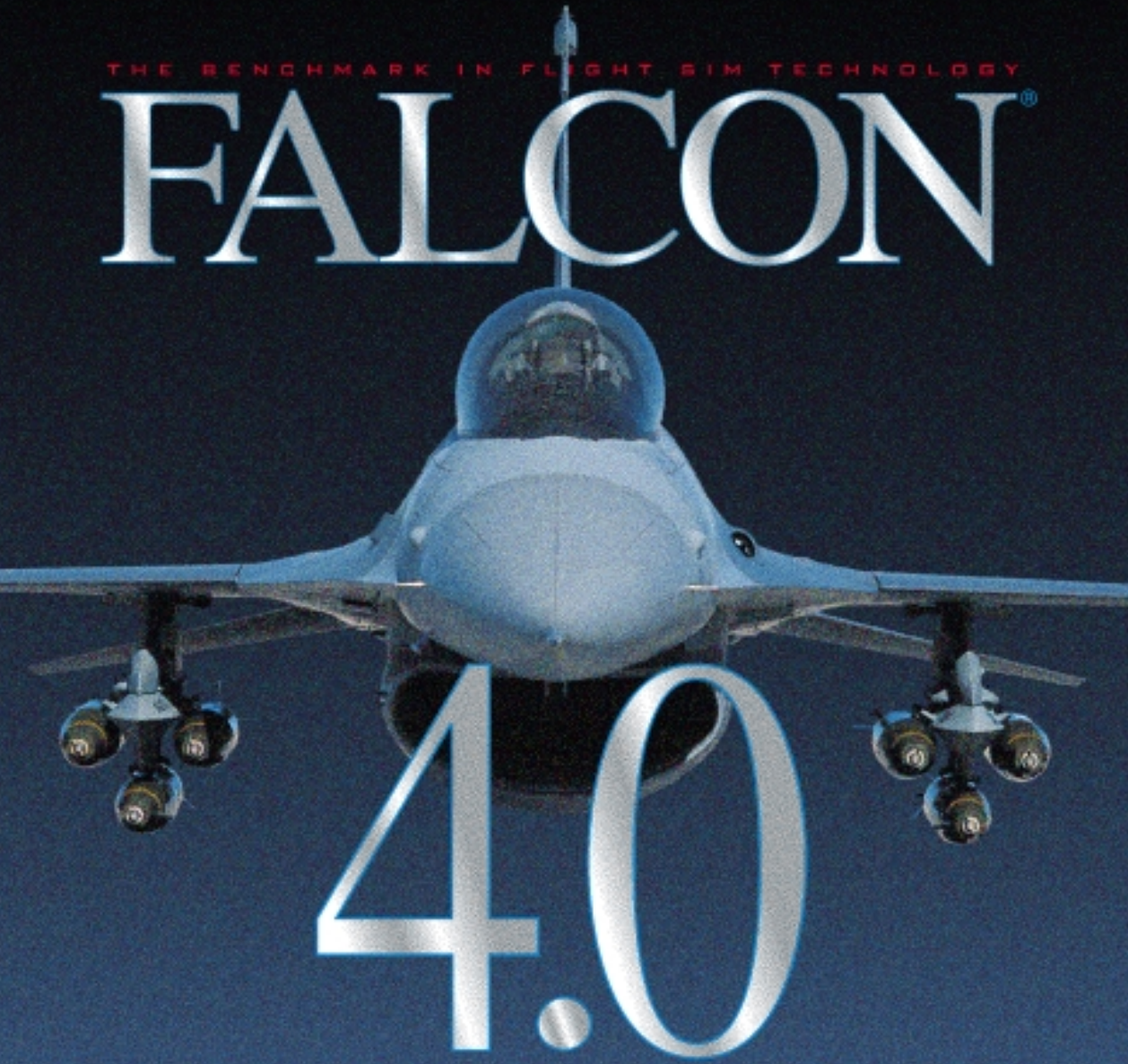
FLIGHT HANDBOOK EXCERPTS

THE BENCHMARK IN FLIGHT SIM TECHNOLOGY

FALCON®



4.0

MICROPROSE

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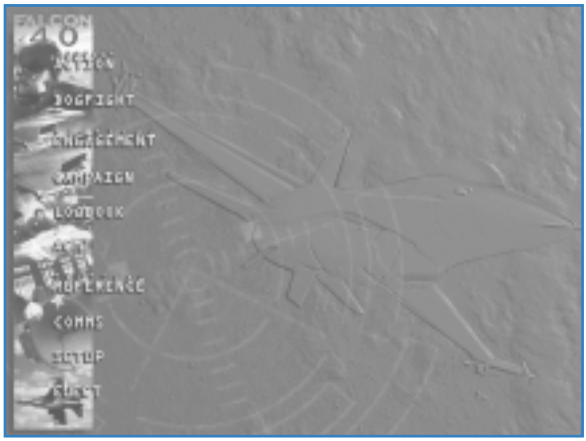
INTRODUCTION

ABOUT FALCON 4.0

Falcon 4.0 carries on a proud tradition of presenting the most accurate, realistic and engaging F-16 flight simulator available anywhere. In *Falcon 4.0* you'll pilot the F-16 Fighting Falcon, one of the premier dogfighting and air-to-ground combat aircraft in the world today. A favorite of experienced combat pilots, the F-16 is widely used by the United States and allied air forces. *Falcon 4.0* simulates the F-16 with unbelievable fidelity. This is as real as it gets!

Inside *Falcon 4.0*, you'll find four main arenas of play.



Instant Action is the place to go for an immediate adrenaline fix. Instant Action puts you into battle without any preliminaries. Your job is to shoot down as many aircraft and blow up as many ground targets as you can before you get killed. And you'll have to be good to stay alive, because in Instant Action the enemies keep coming.

Dogfight is where you'll duke it out in the skies under more controlled circumstances. In Dogfight, you'll go head-to-head with other aircraft, controlled by human or AI pilots. A Dogfight arena can contain from two up to literally hundreds of planes. The action can be a free-for-all or you can fly in teams.

Tactical Engagement is the *Falcon 4.0* construction set in which you'll build your own complete air and ground missions. Or load the missions that come with *Falcon 4.0*, ones that your friends create or others that you find on the Internet. Tactical Engagement is the ultimate free-form mission builder.

Campaign is the final challenge. In it, you're a highly trained F-16 pilot, a combat veteran assigned to a combat theater in which you'll play a vital role. The *Falcon 4.0* Campaign uses a complex real-time simulation engine that wages a major war on the Korean peninsula. Many battles are being fought simultaneously as you fly your sorties. If you successfully complete your missions, the enemy will be deprived of crucial supplies and your side will gain the edge. If you fail, the allied body count will start going up.

Other sections of *Falcon 4.0* provide important features.

The Logbook is where you'll keep your callsign and other personal information. The Logbook is *Falcon 4.0's* way of knowing who's flying and keeps track of your points, rank and other statistics.

Tactical Reference is an important study guide for staying alive in the air. It shows you every aircraft, weapon, ground unit and naval unit you'll encounter in *Falcon 4.0*. Use it to learn to visually identify enemy aircraft. Learn the threat warning signals that enemy missiles and radar make, so you'll know when someone has locked you up with intent to kill.

ACMI (Air Combat Maneuvering Instrumentation) is the package that records everything that happens during a *Falcon 4.0* mission. It's one of the most useful tools you have as a fighter pilot because it gives you a chance to play back your mission, see your mistakes and glory in your brilliant moves.

HOW TO USE THIS DOCUMENTATION

Falcon 4.0 is a sophisticated simulator, but we have organized the documentation to get you flying right away. Be sure to read **The Cadet's Guide** first so you can install and configure the game. If you want to get in the air and shoot things down, **The Cadet's Guide** will tell you how.

Part 1 of this **Flight Handbook** covers all the training missions, from basic flying to operating the avionics and weapons suites. The training missions are where you'll learn the "how to" of flying an F-16. Part 2 describes all the main modules, including Instant Action, Dogfight, Tactical Engagement and Campaign. Part 3 is a reference section that covers the details of avionics, weapons suites, displays, radar, views, radio commands and so on. Part 4 is for the advanced pilot, with lessons about enemy tactics and mission planning.

In addition to the two manuals, be sure to keep the **Quick Reference Chart** handy. The key card is a handy summary of the basic commands and functions. If you're interested in multiplayer games, check out **The Communications Handbook**.

Don't feel overwhelmed by the amount of material presented here. If you're new to flight simulations, start with **The Cadet's Guide** which describes the simplified avionics and flight model. Use the training missions in Part 1 of this manual to learn more about the F-16. If you need help on the interface screens, click the Help icon (which looks like a question mark) for more information. Also, don't forget to check out our Web site at **www.falcon4.com** for even more training information and tips from real fighter pilots.

We've gone to great lengths to accurately model the F-16C Block 50/52 fighter jet. Given the sophistication of today's combat aircraft, it's no surprise that the U.S. government spends more than a million dollars to train a combat pilot. This means you won't learn *Falcon 4.0* overnight. However, each step is guaranteed to be interesting and exciting. Before long you'll be rocking the skies with the best of them. Good luck and good hunting!

PART 1: TRAINING MISSIONS

CHAPTER 1

LEARNING HOW TO FLY

Part 1 of this **Flight Handbook** consists of 31 training missions. The missions themselves are located in the Tactical Engagement section of the game, and the mission descriptions and instructions are contained here in the manual. The missions are task-oriented and teach very specific skills. We'll provide all the instruction you'll need to complete each learning objective, but there is one caveat. The training missions use a building block approach. If you try to fly one of the advanced missions without first learning the skill sets from the earlier missions, you may have difficulty. Pete Bonanni designed these missions and wrote the instruction that follows. He patterned this training syllabus after the training course that the U.S. Air Force uses to teach new fighter pilots how to fly the F-16.

Pete "Boomer" Bonanni is a highly experienced F-16 instructor pilot some of you may remember from *Falcon 3.0.* Pete provided the primary fighter pilot input to the *Falcon 4.0* development team and is the author of *Art of the Kill* along with many other flight simulator books. His new book is titled *The Official Falcon 4.0 Strategy Guide* and is published by Prima.

OVERVIEW

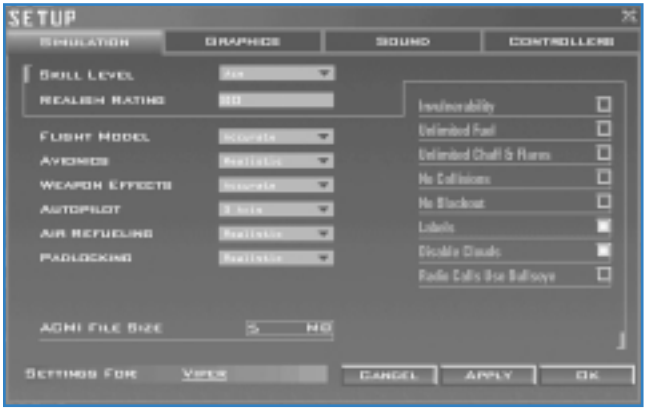
These training missions are designed to teach you how to fly *Falcon 4.0* in the same way as a real F-16 pilot learns to fly his jet. *Falcon 4.0* is the most realistic flight simulation ever built, but it does feature scaleable levels of difficulty to aid new pilots. The skills and knowledge required to use the F-16's systems are not easy to learn, and will take time and effort to master. For this reason, I suggest you eat this elephant one bite at a time.

For further training, tips on techniques and other information about *Falcon 4.0,* don't forget to visit **www.falcon4.com**.

TRAINING MISSION SETUP

All of these training missions assume a specific setup. Please follow these instructions for *all* of the 31 training missions:

1. Select Setup from the main menu.
2. Click the Simulation tab at the top of the window.
3. Select "Ace" from the Skill Level option. This will set the Flight Model, Avionics, Weapons Effects, Autopilot, Air Refueling and Padlocking to the proper options.
4. On the right-hand side of the window, turn Labels on by clicking in the box. Also turn Disable Clouds on by clicking its box.



5. Click the Graphics tab at the top of the window.
6. Make your Graphics selections based on your processor, video card, available RAM, etc. See **Chapter 16: Setup** for recommended settings.

HOW TO LOAD A TRAINING MISSION

To load a training mission, first click Tactical Engagement from the main menu. The Training tab will already be selected, and a list of training missions will appear underneath. Click on the training mission you want and click the Commit button in the bottom right-hand corner. Under Mission Schedule on the next screen, the training mission will be selected and you will see the default name ("2nd Lt. Joe Pilot") next to an aircraft icon. If you already created a pilot in the Logbook, you will see the name you selected instead. Click the Fly icon in the bottom right-hand corner to start the training mission.

FREEZE MODE

You can always press Shift P at any time during the training mission to "freeze" the game. Unlike the regular pause mode (P key), freezing the game lets you operate all the F-16 avionics and instruments, most notably the radar. Note that the mission clock keeps ticking in Freeze mode. If you are supposed to be at a specific location at a specific time, the time you spend in Freeze mode counts against you.

MISSION 1: BASIC AIRCRAFT HANDLING

The objective of this mission is to learn how to control the Falcon. When you complete this mission, you will "know the struts and know the skin, know the barrel roll and spins." Well, maybe not, but I just couldn't resist that line from a famous old fighter pilot song "Barnacle Bill the Pilot."

There is no need to take the venerable Falcon up into the wild blue to duke it out with the bad guys if you can't control the jet. This mission is the first in a series of aircraft handling training missions patterned after the Air Force's real F-16 training syllabus. In the real syllabus, this sortie is called "TR-1" or "Transition Sortie 1." Keep in mind, however, that when a pilot first starts to fly the F-16, he or she already knows how to fly other jets. Since you *Falcon 4.0* faithful have different levels of experience, I will start with the very basics. Bear with me and if you start to nod off, move on to the next mission. Just don't blame me later when you hear the low speed warning horn for the first time and soil your bloomers.

Controlling the plane in *Falcon 4.0* (and the real F-16) is really not very difficult. Fighting in the jet, however, is another matter. Modern fighters like the F-16 are a dream to fly but devilishly hard to fight in. Today's fighters barrage the pilot with information which, when combined with increased speed, creates a tempo of air combat that is close to the limits of human capability. Along with the challenge of sensor fusion and tempo, modern fighters also feature a violent high-G environment. G force is the force that acts on the jet when it turns. It's like the old example of swinging a bucket of water on the end of a rope. The water stays in the bucket because of the force acting toward the outside of the arc. The G force on an aircraft is essentially the same thing except greater in magnitude. The G forces of modern air combat would turn the fighters of old into kindling (or paper clips). The fighter pilots of yore, of course, faced challenges of their own. Their primary challenge was the sheer difficulty of just flying their aircraft. Older aircraft were simply a lot harder to fly than the F-16. Skills such as flying an F-86 close to its maneuvering limit, manual bombing in the F-105 and marksmanship in a P-51 demanded great flying skill. The F-16, in contrast, has a flight control computer that controls Gs and other critical flight parameters to keep the pilot out of trouble. In addition, the F-16 Fire Control Computer puts the bombs on the target. In general, the F-16 is just easier to fly. I experienced the difference between a third and fourth generation fighter when I transitioned from the F-4 Phantom to the F-16. With the exception of landing, I found the F-16 far easier to fly than the F-4.

Since *Falcon 4.0* flies like the real jet, it should be relatively easy to fly. Just because flying the jet is easy, however, does not mean that it is effortless or that there is no learning curve. This mission will help you master flying so you can go on to the more complex and demanding air combat tasks. We will also cover a few displays and instruments that are also shown in other parts of this manual. Everything you need to fly this mission will be presented here.

THE HUD

First, load the training mission by selecting "01 Basic Handling" under the Training tab in Tactical Engagement. Press Shift P to freeze the game while you look around the cockpit.

Falcon 4.0 features several views, but we will start with the cockpit. Press 2 on the top row of the keyboard to make sure you are in the 2-D Cockpit view. This cockpit not only looks exactly like the real F-16 cockpit but also features the same functionality. The most obvious cockpit feature is the HUD (Head-Up Display). The HUD is located at the top of the cockpit and is by far the most useful of all cockpit displays.

Here is a list of the parts labeled in Figure 1-1 and what they are used for in the HUD.

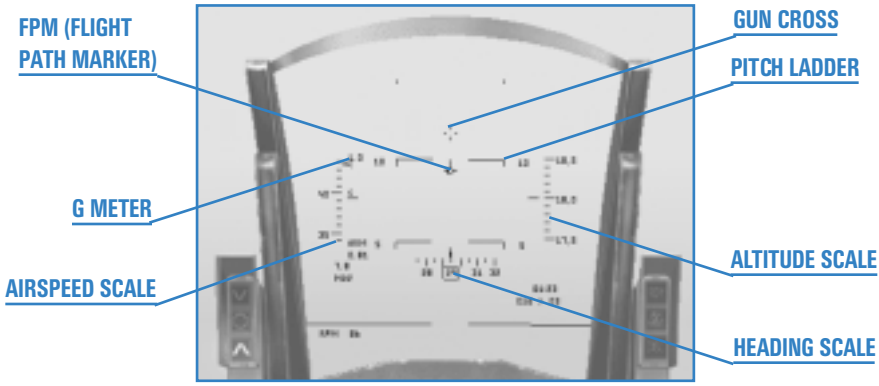


Figure 1-1

The flight path marker is the most useful part of the HUD. This symbol shows the pilot the flight path or vector that the jet is on. If you use your joystick to place the flight path marker on a point over the ground and hold it there, the jet will impact the ground on that exact spot. Hopefully, you won't be doing that too often, but the flight path marker can be used in a very similar way to fly to a precise point on a runway. Just as importantly, the F-16 can be flown in level flight or precise climbs and dives using the flight path marker.

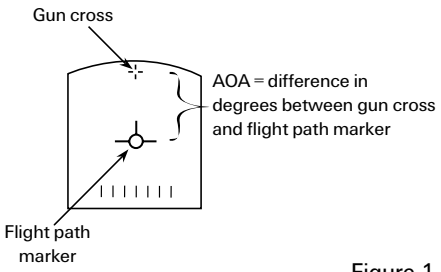


Figure 1-2

The gun cross is the small cross symbol at the top of the HUD. It is an important reference since it represents the nose of the aircraft. Keep in mind that the gun cross is not where the aircraft is pointing (although it is very close to where the aircraft is pointing). The difference between the gun cross (the nose of the aircraft) and the flight path marker is the AOA (Angle of Attack).

The pitch ladder provides a level flight reference along with a reference for climbs and descents. The long solid horizontal line in the middle of the HUD is the 0° pitch line. It can be easily differentiated from the other pitch ladder lines because it has no number associated with it. The dashed pitch ladder lines show descents in 5° increments while the solid lines show climbs.

The airspeed scale is on the left side of the HUD. Since this scale shows airspeed in increments of tens, "40" means that you are going 400 knots (nautical miles per hour). The airspeed scale has a "C" next to the tick mark, which stands for calibrated airspeed.

The altitude scale is on the right side of the HUD. This scale shows aircraft altitude in hundreds of feet *above sea level,* also called MSL (Mean Sea Level). Remember, the HUD altitude scale shows altitude MSL—above sea level—and *not* altitude above the ground (AGL). An altitude of "500" is 5,000 feet above sea level. When your penguin butt gets down below 1,200 feet from the ground, the radar altimeter brings up a new altitude display in the HUD. Since this scale shows hundreds of feet, when the sliding bar is next to "2," you are 200 feet above the ground. Keep in mind that this is the ground directly underneath your jet and not the ground that is in front of you. As you climb and get above 1,500 feet, the scale goes back to the normal sea level scale.

The heading scale at the bottom of the HUD shows aircraft heading. The scale simply shows aircraft heading in tens of degrees. A heading of "27" would be 270°.

The HUD G meter in the top left corner of the HUD shows current G forces acting on the jet, whereas the G meter at the bottom left corner of the HUD shows the maximum G force you have pulled so far during a given flight. See **Chapter 25: Aerodynamics and G Forces** for a detailed explanation of G.

HUD CONTROL OPTIONS

Figure 1-1 shows all the HUD displays called up, which is the way that I fly in both *Falcon 4.0* and the real F-16. Not all fighter pilots, however, use the HUD the same way, so you can configure your HUD display to suit your needs.

Press H to declutter the HUD. The first time you press H, it will remove the pitch ladder, the second time will remove the flight path marker. Press H a third time to return to the default HUD display.

Press Ctrl H to toggle the airspeed indicator and altimeter from tapes to discretes (analog to digital).

Press Alt H to change the HUD color. Since the ground can be colored green, this option can be very useful.

The HUD displays a lot more information, but we will talk more about diamonds and timing cues and that other stuff in the training missions to come.

COCKPIT INSTRUMENTS

We should discuss a number of cockpit instruments and displays before getting airborne. Make sure you are in the 2-D Cockpit view, as shown in Figure 1-3.

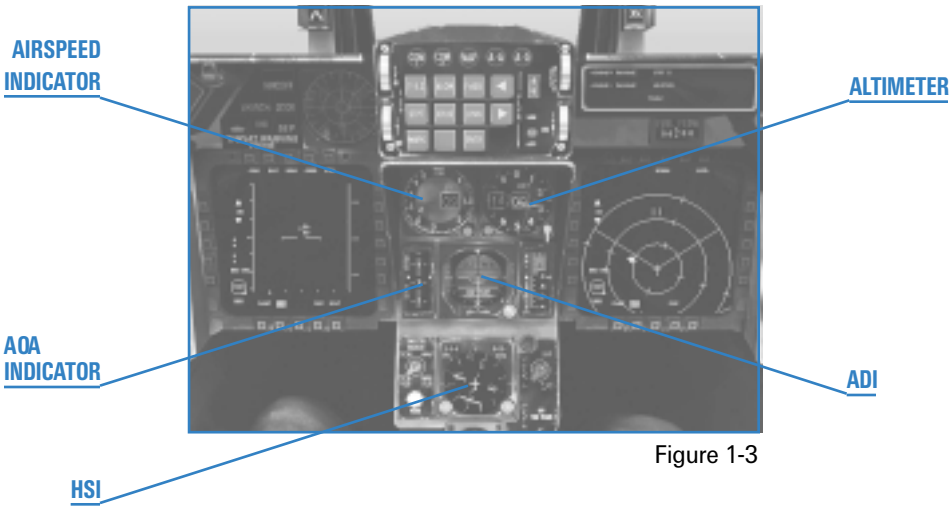


Figure 1-3

The ADI (Attitude Director Indicator) provides an artificial horizon and an aircraft symbol so you can tell the attitude or orientation of the aircraft relative to the earth.

The airspeed indicator shows the aircraft's airspeed in hundreds of knots. When the red needle is on the "4," you are going 400 knots.

The altimeter shows the MSL altitude (altitude above sea level) of the aircraft on the round dial. The digital readout on the inside of the dial shows the altitude in thousands of feet. The white needle on the dial displays the altitude in hundreds of feet.

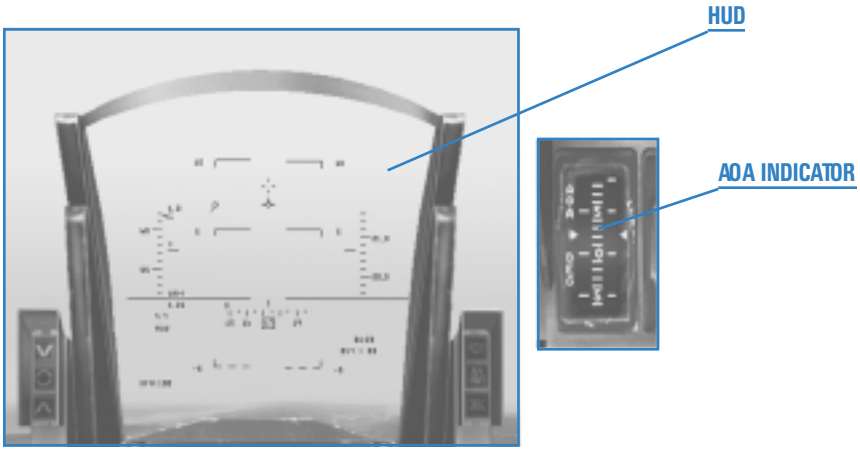


Figure 1-4a

The AOA indicator is a tape that shows the angle of attack of the aircraft. In order to generate lift, the jet needs to have a positive angle of attack or fly at a positive angle into the relative wind (airflow). The F-16 has a 25° positive and 5° negative AOA limit. Remember that the AOA is the angular difference between the gun cross and the flight path marker. Figure 1-4a shows AOA, both in the HUD and on the gauge.

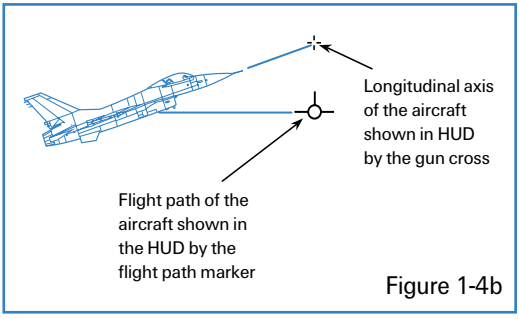


Figure 1-4b

The HSI (Horizontal Situation Indicator**)** is a very complex gauge we will cover in Training Mission 12. For now, all you need to know about the HSI is that it can be used to indicate aircraft heading. The round moving dial on the HSI shows N/S/E/W for north, south, east and west. When the aircraft turns, the dial moves to indicate the change in aircraft heading.

The RPM gauge shows the revolutions per minute of the turbine blades at the core of the engine. RPM is shown as a percentage, with 100% being the fastest the engine can go and 0% being an engine that is not turning at all. 70% is idle power. RPM is directly tied to throttle position, which controls how much thrust the engine produces.

TRAINING MISSION OVERVIEW

This mission starts with the Falcon in the air. Your goal on this mission is to get used to flying the jet and using the keyboard to control your various views.

INITIAL CONDITIONS

- Airspeed: 400 knots
- Altitude: 7,500 MSL and level
- Throttle Setting: Mid-range

MISSION DESCRIPTION

1. Press Shift P to freeze the game. While we are frozen, let's go through the different view options. Access the views by pressing the number keys at the top of the keyboard.

   Press 1 to switch to the HUD Only view. The MFDs are the boxes visible at the bottom (or top) of the display. Change the MFD displays by pressing [for the left MFD,] for the right MFD, Shift [for the top left MFD and Shift] for the top right MFD.

   Press 2 to put you back in the default 2-D Cockpit view. This view is mouseable, which means that you can use the mouse to flip switches, turn dials and move around the cockpit. There are three kinds of mouse pointers that are used in the 2-D cockpit. The red diamond indicates that you cannot interact with a cockpit control or dial. The green circle means that you can interact with a cockpit control or dial (by flipping a switch, etc.). The green arrow means that you can click to change your 2-D Cockpit view to look left, right, etc.

   Press 3 to enter the Virtual Cockpit. In Virtual Cockpit, use the hat switch on your joystick or press ↑, ↓, ← and → on the numeric keypad to move your view around the cockpit. This view is very important because it is very useful in air combat and in improving your situational awareness or SA. SA is understanding where you are in relation to the world around you and, just as importantly, understanding where threats are in relation to you. Practice using the Virtual Cockpit while the simulation is in Freeze mode. If you hold down ← or →, notice that your view will stop near the ejection seat. Since you cannot see past the ejection seat in the real F-16, *Falcon 4.0* has the same view limitation. You will hear a banging sound when you reach that limit. If you want to rotate your head (the view) to the other side of the cockpit, press ← or → on the numeric keypad again and you will move the view to the other side of the cockpit.

   Press ~ to access the Satellite view, which is an overhead view of the world.

To get a closer look at the world, press [L]. Press [L] again to return to normal view. You can also press [7] and [1] on the numeric keypad to zoom an outside view further in or out.

Falcon 4.0 has additional views, but they will not be needed in this mission.

2. Bring up the 2-D Cockpit by pressing [2]. Press [Shift][P] again to unfreeze the game.

3. Set the RPM gauge to 85% by using the throttle on your joystick or press [+] or [-] to set the throttle.

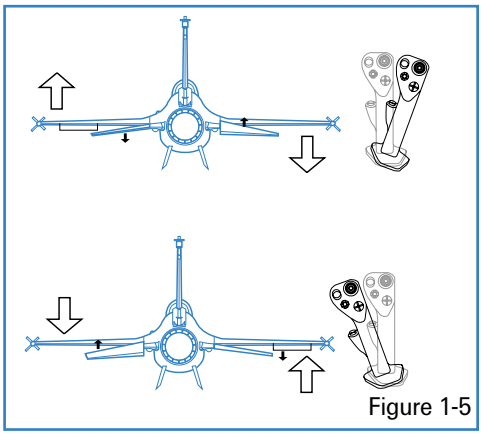
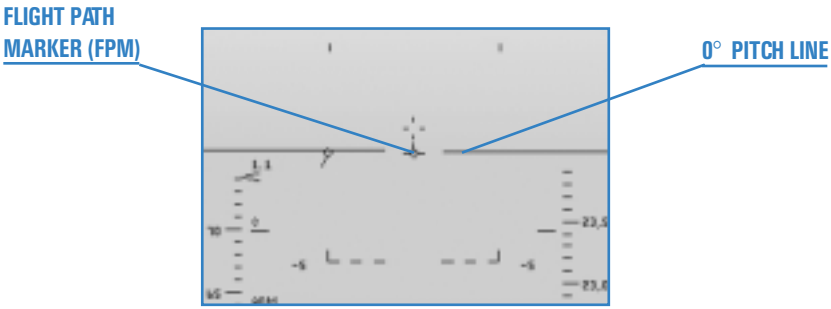


Figure 1-5

4. Move your joystick left to start an easy left turn. Bank the wings to tilt the world about 60° and then pull back on the stick until your G meter reads 2.0. Figure 1-5 shows how to move your joystick and get the turn started.

Notice that when the wings are banked, the jet will turn or change heading. In the 2-D Cockpit view, you can watch the HUD heading scale move and you will see the aircraft banked on the ADI.

5. To keep the aircraft in level flight, ensure that the flight path marker is on the level line of the HUD. Do this by gently pulling back on the joystick until you get the flight path marker where you want it. Figure 1-6 shows the turn with the flight path marker on the level or 0° pitch line. Practice making level turns to the right and left. Turn on the smoke by pressing [Alt][S] to trace your path through the sky. Use the Satellite view ([~] key) to watch your turns from outside the aircraft. When you are done, return to straight and level flight. Bank opposite to the direction you are turning until the HUD 0° line is horizontal. Then move the flight path marker until the horizontal lines of the flight path marker align with the 0° line on the HUD.



6. Next, we will practice climbs and descents. To climb, align the HUD flight path marker with the 5° pitch line. Notice that the aircraft starts to climb and that both the cockpit and HUD altimeters show increasing numbers and that your airspeed decreases (if you don't, add more power). In addition, the movement of your flight path marker lags slightly behind your control inputs. After climbing 1,000 feet, level off for a few seconds by aligning your flight path marker with the level line. Notice that your altitude remains constant with the flight path marker on the 0° pitch or level line.

7. Practice a descent by pushing the joystick gently forward to align the flight path marker with the -5° pitch line. Your altitude will now decrease and your airspeed will increase. You must always manage your energy when flying. Climbs trade airspeed for altitude, whereas descents trade altitude for airspeed. After descending 1,000 feet, level off by placing the flight path marker on the HUD level line.

8. After accomplishing level turns and some straight ahead climbs, start combining turns and climbs together. For example, make a level turn due west, or "27" on your HUD heading tape. When you are heading west, start a climbing turn to east or "09" on the HUD heading tape. Try to climb 2,000 feet precisely. Set up parameters of your own to practice maneuvering the jet precisely.

9. Next, try doing level turns at low altitude, which is flying below 1,000 feet AGL. During these maneuvers, experiment with different HUD altitude options (Auto, Bar and Radar). Switch between these modes by using the mouse to switch to the lower left console in the 2-D Cockpit view. The HUD control panel on this console is a 3-way toggle switch that selects the HUD altitude options.

The next series of maneuvers we are going to practice are called HARTs, which stands for "Horn Awareness Recovery Training." These maneuvers are used to train the pilot to recognize and recover from a nose high attitude. When the jet is above 45° nose high and the airspeed goes below 170 knots, the low speed horn comes on. Actually, it is a combination of pitch (nose relative to the horizon) and airspeed. Figure 1-7 shows the low speed warning horn chart used by the F-16. You don't have to memorize the chart. Just be aware that if you get nose high and slow, the horn will come on.

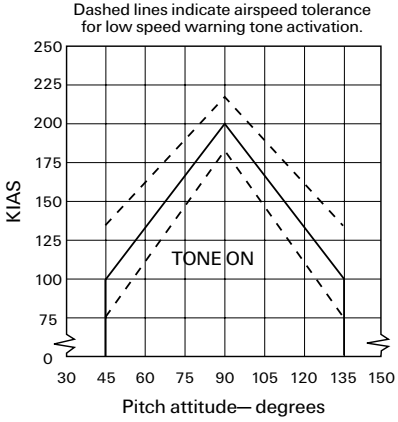


Figure 1-7

Use the following steps to practice HART maneuvers:

1. Climb to 15,000 feet and level off. Set the throttle to 85%.

2. Pull hard back on the stick and start an easy 5 G to 7 G pull-up straight ahead, to set the flight path marker 70° nose high using the HUD pitch ladder. Since the flight path marker will lag the gun cross, use the gun cross initially to set your pitch. The flight path marker will catch up with the gun cross when the AOA is reduced. The AOA initially will be high because you are pulling Gs, but it will come back down as you ease the pull to set your pitch angle at 70°. Figure 1-8 shows the climb.

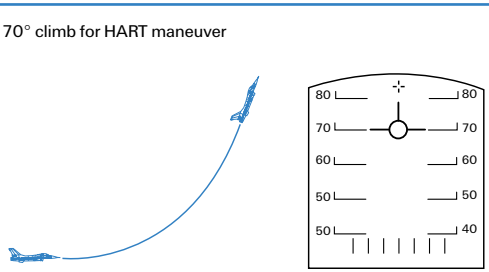


Figure 1-8

3. The horn will come on at about 170 knots. When you hear the horn, start a roll to inverted flight. Make sure you roll the aircraft slowly to avoid losing control. Stop the roll when you are upside down. You can tell you are upside down by looking at the HUD pitch scales. When the vertical legs connected to the ends of the pitch bars are pointed up, then you are inverted.

4. Once the jet is inverted, start a smooth pull to get your nose down below the horizon. Once the nose of the jet is below the horizon, stop pulling on the joystick and let the nose fall through the horizon. Keep the jet inverted (upside-down).

5. When the airspeed gets to 150–200 knots, roll the jet upright and start a 3 G to 4 G pull to level flight (with the flight path marker on the 0° pitch line).

6. Try the exact same procedures except this time pull the nose of the jet up to 90° nose high. Use the Orbit view (0 key) to watch how the aircraft performs at very low airspeeds.

   This first training mission will help you practice controlling the jet using basic cockpit and HUD symbology. When you have turns, climbs and the HART maneuvers down pat, move on to the next mission.

MISSION 2: TAKEOFF

In this training mission, you will learn to fly the jet off the ground. Taking off in the F-16 is simple, and you only have to follow a few procedures. First, be aware that in *Falcon 4.0* that you are part of a realistic runway environment that includes a ground taxiway environment, air traffic control and other flights. All the runways in Korea are busy launching and recovering aircraft, so you must listen up for ATC (Air Traffic Control) radio calls directed at your flight. When taking off, you are not required to ask the tower for permission to take off. As you move down the taxiway, the tower will clear you for takeoff.

When you take off, you are generally combat configured, with bombs or missiles beneath your wings. Combat configurations are heavy. Because of the weight, you should accomplish all of your takeoffs with maximum afterburner. Things happen fast when you are taking off in full afterburner—and that is both good and bad news. The good news is that you don't have much time to get creative and mess up the procedures. The bad news is that if you don't use the correct takeoff procedures, bad things will start happening very fast.

TRAINING MISSION OVERVIEW

Load training mission "02 Takeoff" from Tactical Engagement and click the Commit button. You need to manually place yourself in the lower right-hand aircraft (the #2 plane). Do so by clicking on the plane icon.

Next, determine the callsign of your flight. Click the Briefing icon (which looks like an easel on the bottom of the screen). The third section, labeled "Package Elements," shows the name of your flight. In this case, your flight is Cowboy 1. In the section labeled "Ordnance," your aircraft is highlighted in green. In this case, your aircraft is Cowboy 12 (One–Two). When you hear ATC call "Cowboy One" or "Cowboy One–One," they are talking to your entire flight. If you are on the taxiway and are cleared for takeoff, taxi onto the runway and take off. If you are on the runway, just take off when you are cleared.

Close the Briefing window by clicking the "X" in the upper right-hand corner. Then click on the Fly icon in the lower right-hand corner. While you are waiting for the simulation to load, make sure that the throttle on your joystick is in the idle position.

INITIAL CONDITIONS

- Airspeed: 60 (which is the lowest reading in Realistic Avionics and will change once your airspeed is above 60 knots)
- Altitude: On the runway
- Throttle Setting: Idle
- Configuration: Gear down
- Avionics: NAV

MISSION DESCRIPTION

In this training mission, you will be on the runway. When the mission starts, you will be #2 in a two-ship formation with your flight leader on the runway ready for takeoff.

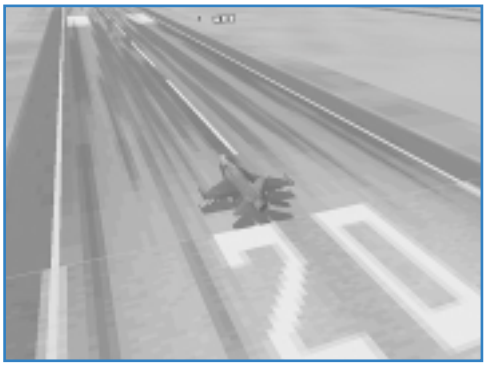


Figure 2-1

1. If your plane is moving as the mission starts, press and hold [K] to apply the wheel brakes. Release the [K] key when the jet comes to a stop.
2. Your callsign for this mission is Cowboy 12. Listen for Cowboy 11 to be cleared for takeoff by ATC. The radio call will be "Cowboy 11 cleared for takeoff." ATC might also call "Cowboy 1, cleared for takeoff." In either case, the entire flight is cleared to take off.

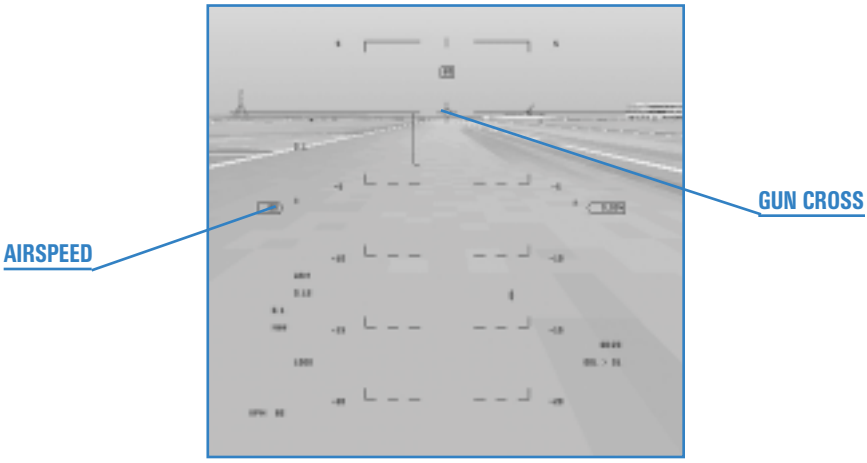


Figure 2-2

3. Increase your throttle to full afterburner by pressing Shift +.

4. Fly the jet straight down the runway using the joystick or rudder pedals to steer. Pay attention to both the runway and the airspeed gauge in the HUD.

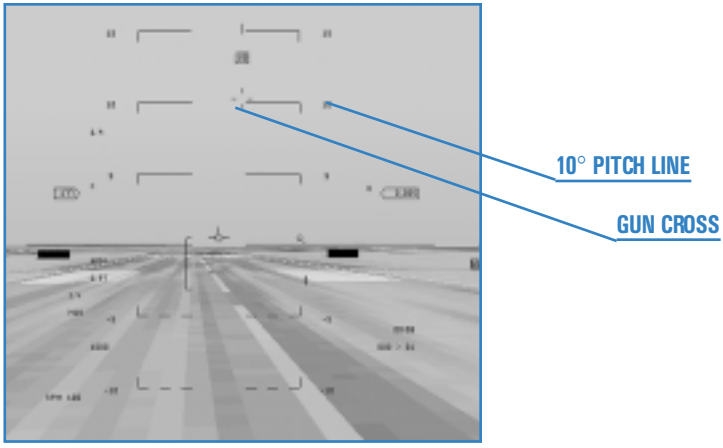


Figure 2-3

5. When the airspeed gets to 150 knots, pull the gun cross up to the 10° line in the HUD. Hold this pitch attitude until the jet flies off the runway. Warning: do *not* exceed a 14° pitch angle or you will scrape the afterburner nozzle on the runway.

Figure 2-4

6. As soon as you are airborne and climbing, raise the landing gear by pressing [G]. This will happen quickly, so be ready to raise the gear *as soon as you get airborne.* Warning: do *not* exceed 300 knots with the gear down while flying or you will damage the landing gear.

7. Confirm the gear are up by switching to the lower left console (by pressing [↓] on the numeric keypad followed by [←] on the numeric keypad). When the gear are in transit either up or down, the red light will be illuminated in the gear handle. When the gear are down and locked, you will see three green gear lights and the red light will go out in the gear handle.

