GRAPHSIM ENTERTAINMENT

F/A-18 Operation Iraqi Freedom

OPERATION MANUAL

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INTRODUCTION: THE F/A-18 HORNET STRIKE FIGHTER

The F/A-18 Hornet is a multi-mission, all-weather strike fighter developed for the US. Navy and Marine Corps, and used by international air forces.

The F/A-18 Hornet has been selected by the defense forces of five international customers. These nations recognized the need for a fully integrated multi-mission aircraft to defeat modern, high-performance threats. The selection of the F/A-18 by these customers was a result of many technical and financial factors. Some of the important technical factors cited by international customers in favor of the F/A-18 are:

- Sensor and crew station technology for situation awareness
- Peacetime safety record
- Combat survivability
- Aircraft handling qualities
- Slow speed maneuverability
- Fully developed systems for beyond visual range air superiority, sea lane defense, defense suppression, and night attack
- Growth flexibility to accommodate customer peculiar requirements and to meet changing threat/mission requirements
- Independent deployment with minimum support
- Weapons carriage flexibility
- Fully mission capable two-seat aircraft.

This report provides technical and operational data to illustrate that the Hornet is the best choice to meet the national defense needs of countries requiring a multi-mission aircraft.

Deliveries to the first U.S. squadron began in February 1981. Today, thirty U.S. squadrons are in service and others are being activated.

The F/A-18 has become a part of the air forces in Canada, Australia and Spain. Deliveries to the Canadian Forces began in October 1982 and the Hornet is now fully operational in the harsh Canadian environment. Deliveries to Australia began in 1984 while those to Spain began in 1986. In 1988, Kuwait chose the F/A-18 to counter the threat of hostile activity in the Arabic Gulf, and Switzerland chose the F/A-18 as the new fighter aircraft to fulfill its demanding missions.

MULTI-MISSION CAPABILITY

The multi-mission capability designed into the Hornet allows it to defeat a multi-dimension threat.

Many U.S. allies confront a large, capable threat that can attack on land, by air, and by sea Air Forces must react quickly and decisively in countering all elements of the threat. The F/A-18 is the multi-mission strike fighter that can meet this requirement.

Because of its designed-in mission flexibility, the Hornet gives the on-scene battle commander an ability to respond rapidly to varying mission demands by changing the tasking and ordnance loads of the Hornets so that he can support Air-to-Air, air-to ground, and anti-shipping requirements. No airframe or avionics conversion is required for the various weapon delivery missions. All weapon modes are in the basic aircraft. It is merely necessary to load the desired weapons or sensors. Electronic countermeasures are internal to eliminate unnecessary drag and allow the use of all external store stations for fuel or armament.

AIR-TO-AIR

The key to success in modern air combat is effective beyond visual range (BVR) missile capability. This capability is crucial in defeating larger air forces. The Hornet is designed to achieve BVR combat superiority. Sensors, controls, displays, and weapon integration are optimized for AIM-7 employment. Hornets have been launching AIM-7's since 1980.

For Air-to-Air combat, the F/A- 18 has an internal 20 mm gun, close-in AIM-9 Sidewinder missiles, and BVR AIM-7 Sparrow missiles. In the fighter escort role, the F/A-18 escorts strike groups safely to their target. In the interceptor role, multiple radar modes, advanced Air-to-Air missiles and acceleration/dash performance allow the Hornet to quickly attain and maintain air superiority.

With the multiple radar modes, sophisticated look-down/shoot-down fire control system, and hands-on-throttle-and-stick (HOTAS) control of the weapon system, one man can counter multiple targets under all weather conditions. Hornet radar performance against small, slow moving targets, such as helicopters, has been demonstrated. Ranges in excess of 35 NM were achieved during flight evaluation of the Hornet. Hornet weapon system characteristics yield substantial advantages over other modem fighters such as the MiG-29 FULCRUM.

Smokeless engines and small visual signature reduce the chances of detection by the threat.

For air combat maneuvering, the F/A-18 has four radar modes for short range target detection and automatic acquisition. Maneuverability is enhanced by excellent pitch response, no angle-of-attack (AOA) limitations and outstanding departure/spin resistance. The pilot also has excellent visibility, a Head-Up Display and the Director Gunsight to further enhance Air-to-Air combat capability.

AIR-TO-SURFACE

For many allied air forces, close air support, day/night interdiction, and all-weather interdiction of reserve forces are key mission requirements. These countries are also subject to attack by naval forces or isolation from trade by blockade of the shipping lanes. With the Hornet, allies can keep sea lanes open by direct attack on enemy shipping and by mining harbors and choke points.

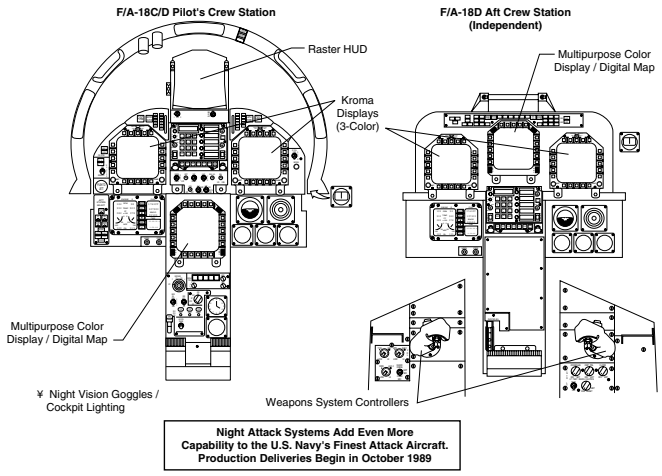
The Hornet combines armament flexibility with high survivability to support all the air-to surface mission requirements. The F/A-18 can carry a flexible array of sensors, missiles, conventional and guided bombs, cluster bombs, rockets, mines, and external fuel to perform day, night, all-weather interdiction, anti-shipping and close air support operations. The Hornet is also effective in employing defense suppression weapons to destroy surface-to-air threats and improve the survivability of the strike force.

To navigate to and from the target, the Hornet has an accurate Inertial Navigation Set (INS), Head-Up Display, high-resolution ground maps, and a digital moving map display. A Forward Looking Infrared (FLIR) set detects infrared radiation from objects in its field of view and displays this information to the pilot. Internal electronic countermeasures provide pilot awareness of a threat, and wing tip Sidewinder missiles provide self defense capability.

Over the target area, the F/A-18 features superior roll performance and speed stability, excellent visibility, precise controllability, and excellent throttle response to maneuver into and then away from the target area after weapon delivery. Accurate first pass weapon delivery is enhanced by a reliable Air-to-Ground ranging radar mode and the Laser Target Designator/Ranger (LTD/R) which provides laser guided weapon capability using FLIR pointing modes to designate targets. A strike camera in the Laser Detector Tracker (LDT) pod photographs the target area before, during, and after weapon delivery. Internal countermeasures deter accurate tracking of the Hornet over the target area while chaff/flare dispensers divert missiles and artillery.

Night Attack Systems - The F/A-18 weapon system is fully integrated for Air-to-Ground missions at night and in limited weather conditions. The night attack equipment includes a raster scan Head-Up Display, a Multipurpose Color Display/Digital Map Set, and crew station instrumentation compatible with night vision goggles. This equipment is used with the existing Targeting FLIR to further improve night attack capability. Additionally, the aft crewmember can operate his displays independent of the pilot.

F/A-18 night attack systems.



RECONNAISSANCE

Real-time reconnaissance capability is being added to the F/A-18 as part of the Advanced Tactical Airborne Reconnaissance Systems (ATARS) program for the U.S. Marine Corps. This additional mission capability enhances the operational flexibility of the fleet and provides more options for the mission planner.

Currently, all F/A-18s have the basic provisions for film-based reconnaissance built into the gun bay area. In FY 89, permanent provisions for avionics equipment and ECS components will be added. In October 1998, an optional

reconnaissance kit containing a sensor mounting pallet, a door with sensor windows and a suite of electro-optical or infrared sensors will be available. The sensor pallet is interchangeable with the 20 mm gun.

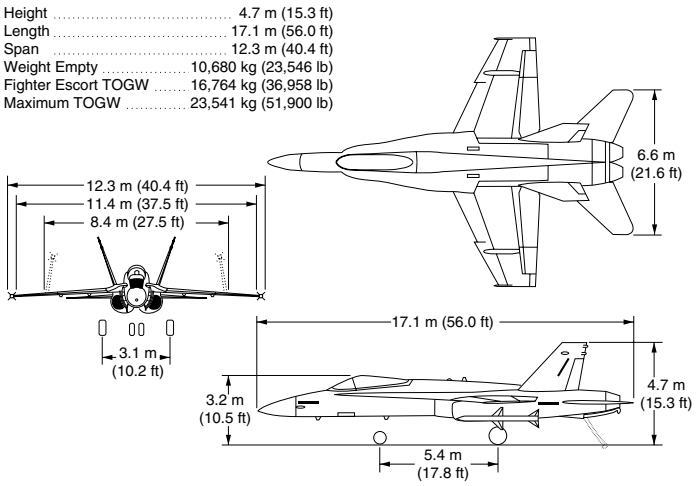
Additional reconnaissance options are available including a reconnaissance mode in the APG-65 radar, Long Range Optical Photography (LOROP), or Tactical Electronic Reconnaissance (TEREC) pods on the centerline station. Control and display of the selected pod option will be programmed into the mission computer.

PHYSICAL CHARACTERISTICS

The Hornet is a highly maneuverable strike fighter that can carry large payloads to defeat threats.

The 10,680 kg (23,546 lb) F/A-18 can carry up to 12,861 kg (28,354 lb) of equipment, fuel and stores for a maximum takeoff weight of 23,541 kg (51,900 lb). With a 4709 kg (10,381 lb) full load of internal JP-4 fuel, the Hornet retains over 7,711 kg (17,000 lb) of additional payload capacity.

Hornet physical characteristics.



The Hornet is a Highly Maneuverable Fighter / Attack Aircraft with Superior Payload - Radius Capability

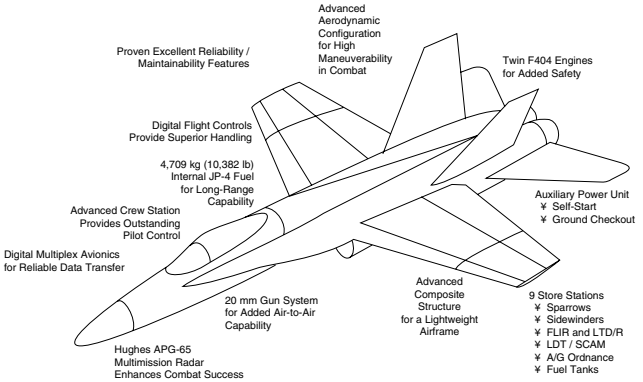
Designed as a carrier based aircraft, the Hornet adapts well to maintenance hangars and shelters. At 4.7m (15.3 ft) high and 17.1m (56.0 ft) long, it can fit easily into confined spaces. Folding the wings reduces the span from 12.3m (40.4 ft) to 8.4m (27.5 ft), further enhancing shelter capability. Because the Hornet is designed for employment aboard aircraft carriers, it provides substantial advantages for operations at dispersed sites such as designated highway strips. The Hornet has a low approach speed and is easily flown on steep approaches to minimize landing distances. Also, the Hornet's nose-wheel steering operates through 75 degrees and allows the aircraft to turn around on a 9m (29 ft) wide strip while taxiing. The Hornet requires no special fluids or liquid oxygen for servicing, has a built-in boarding ladder, and provides its own power and cooling for ground operations. These design features, combined with the Hornet's reliability, result in an aircraft which can meet the need for a deployable, effective weapon system.

KEY DESIGN FEATURES

The F/A-18 Hornet incorporates the latest strike fighter technology which provides an effective weapon system.

- The multi-mission radar, advanced crew station and digital avionics combine to form an unsurpassed Air-to-Air and Air-to-Ground weapon system.
- Nine store stations are compatible with a wide variety of missiles, sensors and Air-to-Ground ordnance.
- Advanced, lightweight airframe and digital flight controls enhance maneuverability and handling.
- Twin F404 engines with proven excellent performance double the safety for peacetime operation.
- An auxiliary power unit aids self start and ground checkout, reducing ground support equipment (GSE requirements).
- Survivability features and defensive systems ensure a safe return from a hostile combat arena.
- Reliability/Maintainability features are superior to other tactical aircraft in service.

F/A-18 key design features.



The F/A-18 Is a Capable Aircraft to Defeat a Capable Threat

CREW STATION

The Hornet crew station integrates advanced control/display technology to ensure effective one-man performance for a wide variety of missions.

The crew station incorporates advanced controls and displays using cathode ray tubes for flight, weapon and sensor information and hands-on-throttle-and-stick control of the aircraft weapons system. This gives the pilot the information he needs quickly and efficiently.

Primary control and display comes from a stroke and raster scan Head-Up Display, three 5-inch cathode ray tube displays (one of which includes a Multipurpose Color Display Digital Map Set) and an Up-Front Control for rapid communication, navigation and identification functions. A hands on-throttle-and-stick concept puts all the needed controls at the pilot's fingertips for all high workload, time-critical portions of the mission.

The pilot can use the proven center control stick with either hand during air combat maneuvering. With the Up-Front Control, the pilot can also use either hand to adjust radios, autopilot and navigation equipment, eliminating the need for vertigo-inducing head movement. Dedicated lights and messages on the left Digital Display Indicator clearly and quickly give the pilot warnings, cautions and advisories. There also are voice warnings and cautions which can be translated to other languages if desired.

The escape system is the NACES zero-zero system. Pilot services include an anti-g suit and an Onboard Oxygen Generating System (OBOGS).

The F/A-18 can incorporate an integrated Helmet Mounted Display (HMD) which enhances the pilot's situational awareness by allowing true "eyes out of the crew station" flying. Altitude, speed, heading, angle-of-attack, sensor alerts and target cueing are provided without having to look at crew station instruments. The HMD is an acquisition system which measures the pilot's line of sight to an object relative to boresight. The F/A-18 mission computer then processes the data to facilitate attack/launch of weapons. Visual target detection ranges can be dramatically increased using slaving cues provided to the HMD. The HMD uses magnetic tracking to determine head position and orientation. It has a hemispherical field of regard relative to the crew station, with an instantaneous field of view of 20 degrees. The HMD is a supplement to the existing F/A-18 wide field of view HUD.

Two-Seat Trainer/All-Weather Crew Station

The two-seat crew station was originally designed only for training missions. In October 1989, the two-seat F/A-18D becomes reconfigurable from a trainer to an all-weather combat aircraft. The aft crew station has independent displays for a weapon system officer while retaining all the control/display features of the forward station. This reconfigurable aft station provides a significant advantage over tactical aircraft that have limited combat capability in their trainer versions. In addition, the F/A-18 retains 93% of its internal fuel while accommodating the aft crew station, thus allowing the F/A-18D to meet mission radius requirements.

DIGITAL MULTIPLEX AVIONICS

Dual mission computers and dual multiplex buses give the Hornet redundancy and flexibility to ensure mission completion.

The avionics system uses new hardware technologies in large-scale integrated circuits, microprocessors and cathode ray tube displays. Electronic noise does not affect digital multiplexing which reliably transfers data using less wiring. Designed for shipboard operation, the Hornet avionics system resists electromagnetic interference far better than typical land-based aircraft. Digital mission computers adapt the avionics suite to changing mission requirements and readily accept new equipment and weapons through software changes.

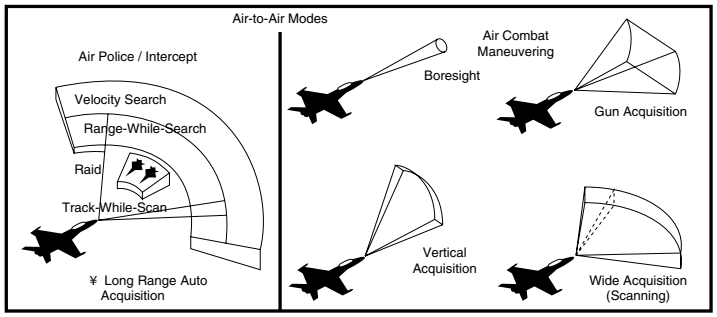
The system has back-up modes to ensure that mission capability is retained if individual avionics equipment fails. For example, each of the mission computers is capable of performing the other's primary functions to ensure the capability for Air-to-Air combat, Air-to-Ground weapon delivery, navigation and all-weather landing approach if one of the mission computers malfunctions.

Digital processors control display and mode selection of all aircraft sensors and make weapon delivery and navigation calculations. The speed and capacity of the onboard computers and the digital interface provide significant growth capability.

TACTICAL SENSORS

Hornet sensors are integrated for Air-to-Air and air-to-surface missions to provide greater mission effectiveness in a combat environment.

AN/APG-65 multimode pulse doppler radar.



An important factor in the Hornet's success as a multirole strike fighter is the overall integration of the sensors needed for Air-to-Air and air-to-surface missions. These sensors include a multimode radar and infrared (IR) navigation and targeting devices. The importance of IR sensors for air-to-surface missions was recognized early in the design of the Hornet and they were totally integrated into the design. For example, the low drag installation of the FLIR was thoroughly evaluated to ensure there were no adverse effects on handling qualities. The integrated sensors on the Hornet support each other in realistic combat scenarios to minimize effects of electronic countermeasures and provide options for controlling ownship emissions. As demonstrated during flight evaluation, the FLIR can be used for Air-to-Air search providing a passive detection capability.

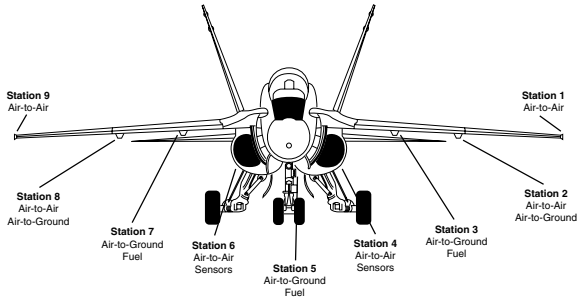
The heart of the Hornet weapon system is the APG-65 pulse-doppler multimode radar. Some key modes include:

- High pulse repetition frequency mechanization in VS and high/medium pulse repetition frequency mechanization in RWS for long-range, all-aspect target detection and situation awareness
- Auto Acquisition capability
- Raid assessment and track-while-scan modes for rapid successive attacks of multiple Air-to-Air targets
- Doppler beam sharpening and SAR for high resolution ground mapping
- Ground moving target indication and track for activity indication and cueing sensor pods
- Terrain avoidance for low altitude penetration
- Sea Surface Search for detection of patrol type vessels and ships
- Precision velocity measurement for accurate weapon delivery
- Short range tracking for Gun Director capability.

Digital technology in the radar provides many modes suited to Air-to-Air or Air-to-Ground missions and permits the entire system to be operated by one man. The key to its flexibility is the programmable signal processor, which performs the high-speed calculations necessary for variable waveform doppler filtering. Changing software modifies existing modes and adds new modes. The radar detection range and dynamic tracking allow full use of both radar-guided and infrared-homing missiles, and gun in the high-g environment.

Alternate mission sensors include the Targeting Forward Looking Infrared (FLIR) set and a Laser Detector Tracker (LDT) in pods that are carried on the fuselage Sparrow missile stations. The FLIR is a passive sensor that detects infrared radiation from all objects in its field-of view. The LDT is a search/track set which acquires, decodes and tracks laser energy reflected from a target designated from the ground or air. A strike camera in the LDT pod rapidly assesses strike damage.

Hornet ordnance carriage.



Air-to-Air	Air-to-Ground	
	Conventional	Guided
¥ AIM-7 ¥ AIM-9 ¥ 20 mm Ammo ¥ Advanced Air-to-Air Missiles	¥ MK-82 SE ¥ MK-82 LD ¥ MK-83 LD ¥ MK-84 LD ¥ Rockeye II ¥ LAU-10 ¥ LAU-61 ¥ LAU-68 ¥ MK-76 ¥ MK-106 ¥ 20 mm Ammo ¥ Mines	¥ Walleye I ¥ Walleye I ER/DL ¥ Anti-Radiation Missile ¥ Laser Guided Bombs ¥ Imagine Infrared Missile ¥ Anti-Shipping Missile

Note: Weapon availability subject to U.S. Government approval

A Wide Variety of Ordnance Capability Gives the F/A-18 Combat Flexibility

ORDNANCE CARRIAGE

The Hornet's designed-in flexibility permits simultaneous carriage of tactical sensors and stores for Air-to-Air, air-to-surface, and defense suppression.

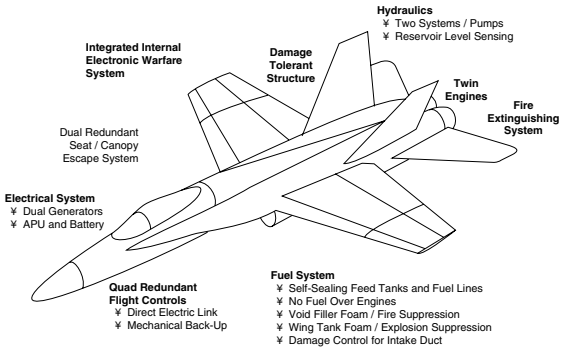
Store stations are at each wing tip, on four wing station pylons, at each engine nacelle and on a centerline pylon. The four wing stations have a common pylon for reduced logistics, and

automatic sway bracing and 14^{O} and 30^{O} lugs for ease of weapon loading.

Armament options for Air-to-Air missions include the AIM-7 Sparrow, AIM-9 Sidewinder, as well as a nose mounted 20 mm gun. Air-to-Ground armament options include conventional and guided bombs, rockets, guided missiles, mines and the 20 mm gun.

The F/A-18 carries external fuel tanks on the centerline and inboard wing stations. The FLIR and LDT pods are carried on the fuselage Sparrow missile stations.

Survivable by design.



All Major Systems of the F/A-18 Are Designed for Survival in Combat

SURVIVABILITY

Hornet systems are designed to survive combat. This feature reduces the peacetime attrition by 50% compared to other U.S. tactical aircraft.

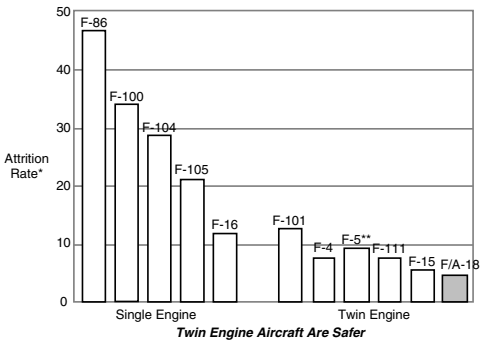
The weapon system incorporates features which enable it to carry out its mission and return safely from a high threat arena.

- The following design features contribute to the F/A-18's survival:
- Twin smokeless engines
- Small visual signature
- Long-range radar/warning systems
- 360 degree crew station visibility
- Speed/maneuverability/weapons
- Internal countermeasures
- Structural redundancy
- Separated hydraulic systems
- Back-up flight control system
- Fuel system protection

Twin-Engine Safety

Twin-engine fighter aircraft such as the F/A-18 are safer than single engine aircraft, according to data from the U.S. Navy and Air Force a rate of one lose per 500,000 cumulative flight hours is expected. While all aircraft are improving, the twin-engine fighters continue to be safer than single-engine fighters by at least two to one. Current F/A-18 attrition rate is 4.8 losses per 100,000 flight hours worldwide.

F/A-18 flight safety.



* Losses per 100,000 flight hours at 500,000 cumulative flight hours
** Data for F-5 is projected
Source: U.S. Air Force and U.S. Navy Safety Centers

The F/A-18 is the Safest Tactical Fighter Aircraft in U.S. History

RELIABILITY AND MAINTAINABILITY

The F/A-18 is a reliable aircraft that is easy and inexpensive to maintain and operate.

The Hornet has met or exceeded all the requirements in the most extensive test program ever undertaken by the U.S. Navy for a new fighter aircraft. The operational squadrons are setting new mission capable standards. When MDC designed the F/A-18, reliability and maintainability engineers worked hand-in-hand with designers. MDC used true F/A-18 mission environments to establish realistic design and test requirements.

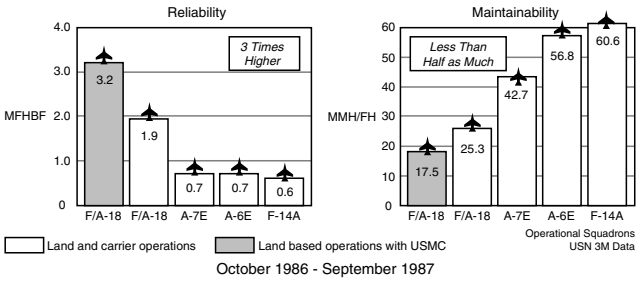
The following features enhance reliability:

- Establishing firm reliability requirements in each procurement specification
- Using a preferred parts list for high reliability parts
- Supplier design reviews to assess progress and solve problems

The F/A-18 is easy, fast and inexpensive to maintain because of the following:

- Onboard self-sufficiency
- Minimal ground support equipment required
- Built-in-test of avionics and hydromechanical equipment
- Direct access to installed equipment
- A reduction in the number and type of fasteners required

Superior reliability / maintainability.



October 1986 - September 1987

The F/A-18 Is Three Time as Reliable and Requires Less Than Half the Mainenance of Other Navy Aircraft

F/A-18 reliability and maintainability are much better than other tactical aircraft in the U.S. Navy. The Hornet has three times better reliability than other current U.S. Navy tactical aircraft and requires half the maintenance effort. Since carrier operations adversely affect reliability and maintainability statistics, the shaded bars in the above figure show F/A-18 experience during land-based operations and are more representative of the aircraft's performance in international customers' environments. The maintenance man-hours per flight hour figures include all direct, indirect, and support general functions.

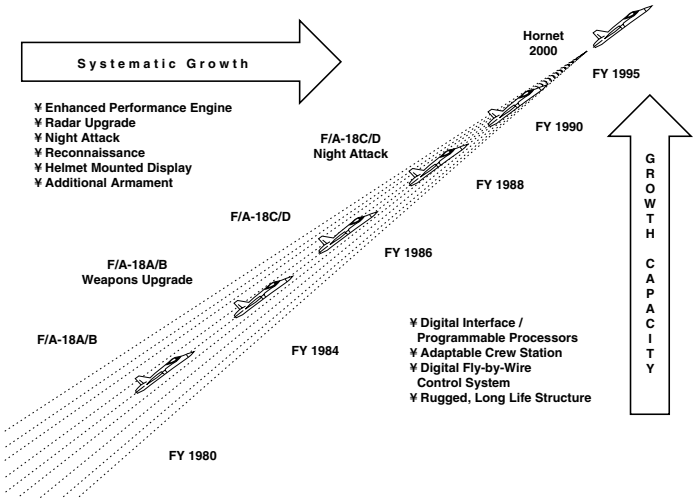
HORNET EVOLUTION

Pre-planned upgrades are an integral part of the Hornet program. This enables us to continuously offer configurations that can meet evolving needs.

The aircraft has shown systematic growth not only in subsystems, such as in the radar upgrades, but also in mission capabilities, as in the incorporation of the night attack and reconnaissance roles. This growth is the direct result of the design features previously described. The capabilities of the F/A-18 will continue to expand as the program proceeds to the F/A-18 E/F and beyond.

The Hornet 2000 provides our allies with an excellent option for the co-development of a premier, front line fighter/attack aircraft at a fraction of the cost of an individual program. The Hornet 2000 cooperative development affects a technology merge while minimizing program cost and risk.

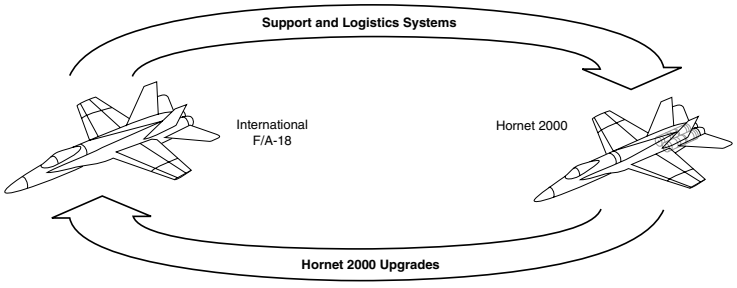
Hornet evolution designed to counter the threat.



The F/A-18 Hornet Has a History of Growth to Counter the Threat. Planned Upgrades Will Maintain Hornet Superiority Into the Next Century

Hornet 2000 development will consist of phased weapon system upgrades which will retrofit into existing F/A-18 fleets. In addition, the support and logistics base established for the F/A-18 will not require major revision when U.S. allies begin to procure Hornet 2000s.

The Hornet 2000 program will provide international Hornet growth into the next Century.



¥ Current Support and Logistics Systems Can Be Used for Both the International F/A-18 and Hornet 2000
¥ Most Hornet 2000 Upgrades Will Retrofit Throughout a Fleet Which Contains Both Aircraft

Hornet 2000 Co-Development Effects a Technology Merge at Low Cost

GAME OVERVIEW

SUPPORT

For product support, updates and additional resources visit www.operation-iraqi-freedom.us, or for support questions send email to service@graphsim.com.

BASIC GAMEPLAY

F/A-18 Operation Iraqi Freedom (F/A-18 OIF) is a realistic simulation of the Navy and Marine workhorse fighter and ground attack aircraft. The game excels at reproducing an environment that requires the employment of real-world tactics to achieve mission objects and to survive. Although setup and mission selection are easy and intuitive, the aircraft simulation itself, with its numerous sensors and weapons, is rather complex. Reading the manual is important to your success and is a big part of enjoying the game.

However, many users may want to get into the game quickly and "learn by doing." It is suggested that you visit the training missions before attempting the combat missions. Most game functionality is explored in these missions and flying is likely more fun than reading the manual.

F/A-18 OIF is primarily a single-player game (you against the computer,) although it contains a multiplayer (internet or local network) component. A separate editor program is included which allows you to create your own missions. The basic flow of a single-player game session is:

1. Run the game from the Windows "Start" menu – choose "FA-18 Op Iraqi Freedom Flight." After enjoying the introduction movie, choose (click) "Mission" from the main menu screen.
2. Choose a mission from those listed. Study the "Brief", "notes", and the mission "Map."
3. Load the ordnance (weapons) necessary to meet the given mission objectives.
4. Fly the mission. When the mission begins, the success or failure is not yet determined. At some point during play, the objective will be met successfully or will have failed (if you survive that long.)
5. The game will automatically terminate flight if one of the following is true: a) you crash or otherwise die; b) you eject; c) you land and shut down the engines when mission objective has been met or failed. At any time you may abort a mission with the 'Esc' key. Aborting a mission after the objective is met gives you full credit as if you had landed.
6. View a debrief screen which summarizes your performance in the mission. At this point only you may choose to save a replay file of the mission just flown. Replays may be viewed later from the "Replays" menu.

SINGLE PLAYER MISSIONS

All single player missions listed in the "Choose a mission" screen follow a naming convention. Missions that you make are not required to follow this convention. A prefix zero (0) designates a training mission. Numbers one (1) through (5) designate regular combat missions, the particular digit indicating the difficulty rating for that mission. The difficulty ratings are: (1) easy; (2) modest difficulty; (3) moderate difficulty; (4) challenging; (5) difficult. The second character simply provides an alphanumeric sorting order to the missions in the list.

The training missions each cover a skill or knowledge essential for successful completion of even the easiest mission. It is recommended that you complete the training missions before expecting success in the combat missions. These training missions are not designed to be an in-depth discussion on a topic but are intended to give you a working knowledge or ability in a critical area.

Refer to the mission's **Brief** for essential details on a mission. The **Notes** section contains additional interesting and sometimes-useful information. The **Map** provides a geographical overview of the mission and depicts some potential threats along the route. The red-shaded disks represent enemy SAM (surface-to-air missile) installations. Blue disks are friendly SAM installations. Waypoints for your aircraft are depicted by yellow flags. WP0 (waypoint zero) is your start location. Other waypoints are normally placed over target locations.

MENU SCREENS OVERVIEW

The main menu provides access to single player missions, multiplayer missions, game settings, and the credits. Clicking the OIF logo replays the introductory movie.

Before your first trip, make sure that the game settings are appropriate for your hardware and preferences.

Settings Screen

The “Settings” screen contains all user-changeable options.

“Resolution” controls the video mode used by the game. Lower resolutions (smaller pixel dimensions) can sometimes prevent slow frame rates. If the simulation seems too slow or jerky, experiment with a lower resolution setting. Most video cards designed in the past year or two can handle at least 1024x768 full color (32 bits-per-pixel).

“Detail” determines the maximum size of the visible terrain. “Low” detail limits visibility to about 20 miles, “Medium” to about 25 miles, and “High” to about 30 miles. This setting can significantly impact game smoothness. If the game jerks often, try reducing this setting to a lower level.

“Realism” affects both realism and difficulty. Setting this to “Easy” prevents crashing, gives you unlimited cannon rounds and makes it easier to kill enemy aircraft. Setting this to “High” makes your aircraft radar have a more realistic scan volume and detection model – thus it is more difficult to lock enemy targets. “High” realism also makes enemy aircraft more aggressive in their combat techniques. Enemy SAM operations might turn off there radar transmitters when they detect a HARM launch against them, thus making it very difficult to take out the SAM installation.

“Squadron” changes your F/A-18’s tail art. The depicted squadrons are real.

“Network” is the DirectX™ service provider for multiplayer gaming. DirectX service providers are simply underlying connection types for your computer and network configuration. Choose the one that mentions “internet” for internet gaming and choose “IP/X” for local area network gaming.

“Callsign” is your name as shown during multiplayer games. Choose anything you wish, but keep it short.

“Flight Control” selects an input device to be used as the aircraft control stick. “Mouse” simulates the action of a joystick with a normal mouse. Use of a joystick input device is highly recommended. The “Joystick” setting allows your joystick to control the aircraft. During flight, you may program any buttons on your joystick by pressing “Ctrl-J”. Follow the on-screen instructions to “train” the game to respond to various buttons. If you have a joystick that requires its own software to program its buttons (usually an old-style serial joystick), select “Joystick (axes only)”. This setting allows the joystick to steer the aircraft, but does not respond to any buttons on the stick. External utility of driver software is relied upon to mimic keystrokes when buttons are pressed.

OTHER DOCUMENTS

This document is the primary instruction and reference guide for F/A-18 Operation Iraqi Freedom. Other specialized documents include **Multi-player**, **Mission Editor** and **Threat Guide**.

CHAPTER 1: IN THE COCKPIT

Upon initiating a flight, you are placed in the pilot's seat of your F/A-18 aircraft. The keyboard controls many aircraft functions and also controls the viewing position of the "camera".

VIEWS

There are many views available in F/A-18 OIF. They are activated from the keyboard "F-keys" (function-keys) and appear in three distinct groups; internal, external and other.

"Padlock" views (included in the first two groups) assist with the all-important "situation awareness" needed to locate enemy aircraft in the sky and ascertain their position and movement in relation to yours. When an aircraft is "padlocked", the view tracks it as it moves. When a padlock view is engaged, a small icon (that looks like a padlock) appears in the upper right portion of your screen. The use of the padlock views during aerial combat is discussed in chapter 7.

F1-F4, Internal

Forward cockpit view/lookdown cockpit view	Press “F1” to toggle between the forward cockpit view and the lookdown cockpit view.
Padlock target	Press “F2” to padlock the currently selected radar target from the cockpit.
Padlock nearest	Press “F3” to padlock the nearest “visually near” enemy airplane from the cockpit.
Padlock wingman 1	Press “F4” to padlock your primary wingman (Hornet One) from the cockpit.
Padlock wingman 2	Press SHIFT and “F4” to padlock wingman 2 from the cockpit.
Momentary look left	Press LEFT ARROW, presents view as long as key is held, shifts view 90^{o} to the left.
Momentary look Right	Press RIGHT ARROW, presents view as long as key is held, shifts view 90^{o} to the right.
Momentary look Up	Press UP ARROW, presents view as long as key is held, shifts view 90^{o} straight up. Also known as “lift vector” view.
Momentary look Back	Press DOWN ARROW, presents view as long as key is held, shifts view 180^{o} to see out the back of the Hornet. Also known as “checking six!”

F5-F8, External

My aircraft	Press “F5” to see and external view of your Hornet.
Padlock target	Press “F6” to padlock the currently selected target with an external Hornet view.
Padlock nearest	Press “F7” to padlock the nearest enemy airplane with an external Hornet view.
Padlock wingman 1	Press “F8” to padlock wingman 1 with an external Hornet view.
Padlock wingman 2	Press SHIFT and “F8” to padlock wingman 2 with an external Hornet view.

F9-F12, Other Views

In-flight weapon view	Press “F9” to view your just released weapon (missile or bomb) while it is in-flight. Press “F9” again to view the same weapon from an internal “weapon-eye” perspective.
Radar target	Press “F10” to view your radar locked target. Press “F10” again to view the same target from an internal target perspective.
Cycle friendly aircraft	Press “F11” to cycle through external views of friendly aircraft.
Cycle friendly vehicles	Press SHIFT and “F11” to cycle through external views of friendly vehicles.
Cycle enemy aircraft	Press “F12” to cycle through external views of enemy aircraft.
Cycle enemy vehicles	Press SHIFT and “F12” to cycle through external views of enemy vehicles.

External view modifiers

Page Up	Move camera in
Page Down	Move camera out.
Down Arrow	Moves camera down.
Left Arrow	Pans camera left.
Up Arrow	Moves camera up.
Right Arrow	Pans camera right.

Any view modifiers

Home key	Optical zoom in.
End key	Optical zoom out.

FORWARD COCKPIT VIEW

The “Forward-looking cockpit view includes not only a forward view of the world, but also includes the most important instrumentation. This view includes necessary access to both weapon and sensor controlling Digital-Display Indicator (DDI)

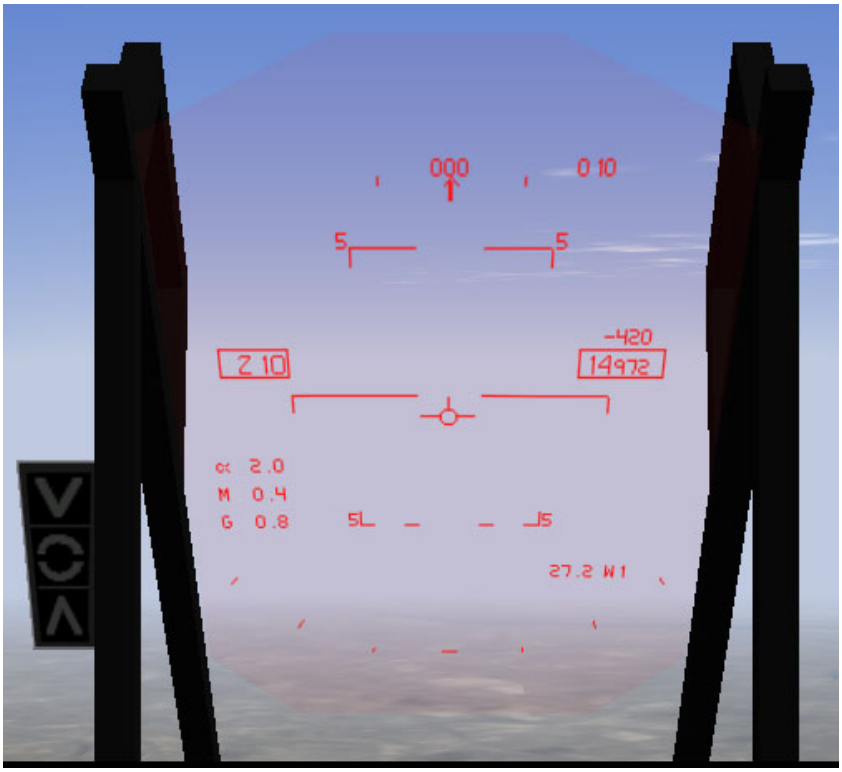
screens (the two green-screen monitors) and the HUD (Head's-Up Display.) This view also includes the UFC (Up-Front Control) and the right and left indicator banks.

HUD

The Head's Up Display or HUD is the primary flight instrument. It displays the aircraft heading, altitude, airspeed and vertical speed. The HUD also provides the pilot with important weapon information, which is covered in the Air-to-air and Air-to-ground chapters of this document. Navigation data is also included on the HUD.

Across the top of the HUD is the heading tape. This tape scrolls to display current aircraft magnetic heading. The current heading is always in the center of the tape HUD display as indicated by the small arrow called the heading caret. To fly the aircraft on a specific heading, turn and place the desired heading directly above the heading caret. Headings are displayed every 10^{o} from 0^{o} to 359^{o} magnetic.

The pitch ladder provides the pilot with a reference for climbs and descents. It ranges from 0^{o} (nose level) to +/- 90^{o} (nose up or nose down). The scale is graduated to every 5^{o} of pitch angle. The nose down or negative pitch horizon lines are segmented for ease of identification.



The velocity vector indicator is the small circle with three ticks at 3, 9 and 12 o'clock. The velocity indicates the actual flight path of the aircraft. The pitch ladder is always read relative to the velocity vector symbol.

The airspeed box is on the left hand side of the HUD and indicates calibrated airspeed in knots (Nautical miles per hour). Calibrated airspeed is corrected for air density and Instrument error.

The altitude box is on the right-hand side and indicates current aircraft altitude. There are two separate modes of altitude display. The default mode is barometric altitude display. This mode displays current aircraft altitude as determined from barometric pressure, and indicated in feet above Mean Sea Level (MSL.)

The second mode displays the current radar altitude or Above Ground Level (AGL) altitude in feet, measured from the ground directly underneath the F/A-18. It is indicated by an "R" off to the right side of the altitude box when it is active. It is only operational to 5,000 AGL. To select the radar altimeter mode of the altitude readout box, press CONTROL "A". This key toggles between the two modes. This mode should be used when operating the F/A-18 in close proximity to the ground. This is especially important when the ground is significantly higher than mean sea level.

The angle of attack (AOA) indicator is located directly below the airspeed box (Greek alpha character) and displays current aircraft AOA. AOA is the angle between the relative wind due to aircraft motion and the mean chord of the F/A-18's wing.

Mach number is below the AOA indicator. It displays the current aircraft speed as a percentage of the speed of sound (or Mach number). Mach is around 662 knots on a standard day at sea level and varies with air temperature and density.

Aircraft instantaneous "g" meter is located below the Mach number readout and displays current acceleration, measured perpendicular to the aircraft wing, as a multiple of earth's gravity. For example, a two-g acceleration is equal to two times the pull of earth's gravity. The F/A-18 Hornet's acceleration limit is 8.5 g's. Any more than this risks the possibility of structural damage to the airframe.

The waterline symbol is a fixed representation of the aircraft's centerline, or nose position. It is visible only when the landing gear is down to aid the pilot in maintaining acceptable landing AOA.

The HUD can be adjusted to better suit your needs while flying. To cycle the brightness or color of the HUD, press CONTROL “B”. You also have the option of removing some of the information on the HUD to make it less “cluttered”. To reduce the amount of information on the HUD, toggle the HUD clutter reject using “Ctrl-C”. If you desire to turn the HUD off completely, you can do so by pressing the CONTROL “H” key.

Left-hand DDI (Digital Display Indicator)

The Stores Management Set (SMS) display viewed on the left DDI. The SMS page (display) shows the current aircraft ordnance load, current weapon selection, the number of remaining cannon rounds (bullets) available for the gun, and the number of chaff and flares remaining. To see the SMS page, press “S”, or select and air-to-air weapon “[“, or an air-to-ground weapon “]”. The Engine status is also displayed on the left-hand DDI. This display includes a detail of the engine speed, thrust, etc. Press “E” to see this display. Electro-optical and HARM weapon image sensors are also displayed on the left DDI.

Right-hand DDI (Digital Display Indicator)

The right DDI shows the radar screen or the aircraft status. Radar display is toggled between Air and Ground master modes with the “R” key. Also displayed on the right DDI is the Equipment Status Display (ESD) using “D”. The ESD indicates failure or proper operation status of the major systems aboard the aircraft.

UFC

The Up Front Control (UFC) is the used by the pilot to engage auto-pilot modes, to perform target IFF (Identification Friend or Foe), and to engage TACAN (Tactical Air Navigation) and ILS (Instrument Landing System) navigation systems.

The textual florescent display above the keypad indicates the UFC mode, and the remaining displays on the left indicate the sub-mode, if available.

The final subsection of the UFC is the two radio frequency channel indicators at the bottom of the UFC. These change whenever you broadcast over the radio to a specific agency. If you are talking to ground, requesting permission to taxi, a “G” can be seen in the left frequency indicator box.

Caution and Warning lights

Above the left DDI is a set of caution and warning lights that provide back up indications of aircraft malfunctions or warnings. The left caution and warning lights have the following meanings:

FIRE	Left engine fire is detected.
MAST CAUT	(Master Caution light) The master caution light comes on, along with a master caution warning tone, whenever an aircraft malfunction is detected. If the malfunction has a warning light associated with it, the light will be on. Otherwise, aircraft system status should be checked on the ESD page (by pressing “d’) on the right DDI.
GO	All systems that are monitored on the ESD are up and operational at this time.
HOOK	When the light is on, this indicates that the aircraft arresting hook is in the DOWN position.
S BRK	Illuminates whenever the speedbrake or the wheel brakes are used. It will also be on whenever the parking brake is set.
L BAR	Launch bar position indication, when it is on the launch bar is down and connected to the catapult. The aircraft is ready for catapult launch. The launch bar is a small but very strong part of the nose landing gear that is lowered and attached to the catapult shuttle.
NO GO	Whenever a system monitored on the ESD malfunctions, this light will illuminate to tell you to check the ESD page on the right DDI.
STBY	This light is on whenever the AN/ALQ-126A ECM system is in standby mode.
REC	This light is on whenever the AN/ALQ-126A ECM system is receiving radar threat signals of significant strength to operate.
XMIT	dicates that the AN/ALQ-126A ECM system is transmitting (trying to jam) detected enemy radar signals.

