iF-22 Raptor Manual

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Contents

1 Introduction

The Lockheed-Martin (Lockheed) F-22 Raptor is the US Air Force's next generation air-to-air fighter, the Advanced Tactical Fighter (ATF). It combines some of the best features of the F-15 Strike Eagle and the F-117A Stealth Fighter. Designed to meet the USAF's requirement for an aircraft with long-range, supersonic cruise (without afterburner) capability, it also relies heavily upon the same stealth technology highlighted by the spectacular performance of the F-117A in Panama and the Gulf War.

The first YF-22 was tested by Lockheed in September 1990. Following some embarrassing episodes in the fly-off competition between the YF-22 and YF-23, including the bizarre crash of one of the two existing YF-22 prototypes about two years later, the Air Force decided to proceed with the Lockheed YF-22 aircraft design.

The final design of the F-22 was approved in February 1995. The Air Force currently has an Engineering and Manufacturing Development (EMD) contract worth $11 billion for the production of nine flightworthy and two ground test aircraft. The first EMD aircraft was officially "rolled out" of the Lockheed assembly plant on April 9, 1997, with its first flight scheduled for May 1997. Low-rate initial production is scheduled to start in late 1998. The Air Force plans to procure 442 F-22s with production running through 2012. The F-22s will take over the air-superiority role with Air Combat Command in 2004 with significant combat deployments starting mid- to late 2003.

The *i*F-22 Raptor simulation

*i*F-22 Raptor is a state-of-the-art flight simulator highlighting the newest weapon in the USAF's arsenal. *i*F-22 Raptor presents a truly remarkable aircraft with unprecedented stealth capabilities, incredible agility though thrust vectoring, blinding supercruise speeds of up to 1.6 Mach, and a cutting-edge integrated avionics package. Combined with a dynamic campaign/mission generation system and photorealistic terrain, these features make *i*F-22 Raptor the most realistic simulation of the F-22.

Use the stealthy nature of your F-22 to locate and attack aerial and ground targets before they even know you exist. With the radar cross-section of a small bird or bee, you can sneak around hostile airspace unseen. One question that constantly faces you is when to use stealth as a weapon and when to use actual weapons at the expense of stealth. You might be able to get those two MiGs, but will the intervening SAM site get you?

*i*F-22 Raptor uses two-dimensional thrust vectoring and a full flight control system to achieve remarkable agility. Through thrust vectoring, your F-22 can maintain angles-of-attack exceeding 60 degrees, or you can snap the aircraft's nose around for a quick missile or gun shot. The flight control system uses any or all of the F-22's control surfaces to perform desired maneuvers, which allows you to perform incredible feats at both high and low speeds.

With *i*F-22 Raptor's integrated avionics package, you can concentrate on your mission objectives while the aircraft's high-tech computer worries about the technical details. For example, when using radar operation, you specify that you want information regarding an aircraft in your Multi-Functional Displays (MFDs). The avionics package then searches all the available sources of data—active radar, passive radar, and In-Flight-Data-Links (IFDLs)—and presents you with the most complete answer. You don't have fumble with horizontal and vertical radar search angles or modes anymore!

Another key feature of this game is the dynamic campaign/mission generation system. Most games use a limited number of prescripted or "canned" missions. Each of these missions is exactly the same every time you fly it. In *i*F-22 Raptor, no two missions are alike; the campaign system generates a new set of missions each time you fly, based on the current state of the war.

Just like the real F-22, *i*F-22 Raptor has supercruise capability, which allows it to reach speeds in excess of Mach 1.6 without the use of afterburners. With afterburners, your plane is capable of speeds over Mach 2.4. Supercruise also greatly increases the combat radius of the F-22 to over 1,500 miles, compared to 700 miles for the F-15.

System requirements

Hardware and operating system requirements are outlined in the next two sections.

Hardware requirements

Minimum: Pentium 90 MHz, 16 MB RAM, 4x CD-ROM, 640x480 SVGA monitor, keyboard, and mouse.

Preferred: Pentium 133 MHz, 16 MB RAM, 4x CD-ROM, 800x600 SVGA monitor, two-button joystick, keyboard, and mouse.

Ideal: Pentium 166 MHz or Pentium Pro, 32 MB RAM, 6x CD-ROM, 1024x768 SVGA monitor, 3D accelerator board, two-button joystick, throttle, rudder pedals, keyboard, and mouse.

OS requirements

*i*F-22 Raptor runs under Windows 95 only. It contains AutoPlay functionality, which detects and launches the simulation whenever the *i*F-22 CD is placed in the CD drive. If AutoPlay is unavailable or disabled on your computer, the simulation also installs and launches using standard Windows 95 icons. See "Installation" on page 3 for details.

Installation

To install *i*F-22 Raptor, insert the Raptor Disc 1: Bosnia Theatre CD into your CD-ROM drive. After a few seconds, an AutoPlay options window is displayed. Click on the **Install iF-22 Raptor** button to start the installation process. An installation wizard, iF-22 Raptor Setup, is launched and guides you through the rest of the setup procedure.

If the computer does not have an AutoPlay-enabled CD-ROM drive or is running 16-bit CD-ROM drivers, the autoplay options window may not be displayed.

In this case, browse the files on the CD-ROM drive in either Explorer or My Computer. Launch the *i*F-22 Raptor Setup wizard by double-clicking on the setup.exe file.

System Drivers

*i*F-22 Raptor and many other Windows 95 products require system drivers to operate correctly. During the installation process you may be asked to update drivers and/or restart your machine to finish the setup. These are normal operations of computers under Windows 95.

If you know in advance that you do not need either the DirectX or Indeo drivers, you can select not to install them during the setup process. They can both be installed later by launching the demos from the **Demos and Drivers** button on the AutoPlay options screen. After the main demo window appears, selecting the **System** menu will provide access to all of the drivers available on the CD. If you have setup problems, please contact Interactive Magic customer service (see "Questions or Problems" on page ii).

DirectX

This is a set of system drivers for high-performance graphics, sound, and network play under Windows 95. The driver set included on *i*F-22 Raptor is DirectX 3.0. To run *i*F-22 Raptor correctly, at least the drivers included on Raptor Disc 1: Bosnia Theatre or their equivalent should be installed.

As video and audio boards continue to evolve, more recent DirectX drivers may become available from the manufacturers of these hardware devices. To aid in the installation and updating of the DirectX subsystem, a special function has been provided to examine your system's DirectX drivers.

Right-click on the CD-ROM icon in either Explorer or My Computer to display a menu with the option (Un)Install DirectX. Select this option to display a window with the current versions and certifications for the drivers currently installed. There are also options for removing and/or updating the individual drivers or driver set.

Indeo

This is the digital video player developed by Intel. It is required to display the animation and video files in *i*F-22 Raptor. It is a high-performance multimedia codec that is used by many Windows 95 applications. The Indeo installation can also be accessed directly in much the same way as DirectX.

Right-click on the CD-ROM icon in either Explorer or My Computer to display a menu with the option Install Indeo. Select this item to launch the Indeo setup wizard.

Acrobat

Acrobat Reader is provided on the CD-ROM and is installed by default at the end of the *i*F-22 Raptor setup. Acrobat is provided to access online documentation found on the CD.

A duplicate version of this manual is provided online with any updates that could not be included at press time. From within the Acrobat Reader the manual file can be viewed and printed. The file is located on Raptor Disc 1: Bosnia Theatre in the manual subfolder.

In addition, a Dash-34 Operations Manual is provided as an online document. This is a Raptor game supplement and provides insight into actual Air Force tactics and operations. The file is located on Raptor Disc 1: Bosnia Theatre in the manual subfolder.

How to use this manual

This manual is divided into the following sections:

- Chapter 1, "Introduction," presents a basic overview of the simulation and explains how to quickly get into the action in the Quickstart section.
- Chapter 2, "General Simulation Concepts and Tutorials," provides a detailed description of the simulation including detailed discussions of general simulation concepts.
- Chapter 3, "Preflight Operations," contains information needed to navigate the simulation's menus and perform functions such as saving simulations, creating/editing pilots, and multiplayer chatting.
- Chapter 4, "Flight Operations," provides the information you need to perform in-flight functions such as flying your aircraft, evading the enemy through stealth and maneuvers, targeting, aircraft instrumentation, and damage control.
- Chapter 5, "Postflight Operations," describes debriefings, victory and defeat, and awards, and pilot death.
- Chapter 6, "General Principles," explains flight dynamics and stealth principles.
- Appendices on campaign scenarios; aircraft, vehicles, and weapons data; ribbon and metal historical data; and pre-scripted communications messages.
- Glossary
- Index

Quickstart

Instant Action is always a great place to start. It gives you a quick feel for the simulation. Here's what you do:

1. Start the simulation by inserting one of the simulation CDs and clicking **Play**. Or, click the **Start** button, select **Programs**, and then select **iF-22 Raptor**.
2. Select **Fly Instant Action** on the Main Options window**.** The first time you start after installation, Instant Action automatically starts after the opening scenes. Otherwise, you can start Instant Action from the Main Options window by clicking **Fly Instant Action**.

You're flying.

Controlling your aircraft

Control your aircraft by using a joystick or the stand-alone keyboard arrow keys. Right and left joystick or arrows roll the aircraft; for example, a 180-degree roll inverts the plane. Up and down arrows (forward and back joystick) control the pitch of the aircraft, pointing the nose up or down; +90 degrees is straight up, and -90 degrees is straight down.

When you begin Instant Action, ignore nearby enemies and get a feel for your aircraft. Use the number keys (**1** through **0**) above the main keyboard (not the ones on the keypad) for throttle control. Preset thrust values run from 10 percent (the **1** key) through 100 percent (the **0** key). The **-** key (hyphen) decreases

throttle by 10 percent and the **=** key (equals) increases throttle by 10 percent. The ***** key (asterisk) on the keypad toggles your afterburners on and off.

Engaging the enemy

After you've gotten a feel for flying the F-22, find an enemy and target it. Locate an enemy aircraft (a filled red circle with a red line extending from it) by looking down at the center Multifunction Display (MFD). It is located directly below the external view and the Heads-Up Display (HUD) in the center of the upper portion of the cockpit that shows the outside world.

If you don't see any enemy aircraft, turn slowly until one appears in the MFD. Target an aircraft by turning toward it and pressing the **L** key. On the MFD, a solid white circle appears around the red circle, indicating your weapons are locked on that target. If the target is within the view area of your HUD, a large targeting triangle appears around the target. If it is not inside the HUD, a line extends from the center of the HUD and points in the direction you should fly to find the target.

Your current weapon is an AIM-120C AMRAAM missile (lower left corner of the HUD), which is a medium-range missile with a range of approximately 5 to 30 miles. When you get within about 15 miles of your target, a SHOOT cue should be displayed along the bottom of the HUD. Press the space bar to fire your missile, and watch it try to track and hit the target.

Instead of using an AMRAAM, try selecting an AIM-9X Sidewinder by pressing **Enter** until it appears in the lower left corner of the HUD. The Sidewinder has a much shorter range of approximately 3.5 miles, so you'll have to get in close to use it. With a little luck, you'll be an Ace in no time (see "Difficulty settings" on page 12 for more information).

Ending Instant Action

Instant Action ends when you press **Ctrl-Q** (to end mission) or **Ctrl-E** (to eject from your aircraft) or if you are shot down. Review the debriefing window to see how you did and then click the **Continue** button (at the bottom of the window) to go to the Main Options window.

To review or change the Instant Action settings, click the **Instant Action Setup** button on the Main Options window. This allows you to select your starting conditions (in the air or on the runway), enemy difficulty level, the default flight model for your F-22, and other general flight settings. If you prefer to go directly into Instant Action after the introduction, select the **Instant Action in Startup** check box. When you're done, select **Accept** to save or **Cancel** to delete your changes.

NOTE: These simulation settings apply only to Instant Action gaming sessions.

Single missions

To get more experience, try flying a single mission. Single missions are more detailed than Instant Action—you get to select the pilot and the setting for the conflict—but do not contribute to a larger conflict in the same way as campaign missions. Follow these steps to start a single mission:

1. Start the program by inserting one of the simulation CDs and clicking **Play.** Or, click the **Start** button, select **Programs,** and then select **iF-22 Raptor.**
2. Select **Report for Duty** on the Main Options window.

3. Select **Single Player** in Report for Duty: Ready Room. The default pilot is a Green Pilot with *green*, or novice, difficulty settings. You can change difficulty settings with the **Edit** button or by selecting the Average Pilot or Ace Pilot.
4. Select a theater, then select **Single Mission** on the Single Player: Theater Selection window. You can select either Bosnia or the Ukraine as your theater. Then click the **Single Mission** button. You may be prompted to insert a different CD in your drive.
5. To view briefings (detailed descriptions of the mission) for the available missions, click on a mission in the left side of the window, and the right side displays the mission briefing. If you don't like any of the available missions, click **Generate New Set of Missions** for another set of missions.
6. Select a mission, then **Accept Mission** on the Mission Selection window.
7. You can edit your mission in the Mission Planning window if you like. On your first mission, we recommend you review the mission plan, but don't edit it. Select **Payload** to review your armaments, **Waypoints** to review your course, and experiment with the map buttons to display pertinent information. When you're done, click **Takeoff**.

You're flying.

Takeoff

Each of the default pilots begin missions at the end of the runway, ready to takeoff. Start both of your engines by pressing **Ctrl-L** and **Ctrl-R.** Next, disengage your wheel brakes by pressing the **W** key. Increase your throttle to full military power by pushing your throttle stick all the way forward or by pressing the **0** key (*not* the keypad 0 key).

When your aircraft reaches 150 knots (middle left side of the HUD) pull back on the flight stick until your pitch is approximately 20° (the revolving ladder in the center of the HUD). Climb out until you reach 10,000 ft. (middle right side of the HUD), and then level off. Look at the center MFD, and turn your aircraft until you line up on your first waypoint leg (green line between the two green waypoint icons). In the HUD, look for a small "tadpole." If the tadpole is not in the center of your HUD, turn your aircraft until it is. You're now ready to go hunting!

Landing

To land, get within 20 miles of your last waypoint. At that point, press the / key (slash) to activate your Instrument Landing System (ILS). In the center MFD, your mission waypoints are replaced by landing waypoints for your home airfield. Follow the line extending from your plane until you reach the first landing point, which is the outer marker. The outer marker, middle marker, and touchdown point form a straight line.

While traveling to the middle marker, decrease your speed to around 150 knots and your altitude to approximately 1,000 ft. Use the radar altimeter (press **Shift-A** until a small R is displayed above your altitude readout in the HUD) to determine your exact height above the terrain; the barometric altimeter shows only the height above sea level. The two lines in the HUD indicate the perfect glide slope to touchdown at the touchdown point. After you reach the middle marker, you need to get the two lines to form a cross in the center of your HUD.

At a range of approximately five miles, you see the runway. Put your landing gear down

(**G** key) and extend your flaps (**H** key). Use your rudder keys (**Z** and **X** keys) to make minor course corrections to line up perfectly with the runway. Be careful not to let your speed rise because your landing gear is automatically raised at 225 knots. You can use your airbrake (**B** key) to help maintain your speed.

