COMBAT

The F-15E was designed as a strike fighter, with primary responsibility to deliver weapons against ground targets. Typically, a strike fighter's air combat is limited to self-defense on the way in and self-defense on the way out; however, the F-15E is well-equipped for such self-reliance. Getting in is typically the hardest part of any mission — the aircraft is at maximum weight, loaded with a full complement of air-to-ground ordnance and enough fuel to complete the mission. Air-to-air combat against nimble interceptors in these conditions is, needless to say, difficult. If you can fire off a few well-placed AIM-120s before the enemy even realizes you're there, you can probably get out of there quickly enough to make it to your target point. If you miss (or the opposition calls in backup) and it comes to a dogfight, you'll probably have to jettison your air-to-ground ordnance to survive. And even if you're able to dance your way out of this with your loadout intact, the fuel you expend afterburning in a combat-weight strike craft could leave you out of fuel before you've completed your mission.

This said, most F-15 missions can be divided into three phases, based on your objectives:

- **Getting In** — or your ingress to target, during which your primary objective is staying intact and hanging on to your ordnance.
- **Taking Care of Business** — or your time over target, during which your primary objective is your actual mission objective.
- **Getting Out** — or your egress from target, during which your primary objective is surviving and possibly (depending on how smoothly the first two phases went) conserving fuel.

Add to this a preliminary, but all-important **Combat Loadout** phase, in which you ensure you have the weapons and fuel necessary to make it through all three phases as they apply to the specific mission at hand, and you have the basic structure of this chapter.

Combat Loadouts, p. 4.3, gives an easy-reference chart of the weapons and targeting systems that can be loaded from the *Select Loadout* screen and a brief discussion of things to consider when loading your aircraft.

Getting In, p. 4.11, discusses the skills you need for a successful ingress:

- Avoiding detection
- Switching to A/A master mode
- Detecting aircraft beyond visual range (using the A/A radar and TEWS)
- Acquiring and tracking BVR targets (using the A/A radar)
- Engaging (with the M61A1, AIM-120As, AIM-7s and AIM-9s)
- Managing your flight

To further underscore the principle that a fully loaded strike aircraft was not meant to dogfight, air combat theory and maneuvers are described under **Getting Out**.

Taking Care of Business, p. 4.51, covers everything you need to know about delivering a payload to target:

- Switching to A/G master mode
- Finding and designating targets (using the A/G radar and the targeting IR camera)
- Selecting weapons and bomb modes (using the A/A Arm page)
- Engaging (with unguided weapons, AGM-65s, GBU-15s and Paveways)

Getting Out, p. 4.70, briefly discusses how the air-to-air skills described under **Getting In** apply on your egress from target — when your plane is lighter, but may have less ordnance and less fuel. Air combat theory and basic fighter maneuvers are described in this section.

COMBAT LOADOUTS

A successful mission begins with a successful loadout. You want to be sure the equipment you have meets the situation you're going to face. How do you know what you're going to face? Read your briefing. Read the intelligence files. Look at the briefing map. They're given to you for a reason — take advantage of them.

KNOW YOUR WEAPONS

This chart provides a quick reference for all of the weapons you can carry. For more in-depth information, see **Weapon Advisor**, p. 1.14.

Weapon. Lists the designation and name of the weapon as they appear on the *Weapon Inventory* screen.

MPD Name. Lists the abbreviation used for the weapon on the A/A Arm or A/G Arm MPD pages.

Max Loadout. Maximum number of weapons of this type you can have loaded on your aircraft. Loading the maximum of one type may preclude you from loading the maximum of another type — for example, if you have 8 AIM-120s loaded, you won't be able to load 4 AIM-7s. Also, your hardpoints limit the different sets of weapons you can load — you can't load 2 AIM-120s and 4 CBUs together on the same station, for example. See **Interface: Arming**, p. 1.10.

Guidance. Sensor used to guide the weapon to target. Laser- and datalink-guided weapons are guided by a laser-designator or datalink pod mounted on the launching aircraft. SARH missiles require the aircraft's radar for guidance until they reach the target. All other entries refer to the seeker mounted on the nose of the weapon itself.

Weapon Type. What the weapon is designed to do. (Preferred targets are listed in parentheses when they are not obvious.)

Weapon	MPD Name	Max Load	Guidance	Weapon Type
M61A1 [1]	n/a	500	Unguided	20mm cannon (aircraft/soft ground targets)
AIM-7F Sparrow	7F	4	SARH	Medium range anti-air
AIM-7M Sparrow	7M	4	SARH	Medium range anti-air
AIM-9L Sidewinder	9L	4	IR	Short range anti-air
AIM-9M Sidewinder	9M	4	IR	Short range anti-air
AIM-9P Sidewinder	9P	4	IR	Short range anti-air
AIM-120A AMRAAM	120A	8	Radar	Medium range anti-air
AGM-65D Maverick	AGM65D	6	IIR[2]	Stand off precision attack (armored vehicles)
AGM-65G Maverick	AGM65G	2	IIR[2]	Stand off precision attack (hardened targets)
BLU-107 Durandal	BLU107	12	Unguided	Taxiway/runway cratering
BSU-49 (MK-82 AIR)	BSU49	12	Unguided	Low altitude general purpose
BSU-50 (MK-84 AIR)	BSU50	7	Unguided	Low altitude general purpose
CBU-52	CBU52	12	Unguided	Anti-personnel/-materiel
CBU-58	CBU58	12	Unguided	Anti-personnel/-materiel
CBU-58A	CBU58A	12	Unguided	Anti-personnel/-materiel (incendiary)
CBU-71	CBU71	12	Unguided	Anti-personnel/-materiel
CBU-71A	CBU71A	12	Unguided	Anti-personnel/-materiel (incendiary)
CBU-78	CBU78	12	Unguided	Anti-armor
CBU-87	CBU87	12	Unguided	Anti-personnel/-materiel
CBU-89	CBU89	12	Unguided	Anti-armor
CBU-97	CBU97	12	Unguided	Anti-armor

Weapon	MPD Name	Max Load	Guidance	Weapon Type
GBU-10 Paveway I	GBU10	5	Laser	Precision attack
GBU-10E Paveway II	GBU10E	5	Laser	Precision attack
GBU-10G Paveway II	GBU10G	5	Laser	Precision attack (hardened targets)
GBU-12 Paveway I	GBU12	11	Laser	Precision attack
GBU-12D Paveway II	GBU12D	11	Laser	Precision attack
GBU-15 (v)-1	GBU15L	2	TV/Datalink[3]	Stand off precision attack
GBU-15 (v)-2	GBU15L	2	IIR/Datalink[2,3]	Stand off precision attack
GBU-15 (v)-31	GBU15S	2	TV/Datalink[3]	Stand off precision attack (hardened targets)
GBU-15 (v)-32	GBU15S	2	IIR/Datalink[2,3]	Stand off precision attack (hardened targets)
GBU-24 Paveway III	GBU24	3	Laser	Precision attack
GBU-24A Paveway III	GBU24A	3	Laser	Precision attack
GBU-28	GBU28	3	Laser	Precision attack (underground targets)
Mk 20 Rockeye II	MK20	12	Unguided	Anti-armor
Mk 82	MK82	12	Unguided	General purpose ground attack
Mk 84	MK84	7	Unguided	General purpose ground attack

[1] Mounted on aircraft and cannot be removed. Max Loadout lists maximum number of rounds loadable.

[2] Has imaging infrared (IIR) seeker head which transmits FLIR video to the launching aircraft before launch/release.

[3] If AN/AXQ-14 datalink pod loaded, can be steered after launch. Seeker head transmits normal (TV) or IIR video to the launching aircraft.

KNOW YOUR TANKS AND PODS

In addition to weapons, you can load sensor pods, extra fuel tanks, and countermeasures on your aircraft. You may or may not need these, depending on your mission.

CHAFF AND FLARES

Countermeasures are a valuable line of defense against surface-to-air missiles and enemy interceptors. They can help you escape a long-range engagement without a dogfight, plow through SAMs flanking a vital enemy target, or ward off undetected IR missiles if it does get down and dirty.

You have three options when it comes to countermeasures:

AN/ALE-40 (1)	120 chaffs/60 flares
AN/ALE-40 (2)	180 chaff/30 flares
AN/ALE-40 (3)	60 chaff/90 flares

AN/AAQ-13

This is the navigation pod of the Low-Altitude Targeting and Navigation Infra-Red (LANTIRN) system. It gives the F-15E nighttime and low-altitude flight capabilities. You must have this pod loaded if you want to:

- Use the terrain-following radar
- Use the NAVFLIR (navigation FLIR)

AN/AAQ-14

This sensor pod is the targeting pod of the LANTIRN system. It gives the F-15E its superior nighttime targeting and guidance capabilities. You must have this pod loaded if you want to:

- Use the targeting IR camera to view IR video of your targets
- Use laser-guided weapons (i.e., Paveways)
- Use automatic weapon cueing for AGM-65s or GBU-15s (see **Guided Weapons**, pp. 4.65-4.69)

AN/AXQ-14

When you have the AN/AXQ-14 datalink pod loaded on your aircraft, you will be able to steer a GBU-15 after launch, by using an indirect launch mode. See **Guided Weapons**, p. 4.68.

FUEL TANKS

The F-15E is capable of carrying three external fuel tanks in addition to its internal fuel — one on the centerline and two on the wings. You carry 23,200lbs internally and each external tank carries a maximum of 3,900lbs of fuel. With only the centerline tank loaded, you have a total of 27,100lbs of fuel. With all three tanks loaded, you have 34,300lbs of fuel. See **Combat Fuel Flow**, p. D.1.

DECIDING WHAT TO TAKE

PRESET LOADOUTS

Relying on the preset weapon loadouts isn't cheating. A real F-15 pilot wouldn't have control over what was loaded on his plane anyway, so you're actually that much closer to realism if you stick with the presets. And you can be sure that all of the sensor packages you need for each specific weapons loadout will also be loaded.

Also, if you like the CAS loadout (for example), but wouldn't mind switching out the MK-20s for CBU-87s, you can load the CAS package onto your plane and then click CUSTOM to fine-tune it all you want. See **Interface: Arming: Custom**, p. 1.12,

CUSTOM LOADOUTS

Many parameters affect what is necessary to win a given mission — ground opposition, air opposition, distance to the target area, local time, whether you have an element of surprise, etc. The following questions give you an idea of the types of considerations that go into planning a loadout. You should be able to find the answers to these in the briefing phase of any mission.

WEAPON ADVISOR SCREEN

This reference is accessible from the *Custom Loadout* screen. It can list either all of the targets a certain weapon can be effectively used against or all of the weapons that can effectively be used against a type of target. See **Interface**, p. 1.14.

Questions to Ask Yourself

What is your primary objective?

It's very important to match the durability of your target to the strength of the warhead. It would be impossible to destroy hardened C&C bunkers with small anti-personnel CBUs, for example. There's no sense fighting your way to a target if you're not very likely to be able to take it out when you get there. The Weapon Advisor (p. 1.14) lists preferred targets for different kinds of weapons.

If the objective is to do a great deal of damage somewhat indiscriminately at a target area, you'll want to think in terms of large numbers of weapons and CBUs. On the other hand, if you're assigned a very precise strike on a very particular target — say one building in a certain compound — you'll need a few precision-guided munitions to do the job.

When in a campaign, you'll also want to consider how difficult the mission is likely to be and how important the target is to the campaign overall. Your stores of guided munitions will be more limited than your stores of unguided ones.

What type of ground resistance is expected? What type of profile do you intend to fly? What type of weapon release profile do you intend to use?

Deciding a *flight profile* is perhaps the most important factor in determining the type and quantity of air-to-ground weapons to carry. A flight profile describes the relative altitude you take during ingress, at the target and on egress:

Hi-lo-hi. Used if the target is far away and enemy SAM/aircraft defense is minimal. You fly at high altitudes to and from your target to conserve fuel, but drop lower at the target area for more precise delivery. If you drop to a significantly lower altitude for delivery, you will want to use retarded bombs, such as the BSU-49 and -50, and the BLU-107 (for airfield/runway attacks), which are slowed down after release by small parachutes, enabling you to get out of the way before the weapon impacts the target. Likewise, if you are using CBUs, you want to be sure you release them from a altitude greater than their height of burst (HOB, set via the A/G Arm page, — see **Set CBU Height of Burst**, p. 4.61). If you release them below their height-of-burst they will explode almost immediately. Note that a low-level delivery may also prevent you from getting the LOS to target required to aim guided munitions, especially over rough terrain.

Lo-hi-lo. Used when SAM and air defense is heavy. You fly very low to avoid detection, but climb to a higher altitude when on target to deploy your weapons. If you have to climb quickly, you may not be able to get high enough soon enough for guided, stand-off weapons, such as the GBU-15. These weapons require you to maintain LOS to target while the entire time you are guiding them, and you will need to be at a fairly high altitude to do this.

Hi-hi-hi. Used in deep strikes. High-altitude flight conserves fuel so you can carry a heavier ordnance load. A high-altitude delivery can minimize ground threats — not only are you above AAA ranges, but since the ground range of most weapons increases the higher the altitude from which they are dropped, you can conceivably drop your ordnance, bank hard and get out without ever flying directly over your target and its attendant S-A defenses. (Your weapons will continue flying along your original flight path due to inertia.) However, higher altitudes also make it harder to hit a precise target — with unguided weapons you run the risk of collateral damage to nearby non-military structures.

Lo-lo-lo. A low-altitude delivery can get you in below minimum altitude for most SAMs and undetected by aircraft, but requires more fuel and can thus only be used when the target is nearby. Guidelines for weapon choice in a lo-lo-lo delivery are similar to those described above under hi-lo-hi. In addition, plan on making a high-speed delivery — you'll have to get in and out quickly to minimize your exposure to AAA.

In addition to flight profile, your *weapon release profile*, or the actual attitude of your aircraft when releasing weapons, also affects which weapons you use and vice versa. All weapons — guided, unguided, stand-off, retarded, etc. — can be released from level flight. *Level* and *loft* deliveries are the best choices for guided munitions. (In a *loft* delivery, you release weapons with a nose-up attitude. This gives the weapon an extra push upward for a greater glide distance — particularly effective with GBUs, which have fins designed to increase glide range. This also helps keep your aircraft from masking the laser-designator.) *Pop-up* and *dive* deliveries are best used in conjunction with CDIP bombing mode (see **Select a Bomb Mode**, p. 4.61) and unguided weapons. Pop-up deliveries consist of flying at very low levels, then popping up and rolling inverted to acquire the target, then diving to engage it. These are incredibly difficult to execute correctly, and they may mask the targeting pod. Dive deliveries may not maintain LOS long enough for guided weapons.

How much fuel do you need?

If it's a deep strike, and there's no chance of refueling, you may need all three tanks to get through the mission. However, when considering fuel requirements, you have to balance the increase in endurance time with the increase in weight and decrease in performance. The greater your weight, the more sluggish your aircraft, and the more fuel it requires to climb and maneuver. In addition, endurance varies greatly with altitude. The higher you fly, the less quickly you burn fuel and the greater your endurance. See **F-15 Fuel Flow**, p. D.1, for a chart illustrating the relationship between airspeed, altitude and fuel flow.

Depending on the situation, fuel conservation — flying slower than full military power, flying at high altitudes, and minimizing the use of your afterburners — is often better than adding fuel weight to your plane.

How much air opposition do you expect, and when?

If air opposition is heavy on ingress and egress, you may have to sacrifice some ground ordnance to take along a few extra air-to-air missiles. To make up for the loss in numbers, it may be worth it to take precision-guided weapons — you're going to have to make every shot count. Less ordnance means less weight, and added maneuverability.

How large is your flight?

Keep in mind you can set separate loadouts for yourself and the other aircraft in your flight. If you are on a strike mission and expecting heavy air opposition, you may need an "eight-ship" flight. You can give aircraft 5, 6, 7 and 8 (as numbered on the *Select Loadout* screen) air-to-air ordnance, and give the other four air-to-ground ordnance. While enroute, you can assign the division (which is comprised of aircraft 5, 6, 7 and 8) to cover you and take on air objectives, while you (aircraft 1), your wingman (aircraft 2) and aircraft 3 and 4 concentrate on your primary ground objectives. Keep in mind that the aircraft in your flight will work in pairs —1/2, 3/4, 5/6, and 7/8. It's a good idea to give a pair the same (or at least similar) ordnance.

Are you flying at night?

IR-guided weapons have a better chance of finding their targets at night. The FLIR video images of the AGM-65, GBU-15-2 and GBU-15-32 are enhanced. On the other hand, unaided vision is hampered — the conventional TV video of the GBU-15-1 and GBU-15-31 would be too dark to be useful and visual references for dropping unguided weapons in CDIP mode are less reliable.

Do you have the guidance systems you need?

Before you leave the loadout screen, make sure you have all of the systems you'll need in order to use the weapons you've loaded. For example, the GBU-15 requires an AN/AXQ-14 datalink pod if you want to steer the weapon after release. All of the Paveways require the AN/AAQ-14 targeting pod. If you're flying at night or nap-of-the-earth (NOE) you'll want the AN/AAQ-13 navigation pod with NAVFLIR and a terrain-following radar.

GETTING IN

This section deals with the skills and weapons systems you will need on your ingress to target. The ingress phase of a mission is often the phase in which you are most vulnerable. You are heavily loaded with both weapons and fuel, so it is harder for you to maneuver. If the enemy knows you're coming, or finds out along the way, you'll find yourself up against aircraft designed and loaded solely for air combat. And then of course there are SAMs ...

AVOIDING DETECTION

Surprise has never been a better ally — if they don't know you're coming, they won't try to stop you. Once you drop your ordnance, they'll have a pretty good idea where you are, but if you can get in and strike without being picked up by aircraft or GCIs (Ground Control Intercepts — ground-based warning and control systems) you'll be able to deal with them unencumbered once you've blown your cover.

STAY LOW

Flying at extremely low altitudes is the best way to remain hidden. Flying below 500ft puts you below the minimum detection altitude for most ground radar systems. Flying nap-of-the-earth (NOE), or hugging terrain contours, decreases the chance you will be detected by aircraft by making it difficult for radar to pinpoint and track your location among the "ground clutter."

NOE Flight with the Terrain Following (TF) Radar

Nap-of-the-earth flight is a challenge for fixed-wing aircraft flying several hundred knots. It's almost impossible without the terrain-following radar housed in the AN/AAQ-13 navigation pod of the LANTIRN system. This radar system sends signals down and in front of the aircraft and calculates your altitude above the terrain from the returns.