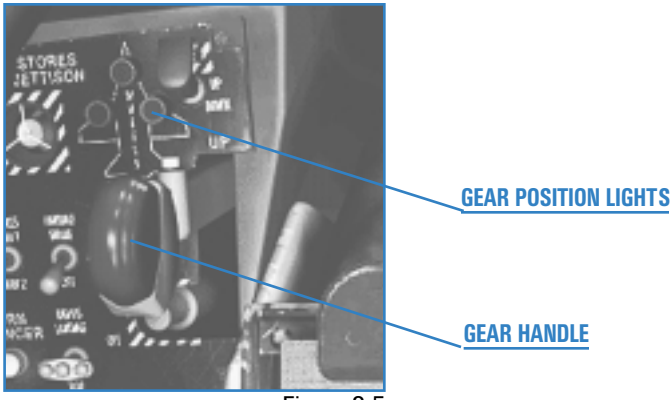


Figure 2-5

When the gear are safely up, the gear handle will be in the up position and the lights in the gear handle and on the panel above it will be extinguished.

CHAPTER

4

AIR-TO-AIR WEAPONS

These training missions will teach you about the F-16's radar and let you practice delivering specific weapons.

MISSION 13: AIR-TO-AIR RADAR MODES

Falcon 4.0 has several avionics difficulty levels: Easy, Simplified and Realistic. The instructions for these training missions assume that you have chosen the Realistic Avionics setting, which displays the most realistic radar modes.

The F-16 AN/APG-68 can find and track targets that are within ±60° of the azimuth and ±60° of elevation from the aircraft nose. This does not mean that your radar can instantaneously search this volume of airspace. It means that your radar can point its beam and search a portion of the airspace within this physical limit.

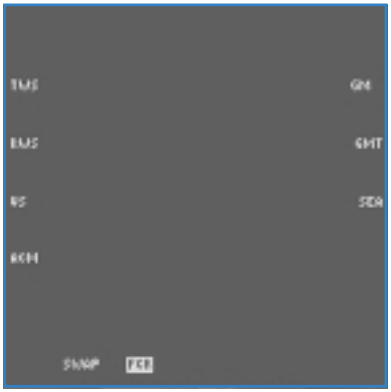


Figure 13-1

The F-16 has several different radar modes, some for use within visual range and others for beyond visual range. Generally, ACM (Air Combat Maneuvering) radar modes are used to lock the radar onto aircraft that are within visual range.

To display the radar on an MFD, press either [for the left MFD or] for the right MFD until the menu shown in Figure 13-1 appears. Then cycle through the different air-to-air radar modes by pressing F1.

OVERVIEW OF AIR-TO-AIR RADAR MODES

To understand Falcon instrumentation, you must understand the concept of master modes and submodes. All the radar modes are controlled using this concept. First, you have to bring up a radar display on one of your MFDs. Switch to the 2-D Cockpit view by pressing 2, as shown in Figure 13-2. The MFDs are the two large square scopes that dominate the cockpit.

The MFD display options are listed around the scope. The option that has been selected is highlighted. In Figure 13-2, the "MENU" option is highlighted. To bring up your radar, select the FCR (Fire Control Radar) option in the top middle. Once you have brought up the FCR on one of your MFDs, you can cycle through the master and submodes of the radar.

Figure 13-2

Most of the time, however, all you have to do to get the FCR to appear is to press [until "RWS" appears on the left MFD. RWS is the default radar mode. Then you can simply press F1 to bring up the desired air-to-air FCR mode. Once you are in a radar mode, change its operating characteristics by pressing F8 to cycle through the submodes. In the case of the ACM master mode, F8 changes the pattern of the radar significantly. The table below shows how the FCR master modes and submodes cycle.

Master Mode	Submode	Submode	Submode	Submode
F1	F8	F8	F8	F8
RWS*	±60° sweep	±10° sweep	±30° sweep	
VS*	±60° sweep	±10° sweep	±30° sweep	
TWS**	±25° sweep	±10° sweep		
ACM	HUD Scan	Vertical Scan	Slewable Scan	Boresight Scan

*Always starts in ±60° sweep

**Always starts in ±25° sweep

Press F1 to step through the master modes. Press F8 to step through the submodes for a given master mode.

ACM

The ACM radar mode in the F-16 is used to cue or point weapons. The BVR radar modes can do the same thing, but are also used to help you find the target. This is not true of the ACM mode. In most cases, when you use the ACM mode, you already see the target and are using the radar to point and fire a missile.

The F-16 has four ACM submodes. Press F8 to cycle through these submodes. These submodes are listed below along with the mnemonic (or label) that is displayed in the radar MFD:

ACM Submode	Radar MFD Mnemonic
HUD Scan (30X20)	ACM 20
Vertical Scan (10X60)	ACM 60
Slewable Scan (20X60)	ACM SLEW
Boresight	ACM BORE

Boresight ACM Submode

All of these ACM submodes are directed at the target using the HUD. The Boresight submode points the radar beam straight out the nose of the jet. When you enter Boresight submode, the HUD will display a boresight cross that represents the radar beam. Figure 13-3 shows the Boresight submode with the radar scan pattern and the associated HUD symbology. When you lock onto the target, you will get a TD (Target Designator) box around the target. This box cues you to the target's position. When the target is outside the HUD with the radar still locked on, the TD box turns into a locator line that originates in the gun cross. This locator line points to the target.

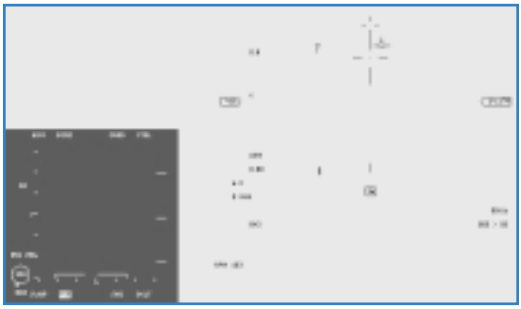


Figure 13-3

Boresight is one of the most commonly used ACM modes because it is very precise. You can lock up the intended target with precision due to the tight scan pattern of the Boresight mode. This mission should start in the RWS mode of the FCR, but if not, press [to get to "FCR" on the MFD. Next, press F1 to cycle through the air-to-air radar modes until "ACM" appears. Then press F8 to cycle through the ACM submodes until "BORE" appears next to "ACM."

Vertical Scan ACM Submode

The next ACM submode is the Vertical Scan (10X60). In this submode, the radar is placed into a vertical sweep 10° wide by 60° vertically. The 60° vertical sweep runs from 10° below the gun cross to 50° above. When you enter the Vertical Scan submode, the HUD will display a vertical line, as shown in Figure 13-4.

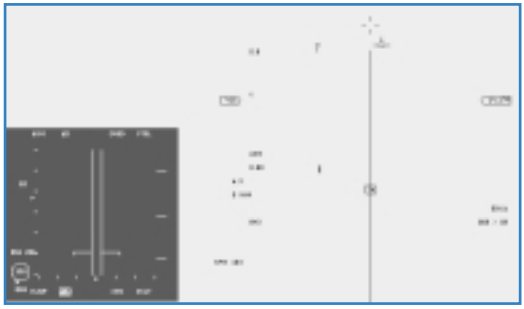


Figure 13-4

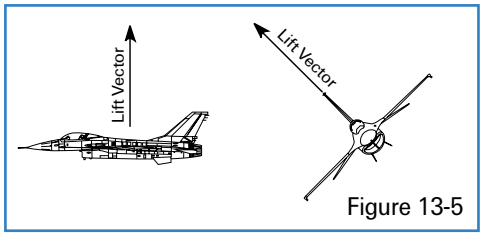


Figure 13-5

The Vertical Scan submode is extremely useful because it can lock up targets that are along your lift vector. The lift vector, shown in Figure 13-5, is a vector line that extends straight out of the cockpit.

Whenever you pull a target toward your nose at high G—and you'll do this often—you wind up pulling them along your lift vector. As you pull your nose toward a target at high G, you can use the Vertical Scan submode to lock them up before they get into your HUD. Another use for this submode is when you do not have enough energy (you cannot turn at a fast enough rate) to get your nose on the target. Use Vertical Scan in this situation to lock the radar onto the bandit and shoot a missile, even though you may not have the energy to point your nose at the target.

To get to the Vertical Scan submode, press [until you see "FCR" on the MFD. Next, press F1 to cycle through the air-to-air radar modes until "ACM" appears. Then press F8 to cycle through the ACM submodes until "60" appears next to "ACM" along with a tight vertical scan pattern in the radar display.

HUD Scan ACM Submode

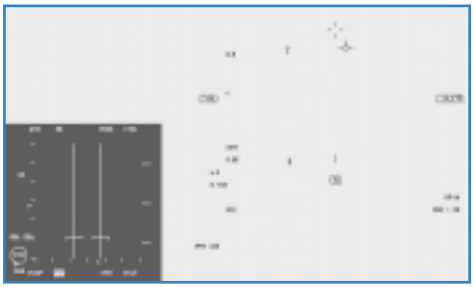


Figure 13-6

The HUD Scan submode is used to lock up any targets that are in a 30X20 field of view. This field of view essentially consists of the Falcon HUD, as shown in Figure 13-6.

This mode is the least useful of all the ACM modes because it is less precise and slower than the Boresight submode. In Boresight, the radar beam sweeps straight out. When it touches a target within 10 nautical miles, it immediately locks on. In the HUD Scan submode, the radar must sweep a pattern to cover the 30X20 area. This, of course, takes time—and time is not something you can afford to waste in air combat. It is far better to go to Boresight and lock up the target quickly than to stooge around in the HUD Scan submode waiting for the radar to find the target.

To get to the HUD Scan submode, press [until you see "FCR" on the MFD. Next, press F1 to cycle through the air-to-air radar modes until "ACM" appears. Then press F8 to cycle through the ACM submodes until "20" appears next to "ACM."

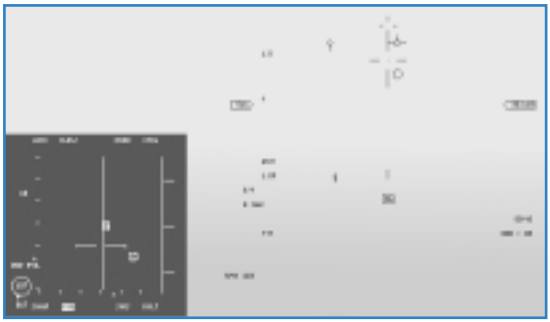


Figure 13-7

Slewable ACM Submode

The Slewable ACM submode provides a slewable or moveable 20X60 scan pattern. When you enter this mode, the HUD shows a vertical cross similar to the Boresight submode cross but with one major difference. In the Slewable ACM submode, a circle will appear somewhere on the cross. This circle represents the center of the 20X60 scan pattern. Figure 13-7 shows the Slewable ACM radar sweep and the associated HUD symbol.

Slewable ACM is a very useful radar mode. It is very different from the other ACM submodes because it is not always used to lock up a target that you see. In fact, this is the only ACM mode that is normally used when you do *not* see a target. The primary use of the Slewable ACM submode is to delouse a piece of airspace that you are going to fly into. For example, let's say you have just bombed a target and are turning to egress the area and head home. As you make your turn to your egress heading, change to the Slewable ACM submode to make sure no bandits are in the area. You can move the scan pattern from level to high above your flight path and then from one side of the HUD to the other. You must do this slowly, though, because it takes the radar time to complete the sweep. Using this technique, you have now swept the area close to you clean of bad guys. You can now change to a longer range (non-ACM) radar mode to look for targets.

Another use for Slewable ACM is when you have a RWR (Radar Warning Receiver) indication that a bad guy is nearby and at a specific azimuth within ±60° of your nose. Use Slewable ACM in this case to find the target quickly.

To get to the HUD Scan submode, press [until you see "FCR" on the MFD. Next, press F1 to cycle through the air-to-air radar modes until "ACM" appears. Then press F8 to cycle through the ACM submodes until "SLEW" appears next to "ACM."

The two primary air-to-air radar modes used for finding BVR (Beyond Visual Range) targets are RWS (Range While Search) and TWS (Track While Scan).

THE B-SCOPE

Both RWS and TWS radar modes are quite complex, but before we go into a detailed description of their radar symbols, you must first understand the concept of a B-scope display. RWS and TWS both present their data in a B-scope format. A B-scope is the best way to present the information from the F-16 radar. So what is a B-scope and how do you read it? It is far easier to answer that question if we first discuss what a B-scope is not. A B-scope does not provide a complete overhead view of the air battle. A B-scope cannot show targets at all altitudes. Finally, a B-scope is limited in both range and azimuth. Figure 13-8 shows a B-scope and how it takes the F-16 radar and presents it on the scope.

Notice in Figure 13-8 how the angular radar beam is pulled apart at the base and spread along the bottom of the scope. When looking at a B-scope, the nose of your jet is not at in the center of the bottom part of the B-scope. The nose of the jet is instead spread along the entire bottom of the B-scope. For example, a target that drifts straight down your scope to the bottom of the B-scope is on a collision course with your jet and will collide with you if you are at the same altitude. Figure 13-9 shows how this geometry works.

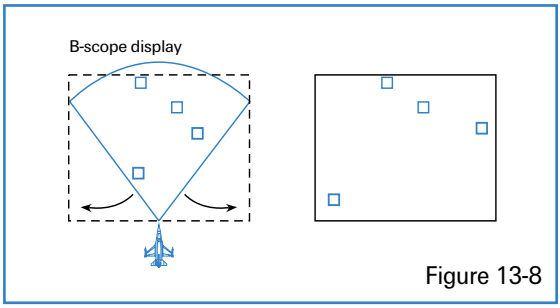


Figure 13-8

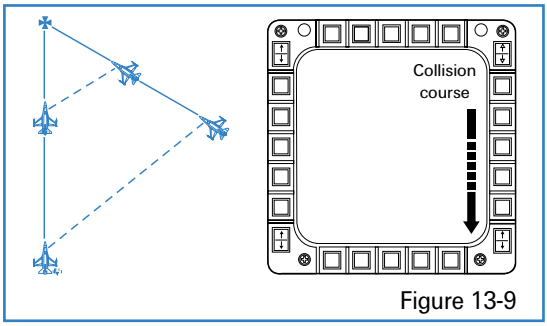


Figure 13-9

Also notice in Figure 13-9 that the beam is only scanning a very specific volume of airspace. It does not reach all the way to the earth or up into space. The pilot must physically move the antenna's elevation in order to cover specific altitude bands. The B-scope picture represents a limited overhead view of the volume of airspace that your radar sweep pattern is covering. I'm afraid that is all that it represents. For these reasons, the B-scope takes a lot of practice to use effectively.

RWS

Range While Search uses a B-scope display and is the primary F-16 BVR radar mode. RWS is used to find targets and point the AIM-120 AMRAAM and AIM-7 Sparrow missiles. In the RWS mode, you have several search options:

- Range
- Azimuth
- Bar scan
- Radar elevation tilt

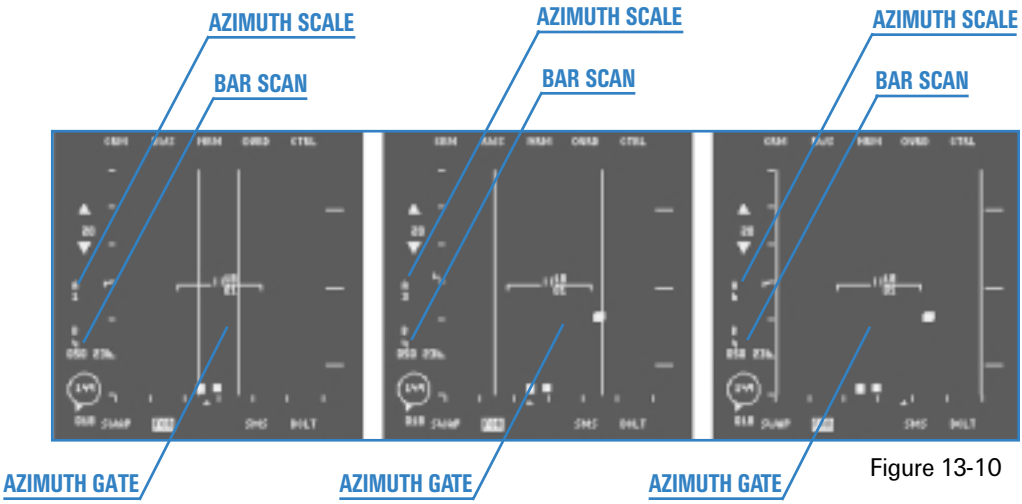


Figure 13-10

In RWS, you can select one of the following range modes: 10, 20, 40, 80 or 160 miles. Most air-to-air targets, however, will not show up on radar until they are well inside of 40 nautical miles. Decrease the radar range by pressing F3 or increase the range by pressing F4.

The next search option is azimuth sweep. In RWS, you can use ±10°, ±30° or ±60° search volumes. Figure 13-10 shows all of these azimuth sweep display options. When you reduce the azimuth sweep, notice how azimuth gates appear on the scope. You will not see targets outside of these gates. Also in Figure 13-10, note the range, azimuth scale and bar scan numbers down the left side of the scope. Change the azimuth sweep of the radar by pressing F8.

In the F-16, you have three sweep options for the radar beam itself. You can select to sweep it straight back and forth. You can have the radar beam sweep one way and then step up a few degrees and sweep back the other way. Or you can have it step up four times after each sweep. These bar scan options are called 1-bar, 2-bar and 4-bar scans, respectively. The number on the bottom of the left side of the scope shows which option you have selected. Figure 13-11 shows how the beam is moved for each bar scan option.

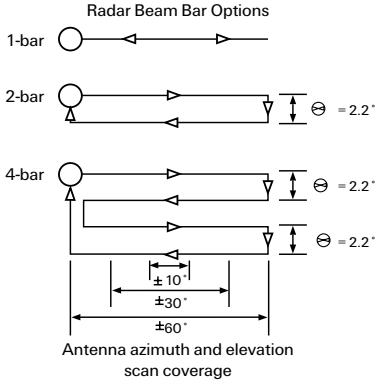


Figure 13-11

Remember that it takes time for the radar to complete a full sweep across the scope. If you select 4-bar (which is the most widely used), it will take longer—in fact, twice as long as in 2-bar—for the radar to complete the sweep and start again. That is why you have the different bar scan options. The

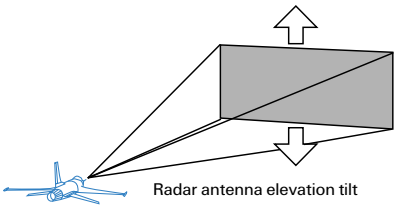


Figure 13-12

drawback is that for a given radar elevation tilt, you are covering less altitude. This can be a major drawback but must be weighed against your need for a fast sweep. As a rule of thumb, if you know where the bandits are, then select 2-bar. Normally, however, it is best to stay in 4-bar scan.

The last option available is the antenna tilt angle. Figure 13-12 shows how you can tilt the entire search volume up and down.

In the F-16, you can tilt the elevation of the entire radar bar scan pattern. Press F5 to tilt the radar down. Press F6 to center the radar at the aircraft altitude. Press F7 to tilt the radar up. You can see the altitude that you are covering with the radar by looking at the radar cursors

The radar cursors are two small vertical lines that can be slewed (moved) in the B-scope display. These cursors are used to lock onto targets displayed. We'll discuss the radar cursors later. For now, let's get back to the radar antenna elevation coverage. Just to the right of the cursors are two small numbers arranged vertically. These numbers show the top and bottom altitude of the bar scan at that cursor range. In other words, these numbers show the minimum and maximum altitude that you are searching with the radar at the radar range of the cursors. Figure 13-13 shows the radar cursors with the altitude numbers just to the right of the cursors.

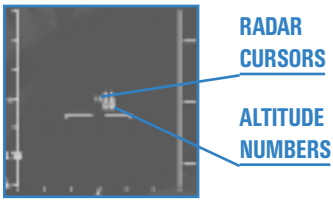


Figure 13-13

Moving the radar cursors does *not* change your elevation tilt or increase the volume of airspace that you are searching. The numbers next to the cursors will change, of course, when you move the cursors up and down the scope. This is because the elevation volume of the radar is angular. For a given bar scan, you are searching a specific volume of airspace that is narrower closer in and wider farther out. This concept is illustrated in Figure 13-14.

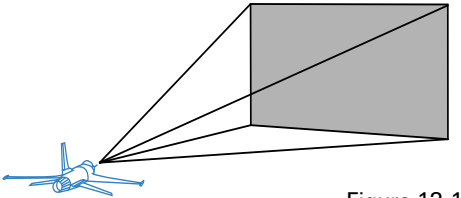


Figure 13-14

When you move the cursors, you can see where the top and bottom of your elevation scan volume is at a specific range.

RWS TARGETS

RWS targets start out life on the scope as small squares. Each time your radar beam passes over the target, another square is generated and displayed. (It's really not that simple, but this is all you need to know for this training mission.) The old square that was generated on the last sweep fades as it stays on the scope for a few radar sweep cycles, creating what F-16 pilots call "target histories." These histories define the path that the target is taking down the scope. When you look at the RWS display, you may see many target squares—but remember, they are not all targets since some are target histories. Figure 13-15 shows the RWS radar cursors, targets on the scope and target histories.

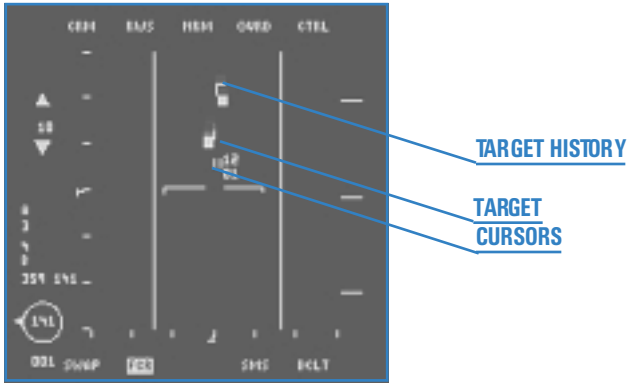


Figure 13-15

Use the radar cursors to lock onto the target. Slew the cursors over the target square with ↑, ↓, ← and →. After getting the cursors over the target square, lock onto the target by pressing 0 on the numeric keypad. When you designate a target, the RWS display will change to RWS-SAM (Situation Awareness Mode).

RWS-SAM MODE

RWS-SAM is similar to RWS, but in SAM mode, the radar will track a designated target (called bugging a target) while it still looks for additional targets. Because RWS-SAM has to track a target, however, it can no longer search the same volume of airspace as before. For this reason, the azimuth gates will appear on the scope showing the reduced radar azimuth coverage.

A few other things change besides the azimuth sweep. The biggest difference you will notice is that you now have a target designated. A TD box or locator line appears in the HUD, and the square target symbol changes to an arrow-shaped target with a velocity vector sticking out the nose. Next to this target is a number representing the altitude of the target. The radar cursors are still present, and you can use them to lock onto a different target.

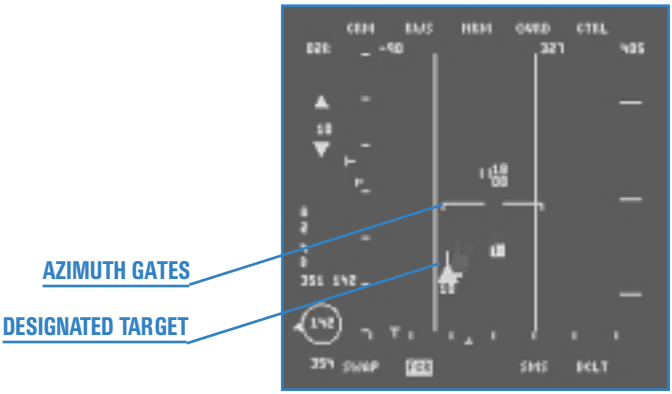


Figure 13-16

TWS

TWS (pronounced "twiz") is a radar mode that tracks multiple targets at the same time. In RWS-SAM, you can track only one target. In TWS (Track While Scan), you can track up to 16 targets simultaneously. That's the good news. The bad news is that you can't search the same volume of airspace in TWS. TWS only allows you to select ±10° 4-bar scan or ±25° 3-bar scan. The other problem with TWS is that the tracking data on each target is not as good as in SAM. You can track a single target in SAM more dependably than you can multiple targets in TWS.

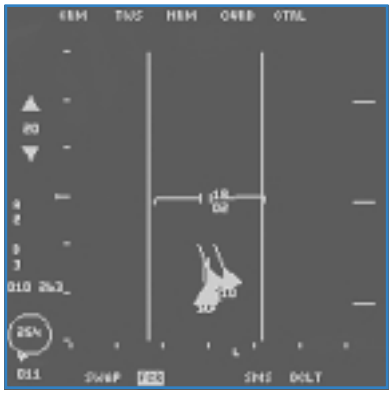


Figure 13-17

To get to the TWS mode, press F1 until you see "TWS" on the MFD. In TWS, you can get a TD box on a target by designating or "bugging" a target. Even though all targets are being tracked in *Falcon 4.0*'s TWS, you still have to place the radar cursors over a specific target and "bug" that target in order to get your air-to-air missiles pointed at that target. After you bug a target, you will get a TD box or locator line (depending on whether or not the target is in the HUD field of view) on the target.

VS

The last and certainly least radar mode is Velocity Search. To get to the VS mode, press F1 until you see "VS" on the MFD. This radar mode changes the MFD from a B-scope to a modified A-scope. An A-scope shows closure (also called overtake). Closure is simply how fast you are closing on a target. In VS you can select either 1,200 or 2,400 knots per hour closure. This means that if you select 1,200 knots on the scale on the left side of the scope, then a target that appears halfway down will be closing on you at 600 knots. The VS scope displays azimuth in the same way as RWS and TWS, but the scope does *not* display range. A Cessna that is 30 miles from you appears at the bottom of the scope while a MiG-25 that is going 600 knots 5 miles away will appear at the top of the scope. It is my theory that this mode was created by a bunch of Westinghouse engineers as a joke on fighter pilots. If you think about it that way, VS is not too bad. I really have no idea how you would use it in combat. Figure 13-18 shows the VS scope with various targets.

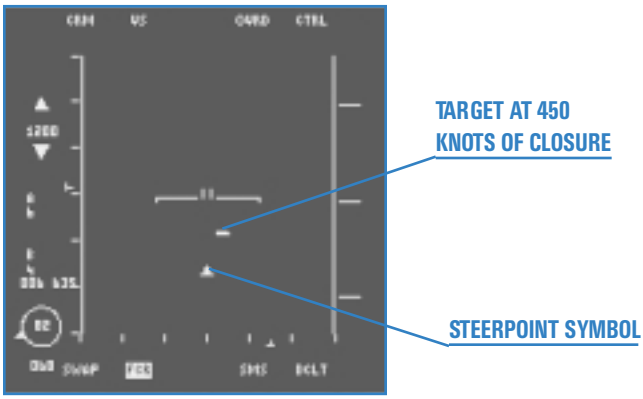


Figure 13-18

TRAINING MISSION OVERVIEW

This mission starts with the jet in the air facing multiple air targets at various aspects and ranges. You will practice using the ACM master modes to lock the targets within visual range and the other master modes to lock up the BVR targets.

INITIAL CONDITIONS

- Airspeed: 400 knots
- Altitude: 15,000 MSL
- Throttle Setting: Mid-range
- Configuration: Gear up, 4 AIM-120s and 2 AIM-9s
- Weapons Mode: NAV (you must call up the FCR mode desired)

MISSION DESCRIPTION

This training mission presents multiple targets. Press Shift P to "freeze" the game. The Freeze mode has been included in *Falcon 4.0* to help you learn radar and other complex F-16 systems. When you first enter the training mission, the jet will be moving. To simply pause the simulation,

press P. This will stop everything. Unfortunately, radar is nonfunctional in Pause mode. On the other hand, the radar and other avionics still work in Freeze mode. To exit Freeze mode, just press Shift P again.

The first modes to practice with are the ACM submodes. They are used to lock onto a target that can be seen visually by the pilot. Use the 30X20 HUD submode, the 10X60 Vertical Scan submode and the 20X60 Slewable ACM submode along with the Boresight submode to lock onto visual targets.

The next modes to practice are the longer range RWS and TWS modes (or even VS if you want). Use the radar cursors and the radar elevation tilt to find and lock onto targets.

Here are the steps to accomplish this training mission. Keep in mind that it may be best to accomplish this mission the first time through in Freeze mode (Shift P).

1. Load training mission "13 A-A Radar Modes" from Tactical Engagement.
2. From the 2-D Cockpit view (2 key), press F1 untl you get into the ACM master mode.
3. The first ACM submode is the 30x20 HUD scan mode. When you first enter ACM, "NO RAD" will be displayed on your HUD and radar display. The radar is not radiating to allow you to select the ACM submode you want before locking onto a target. When you select the submode you want, the radar will automatically turn on.
4. Enter the first ACM submode, the 30X20 HUD scan submode. Since multiple targets are out in front of you, the radar should immediately lock onto the first targets it sees without further action from you. You will hear your VMS call "LOCK–LOCK."
5. Cycle through all the ACM submodes by pressing F8.

The ACM radar submodes are used to lock the radar onto a target that you see. The most useful ACM submode is Boresight. When you see a target, go into the Boresight submode as you are turning to put the target in your HUD. Once the Boresight cross appears in your HUD, place the target under the cross and the radar will lock on. To lock on a target that is straight up your lift vector and out of the HUD, switch to the Vertical Scan submode. The Slewable submode is the one exception to the ACM radar modes. Slewable is primarily used to find a target you do not see. In this training mission, however, you can practice using Slewable by entering the submode and then using ↑, ↓, ← and → to slew the search volume around. Try locking up the targets in this mission using Slewable and you will see that it usually takes longer to lock them up than it does in the other ACM submodes.

6. After first practicing with the ACM submodes, press F1 to call up the RWS mode. This mode is used to find BVR targets, but it will also display the targets that are close in. Note that in the RWS, TWS and VS modes, you can change the range scale in two different ways. The first is to press the OSB next to the range mnemonic on the left side of the FCR MFD display. The two arrows above and below the selected range scale increase and decrease the range. Another

way to change the range scale, however, is to move the radar cursors to the top or bottom of the scope. This bumps the scale further out or closer in. Figure 13-19 shows the range scale buttons and how the cursors are moved to change the range scale.

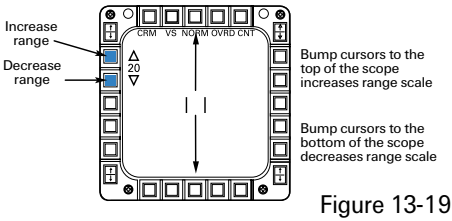


Figure 13-19

7. Change the azimuth sweep by pressing F8 or by pressing the OSB next to the azimuth readout. As the you change the azimuth sweep, notice that some targets near the edge of the scope disappear since you are no longer seeing them with the radar.

8. Change the bar scan options by pressing the OSB next to "B" on the left side of the MFD. This button cycles the bar scans in RWS and VS between 1-bar, 2-bar and 4-bar. Remember that increasing the bar scan level will increase the elevation scan of the radar (in other words, you are searching more altitude).

9. Practice tilting the radar. These keys do not increase the search altitude; they tilt or move the entire beam up (F5), level (F6) or down (F7). Figure 13-20 shows how the beam is tilted.

Notice that when you tilt the beam, the altitude coverage numbers beside your radar cursors change. As you move the beam and give the radar time to sweep, you can detect targets that were not visible on the radar when the mission started.

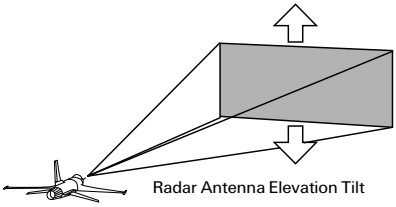


Figure 13-20

10. Lock up targets on the radar by slewing the radar cursors over the target square using ←, →, ↓ and ↑. When the cursors are over the target, press 0 on the numeric keypad once to bug the target. Press 0 again to lock the target.

This mission was designed for you to go through all the radar options and practice detecting and locking onto targets in all of the FCR master modes.

MISSION 14: 20MM CANNON (AIR-TO-AIR)

This mission will show you how to shoot down enemy aircraft with the F-16's 20mm cannon. This gun was first developed for use on the 1960s-vintage F-104 Starfighter and is still in use today by every U.S. fighter.

GUN SIGHT THEORY

A gun is a simple weapon. You pull the trigger, and the gun shoots straight out in front of you on a predictable path. When you shoot a bullet, it travels in a straight line and is primarily affected by two forces: gravity and drag. In other words, a bullet in flight will get pulled toward the center of the earth by gravity and will start slowing down the millisecond it leaves the gun barrel because it keeps banging into air molecules. The results are easy to calculate and very predictable. The movement of the firing platform (your jet), the rotation of the barrel, and even the alignment of the planets are negligible and irrelevant.

Something must be complicated in all of this, but it is not the gun you're firing. The complicated part of aerial gunnery is this prediction stuff. The future event that is difficult to predict is the target's path through the sky. Intersecting the predictable bullet with an unpredictable (or at least difficult to predict) target is a problem that has befuddled fighter pilots since they first strapped machine guns on biplanes.

Modern fighters such as the F-16 have aiming references called gun sights. These references are displayed in the HUD to help the fighter pilot get bullets on the target. The problem of target prediction doesn't go away when you use a gun sight, but it is minimized. So how do they work? Gun sights provide a reference for shooting bullets to a point in space where the target is going to be (not where the target is now). The gun sight computer knows your cannon and displays an aiming reference in the HUD based on the speed and range of its bullets.

Bullet characteristics are an important factor for gun sight calculations, but the biggest factor by far in providing an aiming cue to the pilot is the range to the target. Just think of shooting clay pigeons with a shotgun. If the target is far away, you have to shoot much further out in front of the target since the shotgun pellets will take longer to get there. Conversely, you don't have to shoot very far ahead of a close-in target. The amount of distance that you have to aim out in front of the target is called "lead for target motion" or just "lead." Leading the target is the most important concept in aerial gunnery.

When you shoot clay pigeons with a shotgun, you look down the barrel of the gun to the aiming sight on the end. You use this sight to tell you where shotgun is aimed. This does not tell you how much lead you need on the target, but it does tell you how where you are aiming. In the F-16, you have a similar reference called the gun cross (as shown in Figure 14-1).

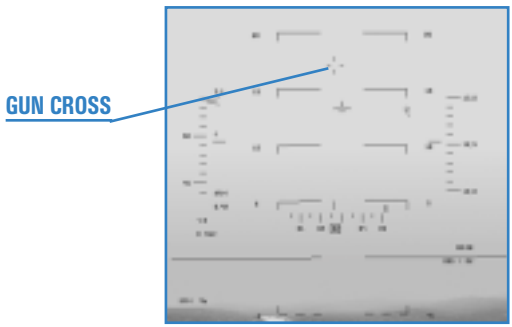


Figure 14-1

The HUD gun cross is like the gun sight on the end of the shotgun barrel. The Falcon gun cross represents the 20mm gun barrel. In other words, the gun cross shows the departure line of the bullets. The bullets will initially travel out the gun cross. Can you ever hit a target with bullets that are fired with the gun cross behind a target? The

answer is no. It is the same thing as trying to hit a clay pigeon moving through the sky with a shotgun that is pointed behind it—impossible. In both of these cases of pointing behind the target, the projectiles will pass well behind the target. Let's examine a case in which you point the gun cross directly at a target moving across the sky, as in Figure 14-2. Can you hit the target?

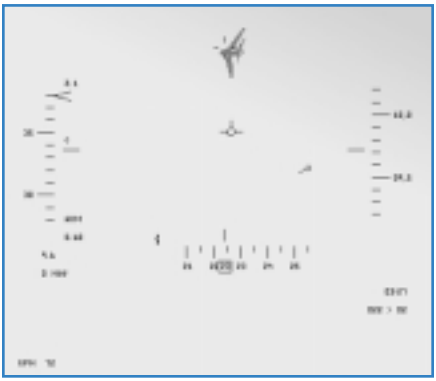


Figure 14-2

The answer is again no. The target, of course, will be gone when the bullets get to this location in space. Let's say you are trying to hit a target at about 2,500 feet. This target is passing at a 90° deflection angle from your jet. Let's say the bullet will take about 1.5 seconds to reach the target. If the target is traveling at 480 knots (approximately 811 feet/second), the bullets you fire directly at the target will pass 1,216 feet behind the target. This example is simplified a great deal, but it does illustrate why you cannot aim the Falcon gun cross directly at a moving target.

How about shooting a target that is flying straight and level (like a KC-10 tanker)? I know that most of us have had the urge to shoot a tanker sometime. Don't be ashamed—it's a universal feeling, kind of like the urge to pop that bubble wrap stuff. Anyway, if you are directly behind a non-maneuvering target, you can point the gun cross straight at the target. All you need to adjust for is gravity.

The gun sights in the F-16 HUD are there to help you aim the gun cross the correct distance out in front of a maneuvering target. Leading the target is not the only thing you need to hit a turning target with the 20mm gun. You must meet two other conditions besides lead: range and plane of motion. Range is simple. You must be in range in order for the bullets to get to the target, somewhere inside of 6,000 feet.

The other parameter you must solve is plane of motion, which means that you must be turning with the target in the same plane. Figure 14-3 shows the target's plane of motion. If the target changes planes, then you must change planes also in order to hit the target with the cannon.

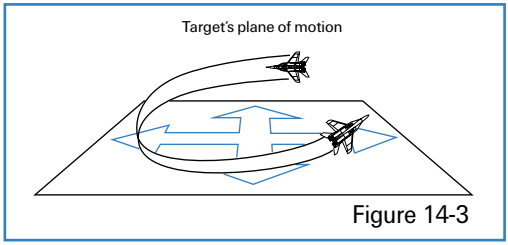


Figure 14-3

In order to understand why this is true, let's go back to our clay pigeon example. When you are swinging your shotgun out in front of a clay pigeon, you are moving it in the pigeon's plane of motion. Think of how hard it would be to hit a clay bird with a shotgun if the target were moving across the horizon and you were moving the gun vertically.

Even if you could determine the proper lead angle, it would be very hard to shoot at the right instant to get a hit. The same thing works for aerial gun shoots. You must be moving the gun in the target's plane of motion in order to hit the target. The three things you need, then, for a successful gunshot: the gun must be out in front of the target (lead), the target must be in range, and you must be moving the gun (your jet) in the target's plane of motion.

FALCON GUN SIGHTS

The following three gun sights are available to help you point your gun out in front of the target: the LCOS, the EEGS and the Snapshoot line. We will discuss each one, but let's talk about how to call them up in *Falcon 4.0*. Press Enter until "EEGS" appears in the HUD. Cycle one of the MFDs until you see "SMS." Click that OSB.

LCOS

LCOS stands for Lead Computing Optical Sight and is shown in Figure 14-4.

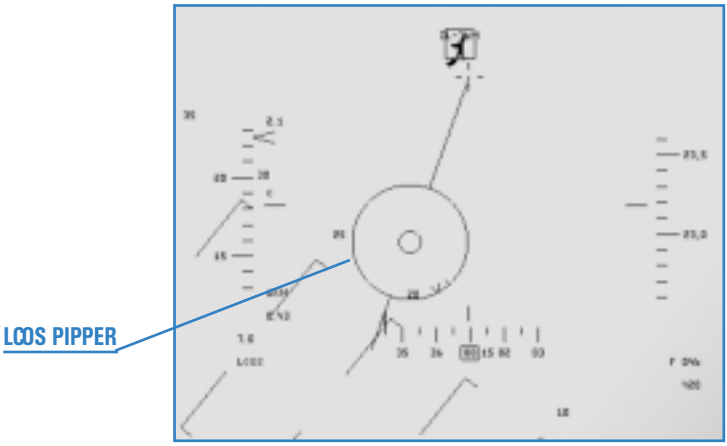


Figure 14-4

The LCOS pipper essentially provides a reference target where the gun barrels are currently aimed if the shooter (you) and the target (the other guy) do not change parameters (airspeed, G, range, etc.) for one bullet's time of flight. What it means is that the LCOS pipper is accurate if you and the target keep flying the same path at the same speed for the time it takes for the bullets to leave your gun and arrive at the target. This sounds bad, but it's just the way all gunshots work. Back to our clay pigeon example. Let's say you have the perfect aim out in front of a clay pigeon with a shotgun and just as you shoot, a big gust of wind changes the path of the target. In this example, the shot might miss because the aimpoint you used for the shot is no longer valid. During the time it takes for the pellets to arrive at the target, the target has changed vectors. This is what LCOS is all about. It is only good if everything stays constant through the time-of-flight for the bullets.

This may lead you to believe that the LCOS pipper is not a very good aiming reference. This is not true. Most 20mm gunshots have bullet time-of-flights of between 0.5–1.5 seconds. If the enemy pilot does not change G, airspeed or maneuver out of plane in this amount of time, the bullets will shred his cranium. The target has a tough task to avoid being hit by the bullets for several reasons.

The first is that your gun has a very high rate of fire, 100 rounds per second. The second is that the bullet's time of flight is very fast. The third is that the gun has a dispersion pattern of 6 milliradians, which means that 80% of the bullets will hit within a 6-foot circle at 1,000 feet. The F-16 cannon, in other words, has a built-in "shotgun type" dispersion pattern that is designed to hit fighter-sized targets. For all these reasons, you have a good chance of getting a hit when you shoot with the LCOS pipper on the target.

EEGS

EEGS (pronounced "eegz") is a gun sight that combines some elements of the LCOS sight with what is called a predictor sight. A predictor sight is a gun sight that will predict the location of a maneuvering target in space one bullet's time of flight in the future (which is tough unless you have a mind-meld with the enemy pilot). EEGS (Enhanced Envelope Gun Sight) is not a predictor but is very close to being one as well as a great all-around aiming reference. The EEGS gun sight is shown in Figure 14-5.

