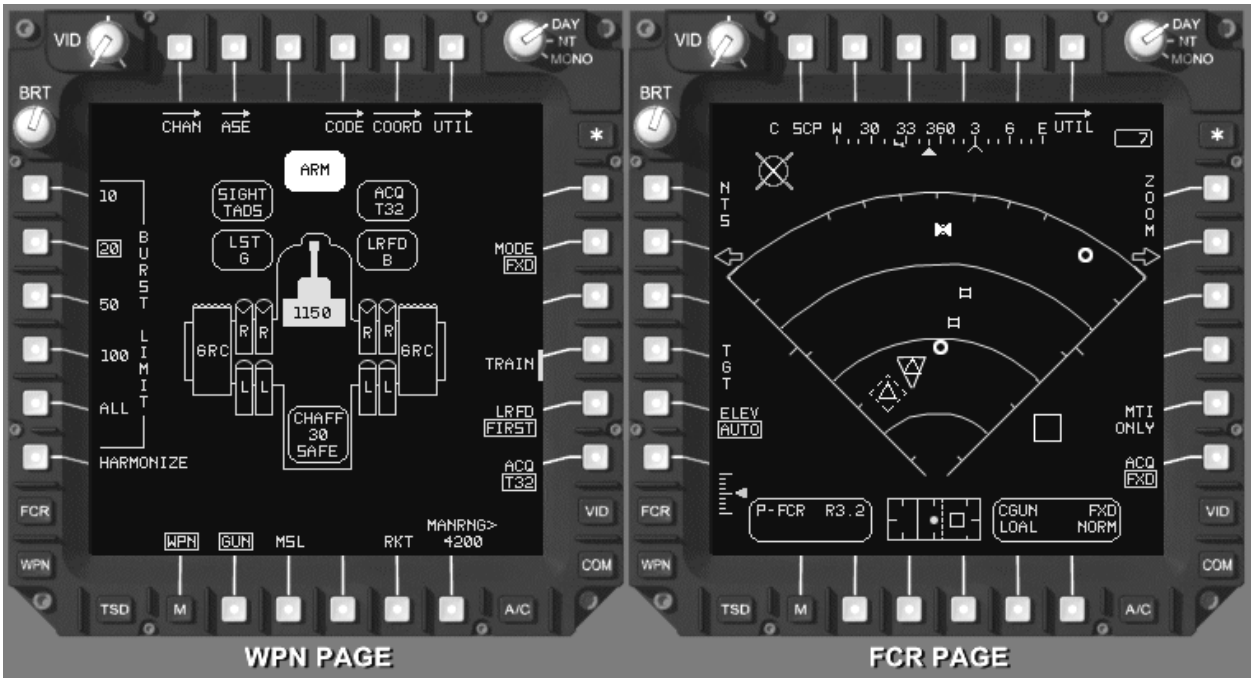

Figure 55. WPN and FCR Pages

(e) Selected sights can also be confirmed on the WPN page sight select status window and in the sight select status field of the FCR page HAD.

(4) Acquire a target with the selected sight.

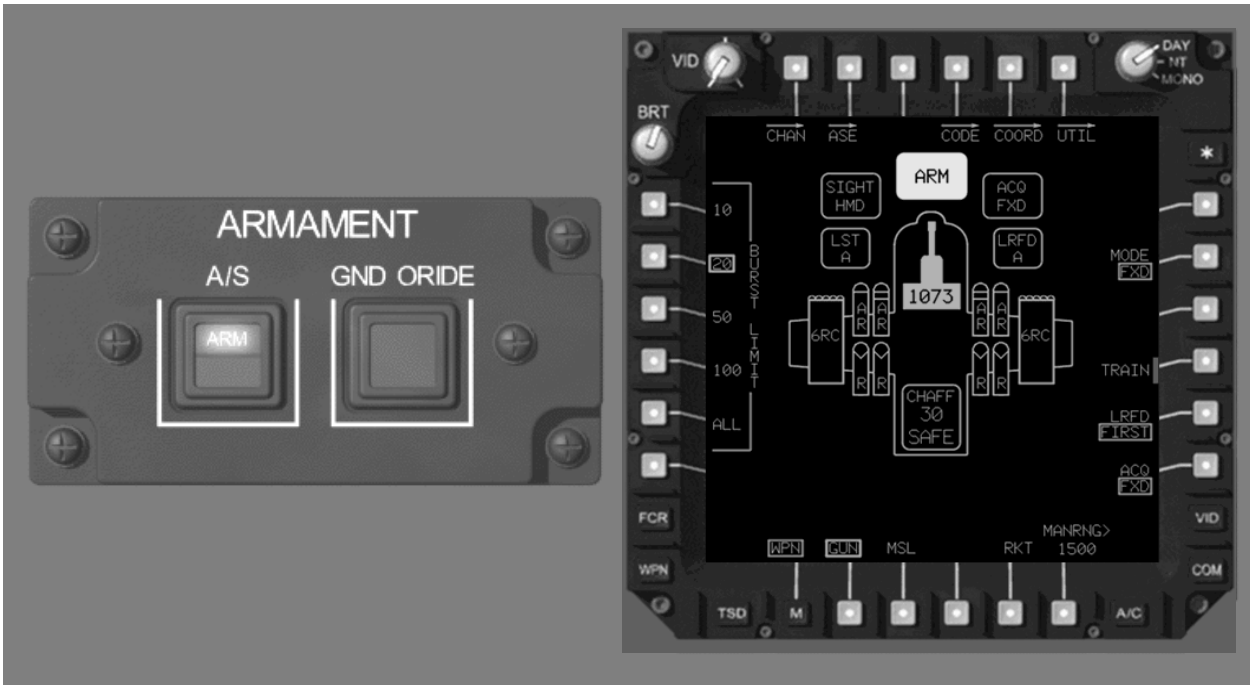

Figure 56. Weapon System Armed

(5) Arm the weapon system on the ARMAMENT panel.

(a) The green SAFE should go out, and the yellow ARM should be displayed.

(b) The ARM/SAFE status window on the WPN page should be an inverse yellow ARM.

(6) Establish range information to the selected target.

(a) Range sources available to the pilot

1) Manual range

2) Auto range

3) NAV range

4) Radar range

5) Crewstation default range

(b) Range sources available to the CPG

1) Manual range

2) Auto range

3) NAV range

4) Radar range

5) Laser range

6) Crewstation default range

NOTE: ONLY the range displayed in the HAD range and range source field of the crewstation that has actioned the weapon will be used by the WP for the engagement.

NOTE: Automatic range is not recommended for use in the FXD GUN mode because of the dynamics in the displayed range and resultant dynamics in the FXD GUN aiming reticle.

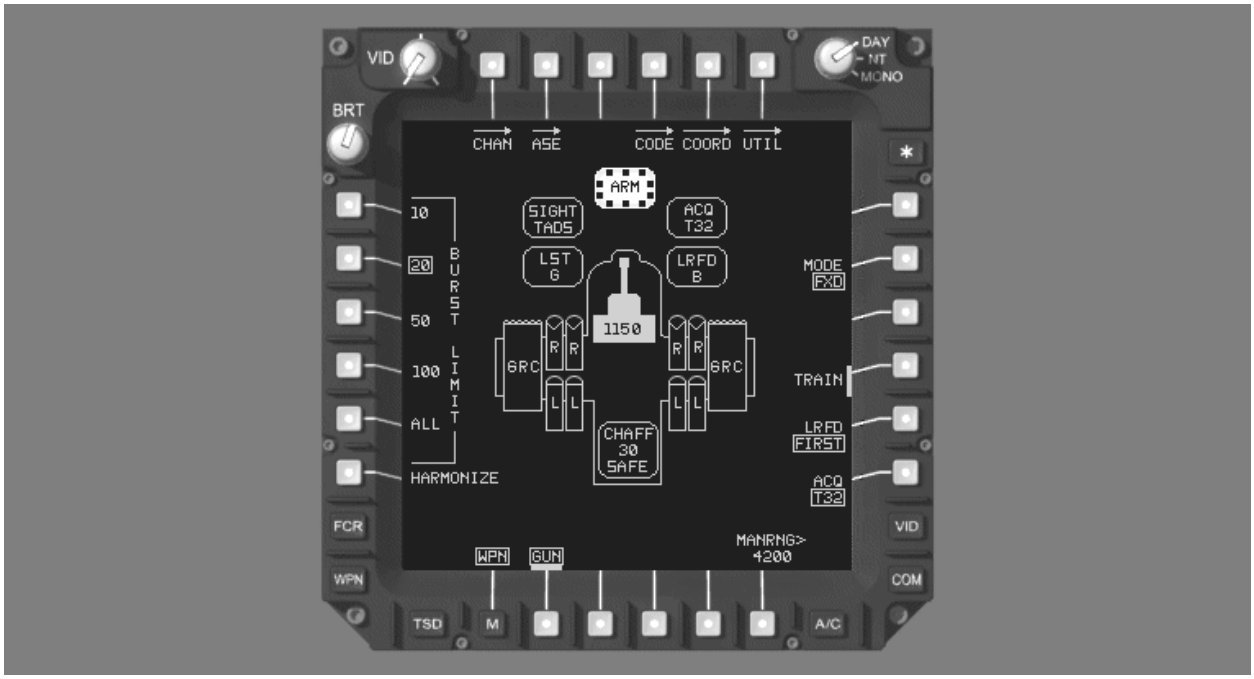

Figure 57. WPN Page—Gun Actioned

(7) Action the weapon

(a) The ARM/SAFE status window on the WPN page of the crewmember that actioned the weapon should have a checkerboard around the edge.