The right caution and warning lights are located directly above the right DDI. These lights also provide backup indications of aircraft malfunctions or warnings. The lights on the right side have the following meaning:

RCDR	Indicates that the HUD recorder is operational and recording.
AI	Part of the RWR set, this light illuminates to indicate that your aircraft is being targeted with radar signals from another aircraft (Airborne Interceptor – AI).
CW	Also associated with the RWR set, this light illuminates whenever your aircraft has detected Continuous Wave (CW) radar energy.
DISP	Illuminates when there are no more dispensables (chaff and flare) left in your aircraft.
SAM	Part of the RWR set, this light comes on to indicate that the RWR has detected radar signals from a Surface- to-Air Missile (SAM) search and track radar.
AAA	Part of the RWR set, this light illuminates when the aircraft is being tracked by Anti-Aircraft Artillery (AAA) radar guidance signals.
APU FIRE	This light indicates that there is a fire in the Auxiliary Power Unit (APU).
FIRE	Illuminated when a fire in the right engine is detected.

LOOK DOWN COCKPIT VIEW

When the lock-down cockpit view is toggled (with “F1”), the HUD is longer, but the lower portion of the instrument panel is visible. This view includes the HSD or Horizontal Situation Display. Other important instruments that are visible only in the cockpit look down view include standby flight instruments, landing gear and flaps, and ordnance jettison status. Also available only in the look down view is the IFEI (Integrated Fuel / Engine Indicator), and mechanical standby flight instruments.

IFEI

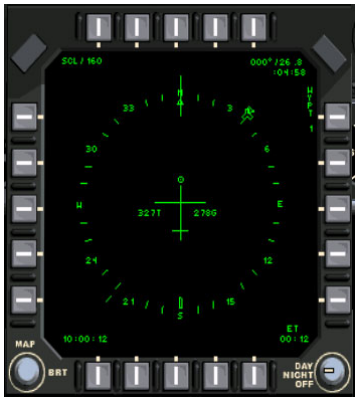
The AEU-12/A Integrated Fuel / Engine Indicator (IFEI) panel provides the pilot with engine status and fuel information. The following information is available on the IFEI concerning engine status:

RPM	Indicates the engine compressor stage’s RPM as a percentage.
TEMP	Exhaust Gas Temperature reading displays current low pressure turbine discharge gas temperature, in degrees centigrade. EGT is your best indication of engine thrust.
NOS POS	Engine nozzle position indicator. This number represents a percentage of allowable expansion size of the engine nozzles for all throttle settings.
FF PPH	Fuel flow in pounds per hour indicated for each engine. Total fuel flow is derived by adding both numbers together.
PSI	Engine oil pressure in PSI.

In addition to engine performance information, there is fuel quantity information displayed on the IFEI. That information is:

TOT FUEL	Combined internal and external (drop tanks, if loaded) fuel amount. Displayed in pounds.
INT FUEL	Total internal fuel amount.
BINGO	Preset low fuel warning amount that indicates you have only enough fuel remaining to reach home base.
TIME	Indicates the flight time reaming at the current time, given fuel flow and fuel quantity remaining.

HSD



The Horizontal Situation Display (HSD) shows either a moving map ("M") or just basic navigation data ("N"). The map mode "M" selects the mode and cycles the map scale. Navigation mode does not have a color map background and is invoked by pressing the "N" key. For further information about the HSD, see the chapter on Navigation/Radar.

Standby Instruments

The standby instrument group is located on the lower right side of the cockpit look down view. These are the only conventional instruments found in the F/A-18 cockpit. They utilize pitot and static air ports independent of Air Data Computer (ADC) sources, providing redundant operation should the primary attitude systems fail. The standby instrument group consists of:

Standby attitude indicator	Provides the pilot with pitch and roll information.
Turn indicator	Moves to provide the pilot with direction of turn.
ILS localizer and GS needles	Operate when ILS is selected to provide the pilot with glideslope and localizer information to the selected runway.
Waterline symbol	Indicates the aircraft nose position. The waterline symbol is NOT a VV.
Standby airspeed indicator	Provides an alternate means of determining aircraft indicated airspeed, should the primary system fail. It reads in knots.
Standby altimeter	Provides a back up method of determining aircraft barometric altitude should the ADC malfunction. The standby altimeter always reads height above sea level.
Standby VSI	This instrument provides static pressure Vertical Speed Indicator (VSI) information to the pilot if the INS should fail. The instrument is calibrated in thousands of feet per minute,

	rate of climb or descent.
RWR scope	Although not a flight instrument, the ALR-67 Radar Warning Receiver (RWR) scope is located in the standby instrument group. For further information about the RWR scope, see the chapter on Navigation/Radar

Selective Jettison Station lamps

Located immediately to the left of the Engine Monitor Display in lookdown cockpit view is the station selective jettison indicator panel. This panel provides advisory information when performing a selective ordnance jettison. To get rid of (or jettison) your undesired under wing stores the lamps will illuminate from top-to-bottom in order. Use "J" to cycle to the desired jettison stations and then press "ENTER" to jettison whatever is located on that rack. Ordnance, which is jettisoned, is dropped in a safe condition and will not explode upon ground impact.

CTR	Center station selected for Jettison (selected by first press of “j” key).
LI and RI	Left #3 (left inboard) and right #7 (right outboard) stations selected for Jettison.
LO and RO	Left #2 (left outboard) and right #8 (right outboard) stations selected for Jettison.

Landing Gear and Flap indicators

The final set of warning and indicator lights located in the cockpit look down view are the landing gear and flap indicator lights. They are located directly below the station selective jettison lamps. They will indicate the gear and flap positions as follows:

NOSE	Green indicates that the nose gear is down and locked. If the light is out then the nose gear is up and locked.
LEFT	Green indicates that the left main gear is down and locked. If the light is out then the left main gear is up and locked.
RIGHT	Green indicates that the right main gear is down and locked. If the light is out then the right main gear is up and locked.
HALF / FULL	Both lights are green when the flaps have been commanded to the full down position by pressing the “f” key. If the flaps are commanded up, then both lights will be out

CHAPTER 2: TAKEOFF AND FLIGHT

This chapter will take you from engine start all the way through getting the Hornet airborne. Additional sections in this chapter that talk about doing acrobatics and formation flying. After reading this chapter and trying some of the suggested techniques, you should feel comfortable with how the F/A-18 handles, with the exception of landing. The functions of the auto-pilot and how to engage and use them are also discussed.

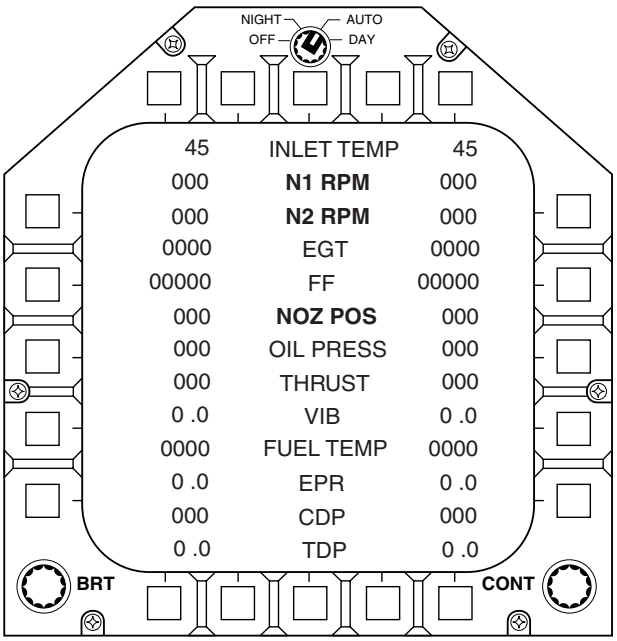
ENGINE START

The F/A-18 Hornet is powered by two F404-GE-400 turbo fan, afterburning engines. These engines produce approximately 10,700 lbs of thrust at military rated thrust, and 16,000 lbs of thrust when using afterburner. These engines give the Hornet a thrust to weight ratio in the class of 1:1 or better. Engine monitoring and control is automatically accomplished by a computer engine monitor that meters fuel and air mixture to the engines in response to pilot movement of the throttles.

The first step in flying the F/A-18 Hornet is to start the engines. This section will discuss how to accomplish that and what normal indications during start should be.

Engine page

The engine page should be initialized to the left DDI, and the right DDI should indicate that the radar is in STBY mode, or turned off. If the engine page is not visible, press "e" to bring it up. Look at the RPM numbers for N^1 and N^2. They should both be zero. It is important to realize that these numbers are a percentage of allowable RPM and don't really have any special significance. That doesn't mean they aren't telling you the current state of your engines. You need to know what certain power settings should be with respect to N^1 and N^2. As we continue to fly the F/A-18, I will tell you what some of these numbers should be.



Start

To engage the APU and start the engines, press the "+" key. You will hear the APU start and will notice the brief warning light test (above the left and right DDI) during start.

Monitor start

Although the engine page should be automatically initialized to the left DDI, ensure that it is there and that you can see it during the whole engine start procedure. Watch the numbers increase from their "off" values to their normal idle values. When EGT, FF and RPM stabilize re-check their values and make sure they fall within the following ranges for ground idle:

RPM	60 to 67 %
FF	3000 to 6000 PPH
EGT	400 to 550 degrees C

Engines up and operating

With both engines up and within normal operating parameters, the aircraft generators will automatically assume the electrical load from the battery (which was powering the aircraft prior to this point, and which was used for starting). All aircraft systems can now be used as desired.

It is not recommended that you turn on the radar until the engines are up and running. The radar is a significant drain of electrical power and the battery should not be used to run it. Battery power should always be conserved for emergency uses only.

TAXIING

"Driving" an aircraft on the ground is called taxiing. To taxi an aircraft, including the F/A-18 Hornet, you must use thrust from the engines and friction from wheel brakes located on the two main landing gear wheels. Steering is accomplished by the nose gear, which turns in response to rudder pedal or aileron input. The nose wheel steering (NWS) has two independent modes of operation to help taxi the F/A-18 in confined spaces, such as an aircraft carrier landing deck.

Power up and taxi

Begin taxiing by powering up the engines. Use the "+" key to increase thrust. Monitor forward velocity by referring to the airspeed box in the HUD. While the F/A-18 is on the ground, with weight on wheels, the airspeed indicator will function to display current forward velocity. To reduce thrust, use the "-" key.

Since your F/A-18 has the same physics properties as all matter (it's inertia we are talking about here…) it will take a little bit more power to get the Hornet started rolling. But once the aircraft is rolling, the thrust required to keep it rolling is not as great. So, after the aircraft starts to move, and airspeed is passing 10 knots, reduce the throttle setting to near idle to keep your speed between 10 and 15 knots. The 10 to 15 knot speed window for taxiing is optimal because it provides enough forward movement to get you where you are going in a timely fashion and it isn't so slow that the aircraft refuses to turn. It is normal during taxi operations to make throttle adjustments and brake applications constantly to get where you need to go.

NWS

The nose wheel steering (NWS) system is automatically engaged with weight on wheels (aircraft sitting on the ground). It allows the pilot to steer the aircraft through the use of the rudder pedals or the aileron controls. NWS has two modes; normal mode and "HI" mode. Normal mode has reduced control sensitivity for use during high-speed taxi. Normal is used during takeoff and landing to make aircraft control less sensitive. NWS HI is automatically enabled whenever weight is on wheels and the aircraft's forward speed is less than 20 knots. Nose wheel steering HI gives the pilot increased nose wheel turn movement to allow for easier control at slower taxi speeds.

NWS is displayed in the HUD below the altitude box. If NWS normal mode is being used the HUD will display just "NWS." If the NWS mode HI is being provided, the HUD display will read "NWS HI."

Brakes

The wheel brake on the main landing gear provides friction-braking capabilities on the F/A-18. To apply brake pressure, press the SPACE bar. The duration of pressure applied is equal to the time the SPACE bar is held down. For long applications of the brakes, press and HOLD the SPACE bar. For short applications, just press the SPACE bar briefly – then release it. Whenever the brakes are pressed the SPD BRK light above the left DDI will illuminate.

Parking brake

The parking brake is also applied through the use of the SPACE bar. To activate the parking brake the plane must be at a complete stop – no forward motion at all. Once the plane is stopped, press the SPACE bar to activate the parking brake. The SPD BRK light above the left DDI will illuminate when the parking brake is set and will remain on until the parking brake is released.

To release the parking brake press the SPACE bar once (tap it). The SPD BRK light above the left DDI should extinguish. The aircraft will now taxi normally.

It is important to note that while on an aircraft carrier, the parking brake controls the launch bar. Procedures for using the launch bar and for performing a catapult launch are covered in the chapter on Carrier operations.

Clearance to Taxi

Before you taxi, you need to request permission to taxi from ground control. You should never move an aircraft on an airfield (or even an aircraft carrier) without the permission of the ground controllers. Ground controllers are part of the Air

Traffic Control (ATC) system that usually work in the tower along side the tower controllers. They are responsible for providing you with safe separation from other aircraft that are also trying to taxi at your airport. So, before you go charging around, check in with ground and request clearance to taxi by pressing the SHIFT "g" key.

TAKEOFF

Takeoff begins on the runway and ends with the Hornet airborne and the landing gear retracted. Takeoff is probably one of the easiest maneuvers to perform; yet it is one of the most potentially dangerous. Statistically, most aircraft accidents occur during the takeoff or landing phase of flight. Pay close attention to what is going on until you are safely away from the ground. Although the F/A-18's ejection seat is an excellent emergency escape system, if you mess up during takeoff, I wouldn't want to be the one that has to explain the aircraft incident to the Commanding Officer (CO).

Clearance for Takeoff

Taxi to the runway as specified by the ground controller. When you reach the end of the assigned runway you must "hold short", or wait for takeoff clearance. Do not taxi on to the runway unless you have been cleared by tower for "takeoff" or "position and hold." "Position and hold" clearance allows you to taxi onto the runway and wait for final takeoff clearance. At the runway hold short, request takeoff clearance by pressing SHIFT "t" for tower. The tower will advise when you are cleared for takeoff. Do not taxi beyond the hold short line until you have clearance.

Taxi into position

With clearance to takeoff from the tower, taxi the aircraft on to the runway and position yourself on the centerline. Try not to leave too much room behind you – unless you have wingman who will be following. If you have an emergency during the takeoff phase, you are going to need all the space you can get.

Engine run up

Before advancing the throttles to the final takeoff setting, set the parking brake and then advance the throttles to military rated thrust. Move the throttles by tapping the backspace key once. If you press it more than once you will select afterburner. Check that RPM is 100% and that everything is functioning correctly. Move the flight controls and make sure that the control surfaces actually move.

Takeoff roll

Once the control check is complete and the engines are checked, advance the throttles to maximum afterburner by tapping the back space key several times. Afterburner has 6 different stages and they are reflected by the nozzle position indication on the engine page. Use the following information to help you set the desired AB setting:

Afterburner setting 1 (lowest)	Nozzle position 10
Afterburner setting 2	Nozzle position 20
Afterburner setting 3	Nozzle position 30
Afterburner setting 4	Nozzle position 40
Afterburner setting 5	Nozzle position 50
Afterburner setting 6 (highest)	Nozzle position 60

Pause momentarily then release the parking brake by hitting the SPACE bar. The aircraft will begin to move down the runway. As airspeed increases, steer to keep the aircraft on runway centerline. Do not apply any back pressure (pull back on the stick – commanding nose up) before the aircraft is ready to fly. Applying back stick pressure can cause premature rotation and possibly a ground loop. Just keep the aircraft in the center of the runway and wait until the aircraft is ready to go flying.

Rotation

At 150 knots in the HUD, depending upon aircraft gross weight, the aircraft will "jump" off the runway. This is most noticeable if you do not hold in any back pressure during takeoff roll. When reaching 150 knots, after the aircraft tells you it's ready to fly by "jumping" off the runway, smoothly apply back stick until the nose reaches 10° nose up. When the VV reaches 10°, hold it there and continue to accelerate.

Clean up

When you're safely clear of the ground and you have established a positive climb rate, check your airspeed. When the airspeed passes 210 knots, raise the landing gear by pressing "g." If flaps were used (not necessary for a normal takeoff) retract them now. Check that both the gear and flaps are safely retracted by pressing the "F1" key to see these indicators.

Weapon systems

If this is a combat sortie, then shortly after takeoff, you want to prepare your weapons and sensors for battle. The first sensor to activate is most likely the radar.

FLIGHT

At this point you should be airborne in your F/A-18 wondering what you should do next. In this section, we will fly some basic maneuvers to give you the feel for how the F/A-18 handles.

Basic FAM maneuvers

Familiarization (FAM) maneuvers help you to learn key handling characteristics of the F/A-18 Hornet. These maneuvers also build skills that will be used during actual tactical operations. Practice the maneuvers as often as needed to feel comfortable with their execution and take note of the key learning objectives associated with each one.

Straight and level flight

This might be more of a challenge than you might think! Pick an altitude, say 5000 feet MSL, and level off there. Level off by placing the VV on the 0° horizon line and keep it there. After you feel comfortable with keeping the aircraft close to level flight, try turning (level turn) to a cardinal heading, such as south (180°). Use any bank angle of your choice, but keep it less than 25° for now. When you feel comfortable again, select a new altitude and climb or descend to get there. Try to hit the altitude exactly and keep the aircraft there once you reach it. Practice this several times until you can hold an altitude within 100 feet and a heading within 2 degrees. Although this may not have as much tactical significance as other FAM maneuvers, flying an exact altitude and heading are important for landing and aircraft carrier operations

Turns

We just practiced some basic turns, but we limited ourselves to 25° or less of bank angle. During actual operations, we will need more than this to get us where we need to go. There are actually three different types of turns that we will need to use while operating the Hornet; instrument, hard and break turns.

Instrument turns

Instrument turns are limited to 30° of bank angle and typically yield a 1 ½ ° to 3° per second turn rate. A 360° turn at 3° per second will take 2 minutes – this is also known as a standard rate turn. Instrument turns are performed by rolling the aircraft into a 25° angle of bank and turning the aircraft in the desired direction. Instrument turns are used when flying the aircraft under Instrument Flight Rules (IFR) and for operations in the landing pattern, both on the boat and at the field.

Hard turns (engaging turns)

Hard turns are energy sustaining turns designed to get the aircraft turning in the most expeditious manner. Energy sustaining means that you do NOT want to lose a lot of airspeed when you perform them. It is a good habit to use hard turns whenever turning the aircraft in a tactical environment. To perform a hard turn, roll the aircraft to 70° - 80° angle of bank and pull to 4 - 5 G's in the HUD. It is alright if you lose a little altitude during the turn, the focus here is on turning the

aircraft and not losing airspeed. Hard turns are used when turning the aircraft toward an Air-to-Air engagement in order to maintain aircraft energy. They are also known as “engaging” turns.

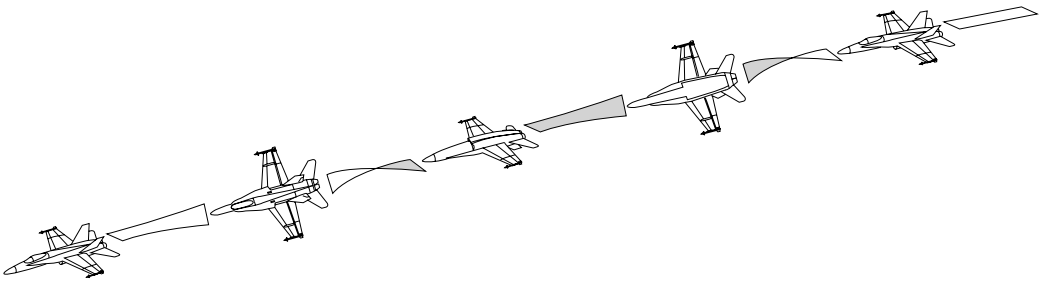
Break turns

Break turns are the energy depleting turns used only for special reasons, primarily to avoid something that has the potential to shoot you down – such as a SAM or A/A missile. To perform a break turn, roll the aircraft to 70° - 80° angle of bank and pull to 6 - 8 G’s in the HUD. Airspeed conservation is not an issue when executing a break turn – survival is. If you want to have enough energy to be capable of using another break turn, execute the break turn with a nose low attitude. Keep track of your altitude, and never execute these too close to the ground. Use break turns in performing missile and gun defense maneuvers.

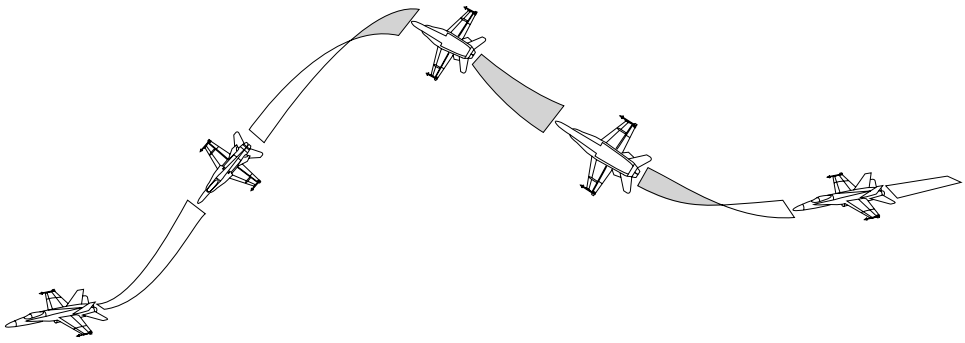
ACROBATICS

Acrobatic maneuvers use bank angles in excess of 60° and pitch angles in excess of 30°. These maneuvers are typically what we see aircraft perform when we watch an airshow. Many of these moves were derived from actual combat.

Aileron roll



An aileron roll is performed by rolling the aircraft about its longitudinal axis for 360°. The procedures for an aileron roll are; begin at 350 knots then pull the nose up to 10° nose high, “bunt” or sharply stop upward nose movement with forward stick input, then roll the Hornet using aileron input only for a full 360°. Recover the aircraft with the VV on the horizon and wings level. The aileron roll can be performed using various roll rates (slow to max stick deflection) to experiment with the handling characteristics of the airplane. You will find that the F/A-18 can reach high roll rates during 1 G flight. You will discover that rolling the aircraft while the aircraft G meter in the HUD indicates 0 G or less will yield even higher roll rates.

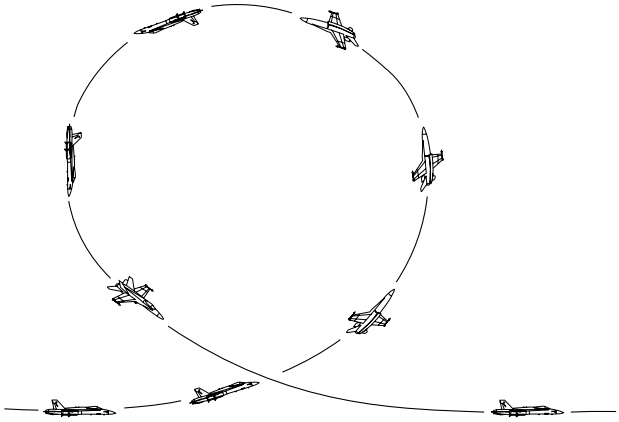


Barrel roll

The barrel roll involves the coordinated use of stick and ailerons to perform correctly. The maneuver basically combines an aileron roll with a loop. The entry airspeed should be 350 knots. To perform the barrel roll begin by smoothly pulling back on the stick until the nose is 25° nose up, use between 3 - 4 Gs. When the nose reaches 25°, start adding aileron input to begin the aircraft rolling in the direction of the barrel roll. Continue the rolling and back stick inputs, using 90° off of your maneuver entry heading while inverted as your next bench mark. After passing inverted, start reducing the roll rate by slowly bringing the stick back to neutral. Apply back stick as necessary during the second half of the maneuver to end the barrel roll on the same altitude you started at. The barrel roll is great maneuvers to help you understand how to actually displace

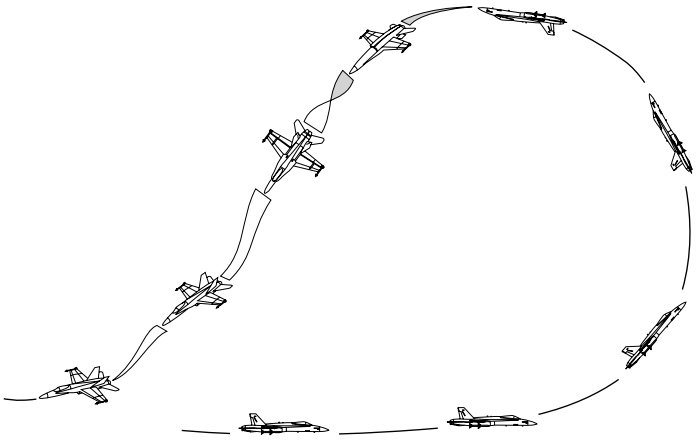
or "move" your aircraft in space. It is fundamentally the same as the missile defensive moves except it is a lot smoother and not performed at high G.

Loop



The loop is mechanically one of the simpler acrobatic maneuvers to complete. It only uses back stick pressure to perform it correctly. Begin the loop at 400 knots on a cardinal heading (N,W,E, or S). Smoothly pull back on the stick until you see 4 – 5 G's in the HUD. Approaching 90° nose up slightly reduce back stick pressure, but keep the nose moving at a constant rate. You should be inverted with a heading 180° out from the entry heading. Passing 90° nose down you will have to start increasing back stick pressure again to avoid losing excessive altitude. Complete the loop on the same altitude and heading you started from. The Loop helps you to understand the force of gravity and how it affects vertical maneuvering during ACM. Note that less stick force was required when the nose was above the horizon and more was required when the nose was below than the horizon. Also try experimenting with your cockpit views while performing a loop. This will help prepare you for flying BFM.

½ Cuban eight



The final acrobatic maneuver we will perform will help us learn a basic bomb "loft" type of flight profile. Begin the maneuver just as in a loop. Continue over the top, but when the aircraft reaches 45° nose low sharply stop nose movement by applying brief forward stick. Then quickly roll the aircraft 180° (ailerons only) to upright. Apply back stick now and attempt to recover from the resulting dive at the entry altitude, 180° out from the entry heading.

SLOW FLIGHT

We will investigate the slow flight regime of the F/A-18's flight envelope to acquaint you with how well the Hornet handles when you are at lower airspeeds. The first drill will help you feel how sluggish the airplane can get when its energy is low. The second drill will introduce how the airplane responds to control inputs when in the landing configuration.

Flaps up

Pick an altitude above 5000 feet AGL to begin the next series of demonstrations. Without putting gear or flaps in, reduce the throttle to flight idle and use the speed brake to slow down. Once below 150 knots, roll the aircraft back and forth. Notice it's reduced pitch and roll rates. For crisp control response you need airspeed, and below 150 knots is not the place to be for best aircraft performance.

Flaps, gear, and hook; down

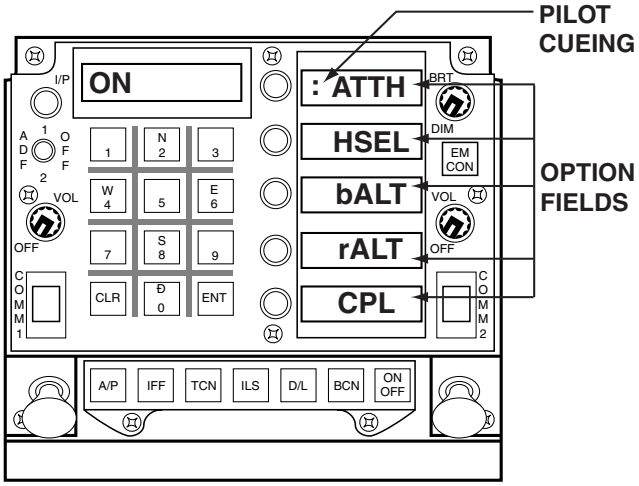
Next configure the airplane for landing while still at altitude and slow. Check gear, flaps and hook all down. Fly the aircraft some in this configuration and experiment with controllability. Try to execute controlled descents on heading and then with gentle turns (no more than 25^{o} angle of bank) at 500 to 1000 feet per minute descent rates.

PILOT RELIEF MODES (AUTO-PILOT)

The autopilot provides relief to the pilot when traveling across long distances. It is good for maintaining altitude and heading and will even fly an ILS approach to the ship. It does not fight the airplane for you and cannot drop any ordnance off the jet. It is merely a tool to help reduce the pilot workload during long missions.

Basic auto-pilot

The autopilot has two basic modes of operation; basic and advanced. The basic autopilot functions to maintain the aircraft attitude that existed at the time of its engagement. If the roll attitude was 5^{o} or less at the time the autopilot was activated, the aircraft will maintain wings level on the current magnetic heading. If the angle of bank is greater than 5^{o}, then the aircraft will maintain the present angle of bank, in the turn.



Advanced auto-pilot modes

The advanced autopilot modes are more capable than the basic autopilot. They not only provide pilot relief during straight and level flight conditions but also have the capability to fly instrument approaches.

To select an advanced autopilot mode, press the SHIFT “a” key. This action will initialize the A/P mode on the UFC and will colonize the first option field for you automatically. Keep pressing the SHIFT “a” key until the option you desire is colonized. Please note that although the proper option is now colonized the autopilot is not yet engaged. To engage the autopilot press the “a” key. The desired autopilot mode is now properly selected and engaged.

The advanced pilot relief options are:

ATTH (Attitude Hold)

The attitude hold function of the auto-pilot maintains the aircraft’s pitch and roll attitude that was present at the time the mode was selected.

HSEL (Heading Select)

The heading select mode will turn to and track the current selected navigation waypoint. This mode will also maintain the same barometric altitude that was being flown at the time of autopilot engagement.

BALT (Barometric Altitude Hold)

Barometric altitude hold will maintain the barometric altitude present at the time of autopilot mode engagement. This is measured above Mean Sea Level or MSL.

RALT (Radar Altitude Hold)

Radar altimeter hold will maintain the last selected absolute altitude reading by maintaining the last radar altimeter altitude when the autopilot mode was engaged. This is Above Ground Level or AGL altitude.

CPL (Couple)

The aircraft and navigation aid coupling mode will automatically fly the aircraft down a localizer and glide slope beam to a perfect landing. This mode provides relief in both attitude and altitude and will perform an almost "picture perfect" approach and landing for you automatically! All you have to do is maintain the proper "on speed" airspeed with the throttle.

ILS Coupling

When landing at airfields you can select the ILS for a specific runway when you get within 10 NM of it. Select the ILS by pressing the "L" key. The ILS needles will initialize to the HUD and will provide you with glide slope and course deviation information. The course line deflects in the direction the actual course lies from your current position if you are pointed toward the runway. You must be close to being aligned with the runway to receive the ILS signal. It is best to be as close to the extended runway centerline as possible at the time of ILS coupling engagement.

ACLS Coupling

Automatic Carrier Landing System or ACLS is a shipboard ILS system that is calibrated to function in concert with the carrier's landing deck. It functions in the same way as the ILS coupling does. When aligned for the carrier deck, within 10 NM of the ship, select ILS by pressing "L." Then couple the autopilot by selecting the CPL mode. To activate the autopilot press "a" with the CPL option colonized. It is much more critical to maintain the "on speed" AOA airspeed during the carrier approach than the field approach. This ensures proper landing orientation for optimum hook - cross deck pendant engagement.

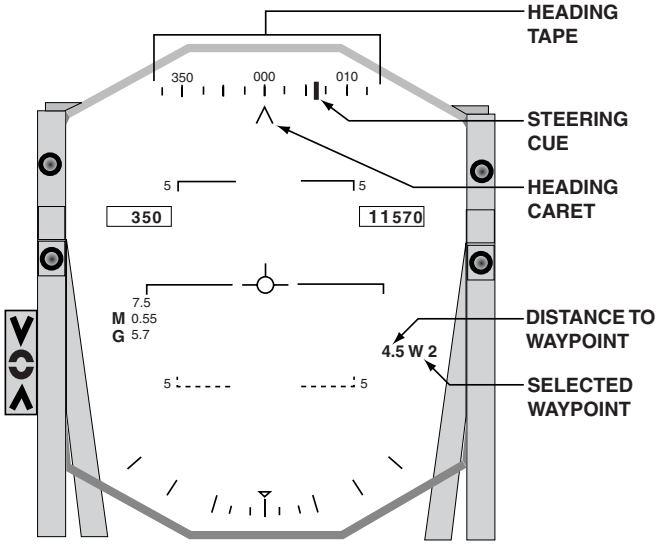
NAVAIDS

This section will briefly demonstrate how to select and use navigation aids in order to fly the Hornet. For more in-depth information concerning Navigation, please refer to the chapter on Navigation/RADAR.

Waypoint Steering

Waypoints are navigation points loaded into the F/A-18's mission computer. To select a waypoint – press the "w" key. Successive presses of the "w" key will cycle through all available waypoints. Navigation waypoint 0 is often home base, so if you need to return to base (RTB) cycle waypoint steering until WYPT 0 is selected. Steering information (the direction you need to go) to the waypoint is presented both on the HUD and on the HSD.

HUD symbology for waypoint steering is dependent upon which master mode is currently selected. Navigation master mode has the most information displayed in the HUD. Both A/A and A/G have less waypoint information available to the pilot on the HUD.



In navigation master mode the HUD display contains the following information:

Waypoint information – located below the altitude box, it displays the distance (in NM) to the current selected waypoint. The waypoint selected is designated with a W and the number of the waypoint. For example waypoint 0 would be W0.

Steering cue – the vertical line located on the heading tape indicates the current heading needed to fly toward the selected waypoint. To fly directly to the waypoint, align the steering cue with the heading caret located in the center of the heading tape.

The waypoint information is also displayed on the HSD in the cockpit look down view accessed by pressing the “F1” key. For more information about the HSD display refer to the chapter on Navigation/RADAR.

TACAN Steering

Radio navigation aids called TACAN’s are also available for use for steering purposes. To select TACAN steering, press the “t” key until the desired TACAN station is displayed in the HUD and on the HSD. Selecting a TACAN for navigation will DE-SELECT the current waypoint, and selecting a waypoint will DE-SELECT the TACAN. Only one can be used at a time.

TACAN steering information provided in the HUD is the same as for waypoint steering with one exception; instead of the waypoint identifier, there is a TACAN station identifier. A TACAN identifier is a station unique, three letter code.

Additional TACAN information (like waypoints) is displayed on the HSD in the cockpit look down view accessed by pressing the “F1” key. For more information about the TACAN display refer to the chapter on Navigation/RADAR.

CAUTIONS/WARNINGS/EQUIPMENT STATUS

In addition to the caution and warning lights visible in both cockpit views, the F/A-18 provides the pilot with other cues as to the general “health” of the aircraft.

Voice alert

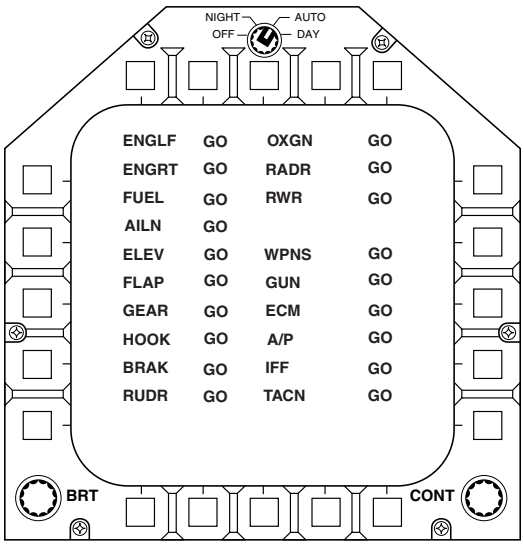
The F/A-18 Hornet has a voice alert system, sometimes referred to as “bitch’n betty.” The system will alert the pilot to problems that exist, that require immediate attention. Specific voice warnings and their meanings are:

“Altitude, Altitude”	Is letting you know that you are below safe altitude and that ground impact is imminent or impending.
“Engine Left or Engine Right”	Is telling you that either (or both) engines are inoperative.
“Fuel Low, Fuel Low”	Is letting you know that you are about to use your last 800 lbs of fuel out of your main fuel tank.
“Bingo, Bingo”	Is telling you that you only have enough fuel to return to base.

ESD

The master caution light will illuminate to indicate that the aircraft computer has detected a fault in one or more of the onboard systems. When this occurs, there will be warning tone to alert the pilot of the master caution condition. To determine which system has a malfunction or to check the current status of your Hornet’s systems press the “d” key. This will initialize the Equipment Status Display (ESD) page on the right DDI.

On the ESD a “GO” indication means that the specific equipment or system is turned on and operational. A “NOGO” indication means that the respective system has sustained some kind of damage and not functioning correctly. The systems monitored on the ESD are:



Acronym	Description
ENGLF	The left engine has failed or is shutdown. This information is derived from EGT, THRUST, VIB or OIL being out of parameters.

ENGRT	The right engine has failed or is shutdown. This information is derived from EGT, THRUST, VIB or OIL being out of parameters.
FUEL	Engine fuel tank pressure is low or there is a cross-feed valve manifold leak.
AILN	Aileron failure, either mechanical or electrical.
ELEV	Elevator failure, either mechanical or electrical.
FLAP	Flap malfunction, flaps will not operate normally.
GEAR	Landing Gear mechanical failure.
HOOK	Arrestor hook is inoperative.
BRAK	Speed Brake is inoperative.
RUDR	Rudder failure, either mechanical or electrical.
OXGN	Oxygen bottle quantity is below 10%, or Oxygen system has failed.
RADR	Radar has failed or is not communicating on Multiplex Bus (MUX) with the Mission Computer (MC).
RWR	Radar Warning Receiver malfunction or MUX I/O failure with the MC.
WPNS	Stores Management Set (SMS) built in test (BIT) failure, or MUX I/O failure with the MC.
GUN	20mm Gun is jammed, overheated, or not communicating on MUX to the Stores Management Set (SMS).
ECM	Interference Blanker is inoperative, Countermeasure Set fails to test correctly, or MUX I/O failure with the MC.
A/P	Autopilot failure to test properly.
IFF	Identification Friend or Foe (IFF) transmit/receive unit test failure.
TACN	Tactical Air Navigation (TACAN) transmit/receive unit test failure.

EMERGENCIES

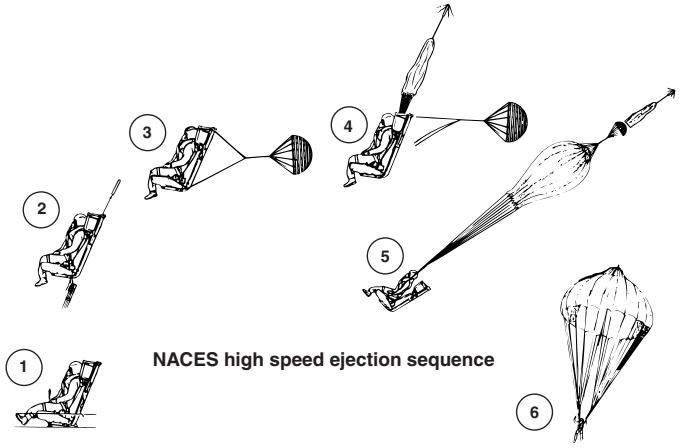
The F/A-18 Hornet is an extremely tough aircraft and is capable of withstanding a good deal of punishment. Unfortunately it is not invincible and will sustain damage if it is caught within the lethal radius of an enemy weapon system. In addition to that, there are occasional system failures that will occur due to no other reason than – it broke. You will probably have to deal with both of these types of emergencies at some point during your career.

On the Ground

Emergencies experienced while the Hornet is on the ground are best handled by stopping and shutting down the aircraft. If the system is something you think will not impact your ability to perform the mission, then by all means just continue with the flight. If the emergency is more serious in nature, then shut down and get yourself in a new jet. The enemy is already trying to do their best to shoot you down, you don't need any additional help from a sick airplane.

Takeoff

Takeoff emergencies occur during a very critical phase of flight. There is usually not much time to think about what actions need to be taken. If you are below 120 knots, stop the aircraft on the runway and taxi clear. If you are above 120 knots, continue the takeoff and handle the problem while airborne. Remain within visual range of the airfield and work out the problem. Determine if the problem is mission "GO" or mission "NO GO." If you decide to keep the jet, then continue on with the mission. If you decide that you need to get a new airplane after you are airborne, then consider jettisoning your external fuel tanks and return to the field for a landing.



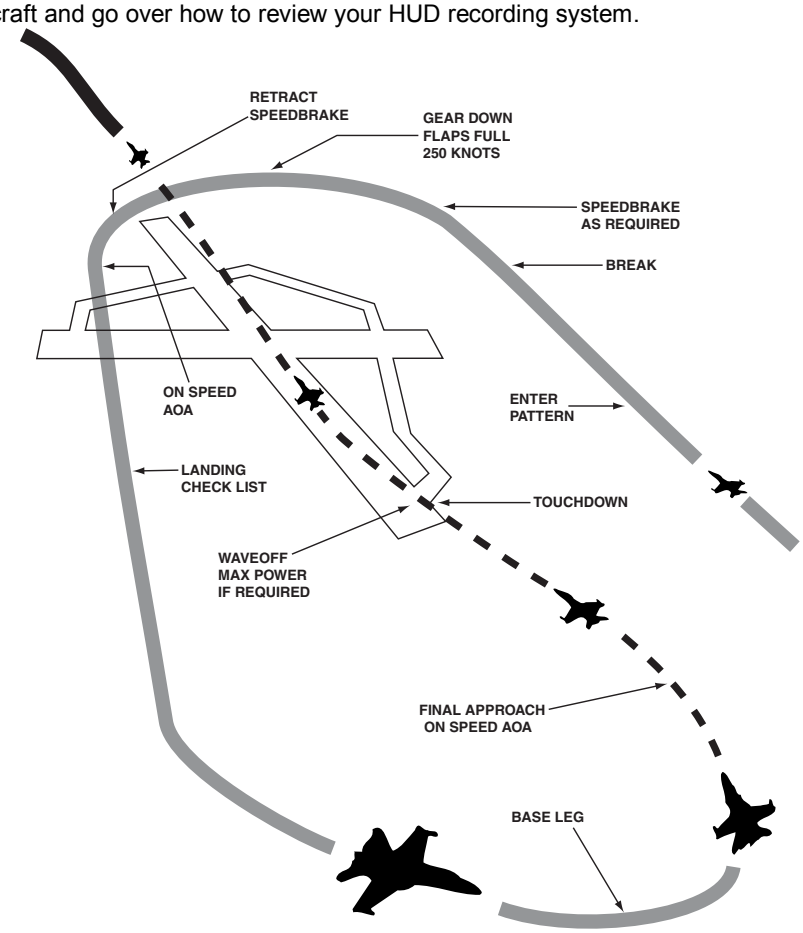
NACES high speed ejection sequence

Ejection

If at anytime while flying you have an emergency that occurs that prevents you from operating the aircraft safely you have the option of using the ejection seat system to exit the plane. To eject – press the SHIFT “e” key. This will activate the Navy Aircrew Common Ejection Seat (NACES) and swiftly and safely pull you from the aircraft. The NACES seat has a Zero – Zero capability and will safely eject you from the Hornet even if you are at 0’ AGL (on the ground) and 0 knots airspeed. Ejection may not get you style points, but it sure beats dying!

CHAPTER 3: LANDING

In the previous chapter we started the F/A-18 and got it airborne. After we got into the air we performed some basic maneuvers to gain handling experience with the jet. Now comes the time to get the airplane back on the ground in one piece. We will first review the landing pattern at the field and then address some landing techniques for the Hornet. We will then shut down the aircraft and go over how to review your HUD recording system.



APPROACH

After completion of your mission you will need to RTB. Getting back to the airfield is as simple as selecting the proper waypoint or TACAN and then centering steering to get home. Within 30 NM of the airport you can request vectors from Approach Control by pressing SHIFT "c." Approach control is the terminal area radar facility (part of the ATC system) that provides aircraft with safe separation while operating within a busy airport's airspace.

Vectors to a landing

Approach control will provide you with vectors based on where you tell them you wish to go. If you have an INS waypoint selected, approach control will vector you to the airport that is closest to your current location. If you have a TACAN station selected, approach control will provide you with vectors to get to the selected station. Once within range of the airport it is up to you to align yourself up for the active runway.

Landing pattern

Navy and Marine Corps airfields have a landing pattern that is slightly different from those in use at other fields. The pattern has its roots in the aircraft carrier pattern and it is therefore unique to Navy and Marine Corps fields. With a little practice you will become comfortable with the landing pattern first at the field and then later, in the next chapter – at the boat.

There are basically two methods of getting into a Navy or Marine Corps field, either under Visual Flight Rules (VFR) or Instrument Flight Rules (IFR). If the weather allows it, the easier method (and more fun) is the VFR method. The weather for the VFR recovery must be at least basic VFR weather or 3000 feet ceiling or better and 5 statute miles (statute miles are used by the weather guess 'ers, nautical miles are used by aircrew…) visibility or more. If the weather is worse than the basic VFR minimums, the IFR recovery will be used to get aircraft to the active runway.

Before entering within 5 NM of the field of intended landing, contact approach control for advisories by pressing SHIFT "c." Approach control will help you by giving you a vector (heading) to fly to get to the field.

VFR recovery

The VFR recovery is designed to get aircraft in to the airport traffic area quickly, and cycle them to land in the most efficient manner. The approach to the field will start on extended runway centerline, 4000 feet above airport elevation at 5 to 8 NM from the end of the runway. The aircraft is then flown directly toward the runway between 300 and 400 knots. Descend to be directly over the beginning of the runway at 1500 feet AGL and between 300 and 400 knots. You should be pointed down the runway, on runway heading. At mid field you will execute a VFR "break." Out of the break, you will dirty up (transition to the landing configuration) and fly the VFR landing pattern and land.