To use TF radar guidance for low-level flight:

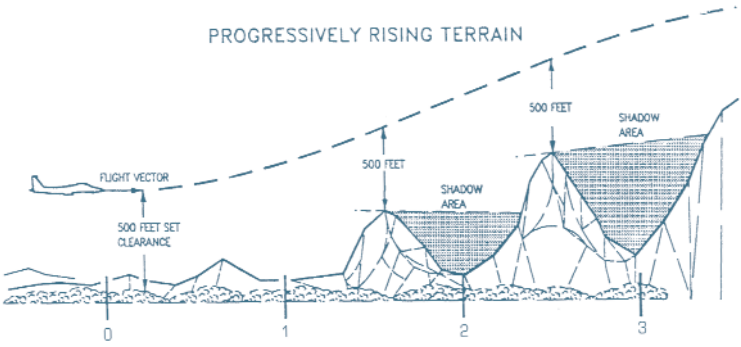
1. Drop down to the above-ground-level (AGL) altitude you want to maintain.
2. Press PB 4 (TFF NORM/OFF) on the UFC main menu until NORM appears beside the button. Activating the terrain-following radar also activates the autopilot. The autopilot will maintain the AGL altitude you are flying at when the TF radar is activated.

The absolute minimum AGL altitude you want to rely on the TF radar maintaining is 300 ft. Anything below that (and you will want to go below that) you'd better fly manually.

Even at 300 ft, you'll want to keep one eye on the autopilot. When the TF radar detects a terrain feature in front of you, the autopilot will attempt to climb above it and a FLY UP message appears in the center of the HUD. The autopilot cannot pull more than 2Gs to excute a climb. If more than 2Gs are required to avoid an obstacle detected by the TF radar, an OBSTACLE warning message appears on the HUD, reinforced by an audio warning, and the OBST light on the console lights up. This signals you to take control of the aircraft to avoid crashing.

You can steer somewhat while the TF radar is on and the autopilot engaged, but you should keep in mind that the TF radar is evaluating the terrain directly in front of you. If you bank too quickly, it may not be able to detect an obstacle quickly enough to avoid it.

Additionally, there are "shadows" in the TF radar returns. When faced with progressively rising terrain, the TF radar may not be able to drop you into all of the valleys along your flight path — see the illustration below for an example.



Manual NOE Flight

LAW System

The LAW system is also indispensable when flying at low altitudes. With this system you can set a minimum altitude and the aircraft will warn you (via both a LOW ALT light on the left side of the console and a verbal cue) when you've dipped beneath it. To set the altitude for the LAW system and enable it:

1. Click PB 9 (A/P ...) of the UFC main menu to call up the autopilot submenu (see **Cockpit: UFC Main Menu**, p. 2.65).
2. The current altitude setting for the LAW system is displayed next to PB 2. Press PB 3 (UP) or 8 (DWN) to increase or decrease this setting.
3. Click PB 5 to toggle the LAW system on (LAW ON) and off (LAW OFF).

See **Cockpit: 1. Low Altitude Warning (LAW) System Submenu**, p. 2.66)

Radar altitude scale. If you manually fly NOE, you will rely heavily on the *radar altitude scale*. This scale graphically represents your AGL altitude and appears on the HUD when you drop below 1500 ft AGL, as long as your pitch angle is less than ± 20° and your bank angle less than ± 60°. (These pitch and bank angle limits are a result of where on the aircraft the radar altimeter is mounted. See **Customizable Basic Symbology**, p. 2.9, for more details.)

NAVFLIR

If you're flying at night, you'll also want to activate the NAVFLIR (navigation FLIR camera). This system projects FLIR video imagery onto your HUD. Because terrain cools off more slowly than the air around it at night, terrain features will show up more sharply against the sky in this FLIR image than they will visually.

PB 7 of the UFC main menu cycles the NAVFLIR between N-F NORM-WH (white-hot — objects radiating the most heat appear brightest on screen), N-F NORM-BH (black-hot — objects radiating the most heat appear darkest on screen) and N-F OFF (no FLIR imagery is projected onto the HUD).

See **Cockpit: 7. NAVFLIR (N-F)**, p. 2.69.

LIMIT RADAR USAGE

When you are using your radar, you become instantly more visible to enemy ground and aircraft detection systems. Whereas their radar systems would normally have to rely on their own emissions bouncing off your aircraft in order to locate you, if your own radar is active you are broadcasting emissions for them like a beacon in the night. Limiting radar emission — i.e., preventing your radar from conducting a scan — helps you remain undetected.

Your radar continues to emit, even when both the A/A and A/G Radar pages are not visible. To prevent your radar from emitting, you must manually disable it using one of the methods listed below.

SNIFF

While flying without radar helps you remain undetected, it also blinds you. When you must use your radar, use it in short bursts, making a quick scan and then hitting the SNIFF button. (Of course, once you've been detected, you can use the radar more liberally — they already know where you are.)

To suspend radar emissions:

- Press PB 18 on the A/A Radar or A/G Radar page until SNIFF is boxed. Press again to remove the box and allow the radar to continue emitting.
- On the A/G Radar page, you can also press PB 17 until FRZ (freeze) is boxed. Freezing the radar display stops it from updating, so that the targeting or map cursor can be more accurately placed. Freezing has the added advantage of halting radar emission, making you temporarily less visible.

See **Cockpit: A/A Radar Pushbuttons**, p. 2.53; **Cockpit: A/G Radar Pushbuttons**, p. 2.48; and **Create an HRM**, p. 4.54.

To have your entire flight suspend radar emissions:

- Press the **FLT_TOGGLE_RADAR** key. Each aircraft will radio back standard acknowledgment (i.e., their flight number), indicating they have heard and complied. Press this key again to have them re-enable radar emission.
- Alternately, press the **RADIO_1_TRANSMIT** Tab key to call up a flight communications menu. Press 4 to choose FLIGHT (SUBMENU), then press 2 to select RADAR ON/OFF. Each aircraft will radio back standard acknowledgment. Repeat the procedure to have them re-enable radar emission. (Note that an aircraft will not disable its radar if it is tracking a target.)

See **Flight Commands**, p. 4.44.

Jammer Control

Even when SNIFF is enabled, your jammer — which also produces detectable emissions — can continue to emit. Jammers are designed to "fool" radars and Radar Warning Receivers (RWRs) by sending out false and garbled radar returns. Other aircraft will be able to detect these emissions, but they will have a hard time pinpointing where and what they are coming from.

You can give the TEWS total control over the Internal Countermeasures Set (ICS, a.k.a. the jammer). In this case it will remain in standby mode and only emit when your RWR senses you are being tracked by a threat radar/SAM. You can also control the ICS manually. Depending on the situation, you may decide that turning your radar off but leaving ICS in standby provides you a welcome bit of protection.

To place the ICS on standby and control it manually:

- Click PB 20 (MAN/SEMI/AUTO) on the TEWS MPD page until MAN appears next to the button. This gives you manual control over the jammer — it will remain in standby until you press the **JAMMER** [J] key. Pressing this key again toggles the jammer back to standby.

To place the ICS on standby and give control to the TEWS:

- Click PB 20 (MAN/SEMI/AUTO) on the TEWS MPD page until AUTO appears next to the button. The jammer will remain in standby until the TEWS detects a threat painting you, at which point it begins to emit. It will continue emit until the TEWS no longer detects a threat.

See **Cockpit: 13. Tactical Early Warning System (TEWS) Page**, p. 2.42.

To have your entire flight suspend jammer emissions:

- Press the **FLT_TOGGLE_JAMMER** key. Each aircraft will radio back standard acknowledgment. Press this key again to have them re-enable jammer emission.
- Alternately, press the **RADIO_1_TRANSMIT** [Tab] key to call up a flight communications menu. Press [4] to choose FLIGHT (SUBMENU), then press [3] to select MUSIC ON/OFF. All aircraft will radio back standard acknowledgment. Repeat this procedure to have them re-enable jammer emission.

See **Flight Commands**, p. 4.44.

EMIS LMT

The EMS button on the keypad of the UFC enables and disables radar and jammer emission. Whenever the EMIS LMT light (right side of the console) is on, your radar and jammers cannot emit.

To prevent both the radar and jammer from emitting:

- Click the EMS button on the keypad of the UFC until the EMIS LMT light is lit. Click the button again to turn off the light and re-enable both systems.

See **Cockpit: Up Front Controls (UFC)**, p. 2.64, and **Cockpit: Indicator Lights**, p. 2.73.

USE AWACS AND JSTARS

AWACS (Airborne Warning and Control System) and JSTARS (Joint Surveillance and Target Attack Radar System) aircraft can also provide you with positional information for nearby targets, without your having to blow your cover. AWACS will report air threats; JSTARS will report ground targets. If things heat up, AWACS can also call in CAP and SEAD assistance, if it is available.

AWACS and JSTARS will give you positions in "BRA" format — bearing, range and altitude relative to your aircraft — or B/E format — bearing, range and altitude from the bullseye point. A bullseye point is used to radio positional information to a friendly unit without compromising the friendly unit's own position. The position of the Bullseye should be given in your briefing. For more information on the Bullseye, see **Mission Builder: Bullseye**, p. 5.50.

To request AWACS information:

1. Press the **RADIO_2_TRANSMIT** Shift Tab key. (Radio channel 2 lets you talk to airfields, tankers, JSTARS, AWACS, etc.)
2. A menu appears in the upper left corner of the screen. Press 1 to select **(1)** AWACS SUBMENU.

3. On the submenu, press one of the following keys:

1	(AWACS) REQUEST PICTURE	After a few seconds, the AWACs will list the positions of all enemy aircraft detected in your area. Positions are given in B/E format — bearing, range and altitude relative to the bull's-eye — if a bull's-eye point has been designated. Otherwise, positions are given in BRA format.
2	(AWACS) REQUEST BOGEY DOPE	After a few seconds, the AWACs will begin rattling off the position of the group of enemy aircraft nearest you. Position is given in BRA format.
3	(AWACS) REQUEST ASSISTANCE	If a Combat Air Patrol (CAP) wing is available, the AWACS will redirect to your area. If no wing is available, you will receive the message, "Negative. No assets are available." Note that while notified of the area to patrol, the CAP wing will find its own aircraft targets.
4	(AWACS) REQUEST WEASELS	If a Suppression of Enemy Air Defenses (SEAD) wing is available, the AWACS will redirect it your area. If no wing is available, you will receive the message, "Negative. No assets are available." Note that while notified of the area to patrol, the SEAD wing will find its own targets.
5	(AWACS) REQUEST NEAREST TANKER	If a tanker is available, the AWACS will list its coordinates in BRA format. If no tanker is available, you'll receive the message "Negative. No assets are available."

To request JSTARS information:

1. Press the **RADIO_2_TRANSMIT** Shift Tab key.
2. A menu appears in the upper left corner of the screen. Press one of the following keys:

2	(JSTARS) CHECK IN/OUT	When you check in with the JSTARS controller (choose this command for the first time in a mission), he will give you the ground target he'd like you to engage (in B/E format if there is a B/E; otherwise in BRA format). When you check out (choose this command for the second time) he'll know you are headed home, and won't assign you any more targets.
3	(JSTARS) TARGET REQUEST	The JSTARS controller will give you the location of a ground target he'd like you to take (in B/E format if there is a B/E; otherwise in BRA format).
4	(JSTARS) NEXT TARGET REQUEST	If for some reason you can't find or can't take the target he assigns you, this command will have him skip to the next on his list.

SWITCHING TO A/A MASTER MODE

A/A master mode configures all of your cockpit systems for air-to-air combat. The first thing you want to do when you expect trouble is switch to this mode. You can do this in any of the following ways:

- Press the **MASTER_MODE_CYCLE** [M] key to cycle through master modes.
- Press the **MASTER_MODE_AA** key to select A/A master mode.
- Click on the A/A master mode button beneath the UFC.

See **Cockpit: Master Modes**, p. 2.3.

The A/A Radar page, A/A Arm page and TSD page come up automatically in the pilot's cockpit. The A/A Radar page, A/A Arm page, TEWS page and TSD page come up in the WSO's cockpit. For information on changing these default settings, see **Cockpit: 6. Master Mode Programming**, p. 2.37.

DETECTING AIRCRAFT BEYOND VISUAL RANGE

If you can't make it to the target area undetected — perhaps the length of your mission requires you to fly at a higher altitude to conserve fuel — your next best strategy is taking out the air opposition with a single pass, before they have a chance to lure you into a dogfight. Doing this requires great skill and a thorough command of your air-to-air targeting weapons and engagement systems. It also requires cooperation with your wingman and intelligent leadership of your flight — rarely will you face just a single bandit.

Any successful engagement begins with finding the enemy — most preferably finding him (even a split second) before he finds you. Letting him catch you unawares could mean your untimely demise.

With the advent of longer-range missiles, air combat moved from close-range visually-guided combat to the engagement of targets that were beyond visual range (BVR). Systems that could detect and/or acquire BVR targets were invented, and the skillful use of these systems (such as radar and radar warning receivers) became the deciding factor in modern missile combat. These detection skills are discussed in this section.

USE THE A/A RADAR

Choose a Search Mode

Your radar has several possible air-to-air search modes, only one of which can be active at a time. Each has its strong points and limitations.

- **RWS High (RWSH) mode** emits high pulse repetition frequency (PRF) radar waves, which are better at detecting high closure contacts (contacts moving at great speed with respect to your aircraft), which return a stronger Doppler shift than low closure contacts. Low or no closure contacts (a contact moving roughly the same speed and direction as you are) may not show up at all, however. You would use this mode if you were expecting fast interceptors moving in head-on, but not to target a MiG you were tailing in a dogfight.
- **RWS Medium (RWSM) mode**, which emits medium PRF radar waves. These cannot detect high closure contacts at as great a range as high PRFs, but they are better at detecting low or no closure contacts.
- **RWS Interleaved (RWSI) mode** will most likely be your primary search mode. With each bar scanned, the radar alternates between high and medium PRFs, returning data on both high and low closure contacts. This is the best general-purpose search mode to use if you don't know exactly what's lurking out there — which is almost always the case unless you're warned in advance that certain high-speed interceptors or low-RCS aircraft will be zooming in over the horizon.
- **Range Gated High (RGH) mode** performs similarly to RSWI mode. It emits radar waves at a single intermediate PRF, but electronically processes the returns to extract data on both high- and low-closure targets.
- **Velocity Search (VS) mode** does not display low closure targets at all, and sorts targets according to their closure rate instead of according to range. You will only use this mode to find very high-closure targets. See **Cockpit: The A/A Radar Grid**, p. 2.54.
- **Vector (VCTR) mode** takes twice as long to complete a scan as the other modes, but uses this extra processing time to scan for smaller, stealthier aircraft. You would only use this mode if you were concerned about picking up frontal or tail aspect targets a great distance away. It only emits at high PRFs, however, and therefore has the same difficulty with low-closure targets as RWSH mode.
- **Track While Scan (TWS)** and **High Data TWS (HDTWS) modes** are used to search for contacts while you have a target designated (normally when you designate a target, all other contacts disappear from your screen).

You can use either to search for targets without having a target designated, but their scan areas are severely limited (4° and 2°, respectively). They are discussed in more detail under **Acquiring and Tracking BVR Targets**, p. 4.27.

How to Activate a Search Mode

You will activate all search modes by clicking on the pushbuttons surrounding the MPD. A box appears around the button's label indicates the currently selected search mode. Only one mode can be active at a time — selecting a mode deselects all other modes.

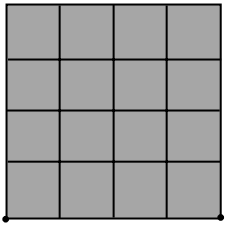
RWSH, RWSM or RWSI	Click PB 6 until the mode you want is boxed.
RGH	Click PB 7 to box RGH.
VS	Click PB 8 to box VS.
VCTR	Click PB 9 to box VCTR.
***TWS** or HDTWS*	Click PB 10 until the mode you want is boxed.

Set Search Scan Limits

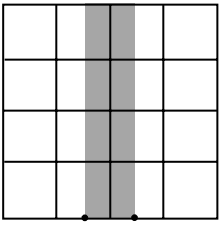
When setting the radar's scan limits, there is a trade-off between the area you can cover and the time it takes to complete a scan. Setting a very large scan area decreases your blind zone — the area to the sides, back, below and above your aircraft that are not scanned — and minimizes the chance that an aircraft will sneak up on you. A large scan area takes longer to scan, however; contact information is updated less frequently, therefore the positions of contacts on the radar screen are less reliable.

Azimuth Limit

Press PB 12 (**15/30/60**) on the A/A Radar MPD page to limit the radar azimuth scan to 15°, 30° or 60° to either side of the aircraft's nose, or a 30°, 60° and 120° total scan angle. Note that the scale of the radar grid does not change when you change the scan angle — the portion of the grid that is updating changes. The radar azimuth limit balls (hollow circles along the bottom of the grid) mark the boundaries of the portion that is updating.



Portion updated when scan angle is 60°

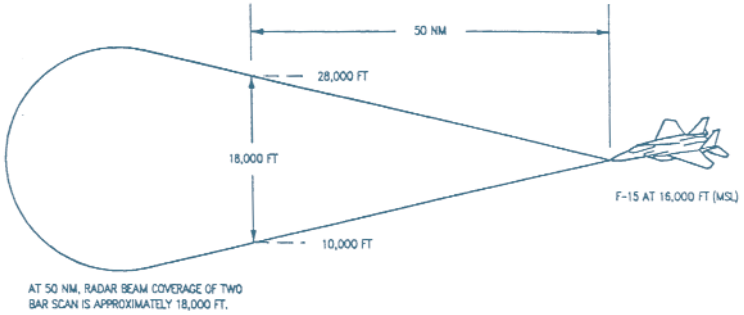


Portion updated when scan angle is 15°

Be careful — in the second example of the diagram at left, the outer columns of the grid aren't being updated. Yet even though they are blank, bandits could be lurking in this sector.

Elevation Limits

The elevation limit of a scan depends on the number of bars in the scan (which controls the vertical angle of the scan) and the radar range setting. Note that the elevation limit — the elevation of the scan at maximum range — dwindles down to zero as it approaches your aircraft. Another aircraft could be flying directly beneath you and you would never know.



PB 2 of the A/A Radar page cycles through elevation settings — 1-, 2-, 4-, 6- and 8-bar scans. (Elevation settings are predetermined for TWS modes, depending on which azimuth angle setting you've selected — see **Cockpit: A/A Radar Search Modes**, p. 2.50.)

Range Limits

Besides limiting elevation coverage, the range setting determines how far from the aircraft the radar scans. Note that this is not necessarily how far away aircraft are detected, however — for example, frontal and tail-aspect contacts (contacts with a low radar cross-section) may not be detected at 80nm.

PB 13 of the A/A Radar page cycles through available radar ranges — 10, 20, 40, 60, 80 and 160nm. The currently selected range appears next to the button.

The Blind Zone

As hinted at in the sections above, it's important to remember that the scan area for air-to-air radar is a *cone* that tapers back to the point of emission. At its widest azimuth angle it's a fairly wide cone, but it still leaves 240° to the sides and back of your aircraft totally "blind." However, as long as you remain conscious of the radar's limitations and know that the blips on the screen aren't always the only aircraft out there, the radar is an indispensable tool for picking enemy aircraft along your mission route.