(b) Weapons system buttons MSL (B3) and RKT (B5) will not be displayed, and the GUN button (B2) will be boxed and barriered when the AWS has been actioned.

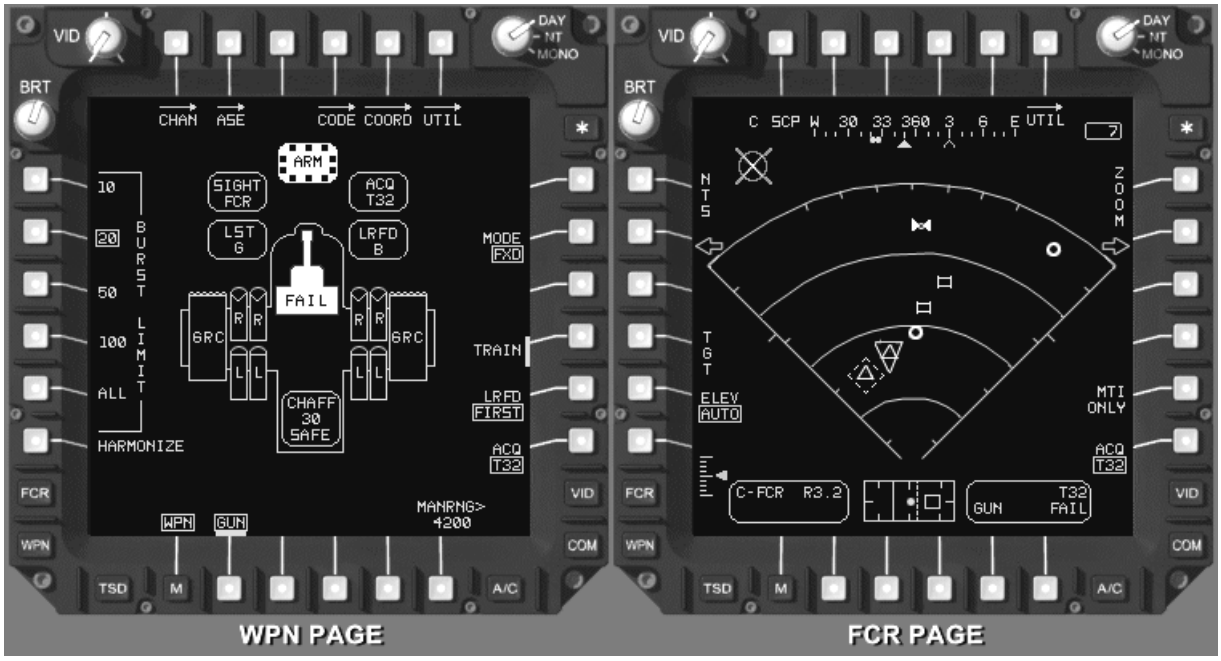

Figure 58. GUN FAIL Indications

(c) If the AWS has been actioned, and the system has been detected in a NO-GO status, GUN FAIL indications will be displayed in three places.

1) The ROUNDS count in the GUN icon on the WPN page will be replaced by FAIL.

2) GUN FAIL will be displayed in the weapon status field of the Weapons/Flight format of the HAD in the crewstation that actioned the AWS.

3) GUN FAIL also will be displayed in the HAD weapon status field of the FCR page in the crewstation that actioned the AWS.

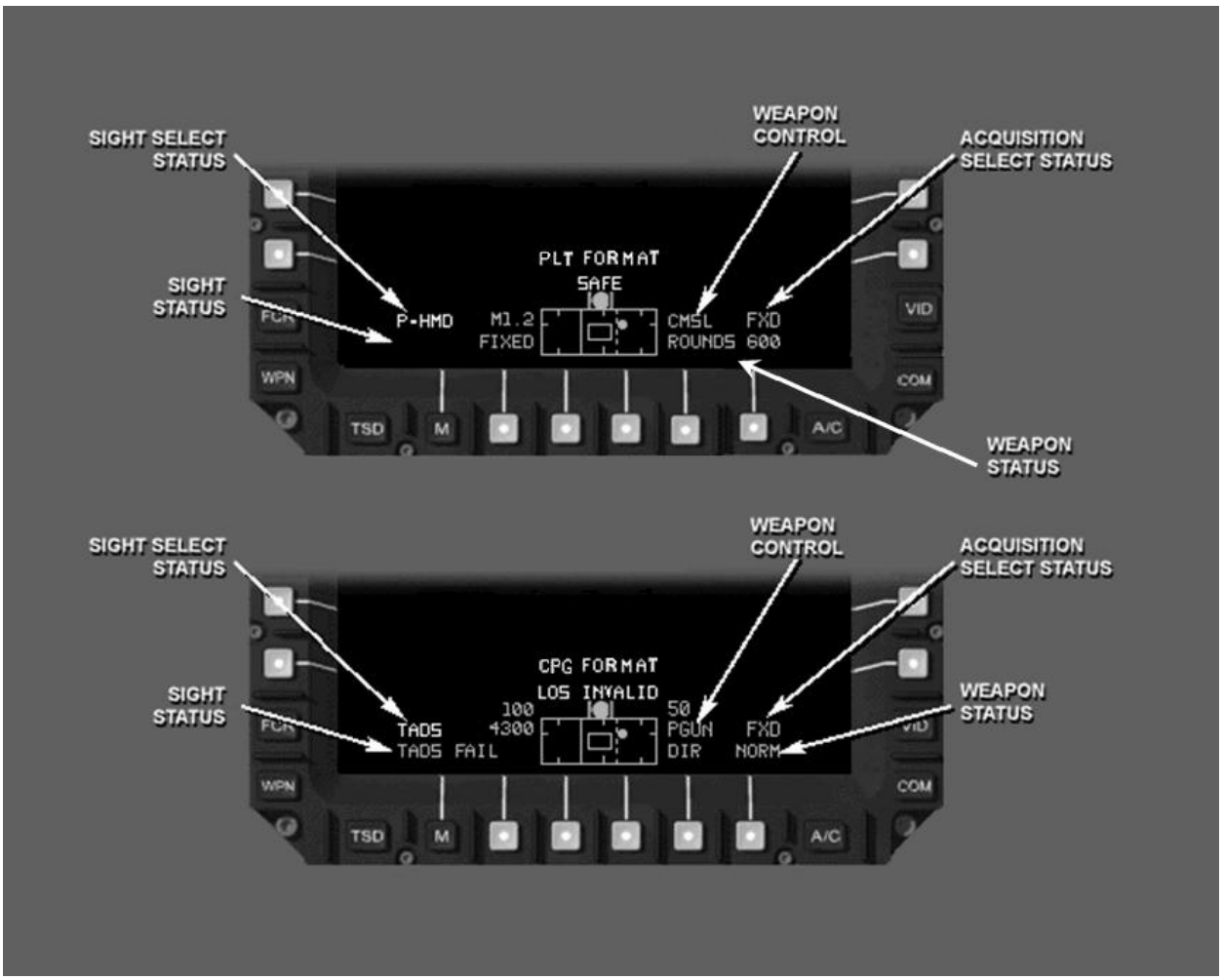

Figure 59. HAD Gun Messages

(8) Confirm appropriate HAD messages.

(a) The crewstation that actioned the AWS should have the ROUNDS message in the weapon status field of the HAD.

(b) The opposite crewstation HAD weapon control status field will indicate who has weapon control.

(9) Pull the weapons trigger switch.