Stay lined up with the runway and continue down until you land on the runway. Immediately after touchdown, cut your throttle to idle (**1** key) and apply your wheel brakes (**W** key) until your speed is below 80 knots. At this speed, you can steer your aircraft's nose wheel by moving your flight stick right and left. If your speed rises above 80 knots, you must steer your aircraft with only the rudders.

Ending single missions

A single mission ends if you press **Ctrl-Q** (to end the mission) while on the ground, or press **Ctrl-E** (to eject from your aircraft), or if you are shot down. Review your results in the Debriefing window. Significant success may earn you a space in the Hall of Fame, a promotion, and even a medal award. After debriefing, you return to the Mission Selection window, where you can select another mission. Select the **Main** button at the bottom of the PDA to return to the Main Options window, or select the **Cancel** button to return to the Theater Selection windows.

2 General Simulation Concepts and Tutorials

Simulation overview

In *i*F-22 Raptor, you are the pilot of the United States' most advanced jet fighter. You use stealth technology, aerobatic skills, and tactical planning to win campaigns in Bosnia and the Ukraine. You are not a lone pilot unrelated to the rest of the war, but part of a full-scale effort. Up to three wingmen fly with you on your mission, while other pilots are simultaneously carrying out other missions vital to the success of your campaign.

To make *i*F-22 Raptor even more interesting, you can fly in one of the three multiplayer modes: Head-to-Head Dogfight, Head-to-Head Capture the Flag, and Cooperative Single Missions.

Simulation modes

There are six modes of simulation in *i*F-22 Raptor:

- Instant Action
- Single missions
- Campaigns
- Multiplayer head-to-head dogfight
- Multiplayer head-to-head capture the flag
- Multiplayer cooperative single missions

Select Instant Action to hit the ground running and swing into action immediately, as described in "Quickstart" on page 4. Single missions are for the times when you want to make decisions that affect your mission success, such as waypoint planning and weapon loadout selection, but aren't interested in a long-term campaign.

The campaign mode analyzes your mission success as part of a larger war effort. As you fly missions, the front line moves to reflect the successes and failures of your side. But be warned, the enemy is doing their best to overcome your efforts, and even though you may fly a perfect mission, your comrades may not!

In *i*F-22 Raptor, you can fly in one of three types of multiplayer modes. In the head-to-head dogfight mode, it's a free-for-all "furball," during which each player uses missiles and cannons to shoot others down. Of course you're free to form your own alliances.

In head-to-head capture the flag mode, players form two teams and attempt to overwhelm

the opposing forces, which consist of opposing players and SAM/AAA sites. The scenario ends when one side captures the intervening neutral air base by landing its computer-controlled C-17 transport on the field.

Finally, in the cooperative single mission mode, players work together, along with computer-controlled wingmen, to accomplish a single goal. But look out, enemy computer-controlled aircraft and SAMs are out to end your plans!

Where to go from here

The remainder of this chapter describes each simulation mode in detail. Read Chapter 3, "Preflight Operations," to understand more about how to navigate through F-22's presimulation windows. Chapter 4, "Flight Operations," discusses the weapons delivery, avionics, and operating principles of the F-22 Stealth Fighter. Chapter 5, "Postflight Operations," explains mission success, campaign progression, pilot rewards, and pilot death. The appendices offers statistical/historical information on the world in *i*F-22 Raptor.

Also included with *i*F-22 Raptor is a *Dash-34 Nonnuclear Weapon Delivery Manual, USAF Series F-22A Aircraft*, which describes F-22A weapon systems and their use.

Setting up a simulation with the personal digital assistant (PDA)

Simulations can be divided into two phases: setting up and playing. The Personal Digital Assistant (PDA) is the mechanism for setting up the simulation.

In the early 21st century, the US Air Force is a highly computerized organization. Printed maps and rulers are no longer used to plot and plan missions. Instead, pilots use small handheld computers called personal digital assistants (PDAs) to review and plan their missions. After entering the mission information, the pilot hands the PDA over to an aircraft technician who uploads the information into the F-22's computer systems. The pilot then has complete access to mission specifics during flight. For more information on PDA settings, see Chapter 3, "Preflight Operations."

Pilot concepts

Pilots and difficulty settings

In *i*F-22 Raptor you are a pilot with a name, career, and predefined difficulty settings. When you initially load the simulation, there are three default pilots available in the Ready Room—Green Pilot, Average Pilot, and Ace Pilot—with difficulty settings reflected by their first name. To select a pilot, click the **Report for Duty** button and then click on a pilot. Your selected pilot and his difficulty settings are then used for all single player sessions, single and campaign missions. To edit a pilot's difficulty settings, click the **Edit Pilot** button in the Ready Room.

Each pilot's history is saved in a single file, which is updated when you save a simulation. This represents the experience you've gained throughout your career, not just in a single mission or campaign. This means that once your pilot is promoted, you are promoted for all subsequently loaded simulations. So although you can save more than one simulation for your pilot, you have only one current career state. When you resume a saved simulation, it's like being transferred to that location. When you resume another simulation or start a new campaign, you're sent to another location.

Creating a new pilot

To create a pilot, select **Report for Duty.** Once in the Ready Room, click the **Create Pilot** button under the Pilot Roster (see "PDA: Create/Edit Pilot" on page 31).

Editing a pilot

To edit a pilot, select **Report for Duty.** Once in the Ready Room, select a pilot and select the **Edit Pilot** button under the Pilot Roster (see"PDA: Create/Edit Pilot" on page 31).

Saving pilots and locations

You can save pilots and their current simulation locations in the Ready Room, Theater Selection, Campaign Update, Mission Selection, Mission Planning, and Debriefing windows. To save a pilot and location, click on the **Save** button on the bottom of the PDA. The window changes to a Save Current Simulation (see "PDA: Save" on page 55) window.

To save your simulation, pick the options you want and select the **Accept** button, which updates the Pilot file with the current status of the pilot and saves the current state of your simulation. You can cancel the save process by selecting the **Cancel** button at any time. After you select the **Accept** button, location information describing your simulation is displayed in the Ready Room to the right of your pilot. This information includes the name of the window where you saved the simulation followed by as much of the save simulation description as possible, which ensures that location names are unique.

Deleting a pilot

To delete a pilot, select **Report for Duty**. Once in the Ready Room, select the pilot you want to delete and select the **Delete Pilot** button under the Pilot Roster.

NOTE: When you delete a pilot, you also delete all of the associated saved simulations (locations).

Deleting a location or saved game

To delete a previously saved game or location, select **Report for Duty.** Once in the Ready Room, select the game you want to delete and the **Delete Location** button under Locations.

Loading saved simulations (locations)

With the PDA Save options (see "PDA: Save" on page 55), you can save a simulation and resume play later. There are two ways to load previously saved simulations:

- Select the **Resume** button on the Main Options window to load and resume the pilot and location shown on the Main Options window.
- Select the **Resume** button in the Ready Room window to load and resume the currently selected pilot at the currently selected location.

When you resume a simulation, the window automatically changes to the saved location window, and the associated pilot and simulation state are loaded.

Deleting saved simulations (locations)

To delete a pilot, click **Report for Duty,** select the saved simulation (location) you want to delete and press the **Delete Location** button. If you delete the last location for a pilot, a default location of Ready Room is automatically created.

Saving mission sets to Custom Mission List

In addition to saving simulations, you can also save sets of dynamically generated missions independent of pilots. Since *i*F-22 Raptor generates new missions on the fly, saving missions lets you play the same mission several times or share a fun mission with a friend. Mission sets are saved after they are generated in the Mission Selection or Mission Planning windows or immediately after mission completion in the Debriefing window.

To save a mission setup, select the **Save** button in the PDA. On the Save window, select the **Save Mission Set** button at the top of the window and type an appropriate description in the New Information field to identify your mission set. Then select the options you want and click **Accept** to save the simulation. Click **Cancel** to return to your previous window without saving.

When you save a mission set during a campaign, only the missions and current campaign state are saved. Therefore, it is not possible to continue a campaign using custom mission sets. Saved missions sets are accessed through the Mission Set option on the Mission Selection window during Custom Mission game sessions.

Loading custom mission sets

To load a previously saved generated mission set, start a Single Player session from the Ready Room. On the Theater Selection window, select the **Custom Mission** button. This takes you to the Mission Selection window, where you can browse the available mission sets (descriptions of all previously saved custom mission sets). Don't worry about which theater is highlighted on the Theater Selection window, because each custom mission set has a theater associated with it. Select a custom mission set from the list. Notice that the available missions change when you select a new custom mission set. After you've selected a mission, you go to the Mission Planning window, fly the mission, get your debriefing, and then return to the Mission Selection window. To end the custom mission session, click the **Cancel** button on the Mission Selection window to return to the Theater Selection window.

Deleting custom mission sets

Custom mission sets are located in the Missions directory under the directory you specified during install. To delete a custom mission set, browse the directory with Windows Explorer and delete the appropriate file.

Difficulty settings

In *i*F-22 Raptor, pilots have their own difficulty settings. When you create or edit a pilot, there are default difficulty settings that you can change.

Single player sessions

In single player sessions, the active pilot's difficulty settings are automatically used.

Instant Action sessions

When you start an Instant Action session, *i*F-22 Raptor uses the difficulty settings specified within Instant Action Setup. You can change these settings through the Instant Action Setup window. Select the **Copy Active Pilot Settings** button to copy your active pilot's settings into the Instant Action Setup window.

Multiplayer sessions

When you start a multiplayer session, the default difficulty settings for the session are

the same as those of the session creator's pilot. The session creator can then decide to allow players to determine their own settings.

Enemy Skill Level setting

The Enemy Skill Level setting deserves special attention because it affects more than just how well the enemy flies. It affects all nonplayer aircraft and ground units and basically sets the overall difficulty of the theater. The settings in order of increasing difficulty are as follows:

- Harmless
- Green
- Fair
- Average
- Veteran
- Ace

When you select a skill level, such as Ace, all computer-controlled aircraft fly at approximately that skill level. Their choice and execution of maneuvers, their general decision-making, and their reactions are all affected. But beware, not all pilots fly alike at the same skill level. Pilots have their own personalities and perform differently. One pilot may react quickly to a threat and fire all of his missiles and miss the target, while another pilot may react slowly, fire only one missile, and hit. Both of these reactions are possible at the same Enemy Skill Level setting because of different pilot personalities.

The Enemy Skill Level setting affects both ground and air units, including the overall awareness of ground units and the rate at which they fire.

Flying single missions

In single missions, you can fly any mission you like without being affected by the circumstances of a campaign. Your pilot can earn promotions and awards, become Missing In Action (MIA), and die. Remember to save your simulation after flying single missions to update your pilot's permanent file.

To fly a single mission, follow the steps outlined in "Quickstart" on page 4.

Flying in campaigns

Campaigns offer a set of single missions with an underlying theme. In a campaign, there is an entire war being waged around you. You are assigned to a squadron stationed at an air base behind the front line. Each mission you fly influences the overall success of the ground and air war, so you help decide the fate of the conflict. The object of each campaign is to push the enemy off the theater map by directly and indirectly supporting the ground war. The ground wars are conducted by computer-controlled generals who decide when and where to mount offensives. Check the Campaign Briefing page of the Campaign Update window for a list of the planned friendly and enemy ground offensives. Remember, you can destroy everything in an area of the front line, but if the ground forces don't move in and secure the ground (have an advance planned there), it isn't yours. There are two campaigns available in *i*F-22 Raptor: the Bosnian Conflict and the Russo-Ukrainian War.

Starting a campaign

To start a campaign, follow the steps outlined in "Quickstart" on page 4, but select the **Campaign** button on the Theater Selection window instead of the **Single Mission** button.

Ending a campaign

There are three ways to conclude a campaign:

- Push the enemy out of the combat area by continually moving the front line forward.
- Survive long enough for United Nations peace negotiations to allow you to end the war in a stalemate (as in the Korean Conflict).
- Get pushed out of the combat area by letting the enemy continually move the front line into friendly-controlled areas.

NOTE: It is possible to play more than one campaign at the same time. Save your current campaign, return to the Theater Selection window, and begin a new campaign. The first time you save the new campaign, use the **Create New** Save option; otherwise you'll overwrite your other campaign.

Flying in multiplayer dogfights

Dogfights are free-for-all fights with everyone against everyone else. This is a great way to show off your piloting prowess. Each aircraft starts in the air near a different edge of the playing area with a specified weapons loadout. Hunt down your opponents by using your missiles or guns, and when your ammunition gets low, fly under 300 ft. over an air base to rearm and refuel. But be warned, you're a sitting duck when you go in to rearm/refuel, and your enemies know it!

Starting a dogfight

To start a dogfight, follow these steps:

1. Start the simulation by clicking on the *i*F-22 Raptor icon.
2. Select **Report for Duty** on the Main Options window. If your simulation goes directly into Instant Action, end it by pressing **Ctrl-Q.** You then go to Main Options window.
3. Select **Multiplayer** in the Ready Room. Choose your pilot or take the default pilot, which is the last pilot saved.
4. Select a multiplayer connection type on the Multiplayer Setup window. DirectPlay in Windows 95 will autodetect all of the connection types available on your machine. After you select your connect type, select the **Accept** button.
5. Navigate the DirectPlay menus to establish a connection.
6. Select either **Join Session** or **Create Session** on the Network Setup window. Select your connection option, **Join** or **Create**. If you choose **Create Session**, then you must first select the type of simulation, **Head-to-Head Dogfight**, the number of potential players, and the session name.
7. Set up the session parameters and change your status to Ready on the Session Setup window. If you created the session, you need to set up the session parameters, which are the same as your pilot's parameters by default. Specify the aircraft armament for the session and then change your pilot's status to Ready by clicking in the checkbox next to your callsign. When at least two people are ready, select the **Accept** button to begin the session. Others can join the simulation after you've begun.

You're flying.

After you exit the session, you go to Debriefing to review your results. When you leave the Debriefing, you go to the Network Setup window.

Ending a dogfight

You can exit a dogfight by pressing **Ctrl-Q.** You can also exit the simulation entirely by pressing **Ctrl-X.** If you exit and you are the session creator, everyone exits with you.

Flying in multiplayer capture the flag missions

Capture the flag is a head-to-head team scenario. Each player belongs to one of two teams, Blue or Red. The playing field is set up with a Blue airfield, a Red airfield, and an intervening neutral airfield.

NOTES: When computer-controlled SAM/AAA are destroyed, they are gone forever. The object of the simulation is to gain air superiority (control the skies) over the neutral air base and then have your computer-controlled C-17 transport aircraft land on the neutral base to seize it. To launch your C-17, send the communications message general (recipient) "Launch the Airbase Attack," using any communications system (**U** key for UHF, **K** key for IFDL, **Ctrl-G** for Guard).