USE THE TEWS

The Tactical Electronic Warfare System (TEWS) is a combination of four different defensive systems:

AN/ALR-56C Radar Warning Receiver (RWR)	Detects and displays threats
AN/ALE-40 Countermeasures Dispenser (CMD)	Dispenses chaff and flares
AN/ALQ-135 Internal Countermeasures Set (ICS)	Emits jamming frequencies
AN/ALQ-128 Electronic Warfare Warning Set (EWWS)	Cues the AN/ALQ-135

The AN/ALR-56C can also be used as an offensive tool to find enemy aircraft even though it was designed for defensive use. Using the RWR to detect enemy aircraft has one major advantage — it's a passive radar detection system that doesn't emit and therefore can't be picked up by enemy radar. In addition, the RWR returns information for an area 360° around your aircraft, and can pick up ground radar emissions as well. Of course, the RWR has one major drawback as well — it only picks up threats that are *actively* using radar. When they turn off their radar, they disappear from the TEWS display.

How the TEWS Displays Contacts

For more information, see **Cockpit: 13. Tactical Early Warning Display (TEWS) Page**, p. 2.42.

The TEWS presents a top-down view of the area around your aircraft. Your aircraft is in the center of the display with its nose always oriented toward the top.

Threat Symbols

The following symbols mark threats:

△ Aircraft □ Ground threat ◇ Missile

A **circle around a symbol** indicates a threat with a radar lock on you.

A **flashing symbol** indicates a threat launching a missile.

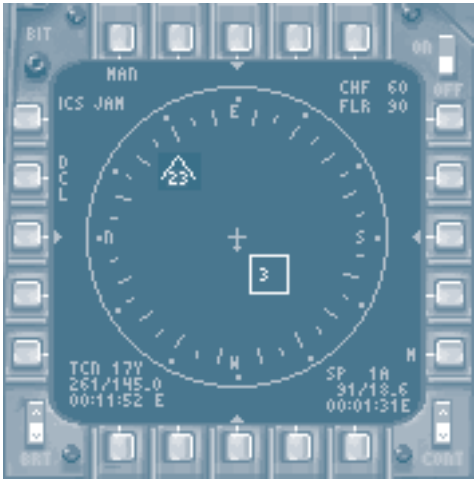
An alphanumeric code inside the symbol identifies the type of aircraft or ground threat. The **Threat ID Code Table** on p. 2.43 of the **Cockpit** chapter lists the alphanumeric code for all threat objects.

Only missiles with active radar seekers (like the AIM-120) will show up on the TEWS display. SARH missiles are guided by the launching aircraft, so only the launching aircraft will appear on the display (the aircraft symbol will flash while the missile is in flight, indicating that the aircraft is launching). Likewise, IR missiles won't show up — only the aircraft that launched them will (and they will only show up if and when they are emitting radar).

Threat Location and Strength

The TEWS indicates a threat's azimuth position relative to yours and how strong its signal is, but does not give any direct indication of how far the threat is from your aircraft. The stronger a threat's emissions, the closer its icon will appear to the marker representing your aircraft on the TEWS display. The weaker a threat's emissions, the further from your aircraft marker its icon is displayed. In some cases signal strength corresponds to range — the stronger the emission, the closer the object, etc. However, signal strength also varies according to the type of radar emitting — the radar on an AWACS aircraft is much more powerful than the radars on fighter aircraft, for example.

The picture below depicts an aircraft about 40° to the left of the nose of your aircraft. Its radar emissions are weaker than that of the ground threat, which is displayed closer to your aircraft marker, at about 130° to the right of your aircraft.



Using Countermeasures

In addition to providing information about radar threats, the TEWS also controls the way countermeasures — jammers, chaff and flares — are used.

Setting the Level of TEWS Control

You can give total control of countermeasures to the TEWS, or you can assume some control yourself. To set the level of countermeasure control, press PB 20 (MAN/SEMI/AUTO) until the level of control you desire appears below the button.

MAN Manual control gives you total control over countermeasures. You must press the **CHAFF** [Del] and **FLARES** [Ins] keys in order to drop them, and one cartridge is dropped per key press. The jammer must be enabled/disabled manually using the **JAMMER** [J] key.

SEMI Semi-automatic control gives you control over *when* chaff is dropped (again, you press the **CHAFF** [Del] key), but the TEWS determines *how many* are dropped with each key press. Flares are still dropped manually and one at a time with the **FLARES** [Ins] key. **JAMMER** [J] till controls the jammer as described above.

AUTO Automatic control gives the TEWS total control over when *and* how many chaff cartridges are released, and when your jammer is enabled or disabled. Flares must still be released manually. *(**Note:** Automatic release of chaff tends to use the cartridges up rapidly.)*

Dropping Chaff and Flares

Chaff cartridges release clouds of small metallic strips that can distort the radar waves guiding an SARH or active-radar-guided missile. The strips are made of Mylar film or fine glass particles covered with aluminum or zinc, and are cut to lengths that match the expected radar wavelengths.

CHAFF [Del] Drop a chaff cartridge. With manual control of the TEWS, one cartridge is dropped with each key-press. With semi-automatic control, the TEWS controls how many are dropped with each keypress. This key has no function when control of the TEWS is set to automatic.

Flares explode into hot, bright fireballs, creating an intense source of heat between an oncoming infrared missile and your aircraft. Since IR-guided missiles home in on heat sources, a well-timed and well-positioned flare has a chance of luring the missile away from your exhaust. Since IR-guided missiles aren't affected by jamming and do not show up on the TEWS display,

flares and quick maneuvering are really the only defense against these deadly weapons.

FLARES [Ins] Drop a flare. One flare is dropped per keypress, regardless of the TEWS control setting. Flares must always be released manually.

The number of chaff (CHF) and flare (FLR) rounds remaining on your aircraft is marked in the upper right corner of the TEWS display.

Activating Your Jammer

Jammers reflect false radar returns to a radar source. Part of the TEWS's function is to vary the intensity, frequency and direction of the jamming transmission in order to best hide the exact position of your aircraft. With manual and semi-automatic control of the TEWS, you must enable and disable the jammer manually.

JAMMER [J] Enable/disable your jammer.

The status of your jammer is indicated in the upper left corner of the TEWS display:

JAM EMIS LMT is off, and the jammer is currently emitting.

STBY Standby — EMIS LMT is off, but the jammer is not currently emitting.

EMIS EMIS LMT is on, disabling the jammer.

Whenever the EMIS LMT light (right side of the console) is on, your radar and jammers cannot emit. Press the EMS button on the keypad of the UFC to re-enable radar and jammer emission. See **EMIS LMT**, p. 4.16.

ACQUIRING AND TRACKING BVR TARGETS

Whether you initially find BVR (beyond visual range) targets with the radar or the TEWS, you will need to pick them up with your air-to-air radar (or at least have the air-to-air radar active) before you can acquire, track and engage them. The following sections assume that you have already picked up contacts on your radar.

For a description of the grid and contact symbology used by the A/A Radar, see **A/A Radar Symbology**, p. 2.54.

SEND AN IFF SQUAWK

Before you consider engaging a target, you want to be certain it isn't a friendly aircraft. Aircraft use "friend or foe" transponders to determine another aircraft's alignment. The transponders on allied aircraft will return a "friendly" message when queried (or "squawked") by another allied aircraft.

You can manually control IFF interrogation or it can be automatic. Press PB 3 (IFF OFF/NORM/AUTO) on the UFC main menu to cycles through control options for IFF interrogation. The currently selected option appears next to the button.

OFF No IFF queries can be sent to other aircraft.

NORM Currently displayed A/A radar contacts will be identified when you press the **IFF_INTERROGATE** [I] key.

AUTO The primary designated A/A radar target is automatically queried when the radar locks onto it.

After an IFF squawk is sent, the contacts that return a friendly response will change from rectangles to circles on the radar display. Contacts that do not respond — either enemy or neutral aircraft — will remain rectangular.

 Denotes a friendly aircraft.

 Denotes an unknown aircraft — enemy or neutral.

DESIGNATE THE TARGET

You can acquire a target in one of two ways — designating one manually or having the radar designate one using one of five auto-acquisition modes.

Manual Target Designation

To designate a target manually, move your cursor over the radar screen and click on a contact. The contact becomes your *primary designated target* (PDT), and its contact symbol changes from a rectangle to a star. (If you have a friendly targeted and an IFF squawk has been sent either manually or automatically, the symbol will flash between a star and a circle. See **Send an IFF Squawk**, p. 4.27.)

Once you have a PDT, the radar automatically switches to a tracking mode — the default is Single Target Track (STT), but you can also select Track While Scan (TWS) tracking using PB 10 of the A/A Radar page. See **Track the Target**, p. 4.30.

A/A Auto Acquisition Modes

Four of the A/A auto acquisition modes are controlled by hotkeys. Pressing an acquisition mode key signals the radar to acquire a target, using the parameters set by the mode you've chosen.

ACQ_SS	5	Super Search acquisition mode
ACQ_BST	6	Boresight acquisition mode
ACQ_LRBST	7	Long-Range Boresight acquisition mode
ACQ_VTS	8	Vertical Scan acquisition mode

The fifth auto-acquistion mode, Guns acquisition mode, is enabled automatically when you are in A/A master mode, you do not have a designated target, and you press the **GUN_SELECT** 1 key.

Once the radar acquires its target, that target becomes your *primary designated target* (PDT), and its contact symbol switches from a rectangle to a star. (If you have a friendly targeted and an IFF squawk has been sent either manually or automatically the symbol will flash between a star and a circle. See **Send an IFF Squawk**, p. 4.27.) The radar then automatically switches to a tracking mode — the default is Single Target Track (STT), but you can also select Track While Scan (TWS) tracking using PB 10 of the A/A Radar page. See **Track the Target**, p. 4.30.

For more details on the symbology described below, see **Cockpit: Head-Up Display (HUD): Auto-Acquisition (ACQ) Mode Symbology**, p. 2.10.

Super Search

Super Search projects a 20° circle onto the center of the HUD. The radar acquires the first target within 10nm to enter this circle.

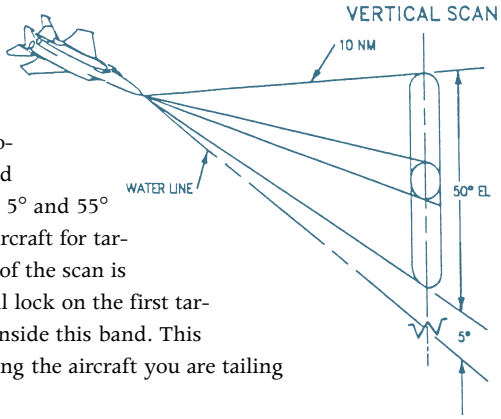
Boresight

Boresight projects a 4° circle onto the center of the HUD. The radar acquires the first target within 10nm to enter this circle.

Long-Range Boresight

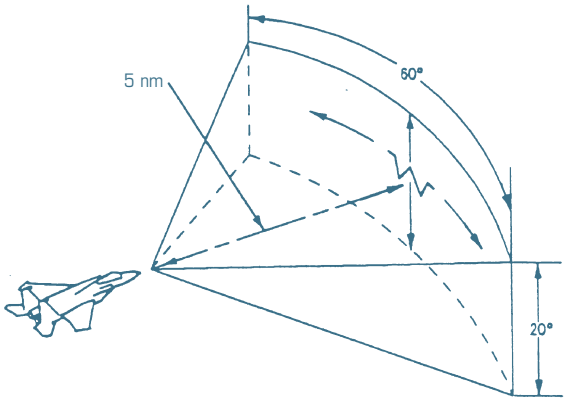
Long-Range Boresight also projects a 4° circle onto the center of the HUD. The radar acquires the first target within ***40nm*** to slip into this circle.

Vertical Scan



Vertical Scan mode changes the direction of the radar antenna. Instead of moving side-to-side, it now moves up and down, scanning between 5° and 55° above the nose of your aircraft for targets. The azimuth width of the scan is about 7.5°. The radar will lock on the first target within 10nm to slip inside this band. This mode is useful for targeting the aircraft you are tailing in a turning fight.

Guns



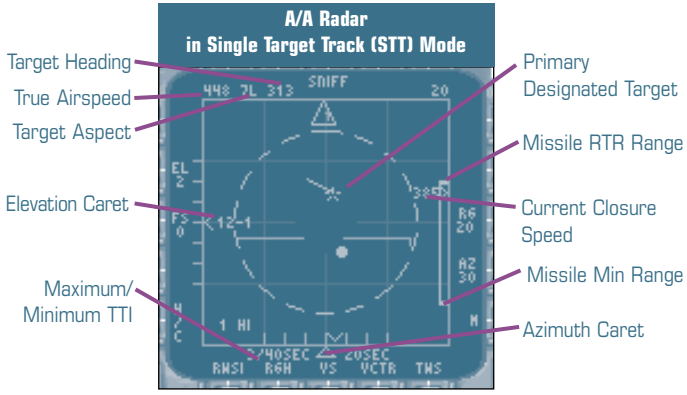
Guns acquistion mode covers a rectangle of roughly 60° azimuth (30° to either side of nose) and 20° elevation (10° above nose, 10° down), out to a range of only 5nm. The first target to enter this area is targeted.

TRACK THE TARGET

Once the radar has acquired a primary designated target (PDT), it begins to track it. By default, the radar uses Single-Target Tracking (STT) mode, tracking only the PDT. All other contacts disappear from the screen. This doesn't help you much if your target has company you want to keep an eye on, so there is a Track While Scan (TWS) mode in which the radar will track the PDT, but continue to update contact information in a small area surrounding it. You can choose this mode using PB 10 of the A/A Radar page.

Single-Target Tracking (STT)

In STT mode, the radar displays range, azimuth, altitude, closure rate, true airspeed, aspect and heading information for the PDT. A long heading vector on the PDT symbol visually indicates the direction the target is heading. When you are in an A/A missile mode, missile mode symbology, such as weapon range, shoot cues, etc., will also appear on the display.



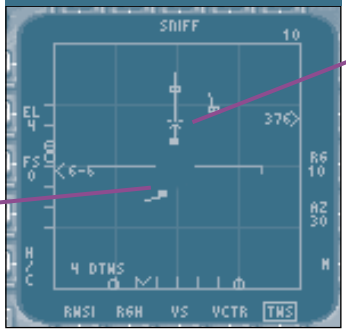
You must be in STT mode in order to launch an AIM-7.

For more information on the symbology used in this mode, see **Cockpit: Symbology — Target Designated**, p. 2.56, and **Cockpit: Missile Mode Symbology**, p. 2.58.

Track While Scan (TWS)

The symbology used to describe the PDT in TWS mode is the same as is the symbology used on the STT display. In addition, however, TWS modes display non-target contacts on a small portion of the radar screen, and you can designate additional *secondary designated targets* (SDTs, see instructions below). Small heading vectors on non-target contacts indicate the contacts' headings. The heading vectors on your primary and secondary designated targets are twice as long as the heading vectors for non-target contacts.

A/A Radar in Track While Scan (TWS) Mode



Using TWS Modes with a PDT

1. Designate your target using one of the methods described under **Designate the Target**, p. 4.28.

2. Select a TWS mode. Press PB 10 of the A/A Radar page to toggle between DTWS and high data rate (HD) TWS modes. Both are TWS modes; HDTWS simply scans a smaller area in a shorter amount of time than DTWS. When one of these modes is boxed, the radar is in a TWS mode.

3. Set the scan area size. In HDTWS, there is only one size — a 30°, 2-bar scan. In DTWS mode, you can cycle between a 2-bar, 60° scan (more useful for contacts flying at the same altitude); a 4-bar, 30° scan (more useful for contacts in stacked formation) or a 6-bar, 15° scan (more useful for targets widely separated by altitude) by changing the radar's azimuth setting (PB 12 of the A/A Radar page).

   See **Cockpit: Other A/A Radar Pushbuttons**, p. 2.53, for more information and diagrams of the HDTWS and DTWS scan area sizes.

Acquiring Secondary Designated Targets (SDTs)

TWS mode is particulary useful when used in conjunction with AIM-120s. In a TWS mode you can designate secondary designated targets (SDTs) as well as primary designated targets (PDTs). Multiple AIM-120s can be fired at all of these targets at the same time.

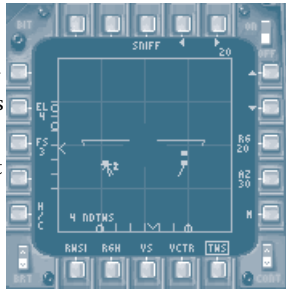
To designate SDTs:

1. Designate a target using one of the methods described under **Designate the Target**, p. 4.28.
2. Switch to a TWS mode, using the steps described under **Using a TWS Mode with a PDT**, above.
3. Click on another contact to designate it. This contact becomes the PDT, and the old PDT becomes an SDT. You can continue designating targets in this manner, to a total of eight (1 PDT and 7 SDTs).

For more information on engaging these targets with AIM-120s, see **Firing an AIM-120**, p. 4.34.

Using TWS Modes without a PDT

You can select a TWS mode before you designate a target. When you do so, the radar picks the closest contact and designates it as your primary non-designated target. Its symbol switches from a square to a star (or a flashing circle and star if you've made an IFF query and the contact returned a friendly response), but its heading vector remains the same size as that of non-target contacts. If you did not previously have a PDT, and you designate one while in TWS mode, you enter STT mode.



Undesignating a Target/Designating a New Target

To undesignate your target at any time, press the **UNDESIGNATE** Bksp key.

In STT mode, you will have to undesignate the target in order to designate another. In a TWS mode, clicking on another contact designates the new contact as a PDT and the old contact as an SDT (See **Acquiring Secondary Designated Targets**, above). If you want to designate a new PDT without making the old PDT an SDT, press the **UNDESIGNATE** Bksp key first, and then acquire your new target.

ENGAGING

When you are enroute to a strike target, taking out your opponent on the first pass (which is *always* the goal of an air attack) is crucial. Successfully detecting an enemy means acquiring him as your target by the time he is within your weapon range, but before you are within his weapon range. (This of course requires you to have longer-range weapons than his.) At this point you have the advantage, and if you destroy him, you can keep it. If you fail to destroy your opponent and are drawn into a dogfight, you will probably find yourself (as a strike aircraft loaded with ordnance and fuel) at a severe disadvantage. Thus your goal is to engage him from as far away as possible and avoid the dogfight.

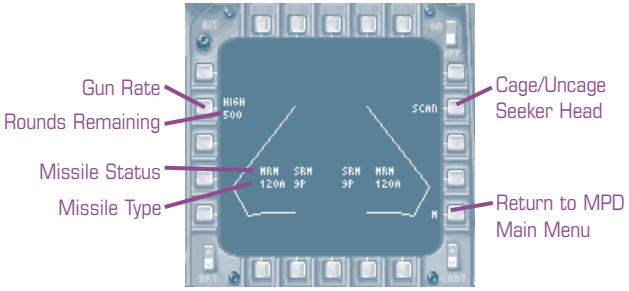
ENGAGE WITH MISSILES

The AIM-120A is by far your first line of defense. Not only does this missile have a longer range than the others, but it also has an onboard active radar seeker. Used in conjunction with the radar in a TWS mode, you can launch and update multiple AIM-120s toward multiple targets — several missiles can be in-flight maneuvering toward different targets at the same time. The shorter-ranged, SARH-guided AIM-7, on the other hand, requires you to keep a radar lock on a single target until the missile impacts.