(10) WAS—Deselect as desired

(11) ARM/SAFE button—As desired

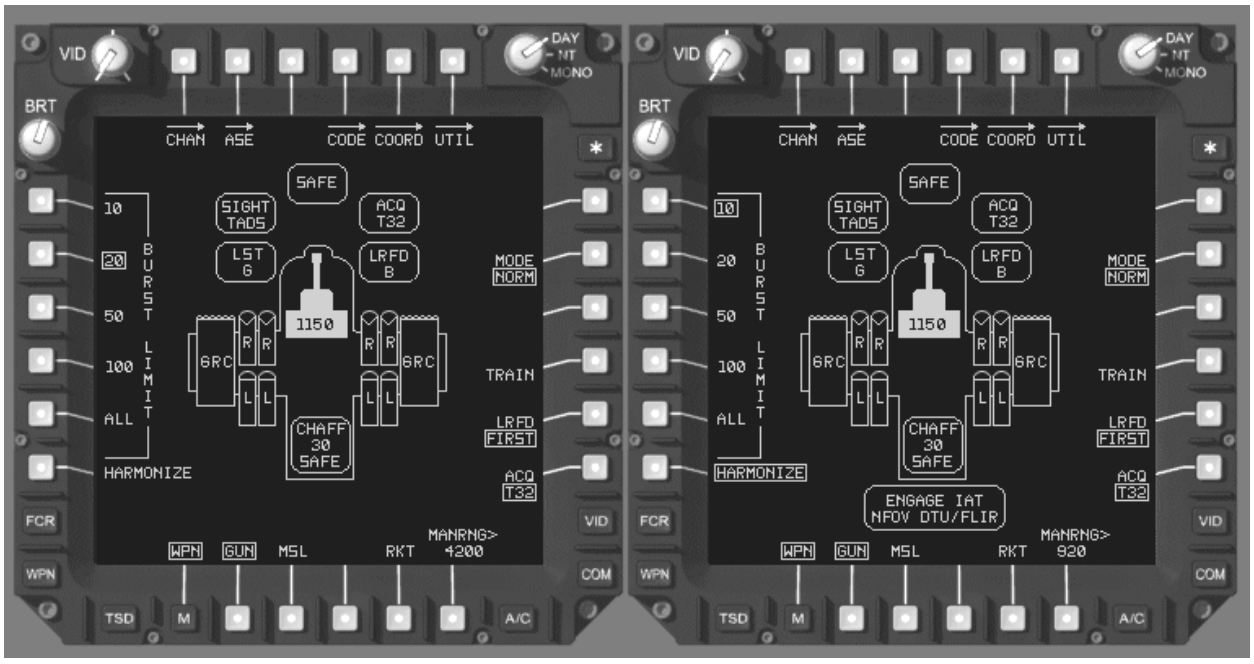

Figure 60. Selecting Dynamic Harmonization (DH)

NOTE: A gun dynamic boresight (harmonization) mode is available to the CPG to improve the accuracy of the AWS, if needed.

(12) AWS harmonization procedures

(a) Select the GUN button (B2) to make the HARMONIZE button (L6) available.

(b) Selecting the HARMONIZE button will select a burst limit of 10 automatically and will bring up a harmonize information status window, below the aircraft icon, stating ENGAGE IAT NFOV DTV/FLIR.

(c) Select the TADS Forward Looking Infrared (FLIR) or Day Television (DTV) as the sight.

(d) Place the TADS LOS on a target at a range of 500 to 1500 meters.

1) Select TADS Narrow Field Of View (NFOV).

2) Engage Image Auto Track (IAT).

(e) Select ARM on the ARM/SAFE button. ARM should appear in the ARM/SAFE status window.

(f) Range target using laser or manual ranging.

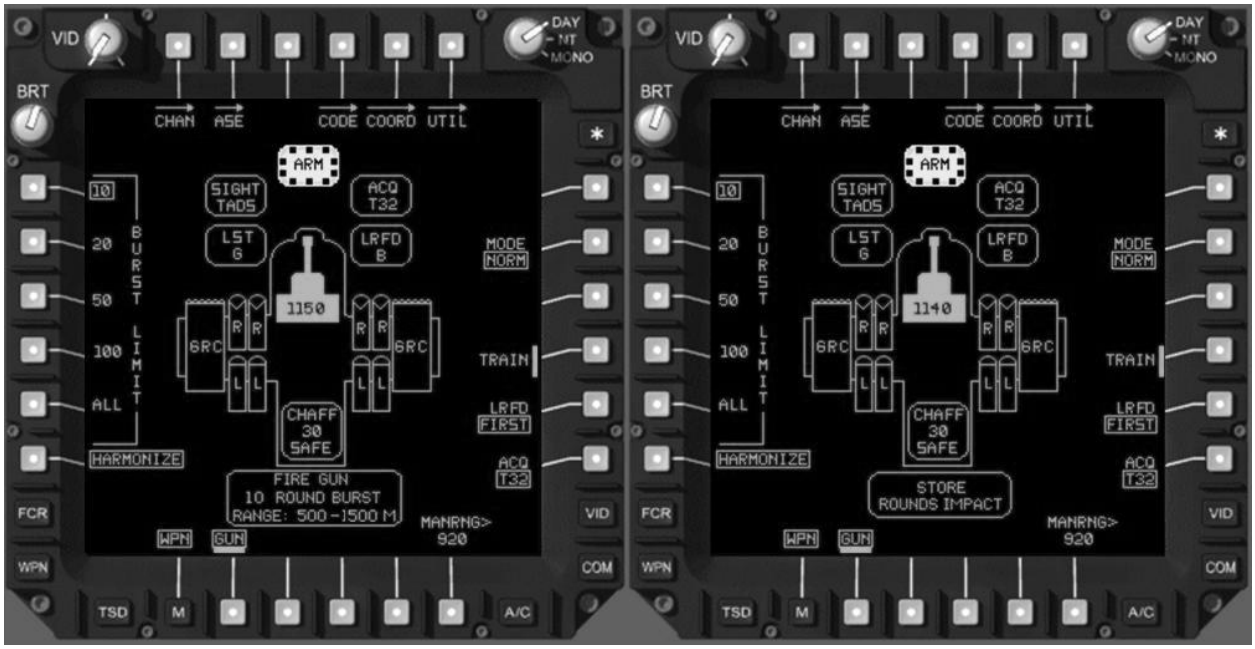

Figure 61. HARMONIZE—FIRE GUN and STORE IMPACT

NOTE: A new message will appear in the status window after engaging the IAT on the target in TADS narrow FOV: FIRE GUN 10 ROUND BURST RANGE: 500–1500 M.

(g) WAS the gun—A checkerboard should appear around the edge of the ARM/SAFE status window.

(h) Weapons trigger–Press to fire the 10-round burst.

1) Observe Mean Point of Impact (MPI) of rounds.

2) A STORE ROUNDS IMPACT message will replace the FIRE GUN message in the status window, and the Dynamic Harmonization (DH) reticle will be available.

(i) Position the dashed Reticle over the MPI, using the MAN TRK thumbforce controller

(j) Press the STORE/UPDATE switch on the LHG of the TEDAC to the STORE position. If the offset corrections are within allowable limits:

1) The DH reticle will disappear.

2) STORE ROUNDS IMPACT message and status window will disappear.

3) The HARMONIZE button will be deselected automatically.

(k) WAS–Deselect the gun as desired.

(l) ARM/SAFE switch–As desired.

(m) Sight select switch–Select as desired.

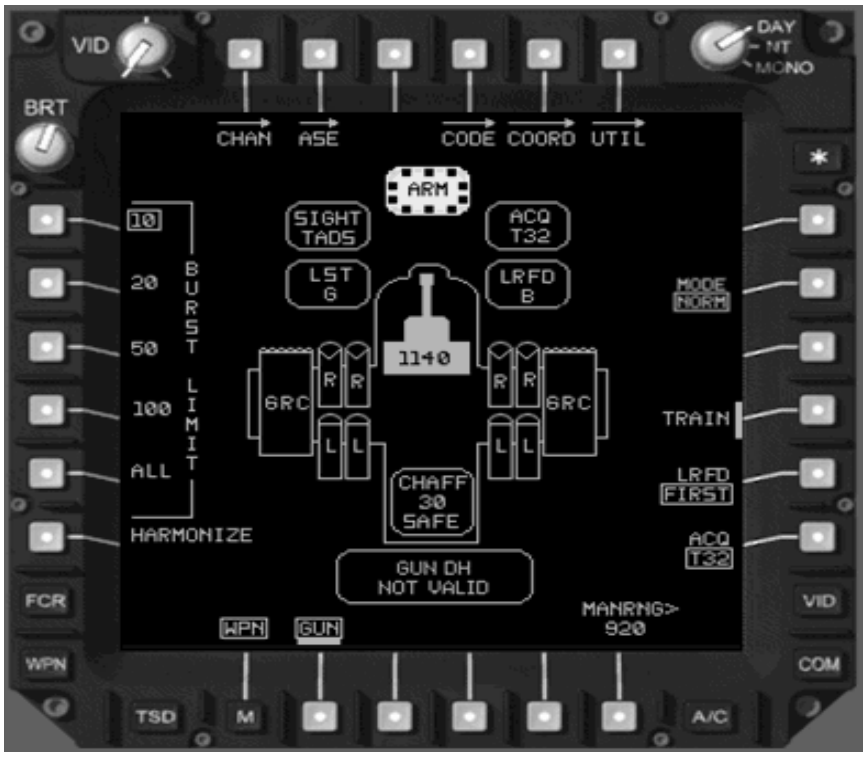

Figure 62. GUN DH NOT VALID

(n) If the dynamic harmonization offset is beyond allowable limits (25 milliradians), the WP will set the values to zero and cause the following:

1) The GUN DH reticle will disappear.