Computer-controlled C-17s regenerate after two minutes. You can refuel and rearm your plane by landing at your own air base (if you began on the runway) and by coming to a complete stop or by flying under 300 ft. above your air base (if you began in the air).

Starting capture the flag

To start a capture the flag session, follow these steps:

1. Start the simulation by clicking on the *i*F-22 Raptor icon.
2. Follow Steps 2 through 5 in "Starting a dogfight" on page 14.
3. Select either **Join Session** or **Create Session** on the Network Setup window. Select your connection option, **Join** or **Create**. If you choose **Create Session,** then you must first specify the type of simulation, **Head-to-Head Capture the Flag**, the number of potential players, and the session name.
4. Set up the session parameters and change your status to Ready on the Session Setup window. If you created the session, you need to set up the session parameters. They are the same as your pilot's parameters by default. Change your pilot's status to Ready by clicking in the checkbox next to your callsign. When all of the players are ready, select the **Accept** button to begin the session.

NOTE: You cannot join this session once it has begun.

You're flying.

After you exit the session, you go to Debriefing to review your results. When you leave the Debriefing, you go to the Network Setup window.

Ending capture the flag

You can exit a capture the flag session by pressing **Ctrl-Q.** You can also exit the simulation entirely by pressing **Ctrl-X**. If you exit and you are the session creator, everyone exits with you.

Flying in multiplayer cooperative single missions

In *i*F-22 Raptor, you can fly cooperative single missions during which one player is the flight leader and up to three others are wingmen. When you set up the multiplayer portion of the session, the mission selection and planning are almost identical to single player missions. The only exception is that the flight leader can edit everything except the wingmen's armaments, which are the only things the wingmen can edit.

Starting a mission

To start a cooperative single mission session follow these steps:

1. Start the simulation by clicking on the *i*F-22 Raptor icon.
2. Follow Steps 2 through 5 in "Starting a dogfight" on page 14.
3. Select either **Join Session** or **Create Session** on the Network Setup window. Select your connection option, **Join** or **Create**. If you choose **Create Session**, then you must first specify the type of simulation, **Cooperative**, the number of potential players, and the session name.
4. Set up the session parameters and change your status to Ready on the Session Setup window. If you created the session, you need to set up the session parameters. They are the same as your pilot's parameters by default. Change your pilot's status to Ready by clicking in the checkbox next to your callsign and under the Status heading. When all of the players are ready, select the **Accept** button to begin the session.

NOTE: You cannot join this session once it has begun.

5. Select a mission and then **Accept** mission on the Mission Selection window. Each time you click on a mission, the briefing on the right changes. The briefing is where you get your best idea as to the true nature of the mission. If there are no missions that you like, select the **Generate New Set of Missions** button to give you another set of missions.
6. Edit your mission as desired and then select the **Takeoff** button on the Mission Planning screen (see "PDA: Mission Planning" on page 43 for more information).

You're flying.

After you exit the session, you go to Debriefing to review your results. When you leave the Debriefing, you go to the Network Setup window.

Ending a mission

You can exit a cooperative single mission by pressing **Ctrl-Q.** Remember, you must land and come to a complete halt to get full credit for your mission. You can also exit the simulation entirely by pressing **Ctrl-X**. If you exit and you are the session creator, everyone exits with you.

3 Preflight Operations

This chapter describes the elements that make up the Personal Digital Assistant (PDA), which you use to complete preflight operations.

PDA buttons

There are three buttons on the PDA:

- **Main**—Sends you to the Main Options window from any other PDA window
- **Save**—Sends you to the Save window where you save pilots/games (locations) and custom missions
- **On/Off**—Exits *i*F-22 Raptor

Chat line

The chat line is the black line at the bottom of the PDA window. Use it to type messages to other human players and to display all incoming messages.

You can send several types of messages:

To send	Press
A chat message	' key (single quote or click in the chat line
A UHF message	**U** key
An IFDL message	**K** key
A guard message	**Ctrl-G**

See "Communications" on page 61 for explanations of the different message types. When you initiate a outgoing message, the chat line expands to two text lines; the top line is for incoming messages, and the bottom line is for outgoing messages. The word "Who:" is displayed on the chat line, and a list of possible recipients is displayed in the upper left portion of the window. Type the number associated with the recipient. After you designate a recipient, the word "What:" is displayed on the chat line along with a list of possible messages in the upper left of the window (only for non-chat messages). You can either type a custom message or type a number corresponding to one of the pre-scripted messages. To send the message, press **Enter** or click the **Send** button. To cancel sending a message, press **Esc.**

NOTES: Computer recipients do not understand custom messages.

While you send a message, the keyboard can be used only for communications—only the flight controls arrow keys work.

Simulation clock

Throughout *i*F-22 Raptor, you'll see different times specified. All times are simulation-related (not actual) times specified with a 24-hour system in Greenwich Mean Time (GMT) or Zulu (Z) time identical to the US military. Zulu time is based on the actual time in Greenwich, England, and therefore may not be intuitive for other locations. Sunrise for an area five time zones east of the Greenwich time zone will be around 0200Z, while in the US, which is five zones west of Greenwich, it's at 1200Z. The sunrise and sunset times for your theater of operation are at the bottom of each briefing on the Mission Selection window.

World coordinates: UTM

In *i*F-22 Raptor, maps and theaters are described in terms of the Universal Transverse Mercator (UTM) map projection. UTM coordinates describe locations in the world with the following format: a two-letter zone designation describing a 100 kilometer by 100 kilometer area in the world; X, a number showing the meters east within the zone; and another number, Y, showing meters north within the zone.

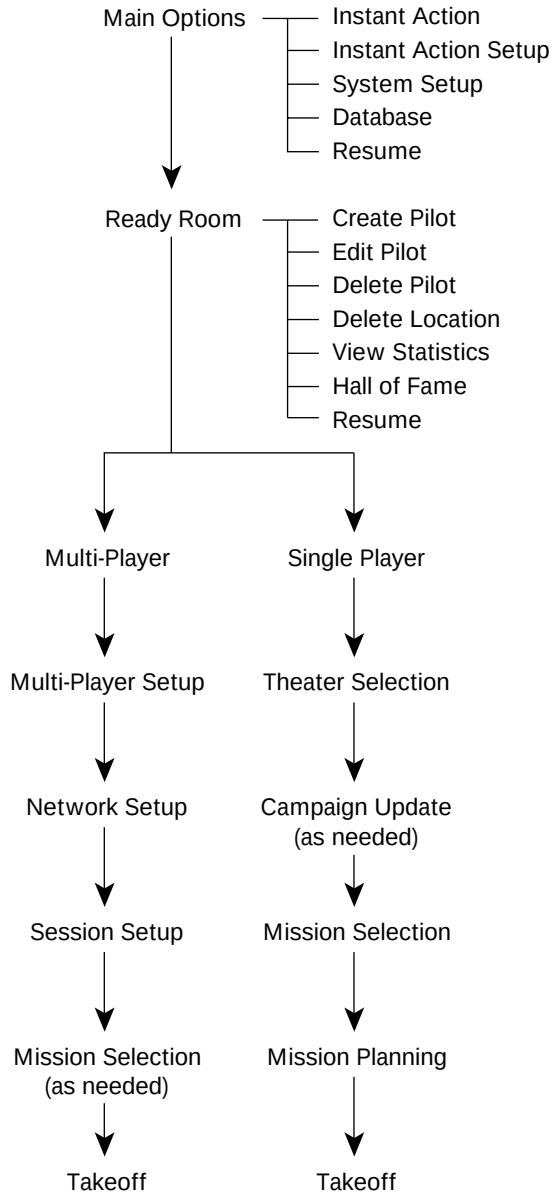
Look at ONC map F-2, which is provided with the game. Find Rome (spelled "Roma") in the center of Italy on the west coast. Rome's UTM coordinates are approximately TG (light blue capital letters below Rome):89000:42000.

The UTM coordinate system is a rectangular grid mapped onto a circular surface, the Earth. This produces some boundary problems because the coordinate system warps to follow the surface. When two UTM grid zones (a group of smaller UTM zones) meet, there tends to be overlap in the X and possibly the Y directions, along with a general renaming of individual UTM zones (XX changes to AF instead of the expected YX). With this in mind, each theater in *i*F-22 Raptor is represented by at least two grid zones, and the UTM coordinates along the intersection of grid zones jump or change rapidly (see the provided ONC).

You can find UTM coordinates in the Mission Planning window under the **Waypoints** button, on the hcat line in the Missing Planning window when the **Info On/Off** button is selected, on the cockpit display over the left MFD, and in the Communications/Navigation MFD mode. The Communications/Navigation MFD and cockpit display provide UTM coordinates to the nearest 100 meters (for example, NS:800:250).

PDA flowchart

The following diagram shows the paths you can take when setting up a simulation:


Main Options
Instant Action
Instant Action Setup
System Setup
Database
Resume
Ready Room
Create Pilot
Edit Pilot
Delete Pilot
Delete Location
View Statistics
Hall of Fame
Resume
Multi-Player
Single Player
Multi-Player Setup
Theater Selection
Network Setup
Campaign Update
(as needed)
Session Setup
Mission Selection
Mission Selection
(as needed)
Mission Planning
Takeoff
Takeoff

PDA: Main Options

The Main Options simulation window is the first window you see when you start *i*F-22 Raptor. It contains the following options:

Fly Instant Action—Initiates an Instant Action simulation session where you can fly short, high-intensity missions when you don't have a lot of time.

Instant Action Setup—Displays a window where you can customize the Instant Action environment.

Fly Training—Displays a window where you can initiate a training mission session.

View Introduction—Shows the introductory movie and then returns you to the Main Options window.

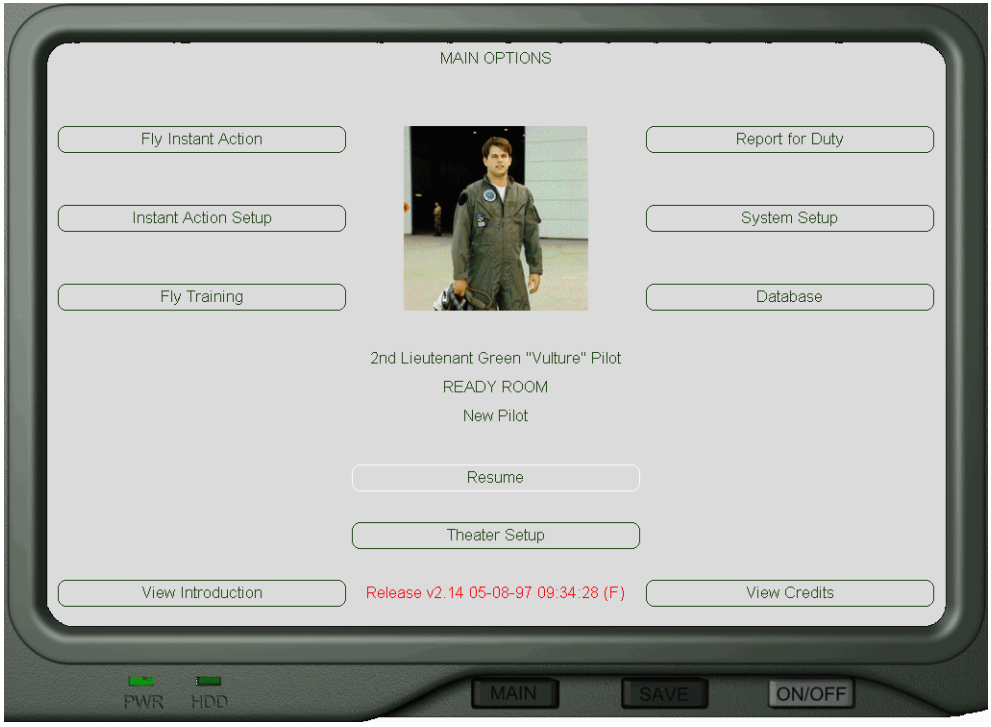
Resume—Resumes the simulation described by the pilot, location, and description listed above the button.

Theater Setup—Displays the Theater Setup window, where you can install and uninstall terrain sets for *i*F-22 Raptor.

Report for Duty—Displays the Ready Room window, where you manipulate pilots, load saved simulations, go to the Hall of Fame, or start a single- or multiplayer simulation session.

System Setup—Displays the System Setup window, where you can customize how the simulation runs.

Database—Displays the Model Database window, where you can review the various models in the simulation.



View Credits—Shows the *i*F-22 Raptor game credits and then returns you to the Main Options window.

PDA: Instant Action Setup

The Instant Action Setup window lets you change the Instant Action environment and how it is accessed. It contains the following options:

Instant Action on Startup—Specifies whether you want to go directly into Instant Action after the introduction windows and movies.

Number of Wingmen—Lets you set the number of wingmen in Instant Action.

Theater—Lets you select the theater to be used in Instant Action.

Number of Enemy Aircraft—Lets you set the number of enemy aircraft in Instant Action.

Flight Model—Lets you specify the flight model you want to use when flying Instant Action.

No Collisions with Objects—Turns off collisions between objects other than weapons and the ground.

No Crashes—Turns off collisions with the ground; your aircraft will bounce off the ground if you crash.

Invulnerable to Weapons—Makes it impossible for your F-22 to be damaged by weapons.

Unlimited Ammunition—Gives your F-22 unlimited ammunition.

Unlimited Fuel—Gives your F-22 unlimited fuel.

Enemy Skill Level—Lets you specify the enemy skill level in Instant Action.

No Blackouts or Redouts—You will not black out or red out when performing severe maneuvers. In addition, you will not suffer from whiteouts when looking at or toward the sun.

Difficulty Level—This is how hard Instant Action sessions are, based on your current settings, with 100 percent being the hardest and 0 percent being the easiest.

Begin Instant Action—*On the runway*: Starts your plane on the runway whenever you start Instant Action. *In the air*: Starts your plane in the air whenever you start Instant Action.

Fly Instant Action—Accepts all changes to this window and initiates an Instant Action session.

Copy Active Pilot Settings—Copies the preferences from your current pilot (see "PDA: Create/Edit Pilot" on page 31) into the Instant Action Setup window.