The IR-guided AIM-9 is a true "fire-and-forget" missile — once it is launched, it homes in on the heat signature of its target. It has a much shorter range than the other two, however.

Checking your Missile Stores

The A/A Arm page displays all of your air-to-air ordnance on a rough top-down view of your aircraft. The nose of your aircraft is oriented toward the top of the display. The large triangular "brackets" represent its wings. At the rough location for each of the eight air-to-air ordnance stations on the underside of your aircraft, the type and status of weapon loaded is indicated. (Only one weapon can be loaded at each station.)



The status of the missiles is indicated by the following:

MRM An AIM-7 or AIM-120 is loaded at this station.

SRM An AIM-9 is loaded at this station.

STBY You are in the correct mode to launch this missile (MRM or SRM), but the missile is not next in sequence.

RDY This is the next missile in sequence. It will launch when you press the pickle (joystick button 2).

HUNG The missile has malfunctioned, and remains on the rail after launch (it hasn't armed, so there's no danger of explosion).

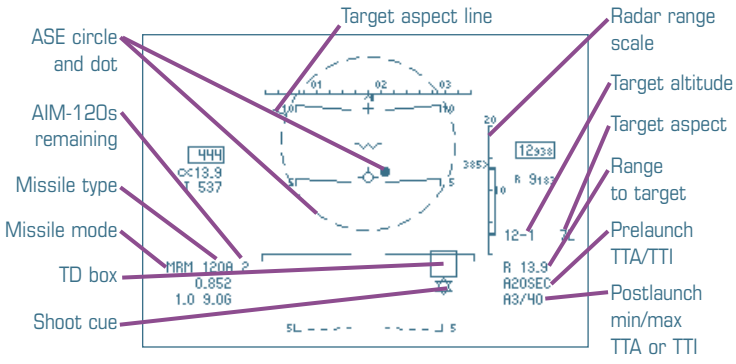
If nothing appears, there is no missile at this station.

For more information on the symbology of the A/A Arm page, **see A/A Arm Symbology**, p. 2.26.

Missile Modes and Launch Sequences

There are two missile launch modes — MRM (medium-range missile) and SRM (short-range missile). MRM mode is used to launch AIM-120s and AIM-7s; SRM is used to launch AIM-9s. For each mode there is a designated launch sequence. You can "step over" or skip a missile in the sequence, but you can in no other way alter it.

See the launch sequence diagrams under **Cockpit: Missile Launch Sequences**, p. 2.27.



Firing an AIM-120A

In order to fire an AIM-120A, an AIM-120A must be the next missile in sequence.

1. Acquire a target using one of the methods described under **Acquiring and Tracking BVR Targets**, p. 4.27. A TD box appears, tracking the position of this target on the HUD. (If this target has been queried by IFF and returned a friendly response, an X appears through this box.) If you want to fire at multiple targets, designate secondary targets according to the instructions under **Acquiring Secondary Designated Targets (SDTs)**, p. 4.32.

2. Press **MRM_SELECT** [3] to switch to MRM missile launch mode. Check to see that an AIM-120A is next in sequence. If not, step over your AIM-7s until you get back to an AIM-120 (press **MISSILE_REJECT** [4] to "reject" or step over a missile), or proceed with the instructions for the AIM-7.

3. An Allowable Steering Error (ASE) circle and dot appear on the HUD. When you have a designated target, this circle represents the maximum steering error for a normal launch. Steer toward the heavy dot to place it inside the large, dashed circle.

   This circle is essentially a function of target range relative to R_{aero} and target altitude, target aspect angle, and the difference in altitude between you and your target. It will increase in size as you move closer to your target, to a certain point, then may begin to decrease as target aspect angle changes.

4. Check the range scale on the right side of the HUD. The caret marks your target's current range and closure rate. The bars on the range scale delineate certain ranges. These will give you an idea of when to release your target.

   R_{aero} This marks the maximum aerodynamic range of the missile at your current altitude. A missile fired at a target within this range has a chance of hitting only if the target doesn't do anything to avoid the missile. It's probably better to hold on to the missile a little longer until you're in better range.

   R_{opt} This marks the optimum range of the missile at your current altitude, against a target that flies straight and level until the missile has almost reached it, then performs a 4G terminal escape maneuver. A missile fired at an unsuspecting target within this range has a chance of hitting, if the target doesn't realize a missile has been launched at him (or at least doesn't maneuver to avoid it) until the terminal phase of the missile's flight.

R_{tr} This marks the maximum turn-and-run range of the missile at your current altitude. Within this range, it is hard for the target to out-maneuver or out-run the missile, even if it begins evasive maneuvers as soon as you launch. (Of course, a target's use of mechanical and electronic countermeasures can still decrease the missile's chance of hitting.)

MAR dot Indicates missile activation range — the range at which AIM-120 active seeker attempts to acquire the target.

R_{min} Minimum range of the missile at your current altitude. The missile will not be able to hit a target inside this range.

On your radar display and on the HUD, the range between R_{tr} and R_{min} will be bracketed.

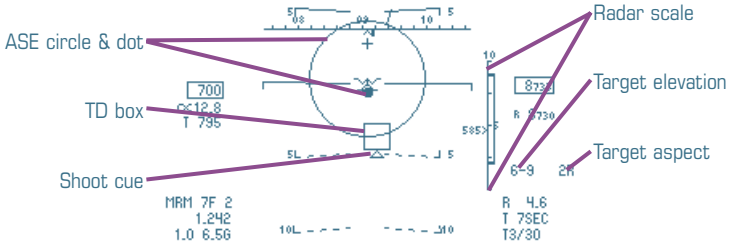
The shoot cue (a six-pointed star) appears under the TD box when your target is between R_{aero} and R_{min}. Depending on the situation, you may not want to fire until the target is within R_{tr} and R_{min}, at which point the shoot cue will flash.

Your decision should in part be influenced by whether the target has a positive or negative closure rate (displayed next to the caret marking the target's range on the range scale). If he has a positive closure, he's moving toward you, continually decreasing the distance the missile will travel and the time it has to lock on to the target and arm. If he's moving away from you, he's increasing the distance the missile will travel.

5. Press the **WEAPON_PICKLE** key or button (typically joystick button 2) to launch your missile. If you have multiple targets designated, continue pressing and releasing the **WEAPON_PICKLE** key or button to launch missiles at each of these targets.

If the target moves within your minimum missile range before you launch, a large X (called a "break X") appears on the HUD and the radar screen. You will have to switch to a shorter-range missile, or break off and reposition yourself for another launch.

For more information on AIM-120 symbology, see **Cockpit: MRM Symbology**, p. 2.12.



Firing an AIM-7

In order to fire an AIM-7, an AIM-7 must be the next missile in sequence.

1. Acquire a target using one of the methods described under **Acquiring and Tracking BVR Targets**, p. 4.27. A TD box appears, tracking the position of this target on the HUD. (If your target has been queried by IFF and returned a friendly response, an X appears through this box.)

   Do not switch to TWS once you've acquired your target. You must be in STT mode (entered automatically when you acquire a target) to fire an AIM-7.

2. Press **MRM_SELECT** [3] to switch to MRM missile launch mode. Check to see that an AIM-7 is next in sequence. If not, step over your AIM-120As until you get to an AIM-7 (press **MISSILE_REJECT** [4] to "reject" or step over a missile) or proceed with the instructions for the AIM-120A.

3. An Allowable Steering Error circle and dot appear on the HUD. When you have a designated target, this circle represents the maximum steering error for a normal launch. Steer toward the heavy dot to place it inside the circle.

   This circle is essentially a function of target range relative to R_{aero} and target altitude, target aspect angle, and the difference in altitude between you and your target. It will increase in size as you move closer to your target, to a certain point, then may begin to decrease as target aspect angle changes.

4. Check the range scale on the right side of the HUD. The caret marks your target's current range and closure rate. The bars on the range scale delineate certain ranges. These will give you an idea of when to release your target.

   R_{aero} This marks the maximum aerodynamic range of the missile at your current altitude. A missile fired at a target within this range has a chance of hitting only if the target doesn't do anything to avoid the missile. Its probably better to hold on the missile a little longer until your in better range.

   R_{opt} This marks the optimum range of the missile at your current altitude against a target that flies straight and level until the missile has almost reached it, then performs a 4G terminal escape maneuver. A missile fired a an unsuspecting target within this range has a chance of hitting, if the target doesn't realize a missile has been launched at him (or at least doesn't maneuver to avoid it) until the terminal phase of the missile's flight.

R_{tr} This marks the maximum turn-and-run range of the missile at your current altitude. Within this range, it is hard for the target to out-maneuver or out-run the missile, even if it begins evasive maneuvers as soon as you launch. (Of course, a target's use of mechanical and electronic countermeasures can still decrease the missile's chance of hitting.)

R_{min} Minimum range of the missile at your current altitude. The missile will not be able to hit a target inside this range.

On your radar display and on the HUD, the range between R_{tr} and R_{min} will be bracketed.

A triangular shoot cue appears under the TD box when your target is between R_{aero} and R_{min}. Depending on the situation, you may not want to fire until the target is within R_{tr} and R_{min}, at which point the shoot cue will flash.

Your decision should in part be influenced by whether the target has a positive or negative closure rate (displayed next to the caret marking the target's range on the range scale). If he has a positive closure, he's moving toward you, continually decreasing the distance the missile will travel and the time it has to lock on to the target and arm. If he's moving away from you, he's increasing the distance the missile will travel.

5. Press the **WEAPON_PICKLE** key (typically joystick button 2) to launch your missile.

6. ***You must maintain a radar lock on your target until the missile impacts.*** Do not undesignate the target or allow it to move outside your radar cone.

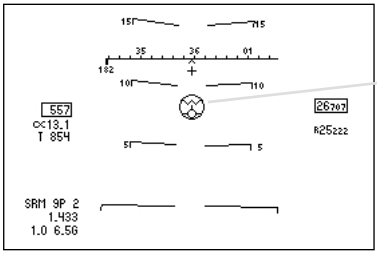
   On the radar screen, missile fly-out dots appear on the target's heading bar, signaling a missile in flight toward it. The estimated time-to-impact, or TTI, appears at the bottom of the radar display and in the lower right corner of the HUD.

If the target moves within minimum missile range before you launch it, a "break X" appears on the HUD and the radar screen. You will have to switch to an SRM, or break off and reposition yourself for another launch.

For more information on AIM-7 symbology, see **Cockpit: MRM Symbology**, p. 2.12.

Firing an AIM-9

The sysmbology displayed for the AIM-9L/M and AIM-9P differs slightly, because the AIM-9L/M is cued to the radar's boresight and the F-15's computer can track the movement of its seeker head on the HUD. The AIM-9P lackes this capability. Thus, the steps for firing an AIM-9 differ slightly, depending on whether an AIM-9M/L or AIM-P is selected, and whether or not you have a radar target designated.



Radar range scale

You can launch either AIM-9 at a target without designating the target, provided the it is within weapon range. Audio cues will tell you when the missile seeker head has gained an IR lock on the target, and this will be your signal to launch. If you fire without designating, your target's RWR will not alert him that he is being "painted," and he is less likely to suspect you are firing missiles at him.

To fire an AIM-9P:

1. a) *Optional:* Acquire a target using one of the methods described under **Acquiring and Tracking BVR Targets**, p. 4.27. If you designate a target, you will see range, altitude and closure information for the target. A TD box also appears, tracking the position of this target on the HUD. (If this target has been queried by IFF and returned a friendly response, an X appears through this box.)

   b) *Not optional:* Get behind your target. The AIM-9P is a rear-aspect only missile, so you will need to be at the rear of your opponent in order for the missile to gain a lock.

2. Press the **SRM_SELECT** [2] key to switch to SRM missile launch mode.

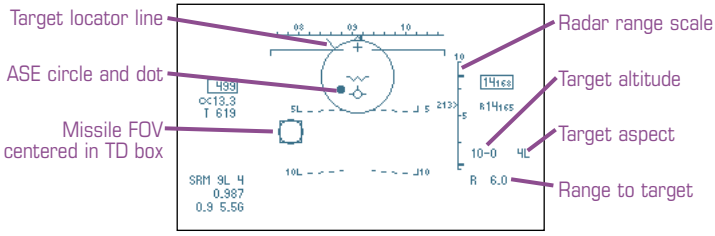
3. An FOV circle appears in the center of the HUD, locked onto the boresight. Steer so that your target is inside the missile FOV. When the missile has locked on to the target, it will generate an audio tone. The strength of this tone varies according to the target's distance, IR visibility and position in the missile's FOV — the louder the tone, the better the launch parameters.

4. Once you've achieved a solid lock, you can:

   a) Press the **WEAPON_PICKLE** key (typically joystick button 2) to launch your missile.

b) Click on PB 14 of the A/A Armament page or press the **AIM9_SCAN** U key until SCAN is boxed. The missile will uncage from the boresight and track the target — a continuous tone indicates successful tracking. When you are ready to launch, press the **WEAPON_PICKLE** key (typically joystick button 2).

If the target moves within minimum missile range, a "break X" appears on the HUD. You will have to switch to guns or break off and reposition yourself for another launch.



To fire an AIM-9L or M with a designated radar target:

1. Acquire a target using one of the methods described under **Acquiring and Tracking BVR Targets**, p. 4.27. A TD box appears, tracking the position of this target on the HUD. (If your target is a friendly, an X appears through this box.)
2. Press the **SRM_SELECT** 2 key to switch to SRM missile launch mode.
3. The missile's seeker head is automatically slaved to the radar antenna LOS (a small circle on the HUD indicates the current position of the seeker head — it may lag a bit from the TD box during heavy maneuvers as the seeker head readjusts).
4. When the seeker head has locked onto the target, you will hear a loud lock tone, and an Allowable Steering Error (ASE) circle and dot appear in the center of the HUD — keep the dot inside the circle.
5. Uncage the missile seeker head by clicking on PB 14 of the A/A Armament page or pressing the **AIM9_SCAN** U key until SCAN is boxed. This step is not always necessary, but it helps ensure that the seeker head continues to lock onto the designated target, as well as track it. When the seeker is uncaged and locked on, the ASE circle doubles in size.
6. Check your range cue to make sure the target is between the missile's maximum and minimum range. A triangular shoot cue flashes next to the TD box when the seeker head is locked on and the target is in range.
7. Press the **WEAPON_PICKLE** key (typically joystick button 2) to launch your missile.

If the target moves within minimum missile range, a "break X" appears on the HUD. You will have to switch to guns or break off and reposition yourself for another launch.

To fire an AIM-9L or M without a designated radar target:

The instructions are the same as those listed for the AIM-9P, except that a seeker head position will move around the HUD when the seeker head is uncaged. (This circle will always remain locked to the boresight when an AIM-9P is in priority, even if the seeker head is uncaged — the seeker head is still moving about, but the computer cannot track its position.)

For more information on AIM-9 symbology, see **Cockpit: SRM Symbology**, p. 2.15.

ENGAGE WITH THE M161A CANNON

Besides the raw thrill of shooting down your opponent at close range, a guns-only kills saves a missile, and you never know when you might need that missile. Still 500 rounds of ammunition won't last long, even with a low gun rate, and the gun requires you to get in close, which you want to avoid on your ingress to target.

Setting Gun Rate

You can set the gun's rate of fire from either the A/A Arm or A/G Arm MPD pages. PB 2 of either page toggles your gun rate between HIGH (6000 rounds per minute) and LOW (4000 rounds per minute). The currently selected rate appears by the button. The number of ammunition rounds you have remaining is listed below this rate.

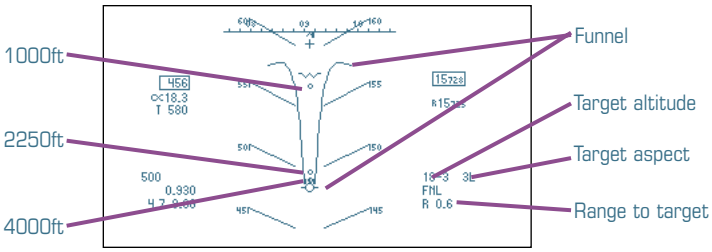
No Target Designated

A/A FNL is the only gun sight available when:

- You are in A/A master mode
- You do not have a target designated
- You press the **GUN_SELECT** [1] key to select your gun.

The radar will simultaneously switch to GUNS acquisition mode and attempt to aquire a target. See **A/A Auto-Acquisition Modes**, p. 2.10.

The funnel represents a target with a 40ft wingspan at ranges between 250 ft (the wide end of the funnel) and 5000 ft (the narrow end of the funnel). There are dots along the funnel marking 1000, 2250 and 4000 ft ranges. Bullets travel down the center of this funnel.



To engage a target with the A/A FNL sight:

1. Line the target up inside the funnel based on how far away you think it is.
2. Press the gun trigger (joystick button 1) to fire.

For more information on the symbology described here, see **Cockpit: A/A FNL Sight Symbology**, p. 2.17.

Target Designated

The GDS and GDS FNL gun sights become available when you are in A/A master mode, you have a target designated and you select your gun. If you designate your target before you select your gun, GDS symbology will appear by default. Otherwise, you are in A/A FNL and will have to cycle through gun sights to get to GDS. Once you have a target designated, all three sights are available, and the **GUN_SELECT** [1] key cycles through them. If you lose radar lock on the designated target, the gunsight will automatically revert to FNL, and the radar will switch to GUNS ACQ mode and attempt to re-acquire the target.

To engage a target with the GDS or GDS FNL sights:

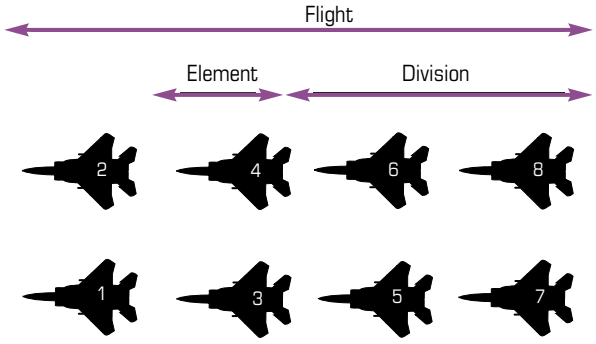
1. Line the target up with the center of the pipper. The GDS FNL provides the funnel for additional guidance.
2. A radar range scale is provided on the right side of the HUD — the caret indicates your target's current range and closure rate, and the tick mark indicates the gun's maximum range. Be sure that the target is inside the gun's maximum range.
3. Press the gun trigger (joystick button 1) to fire.

For more information on the symbology described here, see **Cockpit: GDS and GDS FNL Sight Symbology**, p. 2.17.

MANAGING YOUR FLIGHT

You are the flight leader for a flight of up to eight aircraft. Depending on the task at hand and expected level of resistance, you may want all eight aircraft to play similar roles in the mission, or (for example) you may direct some to take up escort duties while the others perform a strike. Whatever you decide, you will want to arm all of the aircraft in you flight accordingly. Once the mission is underway, their ability to carry out their part of the mission hinges in large part on your ability to effectively communicate with them.