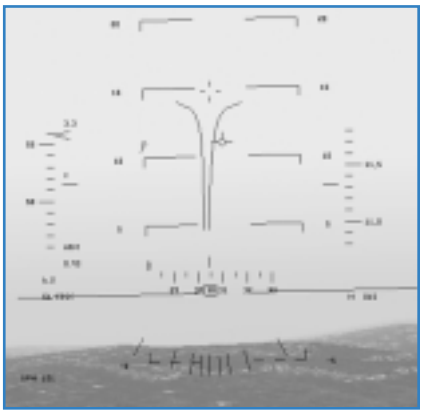


Figure 14-5

The primary feature of the EEGS sight is the funnel. The EEGS funnel provides the pilot with a quick reference to help line up in the target's plane of motion. It's also a great reference for getting the gun cross out in front of the target. The correct gunshot solution exists when the wings of the target are just touching the funnel lines. When this occurs, you are aiming the proper distance out in front of the target—it's that simple. In addition, when you hold the target in the funnel, you are also in plane with the target.

What makes the funnel so good? The funnel is superior to every other gun sight mentioned when the radar is not locked on to the target. In fact, the funnel gun sight works well with or without a radar lock. This is not true of the only other viable F-16 gun sight mode, LCOS. If you do not have a radar lock with LCOS, the target's G and airspeed are assumed to be the same as yours. While this is bad enough, what's worse is that the target is assumed to be at 1,500 feet when the radar is not locked on. What this means is that the LCOS sight is almost always lying to you when the radar is not locked on (unless the target just happens to be 1,500 feet away).

EEGS, on the other hand, provides a cue in the form of the funnel to get the target to the proper range. Remember that when the wingspan of the target is touching the funnel lines, you are at the correct range for a shot. What about aircraft with different wingspans? Well, the wingspan is set to 35 feet. This wingspan is right in between the wingspan of the F-16 (32 feet) and the F-15 (41 feet). But it really doesn't matter anyway because when using the EEGS funnel, you fire a burst and move the target through the funnel. This technique accounts for differences in target wingspans (more on technique later).

In addition to the funnel, the EEGS sight also has a set of MRGS lines (Multiple Reference Gun Sight) lines at the bottom of the EEGS display. The MRGS lines help you line up in the target's plane of motion. Another EEGS feature are the small "+" and "-" signs that appear when you are locked onto the target. These symbols are essentially a 1 G (+) and 9 G (-) pipper. If the target is at 9 Gs, the 9 G pipper provides an accurate reference for a gunshot. Most of the time, however, the target will be somewhere between 1 and 9 Gs so the aiming solution will be somewhere in between these pippers.

SNAPSHOOT LINE

The Snapshoot line is an aiming reference that is not very useful against maneuvering targets. The Snapshoot line is shown in Figure 14-6.

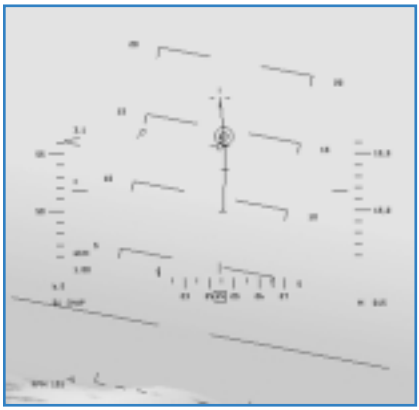


Figure 14-6

The Snapshoot line essentially shows an artificial tracer line of bullets (without your actually having to fire). This tracer line has time-of-flight tick marks at 0.5, 1.0 and 1.5 seconds respectively. In addition to these tick marks, a pipper appears on the Snapshoot line when the radar is locked to the target. If the radar locks onto a target at 1,500 feet and calculates that the bullet will take 0.8 seconds to travel that 1,500 feet, a pipper will appear on the Snapshoot line at that range (in between the 0.5 and 1.0 second tick marks). The Snapshoot line, therefore, essentially shows the history of where the gun cross (your gun barrels) have been. The operative word here is "history." It does not give you a prediction of where to shoot out in front of the target. The only thing it provides is a history of where you have been pointing the gun.

TRAINING MISSION OVERVIEW

In this training mission, you will practice using the EEGS and LCOS symbology to shoot down enemy aircraft. The mission will present several target problems simultaneously. The object is to eventually practice gunshots on all of these targets, but start by pursuing only one target. After finishing off the first target, reset the mission and select another target problem.

INITIAL CONDITIONS

- Airspeed: 400 knots
- Altitude: 10,000 MSL
- Throttle Setting: Mid-range
- Configuration: Gear up and clean
- Weapons Mode: NAV

MISSION DESCRIPTION

This mission starts with three different aircraft in front of your jet. These different targets allow you to practice various gunshot setups. When the mission starts, a Tu-16 Badger bomber will be almost directly on your nose. This target will start a gentle turn. The next target is a MiG-29 Fulcrum that will start line abreast with the Badger, but the Fulcrum will start a more aggressive turn when the mission starts. Both of these targets are at low aspect (that is, you are looking at their tails). The last target is an IL-76 that is low at 9,000 feet and coming straight at you. In this mission, since you will start at a similar speed with the target aircraft, overtake will not be a problem if you watch your power setting. The IL-76 Beagle, however, is a head-on target for you to practice difficult head-on shots.

Here's how it's done for the low aspect and beam aspect targets (the Tu-16 and the MiG-29):

1. Load training mission "14 20mm Cannon (A-A)" from Tactical Engagement.
2. Call up Dogfight mode by pressing [D]. EEGS and ACM radar will appear.

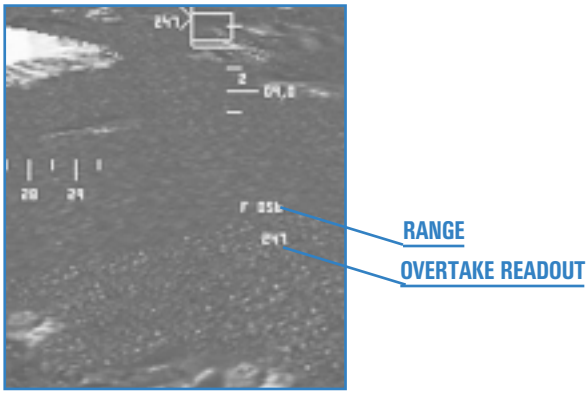


Figure 14-7

3. Do *not* look at your EEGS or LCOS symbology yet. Since all gunshots start at the gun cross, the first step is always to place the gun cross in front of the target. An easy way to do this is to picture a line extending straight out of the nose of the target. The gun cross should be placed along that imaginary line.

   Noting your range and overtake, use the throttle to stabilize behind the target. Figure 14-7 shows where the range and overtake are displayed in the HUD.

4. Use your EEGS or LCOS symbology to get a precise gun solution. In EEGS, start with the target at the bottom of the funnel (pulling a big lead angle) and let the target fly up the funnel by easing off the G. Shoot a 2-second burst as you ease off on the G and let the target fly up the funnel by pressing [/] or joystick button 1. Figure 14-8 shows this technique.

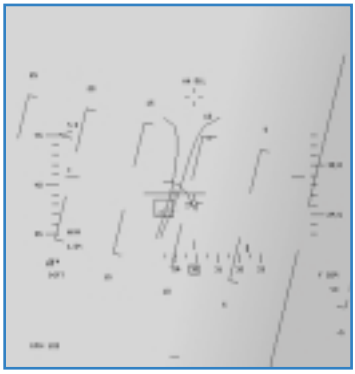


Figure 14-8

With LCOS, you should get a radar lock on the target. The procedure is the same, however, with or without a radar lock. Fly the target under the LCOS pipper by placing the gun cross out in front of the target's nose. When the LCOS is over the target, shoot, adjust and then shoot. This means that you should fire a 1-second burst and then watch where the tracers go. Make an adjustment and then fire another short burst.

5. When the target maneuvers, always readjust your aim by moving the gun cross as discussed in Step #3.

Here is how to take a high line of sight rate shot (the IL-76):

1. Again, look at where the target is going and place the gun cross on an extended imaginary line that sticks straight out the nose of the target.

2. Don't even try to use EEGS or LCOS to line up the shot. When taking head-on shots, the gun cross is your only good aiming reference. Place the gun cross out in front of the target and begin firing early. When the gun cross gets to the nose of the target, cease firing.

Be very careful. If you are taking a head-on gunshot on a fighter target, he may be shooting back at you. If not, there is the danger of midair collisions. Figure 14-9 shows a head-on shot against the IL-76 target.

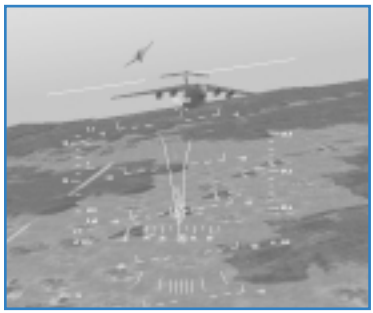


Figure 14-9

Use these procedures to practice gunning all the targets. Try using both EEGS and LCOS with and without radar lock-on. If you get bored and need to waste some time, you can also try using the Snapshoot line.

MISSION 15: AIM-9 SIDEWINDER

In this training mission, you will learn how to shoot the AIM-9 Sidewinder missile. The AIM-9 is a heat-seeking missile that has steadily evolved since it was first developed in the 1950s. Two different models of the AIM-9 are featured in *Falcon 4.0*: the older rear-aspect AIM-9P and the newer all-aspect AIM-9M. The difference in these missiles can be seen in their envelopes or WEZ (Weapon Engagement Zone) shown in Figure 15-1. The WEZ describes the area around the target in range and aspect that the missile can be successfully fired.

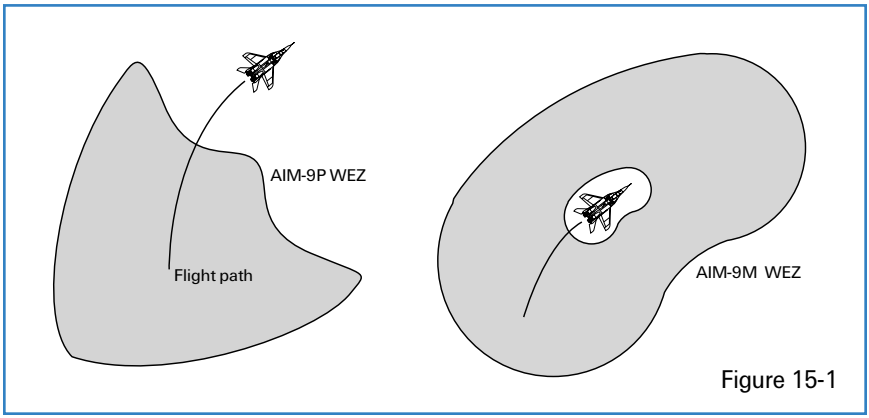


Figure 15-1

AIM-9s are very simple to understand and employ. Aircraft engines produce heat, and the AIM-9 seeker head tracks heat. The AIM-9P can only see the engine heat when looking up the target's tailpipe. The AIM-9M, however, can see the heat from the target's engine from all aspects or, in other words, from 360° around the target.

AIM-9 MECHANIZATION

The current model AIM-9 seeker heads can track targets before the missile is even released. The actual position of the seeker head is fed into the HUD so the pilot can see if the missile is tracking the intended target. This upgrade first arrived in the late 1970s and changed the way the missile was employed. Before this time, the seeker head of the older model AIM-9s (such as the "E" model used in Vietnam) was "caged" or fixed. The pilot pointed the missile at the target, got a heat tone and let it fly. The seeker head would "uncage" or gimbal to look for the target only after it left the rail. The pilot never really knew if the missile was going to track the target until it was fired.

Both the AIM-9P and the AIM-9M have seeker heads that uncage while the missile is still on the jet. The pilot can see the target in the HUD and then check that the missile is tracking the target. The position of the AIM-9 seeker head is displayed in the HUD as a diamond. This "missile diamond" is the primary AIM-9 cue to ensure that missile is on the target.

The other critical AIM-9 display in the HUD is the DLZ (Dynamic Launch Zone) bracket. This bracket tells you if you are in range for an AIM-9 shot. It is important to realize that this DLZ is only present with a radar lock on the target. Figure 15-2 shows Falcon AIM-9 HUD symbology.

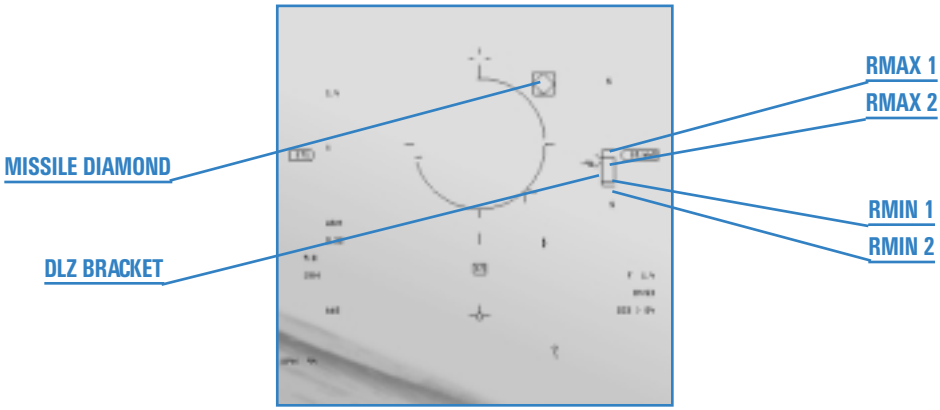


Figure 15-2

The DLZ bracket has several parts that are labeled in Figure 15-2:

- Rmax1 is the maximum range that you can shoot the missile at the target.
- Rmin1 is the minimum range that you can shoot the missile at the target.
- Rmax2 represents the top of the maneuver zone of the DLZ. Rmax2 is a more realistic maximum range for a target that is maneuvering.
- Rmin2 represents the bottom of the maneuver zone of the DLZ. Rmin2 is a better cue for minimum range for a target that is maneuvering.

The DLZ bracket only provides kinematic information on a potential missile shot. Kinematics refers to the ability of the missile to come off the rail and make it to the target—not *guide* on the target—just *get to* the target. Any shot between Rmax1 and Rmin1 can theoretically make it to the target. Shots between Rmax2 and Rmin2, however, have a higher probability of making it to a target that is maneuvering to avoid the missile. Remember that the AIM-9 is a heat-seeking missile and besides kinematics, or the ability to reach the target, the missile must also be able to track the *heat tone* generated by the target.

The heat tone is an audio signal. The heat tone is simply a tone fed into to the pilot's headset that provides feedback on the quality of the missile track. If the tone is faint, the missile is barely tracking the target (even though you can see the missile diamond in the HUD over the target). If the tone is loud, then the missile has a solid track. There is no other good rule of thumb for the heat tone except the level or intensity of the tone. You just have to get a feel for the AIM-9 heat tone.

This brings up a very important point about the AIM-9. You do need a radar lock on the target to provide DLZ information in the HUD, but you do *not* need a radar lock to shoot an AIM-9. The AIM-9 is a launch-and-leave heat-seeking missile. All you need to shoot an AIM-9 is to be in range and have a heat tone from the target. You can use your own eyes to estimate the range to the target for an AIM-9 shot where you can see the seeker head position in the HUD via the missile diamond. If the missile diamond is on target and you estimate that you are in range, shoot the missile. The exception to this procedure is the case of the rear-aspect AIM-9P. With the AIM-9P, you must also be behind the target (as illustrated in Figure 15-1).

While no-lock shots are possible and necessary at times, it does help to a have a radar lock for two reasons. The first is that a radar lock will provide you with the DLZ bracket, which is better than your eyeballs for estimating range. Second, the radar can be used to point the AIM-9 seeker head at the target so you won't have to point the jet at the target to get the AIM-9 missile looking in the right direction.

In *Falcon 4.0* the AIM-9 is *almost* always slaved to the radar. If the radar is not available, then the missile will find the first target it sees in the HUD and lock on. By using slave with a radar lock-on, the pilot has both a missile diamond cue over the target and a DLZ bracket (provided by the radar) to ensure that he is in range of the target. Remember that the missile diamond tells you where the missile seeker head is pointing.

HOW TO CALL UP YOUR AIR-TO-AIR MISSILES

There are two basic ways to view your AIM-9 missile symbology: the Dogfight mode and the stand-alone AIM-9 mode. To call up the AIM-9 modes in the stand-alone mode, press Enter until the AIM-9 appears. In the Dogfight mode, the AIM-9 is called up along with the EEGS gun sight for an air-to-air engagement. In Dogfight mode, as shown in Figure 15-3, you can use both the gun and the AIM-9 missile.

Call up the Dogfight mode by pressing D, which is like flipping the Dogfight switch on the F-16 throttle.

Only missile symbology is displayed in the other AIM-9 missile mode. In this stand-alone mode, you get a much cleaner AIM-9 display but you lose the EEGS gun sight. Figure 15-4 shows the AIM-9 missile mode.

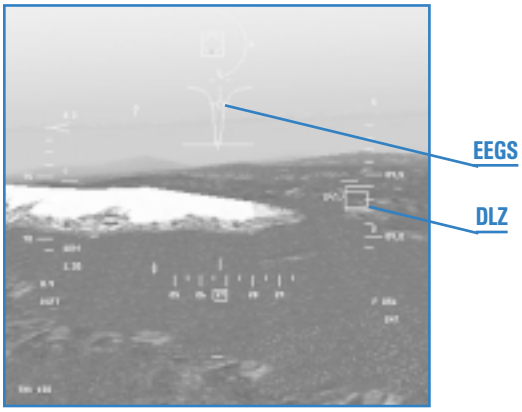


Figure 15-3

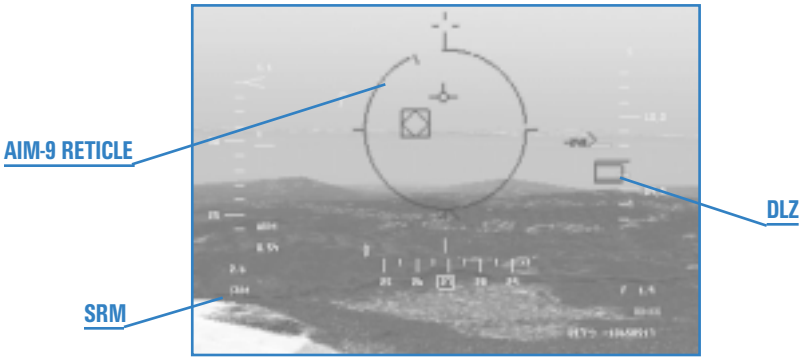


Figure 15-4

Call up the AIM-9 missile symbology by pressing Enter to cycle through your air-to-air weapons until an AIM-9 reticle appears. You can tell when you have AIM-9s because "SRM" (Short-Range Missile) will appear in the lower left corner of the HUD. In addition, the AIM-9 has a missile tone. As you continue to press Enter, you will cycle through all of the air-to-air missiles that you have loaded on your jet. When AIM-7s or AIM-120s appear, the label "MRM" (Medium-Range Missile) appears in the lower left corner of the HUD.

One last very important point. You can have both AIM-9Ps and AIM-9Ms loaded. Cycle between these two missile types by pressing T until "AAM" appears at the top of the left MFD. Now click on OSB-6 to step through all of the air-to-air missiles loaded on your jet. Note that as you press this OSB, the display will step through the missiles on all of the rails on the aircraft. For example, if you have two AIM-9Ps, two AIM-9Ms and two AIM-120s loaded, the first time you press OSB-6, the display will step to the next AIM-9P loaded. The next time you press the OSB, it will step to an AIM-9M, then the next AIM-9M and finally the AIM-120s.

TRAINING MISSION OVERVIEW

In this training mission, you will practice using AIM-9M and AIM-9P Sidewinders to shoot down enemy aircraft.

INITIAL CONDITIONS

- Airspeed: 400 knots
- Altitude: 5,500 MSL
- Throttle Setting: Mid-range
- Configuration: Gear up with 3 AIM-9Ps and 3 AIM-9Ms loaded
- Weapons Mode: NAV

Training Mission Aids

Two aids are available to assist you in this training mission. The first is the Labels function. To see the targets more easily, turn on labels by pressing Shift L. The labels are displayed over the vehicles and other objects.

The other aid is the Freeze mode. Enter Freeze mode by pressing Shift P to pause the simulation but still use the radar and all other avionics. If you are in Freeze mode, you can lock your Sidewinder onto the target but your plane will not move through the sky. You must press Shift P again to see the missile guide toward the target.

MISSION DESCRIPTION

This mission starts with three different aircraft in front of your jet. The targets are the same ones used in Training Mission 12, but in this mission, they are further away. The first target to pursue is the Tu-16 Badger bomber, which is in a gentle right-hand turn. The next is a MiG-29 Fulcrum which starts line abreast with the Badger but will start a more aggressive left-hand turn. Both of these targets are at low aspect (you are looking at their tails). The last target is the IL-76, which is slightly low and 4 nm away, coming straight at you.

In this mission, you can lock on the radar, which will point the AIM-9M seeker head at the target. The all-aspect AIM-9M can be used to shoot at all three targets. The AIM-9P, in contrast, is limited to rear aspect and can only be used when you are within 40° *of the target's tail.* The Badger and the Fulcrum are good targets to practice AIM-9P shots since they are presenting their rear aspects at the start of the fight.

The AIM-9 missile is very easy to use. Follow these steps:

1. Load training mission "15 AIM-9 Sidewinder" from Tactical Engagement.
2. Switch to Dogfight mode by pressing D.
3. Lock onto one of the targets using an ACM radar submode.
4. Freeze the simulation by pressing Shift P.
5. If you do not have the AIM-9P called up, press [until "AAM" appears at the top of the left MFD. Next, press OSB-6 until "AIM-9P" appears. The AIM-9P seeker head should slave to the target. Check to see that the missile diamond in the HUD is over the desired target
6. Listen for a distinct missile growl or tone.
7. Check your DLZ bracket in the HUD. The caret (which looks like a sideways "V") should be between Rmax1 and Rmin1.
8. Unfreeze the simulation by pressing Shift P. If you are not in range, push the power up and get closer to the target.

9. If you are in range and have a good heat tone, shoot—look—and shoot again if the missile fails to guide. Shoot the missile by pressing Spacebar or joystick button 2.

Practice taking shots with both AIM-9Ps and AIM-9Ms. Remember that the AIM-9P is a rear-aspect missile that can only lock onto the stern of the target, while the AIM-9M is an all-aspect missile that can lock onto the target from any angle.

MISSION 16: AIM-120 AMRAAM

In this training mission, we will discuss how to shoot the AIM-120 AMRAAM (Advanced Medium-Range Air-to-Air Missile). This radar-guided missile is the most lethal air-to-air weapon in the U.S. inventory. Developed in the 1980s by the U.S. Air Force, the AIM-120 is now carried on Navy and Marine Corps jets as well as fighters from many allied nations. The key feature of the AMRAAM (nicknamed the "Slammer") is its launch-and-leave capability. The AIM-7 Sparrow missile (which the AIM-120 replaced) requires the shooter to stay locked on the target all the way to missile impact. With the AIM-120, however, you can launch the missile and break radar lock on the target at a specific point during the missile's TOF (Time of Flight). This allows you to leave the fight or look for another target without hurting the missile's Pk (Probability of Kill). This capability gives you a significant advantage over fighters carrying the older AIM-7 type missiles.

The AMRAAM has a radar in the nose of the missile which can lock onto a target. Since this radar is much smaller than the radar in the F-16, it cannot track a target as far away as the F-16's radar. The F-16 therefore must first find the target and guide the AIM-120 to a point close enough for the AIM-120's smaller radar to acquire it. When it reaches this point, the missile becomes autonomous and guides without further help from the F-16. The basic AMRAAM HUD display is shown in Figure 16-1.

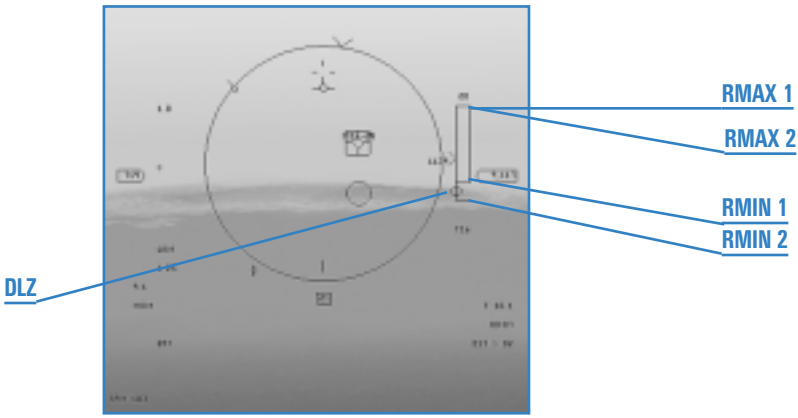


Figure 16-1

Notice that the AIM-120 display looks very similar to the AIM-9 display. Both missiles have a missile reticle and a DLZ bracket on the right-hand side of the HUD with basically the same information. The DLZ information displayed is identical for both missiles.

- Rmax1 is the maximum range that you can shoot the missile at the target.
- Rmin1 is the minimum range that you can shoot the missile at the target.
- Rmax2 represents the top of the maneuver zone of the DLZ. Rmax2 is a more realistic maximum range for a target that is maneuvering.
- Rmin2 represents the bottom of the maneuver zone of the DLZ. Rmin2 is a better cue for minimum range for a target that is maneuvering.

AIM-120 AMRAAM MECHANIZATION

We have discussed how the missile goes autonomous at some point in its TOF. Your HUD symbology will cue you when this key event in the life of the AIM-120 occurs. When you fire an AIM-120 at a target, a time countdown appears directly under the DLZ bracket. The countdown time is displayed on the HUD in two different ways depending on whether the missile is autonomous or not. Figure 16-2 shows where this time is read.

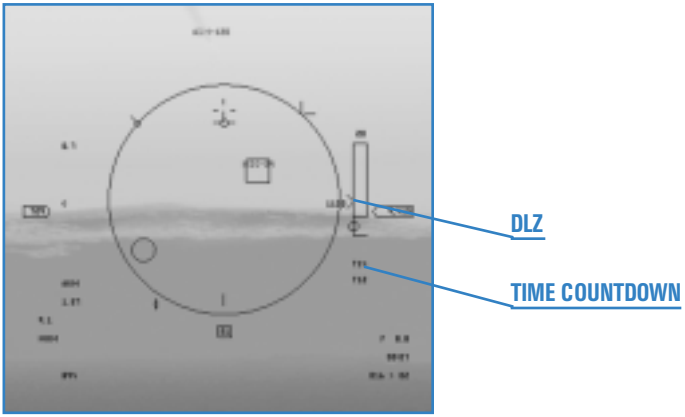


Figure 16-2

If an "A" is displayed in front of this countdown, the time is counting down the seconds it will take for the missile to go autonomous. After the "A time" counts down to zero, the missile can guide on the target without help from the F-16. When the "A-time" gets to zero, a new countdown in seconds starts with a "T" replacing the "A." The appearance of the letter "T" means that the missile is active and pursuing the target. The time that is now being displayed next to the "T" is the time in seconds to missile impact or time to the "Target." Any time you see a "T" in the HUD, you can break lock on the target. To review, the "A" countdown means time before the missile goes autonomous whereas the "T" countdown means time until the missile impacts the target.

Note that when you shoot a missile, another set of AMRAAM timing numbers will appear in the HUD. When there is no missile in the air, you only have one number—but as soon as you shoot, you have two sets. The bottom readout shows information on the missile in flight, while the top readout shows information on the next missile to fire. If you shoot a second missile and have two missiles in air, the information on the first missile will be dropped and now your two sets of readouts will show the last missile fired and the next missile to fire. Your HUD will never show information about two AIM-120s in flight.

HOW TO CALL UP YOUR AIM-120S

The AIM-120 is called up the same way as the AIM-9, with only one minor exception—there is no combined AIM-120 and EEGS gun sight mode like Dogfight. To get to your AIM-120s, hit [Enter] until the AIM-120 reticle appears in the HUD. You can tell when you have AIM-120s because "MRM" (for "Medium-Range Missile") will appear in the lower left corner of the HUD. Notice that the reticle for the AIM-120 is much larger than the reticle for the AIM-9. In addition, you will not hear the Sidewinder tone. Next, press [ ] until "AAM" appears at the top of the MFD. AIM-120 should be displayed on the right side of the display. If the display shows any other missile (AIM-7 or AIM-9), press the OSB until "A120" appears.

You can also call up AIM-120s by pressing [M] for the MRM mode. This mode is similar to the Missile Override position with the Dogfight switch in the real F-16. So far it sounds like the AIM-120 is in its own private AIM-120 world. The truth is that the MRM mode can also be used for the AIM-7 Sparrow. The AIM-120 is the primary medium-range missile for Falcon, but the AIM-7 can also be loaded. If both missiles are present, the AIM-120 will come up first and has higher priority. If only AIM-7s are present, then the AIM-7 will be called up when you press [M].

TRAINING MISSION OVERVIEW

In this training mission, you will practice using the AIM-120 to shoot down enemy aircraft.

INITIAL CONDITIONS

- Airspeed: 400 knots
- Altitude: 10,000 MSL
- Throttle Setting: Mid-range
- Configuration: Gear up with 4 AIM-120s
- Weapons Mode: NAV

MISSION DESCRIPTION

This mission starts with a group of MiG-25s coming straight at you. Use the Freeze mode ([Shift][P]) to take your time analyzing your AIM-120 symbology. Remember, you must exit Freeze mode to actually see a missile fly toward the target.

Practice taking AIM-120 shots on all the targets that appear and watch your missiles time out in the HUD. Here is how to take an AMRAAM shot:

1. Load training mission "16 AIM-120 AMRAAM" from Tactical Engagement.
2. Select the AMRAAM mode by pressing M.
3. Fly in a straight line until you see targets appear on your radar. When they appear, turn to place the targets in the HUD missile reticle.
4. Freeze the simulation by pressing Shift P.
5. Press F4 until your radar is in the 20-mile range. The targets should appear on the radar. Place the radar cursors over one of the targets using ↑, ↓, ← and →. When the radar cursors are over the target, press 0 on the numeric keypad to designate the target.
6. When you are locked onto the target, check the caret in the DLZ to ensure that you are in range for a shot. The caret (the sideways "V") should be between Rmax1 and Rmin1.
7. Unfreeze the simulation by pressing Shift P.
8. Shoot the AIM-120 missile (Spacebar or joystick button 2) and watch the time-to-active ("A") or time-to-impact ("T") count down in the HUD. You can break lock on the target when you see the "A" turn into a "T" in the HUD.

   If you do not see a flash in the TD box as the time to impact goes to 0 ("T 0"), then shoot again.

On this mission, it is important to lock onto all the targets in each target group to see the effect of aspect on the DLZ. Remember that the target controls the aspect. All the enemy aircraft has to do to affect your DLZ is turn his jet.

MISSION 17: AIM-7 SPARROW

In this training mission, you will learn how to shoot the AIM-7 Sparrow. This radar-guided missile was first introduced in the 1960s as an integral part of the F-4 Phantom weapons system. Since then the Sparrow has been repeatedly modified and improved to fire from the F-14, F-15, F/A-18 and F-16 fighter jets. The current model of the AIM-7 in use on the Falcon is the AIM-7M. Block 50/52 F-16s are not armed with AIM-7s, but they are included in *Falcon 4.0* to provide you with all the weapons that can be carried by the F-16.

What are the differences between the AIM-7 and the AMRAAM? The AIM-7 Sparrow missile requires the shooter to stay locked onto the target all the way to missile impact. On the other hand, a pilot firing an AIM-120 can launch the missile and break radar lock on the target at a specific point during the missile's TOF. The requirement to stay locked to the target for the missile's entire time of flight is the biggest limitation of the AIM-7. The missile guides on reflected radar energy that is provided by the F-16 radar. Think of the F-16 radar as a giant spotlight that illuminates the target. The AIM-7 Sparrow then homes in on this spotlight. If the spotlight is ever turned off (that is, if the F-16 radar breaks lock on the target), the missile will lose the target and miss.

As shown in Figure 17-1, the basic HUD display of the AIM-7 is virtually identical as the AIM-120 AMRAAM display.

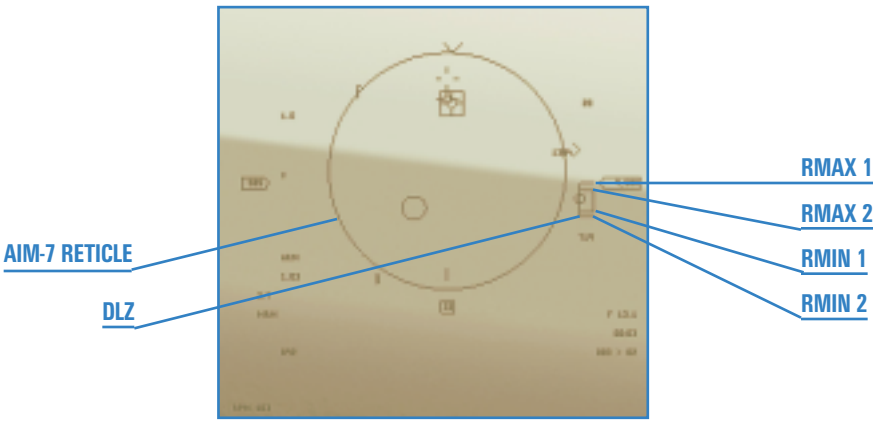


Figure 17-1

Notice that the AIM-7 display looks very similar to the AIM-9 display and identical to the AMRAAM display. All Falcon air-to-air missiles have a missile reticle and a DLZ bracket on the right-hand side of the HUD with basically the same information. The DLZ information displayed is identical for both missiles.

- Rmax1 is the maximum range that you can shoot the missile at the target.
- Rmin1 is the minimum range that you can shoot the missile at the target.
- Rmax2 represents the top of the maneuver zone of the DLZ. Rmax2 is a more realistic maximum range for a target that is maneuvering.
- Rmin2 represents the bottom of the maneuver zone of the DLZ. Rmin2 is a better cue for minimum range for a target that is maneuvering.

AIM-7 SPARROW MECHANIZATION

Remember that the AIM-7 guides on reflected radar energy from the F-16 radar. When the missile is fired, you have a time countdown in the lower right corner of the HUD under the DLZ. You must keep a radar lock on the target until the time in the lower corner of the counts down to zero.

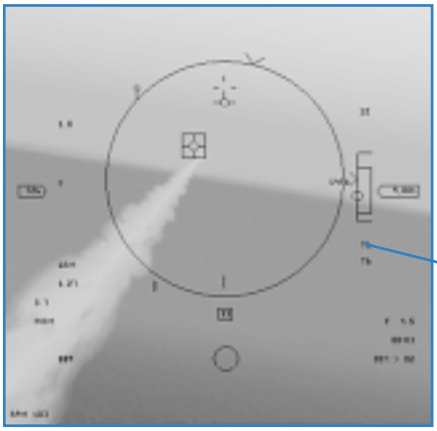


Figure 17-2

Notice how the time readout looks the same as the AMRAAM timeout when the missile goes autonomous.

HOW TO CALL UP YOUR AIM-7S

The AIM-7 is called up the same way as the AIM-120. To get to your AIM-7, press Enter until the AIM-7 reticle appears in the HUD. You can tell when you have AIM-7s because "MRM" will appear in the lower left corner of the HUD. Notice that the reticle for the AIM-7 and the AIM-120 are identical. If you have both AIM-120s and AIM-7s loaded, the only way to determine which missile you have is to look at your SMS page.

You can also call up AIM-7s by pressing M for the MRM mode. This mode is similar to the Missile Override position with the Dogfight switch in the real F-16. Remember that MRM is a mode that is used for both AIM-120s and AIM-7s. If you only have one type loaded (as on this training mission), no problem. If you have both AIM-120s and AIM-7s, however, the AIM-120 will come up first because it has a higher priority. If you have both missiles loaded and you want to switch from AIM-120s to AIM-7s, press] until "AAM" appears at the top of the right MFD. Next, press the OSB next to the AIM-120 mnemonic on the right side of the MFD until "A7" appears.

TRAINING MISSION OVERVIEW

In this training mission, you will practice using the AIM-7 to shoot down enemy aircraft.

INITIAL CONDITIONS

- Airspeed: 400 knots
- Altitude: 10,000 MSL
- Throttle Setting: Mid-range
- Configuration: Gear up, 2 AIM-7s and no guns
- Weapons Mode: NAV

MISSION DESCRIPTION

This mission starts with several MiGs out in front of your jet. Use the Freeze mode to take your time analyzing your AIM-7 DLZs. Practice taking AIM-7 shots on all of the targets and watch your missiles time out in the HUD. Here is how to take an AIM-7 Sparrow shot:

1. Load training mission "17 AIM-7 Sparrow" from Tactical Engagement.
2. Select the AIM-7 by pressing M.
3. When the MiG-25 targets appear, turn to bring them into the missile reticle.
4. Freeze the simulation by pressing Shift P.
5. Place the radar cursors over the target you want to shoot with ↑, ↓, ← and →. When the radar cursors are over the target, press 0 on the numeric keypad to designate the target.
6. When you are locked onto the target, check the caret in the DLZ to ensure that you are in range for a shot. The caret (the sideways "V") should be between Rmax1 and Rmin1.
7. Unfreeze the simulation by pressing Shift P. If you are out of range, drive in closer.
8. When you are in range, shoot the AIM-7 missile by pressing Spacebar or joystick button 2. Watch the time to impact ("T") count down in the HUD. Remember that with the AIM-7, you *cannot* break lock on the target.

If you do not see a flash in the TD box as the time to impact goes to zero ("T 0"), then shoot again.

On this mission, it is important to lock onto all the targets in each target group to see the effect of aspect on the DLZ. Remember that the target controls aspect. All the enemy aircraft has to do to affect your DLZ is turn his jet.

CHAPTER

5

AIR-TO-GROUND WEAPONS

These training missions will teach you about the F-16's air-to-ground radar and let you practice delivering specific weapons.

MISSION 18: AIR-TO-GROUND RADAR MODES

In this training mission, you will learn how to use air-to-ground radar. The air-to-ground and the air-to-air radar have the same purpose: to find targets and point weapons. The air-to-ground radar is optimized to search for both stationary and moving targets on the ground.

GROUND MAP RADAR MECHANIZATION

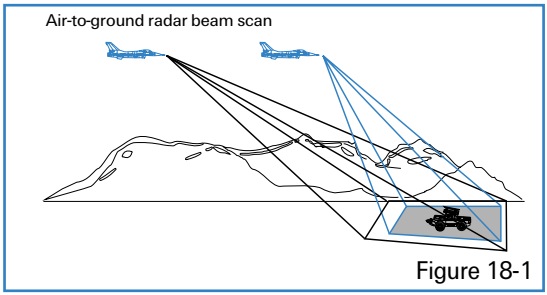


Figure 18-1

The air-to-ground radar maps the terrain with a radar beam and presents a return or picture in the MFD. The radar beam is swept along the ground in a pattern, ±60° in azimuth. In the primary air-to-ground radar modes, the radar beam is *centered* on the selected steerpoint. Figure 18-1 illustrates this very important concept.

In the air-to-air radar modes, the radar searches straight out in front of the jet and moves down track with the jet. This is not how most F-16 air-to-ground radar modes work. In the primary air-to-ground radar, as the selected steerpoint gets closer, the radar antenna keeps tilting to center the beam on that point on the ground. This is done automatically, without it being locked on the target, and without pilot input. If the steerpoint is not on the radar scope because it is more than 60° off the nose or outside the selected range scale, no radar picture is displayed.

Think of the F-16's air-to-ground radar as a way of searching for targets around a steerpoint or a way of looking at the steerpoint itself. This does not mean that the radar cannot find targets that are well away from the steerpoint—it can. It's just that the radar is optimized for searching for targets close to the steerpoint because that is where the radar beam is centered in range. The probability of finding targets, therefore, is much higher if they are close to the steerpoint.

THE AIR-TO-GROUND RADAR DISPLAY

Falcon 4.0 has three master air-to-ground radar modes and numerous submodes. The three master modes are GM (Ground Map), GMT (Ground Moving Target) and SEA . To get to the air-to-ground displays, press [until RWS appears in the left MFD. Then press F2 to cycle through the air-to-ground radar modes. All of these modes have identical radar displays even though they are used to find different types of targets. GM, the primary mode, is used to find stationary targets. GMT is used to find moving targets, such as trucks and tanks. In GMT, stationary targets such as bridges and building are not displayed. The SEA mode is exactly like GM except the radar is optimized to find ships. Figure 18-2 shows an air-to-ground radar display.

Note that the air-to-ground radar display has an artificial horizon line that is identical to the horizon line in the air-to-air modes. Keep in mind that this line does not represent the wings of your jet but rather the earth's horizon. In other words, this horizon line moves opposite the wings of the aircraft when you roll.

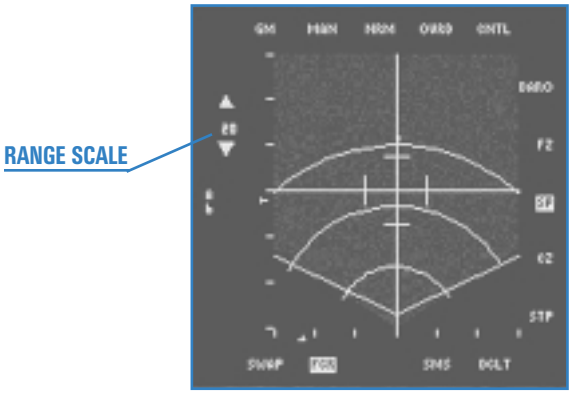


Figure 18-2

The air-to-ground radar display also shows range in the same way as the air-to-air radar. Range to the target is determined by distance from the bottom of the scope and the range scale selected. A target that is halfway up the scope is 20 miles from your jet if the radar is set to the 40-mile range. Select the range scale by pressing the OSB (Option Select Button) next to one of the range scale arrows on the side of the MFD. The azimuth scale, just below the range scale, is permanently set to "A6" or azimuth ±60°. This means that the radar is sweeping ±60° of your heading, a total of 120°.