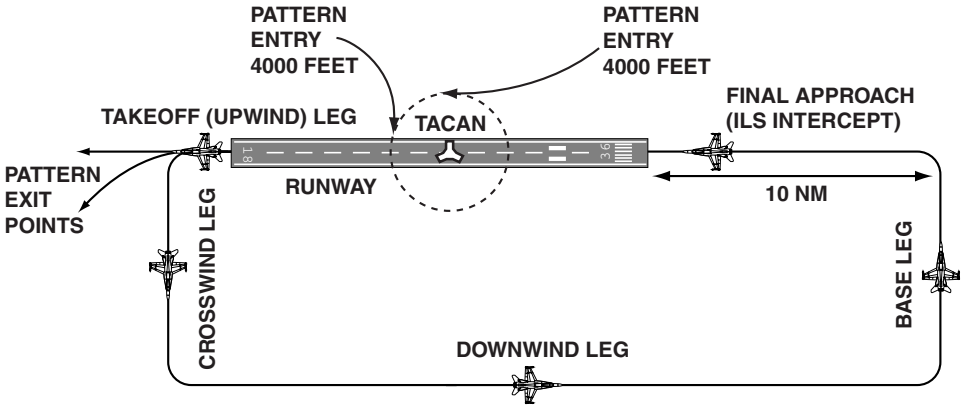
The "Break"

The break is a Navy and Marine Corps landing maneuver which simultaneously aligns your aircraft on the appropriate downwind heading and reduces your airspeed safely to below maximum gear and flap operating speed. It is a level turn from the landing runway heading to the reciprocal heading for the downwind leg.

To fly the "break" be at the active runway numbers at 300 to 400 knots, at 1500 feet AGL, on runway heading (pointed down the runway). At mid field, roll the aircraft sharply into an 80° bank. After completion of the roll, quickly pull back stick to an energy bleeding turn of between 5 to 7 Gs. After applying the G, reduce the throttles to idle while you also fully deploy your speed brake to the open position. Make this a level turn – keeping the VV tracking on the 0° pitch line. Roll out after 180° of turn on the reciprocal heading of the runway. When airspeed is less then 200 knots, add back some power and stow the speed brake. Put the gear and flaps down. Settle the aircraft into the on speed condition and fly a circular 180° descending approach to a landing.

IFR recovery

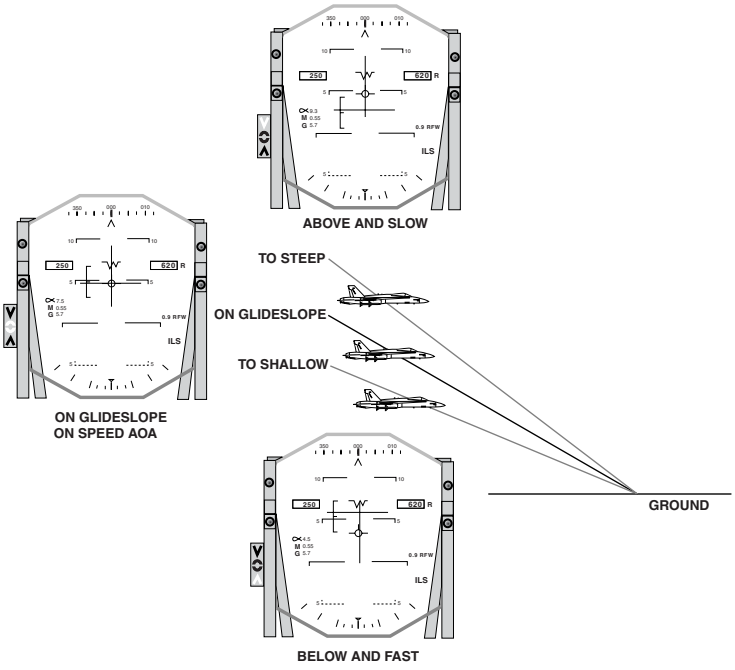
If the weather dictates it, you will have to use the IFR recovery to the field. Whenever you have mechanical problems with the aircraft you should also use the IFR recovery regardless of the weather. The IFR recovery begins by flying directly over the airfield's TACAN at 4000 feet AGL and 250 knots. Just prior to reaching the TACAN, execute an instrument turn to the active runway's reciprocal heading. Continue out the reciprocal heading until 10 NM as indicated by the Distance Measuring Equipment (DME) set incorporated into the TACAN navigation transmitter/receiver. At 10 DME perform another instrument turn for approximately 180°, turning back toward the runway. Activate the ILS and fly the "needles" inbound and land. Note that there is only one ILS active at each airfield, so if the ILS is not receiving valid signals, try another runway.



ILS

The instrument landing system (ILS) provides the pilot with both glide slope (altitude) and localizer (azimuth) information to guide the aircraft down to the runway safely. The ILS provides safe obstacle clearance and proper runway positioning if flown correctly. These safety margins are only assured if you are within a ½ VV width away from the ILS centered needle indication.

The horizontal ILS bar is your glide slope indicator. It will deflect in the direction of the desired glide path in relation to your current position. If the bar is higher than your VV the proper glide path is above you. To correct this you must decrease your rate of descent or

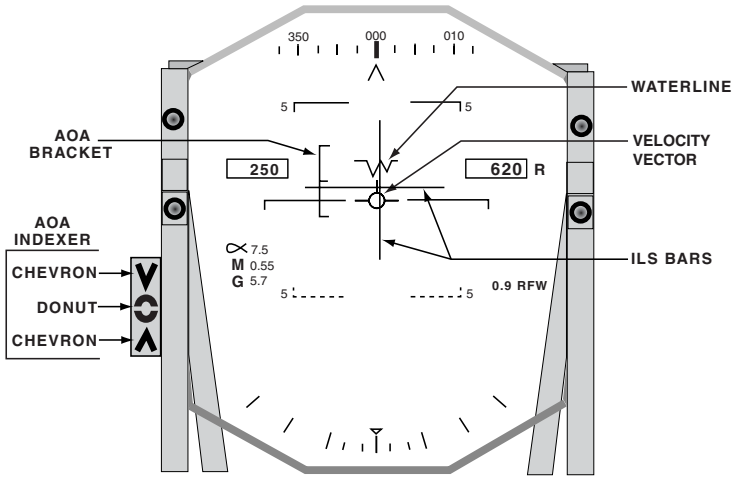


climb to re-center it and get back on the glide path. If the bar is below the VV, you are above the glide path and must increase your rate of descent to re-intersect the proper glide path.

The vertical ILS bar is your localizer or course indicator. It will function to align you with the runway for making a safe landing. The bar deflects to indicate the direction the localizer course lies from your current position. If the bar is deflected to the left of your VV, then the proper course is to the left also. To correct this, begin a slight turn to the left to re-capture the localizer centerline, then reset your heading to correspond to runway heading.

Note that course and glide slope corrections should be more aggressive the further you are away from the runway. As you get closer to landing the needles will move much faster to smaller control inputs, so keep corrections smaller when you are getting close to the runway.

On-speed AOA



On-speed Angle Of Attack (AOA) provides the pilot with optimal lift to drag performance at landing speeds. It is measured by the aircraft's computers and displayed on the HUD whenever the landing gear are in the down and locked position. All landings should be flown at on-speed AOA.

Angle of Attack is defined as the angle between the relative wind and the chord line of the aircraft's wing. A stall will result if the AOA gets too high, because the air can no longer travel across the airfoil and produce enough lifting force to counter the force of gravity. Stalls occur in the F/A-18 at approximately 30^{o} AOA and higher. To avoid stalling the wing, keep AOA less than 38^{o}.

On-speed AOA airspeed occurs in the region of "reverse command" in the F/A-18s flight envelope. What this means is that flight control inputs will not necessarily produce the same effects that they would if performed at higher airspeeds. Usually whenever you are flying at less than 160 knots, you are operating in this region of the Hornets flight envelope. When in the region of "reverse command," nose movement mostly controls airspeed and altitude is mostly controlled by power. This is opposite to the control inputs associated with normal (faster) flight regimes. It is important to understand this part of the flight envelope while flying the Hornet close to the ground in the landing pattern.

Finally, on-speed AOA positions the Hornet in the best attitude for a carrier "trap." If flown exactly on-speed, the hook and the main landing gear wheels will all strike the aircraft carrier's deck at the same time. Any other AOA will either result in a "bolter" (a miss of the wire), or an in-flight engagement of the wire. Both of which are undesirable.

HUD Bracket

On the HUD, the AOA bracket looks like the letter "E" and moves up and down in relation to current aircraft AOA. On-speed AOA is indicated by the centerline on the AOA bracket. The aircraft is perfectly on-speed when the centerline of the "E" is aligned with the left wing on the VV. If the bracket is above the VV, then AOA is low and you are faster than on-speed AOA airspeed. If the bracket is below the VV, then you are slower than on-speed AOA airspeed. The bracket actually represents the allowable deviations from on-speed AOA that still allow for safe wire engagements. The top line is the upper AOA limit, and lower line is the lower AOA limit. The bracket can be extremely sensitive, so make your adjustments small and then wait to see where the bracket settles. Note that any rapid nose movement will immediately cause the bracket to jump.

Chevrons

The AOA chevrons also display the on-speed condition during landing. They are sometimes easier to see than the HUD bracket and provide a good visual back up in case the HUD fails. Like the AOA bracket, they are only active when the landing gear are down and locked. The on-speed condition is displayed with the center, yellow circle or "donut." The lower

red chevron indicates that you are fast and your AOA is lower than the on-speed condition. To correct this, pull the nose up – the chevron is pointing up to remind you. The other extreme is the green chevron which indicates that you are flying at a slower than on-speed airspeed with an AOA which is in excess of on-speed. To correct for this condition, lower the nose slightly to re-capture on-speed AOA.

Here is some advice for flying the proper AOA, if you are having trouble with it. First, it is difficult to do, so you must keep working at it. Never accept a slightly fast or slow indication (that occurs when you see both the donut and a chevron). As previously mentioned in discussion of the "region of reverse command," nose movement controls your AOA. While this is happening the throttle will be providing the majority of the control over your rate of descent. If your sink rate gets to large, add power to stop it. If your sink rate is too small, take some power off. You are keeping on-speed AOA with nose movement all the time. This may seem unnatural at first, so the best solution will be to practice AOA control at a safe altitude. Try controlled descents for 1000 feet and then level off. Then climb back to the starting altitude and level off there. Practice this until you can safely maintain on-speed while gently turning and changing your altitude.

TOUCH DOWN

Prior to touch down, be sure to contact tower by pressing SHIFT "t" for landing clearance. After tower clears you to land perform a final check of your landing configuration just to ensure that your gear are down and locked.

The touch down portion of the landing phase is probably the easiest. The goal is to maintain on-speed AOA and proper glide slope until the ground reaches up and touches your wheels. You FLY the aircraft into the deck, the same way you will land when you go to the aircraft carrier. An actual landing will occur with a rate of descent between 500 to 700 feet per minute! Some have labeled it a "controlled crash" which might help explain the fact that the landing gear on Navy and Marine Corps aircraft are so "beefy!" Be very careful though, and do not land with excessive sink rates, (in excess of 1100 feet per minute) especially at the field. It wouldn't be much fun turning a "controlled crash" into a real one…

Rollout

After landing the aircraft, use ailerons (which are controlling NWS) to maintain runway centerline. After safely reaching the centerline apply wheel brakes with the SPACE BAR and hold them until airspeed is less than 25 knots. Below 25 knots, taxi clear of the runway and contact ground control for further instructions.

Go–around

If you are "waved off" anytime during your approach you must execute an immediate go around. A go around is performed by adding full military rated thrust (MRT) and pulling the nose up to maintain on-speed AOA until you are climbing away from the ground. Once a rate of climb is established, retract the landing gear and flaps, then lower the nose slightly until you reach 250 knots. Maintain 250 knots and join the landing pattern or shoot another approach, whichever one applies to your situation.

SHUTDOWN

Taxi back

After clearing the runway and receiving clearance from ground control to taxi, taxi your aircraft to parking for shut down. If you are going to "hot pump" fuel into to your Hornet, head for the refueling spot and set your parking brake once there. After the brake is set, the ground crew will quickly refuel and rearm your F/A-18.

Shutting down

With the parking brake set, press the "-" key to reduce the engine RPM to idle. It is a good habit to bring up the engine page and monitor the shut down. Once the engines are at idle RPM, tap the "-" key again to secure the engines. Welcome back!

Refueling and re-arming

After landing you have the option to "hot re-fuel" and re-arm your aircraft, and heading back out to fight the war! To do this, taxi to one of the re-fueling spots on the airfield. A large "F" within a square painted on the concrete designates re-fueling spots. In order for the fuel hoses to reach, your aircraft must be completely within the area of the painted re-fueling square.

Bring your aircraft to a complete stop and set the parking brake. To begin fueling press the SHIFT “f” key. To re-fuel and re-arm press the SHIFT “s” key. When your tanks and stores are full again, request taxi clearance and head back out.

DEBRIEFING

After the completion of your flight you will be automatically shown a Debriefing report. This provides you with information concerning your performance during the last mission. On this same screen are the words “Save Mission Replay”. Click this to save a replay file of the just completed current mission. All replays are stored in a directory named "Replays" within the main application directory.

EMERGENCIES

Landing with a sick airplane is not easy. Control response may be degraded or there may be less thrust available than normal (one engine out for example). There is not much time for long decision processes so keep things simple for yourself when you are trying to land a broke jet. Do not perform the VFR entry; it’s best to stick with an IFR recovery with a long straight away to land. Keep your speeds slightly higher, but not so high that you can’t stop on the runway. If you suspect damage to the wings – do not use landing flaps. Finally, if you are only using one engine – jettison all external stores and keep yourself slightly above normal glide path until you have the runway assured. Then reduce power and land –being slightly fast with a single engine is probably not a bad idea either.

In some emergencies you may want to reduce your landing weight by jettisoning any under wing stores or by dumping excess fuel. Usually this is only a problem for single engine flight when you cannot maintain level flight with the operating engine in afterburner.
To jettison stores, invoke the lookdown cockpit view and press the “j” key to select the station you want to get rid of. With the station highlighted press the ENTER key to separate the store from the aircraft. Continue the process as necessary to clean off your wings.

Dumping fuel should only be performed in extremis. Make sure you have enough fuel left to make the nearest suitable landing strip. To dump fuel press the SHIFT “d” key. Fuel dumping will continue as long as the SHIFT “d” key combination is held. It is advisable to monitor the fuel quantity indicator panel on the IFEI while dumping.

Ejection

If the situation degrades, and it might – quickly, don’t forget you always have the option of using your ejection seat – just press SHIFT “e” and you’ll be magically separated from the troubled airplane.

CHAPTER 4: CARRIER OPERATIONS

WELCOME TO THE BOAT!

Carrier operations are probably the most challenging and potentially dangerous flying in aviation. There is little margin for error when you combine a small, constantly moving runway with an extremely high performance airplane. Although the task may seem daunting, armed with knowledge and skill, and a bit of practice… you'll be catching the "three" wire every time.

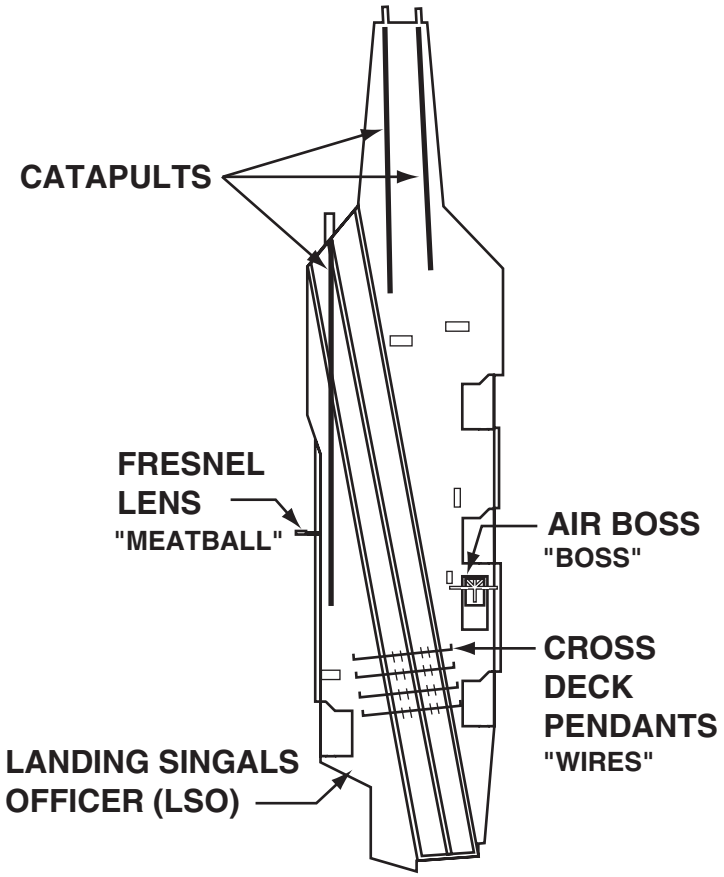
Because the Hornet is designed to operate aboard aircraft carriers, you will be required to be familiar with carrier operations. Even if you have selected a Marine Corps squadron, you will still have to operate off of the boat at some point. This section contains the information to get you "up to speed" with the flight operations performed around the carrier.

Introduction to Carrier Operations

The aircraft carrier is a very powerful asset in shaping and enacting our nation's foreign policy. Carriers are a means by which the United States can rapidly exert pressure upon another potentially hostile country. Sometimes just "stationing" an aircraft carrier in the vicinity of the hostile nation is enough to serve our political objectives, but sometimes it requires more. In the case of the conflict designed for F/A-18 OIF, you will be required by the policy makers in Washington D.C. to perform more than just a "show of force." We are speaking softly, and carrying a really big stick…

THE LAYOUT OF THE CARRIER

As a pilot operating off the decks of an aircraft carrier you should be familiar with some of the boat's sections, as they relate to air operations.



Air Boss

The Air Boss on the aircraft carrier is basically the same as the control tower at the airfield. He is responsible for issuing landing clearance on the carrier. The "Boss" is located in the superstructure of the carrier and is contacted over the radio by pressing the SHIFT "t" key while within radio communications range of the boat.

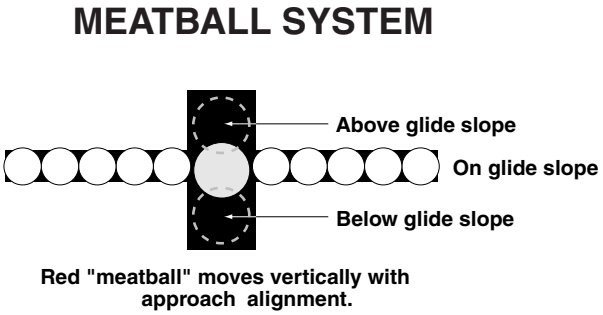
Catapults

The carrier in F/A-18 OIF has three fully functional steam catapults for use to launch aircraft. Two are located on the bow, or front, of the ship and the third is located on the port side, about half the distance back.

Cross deck pendants

The Cross Deck Pendants (CDP) or "wires" are all located in the ships landing area. There are a total of four CDPs available for use to arriving aircraft. The wires are numbered sequentially from the back of the boat to the front, so the number one wire is closest to the back of the boat, number two is next going forward, and so on… The ACLS and visual glide slope information all target the three wire. If a perfect approach and landing is flown to a successful trap, it will be the number three wire which catches your Hornet.

Fresnel Lens



Red "meatball" moves vertically with approach alignment.

The Fresnel Lens or "meatball" is your primary visual glide slope indicator at the carrier. It is located just to the left of the landing area. It shows the pilot where they are in relation to the proper glide path. The lens depicts actual glide slope position with a single amber light. The amber light will be visible while on final approach to the carrier. The amber light moves up and down as your aircraft moves above or below the required glide path. To provide a visual reference there are additional sets of green lights on either side of the "meatball." These are called the datum lights and illustrate where the proper glide slope is in relation to the meatball. If the meatball is above the datum lights, then you are above glide slope. If the meatball is below the datum lights then you are low. Keep the meatball exactly aligned (even) with the datum lights for proper glide slope. This is called a "centered ball."

Landing Signals Officer (LSO)

The Landing Signals Officer (LSO) has been designated the responsibility of ensuring safe landing operations by the Air Boss. You must contact the LSO by ¾ of a NM by pressing the SHIFT "L" key. The LSO will then provide radio calls to help you fly the ball all the way to touch down. The LSO watches your aircraft from a platform just off to the left of the landing area by the stern of the ship. From this position is very easy to tell what is going on with your aircraft as you come down the glide path. The LSO will usually see trends develop well before you notice any ball movement.

Because of their experience at bringing aircraft aboard, you are obligated to listen and comply with all calls the LSO makes during your approach – especially any "waveoff" calls. The following are typical LSO radio calls and their meaning:

"Call the ball at ¾ mile"	Continue flying your approach and "call the meatball" inside of 2.0 DME.
"Clear Deck"	The landing is clear and prepared for your arrival.
"Foul Deck"	The landing area is not clear or properly prepared for your arrival, this call will be followed by a "clear deck" call when the landing area is clear again.
"Check gear"	Check that your landing gear are down and locked (the LSO doesn't see any on your airplane).
"Check flaps"	Check that your flaps are down.
"Roger ball"	This is the LSO's acknowledgement to you when you "call the ball" (see the meatball).
"Hornet in the groove, call the ball"	The LSO is letting you know that he has not yet received your "ball call" at ¾ NM.
"You're fast"	The LSO is telling you that your AOA is low and that your airspeed is high. Remember that you MUST land on-speed at the carrier – no exceptions!
"You're slow"	The LSO is letting you know that your AOA is high and your airspeed is slow.

"Power"	You need to add thrust to your airplane now! Add power! Usually because you are low, slow or perhaps a combination of both.
"Keep it coming"	You are flying a good approach; keep making the correction you are currently working on.
"Bolter, bolter"	The LSO is telling you that your hook has missed all the wires and that you need to execute go-around procedures immediately.
"Wave Off"	You are out of parameters for a safe carrier landing – stop your approach immediately and take it around to try again.

CATAPULT LAUNCH

Operations while at sea begin with the catapult launch to get your Hornet airborne. The carrier has 3 steam driven "cats" to get you flying quickly. You can use any cat that is not currently in use by another airplane, or you can wait for your turn if there is traffic ahead of you.

Taxi

After starting your Hornet you will have to taxi to the cat and prepare for launch. The aircraft carrier deck is extremely small, so you will have to use extreme caution to prevent from running into another aircraft or a part of the ship. Look around before taxiing and be sure to contact the "Boss" BEFORE you move your aircraft.

Clearance

Request permission to taxi by pressing the SHIFT "t" key. The Boss will answer you just like the control tower at the airfield will. When the Boss clears you, taxi to the first unoccupied catapult. If the deck is full, patiently wait your turn. When there are no other aircraft in line, taxi into position and prepare for the catapult shot.

Position

Taxiing into the proper position for a catapult shot is very important. If you miss it, just taxi back and start over. Begin by aligning the aircraft with the catapult track well before arriving at the launch bar engagement point. Use a slower speed than taxiing around the airfield, no more than 10 knots works well. Approaching the start of the catapult track, slow the aircraft taxi speed to less than 8 knots. Continue a slow taxi just past the start and then apply wheel brakes, by pressing the SPACE bar, and come to a complete stop.

LAUNCH BAR

The launch bar on the F/A-18 Hornet is a small attachment to the nose gear that fits into the catapult shuttle. It is pilot controlled and must be manually lowered to the launch position. The only method of carrier launch is through the use of the launch bar.

After coming to a complete stop on the catapult launch track, deploy the launch bar by setting the parking brake. The brake light and the launch bar light will both illuminate to indicate that the bar is successfully deployed. Unless you are perfectly aligned on the track, the carrier's launch crew will automatically move you slightly to ensure proper track alignment. If you are not close enough to alignment with the track or you have not taxied far enough down the track the launch bar will not deploy. If this happens, first try taxiing a little further. If it still doesn't work and you are getting close to ¾ the way down the track, the problem is associated with your alignment. The only way to fix alignment is to taxi back around and start the process again.

Throttle

When you are ready for the "cat" shot, power the engines to afterburner by pressing the BACKSPACE key several times. The shuttle and the launch bar will hold your aircraft in place under this extreme pressure. Check your engine instruments one last time to ensure that you have both engines operating within limits.

Cat shot

The steam catapults are capable of generating massive forces. They can easily propel a combat laden Hornet from 0 to 130 knots in under 5 seconds. The cat shot happens rapidly, so you must be prepared to fly upon reaching the end of the stroke.

The stroke

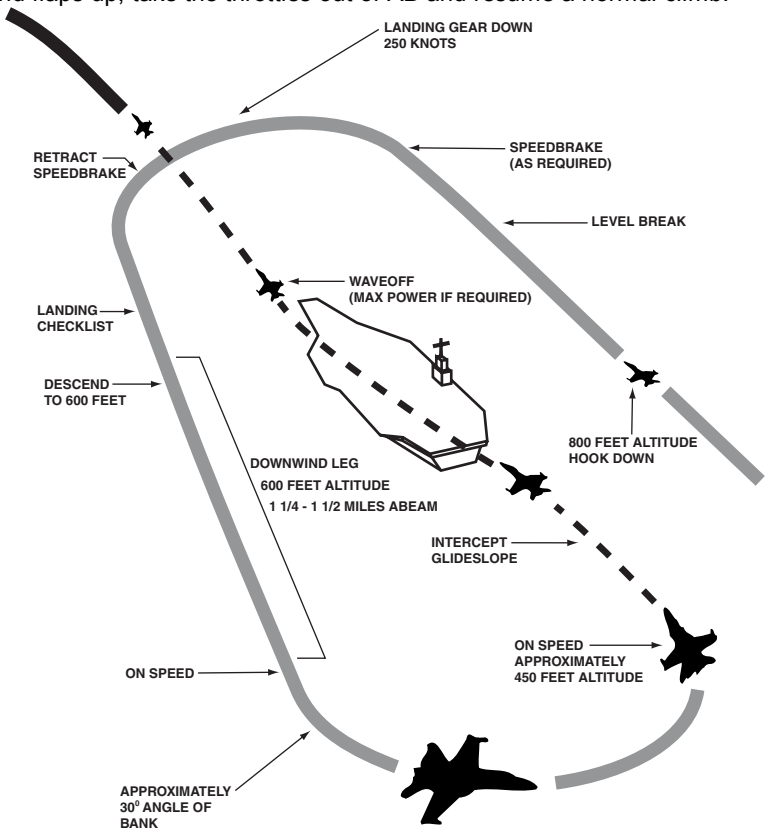
To begin the catapult launch, with engines in afterburner, press the SPACE key once. This will fire the steam catapult and begin your rapidly accelerating movement toward the edge of the carrier deck. Maintain neutral stick and rudder during the stroke. Just before reaching the edge of the flight deck, you should be concentrating on the HUD as your primary attitude reference. Keep a close watch on your VV and the waterline symbol.

Getting airborne

After the flight deck disappears from view below the cockpit, raise the nose to 10^{o} nose up and hold this attitude until airspeed increases over 180 knots. The aircraft will be easy to over-control at this point so concentrate on holding the proper attitude. As airspeed increases over 180 knots raise the gear and flaps. After the airplane is safely climbing away from the water with gear and flaps up, take the throttles out of AB and resume a normal climb.

VFR PATTERN

The aircraft carrier uses two different arrival procedures based upon the current weather or time of day. If it is day and the weather is good (above 3000 feet and 5 NM) the type of pattern flown is the VFR pattern. The VFR pattern requires you to maintain visual contact with the boat at all times. It is a much tighter pattern than the IFR pattern and will usually get you on the deck quicker.



Pattern

The pattern is flown at 600 feet MSL (over the water, this is the same as AGL) and on-speed. With the exception of the entry break maneuver, the gear and flaps should always be down and locked.

Procedures

There are two ways to enter the VFR pattern, a turn to join right after the cat shot or the break. The turn to join after the cat shot is simply a climbing left-hand turn to enter the downwind leg of the VFR pattern. Make this turn at no more than 20^{o}

AOB or you will end up being too close to the ship and overshoot during the turn to the "groove." Note that the "groove" is the final straight away portion of the landing pattern inside ¾ NM range to the boat. In the groove, aircraft are set up for landing and wings level. The downwind leg is 180° out from the Base Recovery Course (BRC) which is basically the magnetic heading of the aircraft carrier. Also note that the BRC and your final landing approach heading (in the "groove") are different because of the carrier's angled deck.

The other VFR entry is the break. The break is flown by approaching the ship on BRC at 800 feet MSL. If the BRC is 000° then approach the ship from outside of 10 DME from due south of the ships position. As you fly toward the ship from outside of 10 DME, turn to ensure that the TACAN needle and your aircraft heading align together on the BRC. Airspeed for the break should be between 350 and 450 knots. Contact shipboard approach control by pressing SHIFT "c." Control will help to vector you toward the ship.

Closing on the ship, make sure your arrival altitude and airspeed are correct. Fly directly over the ship, on BRC. After passing the ships bow, wait a 2 count or so and then execute a break maneuver to the left. For more information on the "break" maneuver – refer to the chapter on Landing. Maintain 800 feet MSL until "dirty" (gear and flaps down) on the downwind leg. Then descend down to pattern altitude of 600 feet MSL. If you plan on trapping (engaging a wire) make sure you have your hook down also – it is kind of hard to catch a wire without a hook!

When abeam the stern of the aircraft carrier, wait another 2 count and then begin a descending left hand turn for landing. Initially set an AOB of approximately 22 to 25°. Then use the arrow keys to look at the carrier and check how your approach is coming. If you are close, you will have to increase your AOB, if you are far you will have to decrease AOB. Maintain on-speed AOA the whole time and control your rate of descent with power. Rate of decent should be between 450 to 750 feet per minute.

Fly your approach to be at the 90° point (only 90° left to turn to final landing heading) at 450 feet MSL. Contact the LSO at this point for final clearance to land. Plan your approach to fly just on the other side of the ship's wake. This "ground gouge" will set you up for a good "groove."

Approaching the "groove" if the LSO has not cleared you, contact him again. Continue to fly toward the landing area and look for the meatball. Roll out and align your aircraft with the landing area centerline. Your VV should be placed directly on the 3 wire and be indicating approximately 3 ½ ° nose low. Roll wings level in the groove then check your line-up again. Make any line-up corrections early. You will also have to take off some power when you roll wings level to avoid getting instantly fast or high – this is to counter the added lift you just acquired by moving both wings parallel to the ground. To fly the groove, maintain on-speed AOA and fly a centered ball all the way till touch down. Power for rate of descent and nose for AOA. Congratulations! You are now a Naval Aviator!

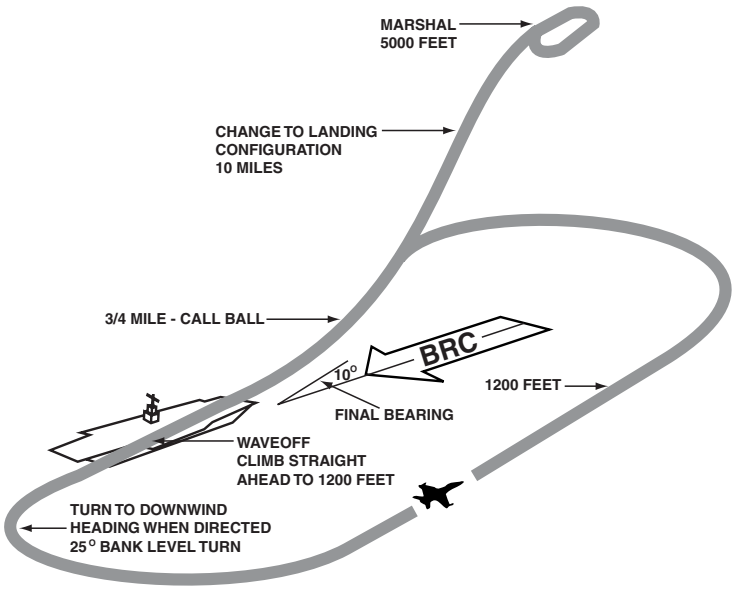
Please note that the VFR pattern is quick and will require some practice to get comfortable with – this is normal. It is not easy – nor is it meant to be! You didn't get those gold wings out of a bubble gum machine! Practice, practice, practice and before long it will become second nature to you.

IFR PATTERN

The IFR pattern will be in use anytime the weather is less than VFR or it is past official sunset. This pattern is basically more of a straight in to land type of approach with any missed landing opportunities being taken around for a second try at it. This is also the pattern you should fly if you have any malfunctions or emergencies to deal with.

Pattern

The IFR pattern is flown inbound at 1200 feet MSL until ILS glide slope interception (which should occur about 3 DME). After glide slope interception, the ILS approach is flown all the way to ¾ NM, where the pilot must choose to either hand fly the rest of the approach or engage the autopilot for landing.



Procedures

Start the approach by positioning your aircraft 15 NM from the boat at 5000 feet MSL. Fly to the inbound TACAN radial that aligns with the BRC. Fly toward the boat aligning BRC and the inbound TACAN pointer. At 10 NM descend to 1200 feet MSL and slow to 250 knots. After reaching 250 knots and 1200 feet, put the gear, flaps and hook down. After the aircraft is dirty, continue slowing to on-speed. You will be flying the remainder of the approach at on-speed AOA.

Continue inbound on BRC. At 5 DME select the shipboard ILS by pressing "L." The ILS symbology will initialize to the HUD. After selecting the ILS, contact approach. At glide slope intercept or 3 NM, whichever occurs first, contact the LSO. From this point fly the needles as a primary reference while listening to the LSO for guidance. At ¾ mile, you have the option of transitioning to a visual scan (look for the ball) or continuing flying the needles to touch down. If you have been using the ACLS up to this point, ¾ of a mile is where you must deselect it if your desire to land manually. Make your "ball" call after your decide how you will fly the approach. Then continue with the either flying the ball or the needles until landing.

WAVE-OFF OR BOLTERS

Every once in a while you will miss a wire, by either your own fault (bad approach, hook not down, etc…) or by equipment failure (hook skip). Don't worry, just continue back around and try it again. There are some procedures you would be wise to follow to avoid landing in the drink in the unlikely event of a late wave-off or bolter.

With all carrier landings, whether you actually catch a wire or not the first thing to do after you hit the deck is to select MRT or AB. This will ensure that you have enough energy (airspeed) on your jet to safely go around. If you don't follow this procedure and miss all the wires, you will probably not have enough airspeed to go flying and end up falling off the deck and crashing into the water. Always remember – at touchdown, select MRT or AB and be prepared to keep flying. The wire will have no problem stopping your aircraft within the confines of the landing area. Do not reduce your throttle setting until the aircraft is almost stopped.

VFR pattern

For a go-around to enter the VFR pattern, keep the gear, flaps and hook all down and start a left hand turn to enter the pattern on downwind. This entry is very similar to the entry after the cat shot.

IFR pattern

To re-enter the IFR pattern after a go-around, climb away from the deck and clean the aircraft up (gear, flaps, hook - all up). Turn the aircraft to BRC and climb to 5000 feet MSL. Maintain 250 knots. At 10 DME turn left 90^{o} and fly till 15 DME. At 15 DME initiate a left turn to the reciprocal of BRC. This will set you up to fly the IFR pattern again and have another go at the deck.

AFTER LANDING

After successfully catching a wire and reducing the throttle you will need to taxi clear of the landing area before shutting down. To drop the wire, raise the tail hook by pressing "h." When the tailhook drops the wire you be able to taxi from the landing area. Contact the Air Boss for taxi clearance by pressing SHIFT "g." Taxi to clear area on the carrier deck and either re-fuel / re-arm or shut down the engines.

Refuel and re-arming

Aboard the aircraft carrier you can re-fuel and re-arm the jet anywhere on the carrier deck to ensure clearance for other recovering airplanes make sure to taxi out of the landing area before setting your parking brake for re-fueling. To re-fuel the aircraft press SHIFT "f", to re-fuel and re-arm press SHIFT "s."

PROBLEMS GETTING ABOARD (HINTS)

Landing on the carrier is not as easy as it seems. The tolerances involved for making a safe controlled approach are very small. Here are some suggestions you may find helpful if your boarding rate (the number of attempts compared to the number of traps) is not what it should be.

Good start

Get a good start each time. A good start involves hitting all the numbers right on, and not settling for anything less. Another key to flying a good pass is to be on-speed early in the approach. Having your on-speed AOA under control early will make AOA one less factor you will have to control when you arrive on the ball.

Meatball

Scan the meatball across from left to right and then from right to left for movement. Sometimes movement will be hard to see, so use you ILS needles as a backup to tell where you are on the glide slope.

LSO

Believe it or not, the LSO is your best friend while you are landing at the carrier. He can see your trends well before you do, and if they are excessive he will call for you to correct them. Take all of the LSO's calls seriously and do your best to honor them. That doesn't mean you should over-control your aircraft in response to an LSO call (wave-off excepted…). But you should realize he is trying to get you aboard so you should always do your best to help him out.

CHAPTER 5: NAVIGATION/RADAR

NAVIGATION OVERVIEW

Navigation skills are essential for flying any aircraft, especially the F/A-18. In this section we will first address the navigation systems of the Hornet and how to operate them. The second part of the chapter will introduce AN/APG-65 radar and the F/A-18's sophisticated Radar Warning Receiver (RWR) and Electronic Countermeasure (ECM) systems.

Where you are

To operate a high performance aircraft like the F/A-18 Hornet, you'll need to know your current position at all times. The distances you have to travel may be quite long and using a map and a compass can be quite an effort. Especially when you should be looking out for the enemy! Knowing where you are is called position keeping. The F/A-18 is an extremely advanced aircraft and does all of this work for you so that you don't have to carry a map. All you have to do is follow the aircraft steering information to get to where you are headed.

What is an INS?

The F/A-18 Hornet has an internal position keeping device called an Inertial Navigation System or INS. It is very good at knowing your current position. It also can show you how to get to your next desired location, and additionally tell you how far it is and how long it will take you to get there at your current speed.

An INS does not need any external navigational aids or satellites to function. It measures the aircraft's actual velocities and computes how far the aircraft has gone from where it was originally. To do this the INS uses three extremely accurate movement-measuring devices, called ring laser gyros. One gyro is mounted in each of the three movement axis X,Y and Z. A computer in the INS receives the input from all three, combines and sorts the information and then provides the resultant aircraft position data to the aircraft's navigation displays. The INS is always performing this function while the aircraft's engines are running and providing the INS and associated navigation systems with electrical power.

WAYPOINTS

A waypoint is an aviation term for a defined location on the earth. The F/A-18 uses waypoints to navigate from starting point, through the target area, and then back to home base. Each step along the plotted course is a waypoint and the F/A-18 can have up to 20 different waypoints stored in it's Mission Computer (MC) for use on any one mission. Starting a new mission will clear all the old waypoint information out of the MC and load in the new data required for the new mission.

What is a waypoint?

A waypoint is comprised of 3 pieces of information; a latitude value, a longitude value, and an altitude or height value. This defines in three-dimensional space exactly where the waypoint is. The default value for altitude is the ground level at that point, expressed in feet above mean sea level.

Steering to a waypoint

Your INS in the Hornet will provide you with steering information to the currently selected waypoint. In other words, the system will tell you how to get to the selected point via the most direct method. Note that only one INS waypoint can be selected at any time.

Heading

Heading is the magnetic course you must fly to reach a selected waypoint. Heading information is provided on both the HUD and the HSD.

Distance

The INS knows the aircraft's current position and it also knows the location of the selected waypoint. Using this data the system can calculate the distance required to reach the waypoint. This distance is depicted on the HUD and the HSD. The distances calculated by the F/A-18's computers are always expressed in Nautical Miles (NM).

Time

Using current ground speed as a basis, the Hornet's navigation systems can calculate the time required to fly from your present position to the selected navigation point. This information is only displayed on the HSD.

Selecting Waypoints

There will usually be more than one waypoint loaded into the F/A-18's navigation computer. You must manually select which one is being used by the system to provide you with steering data. Waypoints can be manually changed through using the mission editor before flight. After reaching the cockpit there is no way to alter waypoint location data.

Cycle

Waypoints are cycled by pressing the "w" key. This will toggle you sequentially through the available waypoints starting at waypoint 0 and counting up with each successive press of the "w" key. After reaching the last loaded waypoint in the aircraft's navigation system, the sequence will start over beginning at WYPT 0 again.

TACAN

The military has it's own unique navigation aids called TACAN's. TACAN or Tactical Aircraft Navigation Stations are located all over the world. If you are familiar with civilian VOR's, a TACAN is very similar to a VOR/DME. In F/A-18 OIF, there are TACAN stations located on the aircraft carrier and at all friendly airfields. You should know how to navigate using TACAN stations in the event you loose your INS.

What is a TACAN

A TACAN is a radio navigation aid that tells the receiving station (aircraft) what their magnetic bearing is relative to the navigation aid. It also tells the receiving station what the slant distance (direct – line of sight distance) is between the station and the TACAN.

How does it work?

A TACAN radiates bearing information to all receiving aircraft navigation sets within its functional range. This information is sent out in all directions for a full 360^{o} of coverage. These bearings from the TACAN station are called radials. A radial is always measured FROM the TACAN station. For example, if you are due east of a selected TACAN station you will be located on the 090^{o} radial. Your current aircraft heading does not affect which radial you are on. Only your position relative to the selected station affects which radial you are on. Note, that the TAIL of the TACAN needle on the HSD depicts your radial from the station.

Display

The current selected TACAN station information is displayed in the HUD, on the HSD, and on the UFC. Whenever you select a new TACAN station by pressing the "t" key, the UFC will switch to the TACAN display page.

Channel

TACAN stations have simplified channel numbers instead of frequencies. This is part of the information displayed on the UFC when a new station is selected. These channels are unique and not repeated between TACAN stations that are close enough in proximity to allow for simultaneous reception by an airborne receiver.

Each TACAN also has a unique three-letter identifier code that helps you verify the proper selection of the desired station. A list of these codes is provided in the reference section of the manual.

DME

All TACAN stations also have Distance Measuring Equipment (DME). All of this means that when you select a TACAN station it will also display you current SLANT range to the station. It is important to know this because, unlike an INS waypoint, TACAN slant range will not count down to zero DME as you fly directly over the station at altitude. Your minimum DME will be equal to your aircraft's height above the station. After which DME will then begin to increase.

Steering to the station

Steering information to the TACAN station is depicted in the HUD and on the HSD. The TACAN needle of the HSD will always point toward the selected station. In addition to the TACAN needle, the actual TACAN station's location is depicted on the HSD relative to your aircraft. A small triangle shaped symbol is the TACAN symbol (the waypoint symbol is a small circle with a dot in the middle).

The following TACAN stations are located in the Hawaii theater:

Airfield Name	*TACAN identifier code*
NAS Barber's Point	*BRP*
Honolulu International Airport	*HNL*
Military OLF (near target area)	*HML*
U.S.S. Enterprise	*E65*

The following TACAN stations are located in the Iraqi theater:

Airfield Name	*TACAN identifier code*
Kuwait International	*KUW*
Al Taqaddum Airbase	TAQ
As Salman Airbase (RNK)	*SAL*
Ali Al Salem Airbase	*ALI*
Al Jarrah Airbase (RNK)	*JAR*
Salman Pak Airbase (RNK)	*PAK*
Tallil Airbase (RNK)	*TAL*
U.S.S. Enterprise	*E65*

The following TACAN stations are located in the Multi-player (NAS Fallon) theater:

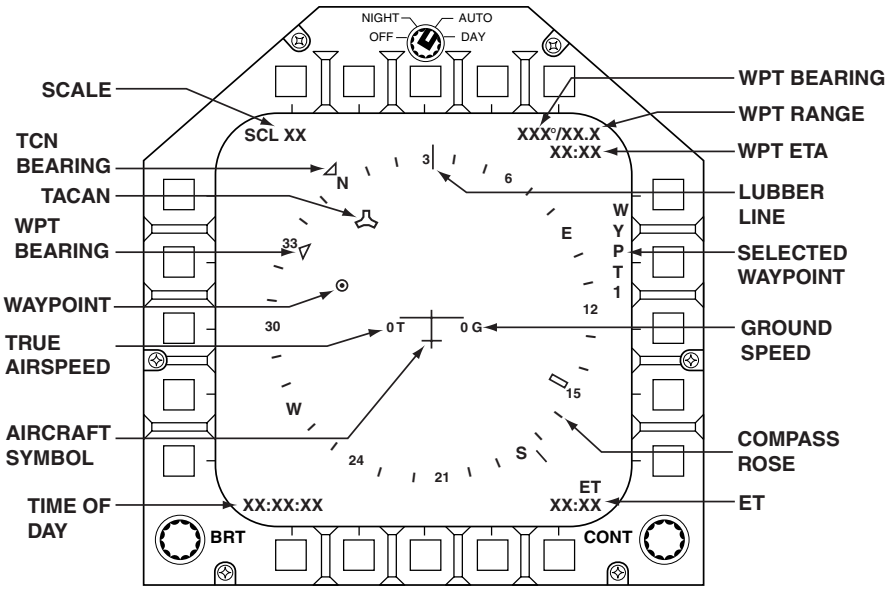
Multiplayer):

Airfield Name	*TACAN identifier code*
NAS Fallon	*NFL*
Gabbs Airfield	*GAB*
Austin Airfield	*AUS*
Red U.S.S. Enterprise	R65
Blue U.S.S. Enterprise	B65

NAVIGATION SYMBOLOGY

HSD

The Horizontal Situation Display (HSD) is located in the center of the cockpit in look-down mode. It provides navigation data and a color moving-map capability. When in navigation master mode the HSD provides a monochromatic display of the aircraft's current navigation situation. The display is a plan view (top-down) of where the aircraft is located in the simulation world. The aircraft's location on the display will always be in the center, represented by a pictorial aircraft symbol. The

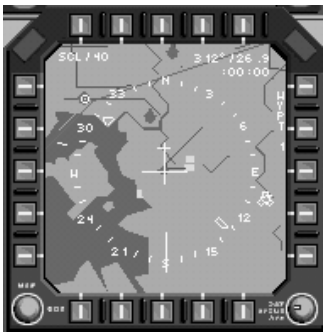


compass rose and all bearing information move to reflect changes in aircraft heading and steering information selection. On the navigation display (no map visible) your aircraft's heading will always be located at the 12 o'clock position on the compass rose. All headings displayed on the HSD are magnetic.