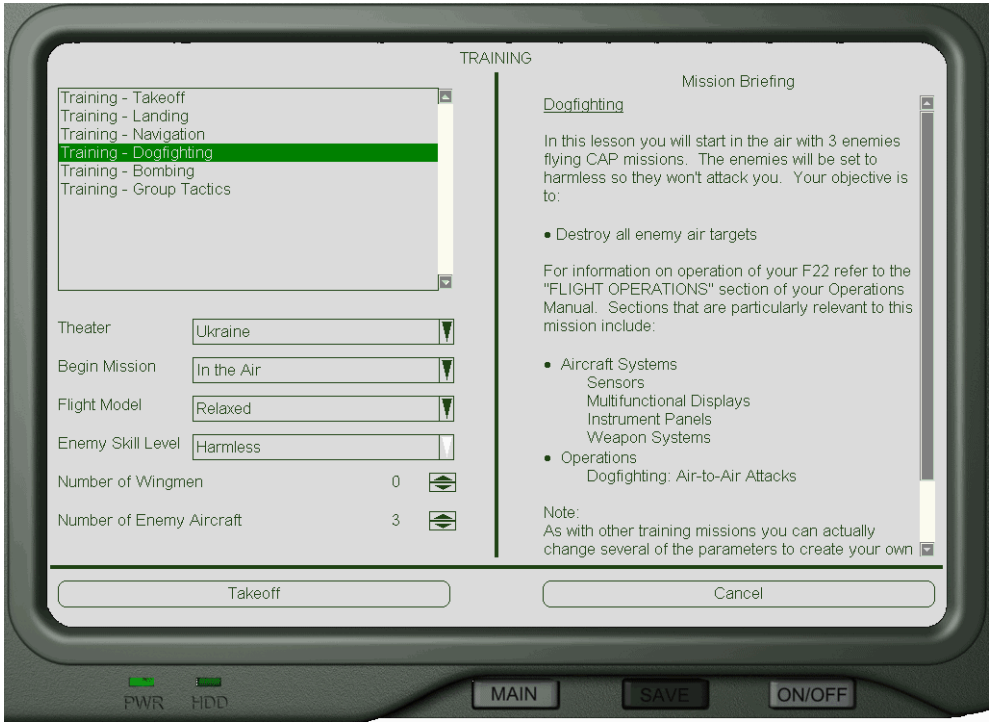
Accept—Accepts all changes to this window and returns you to the Main Options window.

Cancel—Returns you to the Main Options window *without* saving any of your changes.

NOTE: These preferences are for Instant Action only.

PDA: Training

The Training window lets you choose preset training environments or set up custom training environments in which you can sharpen your skills. It contains the following options:



Mission Window—This window allows you to select one of *i*F-22 Raptor's preset training missions

Mission Briefing Window—This window lists the briefing for the currently selected training mission and directs you to sections in the *i*F-22 Raptor manual that are particularly helpful for this mission

Theater—Specifies the theater for training missions

Begin Mission—Specifies the starting position for training missions: in the air or on the runway

Flight Model—Specifies the flight model for training missions

Enemy Skill Level—Specifies the overall skill level for all computer-controlled aircraft and ground units, from Harmless (easiest) to Ace (hardest)

Number of Wingmen—Specifies the number of wingmen present for training missions

Number of Enemy Aircraft—Specifies the number of enemy aircraft for training missions

Take Off—Begins the currently selected training mission

Cancel—Returns you to the Main Options screen

We recommend you fly the training mission with their default parameters before customizing them with the above options.

PDA: Theater Setup

The Theater Setup window allows you to load one or more of *i*F-22 Raptor's theaters onto your hard drive and lets you specify whether you want the small or large install for each theater. You must have at least one theater installed on your hard drive to play *i*F-22 Raptor. This window contains the following options:

***i*F-22 Drive**—This is the complete file path for *i*F-22 Raptor's location on your hard drive

Free Space—This is the remaining hard drive space on the *i*F-22 drive

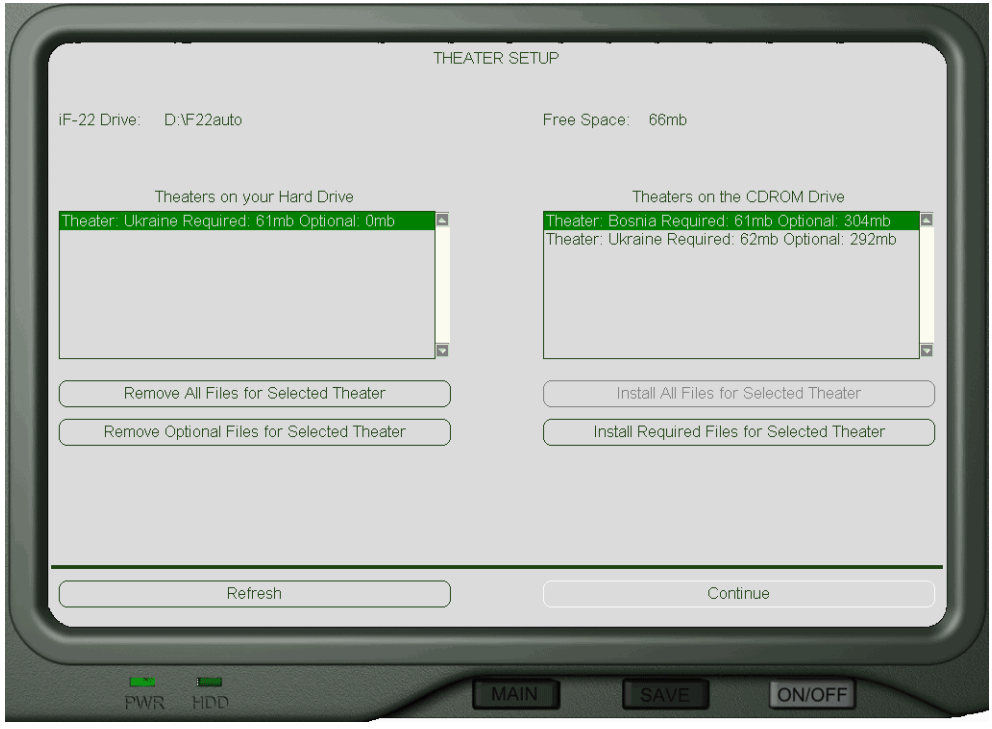
Theaters on the CD-ROM—Specifies the theaters on your current CD-ROM along with their required and optional install sizes; if you change CD-ROMs, you must select the **Refresh** button to display the new theaters

Install Required and Optional Files for Selected Theater—This installs all of the files for the currently selected theater to your hard drive; this option greatly enhances *i*F-22 Raptor's performance

Install Required Files for Selected Theater—This installs only the required files for the currently selected theater to your hard drive; This option saves a lot of hard drive space, but reduces *i*F-22 Raptor's performance

Theaters on your Hard Drive—Lists all of the theaters currently on your hard drive followed by the level of files installed (required only or required and optional)

Remove Required and Optional Files for Selected Theater—Removes all of the files for the currently selected theater from your hard drive; this making the theater unplayable until reinstalled



Remove Optional Files for Selected Theater—This removes only the optional files for the currently selected theater from your hard drive; the means the theater can still be played, but with reduced performance

Refresh—Checks your CD-ROM and hard drive for theater files and updates free space, theaters on CD-ROM, and theaters on hard drive information

Continue—Exits the Theater Setup window and returns you to the Main Options window

PDA: System Setup

The System Setup window lets you customize how *i*F-22 Raptor performs on your computer. It contains the following options:

Preflight Screen Resolution—Sets the preflight or PDA screen resolution.

Flight Screen Resolution—Sets the flight or simulation screen resolution.

Preflight Music Volume—Sets the volume for the preflight music.

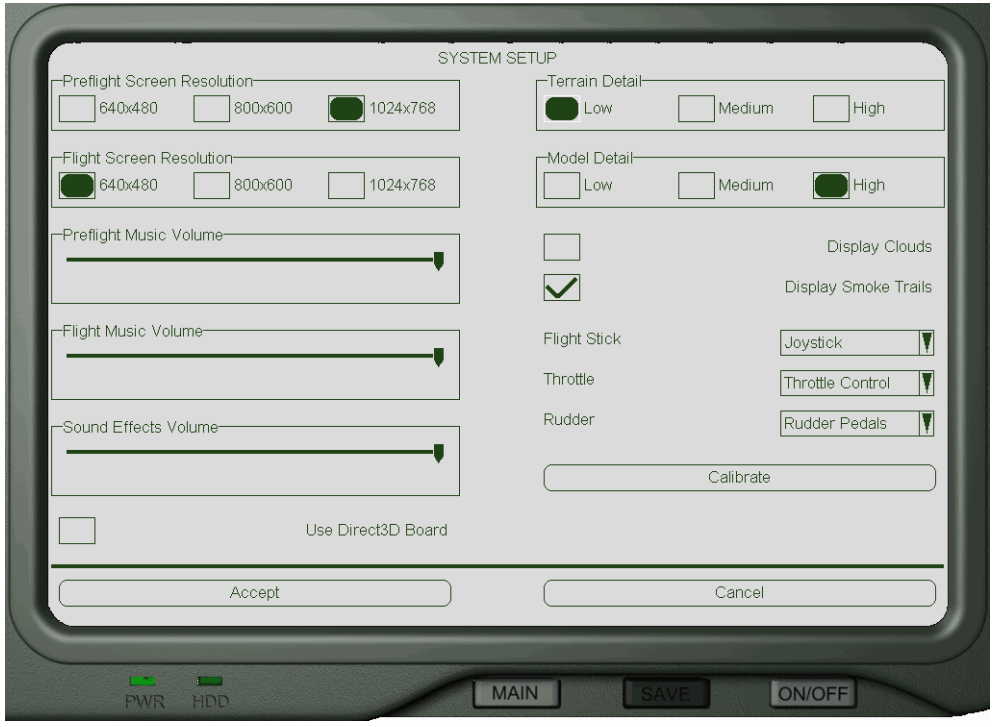
Flight Music Volume—Sets the volume for the flight music.

Sound Effects Volume—Sets the volume for sound effects.

Use Direct 3D Board—Allows you to specify and use a Direct 3D board to enhance your machine's performance.

Terrain Detail— Sets the maximum possible terrain texture detail allowed within the game.

Model Detail—Sets the maximum possible model resolution allowed within the game.



Display Clouds—Allows clouds to be displayed during flight.

Display Smoke Trails—Allows smoke trails to be displayed during flight.

Flight Stick—Lets you select a control device to act as the flight stick: joystick, keyboard, or keyboard autocentering (AC).

Throttle—Lets you select a control device to act as the throttle: throttle or keyboard.

Rudders—Lets you select a control device to act as the rudders: rudder pedals, keyboard, or keyboard AC.

Calibrate—Takes you to the Calibrate window. Use this function to change a control device to anything other than keyboard or keyboard AC.

Accept—Accepts all changes to this window and returns you to the Main Options window.

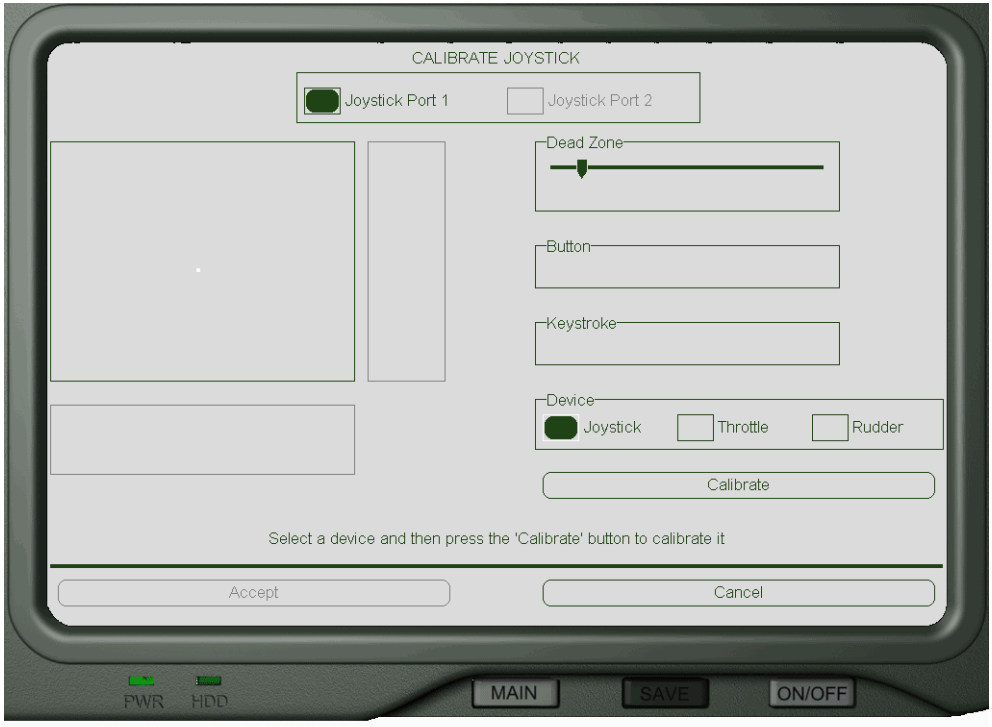
Cancel—Returns you to the Main Options window *without* saving any of your changes.

PDA: Calibrate

The Calibrate window lets you to calibrate your flight controls for optimum performance. It contains the following options:

Joystick Port 1—Makes the Windows 95 Joystick Port 1 controls the active control set. You probably won't change this setting, but you will need to recalibrate your controls before playing the game.

Joystick Port 2—Makes the Windows 95 Joystick Port 2 controls the active control set. You probably won't use this setting.



Dead Zone—Lets you set the dead zone for the current control device. If the bar or dot for a device is "jumpy" after you calibrate it, increase the dead zone until it stops moving.

Button—Shows you the last button pressed.

Keystroke—Shows you the last keystroke; a useful feature for keyboard-emulating control devices.

Device—Lets you choose the device you want to calibrate (joystick, throttle, or rudder).

Calibrate—Begins the calibration sequence for the currently selected device. Follow the directions at the bottom of the window.

Accept—Accepts all changes to this window and returns you to the System Setup window.

Cancel—Returns you to the System Setup window *without* saving any of your changes.

PDA: Database

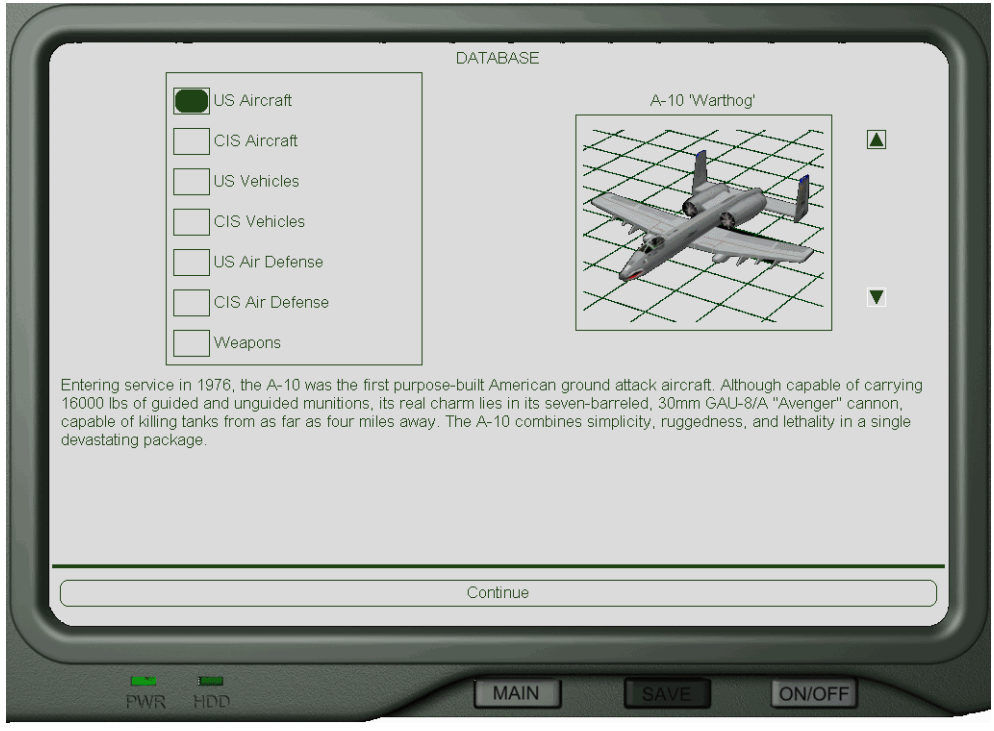
This window allows you to browse some of the models available in *i*F-22 Raptor and to read text descriptions about them. It contains the following options:

Model Type—Lets you choose the category of game models you want to preview.