AIR-TO-GROUND RADAR CURSORS

The radar cursors are used to point and track targets on the radar scope. The air-to-ground cursors consist of a long horizontal and vertical line that intersect to form the tracking point of the air-to-ground radar. The tracking point is centered over the selected steerpoint in the primary air-to-ground radar modes. Move this tracking point off the steerpoint by pressing ↑, ↓, ← and →. Moving the radar cursors moves the center of the radar beam. Just moving the cursors, though, does not actually track or lock onto a target.

To lock onto a target, move the radar cursors over the target with ↑, ↓, ← and → and then designate the target (0 on the numeric keypad). After you designate the target, a diamond will then appear over the target and the cursors will track that target. Figure 18-3 shows the "post-designate" or locked-on display of the air-to-ground radar display.

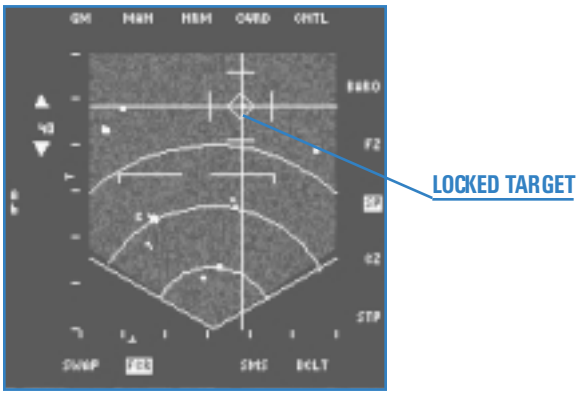


Figure 18-3

When the diamond appears on the scope, the radar beam is tracking the target and is now centered in range and azimuth over the target.

Remember that the air-to-ground radar is used to track targets and point weapons. When you move the cursors and lock onto a target, you get attack steering in the HUD to that target. This attack steering is provided via the CCRP (Continuously Computed Release Point) bombing mode. CCRP is explained in full in the next training mission, but you need to know that CCRP mode is important because it ties the air-to-ground radar display to the HUD. CCRP is an attack mode that provides steering in the HUD to the position of the air-to-ground radar cursors. In other words, when you move the cursors, the CCRP steering in the HUD will also move, as shown in Figure 18-4.

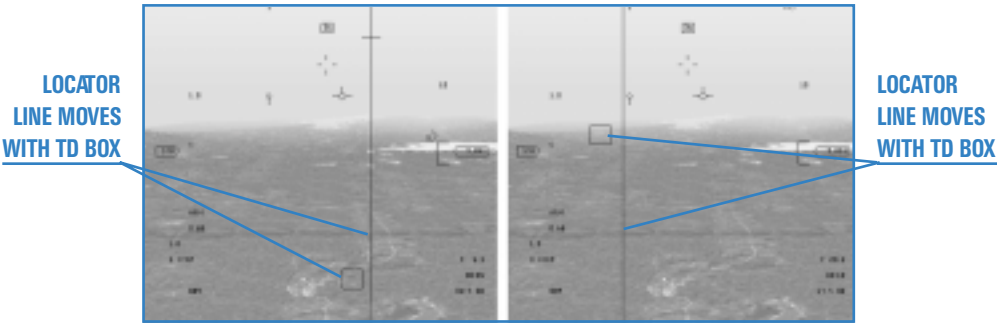


Figure 18-4

To call up CCRP, press Backspace until "CCIP" appears on the top of the right MFD. Next, press ' until "CCRP" appears at the top of the right MFD. You do not need to have CCRP called up to use the air-to-ground radar. You do need CCRP, though, if you want HUD steering to the position of the radar cursors. CCRP mode is very useful if you have slewed (moved) the radar cursors away from the steerpoint. Remember that the radar cursors are initially over the selected steerpoint when you enter the air-to-ground radar modes. When you slew the cursors or lock onto a target that is not co-located with the steerpoint, CCRP is the only way to get steering to that target or cursor position. HUD steering cues are still present in the HUD when you are not in CCRP, but these cues will take you to the steerpoint and not to the position of the cursors.

Other weapons and systems can also be slaved or pointed via the air-to-ground radar cursors:

- AGM-65 Maverick missile
- Targeting pod for LGBs (Laser-Guided Bombs)

How does this work? Let's say you find a target with your air-to-ground radar and lock onto it. If you have a Maverick missile called up, it can be slaved to the air-to-ground radar cursors, which will point the missile's seeker head at the target. Specific training missions later will discuss the use of the air-to-ground radar with all of the systems.

Radar Scope Mnemonics and Functions

Several mnemonics are arranged horizontally around the scope.

GM, GMT and **SEA** stand for Ground Map, Ground Moving Target and Sea. These are the air-to ground master modes. One of these labels will be displayed in the top left corner of the MFD. Cycle through these modes by pressing the OSB on the MFD above "GM" or by pressing F2.

MAN stands for "Manual" and is a fixed display in *Falcon 4.0.*

NRM stands for "Normal" and is one of the four GM submodes. All the other submodes of the air-to-ground display provide the pilot with some form of radar zoom capability. The NORM submode displays four lines that form a box around the outside of the center point. This is the area that will be expanded (or zoomed in) when the next submode, EXP (Expand). is selected. There some important differences between the EXP and its close cousins, DBS1 and DBS2, and the NORM submode.

When you select EXP, the radar picture is zoomed in around the cursors so you can see more detail. When this happens, the radar cursors are centered in the display so you can no longer tell the azimuth or range of the target by looking at the scope. All you see in the EXP mode is the area right around the cursors and you no longer see the pie-shaped NORM display. Figure 18-5 shows the NORM and EXP mode of the exact same target.

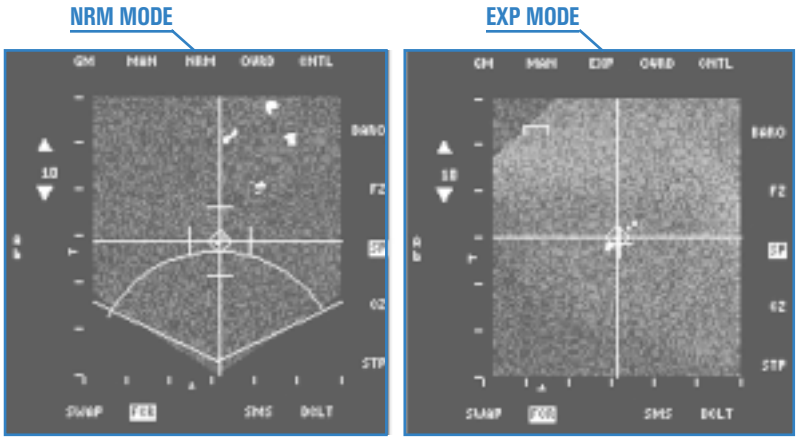


Figure 18-5

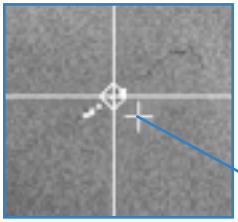


Figure 18-6

Notice in EXP that you have gained another symbol, the situation awareness symbol. This symbol moves on the scope to provide the relative position of the EXP display to the nose of the aircraft. Figure 18-6 shows how this works.

By the way, if you do turn the jet so that the radar can no longer see the EXP point on the ground, the radar automatically reverts back to the NORM mode.

The other submodes that are closely related to EXP are DBS1 and DBS2. DBS stands for Doppler Beam Sharpening. DBS1 provides a slightly better Expand picture with the same basic characteristics. In DBS2 the radar picture is zoomed in even closer than in EXP or DBS1.

EXP expands the radar display around the cursors and centers it on the scope.

DBS1 refines the EXP mode and provides more detail but no more magnification.

DBS2 zooms in on the EXP mode, providing the highest level of magnification around the radar cursors.

All of these air-to-ground radar submode displays are centered on the scope. Do not forget that NORM and EXP are the only available submodes in GMT and SEA. DBS1 and DBS2 are not available in GMT or SEA; they are only mechanized in the GM mode.

OVRD stands for "Override." Press this OSB to turn the radar off and on. If you shut down the radar, you are less likely to be detected by the enemy.

BARO stands for "Barometric" ranging and is a preset option in *Falcon 4.0.*

FZ stands for "Freeze." Press the OSB to toggle the radar into freeze mode, which freezes the radar display but allows you to still have information on the scope even though the radar is temporarily shut down. This mode is used to cut your radar emissions (and thus your signature on the battlefield) and still give you use of the air-to-ground radar modes.

SP stands for "Snowplow." Snowplow is a very important mode because it *disconnects* the radar beam from the steerpoint. When you select Snowplow, the air-to-ground radar beam sweeps out in front of the jet like the air-to-air radar beam. In other words, it is no longer tied to the selected steerpoint.

CZ stands for "Cursor Zero." Press this OSB to zero out or erase any cursor slews that the pilot has put into the system. Let's say you see a radar target just to the right of your steerpoint and slew the air-to-ground cursors over this target. If you change your mind and want to move the cursors back over the steerpoint, just press the OSB for CZ. The radar cursors will return to the steerpoint. CZ is very useful when you start flailing around with the cursors and you need to get them back to where you started.

STP stands for "Steerpoint." This tells you that the cursors are set to track the steerpoint. In the air-to-ground radar modes, either "SP" or "STP" will be highlighted to indicated that the radar is tied the steerpoint or is fixed out in front of your jet.

RADAR TARGETS

Radar targets are displayed as bright spots on the scope. The GM mode can only see man-made objects such as buildings and bridges. In the GMT mode, the radar can only see moving targets such as tanks and trucks. In the SEA mode, the radar will only display ships. Once displayed on the radar scope, however, all of these targets can be tracked and you can point air-to-ground weapons at them.

TRAINING MISSION OVERVIEW

This mission starts with the jet in the air facing both stationary and moving ground targets.

INITIAL CONDITIONS

- Airspeed: 400 knots
- Altitude: 7,000 AGL
- Throttle Setting: Mid-range
- Configuration: Gear up with 2 CBU-87s, 2 Mk-84s and 2 AIM-120s
- Avionics: NAV

MISSION DESCRIPTION

In this training mission, targets will appear on the air-to-ground radar display in several different modes. This purpose of this mission is to gain a working knowledge of the air-to-ground radar.

When you first enter this mission, the radar cursors will be close to Steerpoint 4, which is a bridge.

1. Load training mission "18 A-G Radar Modes" from Tactical Engagement.
2. Once the training mission starts, freeze the jet in the sky by pressing Shift P. In Freeze mode, you can practice using the radar without having to fly the jet.
3. Call up the CCRP mode by pressing Backspace to bring "CCIP" up at the top of the MFD.
4. Click on the OSB next to "CCIP" and "CCRP" will appear.
5. GM radar should automatically appear in the left MFD when "CCRP" comes up in the right MFD. It is useful to be in the CCRP bombing mode when using the air-to-ground radar so that you can see how the air-to-ground radar cursors are tied to the your CCRP HUD steering.

   If GM radar does not come up in the left MFD, select GM master mode by pressing F2 until the "GM" mnemonic appears in the upper left corner of the radar display. Press F2 to cycle through all of the air-to-ground radar modes.

6. As shown in Figure 18-7, Steerpoint 4 is displayed on the DED and a diamond overlays Steerpoint 4 on your HUD.

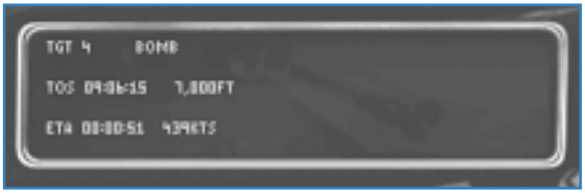


Figure 18-7

7. Once you are in GM mode, slew the TD (Target Designator) box in your HUD over the steerpoint diamond. Look at the GM radar. Note that the cursors are now centered over Steerpoint 4. The target bridge will appear as a bright green dot on the radar scope.

8. While you are slewing the radar cursors, glance at the HUD and notice that your TD box is moving to the left and right of the diamond. This example shows how the TD box in air-to-ground radar is tied to the radar cursors. Slew the cursors well off the diamond. Press the OSB labeled "CZ" (Cursor Zero) on the right side of the MFD and notice how the cursors jump back to the center of the radar display. Remember that when you hit CZ, you zero out any slews that you have made. When you zero out slews in Snowplow mode, the cursors go back to the center of the display.

9. Slew the TD box back over the diamond and lock onto the bridge by pressing [0] on the numeric keypad. Notice how a diamond appears on the radar display.

Figure 18-8

10. Try slewing the cursors and notice that they will not move. When you are locked onto a target, the cursors track only the target and cannot be slewed. Break lock on the target by pressing [.] on the numeric keypad to return the radar to the search mode. When you break lock, the diamond will disappear from the radar display and the cursors will slew again.

    Remember that at any time you can change the radar range scale by pressing [F3] and [F4]. As a rule of thumb, it is best to reduce your range scale when your target of interest is in the bottom half of the display.

The GMT mode is next.

1. Select GMT master mode by pressing F2 until "GMT" appears in the upper left corner of the radar display. It will take a few sweeps for the radar to adjust, but after a few seconds, the radar display will show only moving ground targets. In this mission, several tanks are near the bridge. These targets were not visible on the radar in the GM mode, but when you change to GMT, the tanks appear on the scope (as shown in Figure 18-9).

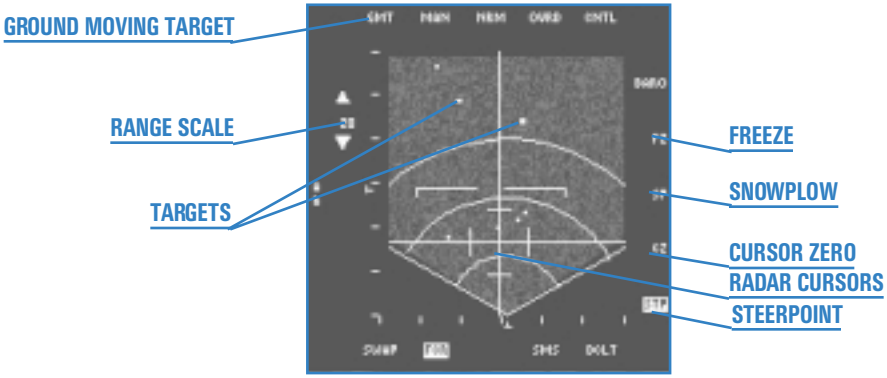


Figure 18-9

2. Lock onto one of these targets by slewing the radar cursors over the target with ↑, ↓, ← and → and pressing 0 on the numeric keypad. A diamond will now appear over the target on the radar display just as in GM mode. The TD box and cursors will now track the moving target.

3. Break lock on the target by pressing . on the numeric keypad. Return to the GM mode by pressing F2 until "GM" appears in the radar display.

These next steps will take you into EXP, DBS1 and the DBS2 submodes.

1. Go to the 40-mile scope either by pressing the OSB next to the range scale on the MFD or by slewing the cursors to the top of the scope. You can also change the range scale by pressing F3 or F4. Recall that in the air-to-air radar you can change the range scale just by moving the cursors to the top or bottom of the scope. The same technique works for the air-to-ground radar display.

2. Click on the OSB labeled "STP" on the left MFD. Select Steerpoint 5 by pressing S to step through the steerpoints. Steerpoint 5 is near a group of buildings. The radar cursors will jump to this new location on the radar display.

3. Slew the cursors around the buildings and then go to the EXP submode by pressing the OSB on the MFD above the "NRM" mnemonic. This button will cycle you through the EXP, DBS1 and DBS2 submodes. DBS1 and DBS2 require some time to build a radar picture to display. Go through all these submodes and notice how the display changes for each one. Keep in mind that in all of these submodes the radar cursors will be centered on the radar display. Return to EXP submode. Figure 18-10 shows the series of radar pictures of this target using NORM, EXP, DBS1 and DBS2.

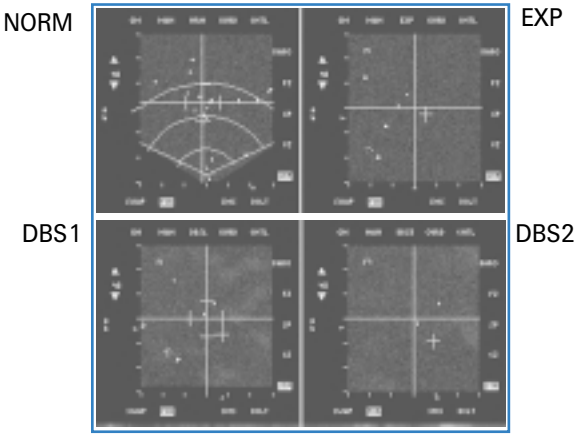


Figure 18-10

4. Slew the cursors around and notice the movement of the "+" symbol on the radar display. This is called the situation awareness symbol and is the only way you know where the radar picture is relative to the nose of the jet. It is there only to let you know where the radar is pointed relative to the nose of your jet, and is not for locking targets.

5. Lock onto a target by pressing [0] on the numeric keypad. Again, the cursors will not slew when the radar is locked onto a target.

6. Increase or decrease the radar gain with [Shift][F4] and [Shift][F3] to change the contrast of the radar display. This will improve the contrast of ground features such as hills and roads. Note that changing the radar gain does not immediately change the radar display, so it will take a few minutes to see the results.

These next steps will take you through the STP (Steerpoint) mode:

1. Select GM master mode by pressing [F2] until "GM" appears in the upper left corner of the radar display.

2. Select the NORM submode by clicking OSB-3 on the MFD until the "NRM" mnemonic appears.

3. Go to Steerpoint mode by clicking on the OSB labeled "STP."

4. Select Steerpoint 4 by pressing S until Steerpoint 4 appears in the DED.

5. Unfreeze the simulation by pressing Shift P. Notice as you fly forward how the radar cursors get closer to you. Remember that the cursors are tied to the selected steerpoint, which in this case is Steerpoint 4.

6. Go to the Snowplow mode by pressing the OSB labeled "SP." As you fly along, notice that the cursors are no longer moving closer to you. Snowplow can be used to search for targets of opportunity that are not around your steerpoints. Figure 18-11 shows the GM display with SP selected.

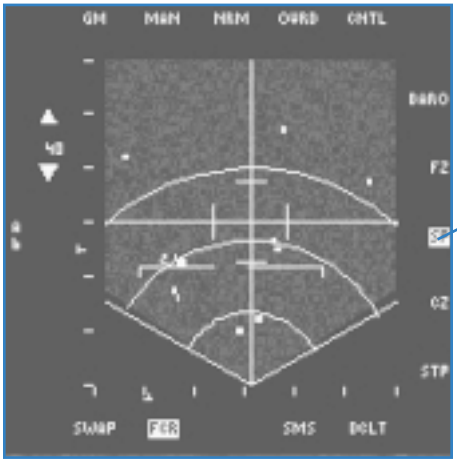


Figure 18-11

In this training mission, you can practice using all of the air-to-ground master and submodes. Once you have mastered the use of air-to-ground radar, you can use it to cue or point your F-16's air-to-ground weapons.

MISSION 19: CCRP WITH UNGUIDED BOMBS

This training mission will discuss how to drop unguided (dumb) bombs using the CCRP (Continuously Computed Release Point) bombing mode. CCRP is a "blind bombing" mode that is used in conjunction with the air-to-ground radar. CCRP is the primary mode used to bomb targets that are not visible due to weather or nighttime conditions. Another important use for CCRP is target cueing. CCRP has excellent HUD steering cues and, when coupled with the air-to-ground radar, can be used to find targets that are beyond visual range. The pilot can find a target on the radar and then drive in following the CCRP steering cues. Once the pilot's eyes are on the target, a visual bombing mode can be used. Target cueing is the reason that CCRP is used at the start of almost all F-16 air-to-ground attacks. Most F-16 bombing attacks start in CCRP even though the bombs may actually be dropped in one of the other modes.

The other use of CCRP is in pointing the laser targeting pod, which we will explore in a later training mission.

THE CCRP BOMBING TRIANGLE

CCRP works in conjunction with the air-to-ground radar. The pilot finds a target on the radar, locks on and then flies the HUD steering until the bomb is released. The air-to-ground radar cursors in CCRP provide the horizontal range to the target. The FCC (Fire Control Computer) is used to calculate all bomb solutions. Since the FCC knows the system altitude of the jet, it knows two sides of the bombing triangle, the vertical and horizontal component. The FCC then calculates the direct slant range or hypotenuse of the bombing triangle. Figure 19-1 below shows the CCRP bombing triangle.

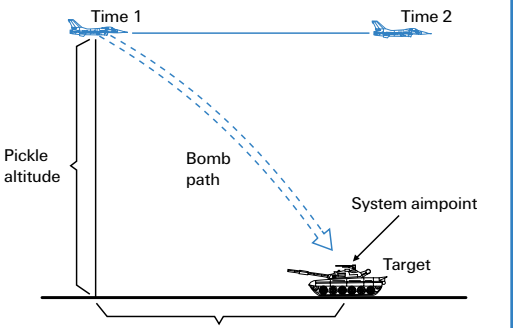


Figure 19-1

In addition to bombing triangle calculations, the FCC also factors in the characteristics of the bomb itself. For example, the Mk-82 (pronounced "Mark-82") general-purpose bomb has both high drag and low drag versions. The FCC calculates the bomb range for each bomb type. All the pilot has to do is follow the HUD steering and *consent to release*. It is important to understand that in the CCRP mode you do not hit the pickle button and watch the bomb drop off the jet. Instead, you consent to release the bomb (by holding down the pickle button) and drive in until the FCC calculates the correct release point. The FCC drops the bomb at this point with consent from your depressed pickle button.

CCRP HUD SYMBOLOGY

The CCRP mode has one major identifying feature, a long vertical steering line that runs from the top to the bottom of the HUD. This steering line, along with a TD box, provides the best air-to-ground target cueing of any F-16 bombing mode. Figure 19-2 shows the CCRP HUD symbology.

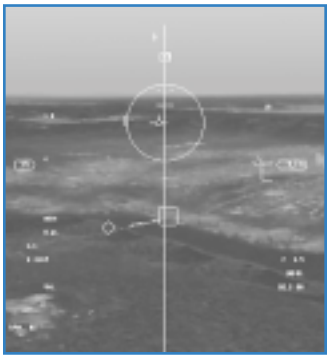


Figure 19-2

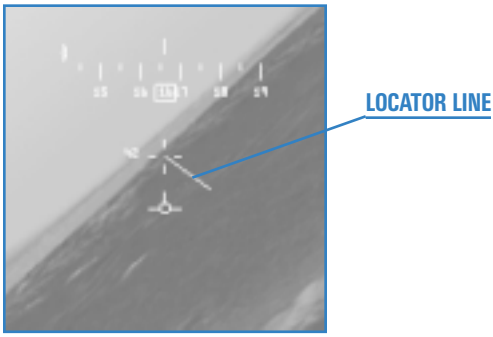


Figure 19-3

If the target is in the HUD's field of view, a TD box will be over the target. If the target is outside the HUD's field of view, then a locator line will show the bearing and range to the target. Figure 19-3 shows a CCRP locator line pointing to a target that is outside the HUD's field of view. To arrive over the target, the pilot flies the HUD flight path marker over the vertical CCRP steering line. If the flight path marker is over the steering line, then you will fly directly over the target.

Along with steering cues to the target, CCRP also has bomb loft and bomb release cues. As you approach the target, the FCC calculates a bomb release point and then displays a small horizontal tick mark at the top of the vertical steering line. This "release" cue moves down the steering line toward the flight path marker. When the cue hits the flight path marker, a loft reticle appears, signaling that you are now in range to loft the bomb. After the reticle flashes, the release cue appears again at the top of the HUD. This time when it drifts down and hits the flight path marker, the flight path marker will flash and the bomb will release. Figure 19-4 shows the bomb release cue on the steering line.

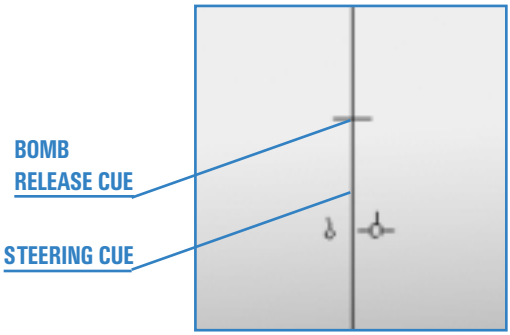


Figure 19-4

To repeat, the release cue will not even appear on the CCRP steering line until the FCC calculates that you can loft a bomb on the target. This means that when FCC calculates that you are in range to loft the bomb to the target, the release cue appears for the first time. It marches down the vertical steering line, hits the flight path marker and the loft reticle flashes. At this moment, you can go to 100% power and loft a bomb that will come off when the jet is in a 45° climb.

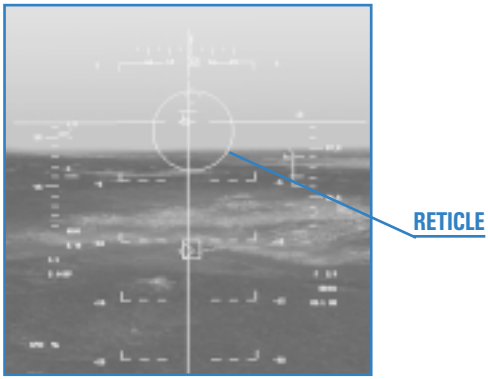


Figure 19-5

Right after the reticle flashes, the release cue will reset to the top of the vertical steering line and again start down to the flight path marker. When the release cue hits the flight path marker, the bomb will be released. Figure 19-5 shows the reticle that flashes in the HUD when you are in loft range.

If you are wondering who thought up this wacky system, I thought the same thing when I first tried to use this system on Wild Cat range in Utah. This is exactly how CCRP works in the F-16. So if you want real, you've got it. If you want something easier, I recommend that you just strafe the target.

TRAINING MISSION OVERVIEW

In this mission, you will practice using the CCRP bombing mode to drop unguided bombs on a ground target.

INITIAL CONDITIONS

- Airspeed: 400 knots
- Altitude: 7,000 AGL and level
- Throttle Setting: Mid-range
- Configuration: Gear up, 2 Mk-84s, 2 CBU-87s and AIM-120s

MISSION DESCRIPTION

In this mission, you will fly a CCRP attack on several targets. The first is a bridge that is 10 miles on your nose. You will perform level and loft attacks on the bridge with Mk-84 GP (General Purpose) bombs. Next, you will attack moving targets on the road across the bridge using CBU-87s. The CBU is a canistered munition, also called a cluster bomb. The canister opens at a predetermined height, releasing bomblets on the target. Since this type of weapon has a bigger footprint that a normal GP bomb, it is better than a GP bomb for destroying moving targets.

1. Load training mission "19 Bombs with CCRP" from Tactical Engagement.
2. Once the training mission starts, freeze the game by pressing Shift P so you can practice using the radar without having to fly the jet.
3. Call up the CCRP mode by pressing Backspace to bring up "CCIP" in the right MFD. Next, press the OSB above "CCIP" until "CCRP" comes up. When CCRP is up, the GM air-to-ground radar mode should appear in the left MFD.

   If GM is not up in the left MFD, press [until "RWS" comes up in the left MFD. Then press F2 until "GM" appears at the top of the left MFD.
4. If the Mk-84 mnemonic is not present in the right MFD, press the OSB next to CBU-87 to bring up "MK84."
5. Go to Steerpoint 4 by pressing S until Steerpoint 4 appears in the DED.

Use the following steps to execute a CCRP level attack on the target:

6. When you look at the radar scope, notice that your radar cursors are very close to a small square on the scope. This is the bridge. You're right: it don't look like a bridge. GM radar displays ground targets as radar returns and since the bridge is a small radar target, it only appears as a small radar return on the scope.
7. Slew the radar cursors in the MFD over the bridge using ↑, ↓, ← and →. Since the radar cursors are tied to the selected steerpoint and since Steerpoint 4 is the bridge, the cursors will be close to the bridge when the mission starts.
8. Lock onto the bridge by pressing 0 on the numeric keypad.
9. Press Shift P to unfreeze the simulation.
10. Fly the steering in the HUD by turning the jet to place the flight path marker directly on the vertical CCRP steering line. Figure 19-6 shows the flight path marker centered on the CCRP vertical steering line.

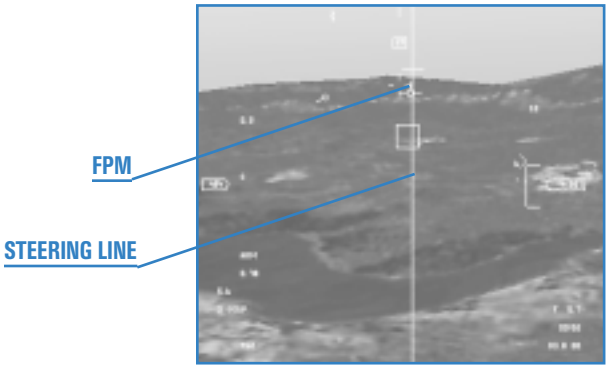


Figure 19-6

11. Reduce the range scale to 20 miles by pressing F3.
12. When the target gets inside of 5 miles, consent to release the bombs by holding down the pickle button (Spacebar or joystick button 2).
13. Drive straight for the target following the CCRP steering until the release cue descends down the vertical steering line to the flight path marker. The flight path marker will flash when the bomb is released.

This next attack will be on the same target with the same weapon. This time, however, we will loft the bomb at the target. Notice that the first five steps are the same.

1. Slew the radar cursors in the MFD over the bridge using ↑, ↓, ← and →. Since the radar cursors are tied to the selected steerpoint (which is the bridge), the cursors will be close to the bridge when the mission starts.
2. Lock onto the bridge by pressing 0 on the numeric keypad.
3. Fly the steering in the HUD by turning to place the flight path marker directly on the vertical CCRP steering line.
4. When the release cue appears (2 seconds after the reticle flashes), push the throttle up to full afterburner by pressing Shift+.
5. Then press and hold down the pickle button.
6. Start a 4–5 G pull in the vertical and ease off the G just before the flight path marker reaches the release cue. Now just fly through the release cue at 1 G. This technique will give you a more accurate bomb because you are not working the FCC so hard.
7. When the flight path marker flashes, roll into a 135° right or left bank and slice back away from the target. Figure 19-7 shows this maneuver.

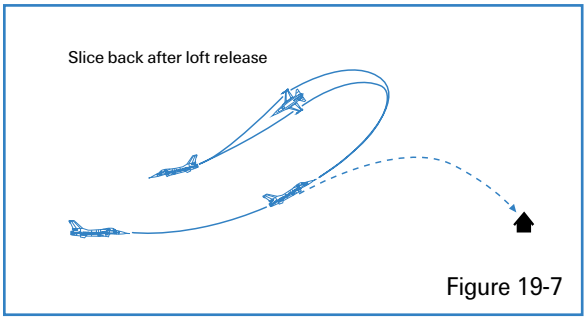


Figure 19-7

The next thing you should try in this training mission is using the GMT (Ground Moving Target) air-to-ground radar mode to lock onto moving targets and attack them using CBU-87s. Use the same procedures listed above for both level and loft deliveries. Before starting, switch the air-to-ground master mode from GM to GMT by pressing F2. Select CBU-87s by calling up the SMS page on the MFD. When the SMS display is called up, press the button on the MFD next to the Mk-84 label to cycle you through all the loaded air-to-ground weapons. Press this button until "CBU-87" appears. You are now ready to try both level and loft CBU attacks.

MISSION 20: CCIP BOMBING

This mission covers bombing using the CCIP (Continuously Computed Impact Point) symbology. CCIP is a visual bombing mode, which means that you must see the target in order to use it. In CCRP, the FCC calculates a release point and releases a bomb after the pilot consents to release. CCIP, on the other hand, continuously computes the bomb impact point and presents it on the HUD. CCIP displays a HUD cue showing where the bomb will hit if you hit the pickle button at that instant. Hitting the target using CCIP involves doing what F-16 pilots call "putting the thing on the thing." The first "thing" is the CCIP pipper, and the second "thing" is the target. If you hit the pickle button when these two "things" come together, you should hit the target.

THE CCIP BOMBING TRIANGLE

In CCIP the F-16 radar is used to get the direct slant range to the target. Figure 20-1 shows the bombing triangle. Note that the hypotenuse of the triangle is calculated directly by the F-16 radar.

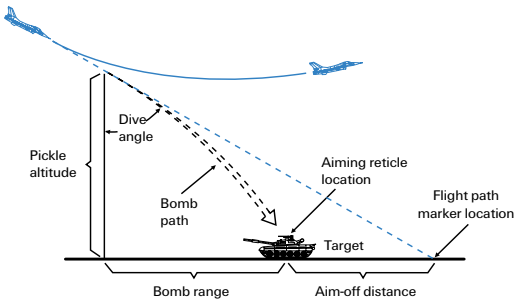


Figure 20-1

The only additional information needed by the FCC to compute the CCIP bombing solution is the weapon type and the jet's parameters (airspeed, G, etc.). The radar constantly ranges on the ground in front of the aircraft (abbreviated "AGR" for "Air-to-Ground Ranging").

CCIP HUD SYMBOLOGY

CCIP symbology simply consists of what is called a bomb fall line with a circular pipper attached to the end, as shown in Figure 20-2. The CCIP bomb fall line is attached at the top to the flight path marker.

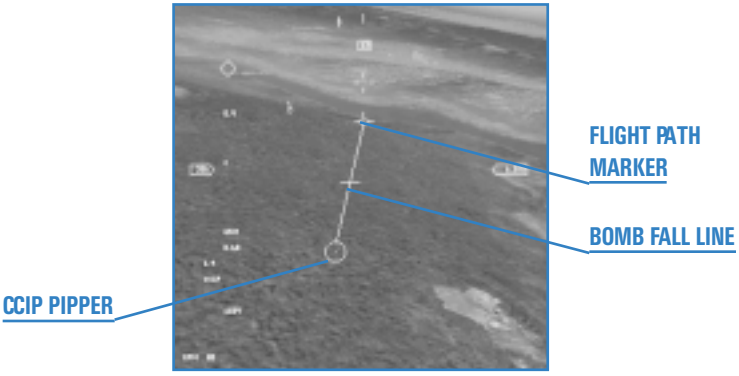


Figure 20-2

The bomb fall line is so named because it represents the path the bomb falls in over the ground. The best technique for hitting the target with the CCIP pipper is to put the bomb fall line over the target. That way the pipper will eventually get to the target and you will have the "thing" on the "thing." Remember that the pipper always tracks up the bomb fall line. Figure 20-3 shows the target through the bomb fall line.

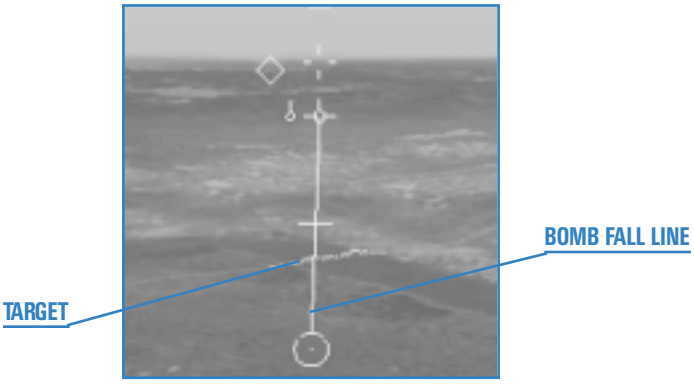


Figure 20-3

This does not mean that you cannot get the pipper on the target without placing the bomb line through the target. You can, but it is harder to get the "thing" on the "thing" this way and is also less accurate. It is less accurate because, if you are not smooth with the jet, the CCIP will lie to you. The FCC simply cannot keep up with violent aircraft maneuvers and cannot compute an accurate CCIP solution.

THE CCIP DELAY CUE (OR HOW CCIP BECOMES CCRP)

So far CCIP seems like a straightforward bombing mode. All you have to do is fly the target under the bomb fall line and drive in to the CCIP pipper gets to the target. In most cases, this is really all you have to do to hit the target with CCIP. Sometimes, however, CCIP is not so straightforward.

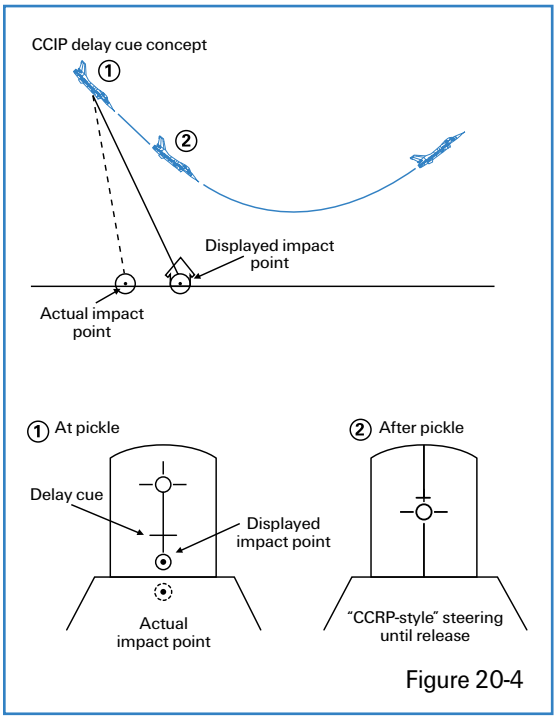


Figure 20-4

CCIP presents the pilot with the point on the ground where the bomb will fall if it was dropped at that instant. What if that point is not on the HUD, but perhaps underneath the nose of the jet below the HUD? For example, let's say you call up CCIP while you are flying along straight and level at 20,000 feet. The point on the ground where the bomb will hit is way under the nose and is not visible in the HUD. In cases where CCIP cannot put the real impact point in the HUD, it places a delay cue on the bomb fall line, as shown in Figure 20-4. The delay cue means that the real pipper is somewhere below the HUD.

When the delay cue is present, your display will be different after you pickle the bomb. Without the delay cue, the bomb will come off when you pickle and the CCIP pipper will not change. With the delay cue, however, you must hold the pickle button down because the real bomb impact point is somewhere under the HUD. Your pickle is a "consent to release" just like in CCRP, and you must fly closer to the target before the bomb will come off the jet. In fact, after you pickle with the delay cue present, your HUD CCIP symbology will change to a CCRP-like display. Figure 20-5 shows what F-16 pilots call "post-designate CCIP."

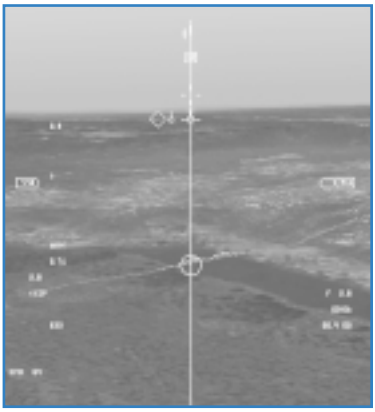


Figure 20-5

You must hold the pickle button down and keep the flight path marker on the vertical steering line in the HUD. When the release cue hits the flight path marker, the flight path marker will flash and the bomb will release. This concept is hard to grasp unless you understand the CCRP mode. Review the previous lesson if you have any questions about CCRP.

TRAINING MISSION OVERVIEW

In this mission, you are set up to practice CCIP bombing with the help of a drone aircraft.

INITIAL CONDITIONS

- Airspeed: 400 knots
- Altitude: 7,000 AGL and level
- Throttle Setting: Mid-range
- Configuration: Gear up with 12 Mk-82s and 2 AIM-120s

MISSION DESCRIPTION

In this training mission, you will perform a dive bomb attack using CCIP. The target is a runway complex. Before you begin, understand that events will unfold much faster during a diving CCIP attack than they did for a level CCRP attack. Since is impossible to read all the following steps as you dive down the chute toward the targets, read them before you start. After you practice this attack several times, the following steps will become second nature.

To execute a CCIP dive bomb level attack on the target:

1. Load training mission "20 Bombs with CCIP" from Tactical Engagement.
2. Once the training mission starts, freeze the game by pressing Shift P.
3. Call up the CCIP mode by first calling up your SMS page on one of your MFDs. Press [or] repeatedly until the SMS page comes up.
4. Click on the OSB next to the "A-G" label. This will put you in the CCIP bombing mode.
5. Press S to go to Steerpoint 4 in the DED.
6. Unfreeze the simulation by pressing Shift P.
7. Switch to the left view by hitting ← on the numeric keypad. Fly straight and level until the far ends of the runways reaches the left edge of your screen. At this time, switch back to the front view by pressing →. Start your roll in. Roll the jet 110° in a shallow left-hand slice and pull down toward the target. Figure 20-6 shows a series of HUD views as you roll in on the target.

Figure 20-6

8. As the runway comes into your HUD's field of view, pick an exact point on the runway complex you want to hit and fly the flight path marker to a point beyond this target.
9. Place the exact aimpoint (target) halfway down the bomb fall line. Stick your flight path marker on the ground by slightly pushing forward on the stick. Do *not* let your flight path market run along the ground in CCIP. This will cause the pipper to track too quickly toward the target.

10. Hold the flight path marker stationary on the ground. The target should be about equidistant from the flight path marker and the CCIP pipper, as shown in Figure 20-7. You will have a delay cue on this delivery when you first roll in, but it should disappear prior to pickle altitude.

Figure 20-7

11. Increase your throttle to 100% for this shallow dive angle. Keep in mind that for steeper dive angles that it is important not to drop bombs while above .95 Mach since this is a transonic region. Since transonic speeds make it hard to predict the airflow pattern around your jet and thus the bomb separation effects, CCIP bombs may miss the target if dropped above this speed.