2) The GUN DH NOT VALID message will appear in the status window.

This may be an indication that a CBHK boresight of the AWS is required.

3) The HARMONIZE button will deselect automatically.

(o) WAS—Deselect the gun as desired.

(p) ARM/SAFE switch—As desired.

(q) Sight select switch—Select as desired.

2. Learning Step/Activity 2

AWS Weapon Training Mode

a. AWS Weapon Training Mode (WTM)

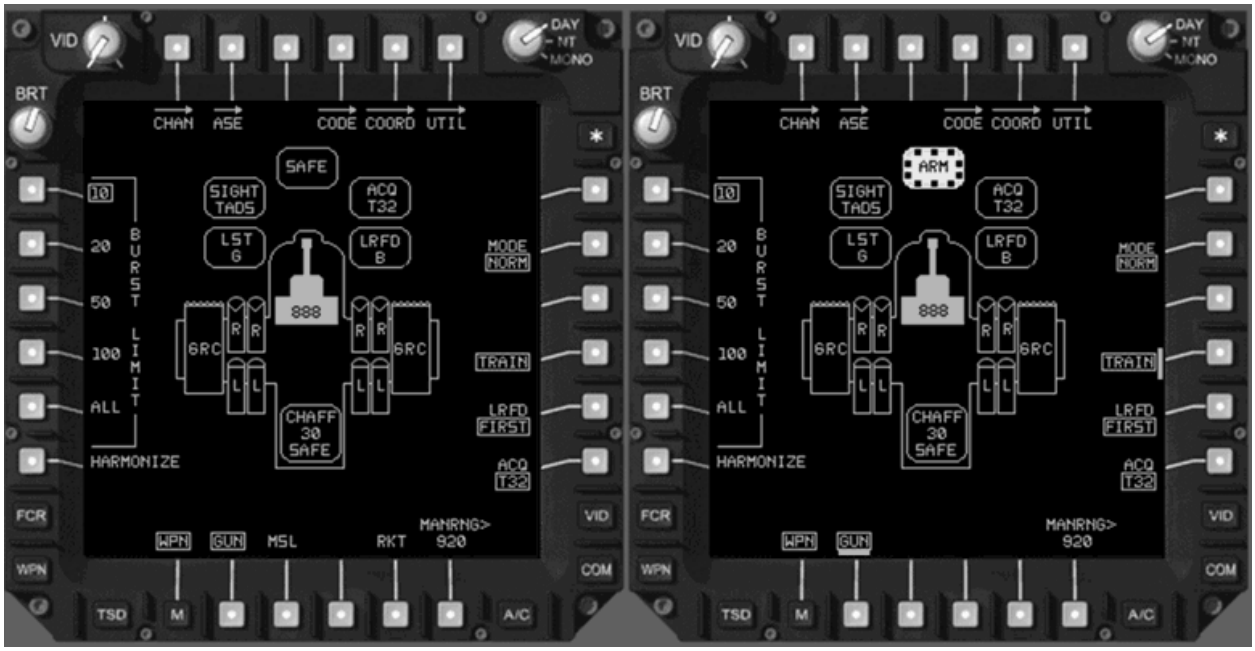

Figure 63. AWS Weapon Training Mode (WTM)

(1) The WTM is an emulation of the weapon system operation that allows aircrew training for all AH-64D weapon systems.

(a) The WTM may be operated with live ammunition on board. The WTM employs multiple safety features to minimize hazards associated with its use.

1) Application of arming power to weapon stations is inhibited by both the SPs and WPs when the mode is active

2) Firing events are simulated. No firing commands are issued to the gun when the WTM is in use.

3) The crew interface imposes a barrier logic that minimizes the potential for accidental exit of the WTM during a simulated engagement. Barrier logic also is used to prevent inadvertent entry into the WTM during a live-fire engagement.

NOTE: Simulated inventories are not considered in aircraft gross weight and performance calculations. A data entry change to the gun rounds count or the use of rocket “spoofing” devices will adversely impact aircraft gross weight.

(2) WTM operation

(a) The WTM is activated and deactivated using the TRAIN button (R4) on the WPN page.

(b) Weapon systems operations (controls and displays) appear to function as they do in the tactical mode.

(c) Any faults or failures experienced by the systems will impact the weapons systems operation in the training mode as it does in the tactical mode.

(d) The aircrew can enter and exit the WTM only when the armament control is in SAFE, and no weapon system is actioned.

(e) While in the WTM, with the ARM/SAFE in ARM, the laser is fully functional.

(3) WTM AWS operation

(a) When the WTM is selected, the armament subsystem will adopt a simulated weapon inventory of 888 gun rounds for the AWS.

(b) Simulated inventories will decrement in response to valid firing requests and are reset each time the WTM is activated.

(c) The Communication Interface Unit (CIU) provides an audio effect when the AWS is fired.

1) One sound file representing 10 rounds is repeated for desired number of rounds 10, 20, 50, 100, and rounds possible.

2) Gun sound effect will stop after 1-second for each 10 rounds.

3) Releasing the trigger or dispensing all rounds terminates sound effects.

NOTE: If aircraft is on the ground, select GND ORIDE.

(4) Prepare the AWS for operation by selecting the GUN format button (B2) on the WPN page and set up the AWS according to training mission requirements

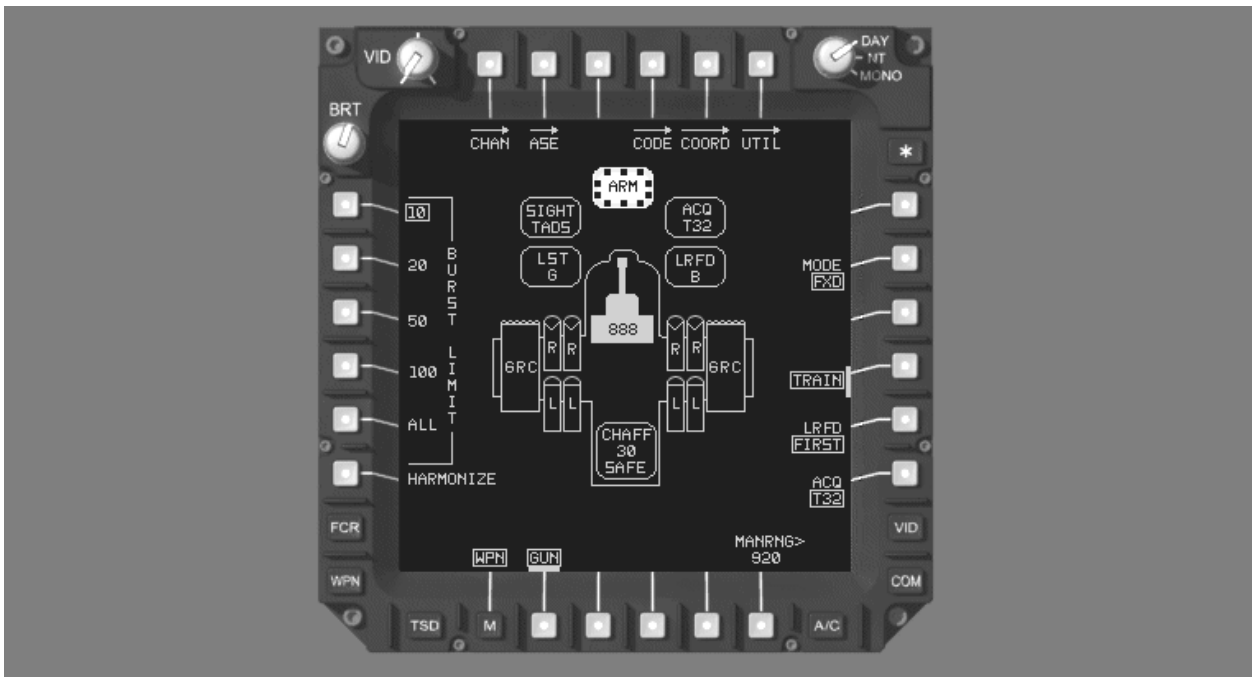

Figure 64. WPN TRAIN Page

(5) AWS WTM procedures (activate)