Model Selector—The up and down arrows on the right side of the currently selected model let you cycle through all models of the selected type.

Description—This is a brief text description of the currently selected model.

Continue—Returns you to the Main Options window.



PDA: Ready Room

The Ready Room window lets you do everything from switching the active pilot to starting a multiplayer session. The window is divided into six areas:

- Pilot Roster
- Pilot Locations
- Location Description
- Active pilot information
- Active pilot picture and squadron emblem
- General buttons

The window contains the following options:

Create Pilot—Displays the Create Pilot window; the default settings are those of the selected pilot in the Pilot Roster list

Edit Pilot—Displays the Edit Pilot window where you can edit the settings for the selected pilot in the Pilot Roster list

Delete Pilot—Deletes the selected pilot in the Pilot Roster list

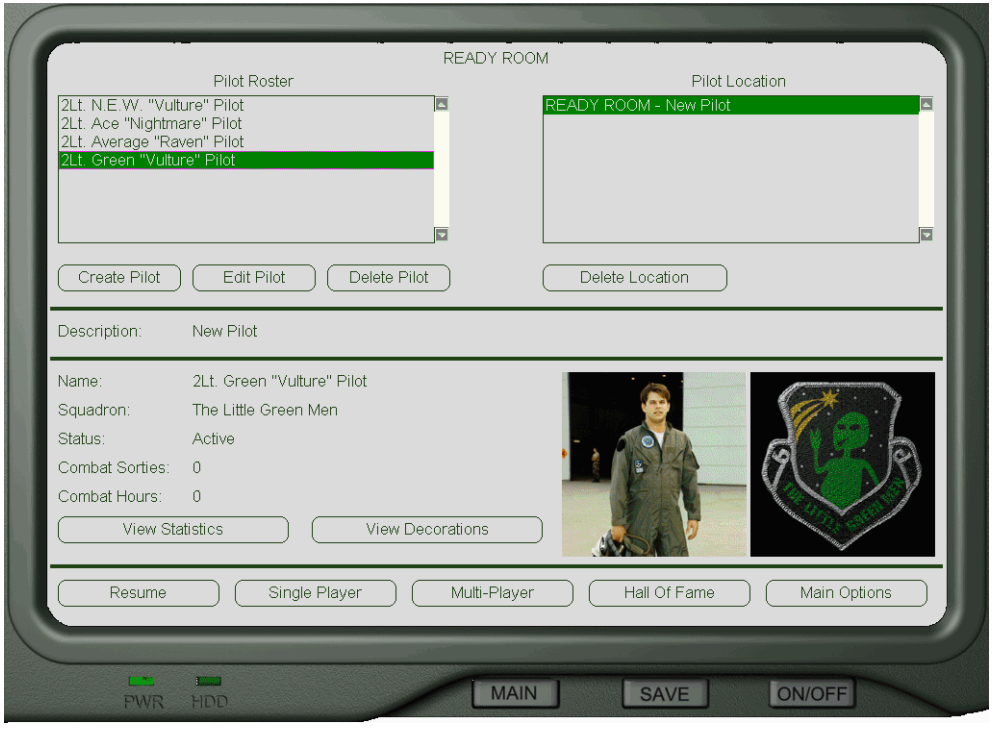
Delete Location—Deletes the selected location in the Pilot Locations list

View Statistics—Displays the View Statistics window for the currently selected pilot in the Pilot Roster list

View Decorations—Displays the View Decorations window for the currently selected pilot in the Pilot Roster list

Resume—Resumes the simulation for the pilot selected in the Pilot Roster list at the selected location

Single Player—Begins a single-player session, which includes single missions, campaigns, and custom missions



Multiplayer—Begins a multiplayer session, which includes dogfights, capture the flag, and cooperative single missions

Hall of Fame—Displays the Hall of Fame window where you can view the top pilots

Main Options—Takes you to the Main Options window

PDA: Create/Edit Pilot

The Create Pilot and Edit Pilot windows are identical. They allow you to create a new pilot or edit an existing pilot. When you press the **Create Pilot** or **Edit Pilot** button on the Ready Room window, the Create/Edit Pilot window is displayed. When you are creating a new pilot, the default settings are identical to the selected pilot in the Pilot Roster, so you can copy the pilot's settings but not his or her career (statistics and decorations). The pilot difficulty or pilot preferences apply to all single and multiplayer sessions, although you can temporarily change them in a multiplayer sessions on the Session Setup window. The Create/Edit Pilot window contains the following options:

Name—Specify a name for your pilot.

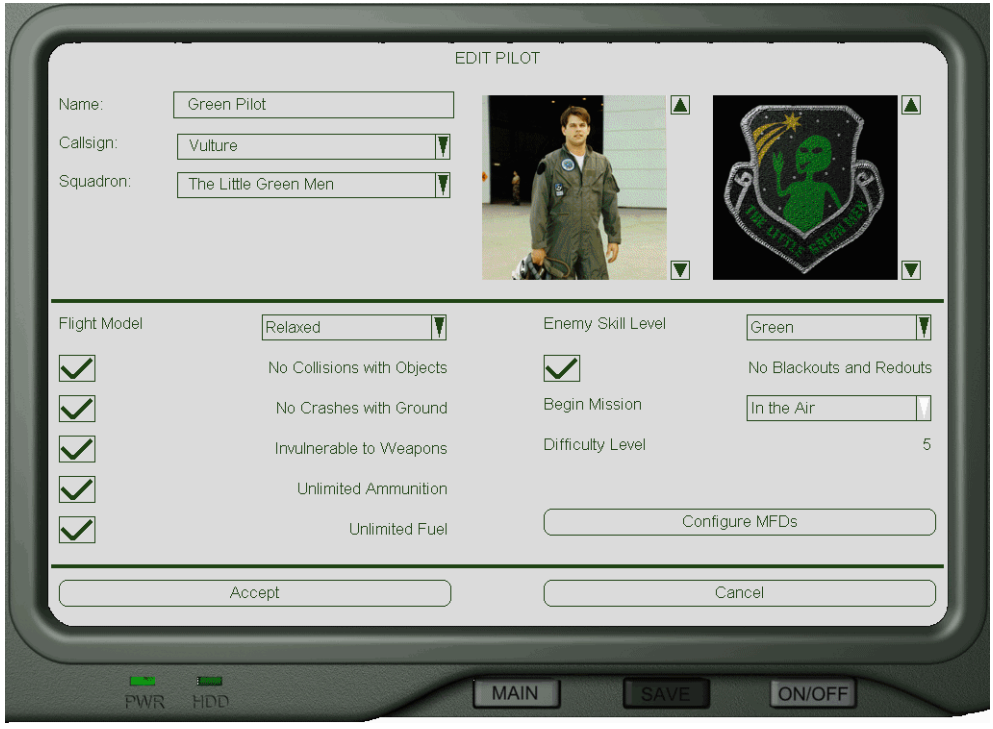
Callsign—Specify a callsign for your pilot.

Squadron—Specify a squadron name for your pilot.

Pilot Picture—Cycle through the available pictures to choose one for your pilot.

Squadron Emblem—Cycle through the available emblems to choose one for your squadron.

Flight Model—Specify the flight model you want to use.



No Collisions with Objects—Turns off collisions between objects other than weapons and the ground.

No Crashes with Ground—Turns off collisions with the ground. Your aircraft will bounce off the ground if you crash.

Invulnerable to Weapons—Makes it impossible to damage your F-22.

Unlimited Ammunition—Gives your F-22 unlimited ammunition.

Unlimited Fuel—Gives your F-22 unlimited fuel.

Enemy Skill Level—Specify the enemy skill level.

No Blackouts or Redouts—Prevents you from suffering a blackout or redout when performing severe maneuvers. In addition, you will not suffer from whiteouts when looking at or toward the sun.

Difficulty Level—Sets the difficulty of the single-player portion of the simulation—single mission, campaign, and custom mission—based on your current settings; 100 percent is the hardest and 0 percent the easiest.

Configure MFDs—Displays the Configure MFDs window, where you can define custom MFD configurations.

Accept—Accepts all changes to this window and returns you to the Ready Room window.

Cancel—Returns you to the Ready Room window *without* saving any of your changes.

PDA: Configure MFDs

This window allows you to customize the MFD configuration sets. MFD configuration sets allow you to change the modes in your four MFDs to a predefined sets of MFD modes based on different actions such as landing or dogfighting. This window contains the following options:

MFD Set—Specifies the MFD set you want to edit

Cockpit graphic—Displayed in the MFDs within this graphic are the MFD modes specific to the currently selected MFD set. To change a MFD to a different MFD mode simply click in the MFD. While your cursor is over a MFD the name of the corresponding MFD mode is displayed under the MFD Set area.

Accept—Saves your MFD sets and returns you to the Create/Edit Pilot window

Cancel—Returns you to the Create/Edit Pilot window without saving any of your changes


CONFIGURE MFDS
Combat Modes
Status Modes
Navigation Modes
Dogfight Modes
Landing Modes
Accept
Cancel
PWR
HDD
MAIN
SAVE
ON/OFF

PDA: Pilot Statistics

The Pilot Statistics window displays a list of statistics for the selected pilot in the Pilot Roster list or for the Hall of Fame pilot that you selected. You cannot edit the pilot statistics and pictures. This window contains the following options:

View Decorations—Displays the Pilot Decorations window

Hall of Fame—Displays the Hall of Fame window

Ready Room—Displays the Ready Room

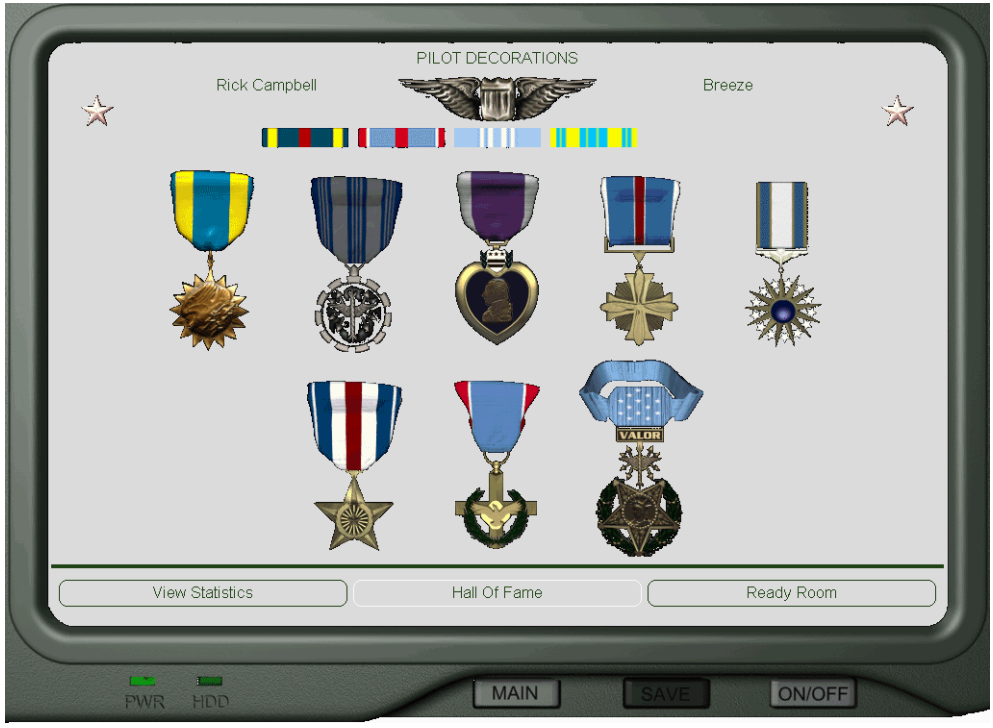
PDA: Pilot Decorations

The Pilot Decorations window displays the decorations (rank and awards) held by the pilot selected in the Pilot Roster or the Hall of Fame pilot that you double-clicked. You can view more information on a given decoration by clicking on it. The Pilot Decorations window contains the following options:

View Statistics—Displays the Pilot Statistics window

Hall of Fame—Displays the Hall of Fame window

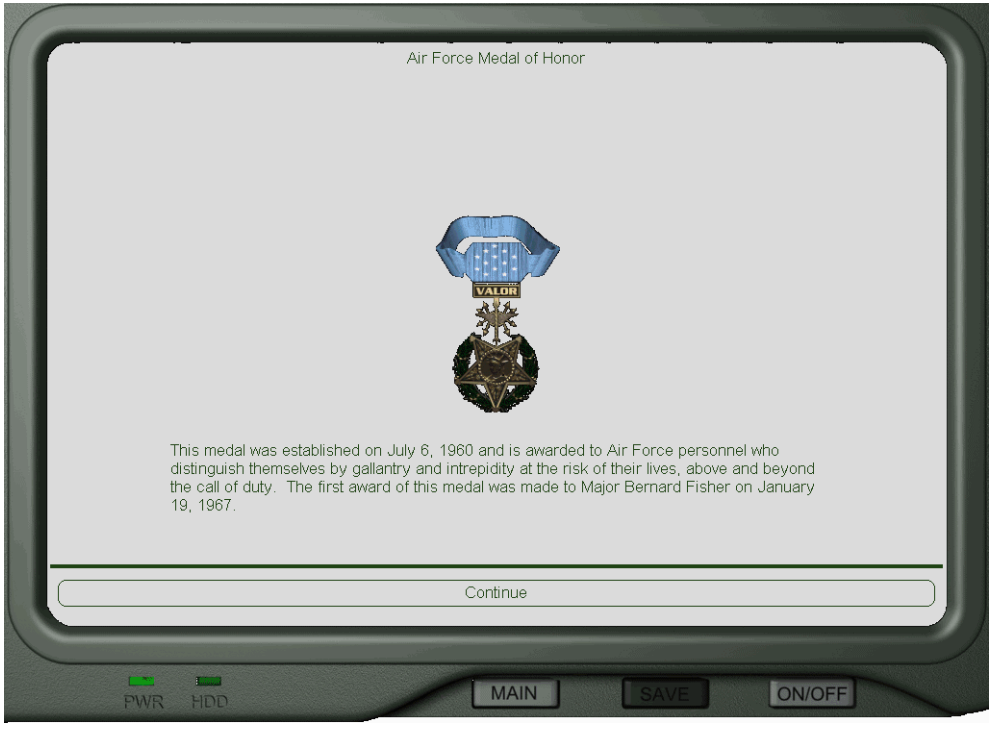
Ready Room—Displays the Ready Room



PDA: Individual Decoration

This window is a view-only window that displays information about an individual rank or award, including its name, picture, and historical description (if available). To display this window, select a rank or award by clicking on it in the Pilot Decorations window. There is only one option on this window:

Continue—Displays the Pilot Decorations window



PDA: Hall of Fame

The Hall of Fame window has two modes: overall and mission. The overall mode looks at the top ten pilots in terms of their overall careers. Overall careers include all of the missions that the pilot has flown including single missions and campaigns. The top ten mission pilots are only considered for the mission rating of their best mission. To view the statistics of any pilot in the Hall of Fame, select the pilot's plaque by clicking on it. The Hall or Fame contains the following options:

Reset—This option resets both Hall of Fame windows with the original sets of ten pilots that were shipped with *i*F-22 Raptor.