THE STRUCTURE OF A FLIGHT



Before you can successfully manage a flight, you will need to understand its structure.

A flight can consist of up to eight aircraft. You, as flight leader, are always in aircraft 1, and your wingman is in aircraft 2. When you issue flight (**FLT**) commands, all aircraft in the flight will respond (see below).

An "eight-ship" or "six-ship" flight consists of two *divisions*. You are division leader of one of these, which consists of aircraft 1, 2, 3 and 4. Aircraft 5 is the division leader of the other, which consists of the remaining aircraft. You do not have control over the individual aircraft in aircraft 5's division, but his entire division will respond as a unit to any division (**DIV**) commands you give (see below).

Each division consists of one or two *elements*. As division leader, you have control over your element, and the element comprised of aircraft 3 and 4. When you issue element commands (**ELM**), only aircraft 3 and 4 will respond (see below). Your wingman will wait for direct wingman (**WN**) orders from you, and aircraft 5 has control over the elements in his own division.

FLIGHT COMMANDS

The general key commands listed in the table below can be used to control your wingman, the element, the division or the entire flight, depending on which prefix it has. **FLT_ENGAGE** tells the whole flight to engage, whereas **ELM_ENGAGE** orders only aircraft 3 and 4 to engage.

WN	Command controls aircraft 2 (wingman)
ELM	Command controls aircraft 3 and 4 (element)
DIV	Command controls aircraft 5, 6, 7 and 8 (division)
FLT	Command controls entire flight

Alternatively, you can access any of these commands by pressing the **RADIO_1_TRANSMIT** [Tab] key. A menu will appear in the upper left corner of the screen. Each of the menu options calls up a submenu, press the key corresponding to the number listed in front of an option to select it Unavailable options are grayed out.

[1]	1) WINGMAN (SUBMENU) (commands for aircraft 2)
[2]	2) ELEMENT (SUBMENU) (commands for aircraft 3 and 4)
[3]	3) DIVISION (SUBMENU) (commands for aircraft 5-8)
[4]	4) FLIGHT (SUBMENU) (commands for all aircraft)

General Commands

The following list of commands can be used to direct your wingman, element, division or the entire flight, depending on which prefix the keyboard command name has or what menu the command is chosen from.

Menu Option. Lists the command options as they appears on the WINGMAN, ELEMENT, DIVISION and FLIGHT submenus described above. Press the key corresponding to the number listed in front of an option to select the option.

Key Command Suffix. Lists the keyboard function name suffixes for the same commands as they appear on the keyboard mapping screen. (The prefix to the commands — **WN**, **ELM**, **DIV** and **FLT** — indicates who responds to a command, while the suffix indicates what the response is.)

Action. Describes what the selected aircraft will do when you press the key command or choose the menu option.

Menu Option	*Key Command Suffix*	*Action*
ENGAGE BANDITS	**ENGAGE**	Engage any enemy air targets they find. If they can't find anything, they will radio you and continue normal flight. If they have acquired targets and want to engage, but you haven't given the OK, they will ask you for it.
SANITIZE RIGHT	**SANITIZE_RIGHT**	Fly out 90° to the right of your flight path, using air radar to search for targets. They will radio back the position of any they find. If they don't find any, they will return to formation. (Not available for **FLT** or from FLIGHT submenu.)
SANITIZE LEFT	**SANITIZE_LEFT**	Fly out 90° to the left of your flight path, using air radar to search for targets. They will radio back the position of any they find. If they don't find any, they will return to formation. (Not available for **FLT** or from FLIGHT submenu.)
COVER ME	**COVER**	Do one of three things — A) begin a CAP, if a CAP was assigned to them for this steer point; B) begin their escort, if escort is assigned for this steer point; C) cover you, otherwise. See **Steering Data**, p. 2.68, for an explanation of steer point assignments. (Not available for **FLT** or from FLIGHT submenu.)

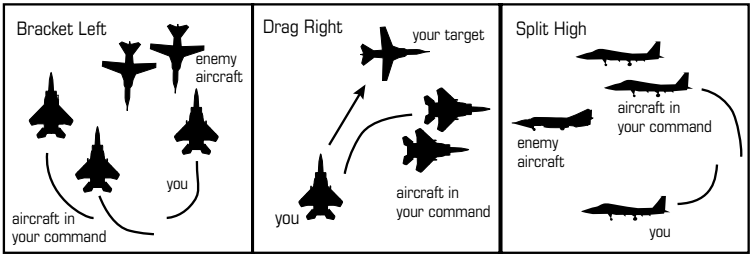
Menu Option	*Key Command Suffix*	*Action*
ORBIT HERE	**ORBIT**	Circle the area until you ask them to return to formation. They will not follow you if you go elsewhere. You can combine this command with another like **ENGAGE** to order aircraft to remain in one place and carry out a specific task. (Not available for **FLT** or from FLIGHT submenu.)
INTERCEPT		Call up the INTERCEPT submenu. (See below)
GROUND ATTACK	**ATK_ANY_GRND**	Call up the GROUND ATTACK submenu. (See below)
REJOIN FLIGHT	**REJOIN_FLIGHT**	Break off attack and return to formation.
RETURN TO BASE	**RETURN_TO_BASE**	Return to the airfield where you began your mission.

Intercept Submenu

None of these options are available for **FLT** or from the FLIGHT submenu.

Menu Option	*Key Command Suffix*	*Action*
BRACKET RIGHT	**BRACKET_RIGHT**	Pull to the right (while you pull to the left) of the group of enemy fighters currently targeted. If an element or division leader does not have a target, he will ask the aircraft under his control for a target. If no one under his control has a target, he will try and determine which target you wish him to bracket. If he cannot, he will radio this to you, and continue normal flight. (See diagram.)
BRACKET LEFT	**BRACKET_LEFT**	Pull to the left (while you pull to the right) of the group of enemy fighters currently targeted. Targets are chosen as described above.

Menu Option	*Key Command Suffix*	*Action*
SPLIT HIGH	**SPLIT_HIGH**	Climb above (while you dive below) the group of enemy fighters currently targeted. Targets are chosen as described for **BRACKET RIGHT.** (See diagram.)
SPLIT LOW	**SPLIT_LOW**	Dive below (while you climb above) the group of enemy fighters currently targeted. Targets are chosen as described for **BRACKET RIGHT**.
DRAW RIGHT	**DRAG_RIGHT**	Lead your target away to the right of you so you can get a better shot at him. Targets are chosen as described above. (See diagram.)
DRAW LEFT	**DRAG_LEFT**	Lead your target away to the left of you so you can get a better shot at him. Targets are chosen as described above.



Ground Attack Submenu

Menu Option	*Key Command Suffix*	*Action*
ATTACK PRIMARY GROUND TARGET	**ATK_PRIMARY**	Attack the primary mission objective (usually a ground target) as defined in the mission briefing.
ATTACK SECONDARY GROUND TARGET	**ATK_SECONDARY**	Attack the secondary mission objective (usually a ground target) as defined in the mission brieing.
ATTACK GROUND TARGETS OF OPPORTUNITY	**ATK_ANY _RND**	Attack whatever ground targets they find.

Wingman-Specific Commands

In addition to the general commands listed above, the following commands will help you work more closely with your wingman in a dogfight.

Menu Option	*Key Command*	*Action*
TACTICAL		Calls up TACTICAL submenu. (See below)
ATTACK MY TARGET	**WN_ATK_MY_TARGET** Ctrl A	Engage your designated air or ground target. If you don't have a target designated, he'll continue normal flight.
HELP ME	**WN_HELP** Ctrl H	Drop what he's doing and come to your aid *unless* he's in hot water himself, in which case he'll tell you you're on your own.

Tactical Submenu

Menu Option	*Key Command*	*Action*
BREAK RIGHT	**WN_BREAK RIGHT**	Turn hard right.
BREAK LEFT	**WN_BREAK_LEFT**	Turn hard left.
BREAK HIGH	**WN_BREAK_HIGH**	Turn hard up (vertical turn).
BREAK LOW	**WN_BREAK_LOW**	Turn hard down (vertical turn).

Flight-Specific Commands

In addition to the general commands listed above, there are several formation commands and information requests that you can only issue to the flight as a whole.

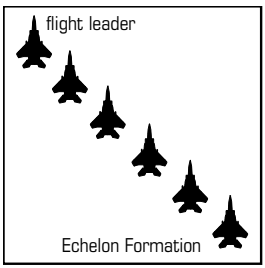
Menu Option	*Key Command*	*Action*
RADAR ON/OFF	**FLT_RADAR_TOGGLE**	Enable/disable radar emission. Note that an aircraft will not disable its radar if it is tracking a target.
MUSIC ON/OFF	**FLT_JAMMER_TOGGLE**	Enable/disable jammer emission.
REPORT CONTACTS		List off all contacts they see, without attempting to sort (see below).
SORT BANDITS	**FLT_SORT_BANDITS**	List off their targets. They will attempt to describe the targets in a way that will help you determine which blips on your radar screen they are referring to, using cardinal directions relative to your aircraft and lead, trail and middle 1, 2, 3, etc. to describe relative range within a group of fighters. If the situation is confusing, they'll list the type of aircraft they are targeting — Striker, CAP, etc.
STATUS (SUBMENU)	**FLT_STATUS** Ctrl A	Call up the STATUS submenu. (See below.)
CHANGE FORMATION		Call up the CHANGE FORMATION submenu. (See below.)

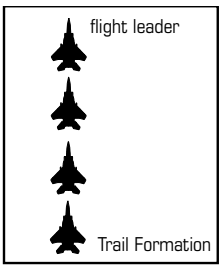
Status Submenu

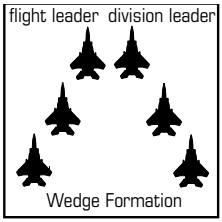
Menu Option	*Key Command*	*Action*
FLIGHT SYSTEMS CHECK	**FLT_STATUS** Ctrl S	Radio in just their flight numbers (if undamaged) or their flight numbers and amount of damage they've taken.
FLIGHT WEAPONS CHECK	**FLT_WEAPON_CHK** Ctrl W	List off their air-to-air ordnance.

Change Formation Submenu

Menu Option	*Key Command*	*Action*
LOOSEN CURRENT FORMATION	**FLT_LOOSEN_FORMATION**	Move further apart in formation — doubling the current spacing.
TIGHTEN CURRENT FORMATION	**FLT_TIGHTEN_FORMATION**	Move closer together in formation — halving the current spacing.
WEDGE FORMATION	**FLT_WEDGE_FORMATION**	Form a wedge formation. (See diagram.)
LINE ABREAST FORMATION	**FLT_LINE_FORMATION**	Form a line formation. (See diagram.)
ECHELON FORMATION	**FLT_ECHELON_FORMATION**	Form an echelon formation. (See diagram.)
TRAIL FORMATION	**FLT_TRAIL_FORMATION**	Form a trail formation. (See diagram.)







TAKING CARE OF BUSINESS

This is the point at which you actually achieve the job you were sent out to accomplish — your Time Over Target (TOT). In some ways, the computer cues for dropped guided and unguided weapons are so extensive, and the smart bombs so smart, that it may seem like getting the whole package to the target is the hardest part of a mission. Still, your altitude, airspeed and flight attitude at the time of an air-to-ground drop affect the weapon's trajectory, and coordinating these while dodging AAA, SAMs and perhaps a few defensive aircraft is no mean feat.

SWITCHING TO A/G MASTER MODE

A/G master mode configures all of your cockpit systems for air-to-ground targeting and engagement. As you near your target area (perhaps when you reach the *initial point* just before the target point), you'll want to switch to this mode.

Press the **MASTER_MODE_CYCLE** [M] key to cycle through master modes ***or*** press the **MASTER_MODE_AG** key *or* click on the A/G button beneath the UFC to select A/G master mode.

See **Cockpit: Master Modes**, p. 2.3.

The A/G Radar page, A/G Arm page and the TSD page come up automatically in the pilot's MPDs. For information on changing these default settings and set defaults for the WSO MPDs, see **Cockpit: 6. Master Mode Programming**, p. 2.37.

FINDING AND DESIGNATING TARGETS

Air-to-ground target designation differs from air-to-air target designation in one crucial way — when you designate an air target, you make the ***object*** you intend to hit with your weapons your target; when you designate a ground target, you make the ***point on the ground*** you intend to hit with your weapons your target. For stationary targets like structures and relatively stationary targets like radar installations, finding the target involves finding the general target area and scanning an HRM of this area to locate the structures. For Ground Moving Targets (GMTs), finding your target involves scanning the general target area in GMT radar mode and cueing the targeting IR to an area of movement.

ORIENTING YOURSELF WITH THE TSD

The Tactical Situation Display (TSD) page displays a digitized satellite map of the area of operation. Superimposed on this map are steer point and flight path symbology. You can focus on your current position, or "look ahead" to other upcoming steer points. It provides mostly navigation and terrain information — even at its highest resolution (10nm) it cannot show individual structures. However it can give you a top-down reference indication of where in relation to your mission route you are currently scanning with radar, creating an HRM or aiming the Targeting IR camera.

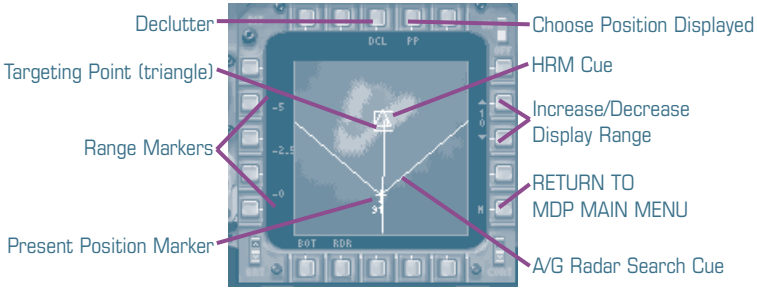
Your route is marked by a series of lines connecting sequence points. *Sequence point* is a term used to describe F-15E navigation symbols. Sequence points can be:

- *Steer points* Ordinary navigational waypoints along your mission route, represented by small circles.
- *Initial points* Steer points just prior to a target point, represented by squares.
- *Target points* Steer points where you are intended to deliver weapons, represented by triangles.

You can cycle forward and backward through TSD display ranges with PBs 13 and 14. Available ranges are 10, 20, 40 and 80nm — the currently selected range appears between the buttons.

To see where your sensors are currently looking, press PB 7 to choose the A/G radar (RDR) or targeting IR camera (FLIR). The selected option appears above the button, and the corresponding cue for this sensor will appear on the display. If you choose the RDR cue, and the A/G radar is in HRM mode, a polygon appears on the TSD, indicating the area displayed in the map. This polygon is connected to the aircraft present position marker by a line indicating the radar LOS. In any mode other than HRM, a "V" appears on the TSD, indicating the area currently being scanned by the A/G radar. If you choose the FLIR cue, an arrowhead indicates where the targeting IR camera is aimed. Again, the line extending from the arrowhead to the present position marker indicates the sensor's LOS to the scan area.

For additional information on TSD functions and symbology, see **Cockpit: 5. Tactical Situation Display (TSD) Page**, p. 2.34.



TARGETING STATIONARY GROUND TARGETS

Once you are within radar range of the target area, you will use the A/G radar in Real Beam Map (RBM) mode to scan the area and pinpoint a location you want to view in greater detail with a High Resolution Map (HRM). RBM mode is far too low-res for targeting — you could be off hundreds of feet, which, depending on the size of your target and munition, could result in your missing it entirely.

Make a Radar Scan of the Area in RBM Mode

For more information on the symbology used on the radar display, see **Cockpit: 14. Air-to-Ground Radar (A/G RDR) Page**, p. 2.45.

RBM mode displays radar returns bounced off terrain features in an arc in front of your aircraft (your aircraft is at the bottom center of the display). It updates with a sweep of 90° per second and has a minimum range of 4.7nm and a maximum range of 80nm (actual ranges are dependent on LOS).

To put the radar in RBM mode, click PB 6 (RBM/HRM/GMT/IGMT) of the A/G Radar page until RBM appears above it.

Setting A/G Radar Scan Limits

PB 9 Cycle through **azimuth scan angles** — FULL (50°, or 25° to either side of your aircraft's nose), HALF (25°) or QTR (12.5°). Lowering the arc size decreases the amount of time it takes the radar to scan, but limits the scan area.

PB 13/14 Cycle through **radar ranges** — 4.7, 10, 20, 40 and 80nm. The currently selected range is displayed between the two buttons.

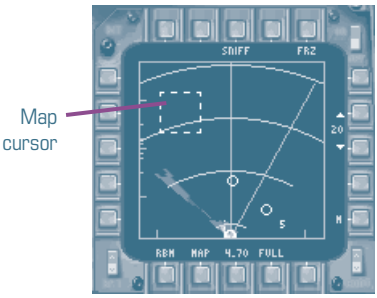
Freezing the Radar Display

Selecting FREEZE stops all data collection and RF transmission, saving the current state of the scan on the display. This can be useful when you are trying to accurately place the map cursor. Exact coordinates for the cursor position (azimuth and range from the aircraft) are given in the upper left corner (these do not freeze when the radar is frozen).

To freeze the radar display, press PB 19 (FREEZE). This option is boxed when the radar is frozen; click PB 19 again to unfreeze the radar.

Create an HRM

High-Resolution Maps (HRMs), or "patch maps," are static, high-detail, top-down Synthetic Aperture Radar (SAR) images. They are used to view an area in greater detail for targeting. Each HRM requires about 4-10 seconds to create.



To create a map:

1. Press PB 7 on the A/G Radar page to change the cursor function to MAP. (MAP appears above the button.)

2. Select the HRM display window (DW) size using PB 8. Available sizes are .67, 1.3, 3.3, 4.7, 10, 20 and 40nm; the current DW size is displayed above the button.

   This option controls how far an HRM map is zoomed in when one is commanded — when it is set to 1.33 for example, the HRM will be 1.33 x 1.33 nautical miles. (It does ***not*** affect the range of an HRM that is already visible on screen.)

3. Position the mouse cursor over the radar display. The exact azimuth and range of the cursor with respect to your aircraft is displayed in the upper left corner of the A/G Radar page.

   An error message will appear at the bottom of the display if the cursor is not within mappable limits. **See Cockpit: A/G Radar Messages**, p. 2.49, for details on what these messages mean.

4. Left-click to command a map. A timer in the lower left corner counts down until the map is ready. When the timer reaches zero, the patch map you've created replaces the RBM display.

HRM Limits

Azimuth limits. Ideally, you should make patch maps in the area between 30° and 50° to the left and right of the nose. This are the HRM "sweet spots" — due to the nature of the Synthetic Aperture Radar, maps can be constructed more quickly and more accurately in these zones. You cannot make a map within 8° to the left or right of the nose (the HRM "blind zone") or more than 60° to the left or right of the nose (outside the radar's gimbal limits).