(a) Select TRAIN button (R4)

1) TRAIN button (R4) is boxed

2) Rounds count in the GUN icon changes to 888

(b) A/S to ARM

(c) Action weapon from desired position

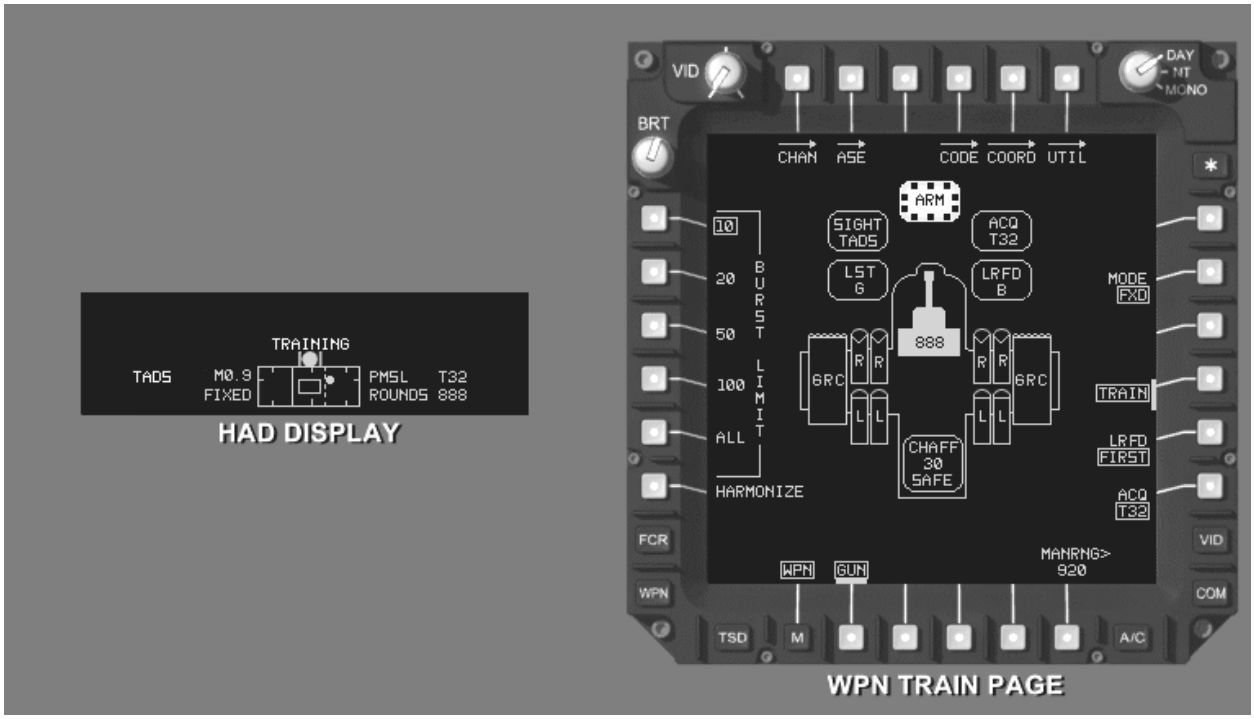

Figure 65. WPN TRAIN Page and HAD Display

1) GUN button (B2) and TRAIN button (R4) are barriered.

2) TRAINING is displayed in the weapon inhibit field on the HAD.

3) AWS performs per tactical design.

(6) AWS WTM procedures (deactivate)

(a) Deselect weapon.

(b) A/S to SAFE.

(c) Deselect TRAIN button (R4).

(d) Deselect GUN button (B2).

NOTE: The WTM is not available when, Tactical Engagement Simulation System (TESS) is engaged. TESS will be discussed in another lesson.

CHECK ON LEARNING

1. If the rounds count in the GUN icon is incorrect, how do you input the proper rounds count?

ANSWER: _____

_____

2. Can you confirm your selected sight on the Fire Control Radar (FCR) page?

ANSWER: _____

_____

3. What will be displayed in the High Action Display (HAD) weapon inhibit field during Weapons Training Mode (WTM)?

ANSWER: _____

_____

4. When the Weapons Training Mode (WTM) is selected, the armament subsystem will adopt a simulated weapon inventory of _____ rounds for the 30mm.

ANSWER: _____

_____

5. Gun dynamic harmonization mode is available to the CPG to improve the accuracy of the 30mm, the CPG places TADS (NFOV) on a target between _____ to _____ meters.

ANSWER: _____

_____

Enabling Learning Objective 8

ACTION: Identify the ballistics that impacts the accuracy of the AWS.

CONDITIONS: Given a written test without the use of student notes or references.

STANDARD: In accordance with TM 1-1520-251-10, TC 1-251, and FM 3-04.140 (FM 1-140).

3. Learning Step/Activity 1

Identify the ballistics that impacts the accuracy of the AWS.

a. Ballistics is the science of the motion of projectiles and the conditions that influence that motion.

(1) Four types of ballistics influence helicopter-fired weapons.

(a) Interior ballistics

(b) Exterior ballistics

(c) Aerial ballistics

(d) Terminal Ballistics

(2) Interior ballistics defines the characteristics that affect projectile motion inside the barrel.

(a) Three factors influence interior ballistics.

1) Barrel wear: The condition of the barrel's inner surface can affect muzzle velocity and accuracy.

2) Propellant charges: Production variances, temperature, and moisture in the storage environment affect the way propellant burns.

3) Projectile weight: The weight of projectiles of the same caliber may vary. These variances do not significantly influence trajectory.

NOTE: Trajectory is the flight path of the projectile as it flies from the muzzle of the weapon to the point of impact (target).

4) Interior ballistics affects the trajectory of the projectile regardless of the method used to acquire a target.

(3) Exterior ballistics defines the characteristics that influence the motion of the projectile as it moves along its trajectory.

When the HMD sight is employed, the WPs does not execute the target-state estimator (TSE) algorithm to estimate target velocities; therefore, no lead-angle compensation is computed. This is critical if the ownship or target is moving.

(a) Air resistance:

1) Air resistance or drag, is caused by friction between the air and the projectile.

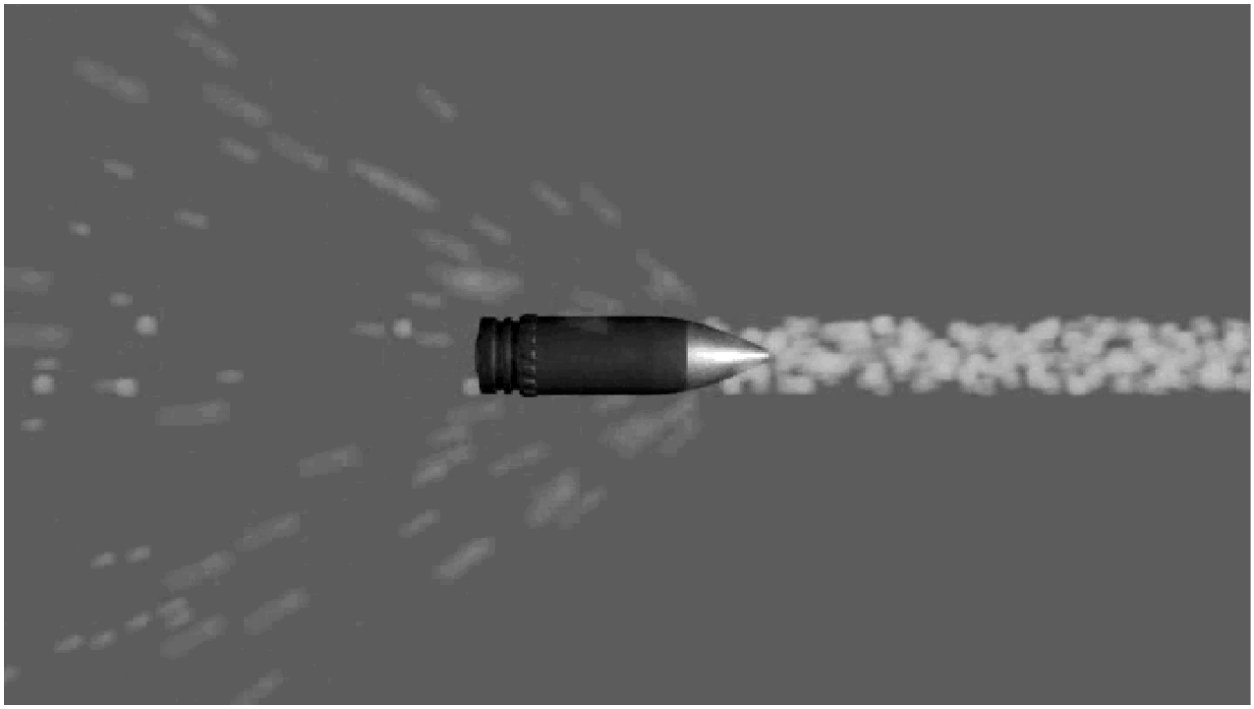

Figure 66. Drag

2) Drag is proportional to the cross-section area of the projectile and its velocity.

