DIGITAL COMBAT SIMULATOR

DCS: AH-64D

Quick Start Manual

AH-64D

EAGLE DYNAMICS

Updated 20 July 2022

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"GEORGE" AI 370

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LATEST CHANGES

Significant changes to the guide will be noted in this section.

20 July 2022 – Corrected typos/errors from initial release. Revised/updated and expanded AH-64 History, AH-64D Overview, and Combat Employment sections. Added Force Trim in DCS World sub-section. Added Aircraft Control section (describes FMC, SCAS and Hold mode functionality/logic). Added Laser-Guided Hellfire engagement (Ripple Fire) to Combat Employment section. Added Appendices for Glossary of Acronyms and Abbreviations, and Frequently Asked Questions.

Future updates planned – Revised/improved Aircraft Procedures and Navigation sections. Update MPD descriptions and George IFF behavior. Add Helicopter Fundamentals section and RLWR symbol/audio appendix.

HEALTH WARNING!

Please read before using this computer game or allowing your children to use it.

A very small proportion of people may experience a seizure or loss of consciousness when exposed to certain visual images, including flashing lights or that can occur in computer games. This may happen even with people who have no medical history of seizures, epilepsy, or "photosensitive epileptic seizures" while playing computer games.

These seizures have a variety of symptoms, including light-headedness, dizziness, disorientation, blurred vision, eye or face twitching, loss of consciousness or awareness.

Immediately stop playing and consult your doctor if you or your children experience any of the above symptoms.

The risk of seizures can be reduced if the following precautions are taken - this advice applies generally when playing computer games.

Do not play when you are drowsy or tired.

Play in a well-lit room.

Rest for at least 10 minutes per hour when playing.

INSTALLATION AND LAUNCH

You will need to be logged into Windows with Administrator rights to install DCS World and the DCS: AH-64D module.

After purchasing DCS: AH-64D from our e-Shop, start DCS World. Select the Module Manager icon at the top of the Main Menu. Upon selection, your AH-64 will automatically install.

The AH-64D module operates within the DCS World PC simulation. When you run DCS World, you in turn launch DCS: AH-64D. A map of the Caucasus region, the Su-25T Frogfoot attack aircraft, and TF-51 training aircraft are also included for free.

After clicking the DCS World icon on your desktop, the DCS World Main Menu screen opens. From the Main Menu, you can read DCS news, change your wallpaper by selecting the AH-64D icon at the bottom of the screen, or select any of the options along the right side of the screen. To get started quickly, you can select Instant Action and play any of the missions listed for the AH-64D.

GAME PROBLEMS

If you encounter a problem, particularly with controls, we suggest you back up and then delete the **`Saved Games\DCS\Config`** folder within your user directory, which is created by DCS on your operating system drive at first launch. Restart the game and this folder will be rebuilt automatically with default settings, including all the controller input profiles.

If problems persist, we suggest consulting our online technical support forums.

USEFUL LINKS

- DCS Homepage
- DCS: AH-64D Forum

CONFIGURE YOUR GAME

Before jumping into the AH-64D cockpit, we recommend configuring your game. To do so, select the Options button at the top of the Main Menu screen. You can read a detailed description of all Options in the DCS World Game Manual. For this Early Access Guide, we will just cover the basics.

Figure 1. DCS World Main Menu

Upon selecting the Options screen, you will see 7 tabs along the top of the page.

SYSTEM. Configure your graphics options for ideal performance. There are PRESET options along the bottom of the panel, but you can further adjust your graphics settings to best suit your computer. If you have a lower-performance PC, we suggest selecting the Low preset and then increasing graphics options incrementally.

Items that most affect performance include Visible Range, Resolution, and MSAA (Multisample Anti-Aliasing). If you wish to improve performance, you may want to adjust these System options.

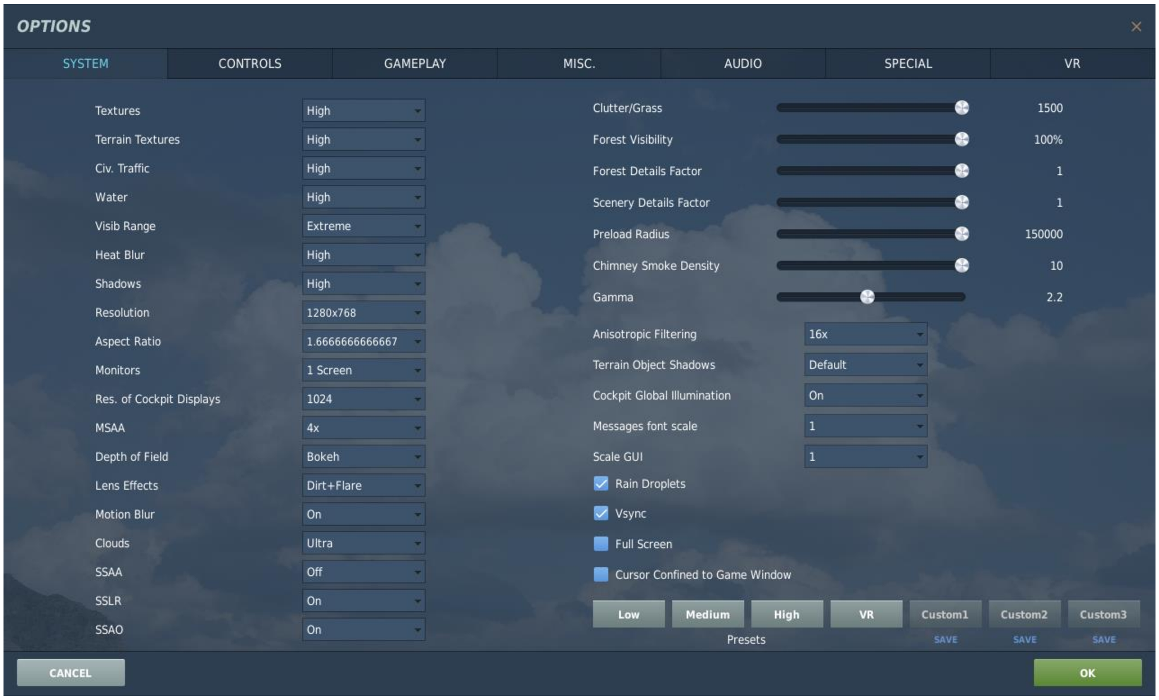


Figure 2. DCS World Options

CONTROLS. Set up your controls and functional bindings. Let's take a closer look at this tab:

First, select the "AH-64D Pilot", "AH-64D CP/G", or "AH-64D George AI Helper" using the Aircraft Selection drop-down in the top left-hand corner of your screen. Next, along the lower left side of the screen are all the ACTIONS associated with the selected commands. To the right are all the input devices that have been detected, including your keyboard, mouse, and any joysticks, throttles, or rudder pedals.

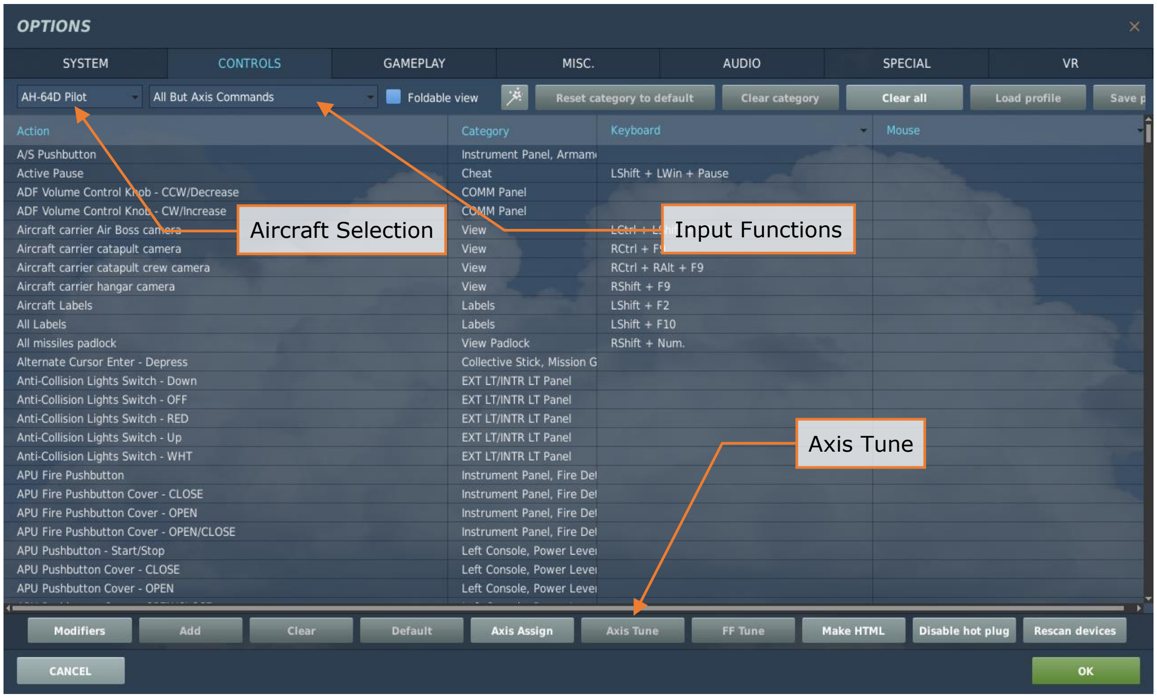


Figure 3. AH-64D Controls Tab

- **Aircraft Selection**. From this drop-down menu, select **AH-64D Pilot**, **AH-64D CP/G**, or **AH-64D George AI Helper**.
- **Input Functions**. This displays various categories of commands, including axis devices, views, and cockpit functions. Each row controls a different function, and each column is an input device. To assign a function or command, e.g. 'Weapon Action Switch – R/Left', choose an input device, and double-click in the cell aligned with the desired function and input device. Once selected, press the button or move the axis of the device to assign it.
    - If setting a pitch axis for a joystick, first select Axis Commands from the Categories drop-down. Find the cell where your joystick and the Pitch axis intersect and double-click in the box. In the Add Assignment panel, move your joystick forward and back to assign the axis. Press OK when done.
    - If setting up HOTAS (Hands On Throttle And Stick) commands (e.g., to change symbology modes), first select the All category. Find the cell where your input device and the 'Symbology Select Switch – Up' action intersects, then double-click in the box. In the Add Assignment panel, press the keyboard or controller button you wish to assign to the action. Press OK when done.
- **Axis Tune**. When assigning an axis (for example the X and Y axes for a joystick), you can use this panel to assign a deadzone, response curve, and

other tuning. This can be very useful if you find the aircraft too sensitive to control. The most common and useful functions to adjust are Deadzone, Response Curve, Saturation Y, and Invert.

GAMEPLAY. This tab primarily allows you to adjust the game to be as realistic or as casual as you'd like. Choose from many difficulty settings like labels, tooltips, unlimited fuel/weapons, etc. Turning the aircraft's Mirrors "Off" can help improve performance.

MISC. These are additional settings to alter your game experience.

AUDIO. Use this tab to adjust the audio levels of the game. You also have the option to turn on and off different audio effects.

SPECIAL. Use this to adjust settings specific to DCS: AH-64D to suit your preferences.

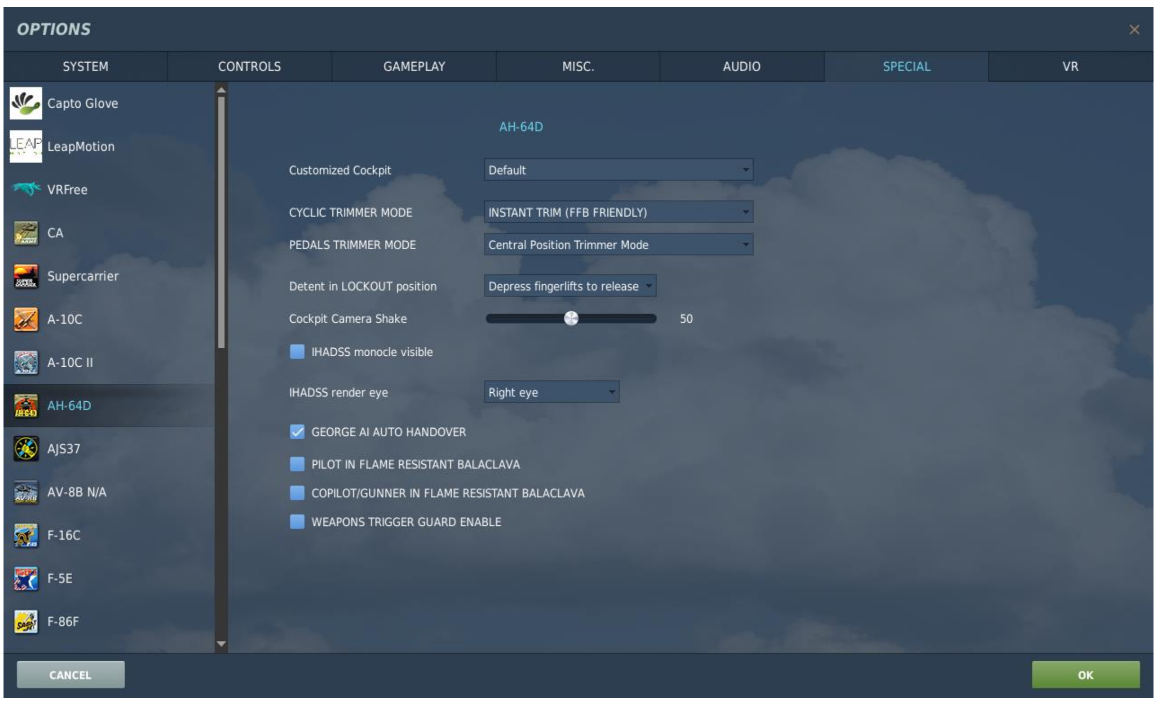


Figure 4. AH-64D Special Tab

- **Customized Cockpit**. "Default" (English) is currently the only available cockpit option.
- **Cyclic Trimmer Mode**. This selection provides options for simulating force trim functions for various types of input devices.
    - Instant Trim (FFB Friendly) – As soon as the Force Trim Release button (trimmer) is released, the new trimmed position of the player's stick will be applied immediately.

  - Central Position Trimmer Mode – After the Force Trim Release button (trimmer) is released, the new trimmed position of the player’s stick will be applied immediately; however any further control inputs will only be applied in each axis after the stick is returned to the neutral position in that axis (pitch and roll are read separately).
  - Joystick Without Springs and FFB – This option is used for joysticks lacking any spring resistance or Force-Feedback (FFB).

- **Pedals Trimmer Mode**. This selection provides the same trimming options as the Cyclic Trimmer Mode but applied to player pedal devices.
- **Detent in LOCKOUT position**.
  - Automatically Jump Over – This option will move the engine quadrant power levers past the FLY position and into LOCKOUT without any detents applied. Recommended for player throttles equipped with physical detents.
  - Depress Finger Lifts to Release Locks – This option will move the engine quadrant power levers past the FLY position and into LOCKOUT only when the Power Lever Finger Lift detent commands are used. Recommended for player throttles that lack physical detents.
- **Cockpit Camera Shake.** Adjusts the intensity of physics applied to moveable cockpit elements.
- **IHADSS monocle visible.** When enabled, a “ghost HDU” outline around the IHADSS symbology will be displayed to simulate the physical obstruction of the HDU monocle. When disabled, only the IHADSS symbology itself will be displayed.
- **IHADSS render eye.** Selects between rendering the IHADSS symbology in either the left or right VR eyepiece, or both eyepieces simultaneously.
- **George AI Auto-Handover.** When enabled, when the player switches position to the front (CPG) seat, George AI will automatically take control of the helicopter flight controls. If disabled, the player will still retain flight control of the helicopter when switching between seats and will need to command George AI when to take the flight controls.
- **Pilot in Flame Resistant Balaclava.** When enabled, the 3D model of the pilot will wear a flame-resistant balaclava.
- **Copilot/Gunner in Flame Resistant Balaclava.** When enabled, the 3D model of the Copilot/Gunner will wear a flame-resistant balaclava.
- **Weapons Trigger Guard Enable.** When enabled, the cyclic trigger guard key commands must be used prior to pulling the trigger. Any time the trigger guards are in the closed position, the cyclic triggers will not respond to key commands. When disabled, the trigger guard positions are ignored,

allowing the player to fire an actioned weapon without a requirement to open the trigger guard prior to pulling the trigger.

VR. The VR tab allows you to enable support for VR headsets. When using VR, be particularly aware of the Pixel Density setting, as it can have a dramatic effect on game performance.

FORCE TRIM IN DCS WORLD

Most helicopters are rarely flown with either the cyclic or the pedals in the neutral position. Many helicopters feature a "force trim" system to reduce pilot workload. Such systems produce a force gradient which maintains the position of the cyclic (and pedals in some cases) using springs or magnetic brakes. The pilot can apply pressure against this force gradient if desired, or they can release the pressure entirely by pressing a button on the cyclic. When this button is no longer pressed, the force gradient is re-applied and holds the controls at their new position(s). This button is often called the "force trim release" or "force trim interrupt" button since it releases or interrupts the force gradient holding the controls in place (the term "Trimmer" is also used to describe this button).

The closest simulation of real-world force trim functionality is facilitated through the use of force-feedback gaming sticks. However, since most flight simulation enthusiasts use more conventional spring-centered joysticks, a special trim function is available in the simulation, with several variation options available to the player. These variable options are set using the Cyclic Trimmer Mode and Pedals Trimmer Mode drop-down selections (described above), but the underlying logic is based around establishing a new "center point" for the cyclic and pedals.

To trim the controls in their current position, press and release the "Trimmer" button, then immediately return the stick and pedals to their neutral positions. It is recommended that players unfamiliar with this force trim simulation spend some time in the cockpit on Active Pause **[LShift + Lwin + Pause]** or while sitting on the ground and observe the behavior of the simulated controls within the cockpit relative to their physical controls in their hands.

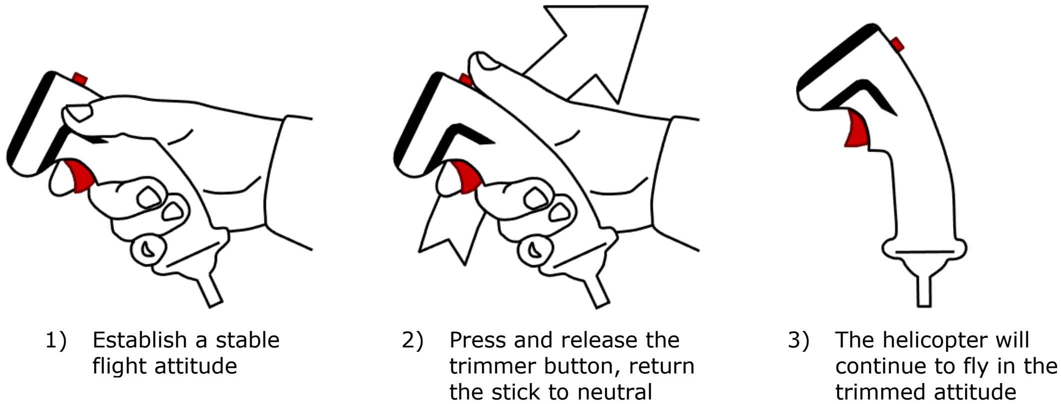


Figure 5. Trimming Procedure

Another means to observe this simulated trimming procedure is to display the Controls Indicator overlay while in game by pressing **[RCtrl + Enter]**.

You can reset trim at any time by pressing **[LCtrl + T]** which will re-synchronize the simulated controls within DCS World with your physical joystick and/or pedals.

Author's Note regarding Trimmer options in DCS: AH-64D

Due to the nature of the AH-64D Flight Management Computer and its associated breakout values and hold mode logic (described in the Aircraft Control section, specifically in the Force Trim & "Breakout" Values and Hold Modes sub-sections), the Trimmer options that are most conducive to interacting with the hold modes are the "Central Position Trimmer Modes". However, during fast-paced action while performing low altitude flight maneuvers or evading enemy fire, it can become mentally counter-intuitive to reposition the stick to the neutral state when instinctive action dictates that you make an input in the opposite direction away from center.

For these reasons, when using a spring-centered cyclic stick and rudder pedals, the author recommends using "Instant Trim (FFB Friendly)" for the Cyclic option, but "Central Position Trimmer Mode" for the Pedal option; since most individuals lack the same physical dexterity and control precision in their feet as compared to their hands. Regardless, it is encouraged that each player tries the different options to assess which Trimmer modes best suit their personal preferences and specific input devices.

NOTE ABOUT THIS MANUAL

(N/I). This denotes a system or function of the DCS: AH-64D within this manual that is not implemented.

AH-64 HISTORY

The AH-64D is the second generation of the AH-64 heritage, which began with the Advanced Aerial Fire Support System program in 1963, culminating in the AH-64A in 1983. The AH-64D design was completed in 1997, centered around the AN/APG-78 fire control radar and an upgraded communications system that permitted the sharing of targeting data between aircraft within the team.

THE KEY WEST AGREEMENT

In 1948, James V. Forrestal, the first U.S. Secretary of Defense, drafted the Key West Agreement, which codified the separation of air assets between the Army and the newly founded US Air Force. In particular, it limited Army Aviation to employing fixed-wing aircraft below 2,500 pounds weight and helicopters below 4,000 pounds. It was believed that the Air Force would provide for the close air support (CAS) role with a new generation of modern multirole fighter aircraft.

In 1960, President Kennedy's Secretary of Defense, Robert S. McNamara, revisited this agreement by starting the Army Tactical Mobility Requirements Board. The Board and its chairman, Lt. Gen. Hamilton H. Howze, recommended that Army Aviation be greatly expanded to include a well-developed attack role, among many others. McNamara followed the board's recommendation, which produced an immediate rebuke from Air Force generals, insistent that fighters were the only effective CAS platforms.

Army leadership was eager to demonstrate otherwise, having noted the success of armed UH-1 Hueys. To that end, in 1963, the Army founded the Advanced Aerial Fire Support System (AAFSS), to design a purpose-built attack helicopter, rather than an armed variant of a utility helicopter. In 1964, the request for proposals (RFP) was announced, and in 1968, Lockheed won the competition with its proposal for the AH-56A Cheyenne, a close air support gunship.

AH-56 Cheyenne (US Army)

In the late 1960s, the US military's strategic concern shifted to the large numbers of tanks that Warsaw Pact countries could employ in a European ground war. Thus, aircraft development priority changed from close air support to the anti-tank role. In response to this shift, the US Air Force founded the A-X program (which would eventually result in the A-10A "Warthog"), and in 1972, the Army canceled development of the AH-56 in favor of a program to develop a more capable anti-tank platform.

ADVANCED ATTACK HELICOPTER PROGRAM

The Army's project to build an anti-tank helicopter was called the Advanced Attack Helicopter (AAH) program, and it was aimed at designing a capable replacement for the AH-1 Cobra, the Army's light attack helicopter of the period.

The AAH RFP was announced in November 1972, specifying that the helicopter would need to operate at night at extremely low altitudes, should utilize the same General Electric T700 engine as the Utility Tactical Transport Aircraft System (which would eventually be won by the UH-60 Blackhawk), and should be armed with a 30mm cannon and sixteen anti-tank TOW missiles. Later, as the separately developed AGM-114 Hellfire missile neared completion, the RFP was modified to include a requirement to carry sixteen Hellfires in place of the TOW missiles.

Bell, Boeing, Vertol/Grumman, Hughes, Lockheed, and Sikorsky all submitted proposals for the AAH program, and in July of 1973, the Department of Defense chose the Hughes Model 77 and the Bell Model 409 to be built and compete for the contract. A few months later, the Army designated the AAH program as one of its "Big Five" top priority projects, reflecting the importance of developing a capable anti-tank helicopter.

Bell Model 409 (US Army)

The Bell Model 409, designated the YAH-63, first flew on September 30, 1975, and the Hughes Model 77 (designated YAH-64) first flew only a day later. After a series of trials, the Army decided to move ahead with the YAH-64, citing its increased survivability over the YAH-63 stemming from the YAH-64's four-blade main rotor and tailwheel landing gear configuration.

Hughes Model 77 (US Army)

AH-64A

Per Phase Two of the AAH program, the YAH-64 entered pre-production. In Phase Two, the YAH-64 airframe was integrated with the weapons and sensor platforms it would employ, in particular the AGM-114, which would be the cornerstone anti-tank missile for the helicopter. During pre-production, the aircraft was re-designated the AH-64A.

The AH-64A was equipped with a revolutionary new targeting system, called the Target Acquisition Designation Sight (TADS). It was designed to allow aircrews to acquire targets and aim the 30mm cannon using a helmet-mounted sight. Combined with the Pilot Night Vision System (PNVS), the helmet-mounted display made the AH-64A a lethal day and night attack vehicle.

YAH-64A (US Army)

Following pre-production, in 1981, three AH-64As were delivered to the Army for Operational Test II. The engines were upgraded to the newer T700-GE-701, with a shaft horsepower of 1,690 shp.

In 1982, the Army approved the AH-64A for full-scale production, and in 1983, the first production AH-64A rolled off the line at Hughes's production facility in Mesa, Arizona. In January 1984, the Army took delivery of its first production AH-64A, and in March 1986, began training its first operational AH-64A unit, the 7th Battalion, 17th Cavalry Brigade, in Ft. Hood, Texas.

AH-64A (US Army)

The AH-64A first saw combat in 1989 as part of Operation Just Cause, the US invasion of Panama. In 1991, two teams of AH-64As from the 101st Airborne Division and U.S. Air Force MH-53 Pave Low helicopters struck the first targets in Iraq during the first hours of Operation Desert Storm.

Guided by the precision GPS navigation units on board the MH-53's across the featureless desert, the teams of AH-64's approached two separate Early Warning Radar sites along the border between Saudi Arabia and Iraq. Flying radio silent, each AH-64 aircrew acquired their assigned targets through their Forward-Looking Infrared (FLIR) sensors. With a single radio call, the attack commenced with an onslaught of Hellfire missiles, followed by rockets and 30mm fire. Within minutes, the radar sites were disabled, and hundreds of coalition aircraft streamed through the gap in radar coverage to begin the air campaign against the Iraqi military.

In all, over one thousand AH-64As were produced, most of which have since been upgraded to the D model. The variant served until July 2012, when the last A model was taken out of service for upgrades.

AH-64A's during Desert Shield (US DoD)

AH-64D

Following Operation Desert Storm, McDonnell-Douglas (which had since acquired Hughes) proposed the AH-64B upgrade, which would incorporate a modernized cockpit and fire control system as well as new rotor blades. The program was approved and funded by Congress but was canceled merely a year later in favor of the AH-64D proposal, which promised a much more ambitious upgrade to the aircraft.

AH-64D (US Army)

The AH-64D incorporated upgraded engines and an expanded fuselage to house an entirely new suite of sensors. Most notable was the addition of the AN/APG-78 fire control radar, mounted above the main rotor, making many D models immediately identifiable. In addition, the AH-64D was upgraded with a new communications suite that included an Improved Data Modem (IDM) and integrated SINCGARS radios, avionics supporting a MIL-STD 1553B data bus, a modern "glass" cockpit equipped with multi-purpose displays, and the ability to fire the radar-guided AGM-114L Hellfire missile.

The first prototype D model was flown in April of 1992, and by 1995, testing had concluded, and full-scale production began. The first AH-64D was delivered to the U.S. Army on March 31, 1997.

Since August 1997, Boeing (which acquired McDonnell-Douglas) has produced AH-64D's domestically for the United States and for foreign partners. Partnered with

Boeing, AgustaWestland produced AH-64D's (designated AH Mk1) for the United Kingdom, and Fuji Heavy Industries produced AH-64D's (designated AH-64DJP) for the Japanese Ground Self Defense Force. Along with the US, UK, and Japan, the AH-64D is also operated by the militaries of the Netherlands, Greece, Israel, United Arab Emirates, Singapore, Saudi Arabia, Kuwait, and Egypt.

UK Army Air Corp AH Mk1 (UK MOD)

RNLAF AH-64D's in Afghanistan (RNLAF)

Along with building new D models, the U.S. Army also awarded McDonnell-Douglas a $1.9 billion contract to upgrade existing AH-64As to Ds. Starting in August of 1997, Boeing has since upgraded all U.S. Army AH-64A's to D models. In all, 2,400 AH-64's have been produced since 1975; over a thousand of them AH-64D's.

UAE Joint Aviation Command AH-64D (US Navy)

AH-64D OVERVIEW

The Boeing AH-64D is a two-person day/night attack helicopter initially developed by Hughes Aircraft Company for the U.S. Army. The helicopter was originally designed for the anti-tank role, employing the AGM-114 Hellfire missile as its primary weapon. Its design incorporates significant survivability and systems redundancy after lessons learned in the Vietnam war.

The AH-64D provides the U.S Army (and other militaries) with one of the most maneuverable, survivable, and heavily armed rotary-winged aircraft on the modern battlefield.

DCS: AH-64D features a U.S. Army AH-64D Block 2 in service between the years of 2005-2010. The DCS: AH-64D simulates Lot 9.1 avionics, which was fielded in 2005, along with additional equipment that was fielded to the U.S Army fleet between 2005 and 2007, such as the Modernized TADS (M-TADS), Common Missile Warning System (CMWS), and revised engine exhaust assemblies.

COCKPIT

The AH-64D has two cockpits in tandem. The aft cockpit is for the Pilot (PLT), and the forward cockpit is for the Copilot/Gunner (CPG). Flight controls and weapons controls are installed for both crewmembers, but some targeting and weapon employment controls are only installed in the CPG cockpit.

Both cockpit seats are protected with ballistic shielding, and an additional ballistic shield sits between the two cockpits. Each crewmember sits within an armored seat that is mounted on compressible pistons that stroke vertically during high-speed vertical impacts. Coupled with the stroking action of the landing gear, this system is designed to attenuate the forces translated to the crewmembers' spines, resulting in higher survival rates during crash sequences.

Both cockpit canopies consist of two heated glass windshield and five acrylic side panels. The canopies open upward and to the side for ingress and egress, and latch for flight. Improper latching is detected and annunciated by the onboard avionics.

For emergency egress, both cockpits include a canopy jettison system. Jettison handles are installed for the Pilot and CPG, as well as an exterior jettison handle for rescue personnel. The jettison system consists of a detonating cord that ejects four of the acrylic side panels for crew egress.

FUSELAGE

The AH-64D fuselage is armored in strategic locations, with 2,500 pounds of ballistic shielding designed to sustain hits from projectiles up to 23mm in caliber. The aft fuselage includes three integral fire/overheat detectors: one adjacent the main transmission, and one on each firewall louver door (where transmission oil is cooled). The indication of a fire in these areas will trigger a visual and audio warning to the crew.

Critical system relays and wiring are installed in opposing areas, permitting redundancy within the avionics in the case of computer failure or damage. Each processor group is composed of two individual computers: one primary and one backup. If the primary processor fails or is damaged from weapons fire, the backup processor immediately takes over the required computing tasks.

ENGINES

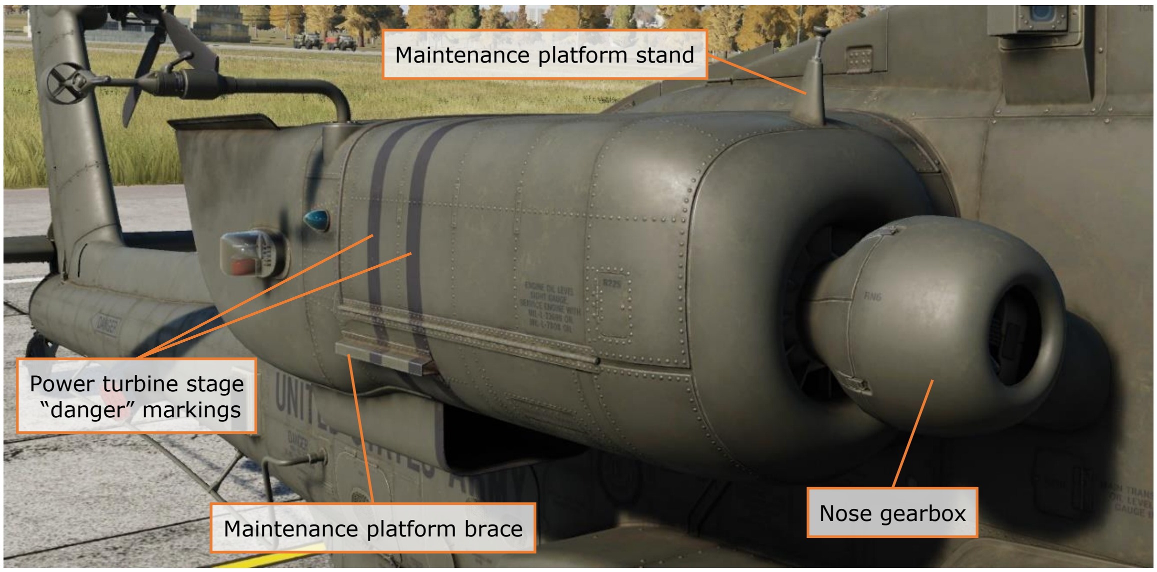
The AH-64D is powered by two General Electric T700-GE-701C turboshaft engines, each generating 1,940 shaft horsepower. The engines are front drive and regulated by a Digital Electronic Control (DEC) and Hydro-Mechanical Unit (HMU) integral with each engine. Each engine consists of a cold section, hot section, power turbine section, and accessory section.

The cold section consists of an inlet particle separator for dust and sand protection, six-stage compressor, variable inlet guide vanes (IGVs), and variable stator vanes. The DEC is mounted to the cold section.

The hot section consists of the annular combustor, nozzle assembly and gas generator turbine stages. The gas generator is connected to the cold section's compressor through a central shaft, which rotates the compressor stage to produce self-sustaining engine power.

The power turbine section consists of two turbine stages and the exhaust frame. The power turbine shaft rotates within the gas generator compressor shaft and runs the full length of the engine to the front-mounted nose gearbox. The engine turbine gas temperature (TGT) thermocouples are mounted to this stage, just aft of the gas generator stages, along with the engine speed and torque sensors that provide cockpit indications of N_P and TQ respectfully.

The accessory section includes the HMU, N_G speed sensor, fuel boost pump, oil system, and the Air Turbine Starter. Each engine's nose-mounted reduction gearbox powers the main transmission through an over-running "sprag" clutch that will disengage the engine from the main transmission if the powertrain system is operating at a higher RPM than the engine power turbine.



Digital Engine Computer and Hydromechanical Unit

The DEC and HMU work together to manage each engine, setting power based on the position of the power levers and collective handles. The power lever position is mechanically transmitted to the HMU via a Power Available Spindle (PAS), and the collective position mechanically via a Load Demand Spindle (LDS). During normal operation, the HMU controls fuel flow to the combustor according to the PAS and LDS. The HMU also schedules the inlet guide vanes, controls the anti-ice and start bleed valve, and regulates discharge air pressure and N_G (gas generator RPM). The HMU includes an automatic N_G overspeed cut-off that will flame out the engine to prevent an engine overspeed.

The DEC coordinates automatic torque load-sharing between the two engines, monitors N_P (power turbine RPM), and limits turbine gas temperature (TGT). Like the HMU's automatic N_G overspeed cut-off, the DEC has an automatic N_P overspeed cut-off. The DEC is normally powered by the engine's alternator but can use aircraft power as a backup. The DEC for each engine can be disabled by placing the engine's power lever into the "lock-out" position momentarily.

The DEC has a contingency power feature that automatically activates during single-engine operations. If an engine fails, the DEC of the opposite engine increases the TGT limiter of the remaining engine automatically.

During high-torque maneuvers (e.g., left pedal turns with no change in collective position), the DEC's maximum torque rate attenuator (MTRA) will automatically reduce fuel flow to assist in preventing an over torque.

Starter System

The starter system consists of a pneumatic starter valve, an ignition system with two igniter plugs, and the DEC. Pneumatic pressure for engine start can be supplied by the Auxiliary Power Unit (APU), Aircraft Ground Power Unit (AGPU), or a running engine (cross-bleed start).

During engine start, the DEC will monitor engine parameters and automatically abort the start if an imminent hot start is detected.

Fire Protection System

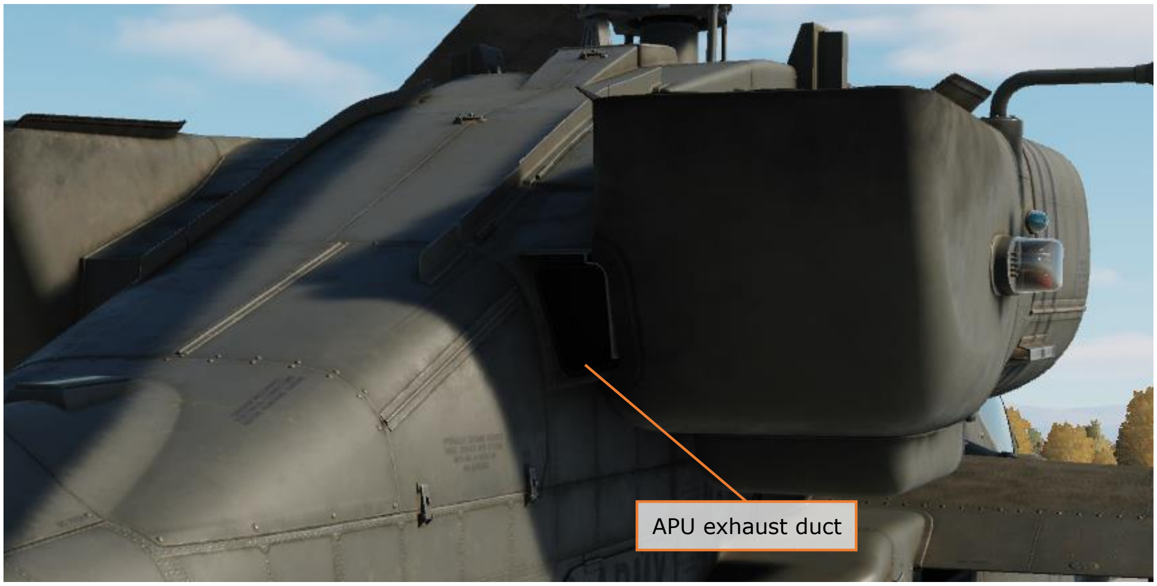
Engine fire detection is provided by two optical flame detectors in each engine compartment, and two in the APU compartment. Two nitrogen fire bottles provide fire suppression. The bottles, labeled PRI (primary) and RES (reserve), can be discharged into either engine or the APU.

Auxiliary Power Unit (APU)

The APU is a self-contained gas generator that can power the accessory section of the main transmission to generate electric and hydraulic power, as well as pressurized air, without the need for engine power. The APU is primarily used to start the engines without requiring external ground power sources but can be used as an auxiliary source of electric or hydraulic power.

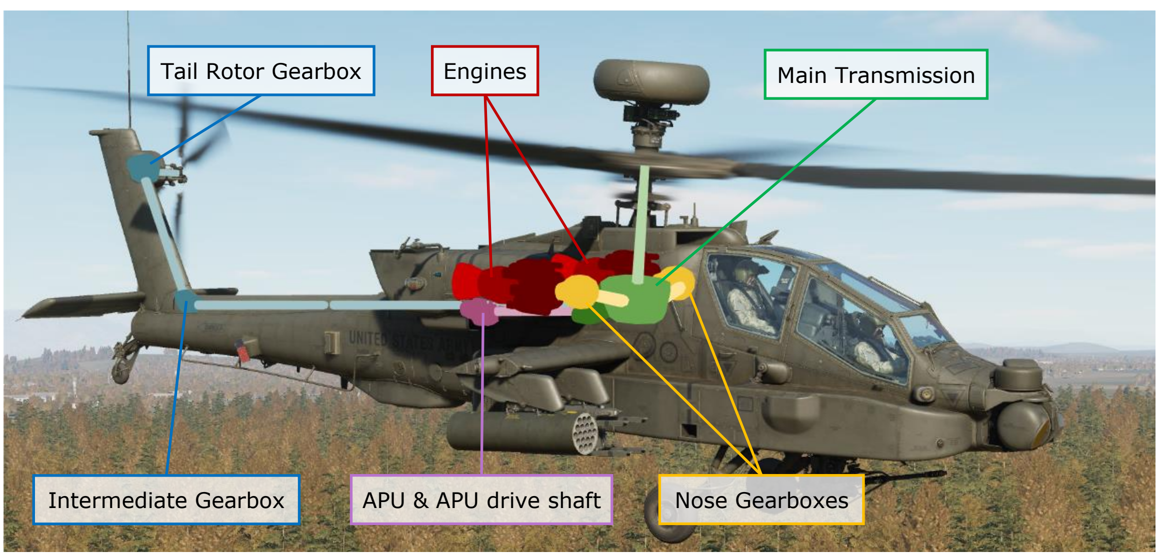
The APU draws fuel from the aft fuel cell only and consumes approximately 175 pounds per hour when active.

The APU is automatically monitored by an Electronic Control Unit (ECU), which detects overspeed and overcurrent anomalies, as well as abnormal oil pressure. The ECU will automatically shut down the APU when an anomaly is detected. The ECU also controls the power takeoff (PTO) clutch engagement to the accessory section of the main transmission.



DRIVETRAIN

The main rotor drive system consists of the main rotor drive shaft, main rotor transmission, three-stage reduction gearing, and dual independent integral oil systems. The main transmission receives power from two nose gearbox inputs, one mounted on each turboshaft engine. The main transmission is used to drive the main rotor.



An accessory gearbox is mounted to the aft side of the main transmission. This gearbox provides mechanical power to the aircraft's two electrical AC generators and two hydraulic pumps, one for the Primary hydraulic system and the other for the Utility hydraulic system. This prevents the loss of generator and hydraulic power during an autorotation when both engines have failed. The APU powers the transmission's accessory gearbox via the APU drive shaft, which provides full electrical power to the aircraft avionics and hydraulic power to the flight controls prior to starting the main engines. The accessory gearbox also includes the rotor brake and the main rotor RPM (N_R) sensor.

The tail rotor drive system consists of the tail rotor drive shaft, intermediate gearbox, and tail rotor gearbox. The tail rotor drive shaft consists of four sections within the tail boom. The sections are connected with flexible couplings and mounted with hanger bearings to accommodate aerodynamic and maneuvering loads from the tail boom. The intermediate gearbox is at the base of the vertical stabilizer, and the tail rotor gearbox is at the base of the tail rotor static mast. Both gearboxes reduce the transmission RPM and change the angle of the drive.

The main and tail rotor drive shafts are designed to carry torque loads only. Each of these shafts pass through and rotate within a static mast. The main rotor static mast carries all vertical and bending loads, and the tail rotor static mast absorbs all tail rotor loads. This allows the aircraft to perform aggressive or aerobatic maneuvers while minimizing stresses to the drive train system.

ROTORS

The AH-64D has a four-blade main rotor for lift and propulsion, and a four-blade tail rotor for anti-torque and directional control.

The main rotor is fully articulated, with each blade able to flap, feather, lead, and lag independently. Mechanical droop stops limit blade droop.

The four-blade tail rotor is semi-rigid of a teetering design. Each opposing pair of rotor blades are offset at 55° for ease of maintenance and to increase tail rotor efficiency. Flapping and feathering of the tail rotor to counter dissymmetry of lift in forward flight is facilitated by the use of a delta hinge installed to each pair of tail rotor blades.

FLIGHT CONTROLS

AH-64D flight controls are hydromechanical, consisting of mechanical linkages between the flight controls and control surfaces, augmented by transmission-driven hydraulic power. The flight controls are conventional and consist of a cyclic, collective, and anti-torque pedals.

The cyclic is mechanically connected to a swashplate on the rotor mast that tilts the main rotor. The collective is mechanically connected to the Load Demand Spindle (LDS) and directly controls rotor blade pitch. The anti-torque pedals control tail rotor blade pitch.

Hydraulic augmentation is provided by the Stability and Control Augmentation System (SCAS), which consists of electro-hydraulic actuators controlled by the Flight Management Computer (FMC). The FMC provides rate damping to smooth flight control inputs and command augmentation. It also provides limited attitude and altitude hold capability for hands-off flying. The command augmentation system provides consistent control feel across the full range of helicopter airspeeds.

The AH-64D has an articulating horizontal stabilator controlled by an electric actuator. The horizontal stabilator improves pitch angle control and improves over-the-nose visibility at low airspeeds. In automatic mode, the FMC schedules the horizontal stabilator position according to collective position, airspeed, and pitch rate. In nap of the earth (NOE)/approach mode, the horizontal stabilator is driven to the 25° trailing edge down position when below 80 knots, to further improve over-the-nose visibility. In manual mode, the Pilot controls stabilator position with a switch on the collective.

To ease pilot workload, a force trim system is provided for the cyclic. The force trim system consists of lateral and longitudinal force trim springs and magnetic solenoids that engage and disengage the force trim. A button on the cyclic disengages the force trim system, allowing the cyclic to move freely without resistance. When re-engaged, the force trim springs hold the cyclic in its current position and provide an increasing force gradient as the cyclic is deflected away from this center point.

Back-Up Control System (BUCS)

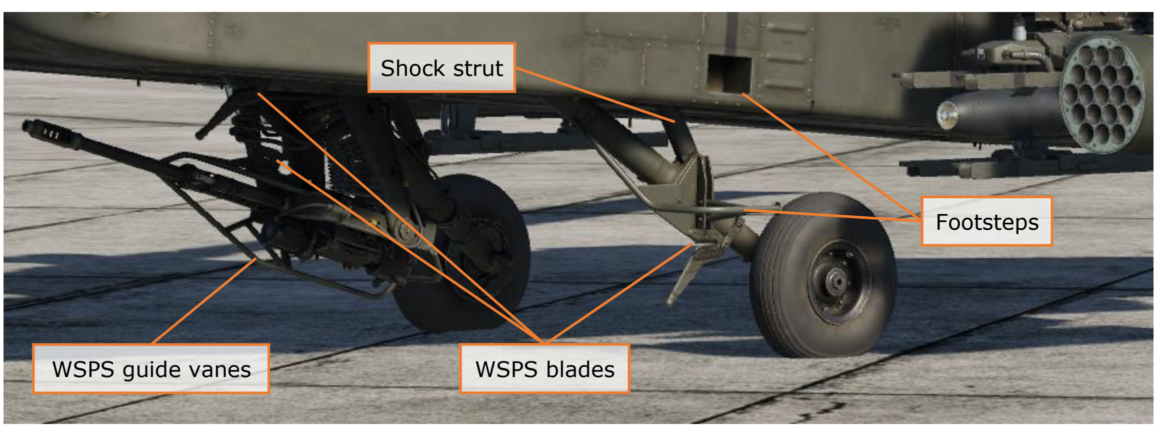
Normally, the Pilot and CPG flight controls are mechanically linked. The mechanical linkages are protected by shear pins and mis-track sensors to prevent a control jam or severance from affecting both sets of flight controls.

If the flight controls are decoupled by the shear pin, or a mis-track is otherwise sensed, the Back-Up Control System is automatically activated. The BUCS is a single-channel, four-axis, non-redundant electric fly-by-wire (FBW) system. The FBW system is designed to replicate the feel of the hydromechanical controls but does not replicate SCAS functionality.

BUCS can only be active for the Pilot or the CPG station. Either the Pilot or the CPG can transfer BUCS control to their station if necessary, depending on the nature and location of the jam or severance within the flight controls.

Landing Gear

The AH-64D has two trailing-link main landing gear (MLG) wheels and a lockable, free-castoring tailwheel. The MLG consists of left and right wheels and tires with integral disc brakes, mounted on separate nitrogen-oil shock struts.



Each anti-torque pedal is connected to a hydraulic disc brake on the corresponding MLG wheel. Each MLG brake is connected to its own master cylinder, which provides hydraulic pressure to the braking system. The Pilot and CPG anti-torque pedals, when pressed downwards, actuate the hydraulic brake system for the corresponding wheel. A parking brake valve maintains brake pressure when closed.

The tailwheel is free-castoring in the full 360° of motion. A spring-loaded tailwheel lock can be hydraulically actuated to hold the tailwheel in position. The tailwheel lock is activated from the collective flight grips or the tail wheel lock pushbuttons.

Both main landing gear shock struts have a one-time capability to absorb loads from a high-stress impact. Shear rings and rupture discs on each strut, when activated by a hard landing, start a controlled collapse of the strut to reduce crash loads on the airframe.

FUEL SYSTEM

The AH-64D includes two internal self-sealing, crash-resistant fuel cells. The forward fuel cell holds up to 156 gallons, and the aft fuel cell holds up to 220 gallons. Fuel is normally balanced between the two cells automatically by the avionics.

A 230-gallon external fuel tank can be mounted on each of the four stub wing pylons. The external fuel tank mounted under the left inboard pylon feeds the forward fuel cell, and external fuel tank mounted under the right inboard pylon feeds the aft fuel cell. If an additional two fuel tanks are mounted under the outboard pylons, the outboard external fuel tanks feed fuel to the inboard-mounted external fuel tanks.

An Internal Auxiliary Fuel System (IAFS) can be installed into the ammunition bay, storing 98 gallons at the expense of reducing the 1200 round ammunition capacity to 300 rounds.

Fuel Transfer Subsystem

Fuel is transferred between the forward and aft cells using pneumatic pressure. Transfer is normally automatic but can be manually controlled by the aircrew.

Fuel transfer from the IAFS or external tanks is one-way only. Transfer from the external tanks to the internal cells is pneumatic, and an electric fuel pump transfers fuel from the IAFS to the internal cells. If fuel is being transferred between the forward and aft fuel cells, any fuel transfer from external or internal fuel systems will be paused.

Normally, the forward cell feeds engine 1 and the aft cell feeds engine 2. The aircrew can control crossfeed modes, where both engines feed from one fuel cell, as necessary in abnormal circumstances.

An electric boost pump is used to provide motive flow from the aft cell during engine start. This boost pump can also be manually selected on during an emergency or operations in extreme cold temperatures. The APU has its own electric boost pump that also draws from the aft cell.

Nitrogen Inerting Unit (NIU)

The fuel cells are inerted using nitrogen to reduce the risk of fire. The NIU is completely self-contained and automatic. It uses aircraft power and pressurized air and generates an inerted mix containing around 99% nitrogen. This inerted gas is used to pressurize the internal cells. It is also routed to the IAFS during fuel transfer.

ELECTRICAL SYSTEM

Electrical aircraft power is managed by the Electrical Power Management System (EPMS). The EPMS is a fully redundant and automatic power system consisting of a distributor for battery, AC, and DC power.

The battery is a 24-volt, 15-amp fiber nickel-cadmium (FNC) design. It can provide power for normal flight loads for up to 12 minutes, assuming at least an 80% charge.

AC power is provided by two brushless, air-cooled generators. Each generator outputs 45 kVA three-phase four-wire power at 115 or 200 volts and 400 Hz. Each generator has its own Generator Control Unit (GCU). A single generator is capable of handling full flight loads without shedding. The generators are mounted to the transmission accessory gearbox.

DC power is provided by two Transformer-Rectifier Units (TRUs), each providing 28 volts and 350 amps of DC power. Like the generators, a single TRU can provide sufficient power for full flight loads without shedding.

An external power receptacle can provide DC and AC power for all systems from an AGPU.

Power is distributed by four AC busses, four DC busses, four battery busses, and a battery hot bus. Each bus and power consumer is protected by a resettable circuit breaker.

HYDRAULIC SYSTEM

The AH-64D has two independent hydraulic systems, labeled Primary and Utility. The Primary system exclusively powers the hydraulic flight control system via the FMC. It's powered by the main transmission and has a total capacity of six pints with a one-pint reservoir.

The Utility system is a secondary source of hydraulic power for the flight controls (bypassing the FMC), and powers all other hydraulic systems: rotor brake, area weapon turret drive, ammunition handling system, APU start motor, tailwheel unlock actuator, and external stores elevation actuators. The utility system is also powered by the main transmission. Because of the higher loads placed on the utility system, it has a higher-volume manifold and larger reservoir.

The utility system also charges a 3,000-psi hydraulic accumulator. The hydraulic accumulator is used to provide hydraulic damping during gun fire, hydraulic power to the rotor brake and APU starter, and can be used to temporarily power the flight controls via the utility system in an emergency.

INTEGRATED PRESSURIZED AIR SYSTEM (IPAS)

The IPAS provides pressurized air to aircraft pneumatic systems. Bleed air is drawn from two ports: a high-pressure port is exclusively used to pressurize the hydraulic systems, and a low-pressure port is used by all other consumers. Low-pressure air is used by the engine air turbine starters, fuel boost and transfer pumps, anti-ice system, ice detection probe, nitrogen inerting unit, vapor cycle cooling system, and environmental control system.

IPAS bleed air can be provided by one or both engines, the APU, or an external source such as an AGPU.

ANTI-ICE SYSTEM

Ice detection is provided by an aspirating ice detect probe, powered by pneumatic air from the IPAS. The ice detect probe activates whenever free air temperature drops to 5° C or below. When the anti-ice system is in AUTO mode, detection of ice will automatically command activation of all anti-ice systems.

Ice protection is provided by engine inlet anti-ice from main engine bleed air, electrical heat to the pitot and air data system (ADS) sensors, electric sensor aperture anti-ice, and electrically heated canopies.

The canopies also include crewmember-controllable windshield wipers and a defog system powered by the IPAS.

ENVIRONMENTAL CONTROL SYSTEM (ECS)

The ECS provides crewmember comfort through ventilation, heating, and air conditioning. Ventilation is provided by Pilot and CPG gaspers, which can be opened to admit outside air into the cockpit. The ECS also powers ventilation fans that provide forced air exchange between the cockpits and for avionics cooling.

Cockpit heating is provided by regulated bleed air from the IPAS.

Air conditioning is provided from two independent vapor cycle cooling systems. One system provides cooled air for the Pilot and aft sections of each Extended Forward Avionics Bay (EFAB); the other system provides cooled air for the CPG, the TADS & PNVS turrets, and the forward sections of each EFAB. A digital control unit (DCU) manages the flow of cooled air for each system.

In the event of a failure of one of the ECS systems, the DCU of the functioning system will automatically open an interconnect valve between the two cockpits. The ventilation fans in the failed cockpit will stop, and the functional cockpit's ventilation fans will force cooled air into both cockpits.

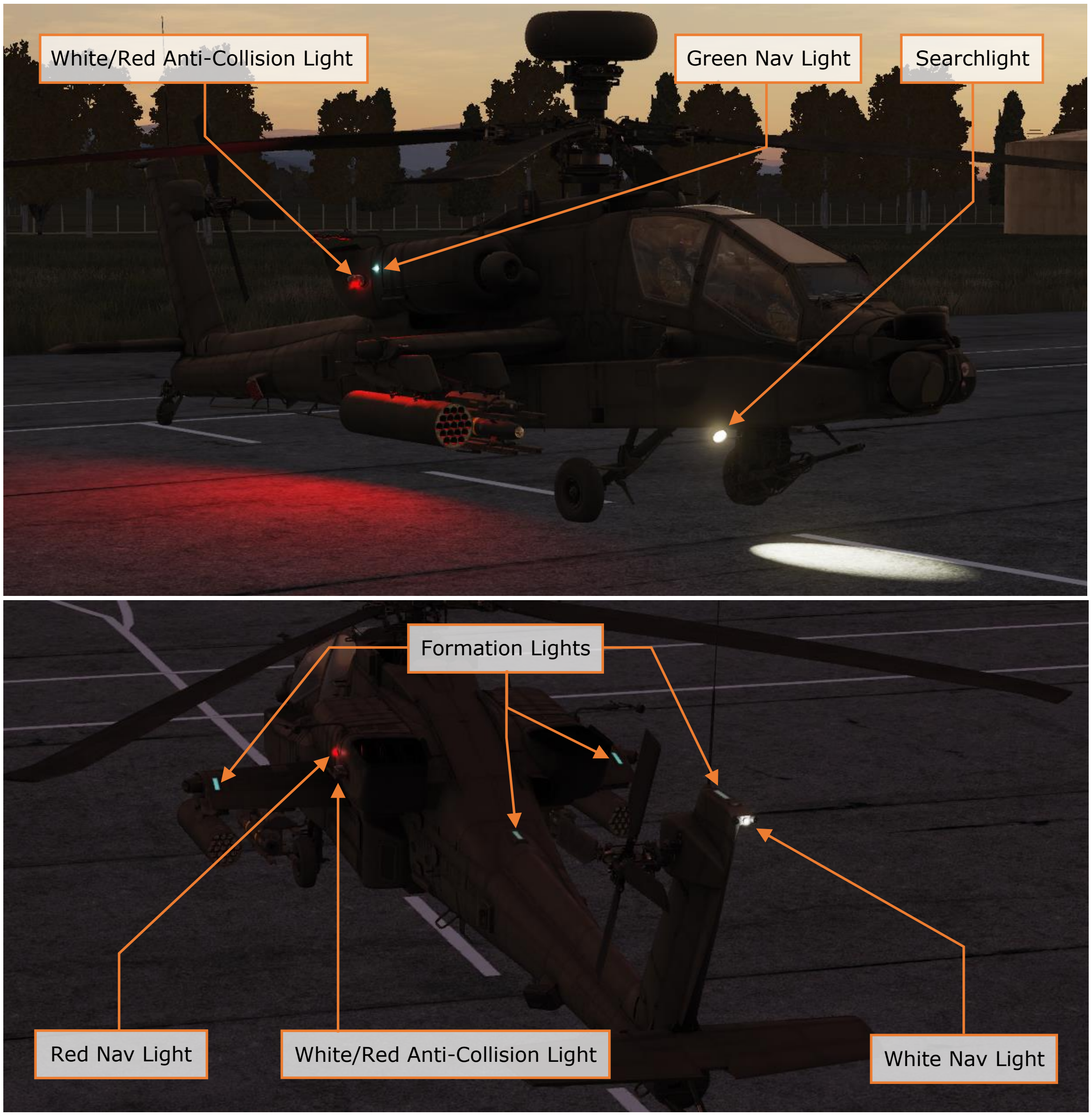
LIGHTING SYSTEM

The AH-64D has interior and exterior lighting. Interior lighting consists of primary and secondary/emergency lighting. The primary lighting is the light plates for switch labels, display bezels, and the keypad. Secondary/emergency lighting is a set of floodlights that illuminate different sections of the cockpit.

The standby instruments in the Pilot cockpit have their own independent lighting.

Each crewmember has a dimmable utility light that can be aimed around the cockpit like a flashlight and is powered by the battery in the event of a dual generator failure.

Exterior lighting consists of formation lights, navigation lights, anti-collision lights, and a steerable search and landing light. Inspection and maintenance lights are also installed throughout the fuselage.



AVIONICS

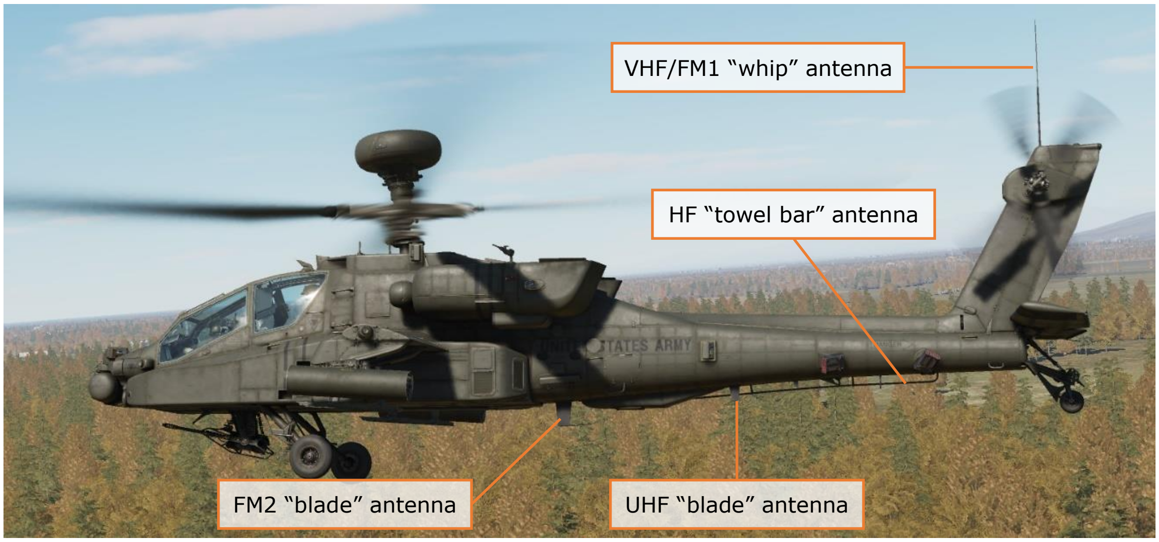
AH-64D avionics subsystems communicate across four redundant multiplex (MUX) bus channels at 1 Mbps. Each bus channel consists of a primary and secondary bus. Channel 1 is used for controls and displays, communications and transponder equipment, and aircraft systems. Channel 2 is used by the Aircraft Survivability Equipment (ASE), Data Transfer Unit (DTU), flight controls, and navigation systems. Channel 3 is used by the sighting, sensors, and weapons systems. Channel 4 is used exclusively by the Fire Control Radar (FCR) and Radio Frequency Interferometer (RFI).

Avionics systems are controlled in both cockpits by Multi-Purpose Displays (MPDs), two per cockpit. Each MPD has six variable-action buttons (VAB) per side. The buttons of the top row are labeled (left to right) T1–T6, the bottom row B1–B6, and the left and right columns are labeled (top to bottom) L1–L6 and R1–R6, respectively. Button B1 always returns the crewmember to the main menu. Each MPD also has six fixed-action buttons (FAB) that allow immediate access to the FCR, WPN, TSD, A/C, COM and VID pages; and a "favorites" button that allows quick access of up to three frequently used MPD pages.

With external power connected and both throttles in the OFF position, the MPDs will enter a “screen saver” mode after five minutes of inactivity. Pressing any MPD button will re-activate all MPDs.

Communications System

The communications system includes an intercom for crewmember communication, an ARC-186(V) VHF-AM radio, an ARC-164(V) UHF-AM radio, two ARC-201D VHF-FM radios, and an ARC-220 HF radio.



The VHF AM radio can receive between 108 and 115.975 MHz and transmit/receive between 116 and 151.975 MHz.

The UHF radio can transmit and receive between 225 and 399.975 MHz. It has a dedicated guard receiver always tuned to 243 MHz. The radio is capable of HAVE QUICK and HAVE QUICK II frequency hopping as an electronic counter-countermeasures (ECCM) technique.

The two VHF FM radios can transmit and receive between 30 and 87.975 MHz. The radios support SINCGARS combat nets and Fire Support (FS) protocols. The FM1 radio can be augmented by an improved FM amplifier capable of providing up to 40 watts of transmit power.

The HF radio can transmit and receive between 2 and 29.9999 MHz.

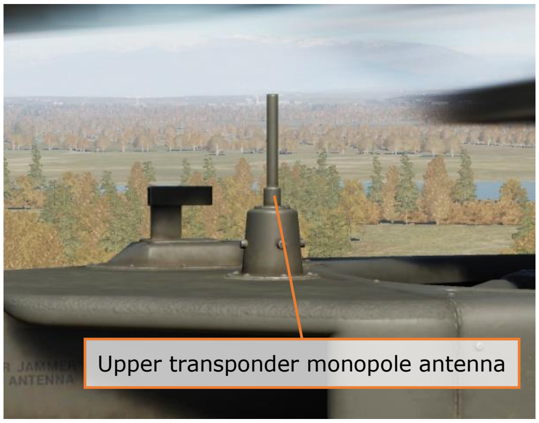
A KY-58 is installed to provide voice message encryption for the UHF radio, and a KY-100 provides voice and data encryption for the HF radio.

All radios are connected to the battery bus and can be used prior to engine start.

The AH-64D includes an MD-1295A Improved Data Modem (IDM) that can transmit and receive TACFIRE (Tactical Fire Direction System) and AFAPD (Air Force Applications Program Development) messages over any radio. It can also utilize either FM radio for Fire Support artillery messages.

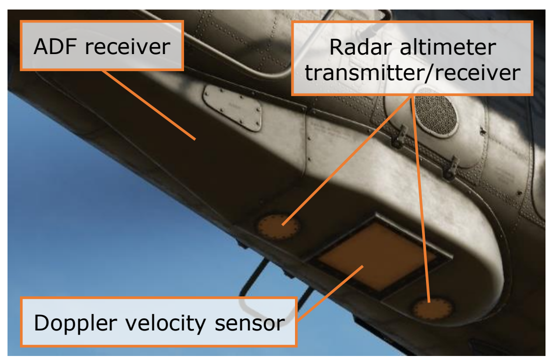
Identification System

The AH-64D includes an APX-118(V) transponder, capable of responding to interrogations in Mode 1, Mode 3/A, and Mode C formats. The APX-118(V) can also reply to encrypted Mode 4 interrogations.



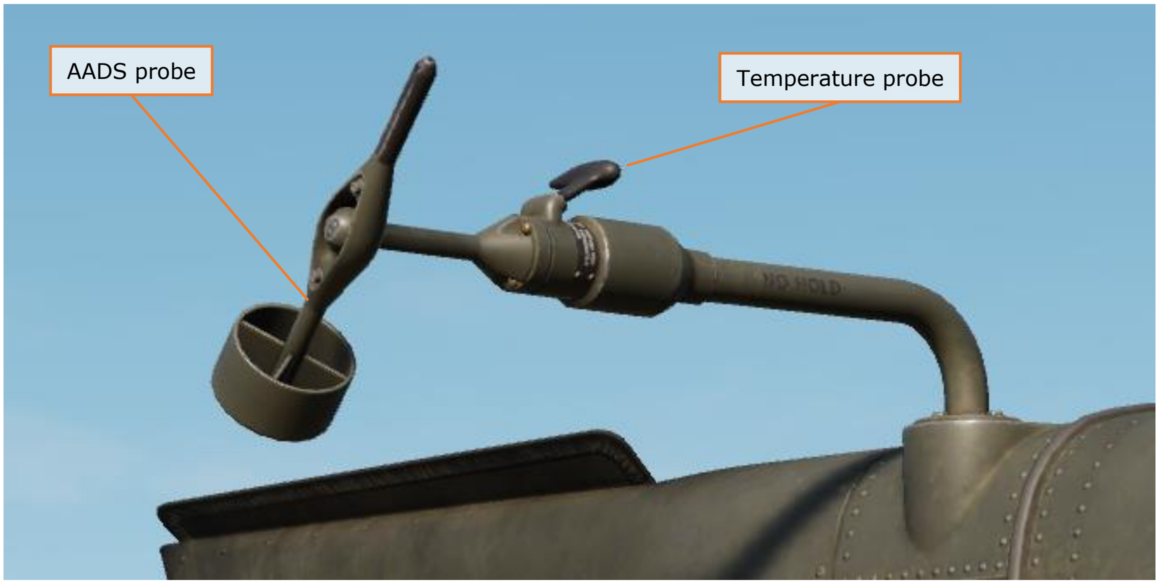
Navigation and Position Systems

The AH-64D's navigation system consists of two embedded GPS Inertial Navigation Systems (EGI), the Doppler Radar Velocity Sensor (DRVS), Air Data System (ADS), radar altimeter, automatic direction finder (ADF), High Integrated Air Data Computer (HIADC), and flight management computer (FMC). Each EGI consists of a five-channel encrypted GPS receiver that provides position updates to a ring laser gyro (RLG) inertial navigation unit (INU). The two EGIs are labeled INU1 and INU2, and the navigation system will select between them automatically as primary and backup.



In addition, the AH-64D has an AN/ASN-157 Doppler Radar Velocity Sensor (DRVS), which uses Doppler radar to determine aircraft groundspeed. This figure is used as a velocity-aiding source for the EGI.

The Air Data System (ADS) consists of two independent air data subsystems: the Flight Management Computer (FMC) and the Helicopter Air Data System (HADS). The HADS is comprised of the High Integrated Air Data Computer (HIADC) and two Airspeed And Direction Sensor (AADS) probes. The AADS probes sense airspeed magnitude, direction, and free airstream temperature. The HIADC uses this data, along with ambient and pitot pressure sensors, to compute air mass related data. The FMC computes pressure altitude, pitot airspeed, and density altitude related information. The FMC receives longitudinal and lateral true air speeds, static temperature, and non-filtered true air speeds from the HIADC.

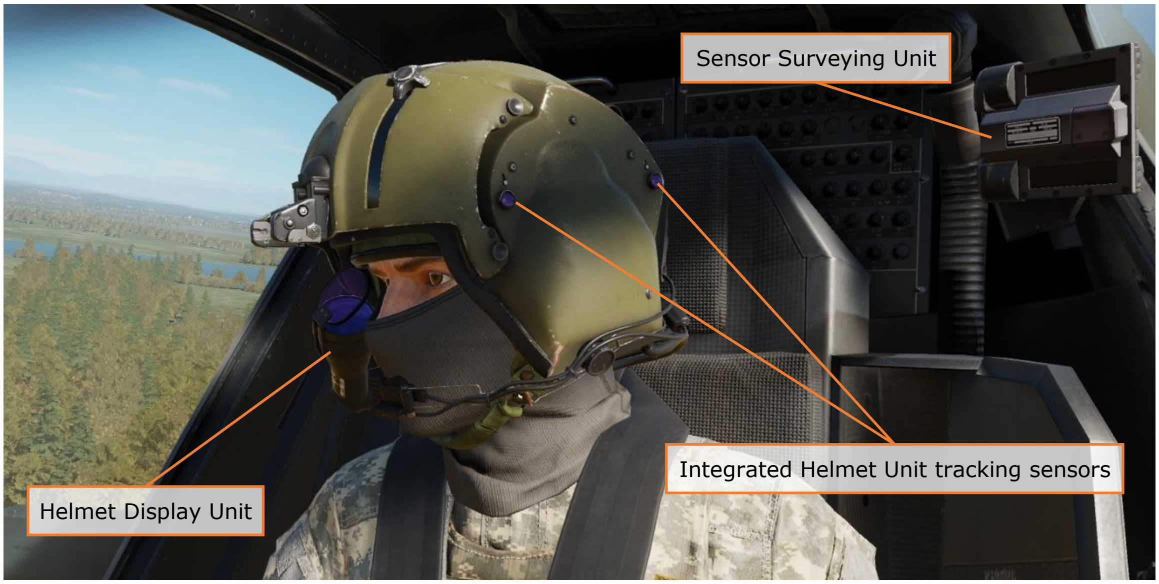


The AN/APN-209 Radar Altimeter provides height above ground level (AGL) to the navigation system. The APN-209 uses a downward-facing radar to determine AGL altitude.

The AN/ARN-149 Automatic Direction Finder (ADF) provides audio and radio direction-finding capability for transmissions between 100 and 2199.5 kHz.

SENSOR AND SIGHTING SYSTEMS

The primary sensor and sighting system for the AH-64 is the Integrated Helmet And Display Sighting System (IHADSS). The IHADSS consists of the Helmet Display Unit (HDU), a small, collimated display placed in front of the crewmember's right eye (on a rotatable arm); the Sensor Surveying Units (SSU) and Integrated Helmet Unit (IHU), a series of sensors in the cockpit that determine crewmember head position and line-of-sight; the Boresight Reticle Units (BRU), which establishes sensor boresight; and avionics systems that can slave sensor and weapon systems to the IHADSS line of sight.



The IHADSS displays sensor, targeting, and aircraft information in the crewmember's line-of-sight, helping the crewmembers to locate and track targets and maintain situational awareness. The HDU symbology format changes depending on the display mode selected by the crew. The display is also capable of overlaying video from the PNVS or TADS sensors, augmenting the crewmembers' view of terrain, obstacles, and targets at night or inclement weather.

FLIR video for the Pilot comes from the AN/AAQ-11 Pilot Night Vision System (PNVS), which provides day- and night-capable infrared capability.

The AN/ASQ-170 Target Acquisition Designation Sight (TADS) is an integrated target acquisition and tracking system for the AH-64D's Copilot/Gunner. It consists of both FLIR and Day TV (DTV) video systems, a laser rangefinder/designator (LRF/D), and a laser spot tracker (LST). This gives CPG the ability to locate, track, and laser designate targets day and night, and in inclement weather conditions.

Unique to the D model AH-64 is the AN/APG-78 Fire Control Radar (FCR) and Radio Frequency Interferometer (RFI). The APG-78 is a millimeter-wave radar with the capability to detect and classify up to 256 air or ground targetsR. The radar is mounted atop the main rotor mast, allowing the helicopter to remain masked while scanning for targets. It has a scan capability of ±90° in azimuth and +23 to -12° in elevation.

Along with the IHADSS and TADS, the FCR can be used as a source of targeting data for the 30mm Area Weapon System, 2.75-inch rockets and AGM-114 Hellfire missiles.

AH-64D ARMAMENTS

The AH-64D was designed primarily to employ the Hellfire Modular Missile System (HMMS), along with its Area Weapon System and Aerial Rocket Subsystem. It has four hardpoints, two mounted to each stub wing. Each hardpoint is capable of articulating between +4° to -15° in elevation.

M139 AREA WEAPON SYSTEM

The Area Weapon System (AWS) consists of an M230 30mm automatic chain-driven gun mounted on the underside of the helicopter between the two main landing gear, its turret, controls, and the ammunition handling system. The weapon is mounted on a hydraulically steered turret that can be slaved to either the TADS line-of-sight or IHADSS line-of-sight, or fixed to a forward-firing position.

The M230 has a magazine of 1200 rounds and fires up to 625 rounds per minute. When the Internal Auxiliary Fuel System (IAFS) is installed, magazine size is reduced to 300 rounds. The turret can steer up to 86° in azimuth. It can elevate up to 11° or depress down to 60°.

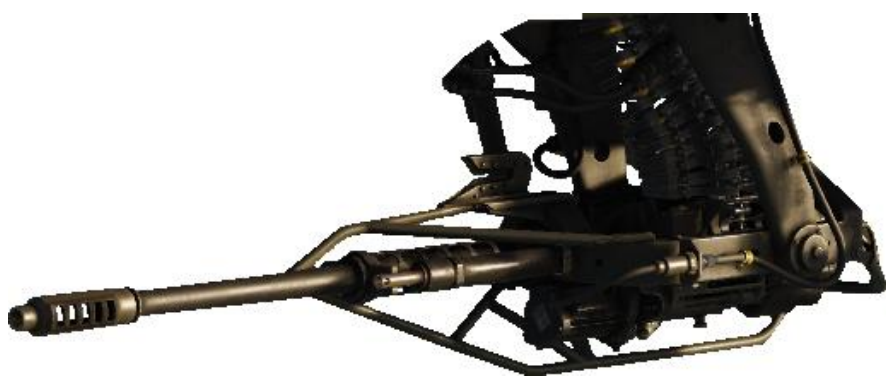


Figure 6. M230 Area Weapon System

The M230 fires 30x113 millimeter link-less, tracer-less ammunition, consisting of either M789 High Explosive Dual Purpose (HEDP) rounds for tactical operations or M788 Target Practice rounds for non-combat use. The M789 has a light armor penetrating capability as well as a bursting fragmentation effect for anti-material and anti-personnel use.

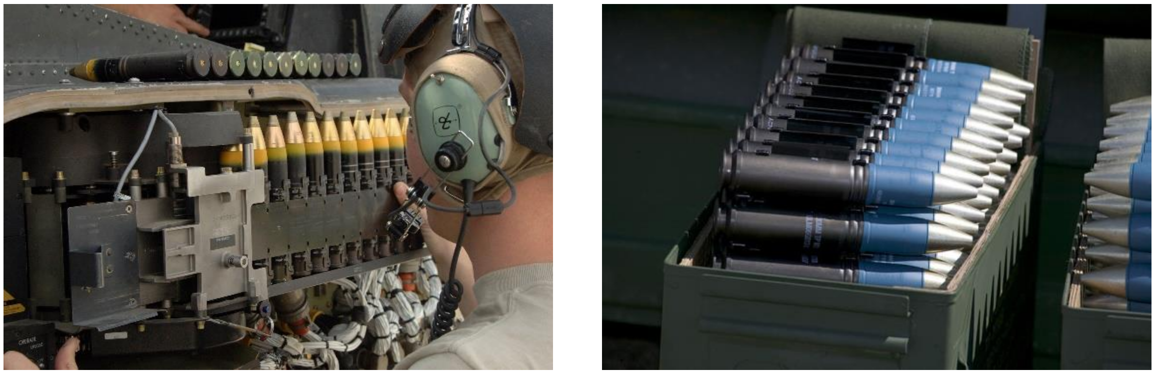


Figure 7. M789 HEDP (left) and M788 TP (right) 30mm ammunition

AERIAL ROCKET SUB-SYSTEM

The Aerial Rocket Sub-system consists of M261 lightweight rocket launchers, capable of firing 2.75-inch folding fin aerial rockets (FFARs), primarily variants of the Hydra-70 rocket. The M261 has 19 rocket tubes, and can be loaded on all four pylons, for a maximum of 76 rockets. Each M261 rocket launcher is "zoned", allowing for carriage of up to three different rocket types with one pair of launchers mounted, or up to five rocket types with two pairs of rocket launchers mounted. Each tube provides individual firing and fusing circuits.

Figure 8. M261 19-tube rocket launcher

The M261 rocket launcher can carry Hydra-70 rockets with the Mk 66 motor. These rockets come in several different variants, differing by warhead. Variants employed by the U.S. Army include the following:

- M151 high-explosive "10-pounder" for use against lightly armored and soft targets. Equipped with both M423 point-detonating (PD) and M433 resistance-capacitance (RC) programmable delay fuses.

Figure 9. M151 HE rocket

- M229 high-explosive "17-pounder" for use as an enhanced “aerial artillery” warhead over the M151. Equipped with both M423 point-detonating (PD) and M433 resistance-capacitance (RC) programmable delay fuses. Minimum range: 140 meters.

Figure 10. M229 HE rocket

- M156 white phosphorous for target marking. Equipped with an M423 point-detonating fuse for ground dispersal of the warhead’s effects, which generates a white smoke marking signal for approximately 2 minutes (depending on wind conditions).

Figure 11. M156 WP rocket

- M259 white phosphorous for generating smoke-screen concealment. Equipped with an M439 variable time delay fuse, which generates a white smoke concentration across several hundred meters for approximately 5 minutes (depending on wind conditions). (N/I)
- M264 red phosphorous for generating smoke-screen concealment. Equipped with an M439 variable time delay fuse, which generates a white smoke concentration across several hundred meters for approximately 5 minutes (depending on wind conditions). (N/I)

- M261 multi-purpose submunition (MPSM) with 9 submunitions for use against lightly- to medium-armored vehicles and soft targets. Equipped with an M439 variable time delay fuse for an airburst just prior to the target. Minimum range 1,000 meters.

Coming later in EA

Figure 12. M261 MPSM rocket

- M255A1 flechette with 1,179 60-grain hardened steel flechettes for use against soft targets or personnel. Equipped with an M439 variable time delay fuse for an airburst just prior to the target. Minimum range 800 meters; Effective range 1 to 3 kilometers.

Coming later in EA

Figure 13. M255A1 Flechette rocket

- M257 parachute illumination flare for battlefield illumination. Equipped with an M442 fixed time fuse, which will deploy the flare approximately 3,500 meters from it’s launch point. Provides illumination for approximately 3 minutes.

Figure 14. M257 ILLUM rocket

- M278 parachute illumination IR flare for covert battlefield illumination. Equipped with an M442 fixed time fuse, which will deploy the flare approximately 3,500 meters from it’s launch point. Provides IR illumination for night vision goggle-equipped personnel for approximately 3 minutes. (N/I)
- M274 "blue spear" training rocket that produce a brief smoke signature for target practice. Equipped with an M423 point-detonating (PD) fuse integrated into warhead casing, which detonates to provide a small, but

noticeable flash and smoke signature for impact spotting. Ballistic match to the M151 HE rocket to provide identical targeting and engagement training for aircrews. (N/I)

- M282 multi-purpose penetrator (MPP) for use against lightly armored vehicles and bunkers. Equipped with a modified M423 fuse providing a fixed delay for penetration effects.

Figure 15. M282 MPP rocket

HELLFIRE MODULAR MISSILE SYSTEM

The Hellfire Modular Missile System is the primary weapon system of the AH-64D. It can employ both semi-active laser-guided (SAL) and active radar-guided (RF) variants of the AGM-114 Hellfire missile. The system consists of the M299 four-rail missile launcher, which can fire all variants of the Hellfire missile.

Figure 16. M299 Hellfire missile launcher

The Hellfire is an air-to-ground, anti-armor missile that has since been expanded in capability to include other air-to-surface applications. The Hellfire is an effective standoff weapon as both a direct and indirect weapon and can be fired from cover or in the open. The Hellfire weighs approximately 100 lbs. and has a 20-pound high-explosive anti-tank (HEAT) warhead, which includes a tandem shaped-charge for defeating reactive armor.

The AGM-114K is a semi-active laser-homing variant with both Lock-On Before Launch (LOBL) and Lock-On After Launch (LOAL) capability. In LOBL mode, the Hellfire uses a nose-mounted laser seeker to lock on to a coded laser designation prior to launch. When launched in LOAL mode, the crew can select from multiple trajectories that the missile will fly using a digital autopilot system until it detects a laser designation mid-flight that matches its assigned laser code.

Figure 17. AGM-114K laser-guided HEAT missile

-Coming later in EA- The AGM-114L is an active radar-guided variant, making it a fire-and-forget weapon, and retains LOBL and LOAL capability like its laser-guided predecessor. In LOBL mode, the Hellfire uses an onboard millimeter wave (MMW) radar seeker to lock on to the target prior to launch. In LOAL mode, the Hellfire guides using an internal inertial guidance system to the target location, where it then locates and locks on to the target with its MMW radar.

Figure 18. AGM-114L radar-guided HEAT missile

Up to four Hellfires can be loaded on a single launcher, for a total of up to sixteen.

COCKPIT OVERVIEW

The AH-64D cockpit has two seats in tandem. The rear seat is for the Pilot and the front seat is for the Copilot/Gunner (CPG).

PILOT SEAT

Pilot's Cockpit, Forward

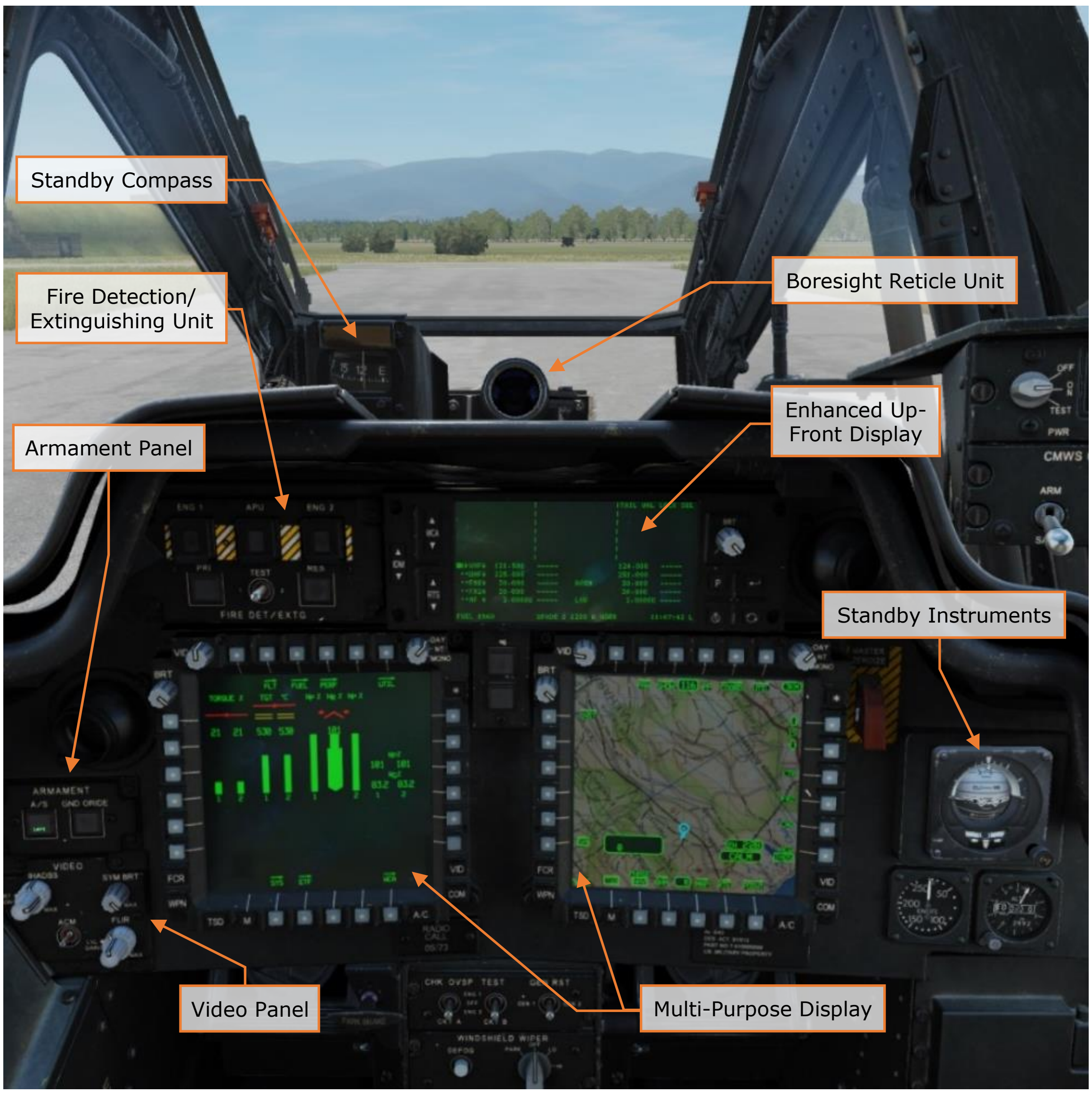


Figure 19. Pilot's Cockpit, Forward

Multi-Purpose Display (MPD)

Figure 20. Multi-Purpose Display

The AH-64D crewstations and associated avionics was heavily designed around the pilot-cockpit interface, efficient coordination between the two crewmembers, and management by exception. If information is not relevant to the current conditions, system states, or selected task, it will not be presented to the crewmembers. Additionally, six colors and two color intensity levels are used in a common convention throughout the avionics to indicate certain items or system conditions:

- Green: Normal indications, advisory conditions
- Yellow: Cautionary indications, hazards to flight
- Red: Warning indications, enemy threats, targets
- White: Attention indications, invalid settings or values
- Blue: Sky on attitude indicators, friendly units
- Brown: Ground on attitude indicators
- Partial intensity colors: de-emphasized indications

The primary method the aircrew interacts with the aircraft systems are through the Multi-Purpose Displays (MPDs). The MPDs allow either crewmember to control aircraft, weapons, and sensor systems using a versatile interface system. Each MPD can display one of several different pages, such as an Engine page or a Fuel page. Every page will be displayed in an initial "top-level" format. These "top-level" pages will be denoted by the page label displayed above the Menu button. When this text is boxed, the MPD is displaying the "top-level" page. If the text is un-boxed, a sub-page has been selected for viewing within the primary page.

Sub-page options are denoted by a right-facing arrow placed above the name of the sub-page option. When the first sub-page level is entered, that sub-page becomes boxed, removing the box away from the parent page label above the Menu button. If a second sub-page level is entered from the first sub-page, the second sub-page label is boxed, with the first sub-page level remaining boxed, but in a "partial-intensity" green.

Some MPD pages include several formats that can be selected by a crewmember for display, which presents different pieces of information on the same MPD page. Formats of the existing page differ in appearance from sub-pages in that their text does not have a right-facing arrow above the format label. A good example of this distinction is on the Weapon (WPN) page. Along the top row of bezel buttons are five sub-page options, whereas along the bottom there are three different weapon formats that can be selected.

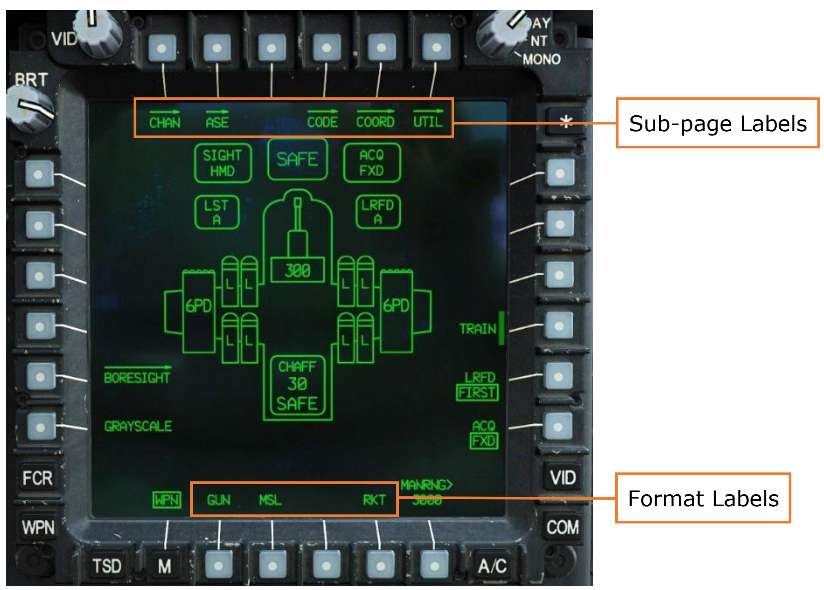


Figure 21. MPD WPN Page

Video Enhancement. Controls the brightness the MPD video underlay displayed from sensors (e.g., FLIR) or the map underlay on the TSD page. In the center detent, unmodified video is displayed. Rotating the knob brightens or darkens the video.

Brightness. Controls the intensity of the entire display.

Menu Button. Accesses the MENU page. If MPD displays the MENU page, accesses the DMS page.

Day/Night/Mono. Controls the available brightness settings. In DAY, the Brightness knob adjusts from medium to high intensity. In NIGHT, the Brightness knob adjusts from low to medium intensity. In MONO, all symbology and video is displayed in green only, and the Brightness knob adjusts from very low to medium intensity.

Favorites Button. Accesses the Asterisk page. Allows the storing of up to three frequently used MPD pages in a queue. Each MPD is capable of storing three unique pages for a total of six pages per crew station. Pressing the * button will cycle through these pages in numerical order.

Variable Action Button (VAB). Each button can be associated with a function, that is displayed on the screen adjacent the button. The function of the button depends on the selected page or page format.

Fixed Action Button (FAB). Each button is associated with an MPD page, with the button label corresponding with the page associated with that button. The A/C fixed action button is dependent on the state of the weight-on-wheels sensor ("squat switch"). When the aircraft is on the ground, pressing the A/C button will display the ENG page. When the aircraft is in the air, pressing the A/C button will display the FLT page.

Fire Detection/Extinguishing Unit

Figure 22. Fire Detection/Extinguishing Unit

The Fire Detection/Extinguishing Unit controls the fire detection and suppression equipment. It consists of pushbutton warning lights that illuminate when a fire is detected.

The top three buttons are labeled "FIRE" and illuminate when a fire is detected in the respective compartment. Pressing the button:

- isolates the fire (by stopping fuel flow to the engine/APU, shutting off bleed air, and closing the cooling louvers),
- arms the fire extinguisher bottles,
- and acknowledges the master warning and voice warning message.

ENG 1 FIRE. Illuminates when a fire is detected in the #1 engine.

ENG 2 FIRE. Illuminates when a fire is detected in the #2 engine.

APU FIRE. Illuminates when an APU fire is detected.

The bottom two buttons are labeled "DISCH" and illuminate when the respective extinguisher bottle is armed and has not yet been discharged. The bottles are armed only when one of the FIRE pushbuttons has been pressed.

PRI. Illuminates when the primary extinguisher bottle is armed and available. Pressing the button discharges the bottle.

RES. Illuminates when the reserve extinguisher bottle is armed and available. Pressing the button discharges the bottle.

Finally, the TEST switch is used to test the extinguisher system. Placing the switch in either the "1" or "2" position tests that respective half of the fire detection circuit for both engines and the APU, as well as the aft deck overheat sensors and voice message warning.

TEST 1. Tests one half of the fire detection circuit. A successful test is indicated when all three FIRE pushbuttons are illuminated.

TEST 2. Tests the other half of the fire detection circuit. A successful test is indicated when all three FIRE pushbuttons and both DISCH pushbuttons are illuminated.

Armament and Video Panels

Figure 23. Armament and Video Panels

The Armament Panel controls the master arm status.

A/S. Toggles master arm status between SAFE and ARM. Either "SAFE" or "ARM" will be illuminated on the button face. Either crewmember can change the master arm status, and any change will be reflected in both crew stations.

GND ORIDE. Overrides the arm inhibit squat switch. Normally, with weight on wheels, the A/S button is disabled, and the master arm is overridden safe. When the GND ORIDE button is pressed, the word "ON" will illuminate on the button face, and the A/S button can be used to set the master arm to ARM on the ground. Pressing the button again re-enables the squat switch to inhibit. Either crewmember can change the ground override status, and any change will be reflected in both crew stations.

The Video Panel controls the brightness and display of sensor video.

IHADSS. Two concentric knobs that controls the brightness and contrast of the Helmet Display Unit (HDU). The outer knob controls video brightness and the inner knob controls video contrast.

SYM BRT. Controls the brightness of the IHADSS symbology displayed on the HDU independently of the video underlay.

ACM (Automatic Contrast Mode). When on, FLIR gain and level is controlled automatically. When off, the FLIR knob is enabled.

FLIR. Two concentric knobs that control the display of FLIR video from the PNVS or TADS. The outer knob controls level and the inner knob controls gain.

Enhanced Up-Front Display (EUFD)

Figure 24. Enhanced Up-Front Display

The Enhanced Up-Front Display (EUFD) provides up-front control of radios and communications equipment and display of warning/caution/advisory (WCA) messages. (see Enhanced Up-Front Display)

Standby Instruments

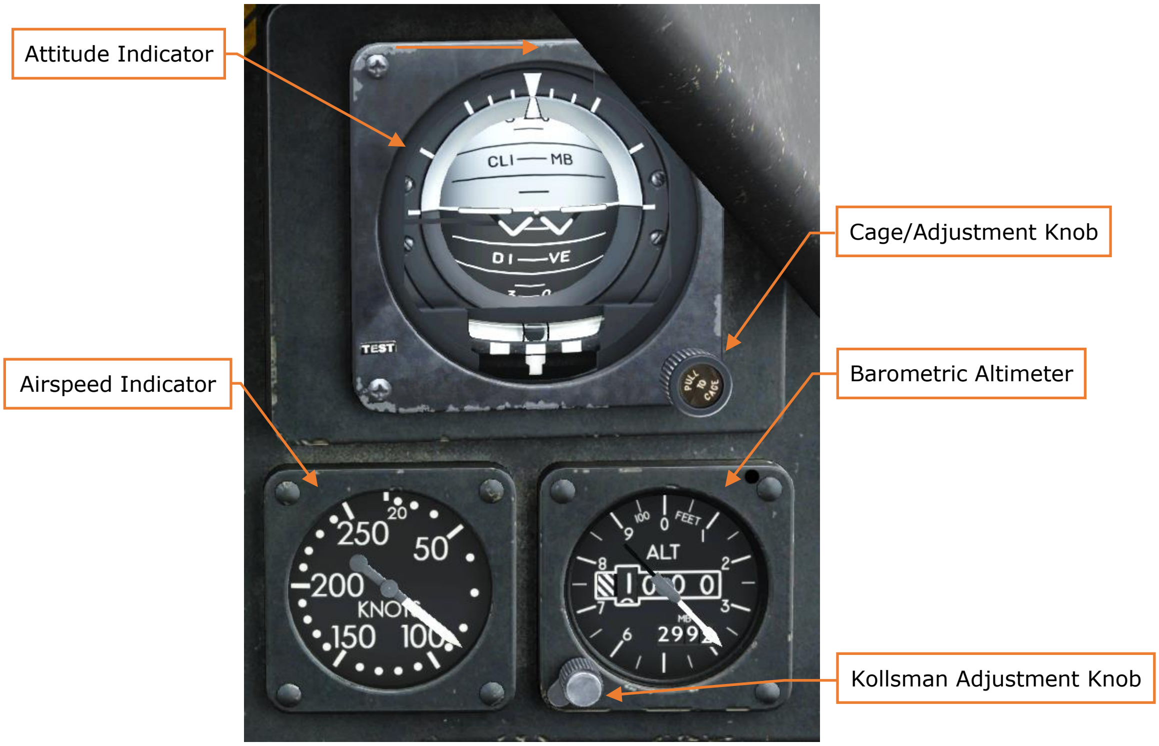


Figure 25. Standby Instruments

The standby instruments provide an independent backup source of critical flight data if primary power or the flight reference system is lost. The standby instruments receive power from the emergency DC bus.

Attitude Indicator. Displays aircraft attitude using an artificial horizon. The watermark symbol is fixed, and the horizon moves to indicate pitch and roll. The gimbal is free to move up to 360° in roll and 85° in pitch. The "Pull to Cage" button, when rotated, moves watermark symbol up or down and is used to set the level attitude reference. When pulled, the gimbal is caged, and the horizon returns to level.

Airspeed Indicator. Indicates helicopter indicated airspeed (IAS) in knots, as measured from the right pitot probe. Airspeed is not corrected for position or instrument error.

Altimeter. Indicates barometric altitude in feet. The hand indicates altitude in hundreds of feet, and the inset dial indicates altitude in thousands and tens of thousands of feet. The inset Kollsman window, and the adjacent Kollsman knob, is used to set reference barometric pressure, in inches of mercury.

Pilot's Cockpit, Left Console

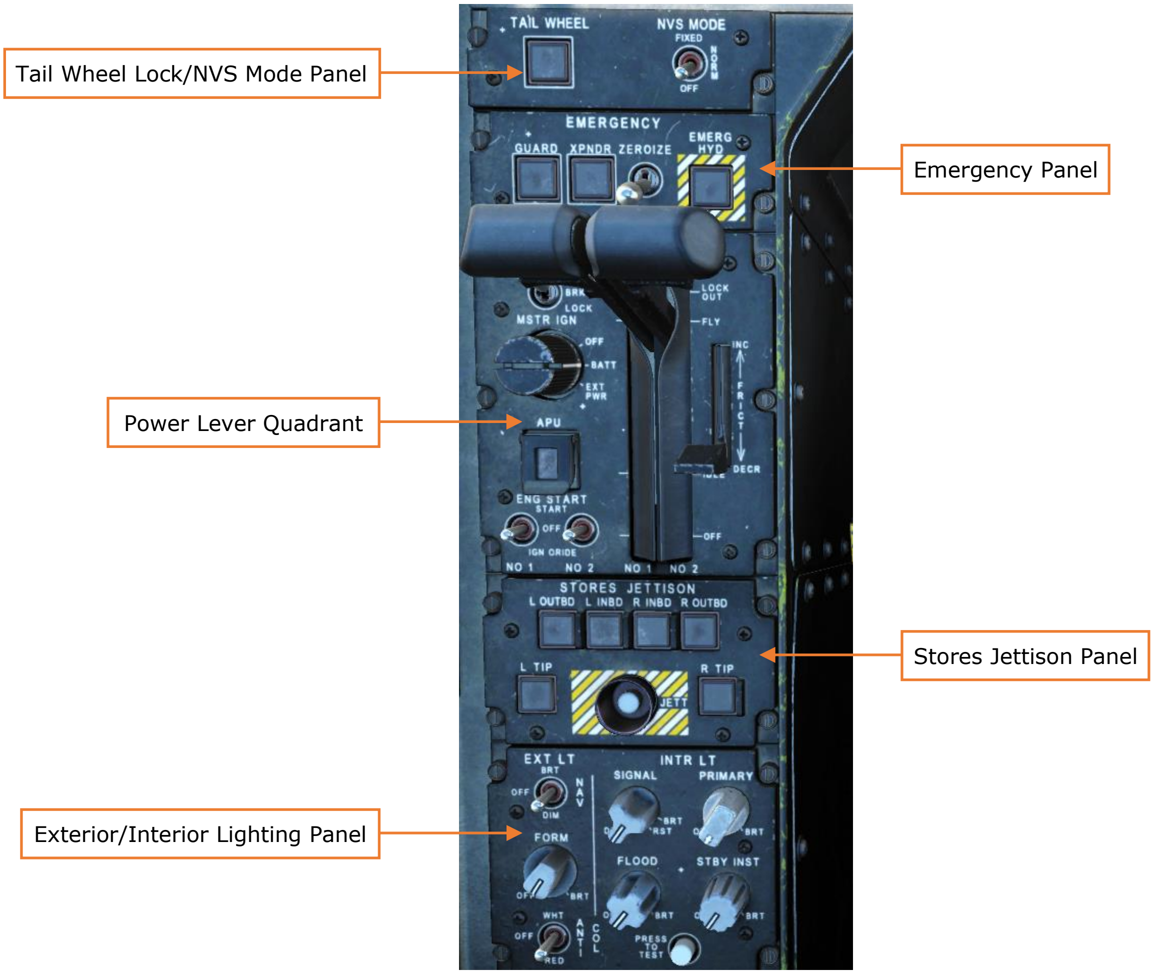


Figure 26. Pilot's Cockpit, Left Console

Tail Wheel Lock/NVS Mode Panel

Figure 27. Tail Wheel Lock/NVS Mode Panel

TAIL WHEEL. Pressing this button toggles the tail wheel lock on or off. When unlocked, the word "UNLOCK" is illuminated on the face of the button. The tail wheel can also be locked or unlocked using the Tail Wheel Lock/Unlock button on the collective flight grip. When the tail wheel is locked, spring force inserts the locking pin; when unlocked, a hydraulic actuator retracts the locking pin. (see Collective Controls)

NVS MODE. Sets the operational mode of the selected night vision system (NVS). The selected NVS is set using the NVS SELECT switch on the collective. (see Collective Controls)

- **OFF.** Stows the selected NVS.
- **NORM.** Commands the selected NVS to IHADSS LOS (line of sight).
- **FIXED.** Commands the selected NVS to fixed forward at 0° in azimuth and -4.9° in elevation.