As waypoints or TACANs are cycled by pressing "w" or "t", the HSD symbology and HUD heading tape course marker will change to display the new information to that navigation point or station. The HSD symbology and data fields are as follows:

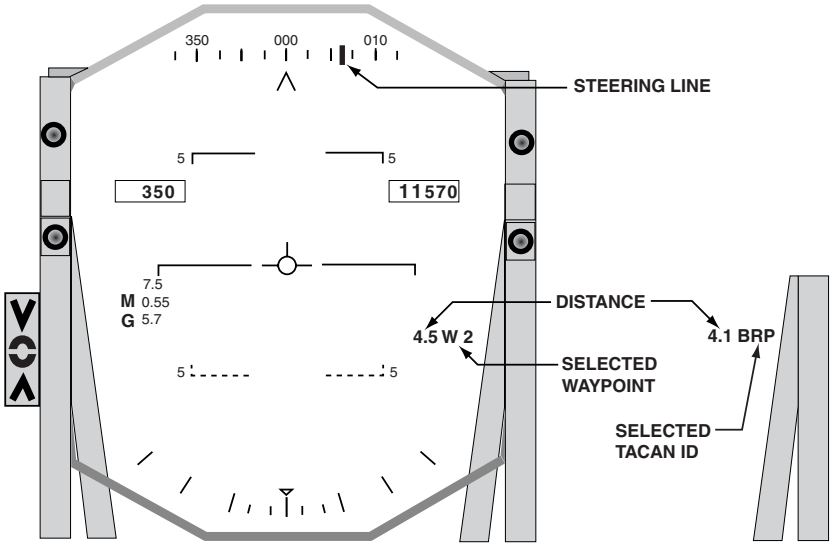
Compass rose	A circular heading scale that depicts current aircraft magnetic heading.
Aircraft symbol	Your location on the HSD.
Lubber line	Line which represents your aircraft's current magnetic heading.
Selected waypoint	Indicates the current waypoint selected. Changes as the waypoint selection is cycled.
True airspeed	Your aircraft's current true airspeed (in knots).
Ground speed	Your aircraft's current ground speed (in knots).
Waypoint	Graphic plot of the location of your currently selected waypoint relative to your aircraft.
TACAN	Graphic plot of the location of the currently selected TACAN station relative to your aircraft.
WPT Bearing	Points toward the currently selected waypoint. To fly to the waypoint align your aircraft's current heading line with the waypoint bearing symbol.
TCN Bearing	Points toward the currently selected TACAN station. To fly toward the TACAN station, align your aircraft's current heading line with this symbol.
Scale	Displays the current scale depicted on the HSD. It works in both navigation and map mode and represents the distance from your aircraft to the compass rose, in NM. The HSD scale can be modified in either NAV or MAP mode by successive depressions of "N" or "M" respectively. Your choice of scale options is 10, 20, 40, 80, or 160 NM.
WPT Bearing readout	Displays the waypoint bearing in degrees to selected waypoint.
WPT Range readout	Displays the range to current waypoint (in NM).
WPT ETA readout	Displays the estimated time of arrival to the current selected waypoint.
ET readout	Displays the total elapsed mission time.
Local Time-of-day readout	Displays the current local time.

HSD Color Moving-Map Display



The Navigation information depicted on the HSD can be overlaid on a color moving-map display by depressing "M". Unlike the navigation display, the moving map orientation is always north-up. Therefore, when in MAP mode, the aircraft reference symbol rotates to indicate current heading and the compass rose remains north up. TIP: By zooming in on the map, you can discern the layout of the runways within the selected range scale at unfamiliar airfields if you need to make an unscheduled stop.

HUD



Navigation and TACAN steering information is available on the HUD. The information available is:

Steering line	This line indicates a heading that will take you directly to the selected waypoint or TACAN station.
Waypoint information-Distance	The current distance in NM to the selected waypoint.
Waypoint information-Waypoint	Displays the selected waypoint number.
TACAN Distance	The current distance to the TACAN in NM.
TACAN ID	Displays the three-letter ID code of the selected TACAN station

AN/APG-65 RADAR

The AN/APG-65 multi-mode radar is a versatile and reliable tool for acquiring and engaging both A/G and A/A targets. The radar is a computer controlled, pulse doppler radar with look down, shoot down capabilities. It is your primary sensor in F/A-18 OIF.

What is a RADAR?

RADAR stands for Radio Detection And Ranging. Understanding the process of radar detection and tracking begins with the knowledge of radar fundamentals. To start with, every radar has 5 basic components: a transmitter, a transmitter antenna, a receiver, a receiver antenna, and a display. In most modern radars both the transmitter and the receiver share the antenna. All radars operate by sending out a radio signal and then “listening” for any returning signals. If the returning signal strength is of sufficient energy to be recognized by the display component, then the radar system will show a target.

Features of the AN/APG-65

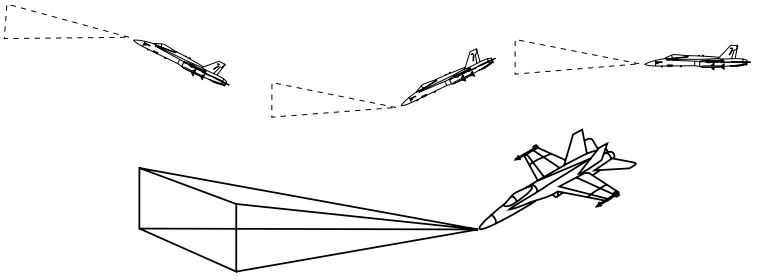
Operating well beyond the realm of basic radars, the F/A-18 Hornet’s AN/APG-65 radar features advanced computer processing for enhanced target detection and tracking, along with superior ground mapping capabilities. The A/A mode of the radar is capable of multi-target detection and tracking. It can search for airborne targets in three different modes, each with its own special capabilities. On the A/G side, the radar can locate and engage small moving vehicles at extremely long ranges. It also features high-resolution ground mapping for stationary target identification.

Antenna stabilization

Located in the nose of the F/A-18 is the AN/APG-65 radar dish. It is capable of moving +/- 70° in elevation and azimuth from aircraft centerline. It is computer controlled through pilot option selection on the radar DDI display.

Stabilized

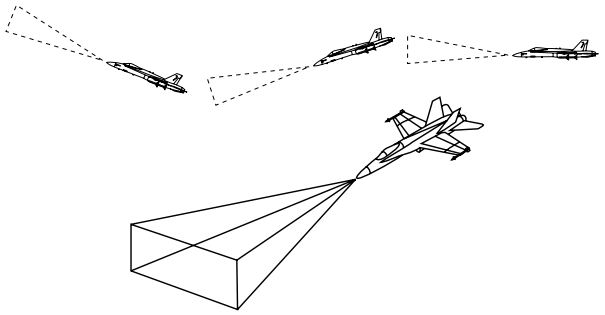
When the antenna moves in elevation with respect to the horizon, trying to track independent of aircraft nose movement, the antenna is said to be stabilized. The long-range search modes of the radar operate in the "stabilized" mode. This is important to understand because the radar will try to maintain level with the horizon, while the nose of the aircraft is moving.



STABILIZED RADAR SCAN VOLUME

De-stabilized

When the antenna moves in elevation relative to the aircraft's centerline, it is said to be "de-stabilized." The ACM modes of the radar operate in a "de-stabilized" mode. This is important to understand because your search volume will move along with the aircraft's nose.



DESTABILIZED RADAR SCAN VOLUME

AIR-TO-AIR MASTER MODE

To employ any A/A weapons from your F/A-18 you must be in the Air-to-Air master mode. This lets the aircraft's mission computer know that you are planning on using the A/A suite of systems and weapons. The MC can then spool up missile seeker heads in preparation for launch. The A/A MM is invoked by selecting any A/A weapon.

AIR-TO-AIR RADAR DISPLAY

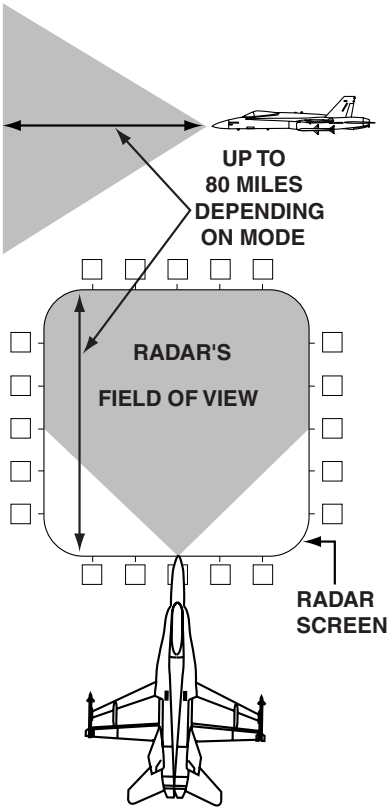
The A/A radar display is completely explained in the A/A chapter. A brief overview is included here.

Concept of looking down on the world

The A/A radarscope displays the airspace out in front of your Hornet in a top down view with your aircraft being located at the bottom center of the scope.

What the scope is showing you

The MC shows you computer-generated images or targets that the A/A radar is picking up. These targets are only shown after the radar antenna has received a valid radar return from a radar reflective target.



Limitations of the RADAR

The radar cannot see through terrain. It is also limited to line-of-sight operations. It does have a limited range and does not tend to see fighter size targets beyond 80 NM.

AIR-TO-AIR SUB MODES

There are sub modes associated with the A/A radar that help the pilot get a quick radar lock in order to employ weapons faster. These are called the Air Combat Maneuvering or ACM modes. The A/A Chapter has further information about the ACM modes and their uses.

AIR-TO-GROUND MASTER MODE

The Air-to-Ground master mode informs the MC that you plan to use the A/G sensor suite and A/G weapons to engage your target. Selecting any A/G weapon or the Electro-optical or HARM sensor pages invoke the A/G master mode.

A/G mapping mode

The A/G radar can create a highly detailed computer generated map of the terrain out in front of the Hornet. This mode of the radar uses many sophisticated processing filters to make the display extremely detailed. For more information about the A/G radar refer to the chapter on Air-to-Ground.

AN/ALR-67 RWR

The Radar Warning Receiver (RWR) set, AN/ALR-67, is a very crucial piece of equipment. As a Strike/Fighter pilot, your very life could depend on it! So it is extremely important that you understand its operation.

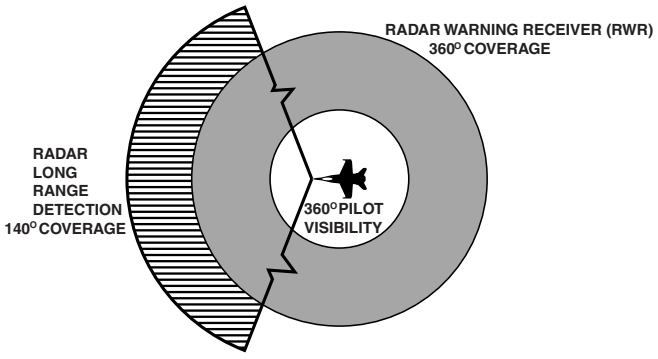
Tells you which RADARS are looking at you

The AN/ALR-67 informs the pilot of what type of Radar energy is hitting the aircraft. It has antennas placed at various places around the F/A-18 to detect incoming Radar signals. The system can then determine what azimuth the Radar energy is coming from. The system also has an extensive radar signal library. It can compare what signals it is receiving to what it already knows, and, if the waveforms match, the system then classifies the radar signal and displays the proper indication on the HUD and the RWR scope. Finally the RWR set can determine respective distance by power of the signal and then classify the signal as a reduced threat (far away) or an immediate threat (close by or shooting). It is important that you know how to determine which is the highest threat and where it is relative to your aircraft.

Capabilities

The RWR set has excellent capability to detect and decipher all of the enemy radar emissions in F/A-18 OIF. Trust your RWR gear and learn how to use it to help you build your situational awareness (SA).

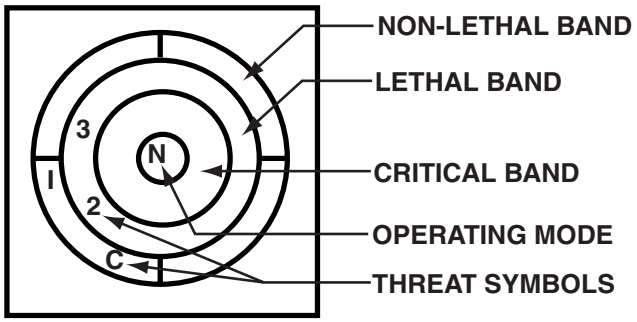
RWR Azimuth display



The RWR azimuth display is depicting a top down view of your aircraft, with your aircraft located in the center of the scope. It displays the complete 360° RWR antenna coverage around your jet. A threat located at 12:00 would be displayed on the top half of the scope, and a threat located at the 5:00 position would be displayed on the lower right hand side of the scope.

Operating Mode

The RWR has only one operating mode. This mode is called the "normal" mode and an "N" which is visible near the center of the display depicts it. If the RWR gear sustains any damage the "N" will no longer be present indicating that the system is no longer reliable.



Threat Level

Based on the information provided to it from its receiver antennas, the RWR set will classify hostile signals into one of three categories. These categories indicate the relative danger to your Hornet from the emitting system. The categories are listed from lowest threat to highest threat.

Non-Lethal Band

The Non-lethal band is the inner most band on the ALR-67 scope that an enemy radar can show up in. All threats in this ring are not yet within the tactical engagement envelope of their respective system.

Lethal Band

The lethal band is the next ring out from the non-lethal band. All threats that appear in this section of the RWR scope are within the respective systems tactical employment range. They can and mostly likely will try to engage you.

Critical Band

The outer most band on the RWR is the critical band. Threats that show up here are currently in the process of engaging your aircraft. A threat in this band requires your immediate attention!

Threat Symbols

To help differentiate which type of threat system is looking at your aircraft the RWR system will display different symbols for each category. The categories are AAA, SAM and AI. The AI and SAM categories also have sub-categories because of the number or threat systems deployed by the enemy.

AAA

An "A" on the RWR set will represent all Anti-Aircraft Artillery (AAA).

Airborne Interceptors

There are two type of signals from enemy aircraft that the RWR gear can decipher, the first is from older generation A/A radars, and will be indicated by an "I" for Interceptor. These type of radars are typically found in MIG-21s or MIG-23s. Another symbol depicted on the RWR gear is a "P" for pulse doppler AI radar. This type of radar is typical of the Su-27 and other advanced radar fighters.

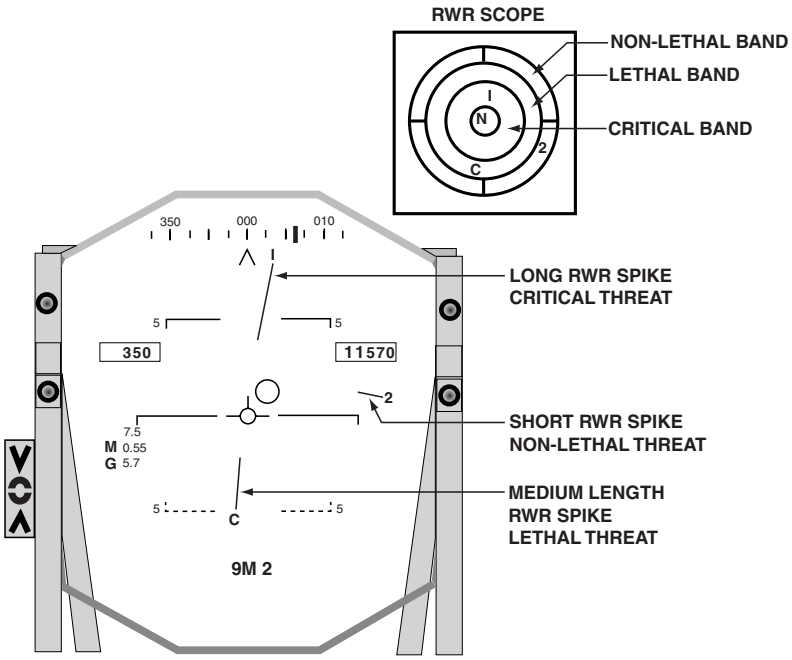
SAMS

The RWR displays surface-to-Air Missiles (SAMs) according to the specific model of SAM that is illuminating your aircraft. The following chart is applicable:

SA-2	each system detected displays a 2
SA-3	each system detected displays a 3
SA-6	each system detected displays a 6
SA-8	each system detected displays an 8

Other

Any systems which the RWR gear senses but cannot classify as one of the above mentioned radar threats will appear as a "C" for Continuous Wave radar based system.



HUD Repeater

All RWR warning cues are reproduced on the HUD to increase pilot situational awareness. The system is slightly different than the display used on the RWR scope, but with an understanding of the differences, the HUD can be used almost completely without reference to the scope.

Azimuth indicator

The azimuth indication for a threat is identical to the RWR scope in that your aircraft is located in the center of the display (the HUD in this case) with a 360^{o} coverage around it. A spike at 12:00 would be in the upper half of the HUD, while a spike from 6:00 would be on the bottom half of the HUD. And a spike from 3:00 would be on the rigth side, and 9:00 on the left.

Signal strength indication

The length of the line pointing to the threat reflects the threat's relative signal strength. The shortest lines are indicating low signal strength. These threats would be displayed on the Non-lethal band of the RWR scope. The next longest line would be representative of a threat in the lethal band. The longest lines indicate signals from threats that can be classified by the system to be in the critical band.

Right Status Panel Lights

A back up indicator lighting system is used in case of HUD failure to provide an alternate means to let the pilot see threat information without using the lookdown cockpit view. These lights are located just below the right glare shield in the forward cockpit view.

SAM (Surface-to-Air Missile)

The SAM light will illuminate steadily anytime the RWR is receiving a SAM system radar signal. This light will flash to indicate a SAM launch.

AI (Airborne Interceptor)

Any form of enemy A/A radar transmissions directed at your aircraft will illuminate this light.

AAA (Anti-Aircraft Artillery)

If any enemy AAA system targets your aircraft this light will be on.

CW (Continuous Wave)

This light illuminates to tell the pilot that a Continuous Wave based radar system, such as the SA-6 is targeting the aircraft. It will also illuminate if the RWR set picks up any unknown signals not in the RWR's database.

Aural warning Cues

A status change tone will sound anytime a new threat is picked up and displayed by the RWR set. There is not a tone associated with the loss of a signal. There is also a separate missile launch tone that will sound when the RWR system confirms that a threat missile is inbound.

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 on the currently tracked radar target by pressing "I". The target that is being interrogated must be an STT or L&S radar target.

If an audible “tone” is heard, the target aircraft has responded positively to the IFF code check and is therefore considered to be a friendly aircraft.

A negative response to the IFF interrogator will NOT produce a tone. The only sound that will be heard from a negative response is a faint “click” as the box resets. No audible tone thus implies that the target is an enemy aircraft.

AN/ALE-39 COUNTERMEASURES DISPENSING SET

The AN/ALE-39 Countermeasures dispensing set is used to deploy chaff and flares. The set keeps count and displays the current remaining number of both chaff and flares on the SMS page. The set can only be reloaded on the ground and has a fixed number (30 chaff and 30 flare) of both types of dispensables that cannot be changed by the pilot.

Chaff and Flare

Chaff is designed to decoy enemy radars, and flares are designed to decoy heat-seeking missiles. Both should be used if you are not sure which type of missile is tracking you.

What is it?

The chaff is actually a small bundle of wire strips that create multiple target returns on the enemy’s radarscope. Several thousand pieces of chaff are contained in each chaff bundle.

A flare is an extremely hot-burning substrate which mimics the IR signature of your F/A-18 Hornets engines. The flare is ignited right after it leaves the airplane and will only burn for a short period of time (approx 6 seconds).

What does it do for me?

In order to confuse enemy radar tracking systems, including missile guidance systems, chaff forces the tracking system to choose a new target to track. Because your aircraft is still one of those targets, chaff may not always be effective. Multiple chaff deployments are usually required to confuse tracking radar.

The flare tries to present the IR or heat-seeking missile with a choice of two or more targets to guide on. Hopefully the missile’s seeker will see a flare and go after its bright signature in favor of your tailpipes.

SMS page

The number of chaff and flares remaining on your aircraft are displayed on the SMS page. The SMS page is viewed on the left DDI by pressing the “s” key. There is only room for a total of 60 dispensables, 30 chaff and 30 flares. Once they are used up you will have to land and re-fuel / re-arm to replenish your supply.

Dispensing chaff

To send out a single chaff container, press the “;” key. Each time the chaff release key is pressed, a chaff bundle comes out and the chaff counter on the SMS page decrease by one.

Dispensing flares

To send out a single flare, press the “” key. Each time the flare release key is pressed a single flare is deployed and the flare counter on the SMS page decrease by one.

RT-1079A/ALQ-126A ECM RECEIVER/TRANSMITTER

The ALQ-126A Countermeasures Set detects and then attempts to deceive enemy fire control and missile guidance radar signals. Pressing the "c" key activates ECM Jamming ("Countermeasures"). The XMIT lamp on the left status panel being illuminated provides active jamming indications. The ECM suite provides effective jamming in lightly defended SAM/AAA target areas. When the threat picture gets more complicated the ECM set becomes less effective.

Use of active ECM is not recommended for those roles that are using the element of surprise to help aid in mission accomplishment. The system may “highlight” your aircraft to other threats that might normally not be capable of detecting your presence.

CHAPTER 6: AIR-TO-GROUND

PHILOSOPHY

Welcome to Air-to-Ground (A/G), this is the place where wars are won! A/G is arguably the most strategically significant mission role you'll fly as an F/A-18 pilot. Air-to-Ground is not simply dropping bombs on a target, it also involves successfully navigating to the target, positively identifying it, employing your ordnance successfully against it, surviving the target area threats, and getting home safely. There is a lot that goes on, and a good game plan will keep you alive and get the job done! Remember that no country has ever won a conflict by just destroying the enemy's aircraft one at a time at 30,000 feet! This chapter will discuss the fine art of A/G ordnance delivery so that hopefully every A/G mission finds you, On Target – On Time, Every time!

WHAT IS AIR-TO-GROUND?

The "A" in F/A-18 Hornet stands for Attack, and that is what this chapter will teach you to do. There are some who like to argue the issue of whether the "A" is bigger than the "F" saying that one mission role is more important than the other. But from your point of view (which is through the HUD I might add…) the answer is both. You will be flying both mission roles in F/A-18 OIF and each has its own fun and unique challenges. For now let's consider ourselves Attack pilots and focus on the "A"!

Define (describe chapter layout)

Air-to-Ground is defined as the successful engagement of a ground target from an aircraft. Successful engagement does not always have to translate into a bomb coming into direct contact with the target; it very often does, but not always. Sometimes a "successful engagement" will be to simply deny the SAM radar time to lock onto the strike package (through the use of HARM missiles).

Importance in modern armed conflict

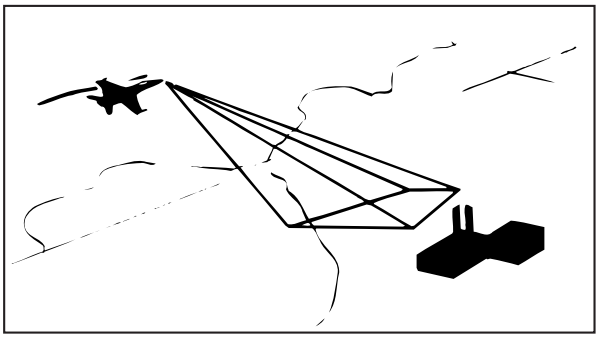
For the Force Commander, aircraft are just another means to exert pressure on an opposing force. So, in the big scheme of things, your F/A-18 could just be considered an intelligent ordnance delivery system!

TYPES OF AIR-TO-GROUND MISSIONS

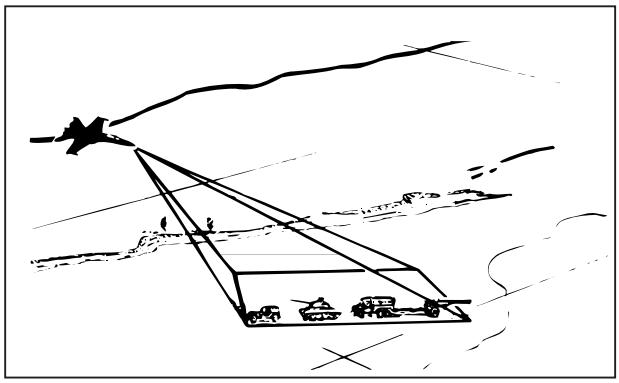
Air-to-Ground missions in F/A-18 OIF can be broken down into three basic categories. Each category represents a different need by the Ground Force Commander. There are times when you'll be called upon to go deep into bad guy territory to destroy some vital enemy center of gravity, or perhaps the immediate problem is right at the Ground Forces Commander's doorstep – where you'll be operating in the vicinity of friendly forces.

Deep Air Support (DAS)

The first category of A/G missions is Deep Air Support (DAS). DAS does not occur in the vicinity of friendly forces. DAS missions can be thought of as the typical "deep strike." Usually the only mission support is organic, that means assigned to the strike package itself. The strike lead is usually given sufficient assets and space to conduct the mission as they see fit. DAS missions can be long range and may involve several Air-to-Air refueling stops along the way. The surface to air threats (SAM, AAA) in the target area are usually more static in nature, and do not tend to change too much from mission brief time until time on target.

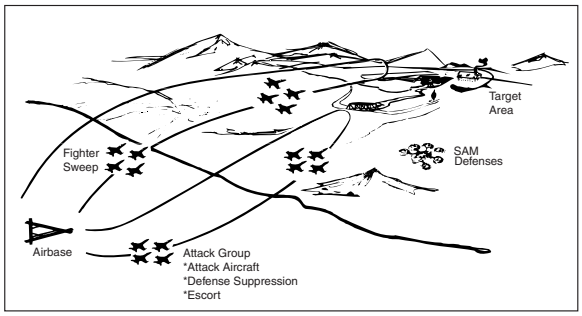


Close Air Support (CAS)



Close Air Support (CAS) is the second category of A/G mission. It is opposite from DAS in the fact that operations are conducted within areas of friendly control. CAS missions require close coordination with friendly units operating in the area. CAS also tends to be a bit more dynamic because the aircrew does not usually know what the target is until they contact the ground forces after they are airborne. Enemy SAMs and AAA also tend to be the mobile variety, so what was true of the enemy situation at mission briefing time, may no longer be true when you get to the target area.

Suppression of Enemy Air Defenses (SEAD)



Suppression of Enemy Air Defenses (SEAD), pronounced SEE-ADD, is a highly specialized A/G mission that focuses on countering the ability of the enemy to use their SAM and AAA systems against friendly aircraft operating in the target area. Such missions have been called "wild weasel" missions. There are two types of system kills in SEAD, a hard kill and a soft kill. A hard kill involves actually destroying the "offending" system. A soft kill affects how the system operates, to reduce its effectiveness. For example, when launching a HARM at a SAM, if the SAM continues to radiate and the missile impacts the target, that would be considered a hard kill. But the SAM suspects a HARM is inbound and stops emitting to prevent itself from being hit, that is considered a soft kill. Either way, you have reduced the effectiveness of that system to target friendly aircraft that are within the target area.

MEASURES OF SUCCESS

A/G missions in F/A-18 OIF will either be DAS, CAS or SEAD. Each mission will also give you a target that you have to address. There are three means of taking care of business and getting credit for the mission: destroy the target, disrupt the target, or degrade the target's effectiveness.

Target destruction

Targets typically assigned in DAS missions will have to be destroyed. Destruction occurs when an Air-to-Ground weapon of sufficient destructive strength explodes within close proximity of the target (or, hopefully, on the target). The heavier the ordnance, the greater its fragmentation pattern is, thus the larger the allowable miss distance. For example: to destroy a particular bunker may require you to drop a 500 lb. Bomb directly on top of it (actually come in contact with the target). However, if you were to drop a 1000 lb. bomb, you could actually miss the target by 50 feet, and still have enough destructive force to destroy the bunker.

Convoy disruption

Convoys of ground vehicles (typically found in CAS missions) do not need to be entirely destroyed to get credit for mission completion. They just have to be stopped, or at least slowed down. The best way to do this is to hit the convoy at the front. Destroy the first couple of vehicles and the convoy will be forced to stop.

Air Defense effectiveness reduced

Reducing the enemy's air defense is the focus of SEAD missions. To gain credit for mission completion simply hard kill or soft kill (your choice) the bad guy SAM and AAA systems. You must prevent the enemy from successfully engaging (shooting down) friendly aircraft.

The ultimate goal of A/G is to assist the Force Commander in winning the conflict.

HOW DO YOU FIT IN?

Within the scope of A/G missions already discussed, how do you successfully complete your mission? There are several key things to think about when you first start reading your mission orders. These key items will help you to focus on the job at hand, and help you decide which factors must take priority while developing a game plan.

Complete assigned mission

Obviously, you should complete your assigned task. Clearly define what needs to be done in order to successfully complete the mission. Primary objectives first – destroy the target. Then if there is time or weapons left, you can go after that pesky fighter or SAM.

Have a plan for what you are going to do in the target area. Gather information about your mission and formulate one. When it comes to attack plans use the KISS principle; Keep It Simple Stupid! In other words, elaborate plans require extraordinary concentration at a time when you will be either trying to locate and attack the target or fighting for survival. There are several things to think about, and all should be addressed before finalizing your attack plan.

Target study

Study the target. Look at the photo in the briefing and try to memorize it. Get a clear picture in your mind of what the target looks like. You should be able to sketch it on a piece of paper. Know what it is before you go after it, that'll make your job "going down the chute," a heck of a lot easier.

What else is in the area? Is the target sitting by itself, or are there going to be other buildings or vehicles around it? Are there any major geographical features near by that may help to identify the target (such as rivers, lakes, hills, roads…)? Try to find at least one feature that will aid in target recognition. The larger that feature is, the easier the target will be to find.

Target – Weapon matching

The right tool for the right job. That's more than a cliché when it comes to selecting the proper weapon for A/G missions. There are a lot of factors to consider in determining what is going underneath your wing.

Sure, you could always opt for the biggest "bang" available (the largest weapon) but do you really need all that extra hardware hanging on the jet? Try to take the least amount of weight necessary in order to get the desired effect on target. Added weight only reduces your maneuverability and increases your fuel consumption, thus reducing your range.

Are you always hitting your targets? Then maybe you don't need to carry as many bombs and can opt for a couple of extra AMRAAMs. It wouldn't be bad to "shack" the target and become an ace on the same mission! Conversely, if you aren't as accurate at A/G ordnance delivery you might want to consider a couple of extra weapons for good measure and leave the A/A stuff to the fighter sweep – that's why it's there anyway.

Familiarization with Weapon displays

You're approaching the target after successfully penetrating the enemy fighter cover. SAM missile launch indications are starting to light up the RWR gear. Now is no time to pause the simulation to re-visit the weapon display pages in the manual. Know how your systems work and practice using them BEFORE you get to the target. - Real Fighter/Attack pilots never use the pause key.

Study Enemy threats

What threats are in the target area? What can I expect to see on the RWR scope? How do I negate those threats? Should the attack plan include flying above or around them? How about using HARM? How can I best use Chaff/Flare and aircraft maneuvering to help me when I am in the SAM engagement envelope? Know what is in the target area and be prepared.

Proper use of ECM

Your aircraft is equipped with sophisticated Electronic Countermeasure (ECM) equipment, so it is recommended that you use it. Like inexpensive insurance, it never hurts to have it. Know how and when to turn it on. Ask yourself "What threat is the ALQ-126A good against?" Be familiar with the systems displays, because proper interpretation can mean the difference between life and… well, you know… (simulated) death.

The moment of Truth!

Armed with all this knowledge, you will be more than ready to complete the task at hand and return home a hero! When it comes down to you and the target, make sure it's the target that isn't seen at their O'Club that night!

With that said, on to Air-to-Ground systems!

OK, all the global information has been passed. You now have the big picture for A/G. Let's see how to operate this weapon system and destroy something.

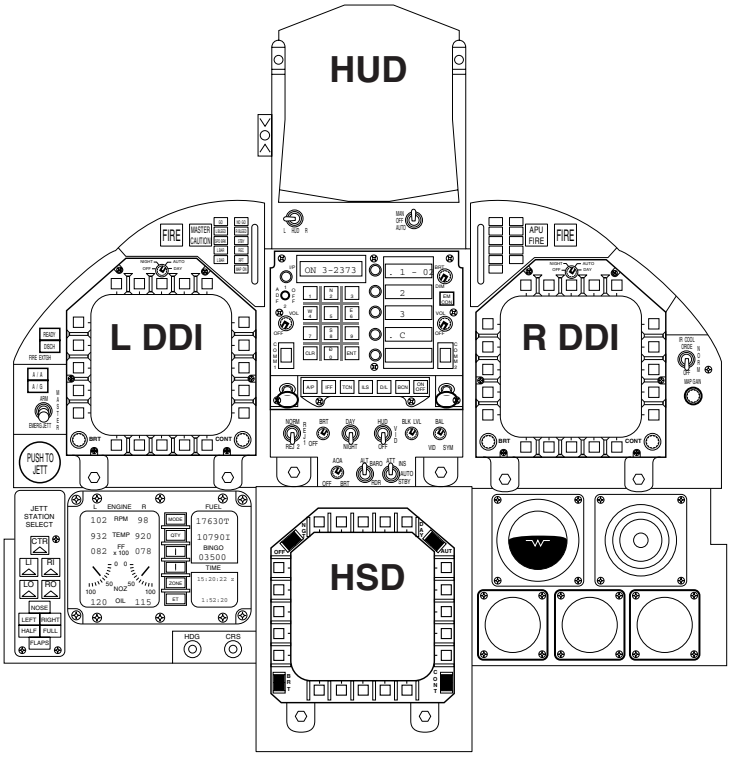
WHAT IS THE TDC?

The F/A-18 is a technological marvel. There are a lot of things it can do extremely well. It can't however read your thoughts. You have to communicate with it and tell it what you want it to do. To aid in effective Human Machine Interface (HMI), the engineers developed the concept of a TDC. The TDC allows you to communicate with your aircraft and tell it a lot of important information, such as where the target is.

TDC stands for Target Designator Control. It controls which system is looking at or "designating" a target. It provides control of the respective sensor. Simply, the TDC allows you to communicate with the weapon system and tell the mission computers where the target is. You supply the mission computer target information (i.e. location) through the process of designating. Designating is nothing more than "slewing" (moving or controlling) a sensor to the target and pressing a designation key. The mission computer will provide you information in return, such as range and weapon launch envelope information.

CONCEPT OF 4 DISPLAYS

The F/A-18 Hornet has four displays that are used for communicating with the mission computer. Each display has it's own unique uses and is associated with specific weapons or weapon sensors displays. Some weapons will have more than one controlling display.



Head's Up Display or HUD.

That's right, this useful device is a primary target designator for a lot of weapon deliveries. The HUD is your <u>visual</u> target designator, in other words the sensor that is being used to locate the target is your very own, MK 1; MOD 0; Eyeball.

Right DDI

The right DDI is used for the radar displays. A/G radar information is depicted here, thus the right DDI is your radar-targeting sensor. With it, you will tell the mission computer where the target is by using the radar to aid you in locating it.

Left DDI

The left DDI is used for Electro-Optical (EO) sensors and advanced (or "smart") weapon displays. EO sensors use other bands of the electromagnetic spectrum to aid the pilot in finding the target. The term "other bands" refers to frequencies and wavelengths not used by other targeting sensors. One band is the area covered by the radar (radio wave frequencies) and another would be the area we know as visible light (our own vision is the sensor used here). The EO sensors will operate more toward the Infra-red (IR) side of the spectrum.

HSD

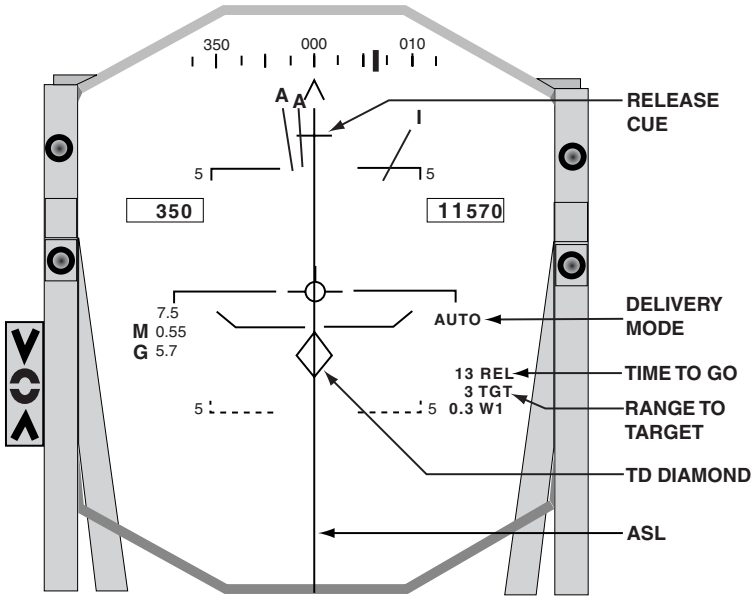
Although the HSD is not used in F/A-18 OIF for any actual targeting purpose, it still functions as one of your displays. It is more for the aircraft to provide you with information about what is going on, such as waypoint information and ground speed (the actual speed the aircraft is traveling across the ground, expressed in knots/Hour) data. There are times when you will need that information so don't forget where it is located!

Which one am I working with?

Now comes the problem of actually telling the mission computer which one of these displays and/or sensors you want to work with. Several can be on and active at a time, so how do you sort out which one is actually being used to designate a target?

TDC "assignment"

The process of deciding which sensor you plan to use, and then inputting that information into the mission computer is called TDC assignment. You are basically "assigning" the TDC to a specific display. Remember that all the TDC does is provide the pilot control of a specific targeting sensor (there may be several operating at the same time). Assigning the TDC is the pilot's way of telling the aircraft which targeting system he wants to use.



What do I plan to do with this airplane? (or drop off of it…)

Most of the time TDC assignment isn't an issue. The mission computer realizes that when you turn something on, or select it, you probably plan to use it. So the MC will automatically assign the TDC to the proper display. But the MC also needs to know what kind of target you are looking for (an A/G target or an A/A target). Finally, the MC will look at what type of weapon you plan to employ before assigning the TDC. But it is important to understand where the TDC is at all times. You don't want to lose the target you just found using the FLIR because you forgot about TDC assignment! To help illustrate the concept of TDC assignment let's discuss how and when it is assigned, and what it controls when it is assigned there.

Auto assignment

The TDC will become active on any sensor screen or weapon display that has just been selected, and is being displayed on a DDI. There is no need to worry about putting it there, if you can see the sensor display you want, the TDC is assigned there automatically.

For example, you desire to use the FLIR to find your ground target. You first select the FLIR by pressing the "O" key. The FLIR display will now initialize on the left DDI. Target Designation Control is now assigned to the FLIR. So when you hit the designation key, the target information for the MC will be taken from the FLIR.

Further elaboration: after the above example, you see a SAM system that you want to hard kill first, just before you bomb the original target. Seeing that the SAM is not too far away and that you don't have much time to re-target with the FLIR, you decide to attack the new target visually, using AUTO mode. First you need to tell the MC not to use the FLIR target, and then you need to tell it where the new target is (the SAM). First you must "Undesignate" the original FLIR target (tell the MC, to forget about the first target) by pressing the Undesignate key. Now the MC is back to waiting for you to input target information. You can then select your desired A/G weapon (say for this example a Mk 82 Low Drag), select AUTO mode, and use the HUD to designate the target.*

In the previous discussion, we assigned and then re-assigned the TDC; first to the FLIR, and then to the HUD. In both cases the active (selected) sensor was used for Target Designator Control (TDC).

Manual assignment

Before leaving the subject of TDC assignment, there is one more topic to cover – Manual assignment. There will be times when you will desire to keep the TDC assigned where it is at and select another sensor. One such example is a "FLIR hand-off." What happens in a FLIR hand-off is that you leave the TDC assigned to the FLIR while you select an A/G weapon. So instead of the TDC being re-assigned to the HUD in preparation for a CCIP delivery, it remains with the FLIR and provides you with AUTO weapon release information in the HUD. The only other time the TDC is not automatically assigned is when locking up A/A targets with the radar while in A/G master mode (which will be explained in the next section).

Moving the TDC

In order for you to describe the target to the MC, you have to find it with a sensor. To search with that sensor you'll need to move it or have some method of controlling it. When a sensor is selected and displayed you will have the ability to move or "slew" it to find and lock onto a target. Different sensors have different methods of control. However, only one active sensor will command the TDC. Any other active sensors will slew to the designated target.

Cursors

The radar display (located only on the right DDI) uses cursors for TDC control. They can be moved around both the A/G and A/A radar displays in the same fashion. The cursors move whenever the SHIFT ARROW keys are pressed. The cursors will move in the same direction as the depressed SHIFT ARROW KEY

UP	SHIFT UP ARROW
DOWN	SHIFT DOWN ARROW
LEFT	SHIFT LEFT ARROW
RIGHT	SHIFT RIGHT ARROW

HUD

The Heads Up Display (HUD) uses the velocity vector (VV) for TDC control. The VV of the aircraft controls where the designation will occur for weapon delivery modes such as CCIP and AUTO. Thus, placement of the VV controls placement of the TDC when using the HUD for designating targets for visual ordnance deliveries. Visual ordnance delivery implies that the target can be seen with the naked eye through the HUD without need for sensor enhancement or detection. TDC movement in this case is directed by moving the aircraft control surfaces (i.e. flying the aircraft to a position to see the target).

Video

The final method of TDC control is with a video display provided by some EO sensor. The EO sensor display will be located in the left DDI. Control of the TDC assigned to an EO display is accomplished by using the CONTROL ARROW keys while the appropriate display is on the left DDI. The arrows slew the sensor in the appropriate direction.

UP	CONTROL UP ARROW
DOWN	CONTROL DOWN ARROW
LEFT	CONTROL LEFT ARROW
RIGHT	CONTROL RIGHT ARROW

AIR-TO-GROUND MASTER MODE

With the topic of TDC behind us, lets address the subject of Master Modes (MM). Aircraft Master Modes control a lot of what is available to the pilot and affects many of the displays.

Define

Air-to-Ground Master Mode is the master mode that allows A/G ordnance to be employed in a tactical method. In other words, the only way to get an A/G store off an F/A-18 – without jettisoning it – is by using A/G mode. When you jettison (or get rid of) ordnance you have no control over where it is going. When you hit the jettison key, off it comes. But A/G master mode not only gives you the ability to release A/G stores, it also provides you with weapon release cues and weapon impact information.

HOW TO INVOKE A/G MM

There are two ways to invoke A/G master mode. The first is to select any A/G ordnance. The second is to select any A/G sensor, with the exception of the radar. Although the radar does have an A/G mode, selecting it does not automatically invoke A/G master mode.

A/G weapon selection

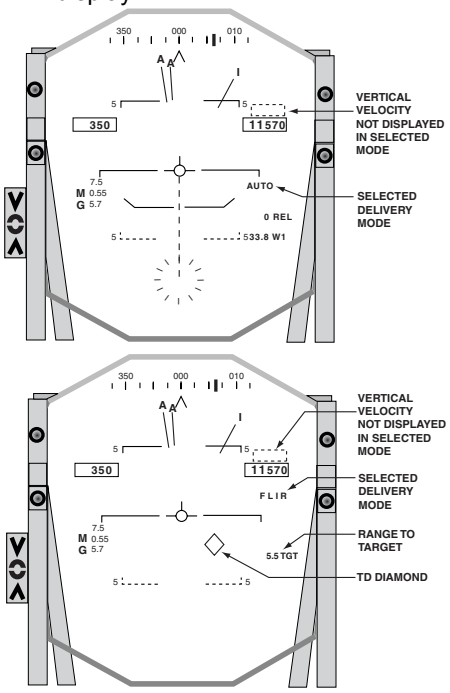
Pressing the "]" key: 1.) Invokes A/G master mode. 2.) Initializes the Stores Management System (SMS) page on the left DDI. 3.) Cycles through all available A/G stores on the SMS page with each successive press.

A/G sensor selection

Pressing the "O" or "U" key will also invoke the A/G master mode and put the selected sensor control display screen on the left DDI. The "O" toggles between all currently onboard Electro-Optical sensors such as the FLIR, Maverick, and Walleye displays. The "U" is exclusively for the High-speed Anti-Radiation Missile or HARM display.

WHY A/G RADAR DOESN'T INVOKE A/G MM

The radar is a very versatile and important sensor. Because the radar detects both A/G and A/A targets at long range, it should have the ability to function in both of its modes A/G and A/A all the time. It should not be restricted to master mode dependent use only. This capability allows the pilot to maintain A/A situational awareness (SA) while performing A/G work. Please note that although you can use the A/A radar while in A/G master mode, if you pull that trigger on your STT target, you'll probably drop something off the aircraft. To shoot an Air-to-Air missile, you must select it. That action would switch you to A/A master mode.



WHAT DOES A/G MM PROVIDE ON THE HUD?

A/G master mode simply tells that MC that you want to do some A/G work. The aircraft then changes its displays to reflect information that is more pertinent to A/G weapon employment. These are changes in the HUD that will be noticed when invoking the A/G MM.

A/G Weapons selection

Going from Navigation MM to A/G MM by selecting a weapon will remove instantaneous VSI readout from the HUD and add the weapon specific information below the Altimeter box.

A/G Targeting control

Selecting an A/G sensor will also affect HUD indications by removing the instantaneous VSI and then adding the sensor specific information to the HUD.

Air-to-Ground Sensors

With the concepts of TDC and master modes behind us, lets take a look at each of the sensors that are available in F/A-18 OIF. Although all are import, none are quite as complex as the radar. The radar is extremely versatile and has several sub-modes in addition to a standard A/G mapping mode.

HUGHES APG-65 MULTI-MODE RADAR

The APG-65 radar has many different operating modes. On the A/G radar operating side of the house, there is one primary mapping mode and three other sub modes. Each mode has different capabilities and has a different display. Three of the

four modes are used to find vastly different kinds of targets. All A/G modes of the radar will be explained here. The primary mode is the ground-mapping mode.