Continue—Takes you to the previous PDA screen.

PDA: Theater Selection

This window lets you select a theater or terrain set for your single mission or campaign. There are two terrain sets in *i*F-22 Raptor: Bosnia and Ukraine. One of these terrain sets is always selected by default. After you select your theater, you select either Single Mission or Campaign. You can also close theater selection by selecting Ready Room. The Theater Selection window contains the following options:

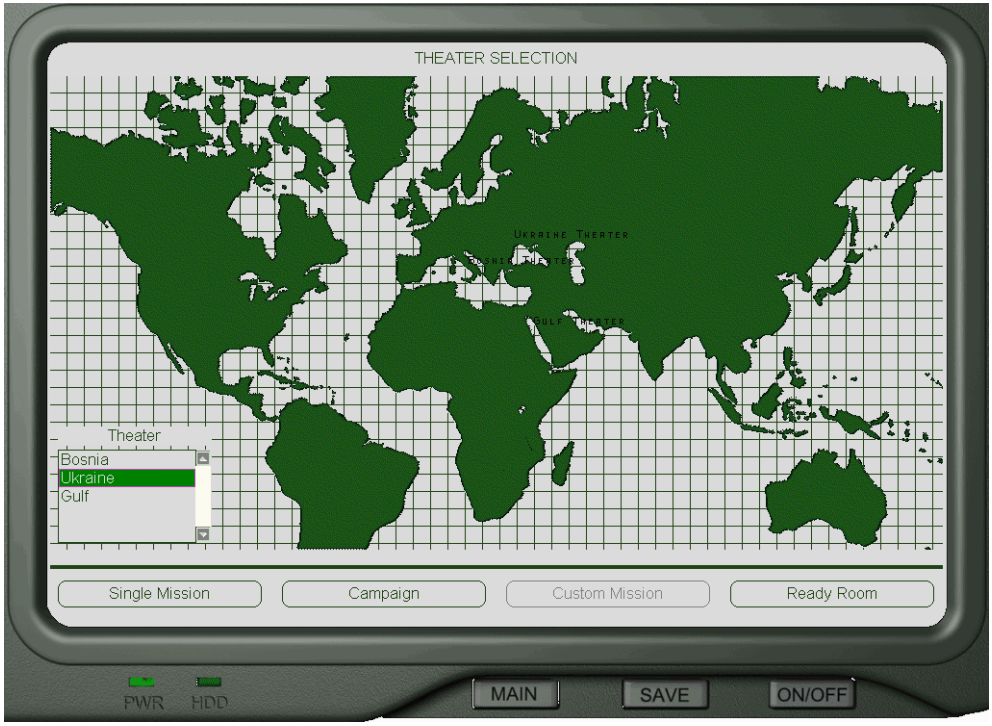
Theater list—Select the theater in which you want to fly.

Single Mission—Begins a single mission and displays the Mission Selection window.

Campaign—Begins a campaign and displays the Campaign Update window.

Custom Mission—Begins a custom mission session and displays the Mission Selection window.

Ready Room—Closes the Theater Selection window and displays the Ready Room.



PDA: Campaign Update

When you start a campaign or after you complete a campaign mission debriefing, the Campaign Update window is displayed. This window has three different pages: Campaign Overview, Campaign Briefing, and Campaign Map. When you start a new campaign, this window defaults to the Campaign Overview page. This page gives a general background for the campaign and tells you how your squadron got involved. It also gives you the overall campaign objectives, with which you can judge your progress.

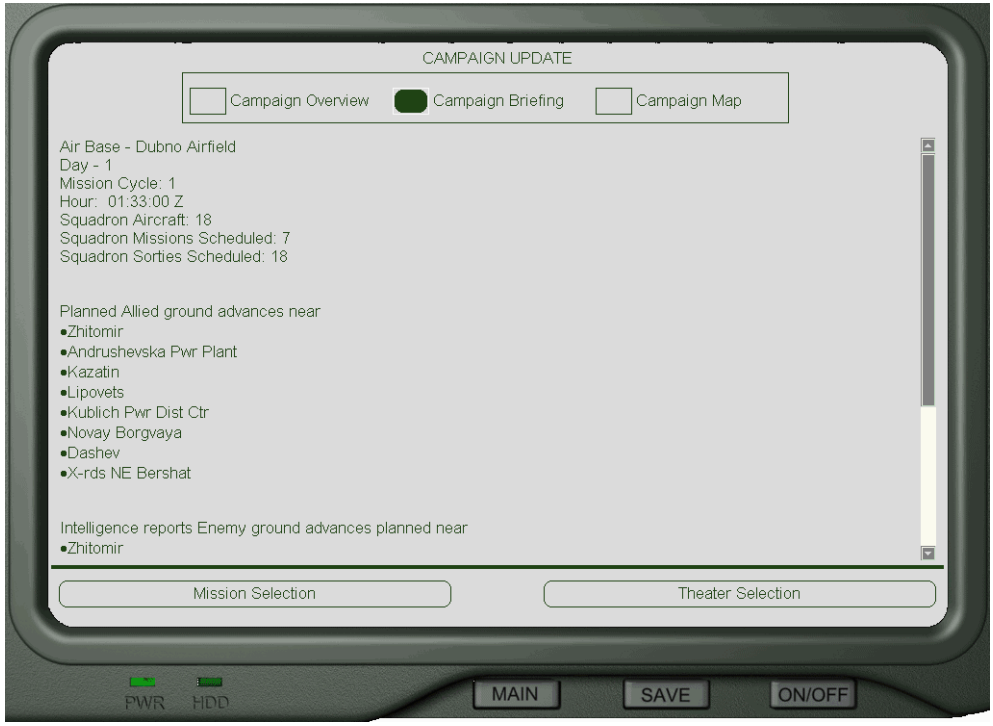
The second page is the Campaign Briefing page. It gives you squadron-specific information, such as the number of squadron aircraft remaining and how many mission and sorties are scheduled. In addition, this page lists the planned friendly and enemy ground advances for the current campaign cycle (turn). You can use this information later to select a mission that takes you where the action is.

The final page is the Campaign Map page, which is dominated by a map of the campaign area. The front line is displayed as a solid line with a series of icons that indicate where ground offensives are planned. To help you judge the progression of the ground war, the previous front line is displayed as a dashed line.

The Campaign Update window contains the following options:

Mission Selection— Displays the Mission Selection window.

Theater Selection—Cancels your session and displays the Theater Selection window.



PDA: Mission Selection

The Mission Selection window is divided into three areas: Missions (left), Mission Briefing (right), and general buttons. When running a custom mission session, the Mission Set option above the Missions area lets you select a custom mission set. During all other sessions, this option is locked to Generated Missions. Generated Missions are missions that were randomly generated for this cycle by the mission generation system. Custom Missions are individual missions that were previously saved by you or another player (see "Saving mission sets to Custom Mission List" on page 12). To select a mission, click on it in the Missions area.

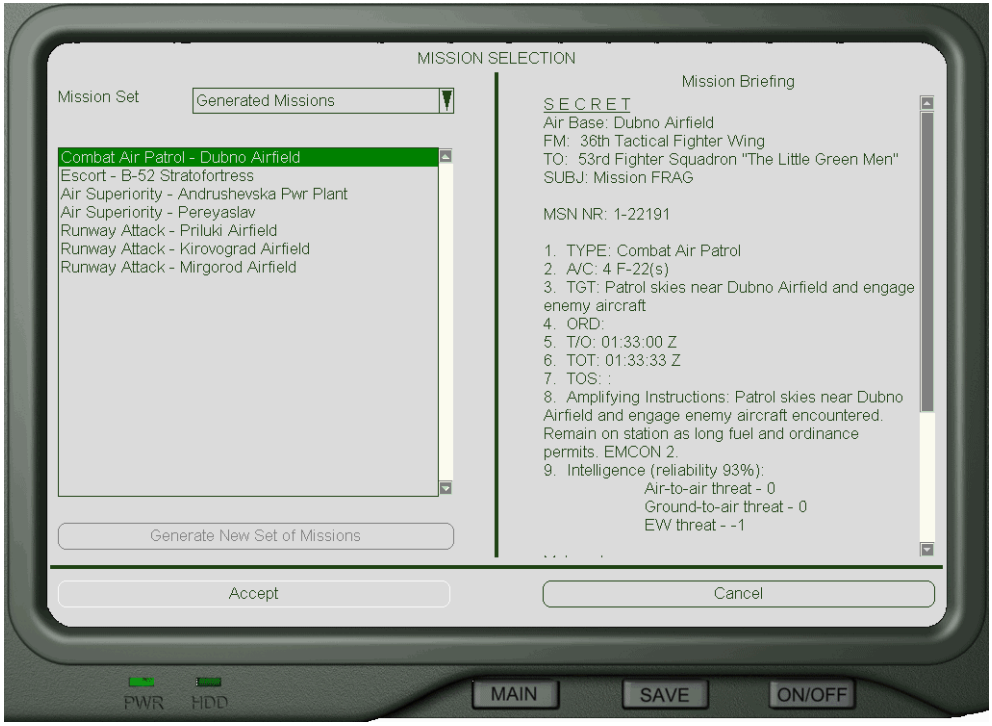
The Mission Briefing area displays the briefing for the missions that is selected in the Missions area. The mission briefing includes the objective, number of aircraft, timing information, aircraft electronic emission control suggestions, and climatology/meteorology data.

The Mission Selection window contains the following options:

Mission Set—Displays available mission sets for current session type. If you are running a custom mission session, use this option to select a mission set.

Missions Window—Displays a list of all the missions related to the current mission set. Select a mission by clicking on it.

Generate New Set of Missions—Prepares a new set of Generated Missions for single mission sessions only. This option is not available for campaigns and custom missions.



Accept Mission—Takes you to the Mission Planning window.

Cancel Mission—Closes the Mission Selection window and displays the Theater Selection window for single missions, the Network Setup window for multiplayer cooperative single missions, or the Campaign Update window for campaign missions.

Mission types

There are 11 types of missions in *i*F-22 Raptor: Close Air Support (CAS), Battlefield Air Interdiction (BAI), Ground Strike, Deep Strike, Runway Attack, Airfield Attack, Combat Air Patrol (CAP), Air Superiority, Escort, Suppression of Enemy Air Defenses (SEAD), and Scramble. Brief descriptions of each mission type and their objectives follow:

CAS—CAS missions are air-to-ground missions supporting front-line troops. Some possible mission objectives are to destroy front-line enemy units such as tanks, infantry fighting vehicles, etc.

A FAC is always available for this mission type. You may use laser-guided munitions such as the Paveway GBU-12B, 16B, 24A, and 24A/B bombs (see "Laser designator" on page 60).

BAI—BAI missions are air-to-ground missions supporting front-line troops by destroying rear area reinforcements and supplies. Some possible mission objectives are to destroy rear area vehicles, supplies, and command centers.

Ground Strike—Ground Strike missions are air-to-ground missions behind enemy lines that are targeted on medium-to-high value enemy units and structures. Some possible mission objectives are to destroy key enemy-held features such as factories, early warning radar stations, and ammo/fuel dumps.

Deep Strike—Deep Strike missions are air-to-ground missions far behind enemy lines that are targeted on medium-to-high value enemy units and structures. Some possible mission objectives are to destroy key enemy held features, including factories, early warning radar stations, and ammo/fuel dumps.

Runway Attack—Runway Attack missions are air-to-ground missions against enemy runways and hardened hangers. This mission requires GBU-31A/B penetration bombs to destroy the targets.

Airfield Attack—Airfield Attack missions are air-to-ground missions against enemy airfield buildings, including control towers. Unlike Runway Attack, this mission does not require special munitions to destroy the targets.

CAP—CAP missions are air-to-air missions during which you patrol an area of friendly airspace and engage all enemy aircraft encountered.

Air Superiority—Air Superiority missions are air-to-air missions during which you patrol an area of enemy airspace and engage all enemy aircraft encountered.

Escort—Escort missions are air-to-air missions during which you protect a flight of friendly aircraft against all enemy aircraft encountered. The flight you are escorting depends on you to protect them from all air-to-air threats.

SEAD—SEAD missions are air-to-ground missions during which you destroy all surface-to-air missile (SAM) and anti-aircraft artillery (AAA) units encountered. Not far behind you is a flight of friendly aircraft, which are depending on you to destroy the ground-to-air threats in their path.

Scramble—Scramble missions are spontaneous air-to-air missions during which your sole objective is to protect your airbase or other

nearby friendly position from invading enemy aircraft.

Mission briefings

Mission briefing description and abbreviations are as follows:

FM: From *message sender.*

TO: To *message recipient.*

SUBJ: Subject.

MSN NR: Mission number.

Type: Mission type.

AIRCRAFT: Aircraft, number, and type of mission aircraft.

TGT: Target.

ORD: Ordinance, default aircraft payload.

T/O: Takeoff time.

TOT: Time on target—the game time you should be at the target; try not to arrive early or late at your targetbecause others are depending on you.

TOS: Time on station—tells you if you need to stay over the target area for an extended period of time by displaying "As Fuel/Ord (ordinance) Permits."

Amplifying Instructions: Other mission details including Emission Controls (EMCON). EMCON is defined as:

EMCON 1: *Radio*—No restrictions; *Radar*—No restrictions; *IFF/IFDL*—No restrictions

EMCON 2: *Radio*—No restrictions at airfield, minimize airborne; *Radar*—Intermittent search outside target area, no restrictions over target; *IFF/IFDL*—No restrictions

EMCON 3: *Radio*—Minimize at airfield, emergency only airborne; *Radar*—Restricted, use over target only; *IFF/IFDL*—Minimize

EMCON 4: *Radio*—Restricted; *Radar*—Restricted, use over target only; *IFF/IFDL*—Restricted, receive only

NOTE: IFF stands for Identify Friend or Foe; IFDL stands for In Flight Data Link.