3) Air resistance has little effect on the 30mm projectile fired by the AWS, within the effective range of the weapon.

(b) Gravity:

1) The projectile's loss of altitude because of gravity is directly related to range.

2) As range increases, the amount of gravity drop increases.

3) This drop is proportional to time of flight (distance) and inversely proportional to the velocity of the projectile.

a) 30mm projectile with a muzzle velocity of 2640 Feet Per Second (fps) will drop 15 mils at 1000 meters, which is approximately 50 feet.

b) 30mm projectile with a muzzle velocity of 2640 fps will drop 60 mils at 2000 meters, which is approximately 200 feet.

c) The weapons processor compensates for gravity.

(c) Yaw:

1) Yaw is the angle between the centerline of the projectile and the trajectory.

2) Yaw causes the projectile's trajectory to change and drag to increase.

3) The direction of the yaw constantly changes in a spinning projectile.

4) Yaw maximizes near the muzzle and gradually subsides as the projectile stabilizes.

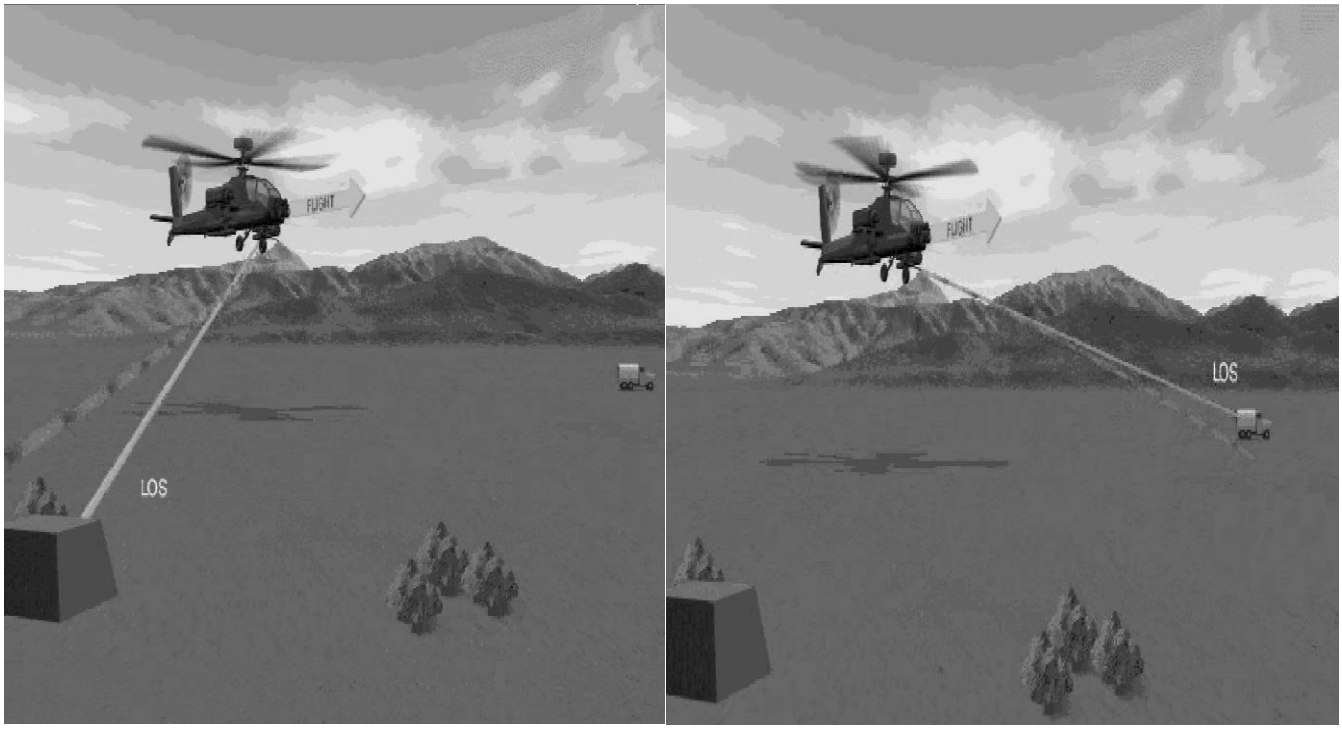

Figure 67. Projectile Drift

(d) Projectile Drift

1) Caused by the projectile spinning in a clockwise direction.

2) This motion results in the projectile drifting to the right; as the range increases, projectile drift increases.

3) To compensate for projectile drift, the gunner establishes combat sight settings or adjusts rounds toward the target. This compensation is known as using "burst on target."

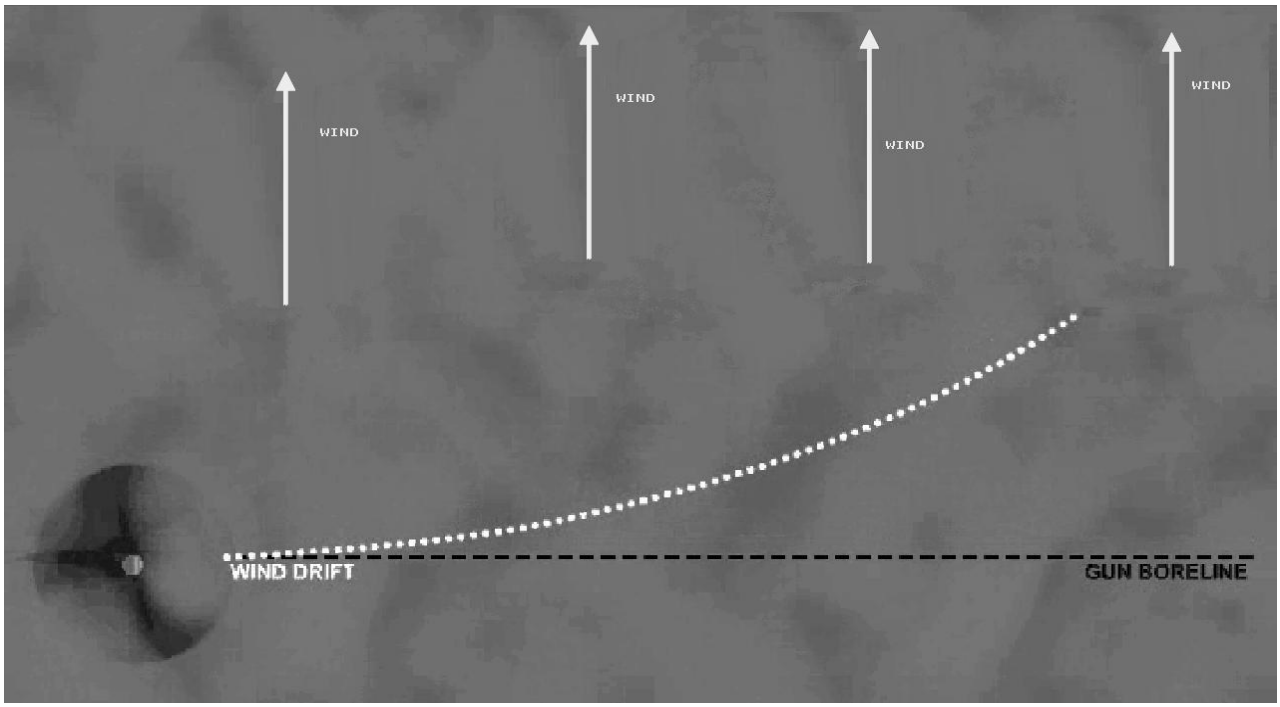

Figure 68. Wind Drift

(e) Wind Drift

1) The effect of wind on a projectile in flight.

2) The amount of drift depends on the projectile's time of flight and the wind speed acting on the cross-sectional area of the projectile.

3) Time of flight depends on the range to the target and the average velocity of the projectile.

4) When firing into a crosswind, the gunner must aim upwind so that the wind drifts the projectile back to the target.

5) Firing into the wind or downwind requires no compensation in azimuth but will require range adjustment.