Emergency Panel

Figure 28. Emergency Panel

GUARD. Tunes the UHF radio to guard frequency (243.0 MHz) and changes RTS to UHF. When selected, the text "ON" is highlighted on the button face. When unselected, the guard frequency is moved to the standby frequency, and the last single-channel frequency is restored to the active frequency.

XPNDR. Sets the Mode 3/A transponder code to 7700. The text "ON" is highlighted on the button face. Note that the transponder must be on, and Mode 3 must be active. Pressing this button again extinguishes the light, but the emergency code of 7700 must be changed manually using the COM page.

ZEROIZE. Zeroes-out classified data. The ZEROIZE switch must be pulled out and up, then forward, then down and in, to start the zeroization process. The data to be erased includes: COMSEC variables (e.g., GPS crypto keys), Mode 4 IFF keys, IDM data, TSD points, and TSD targets/threats.

EMERG HYD. Opens a solenoid that allows hydraulic accumulator pressure to pressurize the utility hydraulic system. When active, the text "ON" is highlighted on the button face. Autopages to the ENG page. (see Engine Page)

Power Lever Quadrant

Figure 29. Power Lever Quadrant

RTR BRK. Controls the rotor brake solenoid valves.

- **OFF.** Rotor brake is disengaged.
- **BRK.** Utility system pressure is used to slow the rotor brake. This reduces the time required for the main rotor to stop after shutdown.
- **LOCK.** Utility system pressure is trapped to lock the main rotor in place. This should be used to prevent main rotor from windmilling in strong winds, and for dual rotor-locked engine starts.

MSTR IGN. Keylock switch that controls master electrical power and enables engine start. The switch can be moved without the ignition key inserted, but engine start is inhibited until the key is inserted.

- **OFF.** Power is removed from all systems except the external Refuel panel.
- **BATT.** Connects the battery to the battery busses. If generator power is available, the battery is isolated from the battery bus and charged.
- **EXT PWR.** Activates the external power monitor, which connects external power to the helicopter and monitors for degraded power supply.

POWER. Two power levers, one for each engine. Each lever includes four primary positions (OFF, IDLE, FLY, and LOCK OUT), an intermediate range between IDLE and FLY, and detents to prevent inadvertently moving the power levers aft to OFF or forward to LOCK OUT.

- **OFF.** Inhibits fuel to the engine, shutting it down if the engine is running. Also used to abort engine starts.
- **IDLE.** Sets ground idle RPM. Used during engine start sequence.
- **FLY.** Sets rotor RPM (N_r) to 101%, N_r is controlled automatically by the load demand spindle.
- **LOCK OUT.** Disables the turbine gas temperature limiting system by locking out the DEC, allowing for manual control of engine RPM. After moving the power lever to LOCK OUT, it should immediately be returned to an intermediate position between IDLE and FLY. The crewmember can then control engine RPM directly using the power lever.

FRICT. Throttle friction control knob.

APU. APU starter pushbutton. Pressing this button initiates automatic APU start and illuminates the text "ON" on the button face. The ECU will automatically shut down the APU if it senses an abnormal indication, or if the Pilot presses the APU button again.

ENG START. These switches initiate the automatic engine start process for either engine. The ignition key must be in the MSTR IGN keylock to actuate these switches.

- **OFF.** Engine starting system is inactive.
- **START.** Momentarily positioning ENG START switch to this position initiates automatic engine start; switch is spring-loaded back to OFF. The engine is pneumatically motored by the Air Turbine Starter, and the ignition system is energized. Starter cutout is automatic when the engine achieves 52% N_g.
- **IGN ORIDE.** Motors the engine with the ignition system off. Used to reduce TGT after an aborted engine start. Must be returned to OFF to cease motoring the engine.

Stores Jettison Panel

Figure 30. Stores Jettison Panel

This panel controls jettisoning of stores. To jettison a wing store, first press the pushbutton(s) corresponding to the station location (e.g., L OUTBD to jettison the outermost left station). The "ARM" light on the button face will illuminate. Then, press the recessed JETT button to jettison the store(s). Pressing an ARM pushbutton a second time will disarm that station for jettisoning.

Note that, although the station is armed for jettisoning, this does not imply that the ordnance is armed for detonation.

L OUTBD. Arms the left outboard station for jettisoning.

L INBD. Arms the left inboard station for jettisoning.

R INBD. Arms the right inboard station for jettisoning.

R OUTBD. Arms the right outboard station for jettisoning.

L TIP. No function.

R TIP. No function.

JETT. Jettisons all armed stations.

Exterior/Interior Lighting Panel

Figure 31. Exterior/Interior Lighting Panel

NAV. Controls the brightness of the navigation lights. The AH-64D has red and green position lights on the left and right engine nacelles, and a white position light atop the vertical stabilizer. Positions are OFF, DIM, and BRT (bright).

FORM. Controls the brightness of the formation lights, used by adjacent aircraft to maintain formation position at night. Green formation lights are on the upper surface of each wing, the upper centerline of the aft fuselage, and the upper surface of the vertical stabilizer.

ANTI COL. Controls the color of the anti-collision lights. A high intensity flashing anti-collision light is located on each engine nacelle. Positions are OFF, WHT (white), and RED.

SIGNAL. Sets the brightness of the warning, caution, and advisory indicators/switches. The rheostat controls the brightness of the warning lights (bright or dim) and the caution/advisory lights (variable intensity). The signal lights will automatically change between bright and dim modes if the FLOOD rheostat is moved across the midpoint position.

- **RST.** If electrical power is interrupted, or if FLOOD knob is moved past the midpoint toward bright, the signal lights revert to daytime brightness. Moving the SIGNAL knob to the RST position momentarily is necessary to restore nighttime brightness. This position is only operable if the FLOOD rheostat is below the midpoint position.

PRIMARY. Controls the brightness of the illuminated light plates behind all control panels.

FLOOD. Controls the brightness of the cockpit flood lights. Moving the FLOOD rheostat past the midpoint position (towards bright) automatically changes SIGNAL light brightness to day-time levels.

STBY INST. Controls the brightness of the integral illumination for the standby flight instruments and standby compass in the Pilot cockpit.

PRESS TO TEST. Pressing and holding this button illuminates all signal lamps, allowing the crewmember to verify their operation.

Pilot's Cockpit, Left Auxiliary Console

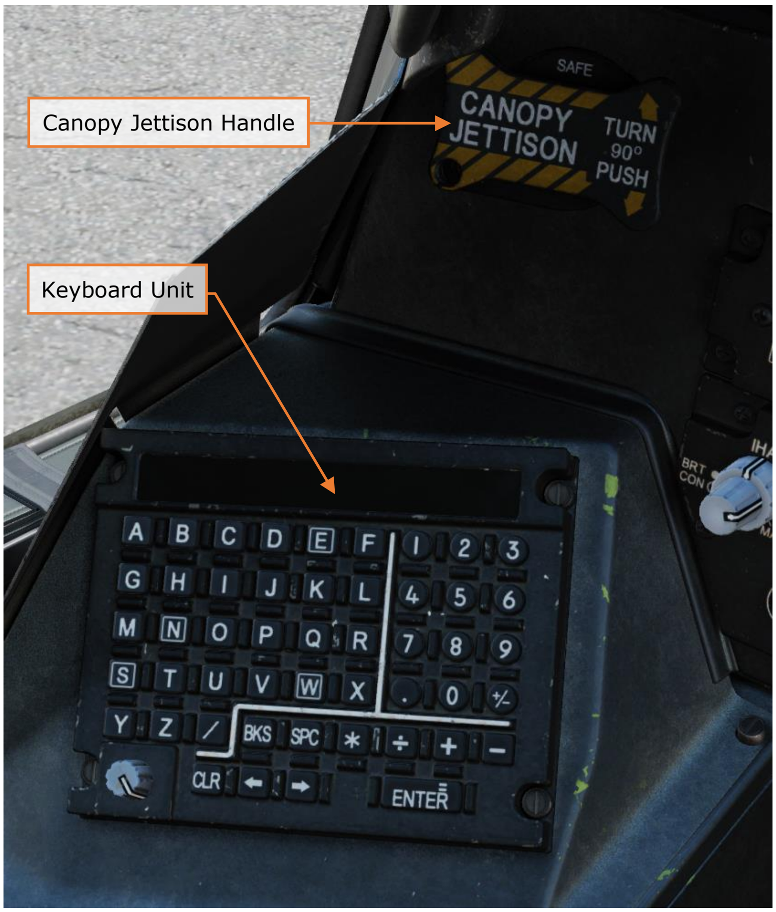


Figure 32. Pilot's Cockpit, Left Auxiliary Console

Canopy Jettison. Turning the handle 90° and pushing inward jettisons the canopy. The four canopy side panels will be jettisoned. Electrical power is not required to jettison the canopy.

Keyboard Unit. Used for data entry to either MPD or the EUFD. Can be used as an in-cockpit calculator. (see Keyboard Unit)

Pilot's Cockpit, Lower Console

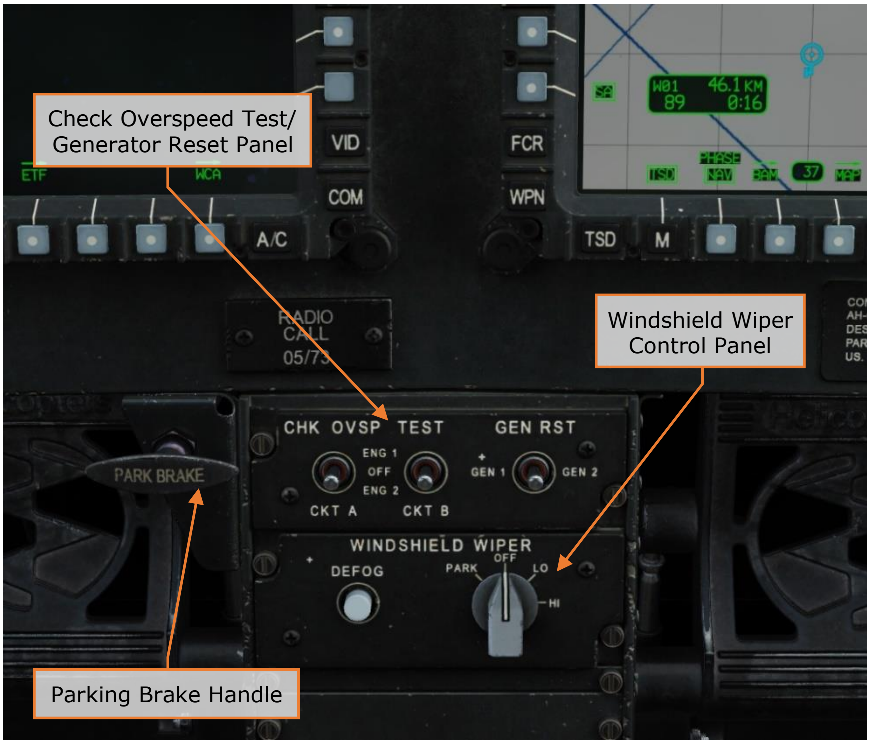


Figure 33. Pilot's Cockpit, Lower Console

Check Overspeed Test/Generator Reset Panel

Figure 34. Check Overspeed Test/Generator Reset Panel

CHK OVSP TEST switches. These switches test the N_P overspeed protection system, which shuts off fuel flow to the engine if N_P rises above 119.6±1%. There are two test circuits, labeled CKT A and CKT B. Each circuit can be tested with either engine (ENG 1 or ENG 2). In the OFF position, no test is performed. These tests are normally only performed during maintenance operational checks.

GEN RST. Two-way momentary switch that can reset either generator 1 (GEN 1) or generator 2 (GEN 2). This can be done to attempt to clear WCA message for that generator. If the message does not clear, the faulty generator can be selected off from the SYS page of an MPD. (see System Page)

Windshield Wiper Control Panel

Figure 35. Windshield Wiper Control Panel

WINDSHIELD WIPER knob. Controls the electrically driven windshield wipers mounted to the canopy. The OFF, LO, and HI positions set wiper speed, and the PARK position returns the wipers to their parked position. The knob is spring-driven out of the PARK position to OFF, and must be held until the wipers have finished parking.

DEFOG. When pressed, bleed air is mixed with conditioned air and directed against the canopy side panels to defog them.

Pilot's Cockpit, CMWS Control Panel

Figure 36. Pilot's Cockpit, CMWS Control Panel

See Common Missile Warning System (CMWS) for more information.

Pilot's Cockpit, Right Console

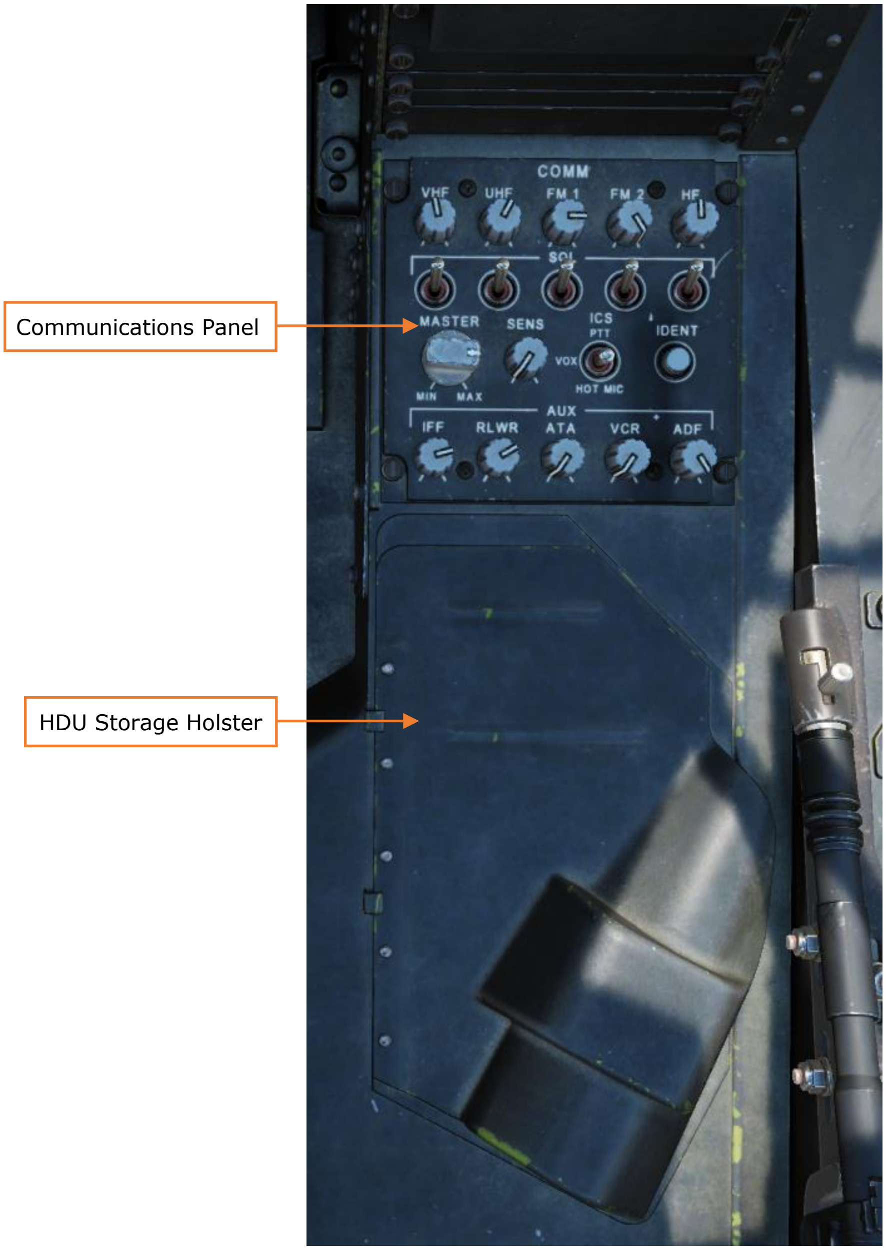


Figure 37. Pilot's Cockpit, Right Console

Communications Panel

Figure 38. Communications Panel

VHF. Adjusts the volume of the VHF radio. Pull the knob out to mute audio.

UHF. Adjusts the volume of the UHF radio. Pull the knob out to mute audio.

FM1. Adjusts the volume of the FM1 radio. Pull the knob out to mute audio.

FM2. Adjusts the volume of the FM2 radio. Pull the knob out to mute audio.

HF. Adjusts the volume of the HF radio. Pull the knob out to mute audio.

SQL switches. Momentary toggle switches that enable or disable the squelch circuit for the VHF, UHF, FM1, FM2, or HF radios.

MASTER. Adjusts the volume level of all communications audio, as well as helmet and wing connection volume levels.

SENS. Adjusts the sensitivity of the ICS squelch circuit when the ICS switch is in the VOX position (see below). The ICS will only transmit when volume levels exceed the selected sensitivity.

ICS. Sets the intercommunications system (ICS) transmit mode.

- **PTT.** The ICS will only transmit when the ICS PTT (push-to-talk) switch is pressed.
- **VOX.** The ICS will transmit automatically when the crewmember speaks loud enough to break squelch. This helps reduce transmission of unwanted background noise.

- **HOT MIC.** The ICS transmits continuously, whether the crewmember speaks or not.

IDENT. When pressed, the Mode 3 transponder performs an ATC identification-of-position function. This is used to highlight your position to ATC and should be done when requested by ATC.

IFF. Controls the volume of IFF mode-4 transponder audio.

RLWR. Controls the volume of radar/laser warning receiver audio.

ATA. No function.

VCR. Controls the volume of videocassette recorder playback audio. Pull the knob out to mute VCR audio.

ADF. Controls the volume of automatic direction finder audio. Pull the knob out to mute ADF audio.

Pilot's Cockpit, HOCAS (Hands-On Collective and Stick)

Cyclic Controls

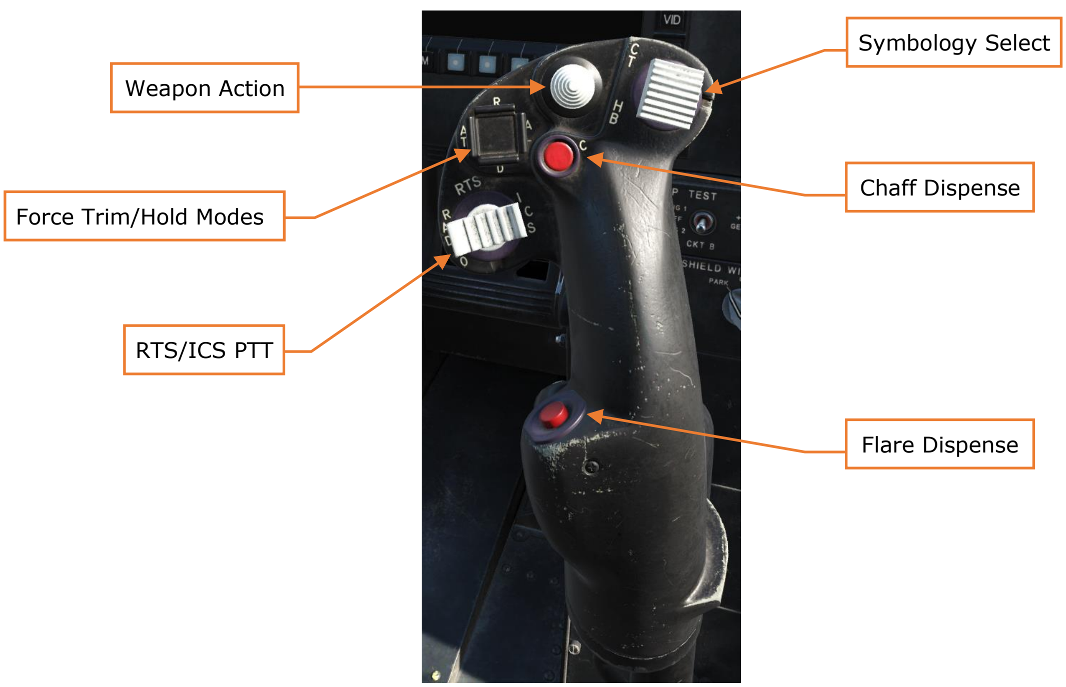


Figure 39. Cyclic, Front

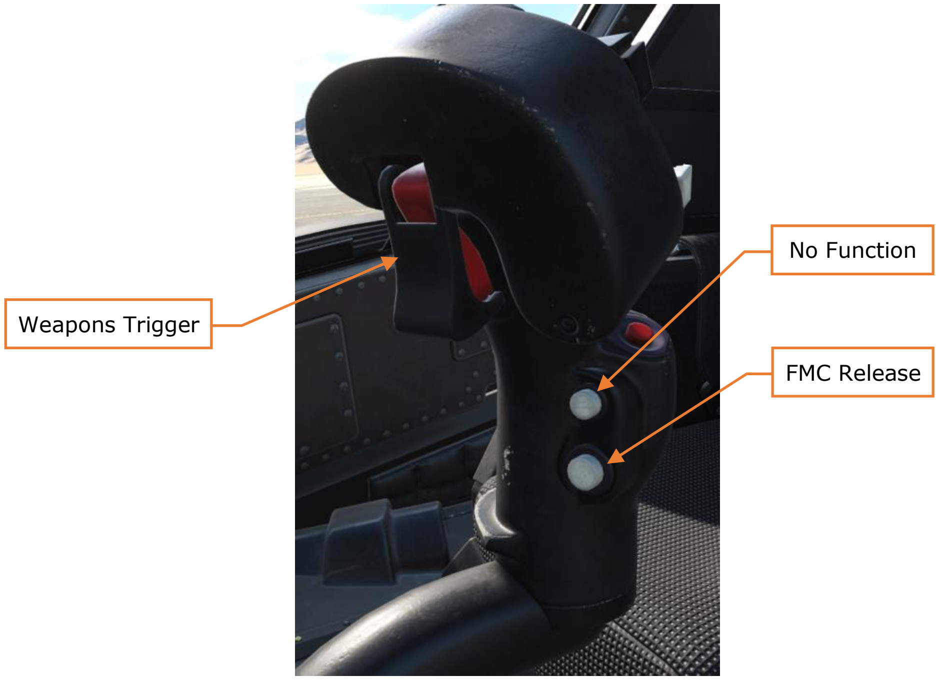


Figure 40. Cyclic, Rear

Force Trim/Hold Mode. Controls the force trim and SCAS.

- **R (Release, Forward).** When held, interrupts the force trim system, and Heading and Attitude Hold modes if applicable. When released, re-engages the force trim system, using the cyclic's current position as the new center point.
- **AT (Attitude Hold, Left).** Toggles Attitude Hold mode on or off. (see Attitude Hold & Position/Velocity Sub-modes)
- **AL (Altitude Hold, Right).** Toggles Altitude Hold mode on or off. (see Altitude Hold Modes)
- **D (Disengage, Aft).** Disengages Attitude modes and Altitude Hold modes.

RTS/ICS PTT. Radio and ICS push-to-talk switch.

- **ICS (Right).** When held, transmits over the intercommunications system.
- **RADIO (Left).** When held, transmits over the selected radio.
- **RTS (Depress).** Moves the radio transmit select (RTS) down to the next radio on the EUFD. If HF radio is selected, moves RTS back up to VHF.

Symbology Select. Selects the active IHADSS symbology mode. (see Flight Symbology)

- **CT (Forward).** Toggles between Cruise and Transition symbology.
- **HB (Aft).** Toggles between Hover and Bob-Up symbology.

Chaff Dispense. Begins selected chaff dispense program. (see Chaff Dispenser)

Flare Dispense. Begins selected flare dispense program. (see Flare Dispensers)

Weapon Action. Selects a weapon system for employment.

- **G (Gun, Forward).** Actions/De-actions the area weapon system for employment and slaves the gun to the currently selected sight.
- **R (Rocket, Left).** Actions/De-actions rockets for employment, activates pylon articulation, and displays the rocket steering symbology.
- **M (Missile, Right).** Actions/De-actions Hellfire missiles for employment, activates pylon articulation, and displays the Hellfire launch constraints symbology.
- **A (Air-to-Air, Aft).** No function.

Weapon Trigger. Fires the actioned weapon system. If no weapon system has been actioned, does nothing.

FMC Release. Disengages all FMC SCAS channels.

Collective Controls

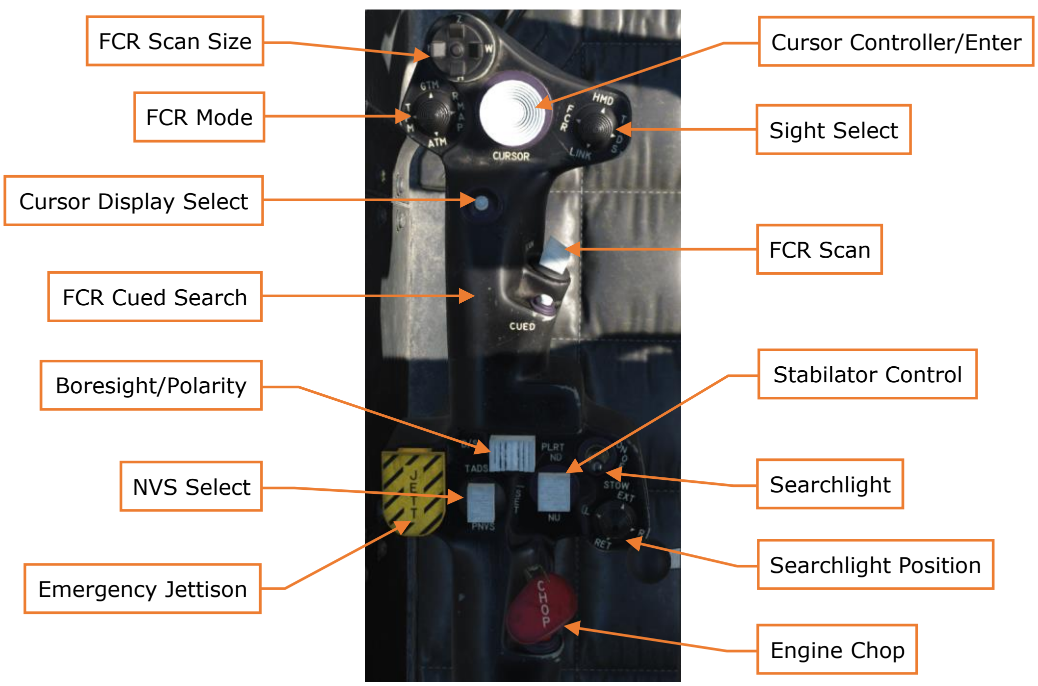


Figure 41. Collective, Top

Figure 42. Collective, Bottom

Emergency Jettison. Jettisons all external stores from the aircraft simultaneously.

Stabilator Control. Provides manual control of the tail stabilator. Moving the switch forward or aft (towards NU [Nose Up] or ND [Nose Down]) will place the stabilator in manual mode and move the stabilator up or down. Pressing down on the switch will reset the stabilator to AUTO mode.

Chop Button. Pressing this button activates the chop circuit, which reduces engine power to idle. Pressing it again resets the chop circuit and restores normal engine power.

Tail Wheel Lock/Unlock. Pressing this button toggles on or off the tail wheel lock, which will engage when the tail wheel reaches center and prevents it from turning.

Searchlight. Controls the retractable searchlight.

- **ON.** Powers the searchlight on.
- **OFF.** Powers the searchlight off.
- **STOW.** Retracts the searchlight.

Searchlight Position. Four-way hat switch that the crewmember can use to aim the searchlight. No function for 1 minute after searchlight stow is selected.

Cursor Controller/Enter. Deflecting the control moves the MPD cursor; a greater deflection results in a faster cursor speed. Pressing down on the cursor selects the item under the MPD cursor.

Cursor Enter. This trigger also selects the item under the MPD cursor.

Cursor Display Select. Toggles the cursor to the other MPD and centers it on the screen. The cursor can also be moved between screens by moving the cursor to the edge of an MPD and "bumping" the cursor controller in the direction of the opposite MPD by releasing Cursor Controller pressure, and then re-applying in that direction.

Sight Select. Selects an active sight or links a sight to the FCR.

- **HMD (Forward).** The IHADSS is selected as the active sight. IHADSS line of sight (LOS) is used for weapons targeting.
- **FCR (Left).** The FCR is selected as the active sight. FCR Next-to-Shoot (NTS) is used for weapons targeting.
- **TADS (Right).** No function for Pilot's collective.
- **LINK (Aft).** Slaves TADS LOS to FCR Next-To-Shoot (NTS). If the CPG's active sight is TADS and the Pilot commands LINK, the CPG's active sight will become HMD.

Boresight/Polarity.

- **PLRT.** Toggles FLIR image polarity (black-hot or white-hot).
- **B/S.** No function.

NVS Select. Selects the image source for the night vision system, TADS or PNVS. When the Pilot selects one NVS source, the other source is automatically assigned to the CPG.

FCR Mode. Selects an FCR mode. No function if FCR is not the active sight.

- **GTM (Forward).** Selects Ground Targeting Mode.
- **RMAP (Right).** Selects Radar Map Mode Re-selection toggles raw radar video underlay.
- **ATM (Aft).** Selects Air Targeting Mode.
- **TPM (Left).** Selects Terrain Profiles Mode.

FCR Scan Size. Selects FCR field of view (FOV).

- **W (Right).** Selects Wide FOV. Scans 90° arc.
- **M (Aft).** Selects Medium FOV. Scans 45° arc.
- **N (Left).** Selects Narrow FOV. Scans 30° arc.
- **Z (Forward).** Selects Zoom FOV. Scans 15° arc.

FCR Scan. Activates or deactivates the FCR transmitter. No function if FCR is not the active sight and the master arm isn't in ARM.

- **S-SCAN (forward).** Performs a single scanburst.
- **C-SCAN (aft).** Activates or deactivates continuous scanburst.

FCR Cued Search. Rapidly orients the FCR antenna towards an emitter detected by the RFI. Scans in the direction of the emitter and attempts to correlate the location of the emitter in the GTM, ATM, or RMAP targeting modes. No function if FCR is not the active sight and the master arm isn't in ARM.

Missile Advance. Manually steps the next Hellfire missile for launch. No function unless the missile mode is Manual.

COPILOT-GUNNER SEAT

The CPG cockpit shares a lot of the same controls as the Pilot cockpit, so only controls specific to the CPG will be documented here.

CPG Cockpit, Forward

Figure 43. CPG Cockpit, Forward

Armament Panel

See the Pilot's Armament and Video Panels.

Fire Detection/Extinguishing Unit

See the Pilot's Fire Detection/Extinguishing Unit.

- Note that if a crew station activates a FIRE pushbutton, shutting off fuel to an engine or the APU, this action can only be reversed from the same crew station. (In other words, if the CPG presses the ENG 1 FIRE button and shuts off fuel to the left engine, only the CPG can reverse this action by pressing the button again.)
- Pressing a FIRE button to arm the DISCH buttons is effective for that crew station only. In other words, if the crewmember presses a FIRE button, arming the DISCH buttons, the CPG will not be able to discharge a fire bottle unless the CPG's FIRE button is also pressed.

Multipurpose Display Unit (MPD)

See the Pilot's Multi-Purpose Displays.

Enhanced Up-Front Display (EUFD)

See Enhanced Up-Front Display.

TADS Electronic Display and Control (TEDAC)

Figure 44. TADS Electronic Display and Control

TEDAC Display Unit (TDU)

Figure 45. TEDAC Display Unit

The TEDAC is a modernized replacement for the Optical Relay Tube (ORT) from the AH-64A and early AH-64D aircraft. It presents the CPG with high-resolution sensor video from the Modernized Target Acquisition Designation Sight (M-TADS). Using the TEDAC, the CPG can use the aircraft's sensors to locate and engage targets.

TDU Video Buttons. Selects the video source for display on the TDU.

- **TAD.** Displays the CPG's HMD symbology when sight-selected to HMD, or TADS symbology and video when sight-selected to TADS.
- **FCR.** Displays the FCR targeting format.
- **PNV.** Displays the Pilot's HMD symbology and selected NVS video.
- **G/S.** Displays a grayscale image for video calibration.

DAY/NT/OFF. Selects between brightness modes or turns off TEDAC Display Unit (TDU) screen backlighting.

- **DAY.** Video is displayed with a high-luminance white backlight.
- **NT.** Video is displayed with a low-luminance, NVG-compatible green backlight.
- **OFF.** All backlighting is extinguished. Video is still routed to the TEDAC display but will not be visible.

LEV. Adjusts FLIR video level for the TADS FLIR imagery. Also adjusts PNVS FLIR imagery if CPG is using PNVS as the selected NVS sensor.

GAIN. Adjusts FLIR video gain for the TADS FLIR imagery. Also adjusts PNVS FLIR imagery if CPG is using PNVS as the selected NVS sensor.

R/F. Adjusts focal distance (range/focus) for DTV or FLIR video. Minimum focal distance is 500 meters for the FLIR in NFOV or MFOV (narrow or medium field of view). Minimum focal distance is 1,500 meters for the DTV in NFOV.

EL. Used to adjust TADS drift in elevation when the AZ/EL enable button is selected.

AZ. Used to adjust TADS drift in azimuth when the AZ/EL enable button is selected.

SYM. Sets symbology brightness of the CPG HDU when HMD is the active sight, from black to white. Sets symbology brightness of TADS LOS crosshairs and IAT gates of the TADS video when TADS is the active sight. A momentary press steps brightness up or down once; a short press commands a slow continuous change; and a long press commands a fast continuous change.

BRT. Adjusts the image or grayscale intensity of the CPG HDU when HMD is the active sight, or the TDU when the TADS is the active sight. A momentary press steps brightness up or down once; a short press commands a slow continuous change; and a long press commands a fast continuous change.

CON. Adjusts the image or grayscale contrast of the CPG HDU when HMD is the active sight, or the TDU when the TADS is the active sight. A momentary press steps brightness up or down once; a short press commands a slow continuous change; and a long press commands a fast continuous change.

***** (asterisk) button. Resets brightness and contrast of the CPG HDU or TDU to default setting. The day/night setting determines whether a bright or dim default is used.

TEDAC Left Hand Grip (LHG)

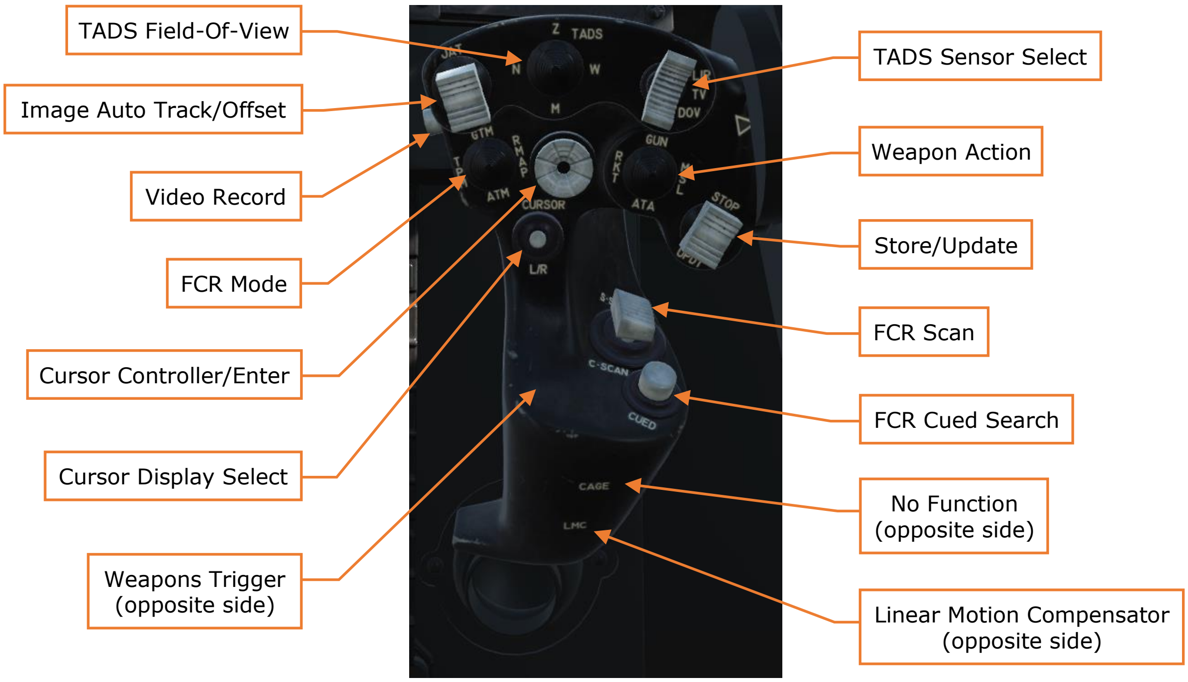


Figure 46. TEDAC Left Hand Grip

Cursor Controller/Enter. Deflecting the control moves the MPD cursor, a greater deflection results in a faster cursor speed. Pressing down on the cursor selects the item under the MPD cursor.

Cursor Display Select. Toggles the cursor to the other MPD and centers it on the screen. The cursor can also be moved between screens by moving the cursor to the edge of an MPD and "bumping" the cursor controller in the direction of the opposite MPD by releasing Cursor Controller pressure, and then re-applying in that direction.

Video Record. Toggles the VCR between STOP/STANDBY and RECORD mode.

TADS Sensor Select. Selects the optical sensor used for TADS. No function if the TADS is being used by either crewmember as an NVS sensor.

- **FLIR.** Forward-looking infrared sensor is used by TADS.
- **DTV.** Daytime television sensor is used by TADS.
- **DVO.** No function.

Linear Motion Compensator. Toggles the linear motion compensator function.

Store/Update. Stores position information or performs position updates.

- **STORE (forward).** Stores selected sensor LOS as a point.
- **UPDT (aft).** Performs a flyover or TADS position update. (see TODO)

TADS Field-Of-View. Selects TADS field of view (FOV).

- **W (right).** Selects Wide FOV. No zoom; for navigation and target detection.
- **M (aft).** Selects Medium FOV. Optical zoom; for target detection and acquisition. Not available when DTV is in use.
- **N (left).** Selects Narrow FOV. Optical zoom; for identification and targeting.
- **Z (forward).** Selects Zoom FOV. Electronic zoom for targeting.

Image Auto Track/Offset. Initiates and controls image auto tracking and offset tracking.

- **IAT (forward), short.** Enables image-auto track and establishes the object under the cursor as the primary track.
- **IAT (forward), long.** Activates manual sizing of the tracking gates.
- **OFS (aft).** When offset tracking, returns TADS LOS to the primary track. When not offset tracking, deletes the current track (primary or secondary).

FCR Mode. Selects an FCR mode. No function if FCR is not the active sight.

- **GTM (forward).** Selects Ground Targeting Mode.
- **RMAP (right).** Selects Radar Map Mode. Re-selection toggles raw radar video underlay.
- **ATM (aft).** Selects Air Targeting Mode.
- **TPM (left).** Selects Terrain Profiles Mode.

FCR Scan. If the selected sight is the FCR and the master arm is in ARM or TADS with the FCR linked, activates or deactivates the FCR transmitter. Otherwise, no function.

- **S-SCAN (forward).** Performs a single scanburst.
- **C-SCAN (aft).** Activates or deactivates continuous scanburst.

FCR Cued Search. Rapidly orients the FCR antenna towards a threat emitter detected by the RFI. Scans in the direction of the emitter and attempts to correlate the location of the emitter in the GTM, ATM, or RMAP targeting modes. No function if FCR is not the active sight and the master arm isn't in ARM.

Weapon Action. Selects a weapon system for employment.

- **G (Gun, forward).** Actions/De-actions the Area Weapon System for employment and slaves the gun to the currently selected sight.
- **R (Rocket, left).** Actions/De-actions rockets for employment, activates pylon articulation, and displays the rocket steering symbology. If the Pilot also actions rocket, COOP mode is entered.

- **M (Missile, right).** Actions/De-actions Hellfire missiles for employment, activates pylon articulation, and displays the Hellfire launch constraints symbology.
- **A (Air-to-Air, aft).** No function.

Weapon Trigger. Fires the actioned weapon system if that weapon was actioned using the Weapon Action Switch on the left TEDAC grip. If no weapon system has been actioned, or the weapon system was actioned using the Weapon Action Switch on the CPG cyclic, does nothing.

TEDAC Right Hand Grip (RHG)

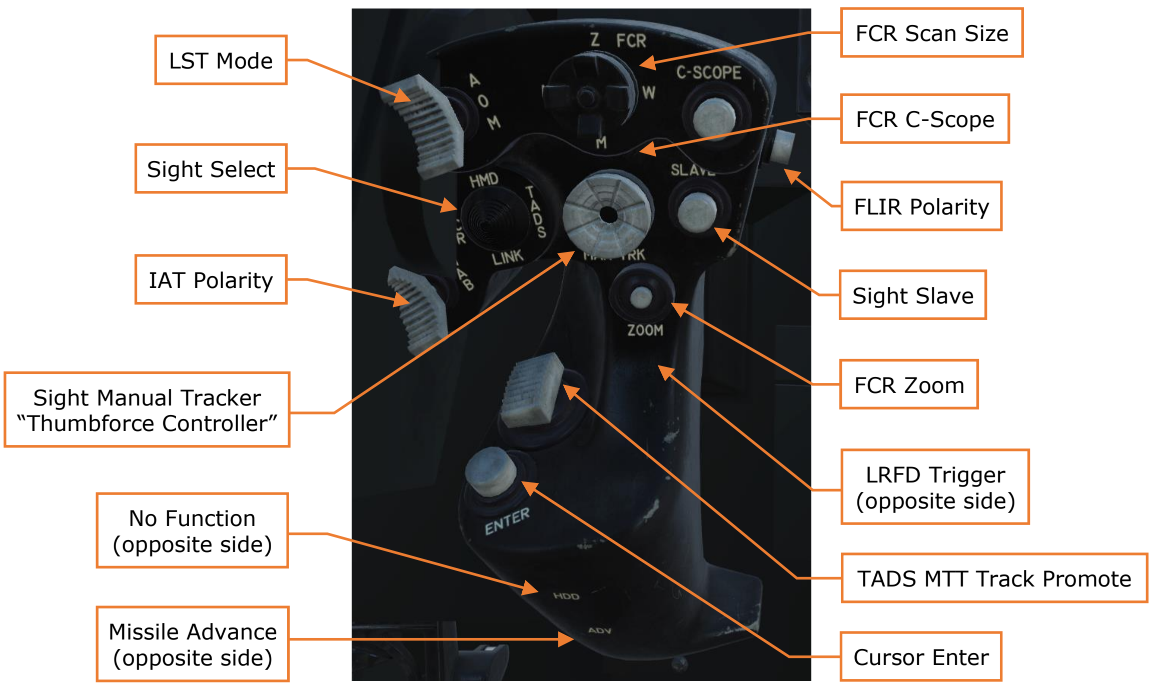


Figure 47. TEDAC Right Hand Grip

FCR Zoom. Changes the FCR targeting format to a 6× zoom, centered around the Next-To-Shoot (NTS). A second press restores the normal FCR format.

Sight Select. Selects an active sight or links a sight to the FCR.

- **HMD (forward).** The IHADSS is selected as the active sight. IHADSS line-of-sight (LOS) is used for weapons targeting.
- **FCR (left).** The FCR is selected as the active sight. FCR Next-to-Shoot (NTS) is used for weapons targeting.
- **TADS (right).** The TADS is selected as the active sight. TADS line-of-sight (LOS) is used for weapons targeting.
- **LINK (aft).** When TADS is the active sight, slaves FCR centerline to TADS LOS. When FCR is the active sight, slaves TADS LOS to FCR Next-To-Shoot

(NTS). If the Pilot's active sight is FCR and the CPG commands LINK, the Pilot's active sight will become HMD.

Sight Slave. Toggles the FCR or TADS tracking mode between Slave and Manual (de-slaved). When in Slave, FCR or TADS LOS is slaved to target acquisition LOS. When in Manual, FCR antenna angle or TADS LOS is controlled by the sight manual tracker.

Sight Manual Tracker. Slews FCR antenna angle or TADS LOS when TADS LOS when Slave is not enabled (tracking mode is Manual).

TADS Multi-Target Track Promote (Forward/Aft). Steps to the next or previous TADS secondary track and promotes it to the primary track.

FLIR Polarity. Toggles FLIR image polarity (black-hot or white-hot).

IAT Polarity. Selects polarity for the image auto tracker.

- **W (White, forward).** Bright objects are tracked by the IAT.
- **A (Auto, mid).** IAT automatically chooses tracker polarity.
- **B (Black, aft).** Dark objects are tracked by the IAT.

LST Mode. Sets the laser spot tracker (LST) mode.

- **A (Automatic, forward).** Enables the LST and commands the TADS to begin a 4-bar scan centered around the current target LOS.
- **O (Off, mid).** LST is disabled.
- **M (Manual, aft).** Enables the LST and sets TADS tracking mode to Manual.

LRFD Trigger. Activates the laser rangefinder.

- **First detent.** LRFD determines target range.
- **Second detent.** LRFD determines target range and designates target for laser guidance.

FCR Scan Size. Selects FCR field of view (FOV).

- **W (right).** Selects Wide FOV. Scans 90° arc.
- **M (aft).** Selects Medium FOV. Scans 45° arc.
- **N (left).** Selects Narrow FOV. Scans 30° arc.
- **Z (forward).** Selects Zoom FOV. Scans 15° arc.

FCR C-Scope. Toggles the FCR C-scope (azimuth over elevation) display within the HMD and TADS symbology.

Missile Advance. Manually steps the next Hellfire missile for launch. No function unless the missile mode is Manual.

CPG Cockpit, Left Console and Left Auxiliary Console

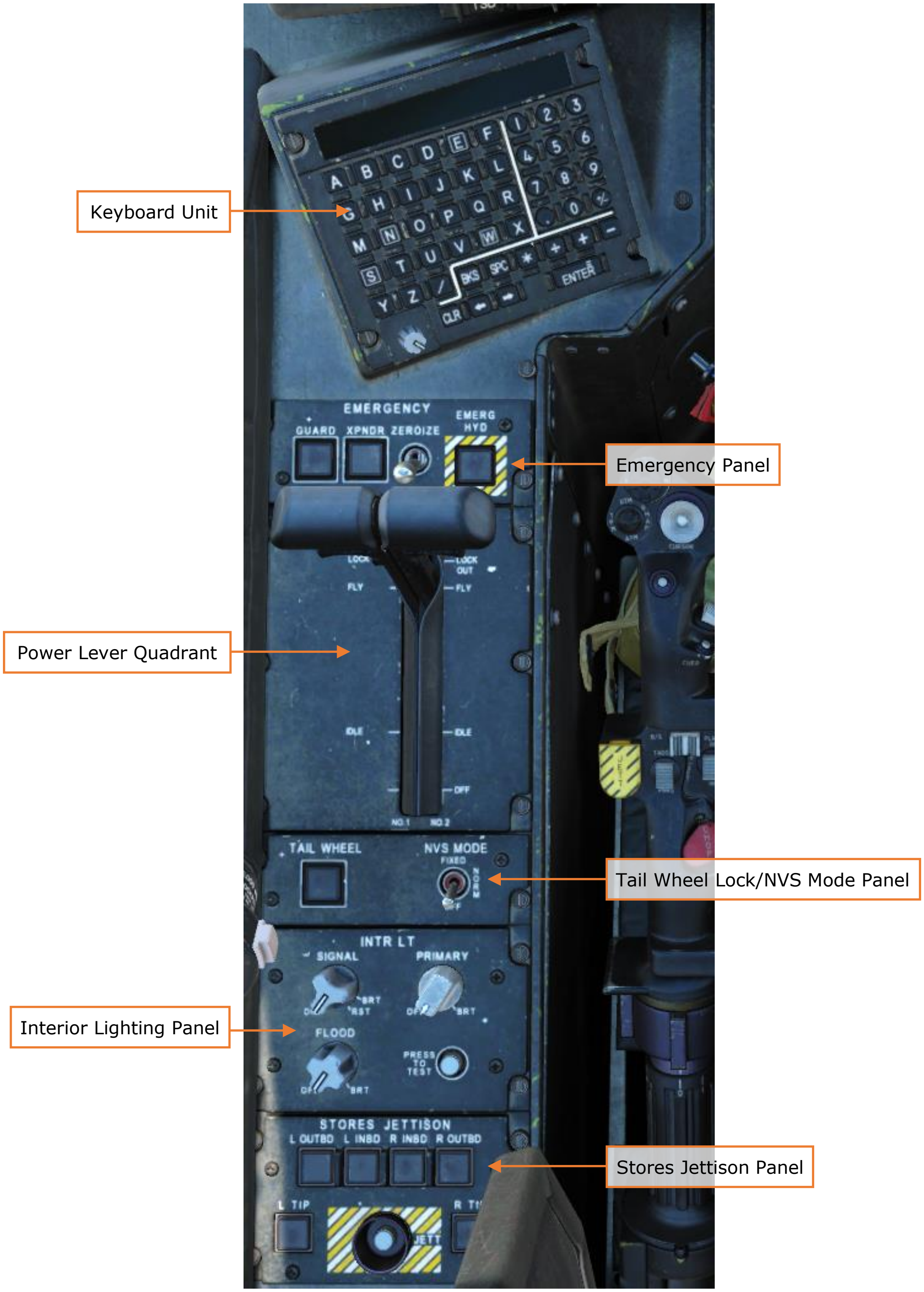


Figure 48. CPG Cockpit, Left Console and Left Auxiliary Console

Keyboard Unit

Used for data entry to either MPD or the EUFD. Can be used as an in-cockpit calculator. (See Keyboard Unit)

Emergency Panel

See the Pilot's Emergency Panel.

Power Lever Quadrant

See the Pilot's Power Lever Quadrant. Note that only the power levers are present on the CPG's quadrant.

Tail Wheel Lock/NVS Mode Panel

See the Pilot's Tail Wheel Lock/NVS Mode Panel.

Interior Lighting Panel

See the Pilot's Exterior/Interior Lighting Panel. Note that only interior lighting controls are available to the CPG.

Stores Jettison Panel

See the Pilot's Stores Jettison Panel. Note that while either crewmember can arm a station for jettison, or jettison the armed stations, only the crewmember that originally armed a station for jettison can disarm that station. (In other words, if the CPG arms the left outboard station for jettison, the Pilot cannot disarm it.)

CPG Cockpit, Right Console

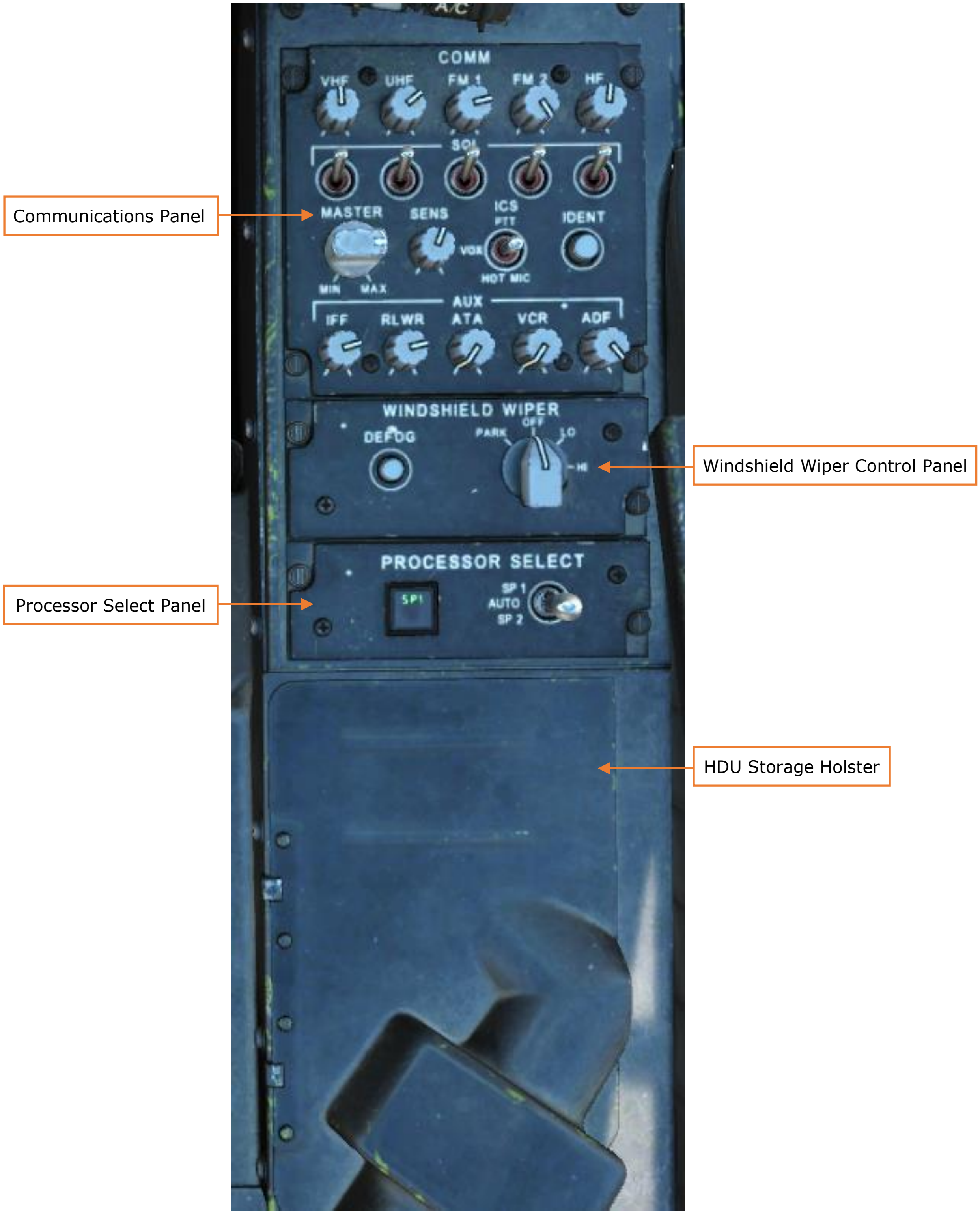


Figure 49. CPG Cockpit, Right Console

Communications Panel

See the Pilot's Communications Panel.

Windshield Wiper Control Panel

See the Pilot's Windshield Wiper Control Panel.

Processor Select Panel

Figure 50. Processor Select Panel

Primary SP Indicator. Provides a lighted indication as to which system processor is primary ("SP1" or "SP2").

SP Select. Allows the CPG to manually select the primary system processor. In the AUTO mode, if a system processor becomes unreliable, the other system processor will automatically become primary. In the two manual modes, the CPG must change the system processor manually if it becomes degraded.

- **AUTO.** The healthiest system processor is automatically chosen as primary.
- **SP1.** SP1 is primary, and SP2 is secondary.
- **SP2.** SP2 is primary, and SP1 is secondary.

CPG Cockpit, HOCAS (Hands-On Collective and Stick)

Cyclic Controls

See the Pilot's Cyclic Controls. The CPG cyclic can be folded down to prevent CPG interference when not flying the aircraft.

Collective Controls

See the Pilot's Collective Controls. The CPG collective has the following specific functions:

Sight Select.

- **TADS (Right).** Selects TADS as the active sight. TADS line of sight is used for weapons targeting.
- **LINK (Aft).** When TADS is the active sight, slaves FCR centerline to TADS LOS. When FCR is the active sight, slaves TADS LOS to FCR Next-To-Shoot (NTS). If the Pilot's active sight is FCR and the CPG commands LINK, the Pilot's active sight will become HMD.

FCR Scan. If the selected sight is the FCR, or TADS with the FCR linked, activates or deactivates the FCR transmitter. Otherwise, no function.

- **S-SCAN (forward).** Performs a single scanburst.
- **C-SCAN (aft).** Activates or deactivates continuous scanburst.

BUCS Select. Manually switches the Back-Up Control System (BUCS) control priority to the CPG cockpit controls (non-reversible).

INTEGRATED HELMET AND DISPLAY SIGHTING SYSTEM (IHADSS)

The Integrated Helmet And Display Sighting System (IHADSS) allows the crewmembers to view flight and navigation information, sensor video, targeting information, and weapon status. The IHADSS also allows each crewmember to independently cue weapons and sensors using their head movements and is integral in performing flight operations at night. The crewmember is presented with a Flight symbology format within the Helmet Display Unit (HDU). The CPG is either presented with Flight symbology format or Weapon symbology format within the HDU, depending on sight selection.

Flight Symbology

Cruise Mode

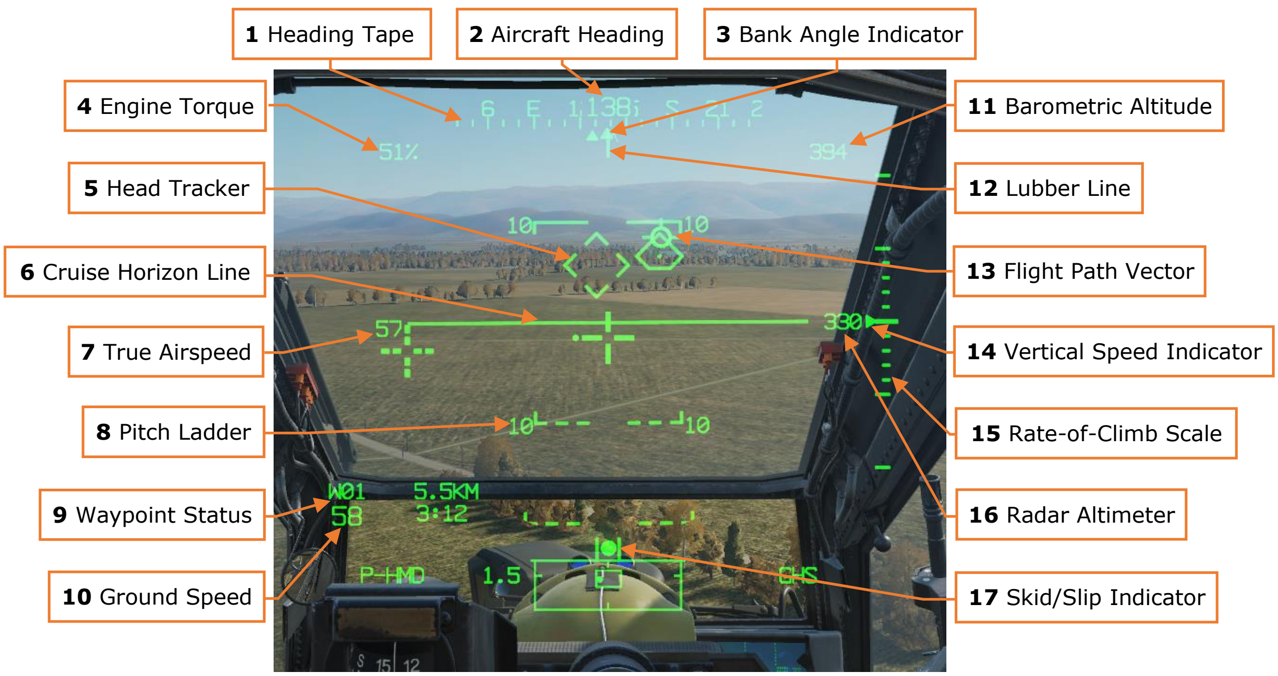


Figure 51. IHADSS Cruise Mode Symbology

Transition Mode

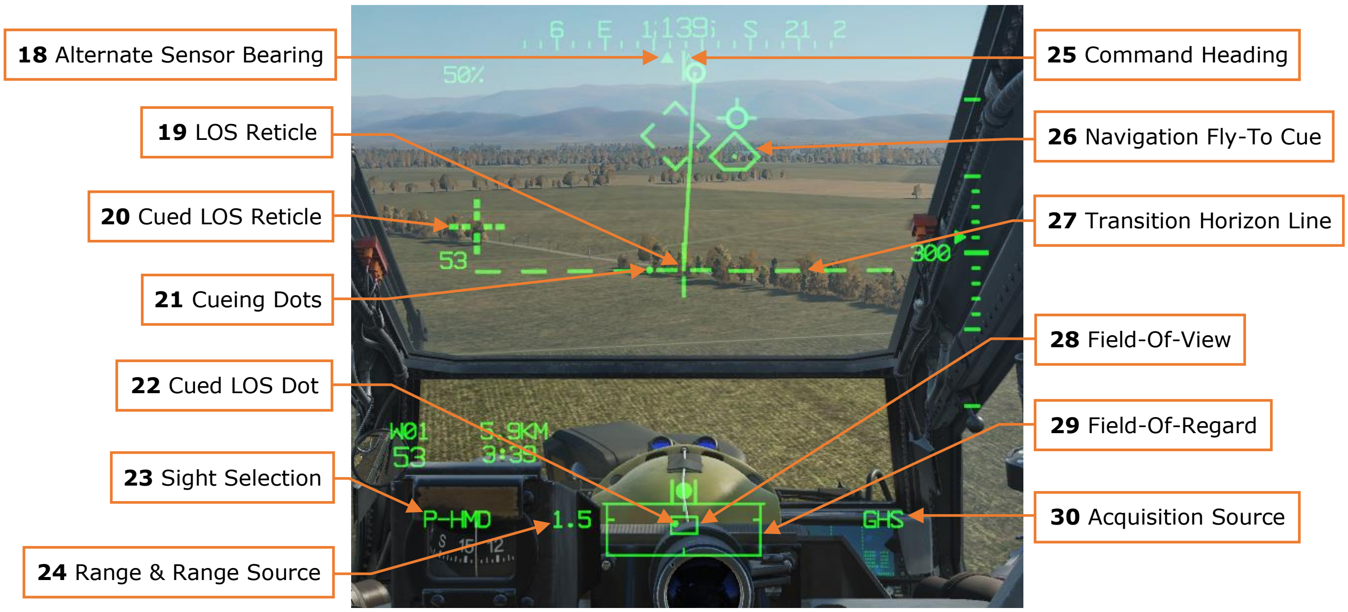


Figure 52. IHADSS Transition Mode Symbology

Hover Mode

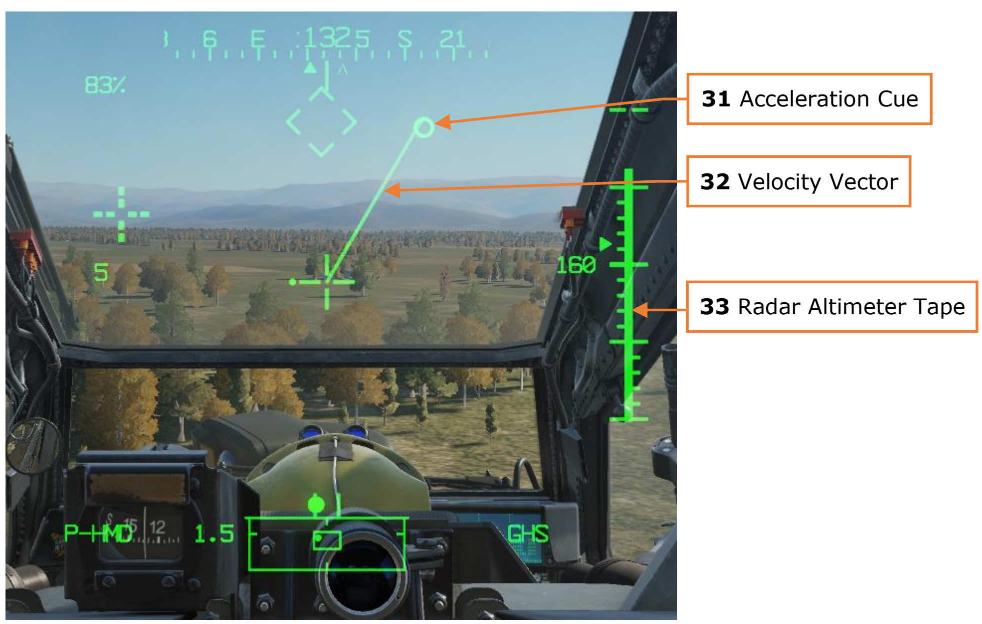


Figure 53. IHADSS Hover Mode Symbology

Bob-Up Mode

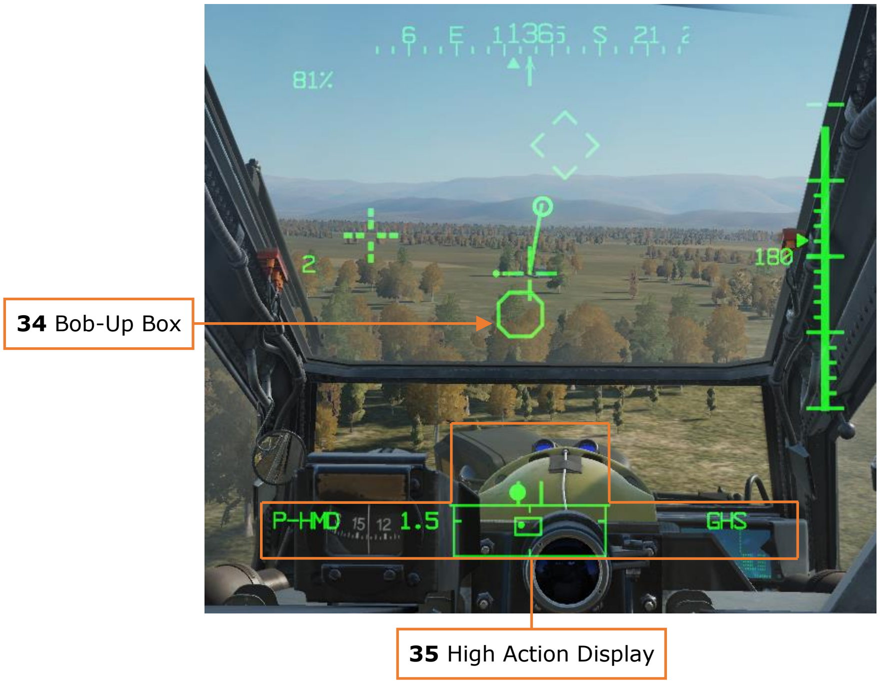


Figure 54. IHADSS Bob-Up Mode Symbology

1. **Heading Tape.** Provides a 180° wide scale of compass directions in 10° increments, with every 30° marked by a cardinal direction or heading to the tenths value.
2. **Aircraft Heading (HDG).** Displays a digital readout of the current aircraft heading in 1° increments, superimposed over the heading tape.
3. **Bank Angle Indicator.** Indicates the bank angle of the aircraft. Only displayed in Cruise mode symbology.
4. **Engine Torque (TQ).** Displays the highest torque of the two engines. When a greater than 12% split occurs between the engine torque values, the torque digital readout will flash. A box will be displayed around the torque at 98% or higher.
5. **Head Tracker.** Represents the armament datum line (ADL, or centerline) of the aircraft; 0° in azimuth and 0° in elevation. Assists the crewmembers in maintaining awareness of their head position relative to the nose of the aircraft, especially under low-light conditions while using the PNVS or TADS systems for flight and navigation.
6. **Cruise Horizon Line.** Indicates the horizon relative to the LOS Reticle in a 2:1 movement ratio in the pitch axis.

7. **True Airspeed (TAS).** Indicates the true airspeed of the aircraft in 1 knot increments, from 0 to 210 knots. The true airspeed is boxed when the airspeed exceeds VNE. When Attitude Hold is engaged, a rounded "status window" box is displayed around the TAS digital readout.

8. **Pitch Ladder.** Indicates aircraft pitch angles in 10° increments, up to a maximum of 30°. Only displayed in Cruise mode symbology.

9. **Waypoint Status.** Displays the name of the current point selected for navigation, its distance in kilometers or nautical miles, current ground speed, and estimated time to arrival (ETE). The ETE is based on the aircraft's current ground speed, and is presented in HH:MM format when the ETE is ≥5 minutes, or M:SS format when ETE is <5 minutes. The ETE is not displayed when ground speed is <15 knots or ETE is >10 hours. The distance remaining is not displayed if there is no active destination point.

10. **Ground Speed (GS).** Indicates the speed across the ground in 1 knot increments. Ground speed is not displayed unless the primary INU is aligned.

11. **Barometric Altitude (MSL).** Barometric altitude of the aircraft, from -2,300 feet up to 20,000 feet in increments of 10 feet. Only displayed in Cruise mode symbology.

12. **Lubber Line.** The lubber line is aligned to the centerline of the aircraft and serves as a reference for both the aircraft heading and Cruise mode symbology bank angle indicator.

13. **Flight Path Vector (FPV).** The flight path vector (FPV) represents the point towards which the helicopter is flying. It is a 3D representation of the aircraft's velocity. The FPV will disappear when the 3D velocity magnitude is <5 knots ground speed, or when weight-on-wheels.

14. **Vertical Speed Indicator (VSI).** The vertical speed indicator moves up and down the rate-of-climb scale to indicate vertical speed. The VSI becomes saturated at the ±1000 fpm tick marks of the rate-of-climb scale.

15. **Rate-of-Climb Scale.** The rate of climb indicator scale presents 100 fpm rate of climb tick marks to ±500 fpm, and then displays 1000 fpm tick marks. When the rate-of-climb exceeds ±1000 fpm, a digital readout in 100 fpm sensitivity is displayed adjacent to the rate-of-climb minimum or maximum tick marks.

16. **Radar Altimeter (AGL).** Aircraft altitude above ground level from 0 to 1,428 feet, displayed in increments of 1 foot up 50 feet in altitude, and increments of 10 feet between 50 feet and 1,428 feet in altitude. The radar altimeter digital readout will be removed when above 1,428 feet. When Altitude Hold is engaged, a rounded "status window" box is displayed around the radar altimeter digital readout.

17. **Skid/Slip Indicator ("Trim Ball").** Indicates the amount of side acceleration and when the aircraft is in coordinated flight ("aerodynamic trim" or "in trim").

18. **Alternate Sensor Bearing.** Indicates the azimuth of the opposite crewmember's selected HMD or TADS LOS. The alternate sensor bearing is not displayed to a crewmember when the other crewmember's selected sight is FCR.

19. **Line-Of-Sight (LOS) Reticle.** Indicates the line-of-sight of the selected sight. It is used as a reference for the Head Tracker, Horizon Line, Velocity Vector, Acceleration Cue, and Bob-Up Box. It is also used as an aiming crosshair for weapons employment. The LOS reticle flashes when the crewmember's LOS is invalid, the selected NVS sensor is at its slew limit, or if the gun is actioned and the gun system has failed and is no longer following the crewmember's helmet. The LOS reticle is bolded when in Cruise mode.

20. **Cued Line-Of-Sight (LOS) Reticle.** Indicates the location of the selected acquisition source to the crewmember. If CUEING (R1) is deselected on the Pilot's WPN UTIL page, this symbol is not visible.

21. **Cueing Dots.** Indicates the quadrant direction of the selected acquisition source to cue the crewmember's LOS to the cued LOS reticle. The dots are removed when the cued LOS reticle is with 4° of that quadrant relative to the LOS reticle. All four dots flash when "IHADSS B/S REQUIRED" message is present within the Sight Status field of the High Action Display, indicating the crewmember needs to boresight their IHADSS. If CUEING (R1) is deselected on the Pilot's WPN UTIL page, this symbol is not visible.

22. **Cued Line-Of-Sight (LOS) Dot.** Indicates the relative azimuth and elevation of the selected acquisition source within the field-of-regard box.

23. **Sight Selection.** Displays the crewmember's selected sight. Available sight selections for the Pilot are HMD or FCR. Available sight selections for the CPG are HMD, FCR, or TADS.

24. **Range and Range Source.** Displays the range source in use and the current range in tenths of kilometers or meters (laser only). Available range sources include:

    a. **Default range:** 1.5 km for the Pilot; 3.0 km for the CPG

    b. **Manual range:** 100-50,000 meters (displayed as M0.1 to M50.0)

    c. **Auto range:** 0.1 km to 50 km (displayed as A0.1 to A50.0)

    d. **Navigation range:** 0.1 to 32 km (displayed as N0.1 to N32.0)

    e. **Radar range:** 0.1 to 9.9 km (displayed as R0.1 to R9.9)

    f. **Laser range:** 500 to 9999 meters (displayed as 500 to 9999)

25. **Command/Bob-Up Heading.** Command heading chevron indicates the heading to the Navigation Fly-To Cue. When operating in Bob-Up it represents the heading of the aircraft at the time Bob-Up mode was entered.

26. **Navigation Fly-To Cue.** Indicates the location of the current point selected for navigation. Also called the "homeplate" symbol, the Navigation Fly-To Cue is sized so the Flight Path Vector fits within it for precise 3-dimensional navigation. The Navigation Fly-To Cue is not displayed when the aircraft is weight-on-wheels.

27. **Transition Horizon Line.** Indicates the horizon relative to the LOS reticle in a 4:1 movement ratio in the pitch axis, up to a maximum of ±30° in pitch. When aircraft pitch attitude exceeds 20° in pitch, the Transition horizon line will remain saturated at maximum deflection until the pitch attitude is less than 30°.

28. **Field-Of-View (FOV) Box.** The FOV box indicates the relative position of the PNVS or TADS 30°x40° field of view within the field-of-regard box.

29. **Field-Of-Regard (FOR) Box.** The outer box indicates azimuth limits for the current sensor. Tick marks around the edges of the FOR box assist in marking the sensor limits for each sensor.

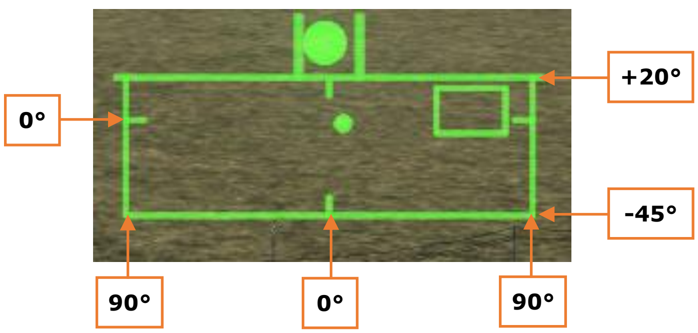


Figure 55. PNVS Field-Of-Regard Box

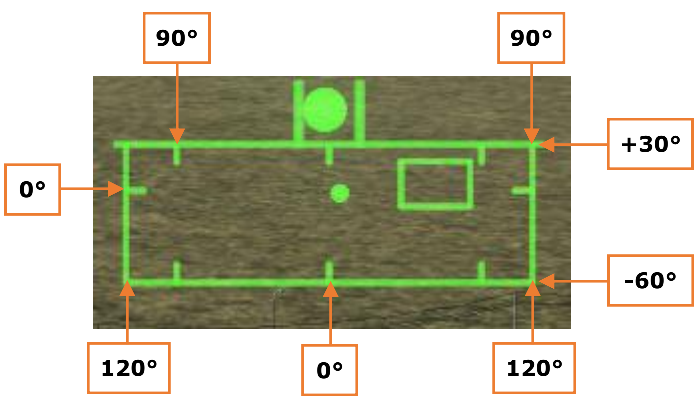


Figure 56. TADS Field-Of-Regard Box

30. **Acquisition Source (ACQ).** Indicates the currently selected acquisition source. Acquisition sources include:

    a. **PHS** – Pilot Helmet Sight

b. **GHS** – Gunner Helmet Sight

c. **SKR** – Tracking missile seeker

d. **RFI** – Radio Frequency Interferometer

e. **FCR** – Fire Control Radar

f. **FXD** – Fixed forward (0° in azimuth/-4.9° in elevation)

g. **W##, H##, C##, T##** – (## is the number of the stored Waypoint, Hazard, Control Measure or Target/Threat)

h. **TRN** – Cursor-selected terrain location on the TSD

31. **Acceleration Cue.** The acceleration cue indicates magnitude and direction of the aircraft's acceleration. The velocity vector will always seek the center of the acceleration cue. The acceleration cue can be thought of as a representation of the cyclic, as displacing the cyclic will displace the acceleration cue.

    When in Hover or Bob-Up symbology modes, the origin of the acceleration cue is from the outer end of the velocity vector when the vector is less than maximum scale (not "saturated"). When the velocity vector is saturated beyond the maximum scale, the acceleration cue will originate from the center of the LOS reticle.

32. **Velocity Vector (VV).** The velocity vector indicates the 2D direction and magnitude of travel of the helicopter across the ground. The center of the LOS represents a point approximating the mast. In Hover mode symbology, the velocity vector will reach maximum saturation at 6 knots ground speed, and in Transition mode symbology at 60 knots ground speed.

33. **Radar Altimeter (AGL) Analog Tape.** Presents tick marks every 10 feet to an altitude of 50 feet, and tick marks every 50 feet to an altitude of 200 feet. When the aircraft has exceeded 200 feet AGL, the radar altitude tape will disappear. The radar altimeter tape will not be displayed again until the aircraft descends below 180 feet AGL.

34. **Bob-Up Box.** Represents a 12 square-foot box anchored to the position it was on the ground at the time Bob-Up mode was entered. This is termed "dropping a Bob-Up box". The box will remain in this position until the crew changes symbology modes. When the Bob-Up box has reached the edge of the display ("saturated"), the aircraft has travelled 40 feet.

35. **High Action Display (HAD).** The High Action Display is displayed in both Flight and Weapons symbology. The HAD provides prioritized sight and weapon status messages to the crew for targeting and weapons employment. See Target Acquisition Designation Sight for more information.

Figure 57. PNVS Under Darkness.

Weapon Symbology

See Target Acquisition Designation Sight for more information.

MULTI-PURPOSE DISPLAYS

The Multi-Purpose Displays (MPDs) are color liquid crystal displays that allow the Pilot and CPG to access different formats. Each format allows the crewmember to view different information or access different functions. There are two MPDs in each cockpit station. The MPDs are identical; either can display any page, sub-page, or format. Many functions that would be controlled by switches or physical controls in other aircraft are MPD functions in the AH-64D.

Each MPD is surrounded by 24 bezel variable-action buttons, six on a side. The function of the bezel buttons changes depending on the displayed format.

The MPDs have a screensaver mode that is armed when the aircraft is on the ground, on external power, with the throttles off. In this situation, the displays will turn off after 5 minutes with no button presses. Pressing any buttons will "wake" the MPDs, turning them back on.

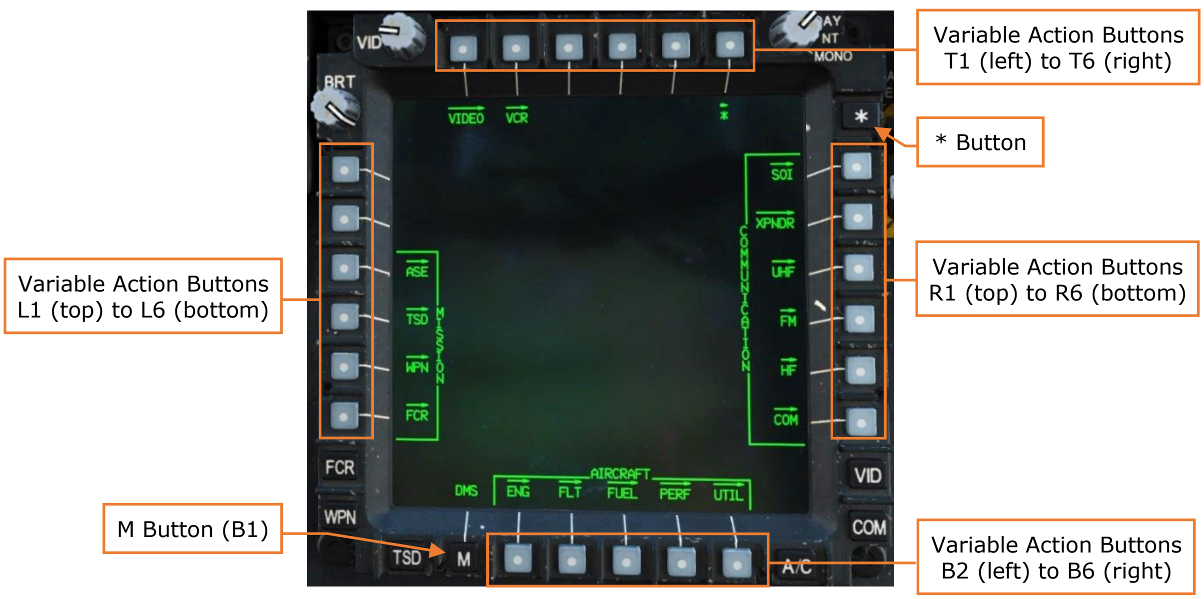


Figure 58. Multi-Purpose Display

Variable Action Buttons (VAB). Each button can be associated with a function, that is displayed on the screen adjacent the button. The function of the button depends on the selected page or page format.

FCR Fixed Action Button (FAB). Displays FCR page.
(see Fire Control Radar Page)

WPN Fixed Action Button (FAB). Displays the WPN page.
(see Weapon Page)

TSD Fixed Action Button (FAB). Displays the TSD page. (see Tactical Situation Display Page)

M Button. Displays the Menu page. (see Menu Page)

A/C Fixed Action Button (FAB). Displays the FLT page when in the air or the ENG page when on the ground. (see Engine Page and Flight Page)

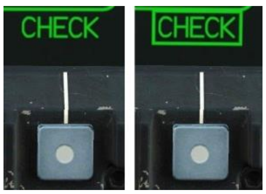
COM Fixed Action Button (FAB). Displays the COM page. (see Communications Page)

VID Fixed Action Button (FAB). Displays the VIDEO page. (see Video Page)

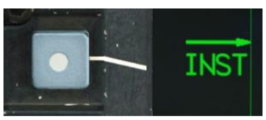
*** Button.** Cycles between up to 3 "favorite" MPD pages. (N/I)

Variable Action Button (VAB) Functions

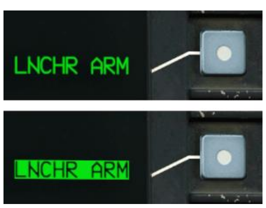
The function of a Variable Action Button is indicated by the format of its label.



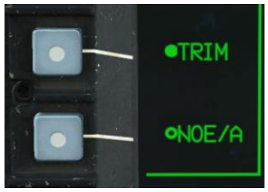
Maintained Pushbutton. Sets hardware or operating modes. The state of the pushbutton is maintained even after switching to a different page.



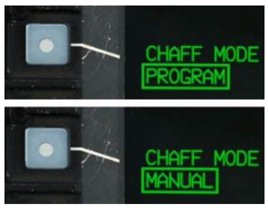
Page Pushbutton. Pressing this button will display a different page on the MPD.



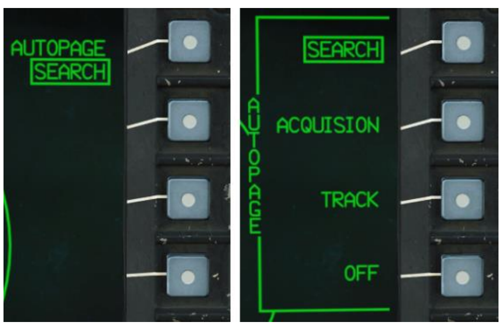
Momentary Pushbutton. Performs an action. The text appears in inverse video while the action is being performed.



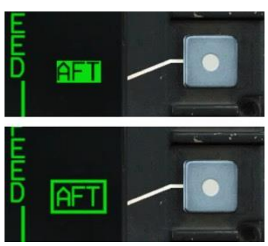
On/Off Pushbutton. Pressing the button toggles a system on or off. If the circle is solid the system is on. If the circle is hollow the system is off.



Two-State Pushbutton. Pressing the button toggles a system between two different states.



Multi-State Pushbuttons. Pressing the button reveals an expanded menu of options that the crewmember can select from. Upon selection of an option the menu will collapse to its previous state, displaying only the current selection.



In-Progress Pushbutton. The text appears in inverse video while the action is being performed. Text will be boxed when that action is complete.

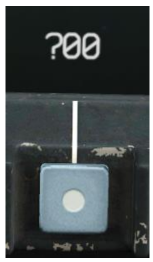
Data Entry Pushbutton. Pressing the button marked with **>** will display a prompt on the Keyboard Unit, where the crewmember can enter new data.

Search Pushbuttons. Pressing the up and down arrow buttons will scroll through the list.

Paging Buttons. Use these buttons to move through pages of a list.

Disabled Button. Buttons with a green barrier next to their label are disabled, because their function is not available.

TODO **Failed Command.** Buttons with a white triangle next to their label indicate that a command was attempted and failed, and the crewmember has the option to retry.



Missing/Invalid Data. Button labels displayed in white with a question mark indicate data that is invalid or missing.

Autopaging

Some pages will present automatically when certain events occur; this is called autopaging. The threshold for ASE autopaging can be set independently in each cockpit. ENG autopaging can be disabled in the CPG cockpit only.

- The ENG page will display when a new warning message appears.
- The ENG page will display if the EMER HYD switch is activated.
- The ENG page will display when an engine starter is engaged.
- The TSD page will display when the RLWR or RFI detects radar or laser energy exceeding the set threshold.
- The FCR page will display when the sight select is set to FCR.
- Depressing (Z-axis) on the Symbol Select Switch on the cyclic will select the FLT page.

Cursor Use

The Cursor Control Switch on the collective is used to slew the cursor on the active MPD. The cursor can be moved to the opposite display using the Cursor Display Select Switch, or by moving the cursor to the edge of one display and "bumping" the cursor controller in the direction of the opposite MPD by releasing Cursor Controller pressure, and then re-applying in that direction.

When FCR is selected for display on the TDU, the cursor can be utilized on the TDU. The "bump" method is required for placing the cursor on the TDU in this instance.

Single DP Operation

If one of the two display processors fails, the crew MPDs will duplicate each other if no priority pages are present. The CPG's left MPD will duplicate the Pilot's current left MPD format, and the Pilot's right MPD will duplicate the CPG's right MPD format. Both the Pilot and CPG will have independent cursors, and the CPG cursor will change to distinguish it from the Pilot cursor (TODO image).

Menu Page

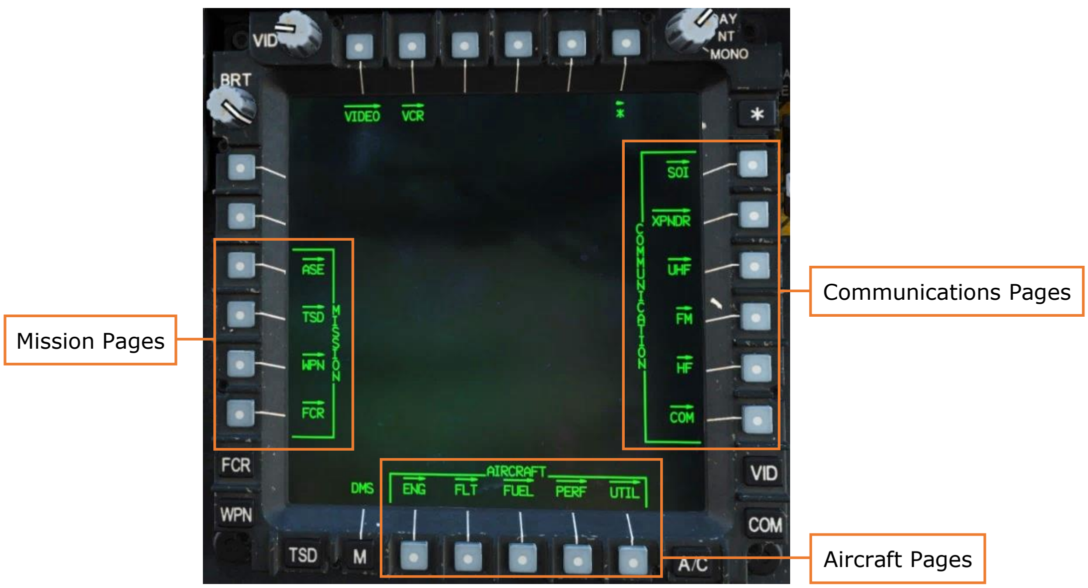


Figure 59. MPD MENU Page

Pressing a button will display the associated page. Most pages are grouped into Aircraft, Mission, and Communication sections.

Aircraft, Engine (ENG) Page

The ENG page displays engine and powertrain data and is formatted based on conditions. ENG page data that is within normal operating ranges are in green, data that is outside of normal operating parameters is colored yellow or red. For data that is displayed using analog tapes, the entire tape is color-coded to indicate operating condition, and the width of the tape will also widen when outside of normal operating parameters.

During initial start-up of the APU, the ENG page will be displayed in Ground format, with engine oil and hydraulic pressure windows displayed in the lower half of the page (see Figure 60 below). When both power levers are brought to FLY, the ENG page will switch to In-Flight format (see Figure 61 below). The ENG page will return to Ground format any time the engine starters switches are moved to START or IGN ORIDE positions.

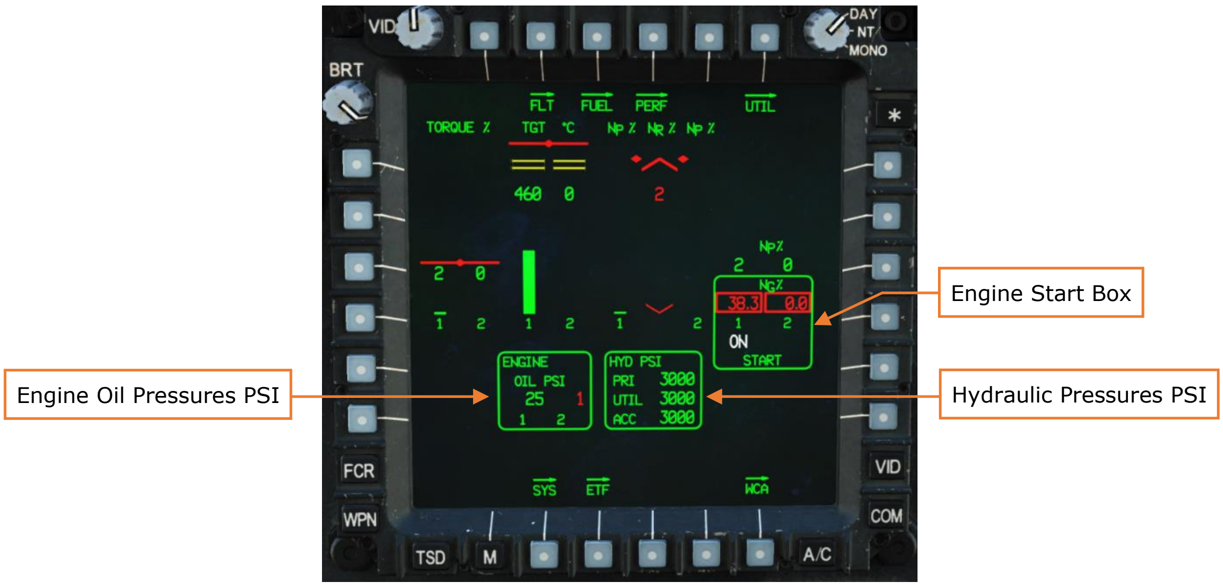


Figure 60. MPD ENG Page, Ground Format

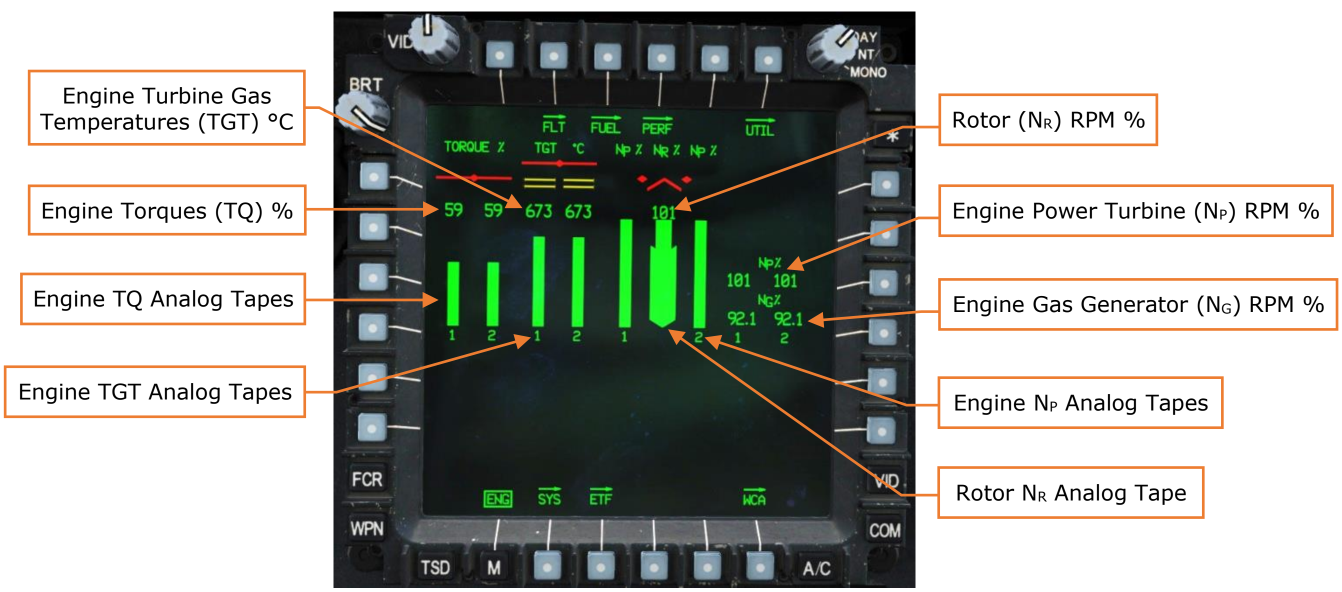


Figure 61. MPD ENG Page, In-Flight Format

Any time a Warning or Caution is displayed on the EUFD, the ENG page will enter Emergency format and display the Warnings and/or Cautions in the lower half of the page (see Figure 62 below). If applicable, an emergency procedure will be displayed in the lower half of the page until acknowledged by the crew, by pressing the ACK (B4) button.

If the hydraulic or engine oil pressures are out of normal operating parameters, the applicable window will be displayed in the top right corner of the ENG page.

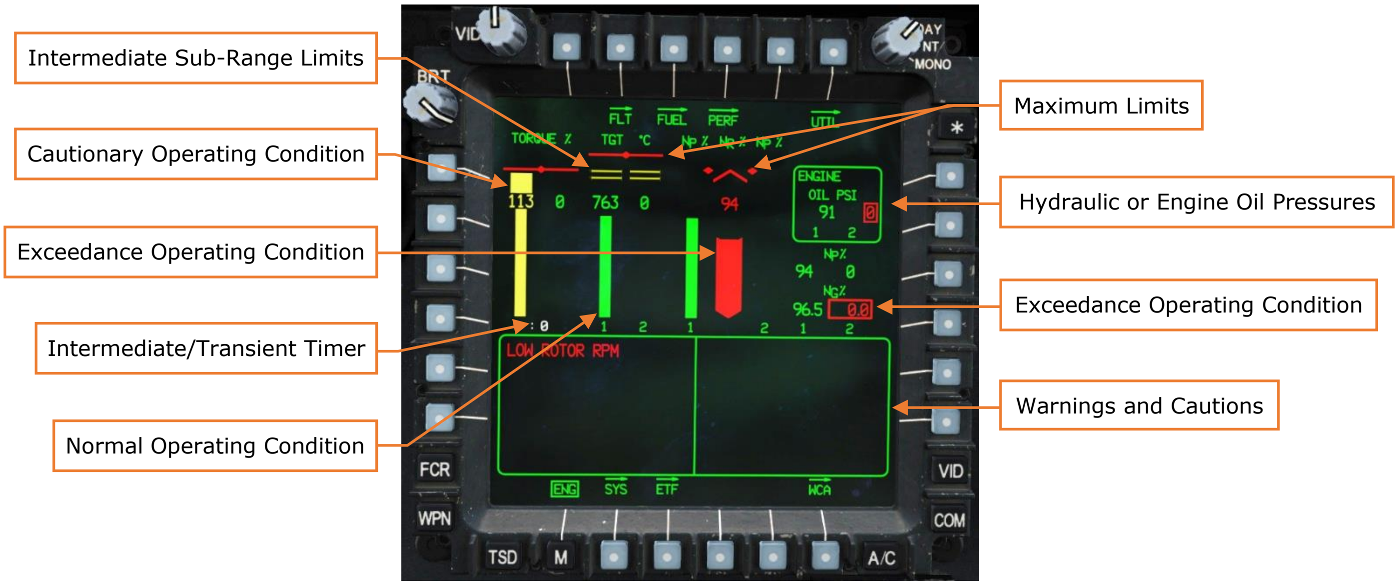


Figure 62. MPD ENG Page, Emergency Format

Engine Oil Pressure (PSI). Displays the pressures (in pounds-per-square-inch) of the #1 and #2 engine oil systems. Hidden when ENG page is not in Ground format and oil pressures are normal.

When the oil pressure of an engine is above 120 PSI or below 23 PSI, the digital readout for that engine will be displayed in red and boxed.

Engine Start Box. Displays to indicate an engine air turbine starter is currently engaged. START or IGN ORIDE will be displayed in white indicating which engine starter is engaged and what starter mode has been commanded by the Pilot.

Hydraulic Pressures (PSI). Displays the pressures (in pounds-per-square-inch) of the primary and utility hydraulic system pressures, as well as the hydraulic accumulator. Hidden when ENG page is not in Ground format and hydraulic pressures are normal.

If the hydraulic pressures of the primary or utility hydraulic systems, or the accumulator, are above 3300 PSI, or if a PSI LOW or LEVEL LOW caution exists for either system, the digital readout for that hydraulic system will be displayed in yellow and boxed. If the hydraulic pressures of the primary or utility hydraulic systems, or the accumulator, are above 3300 for greater than 5 minutes, above

3400 PSI for 5 seconds, or below 1260 PSI, the digital readout for that hydraulic system will be displayed in red and boxed.

Engine Turbine Gas Temperatures (TGT). Displays turbine gas temperatures (in °C) of engine #1 and #2 as analog vertical tapes with digital readouts and maximum and intermediate limits. Each engine incorporates a TGT limiter within the Digital Electronic Control that will limit the engine to a maximum TGT of 867 °C when under dual engine conditions, or 896 °C when under single-engine conditions. If either engine's TQ indicates <51%, the other engine's TGT limiter is increased to 896 °C, allowing the healthy engine to operate in a single-engine contingency mode.

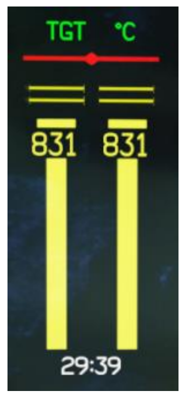


Figure 63. TGT Caution Range

When either TGT enters an intermediate operating range, a 30-minute (811-870 °C) or 10-minute (871-878 °C) countdown timer will be displayed instead of the engine numbers below the analog tapes. When under single-engine power, a third intermediate sub-range limit will be displayed, delineating between the 2.5-minute single-engine contingency range (879-896 °C) and the 12-second transient range (897-949 °C). When operating within these ranges, a 2.5-minute or 12-second timer will be displayed respectively. These timers indicate the maximum acceptable time limit for the intermediate, contingency, and transient operating ranges. The analog tapes and digital readouts will be displayed separately for each engine in yellow when within these ranges and conditions.

The red maximum limit is 949 °C. The analog tapes and digital readouts will be displayed separately for each engine in red when above this limit.

Engine Torques (TQ). Displays engine #1 and #2 torque (in percent) as analog vertical tapes with digital readouts and maximum limits.

The red maximum limit is dynamic and will re-position as necessary based on the maximum allowable torque for the current conditions. If N_R is <50% the TQ red line will be displayed at 30%. If N_R is <90% the TQ red line will be displayed at

70%. If N_R is >90% the TQ red line will be displayed at 115% under dual engine power and at 125% under single-engine power. The analog tapes and digital readouts will be displayed separately for each engine in red when above these limits under these conditions.

If either TQ indicates <51%, the other engine's TGT limiter is increased to 896 °C, allowing the healthy engine to operate in a single-engine contingency mode. A yellow sub-range limit will be displayed at 123% within both TQ analog tape travel ranges above the TQ digital readout, delineating between the 2.5-minute single-engine contingency range and the 6-second single-engine transient range.

If either engine TQ enters the dual-engine transient operating range (101-115% when N_R is >90%) a 6-second countdown timer will be displayed instead of the engine numbers below the analog tapes. If either engine TQ enters a single-engine contingency range (111-122% when N_R is >90%) a 2.5-minute countdown timer will be displayed instead of the engine numbers below the analog tapes. If either engine TQ enters a single-engine transient operating range (123-125% when N_R is >90%) a 6-second countdown timer will be displayed instead of the engine numbers below the analog tapes. The analog tapes and digital readouts will be displayed separately for each engine in yellow when within these ranges and conditions.

Rotor (N_R) RPM. Displays main rotor speed (in percent N_R) as analog vertical tapes with digital readouts and maximum limits. N_R is indicated digitally above the center analog tape.

When the rotor is operating within 106-111% N_R, the analog tape and digital readout will be displayed in yellow. If the rotor is operating below 95% or above 110%, the analog tape and digital readout will be displayed in red.