Intelligence (reliability #%): The quality of the mission intelligence (the reliability of enemy-related information—and of computer-generated waypoints based on known enemy positions) and the anticipated threat levels your F-22 will encounter from air-to-air, ground-to-air, and electronic warfare (EW) threats. Electronic warfare threats are defined as the number of radar or Infrared Search and Track (IRST) units you are expected to encounter. These units are considered a threat because the F-22 relies heavily on stealth.

Ceiling: Height of the lowest cloud layer and its thickness.

Visibility: Average distance to the view horizon in nautical miles.

Wind Speed: Wind speed in knots (nautical miles per hour).

Wind Direction: Wind direction in degrees from north.

Start Twilight: Time that nighttime ends, and nighttime to daytime transition begins.

Sunrise: Time that daytime begins.

Sunset: Time that daytime ends, and daytime to nighttime transition begins.

End Twilight: Time that nighttime begins.

PDA: Mission Planning

The Mission Planning window provides detailed mission information and lets you change your mission plan. This window is divided into four parts: current mission line at top (including mission buttons), mission map in center, map tools around the mission map, and window buttons at bottom.

Current mission line

The mission line displays all pertinent mission information for the primary and, if attached, the escort mission. You are always assigned to either the primary or escort mission. If you are assigned to the primary mission, the following choices are available on the mission line:

Primary: # button—Displays the Mission Aircraft window, where you can add aircraft (if available) or remove aircraft from your flight (see below)

Primary: Payload button—Displays the Payload window, where you can alter the loadouts of aircraft in your flight (see below)

Primary: Waypoints button—Displays the Waypoints window, where you can alter your mission waypoints (see below)

Escort :# button—Displays the Mission Aircraft window, where you can add aircraft (if available) or remove aircraft from the attached escort flight (see below)

If you are assigned to the escort mission, the following choices are available on the mission line:

Escort: # button—Displays the Mission Aircraft window, where you can add aircraft (if

available) or remove aircraft from your flight (see below)

Escort: Payload button—Displays the Payload window, where you can alter the loadouts of the aircraft in your flight (see below)

Mission Aircraft window

The Mission Aircraft window contains two lists of aircraft: a list of aircraft assigned to this mission (left) and a list of available or unassigned aircraft that you can add to the mission (right). This window has the following options:

Remove button—Removes the bottom aircraft from the Assigned aircraft list and adds it to the bottom of the Unassigned aircraft list

Add button—Removes the bottom aircraft from the Unassigned aircraft list and adds it to the bottom of the Assigned aircraft list

Accept—Saves changes and closes the Mission Aircraft window, returning you to the Mission Planning window

Cancel—Deletes changes and closes the Mission Aircraft window, returning you to the Mission Planning window

Payload window

The Payload window allows you to set the payloads of each aircraft in your flight. It has the following options:

Aircraft—This option in the upper left corner of this window lets you pick which aircraft you want to edit.

Suggested Fuel—Estimated amount of fuel required to complete mission.

Fuel—Add or remove fuel from the selected aircraft. The less fuel you take, the lighter and more maneuverable the aircraft is, but make sure you take enough fuel to make it home. This value cannot drop below the Suggested Fuel value.

Weapons—Weight in pounds of all weapons currently on the aircraft.

Margin—Remaining weight that can be carried on the aircraft.

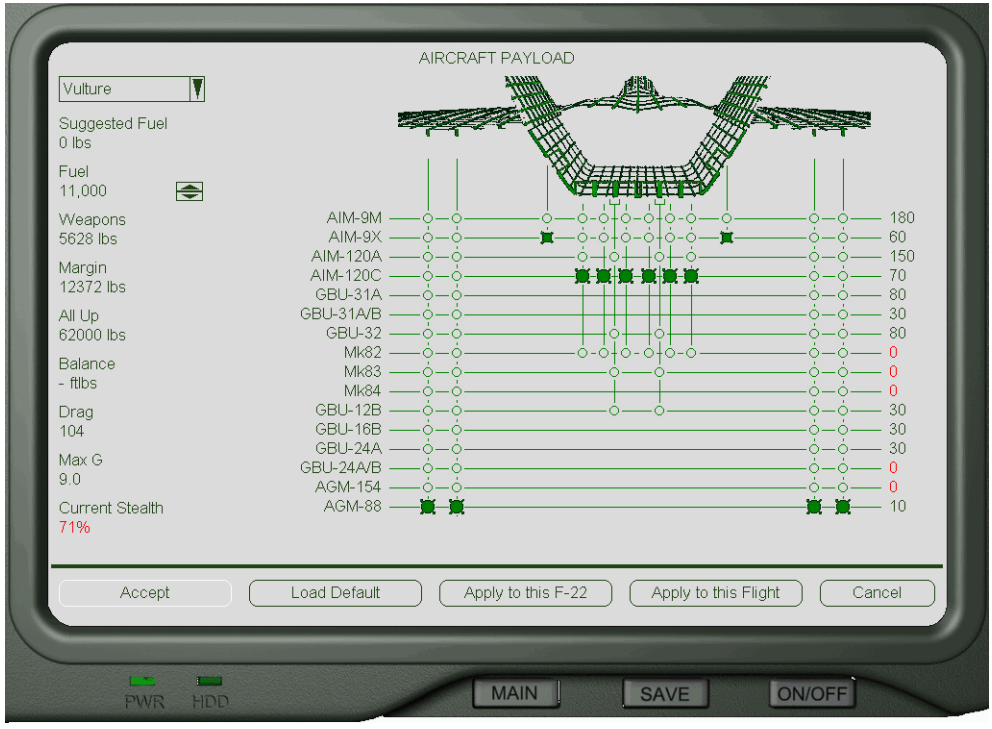
All Up—Maximum possible weight of the aircraft.

Balance—This is the weight balance of the aircraft. If it is unbalanced, Right or Left is displayed with the number of foot pounds that must be removed to balance the aircraft. Look at the loadout to ensure that you have the same weapons on each side of the aircraft.

NOTE: Aircraft that are not balanced exhibit strange handling/flying characteristics.

Drag—This is the drag count of the external ordinance on your aircraft.The higher the number, the lower your acceleration, top speed, and maneuverability.

Maximum G—This is the maximum suggested G-load (related directly to aircraft perfor-



mance) of the aircraft with the current payload configuration.

Current Stealth—This is the aircraft stealth rating (100 percent is best) with the current payload configuration.

Hardpoint/Weapon buttons—Click the intersections of weapon lines and hardpoint lines to load the indicated ordinance on the hard point. At the far right of each weapon line is the number of that weapon type remaining in your arsenal.

Accept—Saves changes and closes the Payload window and returns you to the Mission Planning window.

Load Default—Loads the default mission payload on the selected aircraft, erasing its current payload.

Apply to all Aircraft in Flight—Loads the current payload on each aircraft in the flight.

Cancel—Deletes changes and closes the Payload window, returning you to the Mission Planning window.

Waypoint window

The Waypoint window allows you to review and edit waypoint information for your current mission. It has the following options:

ID—Step through the mission waypoints.

Zone—This is the UTM Zone of the currently selected waypoint. It is editable for navigation and patrol waypoints only.

X—This is the UTM X coordinate in meters for the currently selected waypoint. It is editable for navigation and patrol waypoints only.

Y—This is the UTM Y coordinate in meters for the currently selected waypoint. It is editable for navigation and patrol waypoints only.

Action—This is the desired action for the currently selected waypoint. It is editable for navigation and patrol waypoints only.

Formation—This is the formation used from the currently selected waypoint to the next waypoint.

Altitude—This is the barometric altitude (altitude above mean sea level or MSL) used from the currently selected waypoint to the next waypoint.

Speed—This is the speed used from the currently selected waypoint to the next waypoint.

Accept—Saves changes, closes the Waypoint window, and returns you to the Mission Planning window.

Load Default—Loads the default mission waypoints, erasing the current waypoints.

Insert Waypoint—Creates a new Navigation waypoint with the same altitude, speed, and formation as the current waypoint, located half way between the current waypoint and the next waypoint.

Delete Waypoint—Deletes the current waypoint. This option is only available for Navigation and Patrol waypoints.

Cancel—Deletes changes, closes the Waypoints window, and returns you to the Mission Planning window.

NOTE: In addition to moving waypoints by manually entering coordinates, you can click

and drag navigation and patrol waypoints on the mission planning map.

Waypoints

Waypoints are points along your mission flight path that correspond to changes of direction and possibly in your activity, which includes speed, altitude, and current mission task (for example, prepare to bomb target, bomb target, patrol, navigate, etc.). Mission waypoints include the following points:

Start (S) —Each mission begins with your aircraft at the start waypoint. Take off and fly toward your next waypoint.

Navigation (N) —Navigation waypoints indicate changes of direction, altitude, and speed and indicate that you should *not* engage enemies unless forced to do so.

Patrol (P) —Patrol waypoints indicate changes of direction, altitude, and speed and indicate that you can engage "targets of opportunity" along your waypoint path.

Initial Point (IP) —The initial point is the waypoint at which you begin a bombing run on your ground mission target. You should switch your systems to modes that let you perform ground attacks and begin scanning for your mission targets.

Target (T) —The target waypoint lies directly over your mission target for air-to-ground missions.

Rendezvous (R) —The rendezvous waypoint is only available for escort missions and corresponds to the point at which you meet the flight you are escorting. Be sure you make it to this point on time, or you'll miss the flight you are supposed to escort because it won't wait for you; the flight has a mission of its own.

CAP (C) —The CAP waypoint is the point from which you begin patrolling between the CAP1 and CAP2 points and engaging all enemy aircraft encountered. Fly between CAP1 and CAP2 as long as fuel and ord (ordinance) permit and defend the area from all enemy aircraft.

CAP1 (C1) —CAP1 is the first leg of the CAP circuit. From here, fly to the CAP2 point to continue the CAP circuit as long as fuel and ord (ordinance) permit, at which point you should fly to the next waypoint after CAP2.

CAP2 (C2) —CAP2 is the second leg of the CAP circuit. From here fly to the CAP1 point to continue the CAP circuit as long as fuel and ordinance permit, at which point you should fly to the next waypoint after CAP2.

Landing (L) —The landing waypoint is always the last mission waypoint and is located roughly over the center of your airfield. When you're within about 20 miles of your landing waypoint activate your ILS (/ key), and your waypoint list is replaced by four landing points:

Navigation (N) —Placed directly under your aircraft, a Navigation point is the starting point for the landing process (see "Taking off and landing" on page 92).

Outer Marker (OM) —An outer marker point is approximately 10 miles from the Touchdown Point (TP) and is lined up with the runway.

Middle Marker (OM) —The inner marker point is approximately five miles from the touchdown point (TP) and is lined up with the runway. It also indicates the points at which you should start your descent.

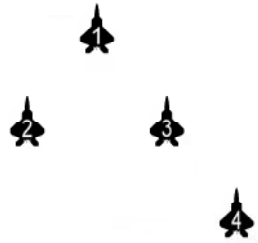
Touchdown Point (TP) —The touchdown point is the point at which you land your aircraft on the runway.

Aircraft formations

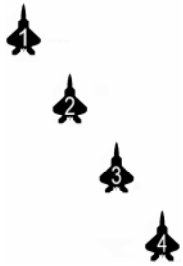
All aircraft in *i*F-22 Raptor, including you and your flight, operate in formations. A formation is a layout of aircraft positions relative to the flight leader that allows multiple aircraft to operate together with a high degree of order. Each formation has strengths and weaknesses and is only appropriate in certain situations. The following subsections explain the available formations in *i*F-22 Raptor.

Normal formations

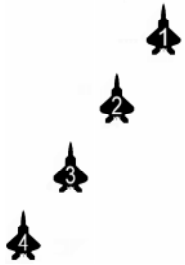
Normal formations are "casual" or lazy formations that can be used at almost any point in a flight.



Wedge formation



Echelon Right formation



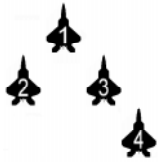
Echelon Left formation

Trail formation
This formation is always used during approach and landing procedures.

Fighting Wing formation
This formation is a very loose right echelon formation.

Radar-Defeating formations

The following formations defeat or fool enemy radar by having the aircraft in the flight fly extremely close together so that they appear as a single radar target. Each formation is also oriented in a specific direction—by choosing a formation oriented toward the enemy radar, the first aircraft can effectively "mask" or hide the rest of the formation behind it



Vic formation

Ladder formation

H Stack formation

Mission map

The mission map is a zoomable map of the entire theater of operations, such as the Ukraine. It consists of many small-scale satellite photographs put together to make a single large-scale map. Use the Map Tools and window buttons to manipulate the map and display different mission related features.

Map tools

Map Tools allow you to display many types of mission-specific data on the Mission map. Located above, below, and to the right of the mission map, the tools are as follows:

North Arrow—This arrow designates the orientation of north for the map.

Map Scroll Arrows—These arrows scroll the map in the four cardinal directions. In the center of the arrows is the current zoom level of the map.

Labels—Displays the theater objective names if the objectives icons are turned on.

Objectives—Displays the theater objective icons on the map: blue are held by friendly forces, green are contested or neutral, and red are held by enemy forces.

FEBA—Displays the Forward Edge of the Battle Area (FEBA) or front line on the map: blue is friendly side, and red is enemy side.

Airfields—Displays the airfield icons on the map: blue is friendly, green is contested or neutral, and red is enemy.

Flight WP—Displays your flight's mission waypoints on the map and labels them according to their ID numbers; squares are initial points or bomb run points, triangles are target points, and stars represent all other waypoint types.

Other WP—Displays attached flight's mission waypoints (if available) on the map and labels them alphabetically according to their ID numbers (A = 1, B = 2, etc.); squares are initial points or bomb run points, triangles are target points, and stars represent all other waypoint types.

Alt—The above ground level (AGL) altitude at which SAM, AAA, and EWR ranges are displayed. Because every ground-to-air system has a range, you can minimize their detection ranges of you by increasing your altitude. For short-range systems, you can even eliminate their detection range altogether by flying above their maximum range. We suggest that you set this to 30,000 ft. or above—at that level, most short- and medium-range SAMs are unable to detect your stealthy aircraft.

RCS—The radar cross-section or radar visibility applied to each SAM, AAA, and EWR range. The maximum detection range of all ground-to-air systems assumes a certain RCS, which the F-22 is always far below. Use this tool to represent your RCS or the RCS of aircraft you are escorting to determine the detection ranges of ground-to-air threats you'll encounter. We suggest that you set this to the F-22 with External Stores (F-22 ES) or F-15 setting to allow you to plan for the worse RCS your aircraft can exhibit. The choices are F-22 FS (full stealth), F-22 ES (external stores), F-15, and C-17.

Armor—Displays blue and red armor unit icons on the map.

Inf—Displays blue and red infantry unit icons on the map.

Arty—Displays blue and red artillery unit icons on the map.

AAA—Displays blue and red AAA unit icons on the map.

AAA Rg—Displays blue and red AAA unit ranges on the map.

SAM—Displays blue and red SAM unit icons on the map.