(4) Aerial Ballistics

(a) Common Characteristics

1) Characteristics of aerial-fired weapons depend on whether the projectiles are spin-stabilized or fin-stabilized and whether they are fired from the fixed mode or the flexible mode.

2) Some characteristics of aerial-fired weapons are discussed below.

3) Angular rate error is caused by the motion of the helicopter as the projectile leaves the weapon. It affects most weapon systems.

(b) Spin-Stabilized Projectiles

1) Certain exterior ballistic characteristics are peculiar to spin-stabilized projectiles fired from weapons with rifled barrels.

2) These weapons include 30mm cannons.

a) Fired in the fixed mode (straight ahead of the helicopter), the projectiles generally have the same ballistic characteristics as ground-fired weapons.

b) Relative wind changes and the velocity of the helicopter increase or decrease the velocity of the projectile.

c) Ballistic characteristics influencing spin-stabilized projectiles fired from positions other than a stabilized hover are discussed below.

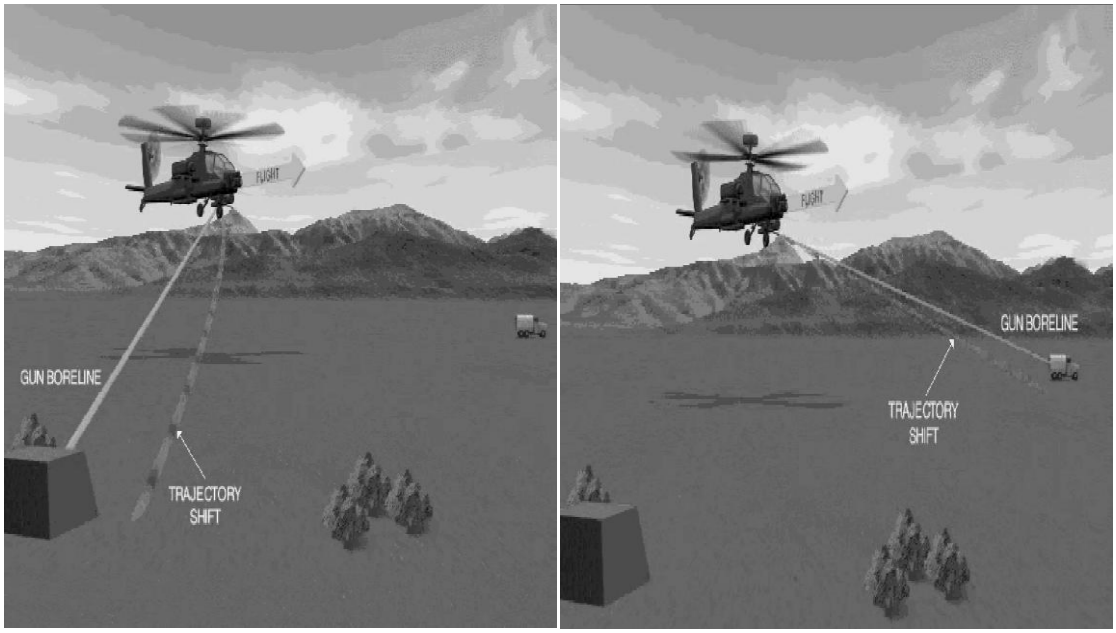

Figure 69. Trajectory Shift

1 Trajectory shift

a When the boreline axis of the weapon differs from the flight path of the helicopter, the movement of the helicopter changes the trajectory of the projectile.

b For off-axis shots within ±90º of the helicopter's heading, trajectory shift causes the round to hit left or right of the target.

c To correct for trajectory shift, the gunner leads the target. To lead the target, the gunner places fire on the near side of the target as the helicopter approaches. The amount of lead depends on the airspeed of the helicopter, angle of deflection, velocity of the projectile, and range to the target.

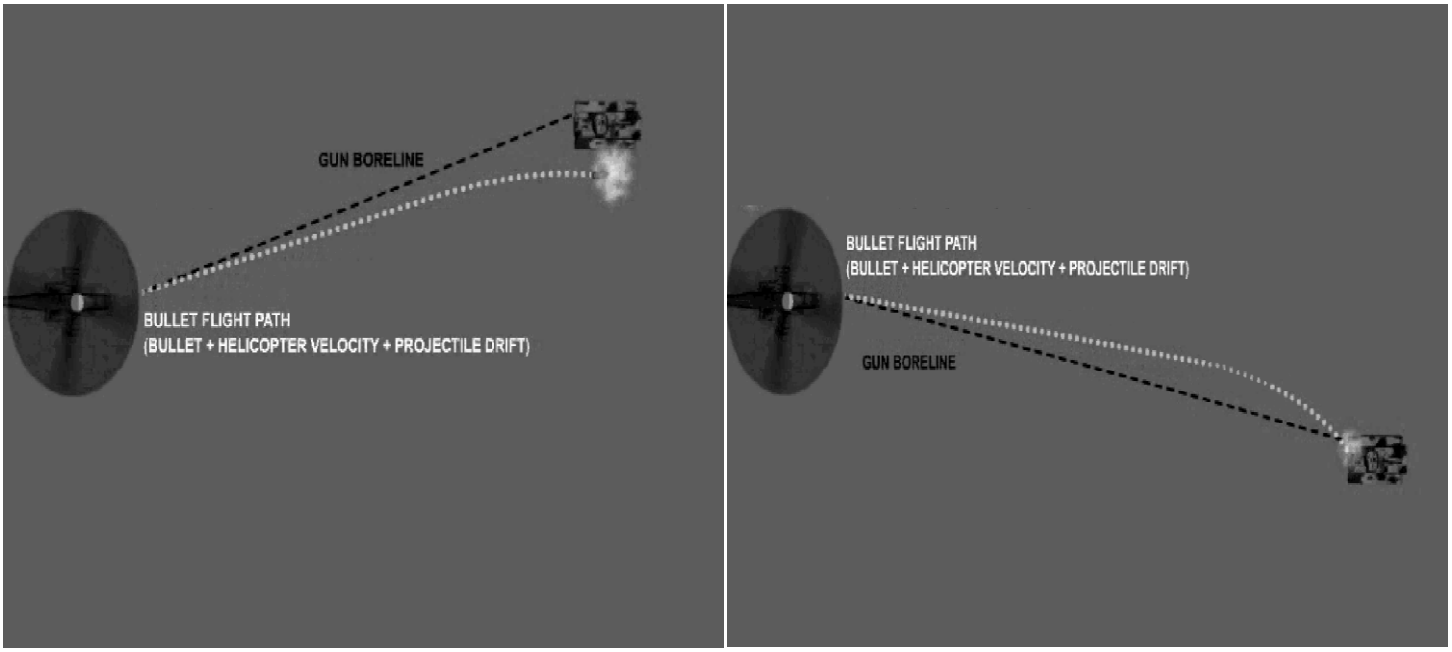

Figure 70. Port Starboard Effect

2 Port–starboard effect

a Trajectory shift and projectile drift combine to constitute the port–starboard effect.

b When targets are on the left, the effects of drift and shift compound each other; both cause the round to move right.

c To hit the target, the gunner must correct for both ballistic effects by firing to the left of the target.

d When targets are on the right, the effect of projectile drift (round moves right) tends to

cancel the effect of trajectory shift (round moves left).

e Firing requires less compensation. The range and airspeed at which a target is engaged determine which effect is greater.

f At ranges less than 1000 meters, trajectory shift is greater. The gunner must fire to the right of the target.

g At ranges beyond 1000 meters, the effect of projectile drift is greater and tends to cancel the effect of trajectory shift.