Altitude vs. range. Mapping from the ideal altitude for the range (to the area being mapped) produces an image of greatest quality. Fly too low and you could limit the air-to-ground radar's range. Fly too high and you could lose detail. The table below lists the maximum range of the radar (**Max R**, in nautical miles) at different altitudes above ground level (**Alt AGL**, in feet) over flat terrain. Note that these ranges are LOS-dependent — if the terrain is mountainous, you may have to climb significantly to afford the radar the same range.

Alt AGL	Max R	Alt AGL	Max R
50 ft	8.1nm	400	22.9
100	11.4	500	25.6
200	16.2	1000	36.2
300	19.8		

DW size vs. range. The display window size you have chosen for the HRM also limits the range at which you can map an area. Generally speaking, the smaller the DW size, the shorter the range at which the map must be commanded. If you attempt to create a map outside the range possible given the DW size setting, a "DW SIZE LIMIT" message will appear at the bottom of the radar display.

The table on the next page lists the **max** and **min cursor ranges** for different HRM display window sizes (**DW sizes**, in nautical miles). These are the maximum and minimum distances (in nm) where you can place a cursor on the display to command a map. (For example, if the radar range is set to 20nm, a cursor at 10nm of range would be in the middle of the display.) **Resolution** is the minimum size (in feet) an object must be to appear on the map. A resolution of 17ft, for example, indicates that objects under 17ft cannot be seen on this map.

DW size	Min cursor range	Max cursor range	Resolution	DW size	Min cursor range	Max cursor range	Resolution
.67	2.7	20	8.5	10	6	80	127
1.3	2.7	40	17	20	12	80	253
3.3	2.7	50	42	40	24	80	507
4.7	2.8	80	59				

Designate the Target

Once you have located your target, you can designate it using the radar or the HUD.

Using the Radar

It may take several HRMs to get a good picture of your target — you may have to climb, fly closer to the target and/or change your heading somewhat to get an image with a high enough resolution to find a specific structure or other target. Once you've found it, however, you can click on it to designate it.

1. Press PB 7 on the A/G Radar page to change the cursor function to target (TGT). (TGT appears above the button.)
2. Position the mouse cursor over the radar display. The exact azimuth and range of the cursor with respect to your aircraft is displayed in the upper left corner of the A/G Radar page.
3. Click on a point to designate it as your target point. Note that you are designating a point on the ground and *not* an object. When designating ground targets, you are simply giving the computer the coordinates of the point where you want to deliver weapons.

   A triangle appears over the point you have designated. It will show up on the A/G Radar page and the Targeting IR page, whenever range and LOS allow. A diamond marks the same target point on the HUD.

Using the HUD

If you can see the structure or area you wish to designate through your HUD, you can designate it by placing the cursor over the HUD and clicking.

1. Position the mouse cursor over the HUD.
2. Click on a point to designate it as your target point. Again, note that you are designating a point on the ground and *not* an object. When designating ground targets, you are simply giving the computer the coordinates of the point where you want to deliver weapons.

   A diamond appears on the HUD over the point you have designated. A triangle marks the same point on the A/G Radar page and the Targeting IR page.

TARGETING GROUND MOVING TARGETS (GMTS)

Finding moving ground targets is a bit trickier than finding stationary objects. The reason isn't simply because they are moving, for their speed in relation to yours is very small. Rather it is the relatively small size of mobile SAMs, tanks and trucks combined with their motion that renders them impossible to pick up on even the highest-rez HRM. Instead the A/G radar has two special modes — GMT and IGMT — designed to pick up motion. You can then cue the targeting IR camera to the source of this motion and examine it.

Make a Radar Scan of the Area in GMT or IGMT mode

In Ground Moving Target (GMT) and Interleaved GMT modes, the A/G radar is capable of detecting targets moving on the ground (e.g., trucks and Scuds). GMT mode has no map background; IGMT places the GMT information on the RBM map terrain. Even in GMT and IGMT modes, however, the radar isn't finding an actual object, so much as a geographical area where movement is occurring. Note too that finding and engaging ground moving targets (GMTs) is relatively close-range work — regardless of the current radar range, GMTs can only be detected up to 32nm away. Areas where motion is detected are marked by crosses on the display.

Click PB 6 on the A/G Radar page to cycle through radar modes until GMT or IGMT is boxed.

Make a Preliminary Target Designation

The radar can only indicate where it detects movement — the position of the moving object could be off by hundreds of feet, and no information on the type or size of the object can be determined. The targeting IR camera allows you to get a better look at a GMT and the area surrounding it. To cue the IR targeting camera to a GMT, you must first designate it as your target.

1. Press PB 7 on the A/G Radar page to change the cursor function to target (TGT). (TGT appears above the button.)
2. Position the mouse cursor over over a GMT on the radar display.
3. Click to designate this area as your target point. (Note that you are designating a point on the ground and ***not*** the object.) A triangle appears on the radar display over the point you have designated. This triangle will also appear on the targeting IR page, marking the same point. If LOS allows, a diamond will mark the target point on the HUD.

View Area with Targeting IR Camera

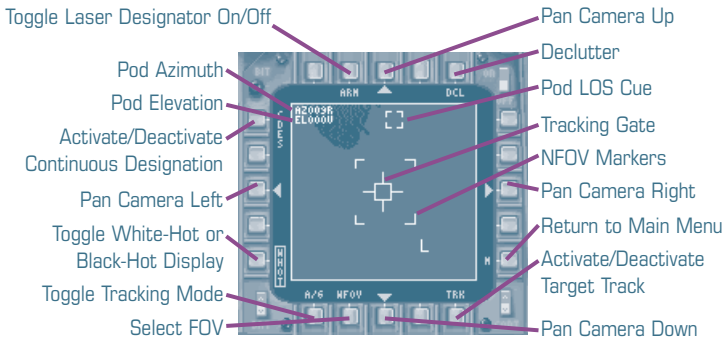
The IR targeting camera automatically cues toward your currently designated A/G target. You can then call up the Targeting IR page and pan the camera to look around.

1. From the MPD main menu, press PB 12 to call up the targeting IR camera.
2. Pan the camera to get a better look, if necessary; using the arrow pushbuttons (PBs 3, 8, 13 and 18) on the Targeting IR page. PB 12 re-centers the camera on the boresight (its unpanned position, aimed forward and aligned with the waterline on your HUD). Zoom the camera in and out using PB 7.

See **Cockpit: Targeting IR Pushbuttons**, p. 2.38.

Designate the Target

Once you're certain you've found your target, you can use the targeting IR camera to designate it.



1. Center your target in the tracking gate using the pushbuttons described above.
2. Enable target track (TRK) by pressing PB 10 on the Targeting IR page. (When enabled, TRK is surrounded by a box.) The camera will begin tracking the area or object in the center of the tracking box. (Note again that the camera tracks the target point you've designated, *not* the movement of the target.)
3. Activate continuous designation (CDES) by pressing PB 1. When active (CDES is surrounded by a box), the current object or area being tracked by the targeting IR camera (TRK is boxed — see PB 10, below) will be designated as the current A/G target.

For more information on the targeting IR camera, see **Cockpit: 12. Targeting IR Camera**, p. 4.58.

SELECTING WEAPONS AND BOMB MODES

Unlike air-to-air weapons, which are fired according to a predetermined launch sequence, you must set up the type and quantity of and intervals at which ground ordnance is released. You will need to take into consideration the size and number of your targets, how close together they are, how durable they are and what types of weapons you are using when determining the quantity and intervals for release. For each run you will:

- Select the stations to release ordnance.
- Choose how the weapons will be released.
- Set the number to be released and intervals at which they are released (ripple releases only).
- Set the height of burst (HOB — for CBUs only).
- Choose a bomb mode.

Most of the actions described below will be performed using the A/G Arm page. For more additional information on the symbology and pushbutton features of this page, see **3. Air-to-Ground Armament (A/G ARM) Page**, p. 2.28.

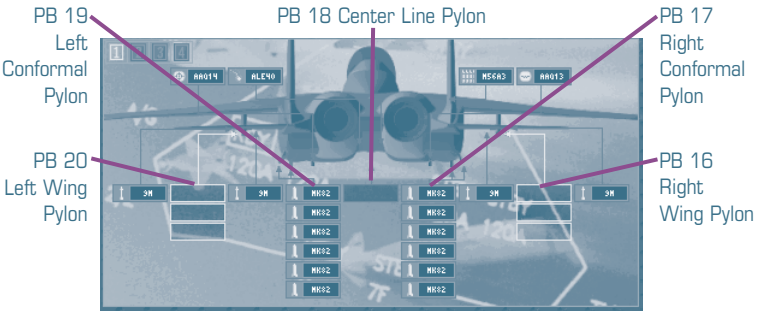
SELECT STATION(S)

1. From the MPD main menu, press PB 3 (A/G ARM) to call up the A/G Arm page.

   Pushbuttons 16-20 of this menu select and deselect air-to-ground weapon stations:

PB 16	Right wing pylon	*PB 19*	Left conformal pylons
PB 17	Right conformal pylons	*PB 20*	Left wing pylon
PB 18	Centerline pylon		

   Below each the quantity and designation weapons carried on that station are listed.



2. Press the PB for each station from which you wish to drop weapons. Multiple stations can be selected, but only if they are carrying weapons with the same designation (i.e., GBU-10, BLU-49, etc.). A box appears around the weapon designation when a station is selected. Press the button again to deselect this option.

CHOOSE A WEAPON RELEASE OPTION

Weapons can be released from the stations you have chosen in one of three different ways:

- **One weapon released per station (1/STA).** With each pickle (i.e., each time you press the **WEAPON_PICKLE** key or button), one weapon is dropped from each selected station. If two stations are selected, two bombs drop. If three stations are selected, three bombs drop.
- **Ripple single weapon (RP SGL).** With each pickle, the total quantity of weapons you have specified will be dropped one at a time at the interval you've set.
- **Ripple multiple weapons (RP MPL).** With each pickle, one weapon is dropped from each selected station at the interval you've specified until the total quantity of weapons you've specified has been dropped. In other words, if you have 2 stations (containing 4 weapons each) selected, and you've specified 8 weapons to be dropped, then once you press the pickle key, weapons will be released two at a time until all eight are released.

To choose an option, press its pushbutton on the A/G Arm page — PB 6 (1/STA), PB 7 (RP SGL) or PB 8 (RP MPL). Only one option can be selected at a time — the selected option is boxed on the display.

SET THE QUANTITY OF WEAPONS RELEASED

You must specify the *total* quantity of weapons released per pickle command when either RP SGL or RP MPL weapon release option is active. This quantity can range from 1 to 29, but the actual quantity dropped is limited by the number of weapons loaded on the selected stations. The current quantity setting appears between PBs 3 and 4 on the A/G Arm page.

PB 3 Controls the tens digit

PB4 Controls the ones digit

If 1/STA (one weapon per station) is your currently selected release option, this setting will have no effect on the total quantity of weapons released. Total quantity is instead determined by the number of stations you have selected.

SET THE INTERVAL BETWEEN RELEASES

You must specify an interval for weapon release when either the RP SGL or RP MPL is active. Intervals are determined in terms of feet of weapon range and can range from 0 to 990ft — an interval of 200 would mean a weapon was dropped every 200ft. The current interval setting appears between PBs 12 and 13 on the A/G Arm page.

PB 12 Controls the hundreds digit
PB 13 Controls the tens digit

If 1/STA (one weapon per station) is your currently selected release option, this setting will have no effect on the weapon release interval. All weapons are released at once.

SET THE CBU HEIGHT OF BURST

Cluster Bomb Units (CBUs) have different radii of effect, depending on the size and type and the height above the ground at which they explode. You determine the size and type when you choose which CBUs to release. You can set the height of burst on the A/G Arm page.

PB 14 Set height of burst (HOB) — cycle through 300, 600, 1000, 1500 and 2000ft above ground level. The higher the CBU explodes, the larger the area it will damage, but the less intense the damage.

SELECT A BOMB MODE

Bomb modes control what symbology is displayed on the HUD to guide the pilot through weapon release, and how much of the release procedure is controlled by the computer. PB 5 of the A/G Arm page cycles through these modes.

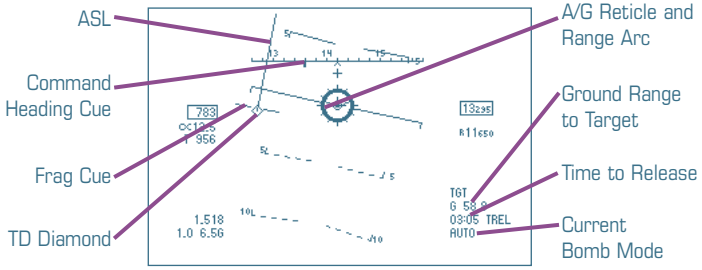
- **Continuously Displayed Impact Point (CDIP)** mode is perhaps most effective when combined with a dive or pop-up delivery. The point where the weapon will impact on the ground is continually re-calculated and projected onto the HUD, and a dive delivery (in which your aircraft is nose-down) or pop-up delivery (in which your aircraft is inverted) helps ensure that this impact point is visible on the HUD until the weapon is released. (In a level or loft delivery, the impact point can drop below the HUD FOV.)
- AUTO mode can be used with any type of delivery or weapon. The HUD provides you with azimuth steering information to help you align with the target, calculates when the weapon should be released and gives you a countdown. If you are pickling (i.e., pressing and holding the WEAPON PICKLE key or button before the countdown reaches zero, the weapon(s) are automatically released.
- AUTO LOFT mode is the same as AUTO mode, except it assumes you want a loft trajectory for the weapon released.

ENGAGING

UNGUIDED WEAPONS

AUTO Bombing Mode

AUTO bombing can be used with level, loft or dive deliveries. The HUD provides you with azimuth steering information, a target designator and information on when to expect the computer release of the bombs.



1. Designate a target, using one of the methods described under **Finding and Designating a Target**, pp. 4.51.
2. Make sure a weapon station is selected, and that the release option, quantity, interval and height of burst are set to your satisfaction. **See Selecting Weapons and Bomb Modes**, p. 4.59.
3. From the A/G Arm page, press PB 5 until AUTO appears next to the button. Steering symbology will appear on your HUD.
4. Steer toward the command heading cue to align yourself with the target. Center the Azimuth Steering Line (ASL) over the A/G reticle to fine-tune the alignment. When your steering error is less than 20° (i.e. your nose is positioned no more than 20° to the right or left of your target's azimuth position), time-to-release (TREL) is displayed at the bottom right of the HUD.
5. When TREL is at 10 seconds, a release cue appears on the ASL. It will move down to intersect the flight path indicator as TREL goes to zero. Press the **WEAPON_PICKLE** key or button *before* TREL reaches zero, and hold it down until TREL reaches zero.
6. When TREL reaches zero, the weapon is dropped. If multiple weapons have been selected for release, the release cue will reposition itself automatically and the process will begin again. Continue to hold down the pickle and center the ASL until all selected weapons have been released — the release cue will disappear, and the A/G reticle will begin to flash at this point.

If your steering error is greater than 20°, TREL and the release cue disappear from the screen. Re-align the ASL over the A/G reticle to bring them back. For more information on symbology, see **Cockpit:** AUTO **and** AUTO LOFT **Bomb Modes**, pp. 4.62-4.63.

AUTO LOFT Bombing Mode

AUTO LOFT is similar to AUTO bombing mode, except it assumes a loft trajectory for the weapon and provides steering symobology to help you achieve it. A loft trajectory gives the weapon a greater range.

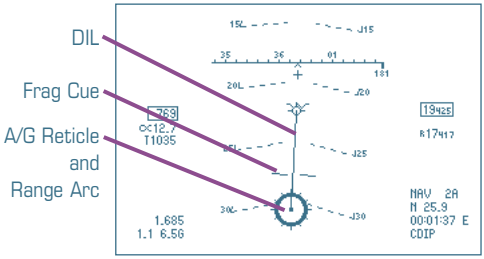
1. Designate a target, using one of the methods described under **Finding and Designating a Target**, pp. 4.51.
2. Make sure a weapon station is selected, and that the release option, quantity, interval and height of burst are set to your satisfaction. **See Selecting Weapons and Bomb Modes**, p. 4.59.
3. From the A/G Arm page, press PB 5 until AUTO LOFT appears next to the button. Steering symbology will appear on your HUD.
4. a) Steer toward the command heading cue to align yourself with the target. Center the Azimuth Steering Line (ASL) over the A/G reticle to fine-tune the alignment. Time-to-release (TREL) and time-to-pull (TPULL) are displayed at the bottom right of the HUD when the target is within weapon range. TPULL counts down the time you have left before you need to pull up to give the weapon its loft profile.

   b) The Elevation Steering Line (ESL, a horizontal bar) will appear five seconds before TPULL expires. Pull up until the ESL is centered over the A/G reticle.
5. Meanwhile, when TREL reaches 10 seconds, a release cue appears on the ASL. It will move down to intersect the flight path indicator as TREL goes to zero. Press the **WEAPON_PICKLE** key or button before TREL reaches zero, and hold it down until TREL reaches zero.
6. When TREL reaches zero, the weapon is dropped. If multiple weapons have been selected for release, the release cue will reposition itself automatically and the process will begin again. Continue to hold down the pickle and center the ASL and ESL until all selected weapons have been released — the release cue will disappear, and the A/G reticle will begin to flash at this point.

If your steering error is greater than 20°, TREL (or TPULL) and the release cue disappear from the screen. Re-align the ASL over the A/G reticle to bring them back. For more information on symbology, see **Cockpit:** AUTO **and** AUTO LOFT **Bomb Modes**, pp. 4.62-4.63.

CDIP Bombing Mode

CDIP bombing mode works best with a dive or pop-up delivery — the computer projects the impact point of the selected weapon onto your HUD, and this point often outside the HUD FOV (i.e., not visible on the HUD) unless you are nose-down or inverted.



1. *Optional:* Designate a target, using one of the methods described under **Finding and Designating a Target**, pp. 4.51. You do not have to have a target designated to use CDIP mode, but it is easier to align your run if you do.

2. Make sure a weapon station is selected, and that the release option, quantity, interval and height of burst are set to your satisfaction. **See Selecting Weapons and Bomb Modes**, p. 4.59.

3. From the A/G Arm page, press PB 5 until CDIP appears next to the button. Steering symbology will appear on your HUD.

4. In CDIP mode, the A/G reticle respresents the point where your weapon(s) will impact. Steer so that the A/G reticle is aligned along the azimuth with the TD diamond (if you have a designated target) or visual target, yet below it.

5. When the A/G reticle is directly over your target, press and hold the **WEAPON_PICKLE** key or button. The computer designates the point where the A/G reticle was at the time of pickle as your A/G target, then shifts to AUTO bombing mode to begin releasing weapons so they will strike this target.

6. *Continue to hold the pickle down* and center the ASL through each weapon release until all weapons are released — the A/G reticle will flash to signal you. If you let up on the pickle, the computer will revert to CDIP mode and the next press of the pickle button will designate a new target point.