MAP

MAP stands for ground mapping mode. It is the primary mode of the radar. MAP actually displays a top down view of the ground ahead of the aircraft.

Define

The AN/APG-65 multi-mode radar functions in A/G mapping mode as follows. Note that this discussion is extremely simplified. You do not need to know how to build the radar in order to operate it.

The MAP (ground mapping) mode of the APG-65 emits radar energy and then listens for returns (or energy bouncing back to the radar dish with significant signal strength to be processed by the radar's computer processors) from solid objects which reflect radar energy. The ground reflects radar energy. Buildings reflect radar energy. Thus, the ground and any buildings will show up as positive radar returns on the MAP display. However, water and other shiny surfaces allow radar energy to bounce off of them, and continue on – never returning to the original radar dish. Water typically does NOT reflect radar energy, and thus will not show on the MAP display of the radar.

Looking at the MAP radar display, areas of returns or radar energy will be depicted in green. The lighter the shade of green, the better the return is. Buildings will have a high return; the ground will have a slightly less return. Water will have no return and will appear as "black" or unshaded on the MAP radar display. In addition to water providing no radar return, there will be other ground features which will prevent radar from getting back to the antenna, such as distortions on the ground (i.e. bomb craters) or shadows created by buildings or other cultural features. These will also appear as black (same color as display) on the MAP radar display.

The display

The MAP display is selected by pressing the "r" key, until the A/G mode of the radar is visible on the display (the default A/G radar display is GMT). Once it is selected, press the "q" key to toggle through the A/G radar options until MAP is visible in the upper left side of the left DDI.

The MAP display represents the ground area directly ahead of the aircraft (0 NM range) out to an operator selectable range. The display is oriented such that, the aircraft can be considered to be at the bottom/center of the scope. The center vertical line represents aircraft azimuth centerline, or the 0^{o} bearing line. In azimuth, the scope is partitioned into 4 sectors, the first line indicates 70^{o} left, the next is 35^{o} left, then the centerline, then 35^{o} right, and finally 70^{o} right, thus dividing the screen into 4 sectors. The screen is also divided into ranges, the top line indicating the maximum range (selected on the top right side of the scope) and is then divided into equal ranges, down to zero range at the bottom. For example, if 40NM range is selected, then the range lines would correspond to (starting at the top of the scope) 40NM,30NM,20NM,10NM.

Azimuth selections directly affect how much ground area the radar is searching. The wider the azimuth scan, the greater the search area. The narrower the azimuth the smaller the search area. At first you might decide to go directly for the widest coverage, but that coverage comes at a cost. The wider the scan, the slower the target updates. This is because the target is updated only when the B-sweep passes over it, and the B-sweep moves at a fixed rate of 10^{o} per second. So, the wider the scan, the more time in between target updates. The less a target is updated, the less accurate the information displayed is, or the longer the time until target detection occurs.

Bar scans directly affect the volume of ground being searched. The more bar scans, the more volume, the less bar scans the less volume. The same principle concerning timely target updates that occurs with azimuth also affects bar scan. Searching through many bar scans is time consuming. Thus, the more bar scans selected the greater the search volume, but the less frequent the target updates and the more time until target detection.

Experiment with adjusting the search volume and find out what works best for you. If you don't have time, or just want a quick decision, go with the default initialization values. These values prove to work the best in most circumstances (and that's why they have been selected as the default values).

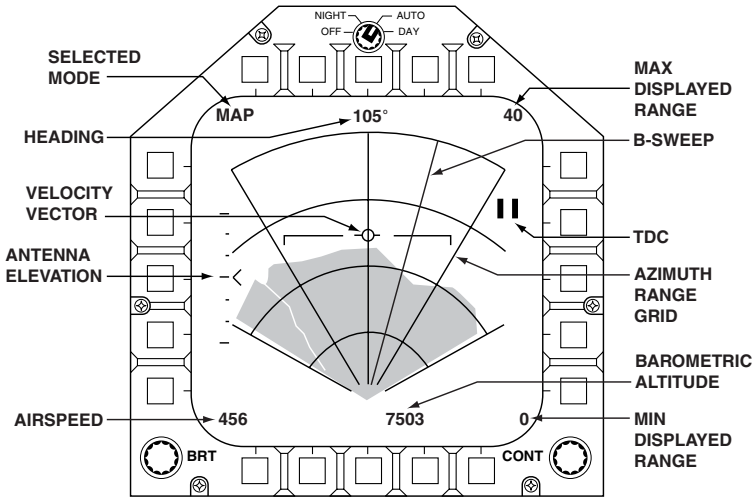
Let's go through the display and talk about each part;

Map

Indicates the current operating mode of the A/G radar.

A/C heading

Indicates the current aircraft heading in degrees (magnetic). This is to allow for "heads down" operation of the radar. It will assist you in maintaining control of the aircraft while you actively use the radar for targeting.



Radar azimuth coverage

Indicates the current selected azimuth area coverage for the radar. The wider the scan, the more ground ahead of the airplane is mapped. Pressing the "z" key can decrease azimuth. Pressing the SHIFT "z" key can increase azimuth. The available options for azimuth selection are 140^{o}, 80^{o}, 60^{o}, 40^{o}, and 20^{o}.

Maximum display range

The number represents the maximum range scale displayed on the radar. It can be adjusted by pressing the "TAB" key and SHIFT "TAB" key. To increase radar range scale SHIFT "TAB". To decrease radar range scale "TAB". The range will cycle through all options with successive presses of the TAB key. The following ranges are available, expressed in Nautical Miles (NM); 80, 40, 20, 10, and 5. Note: The radar range is automatically initialized to 40 NM upon MAP mode selection.

Radar search volume

The area (in range) of the ground surface mapped by the radar is adjusted by changing the bar scan of the radar. 6 bar covers the most area, and 1 bar the least. (The concept of bar scans is talked about in greater detail in the radar section of the Air-to-Air chapter) Selectable options for bar scans: 6, 4, 2, and 1. To decrease the bar scan press the "x" key. To increase the bar scan, press the SHIFT "x" key. Repeated presses of either of these keys will cycle through all available options again.

The TDC cursors

Shown in the initialized position.

Antenna elevation indicators

The moving arrow or "caret" will slide up the down the scale to indicate current antenna position. The middle line on the scale indicates that the antenna is level with aircraft centerline (not the horizon). The upper and lower marks indicate the maximum elevation travel of the antenna.

Artificial horizon and Velocity vector

The horizon and VV are provided to aid the pilot in maintaining control of the aircraft when "heads down" using the radar display for targeting. It is a repeat of the information that is displayed in the HUD. There are no other attitude lines other than 0^{o}. If your aircraft attitude should exceed the limits of the displayed horizon bar, then you will need to check the HUD or standby instruments for further information.

B-Sweep

The B-sweep indicates current antenna position in azimuth from aircraft centerline. It will sweep back and forth as the radar scans the area ahead of the Hornet.

Airspeed

Indicates current airspeed, in knots. Repeat information from the HUD.

Altitude

Indicates current aircraft altitude, in feet. Repeat information from the HUD.

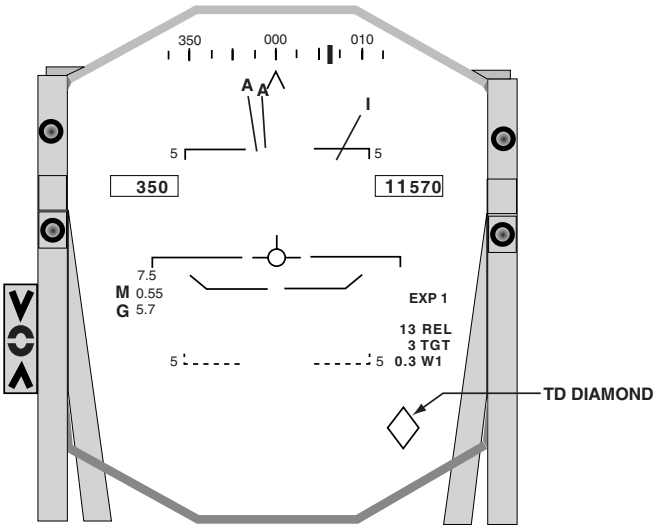
Minimum displayed range

Indicates the minimum range displayed at the bottom of the display.

TDC

The TDC (radar cursors) can be slewed around the radar screen by using the radar slew keys (reference the TDC control section, this chapter).

To designate a target with the A/G radar in MAP mode, slew the cursors over to the intended target and press designate key "\." The target underneath the cursors will be selected and then designated as an A/G target. Upon designation, the MC will display an "X" on the target, and command any other active A/G sensors to slew over to the target.



HUD

When a target has been designated by using the ground-mapping mode of the A/G radar (either MAP or EXP 1) a diamond will appear in the HUD. This indicates to the pilot the exact location of the target on the ground. If the diamond is not within the field of view of the HUD it will move to the side of the HUD that is closest in azimuth to the target and then flash.

Sub-mode

The MAP mode of the radar has a sub-mode associated with it called EXP 1 or Expand 1. A sub-mode operates in much the same way as its parent mode with some exceptions. What this sub-mode provides is the ability to zoom in on a particular area with the radar for more precise targeting control and detail. Using the EXP mode will allow you see more detail on the ground at further distances than is possible with the normal MAP mode.

Expand 1 (EXP 1)

The EXP 1 mode is selected by pressing the "q" key one more time after reaching the MAP mode. All of the functions are similar to MAP mode with the following exceptions:

"EXP 1" is depicted in the upper left hand corner of the Left DDI to indicate that Expand 1 is currently selected and active.

The range scale no longer has 0 NM at the bottom center of the display. The range displayed is now limited to ½ the distance of the maximum selected range. For example: if you select a maximum range of 20 NM for the EXP1 display (by pressing the "TAB" key), the minimum range will be equal to ½ that range, or 10 NM. More detail will be depicted at same maximum range.

Targeting with MAP and EXP 1 is a simple process. The idea is to work from a big picture with less detail to a small picture with more detail. And the MC will help you out when you need to switch to greater detail. You will find MAP and EXP 1 useful whenever you are trying to find a stationary target such as a bunker, building, fixed SAM site, or other immobile items.

Begin looking for the target in MAP mode, and try to pick out the target area. Slew the TDC over to the target area. When the target area is between the maximum selected range and the ½ the maximum selected range, switch to EXP1. When you switch from MAP to EXP 1, the MC remembers the maximum range you have selected and maintains it as the maximum range for EXP 1 sub-mode. While in EXP 1 find the target and designate it.

GMT

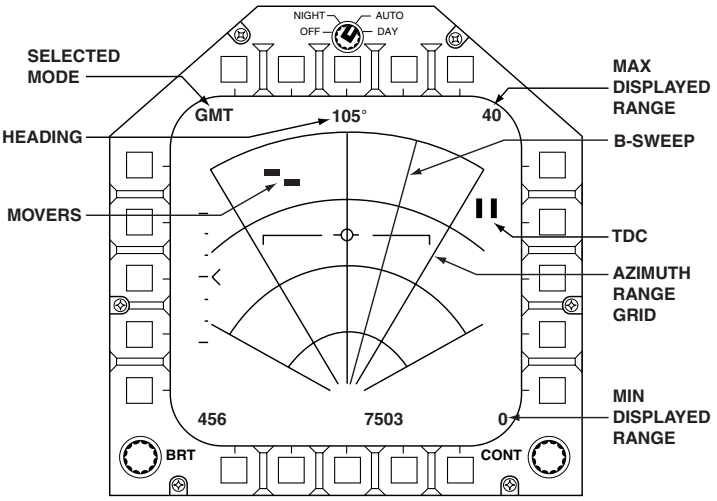
MAP and EXP 1 are great targeting tools for fixed targets. To locate moving targets with the AN/APG-65 there are two separate modes of the radar. One is specialized for land, and the other for sea. Both operate in much the same way.

Define

Ground Moving Target or GMT mode of the radar searches a specified area in front of the F/A-18 for moving targets driving over the ground. The radar uses Doppler shifts in radar frequency (along with many other complicated techniques) to locate and track moving targets over the ground. The targets found are displayed as synthetic targets (computer generated) on the radar display. A single target can then be designated with the TDC and tracked.

The display

The GMT display is selected by pressing the "r" key, until the A/G mode of the radar is visible on the display (the default A/G radar display is GMT). Or if the A/G radar is operating in another mode, press the "q" key to toggle through the A/G radar options until GMT is visible in the upper left side of the left DDI.



The GMT display is setup just like the MAP and EXP 1 displays. It has azimuth lines, bar scan, and range lines. It also begins at 0 NM range and goes out to a pilot selectable number.

The GMT display is slightly different from MAP and EXP 1 in that it does not show any land or cultural features. The information displayed is limited to the synthetic radar targets or "movers" and nothing else.

To designate a return or "mover" as a target, move the TDC down over the desired return and press the designate ("\") key. Upon designation, the GMT mode will display additional information about the radar contact. The information is only supplied for the designated contact and consists of a heading pointer, a velocity, and a magnetic heading readout. When designated with the TDC, all operating onboard sensors will slew to the new target.

To designate another mover, you can:

- Designate a new target using the same process.
- Un-designate, and then designate a new target with the TDC cursors
- Press the designate key successive times to cycle through all available movers

TDC

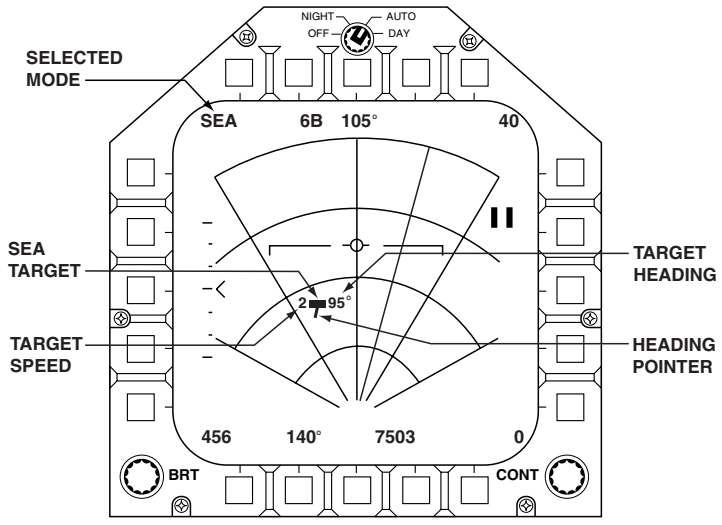
Movement of the TDC acquisition cursors is accomplished in the same manner as with MAP and EXP 1 modes.

SEA

The SEA mode of the A/G radar is used specifically to target movers that are in the water. It should be noted here that GMT will only display targets on land, and SEA will only display targets in water. Other than that GMT and SEA operate the same way.

Define

SEA mode of the A/G radar is selected by pressing the "r" key until the A/G radar (initialized in GMT mode) is visible on the Right DDI. Then, after the GMT mode is selected, press the radar sub-mode key "q" until SEA is displayed in the top right hand side of the display. (From GMT it is only pressed once to get to SEA mode).



The display

The SEA display is the same as GMT, except SEA is displayed in the top right hand corner of the display.

TDC

The TDC acquisition cursors are moved in the same manner as all previous A/G radar modes.

FLIR

The FLIR is an optional EO sensor that occupies load station #4. The FLIR display is an extremely useful device in locating and designating targets.

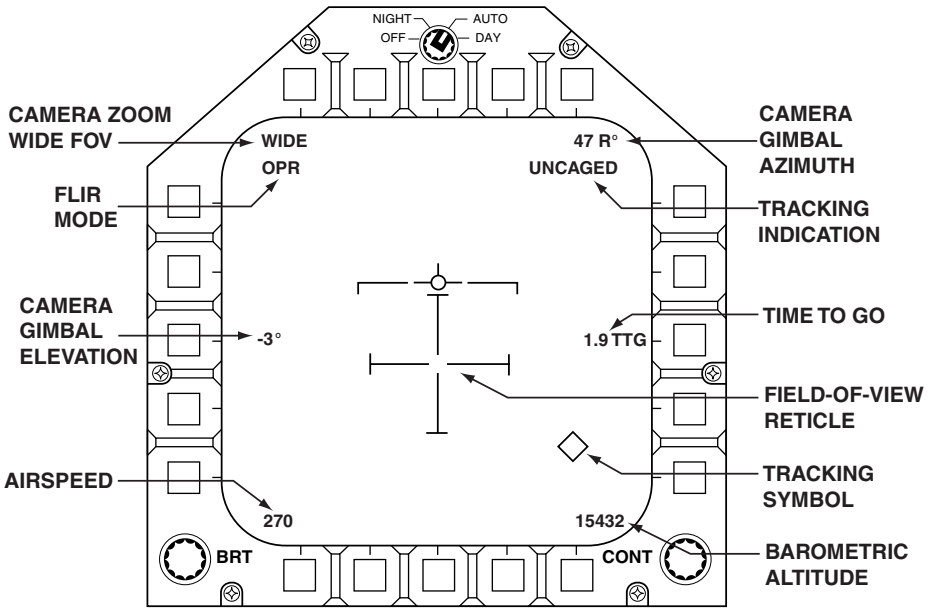
Define

The Forward Looking Infra-Red (FLIR) pod senses and displays the world thermally, or by heat value. It operates by sensing how much heat energy objects emit, then displays the results on the left DDI. The FLIR picture operates outside of visible light portion of the EO spectrum, so the FLIR is good for finding targets when you can't see them out the window (usually because it is dark…). Realize also that what generally limits your vision, other than darkness, will also limit the FLIR's ability to pick up targets. Clouds and other atmospheric phenomena will adversely affect the FLIR and its capability to see objects at range. A FLIR is your ability to locate, identify, and attack targets at night.

The display

Before the FLIR can be selected, it must have been loaded on the aircraft during the stores selection process. To activate the FLIR, press the "O" key. Upon activation:

- Invokes A/G mode
- Displays to the Left DDI
- Initializes to aircraft boresight (0^o bearing, 0^o elevation) if no target is designated.
- Or, if a target is designated, it will immediately slew to and begin tracking that target.



The FLIR display is easily recognized by the large crosshairs that appear on the display. The thermal image is displayed in various shades of green, adjusted by processing filters to maintain an appearance similar to what it looks like without the FLIR.

WIDE

Indicates that the FLIR is zoomed all the way out where magnification is only 4X. The FLIR's magnification is user controlled by pressing the CNTRL "+" to increase magnification or zoom in, and CNTRL "-" to decrease magnification, or zoom out. The magnification is 4 –12X normal, and once out of WIDE, the actual magnification selected is not displayed. The only indication of maximum zoom is when the zoom no longer increases.

OPR

Operational cue, this cue is visible whenever the FLIR is up, running, and operational.

FLIR gimbal azimuth

This information indicates where the FLIR is currently looking. It is expressed as both a number and a letter. The number indicates a numeric heading up to a maximum of 180°. The letter, either L for left or R for right, is telling the pilot that the FLIR is either looking on the left side of the aircraft (L) or the right side of the aircraft (R).

FLIR gimbal elevation

This number indicates where the FLIR is currently looking in elevation. It is expressed as a number, either positive (for UP) or negative (for DOWN). Combining both gimbal numbers, the pilot can get a clear idea of exactly where the FLIR is looking, referenced from aircraft boresight, or centerline.

Artificial Horizon and Velocity Vector

The same is true here as it was for A/G radar, this display is added to help aid the pilot maintain wings level attitude while heads down using the FLIR for targeting.

Crosshairs

Crosshairs are provided as an aiming cue to assist in target location and designation.

TGT

This value indicates the distance to the target, expressed in Nautical Miles. This only appears when a target has been designated.

Airspeed

This is current aircraft airspeed, repeated from the HUD.

Altitude

This is current aircraft barometric altitude, repeated from the HUD.

FLIR Boresight indication

A small bullseye symbol that appears in the HUD that indicates where the FLIR is currently looking. It is limited to the FOV of the HUD.

TDC

To designate a target, move the crosshairs using the TDC EO sensor control keys to slew the FLIR around. Once the crosshairs or HUD FLIR bullseye are on the target, press the CNTRL "\" to designate. If the MC within the vicinity of the center of the crosshairs can find a visible target it will be locked on and tracked, and a set of tracking brackets will appear around the target. If there is no visible target near, the FLIR will track the spot where it was designated. Also note that if the radar has been used to designate a target, then when the FLIR is initialized it will automatically slew to and start tracking that same target.

Note: A target initially designated by the radar and then tracked with the FLIR will appear in the HUD as a square with a "C" next to it. The "C" stands for "correlated." In other words, the radar and FLIR see the same target – so that target location is correlated or agreed upon by both sensors. This is just to provide that "warm & fuzzy" feeling you may need when working in close proximity to friendly troops. The MC is telling you that the same target you locked on radar is the same target you are now seeing in the FLIR.

Let's examine each A/G weapon, its associated displays, and how to employ them.

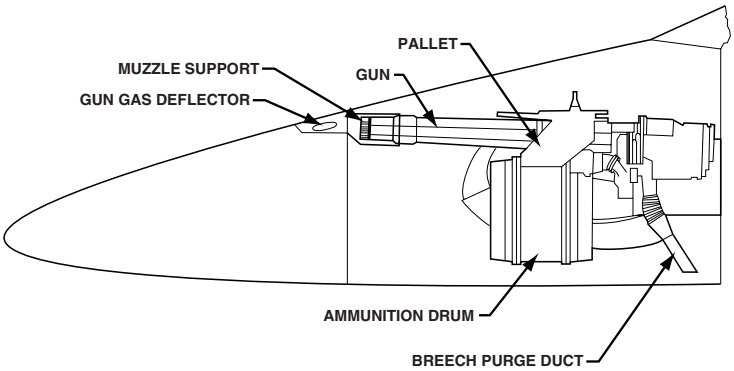
AIR-TO-GROUND GUN M-61A1

Your F/A-18 Hornet is equipped with a 20mm Gatling gun. It has enough destructive force to destroy almost anything from lightly armored vehicles to small ships. It is extremely versatile and always there when you need it. Although the gun is actually mounted slightly above aircraft centerline (more indicative of an A/A gun, as A/G guns tend to be aimed below aircraft centerline) it is very good at engaging ground targets. The gun was designed to provide the ideal mix of both A/A and A/G capabilities. This section will discuss the A/G uses of the M-61A1.

Describe

The A/G gun is selected by toggling to it by pressing the A/G weapon selection key, "]", until the gun HUD is displayed, or the word GUN is displayed in the middle of the weapons display page on the left DDI. Both occur at the same time. It just depends on what your current view is as to which will be visible first.

M61A1 GATTLING GUN



Selecting, CCIP (define)

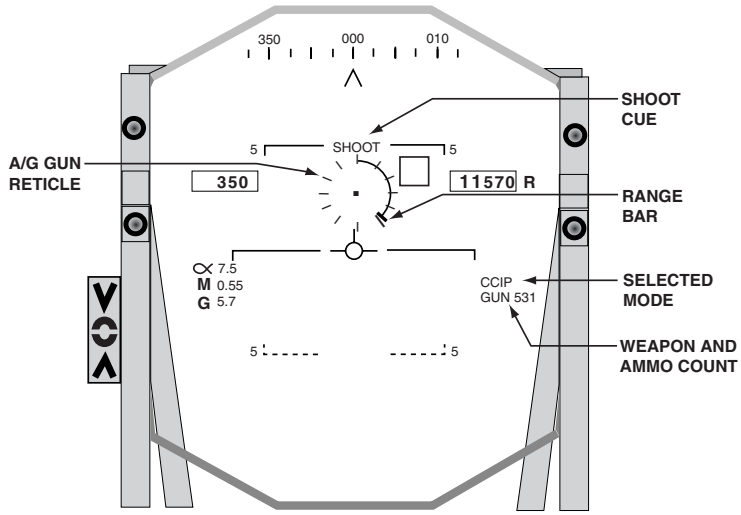
The word CCIP is displayed on the HUD when the gun is selected. CCIP is an acronym for Constantly Computed Impact Point. What the MC is providing you with CCIP is a real time location of bullet or weapon impact if the trigger was pressed right now. CCIP is the only mode of the A/G gun.

HUD display

The HUD display contains all the information necessary to employ the gun.

Gun reticle

The gun reticle is 2.5° in diameter and contains a ranging scale and an aiming pipper. The aiming pipper indicates where bullets will impact if the trigger is pressed.



Ranging bar

The ranging bar slides around the outside of the aiming reticle to indicate current range to bullet impact point. This is not altitude above the ground. It is slant range to impact point. It slides counter clockwise to indicate that you are closing with the impact point, or slides clockwise to indicate you are getting further from the impact point. The 12 o'clock position indicated 6000 feet of range. The 6 o'clock position indicates 3000 feet of range. Note that the ranging bar is not active when the velocity vector is at or above level flight. Only when you enter a dive will it be capable of detecting range to the ground.

SHOOT cue

With a GMT or SEA radar designated target the MC will provide you with a SHOOT cue. When the bullet impact point is within operating lethal range of the gun (indicating the bullets will hit the impact point with enough destructive force to cause damage) the MC will flash a "SHOOT" cue next to the reticle to inform you that such a condition exists. For maximum effectiveness against a ground target, It is recommend that you only shoot with a SHOOT cue. If you choose not to, you may be wasting rounds.

CCIP

Indicates current operating mode of the A/G gun (only one available)

GUN

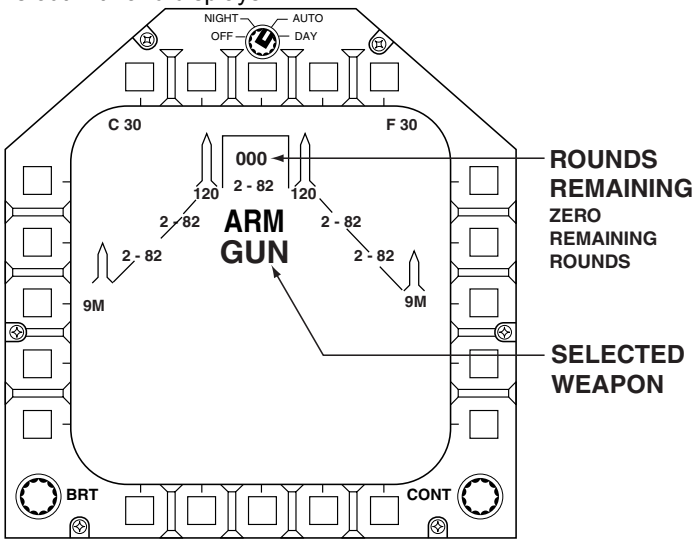
The gun is selected, armed, and ready to shoot. An X through the GUN display would indicate that the gun is not ready, or is unable to shoot.

Round count

Indicates the number of rounds remaining in the aircraft (rounds = bullets). The maximum the Hornet can carry is 578. When bullets remaining reaches 0, then the counter X's out with and displays – XXX.

SMS display

With the gun selected the word GUN is displayed in the center of the weapons display screen. The round count is also repeated here for pilot information or in case the HUD malfunctions. When the number of bullets is zero, XXX will be displayed in the HUD and 000 will be displayed on the SMS display.



Employing the Gun

Using the gun takes a little bit of practice. Since the MC is constantly computing where the rounds are going to hit, the reticle can get a bit jumpy. Be sure to provide as stable a platform as possible when using the gun and you will find that your chances of getting a hit will improve.

Recommended dive angle, velocity

When employing the gun, try to stay between 250 and 400 knots. Above or below these speeds the pipper tends to get a bit too jumpy for precise aiming. Because the gun barrel is elevated slightly above aircraft centerline, you must be in a dive to use the gun (unless you are flying into a mountainside, but then you have other things to worry about…). Try to use between 5^{o} to 15^{o} dive angles. Any less and CCIP has trouble computing the range and any more will probably have you tying the world's lowest altitude record (remember that the world's lowest altitude record can only be tied and never broken…). Allow enough altitude to comfortably enter the dive and smoothly move the pipper to your target. Entry should be more than1500' feet AGL.

Range

Expect to get your SHOOT cue at 3000' and prepare to go trigger down (i.e. SHOOT!) when it appears. Shoot until no lower than 500' and then pull up. If you get pull up cues, break off the attack run and start again.

Suitable targets

The gun is effective against: vehicles, tanks, troop concentrations, radar sites, and small buildings. Small ships can also be destroyed with the gun. Targets which are larger than this tend to require too many bullets to destroy than what your F/A-18 Hornet is capable of carrying.

Off target

After you let up on the trigger and stop firing, execute an immediate pull up to at least level flight. Pulling up to 10^{o} nose up is probably a good habit to get into. Make sure that the aircraft is climbing BEFORE you try to look at target again to assess target damage. Also remember that when off-target your gun is still HOT, or active, and that any accidental presses of the trigger button will waste precious ammunition or possibly inflict damage where it is not desired.

UNGUIDED ORDNANCE (FREE-FALL OR "DUMB" BOMBS)

The next section will address free-fall, high explosive bombs. They are called Free-fall because they have no means of propulsion after they are released from the aircraft. Gravity is their means of propulsion (other than the initial kinetic energy imparted to them by the aircraft) and it also controls their trajectory. Because they have no after release guidance they are called "Dumb" bombs. They can't steer to the target, so you must know where the release point is, steer the aircraft to it, and then release the bombs. If the bombs don't hit their mark then perhaps it is not the bombs that should be considered "dumb!"

MK 80'S SERIES HE BOMBS

The MK 80's series of bombs was designed to be flexible. A single bomb body can be configured to allow for multiple methods of release. It all depends on which type of fins or nose section you attach to it. In this section we will not add anything to the nose of the bomb, just the tail section. The selectable tail sections provide for High drag or Low drag releases. Not all weapons will have all options. In some cases it is not practical or desired in the interest of safe aircraft/bomb separation and fragmentation pattern (or Frag pattern) avoidance. If a high drag option is not selectable, it is not deemed safe enough for use.

Mk 82, 500 lbs

The smallest conventional HE bomb is 500 lbs. This weapon has approximately 275 lbs of HE material encased in metal. Actual weight of this weapon is 531 lbs and it is 7' 6" in length. The Mk 82 has the smallest fragmentation pattern of all the HE bombs. It is also the most versatile and most plentiful of the HE bomb family. The Mk 82 affects aircraft drag and maneuverability the least.

Low Drag

The low drag option, or "slick" bomb is best suited for higher altitude deliveries where safe escape and fragmentation patterns are not a concern of the pilot. Do not drop a low drag bomb from an altitude lower than 500' AGL. If you employ a low drag Mk 82 below this altitude you risk damaging your aircraft as a result of your own bomb's explosive effects.

High Drag

The high drag option, or "snake-eye" bomb is best suited for low altitude deliveries where safe escape from the fragmentation pattern is a problem. The fins function to slow the bomb down and allow the aircraft to exit the frag pattern horizontally before detonation occurs. To be assured of safe escape at low altitudes keep your airspeed above 450 knots. You can employ High drag bombs safely down to 150' AGL. Below that altitude safe escape is not guaranteed.

Suitable Targets

The Mk 82 is effective against vehicles up to a tank, small buildings, fixed radar installations and small to medium sized ships.

Mk 83, 1000 lbs

The next largest weapon in the Mk 80's series is the Mk 83. The Mk 83 weighs 985 lbs and contains 416 lbs of HE surrounded by steel. The weapon is 9' 11" in length. Because the MK 83 is twice the weight of the Mk 82, its affect on aircraft performance will be quite noticeable. There will be almost a 1/4 increase in aircraft drag above an 82.

Low Drag

Because of the increased size of the fragmentation envelope, the Mk 83 is not available for High drag release in F/A-18 OIF. This weapon must be carefully dropped in to ensure sufficient frag avoidance. Try not to drop this weapon below 1000' AGL straight and level or 1500' AGL in a shallow dive. Dives in excess of 30^{o} should drop this weapon above 2200' AGL.

Suitable Targets

The Mk 83 is effective against all vehicles, bunkers, small and medium sized buildings. It can also be employed successfully against ships.

Mk 84, 2000 lbs

The Mk 84 is the largest of the Mk 80's series general-purpose bombs. It weighs 1,973 lbs and contains 945 lbs of HE material. It is 12' 9" in length. The Mk 84 has a significant effect on aircraft performance. Drag can increase up to 1/3 or slightly more and maneuverability is greatly reduced.

Low Drag

The Mk 84 demands the most respect of any conventional (non-nuclear) ordnance. It has the biggest "bang" of all the HE weapons. As such, the Mk 84 should not be dropped below 1500' straight and level or 2000' AGL in a shallow dive. For dives steeper than 30^{o}, use release altitudes in excess of 3000' AGL.

Suitable Targets

The Mk 84 is an excellent weapon to use against the larger, more reinforced structures in F/A-18 OIF. Good targets include buildings and bunkers.

SPECIALTY WEAPONS

The F/A-18 is also capable of employing free-fall ordnance designed for use against specific types of targets. These weapons will be employed in the same manner as the Mk 80's series bombs.

CBU-59B APAM

The Cluster Bomb Unit-59B, Anti-Personnel And Material (APAM) is designed to neutralize soft targets. It is best used against troop concentrations and non-armored convoys. The bomb body itself actually contains 490 smaller units, which are ejected at 100' AGL to cover an area of 100'x100'. The CBU-59B is employed exactly like a Mk 82LD. All of the same restrictions apply.

BLU-107B DURANDAL

The Bomb Live Unit (BLU)-107 B DURANDAL is strictly an anti-runway device. Because general-purpose bombs tend to leave holes in the runway that can be filled quickly, a new design was needed. The idea behind the DURANDAL is that at some pre-determined altitude (runway construction type dependent) the warhead will deploy and bury itself in the pavement. Once buried it will explode causing serious structural damage that can't be quickly repaired. The DURANDAL in F/A-18 OIF is can be dropped in either CCIP or AUTO with a laser designation. For CCIP deliveries see the next section, for AUTO deliveries see the section on LGB's.

DELIVERY METHODS

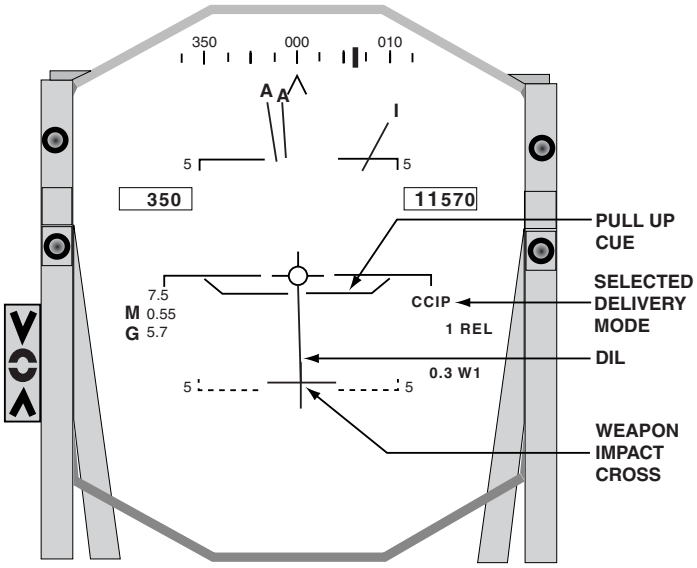
HE Free-fall bombs and specialty weapons can be delivered in one of two ways: CCIP or AUTO modes. As you use each, you may decide that a particular type of method works better for you and stick to that technique. But there are some tactical situations where knowing the other method may make your job easier. You should strive to be able to use both methods equally well.

CCIP

Constantly Computed Impact Point (CCIP) is a quick and easy method of dropping a free-fall bomb. With the proper weapon selected, the MC defaults to CCIP mode as the primary method of release. CCIP releases are available with all bombs.

Selecting

To select CCIP, simply select the ordnance you wish to drop by toggling to it by repeated presses of the "]" key. CCIP will be displayed on the SMS page along with the current number of bombs remaining. To toggle between CCIP and AUTO modes for the current selected ordnance, press SHIFT "]".



HUD

CCIP is specifically designed for visual deliveries by using the HUD. To use CCIP effectively you must be capable of finding the target visually and still have enough time to maneuver the aircraft to weapon release solution.

The CCIP HUD contains the following:

CCIP delivery mode – Displays current ordnance delivery mode.

DIL – Display Impact Line – Displays the trajectory path, in azimuth, for the selected weapon.

Weapon Impact Cross – Marks the spot where the weapon will impact if released. It may not always be visible. If that is the case, the weapon impact point is outside the field of view of the HUD.

Pull up cue – The "horns" provide ground avoidance information. Pulling up from a dive with the velocity vector at the "horns" will require at LEAST 4 G's, wings level pull to avoid colliding with the ground. A pull up started with the VV above the horns will require less G, and a pull up started below will require more.

Break X – The break X will flash across the HUD display to indicate that more than 4 G's are required in the pull up to avoid the ground. You should start your pull up or expect to impact the ground.

Typical delivery, considerations

Using CCIP is easy. Put the CCIP cross where you want the bomb to go and press the release key. CCIP is quick and simple. But there is really more technique involved if you want to be accurate.

To use CCIP you must visually acquire the target. Then ensure that the proper weapon is selected and CCIP delivery mode is toggled on. Fly between 250 and 450 knots toward the target and position the DIL on the target. Fly toward the target until it disappears below the nose of the aircraft. Initiate a dive toward the target, placing the velocity vector on or slightly above the target. Maintain the dive (you should be between 10^{o} to 30^{o}) until the impact cross is visible. Then slowly start raising the nose – moving the CCIP impact cross to the target. When the impact cross touches the target press the release key. Immediately initiate a wings level pull up to a slightly nose high attitude and climb away from the target. Try to be smooth and let the cross track up to the target. This will make your timing for release a little easier.

Common Errors

Here are some common errors to avoid when using CCIP:

- Dive too shallow and/or Airspeed too slow and/or not enough altitude will result in: Very late or no CCIP cross, collision with the ground, or fragging yourself (not enough safe escape time).
- Dive too steep and/or Airspeed too fast will result in: Velocity Vector coincident with the CCIP cross (last thing you see before ground impact), or pull up cues before release solution.

Auto – HUD designate

Automatic mode or AUTO functions a little differently than CCIP. Instead of the MC telling you where the bomb will impact, you tell the MC where you want the bomb to go. You tell the MC where the target is by using the HUD as the TDC and designating it. After designation the MC will display all the information you need to get the aircraft to a release solution and then it will release the bomb all by itself.

Selecting

AUTO is the default mode selection for LGB's and FLIR hand-offs. AUTO can be selected manually for all other free-fall ordnance. To use AUTO, press the A/G weapon select key or "]" to cycle to the desired weapon. If AUTO is not the default setting for your weapon, press the CCIP/AUTO key SHIFT "]" to change to AUTO mode. Doing a FLIR hand-off, first lock your target with the FLIR and then press the A/G weapon select key ("]") ONCE.

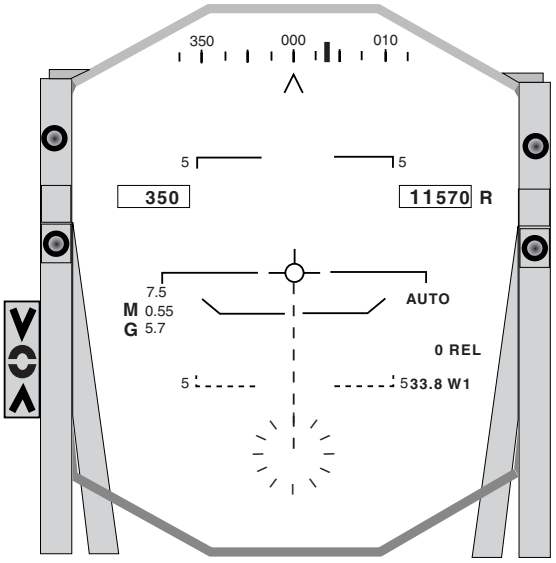
HUD

There are actually two HUD displays associated with AUTO deliveries. The first is displayed when there is no current designated target and the MC is waiting for you to use the HUD to designate. The second appears after a target has been designated and will provide you with steering and weapon release information.

AUTO HUD (no designation)

If no target has been designated at the time of AUTO weapon release mode selection the following symbology is displayed on the HUD:

AUTO – Indicates AUTO mode of weapon release selected.



Weapon Release Timer – This counter displays the time (in seconds) until weapon release. Since no target is designated, it displays 0.

Pull up cue – The "horns" provide ground avoidance information. Pulling up from a dive with the velocity vector at the "horns" will require at LEAST 4 G's, wings level pull, to avoid colliding with the ground. A pull up started with the VV above the horns will require less G, and a pull up started below will require more.

Break X – The break X will flash across the HUD display to indicate that more than 4 G's are required in the pull up to avoid the ground. You should start your pull up or expect to impact the ground.

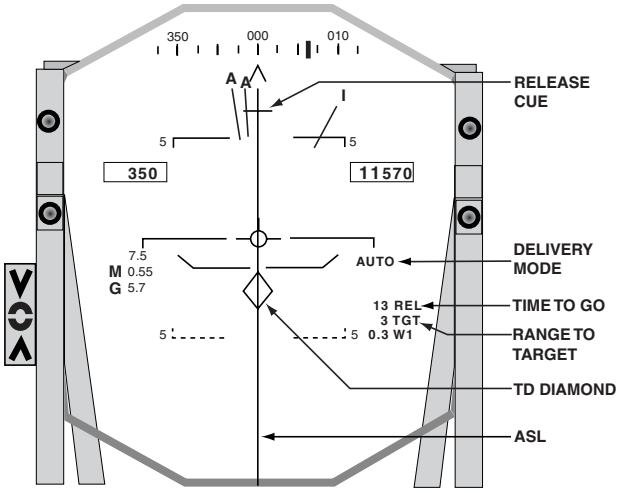
A/G reticle – Aim point used for HUD designation. When the aircraft VV is above 7 ½ ^{o} nose down the reticle will stop and stay at that position and a segmented line will extend from the reticle to the VV as a reminder. If the VV goes below 7-½ ^{o} nose down, the reticle will move to and then follow the VV. Whenever a designation is made, it will always be from the A/G reticle and not the VV (unless they are coincident).

AUTO HUD (with designation)

AUTO – Indicates AUTO mode of weapon release selected.

Weapon Release Timer – This counter displays the time (in seconds) until weapon release. This timer will coincide with release cue movement.

Distance to Target – This displays distance to target expressed in nautical miles (NM).



ASL – Azimuth Steering Line provides steering in azimuth to the weapon release point.

Release cue – A small line, perpendicular to the ASL which provides steering in elevation to the weapon release point. It moves from the top of the HUD downward to the VV. When it reaches the VV the weapon is released from the aircraft. To get the best results with AUTO mode you should fly the VV right through the intersection of the release cue and the ASL on every delivery.

Target Designation Diamond – In AUTO mode the target will be in the center of the TD diamond on the HUD.

Pull up cue – The "horns" provide ground avoidance information. Pulling up from a dive with the velocity vector at the "horns" will require at LEAST 4 G's, wings level pull, to avoid colliding with the ground. A pull up started with the VV above the horns will require less G, and a pull up started below will require more.

Break X – The break X will flash across the HUD display to indicate that more than 4 G's are required in the pull up to avoid the ground. You should start your pull up or expect to impact the ground.

Typical delivery, considerations

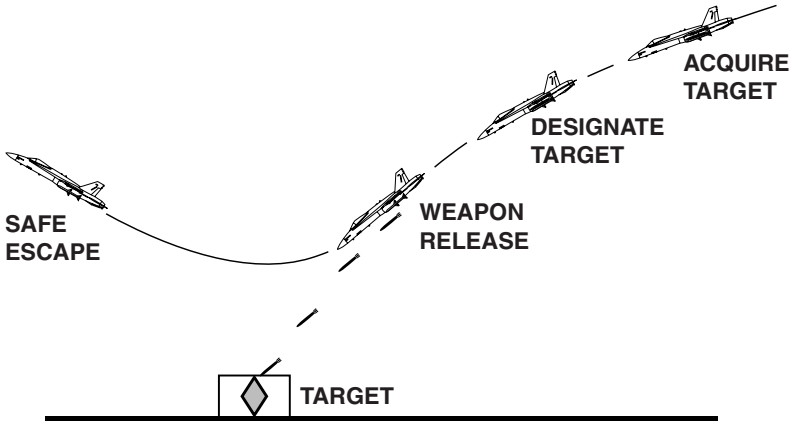
AUTO mode lets the MC (not the pilot) release the bomb. The pilot's duty is to fly the aircraft to the weapon release point (WRP) as best they can. Any deviations from the calculated solution will directly affect the accuracy of the bomb hit. For best results, ensure that the VV flies directly through the intersection of the release cue and the ASL.

Typical dive-bombing with AUTO has many tactical advantages. The first being the fact that the MC will release the bomb. This allows the pilot some extra time in the dive to check other sensors, displays or look for SAMs, AAA etc… The second advantage is the bombing solution will almost always come quicker than CCIP because it is not limited to the field of view of the HUD. This will directly affect how close you have to get to the target. Because of HUD field of view limitations on CCIP, most pilots end up getting closer to the target than they want to. AUTO does not have this limitation and computes its bombing solutions based on aircraft altitude and range to target.

AUTO delivery using HUD designation

The HUD is a fantastic targeting tool. It is both quick and accurate. Use the HUD for target acquisition and designation whenever the target is clearly visible at ranges of 10 NM or less. To use the HUD, first assign the TDC to it by cycling to the desired free-fall ordnance with the A/G weapon select key "]". Then select AUTO mode by pressing the SHIFT "]" key.