12. Make smooth adjustments in bank to keep the bomb fall line over the target and note your altitude as it unwinds and your pipper track.

13. When the CCIP pipper gets to the target, pickle the bomb (Spacebar or joystick button 2).

14. Right after you pickle, start an immediate 5 G wings-level climb to a 30° nose high attitude. This will keep you out of the frag pattern if you pickle above 2,000 feet. The frag pattern is the fragmentation area around the target caused by the bomb blowing up. If you fly into the frag pattern, you may lose an appendage.

15. If you want to see where your bomb hits, press ` to switch to the Satellite view, which is great for watching your bombs.

Don't worry too much about avoiding the frag pattern on your first few practice runs, but as you get better at dropping bombs, you should be acutely aware of your planned pickle altitude. The planned pickle altitude will keep you out of the frag.

This delivery is planned to be a 15° dive bomb pass from 5,000 feet AGL with a planned pickle altitude of 2,000 feet. What if you see that you are going to get to your pickle altitude long before the pipper is going to get to the target? Pull the CCIP pipper up to the target. Just before it gets there, ease up on the G. When it hits the target, pickle the bomb and execute your recovery. On this training mission, it is important to just get used to the symbology so don't sweat the bombing parameters too much.

Remember one last point: if the delay cue appears, you must hold down the pickle button and fly the flight path marker over the vertical steering line. The FCC will release the bomb when the release cue intersects the flight path marker.

BOMBING OPTIONS

To release a string of bombs, change the RP (Release Pulses) count in the right MFD to "12" by clicking on the OSB next to "RP." This number is the number of pulses sent to the bomb racks when you hit the release button to drop the bombs. Since it is "one pass and haul ass" on most combat missions, normally your RP count should equal the number of bombs on the jet.

The next option you have is to change the interval (spacing) of bombs. If you click the OSB next to "25FT," it will change to 75, 125, 175 and then back to 25. This value is the number of feet at impact between each bomb dropped.

Last, you can also select to drop the bombs in pairs. In pairs, you get two bombs that come off together per release pulse (and you gotta love togetherness). Press OSB-8 to switch from single to pair release and back again.

MISSION 21: DIVE TOSS WITH UNGUIDED BOMBS

This mission will cover the Dive Toss bombing mode. Dive Toss (DTOS) is a visual delivery mode that can be used to "toss" or loft bombs on the target. It is very similar to the CCRP mode with one major exception. Dive Toss is a "visual only" mode that does not use the air-to-ground radar to find targets. Instead, the pilot must have "eyes on" the target and place the HUD TD box over the target. After the TD box is over the target, the target is "designated" with the pickle button, which ground-stabilizes the TD box (fixes the TD box to the terrain). After target designation, a CCRP-like steering line appears in the HUD.

DIVE TOSS EMPLOYMENT

When would you use Dive Toss? Let's say your mission is to suppress the AAA guns around an airfield so a flight of F-15Es can bomb the runway. Since you want to stay outside of the 2-mile range of the 23mm guns that surround the field, you choose to loft the bombs into the airfield using Dive Toss. With Dive Toss, all you have to do is see the target and put your TD box over the target and designate with the pickle button. Once the target has been "designated," follow the HUD steering to "toss" (loft) the bombs into the target area. Why not just use CCRP? In CCRP you can find the target with the radar and do the same type of attack, but AAA guns around the airfield will probably not show up on air-to-ground radar display. You will, however, be very visible with the naked eye as the gunfire arcs up from the ground toward your cranium. Why not use CCIP? In CCIP you have to overfly the target. CCIP is more accurate, but in this case Dive Toss will allow you to stand off and deal damage from a safer position.

THE DIVE TOSS BOMBING TRIANGLE

Before going into the HUD symbology, let's take a quick look at how Dive Toss actually works. Figure 21-1 shows the Dive Toss bombing triangle.

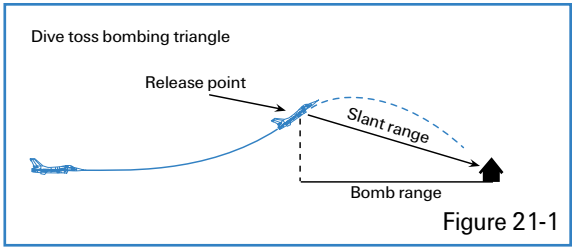


Figure 21-1

In Dive Toss, the F-16 radar provides the FCC direct slant range to the target (just as in CCIP). After the pilot places the TD box over the target and designates with the pickle button, the F-16 radar reverts to AGR (Air-to-Ground Ranging) and looks straight through the TD box. AGR is a radar mode in which the radar provides slant range information to the FCC for a bomb solution. The FCC uses this slant range data along with other input such as aircraft parameters and bomb type to calculate a release point.

DIVE TOSS HUD SYMBOLOGY

There are two basic Dive Toss HUD displays: pre-designate and post-designate. Remember that Dive Toss is used to toss bombs at a target you can see. Pre-designate Dive Toss is used to place the TD box over the target, as seen below in Figure 21-2.

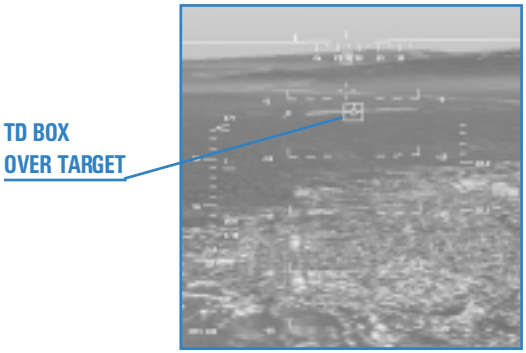


Figure 21-2

In pre-designate Dive Toss, the TD box is stuck to the flight path marker. To drop a Dive Toss bomb, fly the flight path marker over the target and pickle. When the pickle button is pressed, the TD box detaches from the flight path marker and ground-stabilizes over the target. After the TD box sticks to the terrain, you have a new display in the HUD, post-designate Dive Toss (as shown in Figure 21-3).

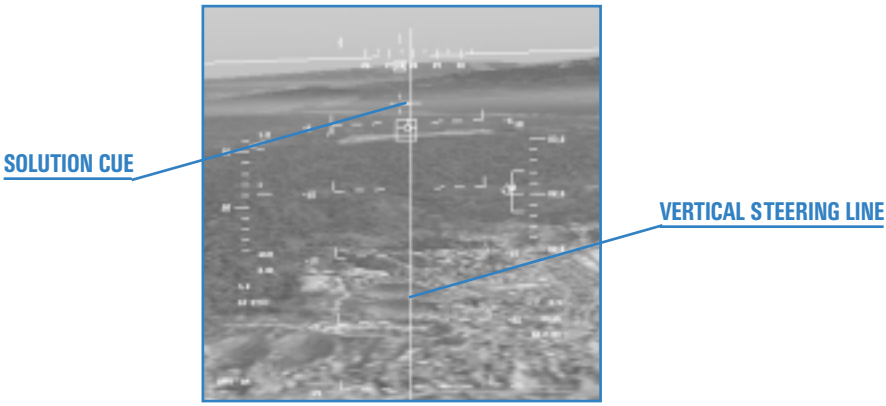


Figure 21-3

Post-designate Dive Toss is essentially CCRP with AGR (Air-to-Ground Ranging). The display to the pilot in post-designate Dive Toss is exactly the same as in CCRP. The only real difference between the two is how FCC computes the bombing solution. Figure 21-3 shows the two main features of post-designate Dive Toss: the vertical steering line and the solution cue. The steering line provides azimuth steering for bomb release. The solution cue appears when you are in range to loft a bomb on the target. This cue will not appear until you are in range to loft a bomb at the target. If you start a pull up to loft the bomb as soon as the solution cue appears, the bomb will release at 45° nose high. The longer you wait to start a loft pull up after the solution cue appears, the shallower your climb angle and the closer to the target you will be at weapons release (this is mechanized exactly the same way as CCRP). The flight path marker will flash when it hits the solution cue and the bombs will release.

Please note one important point about Dive Toss. When you place the TD box on the target and pickle, you are not locking onto the target. In Dive Toss, when you pickle, you are telling the FCC that you are going to drop a bomb on the point on the terrain that is under the TD box. Hopefully, the target is co-located on that piece of earth. If you pickle and ground-stabilize the TD box and miss the target, all is not lost. You can use [↑], [↓], [←] and [→] to slew the TD box over the target. Remember, though, that Dive Toss is a bombing mode. You still have to get your keister lined up with the HUD steering to hit the target with a dumb free-fall bomb. All the bomb is going to do after it leaves the jet is fall to the ground. When you slew the TD box, you will move the HUD steering. This is no problem if you are far away from the target. If you are close to the target, however, you may not have the time to make a correction to line up with the new HUD steering and get the bomb to hit the target.

TRAINING MISSION OVERVIEW

In this mission, you will practice a Dive Toss delivery.

INITIAL CONDITIONS

- Airspeed: 400 knots
- Altitude: 7,000 AGL and level
- Throttle Setting: Mid-range
- Configuration: Gear up and 12 Mk-82s

MISSION DESCRIPTION

In this training mission, you are set up to toss (loft) the bomb to the runway complex. You are set up 4 miles out and 90° from the target. Use the following steps to perform this Dive Toss attack:

1. Load training mission "21 Bombs with Dive-Toss" from Tactical Engagement.
2. Once the training mission starts, freeze the game by pressing Shift P.
3. Call up the Dive Toss mode by first calling up the SMS page on one of your MFDs. Press [or] repeatedly until the SMS page comes up.
4. Click on the OSB next to the "A-G" label. This will put you in the CCIP bombing mode.
5. Press the OSB over the "CCIP" label until you see "DTOS."
6. Unfreeze the simulation by pressing Shift P.
7. Roll into 100° of left bank and pull toward the target. Figure 21-4 shows this maneuver with a series of screen shots.

Figure 21-4

8. As you gain a tally on the runway complex, place the flight path marker just short of your intended bomb impact point. For this attack, just pick a specific part of the runway complex and place the flight path marker below this point.

9. Bring the throttle back to 70%.

10. Let the flight path marker and TD box fly up to the target. Pickle and hold when the TD box hits the target. The TD box will detach from the flight path marker. Remember that you do not need to chase the target with your TD box.

11. If the TD box is not right over the target, make a quick slew with ↑, ↓, ← and → to place the TD box over the target. Do not get mesmerized slewing the TD box around. You only have about 4 seconds to slew because you are closing in on the target at 800 feet per second.

12. Regardless of whether you get the TD box in the exact place you want or not, after 4 seconds, place your flight path marker over the HUD steering line. The release cue should be present on the steering line so start a 2–3 G gentle pull. When using Dive Toss, you must be *gentle* on the stick or the bomb will not release.

13. As your flight path marker gets through the horizon, go to 100% power (Mil power) by pressing + until you get to 100% on the RPM gauge.

14. When the release cue hits the flight path marker, it will flash and the bombs will come off (given that you are still holding down the pickle button). When the flight path marker flashes, roll 100° and slice back away from the runway (as shown in Figure 21-5).

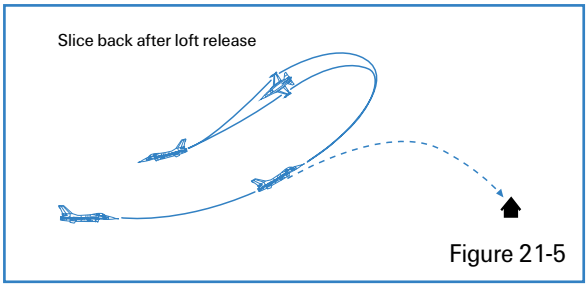


Figure 21-5

If you do not want to toss the bomb on the target, you can also line up the steering cue and fly straight and level over the target until the release cue hits the flight path marker and the bombs come off.

MISSION 22: 20MM CANNON (AIR-TO-GROUND)

Although the 20mm cannon in the F-16 is primarily an air-to-air weapon, it can be used to attack ground targets. The big problem with using the 20mm gun against ground targets is lethality. The 20mm projectile is small and the muzzle velocity relatively slow (about 2,000 feet/second). Slow and small are a bad combination of attributes for most weapons, but the gun does have a few advantages nonetheless. The first and foremost is that you are always carrying it. Even if you have already dropped all of your bombs and fired all of your missiles, you still have the gun and 510 rounds. The next advantage is that it is a point-and-shoot weapon, with no locking onto targets, complicated DLZs or anything like that. In modern air combat where you spend quite a bit of your time with your situation awareness down around your knees, a lot can be said for a simple point-and-shoot weapon. Figure 22-1 shows the Falcon Strafe HUD symbology.

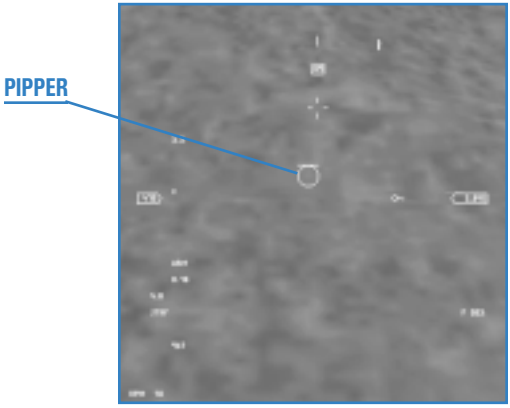


Figure 22-1

Strafe HUD symbology is relatively simple. Place the floating pipper on the target and shoot. The pipper floats because it is placed on the HUD by the FCC (Fire Control Computer). The FCC computes the slant range to the target and aircraft parameters to correctly place the pipper in the HUD. When you are about 8,000 feet from the target, a hat will appear over the strafe pipper to indicate that you are in range.

TRAINING MISSION OVERVIEW

In this mission, you will use the 20mm cannon to destroy a series of ground targets.

INITIAL CONDITIONS

- Airspeed: 400 knots
- Altitude: 4,500 AGL
- Throttle Setting: Mid-range
- Configuration: Gear up and clean

MISSION DESCRIPTION

This mission starts with the Falcon pointing towards a coastline. A building will come into view near the coast, and near the building is a group of target vehicles. Some of these vehicles are trucks, which can be destroyed with the 20mm cannon. Most of the target vehicles in this mission are tanks. The 20mm projectile will bounce right off the tanks. In the same general area as the tanks should be a few lighter-skinned vehicles to shoot up. The building can also be attacked if you need to practice hitting the broad side of a barn.

This mission is not designed for you to shoot all of these targets on a single pass. After practicing on one set of targets, restart the mission and strafe the next group. By the way, it is probably faster to just fly back around for another run at the target if you miss on the first strafing run. In addition, if all you can find is the tanks, don't worry about it. Since this mission is for practicing your strafe technique, you don't have to actually blow stuff up—only hit it.

Use the following steps to fly a strafe attack:

1. Loading training mission "22 20mm Cannon (A-G)" from Tactical Engagement.
2. Once the training mission starts, freeze the game by pressing Shift P.
3. Bring up the HSD display in the right MFD by pressing] until the HSD appears. Next press S until Steerpoint 4 appears in the DED.
4. Call up guns by pressing Backspace until you see "STRF" at the top of the MFD.
5. Unfreeze the simulation by pressing Shift P.
6. Place the flight path marker below the target and set the throttle to 80%.
7. Smoothly fly the pipper up to the target and track the target by gently pushing the stick forward to keep the pipper on the target. You will get a "hat" or horizontal line above the strafe pipper when you get 4,000 feet from the target. This is an in-range cue.
8. Fire a 1–2 second burst and continue to track the target.
9. Start a wings-level 4–5 G pull up to 20° nose high to stay above the frag pattern.

When I first learned to strafe in back in the F-4 Phantom, my instructor always said, "Track—shoot—track." This technique will keep the pipper (and the bullets) from running through the target. A strafe pass should not look like a World War II movie where the bullets stream out in a long line. Instead, your strafe burst should be concentrated in a tight group over the target. The only way to achieve this type of bullet density on the target is by pushing (bunting) forward to stop your flight path marker from running along the ground.

Some of the targets in this training mission are moving. The correct technique for hitting a moving target is to place the pipper out in front of the target and stabilize your aimpoint on that spot on the ground. Fire a short burst and make a correction off that burst. It is helpful with moving targets to line up your pass along the same axis as the target's motion. In other words, if the target is heading straight north, maneuver to make a pass from south to north. Even if you cannot line up exactly with the target's motion, any attack angle you can get that is less than 90° is helpful.

Remember that since you can strafe anything you see out there, press [L] to look closer and find targets. Just remember to get out of this mode (by hitting [L] again) before shooting.

MISSION 23: ROCKETS

Rockets are fun to fire and easy to use. That's the good news. The bad news is that it is difficult to hit a target with rockets, and even if you do, they are not very lethal against hardened targets. Rockets are effective against most vehicles including tanks. Rockets come in pods that must all be fired together in a salvo. A rocket pod contains 19 rockets that all fire over the course of about 2 seconds. Rockets are unguided. Rockets can shoot further than the 20mm gun and are more lethal if they hit a target.

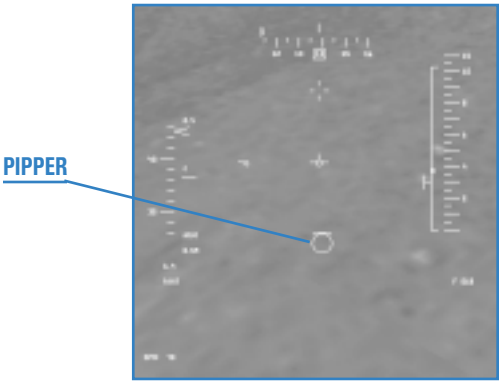


Figure 23-1

The Falcon HUD symbology for strafe and rockets are virtually identical, as shown in Figure 23-1.

A floating pipper is used to aim rockets. The FCC calculates the range to target and aircraft parameters to place a pipper in the HUD. This pipper represents the place on the ground where the rockets will hit if you were to fire at that instant. That's the theory. In reality, rockets are very squirrelly and unpredictable. The pipper seldom shows where the rockets will really hit. The pipper is most accurate when you are close to the target and flying the aircraft smoothly.

TRAINING MISSION OVERVIEW

In this mission, you will use rockets to destroy a series of ground targets.

INITIAL CONDITIONS

- Airspeed: 400 knots
- Altitude: 4,500 AGL
- Throttle Setting: Mid-range
- Configuration: Gear up with rocket pods

TRAINING MISSION DESCRIPTION

This mission starts with the Falcon pointing toward the coastline. A building will come into view near the coast, and near the building is a group of target vehicles. All of these vehicles can be destroyed with rockets. Although rockets can kill the tanks that are near the building, they are not the best weapon for tank killing since they are hard to aim. This mission is designed to let you practice shooting rockets at several vehicles that should be in front of the jet.

Use the following procedures to shoot rockets:

1. Load training mission "23 Rockets" from Tactical Engagement.
2. Once the training mission starts, freeze the game by pressing Shift P.
3. Call up rockets by pressing Backspace until you see "RCKT" at the top of the MFD.
4. Hit S until you get to Steerpoint 4.
5. Unfreeze the simulation by pressing Shift P.
6. You should see some targets near the steerpoint diamond in the HUD. Smoothly fly the pipper up to the target and track the target by gently pushing the stick forward to keep the pipper on the target. A "hat" or horizontal line will appear over the rocket pipper when you get to 8,000 feet. The hat is an in-range cue.
7. Fire the rockets and continue to track the target. It is very important to track the target until all of the rockets have left the pod. To accomplish this, you must push forward on the stick and keep the pipper from running along the ground.
8. Start a wings-level 4–5 G pull up to 20° nose high to stay above the frag pattern.

Please note one important point about firing rockets. If you start firing late, do *not* worry about your rocket pattern. *Pull out of your dive* regardless of where the rockets are going.

Rockets can be fired from further out than the gun and have more penetrating power. They take longer to get to the target, however, and are far more sensitive to aircraft movement while being launched.

MISSION 24: AGM-65 MAVERICK MISSILE

The Maverick missile is an AGM (Air-to-Ground Missile) that is optimized for use against tanks and other armored vehicles. The seeker head in the Maverick missile is similar to a video camera and creates an image of a target that can be viewed by the pilot and tracked by the missile. This image is produced by an IIR (Imaging Infrared) seeker head in the Maverick that presents a heat profile of the target which is very similar to a normal video camera view.

Camouflaged vehicles are extremely difficult to find in the normal visual spectrum but stand out as a hot mass when viewed from the IR (Infrared) spectrum. The Maverick missile takes these hot mass targets and turns them into an IR image that can be tracked by the Maverick. The Maverick target image is displayed in the cockpit on one of the MFDs, as shown in Figure 24-1.

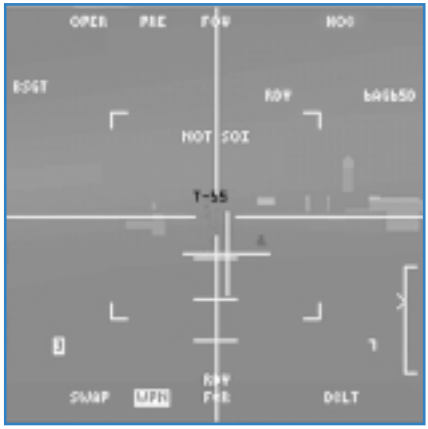


Figure 24-1

Remember this important point about the Maverick MFD image: the Maverick missile on the rail produces the IIR image in the cockpit. When this missile is fired, the video is lost because there is no datalink from the missile to the aircraft. The Maverick is a "launch-and-leave" weapon that is autonomous after it leaves the rail. When the missile is fired, however, the pilot still sees a Maverick image in the MFD if another Maverick is on the jet because the next missile on the rail is slewed to the target. When the *last* Maverick missile is fired, however, the video in the cockpit is lost. The reason for this is obvious; the Maverick missile itself is the source of the target image in the MFD. Once all the missiles are gone, so is the cockpit video.

MAVERICK DISPLAY

The Maverick MFD display has two major components: the tracking gates and the pointing cross (as shown in Figure 24-2).

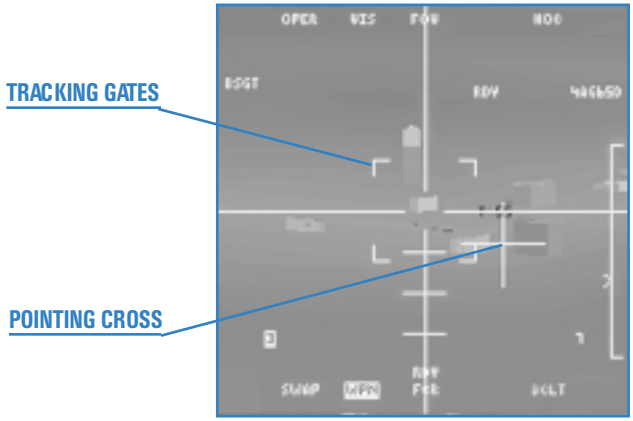


Figure 24-2

The Tracking Gate

The Maverick missile sees the target image and locks on via a tracking gate. This gate is very similar to the radar cursors in several ways. First, the tracking gate can be slewed (moved) over the target by the pilot. Second, it can be slaved to the radar and pointed at the target. And last, once the tracking gate is locked onto the target, it will provide a Dynamic Launch Zone in the HUD for range to the target. The tracking gate locks onto hot targets that are displayed in the MFD. Buildings and other non-vehicular targets are visible to the Maverick along with targets with internal engines. A steel bridge, for example, will be visible to the Maverick because it has been heated passively by the sun. Buildings are visible because of a combination of passive and internal heating. Either way, the Maverick will guide on any target that you can lock on to. You cannot, however, reliably shoot Mavericks at aircraft. The Maverick does not have a guidance computer that can handle the speeds that most aircraft travel. The Maverick, however, can hit a helicopter that is hovering or moving at less than 60 knots.

To lock the tracking gate on a valid Maverick target, simply slew the gate over the target. Once the tracking gate is near the target and the target becomes large enough in the MFD, the brackets around the tracking gate will "breathe" or pulse over the target. This may not occur right after you slew the tracking gate over the target. In *Falcon 4.0,* the tracking gate really consists of two parts. The first part is the intersection of the vertical and horizontal lines in the MFD. The second part is the tracking gate brackets shown in Figure 24-2. After you slew the tracking gate over the target, you must drive in and wait for the Maverick seeker head to determine that this target can be locked up. When the brackets "breathe," you can lock (designate) onto the target by pressing 0 on the numeric keypad. After you lock, the tracking gate brackets should clamp down on the target. At this time, you can fire the Maverick and break away from the target.

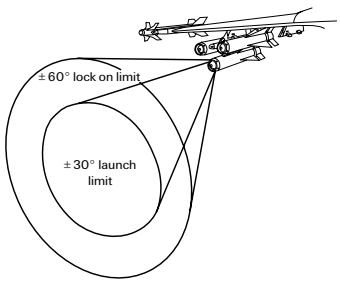


Figure 24-3

The Pointing Cross

The next symbol on the Maverick MFD display is the pointing cross. The pointing cross is a cue to tell the pilot where the Maverick seeker head is looking in relation to the Maverick missile body. This is important because the Maverick missile seeker head has a conical scan limit of *60°*. While the Maverick can see targets up to 60° off axis, it cannot be launched at targets this far off axis. The launch limit is only *30°*. This means that you can see Maverick targets in the MFD that you cannot shoot because of the missile launch limit. Figure 24-3 shows the Maverick scan limit and the launch limit.

A target is centered in the MFD when you lock onto it with the Maverick. When you are looking in the MFD, you cannot tell where that target is in relation to the axis of the missile body without some indication in the MFD itself. The pointing cross shows where the seeker head is in relation to the missile body. The pointing cross works in conjunction with a series of horizontal lines, shown in Figure 24-4. These lines work with the pointing cross to indicate when the missile is 10°, 20° and 30° off boresight.

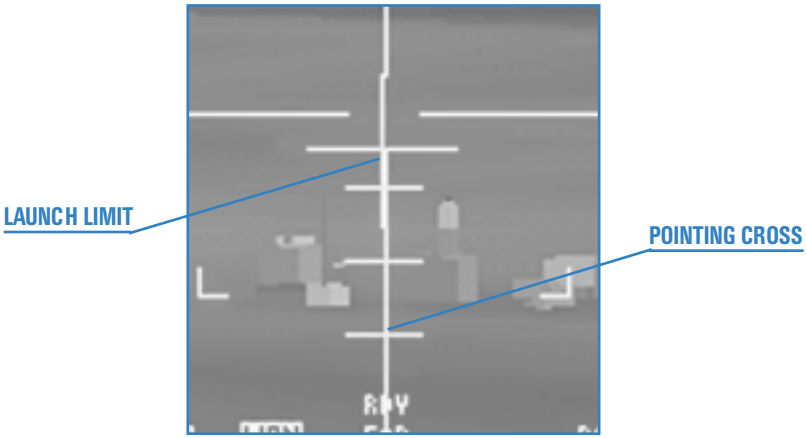


Figure 24-4

MAVERICK MECHANIZATION

When the Maverick missile is selected, an IIR image will appear on the MFD. The Maverick can be selected in several ways, but the simplest way is to press either [or] until the SMS page appears on the MFD, as shown in Figure 24-5.

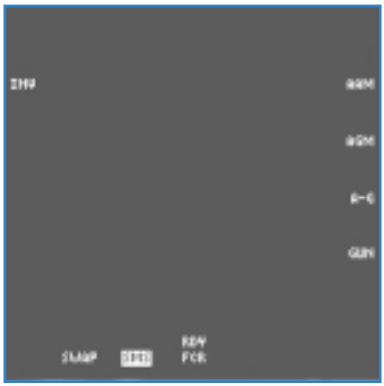


Figure 24-5

When the SMS page is called up, press Backspace to cycle through your air-to-ground weapons. When you get to the Maverick, the video will appear in the MFD. To change to the slave mode, press the OSB on the MFD next to the "BSGT" label on the MFD. This OSB cycles the Maverick between boresight and slave, which are the two basic ways the Maverick can be aimed at the target. In the boresight mode, the Maverick is in a fixed position looking straight out of the HUD. The pilot must find the target visually and point the HUD symbology at the target. Figure 24-6 shows the HUD and MFD in the pre-designate boresight mode. Pre-designate means that the pilot has not designated the target yet.

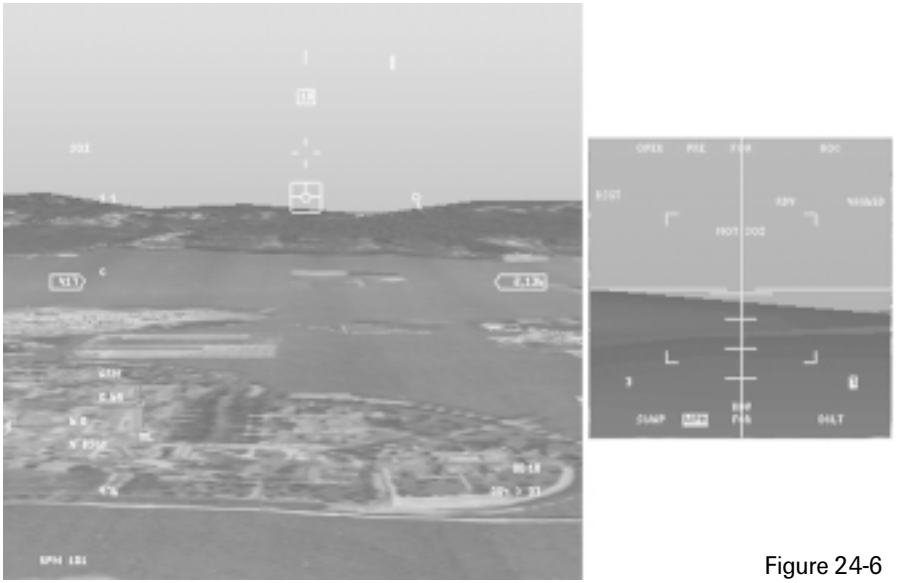


Figure 24-6

Boresight Mode

In boresight mode, the pilot points the TD box in the HUD, designates to ground-stabilize the missile, slews the tracking gates over the target and then designates again to lock the target. After designating the target the first time, the TD box in the HUD ground-stabilizes or fixes itself to the terrain (rather than the HUD). The Maverick can now be slewed or moved over the desired target. To lock onto the target, designate the target a second time once the Maverick tracking gates start "breathing" (pulsing) around the target. If the tracking gates lock onto the target, the Maverick seeker head (and the TD box) will track or follow the target. If the Maverick does not lock onto a target, the Maverick seeker head (and the TD box) will stay fixed to a point on the ground. Figure 24-7 shows the post-designate boresight mode.

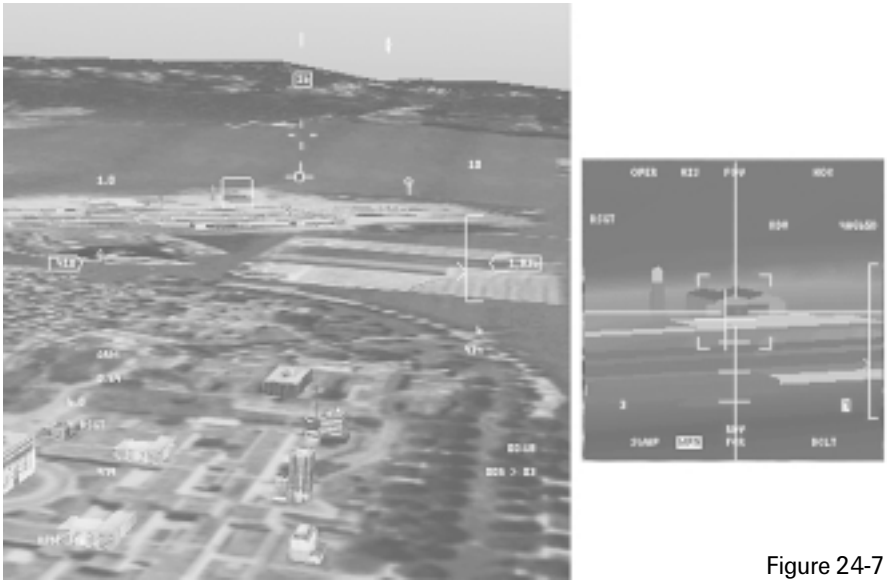


Figure 24-7

To review, locking on the Maverick takes two designates (press 0 on the numeric keypad twice). The first ground-stabilizes the Maverick, and the second locks onto the target when the tracking gate brackets are breathing.

An important Maverick feature is the EXP (Expand) submode. This submode provides 4x magnification of the display. This is a very helpful mode for picking out individual targets. To get to the Expand submode, press the OSB above "FOV" (Field of View) or press '. If at any time you have the wrong target locked up, break lock by pressing . on the numeric keypad. When you do this, the Maverick stays ground-stabilized and you can slew it on a new target.

Slave Mode

The second way of pointing the Maverick is the slave mode, in which the Maverick is slaved or tied to the air-to-ground radar cursors. Using the air-to-ground radar, the Maverick can be slewed to any target that can be tracked by the radar in GM, GMT or SEA. In the slave mode, you simply have to designate a target on the radar scope. This ground-stabilizes the Maverick seeker head near the target, but it will not lock the Maverick onto the target. To lock the missile on the target, you must slew the Maverick over the target and designate it again after the tracking gate brackets breathe over the target. Slave mode is very similar to boresight except that you are using the air-to-ground radar to get the Maverick missile close to the target. Figure 24-8 shows the HUD and MFD views of the Maverick in the slave mode.

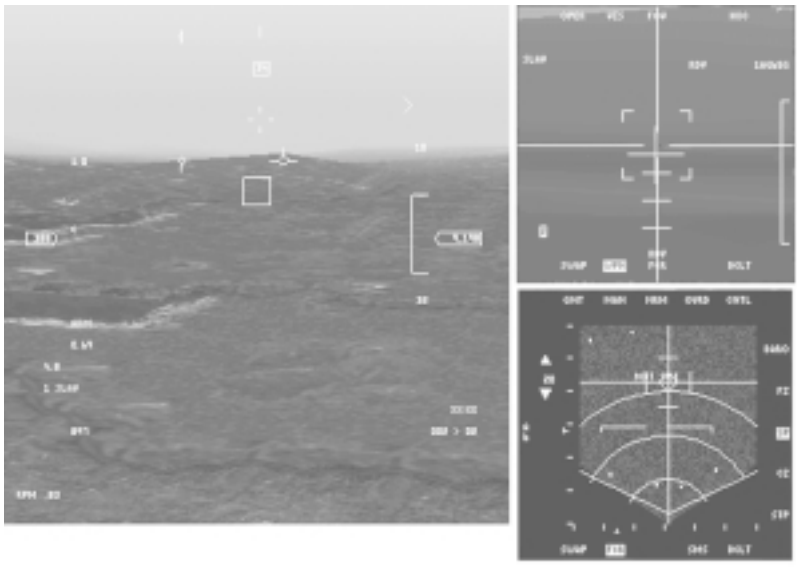


Figure 24-8

The Maverick missile must be locked onto a ground target in all modes of the Maverick before it is fired. If the missile is fired without a lock, it has very little chance of hitting the target. To lock the missile on the target, you must first ground-stabilize the missile by designating (0 on the numeric keypad). The next step is to slew the Maverick directly over the desired target and wait for the tracking gate brackets to breathe over the target. Finally, by designating a second time you can lock onto the target. To break lock or to return the missile to previous mode, press . on the numeric keypad.

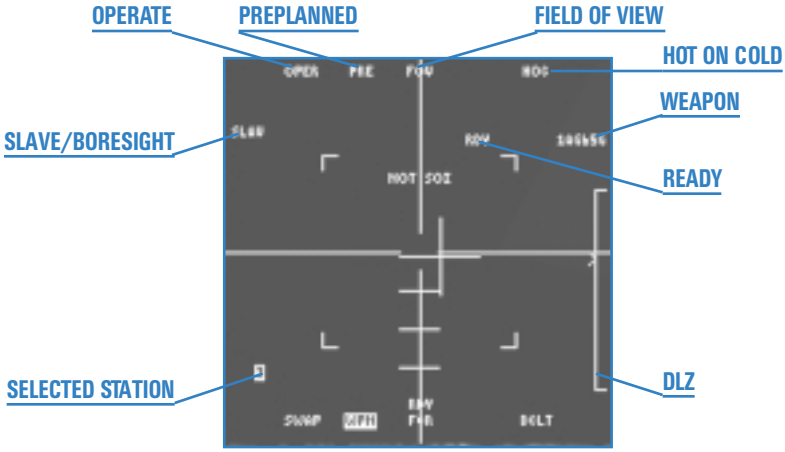


Figure 24-9

The Maverick MFD display has several mnemonics around the outside of the scope:

OPER stands for "Operate" and is always there when the Maverick video is called up.

PRE stands for "Preplanned." This mode is not used in *Falcon 4.0.*

FOV stands for "Field of View."

HOC stands for "Hot on Cold," which sets the polarity of the missile. Since you can only lock onto hot targets in *Falcon 4.0,* this label is permanently set to "HOC."

BORE/SLAVE stands for "Boresight" or "Slave." This label reflects the current Maverick mode.

3/4/6/7 is the number that corresponds to the station where the missile is loaded. Maverick missiles can be loaded on stations 3, 4, 6 and 7. Stations 3 and 4 are on the left side of the jet, and stations 6 and 7 are on the right side. The station that is selected to fire the next missile is highlighted.

RDY stands for "Ready." It indicates that the missile is armed and ready to fire.

MAVERICK DLZ

The Maverick missile uses a similar DLZ (Dynamic Launch Zone) display as the air-to-air missiles. This DLZ has an in-range caret that displays the Maverick's kinematic ability to reach the target. Figure 24-10 shows the Maverick HUD display after a missile is locked onto a target and the Maverick DLZ.

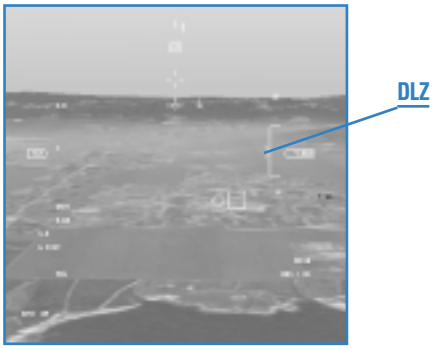


Figure 24-10

TRAINING MISSION OVERVIEW

In this mission, you will practice using the boresight and slave modes of the Maverick missile.

INITIAL CONDITIONS

- Airspeed: 400 knots
- Altitude: 4,500 AGL
- Throttle Setting: Mid-range
- Configuration: Gear up, 6 AGM-65Ds and 2 AIM-120s

MISSION DESCRIPTION

This mission starts with the Falcon pointing toward the coastline. A building will come into view near the coast, and near the building is a group of target vehicles. Most of these vehicles are tanks, perfect targets for the Maverick missile. This mission is designed to let you practice shooting Mavericks at these vehicles.

Use the following steps to fire the Maverick missile in *boresight* mode:

1. Load training mission "24 Mavericks" from Tactical Engagement.
2. Once the training mission starts, freeze the game by pressing Shift P.
3. Bring up the right-hand MFD by pressing] until you see the SMS display. Call up the Mavericks by pressing Backspace until you see "6AG65D" on the right side of the MFD.
4. Press S to select Steerpoint 4 in the DED.
5. Unfreeze the simulation by pressing Shift P.

6. Set the throttle to 80% and fly the TD box in the HUD over the diamond in the HUD. The diamond is over Steerpoint 4 while the TD box is where your Maverick seeker head is looking. There will be several buildings near the steerpoint. When you see them in the MFD video, freeze the simulation by pressing Shift P.

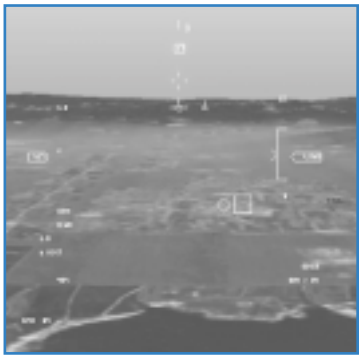


Figure 24-11

7. Make sure you see some buildings or other targets (such as tanks or vehicles) in the Maverick MFD display.

8. Ground-stabilize the TD box by designating the target (0 on the numeric keypad).

9. Slew the maverick tracking gates over a target using ↑, ↓, ← and →. When the Maverick seeker head sees a valid target, the tracking gates will breathe over the target. Slew the missile seeker while focusing your attention on the cockpit MFD video.

10. As you slew with the simulation in Freeze mode, notice how the TD box in the HUD moves also. In the boresight mode, you usually see the targets first in the HUD and slew the TD box over them and next you look at the video on the MFD. For this training mission, we are doing it out of order.

11. When the target is inside the tracking gates and the gates are breathing, lock onto the target by pressing 0 on the numeric keypad. The tracking gate brackets should lock down on the target (stop breathing).

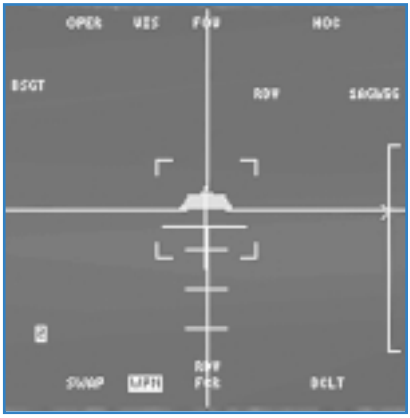


Figure 24-12

12. Ensure that the Maverick is in range by checking the DLZ in the HUD. The in-range caret should be inside the DLZ bracket. If the target is in range, unfreeze the simulation by pressing Shift P. Shoot the missile by pressing Spacebar or joystick button 2. If you are not in range, then drive in closer and shoot when you are in-range.

The next series of steps will take you through shooting the Maverick using the *slave* mode. In this mission, press Shift P often to use the Freeze function to slow down the mission.