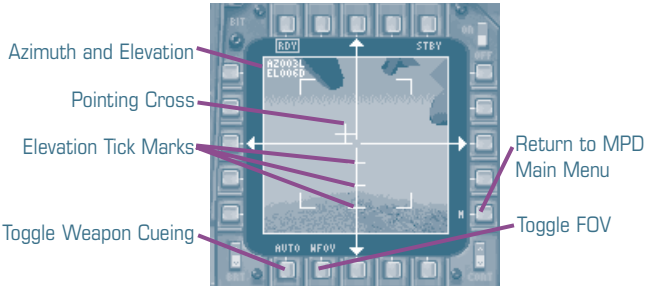
The frag cue represents the edge of predicted frag envelope for the currently selected weapon. To avoid the frag envelope, make sure your exit maneuver brings this frag cue **below** the flight path indicator before the weapon **detonates.**

GUIDED WEAPONS

AGM-65 MAVERICK

The AGM-65D/G has an imaging IR seeker head capable of automatically attempting to lock on to your currently designated target. You can also aim it manually before launch via a video display in the Weapon Video page. Needless to say, having the seeker cue automatically is much less of a hassle for you. Occasionally, however, the seeker for some reason won't be able gain a lock or you might decide to fire a Maverick without designating a target.

The Maverick is an air-to-ground missile. Once you have a lock, you simply fire the missile. You will not need or see any bombing mode symbology.



To aim an AGM-65 automatically:

1. Designate a target, using one of the methods described under **Finding and Designating a Target**, pp. 4.51.
2. Make sure an AGM-65 weapon station is selected. Only one AGM-65 can be released at a time. See **Selecting Weapons and Bomb Modes**, p. 4.59.
3. From the MPD main menu, press PB 19 to call up the Weapon Video page, and press PB 6 on this page until AUTO appears next to the button. The seeker head attempts to lock onto the target — when the targeting cross hairs are centered over the target, you have a lock.
4. Press and hold down the **WEAPON_PICKLE** key or button to launch the Maverick.

To aim an AGM-65 manually:

1. *Optional:* Designate a target, using one of the methods described under **Finding and Designating a Target**, pp. 4.51.
2. Make sure an AGM-65 weapon station is selected. Only one AGM-65 can be released at a time. See **Selecting Weapons and Bomb Modes**, p. 4.59.

3. a) From the MPD main menu, press PB 19 to call up the Weapon Video page, and press PB 6 on this page until MAN appears next to the button.

   b) Slew the targeting cross hairs to center them over your target, using PBs 3, 8, 13 and 18. (PB 7 Toggles between wide and narrow FOVs and may help you zero in on your target.)

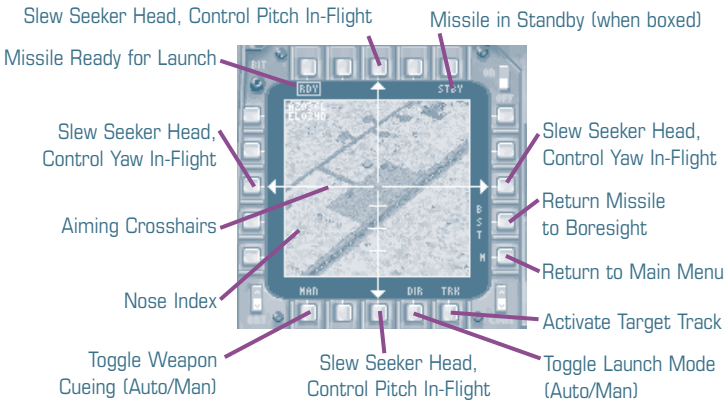
   c) When you have the cross hairs over your target, press PB 10 (TRK) to signal the missile to begin tracking this target.

4. Press and hold down the **WEAPON_PICKLE** key or button to launch the Maverick.

For more information on the symbology and pushbuttons used on this page, see **Weapon Video: AGM-65**, p. 2.59.

GBU-15

The GBU-15 has two launch modes — direct and indirect. In direct (Lock on Before Launch, or LOBL) launch mode, you simply designate your target, aim the seeker head toward it, gain a lock and release — the seeker head can be manually or automatically aimed to target. In indirect (Lock on After Launch or LOAL) launch mode, you can also steer the weapon after it is released using the video information displayed in the MPD. You must have an AN/AXQ-14 datalink pod mounted on your aircraft to do this — this feeds the steering information to the GBU-15.



To release a GBU-15 in direct mode with automatic weapon cueing:

1. Designate a target, using one of the methods described under **Finding and Designating a Target**, pp. 4.51.

2. Make sure a GBU-15 weapon station is selected — only one GBU-15 can be released at a time. Select a bombing mode — the GBU-15 was designed to be released from standoff range, so AUTO LOFT is the preferred bombing mode. See **Selecting Weapons and Bomb Modes**, p. 4.59.

3. a) From the MPD main menu, press PB 19 to call up the Weapon Video page. Press PB 9 on this page until DIR (direct launch mode) appears next to the button.

   b) Press PB 6 on this page until AUTO appears next to the button. The seeker head attempts to lock onto the target — when the targeting cross hairs are centered over the target, you have a lock.

4-6. Continue with steps 4 through 6 as described under **AUTO Bombing Mode** (p. 4.62), **AUTO LOFT Bombing Mode** (p. 4.63) or **CDIP Bombing Mode** (p. 4.64), according to which bombing mode you are in. (AUTO LOFT is the preferred mode for the GBU-15.)

To release a GBU-15 in direct mode with manual weapon cueing:

1-2. As above.

3. a) From the MPD main menu, press PB 19 to call up the Weapon Video page. Press PB 9 on this page until DIR (direct launch mode) appears next to the button.

   b) Press PB 6 on this page until MAN appears next to the button.

   c) Slew the targeting cross hairs to center them over your target, using PBs 3, 8, 13 and 18. (PB 7 toggles between wide and narrow FOVs and may help you zero in on your target.)

   d) When you have the cross hairs over your target, press PB 10 (TRK) to signal the missile to begin tracking this target.

4-6. Continue with steps 4 through 6 as described under **AUTO Bombing Mode** (p. 4.62), **AUTO LOFT Bombing Mode** (p. 4.63) or **CDIP Bombing Mode** (p. 4.64), according to which bombing mode you are in. (AUTO LOFT is the preferred mode for the GBU-15.)

To release a GBU-15 in indirect mode:

For indirect launch mode to be available, you must have an AXQ-14 D/L (datalink) pod loaded on your aircraft. See **AN/AXQ-14**, p. 4.6.

1-2. As on previous page.

3. a) From the MPD main menu, press PB 19 to call up the Weapon Video page. Press PB 9 on this page to select indirect (IND) launch mode.

   b) As soon as you select indirect launch mode, three launch profiles now become available. PB 7 cycles through them, and the currently selected mode appears above the button. The launch profile determines the amount of steering control you will have over the weapon after launch.

   NORM The weapon flies ballistically (i.e., with an unguided trajectory) for 1.75 seconds after release, then automatically enters a transitional (TRANS) profile.

   TRANS Transitional profile — you can control the weapon's yaw (heading), but not its pitch, after launch.

   TERM Terminal profile — you can control the weapon's pitch and yaw after launch.

   c) Slew the seeker head using PBs 3, 8, 13 and 18 until the aiming cross hairs are centered on the target.

   d) When you have the cross hairs over your target, press PB 10 (TRK) to signal the missile to begin tracking this target.

4-6. Continue with steps 4 through 6 as described under **AUTO Bombing Mode** (p. 4.62), **AUTO LOFT Bombing Mode** (p. 4.63) or **CDIP Bombing Mode** (p. 4.64), according to which bombing mode you are in. (AUTO LOFT is the preferred mode for the GBU-15.)

7. After launch, control the missile's yaw with PBs 3 and 13 (TRANS or TERM profiles). Control pitch with 8 and 18 (TERM profile only). Once the GBU-15 is locked onto a target, it will attempt to fly itself to that target.

For more information on the symbology and pushbuttons used on this page, see **Weapon Video: GBU-15**, p. 4.66.

PAVEWAYS

Paveways are laser-guided bombs. You release them as you would ordinary weapons, except that post-release and prior to impact you guide them to target using the laser-designator mounted in the targeting pod of the LANTIRN system.

AUTO bombing mode is the preferred mode for Paveways — in this mode, time-to-impact (TIMPACT) is displayed in the bottom right corner of the HUD (and mirrored on the bottom center of the Targeting IR page) after weapons are released. You will use TIMPACT to determine when to begin lasing your target.

1-6. Follow steps 1 through 6 as described under **AUTO Bombing Mode** (p. 4.62).

7. From the MPD main menu, press PB 12 to call up the Targeting IR page.

8. When TIMPACT is around 20 seconds or less, begin lasing the target. Click on PB 19 of the Targeting IR page to enable the laser designator — LASE appears next to the button when the laser is enabled. Keep an eye on this cue — if the word "MASK" appears, something is blocking the laser LOS and the target is no longer being designated. If the laser becomes masked, the Paveway will continue ballistically (i.e., in an unguided trajectory), and may or may not hit the target. If you are able to unmask the laser and re-lase the target, the missile may or may not be able to re-acquire the laser signal and re-orient to target.

M1A61 CANNON

The CDIP sight is used to aim the gun while in A/G master mode. When you press the **GUN_SELECT** [1] key to select your gun while in A/G master mode, this symbology appears on your HUD. Note that the gun is mainly a defensive weapon to be used against air threats. It is only effective against soft ground targets.

To engage a target:

1. Steer to position the A/G reticle over your target.

2. Wait until the target is within range — the range arc on the reticle marks your target's range in the same way as the range arc in CDIP bombing mode. Each tick mark on the reticle represents 1000ft of range — the range arc moves counter-clockwise as range decreases. When only half of the reticle is covered by the arc, the target is at the gun's maximum range of 6000ft. Minimum gun range is 0ft.

3. Press the gun trigger (joystick button 1) to fire.

GETTING OUT

The principle of getting out is the same as getting in — keep your aircraft intact. Now, however, you are not loaded down with air-to-ground ordnance and don't need to be so eager to avoid an air skirmish. This is a good thing, because those bombs you dropped gave everybody a really good idea where you are.

The only factors that might limit your desire to dogfight on egress are —

- You're out of A/A ordnance
- You're low on fuel
- You've taken significant damage already

In any of these cases, get strategic — check the systems status and air ordnance for the aircraft in your flight (press the **FLT_STATUS** Ctrl S and **FLT_WEAPON_CHK** Ctrl W keys, or press the **RADIO_1_TRANSMIT** Tab key to access the flight communications menu). Use your strongest and best-armed aircraft judiciously.

For a review of flight command hotkeys, see **Flight Commands**, p. 4.44.

If you are low on fuel, remember that flying at high altitudes conserves fuel, especially when flying at higher speeds. Flying at cruising speed at any altitude (Mach 0.8 or so) conserves fuel at any speed. See **Combat Fuel Flow**, p. D.1, for a chart of fuel flow at different altitudes and speeds.

COMBAT THEORY

The F-15E is called a Strike Eagle because it is primarily assigned "strike" — air to ground — missions. This means that for at least part of the mission, it is loaded down with ordnance, and should not be involved in any close-range fighting. The goal is to gain a good aspect angle (firing position) on your opponent while he is BVR (Beyond Visual Range). Once you have a positional advantage, you can fire missiles at the enemy from a prudent distance.

POSITIONAL GEOMETRY

Geometry plays a large role in air combat, even when you never achieve visual contact with your opponent. Positional geometry aids your missile in reaching its target, can keep you from entering a combat area prematurely, and can help get you out of a dangerous situation.

To develop a complete understanding of air combat, you need to know a few geometrical concepts: *angle-off*, *aspect angle*, *closure rate*, *turn rate/radius* and *corner speed*. All describe the differences in position, speed and flight path between your aircraft and an air target.

Aspect Angle

Aspect angle indicates which aspect of the target is facing you, and is measured in degrees. Think of it as a numerical way of expressing what part of the target you're looking at. With radar lock, the target aspect angle appears next to the altitude of the target.

A "9R" aspect angle means you are perpendicular to your target, facing its right wing. At "4R", you see the target's right wing as it crosses your flight path at a 40° angle. At "0" aspect angle, you are facing the aircraft's tail, and at 180°, you are facing its nose.

Closure Rate (V_C)

Closure describes your aircraft's speed relative to the speed of your target. The closure rate appears next to the Target Range caret. A positive closure means the target is approaching you; a negative closure means it is moving away. The larger the number, the faster the range is changing. A closure of -700 knots means the target is moving away from you very quickly while a closure of +70 knots means the distance is decreasing.

Closure also impacts weapon performance. At a high positive closure rate, the range to the target is rapidly decreasing. A missile doesn't have as far to fly, since the target reduces range by flying into the missile. If the closure rate is high and negative, the target is moving away and the missile must fly farther to overtake it.

Turn Rate/Radius

An aircraft's *turn rate* is the number of degrees it can pivot per second. An aircraft with a high turn rate can turn quickly. An aircraft's *turn radius*, is the distance it requires to turn. An aircraft with a low turn radius can turn sharply. Note that an aircraft can have a fast turn rate, but require a large turn radius, or vice versa.

PURSUIT CURVES

There are three types of pursuit — *lead*, *lag* and *pure*. While these are useful in close-range fighting, they can also be used to keep an appropriate distance from the enemy. Depending on the situation, you may find all three necessary.

Lead Pursuit

- To initiate lead pursuit, bank your aircraft so that your nose is headed for a point just ahead of your opponent's nose. (Keep in mind that tighter turns bleed off kinetic energy — continually turning will cause you to lose speed.

As its name implies, *lead pursuit* refers to predicting the flight path of a target. You guess where the threat will be in the immediate future, and then point your nose at that predicted position. By redirecting your flight path so that it crosses the target's flight path, you stand a better chance of striking the enemy with your weapons. Lead pursuit is the best position to be in for firing missiles; it doesn't have to adjust its course as much. Of course, the trick is to accurately predict where your opponent is going to go.

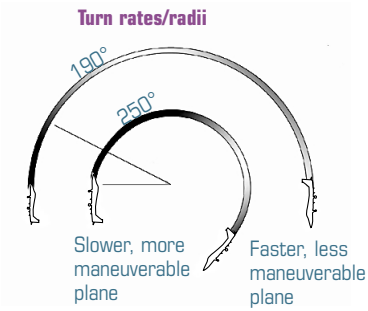
In an unencumbered F-15E, you are about mid-way down the charts regarding agility, i.e., you'll be able to out-turn about half the aircraft that are out there. If you're lucky enough to be in the aircraft with the smaller turn radius, lead pursuit tactics can give you a continuing advantage. By making sharper turns than your opponent, you cut across his flight path. This, in turn, reduces your target aspect angle, brings you closer to your opponent, and increases your closure rate. (If you're in a loaded Strike Eagle, you won't be able to out-turn anyone, and should avoid getting in a turning fight at all costs.)

Lag Pursuit

- To execute lag pursuit, pull back on the stick until the target aircraft is positioned just above the flight path indicator in your HUD. Then, ease up slightly on the stick to maintain the enemy's position in your HUD.

Lag pursuit is the exact opposite of lead pursuit. Instead of making a tight turn in the direction your opponent is headed, you use a "softer" turn with a larger radius to follow a point just behind the tail of the enemy aircraft. The potential advantages of lag pursuit are illustrated in the following example.

The diagram on the right compares the turn rates (measured in degrees per time allotted) of two aircraft. At the low speed needed for a 4G turn, the inner, more maneuverable aircraft obviously has a significant turn rate and turn radius advantage over the other aircraft.



Why shouldn't the outer pilot try to bring the inner aircraft into position with *lead* pursuit? If he does, he'll put a tremendous strain on his F-15, plus risk overshooting his opponent — thereby putting himself at risk. Additionally, his aircraft will rapidly bleed off speed as drag increases, wasting his initial velocity advantage. However, using *lag* pursuit would keep him from overshooting and conserve his energy (in the form of speed).

By using *lag pursuit*, the outer pilot is matching the other aircraft's turn rate. The end result is that you fly in a concentric circle *outside* the other plane's flight path, ending up directly on his tail.

Pure Pursuit

- Pure pursuit is a direct chase — simply point your aircraft directly at the target and follow its maneuvers as closely as possible.

Pure pursuit is most useful when firing weapons at close range, where you can place your sight directly over the target and fire. Don't overlook the danger of overrunning your opponent. In pure pursuit, if you pass by the enemy, you are the perfect position to be shot down: directly ahead of him.

SPEED VS. ALTITUDE

The energy elements of speed and altitude are the core components of aerial combat. Altitude is a measurement of the aircraft's potential energy, which can be converted to speed by diving. Speed is a measure of an aircraft's kinetic energy, which can be turned into altitude by climbing. Think of kinetic energy as energy in motion, and potential energy as energy in reserve.

At any given instant, an aircraft possesses both a certain amount of kinetic energy (speed) and a certain amount of potential energy (altitude). This energy translates directly into maneuverability. Air Combat Maneuvering, or ACM, is a game of managing energy to maximize maneuverability and defeat the enemy. Finding the balance between speed and altitude requires skill and timing.

Exchanging Energy

Potential and kinetic energy are exchangeable. An aircraft at high altitude and low speed has lots of potential energy, but little kinetic energy. By diving, the aircraft can convert its altitude into speed and increase its kinetic energy. Similarly, the aircraft can convert some kinetic energy back to potential energy by climbing. The aircraft slows down, but its altitude increases.

A cardinal rule of air combat is that an aircraft with energy has maneuvering options; an aircraft without energy becomes a target. Maneuvering uses energy, and every unnecessary maneuver you make "burns" kinetic energy. When it's gone, you can't easily get it back. "Low and Slow" is a deadly situation.

Because you want maximum maneuverability from your aircraft at all times, you must ration your energy use, always maintaining a sufficient supply for whatever maneuver you might execute. For example, don't go into a tight turn at a high speed if you can accomplish the same task with a slow turn. Before expending energy, determine whether what you get in return (such as a shot opportunity) is worth the loss of energy.

When you've got an enemy on your six that's about to fire at you, you need to extract every ounce of maneuverability possible from your airframe. And when you're out of energy, you have to get some back. You can do so by applying thrust, relaxing your turn radius or diving to gain airspeed. In some cases, you may even need to bleed off speed by climbing or pulling tight turns.

You can take one of two approaches when you find yourself in a combat situation — you can choose the energy fight or the turn fight. The F-15 is a workhorse much more adapted to an energy fight. Give real thought into who your opponent is before committing to a turning fight — and if you are carrying air-to-ground ordnance, don't even consider it.

CHOOSING YOUR ATTACK

Unarguably, the first few seconds of a fight are the most important and can often determine the outcome. Most dogfights last less than one minute, meaning that whoever gains the initial advantage usually wins. Every fight is different, and an aircraft designed for turn fighting may find itself better suited for an energy fight. How do you decide which to use?

First, estimate your turn performance versus your opponent's. Maintaining your corner speed (the optimal balance between turn rate and airspeed) means nothing if the bandit can out-maneuver your best turn.