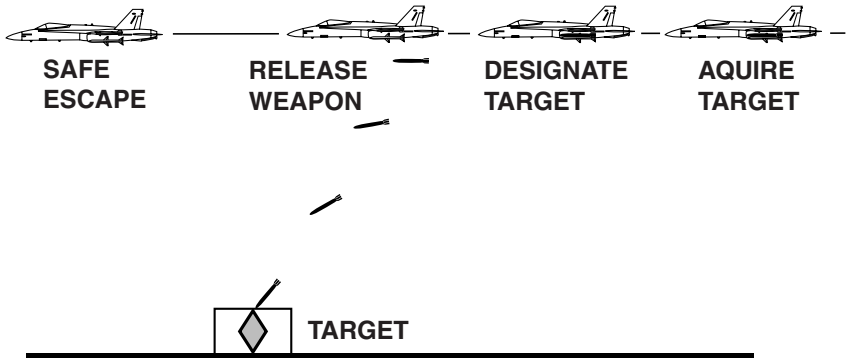
Dive delivery



The dive delivery is probably the most accurate means of employing free-fall, unguided bombs using AUTO mode. Its benefits include reduced weapon time of fall (TOF) and increased accuracy of target designation. It works well against all types of targets.

To perform a dive delivery, fly toward the target at 4000' AGL or above. Airspeed should be between 250 and 400 knots. When the target disappears below the HUD roll the aircraft inverted and pull the nose down until the target is slightly above the VV. Roll the aircraft wings level and check the dive angle between 10^{o} to 25^{o} nose down. Move the VV to the target and designate the target with the "enter" key. Check the designation and ensure it is tracking over the target. If it is not, Undesignate and re-target. Smoothly pull the VV up the ASL until the weapon release cue moves through the VV and the bomb comes off the aircraft. Try not to go lower than 1000' AGL during the delivery for frag avoidance.

Level Laydown

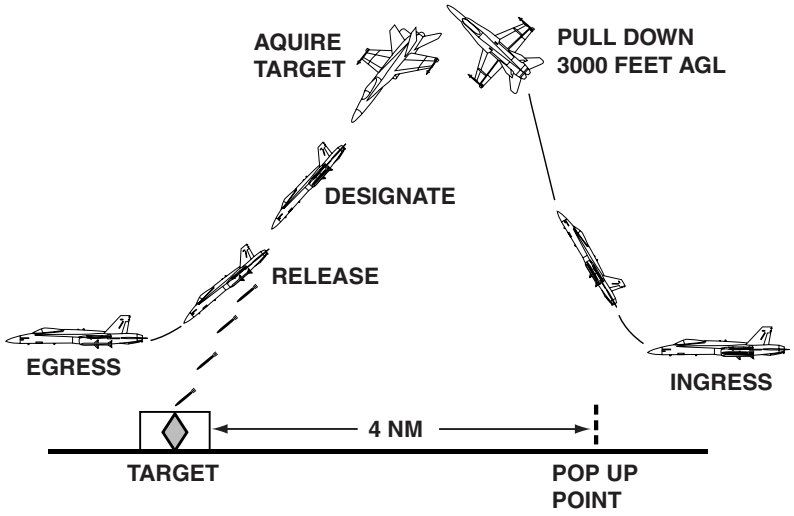


The level laydown should be used against targets with some vertical development. There is no dive associated with a level laydown, and the HUD or FLIR can be used to designate the target. There is no special symbology associated with a level laydown, it is basically a variation of the AUTO dive delivery without entering a dive for the designation or release. The tactical advantage of the laydown is the aircraft will spend less time in the target area. A disadvantage is that finding and designating a target can be more difficult and may be less accurate because of the flat run in.

A level laydown is started at or above 1000' AGL. Find and designate the target using the HUD or FLIR as the TDC. Maintaining level flight attitude, fly the F/A-18 to the release solution by simply maintaining the VV in the center of the ASL. The release cue will fall from the top of the HUD and intersect the VV and the weapon will release automatically.

Low pop up maneuver

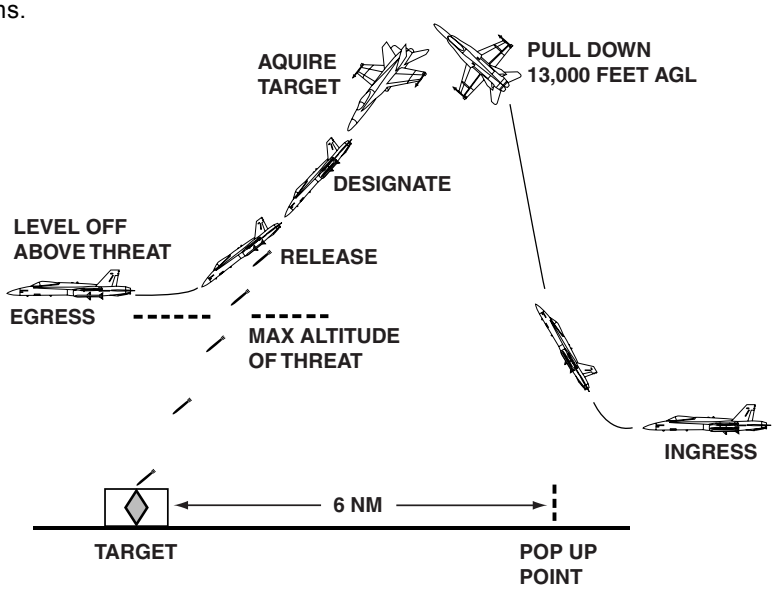
The low pop maneuver is designed to get an aircraft into the target area while flying low to avoid SAMs and fighters. It is fast and must be practiced often to ensure that it is properly executed. The idea is to get into the target area while flying very low and fast and pop up to visually acquire the target. Then quickly attack the target and exit the target area low and fast again.



To execute a low pop, fly directly toward the target area at 500' AGL or less and at speeds in excess of 400 knots. At 4NM from the target (as referenced on the INS from waypoint information) pull the aircraft 15° left or right of current heading and to 30° nose high. While in the climb, select desired ordnance and release method (CCIP is as viable as AUTO here – pilot preference). At 3000' AGL roll the aircraft 135° toward the target and pull until the target is just above the VV. Roll wings level and designate the target (or target appropriately using CCIP). Fly the aircraft to a release solution, remaining above 1000' AGL until clear of the target. Then quickly descend back to below 500' AGL and exit the target area.

Hornet high pop maneuver

If the target area is surrounded by high concentrations of AAA and shoulder launched SAMs you may opt to use a Hornet high pop. The Hornet high is designed to keep you out of the target area AAA. It does however put you at risk from radar SAM systems.



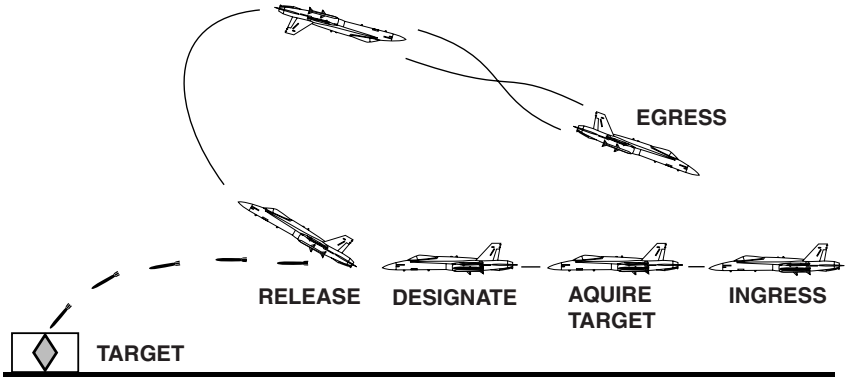
To use the Hornet high pop, begin the maneuver at 400+ knots, less than 500' AGL, and 6 NM from the target. Engage AB and pull the aircraft to 45° nose up, offsetting left or right slightly (no more than 10°). While in the climb select desired ordnance and delivery mode (AUTO is recommended). Passing 13,000' AGL quickly roll the aircraft 135° towards the target, deselect AB, and pull the aircraft down till the target is just above the VV. Use chaff and flares as necessary throughout the maneuver to help negate the SAM threat. Designate the target and fly to a release. Once the bombs are off, quickly pull back up to altitude to avoid target area AAA. When clear of target area AAA, dive for the deck to help avoid any SAM systems and head for your next waypoint.

AUTO delivery using FLIR designation

The FLIR may be used in place of the HUD for target designation in any of the above maneuvers. It does require extra time to use, but it can provide earlier target detection. To use it, first select the desired ordnance. Then initialize the FLIR to the left DDI by pressing the "o" key. Find and designate the target with the FLIR using the appropriate TDC controls. Press the A/G weapon select key "]" once and only once to conduct a FLIR hand-off. Fly to the release solution as described in the above section.

AUTO mode is also best used for situations that call for increased standoff range from the target. This is because AUTO, unlike CCIP, will actually let you "loft" the bomb. "Lofting" the bomb actually means tossing it: physically releasing the bomb while the aircraft is in a nose up attitude. Although lofting a free-fall, unguided bomb will give you a better standoff range, your hits in general will not be as accurate. A lofted bomb spends a lot more time in the air than a bomb dropped in a dive. Anytime you increase time of fall (TOF) of unguided ordnance you also increase the magnitude of any delivery errors you had at release time.

AUTO loft delivery



The AUTO loft delivery is started at 10 NM from the target, 500' AGL and 400 knots or greater. Designate the target using the FLIR. Conduct a FLIR hand-off to get the AUTO symbology in the HUD. Fly the VV on the ASL until the release cue appears at the top of the HUD. When it starts to move down toward the bottom of the HUD, quickly pull the F/A-18 nose up until the VV flies through the release solution and the bomb comes off. Continue the pull to fly the aircraft over the top. Once inverted and 45^{o} nose low, roll the aircraft wings level and continue back down to the ground (executing a ½ Cuban 8). Egress the target area toward the same direction you came in from.

Common Errors

Some common errors with AUTO mode include, poor designation, failure to select proper mode in time for release and not flying the VV through the release cue. Carefully designate your target and smoothly fly the aircraft to the release solution. Although every bad guy in the target area will be shooting at you, your effort will all be in vain if you miss the target. Make your first pass count.

ADVANCED AIR-TO-GROUND WEAPONS

Dropping a bomb from an aircraft and having it hit its intended target exactly is very difficult. Even with fast-thinking computers helping out, sometimes the physics involved are too much to handle. Maybe a weapon needs to hit a specific part of a target to achieve the desired results. Or perhaps the bomb must hit its target because there can be little or no collateral damage to the adjacent structures. In some cases avoiding collateral damage effects can be just as important as the mission itself.

Using free-fall bombs alone, the chances of destroying your target may not be very good. To ensure target destruction you might need an extraordinary number of bombs. Even then, there is probably a good chance you may not hit what you're going after. And there is a good chance that you will destroy most everything else in the surrounding area.

As target area threats have increased in sophistication, aircraft must be able to get in and get out or risk being shot down. The strategic planners turned to the weapon developers for help. The goal was to design a weapon that could destroy its target on the first try, and not rely on several bombs from multiple aircraft doing multiple runs on the target.

Free-fall, HE bombs have been around for a while. Other than an LGB kit, not much else can be done to improve their accuracy. Because they were designed to fall and not to fly, they lack the aerodynamics needed to improve their standoff range.

Why "smart" weapons?

The idea of "smart" weapons was the result of trying to improve accuracy in A/G weapons. The term "smart" was adopted because the weapons themselves possess the ability to "see" and guide to their intended target.

Accuracy

These weapons will be more accurate because they can guide themselves to the target. This allows for a greater margin of launch error. If an LGB is not released with the VV exactly intersecting the release cue, it still has a excellent chance of hitting it's mark. The weapon can now see and fly to the target all by itself.

Fire & forget

Smart weapons are labeled "fire and forget." They only require an initial input of target location followed by a release command. After that, the pilot has done all that is necessary for the weapon to find the target. Once the weapon is released the pilot can then attend to other, perhaps more pressing duties.

Increased standoff range

Because advanced weapons have some means of internal guidance, the restrictions that limit extended range employment of free-fall, unguided ordnance do not apply. After target designation an LGB may be lofted from as far out as the MC will compute a release solution. And even though there will be a significant increase in TOF, this should have little or no impact on the weapon's accuracy. Some smart weapons have built in propulsion means to provide additional flight time to reach distant targets. These weapons will have significantly increased standoff range.

More target specific

Moving targets can be extremely challenging to destroy with conventional ordnance. The process of estimating lead adds another dynamic variable to an already difficult release solution. At extremely short ranges this variable may be small (depending on bomb size) but at longer ranges it makes accurate targeting next to impossible. Some advanced or "smart" weapons have the capability of locking onto and tracking moving targets. This eliminates the need to determine proper lead and allows the pilot to target the mover and still remain at range.

Laser Guided Bombs (LGB's)

The first type of smart weapon we will discuss is the Laser Guided Bomb or LGB. Laser guided bombs are much more accurate than unguided free-fall bombs. These weapons consist of the standard HE bomb unit along with two unique additions. The first is a special set of fins for the back of the bomb. These fins provide more stability during the bomb's flight to the target. The second, which is added to the front, is a laser seeker and guidance kit. The laser seeker kit uses laser energy to locate the target designation and then locks the spot into guidance kit memory. After release, the guidance kit flies the weapon toward the laser spot. LGB's are glide weapons and rely on gravity and aircraft velocity at the time of release to provide sufficient energy to reach the target. In F/A-18 OIF, LGB's remember target locations only, so they are probably not the best weapons to use against moving targets.

HUD designation

If you plan on acquiring the target by visual means alone, then an LBG HUD designation is what you'll need to do.

To perform a HUD designation for LGB's, first select the desired weapon by toggling to it by pressing the A/G weapon select key, "]". With the LGB selected, the HUD will display AUTO mode symbology with the exception of LST replacing AUTO. LST is put on the HUD to remind you that the Laser Spot Tracker (LST) is operative and ready to find your designation. You must first designate a target using the HUD and the A/G aiming reticle, just as in AUTO without a designation. All of the release procedures and symbology are the same as AUTO.

FLIR hand-off

Using a FLIR is another method of designating a target for an LGB. First select the desired store using the A/G weapon select key, "]". Then turn on and initialize the FLIR by using the "o" key. Find the target and designate it with the FLIR. Then conduct a FLIR hand-off by pressing the A/G weapon select key "]" ONE TIME, AND ONE TIME ONLY. Additional

presses of the "]" key will undesignate the target and cycle to another A/G store! All of the remaining release procedures and symbology are the same as AUTO after a target designation.

AGM-65E Maverick

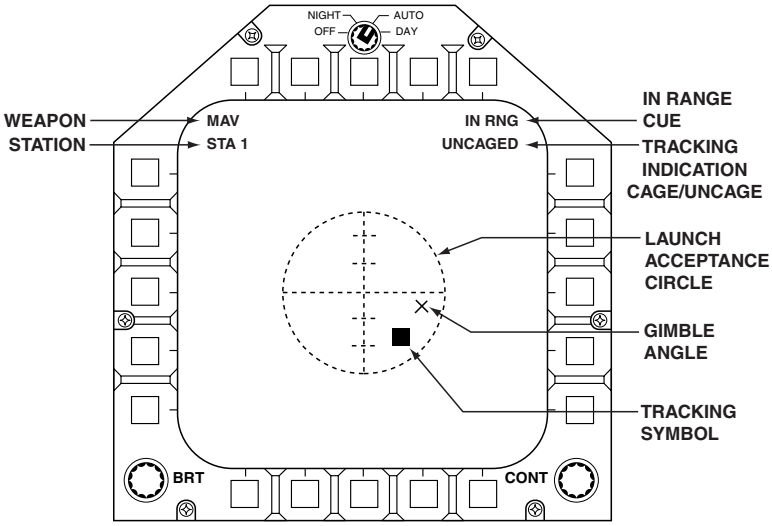
The Maverick is an A/G missile that locks onto and tracks a target, even if the target is moving, all the way until impact. It provides the pilot with exceptional standoff range and accuracy. Although its warhead is not as big as the Walleye, it still is quite useful. The Maverick is also extremely versatile as it can accept a target from the A/G radar, the FLIR, or can use its own sensor.

Weapon description

The Maverick weighs 500 lbs and has a 125 lb HE, shaped-charge warhead. The shaped charge will focus the explosive force of the weapon causing as much (if not more) damage than weapons with twice the weight of HE charge. An aerodynamic shape, 8'3" in length, the Maverick does not have a significant affect on aircraft performance. The Maverick uses a TV seeker head that operates in the visible light spectrum. Because the picture is enhanced for low light level use, the Maverick is an excellent sensor and weapon to use at night.

Display

The Maverick display is invoked by pressing E/O weapon and sensor select key "o" until the Maverick display is visible on the left DDI. The word MAV will also appear in the HUD.



The Maverick display, before the hand-off to the missile is accomplished, is described below.

MAV – Indicates a Maverick missile is selected and operating, providing current E/O display input.

Station number – Indicates current selected station that the Maverick is on.

Uncaged/Caged display indicator – The weapon seeker is either in one of two states: Caged or Uncaged. Caged means that the seeker is slaved to weapon centerline, or is being commanded by the TDC to move from centerline. If a target has been designated with another sensor, the Maverick seeker head will automatically slew to that target upon initialization. Caged indicates that the Maverick is NOT locked on to the target. Uncaged means that the Maverick seeker head has acquired the target and is tracking it by itself. In either mode, if another sensor designates a new target the Maverick will break lock (if it had one) and immediately slew to the new target.

Seeker gimbal position – The X indicates the current Maverick seeker head gimbal position in relation to weapon centerline.

Seeker gimbal position launch acceptance circle – The launch acceptance circle is a 5^{o} circle around weapon centerline. It graphically displays acceptable seeker position required for missile launch. If the X is outside the circle the missile will not guide.

The Maverick can accept target information from either the FLIR or the Radar (GMT and SEA modes only) or it can find a target with it's own sensor.

To perform a FLIR/Maverick hand-off:

- Find and designate a target with the FLIR. You can only hand-off a solid FLIR track, indicated by the presence of the FLIR tracking gates on the FLIR display. Press the "o" key to initialize the Maverick. The display will be caged and slewed to the target. The zoom factor used by the FLIR will be recognized and reproduced by the Maverick. To track the

target, press either the CNTRL "\" key or the ENTER key. A white box will then appear over the target on the Maverick display. Uncaged will also be displayed.

- The HUD will display a target designator diamond over the target that the Maverick has locked up. An IN RNG cue will flash in the HUD to tell the pilot when an IN RNG condition exists. The MC will also display distance to target in the HUD once the Maverick missile has locked on.
- The radar hand-off will usually allow for maximum range employment of the Maverick missile. To execute a radar hand-off to the Maverick:
- Find a designate a GMT or SEA target with the radar.
- A radar TD box will appear in the HUD, along with a range to target readout.
- Cycle to the Maverick display by pressing the "o" key.
- Zoom the display as necessary to positively ID the target.
- Lock the seeker head onto the target by pressing the CNTRL "\" key or ENTER.
- The HUD will display a target designator diamond over the target that the Maverick has locked up. This TD diamond will appear inside the TD box. An IN RNG cue will flash in the HUD to tell the pilot when an IN RNG condition exists. The MC will also display distance to target in the HUD once the Maverick missile has locked on.
- After successful lock on, press the ENTER key to fire the missile. Once the missile has been fired, the Maverick display will go away indicating that the missile has separated from the aircraft.
- For additional Bomb Damage Assessment (BDA) after firing the Maverick, you can select the FLIR display and zoom in to monitor target destruction. To select the FLIR, after firing the Maverick, press "o" once. You can then increase or decrease magnification by pressing the CNTRL "+,-" keys respectively.

Ranges

The Maverick has a range of approximately 12 NM. This range will vary with aircraft airspeed and altitude. To ensure target destruction always fire the Maverick with an IN RNG cue.

Employment profile

The only requirement for Maverick employment is an IN RNG cue. It may be fired from any altitude and airspeed outside of missile minimum missile range. Minimum recommended range for the Maverick is ½ NM.

Suitable targets

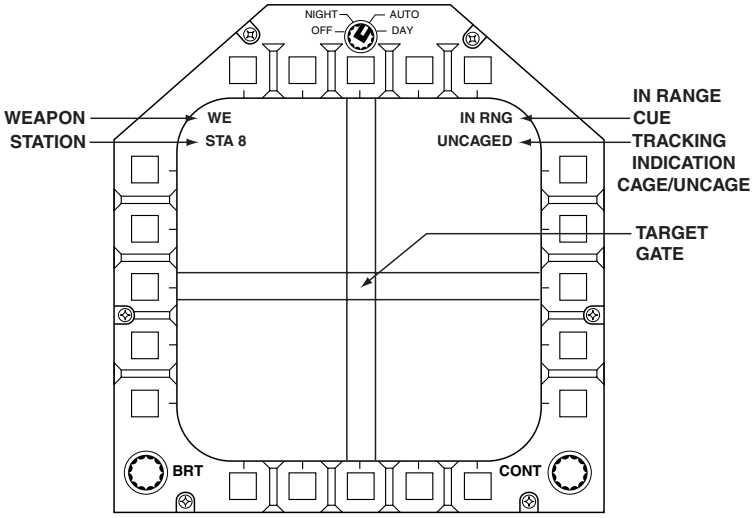
The Maverick has best effects against mobile targets and smaller structures. It has limited capabilities against large reinforced structures. It is good for targeting radar installations and SAM sites, fixed or mobile.

AGM–62 Walleye

The Walleye is a glide bomb that also locks onto and tracks its target all the way until missile impact. It carries a 470 lb shaped-charge warhead, which gives it the largest bang of all the smart weapons. Because it is not rocket-powered, it is not as fast as the Maverick. The Walleye is capable of gliding for significant distances if released with enough altitude and airspeed. Aside from the HARM, the Walleye can have the longest range of all the A/G weapons.

Weapon description

The Walleye is bigger than the Maverick, measuring 10'9" in length. It also weighs significantly more at 1250 lbs per weapon. The Walleye is an older generation of weapon that is still in use today. Its sensor is basically a TV video camera with very little enhancement added. The Walleye is not quite as aerodynamic as the Maverick, and its increased weight will detract slightly from aircraft performance.



Display

The Walleye display has four sets of lines which form a box in the center of the display called a "gate." The gate is used to lock the seeker head onto the target.

The Walleye (WE) display on the left DDI consists of:

Walleye mode indication – Displays a WE to indicate that the Walleye weapon mode is selected and operating.

WE station indication – Displays which aircraft load station the currently selected WE is on.

WE target gate – The box created by the 4 lines (2 in azimuth, 2 in elevation) is the only place the WE seeker is capable of locking on to the target. The target must be within the box to be locked up.

IN RNG cue – Flashes indicating that the WE is within its engagement envelope and will be capable of striking the target.

CAGED/UNCAGED cue – Indicates whether the seeker head is caged (not tracking a target) or uncaged (tracking a target).

HUD indications before WE seeker lock on:

WE – Indicates current selected weapon.

WE A/G reticle – The reticle is fixed just below the airspeed boxes to assist in acquiring targets with the WE seeker.

HUD indications after WE seeker lock on:

TD diamond – Target designator diamond will indicate the WE seeker's target.

Distance to target – Will display current distance to the WE target in NM.

IN RNG cue – Will flash to indicate the WE is IN RANGE and can be successfully launched.

To perform a Walleye lock on and launch:

- Cycle to the WE display by pressing the "o" key until the WE display is visible on the left DDI.
- The HUD will have WE displayed in it to indicate the current selected weapon. A WE aiming reticle will also be displayed to assist the pilot in placing the WE seeker head in the target area.
- The target must be visible on the WE display and must be in the gate for lock on to occur. When it is, press the ENTER key to lock the WE seeker head on to the target.
- If the lock is accepted, the DDI will display an UNCAGED indication, and the missile will track the target. A TD diamond will appear in the HUD to indicate the location of the target when successfully locked. Range to target will also appear in the HUD.
- Wait until the IN RNG cue appears, visible in either the HUD or on the WE display, and then launch the WE by pressing ENTER.
- Upon launch the Walleye the display will reinitialize to the SMS page.

Ranges

The Walleye has a maximum effective range from 5 to 14 NM depending on altitude and airspeed. Do not release the Walleye without an IN RNG cue, otherwise target impact is not guaranteed.

Employment profile

The Walleye achieves its maximum range from high altitude, usually above 10,000' AGL. Acquire the target, lock the seeker head on to it, and wait for IN RNG. Upon IN RNG indications release the WE and exit the target area. With a good seeker lock on, the WE will do the rest.

Suitable targets

The Walleye is an excellent weapon for use against factories, hardened buildings and bunkers, large ships and dams.

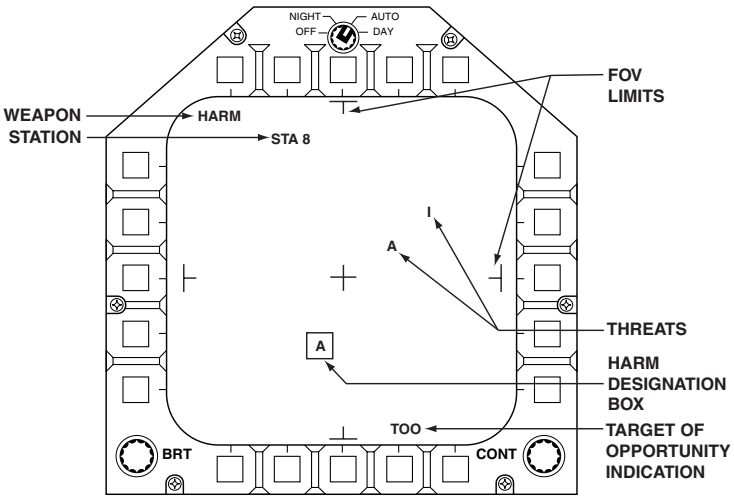
HARM

The High-speed Anti Radiation Missile or HARM is your weapon of choice against enemy surface to air radars. It also serves as an additional sensor, displaying the relative positions of the enemy radar systems in relation to the HARM seeker head. If you are tasked with taking out a SAM radar system, this is the one to use.

Weapon description

The HARM is a passive radar homing receiver that can identify and track enemy radar signals. The missile is 13' 9" in length and weighs 807 lbs. The HARM warhead contains approximately 145 lbs of directed fragmentation HE material. This fragmentation pattern is uniquely designed to destroy radar antenna equipment.

Display



The HARM display is initialized on the left DDI when the "u" key is pressed. At the same time A/G master mode is invoked and a HARM missile is selected and powered up for use (there must be one available on the aircraft). The HARM will display all the radar threats it detects on the DDI display. The display is oriented with the HARM missile (and aircraft) centerline depicted in the center of the display by a cross. All threat radars within the HARM missile's 60^{o} field of view are displayed. The radars are categorized in the same manner as discussed in the ALR-67 RWR display indicator.

HARM – Indicates that HARM is currently selected and operating.

Field of View boundary limit markings – These marks outline the HARM missiles field of view. They represent 30^{o} from missile centerline in every direction.

Selected station indication – Informs the pilot of which aircraft load station the selected HARM is on.

IN RNG indication – The IN RNG indication will flash to indicate that the currently designated HARM target is now within range of the HARM missile. A target must be designated for the MC to provide this cue.

HARM centerline mark – Indicates HARM and aircraft centerline.

HARM targets – Indicate which threat radar signals the HARM is currently receiving and can successfully target. All targets within the HARM field of view, which meet these requirements, will be displayed.

HARM designation box – Indicates current designated target for the HARM missile. Targets are designated and will cycle through all displayed targets by pressing the CONTROL "\" key.

HARM operating mode – Informs the pilot that the HARM is operational and currently working in the Target Of Opportunity (TOO) mode. This is the only operational mode for the HARM in F/A-18 OIF.

HARM HUD display

Before designation a HARM cue appears in the HUD to remind the pilot that a HARM missile is currently selected for use.

After target designation a target designator diamond will appear in the HUD or will flash if HUD limited. Pull up cues will also be present. A range to designated target will be displayed below the HARM indication and will continue displaying target range information until the HARM missile is launched or a new target is designated. The IN RNG cue will flash in the HUD to indicate that the missile is now capable of reaching the designated target.

Ranges

Employment ranges will vary between 6 to 12 NM depending on altitude and airspeed. The lower number is for lower altitude and slower airspeeds, and the higher number is for higher altitudes and airspeeds. This is when the MC will provide

an IN RNG cue. It is not recommended that you employ the HARM without an IN RNG cue. It may hit the target, but your chances of success are significantly reduced.

Employment profile

Fly to place the target area within the field of view of the HARM missile. Determine which radar signal is your target. Designate the target by pressing the CONTROL '\" key. If the designated target is not the proper one press the designate key repeatedly until the desired target is boxed. Fly toward the target until the IN RNG cue is flashed. Launch the HARM by pressing the trigger or ENTER key.

Suitable targets

HARM is used against all enemy radars associated with SAM missiles systems, radar guided AAA, and any enemy surface to air search radars. HARM does not recognize the radar signals from any enemy airborne radar systems.

CHAPTER 7: AIR-TO-AIR

PHILOSOPHY

Welcome to Air-to-Air (A/A). Air-to-Air is probably the more dynamic of the two roles that the F/A-18 Hornet performs. The A/A mission is not simply pulling the trigger at the "SHOOT" cue and watching enemy aircraft explode. The A/A environment contains many variables, thus it is extremely dynamic. The enemy is not restricted to the ground and can react and move much more quickly. A successful fighter pilot must understand and apply many important concepts regarding radar search control, A/A weapon usage, and 3 dimensional maneuvering. Armed with a solid understanding of this information, the pilot can formulate a viable game plan in order to get the mission accomplished and survive. This chapter will introduce you to the F/A-18's arsenal of A/A sensors and weapons, and discuss A/A mission fundamentals so that you will soon be splashing bandits with the best of them!

WHAT IS AIR-TO-AIR?

The "F" in F/A-18 Hornet stands for Fighter. That is what this chapter will teach you to do with the aircraft. Again, there are those who like to argue the issue of whether the "F" is bigger than the "A". For the purpose of this chapter you must consider yourself a fighter pilot, flying an aircraft whose sole mission is to destroy other aircraft. It's a complicated and rewarding mission role, but you must realize that to succeed in F/A-18 OIF, you will be required to do both A/A and A/G!

Define

This chapter will discuss Air-to-Air by first introducing specific types of missions. The A/A applications of the onboard sensors will be next, focusing on the AN/APG-65 radar. Then all of the Hornet's A/A weapons will be explained along with uses, limitations, and displays. The final portion of the chapter will deal with how to employ the Hornet as an A/A weapon platform in the complex A/A environment.

IMPORTANCE IN MODERN ARMED CONFLICT

The modern fighter aircraft performs basically in one of two A/A roles. The roles can be generally described as either offensive or defensive in nature. Offensive roles will usually involve seeking out enemy aircraft and disabling or destroying them. The focus here is on destroying the enemy's aircraft and maintaining air superiority. Defensive roles will deny enemy aircraft the acquisition of a weapon firing solution (with either A/A or A/G weapons) on some friendly unit, possibly an aircraft, or even a home base or an aircraft carrier.

And so it is important to the GFC that fighter aircraft protect his forces in one of two ways: by either destroying enemy air capability preemptively (offensive mission) and thus maintain friendly air superiority, or destroy enemy aircraft that intend to interfere with the GFC's operations by protecting his own forces from hostile intrusion (defensive mission).

Types of Air-to-Air Missions

Under the heading of either of the two mission roles (offensive or defensive) there are several sub categories of missions. The categories of missions will not differ in the basics. Your job will still be to shoot down other aircraft as necessary, but some will present unique twists to the basic "hunt and kill" type of philosophy.

Fighter Sweep (MIGCAP)

The Fighter Sweep or "moving" MIG Combat Air Patrol (CAP) is an offensive A/A mission. It involves destroying any and all enemy aircraft that the sweep encounters. The sweep's primary mission is to gain and maintain air superiority. In a fighter sweep, the friendly fighters will proceed through a patrol zone then seek and destroy any enemy aircraft they encounter. One point about moving MIGCAPs: they tend not to limit your tactics and movement because they are usually well out in bad guy territory. If you begin to feel defensive while flying a moving MIGCAP, there will probably be enough room for you to separate from the fight and reset the MIGCAP when you no longer feel threatened.

Vital Area Defense (VAD)

The Vital Area Defense (VAD) is a defensive A/A mission. It tasks the pilot with keeping a designated area free from all hostile aircraft incursion. The VAD usually involves protecting an aircraft carrier or some other important fixed facility. The primary difference in conducting a VAD will be that the focus will be on finding the attack aircraft and not the fighters. You may have to deal with fighters to get to the attack aircraft, but the central issue is to stop enemy bombs or missiles from impacting the area you are trying to protect. There is not much room here for resetting if you feel you are in danger from hostile aircraft. You must protect the vital area at all costs.

High Value Asset Combat Air Patrol (HVACAP)

The High Value Asset Combat Air Patrol (HVACAP) is a defensive mission. Your objective here will be to protect some airborne asset from enemy fighters. One such example would be to prevent the AWACS from being shot down. You are, however, free to leave your CAP station if you must to engage hostile fighters, but be sure that there are no other enemy fighters within weapon employment range of the High Value Asset (HVA). The bottom line here is, do not let the HVA get shot down or you have failed in performing your mission.

Enemy intercept and escort

The enemy intercept and escort mission is slightly different and involves both offensive and defensive roles. The first task will be to find and identify as non-hostile a defecting aircraft. Once identified, then close with and escort the aircraft across friendly lines. If the enemy sends up resistance to engage the defecting fighter, then you must protect the defector by engaging the enemy fighters.

Measures of Success

There may be a couple of different ways to successfully complete your A/A mission. It all depends on your mission tasking. It does not always involve heading directly at the enemy fighters with your hair on fire, shooting at everything that flies (although that tends to be fun, it may not get you any rank). Know the mission requirements and keep them in mind when executing your game plan. There may be times when you needn't fire a single shot.

Destruction of enemy aircraft

The first and foremost method of winning A/A engagements is to shoot the bad guys down. Destruction of enemy aircraft will probably be the way you end up successfully completing most of your A/A engagements. It can be the best way to ensure that you have fulfilled your mission requirements (assuming the mission briefing calls for it). You won't have to worry about the enemy if you just sent them down in flames.

Disruption of enemy aircraft

Another way to handle enemy aircraft is to "influence" them. To influence them means to cause them to perform in such a manner so as to no longer be a threat to your mission. For example, influencing fighters might be to cause them to commit (leave their assigned CAP station in order to shoot down or engage) on you and then lead them in a direction away from your strike group. Another example might be to chase the incoming strikers and force them into a situation where they end up jettisoning their bombs and fighting you. Once they get rid of their A/G weapons, they can no longer attack the vital area you are protecting. That leaves you the option of either finishing them off or disengaging and going after another potential incoming threat. Either way, you have effectively disrupted their game plan and their chance of achieving their objective is severely reduced.

Successful intercept and escort

The mission may require you to identify and intercept a defector. Your task will be first to determine who the defector is. Then intercept, join up on, and visually identify the defector. (Always maintain the upper hand in these missions! If the defector changes their mind you want to be the first to shoot.) You will have to then escort the aircraft to a selected base where the aircraft will land. After a successful landing of the defector's aircraft, your mission is complete.

Survive the Mission

Needless to say there aren't many dead pilots still flying. If you want to continue you must, above all else, survive until the next mission. Staying alive is the primary objective no matter what the mission requirements are. Stay alive, get home and be there to fight another day.

How do you fit in?

Here are some hints to help get you through your A/A missions. These bits of information will help to focus on the mission at hand and assist you in achieving success.

Complete assigned mission

You must understand and complete the mission objective. If it is to intercept a defecting aircraft, then that is what must occur. Focus on what needs to get done and once that goal is achieved then go looking for other bandits to tangle with.

Study enemy aircraft performance

Be familiar with the threat section concerning aircraft performance. Know the difference in corner speeds between a MIG-21 and an Su-27. You should also have a good idea of what the enemy's top end airspeed is. If he is faster than you, then there is probably a good chance that you aren't going to leave the fight any time soon. If you are faster than they are you can safely disengage and head home at almost anytime you choose. But you won't know for sure unless you have looked at the enemy aircraft's specifications in the threat document.

Know the enemy's weapon envelopes

Another thing all fighter pilots should know is the capability of the enemy's weapons. You should have a darn good idea when you are in danger of being hit by the bad guys. Look at the ranges of their weapons and their weapon's turning capabilities. Try to keep in mind when you are entering an enemy's Weapon Engagement Zone or WEZ. Ask yourself, "Am I just on the edge of the envelope or I am currently in the "heart of the envelope"? Where you are in relation to enemy aircraft's WEZ helps you decide what action to take if they shoot at you.

Watch enemy tactics

Does the enemy pilot always commit on you once you're within maximum range of his missiles or do they wait until you are within visual range? As you fly the missions you should watch how the enemy employ their aircraft. Do they use advanced tactics or are their methods of engagement more direct? Be observant and take note of their operations. Once you feel more familiar with their methods, you can use this information to your advantage.

Know your own aircraft & weapons

This part should go without saying, but I will reiterate it because it is important. You should know your own weapon systems and be capable of using them. Be familiar with the weapon displays on the HUD and the radar. The number of missiles and bullets the F/A-18 Hornet carries is finite, so every shot counts!

With that said, on to Air-to-Air systems!

AIR-TO-AIR SENSORS

The primary A/A sensor is the AN/APG-65 radar. Although the FLIR can be used, it doesn't have the range and flexibility of the radar. The radar is used to employ all of your A/A weapons. You'll also note that the radar has many A/A modes, and as an F/A-18 Hornet fighter pilot, you need to understand each mode's strengths and weaknesses. The next section will explain all of these modes and give you insight into when it is best employed to your advantage.

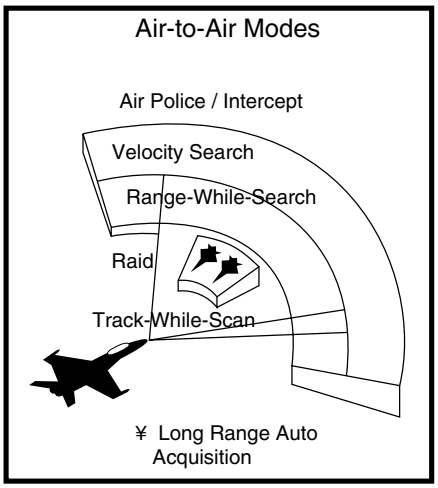
RADAR

The A/A radar operates by systematically searching a pilot controlled volume of airspace in front of the F/A-18 Hornet for any airborne targets. The radar then displays the targets on the A/A radar display.

Define

The AN/APG-65 radar is extremely capable in performing A/A target location and ranging tasks. The A/A radar beam in F/A-18 OIF is extremely narrow, only 5 degrees in diameter. It can only detect one target at a time, however the MC that works in concert with the radar can store target information from multiple targets. The radar also provides the MC with each target's closing velocities and heading. The radar determines this through the use of Doppler filters while the radar is measuring the frequency shift of the returning radar energy from the target. The MC then organizes and displays the information on the A/A radar display. The targets on the display are synthetic (computer generated) for greater clarity and operator ease of use. In this manner, the A/A radar provides the fighter pilot with a significant amount of information about what is going on out in front of the aircraft.

Scan volume



The radar beam is very narrow and would therefore be extremely limited in functionality if the antenna couldn't move. The maximum search area that radar can search is controlled by the radar's gimbal limits (movement limits). The AN/APG-65 radar in F/A-18 OIF moves or "scans" with maximum gimbal limits of 140° in azimuth and 140° in elevation. This creates a maximum search area or "scan volume" which is +/- 70° (in both azimuth and elevation) of the aircraft's nose. If a target is within this volume the radar will eventually find it. If the target is not, the radar will not be able to see it.

To control the azimuth of the radar in F/A-18 OIF, press the "z" key to toggle to the next smallest azimuth scan selection. To increase the azimuth scan, press SHIFT "z" to toggle to the next largest scan available. The possible azimuth selections are 140, 80, 60, 40, and 20. Note that determining which scans are selectable depends on which search mode of the A/A radar you are using. Specifics on each mode's azimuth limitations can be found in the sections describing those modes.

Frame

The radar utilizes a pattern to search its selected scan volume. The volume of the horizontal component is controlled by radar azimuth selection. The number of elevation search bars, or simply "bars" controls the height of the scan volume. The maximum scan volume of the radar is 140° (azimuth) and 6 bar (elevation). This commands the radar to scan in azimuth out to 140° (70° either side of aircraft centerline) and use 6 different elevation settings. Each bar is separated by 2.5°, so out of a possible 70° in elevation volume, only 17.5° is being searched (remember the radar beam is 5° in diameter). One complete radar scan (going through 140° of azimuth 6 times (one pass for each Elevation, or "bar")) is called a radar "frame."

The search bars are controlled in F/A-18 Hornet by pressing the "x" key. This will decrease the bar selection. To increase the bar selection press SHIFT "x". Repeated presses of either key will recycle the bar selections back to the highest (or lowest) selection available. Bar selections available are; 1, 2, 4, and 6.

The bar scan is smaller than the azimuth scan because of a radar characteristic called frame rate. Frame rate is the time it takes a radar to complete one frame, or search through its entire selected search volume. The radar moves in azimuth at a fixed rate of 21.5° per second. Thus a maximum volume search (140° and 6 bar) will take approximately 40 seconds. This is something to consider when selecting search volumes. The larger the volume the longer it will take for the radar to search it.

What does this mean to the fighter pilot? It directly translates into how timely and accurate the information on your radarscope is. If the scan volume is large, it will take a long time for the radar to go through it. This may have adverse affects on your target search. The time it takes to initially find a target will increase with a large scan volume, or worse, the radar may miss a contact. Missed contacts may result because of the time it took the beam to get to the target. When it finally got there, the target was no longer within the radar's search volume. Smaller search volumes mean faster target acquisition and updates thus providing a more timely radar picture. Because the volume is smaller, you need to have a better idea of where the enemy is to maximize your chances of finding them.

Range

The distance at which the AN/APG-65 can detect radar reflections off of the target will determine target acquisition range. The radar display does not control the range at which the radar will see and track targets. It will only limit your ability to see them on the radar display. There may be a target that the radar is tracking beyond the range limit of your display and the only way to know is to cycle to the next higher range selection and check manually.

The range on the F/A-18's radarscope can be adjusted with the TAB key. To reduce the maximum range, press the TAB key. To increase the A/A radar range press the SHIFT TAB key. All available selections will recycle upon repeated presses of the TAB key. The ranges that the radar is capable of searching are 80, 40, 20, 10, and 5 NM.

APG-65 AIR-TO-AIR MODES

The F/A-18 Hornet's radar has several specialized A/A modes and sub-modes. The modes were designed for use in certain tactical situations.

Longer Range Air-to-Air solution

The Beyond Visual Range (BVR) engagement is, for the most part, fought with A/A radar and radar missiles. The targets are detected at long range, sorted and identified, and then engaged and (hopefully) destroyed. All without the benefit of actually seeing the enemy aircraft with your MK1 – MOD 0 eyeball. In these types of battles, the radar is your only sensor. The radar has the capability to perform well in BVR engagements, but you must know how to use it.

How to change Air-to-Air modes

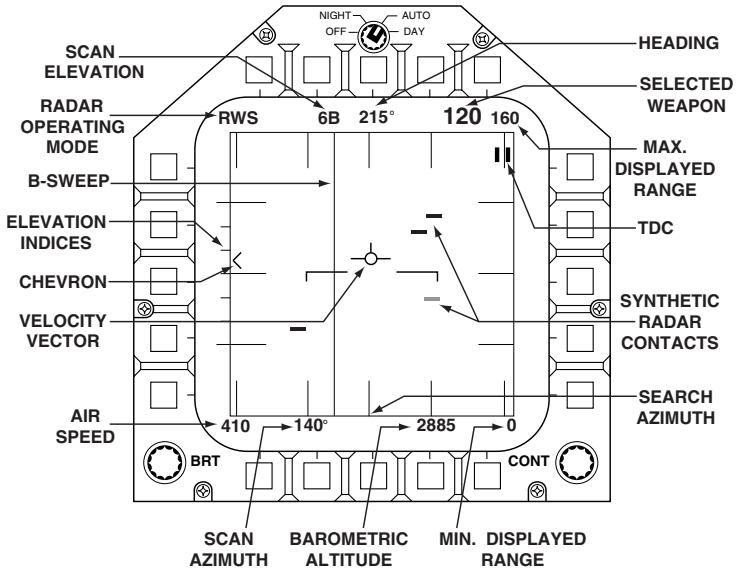
Pressing the "r" key initializes the A/A radar. A/A is the default mode when the radar is activated. The radar is displayed on the right DDI. Successive presses of the "r" key will cycle back and forth between A/A and A/G radar displays on the right DDI. To switch between A/A radar modes press the "r" key until RWS mode is displayed, then press the "q" key to cycle through the A/A radar modes.

RWS

Range While Search (RWS) is the default A/A mode of the radar. It is automatically selected when the A/A radar is first invoked. The RWS mode is probably the best all around mode for long-range A/A use. It offers the flexibility of a large selectable scan volume along with medium to long range detection capabilities.

Define

The RWS mode of the radar scans the selected search volume and displays any targets it encounters on the radar display. The only information the basic RWS display provides is range and azimuth. To get more information about a specific contact you must lock it up when using RWS by commanding the radar to perform a Single Target Track (STT) by pressing "\".



Display

The following description applies to the basic RWS display and does not address the additional indications associated with STT. The RWS A/A radarscope is an azimuth vs. range type of display.

Antenna azimuth - Search azimuth is displayed along the bottom of the DDI. The zero azimuth location (aircraft) is in the center. The azimuth is then broken down into 30° azimuth ticks. They represent 30° and 60° left and right of center. The limit of the radar box is 70° left and right of center. The azimuth ticks are found on both the bottom and the top of the radar screen. The current azimuth of the radar antenna is represented by the location of the B-sweep.

B-sweep – The line that slides side to side on the radar display. It will react to your azimuth restrictions, just adjust them and see!

Selected range – The maximum and minimum ranges are indicated on the right hand side of the radar scope. The max range is at the top, the minimum is at the bottom. Along both sides, on the inside of the radar display, are the range ticks. They are (starting at the bottom and working up) 25%, 50%, and finally 75% of selected range. The top of the radar box display represents the maximum range.