Engine Power Turbine (N_P) RPM. Displays engine #1 and #2 power turbine speed (in percent N_P) as analog vertical tapes with digital readouts and maximum limits. N_P is indicated digitally to the right of the #2 engine N_P analog tape.

When the power turbine speed of an engine is between 106-121% N_P, the analog tape and digital readout for that engine will be displayed in yellow, with the digital readout boxed at 107% and above. If the power turbine speed of an engine is above 121%, the analog tape and digital readout for that engine will be displayed in red (with the digital readout boxed).

Engine Gas Generator (N_G) RPM. Displays engine #1 and #2 gas generator speeds (in percent N_G). N_G is indicated digitally to the right of the #2 engine N_P analog tape.

When the gas generator speed of an engine is between 102.3-105.1%, the digital readout for that engine will be displayed in yellow. If the gas generator speed of an engine is above 105.1% or below 63.1%, the digital readout for that engine will be displayed in red and boxed.

Warnings and Cautions. Displays warnings and cautions. Hidden when no warnings or cautions are present.

Aircraft, Engine Page, System (SYS) Page

The SYS page displays powertrain temperatures and pressures, environmental temperatures of the Extended Forward Avionics Bays (EFAB) and cockpits, as well as stabilator angle and nominal speed.

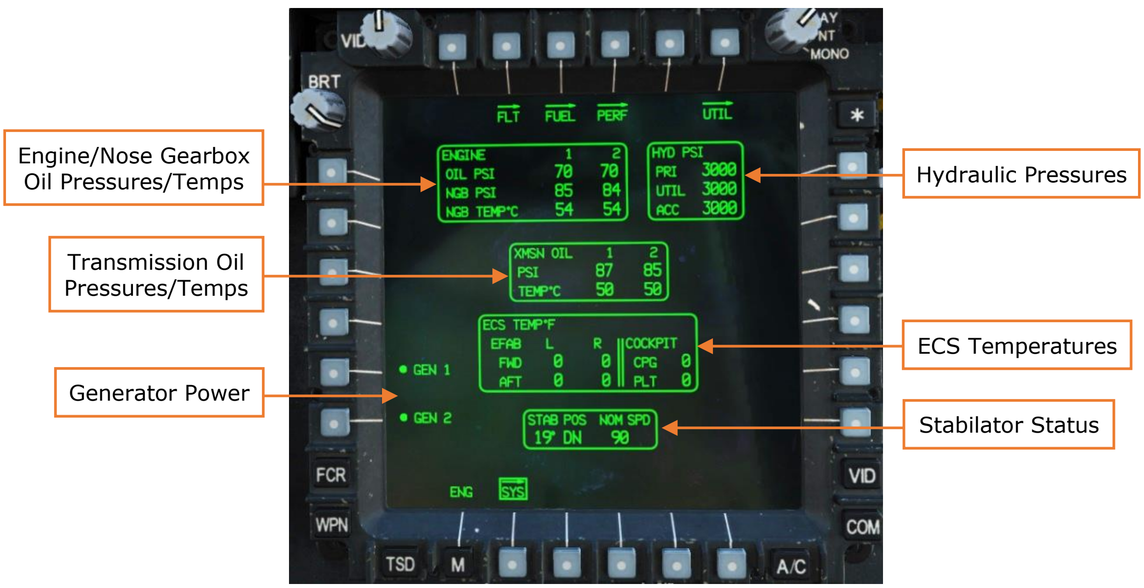


Figure 64. MPD SYS Page

Engine/Nose Gearbox (NGB) Oil. Displays the pressures (in pounds-per-square-inch) of the #1 and #2 engine oil systems and #1 and #2 nose gearbox oil systems, and the temperatures (in °C) of the #1 and #2 nose gearbox oil systems.

When the oil pressure of an engine is above 120 PSI or below 23 PSI, the digital readout for that engine will be displayed in red and boxed.

When the oil pressure of a nose gearbox is below 30 PSI, the digital readout for that nose gearbox will be displayed in red and boxed.

When the oil temperature of a nose gearbox is above 134 in °C, the digital readout for that nose gearbox will be displayed in red and boxed.

Transmission (XMSN) Oil. Displays the pressures (in pounds-per-square-inch) and temperatures (in °C) of the #1 and #2 transmission oil systems.

When the oil pressure of a transmission oil system is below 30 PSI, the digital readout for that transmission system will be displayed in red and boxed.

When the oil temperature of a transmission oil system above 134 in °C, the digital readout for that transmission system will be displayed in red and boxed.

Generator (GEN) Power. Toggles Generator #1 or #2 off. Generators must be reset in the Pilot crewstation to be toggled back on. (see Pilot's Check Overspeed Test/Generator Reset Panel)

Hydraulic Pressures. Displays the pressures (in pounds-per-square-inch) of the primary and utility hydraulic systems, as well as the hydraulic accumulator.

If the hydraulic pressures of the primary or utility hydraulic systems, or the accumulator, are above 3300 PSI, or if a PSI LOW or LEVEL LOW caution exists for either system, the digital readout for that hydraulic system will be displayed in yellow and boxed. If the hydraulic pressures of the primary or utility hydraulic systems, or the accumulator, are above 3300 for greater than 5 minutes, above 3400 PSI for 5 seconds, or below 1260 PSI, the digital readout for that hydraulic system will be displayed in red and boxed.

ECS Temperatures. Displays the environmental temperatures inside the forward and aft sections of each Extended Forward Avionics Bay (EFAB) and each cockpit.

Stabilator Status. Displays the current stabilator angle and nominal airspeed restriction. The angle is referenced to the trailing edge of the stabilator and displays a range of 10° UP to -35° DN. When stabilator is in manual mode, the angle and nominal airspeed values are displayed in white. If the stabilator is detected as failed, the nominal airspeed value will be displayed in yellow. If the position of the stabilator is unknown, the angle indication will be displayed as a white "?" and the nominal airspeed will be displayed in red as the true airspeed equivalent of 90 knots IAS.

Aircraft, Flight (FLT) Page

The FLT page displays basic flight information and allows the aircrew to control various flight settings.

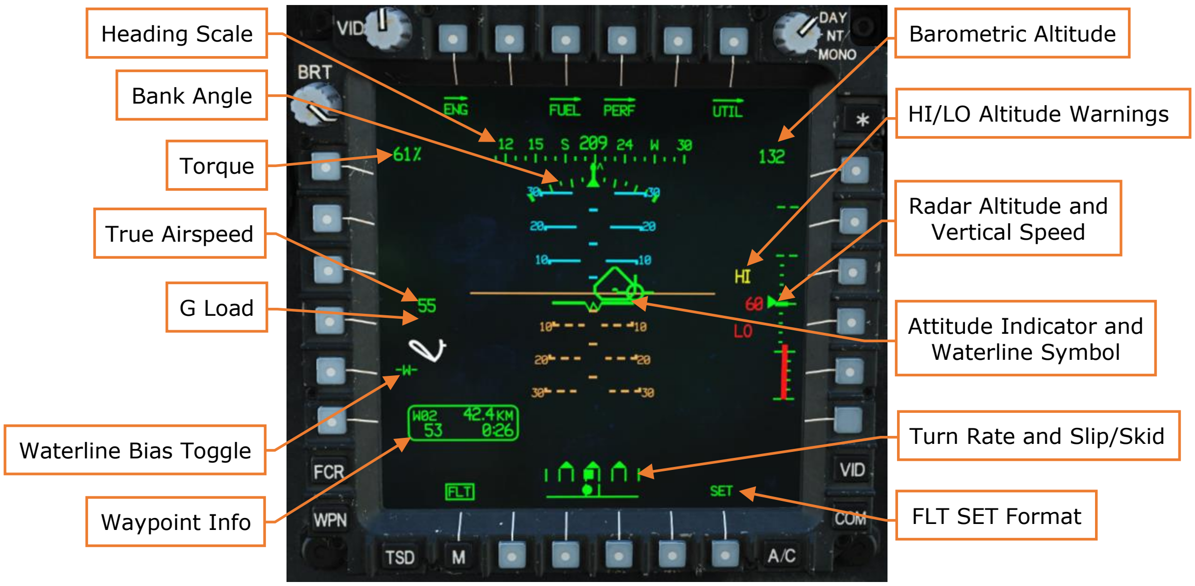


Figure 65. MPD FLT Page

Heading Scale. Displays magnetic heading along a horizontal scale. The chevron icon displayed along the bottom indicates bearing to the next navigation point.

Bank Angle. Shows aircraft bank angle. Major tick marks are in 10° increments. Symbol is displayed in white when bank angle exceeds 20°.

Torque. Highest torque (as a percent) is shown. Torque flashes when a torque split is present (>12% torque difference between engines). Torque is boxed at 98% or higher when under dual engine power and 108% when under single-engine power.

True Airspeed. Displays true airspeed in knots. Displayed in red and boxed when V_{NE} (never-exceed velocity) is exceeded.

If attitude hold mode is engaged, a rounded box is drawn around TAS. This box flashes and disappears when attitude hold mode is disengaged.

G Load. If current load factor is within ¼ of the limit load factor or greater than 2 g, load factor is shown below the true airspeed. Depicted in red if the limit load factor is exceeded. The limit load factor is dynamically determined based on gross weight and environmental conditions.

Waterline Bias Toggle. Toggles on or off the waterline bias. "BIAS" is displayed below "-W-" when bias is applied.

Waypoint Data. Displays navigational information in two lines. Line one displays the name of the selected destination (W## for waypoints, H## for hazards, C## for control measures, or T## for targets/threats) and the distance remaining. Line two displays ground speed and time remaining.

Barometric Altitude. Displays barometric altitude in feet. If barometric data is not present or invalid, displays inertial altitude. When inertial altitude is shown, it will be depicted in white with the text "INRTL" underneath.

Radar Altitude. Radar altitude in feet is displayed as an analog vertical tape on the right side of the vertical speed scale and shown as a digital readout to the left of the vertical speed scale. The graphical scale has tick marks for 10-foot intervals between 0 and 50 feet, and 50-foot intervals to 200 feet. If radar altitude exceeds 1428 feet, the scale is not shown.

If a low-altitude alert height is set and the aircraft is below that height, the word "LO" is displayed in red, and both the analog tape and digital radar altimeter are shown in red. If a high-altitude alert height is set and the aircraft is above that height, the word "HI" is displayed in yellow, and the digital radar altimeter is shown in yellow.

Vertical Speed. Rate of climb or descent (in feet per minute) is shown on the left side of the vertical scale. Tick marks for every 100 feet per minute to ±500 fpm, and then another tick mark is drawn at ±1000 fpm. If aircraft vertical speed exceeds 1000 fpm, vertical speed is shown digitally in white at the top or bottom of the scale.

Attitude Indicator. Indicates aircraft pitch and roll. Pitch ladders are drawn in 10° increments to ±90°. Positive (sky) pitch is displayed in cyan and negative (ground) pitch is displayed in brown. The solid brown horizon line indicates 0° pitch.

Waterline Symbol. The waterline symbol indicates nose position and is a central reference for the pitch ladder. The symbol can be biased (adjusted upward or downward from its normal position) by using the FLT SET page (see Figure 67 below). When the waterline is biased, it appears filled in rather than hollow.

Turn Rate. The top scale of this symbol indicates aircraft rate of turn. Rate of turn is shown as a solid square. Three "doghouses" indicate level (no turn) and standard rate turns to the left or right.

Slip/Skid. The bottom scale of this symbol indicates horizontal acceleration. Horizontal acceleration is shown as a deflection of the oval from the center position.

FLT SET Format. Displays the FLT SET Page (see Figure 67 below).

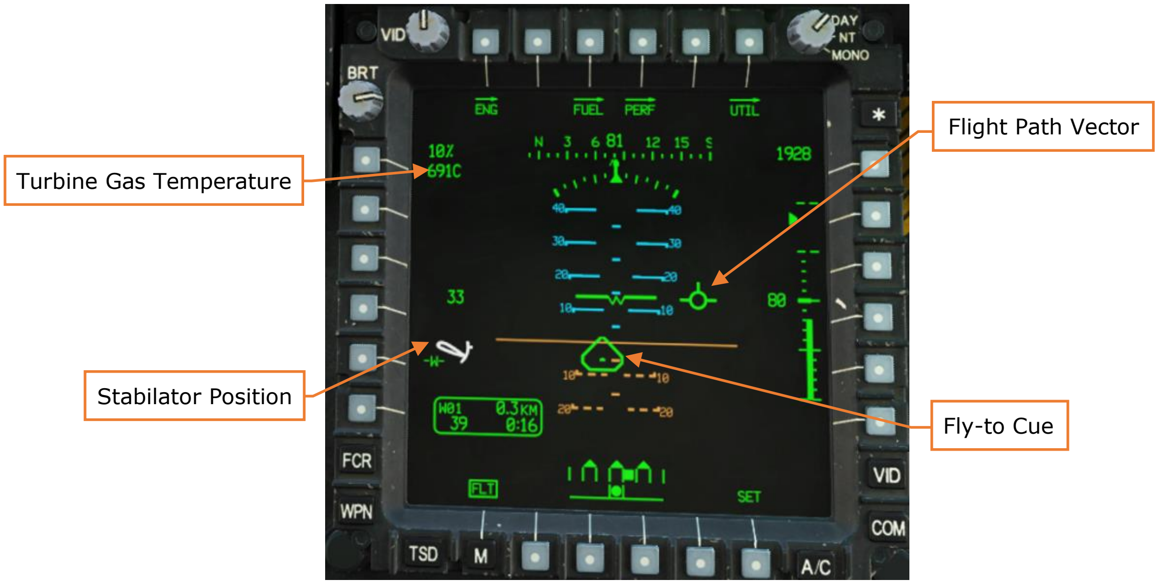


Figure 66. MPD FLT Page

Turbine Gas Temperature. Highest turbine gas temperature (in °C) is shown. The values are color-coded according to the limits on the ENG format. TGT is only shown when two minutes remain until reaching the time limit for a particular temperature.

Stabilator Position. Displays the position of the stabilator and stabilator operating mode. The position is shown graphically on an arc from +10° to -35°, with a small tick mark at 0°. The symbol is not shown when the stabilator is in automatic mode. The symbol color indicates operating mode:

- White: Stabilator is in manual mode.
- Yellow: Stabilator manual mode is failed. If the stabilator position is known, it is shown graphically; otherwise, a question mark "?" symbol is shown inside the stabilator symbol. The maximum true airspeed for the current stabilator position is shown below the symbol.
- Red: Stabilator manual mode is failed, and current airspeed exceeds maximum true airspeed for current stabilator position.

Flight Path Vector (FPV). Displays aircraft trajectory.

Fly-to Cue. Represents the direction to the selected point. If the FPV is placed within the Fly-to Cue, the aircraft will head towards the point.

Aircraft, Flight Page, Set (SET) Format

Pressing the SET button (B6) displays the Flight Set (FLT SET) page. Pressing the FLT button (B1) returns you to the Flight page.

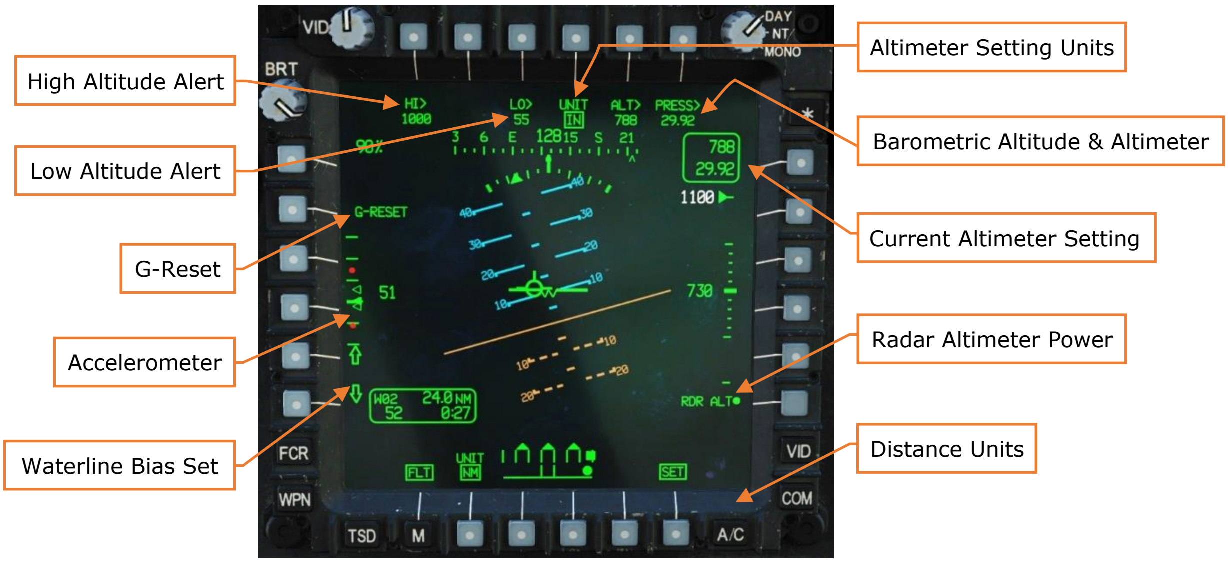


Figure 67. MPD FLT Page, SET Format

High Altitude Alert. Toggles editing of the high-altitude alert. When above this altitude, the word "HI" will appear in yellow next to the altimeter. Disabled if set to zero.

Low Altitude Alert. Toggles editing of the low-altitude alert. When below this altitude, the word "LO" will appear in red next to the altimeter, and an "altitude low" audio alert will sound. Disabled if set to zero.

G-Reset. Pressing this button resets the positive and negative accelerometer telltales to 1 g.

Accelerometer. Displays current load factor (in g) graphically on the vertical scale. A major tick mark indicates 1 g, with minor tick marks every additional g, for a range of +4 to -1 g. Small red circles indicate maximum positive and negative load factor. The solid green triangle indicates current load factor and is displayed in red if a limit is exceeded. Hollow green triangles are positive and negative telltales, which indicate maximum positive and negative g experienced during this flight.

Waterline Bias Set. Biases the waterline symbol up or down in pitch 1 degree for every button press. "BIAS" is displayed if a bias is applied. Up to 10° of up or down bias can be applied.

Altimeter Setting Units. Toggles barometric pressure setting between inches of mercury (IN) and millibars (MB).

Barometric Altitude. Toggles editing of current barometric altitude. When the barometric altitude is changed, the altimeter setting is changed accordingly.

Barometric Altimeter. Toggles editing of current sea-level pressure. When the altimeter setting is changed, the barometric altitude is changed accordingly.

Radar Altimeter Power. Powers radar altimeter on or off.

Distance Units. Toggles distance readouts between nautical miles (NM) and kilometers (KM).

Aircraft, FUEL Page

The FUEL page displays fuel quantity and distribution, and allows the aircrew to control which tanks feed which engines, or transfer fuel between the forward and aft fuel tanks.

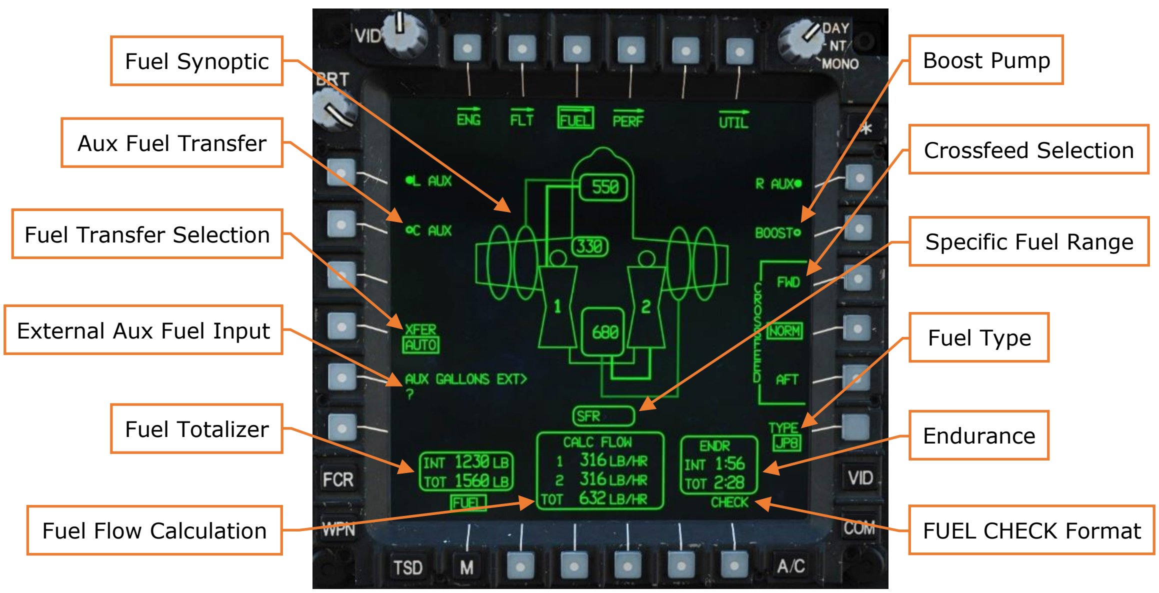


Figure 68. MPD FUEL Page

Fuel Synoptic. A graphical indication of the fuel quantity in each tank and the flow of fuel between tanks and to the engines. The forward and aft tank quantities (in pounds) are shown at the top and bottom of the synoptic. The auxiliary tank quantity, if installed, is shown in the center. Solid lines indicate the flow of fuel from the forward and aft tanks to the #1 and #2 engines, respectively. A dashed line indicates transfer between the two tanks for auto leveling.

If external tanks are installed, they are displayed on the wingform, and solid lines indicate the transfer of fuel from the external tanks to the internal tanks.

Aux Fuel Transfer. If external auxiliary tanks are installed, the L AUX and/or R AUX options will become available at buttons L1 and R1. If an internal auxiliary tank is installed, the C AUX option will become available at button L2. Pressing one of these options will begin transfer of the respective auxiliary tank to the forward and aft tanks. A solid line will be depicted on the synoptic indicating the transfer. When equipped with four external fuel tanks, the outboard external fuel tanks pump fuel into the inboard fuel tanks, which feed the main fuel tanks.

Fuel Transfer Selection. Controls the transfer of fuel between the fuel tanks:

- **AUTO.** Fuel is automatically transferred between the tanks to maintain leveling.
- **FWD.** Fuel is transferred from the aft tank to the forward tank.
- **AFT.** Fuel is transferred from the forward tank to the aft tank.
- **OFF.** Fuel is not transferred and no auto-leveling occurs.

External Aux Fuel Input. The 230-gallon external auxiliary fuel tanks lack fuel quantity sensing probes. If external auxiliary tanks are installed, the aircrew must input the amount of fuel in the external auxiliary tanks at button L5. The internal auxiliary tank has a fuel quantity probe which provides automatic fuel quantity indication.

Fuel Totalizer. Displays the quantity of Internal and Total (internal + external) fuel. Internal fuel only includes fuel in the forward and aft main fuel tanks; the internal auxiliary fuel tank (if installed) is calculated as an "external" fuel tank and is only included in the Total fuel amount. The Total fuel is not displayed if there are no internal or external auxiliary tanks loaded.

Fuel Flow Calculation. Displays the fuel flow (in pounds per hour) to engines #1 and #2, and the total fuel flow. The specific fuel range (SFR) is displayed above the fuel flow window when the helicopter is moving. SFR is equal to ground speed divided by fuel flow and is used to determine best economy power setting.

Boost Pump. Turns the fuel boost pump on or off. When turned on, the crossfeed mode is automatically set to AFT. When turned off, the crossfeed mode is automatically set to NORM.

Crossfeed Selection. Controls the flow of fuel to the engines.

- **NORM.** Engine #1 feeds from the forward tank, and engine #2 feeds from the aft tank.
- **FWD.** Both engines feed from the forward tank.
- **AFT.** Both engines feed from the aft tank.

Specific Fuel Range (SFR). When airspeed is greater than 10 knots, the SFR window will display a calculation based on ground speed divided by total fuel flow for the current power setting. This can be used to determine optimum power settings for fuel economy during cruise. Higher values indicate better fuel economy.

Fuel Type. Sets the type of fuel that was loaded into the aircraft. (N/I)

Endurance. Displays the remaining time until fuel is exhausted based on current fuel flow. If external tanks are installed, displays the remaining time until internal fuel is exhausted, and the remaining time until all fuel is exhausted. Time remaining turns white when 20 minutes or fewer remain.

FUEL CHECK Format. Use this feature to calculate time until entering IFR reserve (30 minutes), VFR reserve (20 minutes), and fuel burnout. Pressing CHECK (B6) displays options for 15-, 20-, and 30-minute checks:

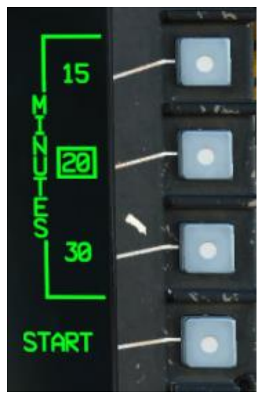


Figure 69. FUEL Page, CHECK Options

Selecting an option and choosing START (R5) begins a countdown timer, during which average fuel flow is determined:

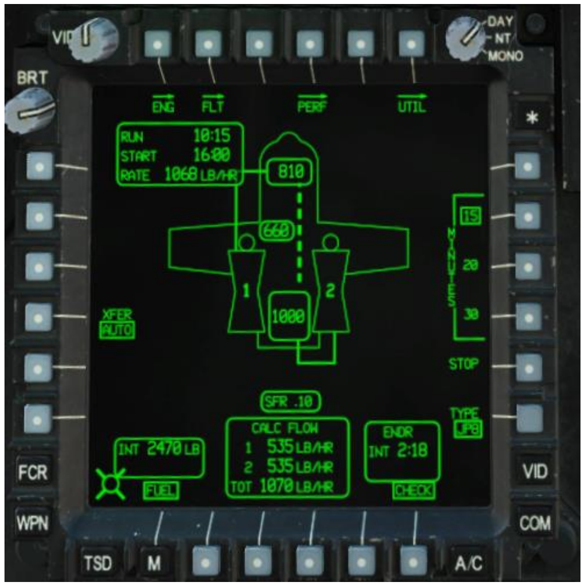


Figure 70. FUEL Page, Check in Progress

After the timer has expired, the burnout and reserve times are displayed:

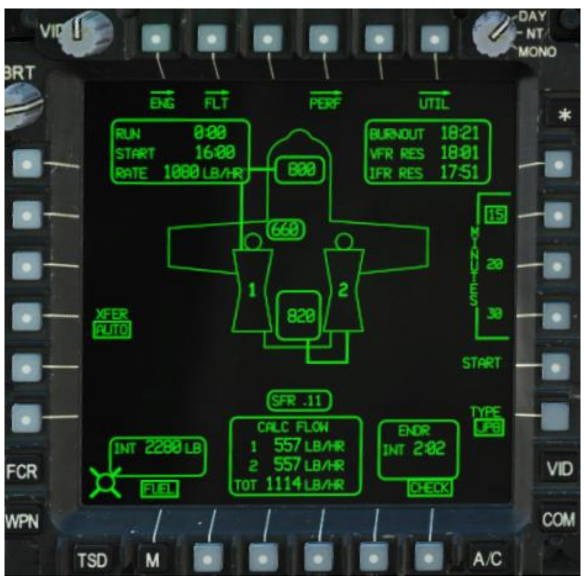


Figure 71. FUEL Page, Check Complete

Aircraft, Performance (PERF) Page

The PERF page allows you to configure aircraft performance values and view performance planning data. ***(PERF page is currently WIP)***

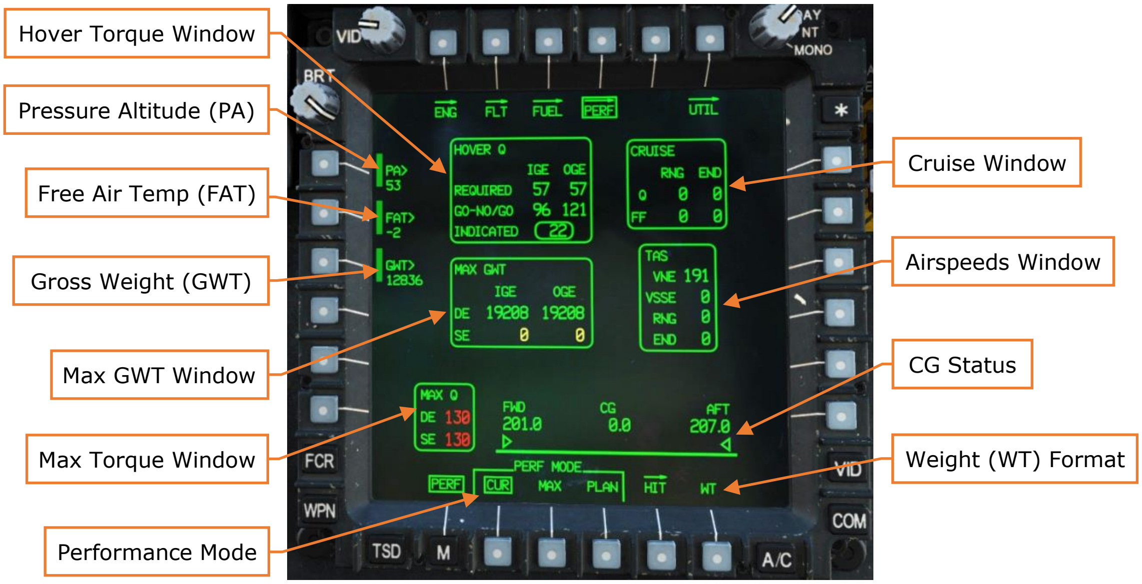


Figure 72. MPD PERF Page

Hover Torque Window. Displays calculated torque values (in percent). Torque values are displayed for both in ground effect (IGE) and out of ground effect (OGE).

- **REQUIRED** hover torque is the minimum torque necessary to maintain a hover in or out of ground effect.
- **GO/NO-GO** torque is the amount of torque that would be necessary to maintain a five-foot hover at maximum gross weight. The flight crew can compare indicated torque to go/no-go torque when performing a hover check to determine if they are above maximum gross weight.
- **INDICATED** torque is the combined torque that the engines are presently generating. It is colored green, yellow, or red based on published torque limits.

Pressure Altitude. Displays the current or manually entered pressure altitude.

Free Air Temperature. Displays the current or manually entered free air temperature.

Gross Weight. Displays the current or manually entered gross weight.

Max Gross Weight Window. Displays the maximum allowable total helicopter weight (in pounds) to maintain a hover in ground effect (IGE) and out of ground effect (OGE), for dual-engine (DE) and single-engine (SE) operations. Values are displayed in yellow when they are exceeded by current helicopter weight.

Max Torque Window. Displays maximum torque available for normal operations (in percent).

- **DE.** Displays 30-minute maximum dual-engine torque. Value is displayed in yellow if above 100% and red if above 115%.
- **SE.** Displays 2.5-minute maximum single-engine torque. Value is displayed in yellow if above 110% and red if above 125%.

Performance Mode. Sets the conditions for the performance calculations.

- **CUR.** Calculate performance using current conditions. When selected, the PA, FAT, and GWT values cannot be modified. In CUR mode, the current anti-ice setting (on or off) is used for calculations.
- **MAX.** Performance calculations are made using the values entered for PA, FAT, and GWT.
- **PLAN.** Performance calculations are made using the values loaded from the DTU.

Cruise Window. Displays calculated cruise performance for maximum range (RNG) and maximum endurance (END).

- **Q.** Maximum-range or maximum-endurance torque value (in percent).
- **FF.** Maximum-range or maximum-endurance fuel flow value (in pounds per hour).

Airspeeds Window. Displays performance-related speeds in knots true airspeed (KTAS):

- **VNE.** Never-exceed speed.
- **VSSE.** Safe single-engine speed. This is the minimum speed that should be maintained during single-engine operations.
- **RNG.** Maximum-range cruising speed.
- **END.** Maximum-endurance cruising speed.

CG Status. Displays the forward and aft center of gravity limits and the current center of gravity (in inches) digitally and graphically.

Weight Format. Displays the Weight Data Entry format (see Figure 73 below).

Aircraft, Performance Page, Weight (WT) Format

The Weight format allows you to enter the weight of personnel and equipment onboard the aircraft for performance and limitations calculation. Press any of the left/right MPD buttons to change a weight value. These values are typically uploaded automatically from the DTU.

Values are displayed in white when the default value is being used, or green when a crewmember-entered value is used.

Figure 73. MPD PERF Page, WT Format

AC BASIC WEIGHT. Enter the basic empty weight (weight of the helicopter plus all permanently installed equipment, full hydraulic fluid, full oil, and unusable fuel).

After pressing ENTER on the KU, the prompt will change to “MOMENT”. Enter the basic empty moment (weight × arm) and press ENTER again.

LEFT AFT BAY. Enter the weight of equipment stored in the left aft storage bay.

SURVIVAL KIT. Enter the weight of equipment stored in the survival kit bay.

PILOT. Enter the weight of the Pilot (including clothing and gear).

CPG. Enter the weight of the Copilot/Gunner (including clothing and gear).

DUMMY MISSILES. Enter the number of M34 dummy missiles loaded onto the aircraft (0–16). Dummy missiles are not automatically detected and must be entered manually.

DUMMY ROCKETS. Enter the number of dummy rockets loaded onto the aircraft (0–76). Dummy rockets are not automatically detected and must be entered manually.

Aircraft, Utility (UTIL) Page

The UTIL page allows the crew to enable or disable aircraft systems.

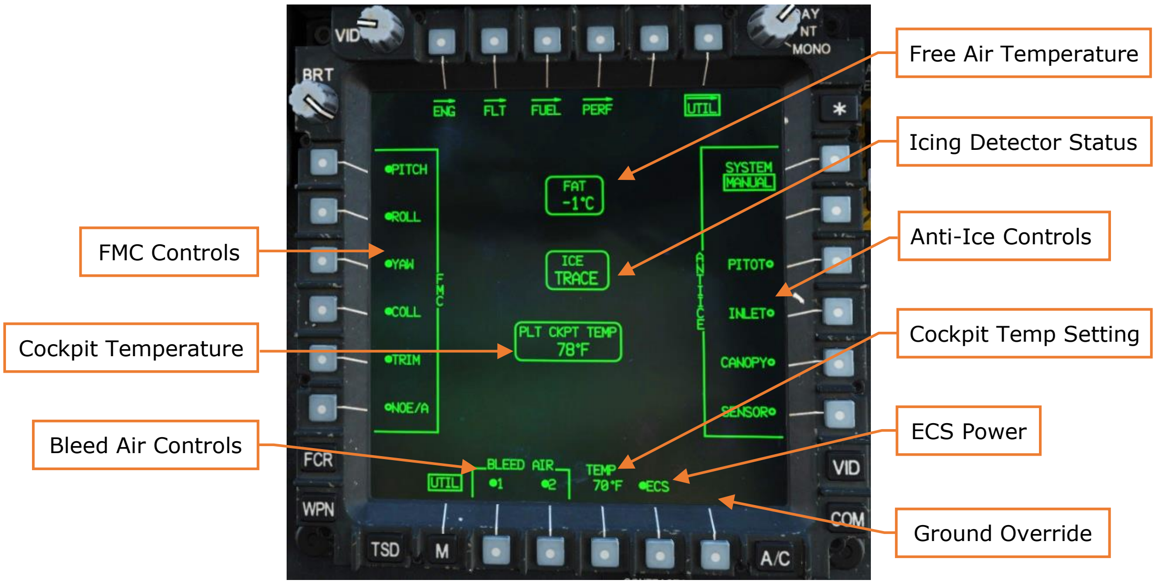


Figure 74. MPD UTIL Page

FMC Controls. Toggles individual FMC SCAS axes/modes:

- **PITCH.** The SCAS will dampen longitudinal (pitch) rates and can command longitudinal cyclic in command mode.
- **ROLL.** The SCAS will dampen lateral (roll) rates and can command lateral cyclic in command mode.
- **YAW.** The SCAS will dampen directional (yaw) rates and provide heading hold and turn coordination.
- **COLL.** The SCAS can command collective application in command mode.
- **TRIM.** Toggles the force trim magnetic brakes on the cyclic and pedals.
- **NOE/A.** Activates FMC nap of earth/approach mode. In NOE/approach mode, the horizontal stabilator is commanded to 25° trailing edge down when airspeed is below 80 knots. This provides better over-the-nose visibility for low-altitude flying.

Cockpit Temperature. Displays current cockpit temperature.

Bleed Air Controls. Enables or disables bleed air from engine #1 or #2.

Free Air Temperature. Displays free air temperature in °C.

Icing Detector Status. Displays level of ice accumulation sensed by the ice detect probe.

Anti-Ice Controls. Sets anti-ice system mode and turns on or off anti-ice equipment.

- **SYSTEM.** Sets anti-ice system mode. When in AUTO mode, anti-ice system controls are enabled automatically when ice is detected by the ice detect probe. When ice is no longer detected, they can be disabled manually by the aircrew. (They are not disabled automatically) In MANUAL mode, the aircrew must enable and disable the anti-icing systems manually depending on the presence of ice.
- **PITOT.** Enables or disables electrical pitot and air data sensor (ADS) heat.
- **INLET.** Enables or disables bleed air heat for the engine and inlet fairings, and electrical heating for nose gearbox fairings.
- **CANOPY.** Enables or disables the electrical heating elements in embedded in the middle forward windshields for the Pilot and CPG stations.
- **SENSOR.** Enables or disables the electrical heating of the turret shrouds, boresight, and sensor windows for the TADS/PNVS. Automatically disabled and "barriered" while on the ground, unless GND (B6) is selected.

Cockpit Temperature Setting. Sets the desired crew station temperature using the KU. Each crewmember can set their own temperature.

ECS Power. Powers the ECS on or off. When powered off, the ECS will not regulate cockpit or EFAB temperature.

Ground Override. When weight-on-wheels, overrides the inhibit that prevents the TADS/PNVS anti-ice from activating, and removes the barrier from SENSOR (B6).

Mission, Tactical Situation Display (TSD) Page

The Tactical Situation Display shows a top-down overview of the aircraft, battlefield, and surrounding airspace. The TSD is a versatile, full color moving map that allows the aircrew to plot and analyze a wealth of navigational, tactical, and sensor information.

Figure 75. MPD TSD Page

Present Position. When boxed, the aircraft position info window is shown. The info window displays MGRS coordinates, latitude and longitude, and elevation.

Aircraft Heading. Displays the current heading of the aircraft.

Ownship. Indicates present location.

SA Overlay. (N/I)

Waypoint Data. Displays information about the next point in the route. The point name, distance remaining, ground speed, and time remaining are displayed.

Heading to Waypoint. Displays the heading to fly to the next point in the route.

Phase. Toggles between navigation (NAV) and attack (ATK) displays. The active phase controls what information is shown on the format.

Grid Width. Displays the distance between grid lines if displayed (in km or NM depending on the units selection on the Aircraft, Flight Page, Set (SET) .

Scale. Changes the scale level of the map. Scale value is displayed in kilometers or nautical miles. Available scale levels are 400 km (216 NM), 150 km (81 NM), 100 km (54 NM), 75 km (40.5 NM), 50 km (27 NM), 25 km (13.5 NM), 15 km (8.1 NM), 10 km (5.4 NM), 5 km (2.7 NM), 2 km (1.1 NM), and 1 km (0.5 NM). Holding a button will continuously zoom the map in or out.

Center. Toggles between centering the display on the Ownship, or de-centering with the Ownship placed towards the bottom third of the display.

Freeze. Freezes the map display. The map and Ownship will not move, but the data blocks will continue to update. When the map is frozen, a bold dashed outline will be rendered around the "TSD footprint".

Cursor Acquisition. Freezes the display and allows the crewmember to designate a symbol or a terrain point for use as an acquisition source. After pressing the CAQ button, the crewmember can move the cursor to a waypoint, hazard, control measure, pre-planned/stored threat, FCR target, RFI target, or an arbitrary location. Pressing Cursor Enter designates that object or location as the acquisition source.

If a terrain point is designated, the location is stored in terrain point T55 (PLT) or T56 (CPG) in the COORD file (see Coordinates Sub-page). A cross labeled "PLT" or "CPG" will appear on the map.

Figure 76. TSD Terrain (TRN) Point

RFI threats are only selectable when TADS or HMD is the active sight.

Acquisition Source. Selects the acquisition source for the active sight.

Endurance Status. Displays the total endurance time available based on remaining fuel in all internal and external tanks.

Wind Status. Displays the winds as computed by the aircraft Air Data System (ADS). "CALM" is displayed when wind speed is less than 5 knots. When N_R is less than 50% and wind speed is greater than 45 knots, wind speed is displayed in yellow.

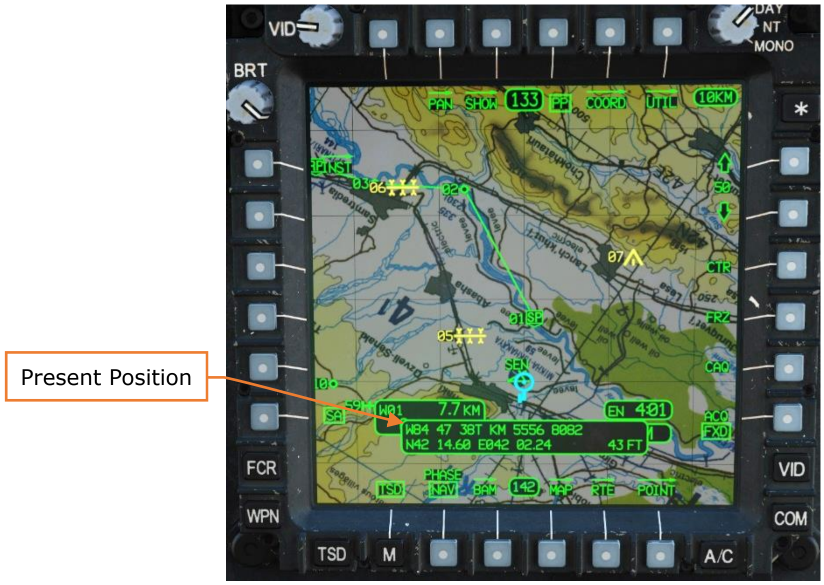


Figure 77. MPD TSD Page, PP Shown

Mission, TSD Page, Pan Sub-Page

Pressing the PAN button (T2) enters PAN sub-page, where you can move and rotate the map independently of the Ownship location. When in PAN sub-page, the TSD page is frozen, indicated by a thick dashed border displayed around the "TSD footprint".

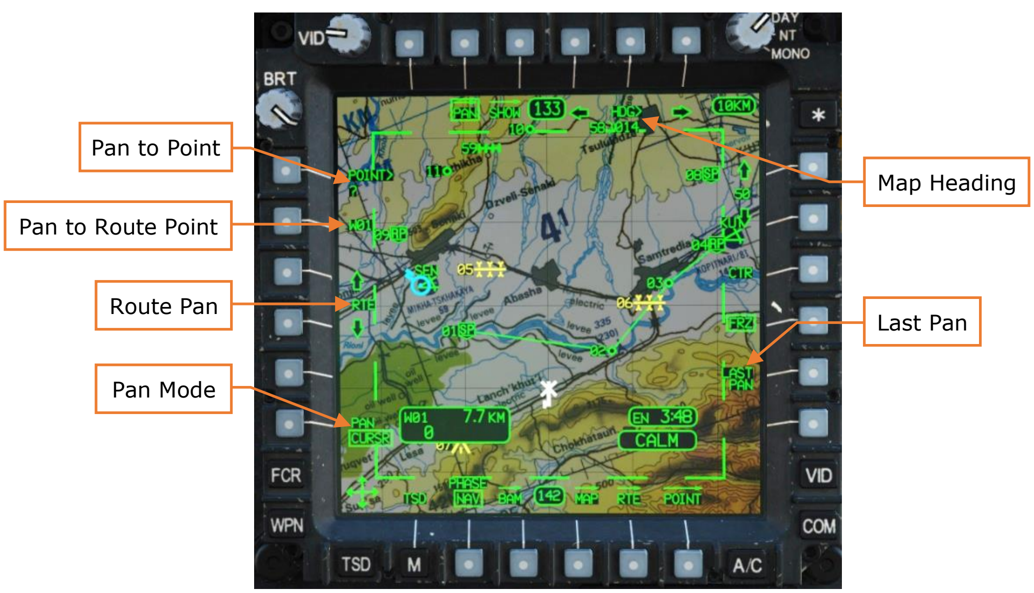


Figure 78. MPD TSD Page, PAN Sub-Page

Pan to Point. Pressing this button allows entry of a point using the KU. After entry, the map will pan to this point.

Pan to Route Point. When using Route Pan, the point labels displayed adjacent L2 and L5 indicate the next and previous points in the route sequence respectively. Pressing the buttons at L2 or L5 pans the map to that point.

Route Pan. Pressing and holding L3 or L4 (adjacent the arrows), smoothly scrolls the view to the next or previous points while held.

Pan Mode. Toggles the pan mode between CURSR (Cursor Control pans map) and NORM (Cursor Control controls on-screen cursor) pan modes.

Map Heading. Pressing the left or right arrows rotates the map in 1° increments, or 40° per second when pressed and held. Pressing HDG> (T5) allows a heading value to be entered via the KU.

Last Pan. Resets the map to the previous pan location.

Mission, TSD Page, Show Menu

The SHOW menu toggles on or off display of different map icons and windows. It displays different options depending on whether the current phase is NAV or ATK (selectable using button B2).

NAV Phase

Figure 79. MPD TSD Page, SHOW Menu (NAV Phase)

Waypoint Info. Toggles display of the Waypoint Info window.

Inactive Zones. Toggles display of inactive fire zones. (N/I)

Obstacles. Toggles display of FCR-detected obstacles. (N/I)

CPG Cursor. Toggles display of the CPG cursor.

Cursor Info. Toggles display of the cursor position window. This window displays the MGRS coordinates and terrain elevation of the cursor's position, and its distance from the Ownship in either KM or NM (depending on UNIT setting on FLT SET page).

Figure 80. MPD TSD Page, Cursor Info Shown

HSI. Toggles display of the Horizontal Situation Indicator.

Figure 81. MPD TSD Page, HSI Shown

Endurance Info. Toggles display of the Endurance Status window.

Wind Info. Toggles display of the Wind Status window.

ATK Phase

The options unique to the attack phase are:

Figure 82. MPD TSD Page, SHOW Menu (ATK Phase)

Current Route. Toggles display of the waypoints and lines making up the current route.

FCR Targets/Obstacles. Toggles display of low-priority FCR targets and obstacles. (N/I)

Mission, TSD Page, Show Menu, SA Sub-Menu

This sub-menu controls display of SA icons. (N/I)

Mission, TSD Page, Show Menu, THRT SHOW Sub-Menu

This sub-menu controls display of the "ASE footprint", lethality rings of targets and threats, and their intervisibility (line-of-sight) status.

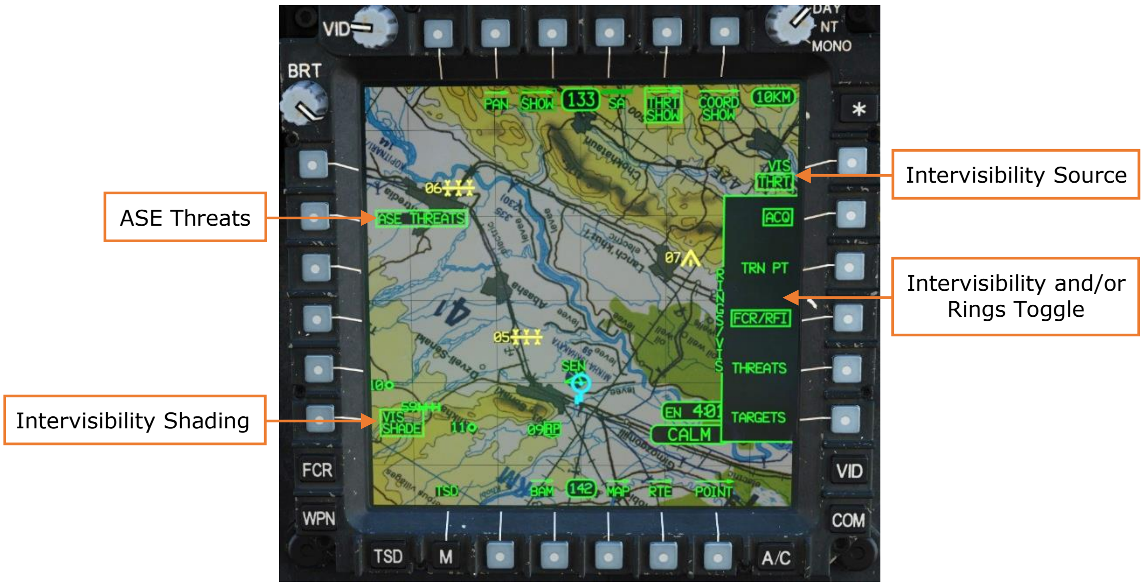


Figure 83. MPD TSD Page, SHOW Menu, THRT SHOW Sub-Menu

ASE Threats. Toggles display of RFI/RLWR detected threats around "ASE footprint". If toggled off, the ASE Autopage setting will override this option and display ASE Threats on the TSD when the ASE Autopage threshold is reached or exceeded.

Intervisibility Shading. Toggles display of line-of-sight shading for the selected threat types.

Intervisibility Source. Selects the source to use for the intervisibility shading.

- **THRT.** Shaded areas represent areas where this aircraft will be detectable by a threat at its current altitude.
- **OWN.** Shaded areas represent the Ownship's line-of-sight at its current altitude.

Intervisibility and Rings Toggle. Toggles display of intervisibility shading and lethality rings for selected threat types.

With the intervisibility source set to THRT, the options are:

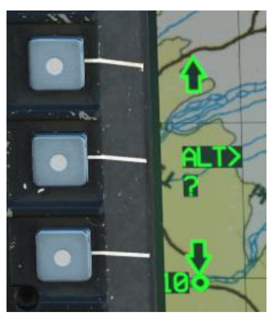
- **ACQ.** Current ACQ source if a point (W##, H##, C##, T##).
- **TRN PT.** Pilot and CPG terrain points. (T55 or T56)
- **FCR/RFI.** FCR targets that have been merged with RFI-detected threats.

- **THREATS.** Threats (T##).
- **TARGETS.** Targets (T##).

With the intervisibility source set to OWN, the options are:

- **OWN.** This aircraft.
- **TRN PT.** Pilot and CPG terrain points.
- **GHOST.** The ghostship when TSD is frozen or in PAN mode. (see Pan Sub-Page)

When TRN POINT shading is active, options appear on the left side to change the terrain point altitude:



The up/down arrows alter the terrain point altitude by 5-foot increments (faster if held down). The ALT prompt, when pressed, allows entry of the terrain point altitude using the KU.

Mission, TSD Page, Show Menu, COORD SHOW Sub-Menu

The COORD sub-menu controls display of points within the database. These options can be set differently between the NAV and ATK phases.

NAV Phase

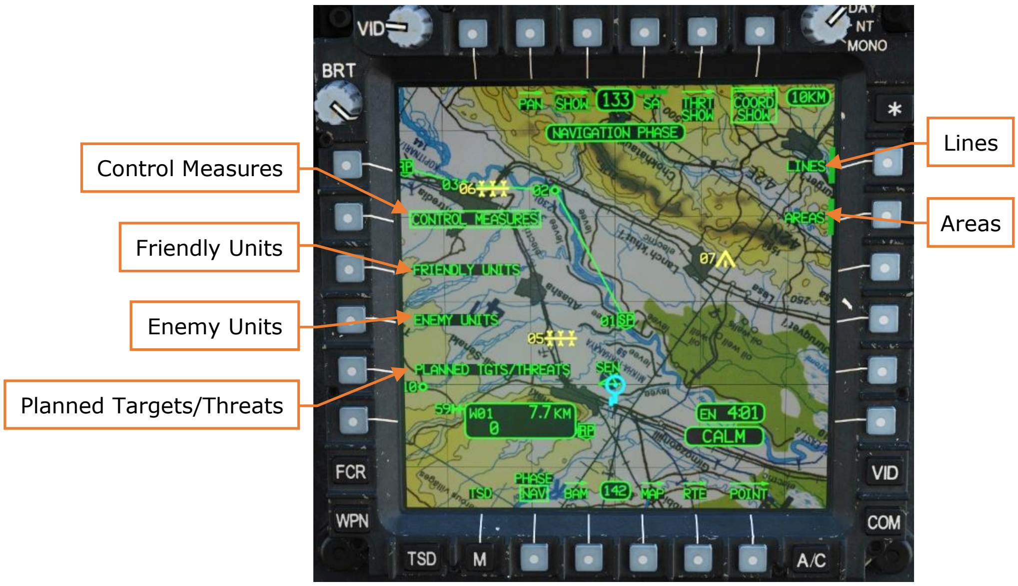


Figure 84. MPD TSD Page, SHOW Menu, COORD SHOW Sub-Menu (NAV)

Control Measures. Toggles display of general control measures. Control measures that are part of the current route (including direct-to navigation) are always shown.

Friendly Units. Toggles display of friendly control measures.

Enemy Units. Toggles display of enemy control measures.

Planned Targets/Threats. Toggles display of stored and pre-planned targets and threats.

Lines. Toggles display of pre-planned lines.

Areas. Toggles display of pre-planned areas.

ATK Phase

The ATK phase adds the following additional controls:

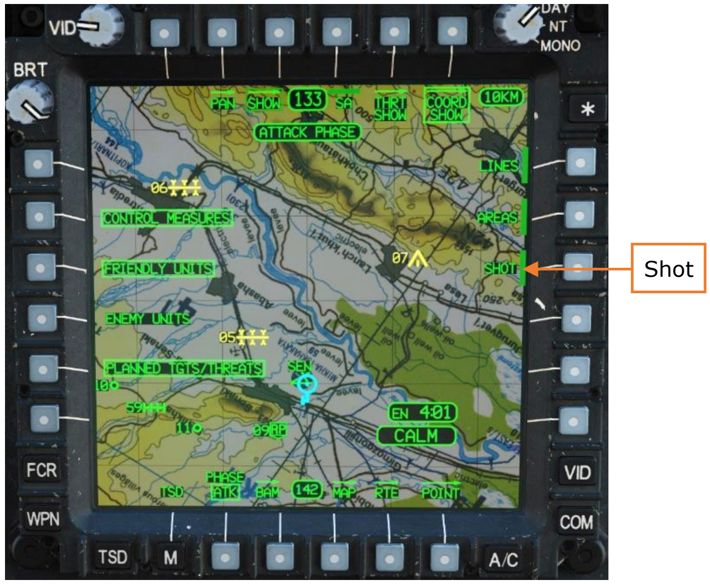


Figure 85. MPD TSD Page, SHOW Menu, COORD SHOW Sub-Menu (ATK)

Shot-At. Toggles display of Shot-At indications. Shot-At indications are generated when Hellfire missiles are employed against a target.

Mission, TSD Page, Coordinates (COORD) Sub-Page

The COORD sub-page displays the coordinates of target and threats (labeled T##).

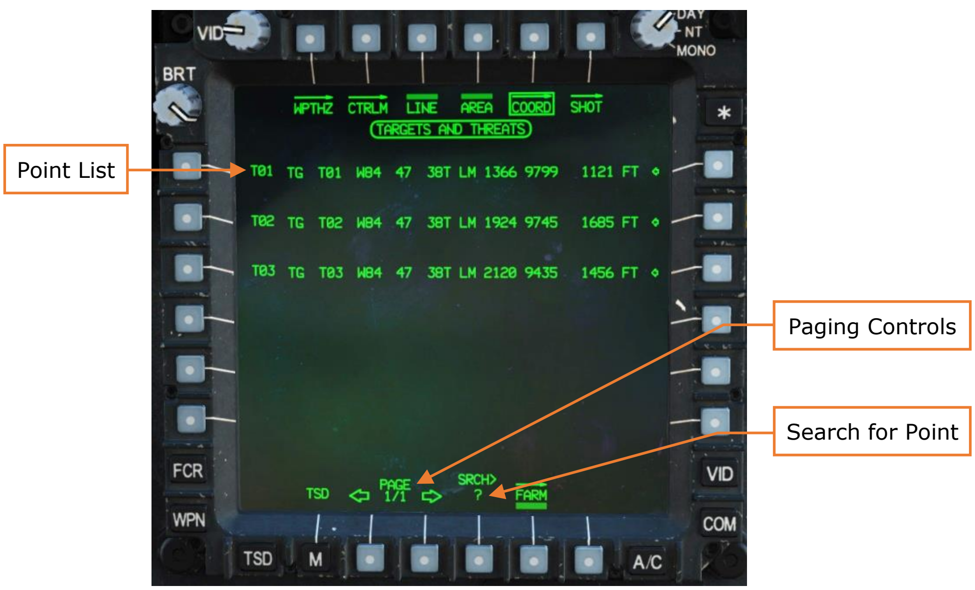


Figure 86. MPD TSD Page, COORD Sub-Page

Point List. Each point is listed in a columnar format. The columns, from left to right, are:

- Point type and number
- Point identifier
- Free text identifier
- Spheroid
- MGRS datum
- MGRS grid
- Elevation in feet MSL

Pressing the left bezel buttons next to a point will set that point as the acquisition source. Pressing the right bezel buttons adjacent the arrow displays the expanded view:

The expanded view additionally shows:

- Estimated time enroute (ETE)
- Estimated time of arrival (ETA)
- Bearing and distance to point (NM and KM)
- Latitude and longitude

Paging Controls. Changes point list to the next or previous page of six points.

Search for Point. Activates KU to permit searching for a point within the database.

Mission, TSD Page, Waypoint/Hazards (WPTHZ) Sub-Page

The WPTHZ sub-page displays the coordinates of waypoints and hazard points (labeled W## and H##). Operation is the same as the COORD sub-page.

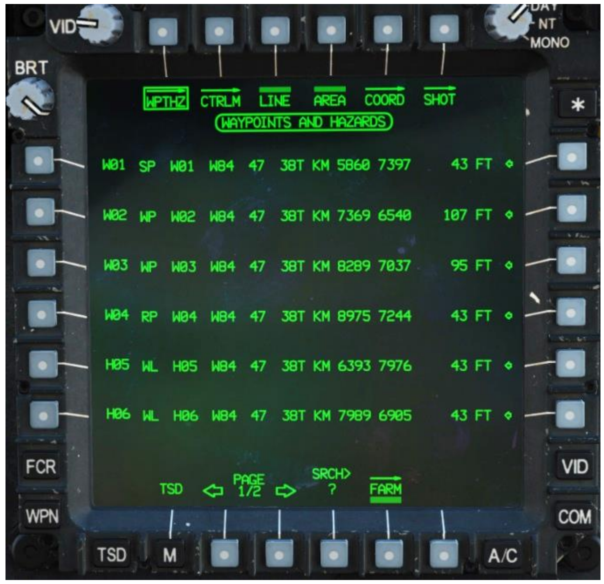


Figure 87. MPD TSD Page, WPTHZ Sub-Page

Mission, TSD Page, Control Measures (CTRLM) Sub-Page

The CTRLM sub-page displays the coordinates of control measure points (labeled C##). Operation is the same as the COORD sub-page.

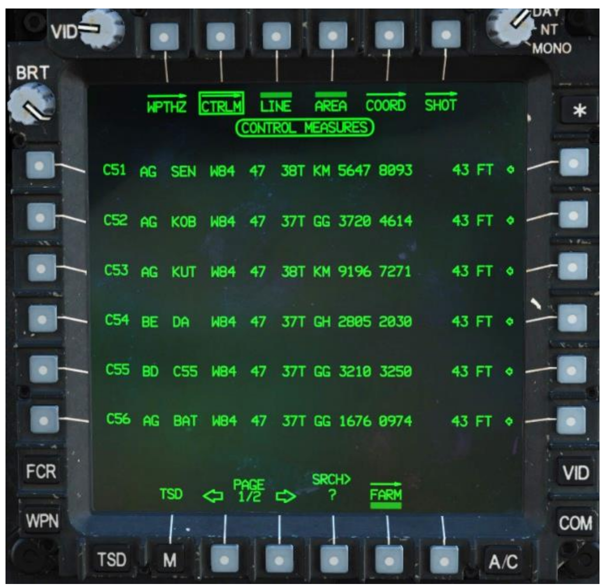


Figure 88. MPD TSD Page, CTRLM Sub-Page

Mission, TSD Page, Line Sub-Page

The LINE sub-page is not implemented.

Mission, TSD Page, Area Sub-Page

The AREA sub-page is not implemented.

Mission, TSD Page, Shot Sub-Page

The SHOT sub-page is not implemented.

Mission, TSD Page, Fuel/Ammo/Rocket/Missile (FARM) Sub-Page

The FARM sub-page is not implemented.

Mission, TSD Page, Utility (UTIL) Sub-Page

The UTIL sub-page contains utility functions for the navigation system.

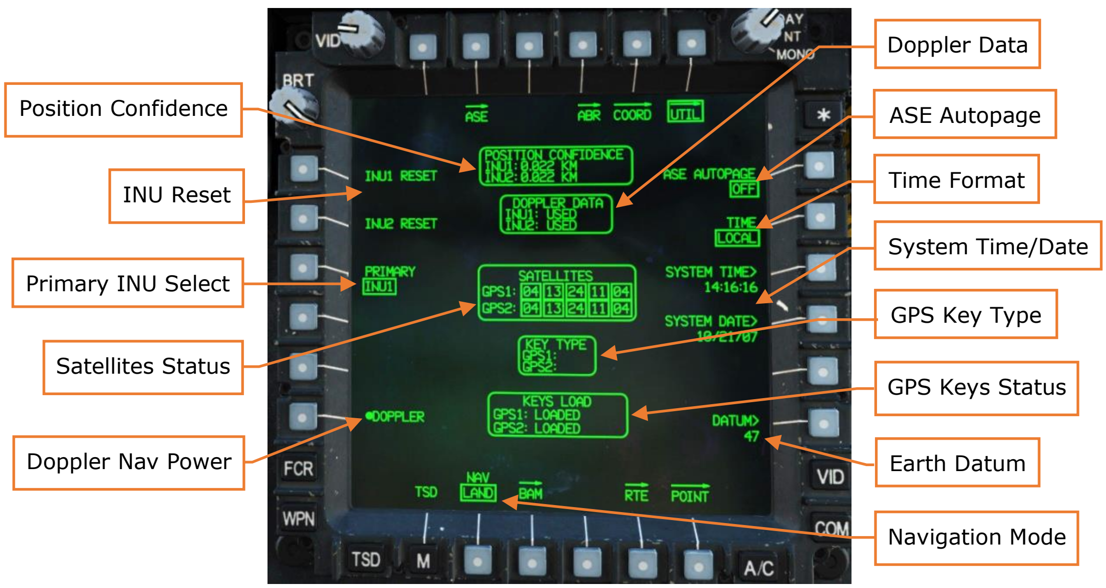


Figure 89. MPD TSD Page, UTIL Sub-Page

Position Confidence. Displays the 95%-probable circular error probability (CEP) for INU1 and INU2.

INU Reset. Resets either INU1 or INU2 when pressed. For use when INU data becomes invalid or unreliable.

Primary INU. Toggles between INU1 and INU2 as primary. Normally set automatically by the system. Button is barriered if the other INU is detected to be unreliable or in a reset state.

Satellites Status. Displays the GPS satellites visible to the GPS antenna. Satellites that the EGI's are using are boxed.

Doppler Nav Power. Toggles power to the Doppler navigation system.

Doppler Data. Displays the Doppler-aiding status of each INU:

- **USED.** INU is using Doppler-aided navigation.
- **REJECTED.** INU is not using Doppler-aided navigation.
- **MEMORY.** Doppler-aided navigation is in dead-reckoning mode.

ASE Autopage. Selects the threat level that will result in an Autopage to the TSD format:

- **SEARCH.** ASE will autopage when a search radar is detected.
- **ACQUISITION.** ASE will autopage when a radar acquisition is detected.
- **TRACK.** ASE will autopage when a tracking radar is detected.
- **OFF.** ASE will not autopage.

Time Format. Toggles between LOCAL and UTC (ZULU) time.

System Time. Allows the aircrew to change the system time using the KU.

System Date. Allows the aircrew to change the system date using the KU.

GPS Key Type. Displays the type of GPS keys loaded into each GPS receiver.

- **GUV.** A Group Unique Variable (GUV) key encryption key has been loaded.
- **(blank).** A Crypto-Variable Weekly (CVW) key production key has been loaded.

GPS Keys Status. Displays the state of the GPS key load for each receiver:

- **LOADED.** CVW key was loaded.
- **VALID.** TODO
- **VERIFIED.** TODO
- **INCORRECT.** GPS key is incorrect for current date.
- **CORRUPT LOAD.** GPS key data is corrupt.
- **NONE.** No GPS key has been loaded, or the key was erased.
- **ERASE FAIL.** The GPS key could not be zeroized.

Earth Datum. Allows the aircrew to set the geodetic system used for navigation. The default is “47”, meaning WGS-84. The aircrew can set another datum by ABR page ID or enter “D” to return to the default datum.

Navigation Mode. Toggles between LAND and SEA. During start-up, the selected mode will control the method of EGI alignment. In flight, the selected mode changes the weighting of the Doppler velocity data to provide the best navigational accuracy.

Mission, TSD Page, Battle Area Management (BAM) Sub-Page

The BAM sub-page allows the crewmembers to create Priority Fire Zones (PFZ) and No-Fire Zones and assign them to wingmen. When the BAM sub-page is displayed, the map freezes.

Up to 8 Priority Fire Zones can be created, one of which is active at a time. Up to 8 No-Fire Zones (NFZ) can be created, any number of which can be active at the same time.

PFZs and NFZs affect prioritization of FCR targets. Targets detected in a PFZ are prioritized higher, whereas targets detected in an NFZ are de-prioritized.

Priority Fire Zone (PF) Format

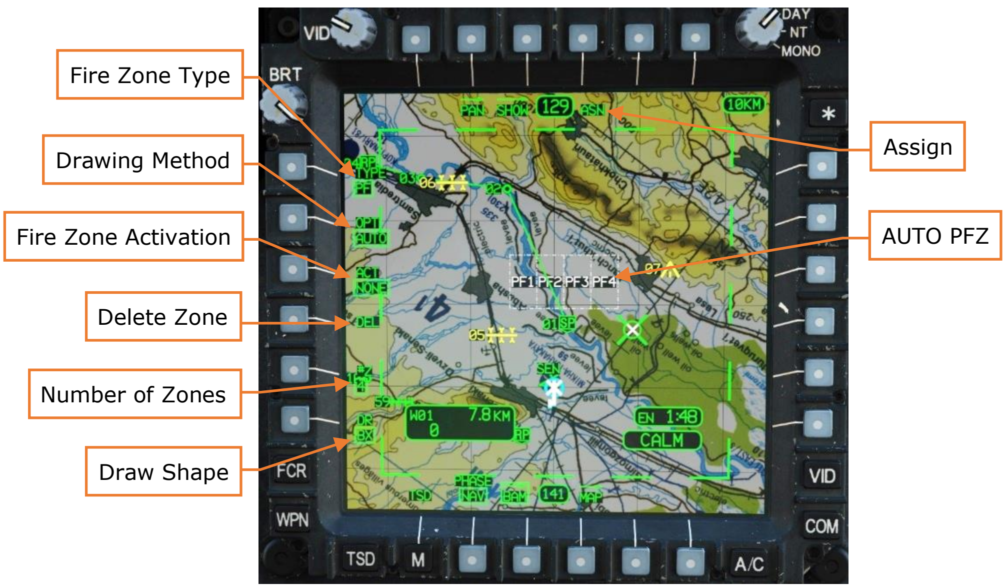


Figure 90. MPD TSD Page, BAM Sub-Page, PF Format (AUTO Option)

Fire Zone Type. Toggles between drawing Priority Fire (PF) Zones or No-Fire (NF) Zones. The current selection determines which type will be transmitted over the DL Net.

Drawing Method. Selects how the fire zones are drawn:

- **Automatic (AUTO).** The crewmember uses the cursor to designate the two opposite corners of a rectangle. If Draw Shape (L6) is set to BX, after selecting the second corner, the area within the rectangle is automatically divided up into equally spaced fire zones. If Draw Shape is set to LN, after selecting the fourth point, the area within the polygon is automatically divided up into equally spaced fire zones, oriented parallel to the first line drawn.

- **Manual (MAN).** The crewmember uses the cursor to draw a single PFZ, which becomes Priority Fire Zone 1. The crewmember repeats this process for each of the remaining Priority Fire Zones, based on the #Z (L5) value selected.
- **Target Reference Point (TRP).** The crewmember designates a target reference point using the cursor. The area around the TRP is automatically divided up into 4 Priority Fire Zones, by quadrant.

Figure 91. MPD TSD Page, BAM Sub-Page, PF Format (MAN Option)

Fire Zone Activation. Used to activate a PFZ. Permits selection of NONE (T3) or one of 8 PFZs (T1, T2, L1-L6). Select the Priority Fire Zone to be active which will collapse the menu. Fire zone activations are transmitted to wingmen over IDM using the SEND button (R6).

Delete Zone. Removes all Priority Fire Zones.

Number of Zones (#Z). Selects the number of zones that will be created when drawing PFZs. The area drawn will be divided up into that number of zones.

Draw Shape. Determines the shape of the zone:

- **BX.** Allows the crewmember to select to opposite corners of a box for a PFZ/NFZ.

Figure 92. MPD TSD Page, BAM Sub-Page, PF Format (BX Draw Shape)

- **LN.** Allows the crewmember to draw a quadrilateral polygon for a PFZ/NFZ shape by selecting four corners in a clockwise or counterclockwise order.

Figure 93. MPD TSD Page, BAM Sub-Page, PF Format (LN Draw Shape)

Figure 94. MPD TSD Page, BAM Sub-Page, PF Format (LN Draw Complete)

TRP KM Size. When using the TRP drawing method, allows the crewmember to select the size of the fire zone. Pressing the button toggles between 1, 2, and 3 km^2.

Figure 95. MPD TSD Page, BAM Sub-Page, PF Format (TRP Option)

Assign Menu (ASN) Menu

Assign Format. Pressing this button displays the Assign menu.

Figure 96. MPD TSD Page, BAM Sub-Page, PF Format (ASN Menu)

Fire Zone Select. Press a button next to displayed PF number to display network Member selections to assign to that PFZ.

Member Select. Press a button next to the displayed network member to assign the currently selected PFZ to that member.

Ownship Assign. Assigns the selected PFZ to the Ownship.

No-Fire Zone (NF) Format

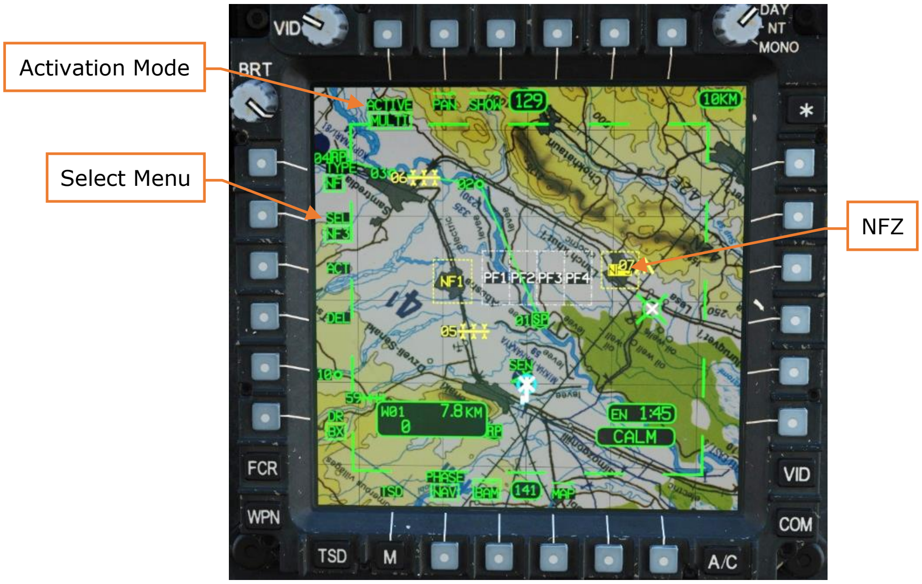


Figure 97. MPD TSD Page, BAM Sub-Page, NF Format

Activation Mode. Sets how NFZs are activated:

- **SINGLE.** Only one NFZ is active at a time. The ACT button activates the selected NFZ, and if different NFZ is already active, deactivates it.
- **MULTI.** Multiple NFZs can be active at a time. The ACT button toggles the selected NFZ active or inactive.

Select Format. Pressing this button displays the NFZ Select menu.

Mission, TSD Page, Map Sub-Page

The MAP sub-page allows the crewmember to configure display of the moving map. Menu options depends on which map type is selected.

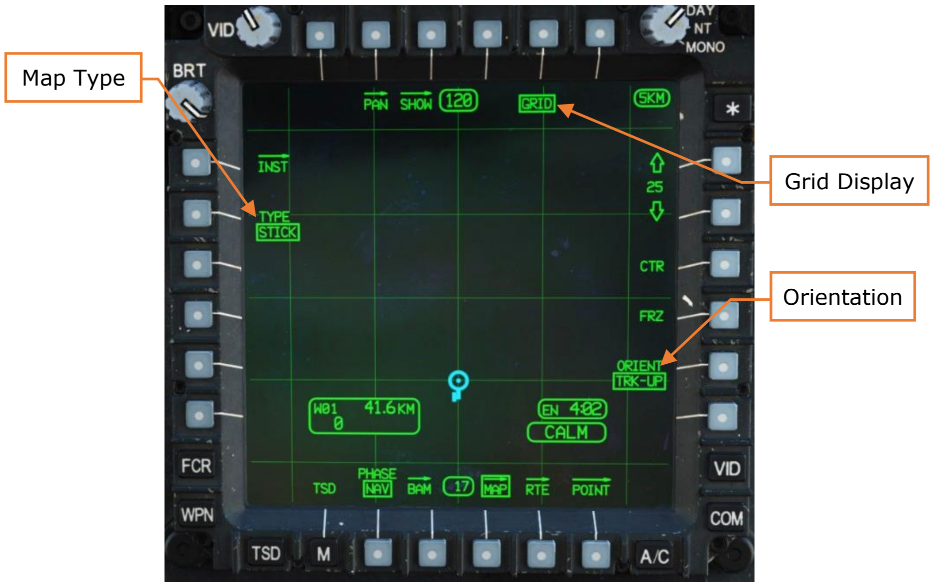


Figure 98. MPD TSD Page, MAP Sub-Page (STICK Mode)

Map Type. Toggles between the different map display formats:

- **CHART.** Underlays a tactical navigation chart.
- **DIG.** Underlays a relief map generated by the digital terrain elevation database (DTED).
- **SAT.** Underlays satellite-based imagery.
- **STICK.** Underlays only the coordinate grid.

Grid Display. Toggles display of the coordinate grid. When displayed, the grid size is displayed in the upper right corner.

Orientation. Sets the map orientation:

- **HDG-UP.** The map is oriented such that aircraft heading is upwards.
- **TRK-UP.** The map is oriented such that aircraft ground track is upwards.
- **N-UP**. The map is oriented such that true north is upwards.

Figure 99. MPD TSD Page, MAP Sub-Page (CHART Mode)

Chart Scale. Selects the chart scale to use. Options are 1:12.5K, 1:50K, 1:100K, 1:250K, 1:500K, 1:1M, 1:2M, and 1:5M. Chart rasters may not be available for all scales.

Color Bands. Selects how elevation bands are colorized on the map:

- **NONE.** No coloring is applied.
- **A/C.** Terrain is shaded based on aircraft altitude. Terrain that rises above the current altitude is shaded red, and terrain within 50 feet of the current altitude is shaded in yellow.
- **ELEV.** Terrain is shaded from green to brown based on its MSL elevation. If the MPD is in MONO (monochromatic mode), shading will be from green to black.

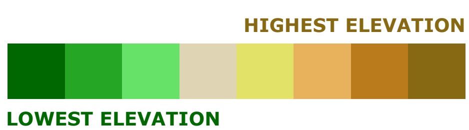


Figure 100. ELEV Shading Legend

View. Select either 2D or 3D map display. (3D display is not implemented.)

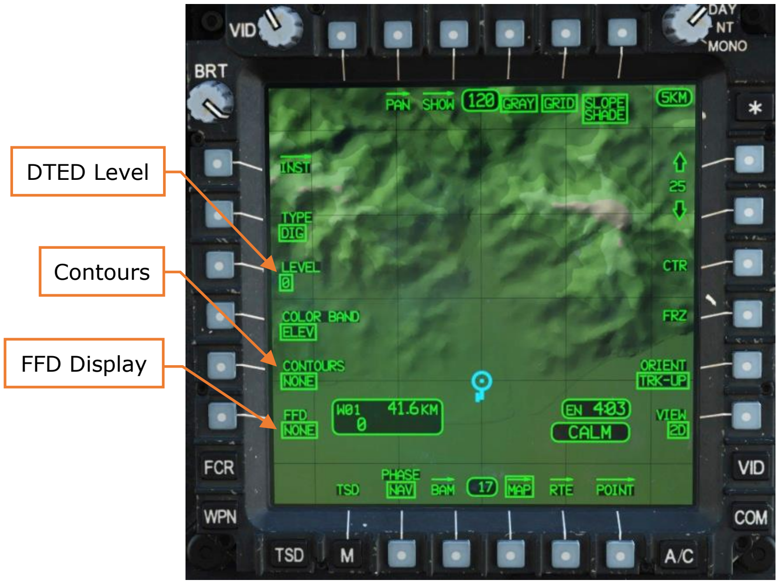


Figure 101. MPD TSD Page, MAP Sub-Page (DIG Mode, with ELEV Shading)

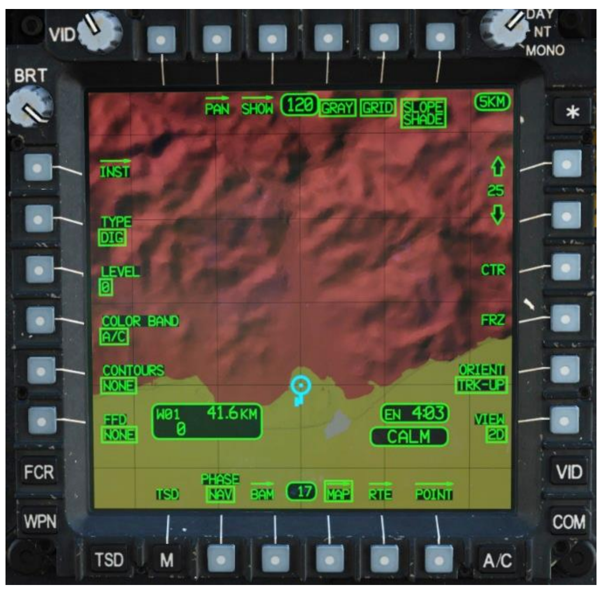


Figure 102. MPD TSD Page, MAP Sub-Page (DIG Mode, with A/C Shading)

DTED Level. Selects the resolution (level 0, level 1, or level 2) of DTED data to use. Normally, data resolution level is selected automatically based on map scale but can be overridden using this button. (N/I)

Contours. Toggles display of terrain contour lines at regular elevation intervals. Options are NONE (no contours) and 50-, 100-, 200-, 500-, and 1000-foot intervals. (N/I)

FFD Display. Selects display of Foundation Feature Data (FFD). FFD includes roads, airports, forests, and other man-made and natural features. (N/I)

- **None.** No FFD is displayed.
- **Area.** Shape-type FFD is displayed. This includes forests, marshes, sand, rock, snow/ice, industrial areas, political boundaries, airports, railroads, towers, water structures, buildings, urban areas, and bodies of water.
- **Line.** Vector-type FFD is displayed. This includes fords/ferries, trees, roads, paths, pipes, cliffs, gullies, political boundaries, runways, towers, buildings, bridges, fences/barriers, and bodies of water.

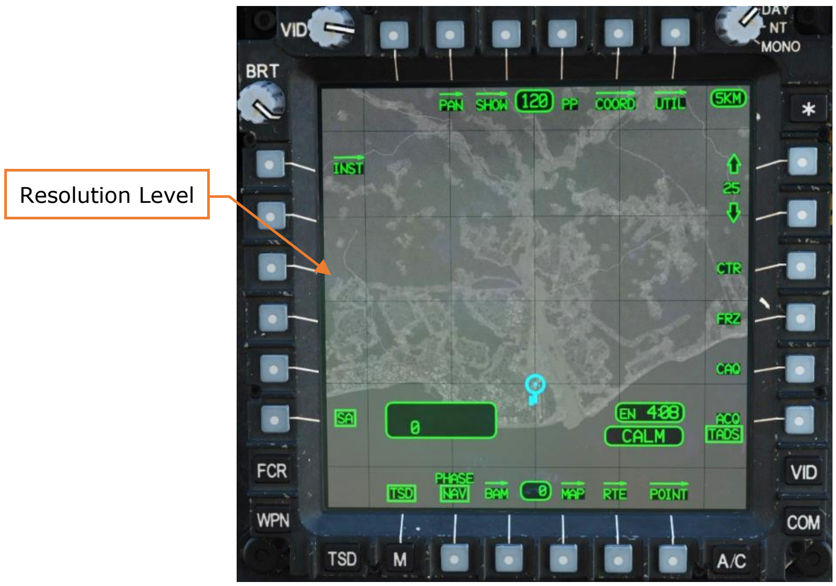


Figure 103. MPD TSD Page, MAP Sub-Page (SAT Mode)

Resolution Level. Sets the resolution level of the satellite imagery to display. (N/I)

Mission, TSD Page, Route (RTE) Sub-Page

The RTE sub-page is used to combine points into routes. Up to ten routes can be created, labeled Alpha, Bravo, Delta, Echo, Hotel, India, Lima, Oscar, Romeo, and Tango. The RTE sub-page shows information about the current route. (see Routes in the Navigation section)

Figure 104. MPD TSD Page, RTE Sub-Page

Add Format. The ADD format allows the crewmember to add points to the end of route or insert points into a route. (see Editing a Route)

Delete (DEL) Format. The DEL format allows the crewmember to remove points from a route. (see Editing a Route)

Direct Route (DIR) Format. Creates a direct route to a point either in the route or outside of the route. Points can be cursor-selected from the TSD footprint or selected from the route sequence list. (see Navigating to a Point)

Figure 105. MPD TSD Page, RTE Sub-Page, DIR Format

Route Sequence. The route sequence window displays the points in the current route. Use the arrows (R1 and R6) to scroll through points in the current route. Use R2–R5 to select points within the route.

The selected point displayed in the Review Status Window is boxed. The next point in the route is displayed with an underline.

Review Status Window. This window displays the following information for the selected point:

- Point type and number
- Point identifier
- Free text characters
- Estimated time enroute (ETE) to the point
- Estimated time of arrival (ETA) at the point
- Distance to go in km and NM

Estimated time and distance are based on the aircraft's position along the route, not straight-line distance to point.

Mission, TSD Page, Route Menu (RTM) Sub-Page

The RTM sub-page allows you to create and delete routes, as well as select the active route. (see Routes in the Navigation section)

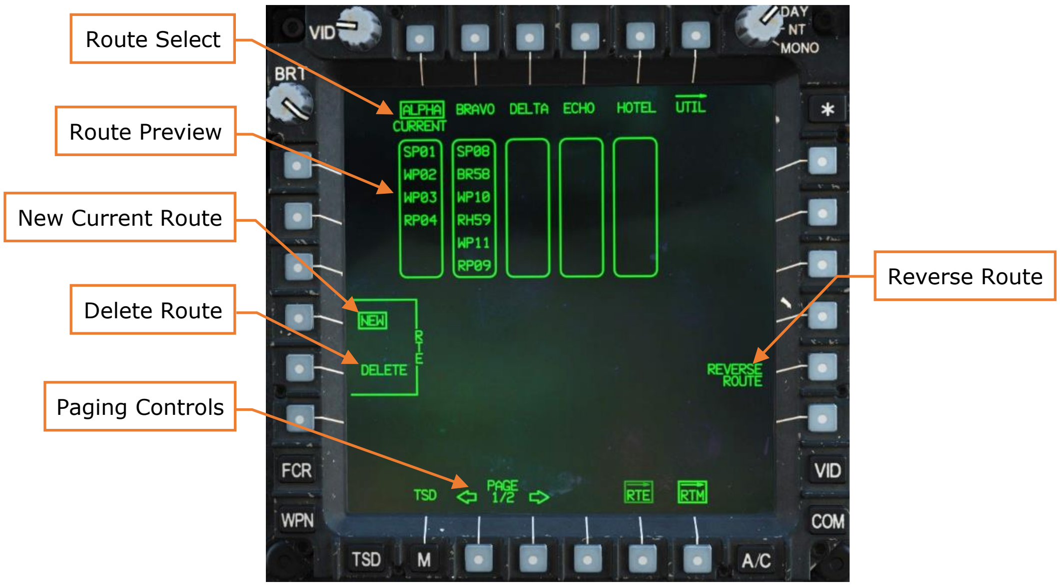


Figure 106. MPD TSD Page, RTM Sub-Page

Route Select. Press buttons T1–T5 to select or delete a route, depending on the boxed route function.

Route Preview. Displays the first six points in each route.

New Current Route. When NEW is boxed, pressing buttons T1–T5 will select a route as current. (see Creating a Route and Selecting a Route)

Delete Route. When DELETE is boxed, pressing buttons T1–T5 will clear the selected route. You will be prompted "YES" or "NO". (see Deleting a Route)

Paging Controls. Cycles between displaying routes the first set of 5 routes, or the second set of 5 routes.

Reverse Route. Reverses the point order in the selected route.

Mission, TSD Page, Point Sub-Page

The POINT sub-page allows the aircrew to create, edit, and delete stored points, as well as transmit them to other flight members.

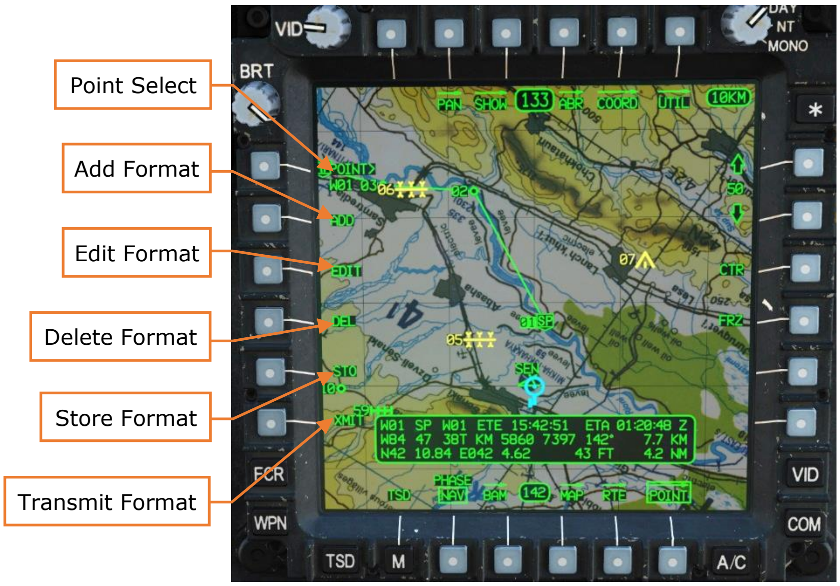


Figure 107. MPD TSD Page, POINT Sub-Page

Point Select. Activates the KU for entry of an existing point, for the purposes of reviewing that point's information, editing the point's information, deleting the point from the database, or transmitting the point to another AH-64D. Entry should be made in the form W##, H##, C##, or T## where "##" is the point's number. You can also use the cursor to select a point.

Add Point Format. Press this button to add a new point. (see Adding a Point)

Edit Point Format. Press this button to edit an existing point. (see Editing a Point)

Delete Point Format. Press this button to remove the selected point. You will be prompted "YES" or "NO". (see Deleting a Point)

Store Point Format. Press this button to create a new flyover point or a new point from the TADS or CPG HMD LOS. (see Storing a Point)

Transmit Point Format. Press this button to display the Transmit menu. (see Transmitting a Point)

Mission, TSD Page, Abbreviation (ABR) Sub-Page

The ABR page allows the Pilot or CPG to look up IDENT codes for specific types of points on the TSD. This page can be accessed from either the TSD POINT or TSD UTIL pages, and can be useful when manually entering points during a mission. A full appendix of all point IDENT codes can be found at the end of this manual.

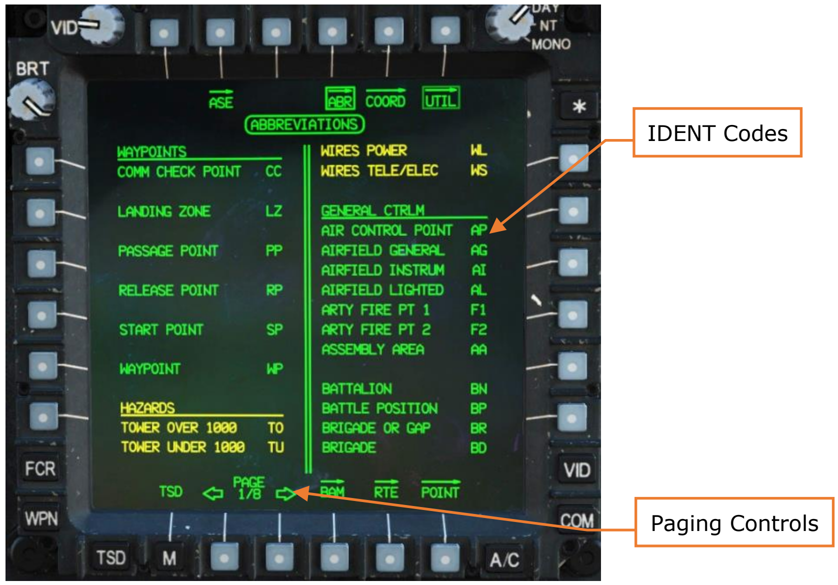


Figure 108. MPD TSD Page, ABR Sub-Page

Mission, TSD Page, Instruments (INST) Sub-Page

The INST page configures the TSD for radio navigation while operating in low-visibility conditions. The page provides necessary controls for setting a heading bug, manually tuning an NDB frequency, testing the ADF system, and an independent timer.

Figure 109. MPD INST Page

Timer Controls. The START/STOP button (T1) is used to start or pause the digital timer digital readout. The RESET button (T2) is used to reset the digital timer readout to zero.

Timer Status Window. The digital timer readout displays the elapsed time in H:MM:SS format, from 0:00:00 to a maximum value of 9:59:59.

Heading Select. Sets the magnetic heading value of the Heading Select Indicator.

NDB Frequency. Manually sets the NDB frequency of the ADF receiver.

Last NDB Frequency. Toggles between the current and previous NDB frequencies the ADF receiver is tuned.

Heading Select Indicator. Indicates the magnetic Heading Select entered. The Heading Select Indicator is displayed around the periphery of the HSI compass. A hollow Reciprocal Heading Select Indicator is displayed on the opposite side of the HSI compass.

NDB Status Window. Displays the current NDB frequency the ADF is tuned to, the station identifier, and the station identifier’s Morse code equivalent for identification via the ADF audio channel. When tuned to an Emergency ADF frequency, the window will display the Morse code for "S-O-S".

ADF Bearing Pointer. Indicates the magnetic bearing to the current signal being received by the ADF.

ADF Tone. Replaces normal ADF audio with 1000 Hz tone.

ADF Identify. Filters ADF audio output for clarity. (N/I)

ADF Test. Pressing the TEST button causes the ADF Bearing Indicator to momentarily shift 90° to the right before returning to the original bearing. A faulty system circuit could cause the Bearing Indicator to shift to a value other than 90° right. The rate the Bearing Indicator returns to the original bearing indicates the relative strength of the station signal being received.

Mission, TSD Page, INST Sub-Page, Utility (UTIL) Sub-Page

The INST UTIL page provides additional options for configuring and tuning the AN/ARN-149 Automatic Direction Finder (ADF).

Figure 110. MPD INST UTIL Page

ADF Presets. Selects preset stations for tuning or editing.

ADF Emergency Frequencies. Tunes the ADF antenna to one of two international distress frequencies of 500 kHz and 2182 kHz.

ADF Preset Identifier. Edits the NDB station identifier letters for the selected ADF preset.

ADF Preset Frequency. Edits the NDB frequency for the selected ADF preset.

ADF Tune. Tunes the ADF antenna to the selected ADF preset.

ADF Mode. Toggles ADF antenna between Automatic Direction Finder (ADF) and Antenna (ANT) modes. ADF mode provides audio and bearing indication to the tuned station. ANT mode provides audio only.

ADF Power. Toggles ADF system on and off.

Mission, Weapon (WPN) Page

The WPN page allows the Pilot or CPG to activate weapon systems and configure weapon parameters.

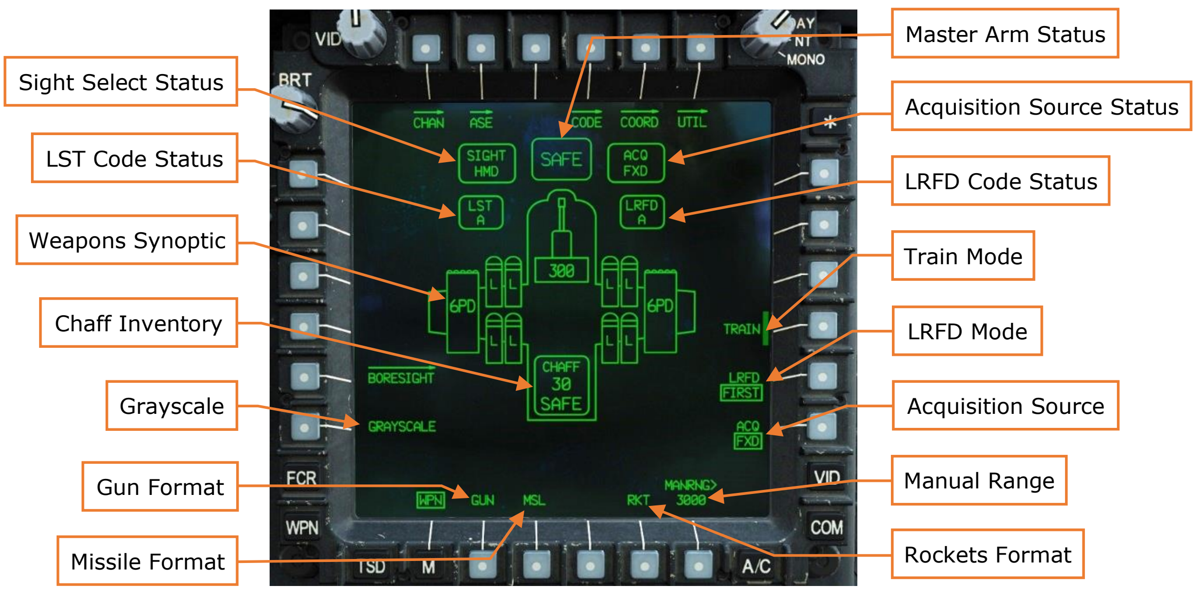


Figure 111. MPD WPN Page

Sight Select Status. Displays the selected sight for this crew station. The Sight Select switch on the collective or TEDAC is used to change the selected sight.

LST Code Status. Displays the selected laser spot tracker code. (see Figure 118 below)

Weapons Synoptic. A synoptic overview of the weapons loaded on the aircraft and their status.

Chaff Inventory. Displays the number of chaff loaded on the aircraft.

Grayscale. Toggles grayscale mode for the HDU.

Gun Select, Missile Select, Rockets Select. Selects gun, Hellfire missiles, or rockets for configuration. (see Figure 112, Figure 113, Figure 114, and Figure 115 below)

Master Arm Status. Displays the master arm status, SAFE or ARM. ARM is displayed in yellow and inverse video.

Acquisition Source Status. Selects an acquisition source. This source will be used to slave or cue the selected sight to a line of sight or point on the ground.

- **PHS.** Pilot helmet sight. (Not available to Pilot station when Pilot is sight-selected to HMD)
- **GHS.** CPG helmet sight. (Not available to CPG station when CPG is sight-selected to HMD)
- **SKR.** Tracking missile seeker, either an SAL Hellfire laser seeker or a next-to-shoot target track from an RF Hellfire.
- **RFI.** Azimuth of highest-priority threat detected by RFI. (N/I)
- **FCR.** Next-to-shoot FCR target. (N/I)
- **FXD.** Fixed line of sight, (0° in azimuth/-4.9° in elevation).
- **TADS.** TADS line of sight. (Not available to the within a crewstation if TADS is being used as a sight or NVS sensor within that same crewstation)
- **W##, H##, C##, or T##.** A stored waypoint, hazard, control measure, or target/threat point. (see Points in the Navigation section)

LRFD Code Status. Displays the selected laser rangefinder/designator code. (see Figure 117 below)

Train Mode. Toggles TRAIN Mode for synthetic weapons engagements, with appropriate symbology and weapons fire audio feedback over the ICS. Aircraft master arm must be SAFE and all weapons de-actioned to enable/disable Train Mode. (N/I)

When enabled, any empty Hellfire stations will display a synthetic AGM-114L missile, any empty rocket pod will receive synthetic rockets of the current zone ballistic setting, and gun round quantity will display 888. Any live missiles or rocket pods with live rockets loaded will be labeled as NA.

LRFD Mode. Selects which segment of a sequence of rangefinder pulses to use when determining target range.

- **FIRST.** The beginning portion of a sequence of rangefinder pulses will be used to determine target range.
- **LAST.** The ending portion of a sequence of rangefinder pulses will be used to determine target range.

Manual Range. When activated, allows the Pilot or CPG to enter a manual target range using the KU. If "A" is entered, an automatic range calculation will be used.

WPN Page, GUN Format

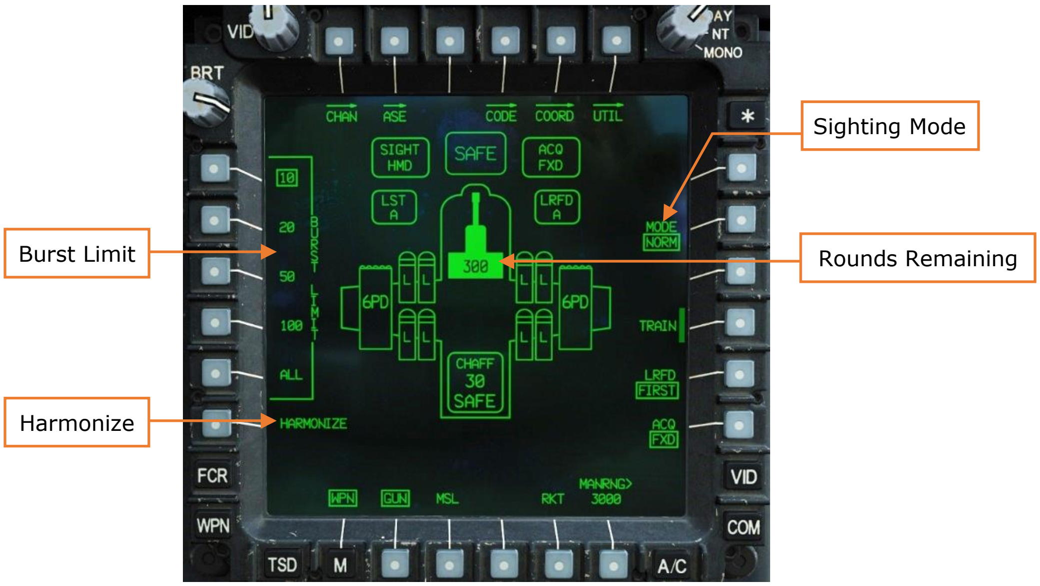


Figure 112. MPD WPN Page, GUN Format

Burst Limit. Sets the number of rounds to fire with each trigger depression.

Harmonize. Performs gun system dynamic harmonization procedure. Only available in CPG station. (N/I)

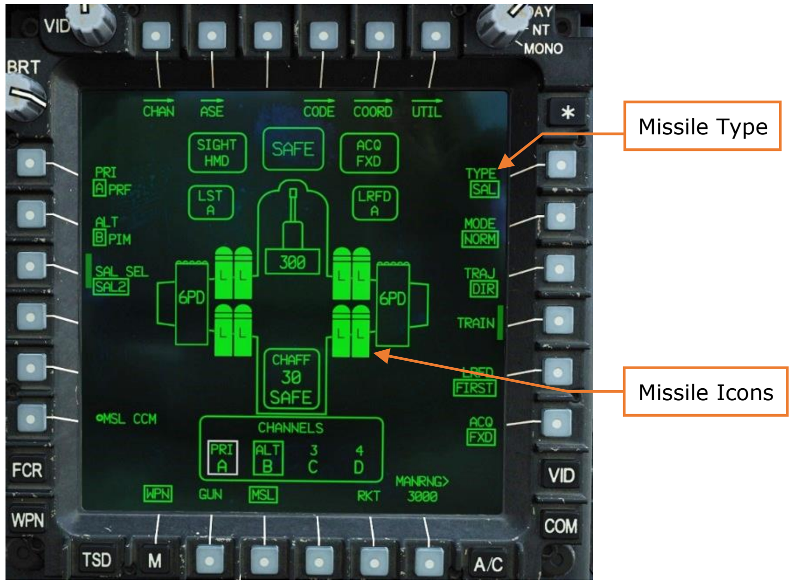
Sighting Mode. Selects gun system sighting mode. Selection is independent for each crewmember.