Second, estimate your energy status. If you enter a fight 200 or 300 knots above your corner speed, don't waste all of that energy and decelerate to achieve your aircraft's corner speed. Instead, initiate an energy fight and make use of your power. A well-flown energy fight is difficult to beat.

Remember, it is easier to transition from an energy fight (high speed) to a turning fight (low speed) than the other way around.

The Energy Fight

In an energy fight, you take advantage of the F-15's superior speed and avoid unnecessary turning. Ideally, you want to start the fight in an advantageous position, such as directly behind the bandit in his 6 o'clock low blind spot. Most of the time, however, that's not an option. You must rely on your energy advantage and skills to overcome your adversary.

When you choose the energy fight, you basically concede turn performance to the enemy and rely instead on speed. With an F-15E that's a good choice, your speed is almost always going to be superior to your turning ability. You must keep your airspeed extremely high, minimizing the distance between you and your enemy's aircraft as you make a series of head-on attacks. The idea is to strike, then outrun your opponent's weapon range (not too difficult if the bandit has only guns or heat-seeking missiles). The Strike Eagle is a beautiful energy fighter, because it has powerful engines that can give it speed enough to attack and then get out of the range of most other aircraft.

While the bandit busily executes a high-G turn to enter the fight, you (as the energy fighter) zoom away in a spiraling dive or climb. Eventually, you can execute a wide turn (to conserve airspeed) and make another offensive pass.

If you execute the initial turn correctly, you'll remain outside your enemy's weapon envelope (range at which his weapons are effective) for nearly the entire fight. You choose when and where to engage, always bringing the fight on your terms. Thanks to your speed surplus, you can enter and exit the fight almost at will.

The energy fight requires discipline, though. One speed-bleeding turn, and you immediately lose your energy advantage.

The Turning Fight

The less optimal choice in combat is to enter a maneuvering fight and rely on your turn performance to win the day. Since the F-15E is less agile than it is fast, if you get caught in a turning fight it's usually the result of poor planning, being on the defensive, or misjudging your opponent.

The idea behind a turning fight is to reduce the amount of room in which the enemy can make a turn. You accomplish this during the merge (head-on pass) by minimizing lateral separation, or the horizontal distance that separates your aircraft from your enemy's.

The merge, or meeting the bandit head on, generally leads to one of two types of turning fights: one-circle or two-circle. You should choose a two-circle fight when you're flying a more maneuverable aircraft than your enemy. Use a one-circle fight if you have all-aspect missiles (or if you believe the enemy doesn't have them).

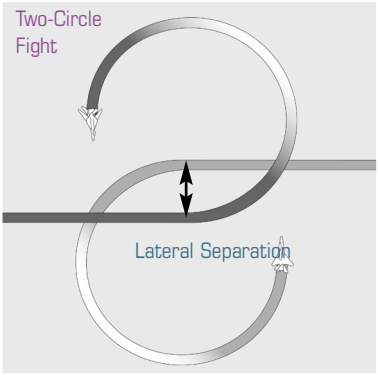
There are situations where a turning fight is could turn out well for an F-15, but usually only when your side outnumbers the enemy. It takes teamwork for an F-15E to make a turning fight work successfully against more nimble opponents.

APPROACH AN ENEMY HEAD-ON

Surprise is a decisive factor in successful air-to-air combat. The goal is to take out an intercept team before they've even spotted you, you save yourself a costly dogfight which you (usually an overloaded strike team) were likely to lose. Often however, you'll pick up a bandit closing in on you rapidly head-on at about the same time he's found you. You're in a race to get off a missile hit first, but if neither of you is successful on this crucial first pass, you're both going to have to loop around and try it again — or you take advantage of an opportunity to make a break for it. Remember, if you're on a strike mission your primary goal is delivering your air-to-ground ordnance to target. You want to avoid having to jettison this ordnance if at all possible.)

Sometimes, however, you'll find yourself in a turning fight regardless of your intention. In this case, take a moment to consider what aircraft you are pitted against. If it is your equal, or better, save yourself and jettison all your air-to-ground ordnance. You'll scrap the mission, but it's better than losing everything.

Two-Circle Fights



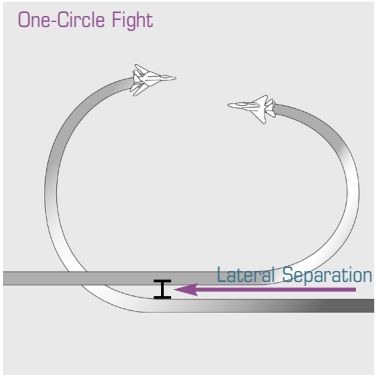
After you and your opponent pass each other (or *merge*), you both loop around in opposite directions, trying to get on each others' tail. The distance between your flight paths is turning room that both of you use. The turn radii of your aircraft overlap.

Two-circle fights rely more on turn rate than turn radius. You create only enough lateral separation at the merge point to allow for your full turn radius, and then rely on a superior turn rate to bring your nose back to bear on the threat. Two-circle fights keep your target in view at all times and tend to increase the lateral separation between the two aircraft.

In two-circle fights, always attempt to minimize lateral separation. If the enemy aircraft has substantially worse turn performance than you, don't give him any extra room to work with — keep lateral separation to the bare minimum you require for your turn.

Conversely, if the bandit has significantly better turn performance than your aircraft, deny him the chance to use it by closing in at maximum speed with as little lateral separation as possible.

One-Circle Fights



One-circle fights commence when you and your opponent loop in the same direction (instead of the opposite direction, as in two-circle fights). One of you loses lateral separation, relying instead on turn radius to outmaneuver the enemy. In general, only use the one-circle fight when you have a significant turn radius advantage over the bandit.

The one-circle fight tends to keep you and your target closer together than the two-circle fight. If you choose to turn away from your opponent, you'll momentarily lose sight of him as he crosses your tail. In fighters with poor rearward visibility, this loss of visual contact can be devastating. Since taking the one-circle approach surrenders the lateral separation to the bandit, you should minimize lateral separation during your next head-on approach.

Making the Initial Turn

Timing the initial turn in a head-on approach is critical to maintaining the advantage during a fight. Turning too soon pulls you across the bandit's nose, which not only gives him a snapshot opportunity, but also puts you on the defensive. Turning too late, on the other hand, puts you out of position and allows the bandit to gain a better target aspect angle on you.

A perfectly timed turn will deny the bandit any advantage while maximizing your own performance. However, while the initial turn is important, you may soon find yourself in a twisting, turning fight. When this happens, you need to apply additional air combat skills and maneuvers (discussed in the next section).

BASIC FIGHTER MANEUVERS

Although a loaded-down Strike Eagle is slow and unwieldy, an unencumbered F-15E in its own right is a perfectly fine fighter. In fact, as far as fighters go, it's about midway down the pecking order. You can hold your own against about half the fighters you might encounter, but you've got to watch out for the other half.

Call for help. For most of the combat you'll encounter, the most effective maneuver you can try is simply calling in the cavalry to take care of enemy fighters. There are usually F-15Cs flying Combat Air Patrols nearby, and they are the solution to most problem situations. When they don't arrive in time, however, you'll need to know the best ways to face down a bandit.

Firing Solution. In the world of combat, getting into position for a good shot is often called "achieving a firing solution." It can happen in half a second, or it may take several minutes. The manner in which you attain this position differs from conflict to conflict, so it's imperative that you develop a good reserve of combat maneuvers.

The following section examines various air-to-air maneuvers and describes how to use them to your advantage during combat. It is assumed that you have jettisoned any air-to-ground ordnance before you begin maneuvering.

BREAK TURN

- Use the break turn to evade enemy fire. Follow with a turn in the opposite direction.
- Initiate a break turn by banking (push the joystick to one side, and then pull it sharply toward you).

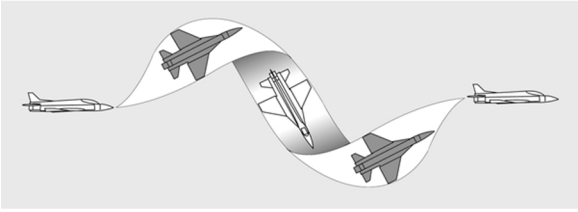
The break turn is the most basic combat maneuver, for it rapidly increases

the aspect angle (angle between you and your enemy's flight path) when a bandit is preparing to shoot you. It is a high-G maneuver that takes advantage of a maximum instantaneous turn rate and forces your attacker to take a high-aspect angle shot.

You can make a tight, instantaneous break turn (in which you lose speed, but increase aspect angle), or you can make a sustained break turn (in which you conserve speed, but may decrease aspect angle). Making a hard break turn bleeds airspeed, which in turn, can cause your enemy to overshoot. Generally, the closer you think the enemy is to firing, the harder you should turn.

Once you move through the break turn, immediately follow it with another maneuver. Sustaining a break turn too long is dangerous — it makes you a wide-open, predictable target. As a rule, your next maneuver should further remove you from the bandit's weapon envelope. Try an immediate scissors turn in the opposite direction. Your opponent will be going too fast to lead your turn, and you may be able to maneuver into a more advantageous position.

BARREL ROLL



- Offensively, use the barrel roll if you're overtaking an enemy too quickly.
- Defensively, use the barrel roll to force your attacker to overshoot and pass you.
- Initiate a barrel roll by rolling slightly and applying pitch. Keep the nose pitched to spiral around the axis of your flight path.

The barrel derives its name from the flight path the aircraft performs, circumscribing the shape of a barrel as the aircraft rolls around a central axis. It is an energy management maneuver possessing both offensive and defensive potential.

Offensive Barrel Rolls

If you find yourself traveling too fast, you may both overshoot your foe and fly directly into his gun envelope. This happens because your closure rate is too high, and you overtake your target. The barrel roll provides an effective solution by wasting speed.

If you can't bleed enough speed with a barrel roll, pull back harder on the stick and execute a roll opposite the direction of your current turn. The increase in pitch reduces airspeed, and the rollout turns you away from the target and keeps you from overshooting. As you complete the roll, you'll be back on your original course, but at a slower airspeed.

Defensive Barrel Rolls

Defensively, the barrel roll can be used to force a quickly approaching attacker to overshoot. It can also maintain enough angle-off-tail to put you out of his lethal cone of fire. Defensive barrel rolls must be carefully timed, however. Initiate the roll too soon, and the bandit will follow you through it. Start too late, and the bandit will have several shot opportunities before you begin the turn. Perfect timing requires that you both surprise the enemy and deny him sufficient reaction time.

SCISSORS

Scissoring occurs when an attacker overshoots, and the target reacts by making a reverse turn too early (before the attacker crosses his weapon envelope). You shouldn't try this against more maneuverable aircraft. The outcome will always favor the most agile competitor.

- Never purposefully enter a scissors fight — it bleeds off speed and altitude.
- To break a stalemate, roll 180° during one of the passes.

Scissoring refers to a series of reversing break turns in which two aircraft turn back and forth toward each other, each trying to force the other out in front. This usually begins when the attacker starts a late high yo-yo (see next page) or barrel roll and realizes he's going to overshoot his target. The defender, predicting the overshoot, reverses his turn. Although this is the right solution, he turns toward the attacker too soon, resulting in a fairly neutral pass and initiating scissors.

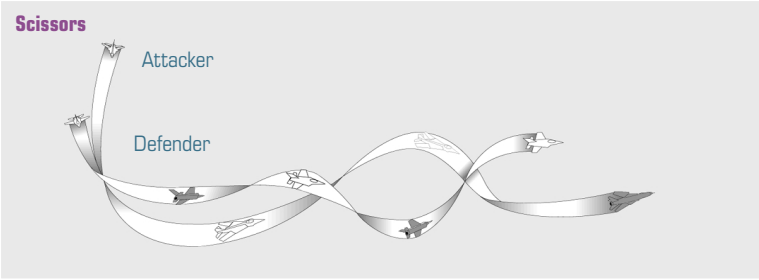
Scissor moves reduce the *forward velocity vector*, or the fighter's speed along the axis of its flight path. The aircraft turns across the flight path at varying speeds, reducing its average forward speed with every turn.

If you're an attacker, the only way you can get into a scissors duel is by starting a maneuver too late and overshooting. If you're on the defensive, you correctly predicted his overshoot, but reacted too quickly and compounded the attacker's error.

Once in a scissors, there's nothing to do but keep turning into the bandit. This bleeds off both speed and kinetic energy. The "winner" of a scissors match is usually whoever can conserve enough energy to force his opponent

out front and bring the aircraft's nose around for a shot. More often than not, scissoring ends when one aircraft loses so much speed that it stalls out and plummets. If the other aircraft has any energy left, it can roll, dive and take a shot before the falling aircraft can recover.

Vertical Rolling Scissors



Alternatively, two pilots about to engage may begin a series of barrel rolls instead of break turns. The resulting vertical rolling scissors is a speed-reducing maneuver as well, draining kinetic energy during the series of climbs, reverse turns and overshoots. Each time the aircraft cross paths, they risk both collision and gunfire. Allowing too much lateral separation (passing too far apart) affords your opponent a shot opportunity, while passing too close may result in a crash.

In a guns-only environment, you may be able to escape scissors by executing a split-S (see p. 4.83) immediately after crossing your opponent's tail. Then, by rapidly increasing your speed, you can outrun his guns.

Don't try this if your enemy has IR missiles — the split-S invites a heat seeker up your exhaust pipe. If you can't get outside the bandit's weapon range, then you have to win the scissors fight. If you can't win the fight by out-turning the bandit, you're as good as dead.

HIGH-SPEED YO-YO

- Use the high-speed yo-yo to reduce target aspect angle and bring a target into your firing cone.
- Perform by relaxing a turn, then pulling up into a sharp climb. Invert, then apply pitch to slide back down onto the threat's tail at a reduced aspect angle.

The high-speed yo-yo is a basic component of offensive air combat and reduces target aspect angle at the cost of increasing the distance between you and your target. The yo-yo begins during a turning fight when you have assumed an aggressive position behind the bandit, but are stuck in lag pursuit and unable to bring your nose to bear. In this case, you can use gravity to your advantage.

Roll out slightly when your enemy initiates a break turn (maintaining lag pursuit), then pull the nose up. At the apex of the climb, invert and roll back down onto your target's six o'clock position. You'll be further away from him, but in a better firing position.

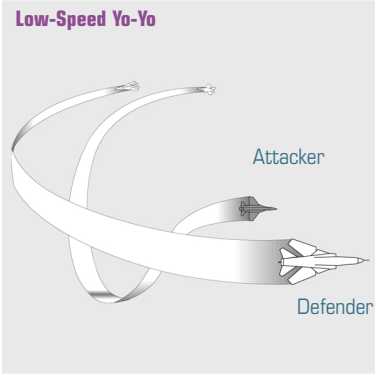
Don't make the yo-yo too extreme. Once you commit to a large one, you'll be unable to respond to any sudden changes the bandit may make. Patiently work small yo-yos by bringing the nose just above the horizon.

ROLLAWAY

A variation of the high-speed yo-yo, the rollaway involves rolling *away* from the target's turn as you invert. By diving and reversing direction with a 180° turn, you can drop in behind the defender's tail as he ends his break turn.

LOW-SPEED YO-YO

- Use the low-speed yo-yo when you have a good firing angle but need to bring the target in range.
- This maneuver decreases range at the cost of increasing target aspect angle.
- Execute by diving inside of a target's turn and gaining airspeed. Then, pitch up and slide onto his tail once more.



The low yo-yo is the logical opposite of the high yo-yo, and achieves the exact opposite effect. While the purpose of the high yo-yo is to decrease target aspect angle (at the cost of increasing range), the low yo-yo is intended to decrease range (at the cost of increasing target aspect angle).

Use the low-speed yo-yo when you have a good shot opportunity, but you're still outside your weapon's maximum range. This often occurs in chases where the bandit has superior speed and is trying to run home in level flight. You're chasing him, but he remains just outside your weapon's effective envelope.

To get closer to your target, lower your nose below the horizon and dive. This increases speed, but almost always forces you into lag pursuit and increases target aspect angle. A low yo-yo, therefore, almost always requires an immediate high yo-yo to correct the angle problem generated by the increase in speed.

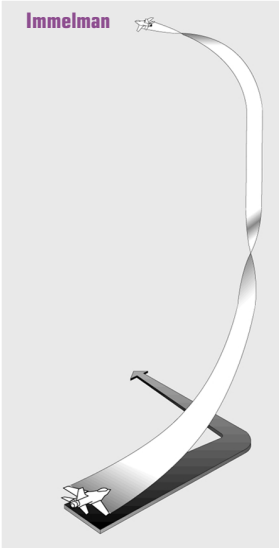
Be careful not to dive too steeply during this maneuver — you may be unable to bring your nose to bear on the target if it ends up too far above you.

Countering a Low-Speed Yo-Yo

If you anticipate your attacker's low-speed yo-yo, try making a half-roll toward the end of your break turn, then roll out of the turn instead of carrying through with the original break turn. By rolling in the opposite direction, you face your attacker's nose as he emerges from his dive. This brings the fight back to a merge pass.

UPHILL TURN (IMMELMAN)

- Use this maneuver to increase altitude and reverse direction.



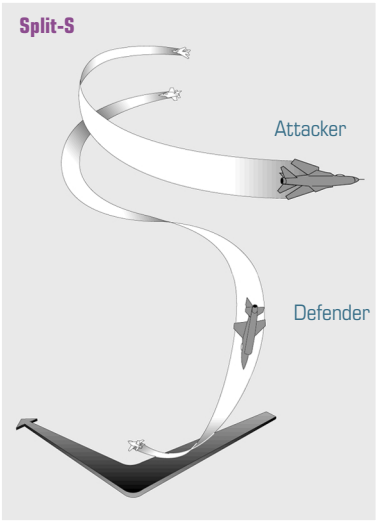
The Immelman is a high-thrust maneuver that changes your bearing and increases your altitude. By pitching the nose up and climbing, you can execute one-half of a loop. To terminate, you roll level. This leaves you flying in the opposite direction, but at a higher altitude.

DOWNHILL TURN (SPLIT-S)

- Use the Split-S to increase airspeed or bleed off altitude.

A Split-S is a diving half loop used to disengage a threat. It requires a lot of vertical airspace, so make sure you're at least several thousand feet above the ground beforehand.

During a turn, invert by rolling, then immediately pull back on the stick to go into a dive. Your aircraft will rapidly accelerate and gain airspeed. Pull back on the stick until the aircraft levels out, then ease into level flight. You'll be un-inverted, and you'll have a higher airspeed and lower altitude.



The split-S has the advantage of providing a quick burst of speed. Additionally, rolling inverted adds the aircraft's lift vector to gravity, thus increasing the force of acceleration and adding speed. On the down side, however, this increased speed increases the vertical turning radius, making it hard to pull the nose up into level flight. Starting a split-S from low altitude, or maintaining too much speed during the dive, can prevent the aircraft from pulling out of the dive.

The split-S makes a great escape maneuver in a guns-only environment because the rapid speed gain moves you out of gun range. It's usually ineffective against missiles, though, since they have significantly longer ranges.