Elevation indices - Radar elevation indices are on the left side of the radar display, outside of the radar box. Zero elevation is directly adjacent to the 50% range tick. The elevation indices above the zero mark are up from aircraft centerline, and the indices below the zero mark indicate the antenna is looking below aircraft centerline. Radar elevation is represented by a small chevron, which moves appropriately to show radar elevation position. It will move in response to the bar scan selection.

Radar operating mode - The A/A mode is indicated in the upper/left-hand side of the radar screen. It should show RWS when the Range While Search mode is active.

Aircraft Heading – Aircraft magnetic heading, repeated from the HUD.

TDC cursors – The TDC cursors.

Velocity Vector – Displays the aircraft's current attitude in relation to the horizon bar. This information is repeated from the HUD.

Calibrated airspeed – Repeats current aircraft airspeed in knots, repeated from the HUD.

Barometric altitude – Repeats current aircraft altitude in feet, repeated from the HUD.

Selected weapon – If an A/A weapon is selected it will be indicated here.

Synthetic radar contacts – Represent the targets that the radar is currently capable of tracking.

Options

The following options are available in the RWS mode of the A/A radar:

Selectable ranges are: 80, 40, 20, 10, and 5 NM.

Selectable azimuth options are: 140, 80, 60, 40 and 20 degrees.

Scan bar options are: 6, 4, 2 and 1.

Uses

RWS mode is the best "all around" mode to use because it has the most flexibility and utilizes the basic range vs. azimuth type of display. The scan volume can be adjusted to suit the tactical picture. RWS is more work to use, however. It is highly recommended that the TDC always be slewed to the target of interest. Pressing the designate key with the TDC stowed may STT the wrong target and lead to confusion.

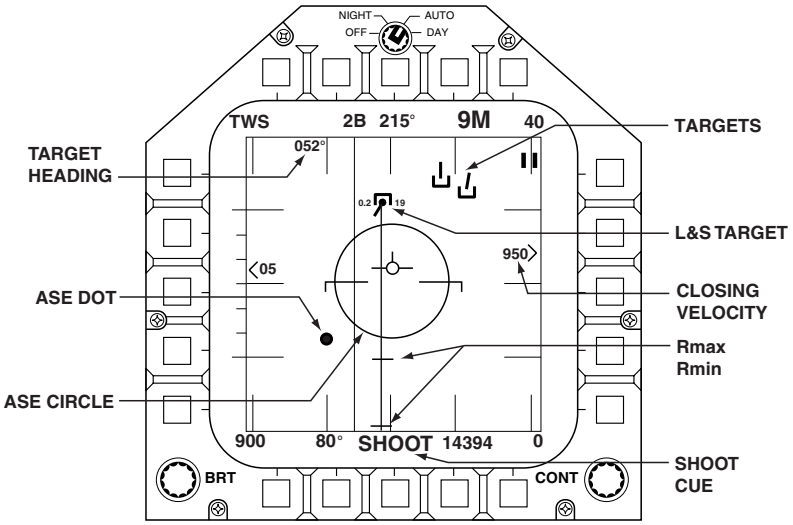
TWS

The Track While Scan (TWS) mode of the A/A radar is more of an automatic mode, where the MC and the radar do most of the work for you. This is a good mode to use if you are not very experienced with running an A/A radar, but TWS does have some limitations you need to be aware of.

Define

The TWS mode automatically searches the selected scan volume and displays target information on the radar display. The information that TWS provides is similar to STT except that you get that information on all displayed targets. The radar does this by creating track files on each contact it encounters as it scans. As the beam passes the target again, new information is added to the track file for each target. The file is then extrapolated and each contact is given a calculated heading and airspeed. The heading and airspeed information is not as accurate as an STT radar lock, because it is based on historical data. A TWS file might be updated once every 20 seconds or so (when the beam actually hits the contact again), but an STT is updated many times a second because the radar is only looking at one target.

Display



The TWS display is set up the same way as the RWS display, so only the differences will be addressed here. As TWS works, it builds a picture of the A/A situation ahead of your F/A-18. It monitors all contacts it encounters and displays them on the scope.

Targets within the TWS scan volume will be displayed and will have aspect vectors attached to them. The aspect vector indicates which direction the contact is headed with respect to your heading.

TWS will also designate one contact as the Launch and Steering (L&S) target. The purpose of the L&S is to allow you to monitor one contact more closely than the rest on the scope. The radar will also update this contact more often to improve the accuracy of the information displayed about it. The L&S target will have more information about it displayed on the scope. The additional information provided by the MC about the L&S is described below.

L&S target – Is indicated by a large target symbol over the contact.

Target airspeed – To the left of the target symbol, expressed in percent of Mach (the speed of sound).

Target altitude – Found on the right of the target symbol, expressed in 100's of feet.

Target heading – Found on the upper left hand side of the radarscope, expressed in degrees magnetic.

Closing velocity – Found on the right hand side of the scope, the number to the left of the range caret represents target-closing velocity, expressed in 100's of knots.

If an A/A missile is selected, the MC will also display weapon employment ranges on the L&S target.

R_{max} – range, maximum - The top horizontal line displayed on the weapon range line is the maximum missile range adjusted for current target flight conditions.

R_{min} – range, minimum - The bottom horizontal line is the minimum range for the selected weapon adjusted for current target flight conditions.

ASE circle – Allowable Steering Error circle represents the maximum aircraft attitude deviations from current attitude to ensure missile remains within its functioning envelope.

ASE dot – Allowable Steering Error dot moves to display if the current aircraft attitude is (dot is within ASE circle) or is not (dot is out of the ASE circle) within the selected missile's functioning envelope.

Shoot cues will also be visible on the radar scope if the target meets successful missile launch criteria, however that will be discussed further in the A/A weapons section.

The HUD will show L&S targets in a Target Designator (TD) box. It will move with the L&S track to indicate relative position in relation to your aircraft's nose. If the TD box becomes HUD limited, it will flash to indicate this condition.

Options

The following options are available in the TWS mode of the A/A radar:

Selectable ranges are: 80, 40, 20, 10, and 5 NM.

Selectable azimuth and scan bars options are available only in the following combinations:

- 2 Bar and 80°
- 2 Bar and 60°
- 4 Bar and 40°
- 6 Bar and 20°

Uses

The TWS is best used if you are new to operating the radar. It provides the most Situational Awareness (SA) of any of the operating modes. This SA does come at a cost that you must realize: the updates on the radar picture will be slower, and the information provided may not be the most accurate.

TWS is also a good choice to use if you have multiple contacts in a relatively confined area (within TWS reduced scan volume). The radar will then provide you with enough information for you to monitor what is going on. It also has enough flexibility to let you target and employ weapons should one of the contacts suddenly meet your commit criteria.

VS

Velocity Search looks very similar to RWS, with one very important exception – the X axis (from the top of the DDI to the bottom of the DDI) of the radar display now represents closing velocity instead of range to target. This is very important to keep in mind when switching radar modes to use VS mode. If you mistake the closing velocity for range the results could be disastrous for you! VS has some very specific times when it should be used, other than those times it is probably best left alone to help avoid confusion.

Define

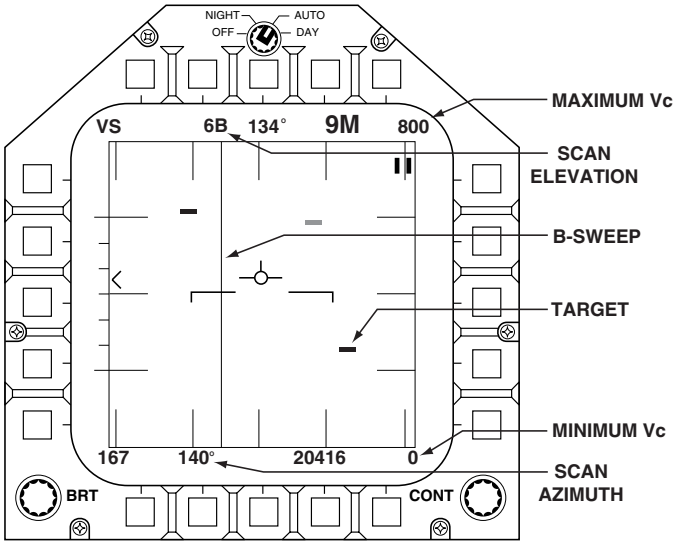
VS displays targets in azimuth and closing velocity (measured in knots). It will display all contacts within its selected search volume. Note that search volume is controlled in exactly the same way as RWS, the only difference is that contacts aren't displayed in range. The AN/APG-65 measures radar signal Doppler shift received from the target and then calculates the V_c or Velocity Closing.

Display

The VS display is a V_c versus azimuth type of display. The differences from RWS and TWS are noted below.

Maximum V_c – Indicates the maximum V_c, expressed in knots, selected for display. There are only two settings to choose from.

Minimum V_c – Indicates the minimum V_c, which is always zero knots.



Options

The following options are available in the VS mode of the A/A radar:

Selectable Vc is: 800 or 2400 knots.

Selectable azimuth options are: 140, 80, 60, 40 and 20 degrees.

Scan bar options are: 6, 4, 2 and 1.

Uses

VS has the least number of internal radar filters associated with it. What this means is that VS has the greatest chance of getting that "early" contact you need, especially with an extremely fast moving target. All things being even, VS will be the

first mode to get a long-range contact. But to gather more information about the target, you will have to go to STT and try for a radar lock.

Unfortunately VS is the least user-friendly mode. RWS is easier to work with because range is much easier to conceptualize than closing velocity. You simply cannot build a good picture of what is going on in front of your fighter with VS. But if the area ahead of your Hornet is clear for several miles, and the target you are looking for is far away and closing fast, consider using VS.

STT

Single Target Track or STT is the target-tracking mode of the AN/APG-65 radar. In STT the radar only monitors a single target (high update-rate tracking). This mode then provides weapon launch envelope information to the STT target. Commanding the radar to perform an STT is the same as taking a "radar lock." An STT will also alert that enemy that you are looking at them.

Define

STT is entered from RWS, VS, TWS, AACQ or any of the ACM modes talked about later in this chapter. The radar will find the designated target and then track that target until the target breaks the lock, the radar reaches it's gimbal limits (+/- 70^{o} in azimuth and elevation), or the STT mode is deselected by the pilot.

From RWS and VS, STT is entered by designating the target by pressing the designate or "\" key.

If the TDC cursors are stowed (located in the upper right hand side of the radar screen) the MC will command an STT on what it thinks is the highest priority target. If there is only one contact on the scope, it will STT that. If the MC has to choose, it will select the target that has the highest closure rate on your Hornet. The highest closure rate for STT will be determined as a function of combining the target aspect and closing velocity. Note, that this may not be the target you want to STT! The STT will cycle to other targets by repeated presses of the designation key. This method will not function after slewing the TDC cursors from the stowed. If you wish to re-stow them to use this process for entering STT, press the undesignate key or SHIFT "\" and start again.

If the TDC cursors are used, they must be moved to a radar contact by using the radar TDC slew keys (SHIFT arrows). When positioned over a contact, press the designate key to STT the contact. The MC will lock the target closest to the center of the area between the cursors.

From TWS the radar will enter STT on the L&S target if the "q" key is pressed.

The radar will STT the first target it finds when an ACM mode is invoked. For more information about ACM modes, see that section.

STT is deselected by switching to another radar mode or by pressing the undesignate key, SHIFT "\".

Display

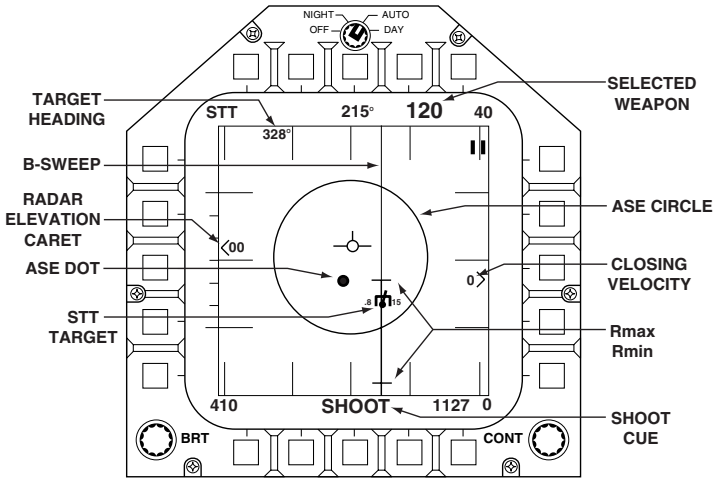
When selected, STT will clear all other radar contact information off the scope, and track the desired target. The information provided is:

STT target – Is indicated by the target symbol.

Target azimuth – Indicated by the position of the B – sweep.

Target airspeed – To the left of the target symbol, expressed in percent of Mach (the speed of sound).

Target altitude – Found on the right of the target symbol, expressed in 100's of feet.



Target heading – Found on the upper left hand side of the radarscope, expressed in degrees magnetic.

Closing velocity – Found on the right hand side of the scope, the number to the left of the range caret represents target-closing velocity, expressed in 100's of knots.

Radar elevation caret – Will display current radar elevation in degrees above or below aircraft centerline.

If an A/A missile is selected, the MC will also display weapon employment ranges on the STT target.

R_{max} – range, maximum - The top horizontal line displayed on the weapon range line is the maximum missile range adjusted for current target flight conditions.

R_{min} – range, minimum - The bottom horizontal line is the minimum range for the selected weapon adjusted for current target flight conditions.

ASE circle – Allowable Steering Error circle represents the maximum aircraft attitude deviations from current attitude to ensure missile remains within its functioning envelope.

ASE dot – Allowable Steering Error dot moves to display if the current aircraft attitude is (dot is within ASE circle) or is not (dot is out of the ASE circle) within the selected missile's functioning envelope.

Shoot cues will also be visible on the radarscope if the target meets successful missile launch criteria. Again, that will be discussed further in the A/A weapons section.

The HUD will show STT targets in a Target Designator (TD) box. It will move with the STT track to indicate relative position in relation to your aircraft's nose. If the TD box becomes HUD limited, it will flash to indicate this condition.

Uses

STT is the F/A-18's radar lock mode, and it provides the pilot with the most accurate information about the radar contact. Other than the L&S target in TWS, it is the only mode that provides weapon employment information about the target. It is used out of RWS or VS to gather information about a contact, then quickly breaking lock and going STT on another contact. By doing this radar target "sampling" the pilot is able to build a picture of what is going on out in front of them.

AACQ

Auto Acquisition (AACQ) mode provides the pilot with a quick STT. The MC will also determine which contact (if there are more than one) is the highest priority threat and will STT that contact.

Define

AACQ commands the radar to take an STT or designate a new L&S (if invoked from TWS) on the highest priority target within the current selected scan volume. The MC determines what the highest priority target is by looking only at target aspect and closure (just like STT from RWS when the cursors are stowed). The MC does not take into account IFF, thus friendly and enemy aircraft are all used in making the determination of which contact represents the highest threat. The MC will lock a friendly if it has a higher target aspect and closure rate than any enemy aircraft in the scan volume.

AACQ mode is invoked by pressing the SHIFT "q" key. It is only available in RWS, TWS and VS. After the AACQ mode enters STT or designates a new L&S target (in TWS only) it will then be reset.

Note: AACQ DOES NOT enter STT from TWS mode if the designate key is pressed. It only reevaluates the priority of the L& S target. To enter STT on the L&S target from TWS mode, press "q".

Uses

The AACQ mode is used when a quick lock is needed on the target that is closing the fastest on you. Remember that it is not selective and will STT friendly aircraft as well as enemy aircraft.

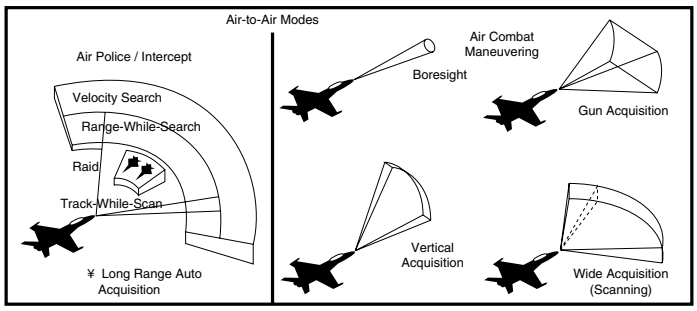
ACM MODES

The F/A-18 is a great platform for ACM. The radar has four modes designed specifically for the close in, BFM arena. Use of these modes will help "lighten" the pilot workload during A/A engagements.

Define

ACM or Air Combat Maneuvering is the politically correct term for "Dogfighting," or one-on-one air combat. Fighting another pilot (performing ACM) requires a fair amount of your cranial processing power, so any help you can get from the aircraft or its sensors can be a real life saver. The folks at Hughes Radar realized this and built 4 automatic targeting modes into their radar for you. They are only for use at short range, and provide the pilot with access to ways of getting a quick radar lock.

AN/APG-65 multimode pulse doppler radar.



The AN/APG-65 does not provide horizon stabilized antenna control when commanded to perform an ACM mode search. The antenna is always moved relative to the aircraft's centerline. As the nose of the F/A-18 moves through space, so does the ACM mode scan volume. The ACM modes are therefore NOT stabilized. Since aggressive aircraft movement is expected in ACM, this non-stabilized antenna movement is desirable. If the antenna tried to maintain a fixed scan volume, relative to the horizon, it would quickly reach it's gimbal limits and thus would not be of any use to the pilot.

Short range Air-to-Air solution

The RWS, VS, or TWS AACQ modes work for you at long range as well as short range, so the focus for the ACM modes of the radar is for use at visual ranges only, which typically occur within 10 NM. This range restriction will significantly reduce radar search volume criteria and get the ACM A/A radar lock in much less time. Because the ACM environment is extremely dynamic there is no single ACM search pattern that fits all circumstances. To reduce search volume and achieve fastest radar lock, four separate scan patterns are implemented in the AN/APG-65 radar. Each of these four patterns has its own unique uses in the ACM arena.

How to invoke ACM modes

The ACM modes of the radar are selected by pressing the SHIFT "r" key. When the ACM mode select key is pressed, the radar will immediately transition to the A/A mode and will initialize in a modified TWS mode specifically designed for short-range contact location. The radar maximum range will be automatically reduced to 10 NM for all of the ACM modes upon mode activation.

The ACM modes will toggle to the next mode with each successive press of the ACM mode key. The first mode is WACQ, then VACQ, then GACQ, and finally BST. Another press of the ACM mode key after BST will command the radar to a TWS mode, with 2 bar, 80^{o}, and 10 NM selected. Pressing the ACM mode select key again (after reaching TWS) will repeat the process.

WACQ

Define

WACQ (pronounced "Wide ACK") is the abbreviation for Wide Acquisition mode. It is the first of the ACM modes the radar will invoke upon pressing the ACM mode select key. The radar will search a large horizontal volume for contacts. The highest priority target the radar finds will be locked, provided it is within the scan volume. Targets outside of the scan volume will be rejected.

Parameters

WACQ searches to +/- 30^{o} in azimuth from aircraft centerline and +/- 7.5^{o} in elevation from aircraft centerline.

Uses

The WACQ ACM mode is best used when the target aircraft is close to level with the nose of the aircraft (not necessarily level on the horizon) and possibly offset to one side.

VACQ

Define

VACQ (pronounced "Vert ACK") is the abbreviation to Vertical Acquisition mode. It is the second of the ACM modes the radar will invoke upon pressing the ACM mode select key. The radar will search a large vertical volume for contacts. Like WACQ, the highest priority target the radar finds will be locked, provided it is within the scan volume. Targets outside of the scan volume will be rejected.

Parameters

VACQ searches to +/- 5^{o} in azimuth from aircraft centerline and from + 20^{o} to – 5^{o} in elevation from aircraft centerline.

Uses

The VACQ mode is good to use when in a tight turning fight and the target aircraft is on your lift vector (directly above your head). It is also used to get the lock and employ a missile when you don't have the energy to pull enough lead to get into a gun solution.

GACQ

Define

GACQ (pronounced "Gun ACK") is the abbreviation for Gun Acquisition mode. It is the third of the ACM modes the radar will invoke upon pressing the ACM mode select key. GACQ searches a small cylinder of air directly in front of your fighter for contacts. Like previous ACM modes, the highest priority target the radar finds will be locked, provided it is within the scan volume. Targets outside of the scan volume will be rejected.

Parameters

GACQ searches a volume +/- 5^{o} in azimuth and +/- 5^{o} in elevation from aircraft centerline.

Uses

The GACQ mode is designed for finding and locking a target quickly so that you can effectively employ the gun against it. The radar lock will provide additional cues to help the pilot develop a firing solution with the gun. This mode was designed to help get the radar lock when you are nearing the guns envelope.

BST

Define

BST is the abbreviation for Boresight Acquisition mode. It is the last of the ACM modes the radar will invoke upon pressing the ACM mode select key. BST immediately stabilizes the radar antenna to aircraft centerline and keeps it there. Like previous ACM modes, the highest priority target the radar finds will be locked, provided the radar beam hits it. Targets outside of the 10 NM range restriction will be rejected.

Parameters

The BST has the dimensions of the radar beam itself; 2.5^{o} wide, in azimuth and elevation, held steady on the aircraft's centerline.

Uses

This is the fastest way to get a radar lock, but you must know exactly where the target is (have visual contact) and place the nose of the aircraft on it for BST mode to lock it up.

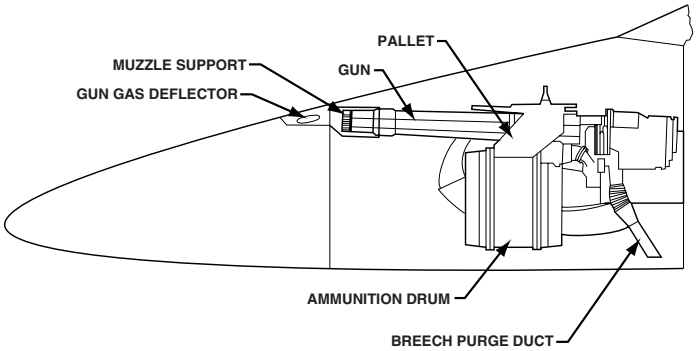
AIR-TO-AIR GUN

The F/A-18 Hornet has three basic A/A weapons. All have been designed to compliment the others in terms of range and employment tactics. Your shortest-range weapon is the M61A1 Gatling gun. In fact, the gun has no minimum range – use it as close to the target as you dare! Just be careful of chunks falling off the target aircraft as you shoot it.

Description

The M61A1 gun is mounted in the nose of the Hornet directly in front of the windscreen. The barrels are elevated 2^0 up from aircraft centerline, which provides a good compromise of A/A and A/G usage. The gun has 6 barrels that rotate rapidly when the weapon is fired. The gun is a 20mm caliber weapon with a maximum rate of fire of 6000 rounds per minute. The projectiles are high velocity, armor piercing rounds that have an incredibly destructive effect on other aircraft (on tanks too). The maximum number of bullets the F/A-18 can carry is 578. This number of bullets provides the pilot with about 5 seconds of "trigger down" time.

M61A1 GATTLING GUN



The gun is selected by pressing the A/A weapons select key "[" until the gun symbology is present on the HUD, the radar scope or the SMS page. The gun is the last A/A weapon that the MC will cycle to, behind AIM-9 and AIM-120, provided these weapons are loaded on your Hornet. The A/A weapon select key will also invoke the A/A master mode and prepare the weapons system for A/A weapon employment.

HUD Symbology

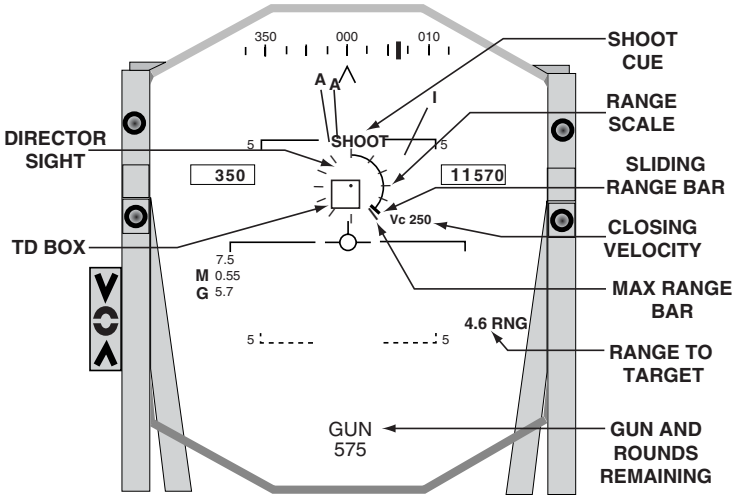
When the gun is selected the HUD will display the word "GUN" at the bottom to indicate the current A/A weapon mode. Below the "GUN" display the MC will show the current number of rounds remaining for the gun. A full gun would display 578. When the gun is empty the counter will display in the HUD "XXX". When the aircraft is on the ground, or a malfunction has disabled your gun the word GUN will be X'd out to indicate that the gun is not capable of being fired.

To fire the gun, press the trigger key, ENTER, or the trigger on your joystick. Bullets will immediately shoot from your Hornet at the maximum firing rate of the gun.

There are two HUD displays associated with the gun. The type of HUD display will be determined by whether or not you have an A/A target locked up with the radar. Note that in either case the gun will still function normally, i.e. shoot bullets, whenever the trigger key is pressed.

With RADAR lock

When the radar has an STT or is monitoring an L&S target, the MC will display gun employment data to the HUD. The mode of the gun with a radar lock is called "Director Mode." In Director Mode, the MC uses radar range rate information and gun employment envelope data to predict where the bullets will land at a given range. The MC then presents the solution to the pilot by placing the gun reticle where the impact point is. The MC also displays other pieces of information necessary for using the gun effectively in gun HUD display. The gun Director Mode of the HUD is described below:



TD box – Target Designator box, displays position of the current radar locked target to the pilot.

GUN – Gun is selected and ready for use (not X'd out).

Rounds remaining counter – Shows current round count loaded in your Hornet.

Radar range to target – Displays current range to target in NM.

Gun director sight – Displays current bullet impact point in relationship to the radar target, i.e. where the bullets will go right now if you shoot. The position of the director sight is calculated constantly by analyzing own ship's (your aircraft) movement, target movement, and gun envelope information.

Pipper – The actual bullet impact point in the reticle.

Range scale – Displays range, increasing counter clockwise from 0 at the 12 o'clock position out to a maximum range of 6000 feet. The top (12 o'clock position) is 0 feet of range, the right side (3 o'clock) is 1500 feet, the bottom (6 o'clock) is 3000 feet, and the left side (9 o'clock) is 4500 feet.

Sliding range bar – Displays current range to target. The range bar will slide as range changes.

Maximum range bar – Shows the current maximum effective range of the gun, while taking into account target airspeed, altitude and heading. Maximum effective range is not the maximum range. Effective means that the MC has calculated that the bullet will hit with enough destructive force to damage the target. Shooting outside the maximum effective range, although possible, does not always guarantee lethal target damage.

V_c – Closing velocity with the designated target express in knots. Opening velocities will have a negative value listed here.

SHOOT cue – The shoot cue will flash here and on the radar scope to indicate that bullets fired right now will strike within 40 feet of the designated target with sufficient destructive force to cause damage. When the condition no longer exists it will stop flashing until the conditions are met again.

Without RADAR lock

If the gun is selected without the A/A radar having an STT or L&S target, the MC will only be able to display a reticle using static information. The MC does not know where the target is or what it is doing so it only takes into account your F/A-18's airspeed and G load. It also will assume and display the reticle for the optimum range of gun employment, or 1500 feet. The non-radar tracking HUD looks like this:

GUN – Gun is selected and ready for use (not X'd out).

Rounds remaining counter – Shows current round count loaded in your Hornet.

Stadiametric reticle – Shows bullet impact point at 1500 feet of range. Moves in response to movements of your own aircraft only.

Pipper – Shows actual impact point of bullets.

2.5^0 target circle – Used for estimating range to target without benefit of radar lock.

Employment

The best way to use the gun is with a radar lock, in the Director Mode. This mode provides the pilot with an instantaneous bullet solution. The pipper may jump some, but practice will help you to keep ahead of it and allow you to position it with some degree of accuracy.

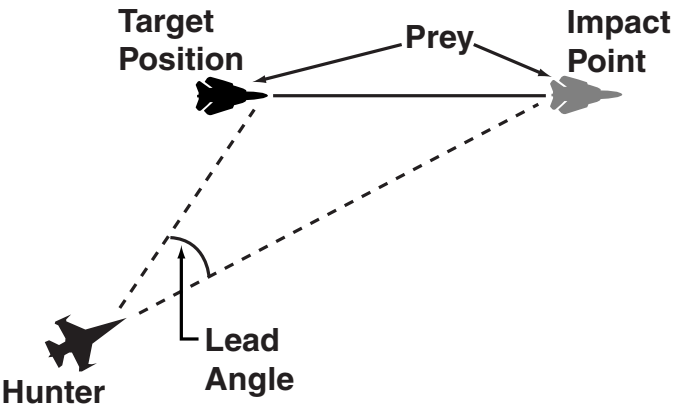
Due to the small number of rounds carried and the fast firing rate you should always be conscious of bullet count. Try to make every shot count, and not waste any extra rounds. Trigger presses should be short and controlled. Anticipate the solution and press the trigger slightly before the solution appears and release the trigger immediately after the pipper passes through the target.

The gun should be used between 500 to 2200 feet of range – ideally. Any closer and you risk damage to your aircraft from particles off the target. Any further and the gun gets too had to position accurately. Head on shots can be taken out to ranges of 3000 feet and possibly slightly beyond that depending on what the closing velocities are.

A final word with regard to range: if you want to hit the target, get as close to it as possible before you shoot. That is the best way to increase you chances of hitting it. Be warned though, that if you collide with the target you risk going down along with the enemy!

Tracking gun shot

The tracking gun shot, or low angle off shot has the highest P_k (probability of kill) of the two types of gunshots. It occurs when the attacker is behind the defender's 3 – 9 line, with the attacker's nose being capable of pulling lead. Closing velocities are typically small and track-crossing angles are low.



Using the director sight, pull to place the pipper on the target and press the trigger. If you are using the stadiametric reticle, close in range until the target's wingspan extends just outside the aiming circle. Pull enough lead to place the reticle ahead of the target and then relax the back stick and press the trigger as the pipper touches the front end of the target. Keep the trigger pressed until the pipper passes all the way through the target. Once the pipper is behind the target, release the trigger. Re-evaluate and reset your shot as necessary.

High angle off shot (Snap shot)

The "high angle off" gunshot or "snap shot" (even called the "deflection shot") is very difficult to do. It occurs when the attacker is able to put their nose out in front of the target aircraft and close enough range to use the gun. Closing velocities can be extremely large and track-crossing angles are great. The gun solution happens very quickly and the opportunity must be recognized early or there typically will not be enough time to set it up properly. Since the shot is so dynamic, neither mode of the gun will really assist you in making it happen. Use either mode, however most pilots prefer using the stadiametric reticle.

The secret to taking good snap shots is to place your gun bore line in the target's plane of motion. You accomplish this by first estimating target plane of motion, i.e. where the target is headed. Then draw an imaginary line from the target to your HUD. Position your gun bore line on this imaginary line – and keep it there! To help you simulate the position of your gun bore line – use the heading caret at the top of the HUD. Basically, put the heading caret in the target's plane of motion. To estimate lead, press the trigger while the target is still outside the field of view of the HUD. Release the trigger just after the target passes the center of the HUD, because any bullets shot now will always end up behind the target (it's a physics thing – you know… time of flight).

Snap shots are difficult to do and take lots of practice to perfect. Even experts miss these on a regular basis, simply because there are just too many variables at work here. Don't let that prevent you from taking a snap shot, should the opportunity occur. Anyone can get lucky, and most fighter pilots would rather be lucky than good any day!

AIM-9 SIDEWINDER

The AIM-9 Sidewinder has been in U.S. service for over 30 years and continues to improve. This missile is an excellent all aspect, "fire and forget" weapon for use in the visual arena. It is fast and accurate and has enough destructive force to dispatch a fighter-sized target with ease. Within 5 NM of the target, this missile should be selected and made ready for firing. The AIM-9 tracks the intended target by following the target's engine heat signature. It will continue to guide on this heat source until missile impact.

Description

The Sidewinder is 9' 6" in length and has a diameter of 5". It weighs 195 lbs. and has a maximum range of 11 NM, limited by rocket motor burn time. The minimum range of the missile is .5 NM, for safe warhead fusing. The warhead is a 22 lbs.

annular blast fragmentation type that contains both an impact and proximity fusing. The F/A-18 Hornet can carry up to 6 AIM-9's if desired. This configuration includes the wing tip only stations, stations 1 and 9, which can only carry Sidewinders.

The AIM-9 is selected by pressing the A/A weapon select key "[" until "9M" appears in the HUD and in the upper right hand corner of the A/A radar screen. This will also transition the F/A-18 weapons system into the A/A master mode. If AIM-9's are loaded, they are the first weapon selected by the MC when the A/A weapon select key is pressed. If no more AIM-9's remain on your aircraft, the MC will automatically select the next available A/A weapon.

HUD Symbology

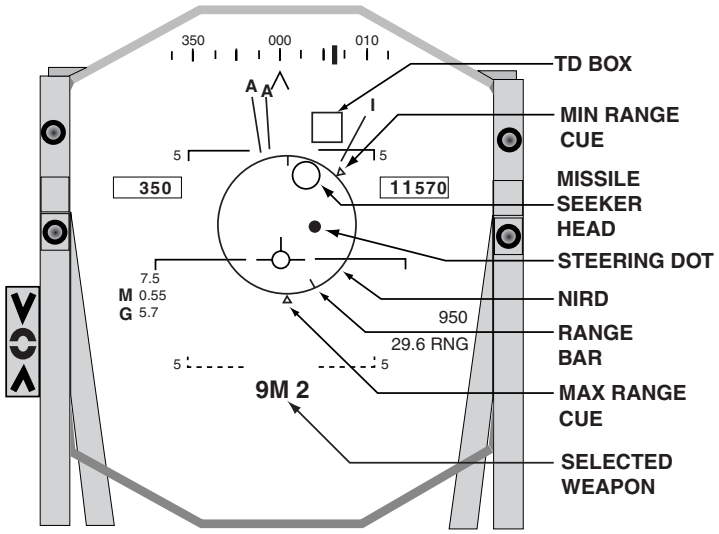
When the AIM-9 is selected, it will perform a radar lock test. If there is a radar lock, either an STT or L&S target available, the MC will automatically slew the missile seeker head to attempt to track the target. Even if there is not sufficient heat energy for the missile to self-track the target, the MC will hold the seeker in position as long as the radar lock is maintained. When the missile seeker has enough heat energy to track the target by itself it will tell the MC and the MC will release the seeker to track the target by itself. The pilot cannot alter this; it is handled between the MC and the missile. The Sidewinder's seeker head will continue to track at this point, even if the radar loses lock. Again, this will only occur if there is enough of a heat signature present to permit independent missile seeker head tracking. Automatic tracking will be signaled by the Sidewinder's low tone, or "growl."

If there is no radar lock, the missile seeker head will "cage" to missile boresight and wait for heat energy. While the seeker head is caged (fixed in place relative to the aircraft) it will not move independent of aircraft movement. It will only follow along with the movement of the aircraft's nose. When the seeker detects enough IR heat to command a missile seeker head lock on, it will automatically do this and then "uncage" and track the heat to the extremes of the seeker's gimbal limits.

The Sidewinder provides the pilot with an analog missile tone that provides clues to the quality of the missile's seeker head lock on. If the missile does not currently "see" any targets there will be no audible tone. As the aircraft flies the missile closer to the heat source, the seeker will gradually pick up the heat signature and provide the pilot with a low pitched "growl." The low growl of the missile is telling you that the seeker head can now see and track the target. However, this is not the best time to shoot the missile because an intelligent adversary can easily spoof the low tone lock. As range to target decreases further, the AIM-9 sound will transition to a high-pitched squeal. This high pitched squeal is telling the pilot that the missile seeker has successfully locked on to the target and will not lose seeker lock, unless the target aircraft employs some kind of sophisticated IR countermeasure.

With RADAR lock

When the radar has an STT or L&S target, the AIM-9 missile will slew to the target and attempt to track it. The HUD symbology is explained below:



9M – X – This is displayed to remind the pilot of the current selected A/A weapon, and the X will display the number of missiles remaining for use.

Missile seeker head – Displays the current location where the selected AIM-9 missile seeker head is looking. With a radar lock it will be superimposed over the TD box.

TD box – Shows the location of the current radar target on the HUD.

NIRD circle – Normalized In Range Display (NIRD) circle represents the maximum missile boresight steering error for optimal employment conditions.

Steering dot – Represents the calculated missile lead required to engage the tracked target. For optimal missile employment, the trigger should be pressed when the steering dot is within the NIRD circle.

Max Range cue – Represents the maximum range for effective missile employment based solely on missile kinematic energy.

Min Range cue – Represents the minimum range for missile employment based on successful weapon fuzing and own ship's safety margin.

Target range bar – Slides along the inside of the NIRD circle and indicates status of effective missile employment range. Used in association with the Max and Min cues.

Shoot cue – Appears and flashes to indicate that optimal missile launch conditions have been met. Will also flash on the radar screen.

Without RADAR lock

If the radar does not have a lock when the AIM-9 is selected, the missile will cage the seeker head to aircraft boresight. The HUD will look like this:

9M – X – This is displayed to remind the pilot of the current selected A/A weapon, and the X will display the number of missiles remaining for use.

Missile seeker head – Displays the current location of where the selected AIM-9 missile seeker head is looking. Without a radar lock, it initializes to aircraft centerline. It will remain caged until it either gets slewed to a radar target by the MC or finds a heat source it can self track.

Shoot Cue

The Mission Computer will flash the SHOOT cue in the HUD and on the radar screen when adequate missile firing parameters are met. The parameters are: an STT or L&S target is being tracked, the missile is within kinematic range of the target, and there is sufficient heat energy present for missile seeker head lock on. The steering dot is not required to be within the NIRD circle, but it is highly recommended to improve the P_k of your missile shot.

Employment

The AIM-9 Sidewinder is shot by pressing the trigger or ENTER key. Upon successful release the MC will automatically step to the next AIM-9 station and prepare to shoot the next missile.

Caution! After shooting all of your AIM-9's the MC will step right to the next available A/A weapon – ALL BY ITSELF. If you have any AIM-120's loaded, they will be automatically selected next. Any further activation's of the weapon firing key or trigger will cause an AIM-120 to launch. Be careful and always try to keep abreast of your weapons status to avoid any unintentional weapon firings.

Optimal employment of AIM-9 will consist of a SHOOT cue (see SHOOT cue section above to review what conditions create the cue), the steering dot within the NIRD circle, and a high-pitched seeker head tone. This will reduce the target aircraft's chances of decoying or avoiding your missile. It will give you the highest P_k shot available for any given set of launch conditions.

If the missile seeker head begins to track a target other than the one desired, you must re-cage the seeker head by pressing the A/A weapon select key until AIM-9 is reselected and the MC reinitializes the missile. Even if the radar begins tracking a different radar target, once the seeker is locked onto a heat source it must be reset in this manner. Upon reselecting AIM-9, the seeker head will be slewed by the MC to the new radar target.

AIM-120 AMRAAM

The AIM-120 Advanced Medium Range Air-to-Air Missile (AMRAAM) has been in U.S. service since the Gulf war in 1991. The AMRAAM is a radar homing missile with excellent maneuverability and relatively long range. The AMRAAM is also a "fire and forget" weapon. It contains an active radar seeker head that finds and tracks the target after launch without any further assistance from your aircraft's radar. The AIM-120 can be used in both the beyond visual and the visual arena. The AMRAAM should be selected anytime the target you desire to engage is outside the 5 NM envelope of your aircraft. This missile is your F/A-18 Hornet's "big stick," and provides you with the long-range capability you need to fight BVR.

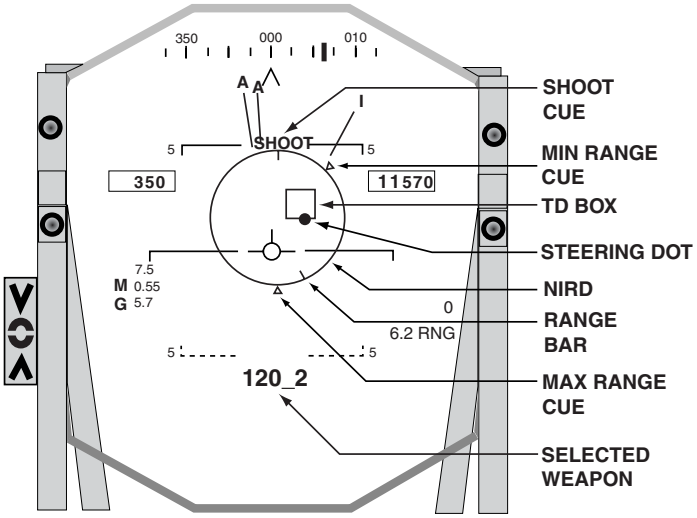
Description

The AMRAAM is 11' 9" in length and has a diameter of 7". It weighs 335 lbs and has a maximum range of 28 NM, limited by rocket motor burn time. The minimum range of the missile is .5 NM, for safe warhead fuzing. The warhead is a 40 lbs. HE blast fragmentation type that uses proximity fusing. The F/A-18 Hornet can carry up to 4 AIM-120's if desired. This configuration includes the two fuselage shoulder stations, and stations 2 and 8.

The AIM-120 is selected by pressing the A/A weapon select key "[" until "120" appears in the HUD and in the upper right hand corner of the A/A radar screen. This will also transition the F/A-18 weapons system into the A/A master mode. If AIM-120's are loaded, they are the second weapon selected by the MC when the A/A weapon select key is pressed. If no more AIM-120's remain on your aircraft, the MC will automatically select the next available A/A weapon.

HUD Symbology

The following symbology is displayed when an AMRAAM is selected and there is an STT or L&S target designated with the AN/APG-65 :



120 – X – This is displayed to remind the pilot of the current selected A/A weapon; the X will display the number of AMRAAM missiles remaining.

TD box – Shows the location of the current radar target on the HUD.

NIRD circle – Normalized In Range Display (NIRD) circle represents the maximum missile boresight steering error for optimal employment conditions.

Steering dot – Represents the calculated missile lead required to engage the tracked target. For optimal missile employment, the trigger should be pressed when the steering dot is within the NIRD circle.

Max Range cue – Represents the maximum range for effective missile employment based solely on missile kinematic energy.

Min Range cue – Represents the minimum range for missile employment based on successful weapon fuzing and own ship's safety margin.

Target range bar – Slides along the inside of the NIRD circle and indicates status of effective missile employment range. Used in association with the Max and Min cues.

Shoot cue – Appears and flashes to indicate that optimal missile launch conditions have been met. Will also flash on the radar screen.

If the AMRAAM missile is selected before the radar has acquired an STT or L&S target, the HUD will display a large circle. Although this circle is a graphic representation of the AMRAAM seeker head field of view, it also serves as an important reminder that the AMRAAM is the current weapon selected for use – not the AIM-9. This circle should help you avoid making the mistake of using the wrong missile in the heat of battle.

Shoot cue

The SHOOT cue will flash on the HUD and on the radar scope when: the STT or L&S target is acquired by the AMRAAM missile seeker head, the target is within maximum and minimum effective range of the missile, and the steering dot is near the NIRD circle. Pulling the trigger and releasing the AMRAAM with a SHOOT cue will result in the highest P_k shot available under the current conditions.

Employment

Employ the AIM-120 with the SHOOT cue as much as is practical. Shots close to maximum range may be easily defeated by a maneuvering bandit, so for best results try to hold your shot until just inside of the R_{max} range marker.

The AIM 120 uses an active radar seeker head missile but still requires radar contact information from the MC before it can guide on a target. If the AMRAAM is launched without an STT or L&S target, it will go "stupid" and fly a ballistic path to the ground, not hitting anything.

BASIC FIGHTER MANEUVERS (BFM)

The use of an aircraft to engage and destroy another aircraft in a visual, close range arena is what BFM or Basic Fighter Maneuvers are all about. It also involves not letting another aircraft shoot you down. BFM can be thought of as a 3 dimensional chess game, with move and counter move. It requires more thinking than the old – "engage the afterburners and pull" philosophy. There are many aspects of the fight that you must become familiar with to help understand what is going on during the highly dynamic, and fast paced world of ACM.

There are some basic philosophies that should be explained to help increase your understanding of flying BFM. Sight, energy, corner velocity and knowledge of the enemy's aircraft and tactics are really essential to understanding the ACM environment. Once you understand ACM and practice it, then you can win.

Padlock views

The padlock system in F/A-18 OIF is designed to help bridge the gap between a 3 dimensional fight and the 2 dimensional computer screen, which you must use. If you haven't used the padlock view system much, it would be in your best interests to review that section before engaging in ACM.

See the enemy

The most important tenet of ACM is to find the enemy. Once you find them, do not take your eyes off them (at least for now). You have many sensors onboard your Hornet to help you get the early "tally ho." Make sure you know how they work.

Can't fight what you can't see

You just can't fight what you don't see. An old axiom states that "you never see the one that gets you!" and this is especially true for ACM. You will realize this the first time you're feeling pretty confident about what's going on out in front of your Hornet, only to see enemy bullet tracers bouncing off of your canopy. Keep scanning the area around your aircraft and never assume that someone you see doesn't also see you.

Can be disorienting at first – practice

Several flavors of the padlock view are available. Press the "F2" key for a cockpit padlock view of selected target. Press "F3" for a cockpit padlock view of the nearest enemy airplane. The equivalent external views are available on "F6" and "F7". Once the chosen view is selected, fly towards, and engage, that target. When you get disoriented, press "F1" again to snap your head back to normal. Most sim pilots use this method with great success. The only way to get better at using a padlock view is to practice. In time, you will feel comfortable enough to concentrate on the BFM aspect of the fight, and not the "where is the enemy plane now?" part.

Know the Enemy

In order to effectively fight your F/A-18 you must be familiar with the characteristics of the enemy airplanes you are fighting against. As the great master of warfare SUN TZU once wrote; "If you know the enemy and know yourself, you need not fear the result of a hundred battles." This is equally as applicable in A/A as in all other forms of combat.