- **NORM.** Gun follows selected sight.
- **FXD.** Gun is fixed forward at +6° degrees elevation. Fixed gun reticle is calibrated for a 1,575 meter range solution.

Rounds Remaining. Displays the number of rounds remaining in the AWS. Displays "FAIL" in yellow if a gun system failure is detected.

WPN Page, MSL Format

The MSL format is used to configure and launch Hellfire missiles in both the semi-active laser homing (SAL) and radio frequency (RF) guidance variants.



Missile Type. Toggles between semi-active laser (SAL) or radio frequency (RF) Hellfire missiles. Only selectable in the CPG station if TADS is the selected sight. When HMD is selected sight, SAL is automatically selected and barriered. If FCR is the selected sight, RF is automatically selected and barriered.

Missile Icons. Displays the status of each missile on each Hellfire launcher rail. Icons are displayed in inverse video when MSL is selected. The next missile to be fired is always displayed in flashing white, normal video. The text within the missile icon indicates its status:

- **L.** Laser missile detected.
  - **LS.** Missile standby, not set to a laser code.
  - **AR.** Missile ready, seeker is in scanning for laser matching A code.
  - **AT.** Missile seeker in track mode, detecting laser matching A code.
  - **NA.** Missile is not available.
  - **MU.** Missile is on an unlatched launcher.
  - **SF.** Missile launcher station is failed.
  - **MF.** Missile has failed BIT.
  - **MH.** Missile hangfire has been detected.
  - **MA.** Missile launch has been aborted.
- **(no text).** RF missile detected.
  - **S.** Missile is powered but not yet aligned.
  - **OT.** Missile over-temperature has occurred.
  - **R.** Missile ready to receive target.
  - **T.** Missile seeker in track mode.
  - **NA.** Missile is not available.

- **MU.** Missile is on an unlatched launcher.
- **SF.** Missile launcher station is failed.
- **MF.** Missile has failed BIT.
- **MH.** Missile hangfire has been detected.
- **MA.** Missile launch has been aborted.

Missile Launcher Status. Displays the status of each missile launcher. The status of each launcher is displayed within its icon:

- **SAFE, white box.** Launcher is safed.
- **BIT, white box.** BIT is in progress.
- **ARM, no box.** Launchers are armed.
- **FAIL, yellow box.** Failure condition is detected.
- **LOAD, white box.** Keyword loading is in progress.

WPN Page, MSL Format, SAL Type

Semi-active laser-guided missiles must be configured with a priority (and optionally an alternate for Ripple mode) laser code channel. The Priority laser code will be used by the missile to scan for a matching laser designation.

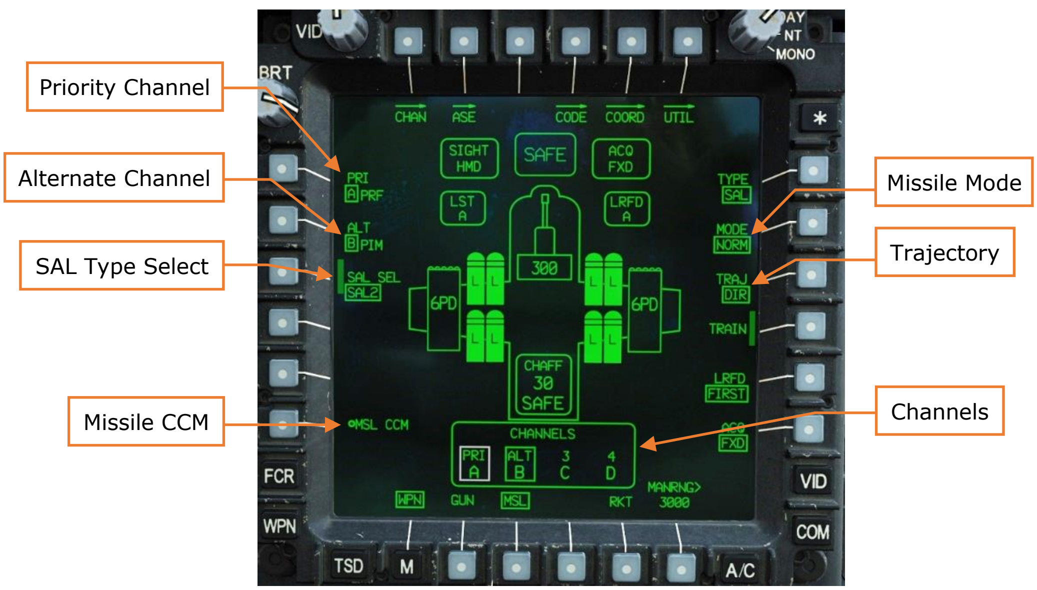


Figure 113. MPD WPN Page, MSL Format, SAL

Priority Channel. Designates the priority missile channel, either NONE or a specific laser code preset. When a laser code is selected, PIM (pulse interval modulation) or PRF (pulse repetition frequency) will be displayed next to the code indicating the type of laser code.

Alternate Channel. Designates the alternate missile channel, either NONE or a specific laser code preset. The alternate missile channel cannot be chosen until a priority missile channel is chosen.

SAL Type Select. Selects the type of SAL missile to fire.

- **SAL 1.** Selects Hellfire I missiles for firing. Hellfire I missiles are only capable of tracking PRF codes.
- **SAL 2.** Selects Hellfire II missiles for firing. Hellfire II missiles can track both PRF and PIM codes.
- **AUTO.** Automatically selects Hellfire I or II missiles. If a PIM code is set, only Hellfire II missiles will be selected. If a PRF code is set, Hellfire II missiles will be prioritized over Hellfire I missiles.

SAL Seeker Deice. Manually deices the missile seeker head in preparation for launch. Jettisons the missile's deice cover. (N/I)

Missile CCM. Enables SAL missile counter-countermeasures. (N/I)

Missile Mode. Selects which laser channel will be used for multiple launches, and how missiles are managed.

- **NORM.** All selected missiles will be guided using the priority laser channel.
- **RIPL.** Selected missiles will be guided alternately between the priority and alternate laser channel for each successive launch.
- **MAN.** A single missile will be launched and guided using the priority laser channel. The Manual Advance button on the collective or TEDAC must be used to ready the next missile between launches.

Trajectory. Selects the post-launch LOAL missile trajectory.

- **DIR.** Missile will fly directly to the target with minimal loft. Requires aircraft to have direct line-of-sight to the target free of obstacles.
- **LO.** Missile will fly a low-altitude loft to the target.
- **HI.** Missile will fly a high-altitude loft to the target.

Channels. Displays which laser codes have been assigned to which missile channels. (see Missile Channel Sub-page)

WPN Page, MSL Format, RF Type

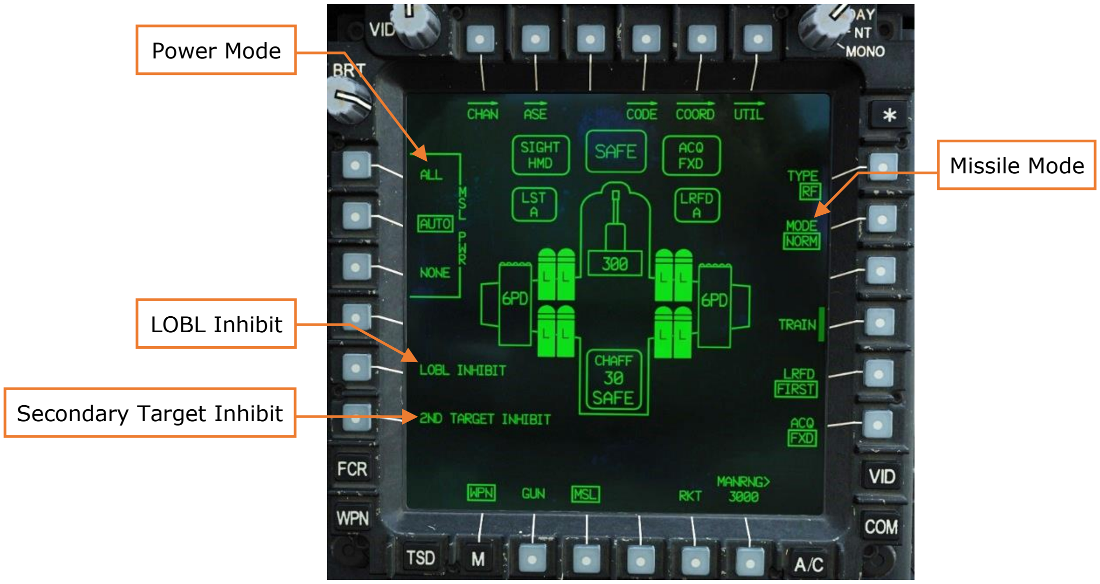


Figure 114. MPD WPN Page, MSL Format, RF

Power Mode. Controls missile power management. Missiles that are left powered on too long can overheat.

- **ALL.** All missiles are powered on continuously.
- **AUTO.** Between zero and four missiles are powered on automatically, depending on total missile inventory.
- **NONE.** All missiles are powered off.

LOBL Inhibit. Inhibits the missile's RF transmitter from transmitting. This will prevent the missile from attempting to track a selected target while still on the rail.

Secondary Target Inhibit. Inhibits secondary target information from being handed over to the missile from the FCR. Only applicable during stationary target engagements.

Missile Mode. Selects how power will be applied to the missiles.

- **NORM.** The weapons system will power on the missiles automatically according to the MSL PWR selection.
- **MAN.** A single missile will be powered on when it is selected using the Manual Advance button on the collective or TEDAC.

WPN Page, RKT Format

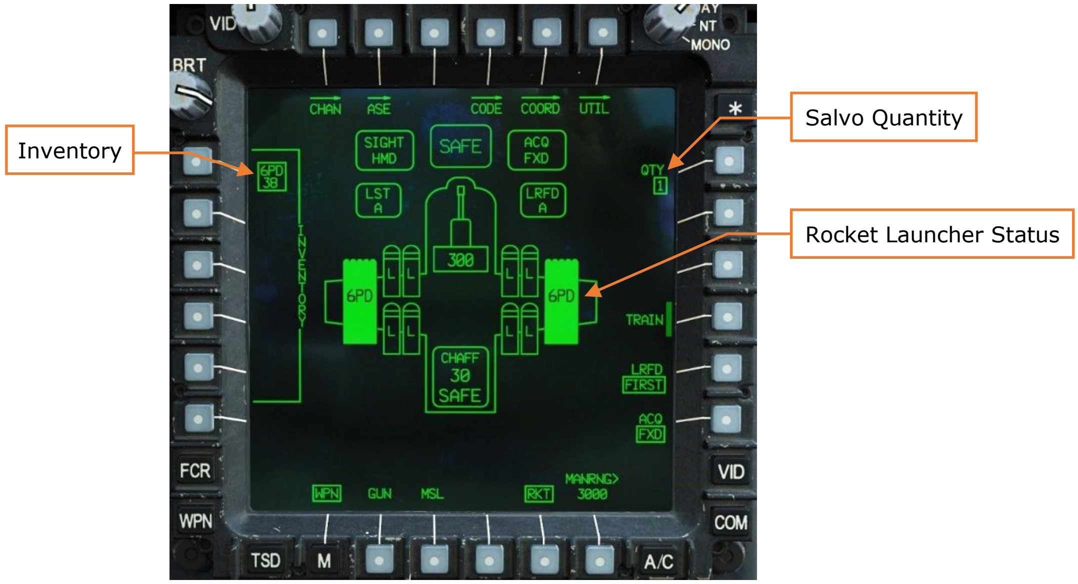


Figure 115. MPD WPN Page, RKT Format

Inventory. Lists the types of rockets loaded and quantity of each.

LABEL	MOTOR	FUZING	WARHEAD
6PD	Mk. 66	Point detonation	High explosive
6RC	Mk. 66	Penetration	High explosive
6MP	Mk. 66	Time delay	Multipurpose submunition
6IL	Mk. 66	Time delay	Illumination
6SK	Mk. 66	Time delay	Smoke
6FL	Mk. 66	Time delay	Flechette

Salvo Quantity. Sets the number of rockets to be launched with each pull of the trigger. Options are 1, 2, 4, 8, 12, 24, and ALL.

Rocket Launcher Status. Displays status of rocket launcher and selected warhead type from Inventory list.

Mission, WPN Page, Missile Channel (CHAN) Sub-Page

The CHAN sub-page is used to assign laser codes to each of the four SAL missile channels.

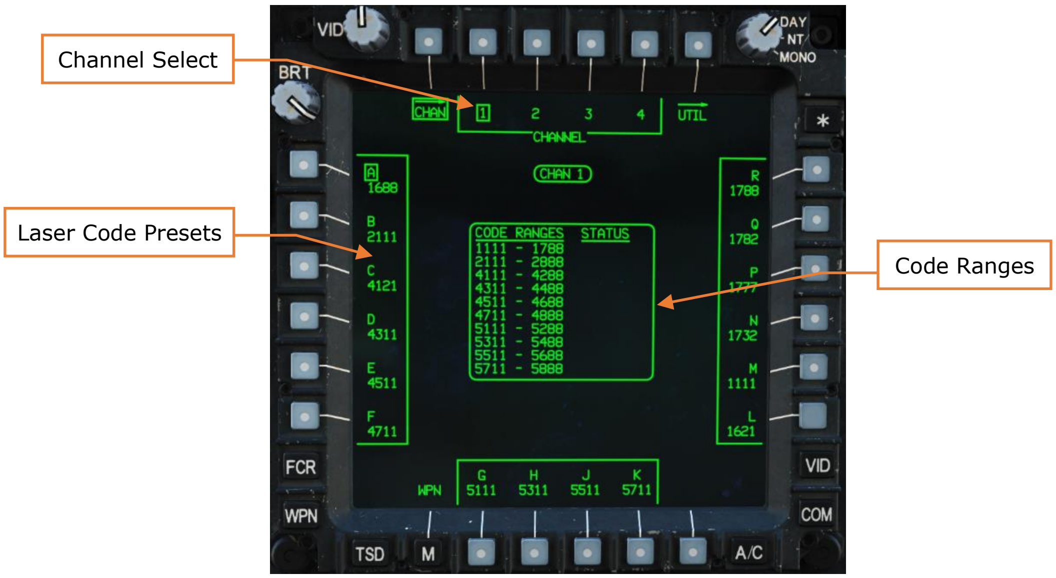


Figure 116. MPD WPN Page, CHAN Sub-Page

Channel Select. Selects a missile channel to assign a laser code to.

Laser Code Presets. Selects a laser code to assign to the selected channel. Laser codes are assigned using one of 16 presets labeled "A" to "R", excluding I and O to prevent confusion with one and zero respectively.

Code Ranges. Displays laser code ranges and the status for that code range. Code ranges and status messages are described below.

CODE RANGE	UTILIZER	TYPE
1111–1788	Tri-Service	PRF
2111–2888	USAF	PIM
4111–4288	Hellfire-A	PIM
4311–4488	Hellfire-B	PIM

4511–4688	Hellfire-C	PIM
4711–4888	Hellfire-D	PIM
5111 AND UP	Copperhead-A, -B, -C, and -D	PIM

STATUS	MEANING
(NO TEXT)	Code range is available to all systems.
FAIL	Checksum error. Code range is not available.
N/A	No onboard equipment can use this code range.
MSL ONLY	Only the missile subsystem can use this code range.
LST ONLY	Only the laser spot tracker can use this code range.
LRFD/LST ONLY	Only the laser spot tracker and laser rangefinder/designator can use this code range.
LRFD/MSL ONLY	Only the laser rangefinder/designator and missile subsystem can use this code range.
LST/MSL ONLY	Only the missile spot tracker and missile subsystem can use this code range.

Mission, WPN Page, Code Sub-Page

The CODE sub-page is used to assign laser codes to the TADS Laser Rangefinder/Designator (LRFD) and Laser Spot Tracker (LST).

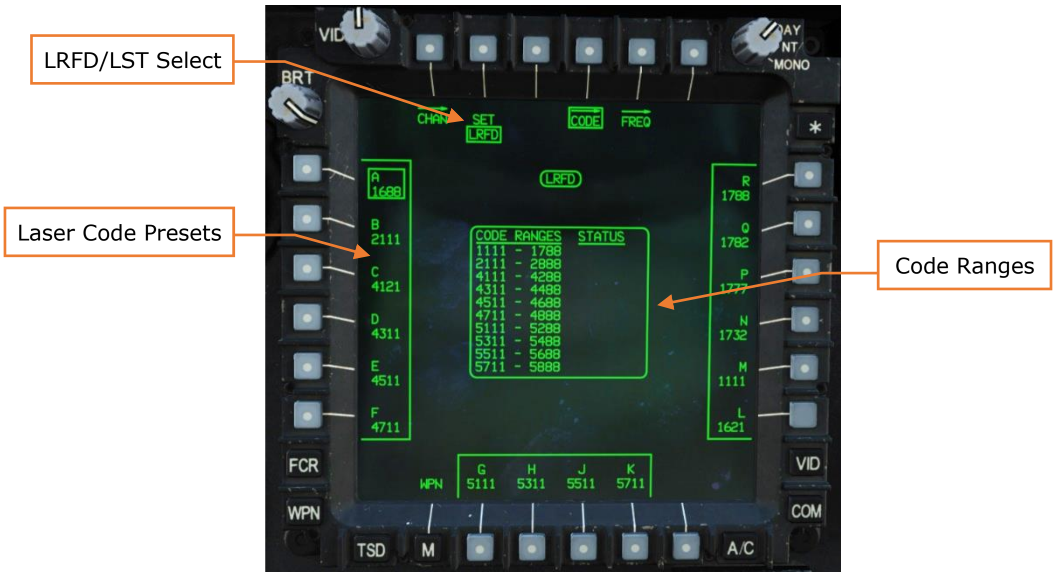


Figure 117. MPD WPN Page, CODE Sub-Page, LRFD Format

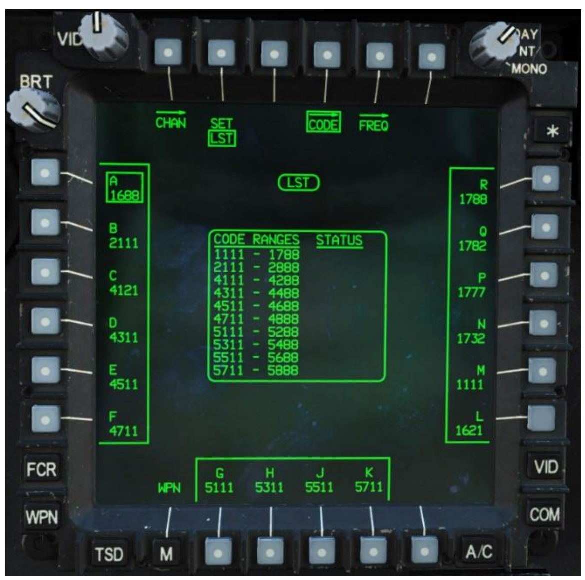


Figure 118. MPD WPN Page, CODE Sub-Page, LST Format

LRFD/LST Select. Selects LRFD or LST to assign a laser code to.

Laser Code Presets. Selects a laser code to assign to either the LRFD or the LST. Laser codes are assigned using one of 16 presets labeled "A" to "R", excluding I and O to prevent confusion with one and zero respectively.

Mission, WPN Page, Code Sub-Page, Frequency (FREQ) Sub-Page

The FREQ sub-page is used to edit the frequencies of the 16 laser codes presets.

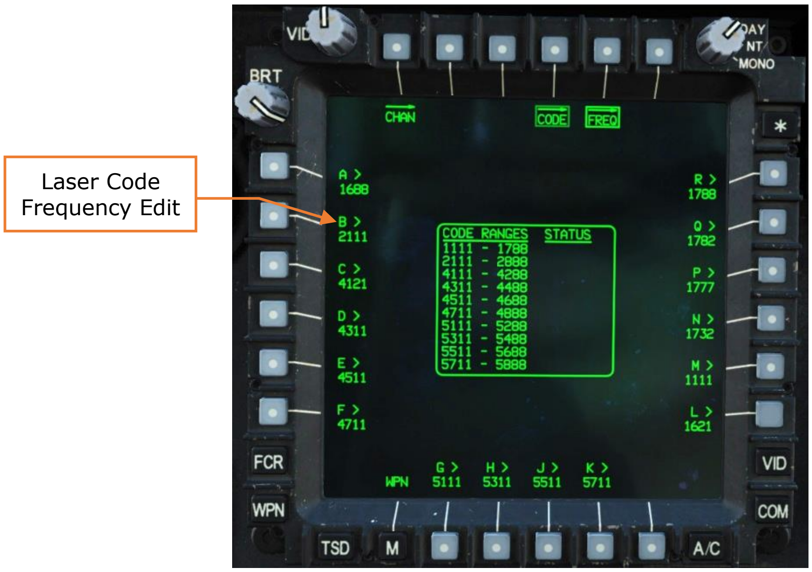


Figure 119. MPD WPN Page, CODE Sub-Page, FREQ Sub-Page

Laser Code Presets. Selects a laser code frequency to edit using the Keyboard Unit (KU).

Mission, WPN Page, Utility (UTIL) Sub-Page

The UTIL sub-page allows the crewmembers to power different weapon systems on and off and set weapon options.

Weapon Utility Sub-Page (PLT)

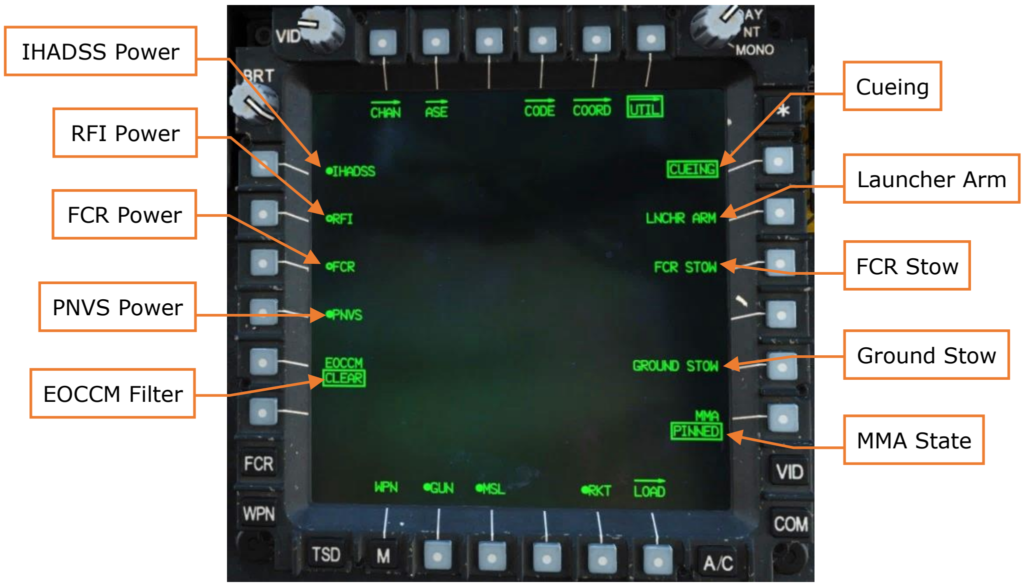


Figure 120. MPD WPN Page, UTIL Sub-Page (PLT)

IHADSS Power. Powers the IHADSS on/off.

RFI Power. Powers the RFI on/off. If the MMA is in NORM, the RFI is powered on automatically.

FCR Power. Powers the FCR on/off. If the MMA is in NORM, the FCR is powered on automatically.

PNVS Power. Powers the PNVS on/off. PNVS is normally powered on automatically one minute after aircraft power-on.

EOCCM Filter. Selects the type of filter used by Pilot's selected NVS sensor. Available options are FILTER 1, CLEAR and FILTER 2.

Cueing. Toggles Cueing Dots on/off in the Pilot's HDU symbology.

Launcher Arm. Arms the Hellfire missile launchers. Commands the Remote Launcher Safe/Arm switch on all missiles to ARM.

FCR Stow. Stows the FCR radome, facing 180° aft.

Ground Stow. Stows the wing pylons to -5° in elevation. This provides optimum ground clearance.

MMA State. Sets the state of the mast-mounted assembly.

- **NORM.** The MMA rotates normally.

- **PINNED.** The MMA maintains a fixed forward position. This can be used to maintain RFI functionality in the event of an FCR failure.

Weapon Utility Sub-Page (CPG)

The options unique to the Copilot/Gunner crewstation are:

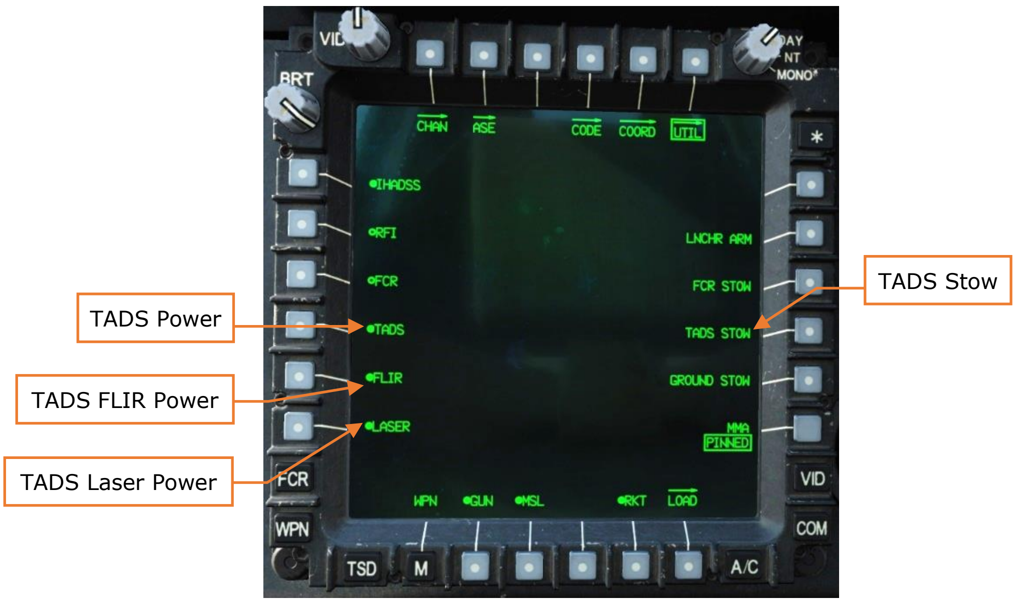


Figure 121. MPD WPN Page, UTIL Sub-Page (CPG)

TADS Power. Powers the TADS on/off. TADS is normally powered on automatically one minute after aircraft power-on.

TADS FLIR Power. Powers the TADS FLIR on/off. The FLIR is normally powered on automatically one minute after aircraft power-on.

TADS Laser Power. Powers the TADS LRFD on/off.

TADS Stow. Stows the TADS turret, facing 180° aft.

Mission, WPN Page, UTIL Sub-Page, Load Sub-Page

The LOAD sub-page allows the aircrew to configure the rocket zone inventory to ensure accurate ballistics calculations and applicable fusing. The functions of this page are currently not implemented.

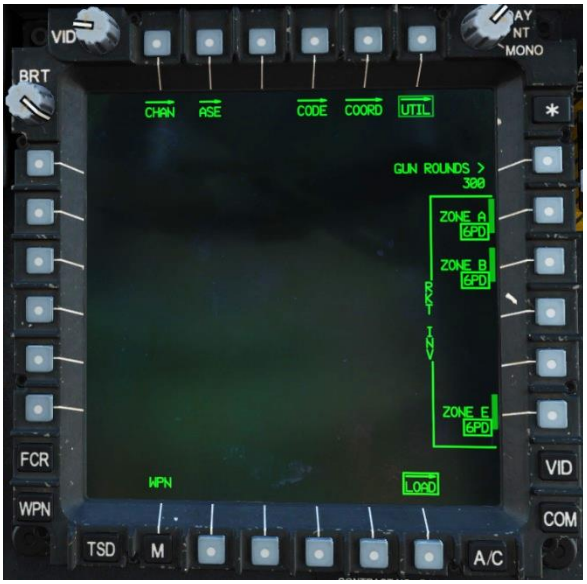


Figure 122. MPD WPN Page, UTIL Sub-Page, Load Sub-Page

Rockets are loaded into pods in five zones, labeled Zone A through Zone E. Each zone can have its own individual rocket type, allowing a diversity of rockets across the different pods.

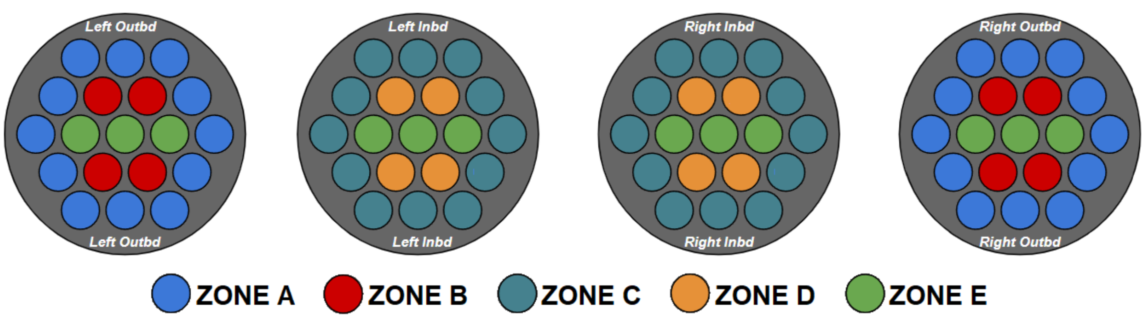


Figure 123. Rocket Zone Inventory Layout

Mission, Fire Control Radar (FCR) Page

The FCR page is not implemented.

Mission, FCR Page, Utility (UTIL) Sub-Page

The FCR UTIL sub-page is not implemented.

Mission, Aircraft Survivability Equipment (ASE) Page

The ASE page provides a de-cluttered, azimuth-only display of any radar or laser threats detected by the aircraft defensive systems, and allows the aircrew to manage the survivability equipment onboard the aircraft, such as the RLWR and chaff dispenser.

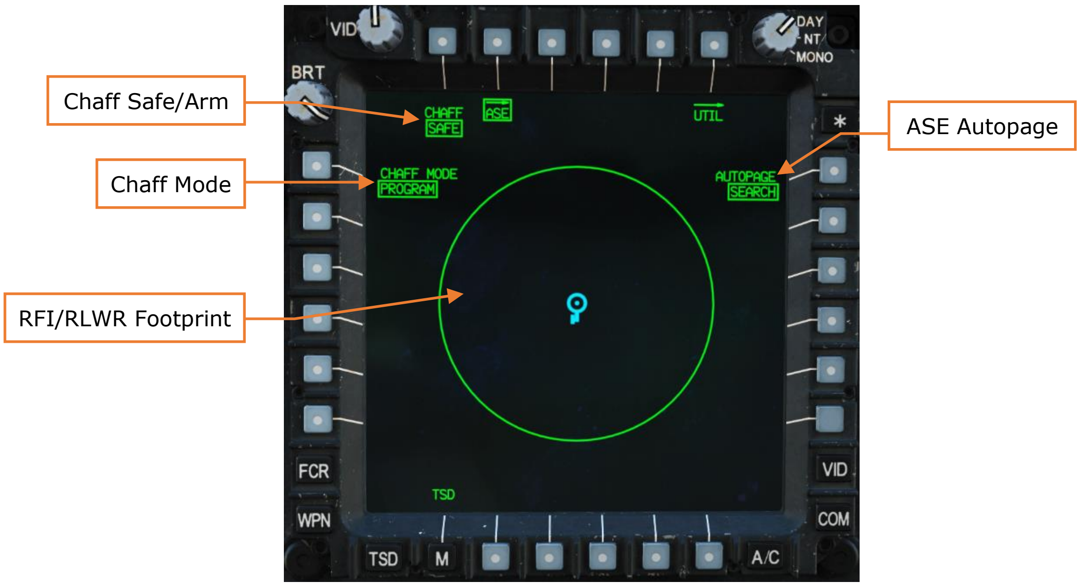


Figure 124. MPD ASE Page

Chaff Safe/Arm. Toggles the chaff status between SAFE and ARM.

Chaff Mode. Toggles the chaff dispenser mode between PROGRAM and MANUAL.

- **PROGRAM.** Chaff is dispensed according to the preset program.
- **MANUAL.** A single chaff is dispensed each time the chaff button is pressed.

ASE Autopage. Sets the autopaging threshold. If ASE page isn't displayed on either MPD, the TSD page will be automatically displayed with ASE footprint when this threshold is exceeded.

- **SEARCH.** A new threat is detected in search mode by the RLWR.
- **ACQUISITION.** A new threat is detected in acquisition mode by the RLWR.
- **TRACK.** A new threat is detected in track mode by the RLWR.
- **OFF.** Autopaging does not occur.

RFI/RLWR Footprint. Plots RFI tracks outside the circle and RLWR tracks inside the circle. (RFI not implemented.)

Mission, ASE Page, Utility (UTIL) Sub-Page

The UTIL sub-page of the ASE page allows you to change chaff programs, power the RLWR, and toggle the RLWR Voice alert mode.

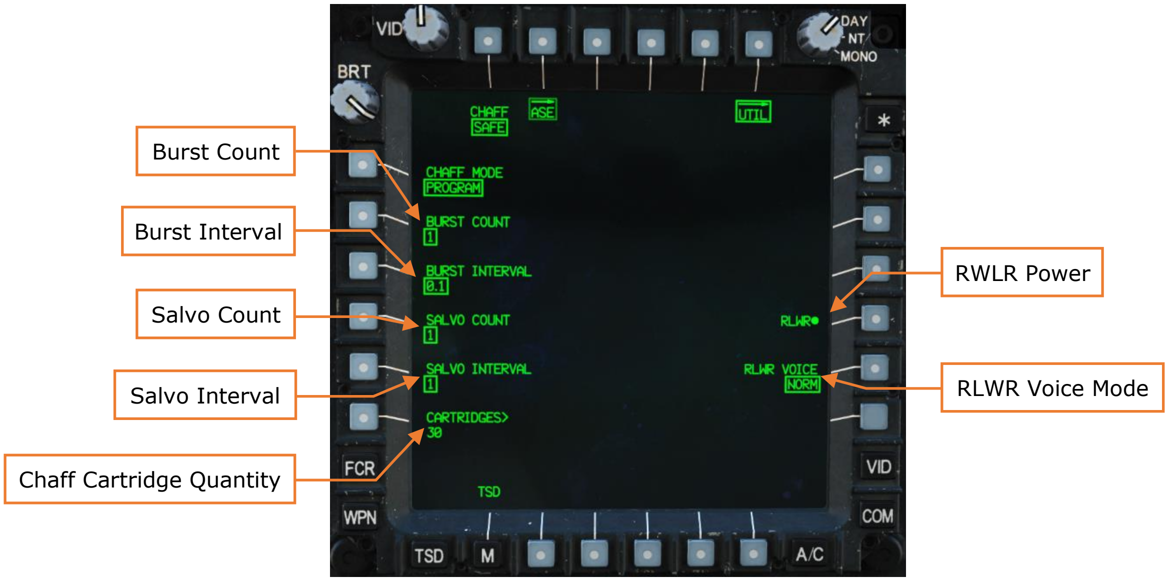


Figure 125. MPD ASE Page, UTIL Sub-Page

Burst Count. Sets the number of chaff to dispense in each salvo. Options are 1, 2, 3, 4, 6, or 8 chaff.

Burst Interval. Sets the dispense interval between individual chaff within a salvo. Options are 0.1, 0.2, 0.3, and 0.4 seconds

Salvo Count. Sets the number of salvos to dispense. Each salvo consists of one or more bursts as defined using the above settings. Options are 1, 2, 4, 8, or CONTINUOUS (dispensing continues until chaff button is pressed again).

Salvo Interval. Sets the dispense interval between salvos. Options are 1, 2, 3, 4, 5, or 8 seconds, or RANDOM. (RANDOM is a set sequence of 3, then 5, then 2, then 4 seconds.)

Cartridges. Enter the number of cartridges loaded into the M141 chaff dispenser (0–30).

RLWR Power. Toggles the radar/laser warning receiver on/off.

RLWR Voice. Toggles between normal (NORM) or TERSE voice message alerts from the RLWR.

Communications, Communications (COM) Page

The COM page is not implemented.

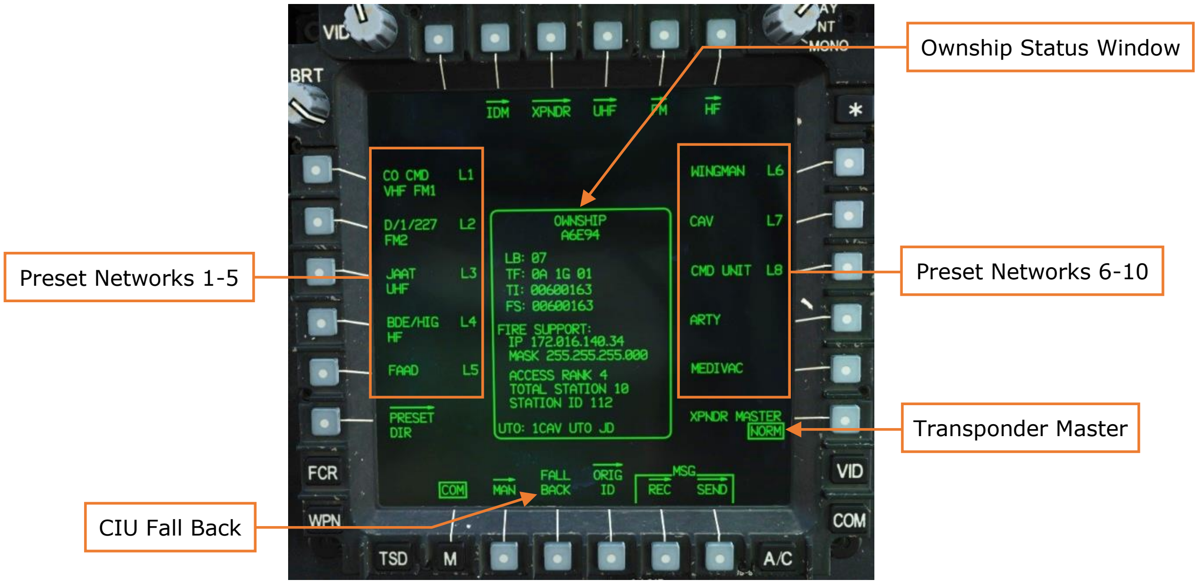


Figure 126. MPD COM Page

Preset Networks. Changes COM page to Preset Format. Each Preset Network provides preset single-channel frequencies and frequency-hopping nets for each radio, unique IDM configuration settings, and network members.

CIU Fall Back. When FALL BACK is pressed, you will be prompted "YES" or "NO". If FALL BACK mode is entered, the Pilot's RTS will be set to the UHF radio, the CPG's RTS will be set to the VHF radio, audio volume levels will be set to a fixed level, and the cockpit ICS will be set to HOT MIC.

FALL BACK mode should be entered if there is a failure of the Communications Interface Unit (CIU), which is indicated by the advisory "GO FALLBACK" on the EUFD.

Ownship Status Window. Displays the aircraft's Originator ID configuration for use with IDM protocols.

Transponder Master. Toggles transponder mode between Standby (STBY) and Normal (NORM).

COM Page, Preset Format

The Preset format is not implemented.

COM Page, Preset Tune Format

The Preset Tune format is not implemented.

Communications, COM Page, Preset Directory (PRESET DIR) Sub-Page

The PRESET DIR sub-page is not implemented.

Communications, COM Page, Modem Sub-Page

The MODEM sub-page is not implemented.

Communications, COM Page, Net Sub-Page

The NET sub-page is not implemented.

Communications, COM Page, Member Directory (MBR DIR) Sub-Page

The MBR DIR sub-page is not implemented.

Communications, COM Page, Originator ID (ORIG ID) Sub-Page

The ORIG ID sub-page is not implemented.

Communications, COM Page, Originator Directory (ORIG DIR) Sub-Page

The ORIG DIR sub-page is not implemented.

Communications, COM Page, Manual (MAN) Sub-Page

The MAN sub-page allows the crew to directly tune the radios to non-preset radio frequencies, tune the VHF or UHF to GUARD frequencies, adjust VHF and UHF reception parameters, and select different HF emission modes.

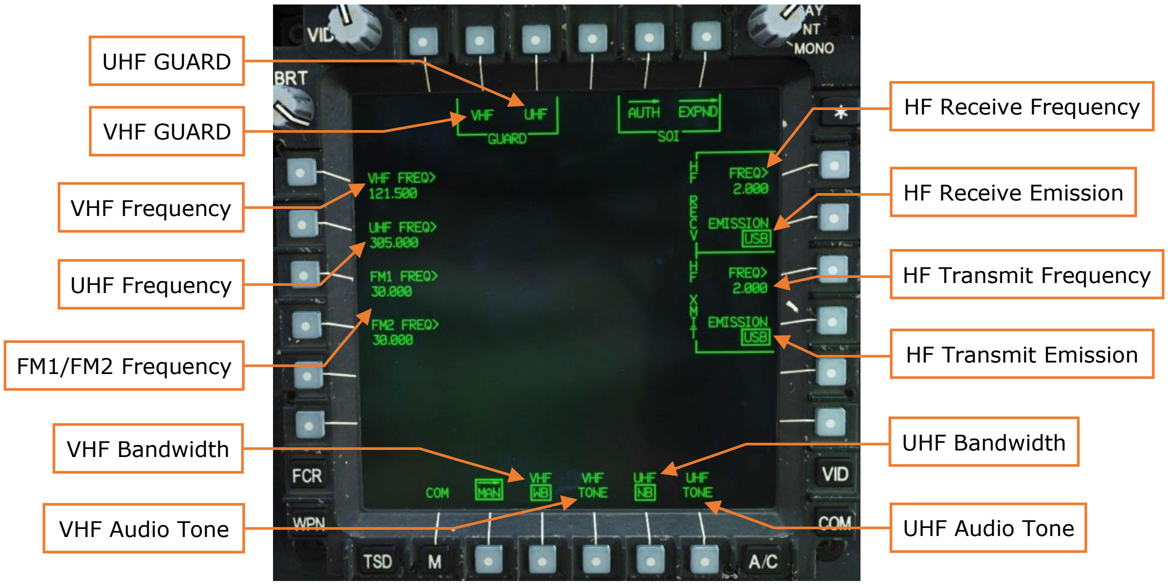


Figure 127. MPD COM Page, MAN Sub-Page

UHF Guard tune. Tunes UHF radio to 243.000 MHz Places primary UHF radio frequency and settings to the standby VHF slot.

VHF Guard tune. Tunes VHF radio to 121.500 MHz Places primary UHF radio frequency and settings to the standby UHF slot.

VHF Frequency. Allows manual entry of an AM frequency into the VHF radio (108.000-151.975 MHz in 0.25 kHz intervals). Places primary VHF radio frequency and settings to the standby VHF slot.

UHF Frequency. Allows manual entry of an AM frequency into the UHF radio (225.000-399.975 MHz in 0.25 kHz intervals). Places primary UHF radio frequency and settings to the standby UHF slot.

FM1/FM2 Frequency. Allows manual entry of an FM frequency into the FM1 or FM2 radio (30.000-87.975 MHz in 0.25 kHz intervals). Places primary FM radio frequency and settings to the standby FM slot.

VHF Bandwidth. Toggles VHF antenna bandwidth reception between Wide Bandwidth (WB) and Narrow Bandwidth (NB).

VHF Tone. Generates an audio tone over the VHF audio channel for 5 seconds for setting volume and performing maintenance.

HF Receive Frequency. Allows manual entry of a shortwave receive frequency into the HF radio (2.0000-29.9999 MHz in 0.1 kHz intervals).

HF Receive Emission. Sets HF emission mode for reception. Setting this option will automatically set the XMIT emission mode to the same setting.

- **LSB.** Selects Lower Side-Band for HF reception.
- **USB.** Selects Upper Side-Band for HF reception.
- **CW.** Selects Continuous Wave for HF reception.
- **AME.** Selects Amplitude Modulation Equivalent for HF reception.

HF Transmit Frequency. Allows manual entry of a shortwave transmit frequency into the HF radio (2.0000-29.9999 MHz in 0.1 kHz intervals).

HF Receive Emission. Selects HF emission mode for transmission.

- **LSB.** Selects Lower Side-Band for HF transmission.
- **USB.** Selects Upper Side-Band for HF transmission.
- **CW.** Selects Continuous Wave for HF transmission.
- **AME.** Selects Amplitude Modulation Equivalent for HF transmission.

UHF Bandwidth. Toggles UHF antenna bandwidth reception between Wide Bandwidth (WB) and Narrow Bandwidth (NB).

UHF Tone. Generates an audio tone over the UHF audio channel for 5 seconds for setting volume and performing maintenance.

Communications, Improved Data Modem (IDM) Page

The IDM page is not implemented.

Communications, Transponder (XPNDR) Page

The XPNDR page is not implemented.

Communications, UHF Radio (UHF) Page

The UHF page is not implemented.

Communications, FM Radio (FM) Page

The FM page is not implemented.

Communications, HF Radio (HF) Page

The HF page is not implemented.

Communications, COM Page, Message Receive (MSG REC) Sub-Page

The MSG REC sub-page is not implemented.

Communications, COM Page, Message Send (MSG SEND) Sub-Page

The MSG SEND sub-page is not implemented.

Video (VID) Page

The VIDEO Page displays video from aircraft sensors and allows the crewmembers to set video underlays and configure video settings.

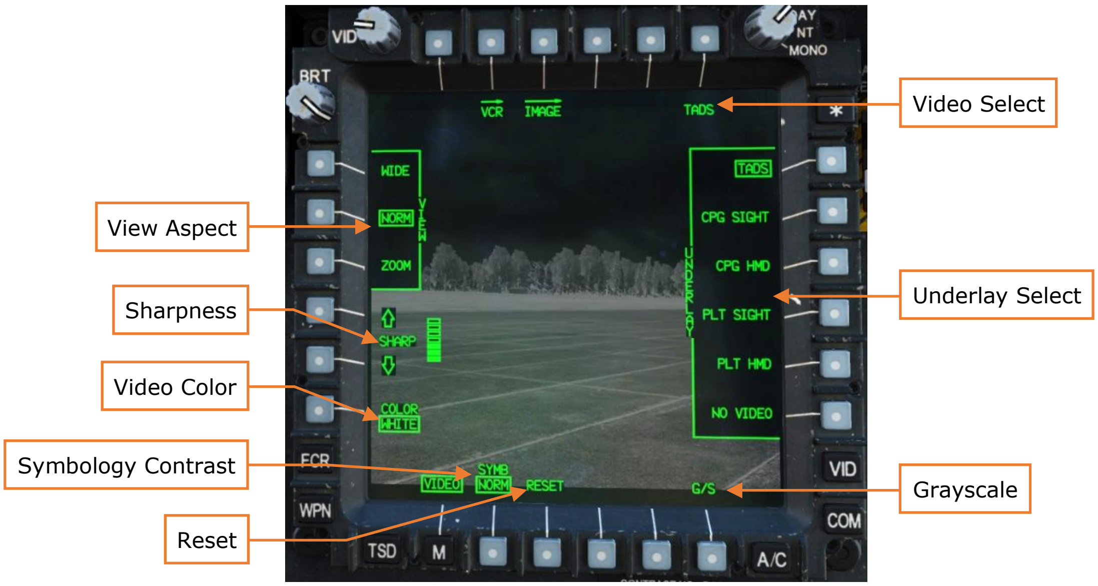


Figure 128. MPD Video Page

Video Select. Selects a decluttered video page for display.

- **C-FLT.** Displays decluttered page along with CPG HMD symbology.
- **P-FLT.** Displays decluttered page along with PLT HMD symbology.
- **TADS.** Displays decluttered page along with TADS symbology.
- **C-FCR.** Displays CPG's FCR footprint. (N/I)
- **P-FCR.** Display's Pilot's FCR footprint. (N/I)

Underlay. Selects the video source for display.

- **TADS.** Displays TADS video.
- **CPG SIGHT.** Displays video from the CPG's selected sight.
- **CPG HMD.** Displays video from the CPG's helmet-mounted display.
- **PLT SIGHT.** Displays video from the Pilot's selected sight.
- **PLT HMD.** Displays video from the Pilot's helmet-mounted display.
- **NO VIDEO.** Blanks the video display.

Symbology Contrast. Toggles between normal (NORM) and boosted (BOOST) symbology contrast.

Sharpness. Increases the sharpness of the image, improving detection of fine detail, but increasing the intensity of video noise.

Video Aspect. Selects between normal, wide, and zoom video aspect.

Video Color. Toggles between white or green video.

Reset. Resets the view, sharpness, and color settings to default (Normal asepct, level 3 sharpness, and white color).

Grayscale. Displays a grayscale calibration image for setting brightness and contrast.

Figure 129. MPD Video Page, Video Select (TADS) Format

Video Cassette Recorder (VCR) Page

The VCR page is not implemented.

System, Data Management System (DMS) Page

The DMS page allows the aircrew to view system advisories and faults, as well as access further sub-menus for diagnostic and maintenance functions.

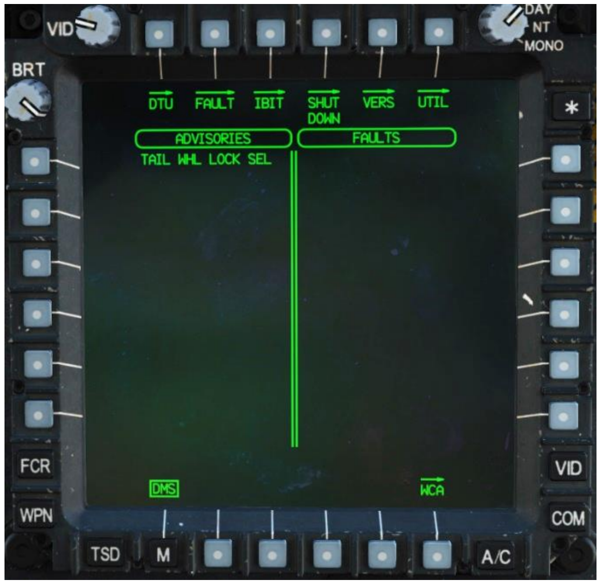
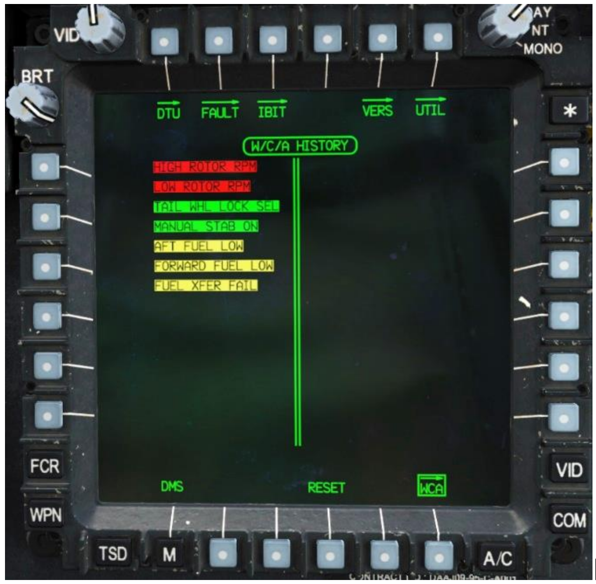


Figure 130. MPD DMS Page

System, DMS page, Warning/Caution/Advisory (WCA) Sub-Page

The Warning/Caution/Advisory sub-page displays crew messages and allows the crew to acknowledge new WCAs. The appearance of a new warning or caution is accompanied by the illumination of the Master Caution or Master Warning lights.



b

Figure 96. MPD DMS Page, WCA Sub-Page

WCA messages are displayed in a two-column list. Up to 128 messages can be displayed. If more messages exist than can be shown, additional pages can be scrolled through using the B2 and B3 buttons.

New warning messages appear in inverse video. Pressing B4 (RESET) acknowledges new messages and restores them to normal video.

System, DMS Page, Data Transfer Unit (DTU) Sub-Page

The DTU sub-page allows the crew to read from and write to the data transfer cartridge (DTC). Currently this format is non-functional.

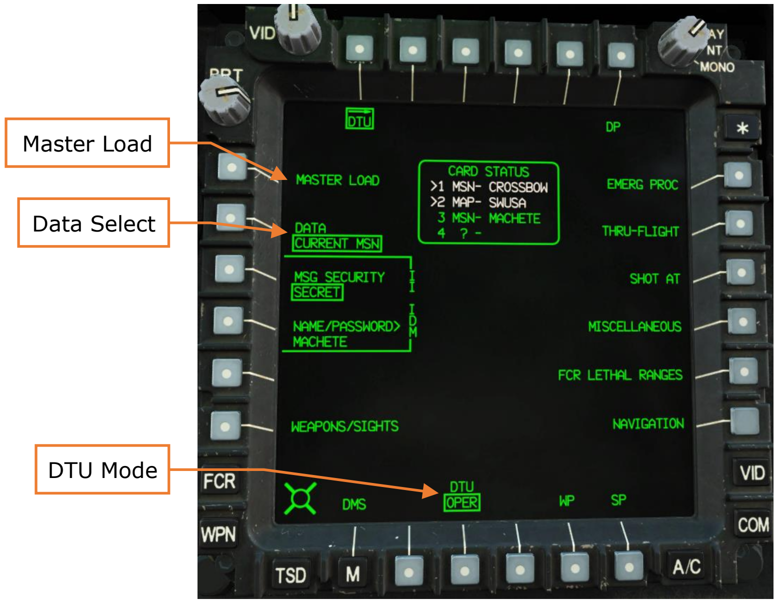


Figure 131. MPD DMS, DTU Sub-Page

Master Load. Loads all primary initialization data from the DTC. (N/I)

Data Select. Toggles between different categories of data. The remaining options on the MPD format correspond to data to upload or download underneath the selected category. Options are CURRENT MSN, MISSION 1, MISSION 2, COMMUNICATION, and AVIONICS UPDT. (N/I)

DTU Mode. Toggles between operational (OPER) and standby (STBY) mode. Standby cancels all upload operations and finishes all download operations. (N/I)

System, DMS Page, Fault Sub-Page

The FAULT sub-page displays faults from power-up built-in tests (PBIT), continuous built-in tests (CBIT), and initiated built-in tests (IBIT). This sub-page is currently non-functional.

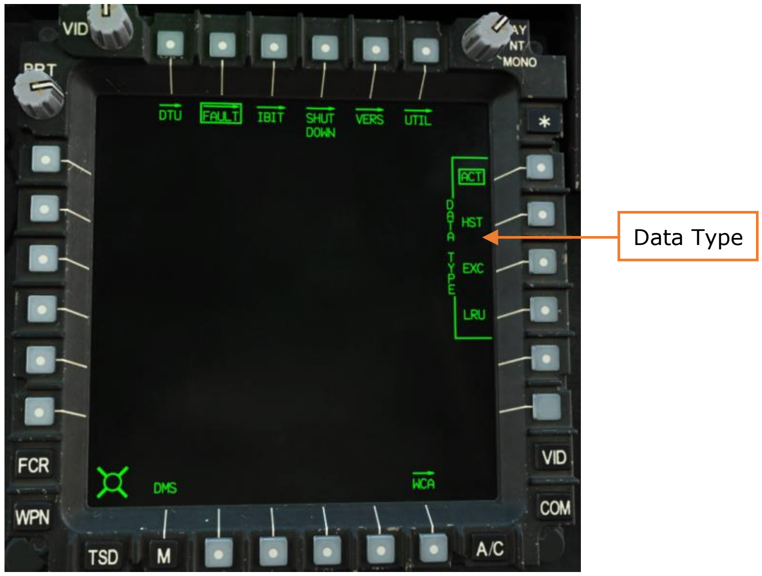


Figure 132. MPD FAULT Sub-Page

Data Type. Selects between displaying active (ACT) faults, historical (HST) faults, exceedances (EXC), or line replaceable unit (LRU) faults. (N/I)

System, DMS Page, Initiated BIT (IBIT) Sub-Page

The IBIT sub-page allows the aircrew to initiate built-in tests (BITs) and see a list of detected faults. The grouped Subsystems buttons toggle between different pages of BITs. The other buttons within a given page open the status page for that subsystem. (N/I)

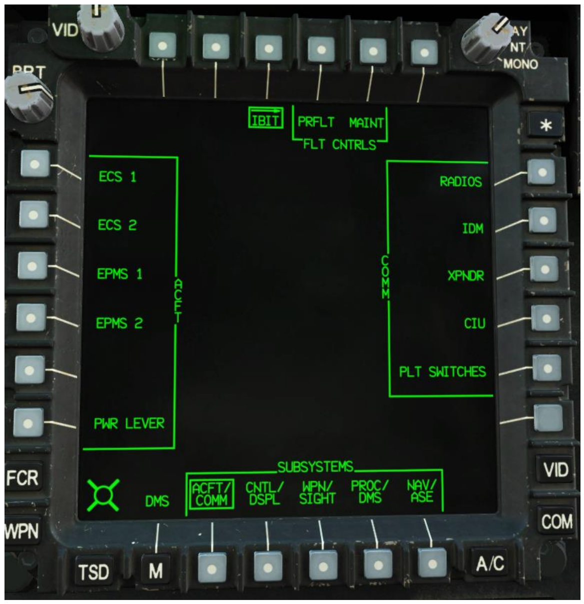


Figure 133. MPD DMS Page, IBIT Sub-Page, ACFT/COMM Format

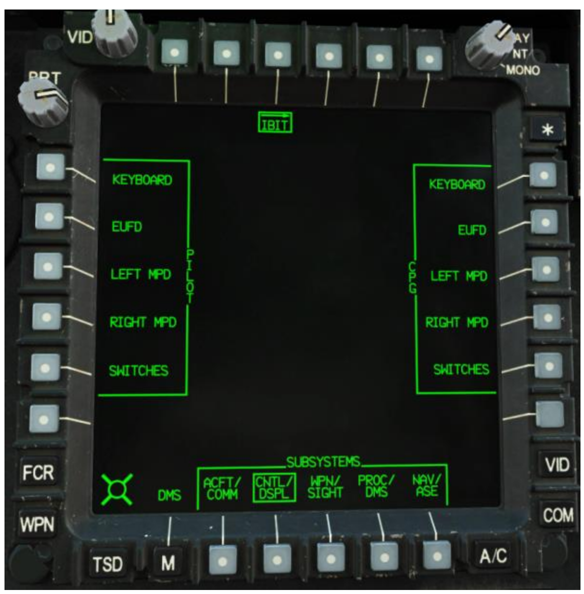


Figure 134. MPD DMS Page, IBIT Sub-Page, CNTL/DSPL Format

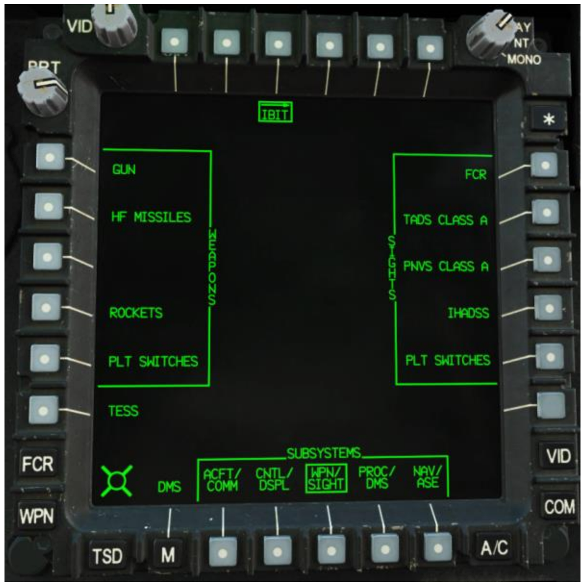


Figure 135. MPD DMS Page, IBIT Sub-Page, WPN/SIGHT Format

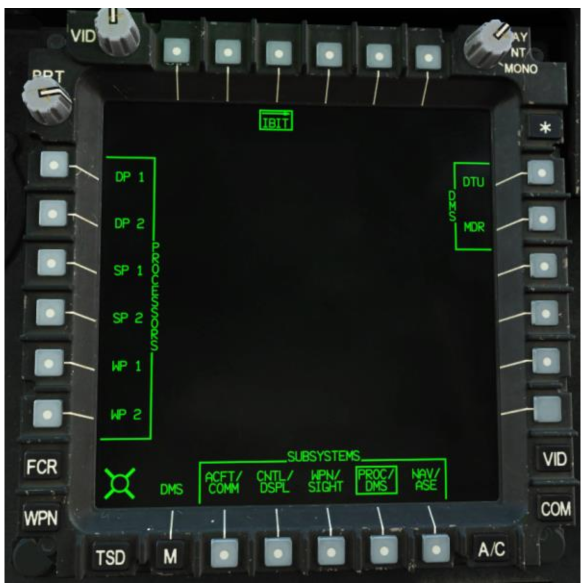


Figure 136. MPD DMS Page, IBIT Sub-Page, PROC/DMS Format

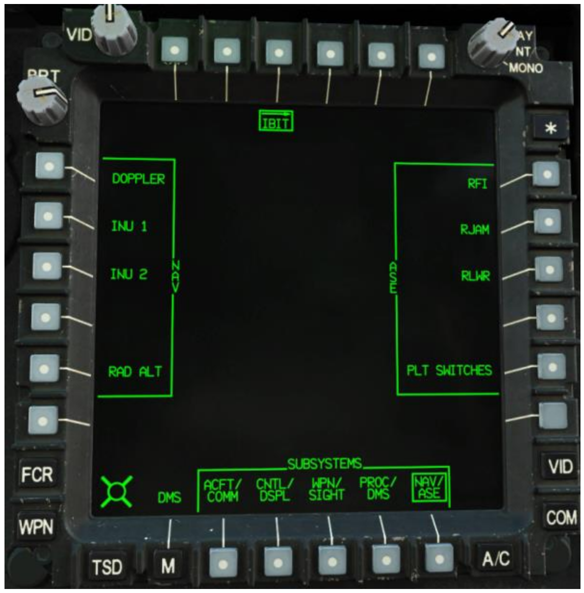


Figure 137. MPD DMS Page, IBIT Sub-Page, NAV/ASE Format

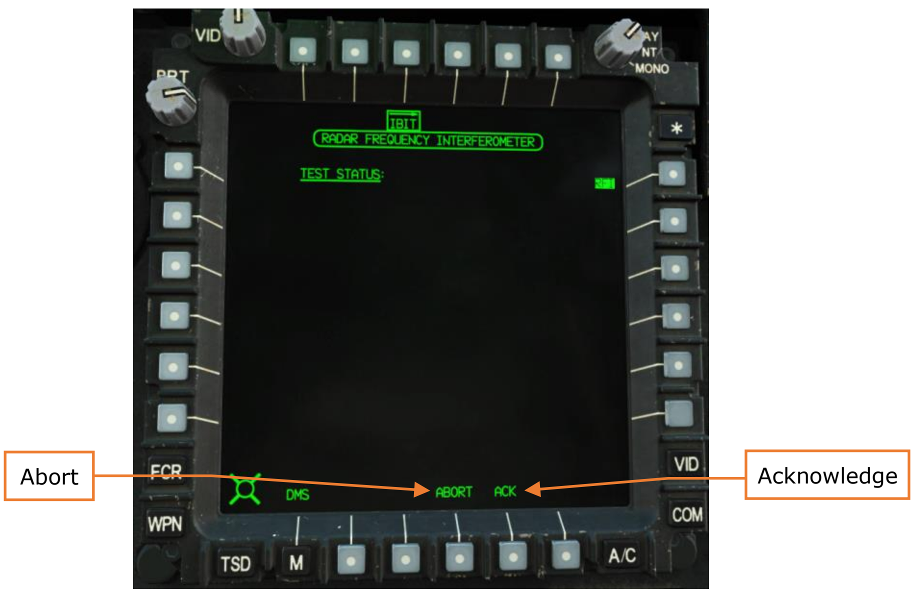


Figure 138. MPD DMS Page, IBIT Sub-Page, Status Format

The status format displays the title of the subsystem and a list of detected faults. Currently, BITs are not implemented, and no faults will be displayed.

Abort. Aborts an IBIT and cancels any faults. (N/I)

Acknowledge. Used to acknowledge a message when performing an IBIT that requires user interaction. (N/I)

System, DMS Page, Shutdown Sub-Page

The Shutdown sub-page is used to remove power to aircraft systems during shutdown. This sub-page is currently non-functional.

Figure 139. MPD DMS Page, SHUTDOWN Sub-Page

Master Off. Powers off the FCR, TADS, and PNVS, and switches DTU and IDM to STBY. (N/I)

FCR Power. Powers the FCR on or off. (N/I)

TADS Power. Powers the TADS on or off. (N/I)

PNVS Power. Powers the PVNS on or off. (N/I)

Mode 4 Hold. If pressed, prevents Mode 4 IFF codes from being zeroized during aircraft shutdown. (N/I)

DTU Mode. Toggles DTU mode between standby (STBY) and operational (OPER). DTU mode must be set to STBY prior to power-off, or DTC may become corrupt. (N/I)

IDM Mode. Toggles IDM mode between standby (STBY) and operational (OPER). IDM mode must be set to STBY prior to power-off, or IDM software may become corrupt. (N/I)

System, DMS Page, Versions (VERS) Sub-Page

The Versions sub-page displays the versions of avionics software and line replaceable unit (LRU) firmware.

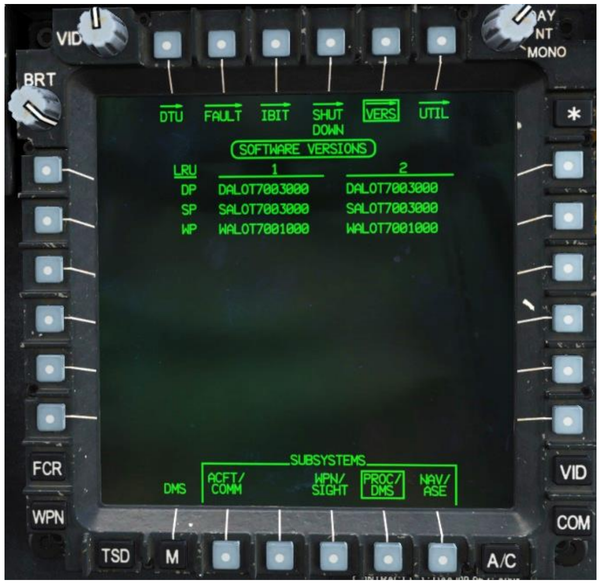


Figure 140. MPD DMS Page, VERS Sub-Page

Subsystems. Allows the aircrew to select between different groups of subsystems.

- **ACFT/COMM.** Displays the versions of aircraft and communications modules.
- **WPN/SIGHT.** Displays the versions of targeting systems firmware (TADS, FCR, etc.).
- **PROC/DMS.** Displays the versions of the processors and DMS software.
- **NAV/ASE.** Displays the versions of the FMC software, and firmware versions for the RWR and ADC.

System, DMS Page, Utility (UTIL) Sub-Page

The Utility sub-page allows the aircrew to configure basic aircraft settings and access diagnostic functions. The functions of this format are currently not implemented.

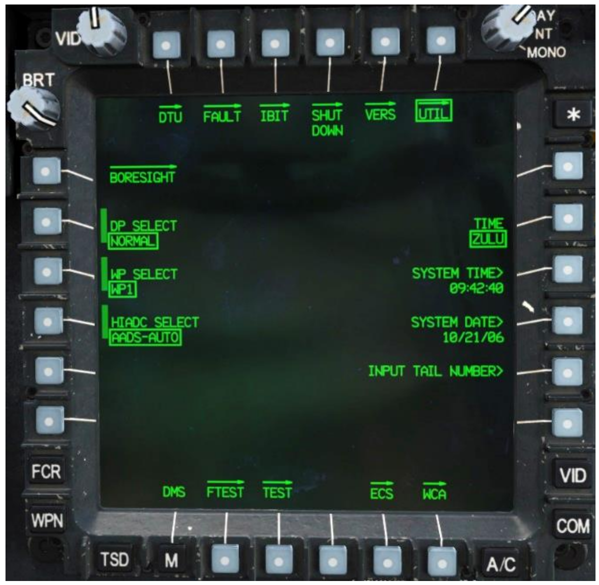


Figure 141. MPD DMS UTIL Page

Boresight. Displays a sub-page where Captive Boresight Harmonization Kit (CBHK) procedures can be conducted, and where different systems can be boresighted. (N/I)

DP Select. Selects which Display Processor is in use. Options are NORMAL, DP1, or DP2. Ground operation only. (N/I)

WP Select. Select which Weapons Processor is in use. Options are NORMAL, WP1, or WP2. Ground operation only. (N/I)

HIADC Select. Selects which Airspeed and Direction Sensor (AADS) is in use. Options are AADS-AUTO, AADS-LH, or AADS-RH. Ground operation only. (N/I)

Time. Toggles between LOCAL or ZULU (UTC) time. (N/I)

System Time. Allows the aircrew to enter the current local or Zulu time. (N/I)

System Date. Allows the aircrew to enter the current local or Zulu date. (N/I)

Input Tail Number. Allows the aircrew to enter the aircraft's registration number. (N/I)

ENHANCED UP-FRONT DISPLAY

The Enhanced Up-Front Display (EUFD) allows quick access to communication radios and critical systems status. Unlike the MPDs, the EUFD operates continuously under only battery power.

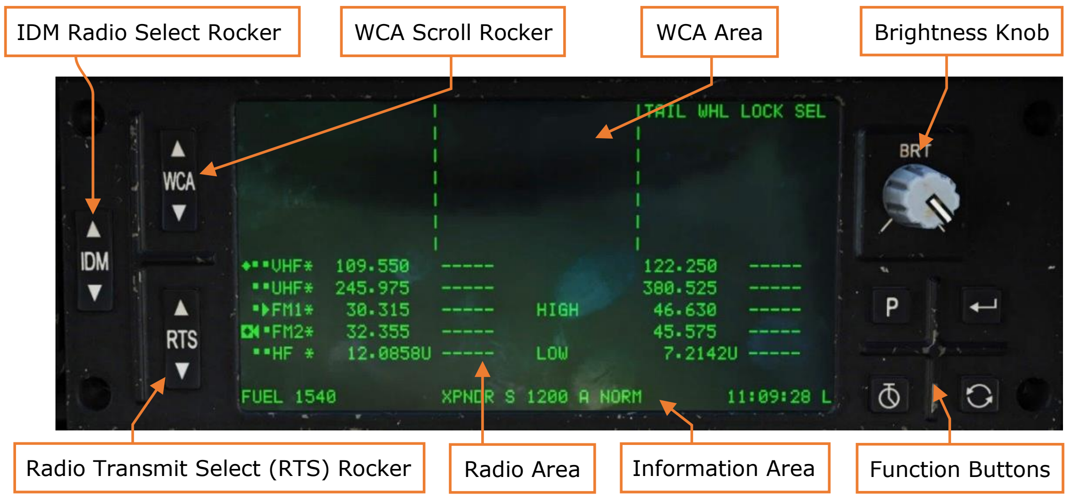


Figure 142. EUFD, Main Format

IDM Radio Select Rocker. Selects a radio for IDM transmission and reception. (N/I)

WCA Scroll Rocker. This rocker can be used to scroll through WCA messages if there are more messages than can fit in the WCA area. A double arrowhead ⬍ is displayed if scrolling is necessary to see all the WCA messages.

WCA Area. The top three columns of the EUFD are dedicated to displaying warnings, cautions, and advisories. Warnings are displayed in the left column, cautions in the middle column, and advisories in the right column.

Brightness Knob. Sets the brightness of the EUFD display.

Radio Transmit Select Rocker. Selects a radio for transmission when the push-to-talk button is held. The Radio Transmit Select control on the cyclic can also be used to select a radio.

Radio Area. The middle three columns of the EUFD are dedicated to selecting and tuning radios. Each radio is displayed in a line with the information shown, from left to right:

- Radio select. The icons shown indicates whether the radio has been selected for voice and/or IDM:
    -  You have selected this radio for voice transmission.

  -  The other crewmember has selected this radio for voice transmission.
  -  Both crewmembers have selected this radio for voice transmission.
  -  Neither crewmember has selected this radio for voice transmission.
  -  You have selected this radio for IDM transmission.
  -  The other crewmember has selected this radio for IDM transmission.
  -  Both crewmembers have selected this radio for IDM transmission.

- Radio identifier ("VHF" for ARC-186, "UHF" for ARC-164, "FM1" for first ARC-201D, "FM2" for second ARC-201D, or "HF" for ARC-220).

- An asterisk, when present, indicates squelch is on.

- Currently tuned frequency or frequency hop net. A frequency is displayed as a decimal number (e.g., 123.000) and a frequency hopping net is displayed prefixed with an "F" (e.g., F123) or a "T" for training mode. HF frequencies can be suffixed with a "U" to indicate upper sideband, an "L" to indicate lower sideband, a "C" to indicate continuous wave, or an "A" to indicate amplitude modulation equivalent.

- Callsign of tuned frequency. Manual tunes are given the callsign "MAN", and "GUARD" is shown for guard frequencies (121.5 MHz or 243.0 MHz).

- Cipher status. When encrypted radio transmission is on, a "C" followed by the crypto variable number is shown (e.g., "C4" when cipher is on using crypto variable #4). Encryption is not supported for the VHF radio.

- For the UHF radio, displays "G" if the dedicated guard receiver is on. Only the UHF radio has a dedicated guard receiver. For FM1 radio, displays LOW, NORM, or HIGH indicating amplifier power mode. For the HF radio, displays LOW, MEDIUM, or HIGH power indicating amplifier power mode.

- The IDM net status. Either an "L" for AFAPD, "T" for Tacfire, or "F" for Fire Support; followed by the net number. (N/I)

- Standby frequency. This frequency will be tuned if the Swap button is pressed while this radio is selected as RTS.

- Standby frequency callsign.

- Standby IDM net status. (N/I)

Information Area. Displays the following information in a single line:

- Total fuel quantity, in pounds.
- Transponder Mode S (TODO).
- Transponder Mode 3/A code (squawk code).

- Transponder Mode 4 code (A or B). Blanked if Mode 4 is disabled.
- Transponder state (**STBY**, **NORM**, or **EMER**).
- Current time. If the stopwatch is active, elapsed time is displayed above current time.

Function Buttons. A set of four buttons that perform different functions:

- P **Preset.** Toggles display of the Preset window. (see Figure 143 below)
- **Enter.** Tunes the currently selected radio to the selected preset.
- **Stopwatch.** Starts and stops the stopwatch. Holding this button for >2 seconds resets the stopwatch and removes it from the EUFD.
- **Swap.** Swaps the radio frequency, encryption mode, and IDM net configuration with the standby values of the currently selected radio.

Preset Menu

Pressing the Preset button displays the preset menu for the selected radio:

Figure 143. EUFD, Preset Format

While this menu is displayed, the WCA rocker is used to scroll up and down within the preset list. Once a preset has been selected with the arrow, the Enter button will tune the active radio to the selected frequency.

This can be useful to tune a radio without changing an MPD to the COM page. The Preset function on EUFD is limited to tuning single-channel frequencies only, and cannot be used to tune Have Quick or SINCGARS presets.

KEYBOARD UNIT

The Keyboard Unit (KU) allows crewmembers to enter alphanumeric data into MPD fields and do simple arithmetic calculations. It can also be used as a simple scratchpad for notetaking.

MPD Data Entry

Pressing an MPD pushbutton associated with a data entry symbol > will show a prompt on the KU:

Figure 144. Keyboard Unit with Prompt

Type the data you wish to input. Your input will appear in the scratchpad. If your input is longer than 22 characters, you can use the Scroll Arrows to move left and right across your text. You can use Backspace to remove incorrect input. When you press Enter, your input is transferred to the MPD. If your input is invalid, it will flash, and you will need to edit it before pressing Enter again.

The scroll arrows can also be used to insert or remove text within the scratchpad input. Pressing the left or right scroll arrow moves the insertion point. Characters typed will appear at the location of the insertion point, overwriting further characters to the right. The Backspace button removes the character under the insertion point, shifting characters to the left.

KU Arithmetic and Note-taking

When a prompt is not displayed, you can use the KU to perform simple arithmetic operations or store temporary notes.

To perform basic arithmetic, enter a number, followed by either the * (multiply), ÷ (divide), + (add), or - (subtract) keys. Enter another number and press Enter (equals). The result will display on the scratchpad.

You can also enter freeform data into the scratchpad. It will remain in the scratchpad until cleared (with the CLR button).

AIRCRAFT CONTROL

FLIGHT MANAGEMENT COMPUTER

The AH-64D incorporates a Flight Management Computer (FMC) that can electronically command movement to the flight control servo-actuators for reduced pilot workload and accurate weapons delivery. The FMC also provides stabilator scheduling based on collective position and longitudinal calibrated airspeed; and Back-Up Control System (BUCS) functionality in case of jams or severances within the cockpit flight controls.

The FMC's three primary functions regarding aircraft control are Stability Augmentation, Command Augmentation, and Hold mode functionality. The Stability and Command Augmentation Systems (SCAS) are always active within each individual FMC channel. Each FMC channel can be toggled on or off via the A/C UTIL page; or all FMC channels can be immediately commanded off using the FMC Release "pinkie" button on the cyclic grip in either crewstation.

The cyclic, collective, and pedals in each cockpit utilize a series of sensors called Linear Variable Differential Transducers (LVDT) to sense the position and movement of each flight control and relay these movements to the FMC. These movements are used by the FMC to process SCAS commands to the flight controls during normal operations, or to provide full "fly-by-wire" flight control functions during an emergency when in BUCS mode.

Each FMC channel corresponds to an individual hydromechanical servo-actuator that manipulates the main or tail rotor swashplate assemblies; and each of these servo-actuators includes an electronically commanded hydraulic valve. This valve can be commanded by the FMC to initiate movement of the servo-actuator control linkage to the swashplate independently of, or in conjunction with, direct mechanical inputs from the flight controls in each cockpit. The component within each servo-actuator that initiates these control movements is called the "SAS sleeve", and each possesses a limited range of motion to provide SCAS and hold mode functionality (±10% authority in all axes except the pitch axis, which is +20% and -10% authority).

The FMC commands the flight control servo-actuators based on the following:

- Flight control inputs as reported through the Linear Variable Differential Transducers (LVDT).
- Aircraft rate information from the EGI's

- Helicopter Air Data System (HADS)
- Radar altimeter
- Pitot and Static Port pressure sensors

The FMC can only command movement to the servo-actuators using the Primary hydraulic system; therefore, if the Primary hydraulic system fails or loses pressure, the aircraft can still be flown using the Utility hydraulic system, but without the stability and augmentation the FMC provides, nor will hold modes or BUCS be available.

Force Trim & "Breakout" Values

Mounted to the cyclic grip in each crewstation is a "Force Trim/Hold Mode" 4-way switch. When this 4-way switch is pressed to the forward "Release" position, the force trim magnetic brakes on the cyclic and pedals are released. Pressing this 4-way switch to this position is analogous to pressing the "force trim interrupt" button in other helicopters.

The force trim release switch in the AH-64D serves three purposes in flight:

- Provides a method to disengage the magnetic brakes of the force trim system on the cyclic and pedals.
- Used to temporarily disengage any active hold modes that are currently engaged and, if necessary, allows the SAS sleeves to re-center in all axes.
- Used to set new reference values of pitch, roll, heading, sideslip, velocity, or position to the FMC, depending on what Attitude hold modes/sub-modes are activated at any given time.

When the Force Trim/Hold Mode switch is pressed to the left "AT" position, Attitude Hold is toggled on/off, and will enter one of three sub-modes based on current ground speed (see Attitude Hold for more information).

When the Force Trim/Hold Mode switch is pressed to the right "AL" position, Altitude Hold is toggled on/off, and will enter one of two sub-modes based on current ground speed and altitude above ground level (see Altitude Hold for more information).

When the Force Trim/Hold Mode switch is pressed to the aft "Disengage" position, Attitude Hold and Altitude Hold modes will be toggled off.

Any time the force trim release switch is pressed, Attitude Hold (if activated) and Heading Hold (always active) will be temporarily disengaged. When the force trim release switch is no longer pressed, these hold modes will attempt to re-engage and "capture" new reference values to hold, based on the sub-mode within which they are operating. Even if the force trim release switch is not pressed, a “breakout” value within each flight control axis of the cyclic and pedals allows the pilot to “fly through” certain hold modes/sub-modes. These breakout values do not deactivate the hold modes altogether but will temporarily disengage their function and no longer hold the commanded reference value(s) until the conditions for re-engagement are met.

STABILITY AUGMENTATION SYSTEM

The Stability Augmentation System (SAS) function of the FMC provides a stable aircraft for reduced pilot workload and increased weapons delivery accuracy. SAS is active in each FMC control axis that is enabled via the A/C UTIL page. SAS inputs are limited by the authority of the SAS sleeves within each flight control servo-actuator (±10% authority in all axes except the pitch axis, which is +20% and -10% authority).

When necessary, the FMC commands movement of the SAS sleeves within the applicable flight control servo-actuator(s) to provide the following:

- Yaw rate damping. When accelerating, yaw rate damping will be present until ground speed is ≥ 40 knots. When decelerating from ground speeds ≥ 40 knots, yaw rate damping won’t return until ground speed is ≤ 30 knots.
- Lateral (roll) and Longitudinal (pitch) rate damping at all airspeeds.
- Atmospheric upset damping.

Rate damping minimizes attitude oscillations within the respective pitch, roll and yaw axes, but will not prevent attitude drift from the force trimmed positions of the flight controls. Atmospheric upset damping reduces the effect of atmospheric disturbances (such as turbulence) from affecting the aircraft's flight path.

The EGI inertial measurements provide airframe movements/rates to the FMC, which compares the EGI data to the flight control LVDTs. If there are no changes in the flight control positions, the FMC commands the respective servo-actuator(s) SAS sleeves to counter the un-commanded movements.

COMMAND AUGMENTATION SYSTEM

The Command Augmentation System (CAS) function of the FMC provides an immediate and uniform aircraft response at all longitudinal airspeeds. CAS is active in each FMC control axis that is enabled via the A/C UTIL page. CAS input limitations are the same as SAS (±10% authority in all axes except the pitch axis, which is +20% and -10% authority).

When a control input is made, the FMC detects the flight control movement in the respective LVDT axis (or axes) and will command movement of the SAS sleeve within the applicable flight control servo-actuator(s). This provides a "power steering" response to remove the lag effect of mechanical inputs into the flight control servo-actuators. At lower longitudinal airspeeds, the amount of CAS input is proportionally increased to ensure the aircraft handling remains consistent with flight at higher airspeeds.

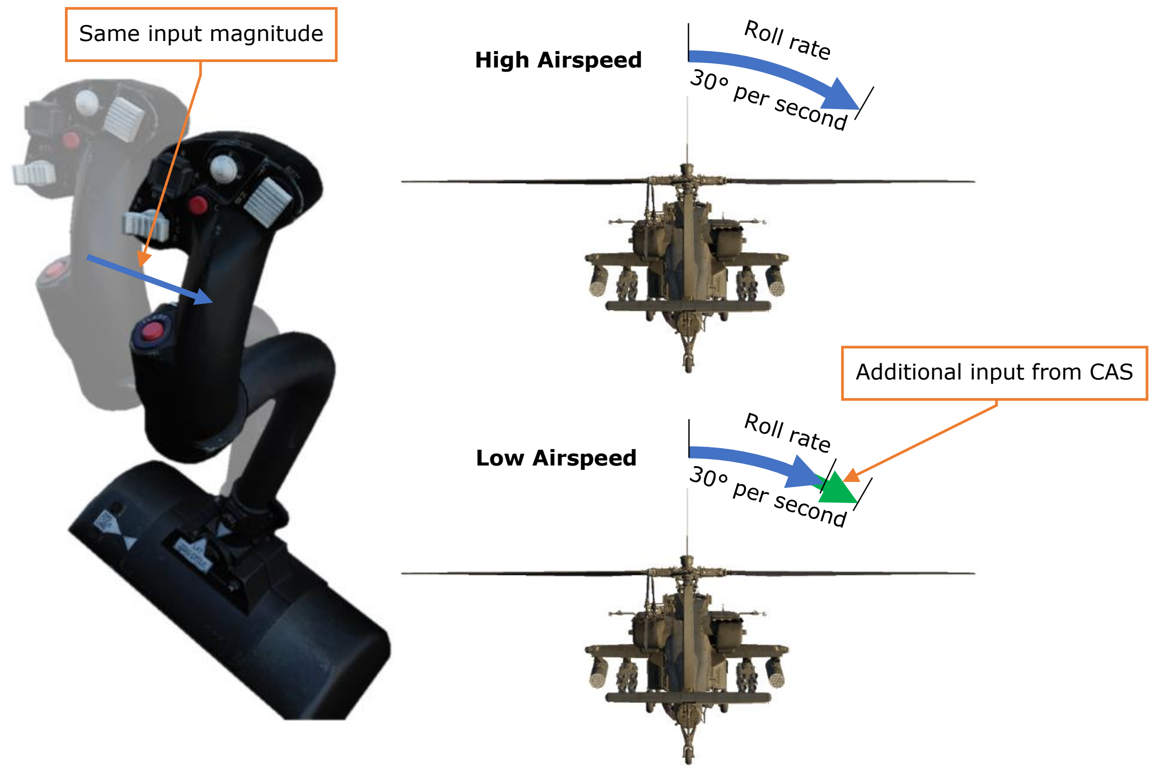


Figure 145. Command Augmentation at different airspeeds

CAS is disabled in the FMC Yaw channel when the aircraft is on the ground (determined by the weight-on-wheels or "squat" switch). This prevents over-steering during ground taxi.

HOLD MODES

The hold modes are designed to provide limited hands-off flight and decrease pilot workload. Like the SAS and CAS functions of the FMC, the hold modes utilize the same SAS sleeves within the servo-actuators to affect the aircraft flight controls. As such, they are subject to the same limited control authorities (±10% in roll, yaw and collective; +20% and -10% in pitch) and are not autopilot functions.

To best utilize the FMC hold mode functionality, the pilot should first fly the aircraft to a stable, force trimmed state. Once the aircraft is set at the desired flight condition, engage the desired hold mode(s).

When Attitude Hold is activated, a box will be placed around the airspeed indicator in the HDU Flight symbology and on the FLT page; and the "ATTITUDE HOLD" advisory will be displayed on the EUFD. When Altitude Hold is activated, a "home plate" box will be placed around the VSI indicator in the HDU Flight symbology and on the FLT page; and either the "RAD ALT HOLD" or the "BAR ALT HOLD" advisory will be displayed on the EUFD, depending on what Altitude Hold sub-mode is entered.

Figure 146. Hold mode indications in symbology

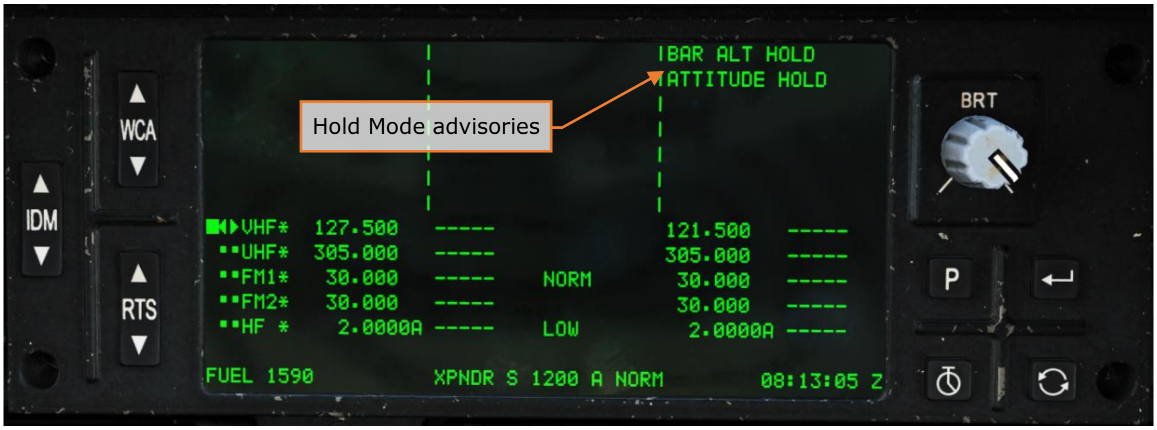


Figure 147. Hold mode indications on EUFD

Any time the Attitude Hold or Altitude Hold are deactivated using their individual toggle positions or the "Disengage" position, the hold mode indicators within the HMD symbology will flash and an audio tone will alert the crew that a hold mode has been deactivated.

Heading Hold & Turn Coordination Sub-modes

The FMC Yaw channel operates within two hold sub-modes: Heading Hold and Turn Coordination. One of these two sub-modes are always activated when the FMC Yaw channel is turned on. However, condition-based logic will determine which sub-mode the Yaw channel is using, and whether that sub-mode is engaged or disengaged from affecting the flight control servo-actuators at any given time.

The primary condition that determines which hold sub-mode the Yaw channel operates within is the helicopter's ground speed. If the ground speed is <40 knots, Heading Hold sub-mode is activated. If ground speed is ≥40 knots, Turn Coordination sub-mode will be activated. Additional switching logic is determined based on whether Attitude Hold is activated and if the force trim release switch is being depressed, as described below.

Yaw breakout values become incrementally larger with forward speed. The purpose behind this is to desensitize the pedals to prevent disengaging the Heading Hold during cruise flight.

Heading Hold sub-mode

Heading Hold assists the pilot in maintaining the magnetic heading reference. If the force trim release switch is pressed, Heading Hold is disengaged, and the FMC Yaw channel will only provide command augmentation and rate damping. When the pilot stops pressing the force trim release switch, the FMC will update the Heading Hold reference to the current magnetic heading.

If Attitude Hold (any sub-mode) is **off**, Heading Hold is engaged when **all** of the following conditions are true:

- One second has elapsed since Heading Hold was disengaged
- The helicopter is off the weight-on-wheels ("squat") switch
- Ground speed <40 knots
- Pedal displacement <3% in yaw axis from the force trim reference position
- Force trim release switch is not pressed
- Yaw rate <3° per second

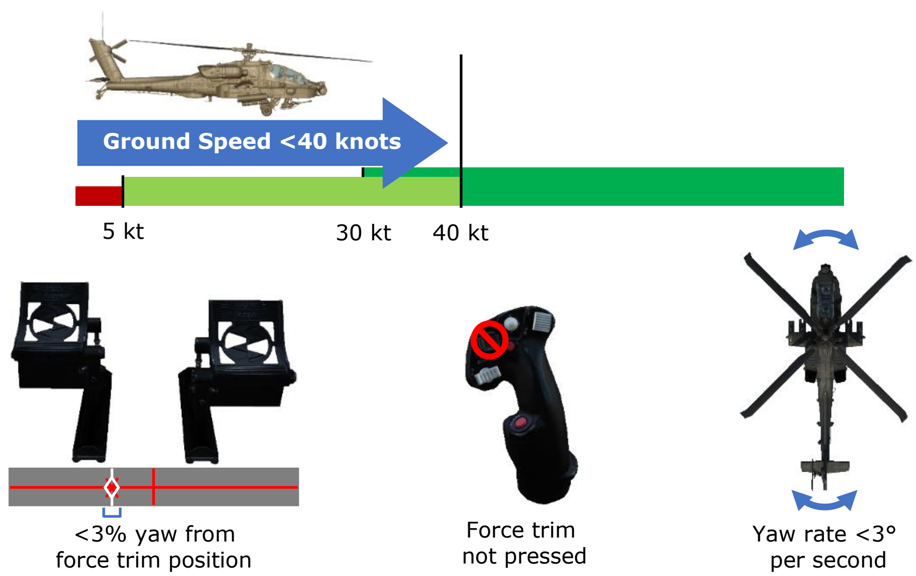


Figure 148. Heading Hold Engagement (Attitude Hold OFF)

If Attitude Hold (in Position or Velocity sub-mode) is **on**, Heading Hold is engaged when **all** of the following conditions are true:

- Pedal displacement <3% in yaw axis from the force trim reference position in Position Hold sub-mode or <6% in yaw axis from the force trim reference position in Velocity Hold sub-mode
- Cyclic displacement ≤2.25% in roll axis from the force trim position
- Yaw rate <3° per second
- Roll (bank) angle is <3° from level attitude
- Force trim is not pressed

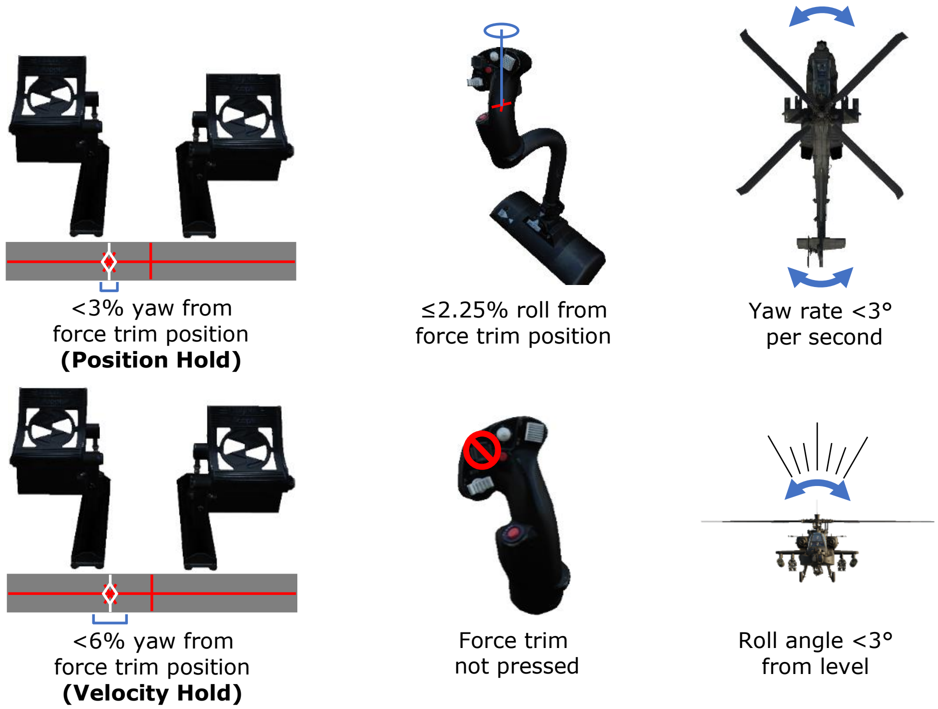


Figure 149. Heading Hold Engagement (Attitude Hold ON)

Heading Hold will engage under certain conditions if Attitude Hold is on and in Attitude Hold sub-mode, but this logic is inter-woven along with Turn Coordination and is described below.

Turn Coordination sub-mode

Turn Coordination sub-mode assists the pilot in maintaining the sideslip angle, and is a function of roll attitude, airspeed, and sideslip. Sideslip angle is a derived quantity based on inertial velocity as opposed to air data. This method of determining sideslip angle provides more stable and reliable sideslip information than can be obtained from an air data sensor. If the force trim release switch is pressed, Turn Coordination is disengaged, and the FMC Yaw channel will only provide command augmentation and rate damping. When the pilot stops pressing the force trim release switch, the FMC will update the Turn Coordination sideslip angle reference to the current trim ball position.

If Attitude Hold is **off**, Turn Coordination is engaged when **all** of the following conditions are true:

- Ground speed ≥40 knots
- Pedal displacement ≤9% in yaw axis from the force trim reference position
- Force trim is not pressed

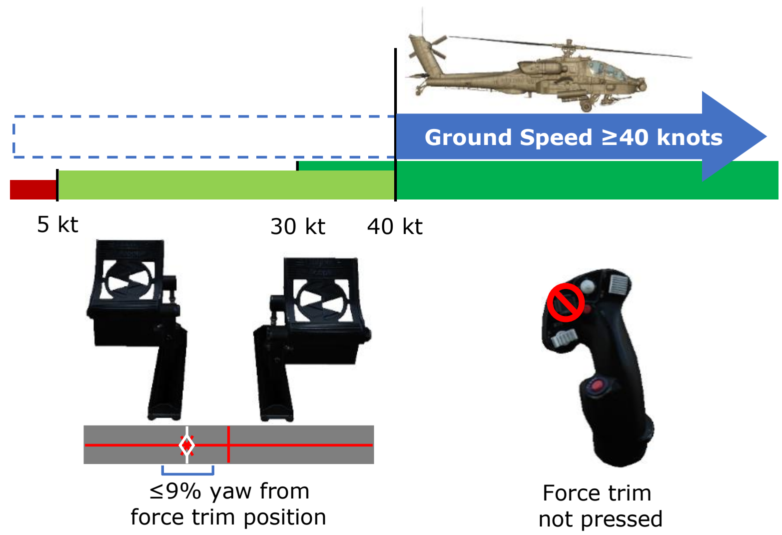


Figure 150. Turn Coordination Engagement (Attitude Hold OFF)

If Attitude Hold is **on** with ground speed ≥40 knots, Turn Coordination will switch to Heading Hold when **all** of the following conditions are true:

- Pedal displacement ≤9% in yaw axis from the force trim reference position
- Cyclic displacement ≤2.25% in roll axis from the force trim position
- Roll (bank) angle is ≤7° from level attitude
- Force trim is not pressed

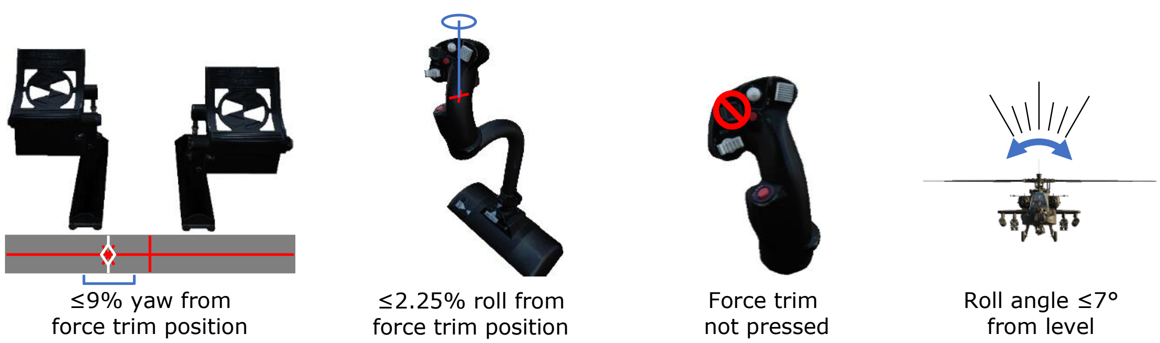


Figure 151. Turn Coordination changes to Heading Hold (Attitude Hold ON)

If Attitude Hold is **on** with ground speed ≥40 knots, Heading Hold will revert to Turn Coordination if **any** of the following conditions are true:

- Pedal displacement >9% in yaw axis from the force trim reference position
- Cyclic displacement >2.25% in roll axis from the force trim position
- Roll (bank) angle is >7° from level attitude

- Force Trim is pressed

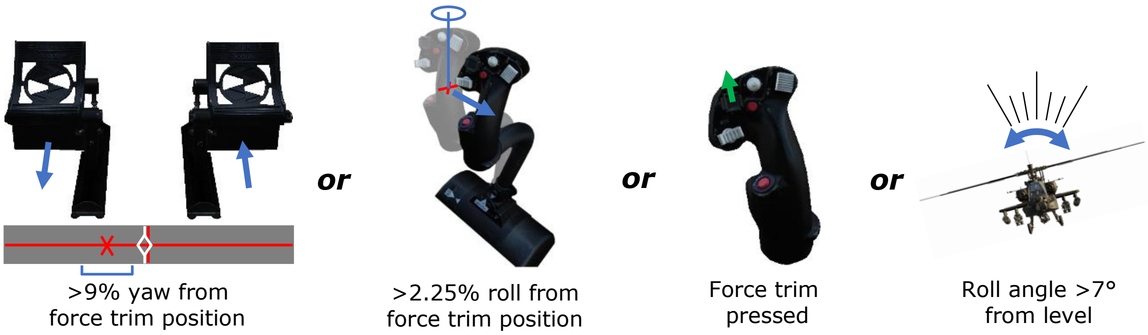


Figure 152. Heading Hold reverts to Turn Coordination (Attitude Hold ON)

Attitude Hold & Position/Velocity Sub-modes

The FMC Pitch and Roll channels operate with Attitude Hold and two additional sub-modes: Position Hold and Velocity Hold. Only one of these three sub-modes can be activated at any given time, only when the Attitude Hold is activated using the Force Trim/Hold Mode switch when pressed to the Left/AT position, and only when the FMC Pitch and Roll channels are turned on. Condition-based logic will determine which sub-mode the Pitch/Roll channels are using, and whether that sub-mode is engaged or disengaged from affecting the flight control servo-actuators at any given time.

The condition that determines which Attitude Hold sub-mode the Pitch/Roll channels operate within is the helicopter's ground speed. If the ground speed is ≤5 knots, Position Hold sub-mode is activated. If the ground speed is >5 knots but <40 knots, Velocity Hold sub-mode is activated. If ground speed is ≥40 knots, Attitude Hold sub-mode will be activated.