1. Load training mission "23 Mavericks" from Tactical Engagement.
2. Once the training mission starts, freeze the game by pressing Shift P.
3. Call up the Mavericks by pressing Backspace until you see the Maverick displayed on the MFD.
4. In the left MFD, call up the air-to-ground radar by pressing [until the RWS radar display is up. Then press F2 until GMT (Ground Moving Tracking) is called up on the MFD.
5. Place the Maverick missile in slave mode by pressing the OSB next to the "BSGT" label on the MFD or by pressing '.
6. Go to Steerpoint 4 by pressing S until Steerpoint 4 appears in the DED. In the bottom right corner of the HUD, a readout like "007>4" will appear, which means that you are 7 miles from Steerpoint 4.
7. The GMT radar display should show several moving targets on the scope, as shown in Figure 24-13. They will be easier to see if you reduce the GMT scope size to 10 mile range by pressing F3. These targets should appear as squares on the scope. Slew the *radar* cursors over one of targets using ↑, ↓, ← and →.

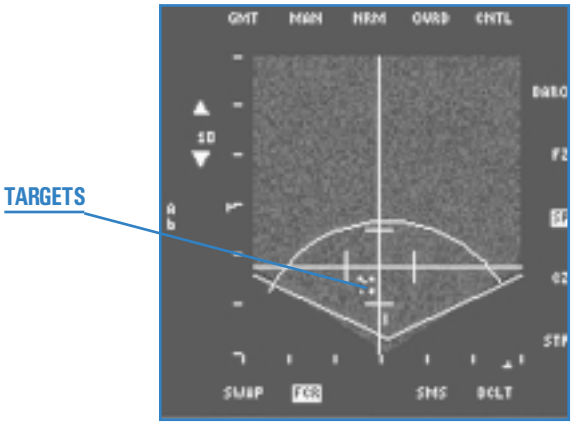


Figure 24-13

8. Once the radar cursors are over the target, lock on by pressing [0] on the numeric keypad. This will lock the GMT radar onto the moving target. A diamond will now appear over the target in the GMT display. If you look in the Maverick display, you should see a target.

9. When the Maverick tracking gate brackets start to breathe over a target, designate it by pressing [0] on the numeric keypad. When the Maverick is locked on, unfreeze the simulation by pressing [Shift][P].

10. Check your HUD DLZ to ensure that you are in range. If so, fire the missile by pressing [Spacebar] or joystick button 2. If not, get closer before shooting. You are in range when the in-range caret on the right side of the HUD is inside the DLZ brackets.

The Maverick missile can be slaved to the GM and SEA modes of the air-to-ground radar to destroy stationary targets and boats, respectively. The procedures for using GM and SEA is exactly the same as the procedure for GMT. Remember that in GM, GMT and SEA, the radar cursors are tied to the selected steerpoint. You can detach the cursors from the steerpoint by switching to Snowplow mode (see Training Mission 18 for more details).

MISSION 25: LASER-GUIDED BOMBS

An LGB (Laser-Guided Bomb) is a free-fall weapon that guides to a laser spot on the ground. Television coverage of the Gulf War featured American laser-guided bombs flying down the air shafts of buildings and straight into aircraft bunkers. The concept is straightforward. The F-16 carries a targeting pod that can track an image of the target. When the target is being tracked, laser energy from the targeting pod bounces off the target and can be picked up by the laser guidance kit in the nose of the bomb. The pilot then flies the jet near the target and drops the bomb using the CCRP bombing mode. In the last phase of the attack, the LGB guides on laser energy reflected from the target.

It is important to keep in mind that an LGB is *guided* but not *powered*. This means that you must get the LGB close to the target just like any other free-fall bomb. In fact, LGBs must be treated exactly like any other free-fall bomb up until release. You must fly your attack steering just as if you were dropping an ordinary CCRP bomb. After the bomb leaves the jet, you must fly a flight path that ensures that the targeting pod stays locked to the target. If it sounds like a lot of work, you're right. Dropping LGBs is not as easy as dropping normal free-fall bombs because you have the extra steps of locking up the target with the targeting pod and then tracking the target after the bombs leave the jet. The good news is that LGBs are very lethal with a very high Pk (Probability of Kill) on virtually all targets. In addition, once you identify and lock onto the target, it is easy to stay locked on.

The targeting pod itself can display and lock onto targets up to 150° in any direction from the nose of the jet. Figure 25-1 shows the gimbal limits of the targeting pod.

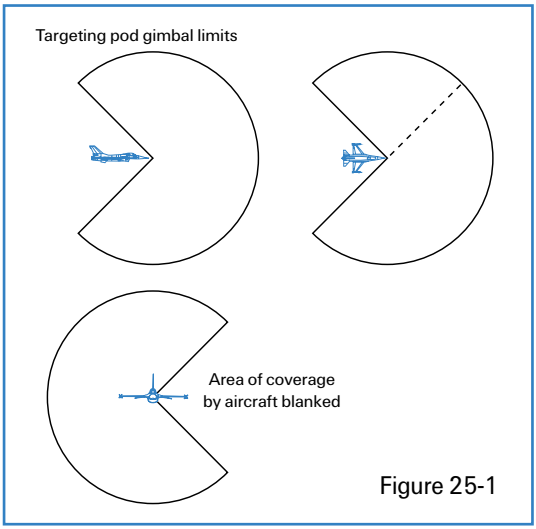


Figure 25-1

I should mention one thing about nomenclature and terms. You will hear the term LGBs and GBUs (Guided Bomb Units) used throughout this discussion. LGBs is a general description of the weapon. GBU, on the other hand, is a designation for laser-guided bombs specific to the U.S. Air Force. For example, a GBU-12 is a 500 lb. LGB. Sometimes, these bombs are referred to as GBUs instead of LGBs, but both of these terms mean the same thing. The targeting pod is the system on the jet that tracks the targets and emits the laser energy to guide the bomb. The targeting pod also provides the picture that is displayed on the cockpit MFD. The targeting pod and a GBU bomb are subsystems of the laser-guided bombing system on the F-16.

TARGETING POD SLAVE MODE

The targeting pod provides an IR image of the target that is similar to the image displayed in the Maverick. Like the Maverick, the targeting pod has both a slave and boresight mode. In the slave mode, the targeting pod is tied to the air-to-ground radar cursors (just like the Maverick). This means that in the slave mode, the targeting pod is always initially looking at the same place as the radar cursors. The only exception is when the pilot selects the SP (Snowplow) mode of the air-to-ground radar.

You will recall that the air-to-ground radar has two basic modes: STP (Steerpoint) and SP (Snowplow). In STP the radar cursors are tied to the selected steerpoint and the radar is looking at that steerpoint. In SP the radar cursors are detached from the steerpoint and are fixed in the middle of the radar scope. In STP mode, the air-to-ground radar cursors stay fixed to the ground at the position of the steerpoint, while in SP they move along the ground at a set range from the target. The targeting pod is tied to these cursors in both STP and SP. Figure 25-2 shows how these modes work.

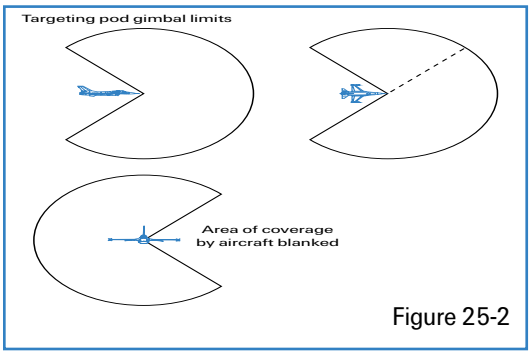
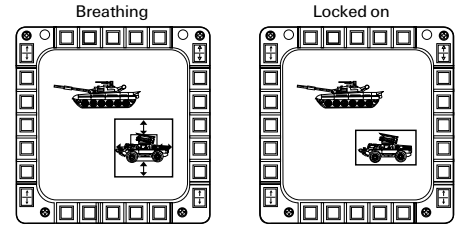


Figure 25-2

Notice that the pod is providing an image of the steerpoint in STP mode and an image that is constantly changing in SP. The important point here is that the targeting pod is always initially looking at the air-to-ground radar cursors. The operative word here is "initially." The targeting pod (like the Maverick) can be slewed around at any time by the pilot. The pod in the slave mode starts out by looking or pointing at the position on the ground that corresponds to the radar cursors. It is better not to lock the air-to-ground radar on a target when using the targeting pod because it may interfere with your ability to search for targets. The radar should only be used to gain an initial picture of the target and get the targeting pod looking in the right area. The pilot can then slew the pod and pick out individual targets with no further action.

The bottom line in the slave mode is that the pilot should slew the targeting pod around to find a target and only use the radar to find the general area. As the pilot slews the targeting pod in the MFD, the laser spot on the ground moves. The bomb has a very good chance of guiding on this ground-stabilized spot without any further action from the pilot. The pilot can, however, raise the probability of kill on the target by locking onto the target. The targeting pod, like the Maverick, will "breathe" (pulse) when it finds a target that it can lock onto. You do not have to lock the targeting pod on a target, however, to hit it. If you do not lock, though, you must slew to keep the pod (laser spot) on the target through the bomb time of fall to the target.



Cursors breathing on a target and locked on

Figure 25-3

Figure 25-3 shows the tracking box both before and after the designate.

Don't forget that when you enter the slave mode, CCRP is selected and CCRP HUD symbology will be displayed in the HUD.

TARGETING POD BORESIGHT MODE

The targeting pod also has a boresight mode that works just like the Maverick boresight mode. The pilot has a TD box in the HUD that is attached to the flight path marker. The targeting pod is looking through that box. Figure 25-4 shows the targeting pod HUD symbology for the boresight mode.

To line the targeting pod up on a target, point the TD box at the target and then designate it. This will detach the TD box from the flight path marker and ground-stabilize the targeting pod over the position on the ground where you designated. If the targeting

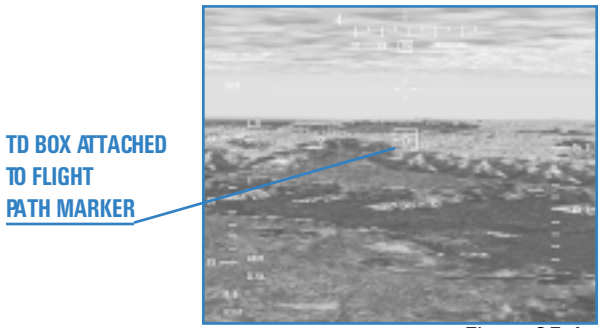


Figure 25-4

pod can see the target at this time, it may jump straight to the lock on mode with this single designate. You will know the targeting pod is locked onto the target because you will not be able to slew the display. This is not a problem, but you may have to break lock on the target and slew your targeting pod to a new target.

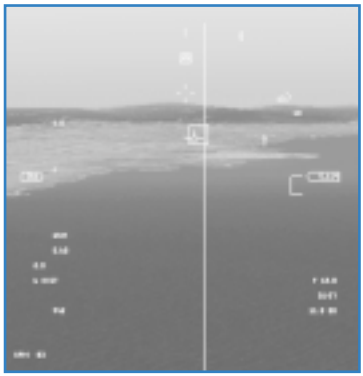


Figure 25-5

After designating the target, CCRP attack symbology will appear in the HUD, as shown in Figure 25-5.

This is different than the slave mode that we have already discussed. In the slave mode, CCRP will come up as soon as you enter the slave mode. In the boresight mode, CCRP symbology will be displayed only after you designate a target.

TARGETING POD MECHANIZATION

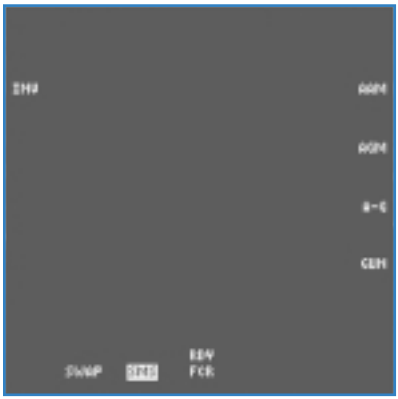


Figure 25-6

The targeting pod is called up in the same way as all the other bombing modes. One way is to press [or] until the SMS page comes up on the MFD, as shown in Figure 25-6.

Once you are in the SMS page, press Backspace to cycle through all available air-to-ground weapons. When the weapon on the right side of the SMS page reads "#GB##," you are in the targeting pod mode for GBUs/LGBs. The first # symbol is the number of that particular weapon on board. The next two # symbols are the specific type of weapon on board. For example 6GB12 means that you have two (2) GBU-12 bombs on the aircraft.

THE TARGETING POD DISPLAY

As shown in Figure 25-7, the targeting pod display that is displayed in the MFD looks very similar to a Maverick display.

The targeting pod display has a pointing cross and a tracking gate or box just like the Maverick display. The tracking gate is a simply a box in the center of the display. As we discussed before, the box will "breathe" (pulse) when the targeting pod has the ability to lock onto a target that is inside the gate. Until the tracking gate

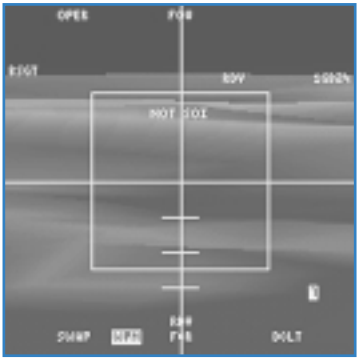


Figure 25-7

breathes over the target, you cannot lock on.

The pointing cross rotates around the display to show you where the target pod is looking relative to the nose of the aircraft. This means that if the pointing cross is centered in the display, then the targeting pod is looking right down the nose of the jet. If it is off to the right side of the display, then the targeting pod is looking to the right of the jet. It is easy to lose track of where the target is relative to your flight path as you gaze into the targeting pod display. A quick glance at the pointing cross should reorient you.

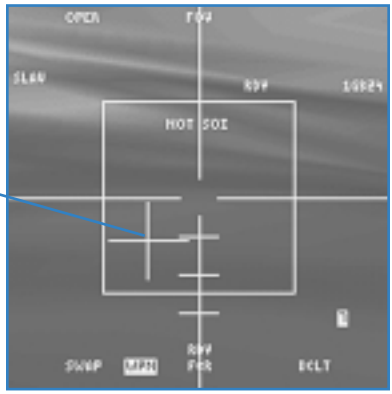


Figure 25-8

The following list explains the mnemonics around the target pod display:

OPER stands for "Operate." This OSB label is always present when the missile video is displayed.

FOV stands for "Field of View." When this mnemonic is displayed, the targeting pod is supplying a normal (non-expanded) picture of the target. If you press the OSB above "FOV," it will change to "EXP," which stands for Expand. Expanded mode provides a 4x expansion of the target area.

3/4/6/7 is the number that corresponds to the station where the bombs are loaded. All stations that are loaded with LGBs will be presented, and the selected station will be highlighted. This is done automatically, and no pilot action is required to select a station.

RDY stands for "Ready." This indicates that the bombs are armed and ready to drop.

NOT SOI stands for "Not Sensor of Interest." This label appears when you cannot control or slew the tracking gate in the MFD. "NOT SOI" tells you that the slew controls are in the HUD. In other words, when you try to slew, you will be moving HUD symbology instead of the tracking gates in the MFD.

An important mnemonic on this list is "FOV/EXP." It is very useful to expand the display. For example, if you want to bomb the control tower on the runway complex, go to Expand, search for the tower and then lock on.

HUD DISPLAYS

When the targeting pod is in the slave mode, the CCRP bombing mode appears in the HUD. CCRP also appears in the boresight mode after you first designate a target.

The CCRP is the only bombing mode that can be used with the targeting pod. Remember that CCRP is tied to the air-to-ground radar cursors. To review, CCRP allows the pilot to bomb the target that is under the radar cursors. CCRP puts a vertical steering cue in the HUD. If you line up the flight path marker with this vertical steering cue, you will fly directly over the target (which is under the radar cursors). As you approach the target, a small horizontal line marches down the vertical steering line as a cue that you are approaching loft range from the target. When this occurs, a circle will appear in the HUD. When the horizontal line descends a second time, it becomes your release cue. The release cue will trigger a bomb release when it intersects the flight path marker.

TRAINING MISSION OVERVIEW

This mission starts with the Falcon pointing at a runway complex. There are numerous buildings around the airfield as well as aircraft on the taxiways.

INITIAL CONDITIONS

- Airspeed: 350 knots
- Altitude: 7,500 MSL and level
- Throttle Setting: Mid-range
- Configuration: Gear up, 6 GBU-12Bs and 2 GBU-24Bs

MISSION DESCRIPTION

In this training mission, you are 15 miles from an airfield complex. Air-to-ground radar is called up with Steerpoint 4 selected, which is the target complex. The radar cursors should be on the selected steerpoint, and the targeting pod should be in the slave mode. You will lock the targeting pod on a building or aircraft on the airfield complex and then drop an LGB on the target.

Use the following procedures to drop bombs with the targeting pod in the slave mode:

1. Load training mission "25 Laser-Guided Bombs" from Tactical Engagement.
2. Once the training mission starts, freeze the game by pressing Shift P.
3. Call up Steerpoint 4 in the DED by pressing S.

4. Call up your LGBs by pressing Backspace until "6GB12" appears on the right side of the MFD display. When the targeting pod video comes up in the MFD, CCRP will come up in the HUD if you are in the slave mode.

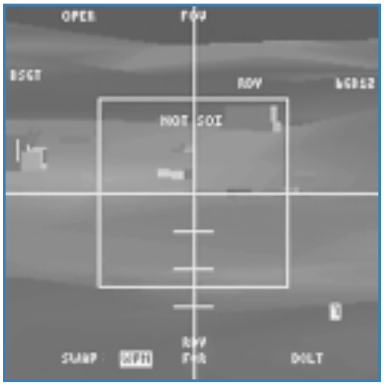


Figure 25-9

5. To switch to the slave mode, press the OSB next to the "BSGT" mnemonic or press '. As you switch between boresight and slave modes, your HUD display will change.

6. In the other MFD, call up the air-to-ground radar by pressing [until you see "RWS" appear at the top of the left MFD. Next press F2 until "GM" is displayed at the top of the MFD.

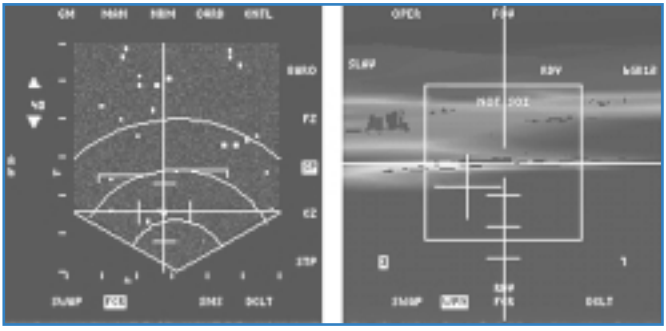


Figure 25-10

7. The radar cursors should be on top of airfield radar returns. Bring the radar range scale down to 20 miles by pressing F3.

8. Go to DBS2 by pressing the OSB above the "NRM" mnemonic on the MFD until you see "DBS2" appear. It is best not to lock the air-to-ground radar on the target. Use the DBS2 radar display to get a long-range picture of the target area. If you are flying in a multiplayer game, you can use DBS2 to divide up the target area among your flight members. Figure 25-11 shows the target area in DBS2.

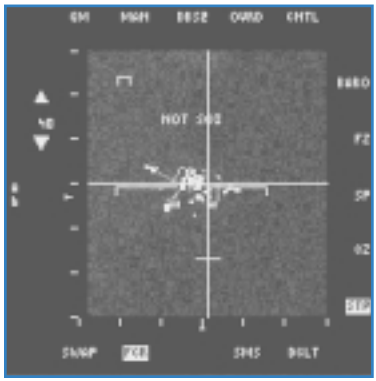


Figure 25-11

9. Unfreeze the simulation by pressing Shift P.

10. Follow the CCRP steering in the HUD by lining up the flight path marker with the vertical CCRP steering line (as shown in Figure 25-12).

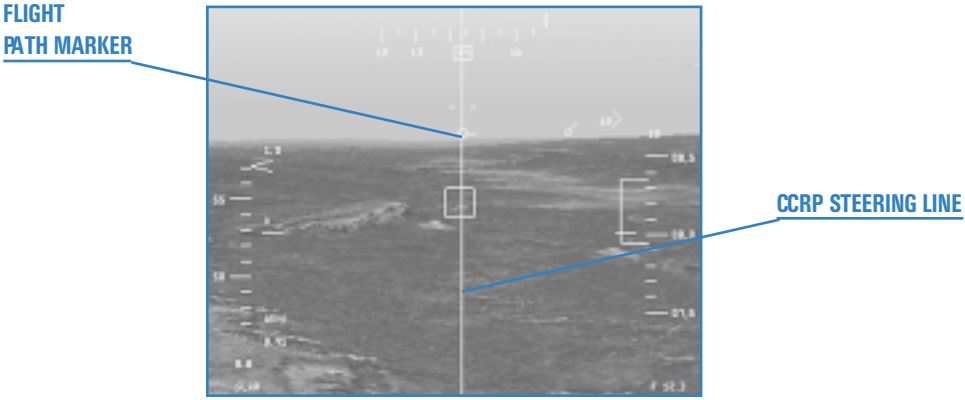


Figure 25-12

11. Watch for the tracking gates to "breathe" over the target. If you are sure that the tracking gates are breathing over the correct target, lock on by pressing [0] on the numeric keypad. If the gates are not breathing or are breathing over the wrong target, continue to look for your target by slewing the targeting pod.

12. You can use the Expand submode of the targeting pod display to aid in finding the target. Press the OSB above "FOV" on the MFD. It will change to "EXP" (Expand) and will magnify the target area by four times.

13. Fly straight and level and line up your CCRP steering. Hold down the pickle button ([Spacebar] or joystick button 2) before the release cue descends to the flight path marker. Keep in mind that the first horizontal line to descend the vertical steering line is the loft cue. The second line is the release cue. Figure 25-13 shows the CCRP mode with the release cue descending the vertical steering line.

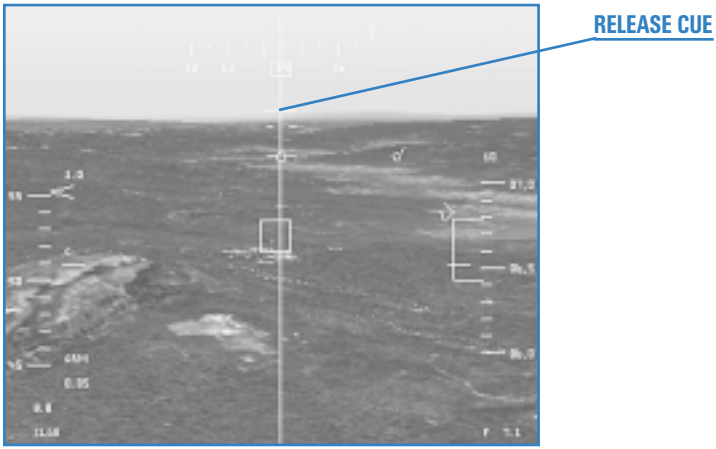


Figure 25-13

14. You should hear the bomb release from the aircraft and the CCRP steering line will fall away to the side of the HUD. At this point, start a left-hand turn using 30°–80° of bank. This "designator turn" is used to keep the laser energy on the target.

15. Watch the targeting pod display in the MFD to ensure that you hit the target. Once the bomb impacts, you are free to maneuver as necessary.

Use the following procedures for dropping a LGB using the boresight mode of the targeting pod:

1. Drive into the target area using the HSD to find the target. Bring up the targeting pod display in the right MFD by pressing [Backspace]. The targeting pod will come up in the boresight mode. Next, call up the HSD in the left MFD by pressing [until the HSD display appears.

2. Select Steerpoint 4 by pressing [S]. Steerpoint 4 will be flashing in the HSD.

3. Since the boresight mode is a visual bombing mode, you have to gain sight of the airfield. To do this, place the TD box in the HUD over the diamond in the HUD. You should now see the airfield complex in the targeting pod video in the right MFD. When you are sure you are seeing the airfield, designate by pressing [0] on the numeric keypad. This will ground-stabilize the targeting pod and change your HUD symbology to CCRP steering.

   Keep in mind that any time you press [0] on the numeric keypad, you may lock the targeting pod on to a target. This may not be the specific target that you want. If you get closer to the target and the pod will not slew to a new target, you are locked on. You must break lock by pressing [.] on the numeric keypad in order to regain control of your targeting pod.

4. Place your flight path marker over the CCRP vertical steering line and fly towards the target. Figure 25-12 shows this HUD display.

5. Watch for the tracking gates to "breathe" over the desired target (if the pod is not already locked on). There is no rush so if you want to get closer to look for the target, go ahead and follow your CCRP steering and drive in. Remember if you lock the wrong target, you need to break lock (I guess you can tell by now that this happens a lot).

   To aid in finding the target, put the targeting pod in Expand submode to magnify the area by four times. Press the OSB above "FOV" on the MFD to switch to EXP (Expand).

6. Fly your CCRP steering and hold down the pickle button ([Spacebar] or joystick button 2) before the release cue descends to the flight path marker. Figure 25-13 shows the CCRP mode with the release cue descending the vertical steering line.

7. You should hear the bomb release from the aircraft and the CCRP steering line will fall away to the side of the HUD. At this point, start a left-hand turn using 30°–80° of bank.

8. Watch the targeting pod display in the MFD to ensure that you hit the target. Once the bomb impacts, you are free to maneuver as necessary.

On this training mission, you can restart the mission and try bombing several of the targets available on the runway. In addition to bombing with the targeting pod locked onto the target, experiment with bombing without locking up the target. You will find that it works if you keep checking to ensure that the tracking box stays on the target. This mission is set up to drop an LGB from medium altitude on a level pass. You are far enough away from the target, however ,to descend to low altitude and loft the bomb at the target. To execute a loft attack, descend to 1,000 feet AGL and accelerate to 500 knots. When you get to about 4 miles from the target, your loft reticle will come into view followed by your release cue (remember all of that CCRP stuff we already discussed). Start a 30° climb with the CCRP steering centered and the pickle button down. When the bomb comes off the jet, start a designator turn to the left staying just high enough to maintain line of sight with the target. After the bomb impacts, you can descend to a lower altitude.

Lofting LGB is graduate-level stuff so it will probably take you a few tries before you get it down pat. The key to low-altitude lofting is getting the target identified correctly and locked up. After that, the only difficult part is getting the bomb off (you have to follow your CCRP steering for this to happen) and keeping the targeting pod locked onto the target.

MISSION 26: HARM AIR-TO-GROUND MISSILE

The HTS (HARM Targeting System) is used to find enemy ground radars and shoot them with the HARM (High-Speed Anti-Radiation Missile). The HTS consists of a passive receiver that detects radar emissions and displays them on a scope. When radar energy hits the Falcon's HTS antennas, it is processed by an onboard computer that determines the bearing and range of the radar signal along with radar type (SA-3, SA-6, etc.). The pilot can then lock onto these symbols on the HTS cockpit display and fire a HARM. Figure 26-1 shows an overhead view of how the radar energy from a threat radar hits the Falcon and is shown on the HTS display.

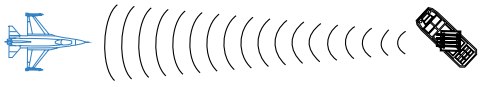


Figure 26-1

The HTS–HARM combination is very similar to the air-to-air radar–AMRAAM combination. With both systems, you detect targets on a scope, lock on and then shoot them when they come within range. There is one significant difference, however, between air-to-air radar mechanization and the HTS. The air-to-air radar has a very high probability of detecting all targets in its search volume. This is not necessarily the case with the HTS. The HTS is not an active system like the radar. In other words, it does not send out any energy to find targets, and will only find radar targets that are radiating. If a threat system has its radar turned off, you may *not* see that system on the scope. You may see the threat because there are two ways that threat symbols appear on the HTS. The first way is that the HTS detects radiating targets within its search volume. The second way is to have it pre-programmed on the display. HTS will display both radiating targets and known radar sites that are pre-loaded into the HTS computer by your squadron intelligence. These pre-programmed sites may or may not transmit but will still be displayed on your scope. The known fixed SAM sites in your mission area are automatically loaded into the HTS display.

The HTS system displays two types of targets: pre-loaded radars and radars that are detected and processed by the HTS computer in real time. You can shoot at both of these target types, but you have a very low probability of hitting any target that is not sending out a radar signal. Remember that the HARM has a very good chance of hitting a threat radar that is in range and transmitting radar energy, but a very poor chance of hitting a threat radar that is not transmitting during the missile's time of flight.

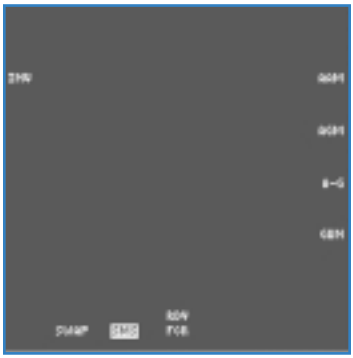


Figure 26-2

HTS MECHANIZATION

The HTS is called up the same way as all other air-to-ground missiles. The most straightforward way is to press [or] until the SMS page comes up on the desired MFD, as shown in Figure 26-2.

Once you are at the SMS page, press Backspace to cycle through all the available air-to-ground weapons until the HTS appears on the MFD.

THE HTS DISPLAY

The HTS display is used to display and lock onto threat radars. It is easily identified on the MFD because it has an oval display that represents the range footprint of the HARM (as shown in Figure 26-3). Any target that appears inside of this oval display is in range of the missile.

The HTS can detect a radar signal anywhere on the scope, including the 6 o'clock position. Once detected, the threat radar will stay on the scope even if it has shut down and is not transmitting radar energy. The HTS symbols are the same as the ones used by the Threat Warning System. The HTS display, however, has these added features:

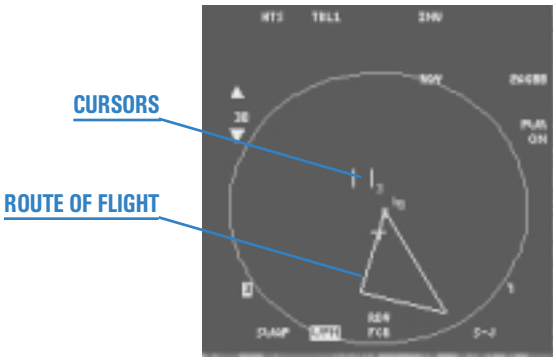


Figure 26-3

- Bright Symbol – threat is searching or emitting
- Reverse Bright Video – threat is tracking a target
- Dim Symbol – threat is known to the HTS but is not currently transmitting radar energy
- Blinking Bright Symbol – threat is launching a missile

For example, if an SA-6 SAM suddenly comes up on your nose at 10 nm, the HTS displays a bright "6" symbol at 12 o'clock and 10 miles (as shown in Figure 26-3A). If it then starts tracking you, it would go to a reverse bright symbol (as shown in Figure 26-3B).

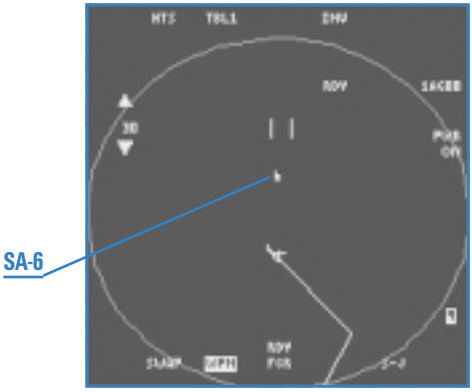


Figure 26-3A

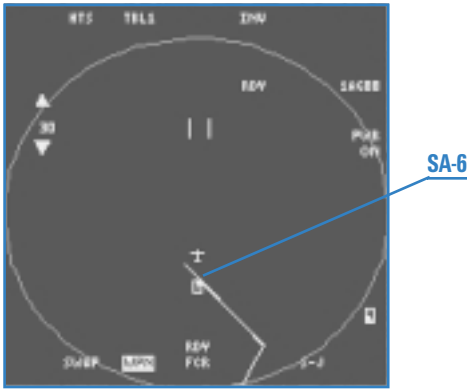


Figure 26-3B

Superimposed on the HTS display is the HSD (Horizontal Situation Display). This allows you to view the proximity of radar threats to your flight route. The HSD provides an overhead view of your planned route.

Around the outside of the HTS display are a series of mnemonics listed below:

HTS stands for the "HARM Targeting System."

TBL1 is a static label that stands for "Threat Table 1."

INV stands for "Inventory." It is not functional on the HTS display.

RDY stands for "Ready." This means that your HARM is armed and ready to shoot.

2AG88 means that two AGM-88 HARMs are called up.

PWR ON means that the missile has power.

S-J stands for "Selective Jettison." Press this OSB to jettison the missile on the selected station.

FCR stands for "Fire Control Computer." Press this OSB to switch from the HTS to the radar.

WPN stands for "Weapon." Press this OSB to cycle through the AAM (Air-to-Air Missile), AGM (Air-to-Ground missile), A-G (Air-to-Ground) and GUN weapon modes.

SWAP swaps the left and right MFD displays.

is the number that shows the station that the selected missile is loaded on. The lower left corner shows a missile station if the HARMs are symmetrically loaded. The next missile to fire is the highlighted station.

15 is a range number for the HTS. Press the OSBs next to the arrows to increase or decrease the range scale from 15, 30, 60 or 120 miles.

SHOOTING A HARM

To shoot the HARM, you must lock onto the threat symbol on the HTS scope. Do this the same way that you lock onto an air-to-air target. The HTS contains a set of small vertical lines called cursors (virtually identical to the cursors in the air-to-air radar). To lock onto a target, place the cursors over the target using ↑, ↓, ← and →, as shown in Figure 26-4.

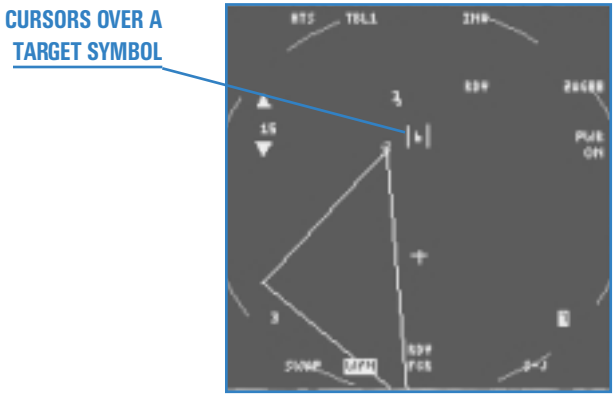


Figure 26-4

Lock onto the symbol by designating the target. Please note that the HTS can be very finicky about locking up targets, so if you can't lock on, just keep trying. Because the symbols may be moving on the scope, you need to anticipate threat symbol movement to get the cursors over the target. When you have the target locked up, a circle will appear over the threat symbol, as shown in Figure 26-5.

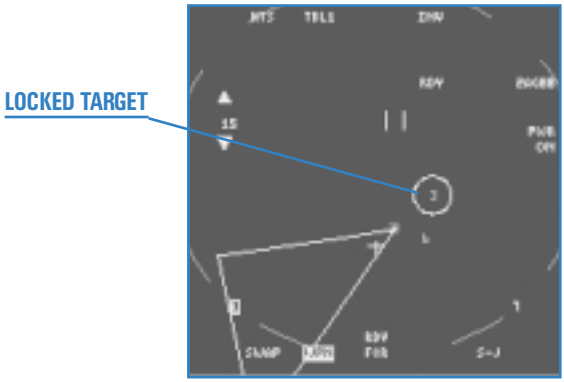


Figure 26-5

The HTS is limited to locking only one target at a time. Since the HARM is a launch-and-leave weapon, once the missile is off the rail, you can immediately break lock on the target you fired on, lock onto a new target and fire the next missile.

HUD DISPLAYS

The HUD displays a missile reticle when the HARM is called up. The purpose of this circular display is to cue the pilot that you have a HARM called up. Since the HARM can be fired at any target within 360° of the Falcon, this missile reticle is not present to indicate any limits of the missile. When the HARM is fired, it will make a high G turn and attempt to go after any target that is locked up on the HTS. This turn burns up a lot of the missile's energy and reduces maximum range. If there are any doubts about the missile's ability to make it to the target, it is far better to turn the jet and put the target on the nose before you fire. As a general rule, the jet will turn faster than the HARM so you can kill the target quicker by turning to put it on the nose.

When the target is locked up on the HTS, a smaller circle will appear in the HUD over the threat radar. If the threat radar is not in the HUD's field of view, a locator line will extend from the gun cross toward the threat radar. Figures 26-6A and 26-6B show a HUD display of threat radars that are locked up and are inside and outside the HUD's field of view.

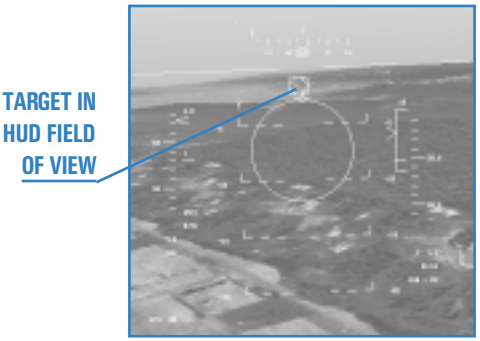


Figure 26-6A

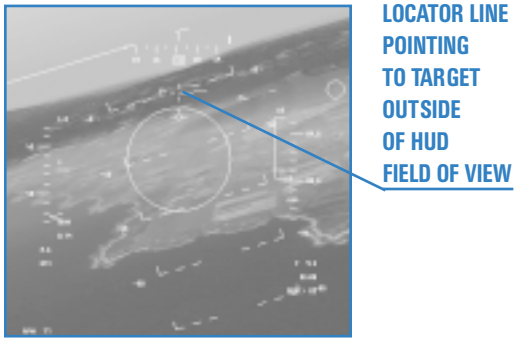


Figure 26-6B

In the above figures, notice that a DLZ (Dynamic Launch Zone) bracket is in the HUD. This bracket appears when a target is locked up on the HTS. The bracket shows the maximum and minimum range that you can fire a missile at the target. Along with the DLZ bracket, you also have a digital range readout in the HUD as shown in the above figures. The range readout and the small circle (or locator line) provide cueing on the location of the threat radar.

TRAINING MISSION OVERVIEW

This mission starts with the Falcon approaching a group of enemy SAMs. These sites are between 10 to 20nm on the nose. Some of the SAMs are radiating constantly, while others are blinking.

INITIAL CONDITIONS

- Airspeed: 350 knots
- Altitude: 15,000 MSL
- Throttle Setting: Mid-range
- Configuration: Gear up, jammer pod and 2 AGM-88 HARMs

MISSION DESCRIPTION

In this training mission, use the HTS to find and engage targets with the HARM. To shoot HARMs:

1. Load training mission "26 HARMs" from Tactical Engagement.
2. Call up the HTS by pressing Backspace until the HTS display is called up on the MFD.
3. As you drive in towards the coastline, threat symbols will appear on the HTS display. The threats that are bright indicate that they are radiating. Freeze the simulation by pressing Shift P.

Figure 26-8

4. Lock onto the nearest radiating threat by placing the HTS cursors over the target using ↑, ↓, ← and →. When the cursors are over the target, lock on by pressing 0 on the numeric keypad.

5. Check that the threat radar is in range by noting the position of the carat on the HARM DLZ bracket in the HUD. In addition, if the symbol is in range, it should be inside the range footprint oval on the HTS scope. The range oval is a dim circle on the HTS scope. The circle is solid if the range on your scope is 30 nm or greater and dashed if the range is at 15 nm.

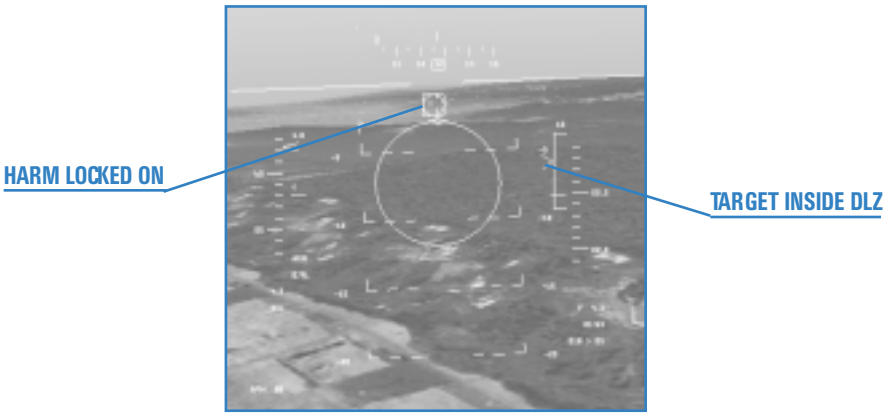


Figure 26-9

6. Unfreeze the simulation by pressing Shift P.

7. Fire the missile by pressing Spacebar or joystick button 2. The aiming circle in your HUD is primarily used as a visual indication that HARMs are the active weapon. HARMs are amazingly agile, even to the extent that an "over the shoulder" launch is possible.

Remember that the HARM will only guide on the target when the threat is radiating. If the radar target shuts down while the missile is on its way to the target, the HARM will probably miss. In this case, the HARM will attempt to guide toward the target but it will not have the radar signal to provide precise guidance at the end of its flight. If the radar goes down and comes back up during the missile's flight, the Falcon HARM has a slight chance of reacquiring the radar signal and hitting the target.

CHAPTER

7

MISSILE THREAT REACTION

Falcon 4.0 features many lethal enemy threat systems. All of these systems have weaknesses, though, that a good fighter pilot can exploit.

MISSION 28: MISSILE THREAT REACTION

This training mission will discuss procedures for defeating both SAMs (Surface-to-Air Missiles) and AAMs (Air-to-Air Missiles), but first we will talk about missiles in general.

MISSILE GUIDANCE

Both SAMs and AAMs use either IR (Infrared) or radar to guide them to their targets. IR systems guide on the heat generated by the target's engine. The missile has a seeker head that can track the heat from aircraft engine exhaust, and the missile guides autonomously to the target after launch. All IR missiles therefore are "launch and leave," meaning that they require no more input from the shooter after launch. The IR SAMs and AAMs that appear in *Falcon 4.0* are:

- SA-7
- SA-9
- SA-13
- SA-14
- Stinger
- AA-2
- AA-8
- AA-11
- AIM-9

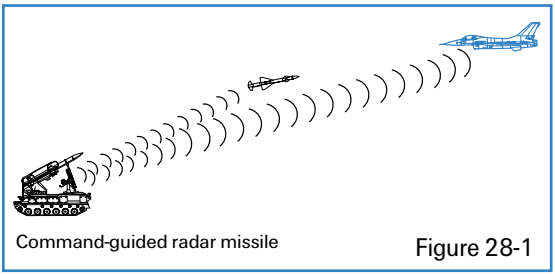

Command-guided radar missile

Figure 28-1

Radar missiles, on the other hand, generally require guidance commands or directions from the shooting platform. There are very few exceptions to this rule for radar missiles. Radar missiles come in two basic types: command-guided missiles and semi-active missiles. Command-guided missiles are fired while the shooter radar tracks the target and sends guidance commands to the missile as it flies toward the target. Figure 28-1 shows how command guided missiles work.

The command-guided systems featured in *Falcon 4.0* are:

- SA-2
- SA-3
- SA-4
- SA-8
- SA-15
- Sea Sparrow
- SAN-4

The other type of radar missile is the semi-active guided missile. This type of missile uses reflected radar energy to guide on the target, and the shooter does not need to send guidance commands. The shooter just tracks the target with a constant wave radar beam. The beam of radar energy acts like a spotlight that lights up the target for the missile to see. Figure 28-2 shows how semi-active guided missiles work.

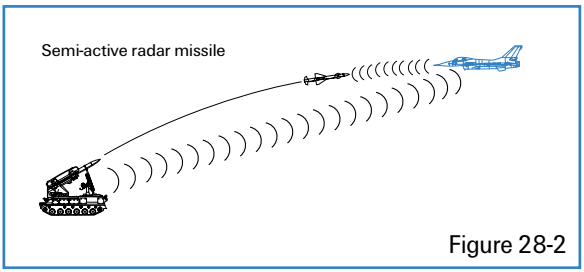
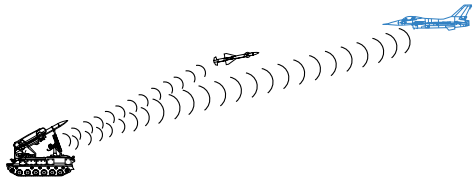


Figure 28-2

The following missiles use semi-active guidance:

- SA-5
- SA-6
- SAN-9
- AA-7
- AIM-7
- AA-10

Another radar guidance technique uses a combination of command guidance and active radar. The AIM-54 Phoenix, AIM-120 AMRAAM and Russian-built AA-10C Alamo use this system. These air-to-air missiles come off the rail and get command guidance until they are close enough to track the target with their own onboard radars. At this point, the missile is autonomous and can guide without further assistance from the shooter aircraft. Figure 28-3 shows how these missiles guide. This type of guidance scheme is needed because a fighter can carry a much bigger radar than an air-to-air missile and can thus track a target further out. In addition, the radar in the missile is on a one-way trip and needs to be far less costly (and is, therefore, less capable) than the radar in the jet.



Command-guided radar missile

Figure 28-3

MISSILE FLIGHT PATHS

All missiles, regardless of guidance technique, fly a similar flight path to the target. In order for the missile to have the maximum range possible, it must attempt to fly the shortest distance to the target. Missiles achieve this by flying a lead pursuit intercept course, like the one shown in Figure 28-4.

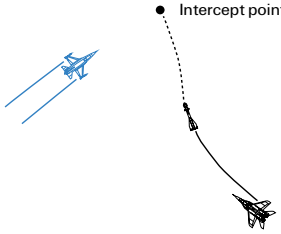


Figure 28-4

For this reason, when viewed from the cockpit, a missile that is guiding on you will be flying a lead pursuit course and will tend to appear stationary in space as it moves toward an intercept with your jet. If the missile is rapidly crossing your canopy either fore or aft, it is probably not going to hit you.

Remember that the word "miss" is part of the word "missile." Most missiles do not need to hit your aircraft in order to kill you. They simply need to get

close enough for the warhead to detonate within a lethal radius. For some missiles, this radius can be a small as a few feet, while others can kill if they explode up to 100 feet away. Your goal is to stay out of that lethal radius by using a combination of jamming, chaff and flares, and maneuvering.

THREAT WARNING SYSTEM

Before you can successfully react to a missile launch, you must first detect that you are under attack. The TWS (Threat Warning System) in your F-16 consists of a scope and a series of lights on the left side of the cockpit. Figure 28-5 shows your cockpit and the position of the threat scope and associated lights. These lights are not critical with the exception of the Missile Launch light. This light will flash when the TWS detects a radar missile launch.

Figure 28-5

The scope is part of the ALR-69 Threat Warning System, which is designed to detect and display radar threats to the pilot. In the F-16, this system uses a series of antennas on the aircraft that detect radar energy. This radar energy is then matched to a specific radar system and displayed on the scope in the cockpit. The scope provides a flashing missile launch indication and a missile launch tone to cue the pilot that a radar missile has been launched.

Notice that I use the word "radar." The ALR-69 in the jet will *not* display or provide any warning of IR SAMs or IR AAMs. These infrared systems are completely passive and guide on the heat from your engine. In other words, since no radar energy hits your jet, there is no way of knowing that a missile is in the air. In the case of the IR air-to-air missiles, however, you may get a lock-on indication from the enemy fighter. Fighters may lock onto your jet in order to ensure that they are in proper range for an IR missile shot. You will not get a missile launch indication when an enemy fighter locks onto your jet for an IR missile shot, so be prepared whenever an enemy jet locks onto your Falcon. Figure 28-6 shows the threat warning symbols and which enemy and friendly radar systems they represent. Symbols enclosed in a circle show a launch warning, while symbols enclosed in a diamond are the highest priority.

Search radar	**S**
Unknown radar	**U**
Active radar missile	**M**
Hawk	**H**
Patriot	**P**
Naval	
Modern aircraft	
Older aircraft	
Anti-aircraft artillery	**A**
Surface-to-air missiles	**2,3,4,5,6,8,15**
Chaparral	**C**
Launch warning	
Highest priority target	
Nike/Hercules	**N**

Figure 28-6

For radar systems, the TWS will not only display a unique symbol but will also provide an audio tone for both radar tracking and missile launch. The radar tracking tones are distinct for each different radar system on the battlefield, but the missile launch tone is the same for all radar missiles. In other words, if the TWS detects a missile launch of any kind, it will put out a generic missile launch tone.

The TWS scope itself displays threat symbols on their proper bearing from your jet. Your aircraft is in the center of the scope. For example, if a symbol appears in the 12 o'clock position on the scope, the threat is in front of the aircraft. If the symbol appears at the 6 o'clock position, then the threat is directly behind the aircraft. One important note, however, is that the TWS does *not* display range to the threat. In other words, the 360° rings on the scope do not represent a range scale. The TWS scope has two rings; the outside ring is used to show the pilot that the threat is inside lethal range. Although this sounds contradictory to the statement above, it is not. When a threat is inside lethal range, the TWS displays that threat inside the lethal threat ring on the scope. Since this "range" is different for each type of SAM, the ring itself does not correspond to a specific range. In Figure 28-7, an SA-8 and an SA-4 ("8" and "4") symbol are both on the scope. The "4" symbol is just inside the lethal ring, while the "8" symbol is outside the ring. Which SAM is closer to you? The answer is the SA-8. Because the SA-4 has more than five times the lethality range of the SA-8, you are inside the lethal range of the SA-4 and not the SA-8—even though a quick glance at the your scope shows the opposite. The lesson: worry about the SA-4 first. Again, keep in mind that the scope will only display lethal radius for a given threat and not a constant range scale.

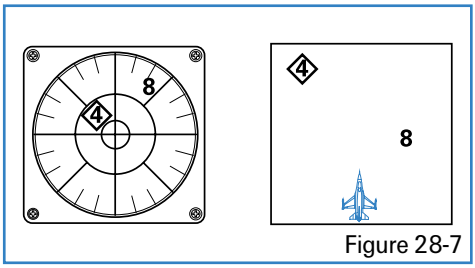


Figure 28-7

COUNTERMEASURES

Falcon 4.0 features a full suite of F-16 countermeasures including chaff and flares and jamming. Chaff consists of small metal strips; when ejected from your plane, they present a false radar target to enemy radars. Drop chaff by pressing X. Flares decoy enemy heat-seeking missiles. Drop flares by pressing Z. Chaff and flares are very simple, but they are also very effective.

Press *a* Z to run an automatic countermeasures program. This will drop a mix of chaff and flares, which allows you to concentrate on maneuvering your jet. The trade-off is that this will use up your stores more quickly.

In addition to chaff and flares, the F-16 can also carry a jamming pod called the ALQ-131. It is used to jam or confuse enemy radars. Jamming essentially makes it harder for an enemy radar system to track your jet precisely. In the Campaign, you should always fly with a jamming pod because it will help reduce the Pk (Probability of Kill) of enemy radar-guided missiles. Turn on your jammer (if you have one loaded) by pressing J .

TRAINING MISSION OVERVIEW

This mission will help you practice missile threat reactions so you can survive both surface-to-air and air-to-air missile attacks.

INITIAL CONDITIONS

- Airspeed: 400 knots
- Altitude: 5,000 AGL and level
- Throttle Setting: Mid-range
- Configuration: Jamming pod, 2 AGM-88s, 2 CBU-87s and 2 AIM-9Ps (your wingman has a jamming pod and 2 AIM-9Ps)
- Weapons mode: NAV

MISSION DESCRIPTION

In this training mission, you are surrounded by four threats. To the north is an SA-8, to the east is an SA-6, to the west is an SA-13 and to the south is a MiG-29 armed with AA-10 Alamo missiles. Each threat is co-located with a steerpoint. The SA-8 in the north is Steerpoint 3. The SA-13 in the west is at Steerpoint 4. The MiG-29 in the south will come out of a CAP (Combat Air Patrol) and engage you when you start moving toward Steerpoint 5. The SA-6 to the east is located at Steerpoint 6. This training mission starts with the jet heading north toward Steerpoint 3, the SA-8.

Pick one of the threats and drive towards it until it launches a missile. When the missile is in the air, start your threat reaction maneuvers. Keep in mind, however, that even though you may do everything correctly, the missile may still shoot you down. Your threat reactions will reduce the Pk of the missile but will not reduce it to zero. The missile always has a chance of overcoming your countermeasures and evasive maneuvers. Before you start the mission, select the Graphics tab at the Setup screen. Set Object Density to at least 5 and the Player Bubble to 5. This will ensure that the threats will appear with plenty of warning.

To take on a missile:

1. Load training mission "28 Missile Threat" from Tactical Engagement.
2. Select either Steerpoint 3, 4, 5 or 6 by pressing S.
3. Drive toward the selected steerpoint until you are engaged.
4. Confirm the missile launch by checking your TWS scope. If it is a radar missile, you will get a launch light and a launch tone from your TWS. If it is an IR SAM, you will hopefully hear a "break turn" call if you have a wingman. Your wingman may be dodging missiles himself and too busy to call out the threat, though. You should always be on the lookout in a combat environment. You will *not* get a missile launch tone or light from the TWS for an IR missile.
5. Since you have an ECM pod in this training mission, press J to turn on your jammer and start an immediate descending turn to place the missile on the beam as shown in Figure 28-8. This turn should be at 6–7 Gs. The beam is essentially your 3 or 9 o'clock position.

   There is one important point to note about placing the missile on the beam. When you use the scope to accomplish this maneuver, you will actually be placing the SAM radar site itself on the beam—and not the missile—since the site is generating the radar signal that is giving you the symbol on the scope. This is not a problem. If you do actually see the missile in flight, however, turn to place the missile on the beam. If not, just place the launching SAM site on the beam.

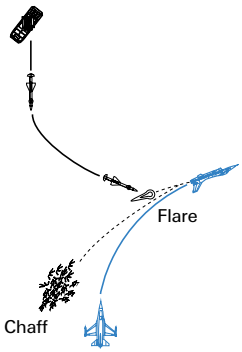


Figure 28-8

6. If you are below 450 knots, make this defensive turn in afterburner. If you are at 450 knots or faster, make the turn in military power (100% but no afterburner).

7. As you start your defensive turn, drop 2–3 bundles of chaff and 2–3 flares by pressing X and Z. If you get a missile launch indication on your scope, just drop chaff and save your flares. Any time you are not sure which type of missile is guiding on you, however, drop both chaff and flares.

8. Get below 300 feet if possible. Don't try to descend this low during your defensive turn. First, complete your turn to the beam and then push the nose of the aircraft slightly forward to get below 300 feet.

9. Gain sight of the missile by switching to the Padlock view (4 key). Step through the visual targets by continuing to press 4 until you have the missile padlocked (in sight). Remember that you need to be looking in the general direction of the missile in order to padlock on the missile. Since the Padlock view will always provide a view of a missile that is guiding on your jet, you can monitor the missile as it moves toward you. Figure 28-9 shows a Padlock view of a missile inbound to a Falcon. When using this view at low altitude, exercise great care to avoid hitting the ground.

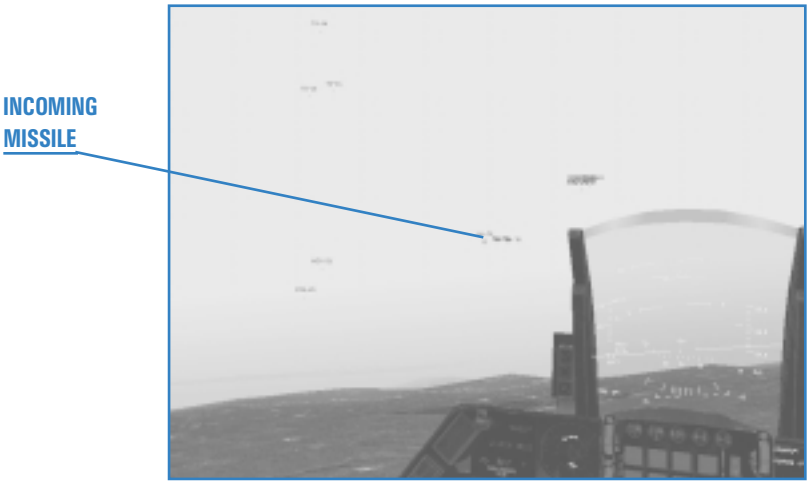


Figure 28-9

10. If the missile continues to guide on your jet, drop 2–3 bundles of chaff and/or flares.

11. As you start to actually see that the missile is a missile and not just a dot on the screen, execute a max G orthogonal break into the missile. This last-ditch break turn is shown in Figure 28-10.

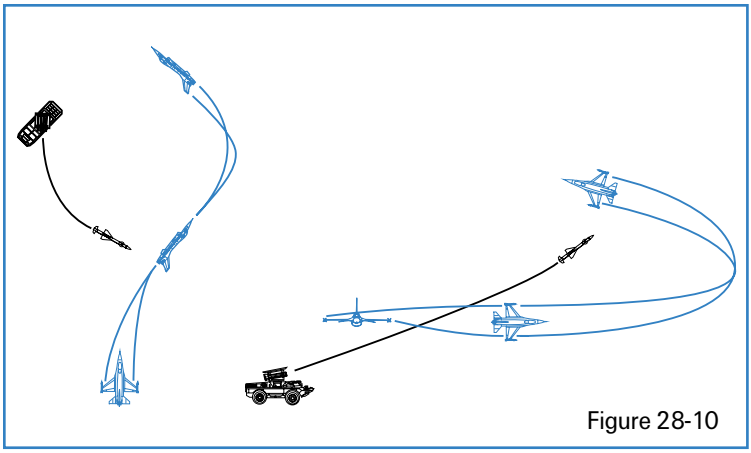


Figure 28-10

12. If you survive the missile attack, confirm that no more missiles are in flight by pressing + on the numeric keypad to cycle through targets in the Padlock view. If another missile is on the way, you will have to repeat the steps you just followed. If there are no more threats, then you can return to the mission.

One last point about missile threat reaction: most SAMs are moving at about Mach 3, which is about 3,000 feet/second. Let's say an SA-6 launches at your jet at 8 nautical miles (about 48,000 feet). Given a missile speed of 3,000 feet/second, you have 16 seconds from launch until impact of the missile on your cranium. My point is that you will not have time to read missile threat reaction procedures and execute them. You have to know them cold and perform many of the above steps simultaneously. This training mission will help you practice these procedures. Keep one more thing in mind: the terrain has a higher Pk than the missile that you are trying to beat.

PART 2: MAIN MODULES

CHAPTER 9

INSTANT ACTION

Instant Action is the place to be when you want to start flying and fighting right away. To get into Instant Action, click the Instant Action menu item on the left of the screen. The Instant Action screen has three sections: the Options area, the Map and Sierra Hotel. Once you've set your options, click the Fly icon at the bottom right of the screen to take off.

INSTANT ACTION OPTIONS

Use the Instant Action options area to customize three areas of your experience. You can also use the main Setup options to further customize the game.

MISSION

The Mission option allows you to choose between a primarily air-to-air mission and a ground attack mission. Choose "Fighter Sweep" for a chance to shoot down lots of air threats. Choose "Moving Mud" for more air-to-ground targets. Your mission choice will affect your weapons loadout.

WAVE

This setting—either Recruit, Cadet, Rookie, Veteran or Ace—determines the enemy difficulty level. The higher the level of enemy difficulty, the smarter, faster and more deadly the enemy will be. This setting applies to both air threats and ground threats. You will encounter more cargo planes and fewer fighter planes at the easier settings and correspondingly more fighters and fewer lightly armed craft at the higher settings.

AIR DEFENSES

Since most countries don't like hostile aircraft flying over their airspace, they prepare ground-based surprises for you. Instant Action has two forms of surface-to-air threats: SAMs (Surface-to-Air Missiles) and AAA (Anti-Aircraft Artillery).

THE MAP

You can select any area in the Korean peninsula for your Instant Action battle. Click inside the gray square and drag it anywhere within the map. This will position your F-16 in the corresponding location at the start of the battle. You can also set the start time by clicking on the clock and then using the arrow icons. Change your start time to fly during the day or night.

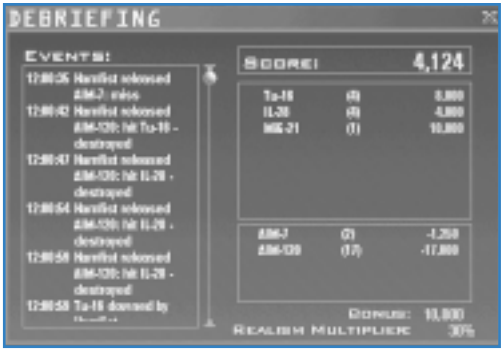
ENDING YOUR MISSION

You fly and fight in Instant Action until you decide to quit, land, eject or get shot down. The enemies are unending and relentless. If you are shot down, the Instant Action mission will automatically end. You can also end at any time by pressing Esc.

When an Instant Action mission ends, you'll return to the Instant Action main screen. If you're fortunate enough to score enough points to put you in Sierra Hotel (the best of the best), your name will be added to the list.

Next, you'll see the Debriefing window. The events list displays the outcomes of all the weapons you and the enemy fired. You'll also see notations of any times you crashed.

Next to the events list is the score list. Your score is determined by your kills of aircraft and ground targets, multiplied by your realism setting. Points are deducted from your score for expending munitions (except guns, which are free). The more missiles and bombs you use that do not hit targets, the lower your score—and on a bad mission, you can even have a negative score. The top right-hand box lists all the enemy targets that you destroyed. Underneath is a list of all the ordnance that you used.



CHAPTER

16

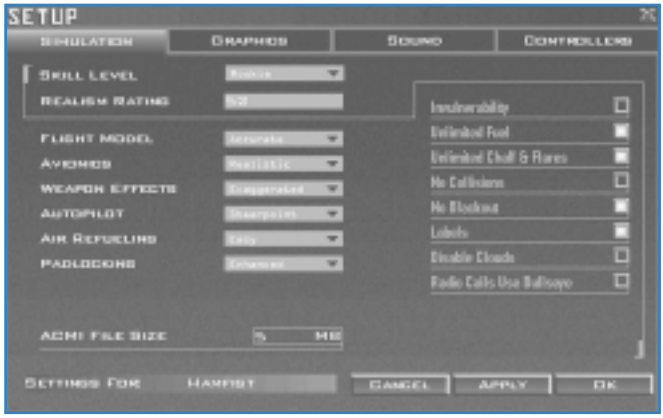
SETUP

Since *Falcon 4.0* is a complex military flight simulator of great depth, we've provided a large selection of configuration options.

You get to the setup screens by clicking Setup in the main menu. The Setup window has four tabs across the top: Simulation, Graphics, Sound and Controllers. At the bottom of the screen are three buttons and a pilot name for whom the settings apply. Since you can have more than one pilot in the Logbook, you can also have individual settings for each pilot. Click on the name after the words "Settings for:" to bring up the Logbook so you can switch pilots.

Apply saves all the settings you have made in all the Setup screens for the current pilot. Cancel will close the Setup window and discard all setup changes that have been made since you last clicked the Apply button. OK applies all the changes and then closes the Setup window.

SIMULATION



SKILL LEVEL

Choose the skill level from a drop-down list box. Your choices are Ace, Veteran, Rookie, Cadet and Recruit. Choosing one of these skill levels automatically sets various game parameters to match the skill level you choose. Depending on the skill level, other settings will change. You can also modify these individual parameters afterwards.

REALISM RATING

The Realism Rating indicates how realistic your settings are. The range is from 100 (highest) to 0 (lowest). This value is computed automatically according to your other Simulation settings. The Realism Rating is used as a multiplier for your score in Instant Action and as a factor in computing your Ace Factor, which is in the Logbook.

Changing any of the Simulation settings below (except for Disable Clouds and Bullseye) will change the value of the Realism Rating.

FLIGHT MODEL

You can select between two Flight Model settings: Accurate or Simplified. The Accurate setting simulates the real flight model of the F-16, including deep stalls and flat spins. The Simplified setting reduces the forces of drag and is more forgiving at low speed. Your plane also bleeds off less energy while turning, and you accelerate more smoothly. In addition, landings are easier in Simplified mode.

AVIONICS

You can choose from three Avionics modes: Easy, Simplified or Realistic. The Avionics setting applies primarily to the radar, although it also affects your HUD and MFDs. The Easy radar shows every aircraft within range all the time. The Simplified radar only shows aircraft that are in front of you and is closer to the real radar. The Realistic radar simulates the real AN/APG-68 radar and submodes. For more information on the F-16's avionics, read **Chapter 18: The HUD** and **Chapter 21: The Radar**.

WEAPONS EFFECTS

Choose from three Weapons Effects settings: Accurate, Enhanced or Exaggerated. When set to Exaggerated, you don't have to be very accurate with your weapons since the radius of the effect and the magnitude of the damage are exaggerated. Enhanced requires you to be a little more precise. The radius of damage is increased but not as large as with the Exaggerated setting. Accurate requires that you accurately hit the target in order to record a kill. Both the radius of effect and the damage are realistic for the weapon used.

AUTOPILOT

Select one of three Autopilot settings: 3-axis, Steerpoint and Combat. If you choose 3-axis, the autopilot keeps your aircraft flying straight and level at whatever heading and altitude you were at when you engaged the autopilot. 3-axis is the most realistic setting. The Steerpoint setting causes your F-16 to automatically fly to the current steerpoint. When in Steerpoint mode, if you change your steerpoint during flight, the autopilot switches your heading toward the new steerpoint. If Autopilot is set to Combat, the F-16 will actually engage in combat maneuvers all by itself. It will evade attacking aircraft and try to get you into position to shoot down any enemy aircraft. Combat mode will fire weapons automatically if it thinks it can hit its target. In addition, the Combat autopilot will automatically refuel for you as soon as you request refueling from a tanker.

AIR REFUELING

Air refueling requires very precise control of speed and heading. Because this level of precise control varies substantially with different joysticks and throttles, air refueling has three settings: Realistic, Simplified and Easy.

In the Realistic setting, you must get into position without help and you have the longest refueling time—approximately one minute. The refueling boom will help to stabilize the aircraft in position once you are connected.

In the Simplified setting, the boom is more forgiving about position. You only need to fly about 50 feet under the tanker at less than 5 kts closure with the correct basic heading, pitch and attitude and then the boom will "grab" you and bring you into position. Refueling time is shorter than it is for the Difficult mode—about 30 seconds.

In Easy mode, the refueling boom is the most forgiving. You can be within 100 feet at 75 kts closure and then the boom will grab and hold you. Refueling time is the shortest in Easy mode, about 15 seconds.

PADLOCKING

Padlocking is a view that automatically changes as you track a target. This setting applies to both Padlock and Extended FOV views. Choose from three levels of padlocking: Realistic, Enhanced and Disabled.

In the Realistic Padlock setting, you can only padlock targets that are within visual range and are in your current 60° field of view. When you press the Padlock or EFOV key (4 or 5 key), a yellow TD (Target Designator) box will jump from target to target in the current view only. One second after the last key press, the current view padlocks on the last selected target and the TD box will turn red. Padlock is dropped if the target is blocked by the cockpit frame and does not reappear after four seconds or if the target leaves visual range (approximately 8 nm).

The Enhanced setting allows padlocking of all the targets around you. Each time you press 4 or 5, the TD box will jump to the next serious threat—but the threat can be in any direction, not just in your current view.

If you prefer not to use padlocking at all, choose "Disabled" from the list.

You'll find more details about padlocking in **Chapter 22: Views**.

INVULNERABILITY

This setting makes you invulnerable to any damage including ground crashes. Turning Invulnerability on drastically lowers your Realism Rating.

UNLIMITED FUEL

If Unlimited Fuel is checked, you'll never run out of fuel. If unchecked, you have a normal fuel load.

UNLIMITED CHAFF AND FLARES

If Unlimited Chaff and Flares is checked, you can shoot off chaff and flares as often as you like. If unchecked, you have a specific load of 60 chaff bundles and 30 flares.

NO COLLISIONS

If No Collisions is checked, you can run into anything (except the ground) and you won't die. If unchecked, collision detection is on and you will crash if you run into things. This includes other aircraft, buildings and pilots parachuting to the ground.

NO BLACKOUT

If No Blackout is unchecked, you will be subject to the forces of gravity when you pull or push Gs. If you pull enough Gs, your vision will start to narrow until you succumb to GLOC (Gravity-Induced Loss of Consciousness). If you push too many negative Gs, you will burst tiny blood vessels in your eyes and your vision will go red. If No Blackout is checked, you won't notice any visual effects from G forces, although they will still affect the dynamics of your aircraft flight. For more information about blackout, see **Chapter 25: Aerodynamics and G Forces**.

LABELS

When Labels is checked, every military object (planes, ground units, ships) is tagged with its name. This identifier floats just above the object, which is useful for identifying objects. If this is unchecked, you won't see the name labels. See **Chapter 22: The Views** for more information.

DISABLE CLOUDS

Checking the Disable Clouds box turns off the clouds. We recommend disabling clouds unless your 3-D graphics accelerator has at least 4MB for texture memory.

RADIO CALLS USE BULLSEYE

If checked, all radio calls to you are relative to a preset location known as bullseye. The bullseye is located at Kaesong in North Korea. Bullseye information will appear on your radar and HSD screen. If unchecked, radio calls reference the position from your aircraft. See **Chapter 21: The Radar** for more information about bullseye.

ACMI FILE SIZE

This indicates the total size in megabytes of your ACMI recording file. ACMI records all the action as you fly. When the file size is exceeded, the ACMI starts recording on a new tape. You can type in a number indicating the maximum size, in megabytes, for your ACMI file. ACMI uses approximately 200K per minute.

GRAPHICS

The Graphics setup section lets you configure your video card and control the level of detail of the simulation graphics. You will want to modify these primarily to affect performance. The higher the level of detail, the better the game looks–but more demands are made on your computer. Adjust the graphics settings to give yourself the best balance of visual realism and performance.

Next to the check boxes are a set of sliders that let you control graphic detail. Moving a slider to the left gives you a better frame rate but less graphic detail, while moving a slider to the right gives you better graphics but a lower frame rate.

You can preview the results of your Graphics options by clicking the Preview check box. To change your view in the Preview window, hold down the trigger button on your joystick and move the stick.

VIDEO DRIVER

Based on your video card, different video drivers will be displayed in this list box. For example, if you have a Voodoo-based 3-D graphics accelerator, you will see options for Direct3D, Glide, Software, etc. If you do not have a 3-D graphics accelerator, then you will only see Software. Be sure that your video drivers are up to date by checking your video card manufacturer's Web site. For more information about video drivers, refer to the Readme file.

VIDEO CARD

This drop-down list box will display the video card in your system. If you have a 3-D graphics accelerator card, choose it from this list box. Otherwise, choose "Display." For more information about specific video card compatibility, refer to the Readme file.

RESOLUTION

Choose a graphics resolution for the simulation.

TEXTURED OBJECTS

Every object in *Falcon 4.0* has a detailed texture map that is "painted" on the object whenever it is displayed. If you turn off Textured Objects, this texture map is not drawn. Objects won't look as detailed, but you'll get better performance.

TEXTURE SMOOTHING

The Texture Smoothing setting smoothes out the ground texture, giving it a more realistic look. This setting should only be used with a 3-D graphics accelerator or if you have a Pentium MMX system; otherwise, performance will suffer significantly.

TRANSPARENCY

The Transparency setting provides transparent smoke when you fire a missile or shoot down an aircraft. This will work without a graphics accelerator card, but it is not recommended.

GOURAUD SHADING

This setting blends the colors of terrain and water. If the Terrain Texture slider is all the way to the right, then Gourard Shading should be turned off.

HAZE

The Haze setting adds haze to the distance, which gives you realistic depth cueing. This setting also controls the ground fog.

TERRAIN TEXTURE

As you move the slider to the right, you turn on terrain texture. The further to the right you move the slider, the further out the terrain texture is drawn. Moving the slider to the left decreases how far out it is textured. When the slider is all the way to the left, textured terrain is turned off.

TERRAIN DETAIL

The Terrain Detail slider controls both how far out the terrain is drawn and how much detail is used in the closest terrain. As you move the slider to the right, terrain is drawn further out. This reduces the effect of mountains "popping" up suddenly. It also increases the detail of the terrain that is closest to you.

OBJECT DETAIL

Objects are drawn at various levels of detail depending on how far from them you are. If you move the slider to the left, you have to be very close to an object to see it at full detail. If the slider is to the right, the object will be drawn at full detail much further out.

OBJECT DENSITY

Moving the Object Density slider to the right increases the number of ground objects, usually in a city area. Moving the slider to the left will give you fewer ground objects. When the slider is all the way to the left, only the most significant buildings are drawn. This setting affects frame rate significantly, especially in Campaign.

PLAYER BUBBLE

The player bubble is the area around you in which grouped objects are broken out into individual objects. Outside the player bubble, objects (such as a squadron of tanks) are grouped together and acted upon as though they were one object. The larger the player bubble, the more individual objects are available to interact, but greater processing power is required to support them. This setting affects frame rate significantly, especially in Campaign.

VEHICLE MAGNIFICATION

When the Vehicle Magnification slider is to the left, objects are drawn at their actual size. Moving the slider to the right increases their size. Since vehicles can be hard to spot on the ground while flying, setting the magnification to greater than their actual size can help you to find them. This magnification also applies to aircraft and missiles in flight. Increasing the apparent size of vehicles will make them appear to move slower.

SPECIAL EFFECTS

The Special Effects slider controls certain graphic effects are in the simulation: how many, how detailed and how long they last onscreen. Special effects include fire, explosions, smoke, dust clouds, etc.

CANOPY CUES

The Canopy Cues list gives you four choices for visual cues. If Lift Line is selected, arrows are drawn on the top of your cockpit while you're in the 2-D Cockpit, Virtual Cockpit and Padlock views. The lift line cue gives you a frame of reference while you are looking up. The arrows point toward the front of your cockpit (three arrows near the back, two in the middle and one near the front) so you'll always know which way your F-16's nose is. Otherwise, all you'd see is the sky with no sense of which way you're looking.

If you select Reflection, your cockpit will show glare reflection, making it visually realistic but also adding some visual interference. This option is not recommended unless you have a 3-D accelerator card installed.

If you select Both, you'll see both the lift line cue and the cockpit reflection. If Canopy Cues is set to None, neither the lift line cue or the reflections will be drawn.

If you have a 3-D graphics accelerator with only 4MB for texture memory, we recommend that you choose either canopy reflections or the lift line—but not both.

DEFAULTS

The Defaults button under the Preview window sets the Graphics settings to the defaults. If you make changes but then click the Defaults button, the graphics will be restored to their original settings.

RECOMMENDED GRAPHICS SETTINGS

Below are two charts that show which settings we recommend for your system configuration. We feel that these recommendations are the best balance between frame rate and gameplay. Frame rate will depend not only on your CPU, but also your available RAM and video card (which is dependent on video chipset and memory).

Please note that the first table is if you do *not* have a 3-D graphics accelerator. The second table is if you do have a 3-D graphics accelerator (Direct3D or Voodoo-based).

WITHOUT A 3-D GRAPHICS ACCELERATOR

CPU	166MHz Pentium	200MHz Pentium	233MHz Pentium	266MHz Pentium II	333MHz Pentium II	450MHz Pentium II
Resolution	640 x 480	640 x 480	640 x 480	640 x 480	800 x 600	800 x 600
Disable Clouds	On	On	On	On	On	On
Textured Objects	Off	On	On	On	On	On
Texture Smoothing*	Off	Off	Off	Off	Off	Off
Transparency	Off	Off	Off	Off	Off	Off
Gourard Shading	Off	Off	On	On	On	On
Haze	Off	Off	Off	On	On	On
Terrain Texture	1	1	1	2	2	4
Terrain Detail	1	2	2	4	4	6
Object Detail	1	2	2	4	4	5
Object Density	1	2	3	3	3	5
Player Bubble	1	1	1	3	3	4
Special Effects	1	2	2	4	4	5
Canopy Cues	Lift Line	Lift Line	Lift Line	Lift Line	Lift Line	Lift Line

* Can be used on a Pentium MMX system

WITH A 3-D GRAPHICS ACCELERATOR

CPU	166MHz Pentium	200MHz Pentium	233MHz Pentium	266MHz Pentium II	333MHz Pentium II	450MHz Pentium II
Resolution	640 x 480	640 x 480	640 x 480	800 x 600	800 x 600	800 x 600
Disable Clouds	On	On	On	Off	Off	Off
Textured Objects	On	On	On	On	On	On
Texture Smoothing	On	On	On	On	On	On
Transparency	On	On	On	On	On	On
Gourard Shading	On	On	On	On	On	On
Haze	On	On	On	On	On	On
Terrain Texture	1	3	4	4	4	4
Terrain Detail	1	5	6	6	6	7
Object Detail	1	5	5	5	6	7
Object Density	1	3	3	4	5	6
Player Bubble	1	2	2	3	4	7
Special Effects	1	2	3	3	5	6
Canopy Cues	Lift Line	Lift Line	Lift Line	Both	Both	Both

SOUND

There is a lot of audio bombarding an F-16 pilot, and the noise can get overwhelming. The Sound setup lets you balance the volumes of the different sounds.

Each of the following items has a volume slider and a test button. Click the test button to hear the sound and then adjust it using the slider. You can play more than one sound on at the same time.

Engine	Your basic engine noise.
Sidewinder	The "growl" your missiles make when they lock onto a heat source.
RWR	The tones from the radar warning receiver, which lets you know if unfriendly radar units have locked on to you. You can listen to the sounds of specific radars in the Tactical Reference section of *Falcon 4.0*.
Cockpit	The Voice Message System sounds, warning tones, etc.
Other Comms	All other communications outside of your flight.
Flight Comms	Communications to and from your flight.
Sound Effects	Basic sound effects such as missile explosions and aircraft crashes.

The following two volume levels do not have a test button.

Interface Sounds	The feedback the program makes in the user interface.
Music	The music used within the program.

In addition, you can control the game's overall volume level by adjusting the Master Volume slider.

CONTROLLERS

This section lets you set up your joystick and change the keyboard mapping.

GAME CONTROLLER

Joystick

Before starting the game, you must calibrate your joystick, throttle and rudder pedals in the Windows 95 Game Controllers control panel. They must be installed and recognized by Windows 95 in order to work with *Falcon 4.0*. Refer to **The Cadet's Guide** for more information. If you have more than one joystick attached to your computer, select the one you want to use with *Falcon 4.0* via the drop-down list on this screen.

To verify that your joystick, throttle and rudders are working, move them and watch the graphics on this screen. When you move the joystick, the ball inside the square will move accordingly. The two bars to the right of the joystick square show the movements of the throttle and rudders. Throttle is on the left, rudders are on the right. If either bar is grayed out, then the program does not detect that controller (throttle or rudders).

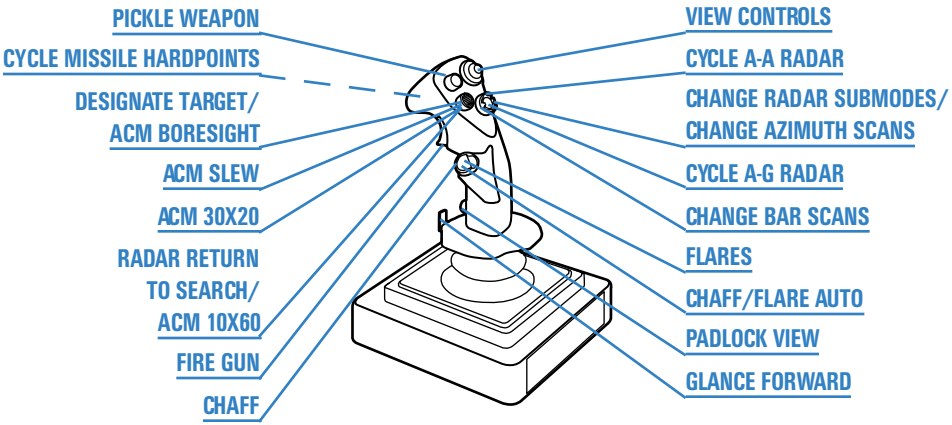
If you have a joystick that has a digital hat on it, you will see a graphic above the throttle/rudder bars. This graphic will let you verify the four-way movement of the hat. Since Windows 95 does not recognize some older joysticks (such as the ThrustMaster FLCS) as having a hat, you won't see it on the Controllers screen.

To center your joystick, let go of the handle and press the Center button.

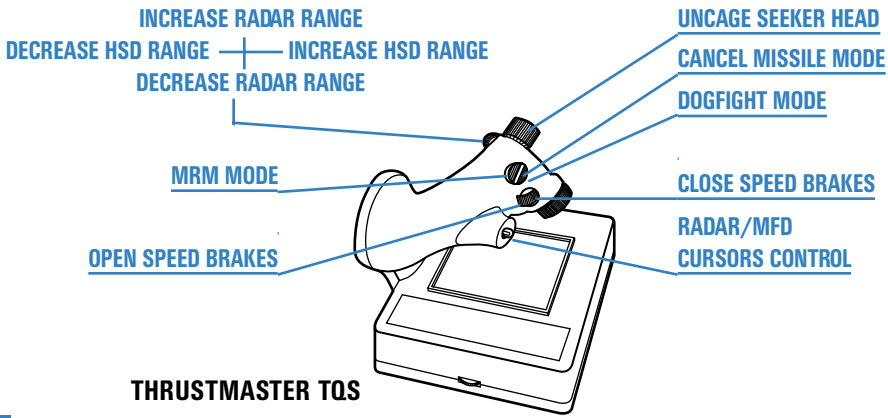
You can also test your joystick buttons by pressing them while in the Controllers screen. They will light up in the Joystick Buttons area. Some joysticks don't actually send out button signals for all the buttons but instead generate keystrokes. For these joysticks, all the button lights won't come on. Instead, you'll see the key equivalent appear under the key mapping area (described next).

SPECIFIC JOYSTICK CONFIGURATIONS

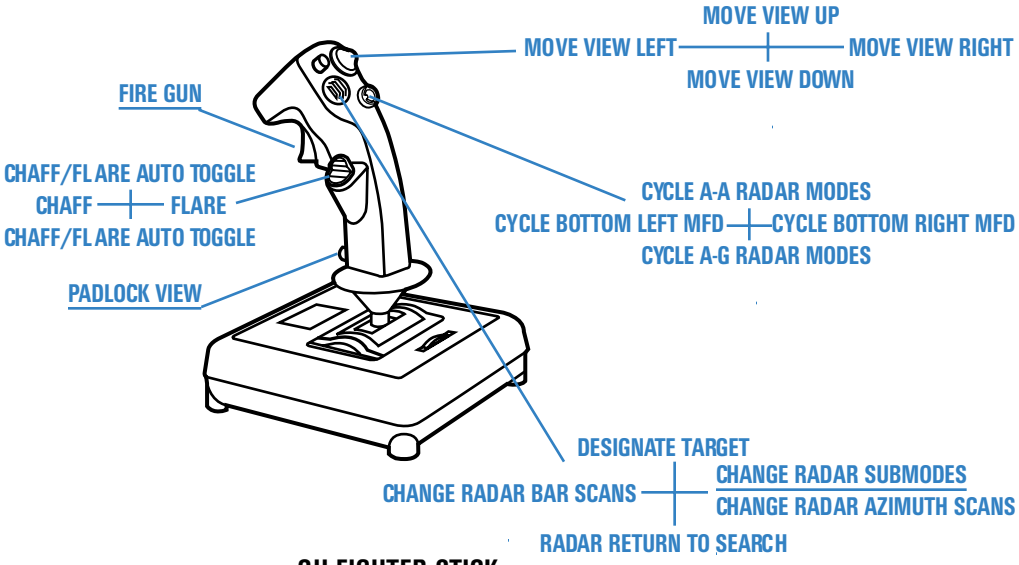
We provide configurations for specific joysticks as shown below. The joystick files are installed in the \JOYSTICK directory in the *Falcon 4.0* directory.



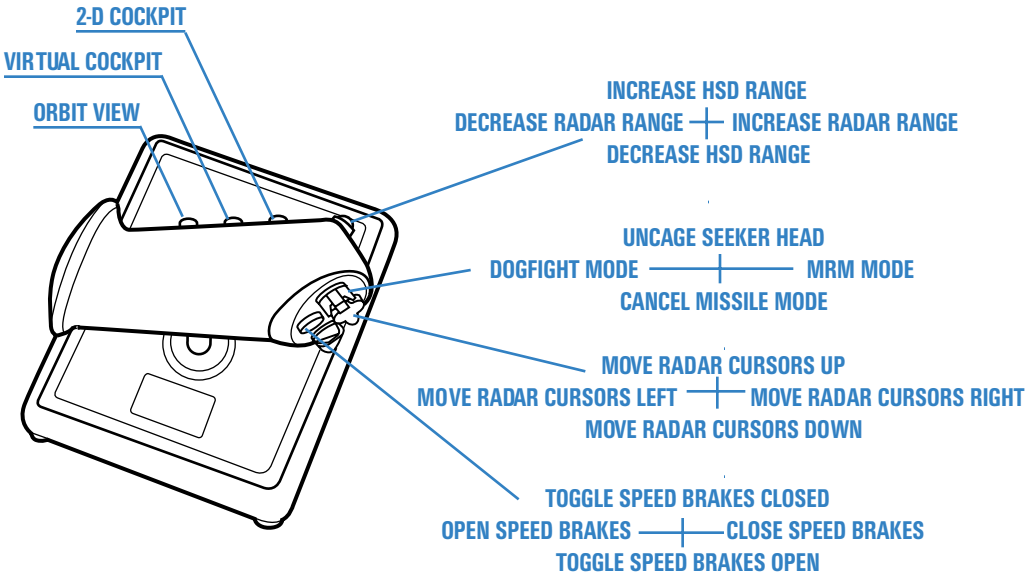
THRUSTMASTER FLCS



THRUSTMASTER TQS



CH FIGHTER STICK



CH PRO THROTTLE

For information on joysticks not listed above, check the Readme file and **www.falcon4.com**.

KEY MAPPING

Falcon 4.0 uses a large number of keys. Although we provide a default mapping of keys, you can change this mapping if you like.

The keyboard mapping area has two columns of text. The column on the left is the key command, and the column on the right is the description of what the key does. Use the two buttons on the bottom for saving and loading keyboard mapping files. In addition, while in the Controllers setup screen, you can press any key or any joystick button and you'll see the key command appear on the Input line with its description underneath. Pressing a key will also jump the key map list to that key command.

The keys in the scrolling list are grouped according to function. White keys are for single key presses, which includes individual keys and keys with modifiers (such as Shift, Ctrl and Alt). All white keys can be remapped. Keys with a light blue background (such as Q for AWACS radio command) cannot be changed.

To change a key mapping, find the function you want the key to represent and click the key that is currently assigned to that function. The key name turns blue. Then press the key you want to map to that function on the keyboard and it will replace the old value.

For example, if you want to change the key for Orbit view from 0 to 5 (which is currently assigned to the Extended FOV view), press 0 to jump to the Orbit view key command. Click on the key command ("0") and it will change color to blue. Now press 5. The 5 replaces the 0, and the key mapping for Extended FOV view (which used to be 5) is now changed to "No Function Assigned." You can't have more than one key assigned to the same function. You can change functions assigned to the joystick or throttle buttons (including the hat) in a similar way.

After you've made changes, you can save them to a file. Use the Save button under the key mapping area.

To load in a previously saved keystrokes file, click Load. You'll get a list of saved keystrokes files. Select the one you want and click Load.

Press OK to save any changes made to the key mapping. This will replace the currently open file. If you use Save and create a new file, this new file will be associated with the current pilot.

CHAPTER

25

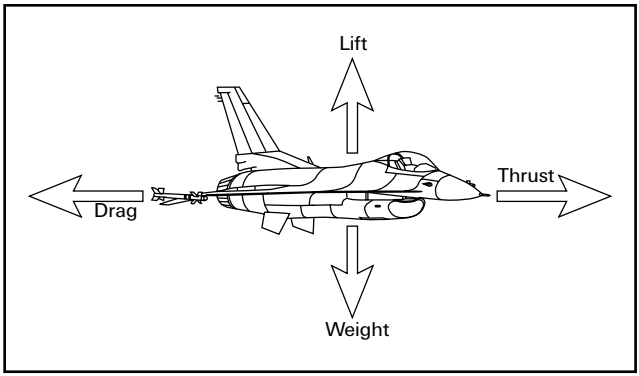
AERODYNAMICS AND G FORCES

Before jumping right into this discussion, I want to tell you a story that demonstrates what a fighter pilot needs to know about aerodynamics. I was flying F-16s out of Kunsan, South Korea, and one day I was riding out to the jets in the crew van with my operations officer. We called him "Wolfman" because he was powerful ugly, even by fighter pilot standards. As I glanced over at Wolfman, I noticed he had little arrows drawn on his flight gloves with words written next to them. His right glove had an arrow pointing forward with the words "Houses get bigger" written next to it. The arrow pointing to the back of the glove had the words "Houses get smaller" beside it. On this same glove, he also had drawn left and right arrows with the words "Jet go this way" next to each one. On his left glove, he had drawn two more arrows. The arrow pointing forward read "Jet go faster." The words besides the arrow pointing to the back of the glove were "Jet go slower." When he noticed me staring at his gloves, he just shrugged and said, "Sometimes I just forget." Fighter pilot humor... God help me, I love it.

Anyway, the arrows and words on Wolfman's gloves sum up what a fighter pilot must understand about aerodynamics. Since that's all I know (and I'm currently flying about 10 F-16 sorties a month), I don't think you need to know too much detail about aero either. With the risk of being redundant, though, I will fill in a few details that Wolfman couldn't fit on his gloves.

THE FORCES ACTING ON THE AIRCRAFT

A Falcon pilot should understand the basic forces that act on an aircraft in flight. This knowledge clears up the great mystery of why the pointy end goes through the air first. The figure below shows these forces and their direction in relation to the F-16.



Thrust pushes the plane through the sky and is produced by the aircraft's engine. The working of a jet engine can be summed up as "Suck, squeeze, mix, ignite and blow." The engine sucks air in through the intake, squeezes it in the compressor, mixes the air with fuel in the combustor and ignites it, causing the air to blow out the back of the engine through the nozzle with great force. On the way out the back, this high-velocity air spins turbine blades that power the compressor and the fan blades at the very front of the engine. The nozzle in the back of the engine closes down as you push the throttle up, creating higher velocity air—and thus more thrust. When the afterburner is engaged, fuel is literally sprayed out the aft end of the engine, creating a controlled explosion that is directed out of the open nozzle. The AB (afterburner) produces an enormous increase in thrust. Throttle position controls the amount of thrust that an engine produces by metering the fuel burned in the combustor. Throttle settings are usually measured in percent, with 100% being the highest non-afterburning setting. This throttle position is referred to by fighter pilots as Mil. As you push the throttle up, you simply convert more jet fuel into noise and produce more thrust (and speed). Afterburner uses considerably more fuel.

Lift is a force produced by the aircraft wings (and possibly the body of the aircraft), which acts perpendicular to your flight path, pushing up on the bottom of the aircraft straight out the top of the plane. Modern fighters such as the F-16 use blended wing-bodies to produce a great deal of lift. This allows the wings to be smaller and saves weight.

Drag acts the opposite of thrust. Drag slows your plane and is mainly created in two ways. The first is through basic aerodynamic shape. Pushing anything through the air causes *form drag*. You can reduce form drag by designing an aircraft with a smaller frontal cross section and by using a clean, aerodynamic shape. A dart, for example, has a very clean aerodynamic shape and low form drag, whereas a cinder block has a dirty, high drag shape. The other type of drag is called *induced drag,* which is created whenever lift is generated. The explanation of why induced drag is produced by lift is beyond the scope of this discussion, but I think it has something to do with inverse tangents and imaginary numbers or something. Since I don't have the time to explain (and don't like to show off), just keep one thing in mind. As you turn the aircraft tightly, you are commanding increased lift from the wings and are thus increasing the effect of induced drag. Induced drag is the dominant form of drag when the aircraft is at slow speeds, whereas form drag produces the majority of aircraft drag at high speeds.

You may wonder why a hard turn causes airspeed to bleed off in *Falcon 4.0*. Under G (acceleration caused by turning the aircraft), the effective aircraft weight increases and lift must go up in order to counter the increase. With more lift comes more induced drag, which causes airspeed to bleed off. To counter this, you need more thrust. Unfortunately, aircraft thrust is always limited, which limits the G available and thus maneuverability. This is the reason modern fighters have thrust–to–weight ratios of close to 1/1. High thrust–to–weight ratios allow great maneuverability because they power the aircraft through the effects of induced drag.

Weight is the last force acting on the jet as it pulls the aircraft toward the earth. Weight is a concept that even a fighter pilot like Wolfman can grasp.

G FORCE

G force is the force acting on the jet when the aircraft turns. That's the simple explanation. G force is really acceleration or the change in the velocity vector of the jet. It can be described mathematically, but I'll use the "Wolfman" approach again to help you understand the concept of Gs. Just remember these words: "Jet turns, jet makes Gs. Jet turns harder—jet makes more Gs." It's that simple. Just think of a bucket of water on a rope. If you swing the rope in circles, the water stays in the bucket due to G force. This force, unfortunately, has a debilitating effect on the pilot. Just like the water in the bucket, a force is applied straight down on the top of the aircraft. In the cockpit of the F-16, this force feels like an elephant sitting on you. G force drains the blood from your noggin and, if held for too long, can cause blackouts. The effect of Gs on the pilot is primarily driven by two variables: G intensity (how much G) and G duration (how long you are pulling Gs). If you stay at high Gs for a long period of time, the effect of the G force on the body is tremendous.

Falcon 4.0 models G force by reducing the pilot's field of view. This simulates the difficulty you'd have turning your head under high Gs. When you pull Gs in the jet, you will get a tunnel vision effect, as shown to the right.

Falcon 4.0, however, does not simply model this blackout effect in direct proportion to the G force on the jet. If you pull 6 Gs, you will not automatically get the 6 G blackout loss of vision. Instead

Falcon 4.0 uses a model developed by the Air Force to trigger the G force tunnel effect. This model was built using actual test data to model the effect of Gs on the pilot.

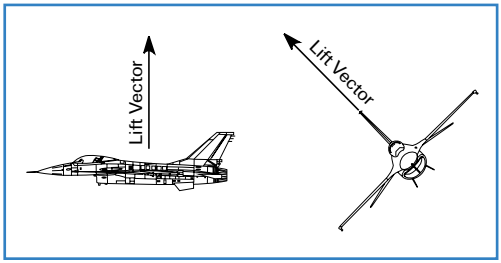
Once the "tunnel vision" effect goes away, the G effect is reset back to the beginning. In other words, we only model pilot fatigue while the G effect is being displayed on your screen.

Another effect that exists in the simulation but is rarely seen is the redout effect. This effect is caused by pulling negative Gs. If you push forward on the stick long enough, you will create enough negative Gs to trigger the tunnel vision—but this time it will be colored red. Positive G force causes blackouts. During a blackout, blood is drained from your eyeballs, causing a loss of vision. Negative G force causes redouts. During a redout, too much blood is being squeezed into your cranium, causing your eyeballs to fill with blood and restricting your vision. I will add to this lovely thought that redouts are extremely rare. There is no tactical reason to push forward on the stick and pull negative Gs for a long duration. Even though the redout effect is triggered by a much lower G intensity than blackouts, you should seldom see a redout in *Falcon 4.0.*

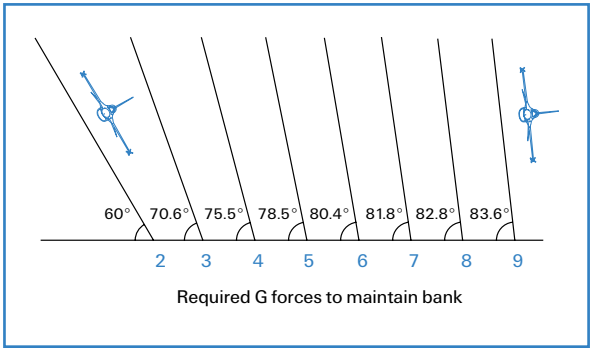
MANEUVERING THE JET

Now that we're all up to speed on basic aerodynamics, it's time to discuss maneuvering in terms even a fighter pilot can understand. When it comes to maneuvering an aircraft, there are only three things you can do: *roll, turn* and *accelerate/decelerate*. *Rolling* is the act of positioning the wings which, in turn, position your *lift vector* (more on lift vector positioning later). *Turning* is nothing more than changing your flight path through sky with the application of "G." The more Gs you command by pulling back on the stick, the faster you turn. *Accelerating or decelerating* is changing the speed of the aircraft. It can be accomplished in several ways, including thrust (throttle setting), drag and aircraft nose position in relation to the earth (weight).

The figure below shows the aircraft's lift vector coming straight up out of the top of the plane. This lift vector is produced by aircraft G and is controlled by the pilot. When the pilot pulls back on the control stick, he or she is commanding more G and a bigger lift vector. Since the aircraft moves in the direction of this vector, the more G the faster the turn. Or said another way, the higher the turn rate.

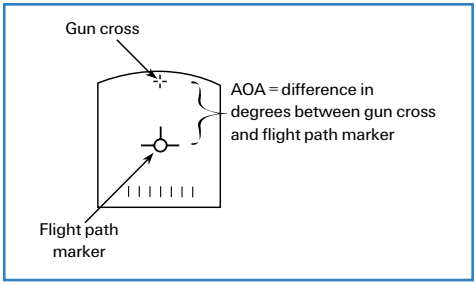


The figure below shows a very important lift vector concept. In this figure, you can see how many Gs (or the size of the lift vector) required to maintain level flight at specific aircraft bank angles. At higher bank angles, you need more Gs to keep the jet in level flight. For example, if you were at 60° of bank and only pulling 1 G instead of 2 Gs, the aircraft would descend. If you pulled more than 2 Gs at 60°, the aircraft will climb.

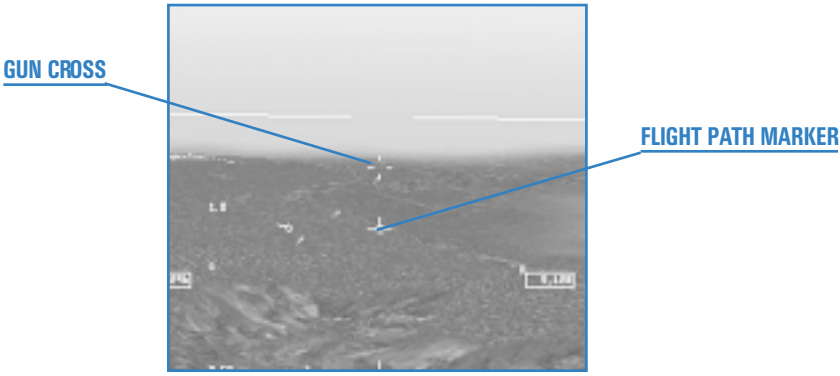


STALLS

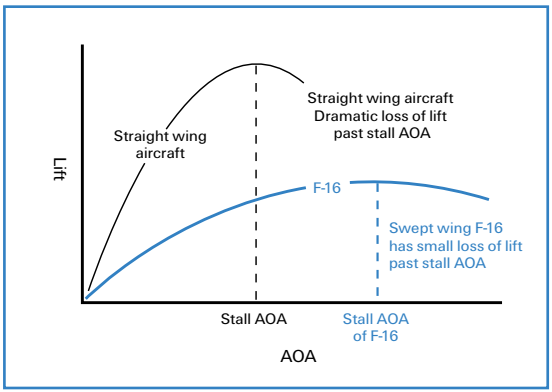
A stall is defined as the reduction in aircraft lift caused by an aircraft exceeding its critical AOA (Angle of Attack). To understand stalls, you must first understand AOA, which is the angle formed by the body of the aircraft and its flight path.



The fuselage reference line is a line that extends straight out of the body of the aircraft. This line is also the path that the bullets take out of the gun. The gun cross in the HUD shows the path of the bullets along with the fuselage reference line.



The difference between that gun cross and the flight path marker is the AOA. (These concepts are discussed in **Chapter 1: Learning How to Fly**.) Just remember that AOA is related to lift. As AOA goes up, so does lift. As the jet slows down, the pilot must raise the AOA to stay in level flight. The reason for this is that total lift produced must be equal to weight in order to maintain level flight. Since lift is directly proportional to AOA and airspeed, as you slow down you will lose lift if you do not raise the AOA of the aircraft. With the increase in AOA, lift will also increase until the critical AOA of the aircraft is reached. At this point, lift will stop increasing and will actually level off or decrease. This point in the AOA curve is called the stall AOA and is depicted in the figure below.



As you increase AOA on the horizontal axis of the graph, the coefficient of lift on the vertical axis goes up. (For our discussion, think of the coefficient of lift as just lift.) As AOA increases past the stall point, lift decreases. The word "stall" brings up images of the nose of the aircraft going straight down and the jet falling out of the sky. Fortunately, F-16s do not stall that way. When an F-16 flies past the stall AOA, the jet will stay in the same attitude (nose position relative to the earth) and start to slowly lose altitude. It will not fall rapidly toward the earth and the nose of the jet will not drop. To get out of a stall, all you have to do is increase power. Because of the high thrust–to–weight ratio, the jet will normally accelerate at this point and the AOA will decrease. For more on stalls, see Training Mission 7 in **Chapter 2: Learning to Turn**.

APPENDIX

B

GLOSSARY

A-A – Air-to-Air.

A-G – Air-to-Ground.

AAA – Anti-Aircraft Artillery.

AAM – Air-to-Air Missile.

AB – Afterburner.

ACM – Air Combat Mode. A short-range air-to-air radar that automatically acquires the closest target.

ACMI – Air Combat Maneuvering Instrumentation. This allows you to record and play back a visual record of your flight.

ADI – Attitude Direction Indicator. The round ball in the center of the instrument panel that displays aircraft pitch and roll.

Afterburner – Acceleration over and above normal military power, achieved by spraying fuel directly into the engine.

AGL – Altitude above Ground Level.

AGM – Air-to-Ground Missile.

AGM-65 – Maverick air-to-ground missile.

AGM-88A – High-Speed Anti-Radiation Missile or HARM.

AGR – Air-to-Ground Ranging.

AIM – Air Intercept Missile.

AIM-7 – Medium-range radar-guided missile known as the Sparrow.

AIM-9M – All-aspect IR Air Intercept Missile.

AIM-9P – Rear-aspect IR Air Intercept Missile.

AIM-120 – Radar-guided AMRAAM.

Aiming Funnel – An element of the HUD display in air-to-air gun mode. See *EEGS*.

Aiming Reticle – An indicator on the HUD that shows point of impact for specific weaponry.

Aimpoint True – Radio call indicating weapons have hit target with desired effects.

Airspeed – The velocity of the aircraft in relation to the surrounding air.

ALQ-131 – A jamming pod mounted on the F-16 designed to counter enemy radar.

ALR-69 – The F-16 Threat Warning System. It detects radar contacting your aircraft and determines its type, strength and bearing.

ALT – Altitude above sea level.

AMRAAM – Advanced Medium-Range Air-to-Air Missile. A radar-guided missile also designated as the AIM-120.

AN/APG-68 – The radar system used by the F-16.

Angels – Radio call indicating altitude in thousands of feet. "Angels 1" = 1,000 feet, "Angels 27" = 27,000 feet, etc.

Angle of Attack – The angle, measured in degrees, between the pitch of the plane and level flight.

Anti-Radiation Missile – A missile that homes on radio frequency radiation produced by radar.

AOA – Angle Of Attack.

APC – Armored Personnel Carrier.

Arizona – Radio call indicating aircraft is out of anti-radiation missiles.

ATC – Air Traffic Control.

ATO – Air Tasking Order.

Augured in – Radio call indicating an aircraft crashed into ground.

Autopilot – Equipment that allows the plane to fly itself.

AVTR – Airborne Video Tape Recorder. The video recorder in the F-16 which is automatically activated when the ACMI is engaged.

AWACS – Airborne Warning And Control System. AWACS aircraft such as the E-3 control aerial battles and provide superior radar information.

Azimuth – The bearing in degrees of a target from the pilot, with the current heading measured as zero.

Azimuth Split – Radio call indicating multiple groups of enemy aircraft are at different bearings from the pilot.

Bandit – A confirmed hostile aircraft.

BARCAP – Barrier Combat Air Patrol. This air-to-air mission is flown to protect a lane for a given period of time. It is very similar to the DCA mission, except that a DCA mission is tied more to a specific asset while BARCAPs are used to protect a lane or avenue of enemy approach. You must stay on station for the time assigned or until you are given permission by AWACS to leave the CAP.

Battalion – An army unit consisting of two to four companies.

BDA – Battle Damage Assessment. BDA missions are identical to reconnaissance missions except they are flown to get post-strike pictures of the target area. These missions help planners determine the extent of damage to a specific target area.

Beaming – Enemy aircraft flying at a right angle to the pilot's flight path in an attempt to break or prevent a radar lock.

Bearing – A 3-digit number indicating direction in degrees ranging from "005" to "360."

BFM – Basic Fighter Maneuvers.

Big Bird – A Soviet-built radar system.

Bingo – Pre-briefed level of fuel at which flight is to end or abort mission in order to safely return to base.

Blackout – A loss of vision (or consciousness) due to pulling too many positive Gs. See *GLOC*.

Bogie or "Bogey" – A radar or visual contact whose identity is unknown.

BORE – Boresight. A weapon delivery submode that slaves SOI to HUD line of sight targeting instead of Ground Map radar.

Bracketing – An offensive maneuver in which two oncoming aircraft split so that they pass on either side of an enemy aircraft.

Break – Radio command directing a sudden high-G maneuver in a specified direction. Usually given when a missile or enemy aircraft is behind the message recipient.

Break-X – An indicator that appears on the HUD as a large "X," which means that you are about to crash into the ground or a radar-locked aircraft.

Brigade – An army unit consisting of three to five battalions.

Buddy Spike – Radio call indicating an aircraft has a radar lock on a friendly aircraft. Given as a warning not to fire.

Bullseye – A predetermined geographic point used as a reference for bearing and range calls instead of a pilot's individual reference.

Bunt – Push forward slightly on the stick.

Buster – Radio command to fly at maximum possible speed.

BVR – Beyond Visual Range.

Callsign – A codename for a particular fighter pilot.

CAP – Combat Air Patrol mission.

CAS – (1) Close Air Support mission. CAS missions are strike missions flown against enemy army units that are in close proximity to friendly forces. Specific CAS targets are usually passed to the fighter from a FAC. (2) Calibrated Airspeed.

CBU – Cluster Bomb Unit.

CCC or "C3" – Command, Control and Communications.

CCIP – Continuously Computed Impact Point. An air-to-ground submode for bombing.

CCRP – Continuously Computed Release Point. An air-to-ground submode for bombing.

CDI – Course Deviation Indicator. A needle on the HSI that deflects to show your position from the selected course.

Chaff – Countermeasures consisting of tiny foil strips, designed to confuse radar-guided missiles.

Chainsaw – A maneuver in which you launch and leave an AIM-120.

Check Six – Radio call indicating you should look behind you for any inbound enemy aircraft or missiles.

Chick – A friendly aircraft.

Clean – An aircraft that is not equipped with any external stores.

Clean and Naked – Radio call indicating no enemies in sight on radar. No spikes on the RWR.

Closure Rate – The rate at which a targeted aircraft is closing on your F-16 (a positive number) or pulling away (a negative number).

Cold – Situation where the tail end of an enemy aircraft is towards the pilot.

Company – An army unit consisting of four platoons.

Continue as Fragged – Radio call indicating you are to continue mission as briefed.

Contrails – Trails of vapor left in an aircraft's wake, sometimes generated by high G turns.

Cover – Radio call indicating a wingman is to adopt a cover role and protect the leader.

CP – Contact Point. A steerpoint at which to contact the FAC.

Dakota – Radio call indicating aircraft is out of air-to-ground ordnance.

DBS – Doppler Beam Sharpening. A submode of GM radar that allows the pilot to tighten the radar beam on a target for greater resolution.

DCA – Defensive Counter Air. This mission is an air-to-air mission flown to protect an asset such as ground forces or AWACS. A critical part of a DCA mission is to stay "on station" for the prescribed period of time. Do not leave your DCA area until your "on station" time has expired or you have been given permission by AWACS.

DED – Data Entry Display. The informational display located over the right MFD.

DGFT – Dogfight mode.

Division – An army unit consisting of three or four brigades.

DLZ – Dynamic Launch Zone. The range between the Rmin and Rmax within which a missile can be fired and still be capable of hitting the target.

Dogfight – A maneuvering air-to-air engagement with enemy aircraft.

DPRK – Democratic Peoples' Republic of Korea (North Korea).

Dragging – A maneuver that involves flying away from an enemy aircraft as a decoy in an attempt to lure it into following.

DTOS – Dive Toss air-to-ground submode for bombing.

Ducks – Alternate designation for missile decoys.

ECM – Electronic Countermeasures. A pod carried under the aircraft uses electromagnetic waves to jam or confuse enemy radar.

EEGS – Enhanced Envelope Gun Sight. A gun sight that displays a funnel to help track a target in a dogfight.

EFOV – Extended Field of View.

Egress – Leaving a target area or engagement.

Element Lead – The number 3 aircraft in a four-ship (four-aircraft) flight.

Engagement Map – A detailed map of Korea that includes the steerpoints in your flight.

EO – Electro-Optical. An MFD mode that displays a camera view for tracking and locking up ground targets.

EOB – Electronic Order of Battle.

Escort – Escort missions are flown to protect aircraft that are ingressing into enemy territory. You must keep enemy fighters from shooting down the aircraft you are protecting.

ETA – Estimated Time of Arrival.

ETE – Estimated Time Enroute.

F-4 – The Phantom II is an older U.S. fighter that is still useful today.

F-15 – The Eagle is a U.S. air-to-air fighter that is also capable of ground attack missions.

F-16 – The Falcon is a highly maneuverable American fighter capable of performing many mission roles.

FAC – Forward Air Controller.

FCC – Fire Control Computer.

FCR – Fire Control Radar.

Fence Check – Radio command to check aircraft weapons and systems to make sure they are appropriate for the situation.

Finger 4 – A line abreast formation in which the aircraft positions are slightly staggered.

Fix – Fix tracking position update.

Flameout – All fuel is gone and the engine has shut down.

Flares – Countermeasures that consist of burning magnesium-based packages; used to foil IR-guided missiles.

FLCS – Flight Control System. This system keeps the jet from going out of control by limiting what the flight controls will let the pilot do.

FLOT – Forward Line Of Troops.

Fluid Four – A Finger 4 formation with increased distance between the aircraft.

Fly-by-Wire – A type of aircraft control in which the stick and throttle do not use mechanical linkages to other parts of the aircraft, such as in the F-16.

FOV – Field Of View. Also the term for the video picture for TV- or IR-guided weapons.

Fox One – Radio call indicating a SARH missile launch.

Fox Two – Radio call indicating an IR-guided missile launch.

Fox Three – Radio call indicating an AMRAAM missile launch.

Foxtrot Uniform – F*cked Up. "My radar is Foxtrot Uniform."

FPM – Flight Path Marker. A small circle with spokes at the tip and sides that appears in the the HUD.

Frag List – A list of military targets ordered by priority.

G – The force of gravity. 1 G is normal gravity, 2 Gs is double normal gravity, etc.

GBU – Guided Bomb Unit. A designation for laser-guided bombs or LGBs.

Gimbal Limit – The maximum area within which radar or LOS can function. Exceeding the gimbal limit causes missiles to lose their lock.

GLOC – Gravity-Induced Loss of Consciousness.

GM – Ground Map.

GMT – Ground Moving Target.

Goose Eggs – Radio call indicating all pilots missed their targets.

Hardpoint – A structurally reinforced area on the outside of an aircraft upon which external stores (bombs, fuel, etc.) may be mounted.

HARM – High-Speed Anti-Radiation Missile, designated as AGM-88A.

HART – Horn Awareness Recovery Training.

HARTS – Hardened Artillery Shelter. An artillery gun dug into a hillside and well protected by concrete.

Horn Silencer – Silences the landing gear and low-speed warning sounds.

Hostile – An aircraft identified as an enemy.

HOTAS – Hands on Throttle and Stick. Controls that allow pilots to control critical combat operations without taking their hands off either the throttle or stick.

Hound Dog – Radio call requesting permission to engage.

HSD – Horizontal Situation Display. An MFD page that shows the relative positions of steerpoints and indicates the flight path.

HSI – Horizontal Situation Indicator. This is used to position the aircraft on final approach when the runway isn't visible.

HTS – HARM Targeting System. A pod mounted on the aircraft that detects targets for the HARM missile.

HUD – Head-Up Display. A glass panel in front of the cockpit that shows important navigation and weapons information.

IADS – Integrated Air Defense System.

ICP – Integrated Control Panel. The control panel directly under the HUD.

IFF – Identification Friend or Foe.

IFV – Infantry Fighting Vehicle.

IL-76 – The Candid is an extremely large Soviet-built transport aircraft.

ILS – Instrument Landing System. Horizontal and vertical lines that appear in the center of the HUD to assist in landing.

Ingress – Entering or approaching an objective.

INS – Inertial Navigation System. Navigational equipment in the aircraft that keeps track of your position based on movement following takeoff.

IR – Infrared. Also the designation for heat-seeking missiles.

Iron Bombs – Standard free-fall bombs that detonate on impact.

Jink – Unpredictable maneuver designed to spoil the aim of an enemy pilot.

Joker – Radio call indicating there is just enough fuel to return to base. No reserve for emergencies is left.

JSTARS – Joint Surveillance and Target Acquisition Radar Sytem.

Juliet Sierra – Radio call indicating all pilots missed their targets.

Kansas – Radio call indicating aircraft is out of air-to-air ordnance.

KC-10 – The Extender is the largest U.S. mid-air refueling tanker currently in existence.

Knife Fight – Pilot terminology for a close-in dogfight.

Knots – Nautical miles per hour. One nautical mile is roughly 1.3 standard miles.

Lawn Dart – (1) Radio call indicating an aircraft crashed into the ground. (2) A derogatory term for the F-16.

LCOS – Lead Computing Optical Sight. An air-to-air gun sight.

Leakers – Enemy aircraft that have gotten past their escorts.

LGBs – Laser-Guided Bombs.

Line Abreast – Line abreast formation (aircraft wingtip to wingtip).

LOS – Line Of Sight.

Mach 1 – The speed of sound at sea level.

Magnum – Alternate designation for the HARM missile.

Manpads – Man Portable Air Defense Systems.

Marking – The practice of aircraft visibly marking a position with rockets, flares, contrails or other methods.

Maverick Missile – An AGM-65 missile.

MFD – Multifunction Display. Two displays on either side of the center console in the cockpit that can show all radar modes including combat and navigation, as well as other vital information.

Midnight – Radio call indicating sent by AWACS when it can no longer provide control functions to friendly aircraft.

MiG-19 – The Farmer is a Soviet-built fighter more than 40 years old that is still used by many nations including North Korea.

MiG-25 – The Foxbat is a Soviet-built interceptor with high speed and a high flight ceiling.

MiG-29 – The Fulcrum is an effective Soviet-built fighter that has design features similar to those used in the F-16.

Mike–Mike – Code for millimeter that is used to describe calibers of AAA, such as "23 mike–mike."

Military Power – 100% thrust (no afterburners).

Movers – Ground vehicles.

MRGS – Multiple Reference Gun Sight lines.

MRM – Medium Range air-to-air Missile (AIM-120 or AIM-7).

MSL – (1) Mean Sea Level. The altitude above sea level. (2) Missile override mode.

Mud – Enemy ground radar indication on the RWR.

Music – Radio call indicating ECM equipment is active.

NAV – Navigational mode. The default setting for the HUD, which guides you to predetermined steerpoints with a small diamond-shaped flight path marker.

NCTR – Non-Cooperative Target Recognition. A system used in the F-16 instead of IFF to identify aircraft as friendlies or enemies.

Nevada – Radio call indicating aircraft is out of Maverick missiles.

NM – Nautical Miles. One nautical mile is roughly 1.3 standard miles.

No Joy – Radio call indicating a pilot can't see the target.

NOE – Nap Of the Earth. Flying as low to the ground as possible to avoid detection by enemy radar.

Notching – Flying a beaming maneuver to break a radar lock.

OCA – Offensive Counter Air. OCA missions are flown against the enemy's air-to-air capability. There are two types of OCA missions: OCA Sweep and OCA Strike.

OCA Strike – OCA Strike missions are essentially air-to-ground missions flown against targets in and around an enemy airfield.

OCA Sweep – OCA Sweep missions are the air-to-air component of OCA whose purpose is to shoot down enemy aircraft. Since you are not tied to protecting something or someone in Sweep missions, they offer the most flexibility to the pilot. In an OCA Sweep mission, you fly along a route and engage any enemy fighters that you detect.

OOB – Order Of Battle. The OOB shows all units that are available in the campaign.

Ordnance – The weapons carried by an aircraft.

OSB – Option Select Button. A set of buttons surrounding the MFD displays that allow you to quickly select system options in the MFDs.

Outlaw – A suspected hostile aircraft.

Package – A group of flights with a common mission.

Padlocked – Keeping eyes "locked" on the current target by moving your head to follow the target's movement.

Pickling – Pressing the "pickle" button to drop bombs, fire missiles or any other function it is currently set to.

Pince – A maneuver in which the flight lead and wingman fly to opposite sides of an oncoming bandit.

Pitch – Movement around the horizontal axis of an aircraft experienced as the nose moving up and down.

Pitch Ladder – An indicator in the center of the HUD consisting of parallel lines that show the angle of climb or descent.

Pk – Probability of Kill.

Platoon – An army unit consisting of three squads.

Playmate – Friendly aircraft involved in the pilot's current mission.

Posthole – A maneuver that involves diving to the ground to avoid radar detection by an oncoming bandit.

Print – Radio call indicating radar contact has been identified.

Push Point – A designated steerpoint for rendezvousing with the package and starting a route into enemy territory.

Push Time – Time to depart the steerpoint.

Radar – Radio Detection And Ranging.

Ray Gun – Radio call meaning the pilot has locked onto an unidentified target at the following position. For example, if you hear "Fury 12, Ray Gun, bullseye 030 for 20," you should respond with "Buddy spike" if you are at that position.

Recon – Reconnaissance. Recon missions are flown to get pictures of an enemy target. To successfully fly a reconnaissance mission, you must fly over the target with a camera pod loaded on the jet.

Redout – A loss of vision (or consciousness) due to pulling too many negative Gs.

RESCAP – Rescue Combat Air Patrol mission.

Res Cell – A tight formation designed to hide the number of aircraft in the flight.

Rifle – Radio call that a Maverick missile has been fired.

Rmax – The maximum range at which a missile can be fired and still be capable of hitting the target.

Rmin – The minimum range at which a missile can be fired at a target and still have time to arm before it impacts.

Rockets – Unguided rocket-powered explosives.

Rockeyes – Code word for a cluster bomb variant.

ROE – Rules Of Engagement.

ROK – Republic of Korea (South Korea).

RTB – Return to Base. Radio call indicating a pilot should return home.

RWR – Radar Warning Receiver. A passive system that warns the pilot of enemy radar emissions and missile launches.

RWS – Range While Search. An air-to-air radar search mode.

SA-2 – The Guideline is among the oldest and largest SAM systems built by the Soviets.

SA-3 – The Ganef is a Soviet-built SAM system that fires huge missiles capable of outrunning virtually any aircraft.

SA-5 – The Gammon is a high-speed, high-altitude Soviet-built SAM system that is inaccurate against modern aircraft.

SA-6 – The Gainful is an improved Soviet SAM system that poses some threat to modern combat aircraft.

SA-7 – The Grail is a Soviet-built shoulder-launched SAM of limited capability.

SA-8 – The Gecko is a smaller and more mobile Soviet-built SAM system intended to replace older AAA.

SA-13 – The Gopher SAM system is an immensely improved version of the SA-9 "Gaskin."

SAD – Search And Destroy.

SAM – (1) Surface-to-Air Missile. (2) Situation Awareness Mode. An automatic mode of the RWS radar that allows you to simultaneously track a single target and see what is nearby.

SAR – Search And Rescue.

SARH – Semi-Active Radar Homing. A missile that requires that the target be locked with radar until it impacts.

SEA – Ground Map radar optimized for use at sea.

SEAD – Suppression of Enemy Air Defenses.

SEAD Escort – SEAD Escort missions are flown to suppress enemy air defenses and thus protect a specific group or package of aircraft. Unlike SEAD Strike missions, it is not necessary to actually destroy enemy air defense systems to successfully fly SEAD Escort. Suppression, not destruction, is the goal of a SEAD Escort mission.

SEAD Strike – SEAD Strike missions are air-to-ground missions flown against air defense assets, such as SAMs and search radars. In a SEAD Strike mission, you must destroy specific enemy air defense assets.

Shooter/Cover – Radio call indicating the flight lead will attack the designated target, while the wingman provides cover against AAA or bandits.

Shooter/Shooter – Radio call indicating both lead and wingman are to attack the designated target.

Sidewinder – Alternate designation for AIM-9 missiles.

Sierra Hotel – Sh*t Hot. A term used to describe the best pilots.

Skosh – Radio call indicating aircraft is out of active radar missiles.

Slapshot – Radio call indicating a directive to fire a HARM missile at a ground target.

Slave – A weapons submode that locks weapon targeting to the current position of the radar.

SMS – Stores Management System. This page displays the stores you have currently loaded.

SNAP – Snapshot. An air-to-air gun mode.

Sniper – Radio call indicating a directive to fire a HARM missile at a ground target emitting radar.

SOI – Sensor Of Interest.

Sortie – A single mission that runs from takeoff to landing. In *Falcon 4.0,* sorties are short engagements centered around one mission or tactical objective.

Sparrow – Alternate designation for the AIM-7 missile.

Spike – An enemy air-intercept radar indication on the RWR.

Splash One – Radio call indicating a pilot has shot down an aircraft.

Spoof – Evading missiles through the use of chaff and/or flares.

Squad – An army unit consisting of approximately 12 men or 4 vehicles.

SRM – Short-Range Air-to-Air Missile.

STBY – Standby. Radar is not emitting.

Steerpoint – A navigational marker which indicates course and destination.

Stinger – A highly effective U.S. shoulder-launched SAM.

Stores – The weapons, pods and fuel tanks carried by an aircraft.

STRF – Strafe. An air-to-ground mode that provides a reticle for strafing ground targets with the F-16's 20mm cannon.

Strike – Strike missions are air-to-ground missions flown against a wide variety of enemy targets. These targets can consist of anything from infrastructure to enemy ground units.

STT – Single Target Track. An air-to-air radar mode that tracks a single target.

Sunrise – Radio call indicating an AWACS has begun providing control functions to friendly aircraft.

Sweep – An aggressive patrol into enemy territory.

T-80 – A Soviet-built main battle tank with better armor, armament and speed than the T-72.

TACAN – Tactical Air Navigation. A cockpit system that detects and sends out radio beacons to assist in navigation and displays the information in the DED.

Tally – Radio call indicating a bogey or target has been spotted.

Tango Uniform – Radio call indicating something is out of operation, broken or not functioning.

TD – Target Designator.

Threat Circles – Radar detection radius around enemy SAM sites.

TMS – Target Management Switch.

TOS – Time Over Steerpoint.

TOT – Time Over Target.

Trail – A formation in which the aircraft trail each other in a line.

Trespass – Radio call indicating a friendly flight has entered the threat ring of an enemy SAM.

Trolling – Trying to get the enemy to shoot in order to find his location.

Tu-16 – The Badger is a Soviet-built medium bomber with anti-ship and nuclear capabilities.

Tumbleweed – Radio call indicating a pilot has no situational awareness.

TWS – (1) Track While Scan mode. An air-to-air mode that allows you to track up to 10 targets simultaneously. (2) Threat Warning System. This system detects radar contacting your aircraft and determines its type, strength and bearing.

UFC – Upfront Controls.

Vector – Bearing and range to a target or destination.

VMS – Voice Message system, also known as Bitching Betty. A computer voice that provides verbal warning of potentially threatening situations.

VS – Velocity Search. An air-to-air radar search mode that will only allow you to track a target if its aspect is 91° or greater to your relative position.

Vulcan – (1) Alternate designation for the M163 Vulcan AAA system. (2) The name of the 20mm cannon mounted on the F-16.

Wedge – A wedge-shaped formation of aircraft.

WEZ – Weapon Engagement Zone.

Wild Weasel – A SAM-hunting mission.

Willie Pete – White phosphorous.

Winchester – Radio call indicating the aircraft is completely out of weapons.

Yaw – Movement around the vertical axis of an aircraft, experienced as the nose moving left and right.

Zeus – A Soviet-built AAA vehicle.

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