What Aircraft is it?

You should know and be able to identify all of the enemy aircraft that are in F/A-18 OIF. When you first see the aircraft at range, the earlier you can identify it the better. Some aircraft might not represent as significant a threat to you as others do. The earlier you can identify the aircraft type, even if it is simply deciding that the target is a fighter of some sort and not an airliner, the better your chances are of getting in the first shot.

Which types of weapons does it carry?

Along with being able to identify your threat aircraft, you should know which type of weapons that platform can employ against you. Does that fighter carry long-range radar missiles or is it capable of only using heat-seeking missiles? Does it have a gun? Can that enemy plane carry bombs? Although you might not get close enough to see the actual aircraft load-out, you should know what weapons it can use. And unless you are absolutely sure, always assume the worst case. If the fighter is capable of carrying radar missiles, then assume that's what its load-out is. This is a good way to avoid unpleasant surprises.

What speed is best?

What speed is the enemy aircraft capable of? Can it run you down and shoot you or could you easily outrun it if you had to? It is important to have some idea of what speed capabilities your enemies have and how they compare to your own. This will help you to decide when it is time to disengage and separate from the fight. Knowing you can safely leave the fight at the next head on pass and not have to worry about the bad guy catching you is comforting.

How does this type of aircraft like to fight?

Some aircraft have a lot of thrust available and will always try to fight a vertical type of fight. Others may have better turn rates and will try to out-turn you instead. Typically this is the "best" type of fight that each aircraft will use against you because it gives them their best chance of shooting you. Understand how each aircraft prefers to fight and be watchful of when they begin to execute their own favorite fight against you. Doing so will help you anticipate their next move so that you can be a step ahead of the bad guys.

Avoid enemy strengths, capitalize on weaknesses

The WW II Japanese Zero was infamous for its outstanding turn capabilities. At the beginning of the war, every pilot who tried to turn with a Zero usually learned a very hard lesson (assuming they lived to tell it). Gradually pilots began to realize that there were other ways to fight against a Zero. Navy and Marine Corps fighter pilots learned that to survive and win a dogfight with a Zero, they should not turn, but climb away from them and then attack in a dive, passing swiftly by and descending away to safety, only to repeat this tactic until the fight was won. This example is ideal for illustrating the concept of avoiding enemy strengths and capitalizing on their weaknesses. If an enemy can out-turn you, don't turn with them. If an enemy can out climb you, don't climb with them. And if you have superior speed or turn rate, use those to your advantage. The Hornet has incredible turn capabilities against most enemy fighters in F/A-18 OIF. Use this to your advantage.

Energy management

The secret to BFM is good energy management. This doesn't mean turning off your radar when you are not using it. It applies to the kinetic and potential energy balance that fighter pilots must be aware of at all times during every fight. Altitude and airspeed are the cockpit indications of the energy battle and you must realize that every move has its associated costs and benefits. You must be keenly aware of these energy tradeoffs and think intelligently about when they should be used, because once energy is lost it will be difficult to regain.

Speed is life? Not always…

There is a saying in the fighter community that "Speed is life." In other words, having a significant kinetic energy advantage over your enemy will place you in a better position. Although there are many examples where this is certainly true, it is not the best rule to live by. When you enter an ACM engagement don't just "light the blowers" and try to pass the bandit with max knots. Instead try to have an idea of what kind of fight you want to get into, and select a target airspeed and altitude to begin at, then work from there.

Corner velocity

Aircraft corner velocity is an important concept to understand when performing ACM. Corner speed (as it is also called) is the airspeed at which you can reach your maximum turn rate. Turn rate is the number of degrees heading change you can accomplish over a period of time. The higher your turn rate, the faster your aircraft can turn.

Reality check: you do not have access to your maximum turn rate all the time. Just because you have 600 knots in the HUD (plenty of energy!) doesn't mean that you can turn at your maximum rate. You must be at corner speed or your turn rate goes up. If you are faster, turn rate goes up (that means you are turning slower in degrees per second), if you are slower than corner, turn rate again goes up. You must be within the window to utilize the benefits that corner speed provides.

The corner speed window is actually pretty small, and it is very important to know where it is. The F/A-18 Hornet's corner speed occurs between 250 and 300 knots in F/A-18 OIF.

Energy bleed and unloads

When you begin a fight you have a certain energy state. The energy state can be spent or banked depending on what you do with the airplane. Turns can spend energy, and dives or unloads can preserve or add to it. An energy bleeding turn is categorized by a significant loss of energy during the maneuver.

To execute an energy bleeding turn or "hard" turn, begin with a level turn and maximum thrust selected. Then apply enough back stick force (aircraft G loading) until your airspeed starts decreasing. Continue the pull until you hear the stall warning tone. Depending on which airspeed you started at, it probably didn't take long to lose almost all of your airspeed. Remember that…

Some turns will use more airspeed than others depending on how much G is applied. Hard turns are typically categorized as any turn at more than 6.0 G's. If you want to minimize your airspeed penalty during a hard turn, let the nose drop below the horizon. This will shift some of your energy penalty from airspeed to altitude. Hard turns can really bleed your energy state down quickly so it is wise to use them only as necessary.

After all this talk about energy bleeding, how do you get airspeed (energy) back? Assuming you have maximum thrust selected, you must "unload" the aircraft to get energy back. To unload, push forward on the stick until the HUD G meter indicates 0 G or less. It may hurt a little bit (and you should see the red out effect) but the results are worth it.

Aggressiveness

There are no style points in ACM, and the end result is the only measure of your success or failure. Being smooth is not required, and in some cases not desirable. This does not mean that you should just pull immediately to aircraft stall tone and bleed away all your energy for no other reason than being aggressive. It does mean, that when given the chance – pull aggressively to turn with your enemy or unload hard (apply negative G or push forward on the stick) to gain back lost energy. Or if you plan to fly at corner speed, be there when you reach the merge. And remember you have a speed brake! Don't hesitate to use it if you need it!

You will know if you are flying your aircraft aggressively if you are going from red-out to gray-out! (red-out is the physiological effect of too much negative G force which causes the screen to turn red, and gray-out results from excessive positive G forces which causes the screen to start fading to black)

Estimate the enemy's energy

When the enemy came to the merge, how fast were they going? How fast were you going? Did it appear that they were going faster or slower than you? These are all clues to help in estimating your adversary's energy state. If the other aircraft has a lot of energy, that could help to explain why they are able to pull nose up and out climb you. Conversely, if the other aircraft was low on energy they might have just stalled at 25^{o} nose up, and not been capable of following you into the vertical. You can develop a feel for where the enemy is as far as energy is concerned and use this information to help you plan your next BFM move. Should you go nose up or nose down? Use your own aircraft as a benchmark to estimate the bad guy's energy state. When you know they are low on energy, make a move and go where the enemy cannot.

Understanding BFM

The task of understanding Basic Fighter Maneuvers begins with the start. The start occurs when both pilots visually acquire each other – remember that you can't fight what you don't see… This can occur at the limits of pilot visibility, which is about 10 NM for fighter size targets. Or it can happen much closer. Once the pilots have sight of one another, the geometry of the aircraft's position relative to each another will determine the type of start. The start can be characterized as only one of three types; offensive, defensive, or neutral. The start refers to whether you are in better position to shoot the enemy (offensive), in danger of being shot by the enemy (defensive) or evenly capable of shooting each other (neutral) at the point the fight begins.

After the start the most important concept you need to understand and apply is the idea of the control zone, or "elbow." The "elbow", if flown correctly will not permit the enemy to escape, in other words – when you are flying in the enemies control zone you have enough time, space, and energy to react to whatever the bandit does to try to lose you. The control zone is described as a point on the target aircraft's flight path approximately 2000 to 8000 feet behind the target aircraft. The range varies with target airspeed and target turn performance. If airspeed in below 250 knots or the aircraft is turning hard, the control zone is closer to 2000 feet. If the airspeed is in excess of 500 knots, or the aircraft is "arcing" (not turning very hard) it is probably closer to 8000 feet. Control zone is not a static position (as you might have guessed by now) it's a dynamic region – try to remain in the zone and the bandit shouldn't be capable of losing you before you can employ your weapons against them.

Offensive

Naturally, this is where you want to be when you see the enemy – in a position to shoot. Offensive BFM occurs when your nose is pointed at the enemy while you are within, or capable of reaching, an A/A weapon employment envelope and you are behind the enemy's 3 – 9 line.

An offensive aircraft does not have to be in the control zone to be offensive. Being offensive allows you easier access to the enemies control zone and often puts your control zone beyond their reach.

Options for you when you are offensive are: shoot (if within a weapons envelope at start), close and shoot (not within a weapons envelope at start), or maintaining a weapon firing position until the enemy complies with your directions.

Defensive

And, naturally, this is where you do not want to be when you see the enemy – in a position to get shot. Defensive BFM occurs when the enemy's nose is pointed toward you, they are within, or are capable of reaching; an A/A weapon employment envelope, and they are behind your 3 – 9 line.

A defensive aircraft needs to deny access to their control zone to enemy fighters. The longer you can keep your control zone enemy fighter free – the better. Hopefully in that time you can force the enemy to make a mistake and get back to neutral or maybe even offensive.

Options for you when you are defensive are: get shot (least desirable – consequences obvious), or prevent the enemy from closing and/or shooting. As you watch the enemy try to get toward your control zone, watch for chances to pull hard into them and try to force the enemy to overshoot and hopefully reverse roles.

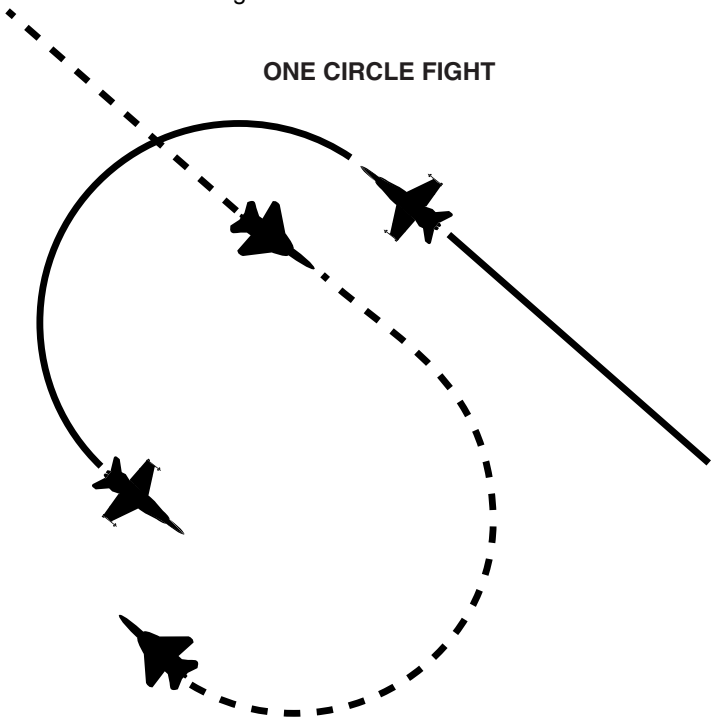
Unless the bandit aircraft is peeling the paint off of your tailpipes with his radome, I wouldn't try the old "use the speed brakes and make them over-shoot " trick. If the enemy knows what they are doing (and most do) this action tends to help make their gun solution easier and it bleeds your energy down without displacing your aircraft in space. It seems to only work well in the movies (sorry…).

Neutral

The neutral start occurs when both aircraft are of equal threat to each other. Aircraft may or may not be within an A/A weapons employment envelope for each other. The most typical example of a neutral start is a head-on pass. In a head-on pass both pilots have seen each other and are attempting to maneuver to get to control zone.

If a head-on pass develops, try to start your turn early, before the aircraft actually pass each other. Early turning or "lead" turns benefit you by giving you less degrees to turn to get nose on than the target that doesn't lead turn.

At the neutral pass you have one of two options to choose from after the pass occurs: You can use either one of two A/A game plans. For the purpose of this discussion let's assume that at the pass the enemy always turns across our tail. That will make your options a little bit clearer to understand. But realize at the merge (head-to-head pass), you can't control which way the bandit is going to go and you may have to switch your game plan at the last second.



1 circle

A one-circle fight will develop if you turn away from the bandits tail, as they turn across yours. If the one circle fight is drawn on a flat piece of paper, the flight path arcs of both fighters would draw a single circle – thus the term "one circle" fight.

Describe

The one circle fight is a tight-turning, close-range, energy-bleeding type of fight. Both aircraft are trying to utilize their best turning radius to maneuver for a

shot. In a one-circle fight, the tighter turn radius wins the fight.

Goods

The F/A-18 has an extremely small turn radius and will do well in one-circle fights. The radius will get tighter as airspeed bleeds off, but then turn rate will suffer. Try to enter one circle fights at around 250 knots for your best performance numbers.

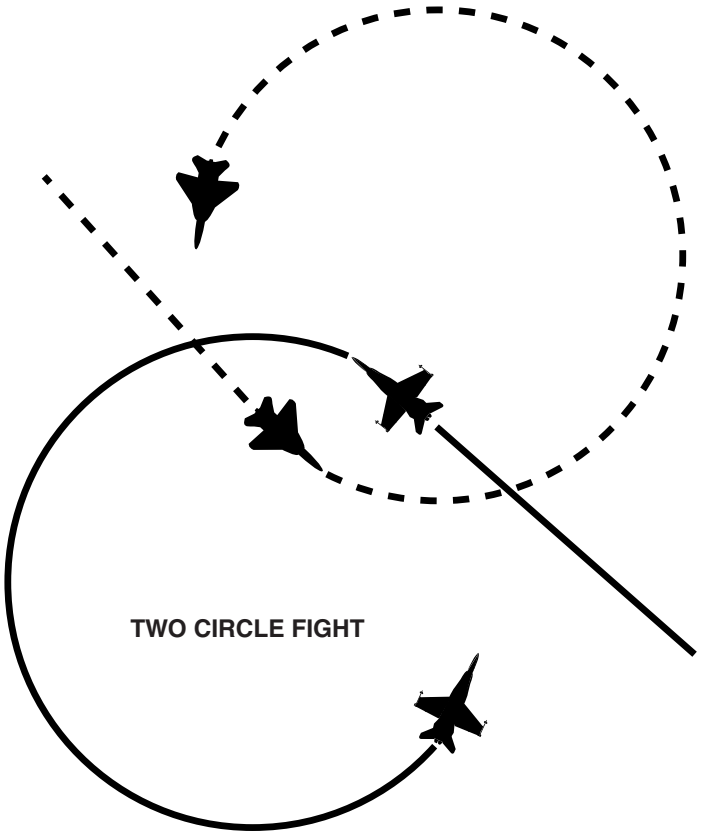
The radar mode suggested for use during a one-circle fight is VACQ. This will most likely provide you with the earliest radar lock after the pass so that you can quickly employ weapons against the enemy.

Others

The down side of one circle fights is that they are energy bleeding and the F/A-18 may not have as much thrust available to keep the turns coming as some threat aircraft might. Another issue is the close range. You may be inside of minimum range for your current A/A weapon before you know it. Anticipate the shorter range, and have an appropriate weapon selected and ready for use.

2 circle

A two-circle fight will develop if you turn across the bandits tail, as they turn across yours. If the two circle fight is drawn on a flat piece of paper, the flight path arcs of both fighters would draw a two circles connected to each other (which will look like a figure "8"), thus the term "two circle" fight.



Describe

The two circle fight is a longer range, get "nose on first," type of fight. Both aircraft are trying to utilize their best turning rate to maneuver for a shot. In a two circle fight, the better turn rate will get nose on first for weapon employment and will win the fight.

Goods

The F/A-18 has a very fast turn rate and will also do well in two circle fights. The rate will get slower as airspeed bleeds off, so try to keep airspeed above 200 knots while turning. Try to enter two circle fights at around 400 knots for your best performance numbers.

The radar mode suggested for use during a two-circle fight is WACQ or perhaps even VACQ. Either mode will get you a radar lock quick enough, while the bandit is still at sufficient range for you to employ a missile against them.

Others

The negative part of two circle fights is that the enemy aircraft is also capable of employing weapons against you at the same time you are shooting at them.

Weapon selection

The selection of the proper A/A weapon for the circumstances is very crucial to A/A success. There typically is not much time to debate the issue either. You must think ahead and be ready with the right weapon when the time comes.

The right Tool for the Job

The proper A/A weapon should basically be a function of range. If the range is longer, probably a missile is the only choice. If the range is extremely close, then you will need to pull your gun!

If range is beyond 8 NM, then the AMRAAM is probably the best weapon to have selected. When range is inside of 8 NM and outside of 1 NM, then the Sidewinder is a good choice. Inside 1 NM, depending on what is going on in the fight, it is always in your best interests to think "Gun."

Never fly through one WEZ to get to another

Always be thinking about which weapon you should be using. Be careful not to fly through one Weapon Engagement Zone (WEZ) just to get to another one. An example of this would be switching from AIM-120 to Gun and then waiting to close with the enemy so you can use the cannon, completely forgetting about the fact that you could have used the AIM-9 and shot them in the mean time.

ACM weapon modes

Rarely in ACM will you have the time to use any mode of the radar other than the ACM modes or possibly AACQ. Don't waste precious time when all you need is a quick lock to make the shot happen. Get used to selecting the ACM modes while maneuvering, and be capable of invoking a specific mode quickly if necessary.

You're probably never alone…

Now that we have discussed about how to fight one other aircraft it is time mention that in combat, a 1 V 1 is rare. Why? Because the enemy has lots of fighters and so do we. And nobody really sends up singles any more, especially on an A/A mission. This is not to say you might not have to complete the mission by yourself if your wingman gets shot down or has a malfunction. Just keep scanning the sky for other fighters and always assume you are never alone.

BEYOND VISUAL RANGE (BVR) ENGAGEMENTS

Detecting and destroying the enemy while they are at range is the purpose of the BVR engagement. BVR has a lot of benefits over turning, 1 V 1, with the bandit aircraft. First, it all happens far away from your aircraft, therefore keeping you further away from bad guy country and other bad guys. Second, your missile performs the BFM with the enemy aircraft – not you. So if the missile fails in its task, just shoot another one. And finally, you always have the option to leave whenever you want to.

BVR also has some drawbacks. First, it relies completely on your ability to find the enemy with your radar. Second, you have to make a positive identification on a target you can't see. And finally, the number of targets you can engage is directly related to the number of radar missiles you have loaded on your aircraft.

Running a Combat Intercept

The heart of BVR is the tactical intercept. The tactical intercept is defined as the process of detecting, and closing with an enemy aircraft for the purpose of A/A weapons employment or the perceived "threat" of employment.

Building Situational Awareness (SA)

Conducting a tactical intercept requires a good game plan and situational awareness (SA). SA is probably the most over used term in A/A but it is most applicable to BVR intercepts. Situational awareness in a tactical intercept means having the "big picture." This picture includes knowing where you are (yes, I know that should be assumed, but…), where you wingman is, where other friendly aircraft are, and where the bandits are - just to mention a few. If it appears that SA requires a lot of work, it does. And no matter how good you are with the radar there will be plenty of times when you just won't have total SA. But SA is a building process and you must always work at it. Work diligently and keep your mission objectives in mind and you should have enough SA to meet with success.

Search volumes

Develop a search plan that suits your mission. Make sure that your radar search frame is not so long that you can't see the A/A picture developing. If you have a wide area to search, a good radar search plan might use RWS and stress more azimuth coverage and less elevation (bars). If your mission requires you to find a single, high speed, aircraft attempting to penetrate friendly lines, then perhaps VS is a good place to start with. If you expect a rapidly changing A/A picture, the best call might be TWS using a medium bar and azimuth selection. The goal with selecting an appropriate radar search volume is determining what the minimum search volume can be and still meet mission objectives based on the anticipated threat.

Determine Hostile Groups

As the radar scans the airspace ahead of your F/A-18, give the radar picture a chance to build. After several frames, look at the number of contacts. How many groups of contacts are there? A group is a series of radar contacts all within close proximity on your radarscope. If you have more than one group you will need to see which group(s) are friendly and which group(s) are "hostile."

STT

To gather further information about a radar contact, you will have to either STT that contact or designate it as the L&S target in TWS. Then you will know what the contact is doing and will also have the ability to use IFF to get information about whether the contact is an enemy or not.

IFF

With an STT, press the "I" key to check the electronic identification feature onboard the locked aircraft. Friendly aircraft will make a beep sound when the IFF is positive. Enemy aircraft will not respond to IFF interrogation and will not provide any feedback to the pilot. Please note that IFF will not tell you what type of aircraft is locked up, just that it is a good guy or a bad guy.

Break lock & continue scan

Continue the process of locking up aircraft in the different groups on your scope and determine the identity of each group. When you have sampled every group on the scope you can then decide what you want to do as far as game plan is concerned. You should now have enough SA to build a crude picture of what is going on within your radar's search volume.

Target Hostile Groups

After you have built your SA, determine which hostile groups are a threat to you and your mission objectives and begin maneuvering to weapons employment range. If the mission objective involves destroying an enemy strike package make sure that is the group to target first. In this case, try to stay away from the enemy fighter sweep until you can get a shot at the strikers.

Employ weapons at desired range

Once the target is within range of your selected weapon, SHOOT! That is all there is left, right? Well, not really… Because you only have so many missiles onboard and you don't want to have to fly the mission over again, you might want to close the range some to increase the P_k of your missile shot. The ideal maximum range would be when the SHOOT cue flashes. Shoot the missile then leave. Let the enemy worry about that AMRAAM now. And if it doesn't work, separate from the enemy and set it up again.

Plan for the Merge

If everything works as advertised you should be going home right now, a hero. Did it happen that way? Not as much as we would all like it to! So what is left? We are too close to leave, and our missile didn't turn the bandit into a smoke trail. Decisions, decisions…

Like all of our A/A planning we need to assume the worst case and then plan for it. Chances are you will be very glad you did! After our missile shot we need to have a plan ready for the upcoming merge.

Offsets

To help reduce the area we need to visually search for the enemy it would be desirable to take a geographic offset. A geographic offset is a lateral displacement from the direct route toward the enemy, usually taken in a cardinal direction (N, S, E or W). The offset must be large enough to actually place all the bandits on one side of the aircraft or it is useless to perform. This doesn't mean you take your nose off the bandits or lose radar lock! The offset is simply a way of isolating the threat in a known direction.

Padlock

As soon as you have radar lock, invoke a padlock view of choice and prepare to fight. Don't wait until the enemy passes you to start thinking about it. You can still employ your weapons from the padlock view the only difference is that you will not be

capable of seeing the radarscope. Not being able to see the radarscope is no longer a problem because we are transitioning to the visual arena anyway.

Best 1v1

Even though we got here through a tactical intercept, be ready to fight a 1 V 1 when the situation arises. Be mentally prepared for the engagement and don't be caught off guard when your "perfect" intercept gets blown. At the merge transition into the BFM mindset and fight your best fight. Make the bad guy regret he didn't soak up your missile at range.

Wingman utilization

Unless you have no other choice, you should not operate in an A/A environment without another set of eyeballs and another radar to help you out. Wingmen are invaluable assets if used correctly. They provide you with additional information that can help build your SA. They can also be directed by you to engage the enemy. You should be able to use your wingman as you would any of your onboard systems. When you do, they will make it worth your while.

Commands

There are several wingman commands you can issue to your wingman in F/A-18 OIF. All of these commands will cause your wingman to do something, and if they cannot comply with your directions they will let you know. Wingmen will acknowledge your commands when they receive and understand them. So if you do not see immediate movement to comply with your directions or do not hear the wingmen telling you why they can't comply, re-issue the command. Note: in the case of an admin formation command, reissuing the command will tell the wingman to tighten or loosen the formation.

In some missions you will have 2 wingmen. The initial press of the command keys will direct the first wingman or Hornet 2. To issue commands to the second wingman, or Hornet 3, press the SHIFT key in addition to the wingman command keys.

Allow you to coordinate in flight tactics

Using your wingmen will allow you to coordinate and to use advanced tactics against the enemy. If you desire, send Hornet 2 to merge first and shoot the trailer (second enemy aircraft following behind their lead). It is all up to you, but remember as flight lead you are responsible for "dash 2 and 3s" safety and well-being.

3 categories of wingman commands

The commands that you can issue to your wingman can be broken down into 3 separate categories depending on when they are best used. Engaged commands are used just before the merge until finally separating from the fight. Tactical commands are used before the merge to set up and execute your BVR game plan. Administrative commands are used to set up your flight's formation.

Engaged Comm

The engaged commands will get your wingmen in or out of the fight, or tell them which bandit you want them to target.

Help Me	This command tells your wingman to clear your six o'clock of any potential threats. Any enemy fighters that can threaten you will be engaged.
Engage	The engage command tells your wingman to attack the A/A target you are currently tracking with STT or L&S.
Resume	Resume command tells the wingman to ignore previous commands and go back to executing their original mission objective.
Go Home	This command will send your wingman home. They will abort the current mission and return to base (RTB).

Tactical Comm

Tactical commands provide you with the ability to execute simple, coordinated A/A game plans with your wingman. They really apply only to pre-merge setups. After the merge occurs, use the engaged commands to control your wingman.

Bracket Left or Right	Bracket commands will direct the dash 2 or 3 aircraft to take an offset in the specified direction from you and run a tactical intercept on your radar locked bandit. This allows you to separate in the other direction, presenting the bandits with an azimuth problem to solve.
Split High or Low	Split commands will direct the dash 2 or 3 aircraft to displace in the specified altitude direction from you and run a tactical intercept on your radar locked bandit. This allows you to separate in the other direction, presenting the bandits with an elevation problem to solve.

Admin Comm

The administrative commands tell your wingman where to position themselves, relative to your aircraft. As previously mentioned, a second issuance of these commands will tighten and then loosen the commanded formation.

Echelon	When this command is issued the wingman will fly at the leads 4:00 position. This is the “parade” position for use around the airfield or the aircraft carrier.
Trail	Trail will cause the wingman to fly in position directly aft of lead.

Communication

The wingman will communicate with you in F/A-18 OIF and help to build your SA. The communication protocols they use are standard. Any radio call should begin with who the speaker is (Hornet 2 or 3) followed by the message. Your wingmen are professionals so expect them to always use appropriate communications brevity code words. A list of the usual code words follows:

Comm Brevity and Code words

Contact	The radar contact is locked up on my radar.
Tally ho	I have sight of the bandit.
No Joy	I do not see the bandit either on radar or visually.
F-3	AIM-120 launch warning from a friendly aircraft.
F-2	AIM-9 launch warning from a friendly aircraft.
Joker	There is only enough fuel left in my Hornet to continue directly to the target and then directly back to base.
Bingo	I must RTB right now for fuel, there is only enough to proceed directly to home base.
Spike	There are RWR indications on my RWR scope. Given along with a clock code to inform you of the direction it is coming from.
Winchester	I have no more ordnance to expend.
Punching out	I have decided to walk the rest of the way from here (just kidding…). Meaning, obvious…
Atoll! Atoll!	A missile has engaged me. I think it is a heat-seeking missile.
Apex! Apex!	A missile has engaged me. I think it is a radar homing missile.

SELF PROTECTION

At some point during your career in F/A-18 OIF you will find yourself at the receiving end of the enemy's weapons. All is not lost just because you are not the first to shoot! There are some techniques that you can use to help you survive through enemy attacks. You should be familiar with them and be ready to employ them at a moment's notice. Your survival is paramount.

Missile detection

The only way to try to defeat an incoming missile is to know that it is coming. There are several systems onboard to help you determine this. Pay close attention to those warnings and indications. Once a missile is inbound with your name on it, there is absolutely no time to waste. Find out where it is, try to guess what it is, what it's range is then defend properly against it. Then switch to the missile padlock view when the missile gets within visual range.

ECM

The RWR scope displays all the radar threats that have you locked up. The longer the spike on the HUD, or an indication on the RWR scope in the critical band indicates a threat that is capable of employing weapons against you. It is highly likely that one of these threats is the system shooting at you. This may not be the case with an IR missile threat. Maintaining a good visual lookout is the best way to see where an IR missile is coming from.

Audio

When the aircraft's sensors detect a missile launch, the MC will provide the pilot with an audible missile warning tone. The missile launch warning tone comes on immediately after enemy missile launch. The warning tone will stop when the system senses that the missile is no longer guiding on your Hornet.

Missile Defense

Defeating an incoming missile is not easy to do. You will basically have to drop everything you are doing and defend against it or risk being shot down. What type of defense you need to execute is a function of range between you and the missile.

There are no systems in your F/A-18 Hornet which can provide you with the distance from the missile to your aircraft. This only comes from having SA. Where is the closest threat? Did they shoot or was it someone else? It will always be a guess, but with good SA it will an extremely educated guess.

At range

To defeat a missile shot at range, try at first to get it to drop lock on you. Dropping chaff and flare while turning away 90o to the incoming missile does this. This will put the missile off one of your wingtips. If you have time, ensure that the ALQ-126 is on and emitting. Monitor the aural missile warning tone - if it goes away resume what you were doing. If it doesn't, use more chaff and flare and try to get a visual on the missile trail. When the missile gets close enough, execute a last ditch maneuver.

Last ditch

The last ditch maneuver is a final attempt to force the missile to overshoot you, or at least detonate further away from your F/A-18. It is also the only short-range answer to missile defense. To execute a last ditch missile defense, dispense chaff and flare, pull the nose up hard and apply full aileron and elevator into the direction of the missile (roll up and into the missile). This is similar to performing a high G barrel roll. The key to doing it correctly is rapidly applying the back stick and roll about 3 – 5 seconds prior to missile impact. The last ditch maneuver is an energy depleting move; realize that you will be low on airspeed and possibly altitude when it's over. The last ditch missile defense can be extremely disorienting and it would be unfortunate to successfully dodge the incoming missile, only to lose control of the aircraft and crash into the ground.

Guns Defense

The way to defend against a gunshot is to attempt to ruin the attacker's gun solution. This is accomplished by rapidly displacing the aircraft away from the bullet stream, holding it for a second or two, and then moving again before the attacker has a chance to reposition. Stick inputs are a rapid roll away from bullet stream, followed by full forward or aft stick

deflection. Hold this input for a couple of seconds and then repeat the process. Keep doing this and don't give up. Look for opportunities to either neutralize or reverse roles. As long as you're still alive the fight is still draw!

CHAPTER 8: TERMS

ABORT – Directive comment to end attack or mission.

ALPHA CHECK - Request for bearing and range from a known point.

ANGELS - altitude of aircraft in thousands of feet.

APEX/ALAMO - Training term used to denote simulated launch of enemy, all-aspect radar missile.

APHID/ARCHER Training term used to denote simulated launch of enemy heat seeking missiles.

ARM/ARMED (Safe/Hot) - Select armament (safe/hot), or armament is safe/hot.

AS FRAGGED - Fighter, FAC, mission package, or agency will be performing exactly as stated by the air tasking order.

ASPECT - Request/comment regarding target aspect information.

BANDIT (Radar/Heat/Striker) - Known enemy aircraft and type ordnance capability, if known.

BEAM/BEAMER (Direction) - Aircraft maneuvering stabilized within 700 to 1100 aspect; generally given with cardinal directions: east, west, north, south.

BELLYCHECK - A momentary unloaded bank to check the blind side of a turning aircraft.

(BINGO - Pre-briefed fuel state which is needed for recovery using pre-briefed parameters.

BLIND - No visual contact with friendly aircraft; opposite of term "VISUAL."

BOAT – The Aircraft Carrier, slang term.

BOGEY - A radar/visual contact whose identity is not known.

BOX - Groups/contacts/formations in a square or offset square.

BRACKET - Indicates geometry where aircraft will maneuver to a position on opposing sides either laterally or vertically from the target.

BREAK (Up/Down/Right/Left) - Directive to perform an immediate maximum performance turn in the indicated direction. Assumes a defensive situation.

BREVITY - Term used to denote radio frequency is becoming saturated/degraded and briefer transmissions must follow.

BUDDY SPIKE (Position/Azimuth/Altitude) - Receiving friendly AI RWR.

BULLSEYE - An established reference point from which the position of an aircraft can be determined.

BURNER - Directive to select/deselect afterburner.

CAP/CAP(Location) - An orbit at a specified location. Establish a combat air patrol at (location).

CHAFF - Call indicating chaff has been detected or to deploy chaff.

CHAMPAGNE - An attack of three distinct groups with two in front and one behind. The leading two groups are attempting to bracket with the trailing third group flying up the middle.

CLEAN - No radar contacts; used to confirm a good battle damage check (i.e., no air-to-surface ordnance remaining on the wingman's aircraft).

CLEARED - Requested action is authorized (no engaged/support roles are assumed).

CLEARED HOT - Ordnance release is authorized.

CLOSING - Bandit/bogey/target is getting closer in range.

COLD - In context; attack geometry will result in a pass or roll out behind the target; or, on a leg of the CAP pointed away from the anticipated threats. Air-to-surface, dry or no-ordnance attack.

COMMITTED/COMMIT - Fighter intent to engage/intercept; weapons director (WD) continues to provide information.

CONTACT - Radar/IR contact at the stated position; should be in bearing, range, altitude (BRA), Bullseye, or geographic position format.

CONTINUE - Continue present maneuver; does not imply clearance to engage or expend ordnance.

COVER - Directive to assume briefed support position and responsibilities.

DEFENSIVE (Spike/Missile/SAM/Mud/AAA) - Aircraft is in a defensive position and maneuvering with reference to the stated condition. If no condition stated maneuvering is with respect to A/A threat.

DIVERT - Proceed to alternate mission/base.

DRAG/DRAGGING (Direction) - Bogey/Bandit maneuvering to 60 degor less aspect.

ECHELON (Cardinal direction) - Groups/contacts/formation with wingman displaced approximately 45 degrees behind leader's wing line.

ELEMENT - Formation of two aircraft.

ENGAGED - Maneuvering with the intent of achieving a kill. If no additional information is provided (bearing, range, etc.), ENGAGED implies visual/radar acquisition of target.

EXTEND (Direction) Directive to gain energy and distance with the possible intent of reengaging.

EYEBALL - Fighter with primary visual identification responsibility.

FEET WET/DRY - Flying over water/land.

FENCE CHECK - Set cockpit switches as appropriate.

FLANK/FLANKING - Target with a stable aspect of 120 degrees to 150 degrees.

FLARES - Flares have been detected or directive to deploy flares.

FLOAT - Directive/informative to expand the formation laterally within visual limits to maintain a radar contact or prepare for a defensive response.

FOX - Air-to-Air weapons employment.

FOX ONE - Simulated/actual launch of radar-guided missile.

FOX TWO - Simulated/actual launch of infrared-guided missile.

FOX THREE - Simulated/actual launch of AMRAAM/Phoenix missile.

FURBALL - A turning fight involving multiple aircraft.

GIMBAL (Direction) - Radar target is approaching azimuth or elevation limits.

GORILLA - Large force of indeterminable numbers and formation.

GROUP - Radar target(s) within approximately 3 NM of each other.

GUN (Direction) - Visual acquisition of gunfire, AAA site, or AAA fire.

GUNS - An Air-to-Air or air-to-surface gunshot.

HARD LEFT/RIGHT – Directive call to perform a High-G, energy sustaining turn to the left or right.

HEADS DOWN - Call to inform aircrew that leader/wingman is head-down in the cockpit and wingman/leader is responsible for clearing.

HIGH - Target altitude at or above 30,000 feet MSL.

HIT - A Radar return on the Radar scope (A/A). Also a weapon impact within lethal distance.

HOLDING HANDS - Aircraft in visual formation.

HOME PLATE - Home airfield or the Aircraft Carrier.

HOT - In context; attack geometry will result in rollout in front of the target; or on a leg of the CAP pointing toward the anticipated threats (A/A). Ordnance employment authorized, expected, or completed (A/G).

ID - Directive to intercept and identify the target; also aircrew ID accomplished, followed by type aircraft.

IN PLACE (Left, Right) - Perform indicated maneuver simultaneously.

JINK - Unpredictable maneuvers to negate a gun tracking solution.

JOKER - Fuel state above Bingo at which separation/bugout/event termination should begin.

KILL - Directive to commit on target with clearance to fire; in training, a fighter call to indicate kill criteria have been fulfilled.

LADDER - Three or more groups/contacts/formations in trail.

LINE ABREAST - Two groups/contacts/formations/aircraft side-by-side.

LOCKED (BRA/Direction) - Final radar lock-on; sort is not assumed LOW - Target altitude below 10,000 feet AGL

MEDIUM - Target altitude between 10,000 feet AGL and 30,000 feet MSL.

MERGE(D) - Informative that friendlies and targets have arrived in the same visual arena. Call indicating radar returns have come together.

MUSIC - Electronic radar jamming. On AI radar, electronic deceptive jamming. NAKED - No RWR indications. Opposite of term "spike".

NO JOY - Aircrew does not have visual contact with the target/bandit; opposite of term "TALLY."

NOTCH (Direction) - All-aspect missile defensive maneuver to place threat radar/missile near the beam.

OFF (Direction) - Informative call indicating attack is terminated and maneuvering to the indicated direction.

OFFSET (Direction) - Informative call indicating maneuver in a specified direction with reference to the target.

PACKAGE - Geographically isolated collection of groups/contacts/formations.

PADLOCKED - Informative call indicating aircrew cannot take eyes off an aircraft/ground target without risk of losing tally/visual.

PAINT - Friendly AAI/APX interrogation return.

PARROT - IFF transponder.

PICTURE - Situation briefing which includes real-time information pertinent to a specific mission.

PITCH/PITCHBACK (Left/Right) - Directive call for fighter/flight to execute a nose-high heading reversal.

POP - Starting climb for air-to-surface attack.

POSIT - Request for position; response normally in terms of a geographic landmark, or off a common reference point.

POST HOLE - Rapid descending spiral.

POWER - Reminder to set the throttles appropriately considering the IR threat and desired energy state.

PRESS - Directive to continue the attack; mutual support will be maintained. Supportive role will be assumed.

REFERENCE (Direction) - Directive to assume stated heading.

ROGER - Indicates aircrew understands the radio transmission; does not indicate compliance or reaction.

SAM (Direction) - Visual acquisition of a SAM or SAM launch. Should include position.

SANDWICHED - A situation where an aircraft/element finds themselves between opposing aircraft/elements.

SEPARATE - Leaving a specific engagement; may or may not reenter.

SHACKLE - One weave; a single crossing of flight paths; maneuver to adjust/ regain formation parameters.

SHOOTER - Aircraft designated to employ ordnance.

SILENT - "GO SILENT" directive to initiate briefed EMCON procedures.

SLICE/SLICEBACK (Left/Right) - Directive to perform a high-G descending turn in the stated direction; usually 180 degree turn.

SLOW - Target with ground speed of less than 300 knots.

SNAP SHOT - High-angle/high-LOS gun shot.

SNAP ( ) - An immediate vector (bearing and range) to the group described.

SORTED - Criteria have been met which ensure individual flight members have separate contacts; criteria can be met visually, electronically (radar) or both.

SPIKE - RWR indication of AT threat is displayed. Add clock position, and type threat (radar/heat) if able.

SPITTER (Direction) - An aircraft that has departed from the engagement.

SPLASH* - Target destroyed (Air-to-Air); weapons impact (Air-to-Ground).

SQUAWK ( ) - Operate IFF as indicated or IFF is operating as indicated.

STACK - Two or more groups/contacts/formations with a high/low altitude separation in relation to each other.

STATUS - Request for an individual's tactical situation; response is normally "offensive," "defensive," or "neutral." May be suffixed by position and heading.

STERN - Request for, or directive to, intercept using stern geometry.

STINGER - Formation of two or more aircraft with a single in trail.

STRANGER - Unidentified traffic that is not a participant in the mission.

STROBE - AI radar indications of noise radar jamming.

SWITCH/SWITCHED - Indicates an attacker is changing from one aircraft to another.

TALLY - Sighting of a target/bandit; opposite of "NO JOY".

TARGET() - Specification of sort responsibility.

THREAT (Direction) - (GCI/AWACS) Informative that an untargeted bandit/bogey is within 10 NM of a friendly.

TRACKING - Stabilized gun solution.

TRAIL - Tactical formation of two or more aircraft following one another.

TRAILER - The last aircraft in a formation.

TRASHED - Informative call; missile in flight has been defeated.

TUMBLEWEED - Indicates limited situation awareness; no tally, no visual; a request for information.

VEE - Three groups/contacts/formations with the single closest in range and an element in trail.

VISUAL - Sighting of a friendly aircraft; opposite of "BLIND."

WALL - Three or more groups/contacts/formations line abreast/side-side.

WEDGE - Tactical formation of two or more aircraft with the single in front and the other aircraft laterally displaced on either side behind the leader's wing line.

WEEDS - Indicates that aircraft are operating close to the surface.

WILCO - Will comply with received instructions.

WINCHESTER - No ordnance remaining.

CHAPTER 9: ACRONYMS

A/A – Air-to-Air

AAA - Antiaircraft Artillery.

AACQ – Automatic Acquisition. Mode of Air-to-Air radar.

AAW - Antiair Warfare.

ABCCC - Airborne Battlefield Command and Control Center.

ACE - Airborne Combat Element (Marine Corps term).

ACM - Air Combat Maneuvering, The process of positioning an attacking aircraft to employ weapons against a target aircraft.

ACT - Air Combat Tactics, Tactical gameplans to achieve desired Air-to-Air objectives.

ADIZ - Air Defense Identification Zone.

A/G – Air-to-Ground.

AGL - Above Ground Level.

AGM - Air-to-Ground Missile.

AI - Air Interdiction/Air Intercept.

AOA – Angle Of Attack, The angle between the mean chord line of a wing and the relative wind.

AOT- Angle Off Tail, The angle formed between the longitudinal axes of two aircraft. The angle is measured from defender's 6 o'clock. Also called track crossing angle (TCA).

AOB - Air Order of Battle.

ARM - Antiradiation Missile.

ASM - Air-to-Surface Missile.

ASUW - Antisurface Warfare.

ASW - Antisubmarine Warfare.

ATO - Air Tasking Order, or Fragmentary Order (FRAG). Daily schedule of air support sorties, includes all pertinent information to perform mission.

AWACS - Airborne Warning and Control System.

BAI - Battle Area Interdiction.

GCE – Ground Combat Element (Marine Corps term).

BDA - Bomb Damage Assessment. Brief description of weapon effectiveness on target.

BFM - Basic Fighter Maneuvers – Series of aerial maneuvers in order to achieve a weapons firing position on another aircraft.

BRAT – Report stating; Bearing, Range, Altitude, and Target aspect of target

BS – Boresight. ACM mode of Air-to-Air radar.

BVR - Beyond Visual Range.

CAG - Carrier Air Group.

CAP - Combat Air Patrol – Fighter mission to destroy enemy aircraft along a specified route or from a specific geographic point.

CAS - Close Air Support.

CBU - Cluster Bomb Unit.

C^2 - Command and Control.

C^3 - Command, Control, and Communications.

CCIP – Constantly Computed Impact Point.

CL_{Max} - Coefficient of Lift, Maximum - The angle of attack at which the most lift is created, the maximum turn rate and maximum G loading also occur at this AOA.

CSAR - Combat Search and Rescue.

DCA - Defensive counter air.

DDI – Digital Display Indicators.

DLZ - Dynamic launch zone.

ECCM - Electronic counter-countermeasures.

ECM – Electronic Counter Measures, Actions taken to prevent or reduce the effective use of the electro-magnetic spectrum by the enemy force.

EMCON - Emission control.

EO - Electro-optical.

EOB - Electronic Order of Battle.

ETA - Estimated Time of arrival.

EW - Electronic Warfare.

FAC - Forward Air Controller.

FAC(A) - Forward Air Controller (Airborne).

FCS – Flight Control System.

FEBA - Forward Edge of the Battle Area.

FLIR - Forward-looking infrared.

FLOT - Forward Line Of Troops.

Frag - Fragmentary Order (ATO).

CHAPTER 9: ACRONYMS

FSCL - Fire Support Coordination Line.

GBU - Guided Bomb Unit.

GCI - Ground Controlled Intercept.

GOB - Ground Order of Battle.

GPS - Global positioning system.

HARM - High Speed Anti radiation Missile, AGM 88.

HSD – Horizontal Situation Display.

HUD – Heads Up Display.

IADS - Integrated Air Defense System.

IFF - Identification Friend or Foe.

ILS – Instrument Landing System.

IMC - Instrument Meteorological Conditions.

IR - Infrared.

IRCM - Infrared countermeasures.

JFACC - Joint Force Air Component Commander.

JFC - Joint Force Commander.

LOS – Line Of Sight - A direct line from the pilot's eye to an object.

LGB - Laser-Guided Bomb.

MIG - Fighter aircraft designed and produced by the Mikoyan Gurevich Aircraft Bureau of the USSR.

M/M – Master Mode.

MSL - Mean Sea Level.

NOB - Naval Order of Battle.

NORDO - No radio.

OCA - Offensive counter air.

P_k - Probability of kill.

P_s - Specific excess power.

RADAR – Radio Detection And Ranging.

RECCE - Reconnaissance.

R_{max} - Maximum weapons range.

R_{min} - Minimum weapons range.

ROE - Rules of Engagement.

RWR - Radar Warning Receiver.

SA - Situational Awareness.

SAM - Surface-to-Air Missile.

SEAD - Suppression of Enemy Air Defenses.

SHRIKE - AGM-45 antiradiation missile.

TACAN – Tactical Aircraft Navigation.

TACC – Tactical Air Control Center.

TACP - Tactical Air Control Party.

TACS - Tactical Air Control System.

TDC – Target Designator Control.

TOF - Time Of Flight; The time from weapon release to weapon impact.

TOT - Time On Target.

TTA – Time Till Active. Time till missile seeker goes active.

TCA - Track Crossing Angle, See AOT.

V_c – Velocity closing; Closure between fighter and target expressed in knots.

VACQ – Vertical Acquisition Mode.

VV - Velocity Vector, Depiction of where the aircraft is actually going .

VID - Visual identification.

VMC - Visual Meteorological Conditions.

UFC – Up Front Control.

WACQ – Wide Acquisition Mode

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