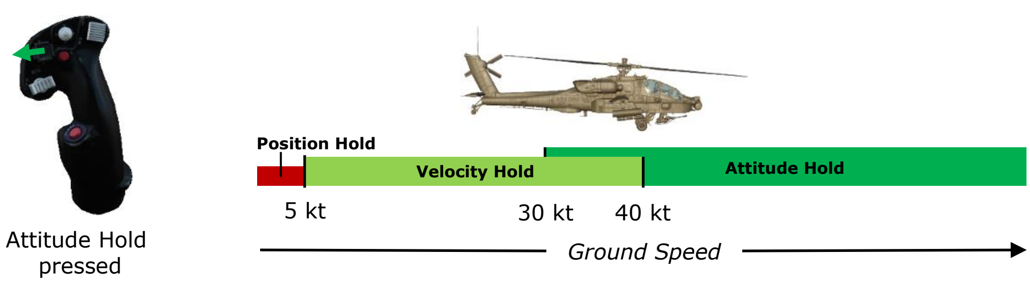


Figure 153. Attitude Hold Sub-modes

Attitude Hold may be activated while still on the ground, however it will not engage in any sub-mode until the helicopter is off the weight-on-wheels ("squat") switch.

Position Hold Sub-mode

When Position Hold sub-mode is engaged, the FMC will use velocities provided by the EGI to approximate and maintain its position. If the pilot displaces the cyclic without pressing the force trim release switch, the FMC will command SAS sleeve inputs into the Pitch and Roll servo-actuators to counter the cyclic inputs to maintain the aircraft's position over the reference location. The SAS sleeves within the respective servo-actuators will continue to counter the pilot inputs until the SAS sleeve becomes "saturated" at their maximum authority. (see Flight Control Audio Tone and EUFD Advisories)

To re-position the helicopter and set a new position reference, the pilot should press and hold the force trim release switch, translate the helicopter to the desired location, and then stop pressing the force trim release switch. Pressing the force trim release switch will not deactivate the Position Hold but it will disengage any FMC inputs from attempting to maintain the helicopter hover over the referenced position until the force trim release switch is no longer pressed, and the new reference position is "captured" by the FMC. If the pilot accelerates the aircraft above 5 knots ground speed, Velocity Hold sub-mode will be entered.

Since Position Hold is only engaged when ground speed is ≤5 knots while the force trim release switch is not pressed, Heading Hold will also be active in the FMC Yaw axis while operating in this sub-mode. However, if the pedals are displaced ≥3% from the force trim reference position, Heading Hold will disengage and will only re-engage given the conditions listed above in the Heading Hold section.

Velocity Hold Sub-mode

When Velocity Hold sub-mode is engaged, the FMC will use inertial velocities provided by the EGI to maintain a 2-dimensional velocity and in the horizontal plane. If the pilot displaces the cyclic without pressing the force trim release switch while Velocity Hold is engaged, the FMC will command SAS sleeve inputs into the Pitch and Roll servo-actuators to counter the cyclic inputs to maintain the aircraft's velocity and vector. The SAS sleeves within the respective servo-actuators will continue to counter the pilot inputs until the SAS sleeve becomes "saturated" at their maximum authority. (see Flight Control Audio Tone and EUFD Advisories)

To establish a new velocity and/or vector reference, the pilot needs to press and hold the force trim release switch, adjust the flight controls to attain the desired velocity and vector, and then stop pressing the force trim release switch. Pressing the force trim release switch will not deactivate the Velocity Hold but it will disengage any FMC inputs from attempting to maintain the helicopter velocities until the force trim release switch is no longer pressed and the new reference velocities are "captured" by the FMC. If the pilot accelerates the aircraft to 40 knots ground speed or greater, Attitude Hold sub-mode will be entered. If the pilot decelerates the aircraft to 5 knots ground speed or slower, Position Hold sub-mode will be entered.

Since Velocity Hold is only engaged when ground speed is >5 knots and <40 knots while the force trim release switch is not pressed, Heading Hold will also be active in the FMC Yaw axis while operating in this sub-mode. However, if pedals are displaced ≥6% from the force trim reference position, Heading Hold will disengage and will only re-engage given the conditions listed above in the Heading Hold section.

Attitude Hold Sub-mode

When Attitude Hold sub-mode is engaged, the FMC will use rates and attitudes provided by the EGI to maintain a pitch and roll attitude. Unlike Position Hold and Velocity Hold sub-modes, Attitude Hold will not counter cyclic inputs by the pilot if the cyclic is displaced beyond it's "breakout" threshold. If the pilot displaces the cyclic >2.5% in pitch or >2.25% in roll from the force trim reference position without pressing the force trim release switch, the Attitude Hold mode will disengage in one or both of the Pitch and Roll axes and will not attempt to counter the pilot inputs into the flight control servo-actuators but will continue to provide CAS and SAS functionality. Once the cyclic has been returned to within 2.5% in pitch and 2.25% in roll from the force trim reference position, Attitude Hold sub-mode will re-engage.

If the pilot displaces the cyclic >2.25% in the Roll axis only, the FMC will disengage Attitude Hold in the Roll servo-actuator only, but still provide CAS and SAS functions for that actuator. The FMC will continue to maintain the referenced pitch attitude by commanding movement to the SAS sleeve within the Pitch servo-actuator.

Likewise, if the pilot displaces the cyclic >2.5% in the Pitch axis only, the FMC will disengage Attitude Hold in the Pitch servo-actuator only, but still provide CAS and SAS functions for that actuator. The FMC will continue to maintain the referenced roll attitude by commanding movement to the SAS sleeve within the Roll servo-actuator.

This axis-specific breakout logic allows a pilot to adjust the airspeed or bank angle without dis-engaging the other axis being commanded by the FMC in Attitude Hold sub-mode. This can be convenient for flying an orbit. However, if the roll reference is <3° from a level roll attitude, the bank angle will be commanded to 0° and the aircraft will auto-level.

To establish new pitch and/or roll reference values, the pilot can also simply press and hold the force trim release switch, fly the helicopter to the desired attitude, and then stop pressing the force trim release switch. Pressing the force trim release switch will not deactivate the Attitude Hold but it will disengage any FMC inputs from attempting to maintain the helicopter attitude in both Pitch and Roll axes until the force trim release switch is no longer pressed and the new reference attitude values are "captured" by the FMC.

If the pilot decelerates the aircraft to below 40 knots ground speed but remains above 30 knots without pressing the force trim release switch, Attitude Hold will be maintained and will not enter Velocity Hold sub-mode.

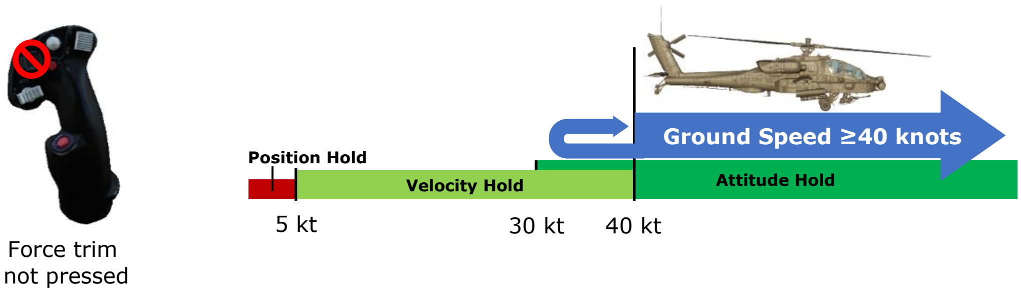


Figure 154. Attitude Hold Sub-mode maintained if force trim is not pressed

If the pilot presses and holds the force trim release switch, decelerates the aircraft below 40 knots ground speed, and then stops pressing the force trim release switch, Velocity Hold sub-mode will be entered. Likewise, if the pilot decelerates the aircraft to below 40 knots ground speed but above 30 knots without pressing the force trim release switch, but then interrupts the force trim prior to accelerating back to 40 knots ground speed or greater, Velocity Hold will be entered.

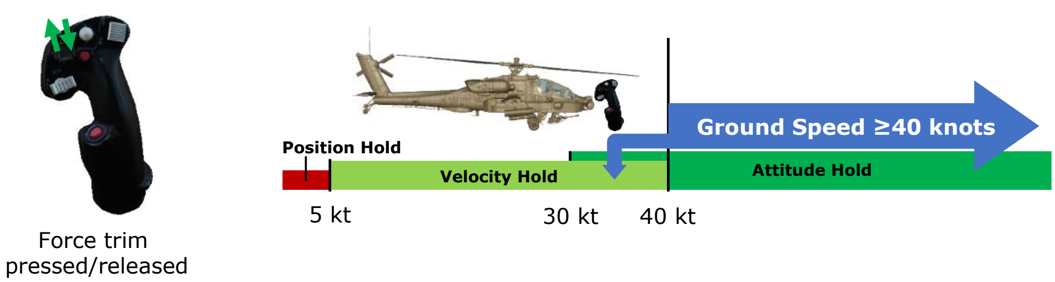


Figure 155. Velocity Hold Sub-mode entered if force trim is pressed <40 knots

If the pilot decelerates the aircraft below 30 knots ground speed, Velocity Hold will be entered regardless of whether the pilot pressed the force trim release switch.

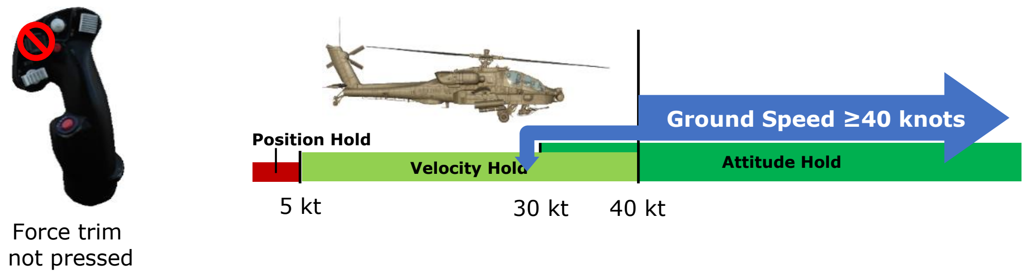


Figure 156. Velocity Hold Sub-mode entered <30 knots

Heading Hold or Turn Coordination will also be active in the FMC Yaw axis while operating in the Attitude Hold sub-mode, subject to the logic described above in the Heading Hold section.

Attitude Hold will only be engaged when all the following conditions are true:

- Ground speed ≥40 knots
- Cyclic displacement ≤2.25% in roll and ≤2.5% in pitch from the force trim reference position
- Roll attitude <±60° and Pitch attitude <±30°
- Pitch and Roll rates <5° per second
- Force trim is not pressed

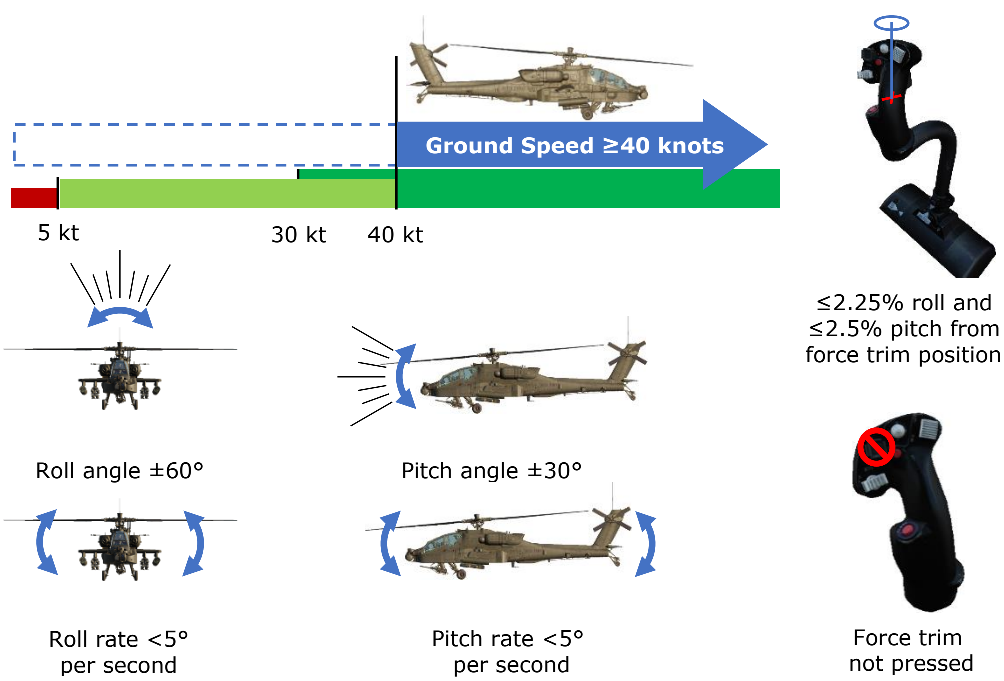


Figure 157. Attitude Hold Sub-mode Engagement

Altitude Hold Modes

The FMC Collective channel operates within two hold sub-modes: Radar Altitude Hold and Barometric Altitude Hold. Only one of these sub-modes can be engaged at any given time, and only when the Altitude Hold is activated using the Force Trim/Hold Mode switch when pressed to the Right/AL position, and only when the FMC Collective channel is turned on. Condition-based logic will determine which sub-mode the Collective channel is using, and whether that sub-mode is engaged or disengaged from affecting the flight control servo-actuators at any given time.


Altitude Hold pressed

The conditions that primarily determine which Altitude Hold sub-mode the Collective channel operates within is the helicopter's ground speed and the radar altimeter. If the ground speed is <40 knots and the radar altitude is ≤1,428 feet AGL, Radar Altitude Hold sub-mode will be activated. If the ground speed is ≥ 40 knots or the radar altitude is >1,428 feet AGL, Barometric Altitude Hold sub-mode is activated. Additional logic governing the activation or de-activation of these sub-modes are listed below.

Radar Altitude Hold Sub-mode

Radar Altitude Hold is not a terrain following mode. It provides distance from the ground directly below the aircraft and does not provide any approaching terrain variation information.

Radar Altitude Hold can only be activated when **all** of the following conditions are true:

- Ground speed <40 knots
- Altitude is ≤1,428 feet above ground level (AGL)
- Vertical velocity is ≤100 feet per minute
- The radar altimeter is powered on and operational

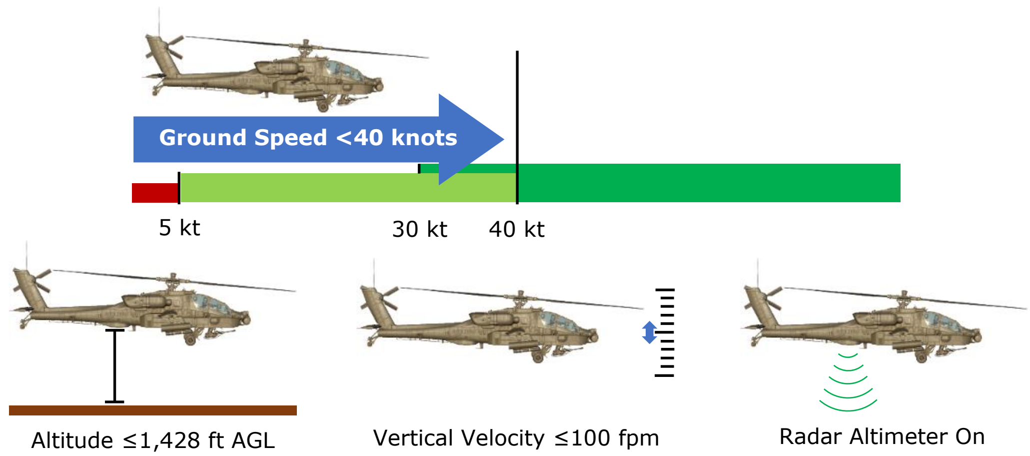


Figure 158. Radar Altitude Hold Activation

Radar Altitude Hold is automatically deactivated when **any** of the following conditions are true:

- Pilot displaces the collective TODO from the reference position (collective position at the time Radar Altitude Hold mode is activated)
- Either engine torque (TQ) >100%
- Either engine Turbine Gas Temperature (TGT) >867° C
- Rotor speed (N_R) is <97% or >104%
- The radar altimeter is turned off or has failed

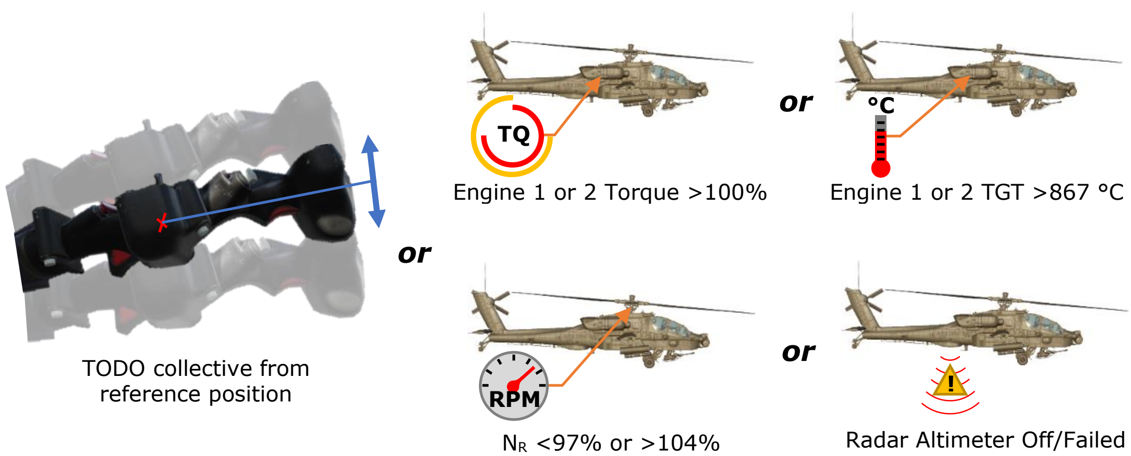


Figure 159. Radar Altitude Hold Deactivation

Barometric Altitude Hold Sub-mode

Barometric Altitude Hold can only be activated when **both** of the following conditions are true:

- If conditions for Radar Altitude Hold sub-mode activation cannot be met
- Vertical velocity is within the limits below as determined by aircraft ground speed:
  - If ground speed ≤5 knots, vertical velocity is ≤100 feet per minute
  - If ground speed is >5 knots but <40 knots, vertical velocity is ≤200 feet per minute
  - From 40 to 160 knots ground speed, the vertical velocity rate limit increases linearly from ±200 feet per minute at 40 knots to ±400 feet per minute at 160 knots. (Example: at 100 knots ground speed, the vertical velocity rate limit must be ≤300 feet per minute)

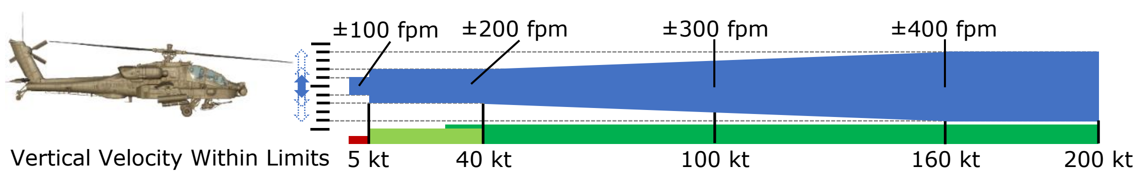


Figure 160. Barometric Altitude Hold Activation

Barometric Altitude Hold is automatically deactivated when **any** of the following conditions are true:

- Pilot displaces the collective TODO from the reference position (collective position at the time Radar Altitude Hold mode is activated)
- Either engine torque (TQ) >100%
- Either engine Turbine Gas Temperature (TGT) >867° C
- Rotor speed (N_R) is <97% or >104%

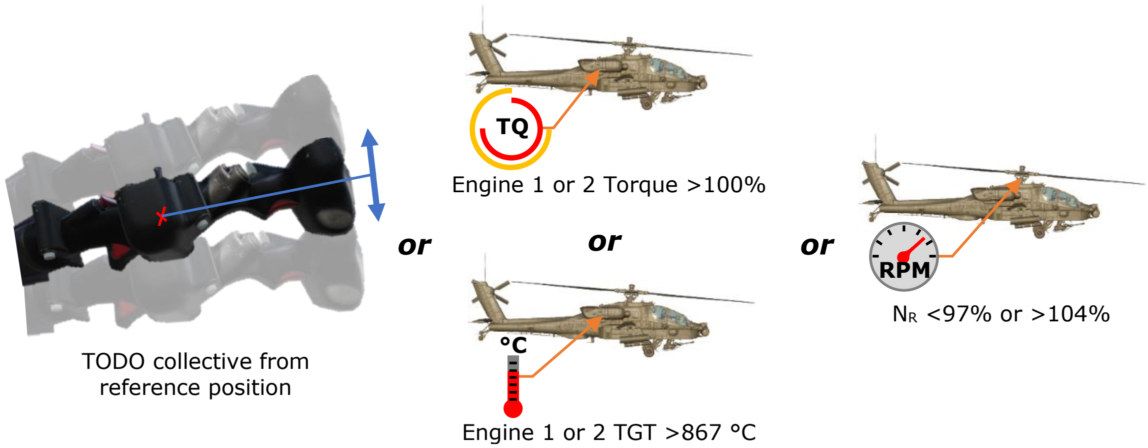


Figure 161. Barometric Altitude Hold Deactivation

Flight Control Audio Tone and EUFD Advisories

As the SAS sleeve within each servo-actuator possess limited authority to affect the flight controls (±10% authority in all axes except the pitch axis, which is +20% and -10% authority), when a hold mode is engaged and the FMC has commanded the SAS sleeve to the limit of its allowable movement, the SAS sleeve is "saturated". If the saturation condition persists, the FMC will begin to lose its ability to maintain the reference values of pitch, roll, heading, sideslip, velocity, or position. Depending on which hold sub-mode is engaged, the flight control audio tone will sound over each crewmember's ICS and the "SAS SATURATED" advisory will be displayed on the EUFD.

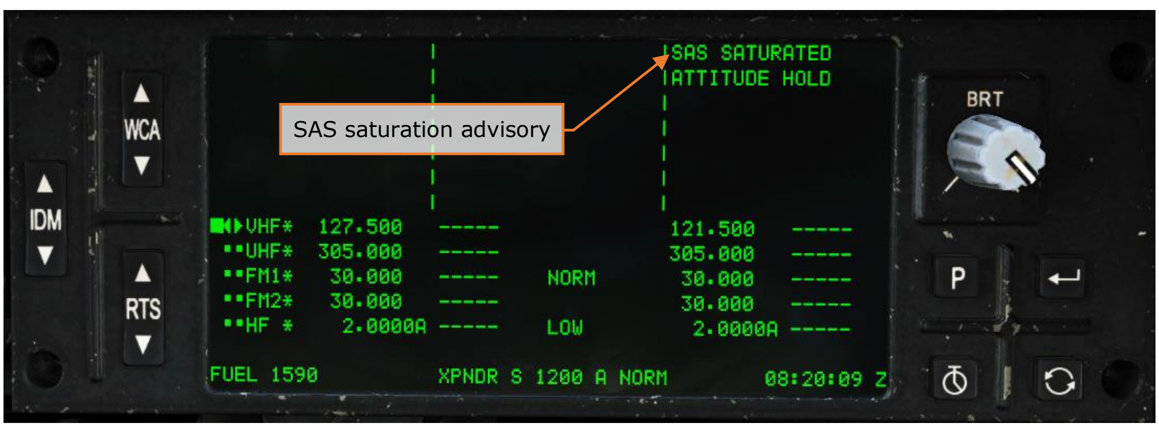


Figure 162. "SAS SATURATED" EUFD advisory

The flight control audio tone will sound with an associated EUFD advisory when the criteria listed below is met for each respective sub-mode:

- If in Attitude Hold sub-mode, the "SAS SATURATED" advisory and flight control audio tone will be presented to the crew after 90 seconds of continuous saturation within the Pitch, Roll or Collective axes and 10 seconds of continuous saturation within the Yaw axis.
- If in Velocity Hold sub-mode, the "SAS SATURATED" advisory and flight control audio tone will be presented to the crew after 2 seconds of continuous saturation within the Pitch, Roll or Collective axes and 7 seconds of continuous saturation within the Yaw axis.
- If in Position Hold sub-mode, the "SAS SATURATED" advisory and flight control audio tone will be presented to the crew after 1 second of continuous saturation within the Pitch, Roll or Collective axes and 5 seconds of continuous saturation within the Yaw axis.
- If in Position Hold sub-mode, the "HOVER DRIFT" advisory and flight control audio tone will be presented to the crew if the aircraft drifts greater than 48 feet (one rotor diameter) from the reference position.

When the pilot presses the force trim release switch (which interrupts any hold modes that are active in the FMC Pitch, Roll and/or Yaw channels) the SAS sleeves within each servo-actuator (except Collective) will return to center within 3 to 5 seconds. While the SAS sleeve is moving to center, it will continue to provide augmentation and rate damping. Therefore, performing aggressive or rapid control inputs can delay the re-centering of the SAS sleeve to the longer duration of 5 seconds.

During sideward flight or hovering flight with high crosswinds without the force trim being pressed, a "SAS SATURATED" advisory and flight control audio tone may be presented to the crew. Under these conditions, the relative wind from sideward flight or high crosswinds will apply force to the vertical tail, creating a weathervane effect in which the nose will turn into the wind. The FMC will attempt to compensate for this weathervane effect while in Heading Hold sub-mode, which may result in saturation of the SAS sleeve within the Yaw axis.

AIRCRAFT PROCEDURES

COLD START

The following procedures are to be completed after pre-flight. Since there is a large amount of commonality between crewstations, checks are combined to save space. Checks specific to the Pilot crewstation will be denoted by **(PLT)** and checks specific to the CPG crewstation will be denoted by **(CPG)**. Where checks are common, they will be denoted by **(PLT/CPG)**.

Interior Checks

Upon entering the crewstation, check the following:

- **(PLT/CPG)** Canopy door, check then as desired (open or intermediate position).

Check the following along the left side of the crewstation, beginning in the back left corner:

- **(PLT)** EXT LT/INTR LT panel – Set NAV lights to BRT, ANTI-COL OFF and PRIMARY to BRT.
- **(CPG)** INTR LT panel – Set PRIMARY to BRT.
- **(PLT/CPG)** Power levers – OFF.
- **(PLT)** ENG START switches – OFF.
- **(PLT)** RTR BRK switch – OFF.
- **(PLT/CPG)** NVS MODE switch – OFF.

On the front panel, beginning on the left side check:

- **(PLT/CPG)** KU brightness knob – As desired.
- **(PLT)** VIDEO panel – Check and position knobs to 12 o'clock position.
- **(PLT/CPG)** MPD and EUFD brightness knobs – As desired.
- **(PLT)** CMWS Control Indicator PWR switch – OFF.

- **(PLT)** CMWS Control Panel – Set Switches as follows:
  - CMWS/NAV – CMWS.
  - BYPASS/AUTO – AUTO.
  - JETTISON – Off (cover closed).
- **(CPG)** TEDAC Right Handgrip LT switch - OFF
- **(PLT)** PARK BRAKE – Set, handle out.
- **(PLT)** Standby flight instruments – Check:
  - Attitude indicator – Caged.

Check the following along the right side of the crewstation:

- **(PLT/CPG)** COMM panel switches – As desired.
- **(PLT/CPG)** HDU – Check and adjust as required.

Before Starting APU

Once the interior checks are complete:

- **(PLT)** MSTR IGN switch – BATT.
- **(PLT)** Searchlight – As required.
- **(PLT)** TAIL WHEEL button – Verify locked, UNLOCK light is off.
- **(PLT/CPG)** EMERG HYD button – Verify pushbutton ON light is off.
- **(PLT)** EXT LT/INTR LT panel – PRESS-TO-TEST button illuminates all signal lights – Check.
- **(CPG)** INTR LT panel – PRESS-TO-TEST button illuminates all signal lights – Check.
- **(PLT/CPG)** MSTR WARN, MSTR CAUT, and EUFD – Check.
- FIRE DET/EXTG panel TEST switch – Test as follows:
  - **(PLT)** Position 1: - MSTR WARN, ENG 1, APU and ENG 2 FIRE buttons are illuminated, an AFT DECK FIRE warning is displayed on the EUFD and voice warning system is activated.
  - **(CPG)** Position 2: - MSTR WARN, ENG 1, APU and ENG 2 FIRE and DISCH buttons are illuminated, an AFT DECK FIRE warning is displayed on the EUFD and voice warning system is activated.

Starting APU

With the Interior and Before Starting APU checks complete, it is now time to start the APU. During extended APU operations, monitor the XMSN OIL temperature on the ENG SYS page. Do not exceed operations for greater than 5 minutes at a XMSN OIL temperature of 120° to 130° C. If the temperature exceeds 130° C, shut the APU down and allow the XMSN OIL temperature to cool for 30 minutes.

- **(PLT)** APU – Start as follows:
    - APU button – Press and release.
    - EUFD – Observe for "APU START", "APU POWER ON" and "ACCUM OIL PRESS LO" advisories.

After Starting APU

Now that the APU has been started, perform the following:

- **(PLT/CPG)** Canopy door, check then as desired (open or intermediate position).
- **(PLT/CPG)** DTU page – Select MASTER LOAD.
- **(PLT/CPG)** Menu page – Systems configuration – Perform DMS sweep.

Data Management System (DMS) Sweep

The Data Management System (DMS) sweep is meant to pre-configure aircraft pages for use during flight. While conducting the DMS sweep, it is important to be consistent. As an example technique, the sweep of any specific page begins at the top of the MPD and moves clockwise to the right, along the bottom and finishing on the left of the MPD. Other techniques may be used based on crewmember preferences or specific mission requirements.

Perform the DMS sweep as follows:

- **(PLT/CPG)** 'M' (B1) button – Press.
    - ASE (L3) – Select.
        - UTIL (T6) – Select.
        - RLWR VOICE (R5) – Set as desired.
        - Chaff settings (L2-L5) – Set as desired.
        - CHAFF mode (L1) – Set as desired.
        - UTIL (T6) – Deselect.

- AUTOPAGE (R1) – Set as desired.

- **(PLT/CPG)** TSD Button – Press.
  - SHOW (T3) – Select and configure NAV SHOW options.
    - PHASE (B2) – Select ATK and configure ATK phase SHOW options.
    - THRT SHOW (T5) – Select and configure THRT SHOW options.
    - COORD SHOW (T6) – Select and configure ATK phase COORD SHOW options.
    - PHASE (B2) – Select NAV and configure NAV phase COORD SHOW options.
    - SHOW (T3) – Deselect.
  - UTIL (T6) – Select.
    - TIME (R2) – Set Zulu/Local as desired.
    - SYSTEM TIME> (R3) – Update Local time if necessary.
    - UTIL (T6) – Deselect.
  - SCALE (R1 & R2) – Set as desired.
  - CTR (R3) – Set as desired.
  - RTE (B5) – Select.
    - DIR (L5) – Set to desired point.
    - RTE (B5) – Deselect.
  - MAP (B4) – Select.
    - GRID (T5) – Set as desired.
    - ORIENT (R5) – Set as desired.
    - COLOR BAND (L4) – Set as desired.
    - SCALE (L3) – Set as desired.
    - TYPE (L2) – Set as desired.
    - MAP (B4) – Deselect.
  - INST (L1) – Select.
    - UTIL (T6) – Select.
    - ADF (B6) – Turn on ADF.

    - Configure ADF as desired.
    - UTIL (T6) – Deselect.
    - INST (L1) – Deselect.
- **(PLT/CPG)** WPN Button – Press.
  - GRAYSCALE (L6) – Select and optimize.
  - BORESIGHT (B5) – Select and perform IHADSS boresight. (see IHADSS Boresight)
  - BORESIGHT (B5) – Deselect.
  - GUN (B2) – Select.
    - Set desired BURST LIMIT L1 thru L5 and MODE on R2.
  - MSL (B3) – Select.
    - CODE (T4) – Select.
    - SET (T2) – Select LRFD and set as desired.
    - SET (T2) – Select LST and set as desired.
    - CODE (T4) – Deselect.
  - Set/Verify PRI (L1) matches the LRFD.
  - Set/Verity ALT (L2) matches the LST.
  - RKT (B5) – Select.
  - INVENTORY (L1 thru L5) – Select as desired.
  - QTY (R1) – Set as desired.
  - RKT (B5) – Deselect.
  - ACQ (R6) – Set as desired, **CPG** select SLAVE for cueing dots.
  - MANRNG> (B6) – Set as desired or enter 'A' for Auto-Range.
- **(PLT/CPG)** A/C Button – Press.
  - FLT (T2) – Select.
    - SET (B6) – Select.
    - HI> (T1) – Set as desired.
    - LO> (T3) – Set as desired.
    - UNIT (T4) – Set as desired.

        - ALT> (T5) – Set airfield elevation if known.

          or

        - PRES> (T6) – Set altimeter if known.
        - UNIT (B2) – Set as desired.
        - SET (B6) – Deselect.
    - FUEL (T3) – Select.
        - CHECK (B6) – Select.
        - Set timer as desired on R2 thru R4.
        - CHECK (B6) – Deselect.
    - PERF (T4) – Select.
        - WT (B6) – Select.
        - AC BASIC WEIGHT> (L1) – Verify/Update.
        - LEFT AFT BAY> (L2) – Verify/Update.
        - SURVIVAL KIT BAY> (L3) – Verify/Update.
        - PILOT> (L4) – Verify/Update.
        - CPG> (L5) – Verify/Update.
        - WT (B6) – Deselect.
    - Verify PERF page with Performance Planning Card (PPC) and ensure aircraft is within CG (Center-of-Gravity) limits.
    - UTIL (T6) – Select.
    - SYSTEM (R1) – Set as desired.
        - Set ANTI-ICE as desired on R3 thru R6.
- **(PLT/CPG)** COM Button – Press.

WILL BE UPDATED LATER IN EA

    - MAN (B2) – Select.
        - VHF FREQ> (L1), UHF FREQ> (L2), FM1 FREQ> (L3), and FM2 FREQ> (L4) – Set as desired.

Once all pages have been configured/updated as desired, set MPD page selections as desired. A common technique is to use the left MPD as the “working” MPD, while the TSD is permanently displayed on the right.

IHADSS Boresight

During start-up, the IHADSS for each crewstation must be boresighted to provide the aircraft systems with accurate azimuth and elevation position data of each crewmember's helmet. This procedure is performed from the Weapon (WPN) page, by accessing the BORESIGHT sub-page.

After entering the BORESIGHT page, the crewmember selects IHADSS (L4) to activate the Boresight Reticle Unit (BRU) on the forward cockpit panel and switch the IHADSS to boresight mode. The BRU bullseye pattern is illuminated by increasing the PRIMARY lighting knob on the INTR LT panel located on the left console.

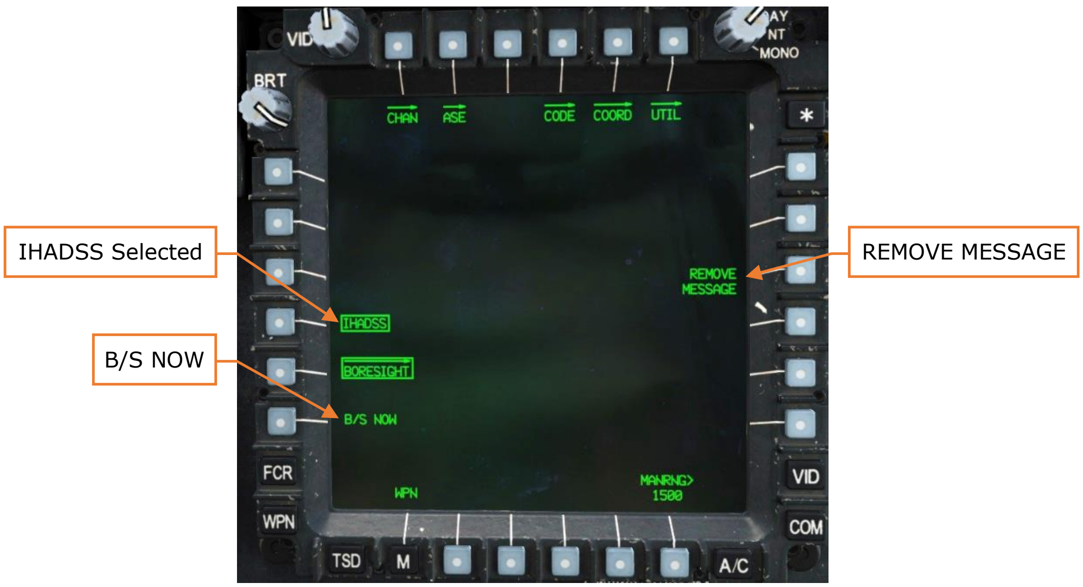


Figure 163. MPD WPN Page, BORESIGHT Sub-Page, IHADSS Selected

Position your head at a natural posture and aim the HDU's LOS reticle at the center of the BRU's illuminated bullseye pattern. When the HDU is aligned within the bullseye, press the B/S NOW (L6) button using the bezel button or MPD Cursor Enter function. If the boresight position is accepted, the BRU bullseye pattern will extinguish, the B/S NOW option will be removed from the MPD page, and the IHADSS (L4) button will become un-boxed.

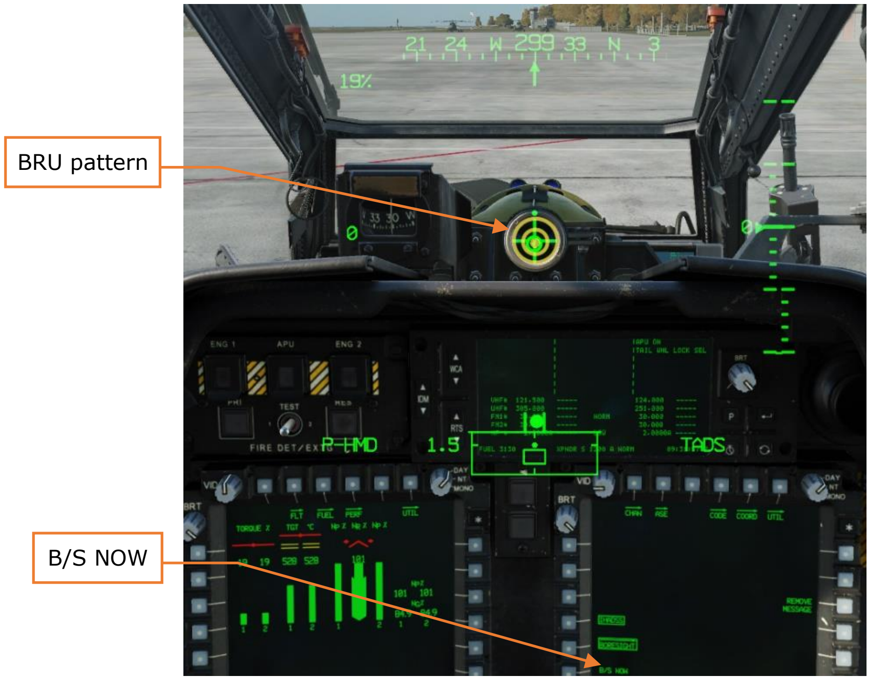


Figure 164. MPD WPN Page, BORESIGHT Sub-Page, IHADSS Selected

To abort the IHADSS boresighting process, simply re-select IHADSS (L4) and the B/S NOW option will be removed and the IHADSS (L4) button will become unboxed. To remove the "IHADSS B/S REQUIRED" message from the Sight Status field of the High Action Display without boresighting the IHADSS, press REMOVE MESSAGE (R3).

Before Starting Engines

Prior to starting the engines, perform the following:

- **(PLT/CPG)** NVS mode switch – As desired.
- **(PLT)** Standby attitude indicator – Uncage.

Starting Engines

- **(PLT)** Area around helicopter – Clear

Rotor locked engine starts shall not be performed with a rotor blade directly over the exhaust for the engine being started.

- **(PLT)** RTR BRK switch – OFF, or LOCK if performing a rotor lock start.
- **(PLT)** EXT LT – ANTI-COL - WHT for day or RED for nights.

During the start if the TGT appears it will exceed 851°C prior to N_G idle speed of 63%; if TGT, N_P and ENG OIL PSI do not increase within 45 seconds after moving power lever to idle; or if the ENG 1 or 2 START advisory is removed prior to attaining 52% N_G, abort the start by taking the power lever to OFF.

While starting the engines, select an ENG and an ENG SYS page to monitor aircraft indications and perform the following:

- **(PLT)** First engine – Start as follows:
    - ENG START switch – START, observe ENG # START advisory on the EUFD and START box displayed on the ENG page.

Prior to advancing the power lever to IDLE, verify TGT is less than 80° C.

- Power lever – IDLE, at first indication of Ng increase.
- ENG OIL PSI – Monitor.
- TGT – Monitor.
- N_G – Monitor.
- MSTR WARN, MSTR CAUT, and EUFD – Monitor.

- **(PLT)** Second Engine – Repeat the steps above.
- **(PLT)** RTR BRK switch – OFF.

Prior to advancing the power levers to FLY, confirm that both ENG 1 and 2 OIL PSI readouts are less than 70 PSI and the NGB TEMP readouts are above 20° C.

- **(PLT)** POWER levers – Advance both POWER levers smoothly to FLY and ensure that both torque indications increase simultaneously.
- **(PLT)** N_P and N_R – Verify 101%.
- **(PLT)** MSTR WARN, MSTR CAUT, and EUFD – Monitor.
- **(PLT)** APU – Off.

Before Taxi

Prior to initiating ground taxi, perform the following:

- **(PLT)** EXT LT panel – Verify NAV lights to BRT, set ANTI-COL - WHT for day or RED for night.
- **(PLT/CPG)** Searchlight – As required.
- **(PLT)** PARKING BRAKE – Released, handle in.
- **(PLT)** TAIL WHEEL button – Unlock as desired, UNLOCK light is on.

TAXI AND TAKEOFF

Ground Taxi

After requesting permission from ATC to taxi, select transition symbology. Press and hold the force trim release interrupted. Increase collective to 27% to 30% TQ or as required depending on aircraft gross weight and surface conditions. Apply forward cyclic until the acceleration cue is at the tip of the LOS reticle, then release the force trim switch. Apply additional collective as required to initiate movement. Interrupt the force trim as necessary and maintain the acceleration cue at the tip of the LOS reticle with fore/aft cyclic. Maintain approximately 5 to 6 knots ground speed, or speed appropriate for the surface conditions. You can also reference the waypoint status window for ground speed.

Prior to initiating a turn, ensure the tail wheel UNLOCK push-button light is illuminated. Apply pedal in the direction of turn and maintain a constant rate of turn with pressure/counter pressure on the pedals. Apply cyclic in the direction of the turn to maintain a level horizon line.

To stop the helicopter, first lock and verify the tail wheel UNLOCK push-button light is not illuminated, then apply aft cyclic to center the acceleration cue in the center of the LOS. Select hover symbology to determine fore/aft drift more accurately. Reference the trim ball and maintain the trim ball centered with left/right cyclic. When the aircraft has stopped, neutralize the flight controls, and reduce the collective.

During ground taxi, perform the following:

- **(PLT/CPG)** Wheel brakes – Check in both crew stations by applying a slight amount of pressure against the toe brakes.
- **(PLT)** ENG page – Check, N_P/N_R 101%, all indications green.
- **(PLT)** FLT page – Check and set/update altimeter.
- **(PLT)** Pilot standby instruments – Check and set/update altimeter.

Before Takeoff

Perform the following prior to picking up to a hover:

- **(PLT/CPG)** Weapons Subsystem – Check the following:
    - A/S button – SAFE.
    - GND ORIDE button – Off.
    - Weapons not actioned – Verify in the High Action Display (HAD).

- **(PLT/CPG)** TAIL WHEEL button – Locked, UNLOCK light is off.
- **(PLT)** PARK BRAKE – Released, handle in or as desired.
- **(PLT/CPG)** Systems – Check as follows:
    - FUEL page options – Verify:
        - XFER – AUTO.
        - XFEED – NORM.
        - BOOST – OFF.
        - CHECK page – select page and start a 15-minute fuel check.
        - CHECK page – Deselect.
    - Fuel quantity – Check and verify enough fuel for the mission to be flown.
    - EUFD – Check clear of Warnings and Cautions.
    - Engine and flight instruments – Check:
        - N_P/N_R 101%, all indications green.
        - Update altimeter as required on FLT page and Pilot's standby altimeter.
    - ASE – As required.
    - Avionics – As desired.
        - Transponder – NORM, or as desired and squawking appropriate codes.
        - COMM – As desired, verify in EUFD.
        - NAV – Update navigation direct or select desired route.

Prior to performing the hover power check, ensure an ENG page and PERF page are displayed.

- Hover Power Check – Perform.

Hovering Flight

With the Before Takeoff Check complete and the flight controls neutral, press and hold the force trim interrupted until the aircraft is light on the wheels (approximately 20% below IGE hover power on the PERF page) then release, allowing heading hold to engage. Maintain the acceleration cue in the center of the line-of-sight reticle with the cyclic, use pressure/counter-pressure on the cyclic to maintain position and pressure/counter-pressure on the pedals to assist the aircraft in maintaining heading. Once the aircraft is established at 5-foot hover, interrupt the force trim as necessary for comfort and engage the hold modes as desired.

If this is the first hover of the day, check that the aircraft control responses and CG feel normal and perform a Hover Power Check.

Hover Power Check

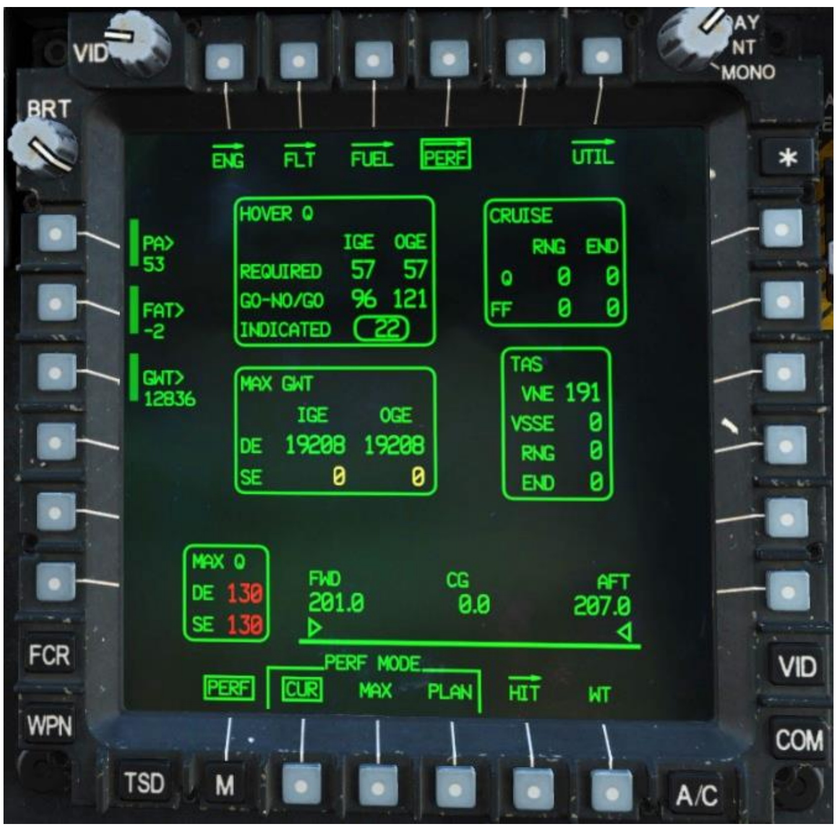


Figure 165. Hover Power Check PERF Page

Referencing the PERF page, verify that the HOVER Q INDICATED value matches the REQUIRED IGE value. Then verify that the INDICATED value is less than the GO-NO/GO OGE value. If the INDICATED value is greater than the GO-NO/GO OGE value, the aircraft does not have enough power to perform the following maneuvers that require OGE power:

- Approach to an OGE hover
- Masking/Unmasking
- NOE flight

For every 200 lbs of Gross Weight (GWT) lost, a 1% TQ reduction can be applied. Use this rule to determine how much fuel or ammo to remove from the aircraft in order to enable out of ground effect flight possible.

Types of Takeoffs

The purpose of the takeoff is to transition from the hover to forward flight, with the implied task being the aircrew remains outside of the heigh-velocity avoid region of the aircraft. Operations within the avoid region guarantee a forced landing due to engine failure with some degree of aircraft damage. Operations outside of the avoid region provide an opportunity to potentially maintain flight under single-engine conditions or permit a force landing with little to no damage to the aircraft.

There are four types of Visual Meteorological Conditions (VMC) takeoffs performed by US Army AH-64D aircrews:

- VMC Takeoff
- VMC Level Acceleration Takeoff is performed when surface conditions and obstacles permit and involves accelerating the aircraft through velocity safe single engine (VSSE) airspeed prior to initiating a climb. This type of takeoff is meant to reduce the risks of operating inside the avoid region should an engine fail.
- VMC Minimum Power Takeoff from the ground/hover is performed when surface conditions are not suitable for a rolling takeoff. During training, the pilot is limited to only IGE hover power when performing this type of takeoff.
- Rolling Takeoff is performed when the aircraft is IGE power limited, and surface conditions are suitable for a rolling takeoff. During training, the pilot is limited to 10% below hover power when performing this type of takeoff.

The preferred takeoff for the AH-64D is the VMC Level Acceleration Takeoff.

VMC Takeoff

From a hover, begin by selecting Transition symbology, then press and hold the force trim release button and apply forward cyclic for a 90-knot climb attitude (wings level) while increasing the collective >10% above hover power or as necessary to establish the desired climb. Release the force trim upon establishing a 90-knot attitude and trim as necessary to maintain a level VSI until through VSSE. Maintain ground track alignment with the pedals and center the trim ball into coordinated flight (termed "in-trim") once clear of all obstacles or 50 feet, whichever occurs first. Maintain the FPV (Flight Path Vector) above any obstacles to assist in ensuring obstacle clearance. When above VSSE adjust the collective to establish >500 fpm (feet-per-minute) rate of climb or as desired.

VMC Level Acceleration Takeoff

From a hover, begin by selecting Transition symbology, then press and hold the force trim release button and apply forward cyclic for a 90-knot attitude (wings level) while increasing the collective approximately 10% above hover power or as necessary to maintain altitude and accelerate the aircraft. Release the force trim upon establishing a 90-knot attitude and trim as necessary to maintain a level VSI until through VSSE. Maintain ground track alignment with the pedals and center the trim ball into coordinated flight once clear of all obstacles or 50 feet, whichever occurs first. Continue adjusting the controls as necessary to achieve 50 knots by the time an altitude of 50 feet AGL is reached or as required to clear obstacles. Maintain the FPV above any obstacles to assist in ensuring obstacle clearance. Once clear of obstacles adjust for a 70-knot attitude and >500 fpm rate of climb or as desired.

VMC Minimum Power Takeoff

To simulate operating in a power limited environment, complete this maneuver using only hover power.

From a hover, begin by selection Transition symbology, then press and hold the force trim release interrupted. Slowly and smoothly apply forward cyclic to begin accelerating the aircraft. Maintain the velocity vector straight up and down the 12 o'clock post of the LOS reticle with the pedals. As the aircraft approaches ETL a slight loss of altitude may occur. Ground contact is permissible, but not recommended. Adjust the collective to maintain hover power, as increasing rotor efficiency will cause the torque to decrease. Interrupt the force trim as necessary to maintain a level VSI. Continue to apply forward cyclic for a level VSI while accelerating to achieve 50 knots. Use the pedals to center the trim ball into coordinated flight commensurate with the obstacles. Avoid pitch attitudes more than 10 degrees below the horizon to avoid ground contact with the rotor system.

As the aircraft approaches 50 knots, adjust for a 70-knot attitude to initiate a climb. Ensure the FPV is above the obstacles. Once clear of the obstacles adjust for a >500 fpm rate of climb or as desired.

Rolling Takeoff

To simulate operating in a power limited environment, begin by completing a 5-foot hover power check and note the torque. If the result of this hover power check was 71%, subtract 10% from this value to determine the 'simulated power limit' to be used during the maneuver, in this example 61%. Land the aircraft and using an ENG SYS page, set the stabilator to zero using the collective flight grip to reduce drag.

From the ground, begin by selecting Transition symbology, then press and hold the force trim interrupted while increasing the collective to 30% torque. Continue increasing the collective to the simulated power limit while simultaneously applying forward cyclic for a 90-knot attitude (wings level), then release the force trim. Interrupt the force trim as necessary to maintain a level attitude. Do not allow the nose to drop below wings level until after liftoff to prevent ground contact with the gun. Maintain the velocity vector straight up and down the 12 o'clock post of the LOS reticle with the pedals. As the aircraft lifts off, continue to apply forward cyclic for a level VSI while accelerating to achieve 50 knots. Use the pedals to center the trim ball into coordinated flight commensurate with the obstacles. Avoid pitch attitudes more than 10 degrees below the horizon to avoid ground contact with the rotor system. As the aircraft approaches 50 knots, adjust for a 70-knot attitude to initiate a climb. Ensure the FPV is above the obstacles. Once clear of the obstacles adjust for a >500 fpm rate of climb or as desired. The maneuver is terminated when a positive rate of climb has been established, the aircraft is clear of obstacles and at or near max endurance/rate-of-climb or desired airspeed. Return the stabilator to auto mode by depressing the stabilator switch.

If performing this maneuver in a power limited environment (high/hot/heavy), it is recommended the pilot use 5% below the maximum dual engine torque available to avoid potentially drooping the rotor.

APPROACH AND LANDING

Before Landing Check

Before landing perform the following:

- **(PLT/CPG)** Weapons Subsystem – Check the following:
  - A/S button – SAFE.
  - GND ORIDE button – Off.
  - Weapons not actioned – Verify in the High Action Display (HAD).
- **(PLT/CPG)** ASE – As required.
- **(PLT/CPG)** TAIL WHEEL button – Locked, UNLOCK light is off.
- **(PLT)** PARK BRAKE – Released, handle in or as desired.

Types of Approaches

There are two main approach types: The Visual Meteorological Conditions (VMC) Approach to a Hover/Ground and the Rolling Landing. When performing a VMC Approach, key considerations are:

- **Size of the landing area.** Is the area large enough for the aircraft to land and depart from? If there are multiple aircraft landing to the area, is it large enough for all the aircraft to land and depart from?
- **Suitability of the landing surface.** Is it an improved landing area? Soft dirt/mud? Snow or Dust which may result in white/brownout conditions?
- **Barriers or obstacles in/around the landing area.** Are there trees, rocks, fences, wires, holes?
- **Approach and takeoff direction.** Are they the same? Or is the approach made in one direction and the takeoff made in another?
- **Termination point.** Perform the approach to the last one-third of the useable landing area, especially if multiple aircraft are landing.
- **Winds.** A landing into the wind is preferred, but if it is not possible, increase the power required during the approach.
- **Power available.** Evaluate both IGE and OGE power required against maximum torque available.

If the aircraft is power limited, and the surface area is suitable, then a rolling landing should be considered, and the aircraft should be kept above ETL or Velocity Safe Dual Engine (VSDE), or if single engine, above Velocity Safe Single Engine (VSSE).

VMC Approach to a Hover

From an altitude and airspeed that affords the best observation of the landing area, place the LOS reticle on the intended point of landing. Press and hold the force trim interrupted and reduce the collective approximately 20% below cruise torque. Place the acceleration cue at the 40 knot ground speed position and adjust the collective for a 500 fpm or desired rate or descent. Maintain the FPV slightly above the intended point of landing to prevent "under-arcing" the approach. Control the flight path vector vertically with the collective and horizontally with the left/right cyclic. Maintain the acceleration cue behind the tip of the velocity vector to ensure a smooth, consistent deceleration while maintaining a 500 fpm or desired rate of descent. Prior to descending below the obstacles or 50 feet, keep the trim ball centered. Once below the obstacles or below 50 feet, use the pedals to align the nose with the landing direction. The decision to abort the approach should be made prior to descending below the obstacles. When the velocity vector is within the LOS reticle, select Hover symbology and terminate to a 5-foot stationary hover. Engage the hold modes as desired to assist in maintaining the hover.

Rolling Landing

From an altitude and airspeed that affords the best observation of the landing area, place the LOS reticle on the intended point of landing. Press and hold the force trim release interrupted and reduce the collective approximately 20% below cruise torque. Place the acceleration cue at the 40 knot ground speed position and adjust the collective for a 300 to 500 fpm or desired rate of descent. Maintain the FPV slightly above the intended point of landing to prevent "under-arcing" the approach. Plan to touch down in the first 1/3rd of the useable landing area. Control the flight path vector vertically with the collective and horizontally with the left/right cyclic. Maintain the acceleration cue behind the tip of the velocity vector to ensure a smooth, consistent deceleration while maintaining a 300 to 500 fpm or desired rate of descent. Prior to descending below the obstacles or 50 feet, keep the trim ball centered. Once below the obstacles or below 50 feet, use the pedals to align the nose with the landing direction. Maintain the velocity vector straight up and down the 12 o'clock post of the LOS reticle with the pedals and lateral cyclic. Maintain at or above ETL or VSDE until touch down, or if single engine maintain at or above VSSE until 30 feet. Once the aircraft touches down reduce the collective slightly to settle the aircraft, then increase the collective to 30% dual engine (60% single engine) or more prior to applying aft cyclic to aerodynamically brake the aircraft. Maintain heading with the pedals and a level attitude with lateral cyclic. When the velocity vector is within the LOS reticle, select Hover symbology and maintain the acceleration cue in the center of the LOS reticle. Neutralize the flight controls and reduce the collective after the aircraft has stopped. It is permissible to utilize the toe brakes to assist in stopping the aircraft.

After Landing Check

After landing, perform the following:

- **(PLT/CPG)** TAIL WHEEL button – As desired.
- **(PLT)** Exterior lights – As required.
- **(PLT/CPG)** Avionics – Transponder to STBY.

SHUTDOWN

Once established in parking, perform the following:

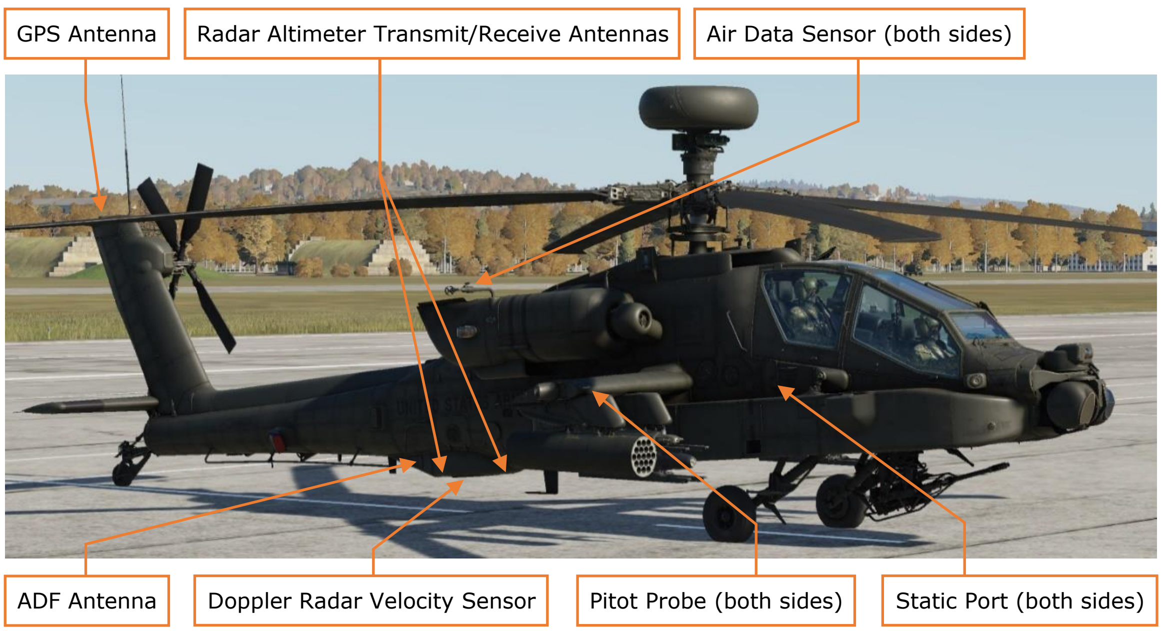
- **(PLT)** APU – Start as follows:
    - APU button – Press ON.
    - EUFD – Observe for APU START, APU POWER ON and ACCUM OIL PRESS LO.
- **(PLT)** TAIL WHEEL button – Locked, UNLOCK light is off.
- **(PLT)** PARK BRAKE – Set, handle out.

Prior to retarding the power levers to IDLE verify the APU ON advisory is displayed on the EUFD.

- **(PLT)** Power levers – IDLE, start 2-minute timer on EUFD.
- **(PLT)** Standby attitude indicator – Cage.
- **(PLT)** CMWS Control Indicator PWR switch – OFF.
- **(PLT/CPG)** NVS MODE switch – OFF.
- **(PLT/CPG)** ACM switch – OFF.
- **(PLT)** Power levers – OFF, after 2 minutes has elapsed.
- **(PLT)** RTR BRK switch – BRK, when N_R is less than 50%.
- **(PLT)** Stabilator – Manually set to 0° using the ENG SYS page.
- **(PLT)** Search Light – OFF.
- **(PLT)** RTR BRK switch – OFF after rotor has stopped.
- **(PLT)** EXT LT/INTR LT panel switches – OFF.
- **(CPG)** INTR LT panel switches – OFF.

NAVIGATION

The AH-64D navigates primarily from using a pair of Embedded GPS/Inertial Navigation Units (EGI) aided by a Doppler velocity radar and a database of stored points. After the APU is started and generator power is applied to the aircraft, both EGI's will automatically begin their alignment process. Unless updated with a new position via the DTC, the EGI alignment process uses the aircraft's previous position and heading stored in the aircraft memory from when it was last shut down. This stored position, aided by GPS position signals, shortens the alignment process considerably, allowing an AH-64D to takeoff within minutes if necessary.



While in flight, the AH-64D receives continuous position updates from GPS satellites to maintain INU position confidence and aid in precision navigation. As an emergency back-up, the AH-64D is equipped with an AN/ARN-149 Automatic Direction Finder.

The AH-64D primarily operates using true airspeed calculations derived from the left pitot probe and both static ports. These, along with the air data sensors, aid in more precise ballistic calculations during weapons delivery and are the primary source of air mass data to the Flight Management Computer (FMC). Despite this, the Pilot crew station's back-up flight instruments provide indicated airspeed and barometric altitude from the second pitot probe and static ports on each side of the airframe.

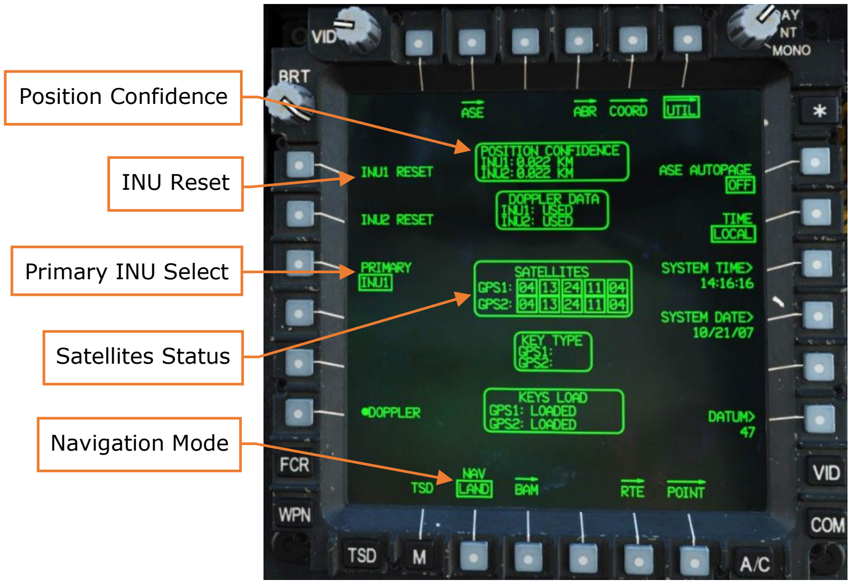


Figure 166. MPD TSD Page, UTIL Sub-Page

POINTS

Points in the AH-64D are stored in one of three partitions, depending on their purpose. The three partitions are Waypoint/Hazards, Control Measures and Target/Threats. The following describes how these partitions are organized:

Waypoint/Hazards 01–50. Points for depicting waypoints and hazards.

Control Measures 51-99. Points for depicting friendly and enemy units, airfields, and other graphical control measures for controlling a mission.

Target/Threats 01–50. Points for depicting targets and threats. Threat icons can display threat rings. (Consists of database files 100-149, but renamed to T01-T50 for presentation to the crew)

Target/Threats 51-56. Points for storing additional TSD file locations, such as the PLT and CPG Terrain (TRN) points. (Consists of database files that reside within the aircraft memory, but cannot be manually added or edited by the crew)

Waypoints Hazards	General Control Measures Friendly Control Measures Enemy Control Measures	Targets Threats	TRN
WPTHZ 1-50	**CTRLM 51-99**	**TGT/THRT 1-50**	**TGT**

Figure 167. Point Database Partitions

There are four main components of information associated with each point within the aircraft database. Identifier (IDENT), free text (FREE), coordinates (UTM LAT/LONG), and elevation above mean sea level (ALTITUDE).

When inputting a point, the crewmember can change how the point is displayed on the TSD by inputting a unique identifier (IDENT). It is important to note however certain identifiers are not available for certain point types. For example, a Communications Checkpoint (CC) identifier is a Waypoint/Hazard, and therefore cannot be used if the selected point type is a Control Measure; a Checkpoint (CP) identifier is a Control Measure, which cannot be used if the selected point type is a Waypoint/Hazard.

The free text of each point consists of up to three alphanumeric characters that can be added for additional information to the crewmembers. For most points, these free text characters are only visible when reviewing a point on the COORD page, or when the Review Status window is displayed on the POINT or RTE sub-pages. Some types of Control Measures will display their free text information directly on the TSD. These types of points can be useful in providing additional information of the nature of that location, even if the icon itself doesn't align with the terrain or situation. In other cases, it may be more useful to have a specific point type placed on the TSD to provide context to the crew at a quick glance.

In the example below, LZ "Falcon" is marked by a Landing Zone point on the left, and a Ground Light point on the right. A Landing Zone point will not display its free text of "FAL" directly on the TSD, but it can be viewed by pressing POINT (B6) and then selecting the point using the cursor to review its information. On the other hand, the Ground Light point can display "FAL" directly on the TSD but it may not be known by the crew to mark an LZ location unless briefed as such. In this situation, it is a question of what the location means versus what it is called. This question of context should be taken into consideration when planning a mission when other players may not be aware of the intent behind the choice of what points are used for certain purposes.

Figure 168. Landing Zone (Left) and Ground Light (Right)

Any time a custom free text is not entered by the crew, the free text defaults to the point type and number within the database (i.e., "W01", "H09", "C51", "T05" etc.).

The location of each point is stored using MGRS coordinates (labeled as UTM in the cockpit) or Latitude/Longitude in Degrees, Minutes, Minute-Decimals format (DD°MM.MMM). Regardless of the method of entry, both coordinate formats can be viewed in the Review Status window or on the COORD page.

The altitude of each point is referenced from mean sea level (MSL) in feet. Any time a custom altitude is not entered by the crew, the altitude defaults to the elevation of the terrain at the point's location using Digital Terrain Elevation Data loaded into the aircraft database.

When a point is selected on the TSD while the POINT or RTE sub-pages are displayed, the point's label will be displayed in inverse video, and the Review Status window will be displayed showing additional information. Any point may be selected as a Direct-To for the purposes of navigation, or as the Acquisition source for the purposes of targeting.

Waypoint/Hazards (WPTHZ)

Waypoint/Hazards include graphics for depicting Generic Waypoints, Communications Checkpoints, route Start and Release Points, and Hazards such as towers or wires. Hazards are depicted in yellow. It is important to note that hazards are ALWAYS perpendicular to the flight path of the aircraft on the TSD and DO NOT depict the actual direction of the hazard, but its general location only. Some of the more commonly used Waypoint/Hazards are shown below. A complete list can be found on the TSD Abbreviation (ABR) page or in Appendix B of this manual.

Waypoint **Start Point** **Release Point** **Tower <1000'** **Wires, Power**

Figure 169. Waypoint/Hazard Examples

Control Measures (CTRLM)

Control measures include graphics for depicting Friendly and Enemy Units, Forward Arming and Refueling Points (FARPS), Battle Positions and others. Some of the more commonly used Control Measures are shown below. A complete list can be found on the TSD Abbreviation (ABR) page or in Appendix B of this manual.

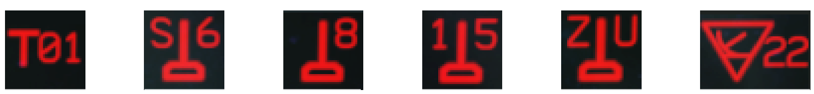
Airfield Battle Position Checkpoint Ground Light Friendly Infantry Enemy Armor

Figure 170. Control Measure Examples

***-Coming later in EA-** Present position reports are stored in Control Measure 93 through 99. It is important to understand that anything stored in Control Measures 93 through 99 will be overwritten when a present position is received from another aircraft.*

Targets/Threats (TGT/THRT)

Targets/Threats include graphics for depicting the location of Targets found during the conduct of a mission or for depicting the location of known or templated threat systems. When a point is entered as a Threat, it can display a threat ring on the TSD. Threat rings are toggleable on the THRT SHOW sub-page on the TSD. Some of the more commonly used Targets/Threats are shown below. A complete list can be found on the TSD Abbreviation (ABR) page or in Appendix B of this manual.



Target Point 2S6 SA-8 SA-15 ZSU-23-4 Radar

Figure 171. Target/Threat Examples

Adding a Point

Points can be added to the TSD using two primary methods: a "cursor drop" method using default points for each type, or entry via the Keyboard Unit (KU). The point type will default to WP (L3) when TSD is in NAV phase or TG (L6) when in ATK phase.

Adding a Point Using "Cursor Drop"

When the "cursor drop" method is used to add a point, the default points that are dropped at the cursor location are listed below:

- WP (L3) – Waypoint (WP)
- HZ (L4) – Tower Under 1000' (TU)
- CM (L5) – Checkpoint (CP)
- TG (L6) – Target Point (TG)

When these points are "cursor dropped" without entering data via the KU, the free text will default to the point type and number within the database (i.e., "W01", "H09", "C51", "T05" etc.). The coordinates will be entered based on the cursor location, and the altitude of the point will be entered based on the terrain elevation data for that location on that map.

To quickly add a point using the "cursor drop" method, perform the following:

1. TSD fixed action button – Press.
2. POINT (B6) – Select.
3. ADD (L2) – Select.
4. Type select (L3 thru L6) – WP, HZ, CM, or TG.

Figure 172. POINT Sub-Page, ADD Menu, Point Type Select

5. Cursor select – Select desired location on TSD.

Figure 173. POINT Sub-Page, ADD Menu, Cursor Drop

Adding a Point Using Keyboard Unit

To add a point using the Keyboard Unit, perform the following:

1. TSD fixed action button – Press.
2. POINT (B6) – Select.
3. ADD (L2) – Select.
4. ABR (T4) – Select, as required.
5. Type select (L3-L6) – WP, HZ, CM, or TG.
6. IDENT> (L1) – Select and enter identifier with the KU, and press ENTER.

Figure 174. POINT Sub-Page, ADD Menu, IDENT selected

7. Enter free text data with the KU, and press ENTER.

Figure 175. POINT Sub-Page, ADD Menu, FREE TEXT entry

8. Enter location data with the KU, and press ENTER. You can enter new coordinates for the point using any of the following methods:

- Using the KU, enter an MGRS coordinate (e.g., "11SGQ52184911") and press ENTER. The default MGRS coordinates will be the current position of the aircraft, with the KU cursor automatically placed at the first digit of the "easting" numericals. If a different grid zone designator and/or square identifier is to be entered, the KU arrow keys should be used to place the KU cursor over the first character to be overwritten, and then the remainder of the coordinate data will be typed over.

- Using the KU, press CLR and enter a latitude and longitude in Degrees, Minutes, Minute-Decimals format in a continuous string without any spaces, decimals, or special characters (e.g., "N74°25.94 W°120°57.68" would be entered as "N742594W1205768") and press ENTER.
- Using the KU, enter the name of an existing point to duplicate its coordinates (i.e., "W01", "H09", "C51", "T05" etc.) and press ENTER.
- Move the cursor to a point on the map and press Cursor Enter.

Figure 176. POINT Sub-Page, ADD Menu, UTM LAT/LONG entry

9. Enter altitude data with the KU, and press Enter. If the default terrain elevation data is desired, simply press Enter without any custom altitude entry.

Figure 177. POINT Sub-Page, ADD Menu, ALTITUDE entry

After the altitude is entered, the new point will be saved in the aircraft database and placed on the TSD.

Figure 178. POINT Sub-Page, ADD Menu, Point Manually Entered

Editing a Point

Existing points can be edited, but limited to the free text, location, and altitude. To edit a point, perform the following:

1. TSD fixed action button – Press.
2. POINT (B6) – Select.
3. POINT> (L1) – Select and enter point type and number (i.e., "W01", "H09", "C51", "T05", etc.)

   or

3. Cursor select – Select desired point on TSD.
4. EDIT (L3) – Select.

Figure 179. POINT Sub-Page, EDIT Menu, Point Selected

5. FREE> (L1) – Select and enter free text with the KU, and press ENTER. If the existing free text is desired, simply press Enter without a different free text entry.

Figure 180. KU Free Text Edit

6. Enter location data with the KU, and press ENTER. If the existing location is desired, simply press Enter without a different location entry. You can enter new coordinates for the point using any of the following methods:

   - Using the KU, enter an MGRS coordinate (e.g., "11SGQ52184911") and press ENTER. The default MGRS coordinates will be the current position of the aircraft, with the KU cursor automatically placed at the first digit of the "easting" numericals. If a different grid zone designator and/or square identifier is to be entered, the KU arrow keys should be used to place the KU cursor over the first character to be overwritten, and then the remainder of the coordinate data will be typed over.

   - Using the KU, press CLR and enter a latitude and longitude in Degrees, Minutes, Minute-Decimals format in a continuous string without any spaces, decimals, or special characters (e.g., "N74°25.94 W°120°57.68" would be entered as "N742594W1205768") and press ENTER.

   - Using the KU, enter the name of an existing point to duplicate its coordinates (i.e., "W01", "H09", "C51", "T05" etc.) and press ENTER.

   - Move the cursor to a point on the map and press Cursor Enter.

Figure 181. POINT Sub-Page, EDIT Menu, UTM LAT/LONG entry

7. Enter altitude data with the KU, and press Enter. If the existing altitude is desired, simply press Enter without a different altitude entry.

Figure 182. POINT Sub-Page, Point with updated Free Text

Deleting a Point

Existing points can be deleted. To delete a point, perform the following:

1. TSD fixed action button – Press.
2. POINT (B6) – Select.
3. POINT> (L1) – Select and enter point type and number (i.e., "W01", "H09", "C51", "T05" etc.)

   or

3. Cursor select – Select desired point on TSD.
4. DEL (L4) – Select.
5. Confirm deletion (L3 or L4) – YES or NO.

Figure 183. POINT Sub-Page, DEL Confirmation

Storing a Point

Locations can be quickly stored to the TSD as Waypoints or Target Points using two store methods: a “flyover point” store or a “CPG LOS” store. When the STO menu is displayed on the POINT sub-page, the Review Status window will display the information that will be saved if the NOW button (L1) were pressed. This includes the next empty point number of the selected type, and the aircraft’s current position and altitude.

Figure 184. POINT Sub-Page, STO Menu

Just as with the ADD menu, the point type will default to WP when TSD is in NAV phase or TG when in ATK phase. Pressing TYPE (L6) will toggle between these two point types.

When a WP or TG is stored using the “flyover point” method, the free text is automatically saved as “FLY”. When a WP or TG is stored using the “CPG LOS” method, the , the free text is automatically saved as either “TAD” or “HMD”, depending on what sight the CPG was using at the time the point was stored.

Storing a Flyover Point

To store a point at the current aircraft position, perform the following:

1. TSD fixed action button – Press.
2. POINT (B6) – Select.
3. STO (L5) – Select.

4. TYPE (L6) – Select WP or TG as desired.
5. NOW (L1) – Select.

After storing the point, the Review Status window will automatically advance to the next empty point number. In the figure below, a flyover point (W09) was stored using this method and is being viewed on the main POINT sub-page. The free text can be seen as “FLY”.

Figure 185. POINT Sub-Page, Review Status Window

Storing a Point from CPG LOS (TADS or HMD)

The CPG can utilize any range source to store a point using either his TADS or HMD LOS. Using a more accurate range source such as a laser while sight-selected TADS will provide more precision when trying to store a location. Less accurate methods include using the HMD as the sight or using an Automatic range or an estimated Manual range. To store a point using the TADS with a laser range, the CPG should perform the following:

1. NVS Mode switch – Off, if applicable.
2. Sight select – TADS.
3. Sight Manual Tracker – Slew to center the location within the LOS reticle.
4. Arm/Safe Switch – Arm.
5. TSD fixed action button – Press.
6. POINT (B6) – Select.

7. STO (L5) – Select.
8. TYPE (L6) – Select WP or TG as desired.
9. TEDAC RHG laser trigger – 1st detent range, or 2nd detent Designate as required.
10. TEDAC LHG Store/Update switch – STO

To store a point using the TADS with an Automatic range, the CPG should perform the following:

1. NVS Mode switch – Off, if applicable.
2. Sight select – TADS.
3. Sight Manual Tracker – Slew to center the location within the LOS reticle.
4. WPN fixed action button – Press.
5. MANRNG (B6) – Select and enter "A" on the KU, and press ENTER.
6. TSD fixed action button – Press.
7. POINT (B6) – Select.
8. STO (L5) – Select.
9. TYPE (L6) – Select WP or TG as desired.
10. TEDAC LHG Store/Update switch – STO

Figure 186. POINT Sub-Page, STO Menu, CPG LOS Store

To store a point using the HMD with an Automatic range, the CPG should perform the following:

1. Sight select – HMD.
2. WPN fixed action button – Press.
3. MANRNG (B6) – Select and enter “A” on the KU, and press ENTER.
4. TSD fixed action button – Press.
5. POINT (B6) – Select.
6. STO (L5) – Select.
7. TYPE (L6) – Select WP or TG as desired.
8. Center the location within the HMD LOS reticle.
9. TEDAC LHG Store/Update switch – STO

Transmitting a Point

-Coming later in EA-

The description of this process will be added in a later edition of this manual.

Figure 187. MPD TSD Page, POINT Sub-Page, XMIT Menu

Navigating to a Point

Navigating to a point is a straightforward process and is accomplished via the TSD, Route (RTE) page. Any point (WPTHZ, CTRLM, TGT/THRT) within the database can be selected as the current Direct-To point. This is an aircraft common selection, meaning that whatever one crewmember selects as the current Direct-To will be the same for both crewmembers.

Key pieces of symbology for navigation include the Navigation Fly-To Cue and the Command Heading Chevron. The Navigation Fly-To Cue is a small diamond shaped icon with a flat bottom and a dot in the center, also called the "Homeplate" symbol. The Navigation Fly-To Cue is meant to be used in conjunction with the Flight Path Vector (FPV) to ensure "point-to-point" navigation. Additionally, the Waypoint Status window provides distance and estimated time enroute to the selected point. It also provides the aircrafts current groundspeed to the crew.

Direct-To Line

When a new Direct-To is input, a straight line is drawn from the Ownship to the selected point. This line *does not* follow the aircraft, but rather represents the original course plotted from the aircraft's position at the moment the Direct-To was entered. The current route will be displayed in partial-intensity green while a Direct-To course is active.

To select a point for direct navigation, perform the following:

1. TSD fixed action button – Press.
2. RTE (B5) – Select.
3. DIR (L5) – Select.
4. POINT> (L1) – Select and enter point type and number (i.e., "W01", "H09", "C51", "T05" etc.)

   or

4. Cursor select – Select desired point on TSD (WPTHZ, CTRLM or TGT/THRT).

Figure 188. MPD TSD Page, Direct-To Line

If a point is selected as the Direct-To, and that point is part of the current route, after arriving at that point the route will sequence normally, starting with the first time that point appears in the route sequence. When this happens, the Direct-To line is removed and the route returns to full-intensity green.

If a point is selected as the Direct-To, and that point is not part of the current route, after arriving at that point, the current Navigation Fly-To Cue and Waypoint Status window will remain at that point, unless a new Direct-To point is selected or a different route is selected on the Route Menu (RTM) page.

Ground Tracking to a Direct-To Point

When ground tracking to a Point, the HDU Transition or Cruise symbology can be used to assist in correcting for winds. Once a Direct-To point has been selected by the crew, first turn in the direction of the Command Heading Chevron. When the Navigation Fly-To Cue appears within the HDU field of view, place the FPV over the top of, or inside, the Navigation Fly-To Cue.

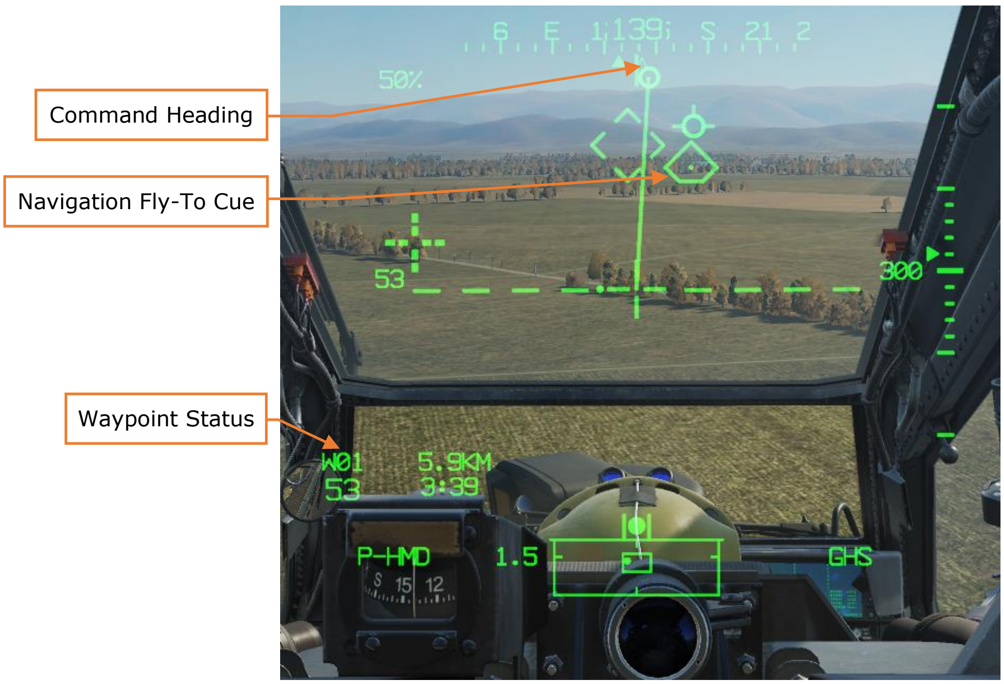


Figure 189. Navigation Symbology

Flying a Ground Track (Wind Corrected Heading)

When not navigating to the current Navigation Fly-To Cue (such as performing traffic pattern flight), the HDU Transition symbology can be used to assist in correcting for winds. With the aircraft in coordinated flight with the trim ball centered (termed "in trim"), the crew can place the desired ground track between the Velocity Vector and the Heading Tape's Lubber Line to correct for winds as shown in the figure below.

Figure 190. Flying a Ground Track

Using this technique, the Pilot can determine where to adjust the heading of the aircraft to ensure that the aircraft's actual track across the ground coincides with the desired course, even without a Navigation Direct-To Cue to reference with the Flight Path Vector.

ROUTES

The aircraft can store 10 unique routes, each consisting of up to 100 points. Separate routes can be selected from the TSD Route (RTE) page, Route Menu (RTM) sub-page. Routes can be built using Waypoint/Hazards and Control Measures only. Targets/Threats cannot be added to a route. The RTE page is where crewmembers can scroll up and down the route point list and either review the time it will take to get to the selected point or make the selected waypoint a Direct-To. (see Navigating to a Point)

The RTE page is also used to edit the current route, by adding or deleting points from the route. It should be noted that when a point is deleted from the route, it is not removed from the point database. Points can only be deleted from the database using the TSD Point page.

Routes typically consist of a Start Point (SP) and end with a Release Point (RP). When planning a mission, it is useful to have multiple ingress and egress routes to and from the objective area. Routes should not be considered a flight plan, but rather an avenue to reach the objective area, reposition to different sectors of the battlefield, or method to control multiple flights of aircraft. As such, most route points do not need to be directly overflown.

In the example below, a basic route is shown that includes a Start Point, a Communications Checkpoint, a standard Waypoint, and a Release Point. Routes can be composed of any number of points, depending on how the aircrews intend to perform their mission.

Figure 191. Route Structure and Format

If a TSD is not displayed on either MPD, a “WAYPOINT APPROACH” advisory will be displayed on the EUFD to alert the crewmember of an impending turn to the next route point. This advisory will display when the estimated time enroute (ETE) to that route point at the current ground speed is 60 seconds. When passing the route point, even if the aircraft does not directly overfly it, the next route point is automatically set as the new destination and “WAYPOINT PASSAGE” is displayed on the EUFD for 90 seconds.

Creating a Route Using the Mission Editor

When using the Mission Editor, the waypoints placed using the Helicopter Group Route tab will auto-populate in the DCS AH-64D as the default TSD route: Route ALPHA. Each Mission Editor waypoint after the initial Helicopter Group location will be displayed as a Waypoint (WP) on the TSD, as part of Route ALPHA, numbered in accordance with their sequence in the Mission Editor.

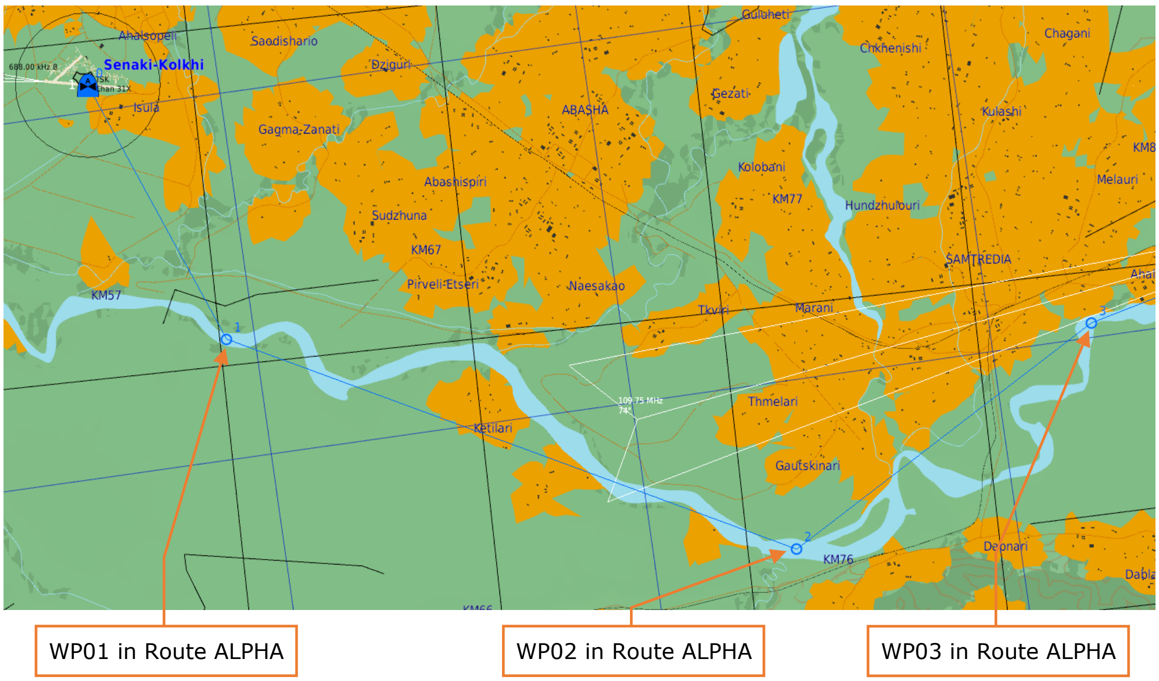


Figure 192. Mission Editor Helicopter Group Route

AH-64D points are entered and displayed in three dimensions, therefore it may be advisable to reduce the altitude of all waypoints in the Mission Editor to the minimum value, so they are located as close to ground level as possible; especially if intended to mark a specific location or landmark. Under certain circumstances, however, it may be useful to place them at higher altitudes, depending on how the player intends to use them. This can be useful to mark locations over the battlefield for illumination rockets, or to build instrument approaches during low-visibility conditions.

Currently it is only possible to generate one route in the Mission Editor; all other routes on the Route Menu (RTM) page will be empty of any points. However, these other routes can be edited by adding points during the mission.

Creating a Route Using the Route (RTE) Page

To build a new route using the Route page, the points that are to be used for the route will need to be added prior, using the POINT page (see Point Sub-Page). Once these points have been added to the TSD, an empty route should be selected on the Route Menu (RTM) page using one of the top bezel buttons above that route.

After an empty route has been selected, it may be necessary to return to the top-level TSD page and pan to the first point to be added to the route, if not currently located within the TSD footprint. To add points to the new route, perform the following:

1. TSD fixed action button – Press.
2. RTE (B5) – Select.
3. ADD (L2) – Select.
4. POINT> (L1) – Select and enter point type and number (i.e., "W01", "H09", "C51", etc.)

   or

4. Cursor select – Select desired point on TSD (WPTHZ or CTRLM).

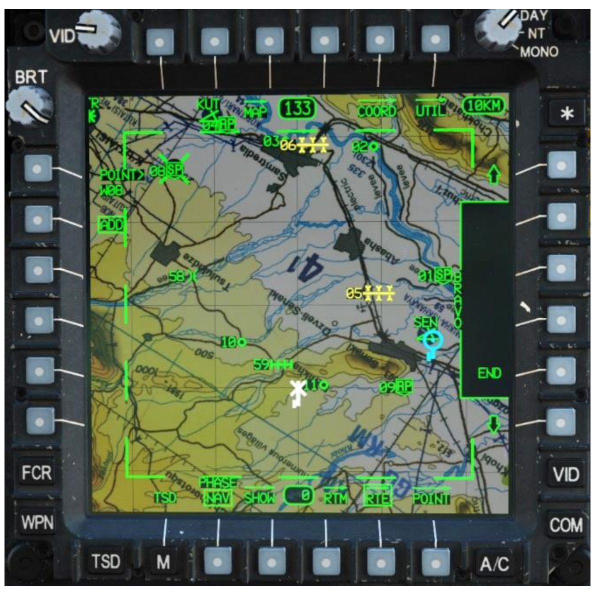


Figure 193. Adding a Point to a New Route

5. Route sequence – Select (R5) "END" to place the point at the start of the route. The "END" identifier will move to the following position within the route sequence.

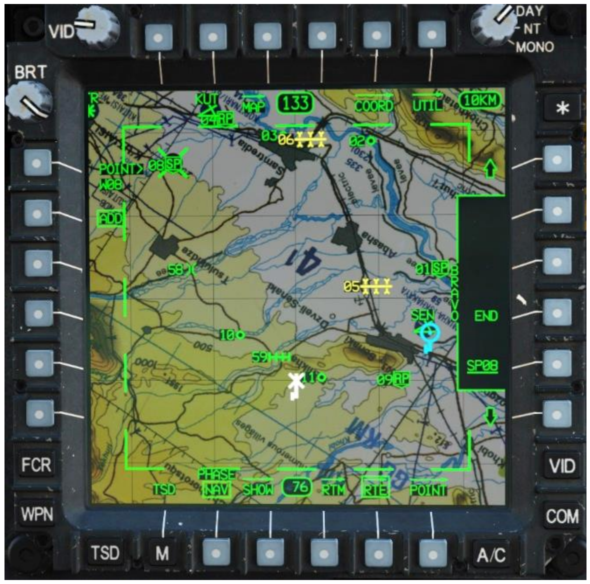


Figure 194. Point added to a New Route

6. Select – Use the MPD cursor to select additional points (WPTHZ or CTRLM) on the TSD. Use the PAN function as necessary.
7. Route sequence – Select (R2-R5) to place additional point within the route. Use "END" identifier to place each subsequent point at the end of the route.

Figure 195. Additional Points added to a New Route

Editing a Route Using the Route (RTE) Page

To insert a point into the current route, use the pan function as necessary and then perform the following:

1. TSD fixed action button – Press.
2. RTE (B5) – Select.
3. ADD (L2) – Select.
4. POINT> (L1) – Select and enter point type and number (i.e., "W01", "H09", "C51", etc.)

   or

4. Cursor select – Select desired point on TSD (WPTHZ or CTRLM).

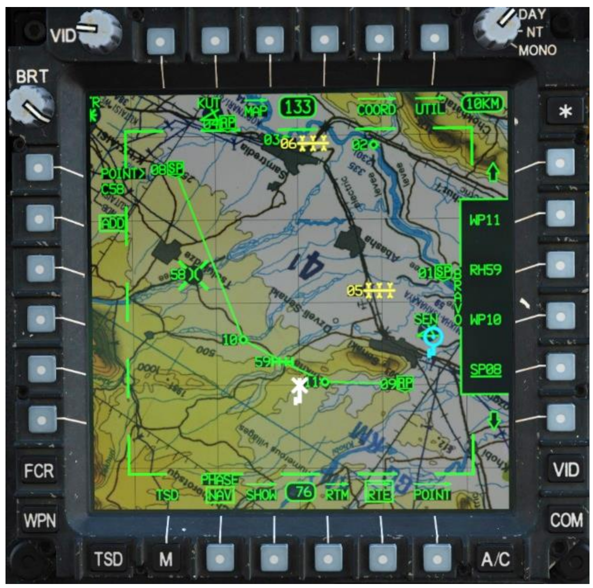


Figure 196. Adding a Point to an Existing Route

5. Route sequence – Select bezel button (R2-R5) to insert the point at that location within the route. The point that is located at that position within the route sequence will move to the following position, and all points that follow will move accordingly.

Figure 197. Point added to an Existing Route

To delete a point from the current route, use the pan function as necessary and then perform the following:

1. TSD fixed action button – Press.
2. RTE (B5) – Select.
3. DEL (L4) – Select.
4. Cursor select – Select desired point on TSD (WPTHZ or CTRLM).

   or

4. Search buttons (R1/R6) – Select.

Figure 198. Cursor-selecting a Point for deletion from an Existing Route

5. Route sequence – Select bezel button (R2-R5) to delete the corresponding point from the route sequence.

Figure 199. Deleting a Point from an Existing Route

Selecting a Route Using the Route Menu (RTM) Page

The route marked as CURRENT is the active route on the TSD. Any time a route is selected on the RTM page with NEW (L5) boxed, the Command Heading Chevron, Navigation Fly-To Cue and Waypoint Status windows will switch navigation to the first point in that route sequence, and any current Direct-To navigation course lines will be deleted. To select a route as CURRENT, perform the following:

1. TSD fixed action button – Press.
2. RTE (B5) – Select.
3. RTM (B6) – Select.
4. NEW (L5) – Verify boxed.
5. Route select – Select bezel button (T1-T5) above the route to activate. Use paging buttons B1 and B2 to access the second set of routes if necessary.

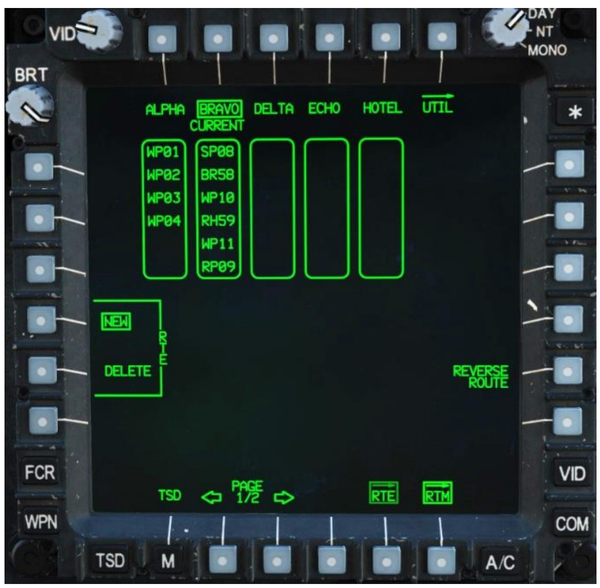


Figure 200. Selecting a Route

Deleting a Route Using the Route Menu (RTM) Page

When a route is deleted from the RTM page, only the points within the route sequence are deleted. The route name itself will remain. To delete a route, perform the following:

1. TSD fixed action button – Press.
2. RTE (B5) – Select.
3. RTM (B6) – Select.
4. DEL (L5) – Select.
5. Route select – Select bezel button (T1-T5) above the route for deletion. Use paging buttons B1 and B2 to access the second set of routes if necessary.

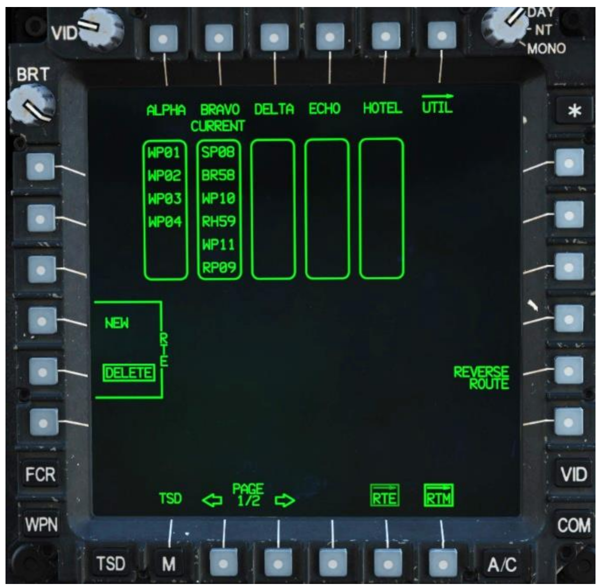


Figure 201. Deleting a Route

6. Confirm deletion (L4 or L5) – YES or NO.

RADIO NAVIGATION IN LOW-VISIBLITY CONDITIONS

The AH-64D was not designed to perform flight within Instrument Meteorological Conditions (IMC). However, the AH-64D does have some functionality to perform limited navigation under such conditions with on board equipment. This equipment primarily includes the AN/ARN-149 Automatic Direction Finder (ADF) receiver, an Instrument (INST) sub-page to the TSD, and associated navigation symbology within the HDU flight symbology and on the FLT page.

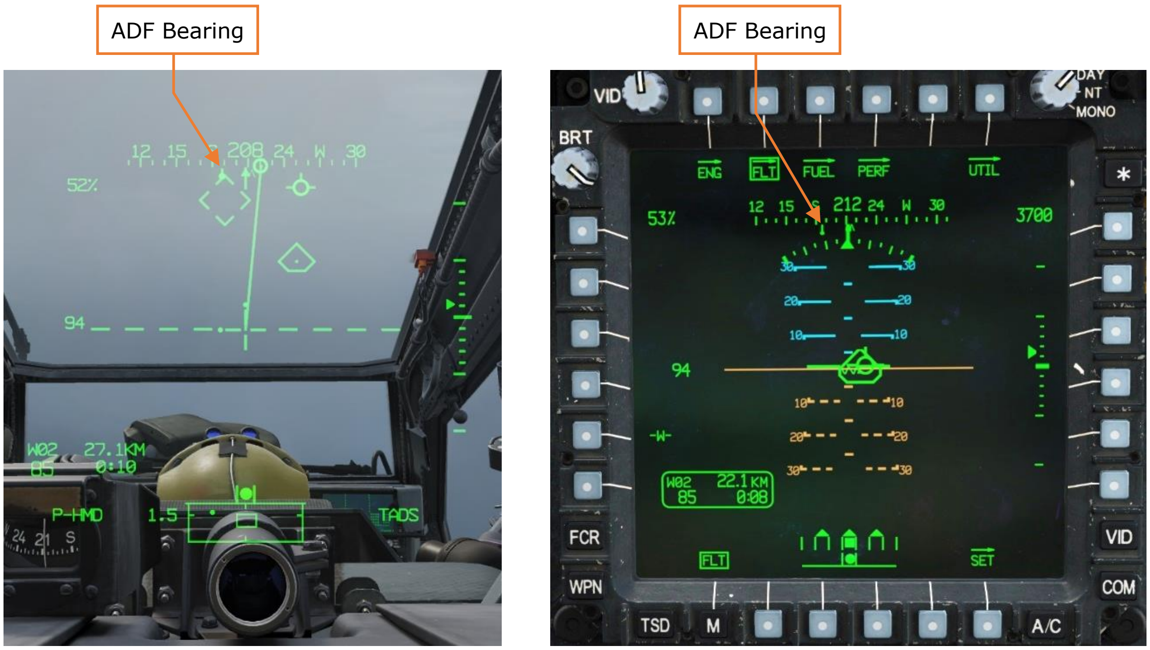


Figure 202. HDU Flight Symbology (Left), MPD Flt Page (Right)

Tuning and Navigating to a Non-Directional Beacon (NDB)

The ADF system is managed from the Instrument (INST) and Instrument Utility (INST UTIL) sub-pages on the TSD. The ADF antenna can determine a coarse azimuth to an AM radio signal within the range of 100 and 2199.5 kHz as well as provide audio to the crewmembers' ICS system.

When the INST sub-page is entered, the HSI compass and Heading Select indicators are automatically displayed around the Ownship, regardless of whether the TSD is centered or de-centered (CTR button at R3). Additional controls for ADF navigation are provided such as a dedicated timer that is crewstation independent and an NDB status window that aids in identifying the selected Non-Directional Beacon the ADF is currently tuned to. This formatting allows the crews to integrate the radio navigation equipment with the existing functionality of the

TSD moving map, routes, points database, waypoint status, winds, and endurance data.

Figure 203. Radio Navigation

Tuning the ADF to an NDB Frequency

The ADF system is primarily tuned from the INST UTIL page. After powering on the ADF (B6), additional options are presented to the crew which include ADF presets and emergency frequencies for tuning. Additionally, each ADF preset can be edited via the KU using the ID> (B4) and FREQ> (B5) buttons. The NDB Status window will automatically look-up and display the expected morse code identifier of the selected preset based on the characters entered for the station identifier.

Figure 204. MPD TSD Page, UTIL Sub-Page

To tune the ADF to a preset station, perform the following:

1. TSD fixed action button – Press.
2. INST (L1) – Select.
3. UTIL (T6) – Select.
4. ADF (B6) – Select.
5. Preset (L2 thru L6 or R2 thru R6) – Select.
6. TUNE (T5) – Select.

To edit an ADF preset, perform the following:

1. TSD fixed action button – Press.
2. INST (L1) – Select.
3. UTIL (T6) – Select.
4. Preset (L2 thru L6 or R2 thru R6) – Select.
5. ID> (B4) – Select and enter identifier with the KU, and press ENTER.
6. FREQ> (B5) – Select and enter frequency with the KU, and press ENTER.

To tune the ADF to a manual frequency, perform the following:

1. TSD fixed action button – Press.
2. INST (L1) – Select.

3. FREQ> (L3) – Select and enter frequency with the KU, and press ENTER.

Navigating to an NDB using the ADF

The best way to navigate to an NDB is to ensure the TSD is set to TRK-UP. This can be set on the MAP page (B4) and then selecting ORIENT button (R5). When the ADF Bearing Pointer swings to the direction of a received NDB signal, the crew turns toward the azimuth indicated by the Bearing Pointer and aligns it with the 12 o'clock of the TSD. The aircraft is now tracking toward the NDB.

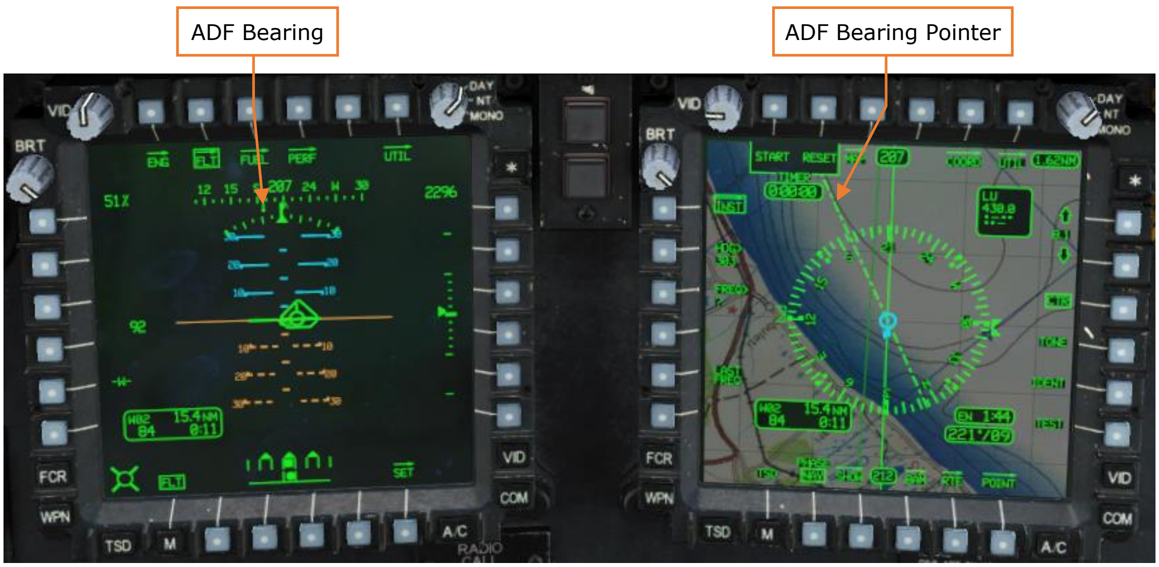


Figure 205. ADF-based Steering

It's important to note that when the TSD is in Track-up orientation, the HSI and the Ownship will "twist" in response to crosswinds and the Current Heading at the top center of the TSD indicates the current aircraft heading, not the heading of the TSD. The TSD moving map will remain oriented to the actual ground track of the aircraft.

Holding Over a Non-Directional Beacon (NDB)

The standard holding pattern for Army helicopters over an NDB is standard-rate right-turns with a 1-minute inbound interval along the depicted inbound course. Typical airspeed while holding is 90 knots, but this can be modified if the situation requires. As an aircraft approaches the NDB, the crew must determine the type of entry turn into the holding pattern they must perform. Typically, the entry method that is used will be the one most conducive to a smooth transition into the holding pattern with the least amount of turns and that remains within the dimensions of the holding pattern itself. This determination can be aided by setting the Heading Select (HDG>) to the inbound course.

Entering the Holding Pattern

The three types of entries into holding are Direct entry, Teardrop entry, or Parallel entry.

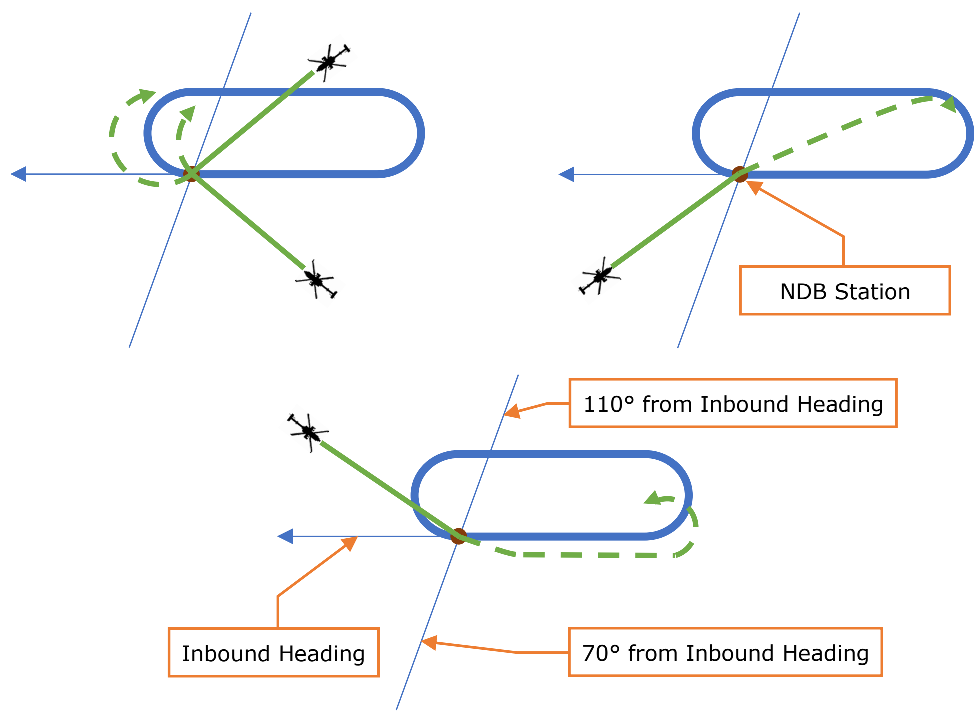


Figure 206. Direct (Top Left), Teardrop (Top Right), Parallel (Center)

When using the Direct entry method, after crossing over the NDB turn directly to the outbound course in a standard-rate right turn (or left-turn if performing a non-standard holding pattern with left-turns).

When performing the Teardrop entry method, after crossing over the NDB turn 30° to the left of the outbound course; track outbound for 1 minute and then make a standard-rate right turn onto the inbound course. If performing a non-standard holding pattern over an NDB, after crossing over the NDB turn 30° to the left of the outbound course; track outbound for 1 minute and then make a standard-rate left turn onto the inbound course.

When performing the Parallel entry method, after crossing over the NDB turn left to parallel the outbound course; track outbound for 1 minute and then make a standard-rate left turn inside the holding pattern and then intercept the inbound course. If performing a non-standard holding pattern over an NDB, after crossing over the NDB turn right to parallel the outbound course; track outbound for 1 minute and then make a standard-rate right turn inside the holding pattern and then intercept the inbound course.

Holding Procedures

Once established into the holding pattern on the inbound course (in the following figures the inbound course is 115°), after crossing over the NDB enter a standard-rate right turn. If performing a non-standard holding pattern with left-turns, the following holding procedures will simply be reversed.

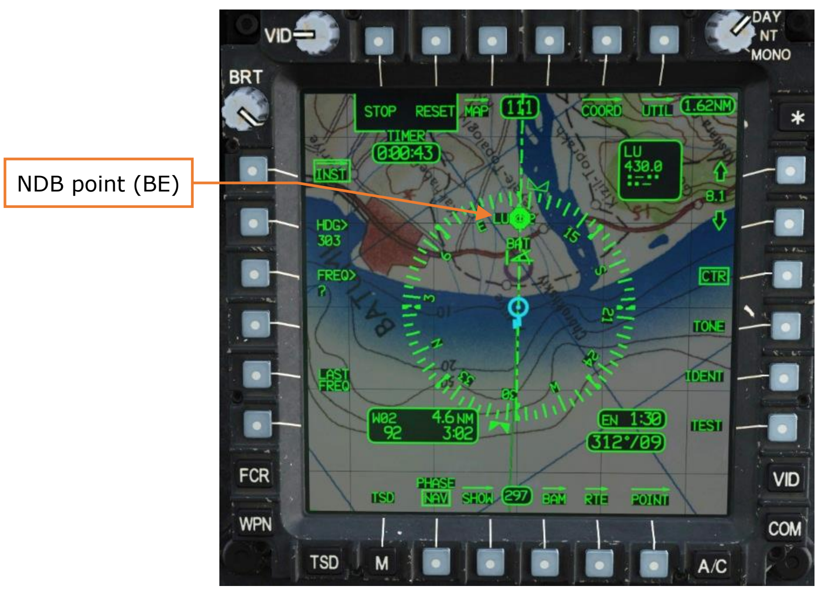


Figure 207. INST Sub-Page, Approaching the NDB

Regardless as to whether you have completed your turn to the outbound course or not, once the ADF Bearing Pointer indicates the Ownship is abeam the NDB (in this case 025° since the inbound course was 115°), the timer is started for a 1-minute outbound.

Figure 208. INST Sub-Page, Abeam the NDB

When the timer reaches 1:00, enter a standard-rate right turn back to the inbound course. Reset the timer.

Figure 209. INST Sub-Page, 1-minute on the Outbound Course

While in each turn, ensure the airspeed remains at 90 knots and the bank angle is maintained at a standard-rate turn, even if is apparent the aircraft will roll out short of the inbound course or will drift past it.

Figure 210. INST Sub-Page, Turning to the Inbound Course

Once the aircraft rolls wings level on the inbound, even if the inbound course hasn't been fully intercepted, start a 1-minute timer. This is to gauge the inbound interval and to assess whether any changes need to be made on the next orbit in holding. In the figure below, the aircraft has drifted outside the holding pattern and is re-intercepting the inbound course to the right.

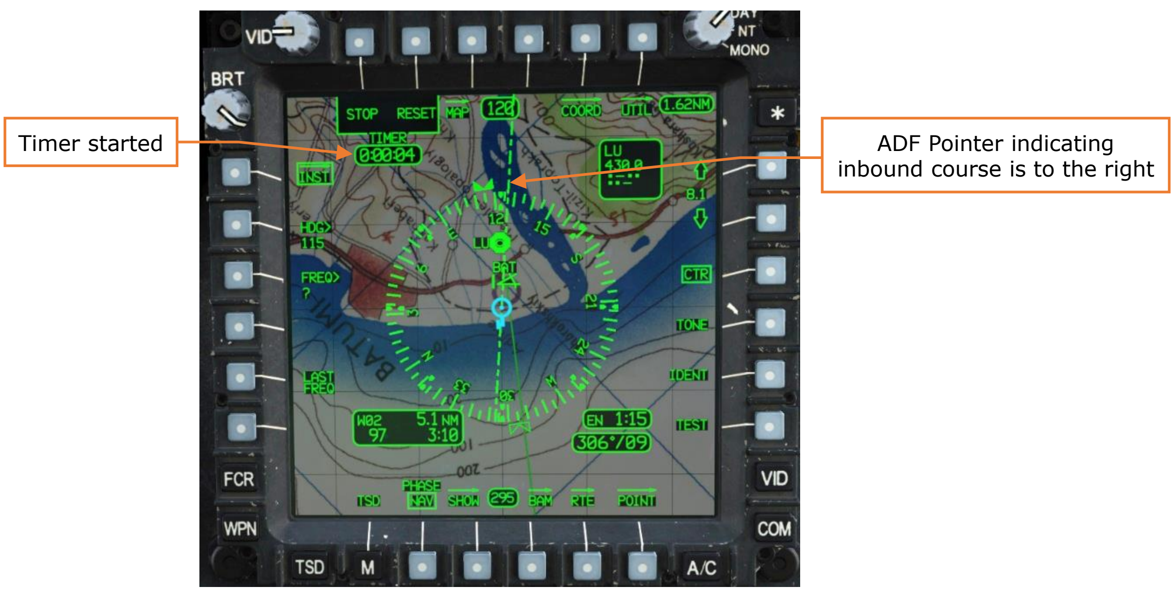


Figure 211. INST Sub-Page, Intercepting the Inbound Course

Once the aircraft passes over the NDB, the inbound time can be used to determine what changes need to be made on the outbound course and follow-on orbits in holding. If the aircraft crossed the NDB station prior to 1:00, the outbound leg should be flown for a longer period than the previous orbit. If the aircraft crossed the NDB station beyond 1:00, the outbound leg should be flown for a shorter period than the previous orbit. If the aircraft rolled out prior to intercepting the inbound course, the outbound heading flown should be further toward the outside of the orbit. If the aircraft rolled out after drifting past the inbound course, the outbound heading flown should be closer toward the inside of the orbit. All adjustments to timings and headings are predicated on a constant airspeed and a standard-rate turn. If the airspeed or turn rates are varied throughout the orbit(s), any adjustments made will not have the predicted effect on the holding interval.

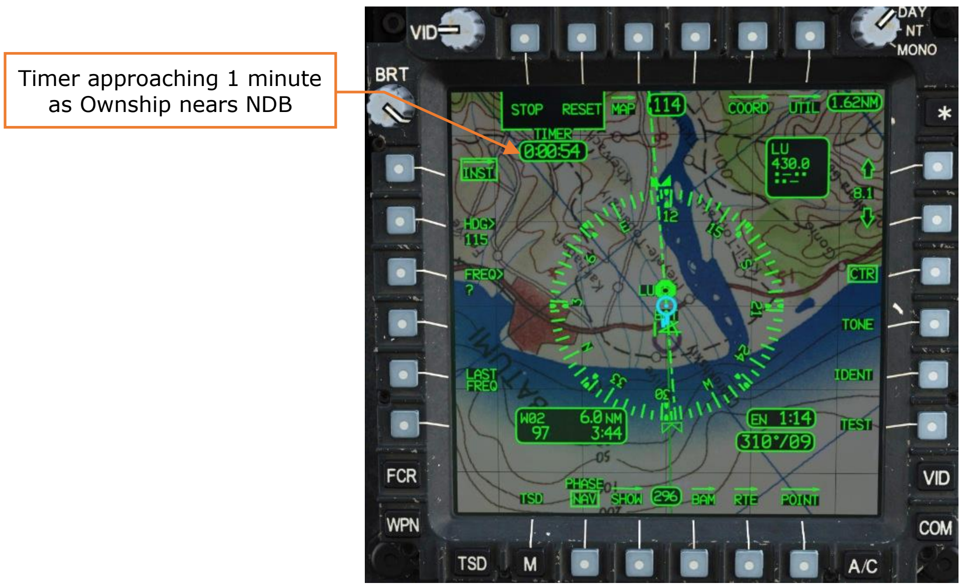


Figure 212. INST Sub-Page, Approaching the NDB

Instrument Approaches Using a Non-Directional Beacon (NDB)

When performing instrument approaches, the ADF can only be used to perform non-precision, time-based approaches. Whether being used as the missed approach point or as the final approach fix, NDB's can only provide limited position data.

The table below provides time/distance calculations based on the ground speed of the aircraft. This can be used to determine how long to track outbound from an NDB before performing a procedure turn, or how long to track inbound from an NDB before executing a missed approach.

GS	1 NM	2 NM	3 NM	4 NM	5 NM	6 NM	7 NM	8 NM	9 NM	10 NM
70	00:51	01:42	02:33	03:24	04:15	05:06	05:57	06:48	07:39	08:30
90	00:40	01:20	02:00	02:40	03:20	04:00	04:40	05:20	06:00	06:40
110	00:32	01:04	01:36	02:08	02:40	03:12	03:44	04:16	04:48	05:20

Procedure Turns from an NDB

Procedure turns are used to fly outbound from an NDB and then reverse course and track inbound on the same bearing course line back to the NDB. There are two main types of procedure turns used by Army helicopters, although there are others that can be performed depending on the airspace that is being operating within.

Figure 213. 45/180 Procedure Turn (Left), 80/260 Procedure Turn (Right)

The 45/180-degree procedure turn is performed by flying outbound from the NDB for a set time or distance. The turn is initiated by turning 45° away from the outbound course using a standard-rate turn and starting a timer for 1 minute at the onset of the turn. After 1 minute has elapsed, the aircraft is turned 180° in the opposite direction back toward the inbound course, which is intercepted normally, and the aircraft proceeds inbound.

The 80/260-degree procedure turn is performed by flying outbound from the NDB for a set time or distance the same as the 45/180. The turn is initiated by turning

80° away from the outbound course using a standard-rate turn. Upon reaching 80° difference in heading, the aircraft reverses its turn direction and continues into a 260° standard rate turn back toward the inbound course, which is intercepted normally, and the aircraft proceeds inbound.

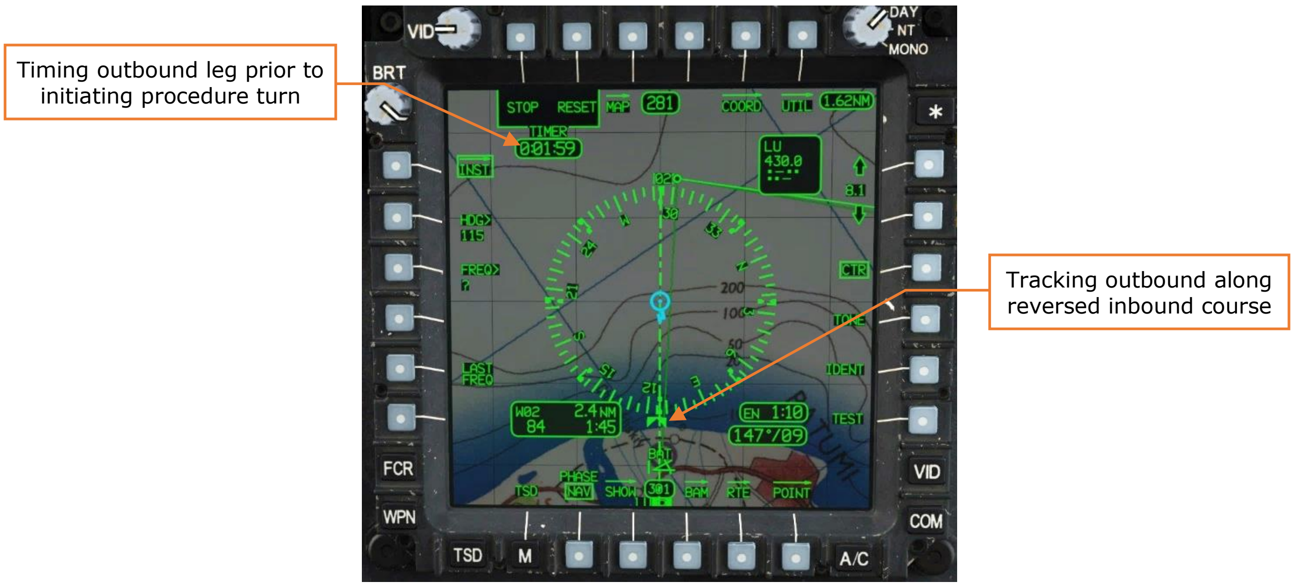


Figure 214. INST Sub-Page, Tracking Outbound from the NDB

Approaches to an NDB

When performing approaches to an NDB, often the NDB itself is used to indicate to the crew when to initiate a missed approach procedure. During these types of approaches, a procedure turn can be used to navigate outbound away from the NDB and then get established on the approach and start the descent after re-intercepting the inbound course. When the Ownship passes over the NDB station as indicated by the ADF Bearing Pointer rapidly reversing direction, the crew can then perform a missed approach if the runway isn't in sight.

Figure 215. NDB Approach to an NDB

Approaches from an NDB

When performing approaches from an NDB, often the NDB itself is used as the Final Approach Fix, and the crew initiates a missed approach procedure based on the time flown outbound from the NDB in the direction of the airfield. During these types of approaches, the approach can usually be started directly from a holding pattern, or immediately after crossing over the NDB station. When the Ownship passes over the NDB station as indicated by the ADF Bearing Pointer rapidly reversing direction, the crew starts a timer. When the timer reaches a certain value, based on the ground speed of the aircraft on the approach, the crew can then perform a missed approach if the runway isn't in sight.

Figure 216. NDB Approach from an NDB

Figure 217. Runway in sight.

COMMUNICATIONS

RADIOS

The ARC-186(V) VHF radio provides two-way line-of-sight communications over VHF-AM frequencies and is normally used for communicating with Air Traffic Control (ATC). The radio is not capable of secure communications. Its antenna is located on the top of the cambered fin.

The ARC-164(V) UHF radio provides two-way line-of-sight communications over UHF-AM frequencies and is normally used for communicating with ATC, other aircraft, or ground forces. The radio contains a separate dedicated guard receiver tuned to 243.0 MHz, the ability to communicate on HAVE QUICK frequency-hopping nets and can be connected to a KY-58 module for secure communications. Its antenna is located on the underside of the tail boom, aft of the sponson.

The AH-64D has two ARC-201D SINCGARS (Single Channel Ground and Airborne Radio System) sets that provide two-way line-of-sight communications over VHF-FM frequencies. Both radios have embedded secure communications capability and can communicate on frequency-hopping nets. The FM1 radio shares the tail-mounted whip antenna with the VHF radio, and the FM2 antenna is located on the underside of the tail boom, forward of the sponson. The FM1 radio is paired with the Improved FM (IFM) amplifier which can vary the output power of the radio.

Figure 218. AH-64D Communications Equipment

The AH-64D is equipped with an ARC-220 HF radio for two-way, non-line-of-sight (NLOS) and over-the-horizon (OTH) communications over shortwave frequencies. The radio has an embedded modem for sending and receiving data transmissions, can operate using frequency-hopping nets, and can be connected to a KY-100 module for secure communications capability. The ARC-220 is also capable of communications using Automatic Link Establishment (ALE) multi-channel nets to decrease crew workload and increase communications reliability. The HF radio utilizes a near-vertical incidence skywave (NVIS) type antenna which runs along the right side of the tail boom. The radio is paired with a dedicated amplifier which can vary the output power of the radio.

USING VOICE RADIOS

The aircraft radios are operated by cyclic controls, the EUFD and the MPD COM pages. A communications panel is also present in each crewstation and allows crews to adjust the volume of each individual radio, toggle radio squelch on or off, and adjust their microphone settings.

Cyclic and Floor Controls

The cyclic Radio Transmit Select (RTS) switch allows the crews to communicate externally via radio and internally via ICS (when ICS mode switch is set to Push-To-Talk), as well as cycle which radio to transmit on. To transmit voice over the selected radio, press the RTS switch to the left. To transmit voice over the ICS, press the switch to the right. By depressing the RTS switch, the crew can select their desired radio as seen on the EUFD indicator.

Figure 219. Pilot RTS Controls

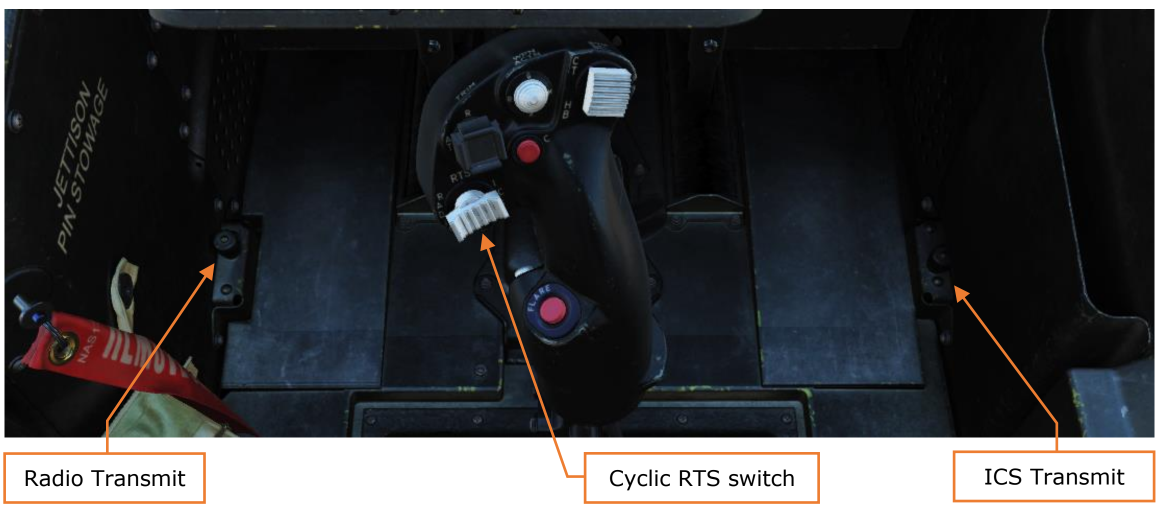


Figure 220. CPG RTS Controls

Two floor-mounted transmit switches are provided in each crewstation to allow the non-flying crewmember to transmit on their selected radio without interfering with the flight controls. The left floor switch allows the crewmember to transmit voice over the selected radio, and the right floor switch allows the crewmember to transmit voice over the ICS (when ICS mode switch is set to Push-To-Talk).

TUNING VOICE RADIOS USING EUFD

EUFD Controls

The EUFD Radio Transmit Select (RTS) rocker allows the crew to cycle their selected radio for voice transmission. The EUFD also features a “swap” button which swaps the currently selected radio’s primary frequency/settings with that radio’s standby frequency/settings. The Preset button can be used to access preset radio frequencies from the COM page.

EUFD Preset Tuning

The EUFD’s Preset list can be displayed at any time to access the 10 preset networks from the top-level COM page. When displayed, the Preset list is overlaid on top of the WCA Advisory column and the standby radio frequencies. While this menu is displayed, the WCA rocker functionality changes from scrolling through EUFD-displayed Warnings/Cautions/Advisories to moving the Preset Select arrow up and down the Preset list. The Preset list will only display preset frequencies for the radio the RTS is set to and is only capable of tuning single-channel frequencies.

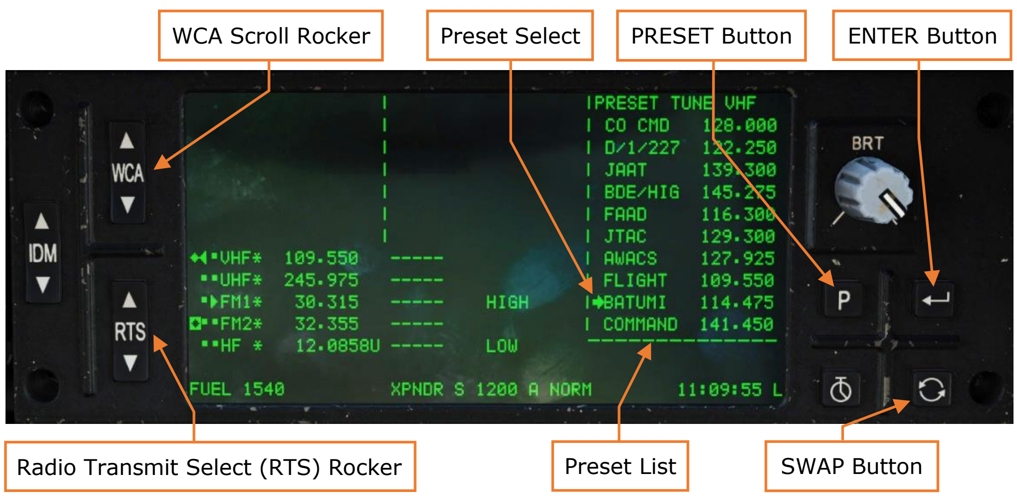


Figure 221. EUFD, Preset Format

To tune a frequency via the EUFD Preset function, perform the following:

6. PRESET button – Press.
7. RTS rocker – Select radio to tune.
8. WCA rocker – Select frequency from Preset list.
9. ENTER button – Press.

TUNING VOICE RADIOS USING AN MPD

MPD Controls

The primary means of tuning a radio is through the MPD COM page, using either manual frequency entry or a preset entry. The COM page is also used to configure individual radio settings.

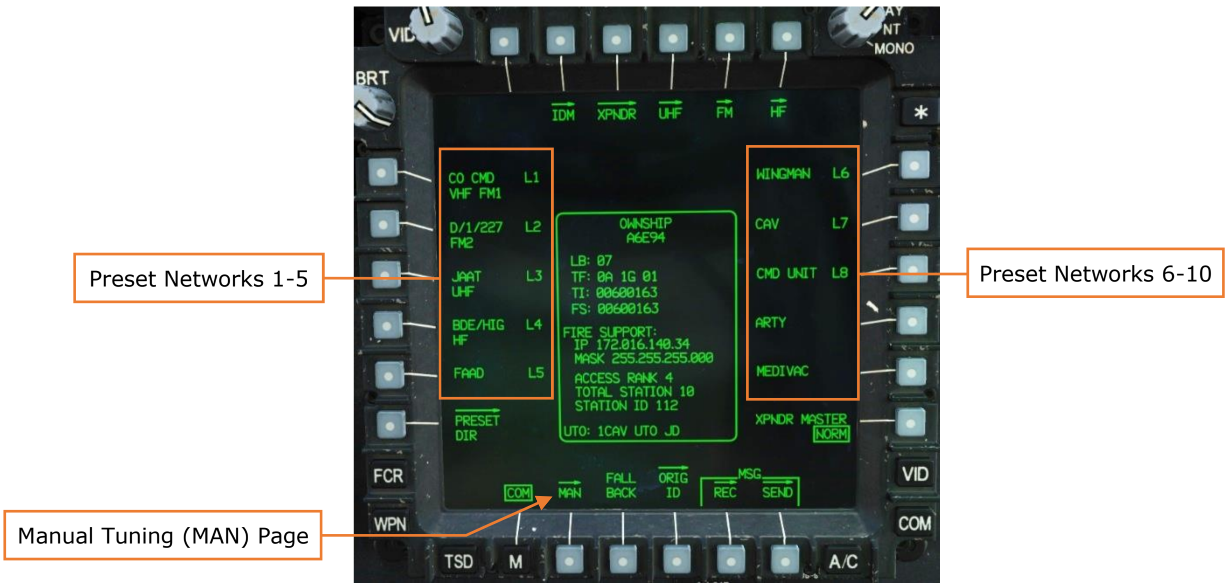


Figure 222. MPD COM Page

MPD Manual Tuning

The MAN page is used to manually enter a frequency into a radio without using a preset. When a radio is tuned to a manual frequency, IDM protocols and networks cannot be utilized over that radio. The MAN page can also be utilized to quickly tune either the VHF or UHF radio to the international GUARD frequencies of 121.5 and 243.0 respectively.

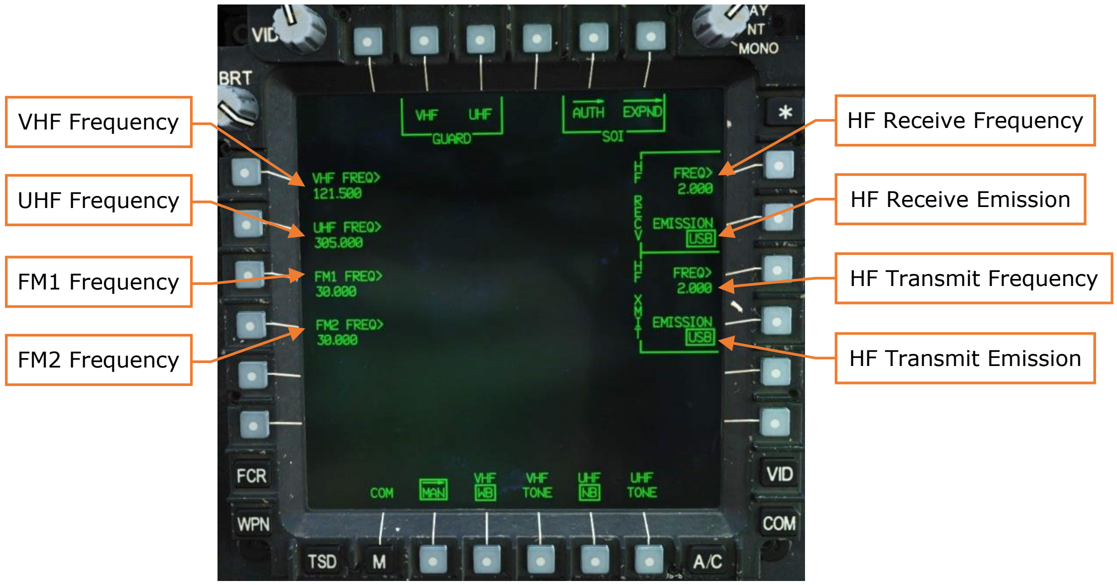


Figure 223. MPD COM Page, MAN Sub-Page

To manually tune a VHF frequency via the COM page, perform the following:

1. COM fixed action button – Press.
2. MAN (B2) – Select.
3. VHF FREQ> (L1) – Select and enter frequency with the KU.

To manually tune a UHF frequency via the COM page, perform the following:

1. COM fixed action button – Press.
2. MAN (B2) – Select.
3. UHF FREQ> (L2) – Select, and enter frequency with the KU.

To manually tune an FM frequency via the COM page, perform the following:

1. COM fixed action button – Press.
2. MAN (B2) – Select.
3. FM1 FREQ> (L3) – Select, and enter frequency with the KU.

   or

3. FM2 FREQ> (L4) – Select, and enter frequency with the KU.

To manually tune an HF frequency via the COM page, perform the following:

1. COM fixed action button – Press.
2. MAN (B2) – Select.

3. HF RECV FREQ> (R1) – Select, and enter frequency with the KU.
4. HF RECV EMISSION (R2) – Select and set appropriately.
5. HF XMIT FREQ> (R3) – Select, and enter frequency with the KU.
6. HF XMIT EMISSION (R4) – Select and set appropriately.

MPD Preset Tuning

-Coming later in EA-

A total of 60 Preset Networks are available to the crew and are usually built during pre-mission planning. The top-level COM page displays 10 Preset Nets (also selected during pre-mission planning and loaded via the DTC). The additional remaining 50 Preset Networks are found in the Preset Directory and can replace the top-level COM page Preset Networks.

Each Preset Network can contain the following:

- 8-character preset name which is displayed on the COM page
- 5-character callsign which is displayed on the EUFD
- VHF single-channel frequency
- UHF HAVE QUICK frequency-hopping net
- UHF single-channel frequency
- FM1 SINCGARS frequency-hopping net
- FM1 single-channel frequency
- FM2 SINCGARS frequency-hopping net
- FM2 single-channel frequency
- HF ECCM frequency-hopping net
- HF ALE multi-channel net
- HF Preset single-channel frequency
- HF Manual single-channel frequency
- IDM Protocol
- Net members and associated address information

Figure 224. MPD COM Page, Preset Format

TRANSPONDER (IFF)

The APX-118(V) transponder set provides Identification Friend or Foe (IFF) responses to friendly force interrogations and identification and altitude reporting to civilian ATC. The transponder includes two selectable antennas: one on top of the fuselage just aft of the cockpit, and the other below the tail boom just forward of the vertical tail fin.

Setting Transponder Codes

To set a transponder code into the APX-118(V) via the COM page, perform the following:

1. COM fixed action button – Press.
2. XPNDR (T3) – Select.
3. MODE 1> (R1) or MODE 3/A> (R2) – Select and enter code with the KU.

IMPROVED DATA MODEM (IDM)

-Coming later in EA-

The IDM provides digital communications capabilities between other AH-64D helicopters via the Air Force Application Program Development (AFAPD), referred to as the DL Net. The IDM can transmit over the VHF, UHF, or FM radios, provided they are configured as a DL Net (denoted by an L in the EUFD) and the crew has selected that radio using the IDM rocker on the EUFD.

The IDM allows other AH-64D helicopters to individually transmit points, routes, FCR targets, text messages, files, or the entire DTC mission database.

SENSORS AND SIGHTS

The AH-64D uses a wide range of sensors to detect, acquire, and engage targets on the battlefield. These sensors range from an advanced Fire Control Radar to the basic Mk1 eyeball, and all are integrated into the AH-64D's Data Management System to provide enhanced situational awareness and rapid engagement of enemy forces during day or night.

The three sights that can be used for targeting weapons are the crewmembers' Helmet-Mounted Displays (HMD), the Target Acquisition Designation Sight (TADS), and the Fire Control Radar (FCR). Each of these sights provides its own advantages and disadvantages when deciding how and when to engage the enemy and should be employed accordingly by the crew. These sights include multiple sensors that can be selectively used for the purposes of targeting or navigation.

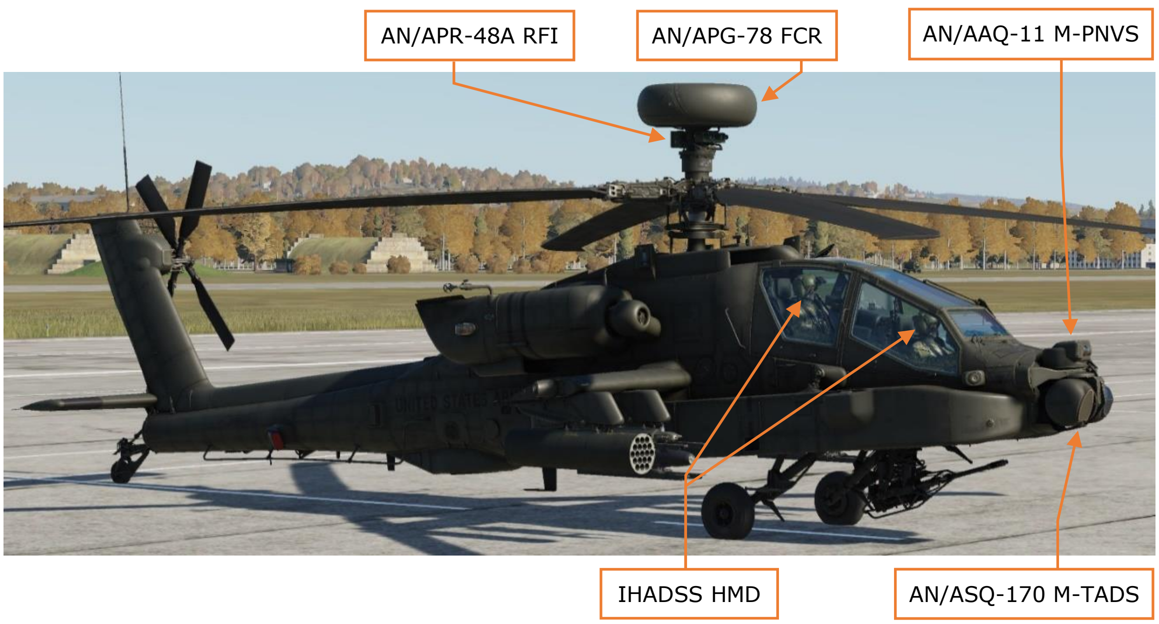


Figure 225. AH-64D Sensors and Sights

The HMD can be used to enhance the crew's ability to target with their own eyes, as well as augment their ability to navigate at night or under low-visibility conditions. The TADS uses a combination of electro-optical sensors in both the visible and infrared spectrums to detect and target enemy forces at long-range, perform reconnaissance, and can also be used to aid in navigation at night or under low-visibility conditions. The FCR consists of both an active radar antenna to scan the battlefield and a passive radio detection antenna array to target enemy air defenses. Like the HMD and TADS, the FCR can also be used to assist the crew in navigation at night and low-visibility conditions.

HELMET MOUNTED DISPLAY (HMD)

The Integrated Helmet And Display Sight System (IHADSS) establishes the crewmember line of sight (LOS). The Weapons Processors use the crewmembers LOS for sensor pointing, ranging and weapons aiming. The Helmet Display Unit (HDU) provides the Helmet Mounted Display (HMD), where symbology and sensor video are displayed. Adjustments to the HDU video are accomplished via the Pilot VIDEO panel, or the CPG TDU bezel buttons. The HDU can be boresighted from the WPN page in conjunction with the Boresight Reticle Unit (BRU). Positioning of the helmet in 3D space is provided by four IR detectors mounted on the Integrated Helmet Unit (IHU), with two on each side.

Figure 226. IHADSS Helmet

Through the HDU, the crewmembers are presented with a 30°x40° field-of-view of the outside world over which flight symbology is overlaid, in addition to sensor video from the Pilot Night-Vision System (PNVS) or Target Acquisition Designation Sight (TADS).

When an Acquisition source is selected from the MPD, cueing dots are provided around the line of sight indicating a direction the crewmember should look to place the Acquisition source within their HMD field-of-view. Typically, during non-combat training flights each crewmember selects each other’s helmet LOS (GHS/PHS) as their Acquisition source to facilitate traffic and obstacle advisories.

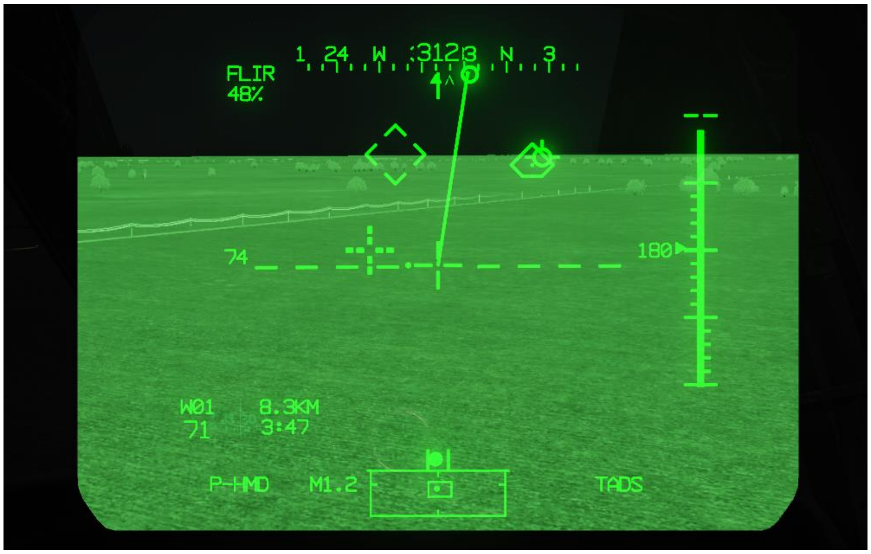


Figure 227. Pilot HDU with Flight Symbology & PNVS Sensor Video

During combat, it is useful for the CPG to be slaved to GHS to facilitate remaining "heads out" while searching for targets, and then de-slaving when a point of interest is detected. The Pilot can use TADS as their selected Acquisition source to have better situational awareness of where the TADS is oriented. This is particularly useful for the Pilot because it provides the Cued LOS Dot within the Field-Of-Regard (FOR) which assists the Pilot in maintaining the CPG's TADS within the allowable slew limits of the TADS turret.

Figure 228. CPG HDU with Weapon Symbology & TADS Sensor Video

AN/AVS-6 Aviator Night Vision Goggles

Either crewmember can be equipped with night vision goggles. The AN/AVS-6 Aviator Night Vision Goggles (ANVIS) provide aircrews with a high-fidelity, binocular, 40° field-of-view under extreme low-light conditions. The AVS-6 NVGs amplify light in the visible and near-infrared spectrum to enable aircrews to operate under any lighting conditions, while flying at NOE altitudes near terrain and other natural or man-made obstacles.

The AVS-6 NVG's are not used at the same time as the HDU, and therefore the HDU will be removed from the crewmember's view when the NVG's are enabled. The IHADSS will continue to track the crewmember's helmet however, therefore crewmembers are still able to cue aircraft sensors to their coarse line-of-sight. The NVG's should not be used as a means of targeting due to the lack of precise aiming symbology.

Figure 229. AN/AVS-6 Night Vision Goggles

PILOT NIGHT VISION SYSTEM (PNVS)

The AN/AAQ-11 Modernized Pilot Night Vision Sensor (M-PNVS) is an aided pilotage solution for day, night, and adverse weather missions. The PNVS has a range of motion of +20° to -45° in elevation and ±90° degrees in azimuth and has a slew rate of 120° per second.

The quality of the FLIR image can be adjusted using the VIDEO panel FLIR knobs. The small inner knob adjusts the FLIR LEVEL and the larger outer knob adjusts the FLIR GAIN. The overall image quality for the FLIR can be adjusted using the IHADSS knobs. The small inner knob controls the IHADSS BRT (brightness) and the larger outer knob adjusts the IHADSS CON (contrast). Additionally, the FLIR can be operated in either WHOT (white hot) or BHOT (black hot) mode by selecting the collective BORESIGHT/POLARITY switch located on the collective flight grip.

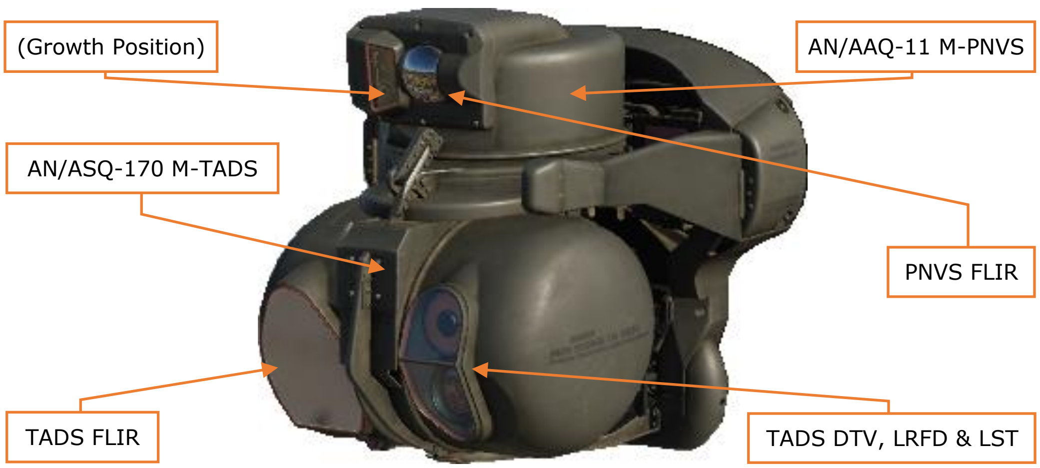


Figure 230. M-PNVS & M-TADS Turret Assemblies

TARGET ACQUISITION DESIGNATION SIGHT (TADS)

The AN/ASQ-170 Modernized Target Acquisition Designation Sight (M-TADS) is a long-range, precision engagement and pilotage solution for day, night, and adverse weather missions. It is comprised of two "sides", the "Night Side" and the "Day Side". The Night Side" contains the Forward Looking Infrared (FLIR) sensor and the "Day Side" contains the Day Television (DTV), Laser Range-Finder/Designator (LRFD) and Laser Spot Tracker (LST). The TADS has a range of motion of +30° to -60° in elevation and ±120° in azimuth and has a slew rate of 60° per second.

The TADS provides the following:

- Target detection via the FLIR (Day/Night) and DTV (Day only)

- Targeting and employment of the Hellfire missile against moving and stationary targets.
- Targeting and employment of the 30mm cannon.
- Targeting and employment of the 2.75” Folding Fin Aerial Rockets (FFAR) in a cooperative (COOP) engagement mode.
- The ability to store targets for recall by the crew.

The TADS video is displayed on the TADS Electronic Display and Control (TEDAC) Display Unit (TDU), which is a 5x5 inch display located in the CPG crewstation, and in the CPG’s HDU. The TDU displays FLIR or DTV video in a 4x3 (Normal) aspect ratio.

When operating the DTV, the CPG has access to two levels of optical magnification (Wide and Narrow) and an additional electronic Zoom field-of-view. When the FLIR sensor is selected, the CPG has access to three levels of optical magnification (Wide, Medium, and Narrow) and an additional electronic Zoom field-of-view. The TADS is operated by the CPG via the TEDAC left- and right-hand grips.

The TADS can be manually controlled using the SIGHT MANUAL TRACKER, more commonly referred to as the “Thumbforce Controller”. The TADS can also be slaved to an acquisition source selectable on the MPD by pressing the RHG SLAVE button. TADS slew rates are reduced when fields-of-view of higher magnification are selected by the CPG to aid in targeting stabilization.

The FLIR sensor video can be adjusted using the TDU LEV (level) and GAIN knobs, and the overall TDU video for both DTV and FLIR can be adjusted using the BRT (brightness) and CON (contrast) rockers. The brightness and contrast controls can be used to adjust the TDU grayscale when the TADS is the selected sight by selecting the G/S (grayscale) button. To return to viewing TADS video, select TAD on the TDU. There is also a R/F (range focus) rocker available to the crew to improve the clarity of the image in both DTV and FLIR. Additionally, the FLIR can be operated in either WHOT (white hot) or BHOT (black hot) mode by selecting the FLIR POLARITY SWITCH located on the RHG.

Weapon Symbology

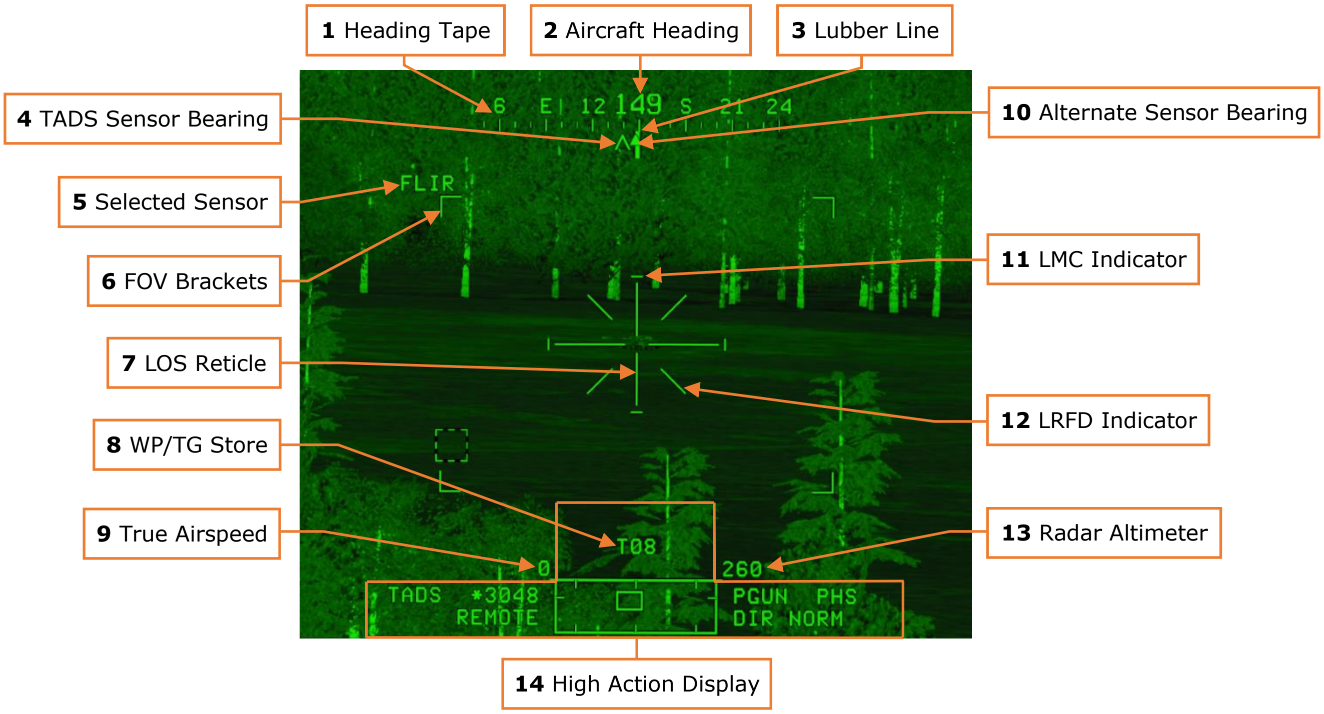


Figure 231. Weapon Symbology

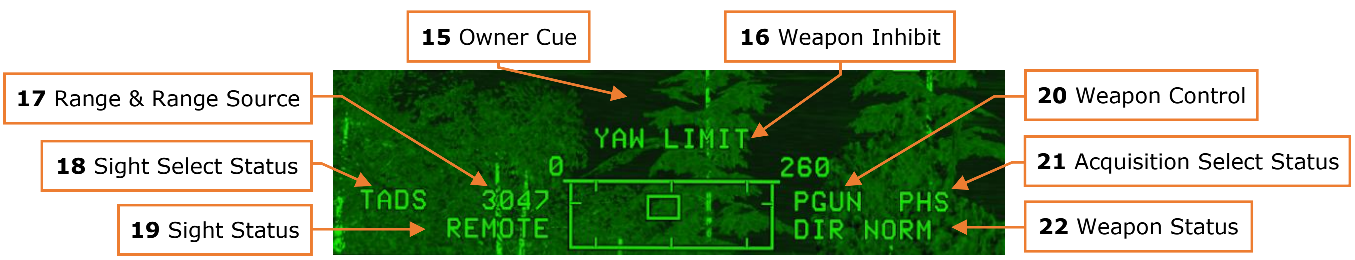


Figure 232. High Action Display

1. **Heading Tape.** Provides a 180° wide scale of compass directions in 10° increments, with every 30° marked by a cardinal direction or heading to the tenths value.

2. **Aircraft Heading (HDG).** Displays a digital readout of the current aircraft heading in 1° increments.

3. **Lubber Line.** The lubber line is aligned to the centerline of the aircraft and serves as a reference for both the aircraft heading and Cruise mode symbology bank angle indicator.

4. **TADS Sensor Bearing.** Chevron that indicates the LOS azimuth of the TADS sensor when TADS video is displayed.

5. **TADS Selected Sensor.** Indicates which sensor is in use (FLIR or DTV).
6. **Field-Of-View (FOV) Brackets.** Indicates the field-of-view that will be visible within the TADS video if the next FOV is selected. Not displayed when in Zoom FOV.
7. **Line-Of-Sight (LOS) Reticle.** Indicates the line-of-sight of the selected sight. It is also used as an aiming crosshair for weapons employment. The LOS reticle flashes when the TADS's LOS is invalid, laser firing is inhibited, or if the gun is actioned and has failed.
8. **Waypoint (WP)/Target (TG) Store.** Displayed for 4 seconds to indicate to the aircrew what Waypoint (WP) or Target (TG) number has been stored by the CPG TADS or HMD LOS.
9. **True Airspeed (TAS).** Indicates the true airspeed of the aircraft in 1 knot increments, from 0 to 210 knots.
10. **Alternate Sensor Bearing.** Indicates the azimuth of the Pilot's helmet when the Pilot's selected sight is HMD. The alternate sensor bearing is not displayed in the TADS weapon symbology when the Pilot's selected sight is FCR.
11. **LMC On Indicator.** Four "caps" are placed at the end of each post of the LOS reticle to indicate when the Linear Motion Compensator is enabled.
12. **Laser (LRFD) Firing Indicator.** Large "X" symbol is displayed around the LOS reticle to indicate when the LRFD is firing.
13. **Radar Altimeter (AGL).** Aircraft altitude above ground level from 0 to 1,428 feet, displayed in increments of 1 foot up 50 feet in altitude, and increments of 10 feet between 50 feet and 1,428 feet in altitude. The radar altimeter digital readout will be removed when above 1,428 feet.
14. **High Action Display (HAD).** The High Action Displayis displayed in both Flight and Weapons symbology. The HAD provides prioritized sight and weapon status messages to the crew for targeting and weapons employment.
15. **Owner Cue.** During single DP operations, "PLT FORMAT" or "CPG FORMAT" will flash for 3 seconds within the HMD whenever the ownership of the video source changes, or when entering or exiting single DP operations.
16. **Weapon Inhibit.** Displays safety or performance inhibit indications based on the currently actioned weapon within the crewstation. Also displays W## or T## messages for 4 seconds in the CPG HMD or TADS symbology when a WP or TG is stored using the CPG's LOS.
17. **Range and Range Source.** Displays the range source in use and the current range in tenths of kilometers or meters (laser only). Available range sources include:

a. **Default range:** 1.5 km for the Pilot; 3.0 km for the CPG

b. **Manual range:** 100-50,000 meters (displayed as M0.1 to M50.0)

c. **Auto range:** 0.1 km to 50 km (displayed as A0.1 to A50.0)

d. **Navigation range:** 0.1 to 32 km (displayed as N0.1 to N32.0)

e. **Radar range:** 0.1 to 9.9 km (displayed as R0.1 to R9.9)

f. **Laser range:** 500 to 9999 meters (displayed as 500 to 9999)

18. **Sight Select Status.** Indicates the sight currently selected within the crewstation. Sight selection statuses include:

    a. **P-HMD:** Pilot's selected sight is HMD.

    b. **P-FCR:** Pilot's selected sight is FCR.

    c. **P-FCRL:** Pilot's selected sight is FCR. TADS has been linked.

    d. **C-HMD:** CPG's selected sight is HMD.

    e. **C-FCR:** CPG's selected sight is FCR.

    f. **C-FCRL:** CPG's selected sight is FCR. TADS has been linked.

    g. **TADS:** CPG's selected sight is TADS.

    h. **TADSL:** CPG's selected sight is TADS. FCR has been linked.

19. **Sight Status.** Displays status messages of aircraft sights and weapon status messages of laser-guided Hellfires launched in Remote Fire mode.

20. **Weapon Control.** Indicates the currently actioned weapon within the opposite crewstation. Weapon Control indications include:

    a. **PGUN –** Pilot's actioned weapon is gun.

    b. **PRKT –** Pilot's actioned weapon is rockets.

    c. **PMSL –** Pilot's actioned weapon is missiles.

    d. **CGUN** – CPG's actioned weapon is gun.

    e. **CRKT** – CPG's actioned weapon is rockets.

    f. **CMSL** – CPG's actioned weapon is missiles.

    g. **COOP –** Pilot's actioned weapon is rockets; CPG has actioned rockets on the left TEDAC grip in cooperative rockets mode.

21. **Acquisition Select Status (ACQ).** Indicates the acquisition source currently selected within the crewstation. Acquisition sources include:

a. **PHS** – Pilot Helmet Sight

b. **GHS** – Gunner Helmet Sight

c. **SKR** – Tracking missile seeker

d. **RFI** – Radio Frequency Interferometer

e. **FCR** – Fire Control Radar

f. **FXD** – Fixed forward (0° in azimuth/-4.9° in elevation)

g. **W##, H##, C##, T##** – (## is the number of the stored Waypoint, Hazard, Control Measure or Target/Threat)

h. **TRN** – Cursor-selected terrain location on the TSD

22. **Weapon Status.** Displays status messages of the currently actioned weapon within the crewstation.

Linear Motion Compensator (LMC)

The TADS features the Linear Motion Compensator (LMC) which is used to aid in tracking. It compensates for helicopter movement and/or target movement and is meant to reduce CPG workload. The LMC slew rate gains are reduced when fields-of-view of higher magnification are selected by the CPG to aid in targeting stabilization, and further modified by the range source in use by the Target State Estimator to adjust for motion parallax.

Multi-Target Tracker (MTT)

-Coming later in EA-

Laser Range Finder and Designator (LRFD)

The TADS Laser Range Finder Designator (LRFD) can provide both range and designation of a target. In both instances, the aircraft must be armed to operate the LRFD. To range a target, the TEDAC RHG LRFD trigger is pulled to the first detent and three ranging pulses are emitted. To designate a target, the TEDAC RHG LRFD trigger is pulled to the second detent and a continuous laser pulse is emitted. Pulling the LRFD trigger to the second detent also engages the Target State Estimator (TSE) to provide lead-angle compensation when employing the gun or rockets. General guidance with regards to the laser are: If neither the target nor the aircraft is moving use first detent ranging, otherwise use continuous second detent designation to employ the TSE.

Laser Spot Tracker (LST)

-Coming later in EA-

FIRE CONTROL RADAR (FCR)

-Coming later in EA-

Figure 233. FCR Mast-Mounted Assembly (MMA)

RADIO FREQUENCY INTERFEROMETER (RFI)

-Coming later in EA-

ACQUISTION SOURCES (ACQ)

An acquisition source can quickly orient a crewmember's selected sight to either a point in space relative to the aircraft nose or a set of three-dimensional coordinates on the battlefield. This could be used for example by the Copilot/Gunner to slave the TADS turret to wherever the Pilot is looking, the Pilot could select TADS as the acquisition source to monitor the direction the Copilot/Gunner is aiming the TADS, or a crewmember could select a target point stored in the database to slave their sight to that location on the battlefield.

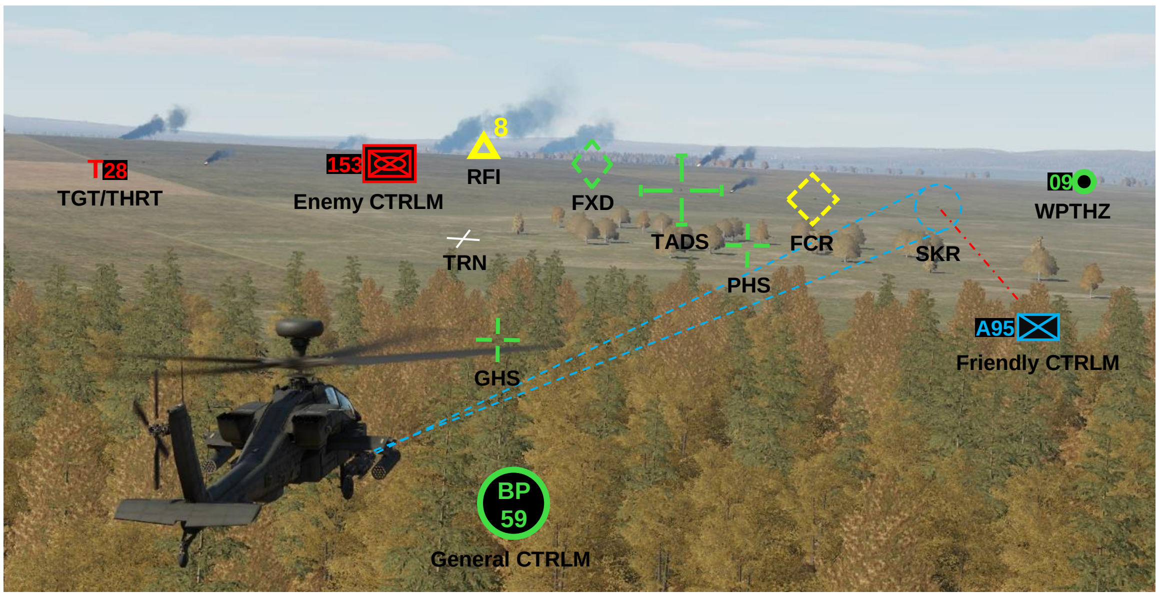


Figure 234. Acquisition sources on the battlefield

The purpose of the acquisition source is to reduce the time needed to manually search and acquire a target with any given sight. In the case of the TADS or FCR, these sights will physically slew to the location of the selected acquisition source. In the case of the HMD, the crewmember will receive cueing indications in their helmet symbology of where they should look to point their head toward the selected acquisition source (in lieu of a robotic arm physically grabbing their head and forcibly turning it in the correct direction).

Each crewmember may select and receive cueing information from the following selectable Acquisition sources:

- PHS – Pilot Helmet Sight
- GHS – Gunner Helmet Sight
- SKR – Tracking missile seeker

- RFI – Radio Frequency Interferometer
- FCR – Fire Control Radar
- FXD – Fixed forward (0° in azimuth/-4.9° elevation)
- TADS – Target Acquisition Designation Sight
- W##, H##, C##, T## - Where ## is the number of the stored Waypoint, Hazard, Control Measure or Target/Threat
- TRN – Cursor-selected terrain location on the TSD

In most cases, any of the available sight selections can serve as an acquisition source for another sight, but a crewmember can never select their current sight to also be their current acquisition source. For example, the Copilot/Gunner cannot select TADS as their sight and their acquisition source at the same time, because you can't slave the TADS to the TADS (it is already looking where it is currently looking).

As is the case with sight selections, choosing the best acquisition source in any given situation is key to reducing the time it takes to search, acquire, and engage enemy targets. In most circumstances, the most important aspect to this is proper coordination and communication between each crewmember; so that each crewmember is aware of what the opposite crewmember's sight is doing, and whether they need to hand off targets between each other for engagement by the appropriate sight/weapon combination.

In the case of setting the acquisition source to a point within the database (W##, H##, C##, T##) or to a cursor-selected terrain location on the TSD (TRN), this action will also set that crewmember's range source to a Navigation range to that point or location when SLAVE is enabled.

The CPG must enable the SLAVE function on the TEDAC right handgrip in order to receive cueing to the acquisition source when sight-selected to HMD, just as it is required to press the SLAVE button to slew the TADS or FCR to the CPG's acquisition source.

The Pilot SLAVE is always enabled and will always receive cueing to the acquisition source (if CUEING is enabled via the WPN UTIL sub-page) if sight-selected to HMD, and the FCR will always slew to the Pilot's acquisition source if sight-selected to FCR.

COMBAT EMPLOYMENT

ATTACK HELICOPTERS IN COMBAT

The most basic description of an attack helicopter is a rotary-winged aircraft that is specifically equipped with weapons and munitions to destroy targets on the battlefield. For attack helicopters that are designed to engage medium and heavy armor units, a common euphemism to describe such helicopters is a “flying tank”. While this may convey the relative lethality that these attack helicopters possess when compared to a main battle tank, it often lends itself to a misconception that attack helicopters are bulletproof or can withstand enormous amounts of punishment while continuing to engage enemy forces.

While most attack helicopters are armored or reinforced against various calibers of weapons fire, such protection is only in the most critical areas of the airframe. Extra armor equates to additional weight, which hinders performance of the aircraft itself, as well as reducing the amount of fuel and/or weapons the helicopter can carry to the fight. Because of this limitation, armored protection is prioritized for the most critical components (to include the aircrew), with system redundancy and crashworthiness making up the rest of the aircraft hardening.

Such redundancy and crashworthiness are implemented to ensure crew survival and recovery of the airframe to friendly locations for repairs. While “fighting to the death” as shown in the movies may seem worthwhile to achieve immediate mission results, in reality it hinders the long-term strategic objectives of a military conflict. An attack helicopter, by its nature as an airborne weapons system, can achieve something that similarly armed ground vehicles cannot: mobility and speed across any terrain or obstacle. This speed and the ability to traverse any terrain by simply flying above it means an attack helicopter can more easily attack targets behind enemy lines, engage targets that are beyond the reach of friendly artillery, perform reconnaissance and screening operations in areas that ground vehicles cannot, and more rapidly respond to changes on the battlefield in real-time.

Attack helicopters can be employed independently of ground forces to shape the battlefield ahead of friendly ground offensives. Alternatively, they can be employed in conjunction with ground forces to mass fires against the enemy at decisive points in a battle; or used as close-in security to protect friendly ground forces from hostile attack.

Depending on which country or branch of service an attack helicopter originates, such units are employed as either Close Air Support (CAS) aircraft or as "maneuver units" (much in the same manner infantry or armor units are employed in conventional maneuver warfare). In the CAS role, one key difference between attack helicopters and most fixed-wing attack aircraft is the economy of firepower. Fixed-wing attack aircraft may be able to physically carry a much greater payload of munitions as far as pure tonnage is concerned, but purpose-built attack helicopters are often equipped with a greater number of smaller munitions that are accurate and highly effective against various types of ground vehicles.

YAH-64A (US Army)

In addition, most attack helicopters are also equipped with machine guns or medium-caliber automatic cannons coupled with highly accurate fire control systems that can engage or suppress ground troops at close ranges, as well as unguided rocket systems for large area suppression. Most modern attack helicopters are quite capable of employing all of these weapon systems against multiple targets within a short time span, without the time needed by fixed-wing attack aircraft to reorient for multiple attack runs against successive targets.

Mobility, Stand-off, and Planning Ahead

The primary advantage of a helicopter on the battlefield when compared to their ground vehicle counterparts is their ability to cover distances across any terrain within a short amount of time. This battlefield mobility allows helicopters to rapidly move troops and equipment to the rear of enemy echelons, rapidly resupply or reinforce dispersed units, evacuate wounded soldiers to receive medical treatment, respond to enemy attacks on flanks of friendly units, respond to calls for fire support along the front line, or exploit targets of opportunity beyond the front line.

As discussed above, helicopters are still quite vulnerable to enemy weapons fire. When hovering or flying at low-speed, helicopters are vulnerable to engagement by ATGM's or even a tank's main gun. The primary method for attack helicopters to mitigate such threat weapons is *standoff*. Whenever possible, an attack helicopter aircrew should always choose a battle position that places the enemy within the maximum effective range of their weapons, while remaining outside the maximum effective range of the enemy's. When standoff cannot be maintained due to changes on the battlefield, the aircrew can utilize its *mobility* to rapidly re-position the attack helicopter to regain and maintain that standoff for as long as possible. This maximizes the attack helicopter's lethality against the enemy, while minimizing the enemy's ability to engage it.

A key part in maintaining standoff from enemy forces, especially in situations where enemy positions are not well known, is *planning*. Even before climbing into the cockpit, air routes, terrain, suspected/known enemy positions, enemy weapon systems, and even the weather, should all be evaluated to understand how each factor will affect the aircrew's ability to maintain standoff or remain masked behind terrain from the enemy. However, even with a thorough plan, discretion should be taken when moving within hostile territory. Blindly bounding from one position to the next without performing reconnaissance of the route to that next position, and any potential fields of observation or fire, is a good way to be surprised by a missile or stream of tracers directed at your aircraft.

Figure 235. Enemy units may be lurking around the next tree line

It is very possible that an attack helicopter aircrew can get themselves pinned down by hostile ground forces. If the aircrew rushes from terrain feature to the next, without verifying the security of their next position or the route to get there, the aircrew may be unable to go forward, they may be unable to go back, and if they climb above the terrain, they may be engaged by air defenses. In this instance, the aircrew may need to risk the success of their mission and fight their way out with significant munition expenditures.

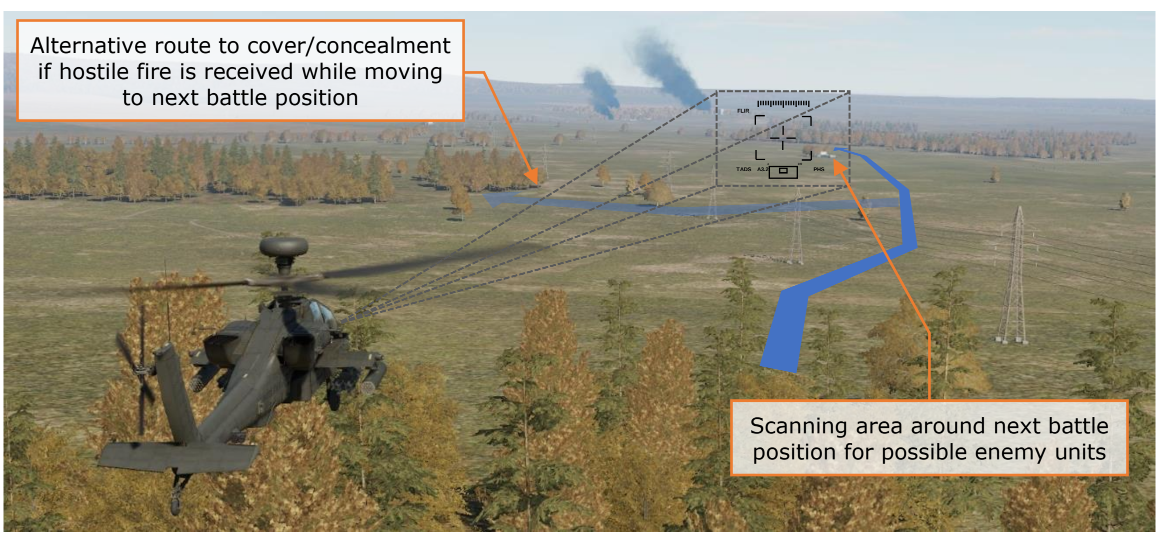


Figure 236. Recon next battle position with alternative sources of cover

Weapons discipline is another practice that is important. Despite its firepower, an attack helicopter only has a limited amount of munitions onboard to achieve the mission. These weapons should be used in a manner that achieves the maximum effect on the battlefield whenever possible. Destroying every enemy that is detected while enroute to the objective may feel satisfying but running out of munitions prior to achieving the mission objective(s) will remove that satisfaction quickly. Attack helicopters, by nature of their mobility and standoff, have the advantage of being more selective about what engagements they get into, from where they engage from, and what targets they bypass and report to higher echelons.

Even when the primary objective is spotted, tactical patience should be exercised to fully develop the situation and determine what else may be in the area. Prior to pulling the trigger, scanning the area for any other enemy positions or air defenses that may be defending the target is important to ensure survival of the attack helicopter team. If the flight has enough weapons to spare, it may be wise to sanitize the target area of any threats (such as air defense units) prior to engaging the primary targets.

Masking/Un-Masking & Terrain Flight

When used in a conflict against armor with air defenses and such, attack helicopters such as the AH-64 are often maneuvered akin to an infantryman or a sniper, rather than a conventional aircraft. Attack helicopters utilize cover and concealment whenever possible (known as "masking"), bounding from one battle position to the next to minimize exposure to enemy fire, and try to remain undetected for as long as possible until they are ready to attack.

To perform sensor scans of the battlefield or engage enemy targets with their weapon systems, attack helicopters must "un-mask" from behind cover/concealment. Depending on the nature of the cover/concealment and the tactical situation, attack helicopters can un-mask vertically or laterally to expose their sensors or weapon systems.

When an attack is initiated, the enemy should be engaged within the shortest amount of time possible before re-masking and relocating to a different battle position. Weapons fire reveals the attack helicopter's presence to the enemy, just as a sniper reveals his position by firing on the enemy.

Figure 237. Un-masking from behind cover

The most advantageous factor attack helicopters can use to their benefit is *terrain*. Mother Earth will always provide the best protection from enemy observation and weapons fire. Low-altitude flight below the horizon and amongst the terrain features allow helicopters to maximize their survivability and remain undetected for as long as possible. However, low-altitude flight can be quite demanding on an aircrew, especially at night or in low-visibility conditions. As such, the speed that helicopters can attain when operating at such altitudes is dependent on the nature of the terrain, the tactical situation, the time of day, enemy air defenses, and how much power margin is available to the aircrew.

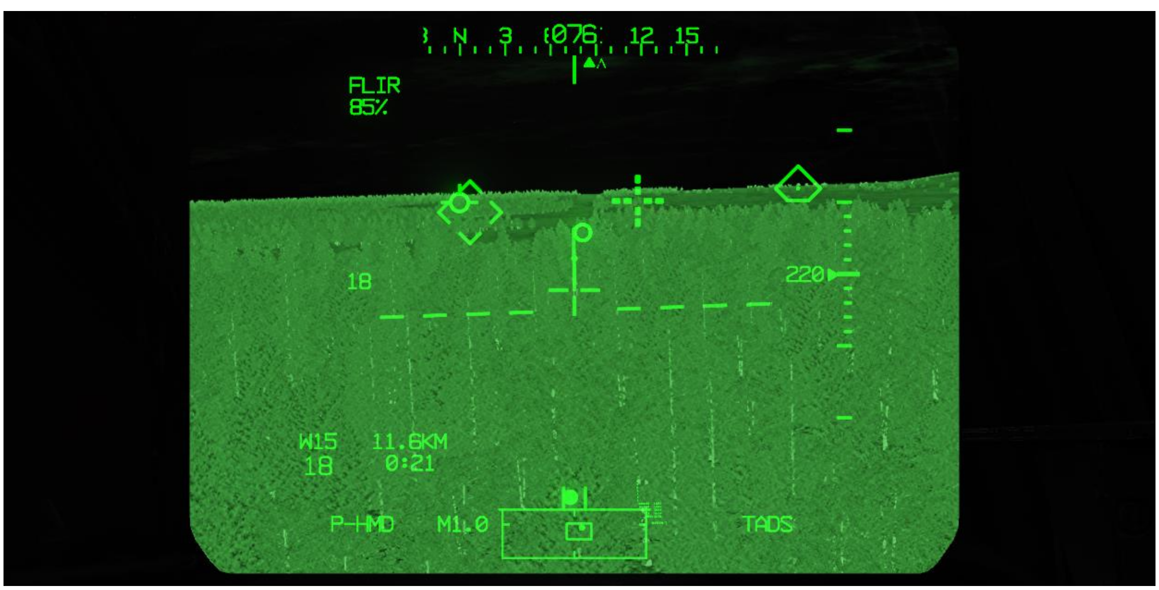


Figure 238. Limited field-of-view, at night, near terrain and obstacles

Conversely, in a threat environment where air defenses are low, and the most prevalent threat to helicopters is small arms fire such as rifles or machine guns, it may be advantageous to maintain a higher altitude outside the engagement ranges of such weapon systems. This will improve the range at which aircrews can detect the enemy, as well as placing less demand on an aircrew when compared to flying at low altitude, allowing them to focus on engaging the enemy.

In most major regional conflicts in theaters that contain large numbers of air defenses, low-level tactics are the best advantage that attack helicopters can employ. While jet-powered fixed-wing aircraft can use high-speed to minimize the time spent inside the engagement zone of an air defense unit, helicopters must use terrain-masking and limit their exposure to attain a reasonable level of survivability. The level of exposure and time spent un-masked should be primarily dependent on threat reaction time, but also may be predicated on the time needed to perform sensor scans of an area or the time needed to employ a weapon against a target. These two factors - time needed by the enemy to detect/engage you versus time needed by you to detect/engage the enemy - should constantly be weighed against the other throughout the mission as the tactical situation evolves.

AH-64 COMBAT EMPLOYMENT

Pre-mission planning is the most important part of any successful combat mission. Just as in the case with other military aircraft, factors such as terrain and threat locations should be considered when planning mission routes, altitudes and weapons loads. Routes and altitudes should be selected to maximize survivability and reduce the probability of detection by threat weapon systems.

Routes, pre-planned targets, enemy threats, and other graphical control measures can be displayed on the Tactical Situation Display (TSD) along with information from the aircraft sensors to enhance situational awareness and provide an overview of the surroundings. The TSD can further enhance situational awareness of potential threat blind spots by using Color Bands (enabled from the TSD MAP sub-page) and selecting an appropriate map type and scale. Configuring the SHOW options on the TSD is important in ensuring critical information is present on the TSD for crews to reference during each phase of the mission.

On departure or when approaching the Forward Edge of Battle Area (FEBA), crews should conduct pre-combat checks and ensure the aircraft is ready to respond to enemy contact. Once beyond the Forward Line of Own Troops (FLOT), the CPG's primary task is to continuously search, acquire, identify, and (if necessary) lase and store targets or points of interest using the TADS. The Pilot can also store targets or waypoints using the fly-over method on the TSD POINT sub-page in

STO format, but for obvious reasons this is the least preferred way of storing a target in the aircraft.

During enroute phases of flight, the CPG is the crewmember primarily responsible for updating the aircraft's route and navigation settings. The CPG is also typically responsible for tuning appropriate radio frequencies, communicating with other units on the battlefield, and coordinating with other CPG's within the team to ensure maximum sensor coverage or fires distribution against enemy targets.

The Pilot's primary task is to facilitate the CPG's ability to operate the aircraft sensors and weapon systems. The Pilot maintains awareness of the crew's surroundings and tactical situation and maneuvers the aircraft as appropriate to ensure the CPG can perform unimpeded sensor scans or employ weapon systems when necessary. Effective communication between the crewmembers is critical to mission success.

The Pilot's secondary task is to maintain security of the aircraft and crew. The Pilot maintains a constant scan of the terrain in the immediate vicinity and is ready to employ the Area Weapon System against threats to protect the aircraft or other team members if necessary.

AH-64 TEAM EMPLOYMENT

The basic building block of any attack helicopter unit is an Air Weapons Team (AWT or simply "team") of two AH-64's under the control of an Air Mission Commander (AMC), which is typically the most experienced Pilot-in-Command (PC) in the flight. The AMC is responsible for ensuring success of the team's mission, is responsible for the movement and maneuver of the team, and is the weapons release authority for the team.

Team Maneuvering

Maneuverability is the primary consideration for the AWT. Lead should maneuver in predictable ways for Wing; Wing should never inhibit Lead's ability to maneuver and should always be able to provide suppressive fire for Lead. Distance between aircraft can vary based on terrain, proximity to the ground, illumination/visibility, and expected or known enemy threats. Typical distances range from 3 to 5 rotor discs up to a kilometer or more. Distances are typically greater when over open terrain, whereas distances between aircraft will be less when operating in restrictive terrain.

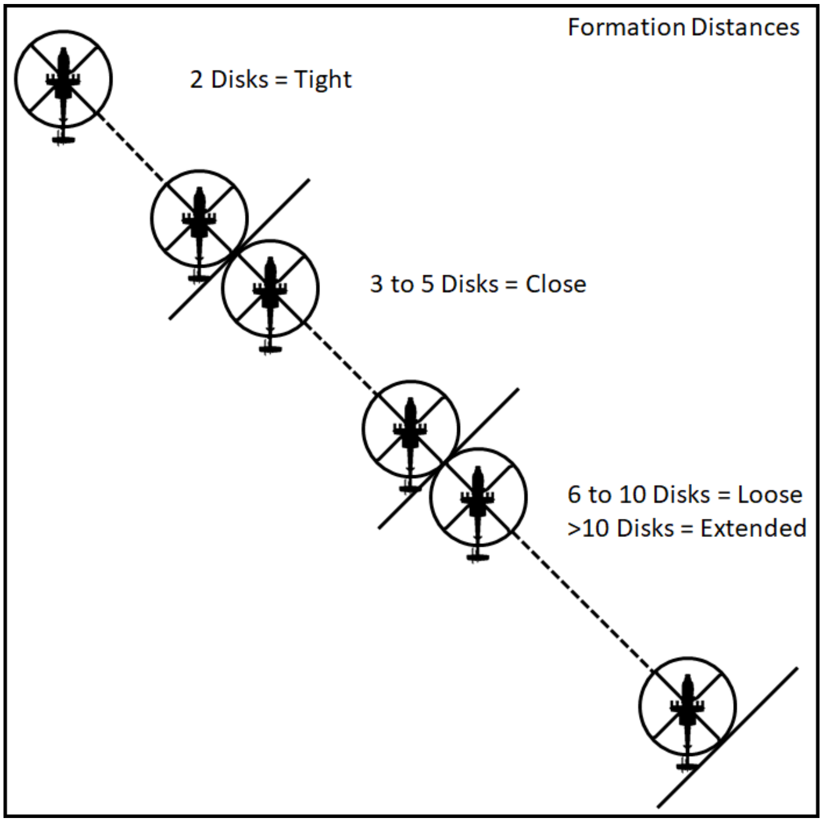


Figure 239. Formation Distances

Combat Cruise is the standard formation for AWT employment. It is preferable at very low altitudes and provides the most flexibility of the flight while reducing predictability. *Combat Cruise* provides a maneuver area to the rear of the Lead aircraft along their aft hemisphere. Wing positions their aircraft in such a way to provide support to Lead if unexpected enemy units are encountered. Combat *Cruise Left/Right* “pins” Wing to one side of Lead during situations in which maneuvers to the opposite side are not feasible, possibly due to terrain.

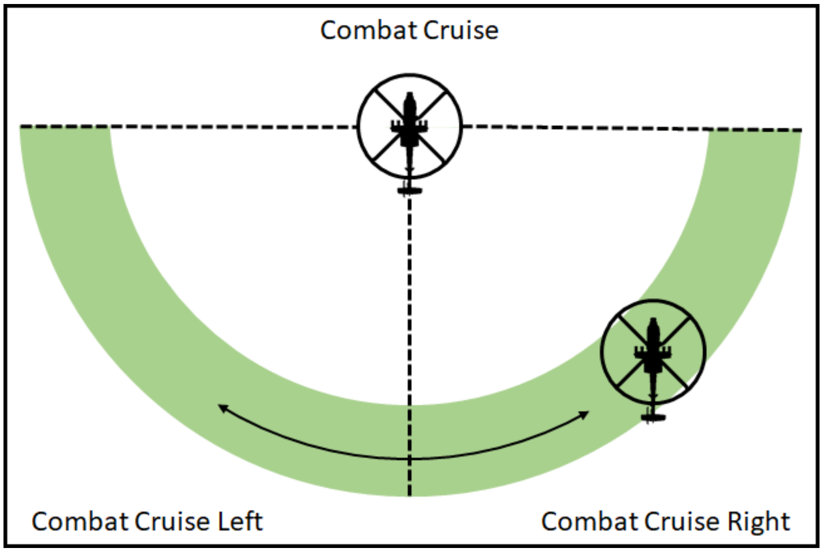


Figure 240. Combat Cruise, Combat Cruise Left/Right

Combat Spread maximizes forward firepower with overlapping sensor fields-of-view and weapons coverage, at the expense of ease of maneuverability and team flexibility. Wing pulls abeam to the 3 o'clock or 9 o'clock positions of Lead. *Combat Spread* requires a high degree of scanning and coordination between Pilot's in each aircraft, particularly at night due to Night Vision Sensor limitations. Distance between aircraft should be based on maneuver room, visibility, terrain, and expected enemy contact.

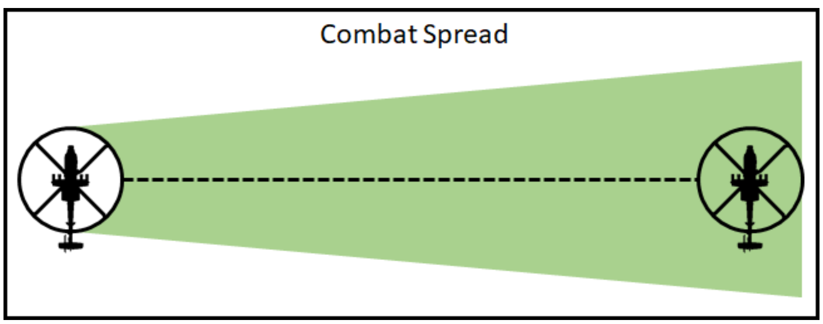


Figure 241. Combat Spread

Terrain Flight Modes

The purpose of terrain flight and the associated modes of flight is to deny enemy forces the ability to acquire, track and engage the aircraft. Terrain flight requires constant scanning to locate and avoid obstacles, particularly at night. The most important rule when conducting terrain flight is to never outfly the capabilities of the sensor being used for flight. If weather and ambient lighting conditions restrict visibility, the crew should decrease their airspeed. Continuous operations in a single terrain flight mode is unlikely, as terrain and vegetation will vary throughout the Area of Operations (AO). Crews can expect to transition into and out of each mode as a natural part of performing terrain flight operations. The modes of terrain flight are defined below:

- **Nap-of-the-earth (NOE)** flight is conducted at varying airspeeds and altitudes as close to the earth's surface as vegetation and obstacles permit, typically up to 25 feet above the highest obstacle (AHO). Crews will typically perform "Bounding Overwatch" movement, where one aircraft provides cover while the other aircraft moves. Crews should not bound farther than the limits of the primary weapon system meant for suppression.

- **Contour** flight is conducted at low altitude conforming to the contours of the earth, typically between 25 to 80 feet AHO. It is characterized by varying airspeeds and altitude, dictated by the terrain and obstacles. Crews will typically perform "Traveling Overwatch" movement and utilize Combat Cruise as their formation.

- **Low-level** flight is conducted at constant altitude and airspeed, typically between 80 to 200 feet AHO. Crews typically perform "Traveling" movement to rapidly transit from one place to another, however this method provides the least amount of security for unexpected enemy encounters.

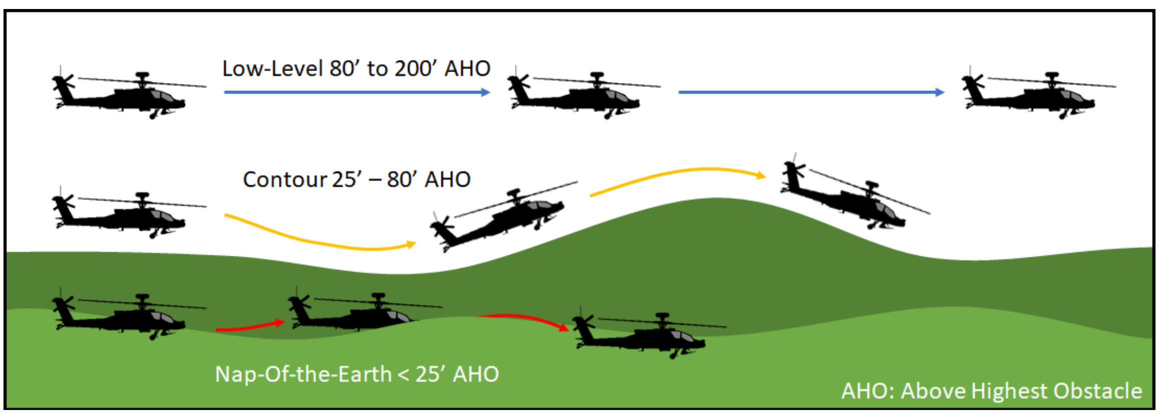


Figure 242. Terrain Flight Modes

Weapon Delivery Techniques

The three techniques for weapons delivery are defined below:

- **Hover Fire** is typically conducted at speeds less than effective translational lift (ETL, roughly 16-24 knots airspeed) and may be either moving or stationary.
- **Running Fire** is typically conducted at speeds greater than ETL. Forward airspeed adds stability to the helicopter and increases the delivery accuracy of unguided weapon systems, particularly rockets.
- **Diving Fire** is an engagement conducted in a diving profile, typically between -10° to -30° pitch attitudes. Airspeed and altitude will be determined by the expected threat level from enemy defenses and desired weapons effects, with a steeper dive providing a smaller "beaten zone" and improved accuracy. However, a steep dive will also require more altitude for recovery. Diving fire may be performed from low altitude with a climb or "bump" from behind cover or from level flight at high altitude.

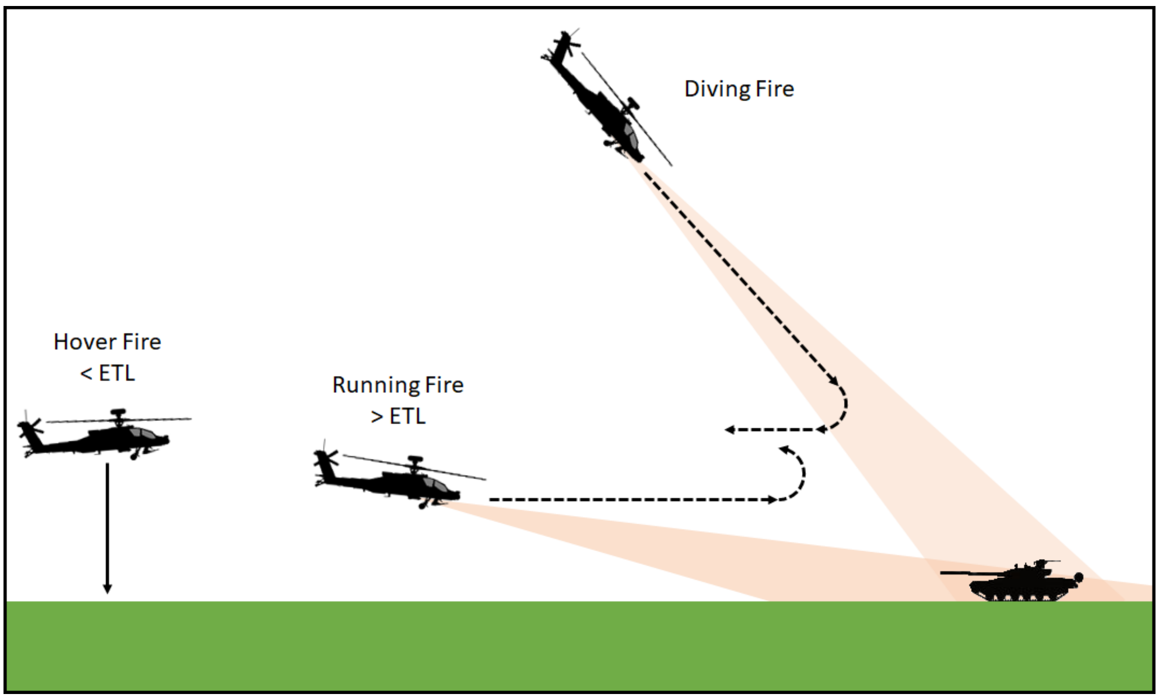


Figure 243. Hover, Running, and Diving Fire

AREA WEAPON SYSTEM (AWS)

The Area Weapon System is designed for engaging area targets and suppressing close-in threats and is highly effective against personnel and lightly armored vehicles. The AWS can be employed by either crewmember using the HMD or FCR or by the CPG with the TADS. It can be operated in the Normal (NORM) or Fixed (FXD) mode.

Gun engagement in NORM mode using TADS

When employing the AWS with the TADS, the Target State Estimator provides lead angle and other ballistics compensations when used in conjunction with the laser rangefinder/designator in designation mode (2nd detent on LRFD trigger). The Linear Motion Compensator (LMC) aids the CPG in maintaining a stable TADS LOS reticle on target for proper ballistics computations.

To engage a target from the CPG crewstation while using the TADS as the sight:

1. Determine the appropriate acquisition source for acquiring the target.
    a. If acquired visually by either crewmember, select PHS to set the Pilot's helmet as the acquisition source, or GHS to set the CPG's helmet as the acquisition source.
    b. If the target location exists as a point within the aircraft database, set that point as your acquisition source via the COORD page or use the Cursor Acquisition (CAQ) method on the TSD.

Figure 244. TADS Gun Engagement – Pilot HMD symbology

2. Press the SLAVE button on the TEDAC right handgrip (RHG) to slew the TADS to the target location, then press the SLAVE button again to switch to manual track.

3. Action the gun by pressing Weapon Action Switch (WAS) – Forward on the TEDAC left handgrip (LHG).

4. Verify or select the desired burst length on the WPN page. Ensure MODE (R2) is set to NORM.

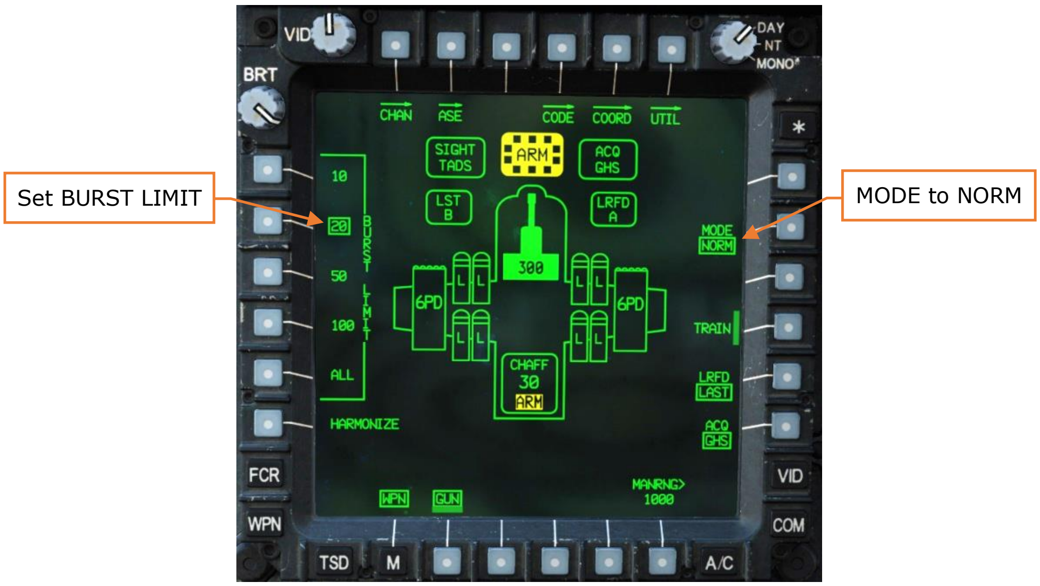


Figure 245. TADS Gun Engagement – CPG WPN Page

5. Arm the aircraft if not already armed.

6. Verify or select the desired range source: Laser, Navigation (if ACQ is set to a Point), Auto or Manual.

7. If the target or aircraft are moving, engage the LMC to assist in maintaining the TADS LOS reticle on target with the MAN TRK switch ("Thumbforce controller") on the RHG.

8. If laser ranging is desired, begin lasing the target with the laser trigger on the RHG. If both the target and the aircraft are stationary, first detent ranging may be used. If either the target or the aircraft are moving, the second detent designation should be used.

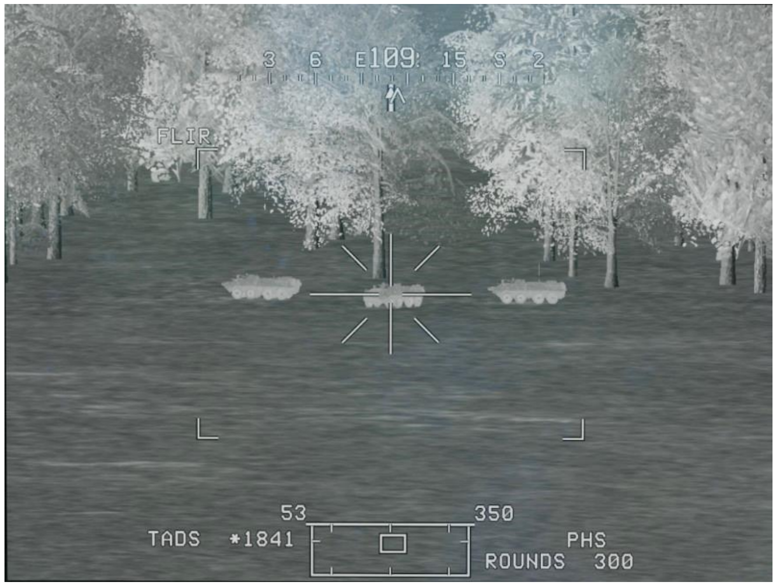


Figure 246. TADS Gun Engagement – Sight on Target

9. Verify no COINCIDENCE, AZ LIMIT, EL LIMIT or BAL LIMIT messages are displayed in the High Action Display.

10. Fire the gun with the weapon trigger on the LHG.

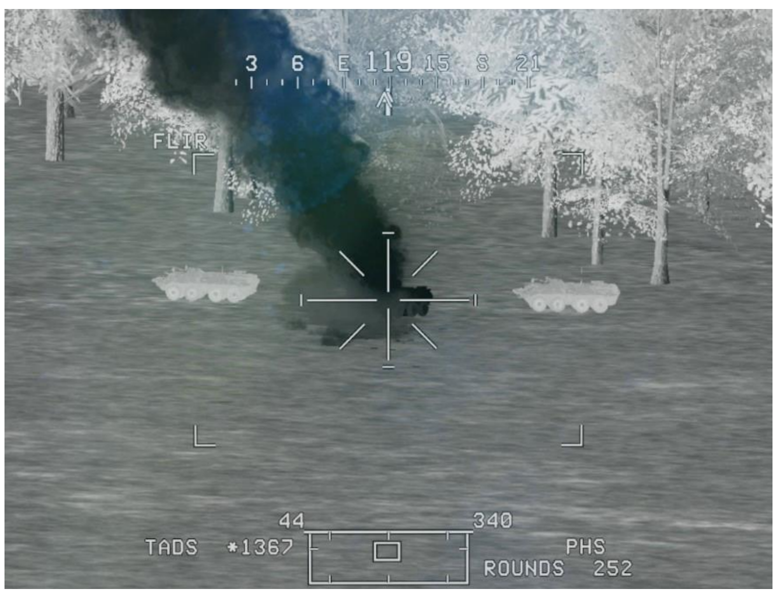


Figure 247. TADS Gun Engagement – Rounds on Target

Gun engagement in NORM mode using HMD

When employing the AWS with the HMD, the gun can be used to rapidly suppress close-in threats to the aircraft. However, unlike the TADS, the HMD does not provide any complex ballistics calculations for the gun. Lead angle and other compensations must be manually provided by the crewmember by adjusting the LOS reticle of the HMD accordingly.

To engage a target from either crewstation while using the HMD as the selected sight:

1. Sight select – HMD.
2. Action the gun by pressing Weapon Action Switch (WAS) – Forward on the cyclic or the TEDAC left handgrip (LHG). It should be noted that if the CPG uses the TEDAC LHG WAS, only the CPG's TEDAC LHG trigger will be active; accordingly, if the CPG uses the cyclic WAS, only the CPG's cyclic trigger will be active.
    a. **NOTE** - When the gun is actioned with the HMD as the selected sight, the range source will automatically change to a Manual range based on the range value set on the WPN page, MANRNG (B6).
3. Verify or select the desired burst length on the WPN page. Ensure MODE (R2) is set to NORM.

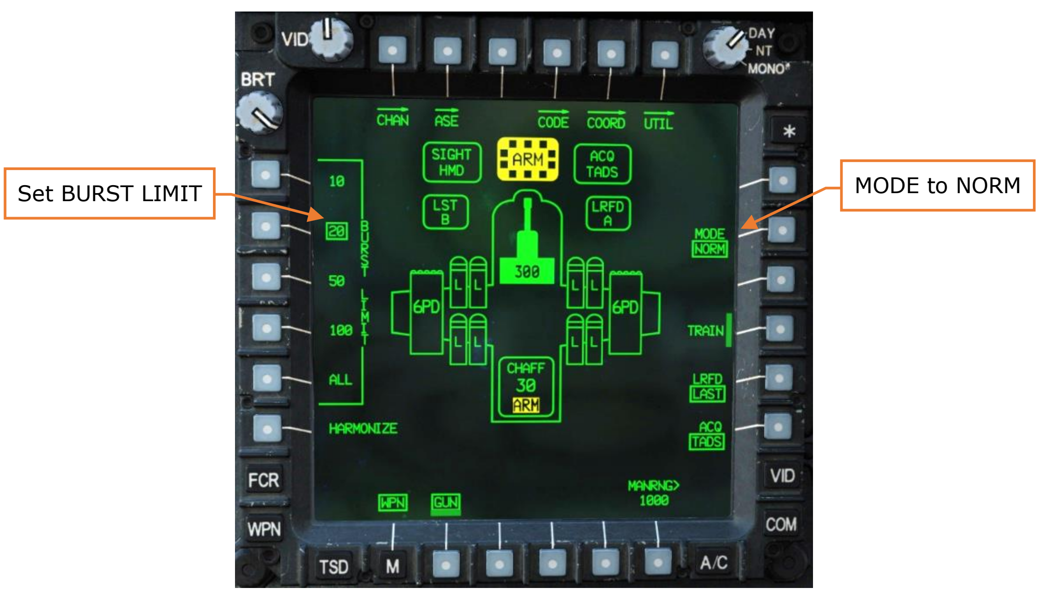


Figure 248. HMD Gun Engagement – PLT WPN Page

4. Arm the aircraft if not already armed.

5. Verify or select the desired range source: Navigation (if ACQ is set to a Point), Auto or Manual.

Figure 249. HMD Gun Engagement – HMD LOS reticle on target

6. Verify no COINCIDENCE, AZ LIMIT, EL LIMIT or BAL LIMIT messages are displayed in the High Action Display.

7. Fire the gun with the weapon trigger on the cyclic or TEDAC LHG.

Figure 250. HMD Gun Engagement – Rounds on target

Gun engagement in FIXED mode using HMD

When employing the AWS in Fixed mode with the HMD, the gun is fixed forward at a ballistic solution of 1,575 meters. The Fixed Gun Reticle is identical to the Cued LOS Reticle symbology of the acquisition source and represents the virtual location in front of the aircraft that coincides with the 1,575-meter ballistic solution. Because the gun is fixed, the aircrew must maneuver the aircraft to aim the gun at the target. Any adjustments in aim that must be made after observing round impacts must be made by the crewmember flying the aircraft.

To engage a target from either crew station while using the gun in Fixed mode and the HMD as the selected sight:

1. Sight-select HMD on the collective flight grip.
2. Action the gun by pressing Weapon Action Switch (WAS) – Forward on the cyclic. Note the range source will automatically change to a Manual range based on the range value set on the WPN page, MANRNG (B6), but this *will not* affect the range compensation for the gun.
3. Verify or select the desired burst length on the WPN page. Ensure MODE (R2) is set to FXD.

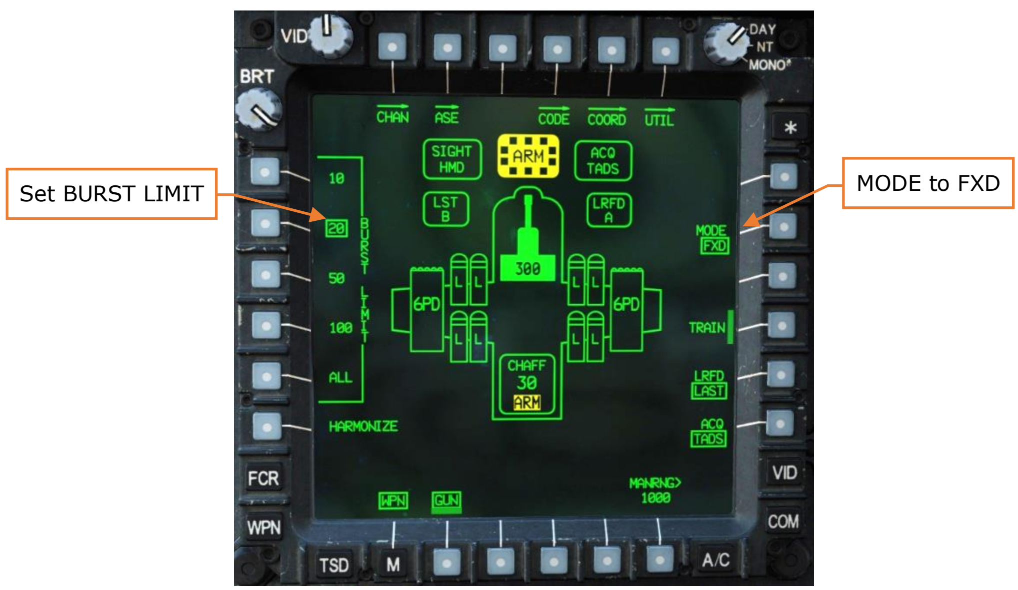


Figure 251. HMD Fixed Gun Engagement – PLT WPN Page

4. Arm the aircraft if not already armed.

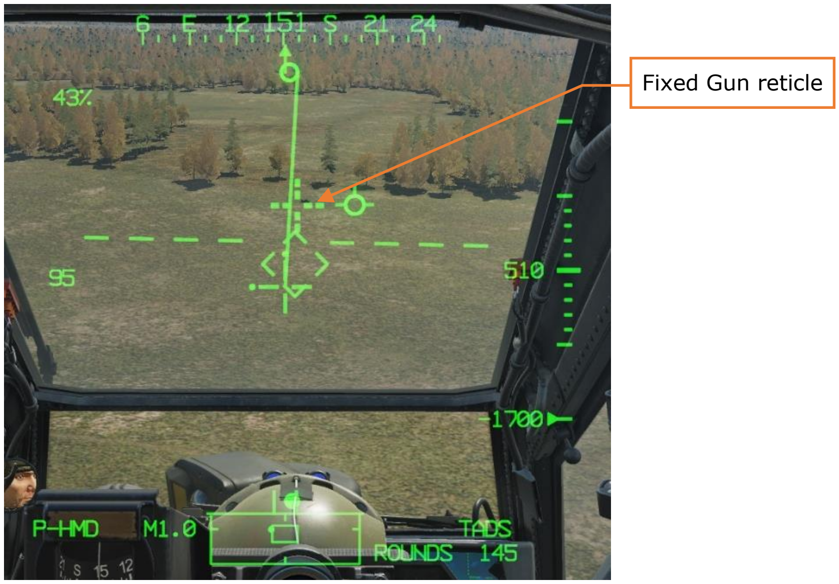


Figure 252. HMD Fixed Gun Engagement – Sight on Target

5. Fire the gun with the weapon trigger on the cyclic.

AERIAL ROCKET SUB-SYSTEM (ARS)

The Aerial Rocket Sub-system is meant to enable accurate delivery of massed fires against area targets. The ARS provides an AH-64 team with a direct and indirect fire capability akin to a light rocket artillery battery. The key piece of symbology associated with employing rockets is the Rocket Steering Cursor, an I-beam shaped symbol which represents the allowable ballistic solution provided by the pylon articulation, and how to maneuver the nose of the aircraft so that it is placed within that ballistic solution for accurate rocket delivery.

Rocket Steering Cursor

The Rocket Steering Cursor is exactly what its name implies: a steering, or maneuver cue, to the aircrew. It is not a Continuously Computed Impact Point (CCIP); nor is it a virtual symbology element, in that its displayed location does not correspond with a real-world location "out-the-window" like the Head Tracker or Flight Path Vector (FPV). It indicates the direction to turn the aircraft, by either cyclic or pedal inputs; as well as the required pitch angle of the aircraft to place the calculated ballistic solution within the articulation limits of the pylons. Each weapon pylon can articulate in elevation +4° to -15° relative to the nose of the aircraft.

The Aircraft Datum Line (ADL) is a line that is drawn straight out from the nose at -4.9° elevation and is represented by the Head Tracker symbol within the HMD flight symbology. In a stable hover with no winds, the ADL will be level with the horizon; and is at an approximate mid-point between the upper and lower articulation limits of the pylons.

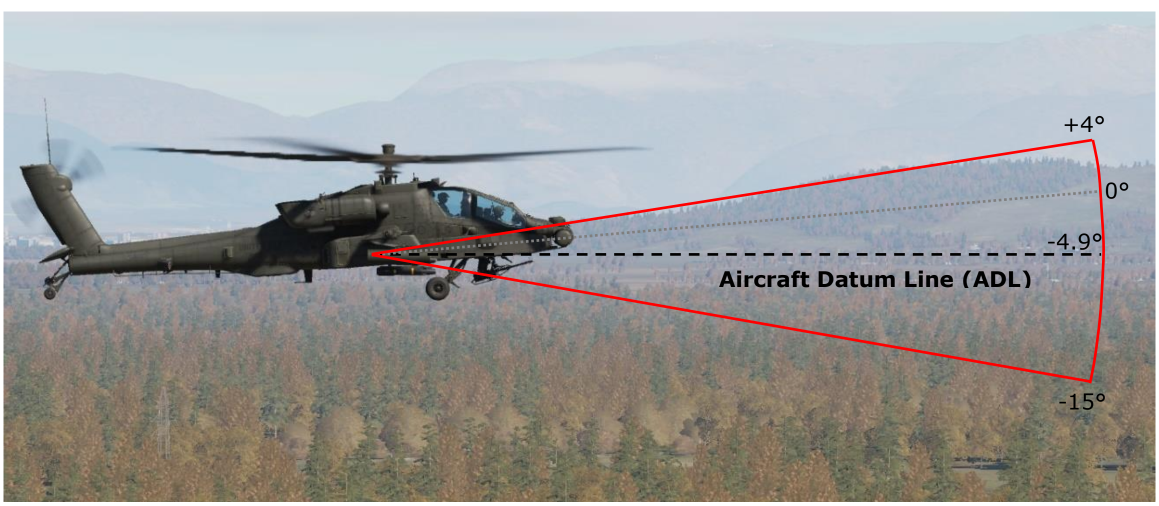


Figure 253. Pylon Articulation Limits

Comparing the symbology in the image on the left to the graphics on the right in the figure below, the relationship between the Rocket Steering Cursor and the articulation range can be seen. The Rocket Steering Cursor is not a direct representation of the pylon articulation range itself (red box). Rather it represents the required position in azimuth and elevation the ADL of the aircraft needs to be placed (blue box) relative to the aimpoint, to keep the ballistic solution within the pylon articulation range. In the figure below, the Pilot has actioned rockets while using the HMD as the selected sight. The HMD LOS reticle is aligned with the ADL (Head Tracker, broken diamond), which illustrates the Rocket Steering Cursor with 8.9° of total permittable ADL travel below the aimpoint, and 10.1° of total permittable ADL travel above the aimpoint.

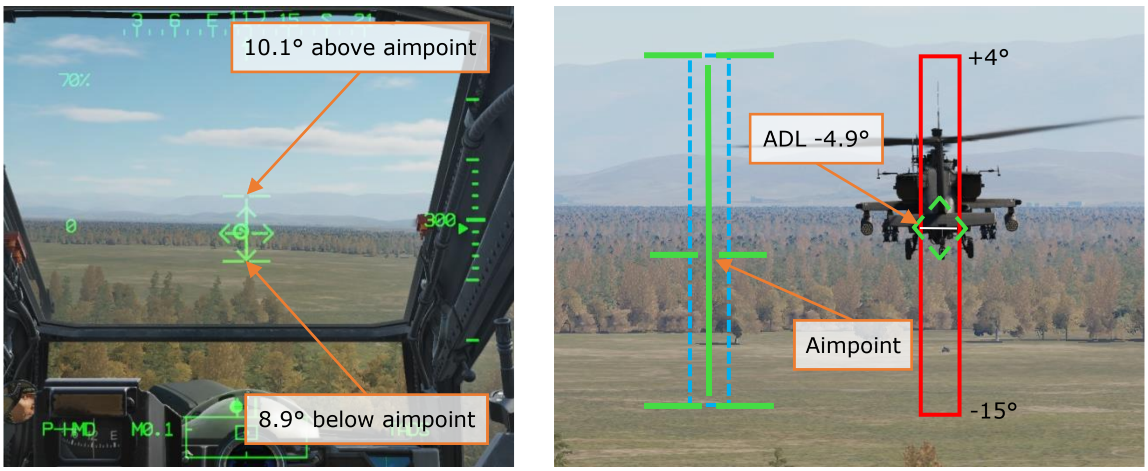


Figure 254. Rocket Steering Cursor

In the next figure below, a Manual range of 100 meters is being used for illustration purposes only, to remove any ballistics compensation for longer ranges. If the ADL (black dot/black dotted line) was placed at the bottom of the blue box, the rocket pods would still be within the +4° articulation limit, and would still be aligned with the ballistic solution aimpoint (white dot/white dotted line); and if the ADL was placed at the top of the blue box, the rocket pods would still be within the -15° articulation limit, and would still be aligned with the aimpoint. This is what the Rocket Steering Cursor represents.

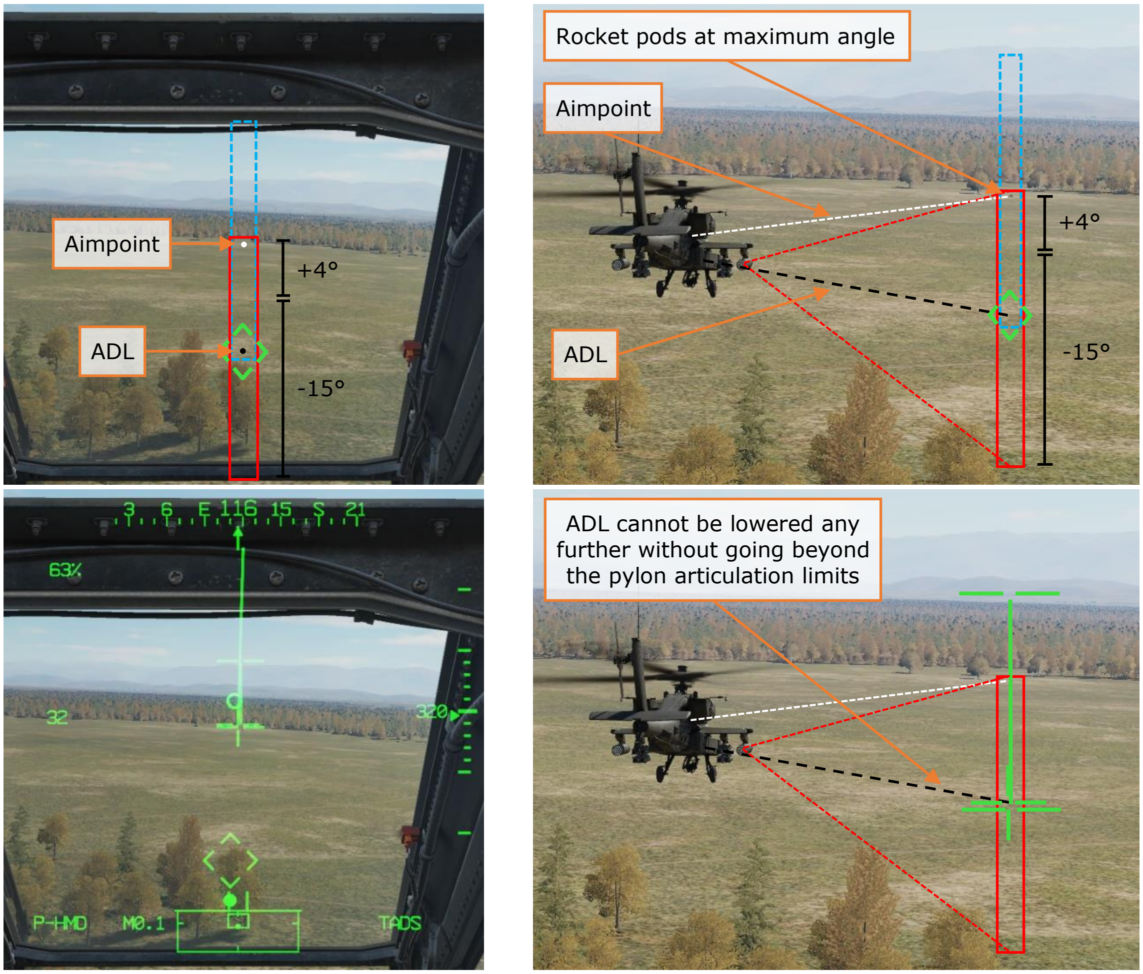


Figure 255. Ballistic Solution (Top), Symbology Equivalent (Bottom)

When the HMD is the crewmember's selected sight, the LOS reticle is used to designate the target location. This is done regardless of wherever the crewmember is looking, and the ballistic solution is updated continuously as the crewmember looks around. In the next figure below, the Pilot has aimed the HMD LOS reticle at a tank in front of the tree line (white dotted line) to the left of the ADL (black dotted line).

In the first set of images of the figure below, the allowable aiming area of the ADL is outlined in a blue box. In the second set of images, the blue box is replaced by the Rocket Steering Cursor, and the Head Tracker is replaced by the LOS reticle. This illustrates the simultaneous use of the LOS reticle to designate the target location while also using the LOS reticle to represent the ADL to display the relative location of the Rocket Steering Cursor.

The Pilot simply needs to maneuver the nose of the aircraft so that the ADL of the aircraft is somewhere within the blue box, while keeping the HMD LOS reticle on the intended target. If the Pilot accomplishes this, the ballistic solution will be within the articulation range of the weapon pylons, and the Rocket Steering Cursor will be aligned.

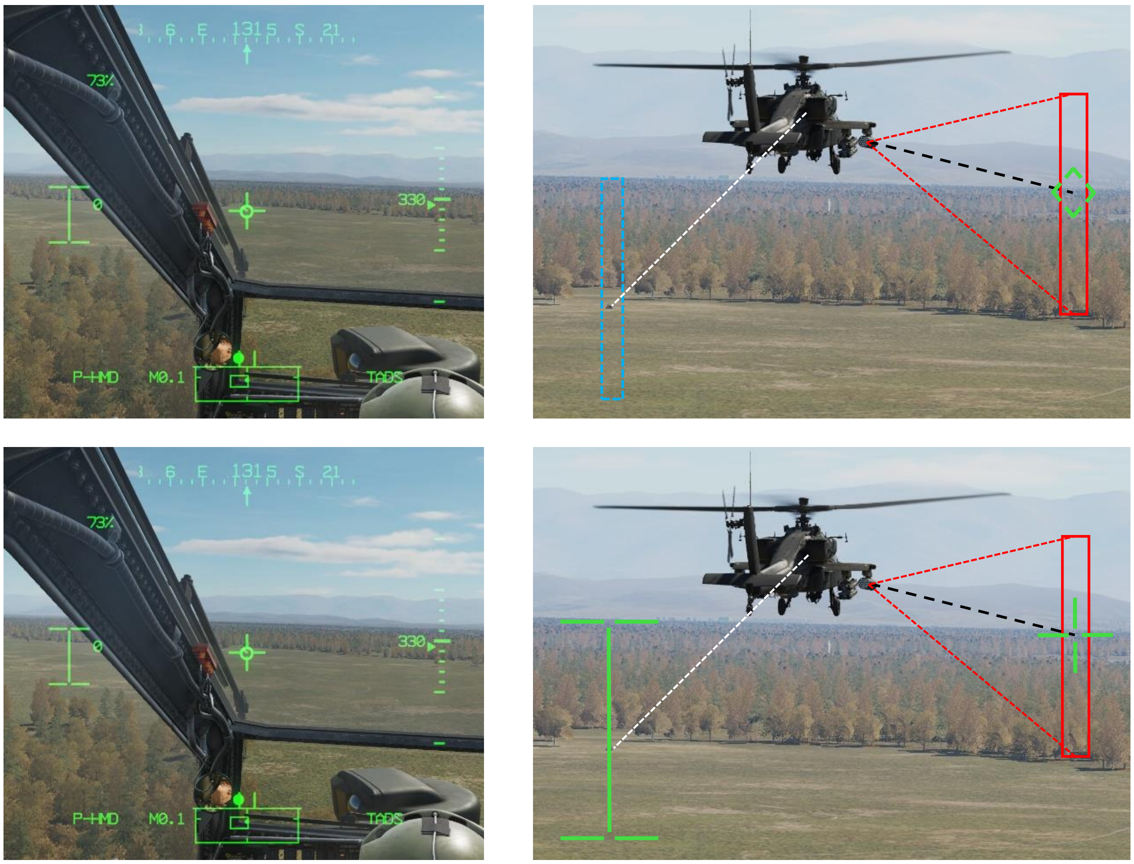


Figure 256. Ballistic Solution (Top), Symbology Equivalent (Bottom)

The remaining factors that influence where the Rocket Steering Cursor is placed are the range to the target and the relative winds and air mass as calculated by the High Integrated Air Data Computer (HIADC).

If a longer range is used for ballistic calculations, as displayed within the Range & Range Source data field of the High Action Display (HAD), the ballistic solution will be higher in elevation, which will drive the Rocket Steering Cursor higher as well. This higher ballistic solution accounts for the weight and aerodynamic profile of the rocket, and the expected changes in the trajectory based on gravity and time of flight. When engaging targets with rockets at long-ranges, it may be necessary to pitch the aircraft up to align the HMD LOS reticle with the Rocket Steering Cursor's ballistic solution. This is called "super-elevating" the nose, and it overcomes the weapon pylons' limited articulation range above the ADL.

Depending on the computed air mass and relative winds, the Rocket Steering Cursor may be offset to the left or right from the target to account for wind effects on the cross-section of the rocket body, as well as any weather-vane effects the winds may have on the deployed tail fins. It is important to note that the most accurate rocket employment with forward airspeed results when the aircraft is kept within coordinated flight with the trim ball centered.

Despite each crewmember having the capability to independently employ rockets from either crew station, the most accurate method of employing unguided rockets from the AH-64 is using the Cooperative engagement mode. This mode allows the Pilot and CPG to work in unison by allowing the CPG to perform the targeting for the ballistic solution while the Pilot focuses on flying the aircraft to align the nose within the Rocket Steering Cursor. This mode leverages the stability of the TADS as a sight and allows the crew to generate an accurate ballistic solution at much further ranges than what would be possible with a conventional CCIP.

For the Pilot, the primary distinction of COOP mode is that the Rocket Steering Cursor is not affected by head movement. The CPG's TADS LOS reticle and range source drives the ballistic solution, which therefore determine where the Rocket Steering Cursor is displayed within the Pilot's HMD symbology. A common practice by the Pilot is to set the TADS as the acquisition source to provide increased situational awareness of where the TADS is pointing relative to the nose of the aircraft.

To enter this mode, the CPG must action rockets using the Weapon Action Switch (WAS) on the TEDAC left handgrip (LHG) while the Pilot actions rockets using the WAS on the cyclic as normal. Both crewmembers will be presented with "COOP" in the Weapon Control field of the HAD. When COOP mode is entered, the WPN page becomes common for each crewmember, and the current settings on the CPG's WPN page, RKT format will override the Pilot's settings. However, once in COOP mode, either crewmember can change the rocket selection in the INVENTORY (L1-L5) or the QTY (R1) as necessary. Either crewmember can fire the rockets using their respective weapon triggers (TEDAC weapon trigger for the CPG, cyclic weapon trigger for the Pilot), but this is normally left to the Pilot.

When using Cooperative mode, the aircrew may elect to employ rockets with the Direct Fire method or the Indirect Fire method. Direct Fire allows the aircrew to observe the target area and make immediate adjustments, but this requires the aircraft to remain exposed to enemy detection and weapons fire. Indirect Fire allows the aircrew to remain behind cover and fire rocket salvos over a mask onto a target location stored in the aircraft database, but direct observation of the target area and corrections are more difficult. Indirect Fire is typically only used for large area suppression.

Rocket engagement in COOP mode using TADS (Direct Fire)

To engage a target with Direct Fire rockets in Cooperative mode, using the TADS as the sight:

1. **(PLT)** Sight select – HMD.
2. **(CPG)** Sight select – TADS.
3. **(CPG)** Determine the appropriate acquisition source for acquiring the target.
    a. If acquired visually by either crewmember, select PHS to set the Pilot's helmet as the acquisition source, or GHS to set the CPG's helmet as the acquisition source.
    b. If the target location exists as a point within the aircraft database, set that point as your acquisition source via the COORD page or use the Cursor Acquisition (CAQ) method on the TSD.
4. **(CPG)** Press the SLAVE button on the TEDAC right handgrip (RHG) to slew the TADS to the target location, then press the SLAVE button again to switch to manual track.
5. **(PLT)** Action the rockets by pressing Weapon Action Switch (WAS) – Left on the cyclic.
6. **(CPG)** Action the rockets by pressing Weapon Action Switch (WAS) – Left on the TEDAC LHG.
7. **(PLT & CPG)** Verify COOP is displayed in HAD Weapon Control field and "RKT NORMAL" is displayed in the HAD Weapon Status field.
8. **(PLT or CPG)** On the WPN page, ensure INVENTORY (L1-L5) selection is set to desired rocket type; ensure QTY (R1) is set as desired.

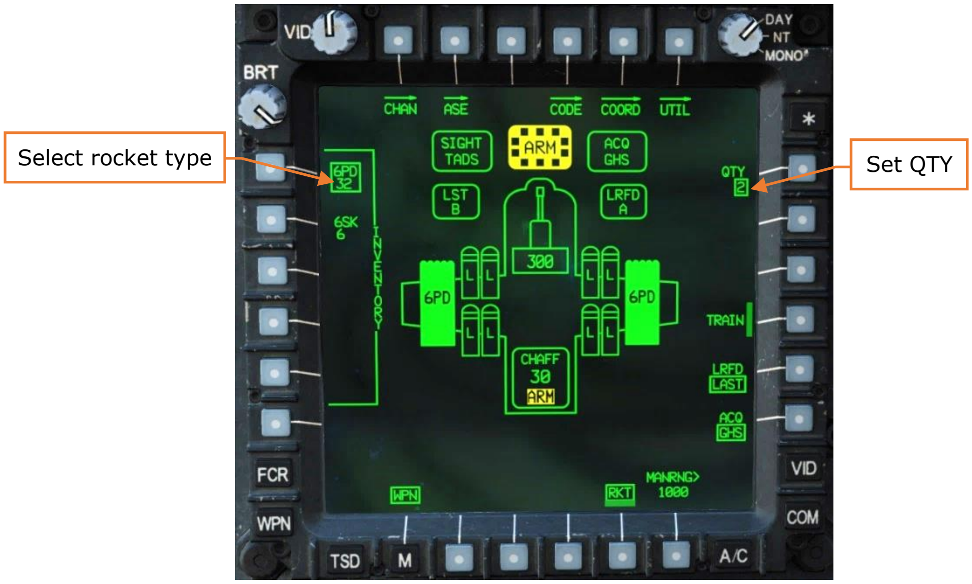


Figure 257. COOP Rocket Engagement – CPG WPN Page

9. **(CPG)** Arm the aircraft if not already armed.
10. **(CPG)** Verify or select the desired range source: Laser, Navigation (if ACQ is set to a Point), Auto or Manual.
11. **(CPG)** If the target or aircraft are moving, engage the LMC to assist in maintaining the TADS LOS reticle on target with the MAN TRK switch ("Thumbforce controller") on the RHG.
12. **(CPG)** If laser ranging is desired, begin lasing the target with the laser trigger on the RHG. If both the target and the aircraft are stationary, first detent ranging may be used. If either the target or the aircraft are moving, the second detent designation should be used.

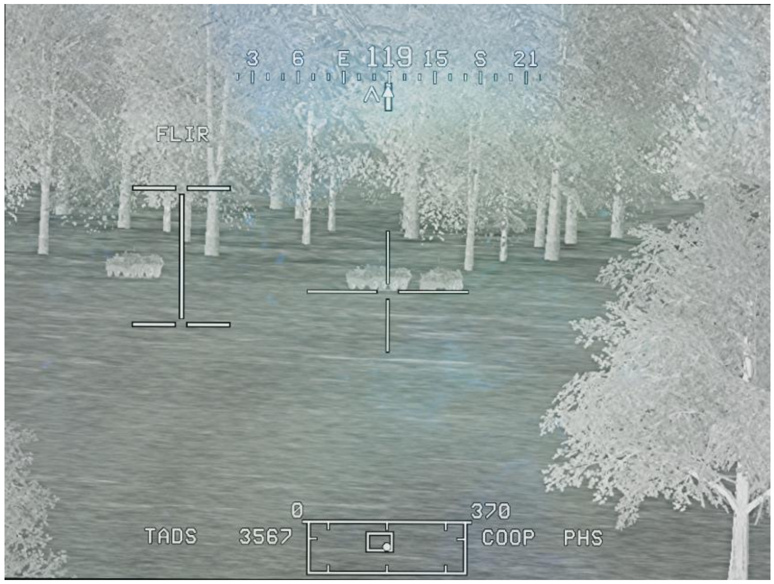


Figure 258. COOP Direct Rocket Engagement – CPG TADS Video

13. **(CPG)** Instruct the Pilot to align the aircraft with the Rocket Steering Cursor and fire, using the phrase "Match and Shoot".

Figure 259. COOP Direct Rocket Engagement – PLT HMD Symbology

14. **(PLT)** If in a hover, use pedal inputs to turn the aircraft in the direction of the Rocket Steering Cursor. When Rocket Steering Cursor is aligned with the HMD LOS reticle, stop turning and stabilize the aircraft attitude and heading. At longer ranges, the Pilot may need to adjust the pitch attitude up to the Rocket Steering Cursor.

or

14. **(PLT)** If flying with forward airspeed above ETL, use cyclic roll inputs to turn the aircraft in the direction of the Rocket Steering Cursor. When Rocket Steering Cursor is aligned with the HMD LOS reticle in the vertical axis, stop turning and stabilize the aircraft attitude and heading with cyclic. Maintain the trim ball centered with the pedals. At longer ranges, the Pilot may need to adjust the pitch attitude up to the Rocket Steering Cursor.

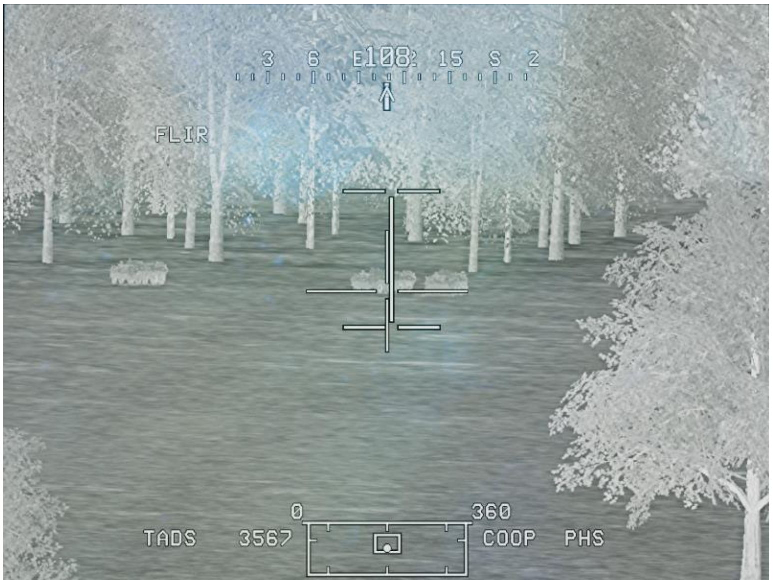


Figure 260. COOP Direct Rocket Engagement – CPG TADS Video

Figure 261. COOP Direct Rocket Engagement – PLT HMD Symbology

15. **(PLT & CPG)** Verify no inhibit messages are displayed.
16. **(PLT)** Fire the rockets with the weapon trigger on the cyclic.
17. **(CPG)** After rockets are fired, decrease the TADS field-of-view (FOV) one level to observe for rocket impacts. Make required adjustments to aimpoint and repeat rocket salvo as necessary until target effects are achieved.

Rocket engagement in COOP mode using TADS (Indirect Fire)

To engage a target with Indirect Fire rockets in Cooperative mode, using the TADS as the sight:

1. **(PLT)** Sight select – HMD.
2. **(CPG)** Sight select – TADS.
3. **(CPG)** Determine the appropriate point to use as the acquisition source.
    a. If the target location exists as a point within the aircraft database, set that point as your acquisition source via the COORD page or use the Cursor Acquisition (CAQ) method on the TSD.
    b. If the target location does not exist as a point within the aircraft database:
        i. Use LRFD to range the target and then store the target location using TEDAC LHG STO/UPT button – STO.
        ii. Set that point as your acquisition source via the COORD page or use the Cursor Acquisition (CAQ) method on the TSD.

        or

        i. Receive the target location (MGRS or Latitude/Longitude in Degrees, Minutes, Minute-Decimal formats) and input the target location as a point within the aircraft database.
        ii. Set that point as your acquisition source via the COORD page or use the Cursor Acquisition (CAQ) method on the TSD.
4. **(CPG)** Press the SLAVE button on the TEDAC right handgrip (RHG) to slew the TADS to the target location.
5. **(PLT)** Action the rockets by pressing Weapon Action Switch (WAS) – Left on the cyclic.
6. **(CPG)** Action the rockets by pressing Weapon Action Switch (WAS) – Left on the TEDAC LHG.

7. **(PLT & CPG)** Verify COOP is displayed in HAD Weapon Control field and "RKT NORMAL" is displayed in the HAD Weapon Status field.

8. **(PLT or CPG)** On the WPN page, ensure INVENTORY (L1-L5) selection is set to desired rocket type; ensure QTY (R1) is set as desired.

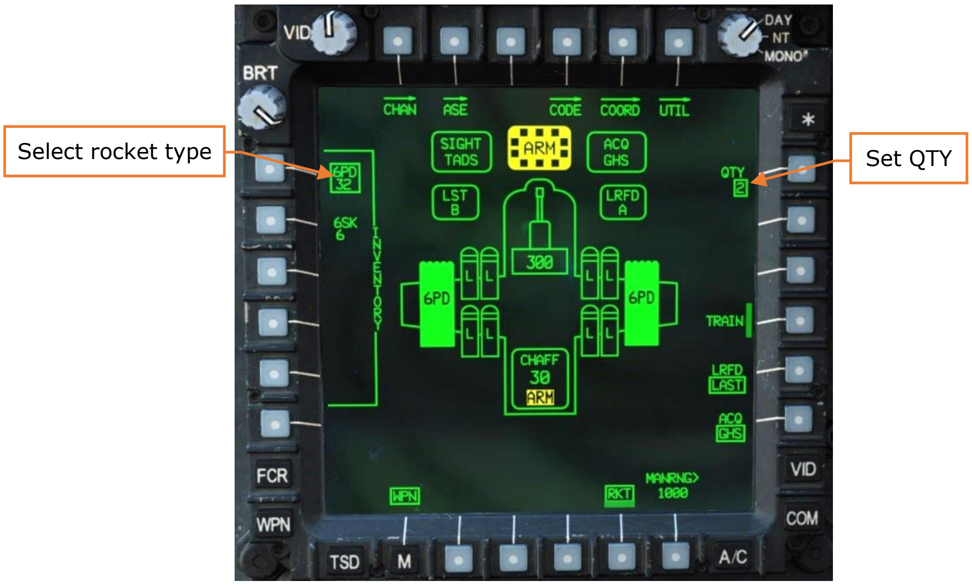


Figure 262. COOP Rocket Engagement – CPG WPN Page

9. **(CPG)** Arm the aircraft if not already armed.

10. **(CPG)** Verify range source: Navigation.

11. **(CPG)** Instruct the Pilot to align the aircraft with the Rocket Steering Cursor and fire, using the phrase "Match and Shoot".

Figure 263. COOP Indirect Rocket Engagement – CPG TADS Video

12. **(PLT)** If in a hover, use pedal inputs to turn the aircraft in the direction of the Rocket Steering Cursor. When Rocket Steering Cursor is aligned with the HMD LOS reticle, stop turning and stabilize the aircraft attitude and heading. At longer ranges, the Pilot may need to adjust the pitch attitude up to the Rocket Steering Cursor.

or

12. **(PLT)** If flying with forward airspeed above ETL, use cyclic roll inputs to turn the aircraft in the direction of the Rocket Steering Cursor. When Rocket Steering Cursor is aligned with the HMD LOS reticle in the vertical axis, stop turning and stabilize the aircraft attitude and heading with cyclic. Maintain the trim ball centered with the pedals. At longer ranges, the Pilot may need to adjust the pitch attitude up to the Rocket Steering Cursor.

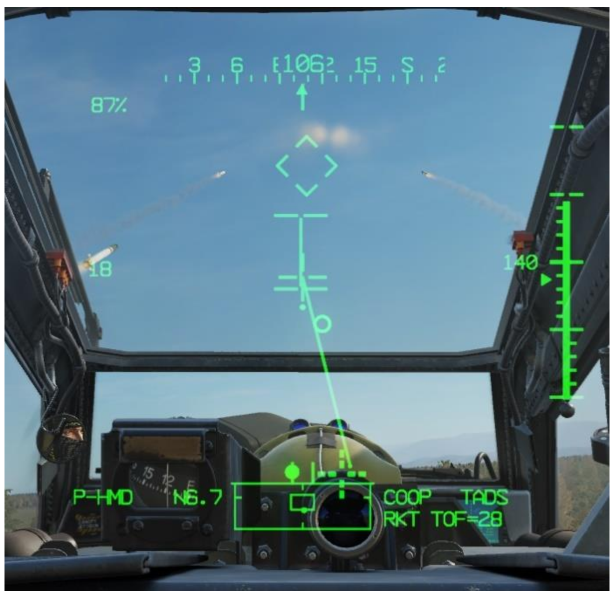


Figure 264. COOP Indirect Rocket Engagement – PLT HMD Symbology

13. **(PLT & CPG)** Verify no inhibit messages are displayed.

14. **(PLT)** Fire the rockets with the weapon trigger on the cyclic.

15. **(CPG)** After rockets are fired, it may be necessary to un-mask and observe the target area to determine if the desired target effects are achieved, if no external observers are able to provide a damage assessment.

Rocket engagement using HMD (Hover Fire)

To engage a target with rockets from the PLT crewstation while in a hover, using the HMD as the sight:

1. Determine the appropriate acquisition source for acquiring the target.
    a. If acquired visually by the CPG, select GHS to set the CPG's helmet as the acquisition source.
    b. If the target location exists as a point within the aircraft database, set that point as your acquisition source via the COORD page or use the Cursor Acquisition (CAQ) method on the TSD.
2. Action the rockets by pressing Weapon Action Switch (WAS) – Left on the cyclic.
3. On the WPN page, ensure INVENTORY (L1-L5) selection is set to desired rocket type; ensure QTY (R1) is set as desired.

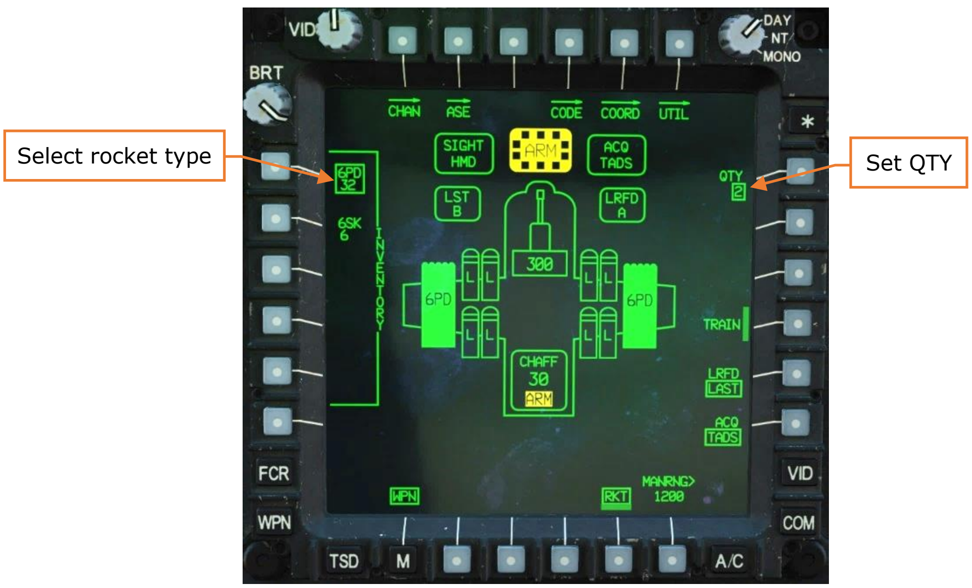


Figure 265. HMD Rocket Engagement – Pilot WPN Page

4. Arm the aircraft if not already armed.
5. Verify or select the desired range source: Navigation (if ACQ is set to a Point), Auto or Manual.
6. Place HMD LOS reticle on the target.

Figure 266. HMD Rocket Engagement – Pilot HMD LOS reticle on target

7. Use pedal inputs to turn the aircraft in the direction of the Rocket Steering Cursor, <u>while maintaining the HMD LOS reticle on the target</u>. When Rocket Steering Cursor is aligned with the HMD LOS reticle, stop turning and stabilize the aircraft attitude and heading.

Figure 267. HMD Rocket Engagement – Rocket Steering Cursor alignment

8. Verify no weapon inhibit messages are displayed in the High Action Display.

9. Fire the rockets with the weapon trigger on the cyclic.

Rocket engagement using HMD (Running/Diving Fire)

To engage a target with rockets from the PLT crewstation while in forward flight or a dive, using the HMD as the sight:

1. Determine the appropriate acquisition source for acquiring the target.
    a. If acquired visually by the CPG, select GHS to set the CPG's helmet as the acquisition source.
    b. If the target location exists as a point within the aircraft database, set that point as your acquisition source via the COORD page or use the Cursor Acquisition (CAQ) method on the TSD.
2. Action the rockets by pressing Weapon Action Switch (WAS) – Left on the cyclic.
3. On the WPN page, ensure INVENTORY (L1-L5) selection is set to desired rocket type; ensure QTY (R1) is set as desired.

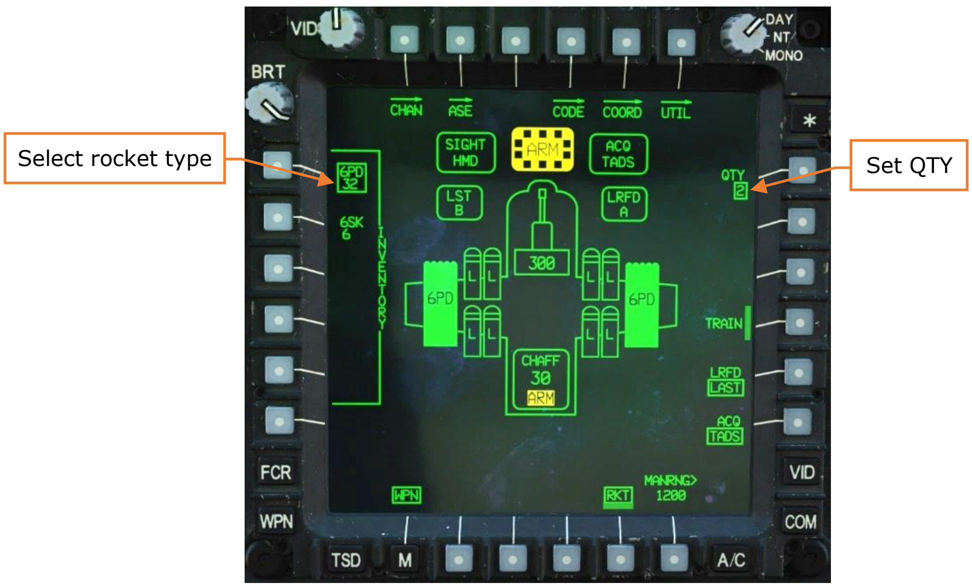


Figure 268. HMD Rocket Engagement – Pilot WPN Page

4. Arm the aircraft if not already armed.
5. Verify or select the desired range source: Navigation (if ACQ is set to a Point), Auto or Manual.
6. Place HMD LOS reticle on the target.

Figure 269. HMD Rocket Engagement – Pilot HMD LOS reticle on target

7. Use cyclic roll inputs to turn the aircraft in the direction of the Rocket Steering Cursor, <u>while maintaining the HMD LOS reticle on the target</u>. When Rocket Steering Cursor is aligned with the HMD LOS reticle in the vertical axis, stop turning and stabilize the aircraft attitude and heading with cyclic. Maintain the trim ball centered with the pedals.

Figure 270. HMD Rocket Engagement – Banking toward "I-beam"

8. If performing a dive, use cyclic to adjust the pitch attitude of the aircraft (maintain applied power setting with the collective) until the Rocket Steering cursor is overlaid on the HMD LOS reticle and aligned in azimuth, <u>while</u>

maintaining the HMD LOS reticle on the target. Continue to maintain the trim ball centered with the pedals throughout the dive.

9. Verify no weapon inhibit messages are displayed in the High Action Display.

10. Fire the rockets with the weapon trigger on the cyclic.

Figure 271. HMD Rocket Engagement – Rocket Steering Cursor alignment

HELLFIRE MODULAR MISSILE SYSTEM (HMMS)

The Hellfire Modular Missile System provides precision fire capability against point targets at long range. The AGM-114K "Kilo" and AGM-114L "Lima" Hellfires were designed as modern-day tank killers, able to defeat any known armor on the battlefield.

To minimize the time the AH-64D is un-masked and exposed to enemy detection and engagement, the HMMS provides various levels of automation (when in NORM or RIPL modes) for managing the missile inventory, allowing the crew to focus on targeting and engagement of ground targets. The aircraft weapon and sighting systems also provide messages within the crewmembers' High Action Display (HAD) to prompt the aircrew when to perform critical targeting tasks and any required corrective actions to ensure a successful missile engagement.

The AGM-114K semi-active laser-guided (SAL) can be engaged using several methods. The SAL missiles can be selectively employed using Lock-On-Before-Launch (LOBL) or Lock-On-After-Launch modes (LOAL); laser designation can be performed autonomously by the same AH-64 launching the missile(s) or off-board laser guidance (Ripple Fire and Remote Fire); and missiles can be launched singularly against individual targets or sequentially against multiple targets at once (Rapid Fire and Ripple Fire). The launch mode, source of guidance, and method of engagements will all depend on the tactical situation.

Missile Constraints Box

When employing the AGM-114 missile, the AH-64 aircrew is presented with the "Missile Constraints Box" to assist in successful launch and destruction of ground targets. The constraints box is not a virtual symbology element, in that its displayed location does not correspond with a real-world location "out-the-window" like the Head Tracker or Flight Path Vector (FPV). Rather the location of the constraints box is used to indicate the position of the missile seeker itself relative to the missile datum line (0° in azimuth and elevation from the missile body).

The constraints box is displayed in two sizes to indicate whether the missile seeker is tracking a laser designation that matches the laser frequency assigned to it by the aircraft; and is shown in either a dashed format (not in constraints and/or not ready to fire) or a solid format (in constraints and ready to fire). A large constraints box is displayed when the missile is tracking laser energy in LOBL mode, and a small constraints box is displayed when the missile is not detecting laser energy in LOAL mode. These sizes indicate to the aircrew how far they can offset the aircraft nose from the target before a successful engagement is in question.

When the missiles are actioned by a crewmember with SAL as the selected missile type, all pylons that are equipped with an M299 Hellfire missile launcher (and has SAL missiles loaded on its launcher rails) will be commanded to articulate and maintain +4° above the horizon, independently of aircraft attitude. If the missile launchers cannot articulate to within 10° of this commanded angle due to articulation limits, a PYLON LIMIT message will be presented to the crewmember that has actioned the missiles. This translates into an allowable aircraft pitch attitude of -10° to +29° before a PYLON LIMIT message is incurred. The missiles can still be fired with a pull of the weapon trigger to the 2nd detent.

The LOAL constraints box indicates a maximum allowable offset angle at launch of 7.5° from the missile datum line. If the aircraft maneuvers to an extent that the source of the constraints box shifts outside of this 7.5° offset angle, the constraints box will switch to a dashed LOAL box.

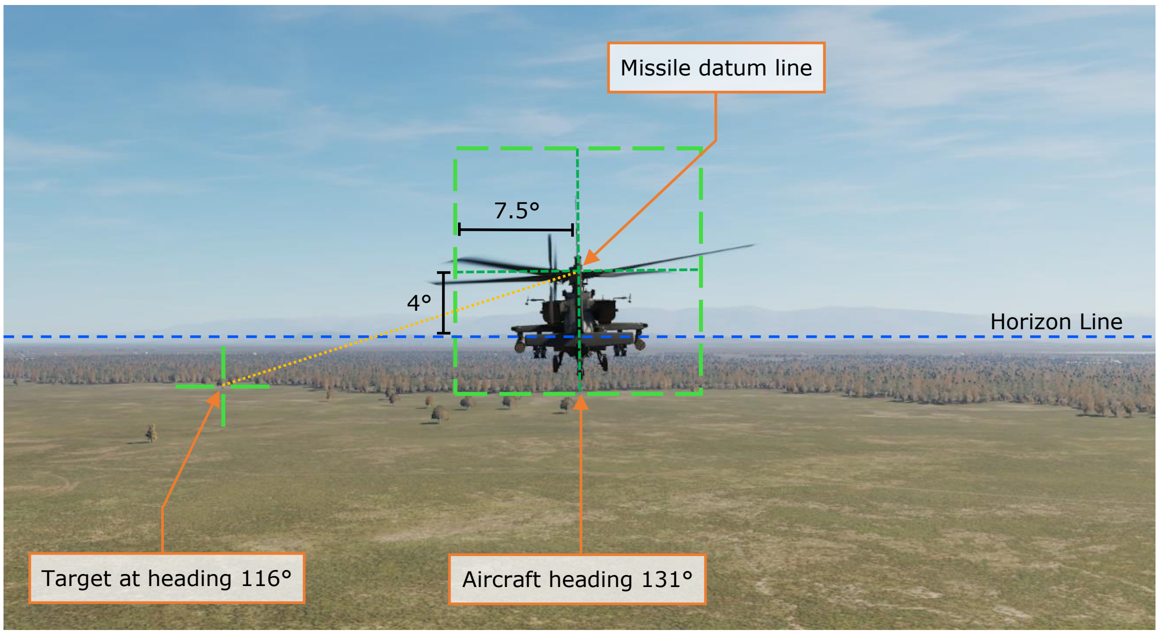


Figure 272. LOAL Constraints Box

The LOBL constraints box indicates a maximum allowable offset angle at launch of 20° from the missile datum line. If the missile detects and tracks a matching laser designation within this range, the LOAL box will automatically switch to a larger LOBL box, which will indicate the increased allowable offset angle of the missile seeker. If the aircraft maneuvers to an extent the laser designation shifts outside of this 20° offset angle, the constraints box will switch to a dashed LOBL box. If the laser designation is no longer tracked by the missile seeker, the constraints box will revert to LOAL and will be driven by the selected LOAL trajectory.

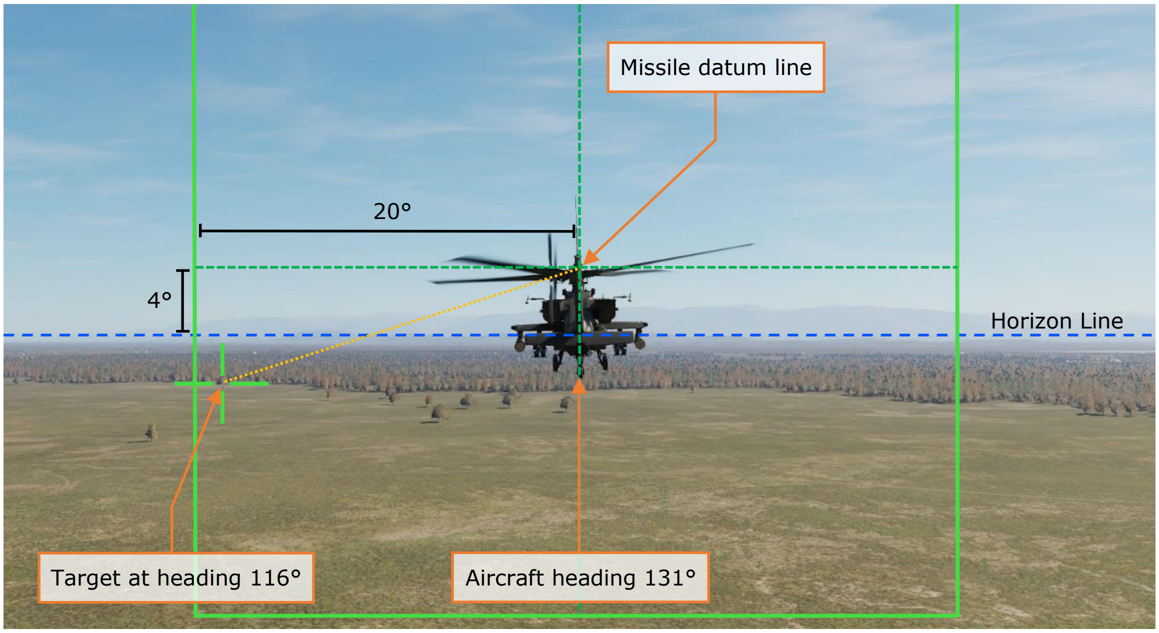


Figure 273. LOBL Constraints Box

When intending to engage targets with laser-guided Hellfire missiles, the most important step is verifying the Priority missile channel is set to the same laser code as the TADS LRFD. If these do not match, the CPG will receive a "REMOTE" message in the Sight Status field of the High Action Display, to indicate the requirement for an off-board laser designation source (see Remote Fire). It is worth noting that if the Pilot intends to employ laser-guided Hellfire missiles from the backseat, the "REMOTE" message will not be displayed due to the fact the Pilot always requires a laser designation provided by another source, whether that be his/her own CPG or another asset on the battlefield.

Laser-guided Hellfire engagement (LOBL)

To engage a target with a Hellfire missile in LOBL mode from the CPG crewstation, while using the TADS as the sight to provide autonomous designation:

1. **(CPG)** Determine the appropriate acquisition source for acquiring the target.
    a. If acquired visually by either crewmember, select PHS to set the Pilot's helmet as the acquisition source, or GHS to set the CPG's helmet as the acquisition source.
    b. If the target location exists as a point within the aircraft database, set that point as your acquisition source via the COORD page or use the Cursor Acquisition (CAQ) method on the TSD.

2. **(CPG)** Press the SLAVE button on the TEDAC right handgrip (RHG) to slew the TADS to the target location, then press the SLAVE button again to switch to manual track.

3. **(CPG)** Action the missiles by pressing Weapon Action Switch (WAS) – Right on the TEDAC left handgrip (LHG).

4. **(CPG)** On the WPN page, verify the Priority missile channel matches the LRFD; ensure TYPE (R1) is set to SAL; ensure MODE (R2) is set to NORM.

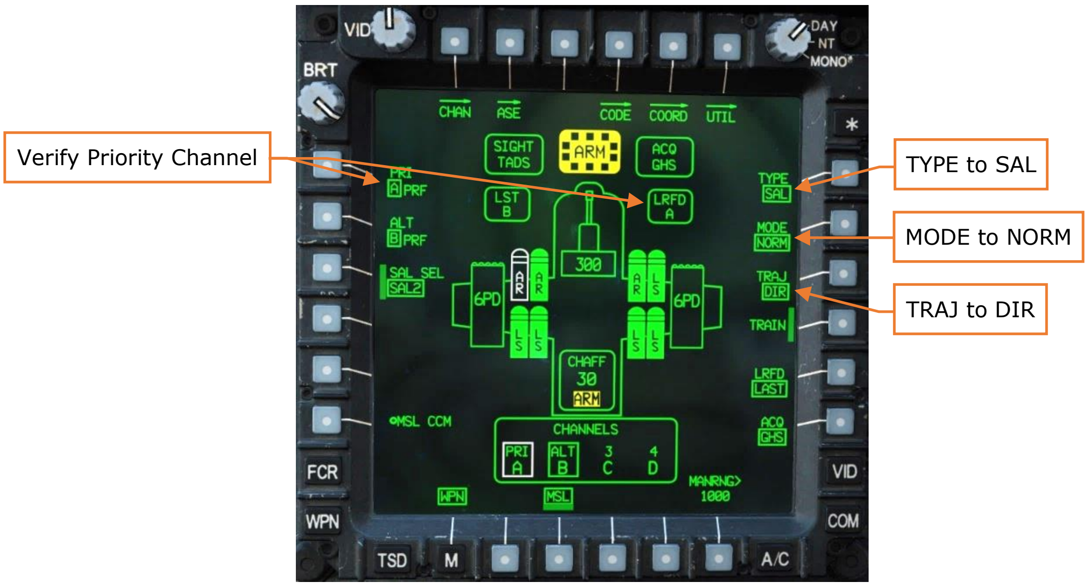


Figure 274. TADS LOBL Hellfire Engagement – CPG WPN Page

5. **(CPG)** Arm the aircraft if not already armed.

6. **(CPG)** If the target or aircraft are moving, engage the LMC to assist in maintaining the TADS LOS reticle on target with the MAN TRK switch ("Thumbforce controller") on the RHG.

7. **(CPG)** Instruct the Pilot to bring the aircraft into launch constraints if necessary, using the phrase "Constraints".

8. **(PLT)** Align the aircraft into launch constraints if necessary.

9. **(CPG)** Begin designating the target with the laser trigger, 2nd detent, on the RHG.

10. **(CPG)** Verify PRI CHAN TRK is displayed in the High Action Display.

11. **(CPG)** Verify no weapon inhibit messages are displayed in the High Action Display.

12. **(CPG)** Fire the missile with the weapon trigger on the LHG. Ensure continuous laser designation is provided on the intended target for the duration of the missile flight time until impact is observed.

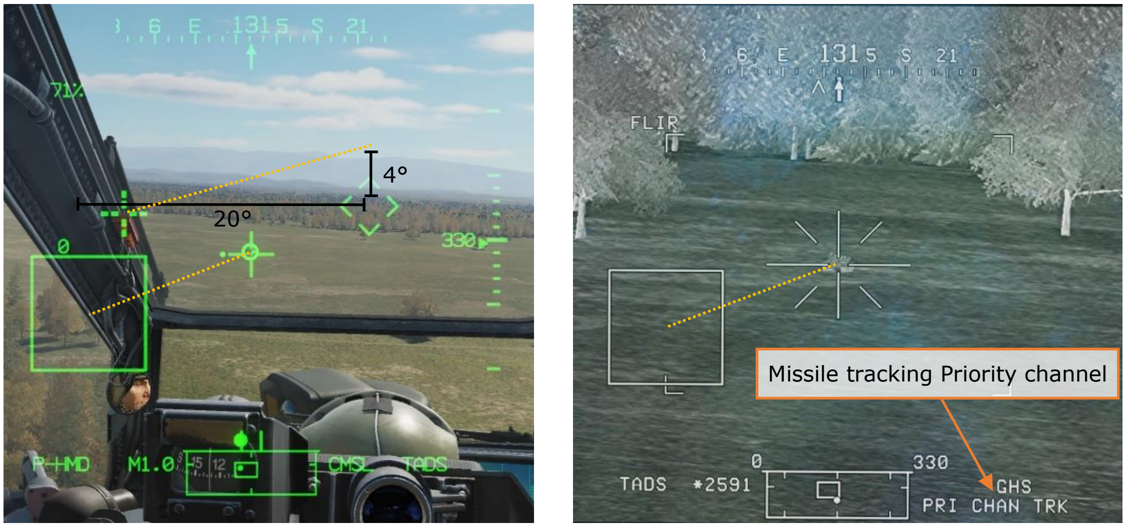


Figure 275. LOBL launch, Pilot HMD (Left), CPG TADS (Right)

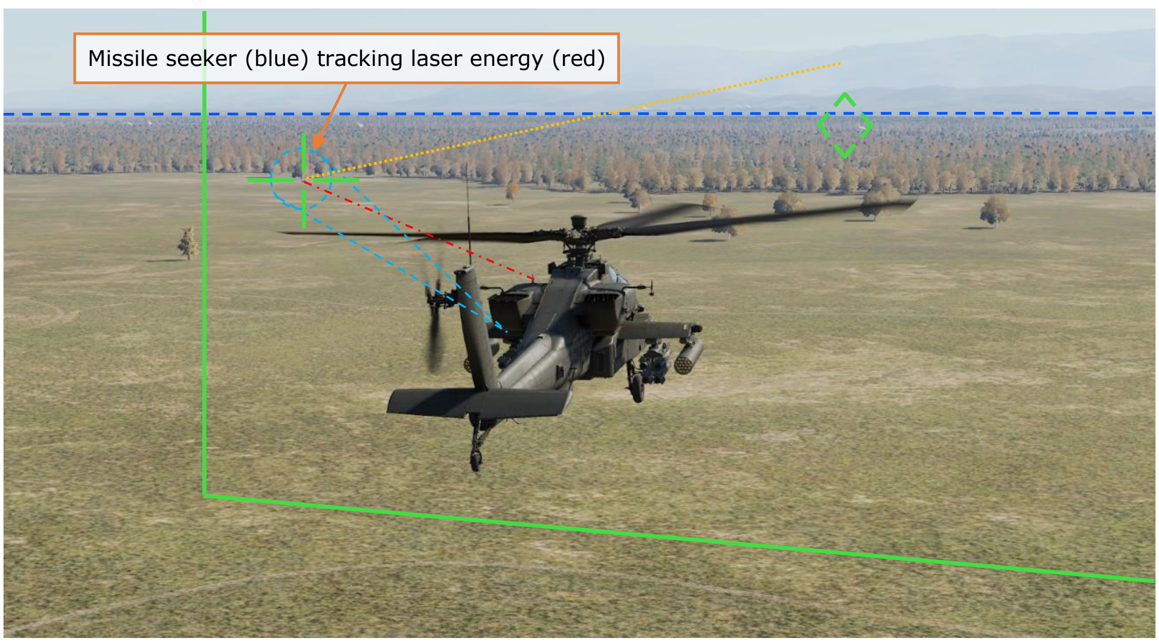


Figure 276. TADS Hellfire Engagement – LOBL launch

Laser-guided Hellfire engagement (LOAL-DIR)

When the missile LOAL trajectory (TRAJ) is set to Direct (DIR), the missile's seeker will be slaved to the TADS or HMD LOS reticle (depending on selected sight of the crewmember). Regardless of the LOAL trajectory setting, if at any time the missile detects a matching laser designation, the seeker will begin tracking the laser designation, the missile will switch to LOBL mode, and the missile constraints box will switch to the larger LOBL format. At this point, the missile will ignore the LOAL trajectory setting and will operate as LOBL. If the laser designation is no longer tracked by the missile seeker, the constraints box will revert to LOAL and will be driven by the selected LOAL trajectory.

The purpose of LOAL is to fire the missile and then provide laser guidance after weapons release. When conducting an autonomous missile engagement (laser designation provided by launching aircraft), the most common reason for firing a missile in LOAL-Direct instead of LOBL is backscatter. Backscatter can exist when an obscurant is between the aircraft and target, and/or the angle between the TADS LOS reticle and missile seeker differ by greater than 2°. When this 2° difference is detected by the aircraft, a "BACKSCATTER" message will be presented to the CPG, which will prevent the missile from being launched, regardless of which weapon trigger detent is used. The gunner should cease lasing, which will cage the missile seeker back to the TADS LOS and attempt to lase again. If backscatter cannot be overcome, the CPG should fire the missile using LOAL-Direct and then begin laser designation after the missile has successfully launched.

To engage a target with a Hellfire missile in LOAL-DIR mode from the CPG crewstation, while using the TADS as the sight to provide autonomous designation:

1. **(CPG)** Determine the appropriate acquisition source for acquiring the target.
    a. If acquired visually by either crewmember, select PHS to set the Pilot's helmet as the acquisition source, or GHS to set the CPG's helmet as the acquisition source.
    b. If the target location exists as a point within the aircraft database, set that point as your acquisition source via the COORD page or use the Cursor Acquisition (CAQ) method on the TSD.
2. **(CPG)** Press the SLAVE button on the TEDAC right handgrip (RHG) to slew the TADS to the target location, then press the SLAVE button again to switch to manual track.
3. **(CPG)** Action the missiles by pressing Weapon Action Switch (WAS) – Right on the TEDAC left handgrip (LHG).

4. **(CPG)** On the WPN page, verify the Priority missile channel matches the LRFD; ensure TYPE (R1) is set to SAL; ensure MODE (R2) is set to NORM; ensure TRAJ (R3) is set to DIR.

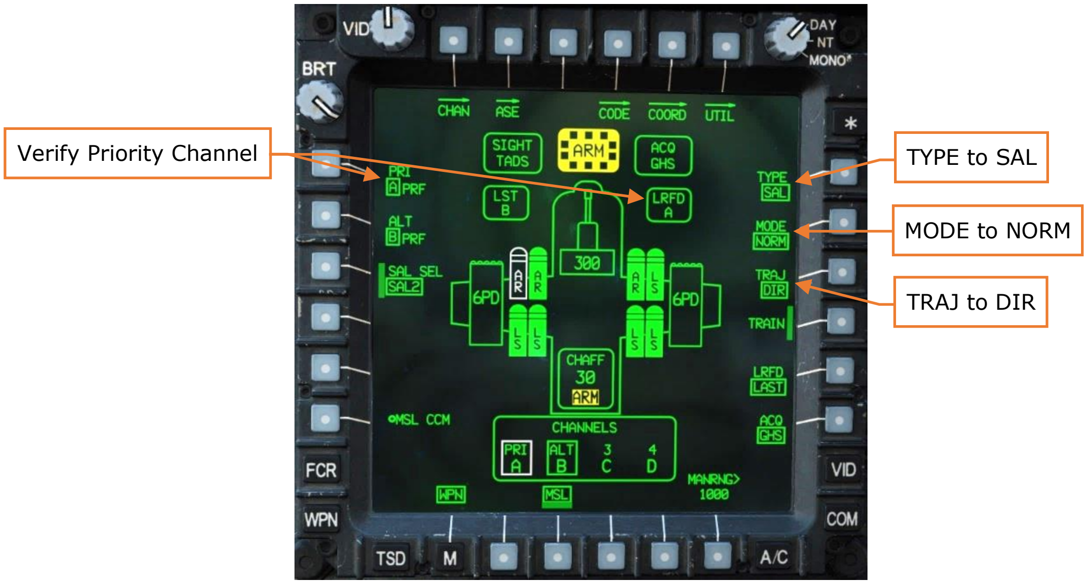


Figure 277. TADS LOAL-DIR Hellfire Engagement – CPG WPN Page

5. **(CPG)** Arm the aircraft if not already armed.
6. **(CPG)** If the target or aircraft are moving, engage the LMC to assist in maintaining the TADS LOS reticle on target with the MAN TRK switch ("Thumbforce controller") on the RHG.
7. **(CPG)** Instruct the Pilot to bring the aircraft into launch constraints if necessary, using the phrase "Constraints".
8. **(PLT)** Align the aircraft into launch constraints if necessary. The nose of the aircraft will need to be aimed relatively close to the target LOS in both azimuth and elevation.
9. **(CPG)** Verify no weapon inhibit messages are displayed in the High Action Display.
10. **(CPG)** Fire the missile with the weapon trigger on the LHG.
11. **(CPG)** After missile launch, begin designating the target with the laser trigger, 2nd detent, on the RHG. Ensure continuous laser designation is provided on the intended target for the duration of the missile flight time until impact is observed.

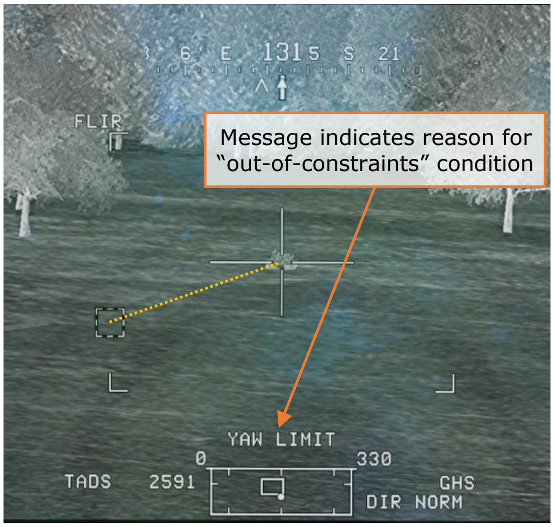


Figure 278. LOAL-DIR launch, Pilot HMD (Left), CPG TADS (Right)

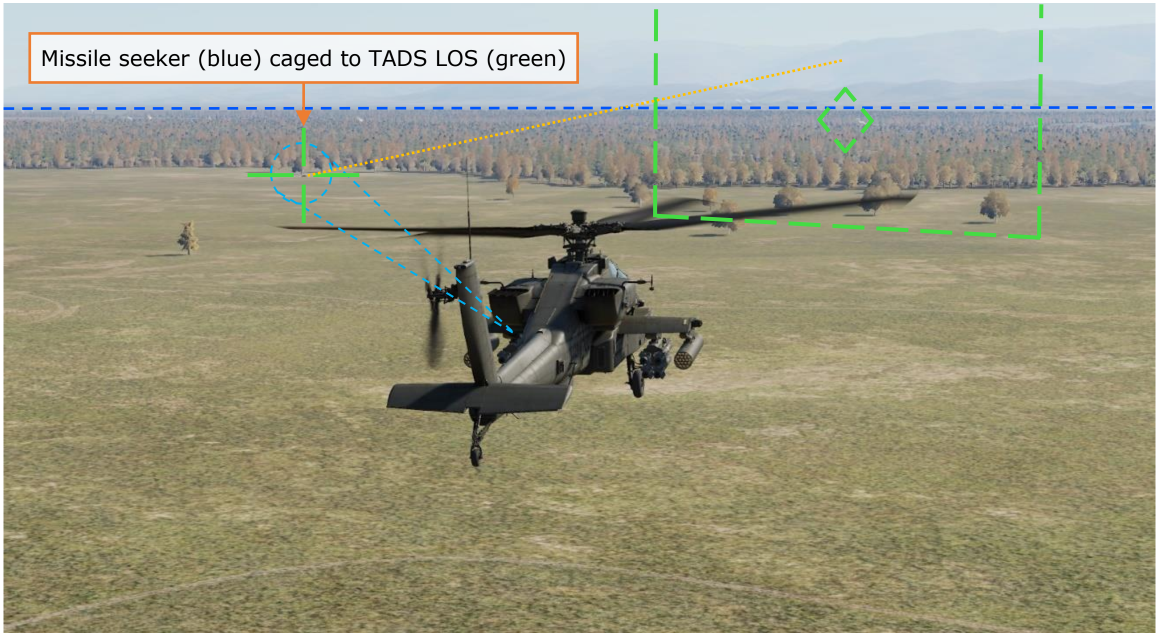


Figure 279. TADS Hellfire Engagement – LOAL-DIR launch

Laser-guided Hellfire engagement (LOAL-LO or LOAL-HI)

When conducting a long-range missile engagement, it may be necessary to use LOAL-Low or LOAL-High trajectory modes. These trajectory modes are optimized to allow the AH-64 to fire its missiles from behind cover at maximum stand-off range, and then un-mask to designate for the missile's final moments of flight. These modes are also useful if intending to remain behind cover while another source of laser designation provides terminal guidance, such as OH-58D scout helicopters, another AH-64, or friendly ground forces equipped with the required laser designation equipment.

After launch, if the trajectory is set to LO the missile will initially perform a shallow climb to clear a low obstacle in front of the aircraft. When the trajectory is set to HI the missile will initially perform a steep climb to clear a high obstacle in front of the aircraft.

When LO or HI is the selected LOAL trajectory, the missile's seeker will be caged forward, regardless of the selected sight. The most recent TSD point selected as an acquisition source drives the constraints box (point number shown above bezel button B5 after selecting the ACQ expanded menu on the WPN or TSD page). If no point has been selected as an acquisition source yet in the flight, the text above B5 within the ACQ menu will display "?00" in white; the missile constraints box will be dashed and will be frozen in the center of the LOS reticle until a point is selected.

It's important to note that regardless of the selected sight's LOS angle, the constraints box will remain driven off the offset angle of the point residing within the ACQ menu B5 when the LOAL trajectory is set to LO or HI. This is illustrated in figures below. As is the case with DIR, regardless of the LOAL trajectory setting, if at any time the missile detects a matching laser designation, the seeker will begin tracking the laser designation, the missile will switch to LOBL mode, and the missile constraints box will switch to the larger LOBL format. At this point, the missile will ignore the LOAL trajectory setting and will operate as LOBL. If the laser designation is no longer tracked by the missile seeker, the constraints box will revert to LOAL and will be driven by the selected LOAL trajectory.

To engage a target with a Hellfire missile in LOAL-LO or LOAL-HI modes from the CPG crewstation, while using the TADS as the sight to provide autonomous designation:

1. **(CPG)** Determine the appropriate point to use as the acquisition source.
    a. If the target location exists as a point within the aircraft database, set that point as your acquisition source via the COORD page or use the Cursor Acquisition (CAQ) method on the TSD.

b. If the target location does not exist as a point within the aircraft database:

i. Use LRFD to range the target and then store the target location using TEDAC LHG STO/UPT button – STO.

ii. Set that point as your acquisition source via the COORD page or use the Cursor Acquisition (CAQ) method on the TSD.

or

i. Receive the target location (MGRS or Latitude/Longitude in Degrees, Minutes, Minute-Decimals formats) and input the target location as a point within the aircraft database.

ii. Set that point as your acquisition source via the COORD page or use the Cursor Acquisition (CAQ) method on the TSD.

2. **(CPG)** Press the SLAVE button on the TEDAC right handgrip (RHG) to slew the TADS to the target location, then press the SLAVE button again to switch to manual track.

3. **(CPG)** Action the missiles by pressing Weapon Action Switch (WAS) – Right on the TEDAC left handgrip (LHG).

4. **(CPG)** On the WPN page, verify the Priority missile channel matches the LRFD; ensure TYPE (R1) is set to SAL; ensure MODE (R2) is set to NORM; ensure TRAJ (R3) is set to LO or HI.

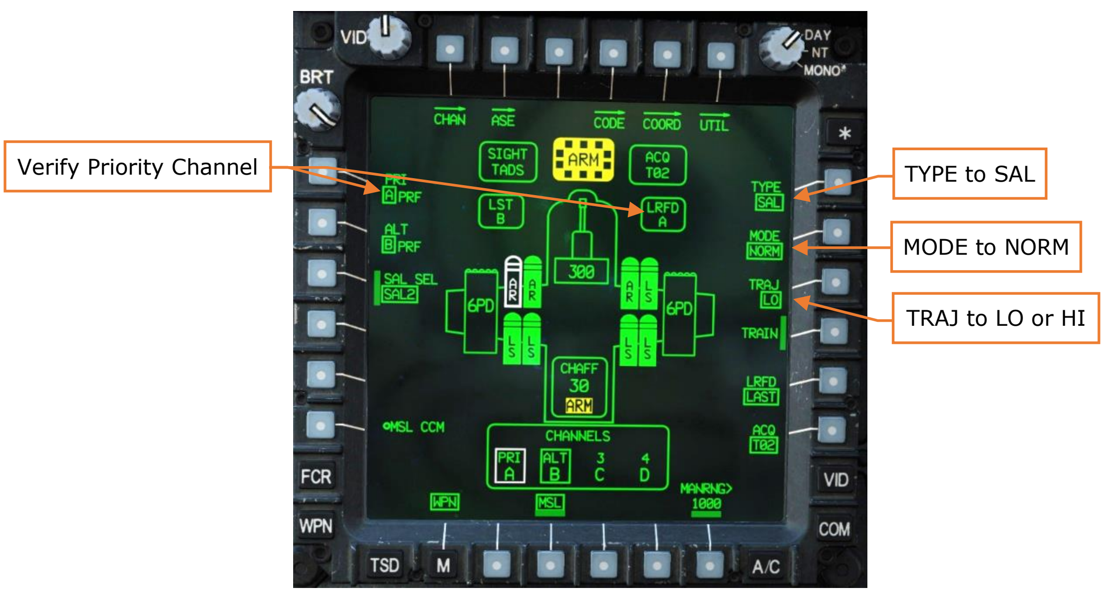


Figure 280. TADS LOAL-LO Hellfire Engagement - CPG WPN Page

5. **(CPG)** Arm the aircraft if not already armed.

6. **(CPG)** If the target or aircraft are moving, engage the LMC to assist in maintaining the TADS LOS reticle on target with the MAN TRK switch ("Thumbforce controller") on the RHG.

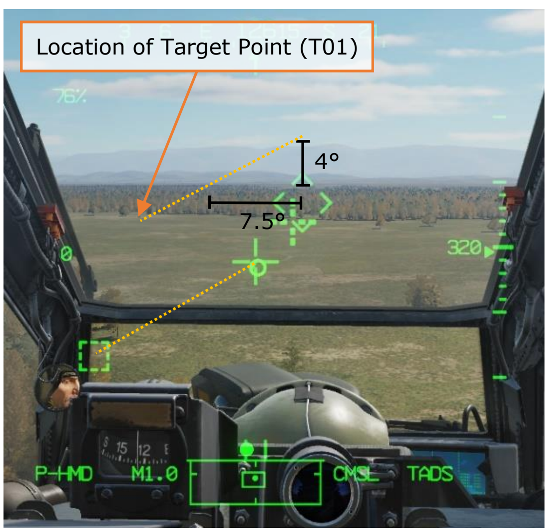
7. **(CPG)** Instruct the Pilot to bring the aircraft into launch constraints if necessary, using the phrase "Constraints".

8. **(PLT)** Align the aircraft into launch constraints if necessary. The nose of the aircraft will need to be aimed relatively close to the target LOS in both azimuth and elevation.

9. **(CPG)** Verify no weapon inhibit messages are displayed in the High Action Display.

10. **(CPG)** Fire the missile with the weapon trigger on the LHG.

11. **(CPG)** After missile launch, begin designating the target with the laser trigger, 2nd detent, on the RHG. Ensure continuous laser designation is provided on the intended target for the duration of the missile flight time until impact is observed.



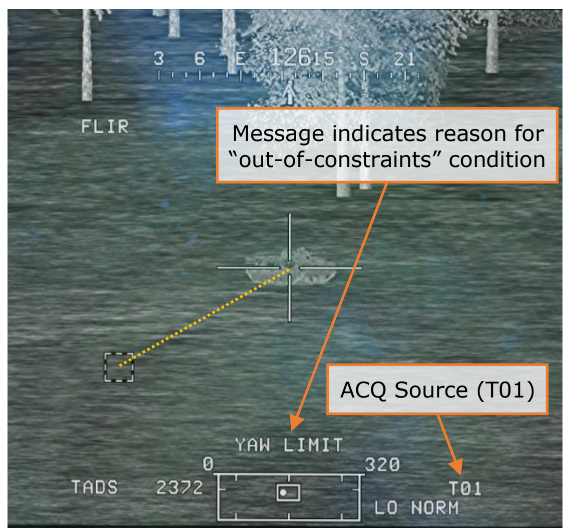


Figure 281. LOAL-LO launch, Pilot HMD (Left), CPG TADS (Right)

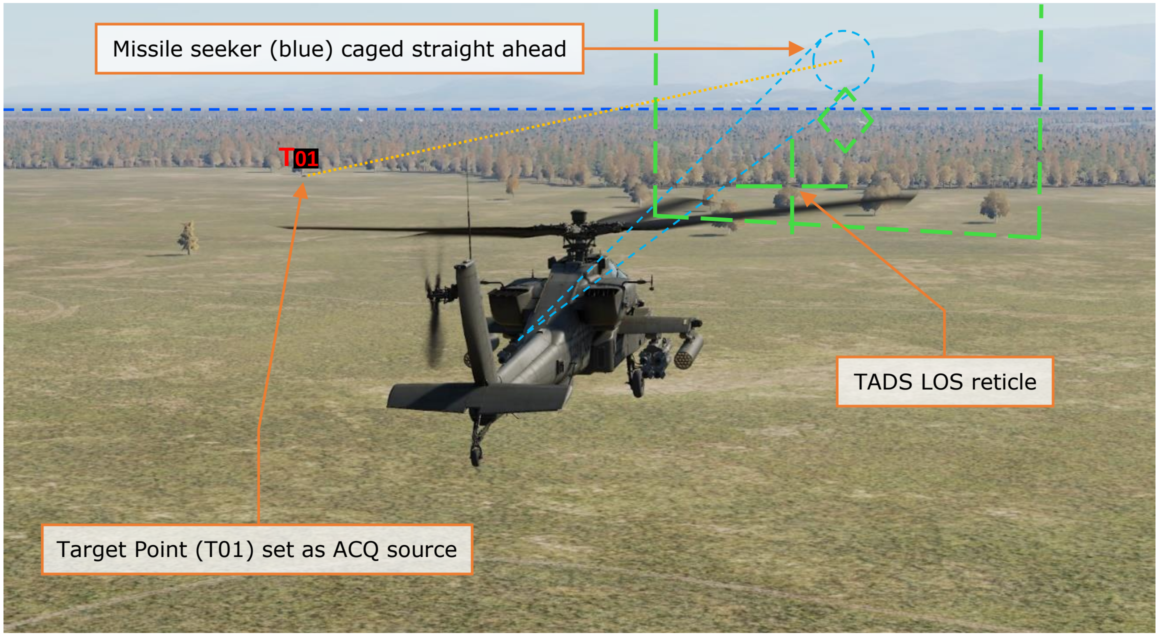


Figure 282. TADS Hellfire Engagement – LOAL-LO launch

Laser-guided Hellfire engagement (Rapid Fire)

When the tactical situation requires rapid engagement of multiple targets within relatively close proximity, laser-guided Hellfires can be employed using the "Rapid Fire" technique. Rapid Fire is defined as multiple missiles launched while being guided by the same laser designation code at the same time, with the laser designation shifting to the next target after each subsequent missile impact. It can be performed in either LOAL or LOBL launch modes.

The primary consideration when engaging targets using Rapid Fire is the time required to transition the laser designation between targets, which will drive the time interval between each missile launch. This is a function of physical separation between targets and gunner skill. The CPG must assess how long is needed to facilitate smoothly transitioning the laser designation from one target to the next before firing the first missile.

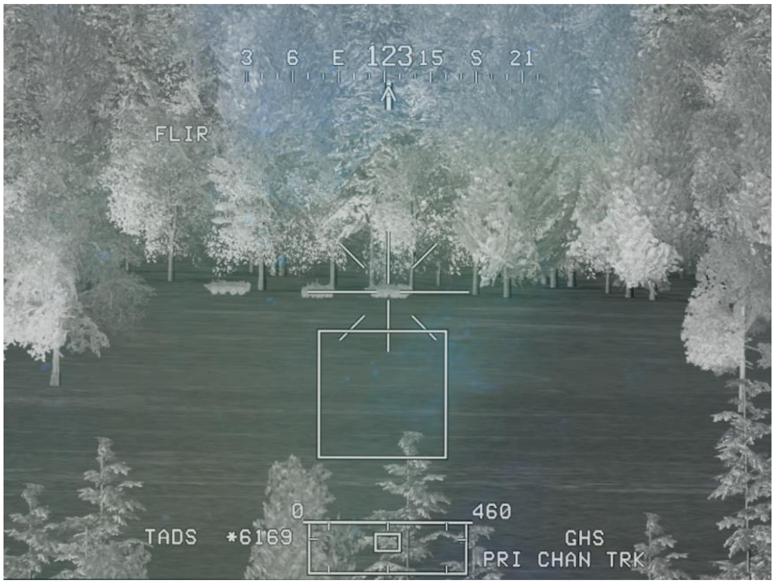


Figure 283. TADS Rapid Hellfire Engagement – Multiple targets

As each missile is launched, the aircraft systems will calculate the missile time-of-flight (TOF) based on the range value displayed in the High Action Display and monitor the elapsed time for each missile that is calculated to be in flight. 8 seconds after a missile is launched, “FIRE MSLS” will be displayed momentarily in the High Action Display as a cue to the CPG to fire the next missile in sequence. The “HF TOF=##” with the least remaining time to impact will always be displayed before others in the flight queue. When the lowest TOF reaches 12 seconds prior to impact, “LASE 1 TRGT” is displayed to cue the CPG to start designating the target if not already doing so.

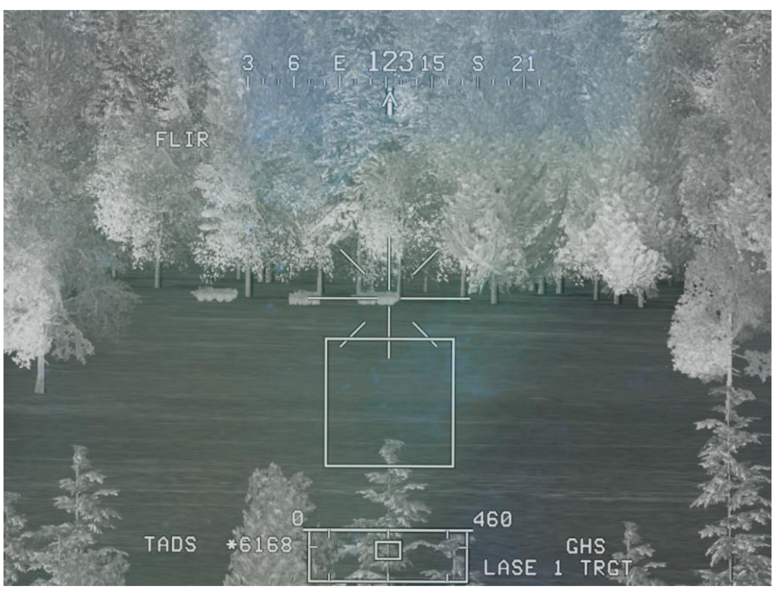


Figure 284. TADS Rapid Hellfire Engagement – Three missiles launched

When the lowest TOF reaches 0, the next TOF counter in sequence is displayed until it too reaches 12 seconds prior to impact, in which case "LASE 2 TRGT" is displayed, and so on.

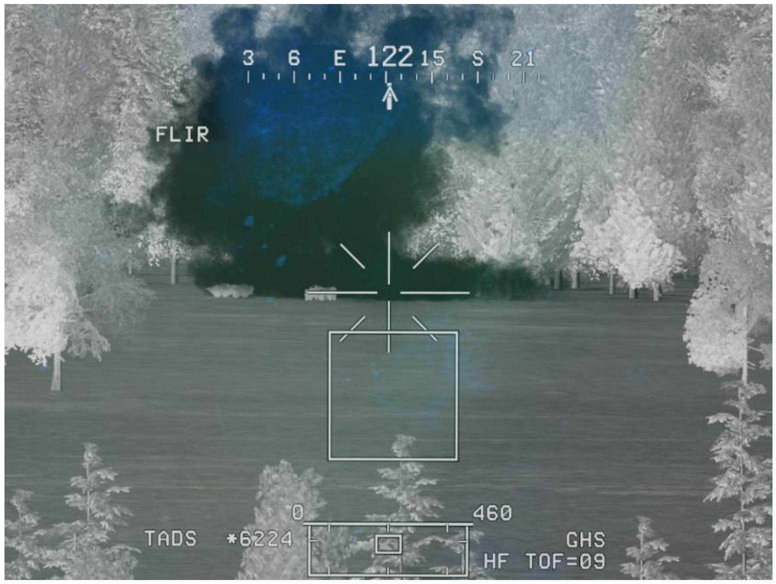


Figure 285. TADS Rapid Hellfire Engagement – Shift to next target

As each missile impacts, the CPG should ensure there is a constant source of laser designation as the TADS LOS reticle is shifted to the next target. Each missile still in flight will continue to guide on the laser designation accordingly.

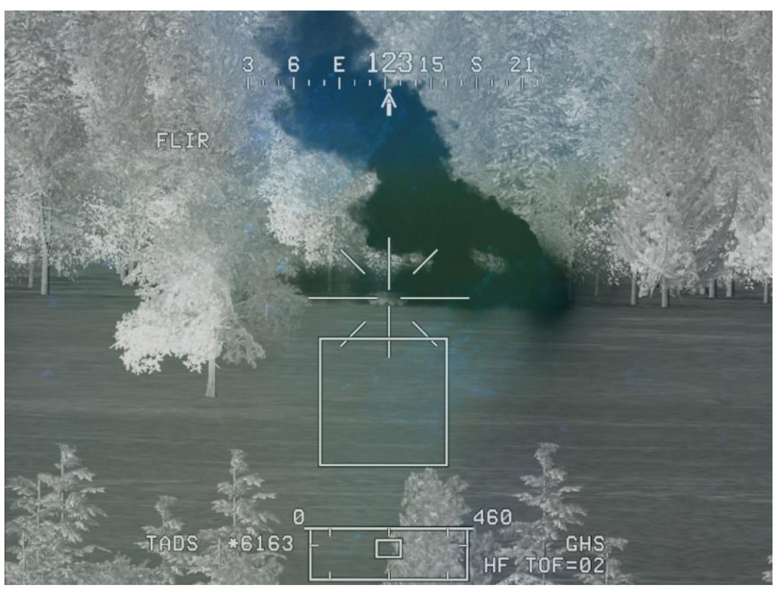


Figure 286. TADS Rapid Hellfire Engagement – Shifted to final target

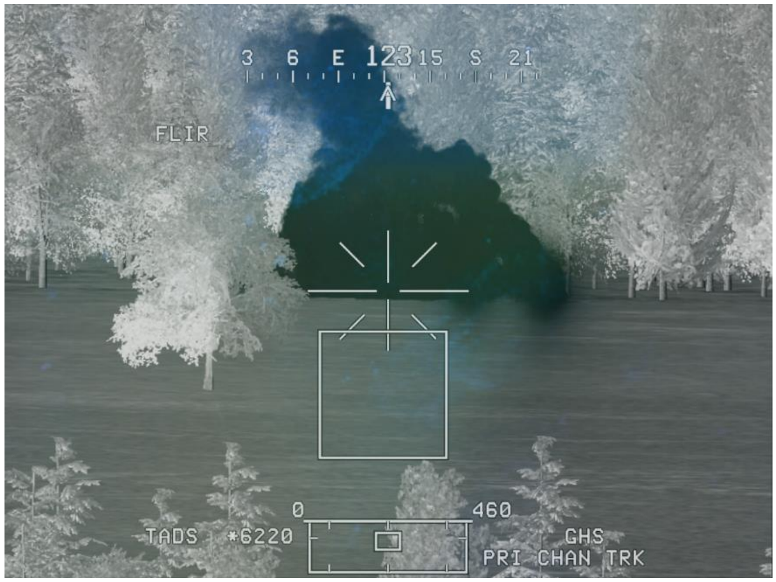


Figure 287. TADS Rapid Hellfire Engagement – Three targets destroyed

Laser-guided Hellfire engagement (Ripple Fire)

When the tactical situation requires simultaneous engagement of multiple targets using missiles fired from a single aircraft but directed at two different laser designation codes, laser-guided Hellfires can be employed using the "Ripple Fire" technique. Ripple Fire is defined as multiple missiles launched while being guided by two unique laser designation codes at the same time, with each missile launch alternating between two assigned laser designation codes. It can be performed in either LOAL or LOBL launch modes, and the launching aircraft may provide one of the two sources of laser designation or neither of them.

The primary consideration when engaging targets using Ripple Fire is ensuring that each subsequent missile is launched in the direction of the laser designation that matches it's assigned laser code, especially if launching in LOAL mode at two target locations that are laterally separated by a significant distance.

RIPL mode provides automatic missile management, coding three missiles to the Priority missile channel and another three to the Alternate missile channel. With every missile launch, the Priority and Alternate channels are automatically swapped, so that missiles are launched sequentially for each missile channel in an alternating sequence. RIPL mode also provides two additional Weapon Status messages to provide an indication to the crew when missiles are tracking a laser code matching the Alternate channel ("ALT CHAN TRK") or if missiles are tracking laser codes matching both the Priority and Alternate channels ("2 CHAN TRACK").

Figure 288. Ripple Fire Hellfire Engagement with two AH-64D's

To engage targets with Hellfire missiles using Ripple Fire in LOBL mode from the CPG crewstation, while using the TADS as the sight to provide autonomous designation for one of the missiles to be launched:

1. **(CPG)** Determine the appropriate acquisition source for acquiring the target.
    a. If acquired visually by either crewmember, select PHS to set the Pilot's helmet as the acquisition source, or GHS to set the CPG's helmet as the acquisition source.
    b. If the target location exists as a point within the aircraft database, set that point as your acquisition source via the COORD page or use the Cursor Acquisition (CAQ) method on the TSD.
2. **(PLT; *Optional*)** When conducting Ripple Fire in LOBL mode, the PLT may wish to select SKR as the acquisition source to maintain awareness of where the seeker of the next missile to be fired is pointing, and whether the next missile is tracking the correct target prior to launch.
2. **(CPG)** Press the SLAVE button on the TEDAC right handgrip (RHG) to slew the TADS to the target location, then press the SLAVE button again to switch to manual track.
3. **(CPG)** Action the missiles by pressing Weapon Action Switch (WAS) – Right on the TEDAC left handgrip (LHG).
4. **(CPG)** On the WPN page, verify the Priority missile channel matches the LRFD; verify the Alternate missile channel matches the second laser designator; ensure TYPE (R1) is set to SAL; ensure MODE (R2) is set to RIPL.

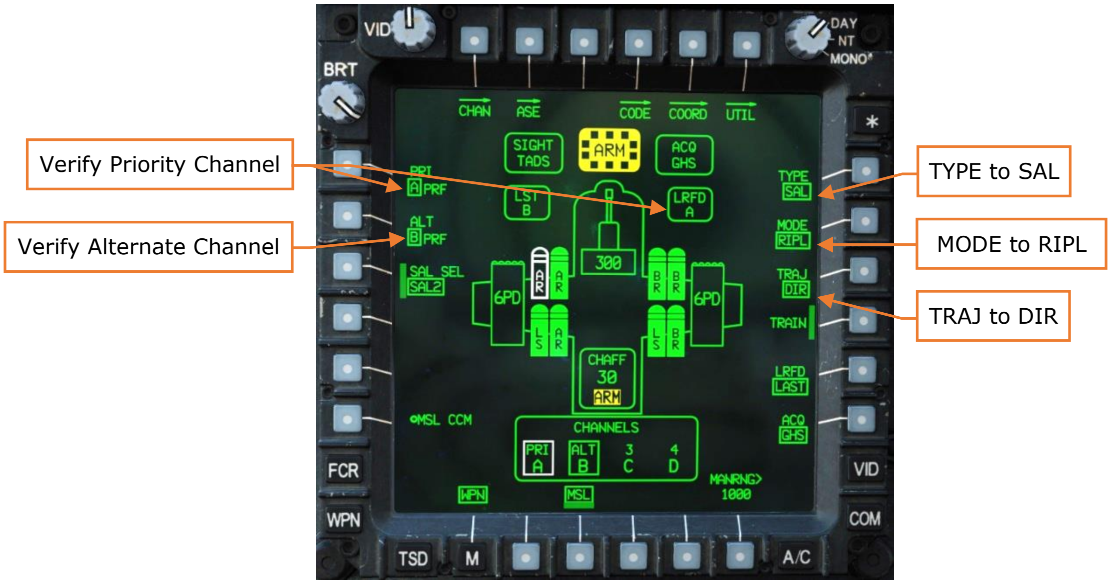


Figure 289. TADS RIPL Hellfire Engagement – CPG WPN Page

5. **(CPG)** Arm the aircraft if not already armed.
6. **(CPG)** If the target or aircraft are moving, engage the LMC to assist in maintaining the TADS LOS reticle on target with the MAN TRK switch ("Thumbforce controller") on the RHG.
7. **(CPG)** Instruct the Pilot to bring the aircraft into launch constraints if necessary, using the phrase "Constraints".
8. **(PLT)** Align the aircraft into launch constraints for the first missile if necessary.
9. **(CPG)** Begin designating the target with the laser trigger, 2nd detent, on the RHG.
10. **(PLT/CPG)** Instruct the second designator to begin designating their target.
11. **(CPG)** Verify "PRI CHAN TRK" is displayed in the High Action Display. If the second designator is also lasing, ensure "2 CHAN TRACK" is displayed in the High Action Display.
12. **(CPG)** Verify no weapon inhibit messages are displayed in the High Action Display.
13. **(CPG)** Fire the first missile with the weapon trigger on the LHG.
14. **(PLT)** Align the aircraft into launch constraints for the second missile if necessary.
15. **(CPG)** Fire the second missile with the weapon trigger on the LHG.
16. **(PLT/CPG)** Notify the second designator of missile launch toward their target.

17. **(CPG)** Continue to provide continuous laser designation of the intended target within the TADS until impact is observed from the first missile.

Figure 290. RIPL/LOBL launch, Pilot HMD (Left), CPG TADS (Right)

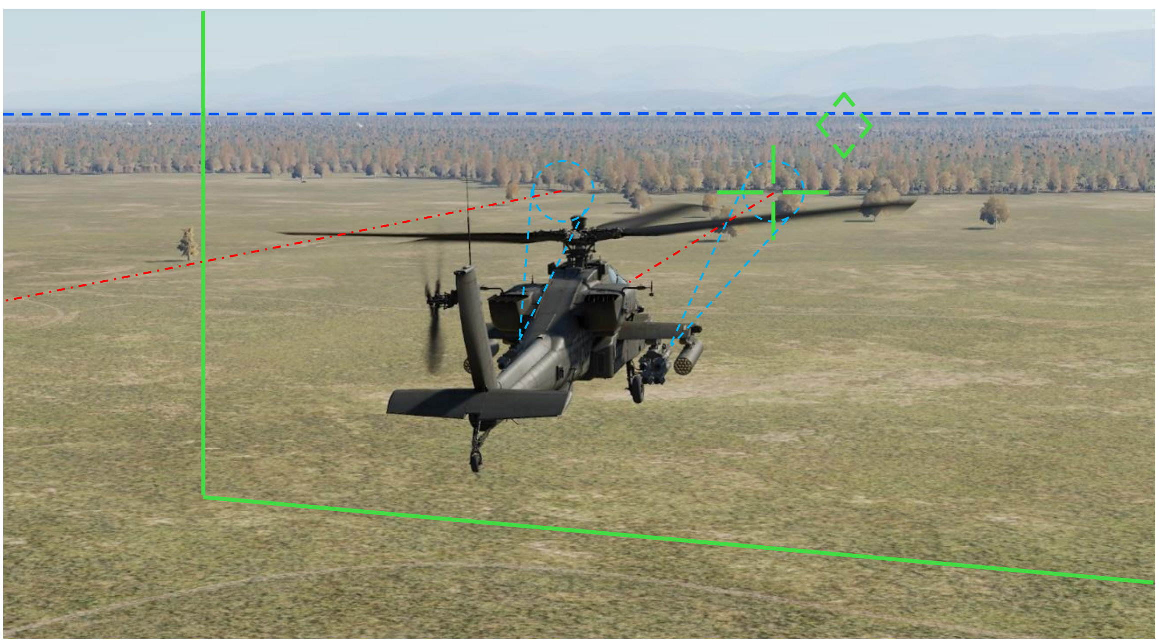


Figure 291. TADS Hellfire Engagement – RIPL/LOBL launch

RIPL mode may be used in conjunction with LOAL modes as well, however it is important that the Pilot ensures the aircraft is pointed towards the intended target prior to each missile launch. Careful selection of the acquisition source in the Pilot crewstation can aid in this task.

Laser-guided Hellfire engagement (Remote Fire)

A "Remote" Hellfire engagement is conducted when another aircraft (such as an OH-58D) or ground element provides laser designation for the aircraft launching the missile. The designating aircraft informs the firing aircraft what code they will use to designate the target, and the firing aircraft sets that code as their Priority missile channel on the WPN page, MSL format. When the PRI channel (L1) and LRFD codes differ, a "REMOTE" message will be displayed in the HAD Sight Status field, alerting the gunner to the fact that the missile is not coded to match their current LRFD code.

When conducting a Remote engagement, the firing aircraft will typically fire from behind cover. A LOAL-LO or LOAL-HI trajectory is recommended depending on the height of the obstacle in front of the aircraft.

Prior to conducting a Remote engagement, the designating element should pass the MGRS or Latitude/Longitude location for the target, along with their laser code/frequency. The aircrew in the firing aircraft will input the target location as a point on the TSD, set that point as their acquisition source, and then re-orient and/or re-position the aircraft as necessary to launch the missile. While the Pilot is re-positioning the aircraft, the CPG will then set their PRI channel to the designator's laser code and select the desired LOAL trajectory. Once the missile is properly configured for launch, and the Pilot has placed the aircraft into proper launch constraints, the aircrew of the firing aircraft will notify the designating element they are ready to fire and then coordinate for the designation as appropriate.

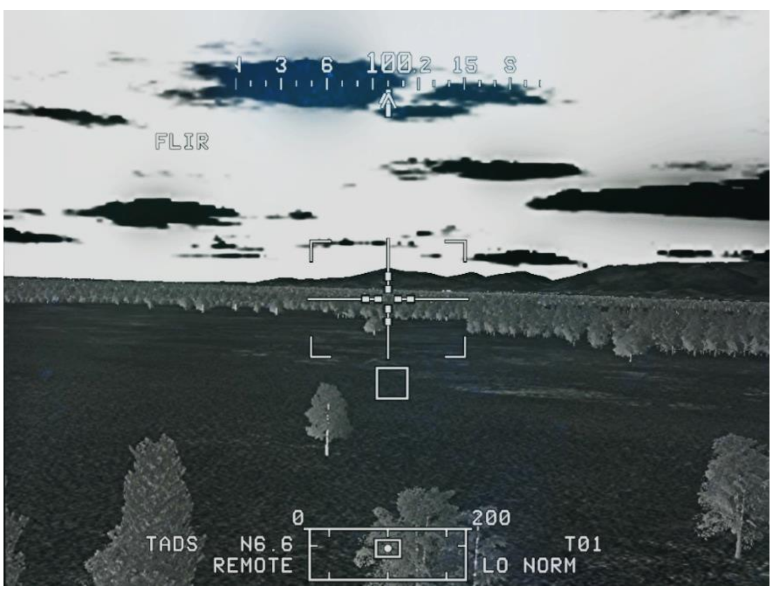


Figure 292. TADS Remote Hellfire Engagement – REMOTE message

As with other Hellfire engagements, "MSL LAUNCH", "FIRE MSLS", "HF TOF=##" and "LASE # TRGT" messages are displayed in the same sequence following the same logic. However, when a missile is launched on a laser code that does not match the launching aircraft's LRFD, the aircrew is presented with these messages in the Sight Status field of the HAD instead of the Weapon Status field. This allows the aircrew to engage other targets with missiles autonomously while the Remote missile is still in flight, monitor the times-of-flight of each missile separately, and provide cueing to the designating element of when laser guidance is required prior to impact if not already coordinated.

Figure 293. TADS Remote Hellfire Engagement – Launch commanded

As soon as the missile is launched using the Remote method, the aircrew is free to change their Priority channel back to their own LRFD code and continue engaging targets as necessary. The "FIRE MSLS", "HF TOF=##", and "LASE # TRGT" messages for the Remote missile will continue to be displayed in the Sight Status field, even if the missiles are de-actioned by the aircrew.

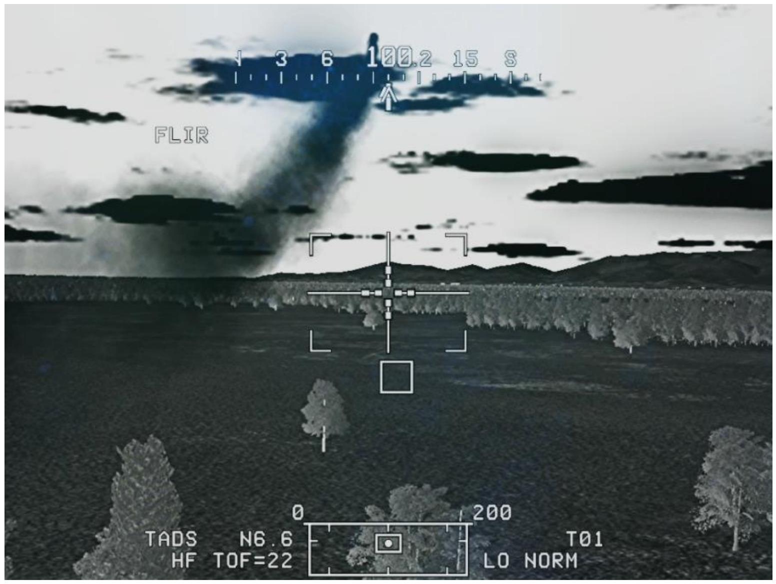


Figure 294. TADS Remote Hellfire Engagement – Time of flight displayed

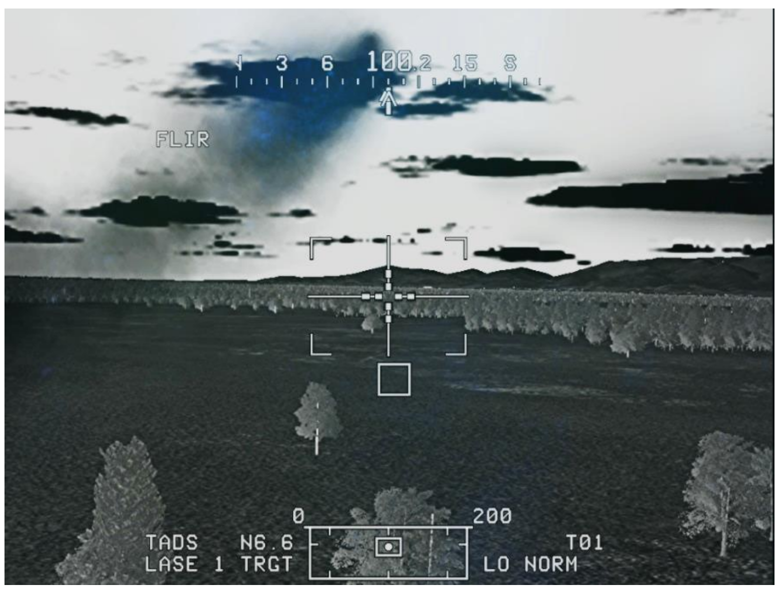


Figure 295. TADS Remote Hellfire Engagement – Lasing cue

To engage a target with a Hellfire missile in the CPG crewstation, while employing a Remote source of laser designation:

1. **(CPG)** Determine the appropriate point to use as the acquisition source.
    a. If the target location exists as a point within the aircraft database, set that point as your acquisition source via the COORD page or use the Cursor Acquisition (CAQ) method on the TSD.

b. If the target location does not exist as a point within the aircraft database:

    i. Use LRFD to range the target and then store the target location using TEDAC LHG STO/UPT button – STO.

    ii. Set that point as your acquisition source via the COORD page or use the Cursor Acquisition (CAQ) method on the TSD.

    or

    i. Receive the target location (MGRS or Latitude/Longitude in Degrees, Minutes, Minute-Decimals formats) and input the target location as a point within the aircraft database.

    ii. Set that point as your acquisition source via the COORD page or use the Cursor Acquisition (CAQ) method on the TSD.

2. **(CPG)** Receive the designator's laser code/frequency.

    a. If the laser frequency already exists as a pre-configured laser code on the WPN CODE page:

        i. Ensure the matching code is set to one of the 4 missile channels on the WPN CHAN page.

        ii. Set that missile channel as PRI (L1) on the WPN page, MSL format.

    b. If the laser frequency does not exist on the WPN CODE page:

        i. Manually edit a code preset on the FREQ sub-page to match the designator's laser frequency.

        ii. Ensure the matching code is set to one of the 4 missile channels on the WPN CHAN page.

        iii. Set that missile channel as PRI (L1) on the WPN page, MSL format.

3. **(CPG)** Action the missiles by pressing Weapon Action Switch (WAS) – Right on the TEDAC left handgrip (LHG).

4. **(CPG)** On the WPN page, ensure TYPE (R1) is set to SAL; ensure MODE (R2) is set to NORM; ensure TRAJ (R3) is set to DIR, LO or HI, as appropriate.

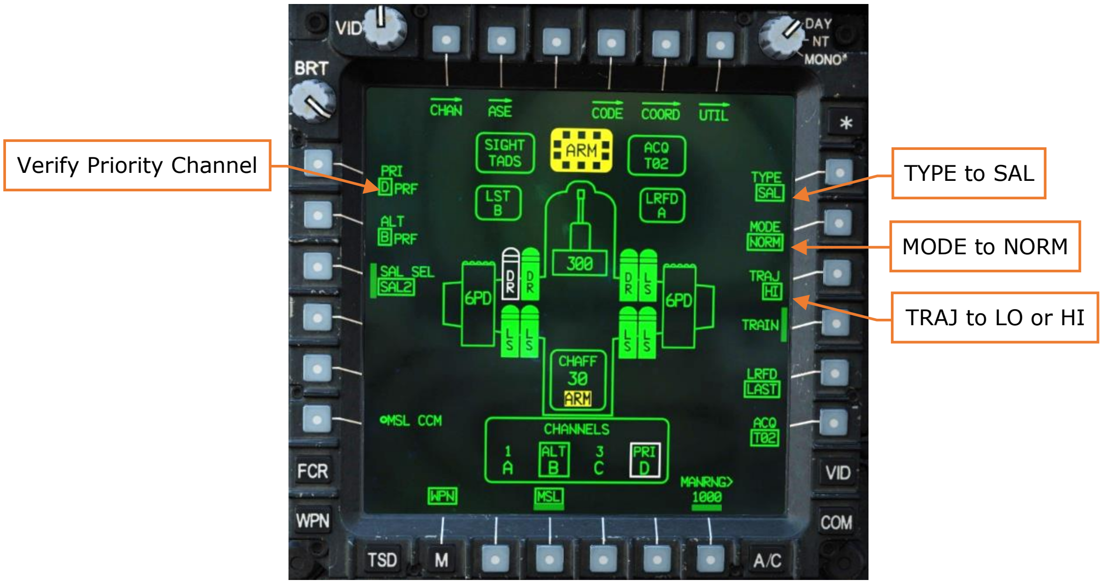


Figure 296. TADS Remote Hellfire Engagement – CPG WPN Page

5. **(CPG)** If TRAJ is set to DIR, press the SLAVE button on the TEDAC right handgrip (RHG) to slew the TADS to the target location to ensure proper missile constraints box alignment.

6. **(CPG)** Arm the aircraft if not already armed.

7. **(CPG)** Instruct the Pilot to bring the aircraft into launch constraints if necessary, using the phrase "Constraints".

8. **(PLT)** Align the aircraft into launch constraints if necessary. The nose of the aircraft will need to be aimed relatively close to the target LOS in both azimuth and elevation.

9. **(CPG)** Verify no weapon inhibit messages are displayed in the High Action Display.

Figure 297. TADS Remote Hellfire Engagement – CPG TADS Video

10. **(PLT/CPG)** Verify designating element is ready to provide laser designation of the target.

11. **(CPG)** When designating element is ready, fire the missile with the weapon trigger on the LHG.

12. **(PLT/CPG)** Advise the designating element when laser designation of the target is required.

AIRCRAFT SURVIVABILITY EQUIPMENT (ASE)

The AH-64D features a comprehensive suite of active and passive defensive systems that are designed to ensure the survival of the aircraft while operating at NOE (Nap-Of-the-Earth) altitudes in a high threat environment, to include a Wire Strike Protection System (WSPS) installed on the forward fuselage and underside.

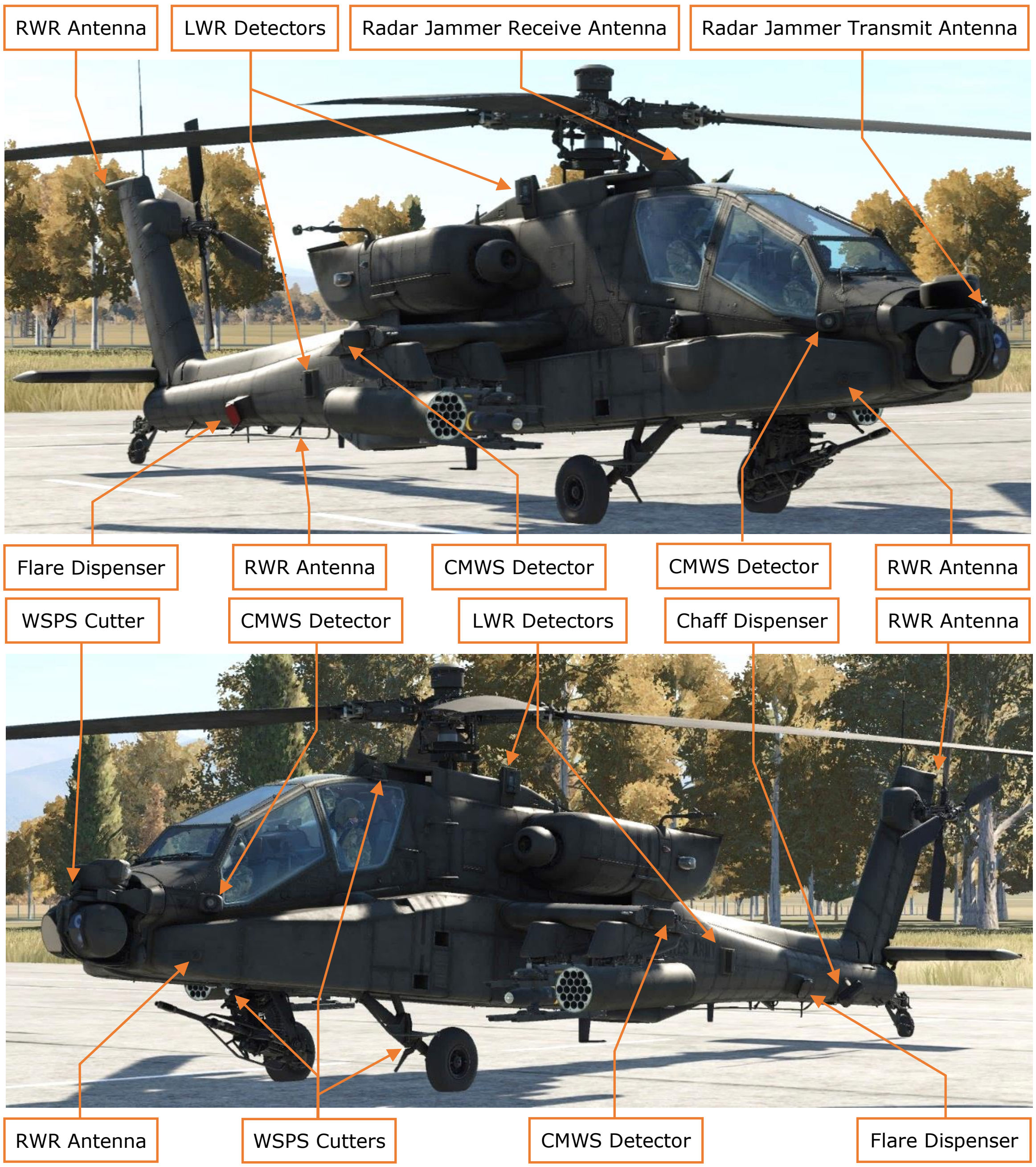


Figure 298. AH-64D Aircraft Survivability Equipment (ASE)

Radar Signal Detecting Set

The AN/APR-39A(V)4 provides detection of threat radar emissions. The system uses a series of external antennas to passively detect and identify radar signals and display them to the crew on the MPD TSD and ASE pages. Combined with the AN/AVR-2A Laser Signal Detecting Set as the RLWR, the APR-39 can also provide audio warning to the crew describing the type of threat, threat direction, and what mode the radar is operating, allowing the crew to remain focused outside for obstructions to flight or searching for enemy targets.

The MPD TSD and ASE pages provide a singular "footprint" for the combined indications of the RLWR (and RFI if equipped with an FCR mast-mounted assembly). The display is an azimuth-only top-down display, with the type of threat symbol displayed within the inside of the RFI/RLWR "footprint". The nature of the threat is indicated by the type of icon and its label, and the severity of the threat is indicated by additional formatting placed around the symbol.

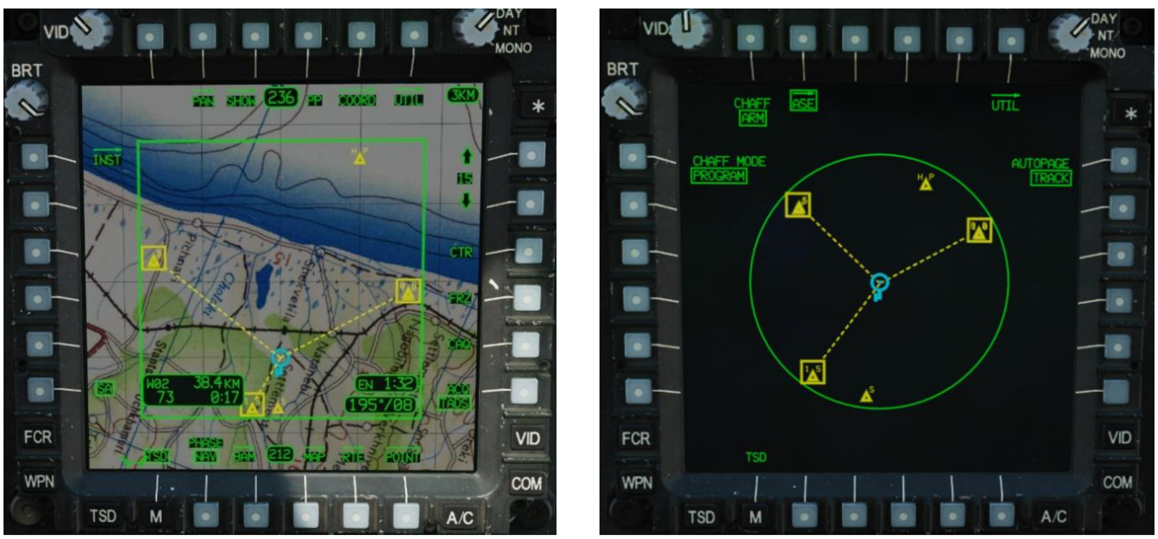


Figure 299. MPD TSD Page (Left) and ASE page (Right)

- **Search Mode.** Radar threat is displayed as a yellow triangle icon with a one- or two-digit label identifier.
- **Track Mode.** Radar threat icon is displayed with a box placed around the icon and a dotted line leading to the Ownship.
- **Launch Mode.** Radar threat is displayed with a flashing box placed around the icon and a flashing dotted line leading to the Ownship.
- **New Threat.** A new radar threat is displayed as a bolded yellow triangle for 3 seconds.
- **Threat no longer detected.** A radar threat that is no longer detected will be displayed in partial intensity yellow for 10 seconds before being removed from the RLWR "footprint".

Laser Signal Detecting Set

-Coming later in EA-

The AN/AVR-2A provides detection of threat laser emissions. The system uses a series of external detectors to passively detect and process laser sources and display them to the crew on the MPD TSD and ASE pages. Combined with the AN/APR-39A Radar Signal Detecting Set as the RLWR, the AVR-2A can also provide audio warning to the crew describing the type of laser threat and threat direction, allowing the crew to remain focused outside for obstructions to flight or searching for enemy targets.

Common Missile Warning System

The AN/AAR-57 provides detection of threat missiles via a series of external detectors to passively detect missiles after launch. The system displays the threat direction to the Pilot via the Control Indicator, along with an associated audio alert to the crew. The AAR-57 is also capable of initiating automatic dispensing of flares without crew interaction, but still retains a manual flare dispense capability via the cyclic-mounted FLARE buttons in both crewstations.

As a post-production modification to the AH-64D, the AAR-57 uses the ADF audio channel to provide audio alerts to the crew. As such, the ADF audio volume knob in each crewstation is utilized to control CMWS threat warning audio volume separately from the RLWR audio volume. While providing threat audio, the crew will be unable to tune and identify navaids using the ADF receiver. The CMWS/NAV switch is used to switch between ADF receiver audio when in the NAV position and CMWS threat alert audio when in the CMWS position. The Pilot should ensure this switch is set to the CMWS position if operating in a hostile area where missile threats are expected.

Figure 300. CMWS Control Indicator

Control Indicator Display. Displays the current inventory of expendable countermeasures onboard the aircraft, threat direction, status of the system, and results of Built-In-Test (BIT).

- **F ##.** Indicates total quantity of flares on board. Will alternate between "F 0" and "F OUT" when flare dispensers are detected as empty.
- **C ##.** Indicates total quantity of chaff on board. Will alternate between "C 0" and "C OUT" when chaff dispenser is detected as empty.
- **D.** When illuminated, indicates dispensing of flares or chaff is in progress.
- **R.** When illuminated, indicates system is in a ready state for flare dispensing.
- **Quadrant Arrows.** Indicates direction of threat missile detected.

Power/Test Knob. Powers on CMWS system by moving knob to ON position. Initiates BIT process by momentarily moving knob to TEST position.

CMWS/Nav Switch. Toggles ADF audio channel between CMWS threat reporting when in CMWS mode, and ADF navaid audio when in NAV mode.

Arm/Safe Switch. Arms flare dispensers for automatic or manual dispensing. Flare dispensing is inhibited when aircraft is weight-on-wheels.

Audio Knob. No function.

Lamp Knob. Adjusts the brightness of the Control Indicator Display.

Jettison Switch. Guarded switch that jettisons all flares on board the aircraft.

Auto/Bypass. Toggles between automatic flare dispensing when a missile threat is detected in AUTO mode, or manual flare dispensing when in BYPASS mode. Missile threat warning is provided regardless of switch position, and manual dispensing is retained when in AUTO mode.

Radar Jammer

-AN/ALQ-136(V)5 electronic countermeasure system coming later in EA-

Chaff Dispenser

The M-141 chaff dispenser is mounted on the left side of the tail boom and can hold 30 chaff cartridges. Chaff can be dispensed one at a time in MANUAL mode, or sequentially when in PROGRAM mode. The chaff mode is toggled between MANUAL and PROGRAM on the MPD ASE or ASE UTIL pages, and dispensing is performed via the chaff button mounted on each cyclic.

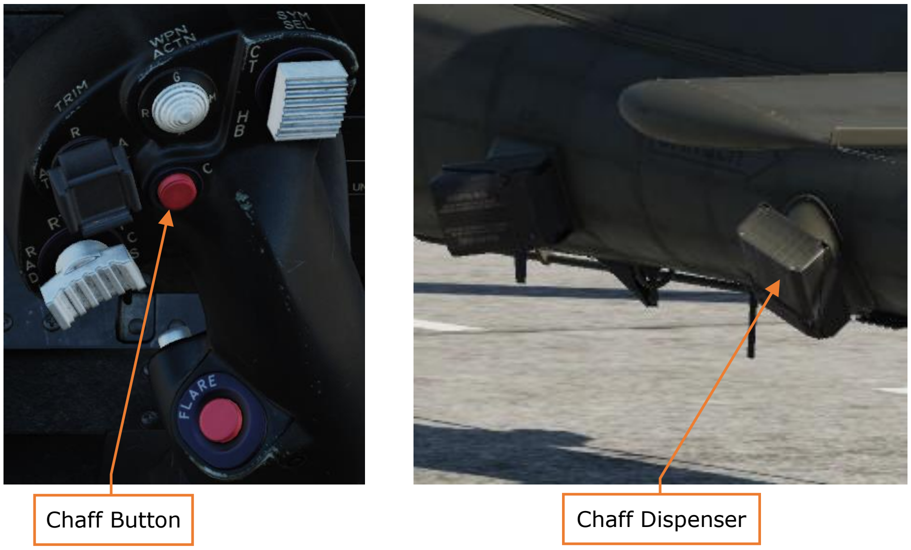


Figure 301. Chaff Button (Left) and M141 Chaff Dispenser (Right)

The chaff program can be modified via the ASE UTIL page, with options for Burst Quantity, Burst Interval, Salvo Quantity, and Salvo Interval. The chaff dispenser can be set to ARM on the MPD ASE or ASE UTIL pages but is automatically switched to SAFE and inhibited from dispensing when the aircraft is weight-on-wheels.

The chaff quantity and ARM/SAFE status is also indicated on the MPD WPN page.

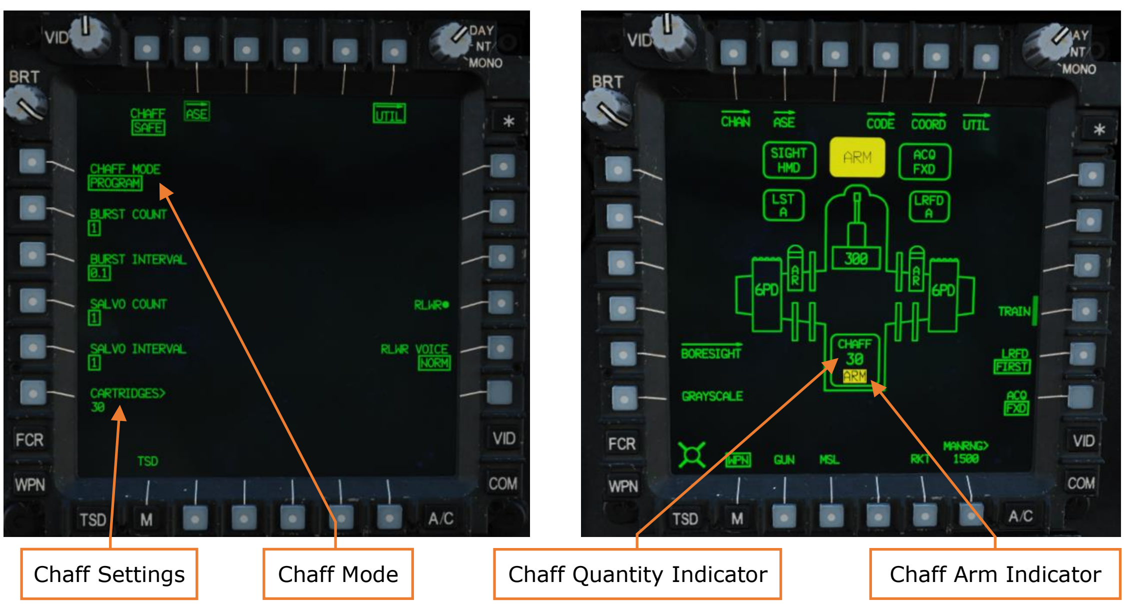


Figure 302. MPD ASE UTIL Page (Left) and WPN Page (Right)

Flare Dispensers

A pair of Improved Countermeasures Dispensers (ICMD) are mounted on opposing sides of the tail boom and can hold 30 flare cartridges each. These utilize a pre-set flare program, and which can only be modified when on the ground or from within the Mission Editor. Flares can be dispensed automatically or manually when CMWS is set to AUTO mode, or manually when CMWS is set to BYPASS mode. Manual dispensing is performed via the flare button mounted on each cyclic.

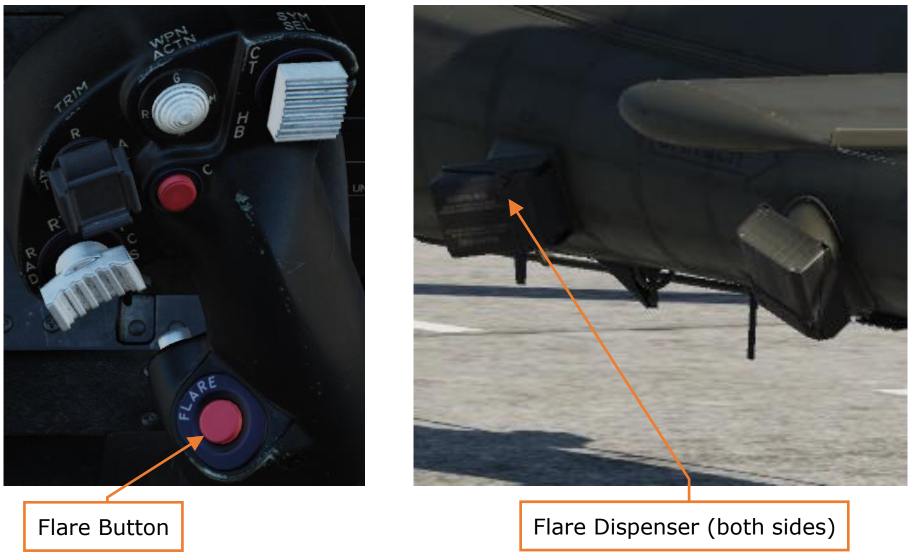


Figure 303. Flare Button (Left) and ICMD Flare Dispensers (Right)

The CMWS flare program can only be modified by ground personnel utilizing the kneeboard settings (or pre-set in the Mission Editor) while the engines are off. The available program options include Burst Count, Burst Interval, Salvo Count, Salvo Interval, and Minimum Time Between Programs. The flare dispensers can be set to ARM on the CMWS Control Indicator panel in the Pilot's crewstation but will be inhibited from dispensing while the aircraft is weight-on-wheels.

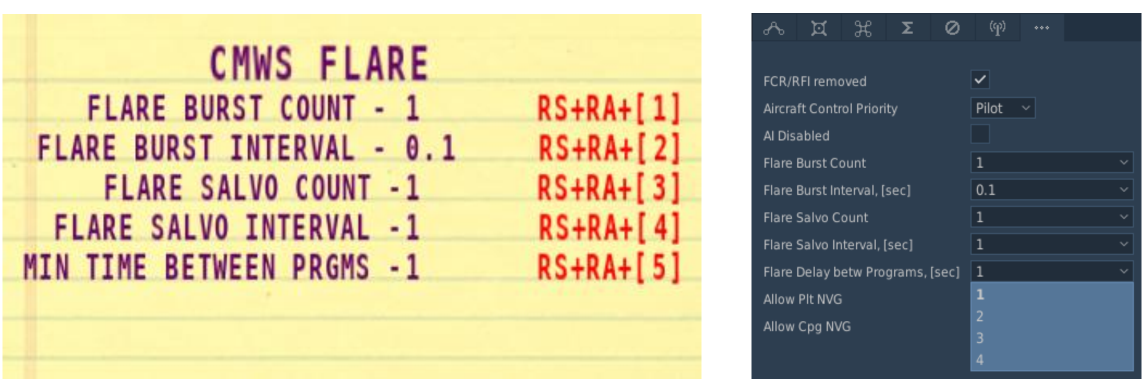


Figure 304. Flare Settings via Kneeboard (Left) and Mission Editor (Right)

"GEORGE" AI

The AH-64D is crewed by two crewmembers: a Pilot (PLT) and a Copilot/Gunner (CPG). The DCS: AH-64D module supports multicrew capability, where two players can occupy the two seats in a multiplayer session for cooperative play. To accommodate a single-player experience, we have created George, a virtual crewmember that allows single-player Pilots to control mission-critical items in the cockpit that the player is not occupying. George was designed to mimic the real-life procedures used by AH-64D crew members. It enables single-players to coordinate and control AI actions.

George can be controlled by a four-way hat on your HOTAS or using joystick buttons. The Early Access version of George will continue to be refined, and have new features added.

AH-64D AI CONTROLS STRUCTURE

The George control bindings are divided into two areas: Under the **AH-64D Pilot** aircraft selection, the **AH-64D George AI Helper** input functions category contains bindings that show the helper interface, as well as "quick action" bindings for giving George basic orders (e.g., "Consent To Fire").

Under the **AH-64D George AI Helper** aircraft selection, you can set controls to navigate the George AI Helper Interface. You will likely want to bind these controls to a four-way hat on your joystick. The controls you bind to the AI Interface can be dual-bound to commands under the **AH-64D Pilot** module — for example, the four-way hat on your joystick can be bound to Sight Select Switch controls under **AH-64D Pilot**, and to the George AI Helper Interface under **AH-64D George AI Helper**. Now your four-way hat will function normally as a Sight Selection control but can also be used to issue commands from the AI Helper Interface.

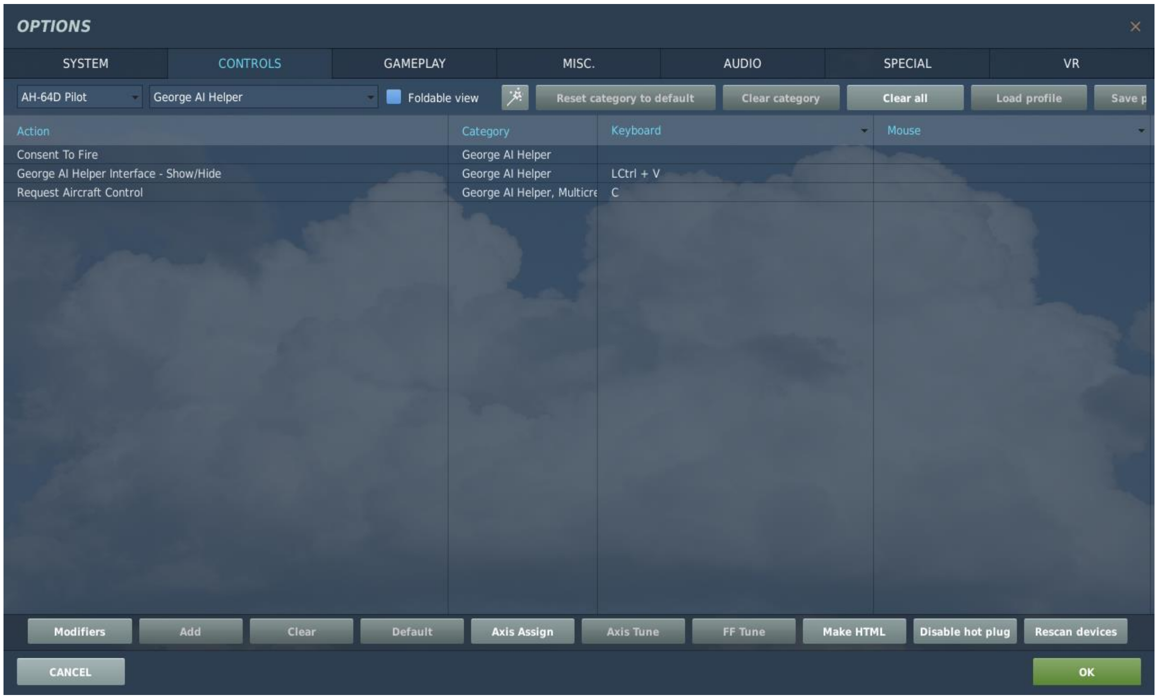


Figure 305. George AI Controls Under **AH-64D Pilot**

Figure 306. George AI Controls Under **AH-64D George AI Helper**

To control George, you will need to bind the **George AI Helper Interface Up/Down/Left/Right** commands, the **George AI Interface Hide** command (under AH-64D George AI Helper aircraft selection), and the **George AI Helper Interface Show/Hide Menu** command (under AH-64D Pilot aircraft selection).

The AI Menu uses both short- and long-presses of the interface commands to perform different functions. A short press is held down for less than 0.5 seconds, and a long press is held down for more than 0.5 seconds.

Note that some commands have built-in delays, to simulate the time it takes to communicate the commands over the intercom mode, or for George to perform the commanded action(s).

The AI Interface operates in different modes. You can use the directional buttons to cycle between these modes.

AH-64D AI Helper Controls

George AI Helper Interface – Hide. Hides the on-screen George AI Interface. We recommend mapping this to the same button as **George AI Helper Interface – Show/Hide** under **AH-64D Pilot** aircraft selection.

George AI Helper Interface – Down. Performs the function associated with the Down action (see command list tables below).

George AI Helper Interface – Left. Performs the function associated with the Left action (see command list tables below).

George AI Helper Interface – Right. Performs the function associated with the Right action (see command list tables below).

George AI Helper Interface – Up. Performs the function associated with the Up action (see command list tables below).

AH-64D AI Helper Commands

Consent To Fire. If George is tracking a target, pressing this button will give George clearance to fire his assigned weapon at that target, even if his ROE is set to Hold Fire. The AI Interface does not need to be displayed to use this command.

George AI Helper Interface – Show/Hide. Shows the George AI Interface. We recommend mapping this command to the same joystick button as **George AI Helper Interface – Hide** under **AH-64D George AI Helper** aircraft selection.

Request Aircraft Control. This command is used in multi-crew play to request control of the helicopter from the other player. For example, if the Pilot (PLT) is flying the helicopter, the Copilot/Gunner (CPG) presses this button to request control, and the PLT accepts the handoff. The CPG's cyclic stick will un-stow, and the PLT's flight controls will become active. (The flight controls are the cyclic and collective controls, and the rudder pedals.

In single-player sessions, this command gives flight control to George, or returns it to the player.

Player-as-CPG George Commands

When you are in the front (Copilot/Gunner) cockpit, pressing the AI Interface Show/Hide button will display a horizontal situation indicator that can be used to give commands to George (acting as Pilot).

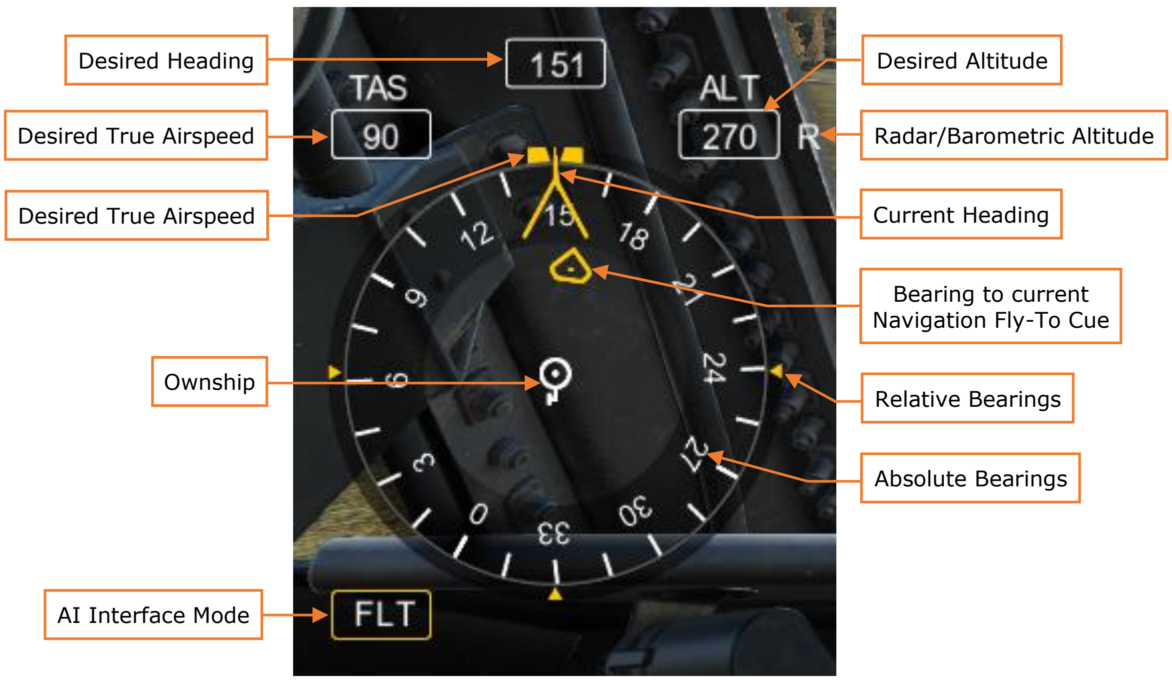


Figure 307. Player-as-CPG George AI Interface

The AI Interface Mode window displays the current AI command mode. The current mode changes the function of the Up/Down/Left/Right buttons, as described below.

When the helicopter is flying above 30 knots, only FLT (Flight), CMBT (Combat Maneuvering) and CMWS (Pilot CMWS Settings) modes are available. When the helicopter is flying below 30 knots, the H-B (Hover/Bob-Up) mode is available in addition to the other three.

The Desired Heading, Speed, and Altitude windows show the commanded parameters given to George. George will strive to attain these parameters. They can be changed using the interface commands described below.

When CMWS mode is entered, an additional interface element will be displayed to the player, showing the current settings of the CMWS control panel in the Pilot cockpit.

Figure 308. Player-as-CPG George AI Interface (CMWS Mode)

The on-screen interface outline changes color depending on the active Arm/Safe status of the CMWS:

- **Green**: CMWS Safed (same as the SAFE light on the Armament Panel)
- **Yellow**: CMWS Armed (same as the ARM light on the Armament Panel)

The AI Interface commands have the following functions when used with the from the Copilot/Gunner cockpit:

MODE	COMMAND	ACTION
FLT (FLIGHT)	Left Short	If >30 knots, changes the AI Interface mode to CMBT (Combat Maneuvers). If <30 knots, changes the AI Interface mode to H-B (Hover/Bob-Up).
	Left Long	Moves desired heading bug left. After the button is released, commands George to turn the helicopter to the new heading.
	Right Short	Commands George to turn the helicopter toward the direction you are looking.

	Right Long	Moves desired heading bug right. After the button is released, commands George to turn the helicopter to the new heading.
	Up Short	Increases the desired speed in the TAS window. After a short delay, George will accelerate the helicopter to the new speed.
	Up Long	Increases the desired altitude in the ALT window. After the button is released, George will increase the helicopter's altitude. If set to <1420 feet, George will hold the radar altitude. If set ≥1420 feet, George will hold the barometric altitude.
	Down Short	Decreases the desired speed in the TAS window. After a short delay, George will decelerate the helicopter to the new speed. H-B (Hover/Bob-Up) mode becomes available if speed decreases below 30 knots.
	Down Long	Decreases the desired radar altitude in the ALT window. After the button is released, George will decrease the helicopter's altitude. If set to <1420 feet, George will hold the radar altitude. If set ≥1420 feet, George will hold the barometric altitude.
H-B (HOVER/ BOB-UP)	Left Short	Changes the AI Interface mode to CMBT (Combat Maneuvers).
	Left Long	George translates the helicopter leftward while the button is held.
	Right Short	Same function as FLT mode.
	Right Long	George translates the helicopter rightward while the button is held.

	Up Short	George increases radar altitude by 10 feet.
	Up Long	George translates the helicopter forward while the button is held.
	Down Short	George decreases radar altitude by 10 feet.
	Down Long	George translates the helicopter backward while the button is held.
CMBT (COMBAT MANEUVERS)	Left Short	Changes the AI Interface mode to CMWS (Pilot CMWS Settings).
	Left Long	Commands George to perform a 90° turn to the left to defend or more quickly re-attack.
	Right Short	Commands George to fly a direct path to the current Navigation Direct-To Cue. If the point is part of a route, George will continue along that route in sequence. If the point is not part of a route, or is the final point in the route, George will come to a hover at that location.
	Right Long	Commands George to perform a 90° turn to the right to defend or more quickly re-attack.
	Up Short	Commands George to turn the aircraft to the heading of the TADS LOS reticle. Good for starting an attack run, bringing the helicopter into Hellfire launch constraints, or aligning the Rocket Steering Cursor.
	Up Long	No Function.
	Down Short	No Function.

	Down Long	Commands George to perform a 180° turn to evade or turn away after an attack.
CMWS (PILOT CMWS SETTINGS)	Left Short	No Function.
	Left Long	No Function.
	Right Short	No Function.
	Right Long	No Function.
	Up Short	Toggles CMWS between ARM and SAFE.
	Up Long	No Function.
	Down Short	Toggles CMWS between AUTO and BYPASS.
	Down Long	No Function.

Player-as-PLT George Commands

When you are in the back (Pilot) cockpit, pressing the AI Interface Show/Hide button will display a weapon settings interface that can be used to assign a weapon to George, what specific settings he should use for that weapon, and an indication of when George (acting as Copilot/Gunner) currently has the TADS slaved to your HMD LOS reticle.

Figure 309. Player-as-PLT George AI Interface (GUN Format)

Figure 310. Player-as-PLT George AI Interface (HELLFIRE Format)

Figure 311. Player-as-PLT George AI Interface (RKTS Format)

The on-screen interface outline changes color depending on the active rules of engagement (ROE) setting for George:

- **Green**: Weapons Free
- **Yellow**: Weapons Hold

The AI Interface commands have the following functions when used with the from the Pilot cockpit:

MODE	COMMAND	ACTION
TARGET DESIGNATION/	Left Short	Cycles CPG weapon GUN-MSL-RKT
	Left Long	If MSL: toggles TYPE between SAL and RF If RKT: cycles TYPE of HE-ILL-MPP-SMK

WEAPON CONTROL		(Only missile and rocket types loaded onboard will be shown in the interface)
	Right Short	If MSL: toggles between LOBL and LOAL If RKT: cycles QTY of 1-2-4-8-12-24-ALL If GUN: cycles BURST of 10-20-50-100-ALL
	Right Long	If MSL: cycles TRAJ of DIR-LO-HI. (Only available if LOAL is selected)
	Up Short	Commands George to slave TADS to Pilot Helmet Sight (PHS) and search along designated line of sight for targets. If George finds more than one target, a target list will be displayed. Targets in list will be ordered by threat (meaning air defense units will be at the top of the list even if they are not in the center of designated area).
	Up Long	Command is given to change rules of engagement (ROE) for George. By default, “Hold Fire” state is active.
	Down Short	Commands George to cease laser designation and stop tracking his target. George will slave TADS to fixed forward.
	Down Long	If George has already found a target, commands George to repeat search along the current TADS line of sight.
TARGET LIST	Left Short	Cancels target list selection.
	Left Long	Displays default list, excludes friendlies if enemy or unknown contacts are in sight
	Right Short	Designates the selected target
	Right Long	Displays all contacts, including friendlies

	Up Short	Moves target list selection up.
	Up Long	Commands George to increase sensor magnification to the next field-of-view
	Down Short	Moves target list selection down.
	Down Long	Commands George to decrease sensor magnification to the previous field-of-view

You can move your head to place the HMD LOS reticle on a target, then press Interface Up Short to designate it. The designation command orders George to slave the TADS to your HMD LOS reticle and scan along your HMD line of sight. It may take a moment for George to set his acquisition source to PHS, press SLAVE, and the TADS to slew to that location.

George will scan the designated area for targets. If a single target is found, George will track it. If multiple targets are found, you will be shown a list of possible targets, and you can use the AI Interface commands to select a target to track (see command list tables below). The target list will be sorted in threat order (air defense targets at the top).

Figure 312. AI Interface Target List

If you do not want George to track any of the targets listed, press Interface Left Short to cancel and remove the target list. Once a target is designated, George will observe it using the TADS and switch to a narrower field-of-view. If George fails to locate any targets, he will maintain the current TADS bearing and continue to scan for targets in the designated area.

To employ Hellfire missiles against George's tracked target, you must fly the helicopter to align the Hellfire missile constraints box as described in the Hellfire Modular Missile System section (see Missile Constraints Box in the Combat Employment section). Once the helicopter is within missile launch constraints, George will act according to the current ROE:

- If ROE is green (Weapons Free), George will launch and guide a Hellfire missile as soon as launch parameters are met.
- If ROE is yellow (Weapons Hold), George will wait for your consent to fire the missile. Consent is given with the **Consent To Fire** command binding.

Once the Hellfire either hits the target, George will stop designating the target and switch to a wider field-of-view in the TADS.

Additional Features

George has some other features that are always available:

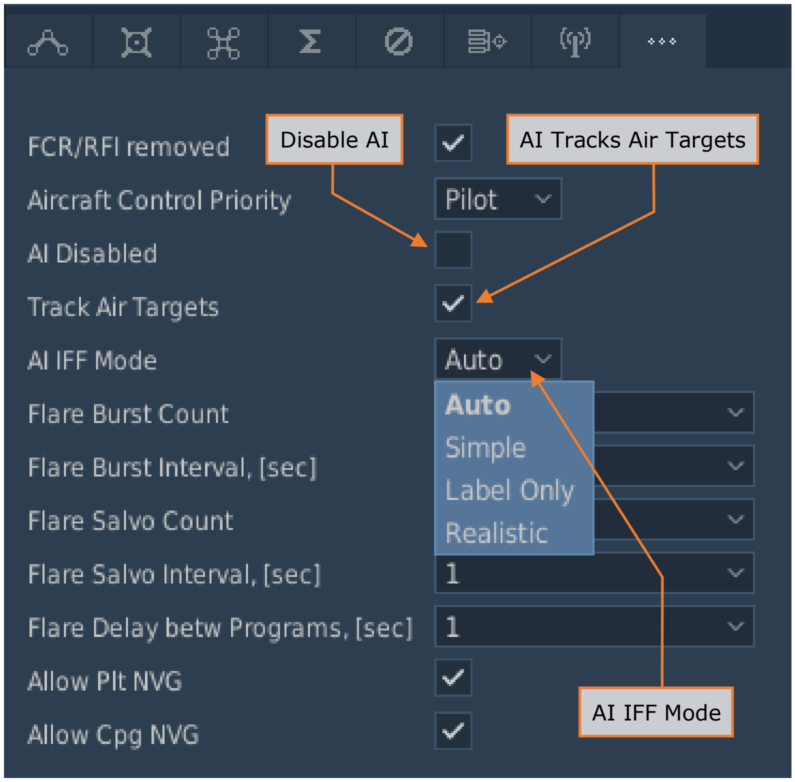
- During a cold start, George will close his cockpit canopy when you close yours, or after the APU is powered on, whichever comes first.

Some other important notes about George:

- George will not ground taxi. When you are in the Copilot/Gunner seat, you can order George to takeoff by increasing the Desired Altitude above zero, or order him to land by decreasing the Desired Altitude to zero. Once airborne, you can use the FLT and H-B modes to order George to fly, hover, or translate in any direction. This can be useful to hover taxi around a FARP or airfield or maneuver the aircraft within a battle position.
- George currently communicates via on-screen text messages only. George will acknowledge commands, flight directions, weapon assignments, and when he can't perform a requested order. Voiceovers and reactions will be added in a later update.
- When you are in the Pilot seat, and George is tracking a target, he will automatically laser designate the tracked target if required for the current weapon and engagement type.
- George is not immortal. If you die, George cannot assume your position.

You can adjust the flight controls handover behavior by going to the Options → Special tab → AH-64D panel, and toggling the checkbox labeled GEORGE AI AUTO HANDOVER (checked by default). When checked, George will take over the flight controls whenever you switch from the Pilot position to the CPG position. It will attempt to maintain your current flight parameters. When unchecked, you continue to have the flight controls from the Copilot/Gunner position.

Mission creators have an additional option over George's behavior in their missions. Each AH-64D has additional options under the Additional Properties tab.



AI Disabled. Disables all George interface functions when checked. George will not scan for targets, will not use the TADS, and will not take control of the aircraft. As Pilot, you can still employ any weapon system of your choosing, but George will not provide laser designation for laser-guided Hellfires or enter COOP rocket mode (If in singleplayer, you will need to assume the Copilot/Gunner role and laser designate the target with the TADS yourself).

Track Air Targets. Enables George to track aircraft and/or include such targets in his target list if generated. If un-checked, George will ignore helicopters and fixed-wing aircraft.

AI IFF Mode. Sets the level of Identification-Friend-or-Foe that George will utilize when detecting, acquiring, and identifying targets. Depending on the selection, F10 View Options and Labels selections will affect the level George is able to identify whether a contact is friendly or enemy, and what type of target it is.

APPENDICES

APPENDIX A
ABBREVIATED COCKPIT PROCEDURES

Add a Point on the TSD

To quickly add a point using the “cursor drop” method, perform the following:

1. TSD fixed action button – Press.
2. POINT (B6) – Select.
3. ADD (L2) – Select.
4. Type select (L3 thru L6) – WP, HZ, CM, or TG.
5. Cursor select – Select desired location on TSD.

To add a point using the Keyboard Unit, perform the following:

1. TSD fixed action button – Press.
2. POINT (B6) – Select.
3. ADD (L2) – Select.
4. ABR (T4) – Select, as required.
5. Type select (L3 thru L6) – WP, HZ, CM, or TG.
6. IDENT> (L1) – Select and enter identifier with the KU, and press ENTER.
7. Enter free text data with the KU, and press ENTER.
8. Enter location data with the KU, and press ENTER.
9. Enter altitude data with the KU, and press Enter.

Edit a Point on the TSD

To edit a point, perform the following:

1. TSD fixed action button – Press.
2. POINT (B6) – Select.

3. POINT> (L1) – Select and enter point type and number (i.e., “W01”, “H09”, “C51”, “T05”, etc.)

   or

3. Cursor select – Select desired point on TSD.
4. EDIT (L3) – Select.
5. FREE> (L1) – Select and enter free text with the KU, and press ENTER. If the existing free text is desired, simply press Enter without a different free text entry.
6. Enter location data with the KU, and press ENTER. If the existing location is desired, simply press Enter without a different location entry.
7. Enter altitude data with the KU, and press Enter. If the existing altitude is desired, simply press Enter without a different altitude entry.

Delete a Point from the TSD

To delete a point, perform the following:

1. TSD fixed action button – Press.
2. POINT (B6) – Select.
3. POINT> (L1) – Select and enter point type and number (i.e., “W01”, “H09”, “C51”, “T05” etc.)

   or

3. Cursor select – Select desired point on TSD.
4. DEL (L4) – Select.
5. Confirm deletion (L3 or L4) – YES or NO.

Store a Point on the TSD

To store a point at the current aircraft position, perform the following:

1. TSD fixed action button – Press.
2. POINT (B6) – Select.
3. STO (L5) – Select.
4. TYPE (L6) – Select WP or TG as desired.

5. NOW (L1) – Select.

To store a point using the TADS with a laser range, the CPG should perform the following:

1. NVS Mode switch – Off, if applicable.
2. Sight select – TADS.
3. Sight Manual Tracker – Slew to center the location within the LOS reticle.
4. Arm/Safe Switch – Arm.
5. TSD fixed action button – Press.
6. POINT (B6) – Select.
7. STO (L5) – Select.
8. TYPE (L6) – Select WP or TG as desired.
9. TEDAC RHG laser trigger – 1st detent range, or 2nd detent Designate as required.
10. TEDAC LHG Store/Update switch – STO

To store a point using the TADS with an Automatic range, the CPG should perform the following:

1. NVS Mode switch – Off, if applicable.
2. Sight select – TADS.
3. Sight Manual Tracker – Slew to center the location within the LOS reticle.
4. WPN fixed action button – Press.
5. MANRNG (B6) – Select and enter "A" on the KU, and press ENTER.
6. TSD fixed action button – Press.
7. POINT (B6) – Select.
8. STO (L5) – Select.
9. TYPE (L6) – Select WP or TG as desired.
10. TEDAC LHG Store/Update switch – STO

To store a point using the HMD with an Automatic range, the CPG should perform the following:

1. Sight select – HMD.
2. WPN fixed action button – Press.

3. MANRNG (B6) – Select and enter “A” on the KU, and press ENTER.
4. TSD fixed action button – Press.
5. POINT (B6) – Select.
6. STO (L5) – Select.
7. TYPE (L6) – Select WP or TG as desired.
8. Center the location within the HMD LOS reticle.
9. TEDAC LHG Store/Update switch – STO

Select a Point for Direct-To Navigation

To select a point for direct navigation, perform the following:

1. TSD fixed action button – Press.
2. RTE (B5) – Select.
3. DIR (L5) – Select.
4. POINT> (L1) – Select and enter point type and number (i.e., “W01”, “H09”, “C51”, etc.)

   or

4. Cursor select – Select desired point on TSD (WPTHZ, CTRLM or TGT/THRT).

Add a Point to the Current Route

To insert a point into the current route, use the pan function as necessary and then perform the following:

1. TSD fixed action button – Press.
2. RTE (B5) – Select.
3. ADD (L2) – Select.
4. POINT> (L1) – Select and enter point type and number (i.e., “W01”, “H09”, “C51”, etc.)

   or

4. Cursor select – Select desired point on TSD (WPTHZ or CTRLM).

5. Route sequence – Select bezel button (R2-R5) to insert the point at that location within the route.

Delete a Point from the Current Route

To delete a point from the current route, use the pan function as necessary and then perform the following:

1. TSD fixed action button – Press.
2. RTE (B5) – Select.
3. DEL (L4) – Select.
4. Cursor select – Select desired point on TSD (WPTHZ or CTRLM).

   or

4. Search buttons (R1/R6) – Select.
5. Route sequence – Select bezel button (R2-R5) to delete the corresponding point from the route sequence.

Select a New Route

To select a route as CURRENT, perform the following:

1. TSD fixed action button – Press.
2. RTE (B5) – Select.
3. RTM (B6) – Select.
4. NEW (L5) – Verify boxed.
5. Route select – Select bezel button (T1-T5) above the route to activate.

Delete a Route

To delete a route, perform the following:

1. TSD fixed action button – Press.
2. RTE (B5) – Select.
3. RTM (B6) – Select.

4. DEL (L5) – Select.
5. Route select – Select bezel button (T1-T5) above the route for deletion.
6. Confirm deletion (L4 or L5) – YES or NO.

Tune the ADF to a Manual Frequency

To tune the ADF to a manual frequency, perform the following:

1. TSD fixed action button – Press.
2. INST (L1) – Select.
3. FREQ> (L3) – Select and enter identifier with the KU, and press ENTER.

Tune the ADF to an NDB Preset

To tune the ADF to a preset station, perform the following:

1. TSD fixed action button – Press.
2. INST (L1) – Select.
3. UTIL (T6) – Select.
4. ADF (B6) – Select.
5. Preset (L2 thru L6 or R2 thru R6) – Select.
6. TUNE (T5) – Select.

Edit an NDB Preset

To edit an ADF preset, perform the following:

1. TSD fixed action button – Press.
2. INST (L1) – Select.
3. UTIL (T6) – Select.
4. Preset (L2 thru L6 or R2 thru R6) – Select.
5. ID> (B4) – Select and enter identifier with the KU, and press ENTER.
6. FREQ> (B5) – Select and enter identifier with the KU, and press ENTER.

Select an Acquisition source

To select an acquisition source from the ACQ expanded menu, perform the following:

1. TSD or WPN fixed action button – Press.
2. ACQ (R6) – Select.
3. ACQ select - Select desired ACQ source from expanded menu options.

To select an existing point as an acquisition source directly from the TSD, perform the following:

1. TSD fixed action button – Press.
2. CAQ (R5) – Select.
3. Cursor select – Select desired point on TSD.

To select an existing point as an acquisition source from the database, perform the following:

1. TSD or WPN fixed action button – Press.
2. COORD (T5) – Select.
3. WPTHZ (T1) or CTRLM (T2) – Select if necessary.
4. Use paging controls (B2/B3) – Select.

   or

4. SRCH> (B4) – Select and enter data with KU.
5. Point select – Use the left bezel button (L1-L6) to select a point.

Perform Pre-Combat Checks

When approaching the Forward Edge of Battle Area (FEBA), the following should be considered:

1. Weapons – Set Armament panel to ARM and ensure weapons are properly configured for the mission
2. ASE – Arm protection systems on the ASE page and CMWS control panel
3. IFF (N/I) – Ensure Identification Friend-or-Foe systems are configured
4. Lights – Set to Off (or set Formation lighting as appropriate).

5. Recorder (N/I) – Configure and set appropriately.
6. MPDs – Select TSD phase and pages as desired.

Engage a Target with 30mm Area Weapon System

To engage a target with the 30mm Area Weapon System (AWS) perform the following:

1. Sight select – TADS, HMD or FCR as desired or verify in HAD Sight Select Status field.
2. Weapon – Weapon Action Switch (WAS) – Forward to GUN.
3. Arm/Safe button – ARM (Performed by crewmember not on the controls).
4. Range – Set as desired or verify in the HAD Range/Range Source field.
5. Messages – Verify no inhibit messages are displayed. Verify "ROUNDS ####" is displayed in the HAD Weapon Status field.

Engage a Target with 2.75-inch Unguided Rockets

To engage a target with independent (HMD/FCR) rockets perform the following:

1. Sight select – HMD or FCR as desired or verify in HAD Sight Select Status field.
2. Weapon – Weapon Action Switch (WAS) – Left to RKT.
3. Arm/Safe button – ARM (Performed by crewmember not on the controls).
4. Range – Set as desired or verify in the HAD Range/Range Source field.
5. Messages – Verify no inhibit messages are displayed. Verify "RKT NORMAL" is displayed in the HAD Weapon Status field.

To engage a target with cooperative (COOP) rockets perform the following:

1. **(PLT)** Sight select – HMD.
2. **(CPG)** Sight select – TADS.
3. **(PLT)** Weapon – Cyclic Weapon Action Switch (WAS) – Left to RKT.
4. **(CPG)** Weapon – TEDAC LHG Weapon Action Switch (WAS) – Left to RKT.

5. Arm/Safe button – ARM (Performed by crewmember not on the controls).
6. **(CPG)** Range – Set as desired or verify in the HAD Range/Range Source field.
7. **(PLT & CPG)** Messages – Verify no inhibit messages are displayed. Verify COOP is displayed in HAD Weapon Control field and "RKT NORMAL" is displayed in the HAD Weapon Status field.

Engage a Target with AGM-114K Laser-Guided Hellfire Missile

To engage a target with a laser-guided Hellfire perform the following:

1. **(CPG)** Sight select – TADS.
2. **(CPG)** Weapon – Weapon Action Switch (WAS) – Right to MSL.
3. Arm/Safe button – ARM (Performed by crewmember not on the controls).
4. **(CPG)** Range – Set as desired or verify in the HAD Range/Range Source field.
5. **(CPG)** Messages – Verify no inhibits are displayed. Verify trajectory and mode is displayed as desired in HAD Weapon Status field.
6. (*Optional, if launching LOBL*) Designate – Squeeze TEDAC RHG laser trigger, 2nd detent.
7. (*Optional, if launching LOBL*) Messages (CPG) – Verify no inhibits are displayed. Verify "PRI CHAN TRK" is displayed in the HAD Weapon Status field if launching LOBL.

Engage a Target with AGM-114L Radar-Guided Hellfire Missile

-Coming later in EA-

Perform Post-Engagement Procedures

Following an engagement, the crewmember should:

1. Ensure finger is off the weapon trigger.
2. Ensure weapon is de-actioned.
3. Arm/Safe button – SAFE, as required (Performed by crewmember not on the controls).

APPENDIX B
ABR PAGE – POINT/SYMBOL TABLES

The Abbreviation (ABR) page provides the crew a library of aircraft point symbols that can be added to the TSD for the purposes of navigation, increasing situational awareness, or as a method of cueing sensors. This page can be accessed via the TSD > POINT or TSD > UTIL pages and can provide a quick look-up of required IDENT codes for inputting new points.

In the tables below, icons with "AAA" associated with the point symbol will display the three-character free text of that point directly on the TSD itself.

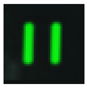
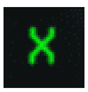
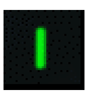
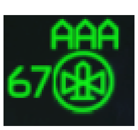
Table 1. Waypoint/Hazards

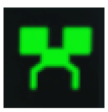
Symbol	Identifier (IDENT)	Point Name
	CC	Communications Check Point
	LZ	Landing Zone
	PP	Passage Point
	RP	Release Point
	SP	Start Point
	WP	Waypoint
	TO	Tower Over 1000'

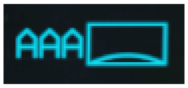
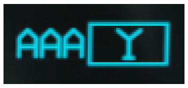
	TU	Tower Under 1000’
	WL	Wires Power
	WS	Wires Telephone/Electric

Table 2. Control Measures

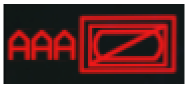
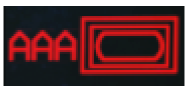
Symbol	Identifier (IDENT)	Point Name
	AP	Air Control Point
	AG	Airfield General
	AI	Airfield Instrument
[Needs Corrected]	AL	Lighted Airport
	F1	Artillery Firing Point 1
	F2	Artillery Firing Point 2

	AA	Assembly Area
	BN	Battalion
	BP	Battle Position
	BR	Bridge or Gap
	BD	Brigade
	CP	Checkpoint
	CO	Company
	CR	Corps
	DI	Division
	FF	FARP Fuel Only
	FM	FARP Ammo Only

	FC	FARP Fuel and Ammo
	FA	Forward Assembly Area
	GL	Ground Light/Small Town
	HA	Holding Area
	NB	NBC Area
[Needs Corrected]	ID	IDM Subscriber
	BE	NDB Symbol
	RH	Railhead Point
	GP	Regiment or Group
	US	US Army
Friendly Control Measures		

	AD	Friendly Air Defense
	AS	Friendly Air Assault
	AV	Friendly Air Cavalry
[Needs Corrected]	AB	Friendly Airborne
	AM	Friendly Armor
	CA	Friendly Armored Cavalry
	MA	Friendly Aviation Maintenance
	CF	Friendly Chemical
	DF	Friendly Decontamination
	EN	Friendly Engineers
	FW	Friendly Electronic Warfare
	WF	Friendly Fixed Wing

	FL	Friendly Field Artillery
	AH	Friendly Attack Helicopter
	FG	Friendly Helicopter, General
	HO	Friendly Hospital
	FI	Friendly Infantry
	MI	Friendly Mechanized Infantry
	MD	Friendly Medical
	TF	Friendly Tactical Operations Center
	FU	Friendly Unit
Enemy Control Measures		
	ES	Enemy Air Assault
	EV	Enemy Air Cavalry

	ED	Enemy Air Defense
[Needs Corrected]	EB	Enemy Airborne
	EC	Enemy Armored Cavalry
	AE	Enemy Armor
	ME	Enemy Aviation Maintenance
	CE	Enemy Chemical
	DE	Enemy Decontamination
	EE	Enemy Engineers
	WR	Enemy Electronic Warfare
	EF	Enemy Field Artillery
	WE	Enemy Fixed Wing
	EK	Enemy Attack Helicopter

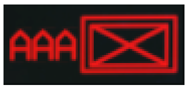
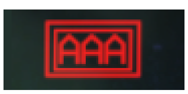
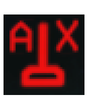
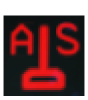
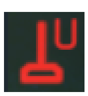
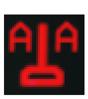
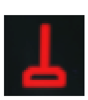
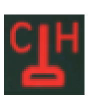
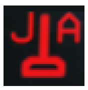
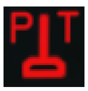
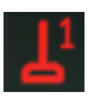
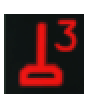
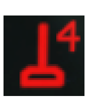
	HG	Enemy Helicopter, General
	EH	Enemy Hospital
	EI	Enemy Infantry
	EM	Enemy Mechanized Infantry
	EX	Enemy Medical
	ET	Enemy Tactical Operations Center
	EU	Enemy Unit

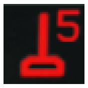
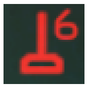
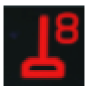
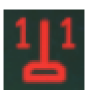
Table 3. Target/Threats

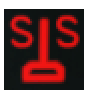
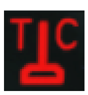
Symbol	**Identifier (IDENT)**	**Point Name**
	TG	Target Point
	AX	AMX-13 Air Defense Gun
	AS	Aspide SAM System

	AD	Friendly Air Defense Unit
	GP	Gepard Air Defense Gun
	G1	Growth 1
	G2	Growth 2
	G3	Growth 3
	G4	Growth 4
	SD	Spada SAM System
	83	M1983 Air Defense Gun
	U	Unknown Air Defense Unit
	S6	2S6 / SA-19 Air Defense Unit
	AA	Air Defense Gun
	GU	Generic Air Defense Unit

	MK	Marksman Air Defense Gun
	SB	Sabre Air Defense Gun
	GS	Self-Propelled Air Defense Gun
	GT	Towed Air Defense Gun
	ZU	ZSU-23-4 Air Defense Gun
	NV	Naval Air Defense System
	SR	Battlefield Surveillance Radar
	TR	Target Acquisition Radar
	70	RBS-70 SAM System
	BP	Blowpipe SAM System
	BH	Bloodhound SAM System
	CH	Chapparal SAM System

	CT	Crotale SAM System
	C2	CSA-2/1/X SAM System
	HK	Hawk SAM System
	JA	Javelin SAM System
	PT	Patriot SAM System
	RE	Redeye SAM System
	RA	Rapier SAM System
	RO	Roland SAM System
	1	SA-1 SAM System
	2	SA-2 SAM System
	3	SA-3 SAM System
	4	SA-4 SAM System

	5	SA-5 SAM System
	6	SA-6 SAM System
	7	SA-7 SAM System
	8	SA-8 SAM System
	9	SA-9 SAM System
	10	SA-10 SAM System
	11	SA-11 SAM System
	12	SA-12 SAM System
	13	SA-13 SAM System
	14	SA-14 SAM System
	15	SA-15 SAM System
	16	SA-16 SAM System

	17	SA-17 SAM System
	SM	SAMP SAM System
	SC	SATCP SAM System
	SP	Self-Propelled SAM System
	SH	Shahine/R440 SAM System
	SS	Starstreak SAM System
	TC	Tigercat SAM System
	ST	Stinger SAM System
	SA	Towed SAM System
	VU	Vulcan Air Defense Gun

APPENDIX C
TSD/ASE PAGE – RLWR SYMBOL TABLES

Table 1. RLWR-detected Radar Threats

-Coming soon-

Table 2. RLWR-detected Laser Threats

-Coming later in EA-

APPENDIX D
GLOSSARY OF ACRONYMS AND ABBREVIATIONS

A/C	Aircraft; MPD fixed action button or COLOR BAND option on the TSD>MAP page
ACM	Automatic Control Mode; automatic gain control of the FLIR sensors
ACQ	Acquisition source; method of cueing sensors or sights to locations on the battlefield
ADF	Automatic Direction Finder; a receive-only radio antenna for determining relative bearing to radio transmissions.
AGL	Above Ground Level; altitude above the surface directly underneath the aircraft as indicated by the radar altimeter
ALT	Alternate missile channel; the laser code to which the follow-on SAL missile is scanning when missile system is set to RIPL mode of operation
APU	Auxiliary Power Unit; a small gas turbine engine that powers the accessory section of the main transmission (which provides generator power and hydraulic pressure) and provides pneumatic pressure to the air turbine starter of each main engine.
ARS	Aerial Rocket Subsystem; the M261 rocket launchers and associated aircraft interface systems
ASE	Aircraft Survivability Equipment; the suite of sensors and external components designed to enhance the survivability of the aircraft
ATM	Air Targeting Mode; a mode of the APG-78 Fire Control Radar
AWS	Area Weapon System; the M230 gun, its turret, the ammunition handling system, and associated aircraft interface systems
AZ	Azimuth; regarding angular direction along the horizontal plane, either in relative azimuth from the aircraft nose or relative azimuth from North
BAM	Battle Area Management; sub-page of the TSD which provides a means of creating, editing, and deleting Priority Fire Zones (PFZ) and No Fire Zones (NFZ), or transmitting them to other flight members
BIT	Built-In Test; self-diagnostic test that can provide indications to equipment or system malfunctions

BRU	Boresight Reticle Unit; scope-like device mounted on top of the glareshield in each crewstation that provides a reticle to align the HDU LOS crosshairs during an IHADSS boresight procedure
CG	Center-of-Gravity; the average location of the weight of an aircraft, around which the force of gravity appears to act
CHAN	Channel; one of four possible missile channels set on the WPN page for SAL missile guidance, of which at least one needs to be set as the PRI channel, and another may be set as ALT; corresponds to one of 16 laser code presets
COM	Communications; MPD fixed action button
COOP	Cooperative; a mode of rocket employment in which the CPG uses the TADS to provide a targeting solution for the PLT during a rocket engagement
COORD	Coordinate; an MPD sub-page accessed via the WPN or TSD pages to view detailed information of any Point, Line, Area, Shot-At or FARM files stored within the database
CPG	Copilot/Gunner; the crewmember occupying the front crewstation
C-SCAN	Continuous Scan; a scan mode of the APG-78 Fire Control Radar
CTR	Center; regarding the TSD option to center or de-center the TSD relative to the ownship position
CTRLM	Control Measure; a Point type within the database used to control the positioning of the flight, aid in navigation, or provide situational awareness on the battlefield
DE	Dual Engine power or Dual Engine operations
DIR	Direct; LOAL trajectory option on WPN page in MSL format, or a method of navigation directly to a Point within the database independent of the currently selected route (accessed via the TSD>RTE page)
DTED	Digital Terrain Elevation Data; stored data within the aircraft memory of the surface elevation above sea level of any location or set of coordinates at ground level
DTV	Day Television; a passive sensor within the TADS for electro-optical-based targeting at medium- to long-ranges

DVO	Direct View Optics; a passive sensor within the TADS for optical-based targeting, but was removed from the AH-64D fleet and is not present in aircraft equipped with the M-TADS upgrade, despite the switch option being present on the LHG
ECS	Environmental Control System; provides temperature management for the EFAB compartments, TADS and PNVS turrets, and crewstations
EFAB	Extended Forward Avionics Bays; equipment bays that run alongside the fuselage from just aft of the TADS turret to underneath each stub wing and provide storage and mounting to much of the aircraft avionics
EGI	Embedded GPS/INS; a navigational device that uses a combination of inertial measurement devices coupled with a Global Positioning System for enhanced accuracy and calibration correction
EL	Elevation; regarding angular direction within the vertical plane, either in relative elevation from the aircraft nose or relative elevation above or below the horizon
ELEV	Elevation; regarding the COLOR BAND option on the TSD>MAP page
ENDR	Endurance; indication of the flight time remaining based on fuel quantity on board and current burn rate
ENG	Engine; regarding Engine 1 or Engine 2 on the cockpit panels and displays
ETA	Estimated Time of Arrival; the clock time (Local or Zulu) at which the aircraft will arrive at the designated reference point
ETE	Estimated Time Enroute; the amount of time (duration) it will take the aircraft to travel to a reference point or a certain distance
EUFD	Enhanced Up-Front Display; LED display under the glareshield of each crewstation that displays active Warnings, Cautions and Advisories; radio, transponder and IDM configurations; total fuel quantity; system time; and a stopwatch function
FARM	Fuel/Ammo/Rockets/Missiles; the amount of fuel and weapons that are present on an aircraft
FARP	Forward Arming and Refueling Point; a location relatively close to the combat area or objective that can provide rearming and/or refueling services

FAT	Free Air Temperature; an indication of the ambient air temperature as directly read by probes outside the aircraft unaffected by nearby component heating
FCR	Fire Control Radar; sight selection option, acquisition source option, MPD fixed action button, or the FCR component of the MMA
FLIR	Forward-Looking Infrared; a passive sensor within the PNVS and TADS for navigating under darkness/low-visibility conditions, or thermal-based targeting at short- to long-ranges (TADS FLIR only)
FMC	Flight Management Computer; provides enhanced aircrew control of the aircraft via the SCAS
FOR	Field-Of-Regard; the large box within the High Action Display (HAD) that indicates the slew limits of the crewmember's selected sight or NVS sensor, as well as the relative direction of the crewmember's acquisition source
FOV	Field-Of-View; the small box within the FOR that indicates the current azimuth and elevation of the crewmember's selected sight or NVS sensor
FPV	Flight Path Vector; airplane-shaped symbology within the HMD flight symbology that indicates the three-dimensional flight direction of the aircraft when above 5 knots of 3D ground speed
FTR	Force Trim Release; when pressed, the magnetic brake system on each crewstation cyclic and pedals releases; suspends any active hold mode inputs to the flight control servos
FXD	Fixed; acquisition source option, AWS mode of operation, or NVS mode of operation
GRBX	Gearbox; regarding the Intermediate Gearbox (IGB) or the Tail Rotor Gearbox (TGB), both of which are mounted to the vertical stabilizer.
GEN	Generator; regarding Generator 1 or Generator 2 on the cockpit panels and displays
GHS	Gunner Helmet Sight; acquisition source option
GPS	Global Positioning System; constellation of United States Government-owned satellites that provide radio-based precise navigation and timing signals to receivers anywhere in the world

G-S	Ground Stow; regarding the “RKT G-S” indication of the weapon pylons manually selected to GND STOW on the WPN>UTIL page when a crewmember actions rockets
GTM	Ground Targeting Mode; a mode of the APG-78 Fire Control Radar
GWT	Gross Weight; the current total weight of the aircraft to include fuel, munitions, expendables such as chaff and flares, and crew
HAD	High Action Display; the bottom portion of each crewmember’s HMD, TADS or FCR symbology that provide key information regarding sight and acquisition source selection, range data, sight and weapon data, and any messages that affect successful engagement using the currently actioned weapon
HDD	Head Down Display; button on RHG that has no function on TEDAC-equipped aircraft
HDU	Helmet Display Unit; the physical helmet display component of the IHADSS mounted to each crewmember’s helmet
HIT	Health Indicator Test; regarding a check of an engine’s expected performance by comparing its current TGT at a set torque output to a baseline TGT for a given pressure altitude (PA) and free air temperature (FAT)
HMD	Helmet Mounted Display; sight selection option to utilize the IHADSS for sensor cueing or weapon aiming
IAFS	Internal Auxiliary Fuel System (aka “Robbie tank”); an assembly manufactured by Robinson Fuel Systems that can be mounted in place of the standard ammunition magazine; can hold 100 gallons of fuel along with 242 rounds of 30x113mm ammunition
IAS	Indicated Airspeed or Knots Indicated Airspeed (KIAS); airspeed measured directly within the pitot-static system
IAT	Image Auto Track; an automatic tracking mode of the ASQ-170 TADS that uses image contrast to control turret slew
ICS	Inter-Communication System; regarding the audio communication system between each crewstation
IDENT	Identification; regarding the button on the communications panel that highlights the aircraft position to air traffic controllers via an additional signal via the transponder Mode 3A

IDM	Improved Data Modem; a communications device that relays digital data between aircraft using radio transceivers
IFF	Identification Friend or Foe; a series of coded replies sent via the transponder antennas to interrogating IFF transmitters to indicate that the aircraft is friendly
IGN ORIDE	Ignition Override; motors the T701C engines using the air turbine starters but inhibits the ignitors from firing to prevent combustion
IHADSS	Integrated Helmet And Designation Sight System; the entire system of the crewmembers' helmets, helmet position sensors, each HDU, and associated symbology
IMC	Instrument Meteorological Conditions; weather conditions exist in which visual separation from terrain, obstacles and other aircraft cannot be achieved through visual means; requires navigational aids to fly safely
IN	Inches; regarding the UNIT setting on the FLT page that displays the barometric pressure setting in inches of Mercury
INU	Inertial Navigation Unit; a navigational device that uses inertial measurement devices to output attitude, velocity, and position information
KM	Kilometer; regarding the UNIT setting on the FLT page that displays navigational distances, TSD range scale, and TSD grid-lines in kilometers
KU	Keyboard Unit; device in each crewstation for inputting data into the avionics; includes calculator functions for basic arithmetic
LAT	Latitude; regarding the North/South portion of a set of Lat/Long coordinates
LB	Pound; regarding the unit of weight measurement in determining the aircraft gross weight and/or fuel quantity on board
HMMS	Hellfire Modular Missile System; the AGM-114 M299 missile launchers and associated aircraft interface systems
LHG	Left Handgrip; the CPG left TEDAC handgrip
LMC	Linear Motion Compensator; a toggleable slew logic within the ASQ-170 TADS that allows the CPG to adjust and maintain continuous turret slew rates instead of using raw MAN TRK controller inputs

LN	Line; a method of drawing PF or NF zones on the BAM sub-page of the TSD
LOAL	Lock-On After Launch; the AGM-114 Hellfire missile will lock on to a target designation or achieve a target track after the missile has been launched
LOBL	Lock-On Before Launch; the AGM-114 Hellfire missile will lock on to a target designation or achieve a target track prior to the missile being launched
LONG	Longitude; regarding the East/West portion of a set of Lat/Long coordinates
LRFD	Laser Rangefinder/Designator; an active ranging sensor within the TADS; designates targets for weapons utilizing SAL guidance
LST	Laser Spot Tracker; a passive sensor within the TADS for detecting laser designations from other platforms
MAN	Manual; missile management mode of operation
MANRG	Manual Range; regarding the option to set a manual range value for ballistic solutions using the WPN page MANRG option
MB	Millibars; regarding the UNIT setting on the FLT page that displays the barometric pressure setting in millibars
MGRS	Military Grid Reference System; a UTM-derived coordinate system that divides each UTM grid zone into a series of square identifiers that measure 100 kilometers wide, and is in widespread use by various military services in many nations
MMA	Mast-Mounted Assembly; the entire assembly that includes the FCR, RFI and de-rotational mount on top of the main rotor mast
MPD	Multi-Purpose Display; one of two primary displays in each crewstation
M-PNVS	Modernized PNVS; an upgraded version of the AAQ-11 PNVS that includes a next-generation FLIR (part of the M-TADS upgrade)
MSL	Missile *or* Mean Sea Level; WAS option of the HMMS *or* altitude above Mean Sea Level as indicated by the barometric altimeter

M-TADS Modernized TADS; an upgraded version of the ASQ-170 TADS system that includes a next-generation FLIR along with enhanced tracking, processing and boresighting functions

MTT Multi-Target Tracker; regarding the ability to set contrast locks onto multiple targets using the ASQ-170 IAT function

NDB Non-Directional Beacon; an omni-directional radio navigational aid that can be tuned by the ADF receiver

NFZ No Fire Zone; a geographical area set on the BAM sub-page of the TSD that precludes target prioritization by the APG-78 Fire Control Radar

N_G RPM speed of the gas generator stage (sometimes referred to as N1 stage or gas producer stage) as measured from the accessory gearbox of each T701C engine

NGB Nose Gearbox; regarding the gearbox mounted to the front of each engine that redirects shaft horsepower into the main transmission

NM Nautical Mile; regarding the UNIT setting on the FLT page that displays navigational distances, TSD range scale, and TSD grid-lines in nautical miles

NOE Nap-Of-the-Earth; a mode of terrain flight in which the aircraft flies as close to the ground as possible with varying airspeeds and altitudes

NORM Normal; missile management mode of operation, gun mode of operation, or NVS mode of operation

N_P RPM speed of the power turbine stage (sometimes referred to as N2 stage) as measured from the power turbine shaft of each T701C engine

N_R RPM speed of the AH-64D powertrain system as measured from the main transmission

NTS Next-To-Shoot; the current target being engaged when using the APG-78 Fire Control Radar as the selected sight

NVG Night Vision Goggles; AN/AVS-6 aviator night vision goggles

NVS Night Vision System; the PNVS or TADS being utilized as an aided pilotage system to a crewmember

OPER	Operate; sets the selected system or device to operational status
PA	Pressure Altitude; the altitude above the standard datum plane, which is the point where the atmospheric barometric pressure is 29.92 inches of mercury or 1013.2 millibars (not to be confused with true altitude as reported by the barometric altimeter when corrected for non-standard temperature/pressure via the Kollsman window)
PEN	Penetration; time delay setting on the WPN page for the M433 fuse when used in conjunction with the 6RC rocket type selection
PERF	Performance page; provides key performance-related data of the helicopter given current or predicted pressure altitude (PA), free air temperature (FAT) and gross weight (GW)
PFZ	Priority Fire Zone; a geographical area set on the BAM sub-page of the TSD that affects target prioritization by the APG-78 Fire Control Radar
PHS	Pilot Helmet Sight; acquisition source option
PLRT	Polarity; toggles FLIR sensor between White-Hot and Black-Hot brightness scales
PLT	Pilot; the crewmember occupying the aft crewstation
PNVS	Pilot Night Vision System; the top sensor turret on the nose consisting of a FLIR sensor
PP	Present Position; the 3-dimensional position of the aircraft or flight members
PRI	Priority missile channel; the laser code to which the next to fire SAL missile is scanning
PSI	Pounds per Square Inch; unit of measurement of pressure within the various oil and hydraulic systems of the AH-64D
PTT	Push-To-Talk; initiates radio transmission when activated
RAD ALT	Radar Altimeter; uses radar pulses transmitted by a ventral-mounted radio antenna below the aircraft to measure absolute altitude above ground level (AGL)
REC	Receive; option presented on the main TSD page to receive a report, a point, or a file residing in the IDM buffer

RF	Radio Frequency missile; the AGM-114L air-to-surface missile that utilizes active radar guidance
RFHO	Radar Frequency Hand-Over; method of receiving a target location for an AGM-114L missile engagement via the IDM
RFI	Radio Frequency Interferometer; acquisition source option or the RFI component of the MMA
RHG	Right Handgrip; the CPG right TEDAC handgrip
RIPL	Ripple; missile management mode of operation
RJAM	Radar Jammer; regarding the ALQ-136 electronic countermeasure (ECM) device
RKT	Rocket; WAS option of the ARS
RMAP	Radar Mapping Mode; a mode of the APG-78 Fire Control Radar
RLWR	Radar/Laser Warning Receiver; regarding the combined components and functions of the APR-39 Radar Signal Detecting Set and the AVR-2 Laser Detecting Set
RPT	Report; sub-page of the TSD for sending or requesting reports to/from flight members via the IDM
RST	Reset; regarding the generator reset switches in the Pilot cockpit, which permits the Pilot to reset generator power when the MPDs are not operational due to lack of DC power
RTE	Route; sub-page of the TSD within which the crew can edit routes or set direct routes to individual points
RTM	Route Menu; sub-page of the TSD within which the crew can select or delete routes
RTS	Radio Transmit Select; voice radio controls on the cyclic and EUFD
RVW	Review; regarding the review of data, messages or points that reside within the aircraft memory
SAL	Semi-Active Laser missile; the AGM-114 family of air-to-surface missiles (excluding the AGM-114L) that utilize semi-active laser guidance
SCAS	Stability and Command Augmentation System; the system that enhances the stability of the aircraft for weapons delivery, increases

the maneuverability of the aircraft at lower airspeeds, and provides hold mode functionality for decreased pilot workload

SE	Single Engine power or Single Engine operations
SINC	SINCGARS; Single Channel Ground and Airborne Radio System family of radios used by militaries of the United States and NATO members that permit secure voice and data radio transmissions between a wide number of military units
SKR	Seeker; acquisition source option utilizing a SAL missile tracking the PRI missile channel
SP	System Processor; commands all subsystem initiated tests, monitors system status and faults, and processes information for display
SPQ	Super Quick; minimal time delay setting on the WPN page for the M433 fuse when used in conjunction with the 6RC rocket type selection
SQL	Squelch; a function that suppresses the audio output of a radio system until a signal is received that exceeds the set squelch threshold
S-SCAN	Single Scan; a scan mode of the APG-78 Fire Control Radar
STAB	Stabilator; regarding the movable horizontal tail plane mounted to the end of the tailboom that provides additional attitude control in the pitch axis
STBY	Standby; sets the selected system or device to standby status
STO	Store; regarding the STO/UPT button on the CPG left TEDAC grip pressed to perform a position store of a location designate by the TADS or CPG HMD
SYM	Symbology; regarding any characters, shapes or symbols that are displayed to the crew to represent quantifiable data, provide feedback regarding system status, or indicate current settings/selections/modes of operation.
TADS	Target Acquisition Designation Sight; sight selection option, acquisition source option, or the bottom sensor turret on the nose consisting of FLIR, DTV, LST, and LRFD

TAS	True Airspeed or Knots True Airspeed (KTAS); the speed of the aircraft through an air mass, corrected for air density that affects the measurement of indicated airspeed
TDU	TEDAC Display Unit; the video screen component of the TEDAC assembly
TEDAC	TADS Electronic Display And Control; the assembly that includes both TEDAC grips (LHG and RHG) and the TDU
TGT	Turbine Gas Temperature; temperature of the hot expanding gases entering the power turbine stage of the T701C as measured between the 2nd stage of the gas generator section and the 1st stage nozzle of the power turbine section
TGT/THRT	Target/Threat; a Point type within the database used to designate targets for engagement, or locations of air defense threats
TOF	Time Of Flight; the duration of time a munition is in the air toward its intended ballistic solution, target or impact point
TPM	Terrain Profile Mode; a mode of the APG-78 Fire Control Radar
TQ	Torque; the measurement of engine power applied to the transmission as measured from the power turbine shaft of each T701C engine
TRAJ	Trajectory; regarding the selection of DIR (Direct), LO (Low), or HI (High) LOAL trajectory options on the WPN page in MSL format
TRK	Track; regarding the Hellfire missile tracking in LOBL mode
TRN	Terrain; acquisition source option via the TSD page
TRP	Target Reference Point; a geographic location (that can typically be identified through visual or optical means) from which fires can be referenced and, if necessary, adjusted
TSD	Tactical Situation Display, MPD fixed action button
UPT	Update; regarding the STO/UPT button on the CPG left TEDAC grip pressed to perform a navigational position update
UTM	Universal Transverse Mercator; a grid coordinate system from which the Military Grid Reference System (MGRS) is derived
VID	Video; MPD fixed action button

VMC	Visual Meteorological Conditions; weather conditions exist in which visual separation from terrain, obstacles and other aircraft can be achieved through visual means; does not require navigational aids
VNE	Velocity Never Exceed; an airspeed that, if exceeded, may cause structural damage to the AH-64D
VSSE	Velocity Safe Single Engine; the minimum airspeed at which the AH-64D can maintain level flight with one engine inoperative
WAS	Weapon Action Switch; pronounced "Woz" or "Wahz", or used as a verb as "WASing", a crewmember selects or "actions" one of the three available weapon systems for engaging their intended target
WCA	Warnings, Cautions, Advisories
WPN	Weapon; MPD fixed action button
WPTHZ	Waypoint/Hazard; a Point type within the database used for navigation, routing or to designate locations of hazards to flight such as towers and wires
WSPS	Wire Strike Protection System; assortment of devices mounted to the external fuselage to guide wires around key portions of the airframe and into sharp blades to aid in severing the unseen wire obstacles that may be encountered during low-altitude flight
XMSN	Transmission; regarding the main transmission
XPNDR	Transponder; regarding the APX-118 transponder
ZN	Zone; sets the number of PFZs to be drawn on the BAM sub-page of the TSD when in PF format

APPENDIX E
FREQUENTLY ASKED QUESTIONS (FAQ)

What version of the AH-64D does the DCS: AH-64D simulate?

The DCS: AH-64D simulates an AH-64D Block II in service with the United States Army between the years of 2005-2010, with a specific equipment configuration that was common (but not exclusive) within that time period. The specific avionics version that is being modeled is Lot 9.1, which was fielded to US Army AH-64D Block II aircraft in 2005.

What is the difference between an AH-64D equipped with a mast-mounted Fire Control Radar and an AH-64D without the FCR?

There is very little difference between these aircraft configurations. The presence (or absence) of the FCR mast-mounted assembly does not denote a different model of AH-64 but is simply a removeable sensor system (much like a targeting pod on a strike fighter). When the FCR system is removed, the aircraft will still perform and operate the same, albeit with less overall gross weight and more limited sensor/targeting options to the crew. Further, while the US Army has operated AH-64D's with a mixed fleet of FCR and non-FCR aircraft, some countries have operated exclusively FCR-equipped AH-64D variants (such as the United Kingdom's Army Air Corps), or exclusively non-FCR-equipped variants (such as the Royal Netherlands Air Force).

What is the difference between the Pilot Night Vision System (PNVS) and the Target Acquisition Designation Sight (TADS)?

The PNVS is a *FLIR-only* steerable turret that is designed to aid the Pilot in the back seat to fly under total darkness. The TADS is a *multi-sensor* steerable turret that allows the Copilot/Gunner in the front seat to target and designate enemy locations and vehicles for weapon systems. The TADS can also be used to fly under total darkness and serves as a backup to the PNVS in this regard. Either crewmember can select either the PNVS or the TADS FLIR sensors for flying.

Can the PNVS be used to aim weapons?

The PNVS is simply a Forward-Looking Infrared (FLIR) sensor that provides a video underlay to the crewmember using it for flying at night; it is not a sight and it does not perform targeting or aim any weapon systems. In such an instance where the Pilot is using the PNVS to fly at night, the Pilot can be sight-selected to HMD while using the PNVS, and the HMD *does* aim weapon systems while the PNVS provides video imagery of the surroundings.

Can the TADS be used by the Pilot in the backseat?

The TADS can be used in one of two ways: as a sight for targeting or as a sensor for flying. In the case of the former, only the Copilot/Gunner in the front seat can directly control the TADS for the purposes of targeting and aiming of weapon systems. In the case of the latter, the TADS FLIR can also be used as a night-flying sensor using the NVS Sensor Select switch on the collective. Because of this, either crewmember can select the TADS as their NVS sensor, but only the Copilot/Gunner can select the TADS as their sight for targeting.

What is the difference between the Pilot Night Vision System (PNVS) and night vision goggles?

The PNVS is a steerable Forward-Looking Infrared (FLIR) turret that follows the helmet movements of the Pilot and transmits a thermal-based video of the environment to the Pilot's Helmet Display Unit (HDU). This system displays the thermal environment through various shades of brightness to distinguish varying levels of heat emissions from objects within the FLIR's field of view. Night vision goggles on the other hand amplify light sources and reflected light from the environment to allow a human eye to distinguish detail and contrast.

Why can I see IR pointers when using night vision goggles, but I cannot see them when using the TADS or PNVS?

Typical night vision goggles (such as the AN/AVS-6 goggles simulated in the DCS: AH-64D) amplify visible and near-infrared light to a level that can be used by the human eye to distinguish detail and contrast. Because of this, devices that transmit light in the near-infrared spectrum (such as IR beacons or IR pointers) can be seen by individuals wearing NVG's; whereas some FLIR systems that operate on different portions of the IR spectrum, such as the AH-64D PNVS and TADS turrets, cannot.

Why can't night vision goggles be used at the same time as the Helmet Display Unit (HDU)?

The HDU itself can physically interfere with the proper wear of the AN/AVS-6 night-vision goggles. However, more importantly, the use of NVG's and the HDU simultaneously can often present circumstances where the two devices are not properly aligned and can incur aiming errors when employing the helicopter sensors or weapon systems. For this reason, use of the two devices in such a manner is a prohibited practice for US Army crewmembers.

Is an IR pointer and a laser designator the same?

No, an IR pointer is a tightly focused laser beam of light that continuously emits in the near-infrared spectrum, whereas a laser designator employs a coded pulse of laser energy that can be read by compatible sensors or weapon systems that are scanning for that precise laser pulse sequence.

Why does the horizon line in the IHADSS symbology not coincide with the real horizon?

The IHADSS allows the crewmembers to maintain situational awareness of the majority of the AH-64D's flight state, sensors, and weapon systems, regardless of where the crewmember is looking at any given time. Either crewmember can look independently of the helicopter's flight path or nose direction without losing key pieces of data necessary to fly and fight. This allows the Pilot on the controls to be looking back over his/her shoulder while in a steep pitch-back turn and still have full awareness of the aircraft's attitude and flight state; or be scanning out to either side for threats or obstacles while flying slowly at nap-of-the-earth altitudes just feet over the treetops.

When viewing the horizon line (and/or pitch ladder in Cruise mode), the Line-Of-Sight (LOS) reticle – or central crosshairs – within the symbology represents the nose of the aircraft, much like the watermark on a cockpit attitude indicator. If the artificial horizon line bisects the LOS reticle, the helicopter's pitch attitude is level with the horizon.

Why does the AH-64D "crab" in forward flight with the nose slightly offset to the left even though the skid/slip "trim" ball is centered?

TODO

Why is the AH-64D's gun called the Area Weapon System?

The AWS was designed primarily as a close-in defensive weapon system when directed by a crewmember's helmet sight to provide suppression against immediate threats to the aircraft or the team. However, the AWS can be effectively used as an offensive weapon against light armor, soft-skinned vehicles, or personnel, especially when directed by the TADS as the sight.

Why does my range source keep switching to Manual when I action the gun?

As described above, the gun is designed to be used as a close-in defensive weapon system when employed by the aircrew's helmet sights. As such, when a crewmember's selected sight is HMD (Helmet Mounted Display), the range source will automatically revert to the Manual range (as set on the WPN page) whenever that crewmember actions the gun. This prevents an un-intended ranging value from being used when hasty, close-in fires are needed, as an example if the crewmember had a Nav range to a target 4 km away, the gun would attempt to elevate for a ballistic solution of 4,000 meters, and the rounds would impact a location much further than anticipated. For this reason, it is wise to set a Manual range on the WPN page that you are proficient with in engaging targets at close range.

However, this does not prevent the crewmember from setting a different range source such as Auto or Nav *after* the gun is actioned.

Why does the Rocket Steering Cursor not behave as a conventional Continuously Computed Impact Point (CCIP) reticle?

The Aerial Rocket Sub-system on the AH-64D was designed to be employed as "aerial rocket artillery", making a team of AH-64D's akin to a hovering MLRS battery. Because unguided rockets can only be employed using ballistic trajectories (like bullets), the accuracy of the weapon is heavily determined by what sighting method is used to generate a targeting solution. With CCIP targeting methods, the target must not only be visible to the naked eye, but any adjustments made to the aimpoint must also be precise enough to make corrections for unguided munitions, and such adjustments must be distinguishable to the crew. At longer ranges, the very thickness of any elements of a CCIP reticle itself on a HUD or helmet display may be the difference of several hundred meters. For this reason, CCIP reticles are only effective at relatively close ranges, and within visual range of the naked eye.

In order to engage ground targets with unguided rockets beyond normal visual ranges on the battlefield, and with such aimpoint accuracy that can be distinguishable at such ranges, the Rocket Steering Cursor is employed to enable the crew in aligning the helicopter with the required targeting solution for rocket delivery. While used in Cooperative mode, a secondary advantage to the Rocket Steering Cursor is that the Pilot can use the symbology to align the helicopter with the required targeting solution provided by the Copilot/Gunner while the Pilot continues to scan the surrounding terrain for immediate threats, without ever looking in the direction the aircraft is pointed for rocket delivery. Further, since the TADS itself can be slaved to a set of three-dimensional coordinates, the Rocket Steering Cursor allows the crew to deliver rockets to an area target from behind cover without having a direct line-of-sight (LOS) to the target.

Why does the DCS: AH-64D not have Stinger or Sidewinder air-to-air missiles?

The DCS: AH-64D is simulating a US Army AH-64D. US Army AH-64's have never been equipped or capable of firing Stinger or Sidewinder missiles, despite a small number of weapons tests conducted with such missiles. There are several "growth" provisions within the AH-64D cockpit controls (such as an Air-To-Air weapon select position as well as a missile Cage button) to support future additions of such capability to the AH-64D, however the avionics of AH-64D's in US Army service have never supported such weapon systems.

What is a "sight" and how do I determine which one I should use in a tactical situation?

There are three possible "sights" that can be selected to directly aim a weapon or generate a targeting solution in the AH-64D. These selections are the Helmet-Mounted Display (HMD), the Target Acquisition Designation Sight (TADS), or the optionally mounted Fire Control Radar (FCR). Any of these three sight selections can be used by the Copilot/Gunner, but only HMD and FCR are available to the Pilot. The sight currently selected by the crewmember can be seen in the bottom left corner of the IHADSS symbology.

Each sight used by the AH-64D has both advantages and disadvantages that must be known and evaluated for any given tactical situation. For example, the TADS is very useful for long-range target identification and designation for Hellfire missiles, however it may not be the quickest method for engaging a target that is at close-range. On the other hand, the HMD is very useful for rapidly engaging targets at close-range simply by using the crewmember's helmet-tracking capabilities, but the HMD is less accurate than the TADS and cannot designate targets for missile engagement. For more information regarding sights, see Sights and Sensors.

What is an "acquisition source" or "ACQ" and how do I determine which one I should use in a tactical situation?

An acquisition source can quickly orient a crewmember's selected sight to either a point in space relative to the aircraft nose or a set of three-dimensional coordinates on the battlefield. The purpose of the acquisition source is to reduce the time needed to manually search and acquire a target with any given sight. In the case of the TADS or FCR, these sights will physically slew to the location of the selected acquisition source. In the case of the HMD, the crewmember will receive cueing indications in their helmet symbology of where they should look to point their head toward the selected acquisition source (in lieu of a robotic arm physically grabbing their head and forcibly turning it in the correct direction).

As is the case with sight selections, choosing the best acquisition source in any given situation is key to reducing the time it takes to search, acquire, and engage enemy targets. For more information regarding acquisition sources, see Acquisition Sources (ACQ).

How do I enter a set of MGRS coordinates if a JTAC or other ground unit gives me MGRS in 4-, 6- or 10-digit formats?

The AH-64D will only accept MGRS coordinates in an 8-digit format. If coordinates are entered using a 4-, 6- or 10-digit MGRS format, the Keyboard Unit (KU) will not accept this entry and the KU will simply flash. If given a 4-digit or 6-digit MGRS location, simply append zeros to the easting and northing to achieve the number of required digits, such as 12<u>00</u>12<u>00</u> when given "1212" or 123<u>0</u>123<u>0</u> when given "123123". Conversely, when given a 10-digit MGRS coordinate, simply remove the

5th digit from both the easting and northing to achieve the required 8-digit format, such as 12341234 when given "1234~~5~~1234~~5~~"

APPENDIX F
CALCULATION AND CONVERSION FORMULAS

Use these formulas and conversions for pre-mission planning or while in flight using the KU arithmetic functions. Desired resultants are in bold font.

Speed/Time/Distance

Ground Speed Required (knots) = (Distance ÷ Minutes) × 60
Time of Flight (mins) = (Distance ÷ Ground Speed) × 60

Fuel/Endurance

Bingo Fuel (lbs) = (Time of Flight ÷ 60) × Fuel LB/HR
Objective Time (mins) = ([Total Fuel – Bingo Fuel] ÷ Fuel LB/HR) × 60

Fuel/Range

Specific Fuel Range (SFR) Factor = Ground Speed ÷ Fuel LB/HR
Flight Range (NM) = SFR × Total Fuel

Distance Conversion

km to **NM**	NM to **km**
[km] ÷ 1.85 = [NM]	[NM] × 1.85 = [km]

Altitude/Elevation Conversion

Feet to **Meters**	Meters to **Feet**
[ft] ÷ 3.281 = [m]	[m] × 3.281 = [ft]

Latitude/Longitude Conversion

DDD-MM-SS.SS to **DDD-MM.MMM**

SS.SS ÷ 60 = .MMM

DDD-MM.MMM to **DDD-MM-SS.SS**

.MMM × 60 = SS.SS

Good hunting!

The Eagle Dynamics SA team