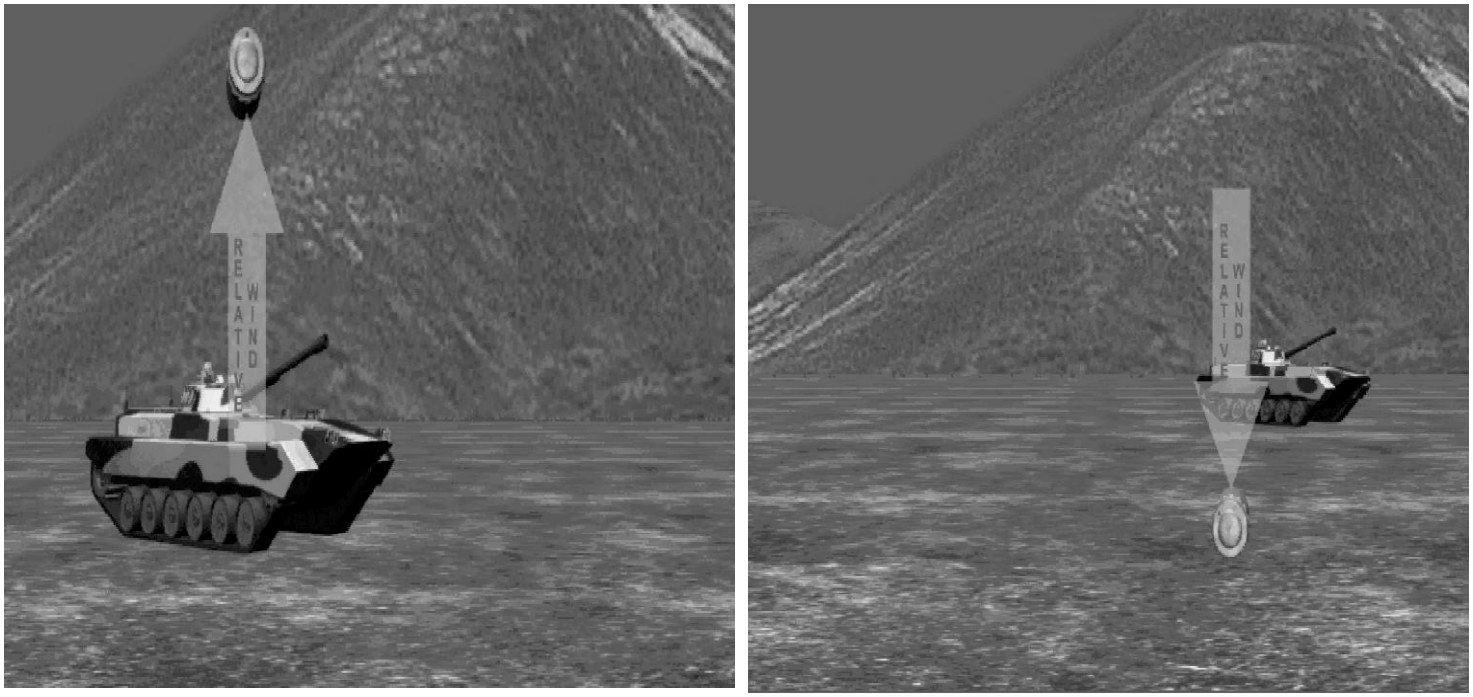

Figure 71. Projectile Jump

3 Projectile jump (vertical plane gyroscopic effect)

a When a crew fires a weapon from a helicopter in flight, and the weapon's muzzle is pointing in any direction other than into the helicopter's relative wind, the projectile will experience projectile jump.

b Projectile jump begins when the projectile experiences an initial yaw as it leaves the muzzle. The yaw is in the same direction as the projectile's direction of rotation.

c The jump occurs because of the precession (change in axis of rotation) induced by crosswind.

d The amount a projectile jumps is proportional to its initial yaw.

e Firing to the right produces a downward jump; firing to the left produces an upward jump.

f To compensate, the gunner must aim slightly above a target on the right of a helicopter and slightly below a target on the left.

g The amount of compensation required increases as helicopter speed and angular deflection of the weapon increase.

h Compensation for projectile jump is not required when firing from a hover.

(5) Terminal ballistics defines the characteristics and effects of the projectiles at the target. Terminal ballistics have little influence on the 30mm projectile fired by the AWS.

Figure 72. DISPERSION

(6) Dispersion

(a) If several projectiles are fired from the same weapon with the same settings in elevation and deflection, their points of impact will be scattered about the mean point of impact of the group of rounds.

(b) The degree of scatter (range and azimuth) of these rounds is called dispersion. Turret bending is the single largest contributor to perceived dispersion associated with the 30mm cannon. Specifically, the airframe and gun-turret experience flexure in response to sustained recoil. The weapons processor provides compensation for this phenomenon . No compensation is required for the first round in a burst because recoil effects do not yet apply. The aiming point is adjusted for one-half of the bending table value for the second round in a burst. Full table values are applied thereafter until gunfire is terminated.

(c) The mean point of impact with respect to the target center, or intended air point, is an indication of the weapon's accuracy. Both dispersion and accuracy determine whether a particular weapon can hit an intended target.

1) Firing rockets at maximum ranges decreases range dispersion and normally increases accuracy. The reverse is true with other weapon systems; that is, as range increases, dispersion increases, and accuracy decreases.

2) Dispersion is caused by errors inherent in firing projectiles. These errors are influenced, in part, by the factors discussed. In addition, they may be influenced by the vibrations in the mount and the condition of the sighting systems.

a) Vibrations

1 Because mounts for weapons are fixed to the helicopter, vibrations in the helicopter transmit through the mounts.

2 These vibrations affect azimuth and elevation.

b) Sights

The condition of the sights and the accuracy of their alignment with the bore axes of the weapons cause a displacement of the dispersion pattern of the projectiles.

c) Boresight

1 Proper boresighting of aircraft weapons is critical to accurate fires. Improper boresighting is a factor in dispersion differences between like aircraft.

CHECK ON LEARNING

1. What are the four types of ballistics that affect helicopter-fired weapons?

ANSWER: _____

_____

2. What is turret bending and will the weapons processor compensate for this phenomenon?

ANSWER: _____

_____

3. The gunner must compensate for lead angle compensation when using which of the available sights; why?

ANSWER: _____

_____

4. What effect does the combination of trajectory shift and projectile shift produce?

ANSWER: _____

_____

5. How much compensation is required for projectile jump when firing from a hover?

ANSWER: _____

_____

F. ENABLING LEARNING OBJECTIVE 9

ACTION: Identify the safety and performance inhibits of the AWS.

CONDITIONS: Given a written test without the use of student notes or references.

STANDARD: In accordance with TM 1-1520-251-10 and TC 1-251.

1. Learning Step/Activity 1

Identify the safety and performance inhibits of the AWS.

SAFETY	PERFORMANCE	GENERIC
COINCIDENCE	BAL LIMIT	SAFE
AZ LIMIT		TXX
EL LIMIT		TRAINING
ALT LAUNCH		
LOS INVALID		

Figure 73. AWS Safety and Performance Inhibits

a. AWS safety and performance inhibits

(1) Gun constraints are organized into gun system safety, performance, and other inhibits.

(a) Gun system safety inhibits

1) Safety inhibits cannot be overridden.

2) The following will cause the WP to inhibit gun firing due to safety inhibits:

a) COINCIDENCE: The gun is out of coincidence; there is at least a 2-degree difference between the gun's actual azimuth and the selected LOS.

b) AZ LIMIT: The gun is at or beyond the defined limits in azimuth.

c) EL LIMIT: The gun is at or beyond the defined limits in elevation.

d) ALT LAUNCH: For 2.0 seconds following a missile or rocket launch.

e) LOS INVALID: The selected sight has failed or is invalid; additionally, because of the capability to shoot FCR targets with the M230E1 30mm automatic gun, the FCR target data must be valid for gun engagements.

(b) Gun performance inhibits

1) The following will cause the WP to inhibit gun firing at the first detent.

2) Performance inhibits can be overridden by a trigger pull to the second detent.

BAL LIMIT: Indicates range or other engagement parameters exceed the ballistics processing capability of the system.

(c) Generic HAD weapons inhibit status field messages

1) SAFE: Indicates that the weapons system has not been armed through the armament panel.

2) TXX: Displayed for 4 seconds to indicate the file address in which the coordinate data has been stored .

3) TRAINING: Displayed when the gun is in the WTM.

(2) Gun Limits

The WP will limit the gun travel from +11° to –60° in elevation and ± 86° in azimuth except as follows:

(a) If the gun is within 10° of the aircraft centerline, elevation is limited to +9.0°.

(b) If missiles are selected, and the priority missile is on the inboard rails of the inboard launcher, the WP limits the azimuth to –52° on that side.

(c) If rockets are selected, and the selected rocket type is in the inboard launcher, the WP limits the gun azimuth to –60° on that side.

(d) The WP will inhibit gun firing if a performance constraint is detected, and the weapons trigger is not depressed to the second detent.

CHECK ON LEARNING

1. The gun is inhibited for ____ after a missile or rocket launch.

ANSWER: _____

_____

2. What is the weapon inhibit status field message that indicates range or other engagement parameters exceed the ballistics processing capability of the system?

ANSWER: _____

_____

3. If missiles are selected, and the priority missile is on the inboard launcher, the WP limits the gun's firing azimuth to ____ on that side.

ANSWER: _____

_____

4. If rockets are selected, and the selected rocket type is in the inboard launcher, the WP limits the gun azimuth to _____.

ANSWER: _____

_____

5. How can performance inhibits be overridden?

ANSWER: _____

_____

NOTES: