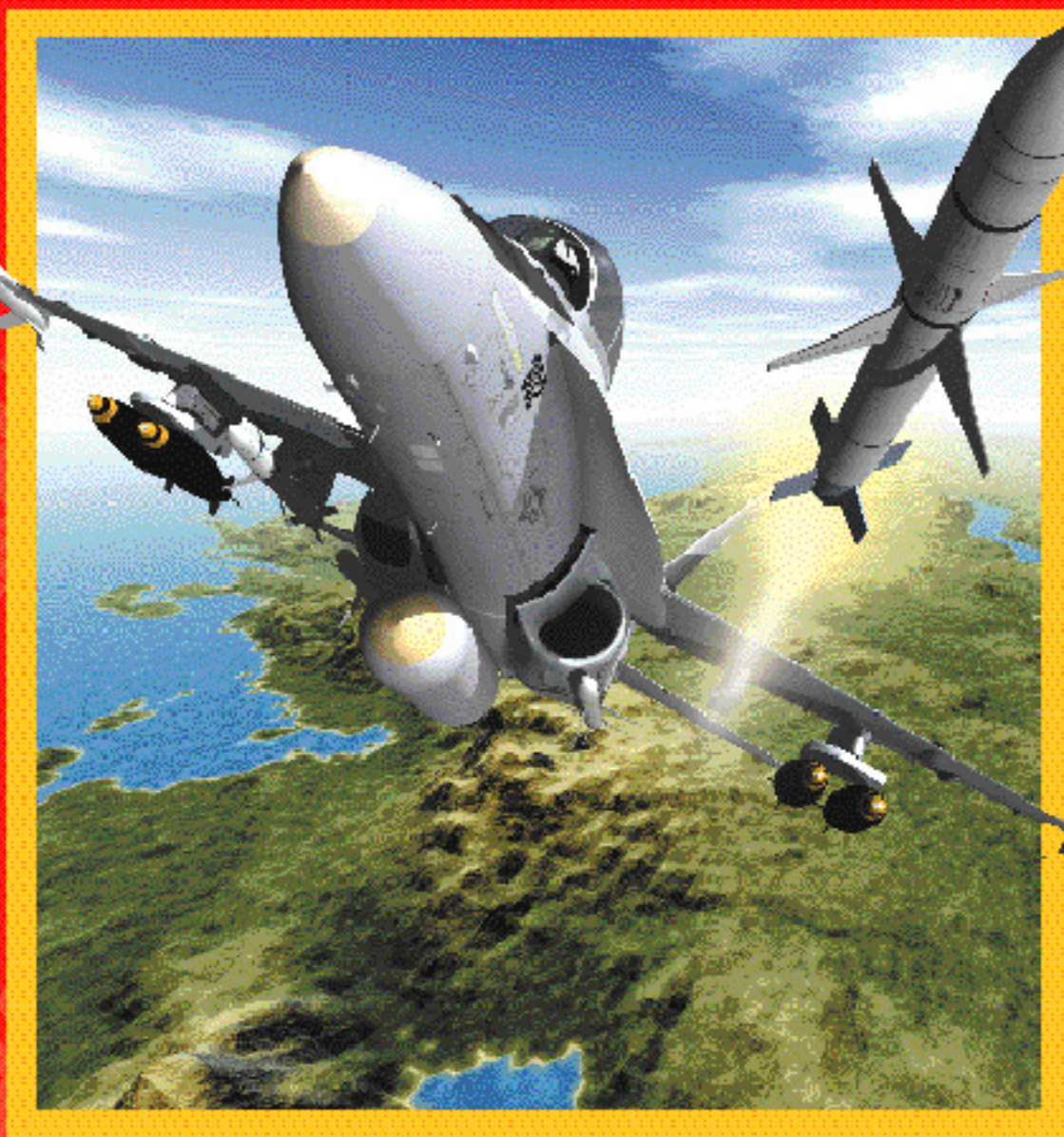


STRIKE FIGHTER SIMULATION

F/A-18 HORNET 3.0



A GAME BY TREY SMITH

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OPERATION OF THE F/A-18 AVIONIC SUBSYSTEM

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HORNET HISTORY

The F/A-18 Hornet made its first public appearance in the form of a full-scale mockup at the Paris Air Show in 1971. Then called the P-530 Cobra, it was intended to be Northrop's next generation fighter; the successor to the F-5. It was to be a lightweight fighter that could out-perform the MiG-17, yet still carry a large external weapons load.

Though unconvinced of the value of a small fighter, the US Air Force was persuaded to sponsor a competition in which two designs would be built and flown. In April of 1971, the finalists were announced: General Dynamics would develop the YF-16 Lightweight Fighter (LWF), and Northrop would develop a Cobra derivative, the YF-17. By the time the prototypes finally flew, the Air Force was in the market for 650 new fighter aircraft, and four NATO nations were shopping for F-104 replacements. The winner could be assured of substantial sales. Industry observers were more than a little surprised when the General Dynamics design out performed the Northrop design and won the competition.

Although the F-16 was added to the USAF stables, Congress directed the US Navy to choose one of the two LWF designs for their required fighter/attack vehicle, known as the Navy Air Combat Fighter (NACF). Navy requirements were in many ways tougher than those of the USAF. Stronger landing gear were necessary for carrier operations. A larger radar antenna than could fit in either prototype was also required. In addition, the Navy wanted the manufacturer to have experience in carrier aircraft design. Corporate alliances were formed, and General Dynamics teamed up with Vought, while Northrop was joined by McDonnell Douglas. In May 1975, the YF-17 was awarded the prize, and after considerable evolution, first flew as the F/A-18 in 1978.

After nearly two decades, versatility has been the key to the continued success of the F/A-18. Upon cancellation of the Navy's A-12 stealth attack aircraft in 1991, it was decided that a growth program based on the F/A-18 would serve as the replacement for the A-6 and, to some extent, the expensive F-14. By the early 2000s, a typical carrier wing will include 36 F/A-18s and 14 Grumman F-14s. The US Navy and other NATO nations plan on purchasing 2,500 new F/A-18s by the year 2015.

INSTALLATION INSTRUCTIONS

Mac OS

- 1) Insert the CD-ROM into your CD drive.
- 2) Run the Installer, located on the CD.
- 3) Follow the instructions to install new files onto your hard disk.
- 4) Locate "F/A-18 Hornet 3.0" on your hard drive and run it. The CD must be in the drive for all normal missions. Joined network missions may be flown without the CD inserted.

Windows95/NT 4.0

- 1) Insert the CD-ROM into the CD drive.
- 2) Follow the on-screen instructions to install new files onto your hard disk.
- 3) Locate "FA18" on your hard drive and run it. The CD must be in the drive for all normal missions. Joined network missions may be flown without the CD inserted.

QUICK START

- 1) Open/Run the F/A-18 Hornet 3.0 icon.
- 2) Click on the **Settings** button.
- 3) Click on the **Preferences** button.
- 4) Select your controller type under **Input Device**.
- 5) Click on the **Theater** button.
- 6) Click on the theater in which you would like to fly. Three selections are available:
 - Training: Missions which allow you to familiarize yourself with basic operations of the F/A-18 Hornet.
 - Network: Multi-player missions which allow you to fly with and against your friends.
 - Kuwait Tour: Live combat missions with objectives, scoring, and awards.
 - Red Flag Missions: Advanced training missions in Persian Gulf.
- 7) Click on the flashing **Preflight** button.
- 8) Select your weapon loadout for the mission.
- 9) Click on the **Fly** button.
- 10) Increase or decrease throttle controls by pressing "+" or "-".
- 11) The aircraft lifts off when sufficient ground speed is attained (about 140 kts).
- 12) Raise the landing gear by pressing "G".
- 13) Select Air-to-Air weapons by pressing "[".
- 14) Select Air-to-Ground weapons by pressing "]".
- 15) Release weapons with "ENTER" or "TRIGGER" ("RETURN" on Macintosh)
- 16) Exit the simulation and return by pressing "SHIFT ESC".

INTERFACE ENVIRONMENT

The F/A-18 Hornet interface provides a series of areas, or Rooms, each providing a specific function. These areas are all accessible from the Main Room.

F/A-18 Hornet operates under a career-oriented paradigm. The user assumes the identity of a pilot just beginning a career. As the pilot achieves score and ranking, the dossier is updated and the pilot is promoted accordingly. A complete Tour of Duty consists of seven missions, each one chosen from a group of four. When the last mission is completed, the pilot dossier must be reset to begin again. In addition to flying career missions, all of the Tour of Duty Missions are available for "Instant Action". Flying an Instant Action mission has no effect on the pilot's career.

A series of six Training missions are available for practicing common roles. Topics include: Basic flight operations, Takeoff/landing, Carrier operations and procedures, Navigation, Air-to-ground attack, and Air-to-air combat. As with Instant Action missions, Training missions do not affect the pilot's dossier.



Figure 1 - Main Room

Main Room

The primary area of the interface is called the Main Room. From here the user may navigate to other areas of the interface, change game preferences, choose missions, and fly the aircraft. The Main Room is divided into three primary areas:

- DDI: Monochrome CRT with buttons surrounding it. Clicking these buttons allows the user to navigate through the various menu options and selections.
- Kneepad: Small rectangular note pad to the right of the DDI. The kneepad contains "pages" of information and/or buttons used to select various options. Mission briefings are also displayed here.
- Tabs: Positioned to the right edge of the kneepad. The tabs allow the user to navigate to different areas of the interface, such as the classroom, film library, or debrief room.

Using the interface is as simple as clicking (with the mouse) on any DDI button or any active button or field on the Kneepad. For example: To change the monitor resolution, click on the **Settings** DDI button and then click on the **Preferences** button. The monitor resolutions appear in the lower right-hand corner of the kneepad. Click on the desired resolution.

Kneepad Tabs

The kneepad tabs are used to navigate to other rooms of the interface. The five tabs are located to the right side of the kneepad.

- Flight: Provides a shortcut directly to the Preflight page using current theater and mission settings.
- Training: Goes to the Training Classroom which provides extensive online tutorial and video sequences.
- Debrief: Shows the debriefing for the last mission flown, and allows replays to be saved.
- Replay: Goes to the Replay Room, where previously saved video can be recalled and viewed.

DDI Pilot Menu

The Pilot menu on the left side of the DDI displays the following options on the right side of the DDI:

- Dossier: Clicking on Dossier brings up the kneepad page containing the pilot's active duty history. Name, rank, serial number, picture ID, callsign, score, and personal notes are stored here.
- Kills: This is a list of the pilot's kills for each target type, along with the score value of each type. At the bottom of the page is the total score.
- Awards: This page displays ribbons awarded for successful Tour-of-Duty missions.
- Top Tours: This is a list of the ten highest-scoring careers.

Reset Pilot: Deletes the current pilot and creates a new one at the beginning of a career. Resetting the pilot is required when the pilot dies, or when the pilot completes a career and retires.

DDI Settings Menu

Settings are altered by clicking on **Settings**, located on the left side of the DDI. The following options are available through this selection:

Detail: This is where the various graphic effects and controls are set. Lowering detail and using fewer graphic effects improves performance. Effects of certain graphic changes on the environment are displayed in the picture window at the bottom of the page.

Difficulty: This page is used to inhibit or completely override damage to the pilot's aircraft. Enemy skill levels may also be adjusted.

Preferences: This is where controls for sounds, flight and video mode are located. Two frame rates are available; 10 and 20 frames per second. Faster computers can easily support the 20 FPS option, whereas slower computers may require the lower setting.

DDI Theater Menu

There are three theaters of operation:

Training: This theater depicts a training area in beautiful Hawaii.

Network: This theater, a joint military installation in Arizona, is for flying with or against other live pilots.

Kuwait Tour: These Tour-of-duty missions advance the pilot's career.

Choosing a theater displays a map page on the keypad. Clicking within the map region zooms the map. The map may then be scrolled in any direction up to its geographical limits by pressing and holding the mouse button while dragging the mouse within the map window. Clicking in the map legend area zooms out.

DDI Mission Menu

The Mission menu functions differently depending on the currently selected theater. When the Training or Network theater is active, the missions menu displays a scrolling list of the six training or network

missions. Clicking on a mission name selects that mission for flight. The **Up** and **Down** buttons scroll the list. When the Kuwait theater is current, the Mission menu displays a group of four missions, one of which must be chosen for flight. After successfully completing the mission, the DDI displays "Get Next Mission". Clicking this fetches the next group of four missions. Each group of four missions is successively more difficult. Upon completion of seven missions, the pilot retires.

The keypad displays the briefing for the selected mission. Study the briefing before flying, as it describes the objective for the mission. Click on the curled page corner to view additional briefing information.

DDI Preflight Menu

The Preflight option is available from the Mission page. The Preflight page offers the following menu choices:

- | | |
|----------------|---|
| Fly: | Initiates the current mission with the selected loadout. |
| Air-To-Air: | Recalls a previously stored default A/A weapon loadout. Holding the SHIFT key down while pressing this button saves the currently chosen custom loadout as the default A/A loadout. |
| Air-to-Ground: | Recalls the current default A/G weapon loadout. Holding the SHIFT key down while pressing this button saves the currently chosen custom loadout as the default A/G loadout. |
| Cancel: | Returns to the previous page. |

Loadouts are selected for each mission by filling out the form on the keypad. Weapons are loaded by clicking on the desired spaces, one selection for each aircraft station. Stations which cannot accept a particular ordinance are gray and cannot be selected.

Flying a mission

After loadout, click on Fly to begin the mission. Loading the mission may take several seconds. Training and network missions are restarted by pressing "ESC". Pressing "SHIFT ESC" aborts the current mission and enters the debrief room.

The current mission automatically ends under any of following circumstances:

- * Pilot dies.
- * Pilot bails out.
- * Pilot ditches.
- * Pilot spools down the engines below 60% (turns them off) with weight on wheels.

CLASSROOM

The Classroom provides access to an aviation curriculum which teaches the required skills and systems knowledge necessary to adequately operate an F/A-18 Hornet. Included are around 60 lessons, divided into six basic topics. The topics correspond to the six training missions. The lessons are comprised of video replays with overlaid voice instruction or animated chalkboard illustrations with overlaid voice instruction. Begin a lesson by first clicking on the desired topic, then clicking on the desired lesson. At any time the related training mission may be flown by clicking on the airplane at the bottom of the screen. Click on the kneepad to return to the Main Room.



Figure 2 - Training Classroom

DEBRIEFING ROOM

After flight, the pilot enters the Debriefing Room, where a detailed report of mission activity prints (to the screen). Points for all destroyed targets are awarded at this time. If sufficient points for rank promotion are accumulated, the pilot is informed of the new rank on "printout".

The Debriefing Room is accessed from the Main Room by pressing the Debrief tab on the Kneepad. To return to the Main Room, click on the kneepad to the right of the printer.

Mission Debrief Printout

The Debrief Printout contains information on the number and type of targets killed along with the overall success of the mission. The printout can be advanced at anytime by clicking on the paper itself.

Saving Replays

To the left of the printer is a videotape. Clicking on this tape brings up a Replay Save Dialog which resembles a videotape. A file name is entered, along with some optional notes about the replay. Once a replay has been saved, the videotape no longer appears behind the printer.



Figure 3 - Debrief Room

FILM LIBRARY

The Film Library provides an interface from which videotapes may be "viewed". Videotapes are either saved from the Debriefing Room, or manually copied to the "Replays" directory on the hard disk. The Film Library is accessed from the Main Room by clicking the Replay tab on the Keypad.

The DOS computer screen is divided into three areas:

Replay List: This area provides a scrollable list of all replays in the replay directory. Pressing "ENTER" with a replay selected on the scrolling list runs the replay.

Notes: Notes saved with the selected replay appear here.

Search: Type characters to navigate the list.

Replay Files

F/A-18 Hornet 3.0 replays are small, highly efficient files which contain everything that happened during flight. Although view positions are stored internally for playback just as they were recorded, view

playback may be overridden anytime during playback, allowing manual view control, by pressing "CONTROL U".

All replays are stored in a directory named "Replays" within the main application directory. Adding and removing replay files to this directory updates the replay list in the Replay Room.



Figure 4 - Film Room

Click the kneepad image to exit the Film Library and return to the Main Room.

NETWORK PLAY

F/A-18 Hornet 3.0 allows up to four-player networking over AppleTalk under MacOS, or DirectPlay under Windows95/NT 4.0. Cross-platform networking is not supported. Missions are arranged as teams, Red Team and Blue Team. The Red Leader (RL) is always the mission host. The Red Wing (RW), Blue Leader (BL), and Blue Wing (BW) are the remaining players.

- Network players must have the same version of F/A-18 Hornet.
- The **Host** must have the F/A-18 Hornet 3.0 CD in the CD-ROM drive.
- Difficulty levels are normal for all players and are not influenced by the **Difficulty** page.
- The Pilot Dossier is not affected by network missions.

Network Host

The Host of a network mission is responsible for choosing the mission to be flown and choosing the appropriate connection options.

- 1) From the **Theater** menu select the **Network** theater.
- 2) From the **Mission** menu select a network mission to fly.
- 3) Press **Preflight** for stores selection.
- 4) Press **Host**.

Windows95/NT 4.0

Before flight, a network connection method must be chosen. A dialog is provided the first time a network mission is flown. The choice is saved internally, but may be changed from the **Preferences** menu in the Main Room. Connection choices are system dependent; they typically include Dial-up, TCP or IPX. Please refer to Windows95/NT documentation for details concerning built-in networking.

Macintosh

The Host has two network choices, available at the bottom of the "Host" dialog box:

Low Traffic Network: This option causes network players to exchange aircraft state data (packets) twice as often as normal. This higher data rate increases accuracy of remote aircraft positions but also creates a higher demand on the network. More than two players using either LocalTalk or ARA (Apple Remote Access) may want uncheck this option. If players experience excessive "surging" when viewing other aircraft, uncheck this option.

Precision Positioning: This option modifies the internal interpolation algorithm used to update aircraft positions. This option gives better apparent positions for remote aircraft but might cause excessive surging. This option is recommended when all players are using fast computers on a local area network. If the speed disparity between two players is great, this option should be unchecked. Experimentation is the best way to decide which options should be used.

Network Join

- 1) From the **Theater** menu select the **Network** theater.
- 2) From the **Mission** menu select the net mission you wish to fly.
- 3) Press **Preflight** for stores selections.
- 4) Click on **Join**.

Net-player Communication

During flight, typed messages may be sent to other network players. Press "CONTROL " (control-single quote), type the message, then press "ENTER". Messages are sent to all players by default. Private messages may be sent to a teammate by holding down "CONTROL" when pressing "ENTER" to send the message.

Flying a mission

After stores are selected and the Host or Join button is pressed, the screen darkens as the currently selected mission is initiated. Loading the mission may take several seconds.

SCORING

Rank Promotion Values

The following list shows the points required to achieve promotion:

| <u>Rank</u> | <u>Required score</u> |
|----------------------|-----------------------|
| Ensign | 0 |
| Lieutenant J.G. | 5000 |
| Lieutenant | 12000 |
| Lieutenant Commander | 25000 |
| Commander | 45000 |
| Captain | 75000 |

Target Point Accumulation

Score is awarded for each target killed during a mission. Point values depend on the target.

In addition to points for enemy kills, bonus points are awarded as follows:

| | |
|-------|--|
| +4000 | Points for successfully completing the mission objective. |
| +2500 | Points for safely landing the aircraft after a successful mission. |
| -2500 | Points for failing to land (or ditch)the aircraft in friendly controlled territory (Red Zone). |

INDEPENDENT SYSTEMS

The F/A-18 Hornet operates in one of three "Master Modes":

- Navigation Master Mode (NAV)
- Air-to-Air Master Mode (A/A)
- Air-to-Ground Master Mode (A/G)

Although many avionic systems operate according to the current Master mode, many other systems operate independent of the Master Mode setting.

AVIONIC CONTROLS AND DISPLAYS

F/A-18 Hornet 3.0 faithfully reproduces all major components and functionality of the F/A-18 avionics suite. This section explains the basic flight instruments and controls common to all systems. To view the entire instrument panel, press "2" for look-down view. Press "1" to return to the normal cockpit view.

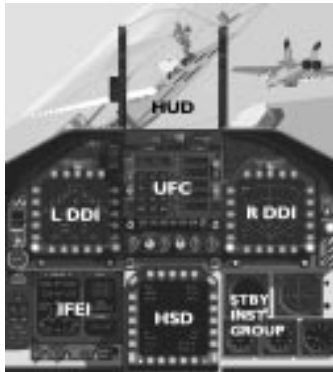


Figure 5 - Instrument Panel Layout

HUD Basic Flight Data

AN/AVQ-28 Raster Head Up Display (HUD): The HUD is the primary flight instrument of the aircraft, providing the operator with basic flight status, navigational steering, and weapon delivery information.

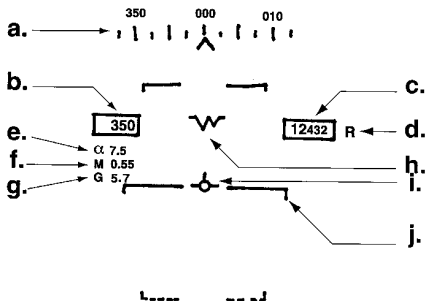


Figure 6 - Basic HUD Display

HUD symbology common to all systems includes:

| <u>REF</u> | <u>DISPLAY</u> | <u>DESCRIPTION</u> |
|------------|-----------------------|--|
| a. | Heading Tape | The aircraft's magnetic heading is indicated on a moving scale. The aircraft's current heading is represented by the tic mark directly over the heading caret (^). |
| b. | Airspeed | Calibrated air speed is provided in the box on the left side of the HUD. Thousands digits are 150% of standard size. |
| c. | Altitude | Altitude is provided in the box to the right side of the HUD. Readout can be configured to reflect radar or barometric calibration. |
| d. | Radar Altitude Cue | When the altimeter is in radar mode, an "R" cue is displayed to the right of the altimeter box. |
| e. | Angle-of-Attack (AOA) | True Angle of Attack in degrees is displayed to the left center of the HUD. In any established flight attitude, the distance in degrees between the aircraft waterline reference and the velocity vector, is equal to AOA. |

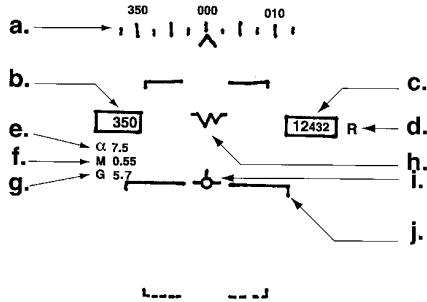


Figure 6 - Basic HUD Display

- | | |
|--------------------|--|
| f. Mach Number | Mach percentage is displayed immediately below the AOA. |
| g. Aircraft Gs | Normal aircraft G-force. |
| h. Waterline | The aircraft nose direction. |
| i. Velocity Vector | True flight path of the aircraft. If velocity vector is HUD-limited, it flashes at 2.5 times per second to indicate that it cannot accurately indicate flight path. |
| j. Pitch Ladder | Flight path/pitch angle lines, or "rungs" represent 5 degrees of angle each between plus and minus 90 degrees. Positive rungs are solid indicating they are above the horizon line. Negative rungs are dashed indicating they are below the horizon. Vertical flight path angle of the aircraft is indicated by the position of the velocity vector with respect to the flight path/pitch ladder. Aircraft pitch attitude is indicated by the position of the pitch ladder with respect to the waterline symbol. |

The display of HUD symbology is operated in Normal or Clutter Reject mode by toggling "CONTROL C". Reject blanks low-priority information. HUD brightness level is cycled with "CONTROL B". Display of altitude source is toggled between Barometric (BARO) and Radar (RDR) with "CONTROL A". HUD rasterization is toggled on or off with "CONTROL H".

IP-1317/A Digital Display Indicators (DDIs)

The left and right Digital Display Indicators "DDIs" are identical IP-1317 monochrome displays. On power up, the left DDI is initialized to the Engine Monitoring Display (ENG) page and is primarily used for stores management, electro-optical displays, and advisory data. The Right DDI is initialized to the Standby (STBY) radar mode and is primarily used for sensor displays.

The Left DDI provides the following display formats:

| <u>Key</u> | <u>Acronym</u> | <u>Description</u> |
|------------|----------------|---|
| "E" | ENG | Electronic Engine Display format. |
| "U" | HARM | High-speed Anti-Radiation Missile display format. |
| "O" | EO | Electro-optical display format. |
| "S" | SMS | Stores Management System display format. |

The Right DDI provides the following display formats:

| <u>Key</u> | <u>Acronym</u> | <u>Description</u> |
|------------|----------------|-----------------------------|
| "R" | AIR | Air-to-air radar format. |
| "R" | GND | Air-to-ground radar format. |
| "D" | ESD | Equipment Status Display. |

IP-1350/A Horizontal Situation Display (HSD): The HSD, located in the center of the cockpit in look-down "2" view. It is slightly larger than the DDIs and is capable of providing full-color raster display of navigation information. It has two modes, Navigation (NAV) "N" and Moving Map (MAP) "M" Both modes are described in detail in Navigation System.

C-10380/ASQ Up-Front Control (UFC)

The UFC, whose official nomenclature is Electronic Equipment Control (EEC), is located in the center of the instrument panel, below the HUD. The UFC's role is to control pilot relief (autopilot) modes, IFF, TACAN, ILS, and UHF radio. Since the UFC provides interface to a variety of modes, it is discussed throughout this documentation as it pertains to individual functions.



Figure 7 - Up Front Control Panel

| <u>REF</u> | <u>DISPLAY</u> | <u>DESCRIPTION</u> |
|------------|----------------|--|
| a. | Scratchpad | Indicates UFC option. |
| b. | Pilot Cueing | Colon (:) illuminates to the left of active field. |
| c. | Option Fields | A four-character alphanumeric display fields. |

Indicator Lamps

Left Status Display Group: Located immediately above the left DDI, this bank of lamps provides warning and advisory indication in the following top-to-bottom, left-to-right order:

| <u>Acronym</u> | <u>Priority</u> | <u>Description</u> |
|----------------|-----------------|--|
| FIRE | Warning | Left Engine Fire detected. |
| MAST CAUT | Caution | Master Caution condition occurs. At the same time, a tone is |

| | | |
|-------|----------|--|
| | | enunciated. Specific diagnosis of the caution is provided by invoking the Equipment Status Display (ESD) "D" on the right DDI. |
| GO | Advisory | Functional System (ESD). |
| HOOK | Advisory | Arrestor Hook extended. |
| S BRK | Advisory | Speed or Wheel Brake deployed. |
| L BAR | Advisory | Launch Bar coupled to catapult shuttle. |
| NO GO | Advisory | Dysfunctional System (ESD). |
| STBY | Advisory | AN/ALQ-126A ECM in Standby Mode. |
| REC | Advisory | AN/ALQ-126A ECM Receiver active. |
| XMIT | Advisory | AN/ALQ-126A ECM Transmitter active. |

Right Status Display Group: Located immediately above the right DDI, this bank of lamps provides advisory and threat warning indication in the following left-to-right, top-to-bottom order:

| <u>Acronym</u> | <u>Priority</u> | <u>Description</u> |
|----------------|-----------------|---|
| RCDR | Advisory | Illuminates when HUD camera is recording. |
| AI | Warning | Radar Warning Receiver (RWR) has detected pulse-Doppler typical of Airborne Interceptor (AI). |
| CW | Warning | RWR has detected Continuous Wave (CW) patterns. |
| DISP | Advisory | Flare and/or chaff dispenser is exhausted. |
| SAM | Warning | RWR has detected emissions with a band, frequency and wavelength consistent with that of Surface to Air Missile (SAM) search and track radar. |
| AAA | Warning | RWR has detected emissions with a band, frequency, and wavelength consistent with that of Anti Aircraft Artillery (AAA) search and track radar. |
| APU FIRE | Warning | Auxiliary Power Unit (APU) fire detected. |
| FIRE | Warning | Right Engine fire detected. |

Located immediately to the left of the Engine Monitor Display in look-down mode, this panel provides the following advisory information in left-to-right, top-to-bottom order. Use "J" to cycle jettison station and "ENTER" to jettison the selected stores.

| <u>Acronym</u> | <u>Priority</u> | <u>Description</u> |
|----------------|-----------------|--|
| CTR | Advisory | Center stores station selected for Jettison. |
| L1 | Advisory | Left #1 stores station selected for Jettison. |
| R1 | Advisory | Right #1 stores station selected for Jettison. |
| L2 | Advisory | Left #2 stores station selected for Jettison. |
| R2 | Advisory | Right #2 stores station selected for Jettison. |
| NOSE | Advisory | Nose gear is down and locked. |
| LEFT | Advisory | Left main gear is down and locked. |
| RIGHT | Advisory | Right main gear is down and locked. |
| HALF | Advisory | Flaps are in half-down position. |
| FULL | Advisory | Flaps are in full-down position. |

Voice Alert System

Voice warning alerts advise the pilot to critical aircraft functions or states. Each alert is enunciated twice:

| <u>Indication</u> | <u>Priority</u> | <u>Description</u> |
|-------------------|-----------------|---|
| Low Altitude | Warning | Enunciated as "Altitude". |
| Engine Fail | Warning | Enunciated as "Engine Left(right)". |
| Low Fuel | Warning | Enunciated as "Low Fuel". Total fuel is below 800lbs in either feed tank. |
| Bingo Fuel | Caution | Enunciated as "Bingo". Total fuel quantity is below bingo (pre-programmed minimum number of pounds needed to return). |

Equipment Status Display (ESD)

Master Caution illuminates when the mission or data computers have detected a fault in one of the aircraft systems. The Equipment Status Display (ESD) should be selected to determine the system affected and nature of the failure.

The ESD DDI format is enabled with "D". Messages are displayed as a function of equipment status. GO means equipment is on and operational. NOGO means damage. ESD status fields are formatted as followed:

| <u>ACRONYM</u> | <u>DESCRIPTION</u> |
|----------------|--|
| ENGLF | Left engine fail/shutdown derived from EGT, THRUST, VIB or OIL. |
| ENGRTR | Right engine fail/shutdown derived from EGT, THRUST, VIB or OIL. |
| FUEL | Fuel Feed Tank or Cross-feed Valve pressure leak. |
| AILN | Aileron mechanical or communications failure. |
| ELEV | Elevator mechanical or communications failure. |
| FLAP | Flap mechanical or communications failure. |
| GEAR | Landing Gear mechanical or communications failure. |
| HOOK | Arrestor hook mechanical or communications failure. |
| BRAK | Speed Brake mechanical or communications failure. |
| RUDR | Rudder mechanical or communications failure. |
| OXGN | Oxygen bottle quantity is below 10%, or Oxygen system failure. |
| RADR | Radar has failed or is not communicating on Multiplex Bus (MUX). |
| RWR | Radar Warning Receiver or MUX I/O failure. |
| WPNS | Stores Management Set (SMS), or MUX I/O failure. |
| GUN | 20mm Gun is jammed, overheated, or not communicating on MUX. |
| ECM | Interference Blanker, Countermeasure Set, or MUX I/O failure. |
| A/P | Inertial Navigation Set (INS) or FCS outer loop mode failure. |
| IFF | Identification Friend or Foe (IFF) transmit/receive failure. |
| TACN | Tactical Air Navigation (TACAN) transmit/receive failure. |

Standby Flight Instrumentation

Standby, or backup instrumentation is located to the right of the HSD in look-down "2" view. These conventional indicators utilizes pitot and static air ports independent of Air Data Computer (ADC) sources, providing redundant operation should primary systems fail. These standby indicators are as follows:

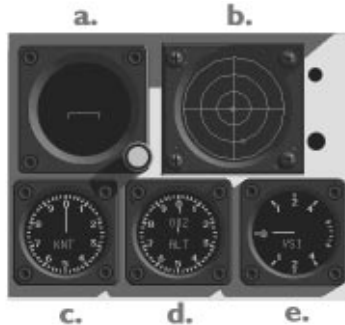


Figure 8 - Standby Instruments

a. Attitude Reference Indicator: This instrument provides the pilot with aircraft pitch and roll parameters as well as turn and bank coordination, and ILS localizer deviation. Turn coordination, possibly required in the event of a Flight Control System (FCS) malfunction, is accomplished by observing the liquid-suspended bubble while applying rudder in the direction of the turn. When the bubble is centered, the turn is coordinated.

b. Radar Warning Receiver Azimuth Display. (See ALR-67 Electronic Radar Warning Receiver).

c. Indicated Airspeed: This instrument displays the aircraft's speed (in knots) before compensation for atmospheric pressure. The speed displayed is lower than the actual airspeed at altitude.

d. Barometric Altimeter: Measure the height of the aircraft above a given reference plane. The barometric altimeter is calibrated by barometric pressure setting and can be utilized at any altitude.

e. Vertical Speed Indicator: This instrument provides vertical airspeed information in hundreds of feet per minute based on static air pressure.

AN/ASW-44 FLT.CONTROL SET (FCS)

The F/A-18 Hornet makes use of a quad-digital control-by-wire system providing quadruple redundancy. This system is commonly known as the Flight Control Set (FCS). The FCS provides nose wheel steering, three-axis auto-trim, multiple pilot relief (autopilot) modes, data link coupled automatic carrier and airstrip landing, as well as stall warning indication.

Flight Control Stick and Rudder Functions

Control Stick: Force transducer simulation provides longitudinal and lateral axis (pitch and roll) commands to the FCS via the numeric keypad. Additionally, left and right aileron may also be used to control Nose Wheel Steering (NWS):

| <u>Stick/Key</u> | <u>Control</u> | <u>Description</u> |
|------------------|----------------|--------------------|
| Left/"KPD4" | Left Aileron | Roll left. |
| Right/"KPD6" | Right Aileron | Roll right. |
| Fwd./"KPD8" | Down Elevator | Pitch nose down. |
| Back/"KPD5" | Up Elevator | Pitch nose up. |

Rudder: Vertical axis rotation (yaw) as well as Nose Wheel Steering (NWS) is controlled via the rudder keys (or rudder pedals):

| <u>Key</u> | <u>Control</u> | <u>Description</u> |
|------------|----------------|--------------------|
| "/" | Left rudder | Yaw nose left. |
| "/" | Center rudder | |
| "/" | Right rudder | Yaw nose right. |

Nose Wheel Steering (NWS) is controlled by aileron or rudder, and is operational at ground speeds of 100 knots or less. At speeds over 100 knots it is automatically disengaged by the FCS. The NWS system provides two operating modes designed to prevent oversteer. The current operating mode is indicated in the lower-right bank of fields in the HUD, with weight-on-wheels. NWS is automatically toggled to the following mode based on the current ground speed:

| <u>ACRONYM</u> | <u>DESCRIPTION</u> |
|----------------|---|
| NWS | Low-gain nose wheel steering for high-speed takeoff and landing configurations. Engaged at 20 to 100 knots. |
| NWS HI | High-gain nose wheel steering designed for low-speed taxi conditions. Engaged at 1 to 19 knots. |

Flight Control Trim (FCT): FCT is electronically updated by the FCS to provide three-axis auto-trim and turn coordination throughout the entire operating envelope.

Throttle Control and Engine Monitoring

F404-GE-400 Enhanced Performance Engine (EPE): F/A-18 power is supplied by two GE F404 EPE afterburning turbofan engines which can develop over 16,000 pounds of thrust each, giving the Hornet a thrust-to-weight ratio of approximately 1:1. Top speed at altitude is approximately 1.8 times the speed of sound. The F/A-18 can carry just over 11,000 pounds of fuel internally, distributed among multiple self-sealing cells.

The use of a Hands On Throttle and Stick (HOTAS) set, such as the F-16 Series by CH products, or the ThrustMaster FCS, is highly recommended for use with F/A-18 Hornet. The ability to operate controls without removing hands from the stick can mean the difference between winning and dying. F/A-18 Hornet 3.0 provides hardware support for both of these systems.

Throttle is controlled by "-" and "+" and operates through a range of 60% to 100% military (MIL) power. Engaging the throttle at simulation start engages the on-board Auxiliary Power Unit APU and begin startup BIT tests. The engine then spool to 60% RPM (idle) and hold. Decreasing RPM below 60% with weight-on-wheels causes engine shut-down, and terminates the simulation.

Afterburner: The F/A-18 Hornet provides six afterburner stages from 11,000 to 16,000 lbs thrust per engine. Burners are ignited with "BACKSPACE" key ("DELETE" key on Macintosh systems). Subsequent key depressions cycle burner stages up. Afterburners are shut down by pressing "+" or "-". Display of burner stages in percent of exhaust nozzle area, is provided by the Integrated Engine/Fuel Monitor (EIFI) and DDI Engine Monitor Display.

AEU-12/A Integrated Fuel/Engine Indicator (IFEI): The IFEI is an integrated engine/fuel monitor providing engine parameter and fuel consumption indication for both internal and external supplies. The IFEI is located between the Jettison Station Select panel and HSD in look-down "2" mode. The IFEI provides the following monitoring parameters:

| <u>ACRONYM</u> | <u>DESCRIPTION</u> |
|----------------|---|
| N2 RPM | Compressor Rotor Speed (percent) |
| EGT | Low Pressure Turbine Discharge (degrees centigrade) |
| NOS POS | Exhaust Nozzle Area (percent) |
| FF | Main Engine Fuel Flow (PPH) |
| OIL PRESS | Oil pressure (PSI differential). |

In addition to engine performance monitoring, the IFEI provides the following fuel status indication and time of flight calculation:

| | |
|----------|--|
| TOT FUEL | Combined int. and ext. fuel supply (pounds) |
| INT FUEL | Total internal fuel supply (pounds) |
| BINGO | Preset low-fuel return quantity (pounds) |
| TIME | Flight time remaining given current rate of consumption. |

DDI Engine Display (ENG): The ENG format is available on the left DDI with "E". Initialized and displayed at startup, this format serves as a backup for the IFEI and displays all engine (excluding fuel) parameters supplied by the IFEI including additional fields for:

| <u>ACRONYM</u> | <u>DESCRIPTION</u> |
|----------------|--|
| INLET TEMP | External Temperature (degrees centigrade) |
| N1 RPM | Fan Rotor Speed (percent) |
| THRUST | Thrust (percent) |
| VIB | Vibration (inches per second) |
| FUEL TEMP | Fuel Inlet Temperature (degrees centigrade) |
| EPR | Engine Pressure Ratio (N/A) |
| CDP | Compressor Discharge Pressure (PSI absolute) |
| TDP | Turbine Discharge Pressure (PSI absolute) |

Aerodynamic Augmentation Systems

Flaps: When extended with "F", flaps provide additional lift. This is advantageous when attempting to land at low speed or high AOA conditions, or to increase lift for high-payload takeoffs. Extended flaps also increase the amount of drag on an aircraft which is helpful for lowering airspeed, but can also be detrimental in a knife-fight, where energy conservation and conversion is critical. The flaps indicator is located in look-down mode "2" below the Jettison Station Select panel.

Speed Brake: The Speed Brake is used to retard airspeed during flight by producing additional form drag. The speed brake is extended by pressing and holding "SPACE BAR". If a weight-on-wheels condition exists, the MC disengages the speed brake in favor of the wheel brake (see below).

Launch, Recovery and Safety Systems

Main Landing Gear (MLG): The landing gear are essential for all normal landings. The gear are lowered and raised by pressing "G" on the keyboard. The Gear Indicator Lamps, located just below the Jettison Station Select Panel in look-down "2" mode, illuminate when all three gear are down and locked. If a positive gear indication has not appeared several seconds after lowering the gear, the gear or hydraulic system may have sustained damage preventing a positive lock.

Wheel brakes, applied with "SPACE BAR" are used to slow the aircraft with weight-on-wheels either while taxiing or just after touchdown. If the airplane is on the ground with no forward velocity, the brake locks in "park" mode. Press "SPACE BAR" again to release the brake. Wheel brake status is indicated by the BRK (S BRK in certain screen sizes) lamp on the left status panel. Note: this lamp is shared by the speed brake.

Arrestor Hook: The arresting hook, extended and retracted with "H" is used only for carrier landings. It is located between the engine ducts and is used to catch, or "trap" one of four arrestor cables, or "wires", stretched perpendicular to the angled flight deck near the aft end of the boat. An aircraft cannot be able to stop in time to avoid ditching if an arrestor cable is not trapped. A missed trap is known as a "bolter". Standard procedure during a carrier trap is to apply full throttle immediately prior to touchdown in the event of a bolter. The HOOK indicator lamp is located on the left status panel.

Launch Bar: The Launch Bar is automatically extended for hookup to the catapult shuttle mechanism by applying the wheel brake "SPACE BAR" until the aircraft comes to a complete stop while positioned over a catapult. The L BAR indicator lamp is located on the right status panel. If after coming to a complete stop over a catapult the L BAR lamp does not illuminate, the aircraft is either not positioned over the catapult or the launch bar has sustained damage.

Navy Aircrew Common Ejection Seat (NACES): When a safe landing is not possible, ejection is the only practical way out of the aircraft. Ejection is completely automatic once the procedure is initiated. The F/A-18 features a "zero-zero" ejection system, meaning it is possible to eject at zero altitude and safely recover. The ejection mechanism is activated with "SHIFT E".

ELECTRONIC WARFARE EQUIPMENT SET

Electronic warfare equipment includes the ALR-67 Radar Warning Receiver (RWR), the ALQ-126A Countermeasures Set and the ALE-39 Countermeasure Dispensing Set. The ALR-67 detects and classifies hostile radar emissions while providing Threat Warning Indication (TWI) via audible and visual cues. The ALQ-126 detects and deceives enemy fire control and guidance radar. The ALE-39 dispenses expandable chaff and flare payloads for protection against enemy radar-guided and infrared-guided missiles.

ALR-67 Electronic Radar Warning Receiver (RWR)

The ALR-67 Radar Warning Receiver (RWR): Always active, the RWR provides passive, top-down, 360 degree visibility of potential radar illumination threats. The RWR Azimuth Display is located in the Standby Instruments Group. In addition, RWR symbology is provided in the HUD for complete RWR look-up capability. The RWR displays only enemy threats. It should be noted that the RWR cannot measure range to emissions (azimuth only), and relies on signal strength and waveform to determine threat priority and type.

RWR Azimuth Display: Located immediately to the right of the Attitude Reference Indicator (artificial horizon) in the Standby Instruments Group, this display provides source classification as well as relative azimuth and signal strength. Symbols representing the class of emissions are positioned within three circular threat priority bands, corresponding to varying source signal strength, and waveform characteristics. Threat band priorities are as follows:

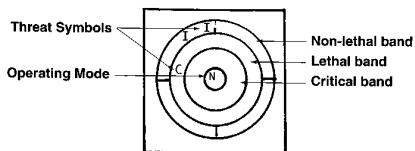


Figure 9 - RWR Azimuth Display

| <u>BAND</u> | <u>PRIORITY</u> | <u>DESCRIPTION</u> |
|-------------|-----------------|---|
| Outer | Non-lethal | Emissions with insufficient signal strength or waveform characteristics to provide effective targeting. |
| Middle | Lethal | Emissions strong enough to suggest potential launch capability. |
| Inner | Critical | Emissions indicating that a missile ready (MR) or missile launch (ML) conditions exist. |

Azimuth Display symbology is as follows:

| <u>SYMBOL</u> | <u>DESCRIPTION</u> |
|---------------|---|
| I | Emissions indicative of Airborne Interceptor (aircraft). |
| S | Emissions indicative of SAM search and track radar. |
| A | Emissions indicative of AAA acquisition and fire control radar. |
| C | Generic Continuous wave radar emissions. |

RWR HUD Repeater: The RWR provides HUD display of RWR data via Threat Vector symbology rotating about an imaginary eight degree diameter circle, centered at the HUD optical center. Vectors are projected from a top-down perspective corresponding to the format of the RWR Azimuth Display. Vectors are displayed in three lengths, which correspond to Non-lethal, Lethal and Critical threats respectively. At the outer end of each Threat Vector is a single alphanumeric character corresponding to that of the RWR Azimuth Display symbology.

RWR Audio/Visual Warning: The RWR also provides right status panel indication of threat type, as well as audio tones to cue the pilot.

AN/ALE-39 Countermeasures Dispensing Set

The AN/ALE-39 Countermeasures Dispensing Set provides infrared flare and chaff bundle dispensing to degrade the threat's infrared and radar capability. Counters are provided in the upper DDI Stores Management Display "S" for both chaff and flare.

Flares, dispensed with "", provide infrared deception by dispersing high-temperature phosphors over an approximately a two meter radius area and burning for several seconds. Infrared-guided missiles as well as infrared tracking devices can be spoofed momentarily, providing the pilot with an opportunity to maneuver out of the weapon's lethal envelope.

Chaff Bundles, dispensed with ";" consist of many light-weight, highly radar-reflective, planar metallic strips. The bundles expand after they are ejected and spin as they slowly fall to earth. Because of the fairly small dispersion pattern created, chaff bundles are generally immune to radar clutter filtration. The chaff 'cloud' which forms resembles a single, fairly massive object (such as an airplane) to most radar. Chaff can be used to momentarily spoof radar guided missiles as well as tracking radar, providing the pilot with an opportunity to escape a lethal envelope.

RT-1079A/ALQ-126A ECM Receiver/Transmitter

The ALQ-126A Countermeasures Set detects and deceives enemy fire control and guidance radar. ECM Active Jamming is toggled with "C" ("Countermeasures"). Active jamming indication is provided by the XMIT lamp on the left status panel. While ECM provides effective jamming in SEAD roles where SAM/AAA suppression is high-priority, it is not recommended for those roles which require low-profile air-interdiction or ground attack.

COMMUNICATION AND IDENTIFICATION

Radio, TACAN, ILS, and IFF interface with the Up Front Control via the Communication Systems Control (CSC).

ARC-182 Radios

The ARC-182 radios transmit and receive audio signals through a frequency band of 30MHz to 399.975MHz, using AM and FM modulation. The radios can be used to communicate with various air and ground-based simulation entities such as wingmen, control towers, etc., in both command and advisory roles.

Advisory Communication: Several commands are provided for communicating with simulation entities. Ranging from carrier final approach instruction from the Landing Signal Officer (LSO), to takeoff and landing permissions from the local control tower, these commands are strictly advisory. Visual acknowledgment for sent/received transmission is provided within the UFC COM1/COM2 fields respectively.

| <u>KEY</u> | <u>ENTITY</u> | <u>DESCRIPTION</u> |
|------------|----------------|-----------------------------------|
| "SHIFT G" | Ground Control | Taxi instructions to/from runway. |
| "SHIFT T" | Tower | Takeoff/landing permissions. |
| "SHIFT O" | Flight Ops. | Current mission status. |
| "SHIFT C" | Approach Ctrl. | Vectoring to selected TACAN. |
| "SHIFT L" | LSO | Carrier final approach vectoring. |

Wingman Verbal Communications: Wingmen report tactical activities, comment on given situations, and acknowledge commands. The wingman first identifies himself with a callsign, followed by:

| | |
|-----------------|---|
| "Contact <xxx>" | Radar contact with bandit, <wingman's bearing>. |
| "Tally ho!" | Visual contact with bogie/bandit. |
| "Fox three!" | Wingman has launched an AIM-120 missile. |

| | |
|-----------------------------|--|
| "Fox two!" | Wingman has launched an AIM-9 missile. |
| "Hornet two's joker" | Wingman's fuel is low. |
| "Hornet two's bingo" | Wingman is bingo fuel and breaking off. |
| "Spike" | Wingman is locked-up in track radar. |
| "Two's Winchester missiles" | Wingman has depleted missiles and going to guns. |
| "Two's Winchester" | Wingman has depleted all weapons and breaking off. |
| "Two's punching out" | Wingman is preparing to eject. |
| "Atoll! Atoll!" | Wingman detects a short range missile launch. |
| "Archer! Archer!" | Wingman detects a medium range missile launch. |

Wingman Commands: Wingman commands allow the pilot to coordinate in-flight tactics for a variety of roles. Commands are issued directly from the function keys. Wingman command keys are organized into three groups: Engagement, Attack Formation, and Standard Formation as follows:

| <u>KEY</u> | <u>COMMAND</u> | <u>DESCRIPTION</u> |
|------------|----------------|--------------------------------------|
| "F1" | Assist | Clear six o'clock. |
| "F2" | Engage | Engage selected radar target. |
| "F3" | Resume | Resume mission objectives. |
| "F4" | Go Home | Return to base. |
| "F5" | Bracket Left | Form up co-altitude at 9:00. |
| "F6" | Bracket Right | Form up co-altitude at 3:00. |
| "F7" | Split High | Form up staggered altitude at 9:00. |
| "F8" | Split Low | Form up staggered altitude at 3:00. |
| "F9" | Echelon | Form up co-altitude at 4:00. |
| "F10" | Trail | Form up single-file, co-alt at 6:00. |
| "F11" | Combat Spread | Form up staggered altitude at 9:00. |
| "F12" | Lead | Form up co-altitude at 12:00. |

Wingman commands are issued to the primary wingman, "Hornet Two". Some missions include a second wingman, "Hornet Three". Use "SHIFT" in conjunction with the appropriate command to direct the second wingman.

Commanding a wingman to his present formation tells him to alternately tighten or loosen his distance. For example: After Hornet Two is commanded to Echelon, a second Echelon command tightens formation. Subsequent Echelon commands alternately loosen and then tighten the formation.

Tactical Air Navigation (TACAN)

Tactical Air Navigation (TACAN) channels are displayed in the UFC and cycled with "T". TACAN is an omni-directional military transceiver system providing coded distance and bearing data to and from fixed surface stations. Although TACAN function is technically an Independent System, operating instructions are more appropriately covered in the Navigation Systems section. A TACAN is located at each base. Use A/P CPL to fly to the current TACAN.

Identification Friend or Foe (IFF)

Identification Friend or Foe (IFF) is a coded transponder system designed for the identification of friendly aircraft and ground units. IFF Identification is performed for the currently tracked radar target by pressing "I". If a tone is played, the target aircraft has responded to the IFF code, and is therefore considered friendly. No tone implies the target is an enemy.

NAVIGATION MASTER MODE

The Navigation (NAV) system is entered automatically when the aircraft is either powered up, or the landing gear are lowered. The Navigation system may also be entered at any time by depressing the NAV master mode key "N". The most obvious difference between the NAV system and A/A and A/G systems is the HUD symbology. In the NAV master mode the symbology is navigation oriented, while in A/A and A/G modes, symbology is attack oriented.

The Horizontal Situation Display (HSD) is the primary source of navigation related information in all systems.

AVIONIC CONTROLS AND DISPLAYSNAV System HUD Symbology

In Navigation (NAV) system the HUD symbology is primarily tailored to takeoff, navigation, and landing scenarios. HUD symbology includes basic flight data, steering, landing, and advisory data.

NAV HUD Basic Flight Data: With the exception of the Angle of Attack (AOA) Bracket, Bank Angle Scale, Vertical Velocity readout, Horizon Bar and Waterline Symbol, basic HUD data is common to all systems. The Angle of Attack Bracket, Horizon Bar and Waterline Symbol are only displayed when the landing gear are down.

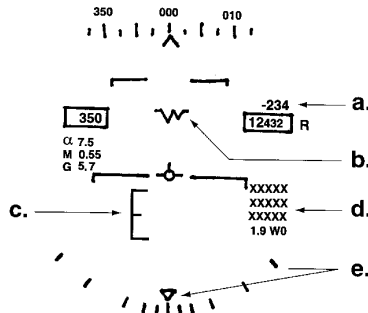


Figure 10 - Navigation (NAV) Master Mode HUD Data

| <u>REF</u> | <u>DISPLAY</u> | <u>DESCRIPTION</u> |
|------------|-------------------|---|
| a. | Vertical Velocity | Vertical velocity in feet per minute. This field provides vertical descent or ascent rate in feet per minute and is displayed only in NAV system. |
| b. | Waterline Symbol | Provides pitch attitude reference with gear down. The waterline symbol is provided when the gear are down and provides pitch attitude reference. Parallel with the tops of the altitude and airspeed boxes, these can be used for waterline reference when the waterline symbol is not displayed. |
| c. | AOA Bracket | Represents optimum approach AOA. The AOA bracket is displayed when the gear are down and is referenced to the velocity vector. It is the primary reference for optimum approach AOA during landing. The bracket center represents the optimal approach angle of attack. The bracket moves lower with respect to the velocity vector as AOA increases and moves higher as AOA decreases. |
| e. | Bank Angle Scale | Provides roll attitude reference at base of HUD. The bank angle scale is divided into 5 degrees, 15 degrees, 30 degrees, and 45 degrees tic marks, referenced by a swinging pointer. |
| d. | Advisory fields | Condition dependent data. |

Backup Angle of Attack Indexer

The Backup AOA Indexer is mounted on the left HUD upright. It provides three lamps: A green chevron pointing down, a yellow doughnut, and a red chevron pointing up. These lamps provide the pilot with identical information concerning angle of attack to that of the AOA bracket. AOA and landing are discussed in the ILS section.

| <u>LAMP(S)</u> | <u>INDICATION</u> | <u>ACTION</u> |
|-----------------|-------------------|----------------|
| Top (Green) | AOA too high | Decrease speed |
| Top/Center | AOA slightly high | Decrease speed |
| Center (Yellow) | AOA is "on speed" | |

| | | |
|---------------|---------------------|----------------|
| Bottom/Center | AOA is slightly low | Increase speed |
| Bottom (Red) | AOA is too low | Increase speed |

Horizontal Situation Display (HSD)

The Horizontal Situation Display (HSD) is located in the center of the cockpit in look-down "2" mode, and provides navigation data and color moving-map capability. When in NAV mode ("N") the HSD provides a monochromatic display of basic aircraft navigation geometry based on the current steering mode. The display is a plan view (top-down) of the navigation situation with an aircraft reference symbol located at the center of a compass rose. The compass rose and all bearing information is magnetic. If in HSD NAV mode, the compass rose rotates around the aircraft reference symbol to indicate heading. The aircraft reference symbol turns to reflect vertical axis rotation.

As waypoints or TACANs are cycled with "W" or "T", the HSD symbology and HUD heading tape course deviation marker are updated. HSD symbology and data fields are as follows:

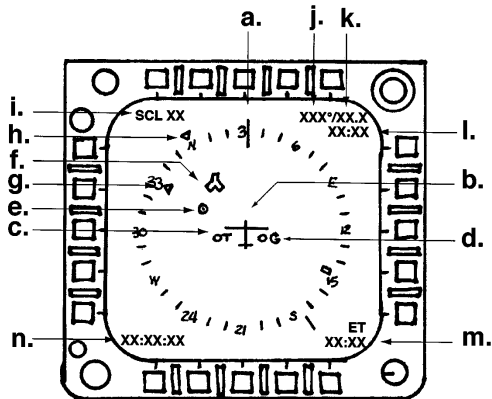


Figure 11 - Horizontal Situation Display

| <u>REF</u> | <u>SYMBOL/DATA</u> | <u>DESCRIPTION</u> |
|------------|--------------------|--|
| a. | Compass rose | Circular heading scale. |
| b. | Aircraft | Aircraft reference symbol. |
| c. | T | True airspeed. |
| d. | G | Ground speed. |
| e. | Waypoint | Graphic plot of selected waypoint. |
| f. | TACAN | Graphic plot of selected TACAN. |
| g. | WPT Bearing | Waypoint bearing pointer. |
| h. | TCN Bearing | TACAN bearing pointer. |
| i. | Scale | Current HSD (NAV or MAP) scale. |
| j. | WPT Bearing | Bearing in degrees to selected waypoint. |
| k. | WPT Range | Range to current waypoint (NM). |
| l. | WPT ETA | Estimated time of arrival to waypoint. |
| m. | ET | Elapsed mission time. |
| n. | ZULU Time-of-day | Local time. |

HSD Color Moving-Map Display: Navigation information can be overlaid on a color moving-map display by depressing "M". Moving map orientation is always north-up. Therefore, when in MAP mode, the aircraft reference symbol rotates to indicate heading and the compass rose remains north-up.

HSD scaling: The HSD scale can be modified in either NAV or MAP mode by successive depressions of "N" or "M" respectively. Scales are 10, 20, 40, 80, or 160 NM, as measured from the reference aircraft to the outside edge of the compass rose.

Pilot Relief System (Autopilot)

Although Autopilot (A/P) systems are technically system independent, the navigational nature of the system provides for some latitude. Therefore, all autopilot functions are covered here.

The A/P system provides six modes of operation to relieve pilot workload throughout the operational envelope. The A/P system is capable of controlling aircraft attitude, heading, and altitude via the FCS. A/P may also be coupled to external data link sources of Automatic Carrier Landing System (ACLS) and Instrument Landing System (ILS).

Basic Autopilot

Basic A/P functions in one of two modes depending on the roll attitude at time of engagement. Basic A/P maintains the aircraft pitch attitude which existed at time of engagement. If roll attitude is less than or equal to +/-5 degrees at engagement, then magnetic heading at time of engagement is maintained. If roll attitude at time of engagement is greater than +/-5 degrees, then roll attitude is maintained.

A/P is enabled with "A". When A/P is activated, the Basic Autopilot mode is enabled by default. The UFC then displays an "ON" indication. In addition, a list of optional A/P modes is provided in the UFC option fields.

Optional Autopilot Modes

Optional autopilot modes are designed to provide pilot relief in a variety of modes tailored to various operational and terrain factors.

| <u>ACRONYM</u> | <u>DESCRIPTION</u> |
|----------------|--|
| ATTH | When engaged, ATTH maintains aircraft pitch and roll attitude. |
| HSEL | Captures the current barometric altitude and steers to the current waypoint. |
| BALT | Captures barometric altitude at time of engagement and levels the wings. |
| RALT | Captures radar altitude at time of engagement and levels the wings. |
| CPL | Data link coupling is a unique A/P mode designed to couple with Automatic Carrier Landing Systems (ACLS) and Instrument Landing Systems (ILS), providing automatic pitch/roll for landing in any weather conditions or sea states. The data link source must be within 10 NM for the system to function. |

To select an alternate A/P mode:

- 1) Press "SHIFT A" to cycle A/P options. A Colon(:) appears by the choice.
- 2) Press "A" to engage the new A/P selection.

To operate the A/P CPL option and perform an auto-land:

- 1) Activate ILS navigation with "L".
- 2) Enter the final approach leg of a base or carrier, no more than 10 NM downwind.

- 3) Press "SHIFT A" until the colon (:) is cycled to the CPL option field.
- 4) Press "A" to engage CPL option.
- 5) Control throttle to maintain AOA until touchdown.

NAVIGATIONAL STEERING

Various sources of steering information for HUD, HSD, and A/P functions can be selected. These include the Instrument Landing System (ILS), Data Link (D/L), Waypoint (WYPT), and TACAN (TCN).

Waypoint Steering (WPT)

Waypoint steering is enabled with "W". Subsequent depressions of "W" cycles available waypoints. TCN and WPT steering are mutually exclusive and selecting one source automatically deselects the other. WPT steering provides navigation to and from waypoints pre-programmed into the INS. Waypoints are programmed into the INS by ground crew prior to flight and cannot be altered in flight. The number and locations of waypoints vary on an individual mission basis, however waypoint 0(zero) is always downwind of the originating base, aligned with the ILS. Navigating to waypoint zero puts the aircraft in the ILS localizer, where the pilot can then maneuver to intercept the glideslope.

Waypoint HUD symbology: If WPT steering is enabled, the HUD provides "WPT" cue in a data slot to the right side of the HUD, preceded by the distance in nautical miles to the currently selected waypoint. The format is: XXX.X WPT. Additionally, the command heading symbol points to the currently selected waypoint. Turning the aircraft until the command heading symbol is aligned with the heading caret, indicates a direct course to the waypoint.

Waypoint UFC Symbology: Waypoints are not radio navigation aids, but rather pre-programmed into the INS. Data is therefore not processed through the UFC.

Waypoint HSD Symbology: Waypoint steering via the HSD involves the Waypoint Symbol, the Waypoint Bearing Pointer, and a variety of data fields. Waypoint data is displayed on the UFC regardless of the current steering mode. After selecting a waypoint, the HSD symbology is updated by aligning the waypoint symbol with the corresponding geographic location of the waypoint. Additionally the waypoint bearing pointer is aligned relative to the aircraft reference symbol, pointing toward the current waypoint. Aligning the nose of the aircraft symbol with the waypoint bearing pointer provides a direct great circle course to the current waypoint.

HSD waypoint data fields provide navigational information based on the currently selected waypoint.

TACAN Steering (TCN)

TACAN Steering is enabled with "T". Subsequent depressions of "T" cycle available TACAN stations (airbases). TACAN steering is provided for navigating to and from airbases, independent of waypoint selections. TCN and WPT steering are mutually exclusive and selecting one source automatically deselected the other.

TACAN HUD symbology: If TCN steering is enabled, the HUD provides the Morse code station identifier cue (three letters) on right side of the HUD. The code is preceded by the DME slant range in nautical miles to the indicated TACAN. Additionally, the command heading symbol points to the current TACAN. Turning the aircraft until the command heading symbol is aligned with the heading caret indicates a direct course to the TACAN.

TACAN UFC Symbology: The TACAN is a radio navigation aid and therefore controls are routed to the UFC. Upon selecting TCN steering, the UFC displays "ON", followed by the current TACAN channel.

TACAN HSD Symbology: TACAN HSD steering is similar to that of waypoint steering with the exception of symbology.

Instrument Landing System Steering (ILS)

ILS can work independently as a steering reference, or in conjunction with the autopilot to provide semi-automatic (no throttle control) landing functions at both carrier and land-based ILS equipped facilities. The ILS is activated by "L", which initializes the ILS Steering Display on the HUD.

ILS HUD Symbology: Upon selection of ILS steering, two needles are displayed on the HUD, referenced to the velocity vector. If a valid ILS signal is received (the aircraft is within a microwave localizer), the ILS needles deflect to show localizer elevation and azimuth. To intercept ILS azimuth (left/right deviation), the velocity vector is flow toward the azimuth (vertical) needle. To intercept glideslope, the velocity vector is flow toward the elevation (horizontal) needle. If the elevation and azimuth needles are centered on the velocity vector, the aircraft is lined-up and on glideslope. At this point the pilot needs only to place the velocity vector on the touchdown aim point and adjust AOA.

Automatic Landing System: Autopilot/ILS interlock provides semi-automatic (lateral and longitudinal axis) landing control of the FCS for both carrier and land-based facilities with SPN-42 data link equipment. Auto-land requires that the aircraft have a valid SPN-42 up-link signal and be within an ILS localizer.

Upon activating ILS with "L", one of the following mutually exclusive advisory HUD displays provides cueing as to the linkage status:

THE AIRCRAFT IS:

Not Receiving valid ILS
Receiving carrier ILS
Receiving land-based ILS
FCS coupled with ILS

DISPLAY

"TILT" is displayed in HUD
"ACL RDY" is displayed in HUD
"CPL P/R" is displayed in HUD
"CPL HDG" is displayed in HUD

If the aircraft is receiving a valid data link in ILS mode ("ACL RDY" or "CPL HDG") and the A/P is engaged in CPL mode, the HUD display changes to "CPL P/R" indicating that lateral (pitch) and longitudinal (roll) FCS linkage has occurred, and the aircraft is now under the control of ground/carrier-based data link commands. To remove data link coupling, the A/P and/or ILS must be disengaged with "L". Disengaging the ILS and leaving the A/P in CPL mode, causes the A/P to revert to TACAN command heading with "CPL HDG" displayed in the HUD.

AIR-TO-GROUND MASTER MODE

Air-to-Ground (A/G) mode includes visual attack capability for delivering conventional and laser-guided bombs, nuclear bombs and for firing the M61 cannon. Also provided are sensor-aided attack capabilities for using the AGM-88 High-speed Anti-Radiation Missile (HARM) and the AGM-65 Maverick, and for using the Forward-Looking Infrared (FLIR).

AIR-TO-GROUND RADAR MODES

The radar set supports four A/G sub-modes, which assist during ground attack. Two of the sub-modes (GMT and SEA) provide only synthetic (computer generated) target imaging, while the other two (MAP and EXP1) provide an image of the ground ahead.

All radar A/G sub-modes are displayed on the right DDI. A/G radar master mode is enabled with "R" Additional discussion of the Radar Set appears in the Air-to-Air Master Mode section.

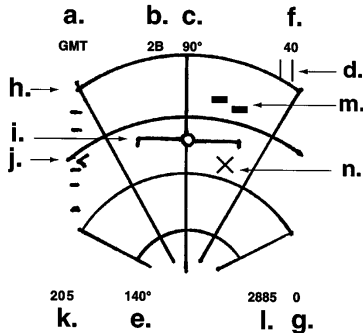


Figure 12 - Typical A/G Radar Display

REF DISPLAY

a. Sub-mode indication

DESCRIPTION

Radar sub-mode: GMT, SEA, MAP, EXP1.
Sub modes are cycled using "Q".

- | | |
|-----------------------------|---|
| b. Scan elevation | Height of the antenna scan volume in scan bars (1B, 2B, 4B, 6B - 1Bar equals 2.5 degrees). Only displayed in GMT and SEA modes. Note that the A/G radar scan is centered 10 degrees below the horizon. |
| c. Heading. | Aircraft magnetic heading. |
| d. TDC | Target acquisition cursor. Use "SHIFT ARROW" to move the TDC from the stowed position onto the display. Designate the target under the TDC with "\". Note: with the TDC in its stowed position, "\" designates then cycles targets. |
| e. Scan azimuth | Width of the radar scan volume in degrees right and left of the aircraft center. Only displayed in GMT and SEA modes. |
| f. Maximum displayed range. | Range is cycled down with "TAB" and cycled up with "SHIFT TAB". As with A/A radar modes, range only affects the display, not the distance at which the radar can detect targets. |
| g. Minimum displayed range. | |
| h. Azimuth/range grid. | Displays radials at +/-30 degrees and +/-60 degrees, and arcs at quarter-range intervals. |
| i. Velocity vector | Displayed at a fixed position, and used in conjunction with the horizon line to indicate aircraft vertical flight path and roll attitude. |
| j. Antenna elevation caret | Indicates the antenna elevation, relative to the local horizon. The scale covers +/-60 degrees. |
| k. Calibrated Air Speed. | |
| l. Barometric Altitude | Indicated in feet above mean sea level (MSL). |

Air-to-Ground Radar Sub-modes

- GMT: Ground-Moving Target detects small moving vehicles, such as trucks or mobile AAA units. Synthetic targets are shown as small rectangles. Targets may be designated using the TDC or "\". The designated target is displayed with a heading vector, and with digital heading degrees to its right to the target and velocity in 10's of knots to its left.
- SEA: Sea Surface Search filters radar returns from waves and land, so that only ships are displayed. SEA targets are displayed and designated identically to GMT targets.
- MAP: Ground Map Mode provides an image of the terrain ahead of the aircraft from the nose of the aircraft out to the selected range. MAP mode supports target point designation using the TDC. Use "SHIFT ARROWS" to move the TDC over display. Press "\" to designate the point. A stabilized cue "X" indicates the designated target point.
- EXPl: Expand Mode is identical to MAP mode, except that the Minimum Displayed Range is always one-half the selected range.

AIR-TO-GROUND WEAPONS MODES

Air-to-Ground weapons are delivered from one of three modes, depending on the weapon type. These include conventional, laser-guided, and nuclear bombs, as well as A/G GUN.

| <u>KEY</u> | <u>DESCRIPTION</u> |
|------------|--|
| "J" | Cycle conventional A/G weapons. |
| "O" | Engage electro-optical modes for delivery of the AGM-65 Maverick or the AGM-62 Walleye, or to engage the FLIR. |
| "U" | Engage HARM mode for delivery of the AGM-88 missile. |

Conventional A/G attack modes

GUN mode is indicated when GUN is selected in the stores display. Use this mode to attack small, soft targets.

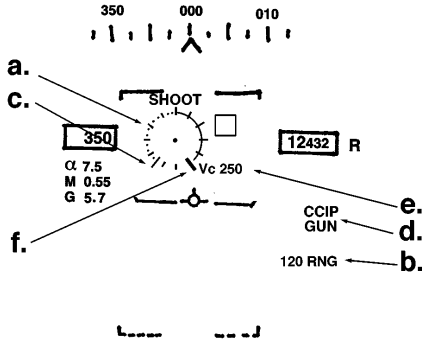


Figure 13 - CCIP GUN HUD Format

REF DESCRIPTION

- a. A/G GUN reticle is displayed at the visual intersection of the bullet stream with the ground. Each tic on the reticle indicates 1000 feet, with 12 o'clock representing zero range.
- b. The range cue indicates where fired rounds impact the ground.
- c. Maximum cannon range.
- d. "CCIP" and "GUN" indicate this mode.
- e. Closing velocity.
- f. The range bar moves clockwise with increasing range.

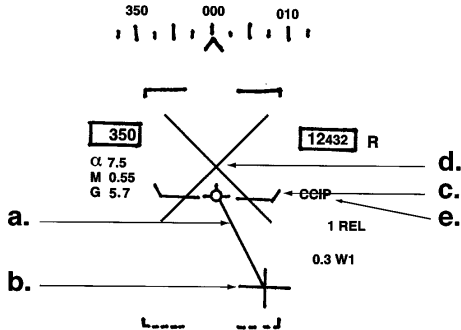


Figure 14 - CCIP Bomb Mode

Conventional and Nuclear Weapons Delivery

Iron bombs (Mk-82, Mk-83, and Mk-84), laser-guided bombs (Mk-83LGB, and Mk-84LGB) and nuclear bombs (N-57) are delivered using either Continuously-Computed Impact Point (CCIP) or Auto-release (AUTO) mode. Laser-guided bombs are set to deliver using AUTO mode, while unguided bombs default to CCIP mode. The mode may be toggled with "SHIFT]".

| <u>REF</u> | <u>ITEM</u> | <u>DESCRIPTION</u> |
|------------|----------------|--|
| a. | Fall line | Extends from the velocity vector to the impact point (cross). |
| b. | Impact cross | Indicates the point on the ground where a bomb would impact if instantly released. |
| c. | Pull-up Cue | Indexed to the velocity vector, graphically shows aircraft altitude above the ground. |
| d. | Break-away "X" | Flashed on the HUD when a 4-G pull up is required to prevent crashing into the ground. |
| e. | CCIP | Indicates the current delivery mode. |

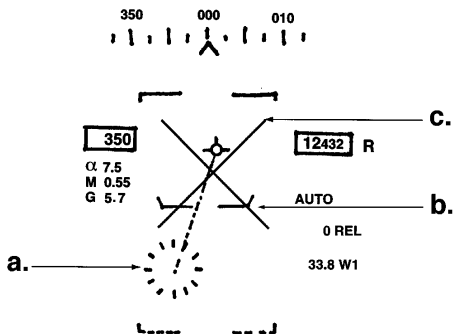


Figure 15 - AUTO Mode (Before Designation)

To deliver using CCIP, select the desired weapon with "]". If required, toggle to CCIP mode with "SHIFT]". Enter a shallow dive over the desired target until the impact cross is visible on the HUD. Fly over the target. When the cross is directly over the target, release the bomb with "ENTER" or "TRIGGER". Pull up to avoid the ground.

| <u>REF</u> | <u>DESCRIPTION</u> |
|------------|--------------------|
|------------|--------------------|

- | | |
|----|---|
| a. | The A/G reticle is used to designate a target point on the ground. The reticle is positioned 7.5 degrees below the horizon when the aircraft dive angle is less than 7.5 degrees. If the dive angle is more than 7.5 degrees, the reticle is pinned to the velocity vector. |
| b. | The Pull-up Cue, indexed to the velocity vector, graphically represents aircraft altitude above the ground. |
| c. | The Break-away "X" is flashed when a 4-G pull up is required to prevent crashing into the ground. |

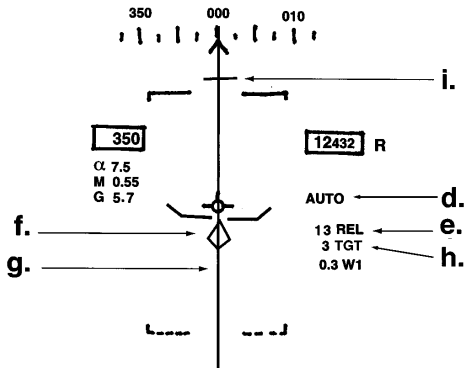


Figure 16 - AUTO Mode (After Designation)

- d. "AUTO" indicates the current delivery mode.
- e. Time-to-Go (TTG) indicates the time in seconds until the weapon is automatically released, displayed as "xx REL".
- f. After designation, a diamond appears over the target point.
- g. After designation, the Azimuth steering line (ASL) indicates the relative heading to the target point. A range cue graphically represents the distance to release when compared to the velocity vector.
- h. After designation, the range to target to the nearest 1/10th nautical mile appears as "x.x TGT".
- i. Release cue, moves down toward the velocity vector. When it reaches the velocity vector, the bomb releases.

To deliver using Auto-Release mode, select the desired weapon with "]"". If required, toggle to AUTO mode with "SHIFT]". Maneuver to position the designation reticle over the desired target and designate with "ENTER". Fly level using the ASL to pass directly over the target point. When the range cue reaches the velocity vector (and the TTG seconds reach zero), the weapon automatically releases. To un-designate a target point and try again, use "SHIFT \".

Electro-Optical Delivery Modes

Electro-optical (EO) mode allows use of Forward-looking Infrared (FLIR), the AGM-65 Maverick (MAV), or AGM-62 Walleye (WE) A/G weapons. EO devices are cycled with "O" and must be loaded before flight. "NO SRC" (no source) is displayed when there are no EO devices onboard. EO devices can track both static and moving targets, and is ideal for attacking soft and armored ground vehicles. EO mode display appears in the left DDI.

| <u>EO MODE</u> | <u>DESCRIPTION</u> |
|----------------|--|
| FLIR | Provides night vision capability and may be used to designate a target point for AUTO mode conventional weapons. The FLIR may also be used to designate a target vehicle or building which is then "handed off" to a Maverick. The FLIR is not releasable and contains no warhead. |
| MAV | AGM-65 Maverick is a rocket powered, self-guided missile. The target is optically designated using the FLIR or the AGM-65's own camera. |
| WE | AGM-62 is an un-powered, optically guided glide bomb with a large warhead. |



Forward-Looking Infrared (FLIR)

All three EO cameras may be optically zoomed using "CONTROL +" and "CONTROL -". Both the FLIR and MAV modes allow slewing the camera with "CONTROL ARROW". The WE always points three degrees below the waterline.

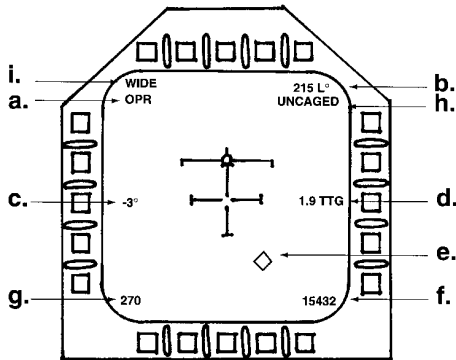


Figure 17 - FLIR EO Display

REF DESCRIPTION

- a. Indicates FLIR mode.
- b. Camera gimbal azimuth is the angle right (R) or left (L) at which the camera is pointing.
- c. Camera gimbal elevation Indicates the angle below aircraft waterline.
- d. Time to go (TTG) appears when a target is designated.
- e. Tracking symbol indicates that the FLIR is locked on to a vehicle or building. The camera continues to track until repositioned using "CONTROL ARROW".
- f. Barometric altitude.
- g. Indicated airspeed.
- h. "CAGED" indicates the device is NOT tracking, "UNCAGED" indicates the device is tracking.
- i. "WIDE" means zoom is out.

To use the FLIR, select it with "O". A small circle appears in the HUD, showing the camera slew position. If a radar A/G target is currently designated, the FLIR slaves to and tracks the radar target. Zoom in using "CONTROL +". Reposition the camera using "SHIFT ARROWS" and designate a target with "ENTER". If the camera is pointing at a vehicle or small building, the FLIR begins tracking it. If no vehicle or building is in the camera line-of-sight, then a ground target point is designated and tracked. At any time, designating an A/G radar target slaves the FLIR and the FLIR begins tracking the radar target. Undesignate the FLIR target with "SHIFT \\" or "CONTROL ARROWS". After designation, "CONTROL \\" cycles the target designation to nearby vehicles or buildings. The designated target appears as a small diamond in the HUD.

AGM-65 Maverick (MAV)

The AGM-65 Maverick is delivered using the MAV mode. Cycle to MAV using "O". Prior to flight, AGM-65s are loaded onto the wing pylons.

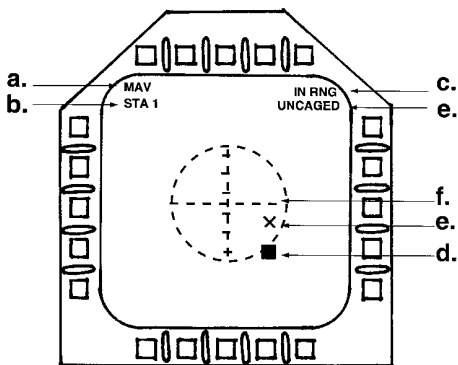


Figure 18 - Maverick (MAV) EO Display

REF DESCRIPTION

- a. Indicates MAV mode also repeated in the HUD.
- b. Indicates the selected station.
- c. "IN RNG" cue flashes when launch criteria are met. Press "ENTER" to release the weapon.

- d. Tracking symbol appears when the FLIR is locked on to a vehicle or building. The camera continues to track until it is repositioned using "CONTROL ARROWS"
- e. Gimbal position "X" Shows the camera angle.
- f. Circle represents a 5 degree radius around missile boresight. The target must be in-range and the gimbal "x" must be inside this circle to meet launch conditions.

To deliver a Maverick, cycle to the MAV display with "O". If a radar A/G target is currently designated, the camera slaves to and tracks the radar target. Zoom in using "CONTROL +". Reposition the camera using "SHIFT ARROWS" and then designate a target with "ENTER". If the camera is pointing at a vehicle or small building, the camera begins tracking it. Designating an A/G radar target slaves the FLIR, and the FLIR begins tracking the radar target. Undesignate the FLIR target with "SHIFT \\" or "SHIFT ARROWS". After designation, "CONTROL \\" cycles target track to nearby vehicles or buildings. The designated target appears as a small diamond in the HUD. Target lock is broken if gimbal limits are exceeded, or if the camera is manually repositioned.

AGM-62 Walleye (WE)

The AGM-62 Walleye is delivered using the WE mode. Cycle to WE using "O". Prior to flight, AGM-62s are loaded onto the wing pylons

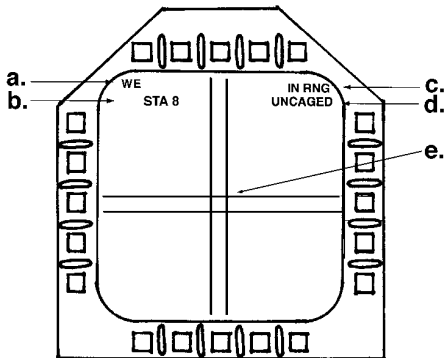


Figure 19 - Walleye (WE) EO Display

REF DESCRIPTION

- a. Indicates WE mode, also repeated in the HUD.
- b. Indicates the selected station.
- c. "IN RNG" cue is flashed when launch criteria are met. Press "ENTER" to release the weapon.
- d. "CAGED" indicates the device is NOT tracking, "UNCAGED" indicates the device is tracking.
- e. Target gates are used to designate a vehicle, ship, or building.

To deliver a Walleye, cycle to the WE display with "O". Zoom in using "CONTROL +". The WE camera may not be slewed and does not track the designated radar target. An aiming reticle appears in the HUD, corresponding to the camera line-of-sight. Fly to place the desired target within the target gate and designate with "ENTER". The designated target appears as a small diamond in the HUD. Fly level toward the target and release with "ENTER" when the "IN RNG" cue flashes in the HUD and in the DDI. Undesignate using "SHIFT \".

FLIR Target Hand-off

To effect target hand-off from FLIR to conventional mode, first cycle to the desired conventional weapon with "]". Then select the FLIR with "O" and designate a target as outlined above. With the target designated, press "]" to hand-off the target to the conventional weapon.

To effect hand-off from the FLIR to Maverick, simply select "O" while a FLIR target is designated. The Maverick slaves to and tracks the FLIR. Press "ENTER" to designate the target and release as outlined above.

HARM Mode

The AGM-88 High-speed Anti-radiation Missile (HARM) mode provides Surface-to-Air Missile (SAM) and Anti-aircraft Artillery (AAA) suppression and attack capability. Using the missile seeker as the display sensor, radar-emissive targets may be acquired, designated and launched upon. The HARM display provides a missile boresight (azimuth and elevation) view of targets which lie within its field-of-view (+/- 30 degrees). HARM mode appears in the left DDI.

| <u>REF</u> | <u>DESCRIPTION</u> |
|------------|--|
| a. | Mode indication. |
| b. | Station indication |
| c. | Target-of-opportunity mode indication, always on. |
| d. | Targets are displayed using code letters: I for Airborne Interceptor; S for SAM site; A for radar-guided AAA; C for Continuous-wave radar (i.e. - other than I, S or A). |
| e. | Designation box. Shows the designated target. |

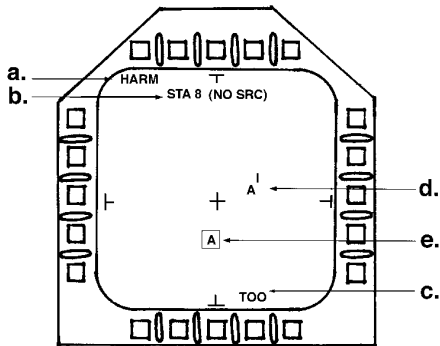


Figure 20 - HARM Display

To deliver an AGM-88 HARM, select HARM mode with "U". Fly in the general direction of the target(s) until letter codes appear on the display. Designate with "ENTER" or "CONTROL \". Cycle targets using "CONTROL \\" until the desired target is boxed. Fly in the direction of designated target until the "IN RNG" cue is flashed in the HUD. Press "ENTER" to release the missile.

AIR-TO-AIR MASTER MODE

The Air-to-Air (A/A) master mode is optimized for performance in visual, short-range Air-to-Air combat with M61 cannon and AIM-9 "heat seeking" Sidewinder missiles. It also provides effective medium (beyond visual) range attack capability with the Advanced Medium-Range Air-to-Air Missile (AMRAAM). Automatic features which manage weapons and avionics equipment leave the pilot free to concentrate on the tactical situation in a rapidly changing air-to-air environment.

RADAR FUNCTION

The Radar Set employs a forward-looking, gimballed antenna in the nose of the aircraft. As the radar searches, the antenna rotates through its scan volume. The size of the scan volume is determined by the antenna scan azimuth and elevation settings. Elevation (height) is specified in bars, with 1 bar equal to 2.5 degrees. Elevations of 1, 2, 4, and 6 bars are supported. Antenna scan azimuths (widths) of 140, 80, 60, 40, and 20 degrees are supported. Scan volume is important in that targets must lie within the antenna scan volume for detection. Larger scan volumes take longer to complete and thus have a higher update latency. Upon selection, each radar sub-mode (described below) sets its own defaults for scan elevation and azimuth.

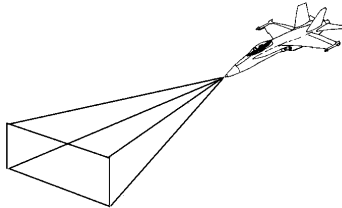


Figure 21 - Destabilized Radar Scan Volume

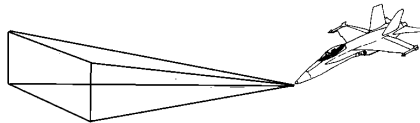


Figure 22 - Stabilized Radar Scan Volume

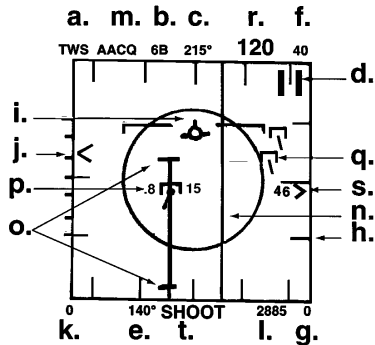


Figure 23 - TWS A/A Radar Mode

| <u>REF</u> | <u>DISPLAY</u> | <u>DESCRIPTION</u> |
|------------|---------------------|---|
| a. | Sub-mode indication | Normal sub modes are; RWS, VS, TWS, STT - cycled using "Q"; ACM sub-modes are; WACQ, VACQ, GACQ or BST - cycled with "SHIFT R". Sub-modes are described below. |
| b. | Scan elevation | Height of the antenna scan volume in scan bars. Using "X" cycles scan elevation down, and "SHIFT X" cycles scan up. |
| c. | Heading | Aircraft magnetic heading. |
| d. | TDC | Target acquisition cursor. Use "SHIFT ARROW" to move the TDC from the stowed position onto the display. Designate the target under the TDC with "\". Note: with the TDC in its stowed position, "\" designates then cycles targets. |
| e. | Scan azimuth | Width of the radar scan volume in degrees right and left of the aircraft center. Only displayed in GMT and SEA modes. Using "Z" cycles scan azimuth down, and "SHIFT Z" cycles up. |

- | | |
|----------------------------|--|
| f. Maximum displayed range | Range is cycled down with "TAB" and cycled up with "SHIFT TAB". Range only affects the radar display, not the distance at which the radar can detect targets. |
| g. Minimum displayed range | |
| h. Azimuth/range grid | Each horizontal and vertical mark represents 30 degrees. |
| i. Velocity vector | Displayed at a fixed position, and used in conjunction with the horizon line to indicate aircraft vertical flight path and roll attitude. |
| j. Antenna elevation caret | Indicates the antenna elevation, relative to the local horizon. The scale covers +/-60 degrees. When a target is designated, digits to the right show relative altitude per 1000 feet. |
| k. | Calibrated Air Speed |
| l. Barometric Altitude | Indicated in feet above mean sea level (MSL). |
| m. AACQ indication | When used in conjunction with RWS, SV or TWS, indicates that when detected, a target is automatically acquired. Upon target acquisition, AACQ is cleared. |
| n. B-sweep | Indicates the instantaneous antenna azimuth position. |
| o. Launch range markers | Show minimum and maximum range of the selected A/A missile. |
| p. Designated L&S | Launch and Steering target or STT target. |
| q. Undesignated target | |
| r. Selected weapon | One of: AIM9, Al20 or GUN. |
| s. Target range graph | Positioned to show range, the digits show closure rate to the nearest 10 knots. |
| t. "SHOOT" cue | Appears when launch conditions are met. |

Air-to-Air Radar Sub-Modes

The AN/APG-65 Radar Set provides range and track functions for multiple airborne targets. The radar set may operate in any of the following sub-modes during A/A attack:

- * Range While Search (RWS): The RWS provides target detection and tracking for both high-closure and low-closure attacks. Targets are presented in a range-azimuth format. RWS mode is useful for long-range searching, and for large scan volume searching.
Cycle to this mode with "Q". Designating a target with "\" changes to STT mode and the target is tracked (see below).
- * Velocity Search (VS): The VS mode detects targets as a function of closing velocity. Targets are presented in a velocity-azimuth format.
Cycle to this mode with "Q". Use velocity search to identify closing targets. Designating a target with "\" changes to STT mode and the target is tracked (see below).
- * Track While Scan (TWS): The TWS mode provides multiple-target track capability. Targets are presented in a range-azimuth format. TWS mode supports designation of a priority Launch & Steering (L&S) target. All targets appear with aspect angle pointers, which indicates the direction the target is moving. The L&S target is indicated by a small highlight box in its center.
Cycle to this mode with "Q". Selecting a target with "\" or with the TDC designates the target as the L&S target. The L&S target is accompanied by target mach (percent of speed-of-sound) to its left, and target altitude to its right.
- * Single Target Track (STT): The STT track mode provides high-update rate tracking of a single target. STT may be entered manually from RWS, VS or TWS modes, or automatically from the ACM modes. Full antenna deflection allows continued tracking of the target through +/-70 degrees azimuth and elevation.
Cycle to this mode with "Q". This mode is only available when a target is designated in RWS, VS or TWS modes.
- * Air Combat Maneuvering Modes: The radar supports Air Combat Maneuvering Modes; Wide Acquisition (WACQ), Vertical Acquisition (VACQ), Gun Acquisition (GACQ), and Boresight (BST). These modes employ special antenna scan patterns for target detection, and automatically acquire and track (with STT) the first target detected.

Targets outside 10 NM are rejected, making them ideal for use during high-G air combat maneuvering. The following scan volumes are employed:

| <u>MODE</u> | <u>Azimuth</u> | <u>Elevation</u> |
|-------------|----------------|------------------|
| WACQ: | +/-30 degrees | +/-7.5 degrees |
| VACQ: | +/-5 degrees | +20/-5 degrees |
| GACQ: | +/-5 degrees | +/-5 degrees |
| BST: | +/-2.5 degrees | +/-2.5 degrees |

ACM modes Cycle with "SHIFT R". When a target is acquired, the radar switch to STT to track the target. If the target moves beyond the radar field of view, the radar returns to the ACM mode and begins searching.

- * Auto Acquisition (AACQ): The Radar supports automatic acquisition in conjunction with RWS, VS, and TWS modes. Use "SHIFT Q" to toggle the mode. Upon completion of a scan, the radar automatically acquires the highest priority target and either; enters STT mode if used with RWS or VS modes, or designates the current L&S target from TWS mode. When a target is acquired, AACQ is reset.

Target Acquisition

RWS, VS, and TWS are stabilized radar modes. That is, the scan volume is always expressed upright relative to the horizon, regardless of aircraft attitude. ACM modes (WACQ, VACQ, GACQ and BST) are not stabilized. Their scan volume is relative to the aircraft waterline.

Target size and relative altitude affect the range at which the target may be detected. Larger targets are detected from a greater distance than small ones. Also, targets above the aircraft horizon are detected further than those below the horizon. Upon selection, each radar sub-mode enters its own default range.

When a target is tracked on radar, a box is placed on the HUD over the target. This is the Target Designation (TD) box. A/A radar mode is entered using "R", which subsequently toggles between A/A and A/G radar master modes. The radar employs the right DDI.

A/A WEAPONS DELIVERY

The stores management display (left DDI) graphically depicts the weapons on the aircraft wing. Use "[" to cycle A/A weapons; GUN, AIM-9 and AIM-120 AMRAAM. "S" displays stores. Stations are numbered 1 through 9 (left to right). The delivery method for each of the A/A weapons depends on whether or not the radar set is tracking a target - either STT or TWS with a L&S target.

AIM-9M Sidewinder - Radar NOT Tracking

The AIM-9L Sidewinder is an all aspect, heat-seeking A/A combat missile. It is self-guided and "homes in" on jet engine heat sources. Its warhead is relatively small and its range is relatively short, usually less than 10 NM.

Cycle using "[" until AIM9 appears in the HUD. If the radar is not tracking a target, the AIM-9L displays a small seeker circle on the aircraft waterline. Maneuver to place the desired target within this circle. When the AIM-9 can "see" heat in its circle, it tracks the target and generates a growling sound. The growling sound increases in pitch when the heat source is strong (i.e. - the target is close). Press "ENTER" or "TRIGGER" to release the weapon.

AIM-9M Sidewinder - Radar Tracking

With the radar set tracking, the Normalized In-Range Display (NIRD) appears on the HUD. The NIRD consists of a circle with caretts at the 2:30 and 6:00 positions. The radar display also represents a steering circle and steering dot.

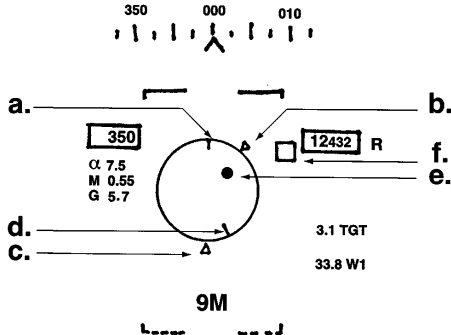


Figure 24 - Normalized In-Range Display (NIRD)

REF DESCRIPTION

- a. Steering circle represents the missile boresight.
- b. Minimum range caret is fixed at the 2:30 position.
- c. Maximum range caret is fixed at the 6:00 position.
- d. Range bar moves clockwise around the circle to indicate the relative to the target, based on the fixed-position range carets and the minimum and maximum range of the selected weapon.
- e. Steering dot indicates the required lead on the selected radar target.
- f. Target Designator (TD) box.

Placing the steering dot inside the NIRD steering circle, while the target is visible on the HUD assures correct launch conditions, and "SHOOT" cue flashes above the TD box. The radar also displays range via the launch range markers.

AIM-120 AMRAAM - Radar Tracking

The AIM-120 Advanced Medium-range Air-to-Air Missile (AMRAAM) is a self-guided, active radar, medium range missile. It is employed only in conjunction with the radar. Cycle to AIM-120 with "[". Manipulate the radar to acquire a target. When the radar is tracking a target, the NIRD appears in the HUD. Launch as described above in "AIM-9M - Radar Tracking."

M61 Gun - Radar Not Tracking

The M61 Vulcan Cannon carries 578 rounds of ammo, and may be used in both A/A and A/G modes. Cycle to A/A GUN mode with "[". Rounds remaining are displayed in the HUD. Also in the HUD is a pipper (a small dot) inside a circle. This pipper represents the position of an imaginary cannon round, 1500 feet from the aircraft. To visually attack, fly to maneuver the pipper over the desired target. When within about 1500 feet of the target, press and hold "ENTER" or "trigger" to fire cannon.

M61 Gun - Radar Tracking

Designate a radar target and cycle to A/A GUN with "[". While tracking, a pipper, surrounded by a reticle is displayed in the HUD. Tics on the reticle represent 1000 foot range increments. A range bar is positioned clockwise on the reticle to indicate the distance to the radar target. The pipper is displaced to show the position of an imaginary cannon round at the distance equal to that of the tracked target. To hit the target, maneuver so as to place the pipper over the target and press "ENTER" or "TRIGGER".