SAM Rg—Displays blue and red SAM unit ranges on the map.

Supp—Displays blue and red support unit icons on the map.

AWACS—Displays blue and red AWACS patrol routes on the map.

CAP—Displays blue and red CAP patrol routes on the map.

EWR Rg—Displays blue and red early warning radar facility ranges on the map.

Window buttons

The window buttons at the bottom of the map perform general map and game functions as follows:

Takeoff—Accepts the current mission plan and begins the mission

Fit Map—Centers the map on your mission waypoints

Zoom In—Zooms the map to 2x resolution

Zoom Out—Unzooms the map to 1x resolution

Grid On/Off—Toggles a 10-kilometer-by-10 kilometer grid overlay on the map

Info On/Off—Toggles the display of the UTM coordinates of your mouse and other information on the chat line

Cancel—Deletes changes and returns you to the Mission Selection window

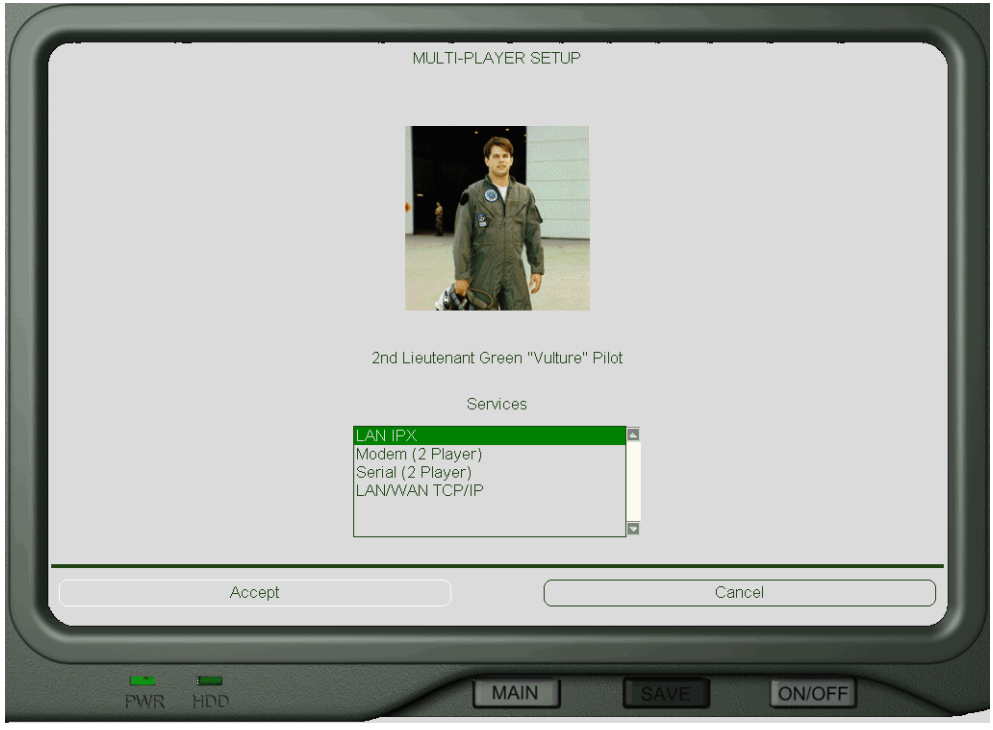
PDA: Multiplayer Setup

When you start a multiplayer session from the Ready Room, the Multiplayer Setup window is displayed. This window lists all possible services or communication options presently available to your computer. The services are presented in the center of the window, with the top service selected. To select another service, click on your choice. The Multiplayer Setup window has the following options:

Services—Select the connection service you want from the **Services** list

Accept—Begin the connection process using the specified connection and appropriate Direct Play connection windows

Cancel—Exit the multiplayer session and return to the Ready Room



PDA: Network Setup

After you have successfully made a multiplayer connection, the Network Setup window is displayed, where you can create a new session or join an existing session. This window has the following options:

Sessions—Lists all of the current *i*F-22 Raptor sessions currently running for the given connection type.

Session Name—Specifies the name of your session if you select the **Create Session** button.

Session Type—Specifies your session type (dogfight, capture the flag, or cooperative) if you select the **Create Session** button.

Number of Players—Specifies the maximum number of players allowed for your session if you choose the **Create Session** button.

Callsign—Specifies your callsign for multiplayer sessions.

Players—Lists the callsigns of the players in the currently selected session.

Search for Callsign—Type another player's callsign here and select the **Search** button.

Search—Searches all sessions on the current connection type for a player using that callsign. If the player is found, the session containing that player is selected in the Sessions list.

Create Session—Creates a new session using the Session Name, Session Type, and Number of Players settings and displays the Session Setup screen.

Refresh—Refreshes the screen and scans the network for new sessions.

Join Session—Joins the currently selected session in the Sessions list and takes you to the Session Setup screen.

Cancel—Exits the Network Setup screen and returns you to the Multiplayer Setup screen.

PDA: Session Setup

There are two ways to reach the Session Setup window: as session creator or as a session participant. To get to this window as a session creator, select the **Create Session** option on the Network Setup window. To be a participant, select the **Join Session** option on the Network Setup window. The options on this window vary according to your status:

Session Name—Specifies the name of session.

Session Type—Specifies the type of session.

Session Creator—Specifies the callsign of the player who created the session.

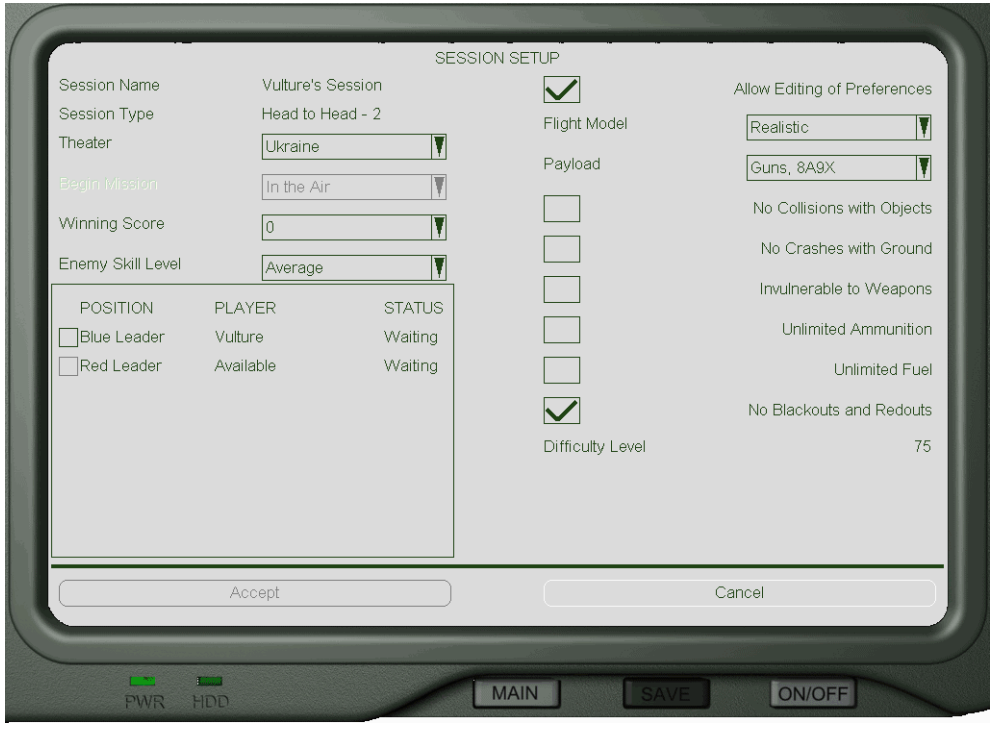
Theater—Specifies the theater or terrain set of the session; available to the session creator only.

Winning Score— This option is available for Dogfight sessions and specifies the number of kills one player must get in order to win the game and end the session; available to the session creator only.

Enemy Difficulty Level—Specifies the enemy skill level for the session; available to the session creator only.

Player List—Each player has access only to his own status:

Position— This is the allegiance of the player and his position relative to everyone



on his side, such as Blue Leader and Blue Wingman 2.

Player— This is the callsign of the player currently in this position.

Status— This is the status of this player, Ready or Waiting, which can be changed by clicking in the box to the left of the player's position.

Allow Editing of Preferences—Available to the session creator only, this option lets the session creator "lock down" the following preferences for every player in the session or allow each player to set his own settings:

Flight Model—Specifies the flight model you use in this session.

Payload—In Dogfight sessions, this specifies the payload you use in this session.

No Collisions with Objects—Turns off collisions between objects other than weapons and the ground.

No Crashes with Ground—Turns off collisions with the ground. Your aircraft will bounce off the ground if you crash.

Invulnerable to Weapons—Your F-22 cannot be damaged.

Unlimited Ammunition—Gives your F-22 unlimited ammunition.

Unlimited Fuel—Gives your F-22 unlimited fuel.

No Blackouts or Redouts—You will not black out or red out when performing severe maneuvers. In addition, you will not suffer from whiteouts when looking at or toward the sun.

Begin Mission—Shows how the aircraft begins the scenario: in the air or on the runway.

Difficulty Level—This is how hard the multiplayer portion of the simulation—cooperative single mission, head-to-head dogfight, or head-to-head capture the flag—is based on your current settings, with 100 percent being the hardest and 0 percent being the easiest.

Accept— Accept the current options and begins the session; only available if every player has a status of Ready.

Cancel—Cancels the network session if you are the session creator or leaves the current session if you are a session participant, and displays the Network Session window.

PDA: Save

Go to the Save window by selecting the **Save** button while in one of the following windows:

- Ready Room
- Theater Selection
- Campaign Update
- Mission Selection
- Mission Planning
- Debriefing

When you display the Save window, you get information describing the last saved simulation for the current pilot and a number of options for saving your current simulation, a set of generated missions, or both. The last saved simulation, Old Information, is described as follows:

Old Information, Location—Preflight window where pilot was last saved

Old Information, Description—Player-defined description of the last saved simulation

To save your simulation, type a description under New Information that identifies your save state. This description is also used to describe the set of generated missions should you choose to save them. Use the following options to save your simulation:

Save Simulation—Allows you to save the current simulation and update your pilot file.

Save Mission Set— Allows you to save the generated mission set to the custom mission set list on the Mission Selection window. This option does not update your pilot file.

New Information, Location—Preflight window from which you activated the Save window.

New Information, Description—Type in a description for your current save simulation or custom mission setup.

Save Preferences, **Overwrite Last Save**—Overwrites the save file described under Old Information with the current save file.

Save Preferences, **Create New Save**—Creates a new save file.

Save Preferences, **Use More Disk Space (faster load time)**—Creates a save file requiring more disk space, which loads faster than the small file.

Save Preferences, **Use Less Disk Space (slower load time)**—Creates a save file requiring less disk space, which loads slower due to the mission set being regenerated from scratch.

Accept— Save the current simulation with the parameters above and exit the Save window.

Cancel—Exit the Save window without saving.

4 Flight Operations

Aircraft Systems

Flight Controls

You can fly your plane by using any combination of controls on the keyboard, joystick, throttle, and rudder pedals. Here's a list of aircraft controls by control device:

Keyboard

Pitch up	Down arrow
Pitch down	Up arrow
Roll right	Right arrow
Roll left	Left arrow
Rudder right	x
Rudder left	z
10% throttle increase	=
10% throttle decrease	-
Set throttle 10%	1
Set throttle 20%	2
Set throttle 30%	3
Set throttle 40%	4
Set throttle 50%	5
Set throttle 60%	6
Set throttle 70%	7
Set throttle 80%	8
Set throttle 90%	9
Set throttle 100%	0
Afterburner on/off	* key on keypad

Two-Button joystick

Pitch up	Pull back
Pitch down	Push forward
Roll right	Push right
Roll left	Push left
Fire selected weapon	Button 1 (trigger)
Select next weapon	Button 2

Four-Button joystick with hat switch

Pitch up	Pull back
Pitch down	Push forward
Roll right	Push right
Roll left	Push left
Fire gun	Button 1 (trigger)
Fire selected weapon	Button 2
Select next weapon	Button 3
Arm selected weapon	Button 4
Snap view top	Hat up
Snap view rear	Hat down
Snap view right	Hat right
Snap view left	Hat left
Snap view front	Hat center

Programmable joystick

See loading instructions for your joystick located in the Readme.txt file and the joystick function files included with the simulation.

Throttle

Increase throttle	Push forward
Decrease throttle	Pull back

Programmable throttle

See loading instructions for your throttle and the located in the Readme.txt file and the throttle function files included with the simulation.

Rudder pedals

Right rudder	Push right pedal
Left rudder	Push left pedal

Flight Models

To allow both experts and novices to play *i*F-22 Raptor, we have included two flight models: a Relaxed realism model and a Realistic model. *i*F-22 Raptor's realistic flight model presents a state-of-the-art six-degree freedom of motion model. To compensate for the F-22's inherent instability, the flight model includes a three axis digital-flight-control system. Finally, it includes a detailed engine/thrust model incorporating thrust vectoring. The key to flying this flight model is controlling your AoA and not having it control you!

The Relaxed realism flight model is a much simpler model that allows you to concentrate on things other than flying. This flight model includes reduced fuel flows, an automatic AoA limiter that constantly tries to reduce your AoA to 0, and performs almost instantaneous responses to you control inputs. So, if your more interested in blowing things up and looking around than in super-realistic, hardcore flying, this is the flight model for you.

Angle-of-Attack limiter

The F-22 is a highly unstable aircraft with many computer programs and controls to aid the pilot in maintaining control of the aircraft. One of these controls is an angle-of-attack (AoA) limiter. Since *i*F-22 Raptor's realistic flight model simulates the real F-22, you also have an AoA limiter available. Press **Alt-A** to toggle your AoA limiter on and off. While on, your aircraft is limited to a maximum AoA of approximately 12°, and an "L" is displayed after your AoA readout in the HUD (see

"Heads-Up Display" on page 63).Without the AoA limiter, your aircraft is capable of more than 90 degrees AoA, which presents some interesting flying.

Autopilots

Most (if not all) modern aircraft are equipped with an autopilot—a computer program capable of flying the aircraft. The autopilot in *i*F-22 Raptor is a computer pilot that flies your waypoint list at the speeds and altitudes specified by each waypoint (**A** key).

To disengage autopilot, press the **A** key or move any of your flight control devices (joystick, throttle, rudders, or keyboard). The autopilot does not perform any functions other than basic flight of your aircraft. It does not engage enemy aircraft, bomb ground targets, or take evasive maneuvers to avoid enemy missiles.

Accelerated time

To speed though routine portions of missions, activate *i*F-22 Raptor's accelerated time feature. You can accelerate time up to eight times the normal rate by pressing the Tab key from one to four times (1x, 2x, 4x, 8x). Press **Shift-Tab** to decelerate time (8x, 4x, 2x, 1x). To instantly return to normal time (1x acceleration), press **Ctrl-Tab** or the \ key (backslash).

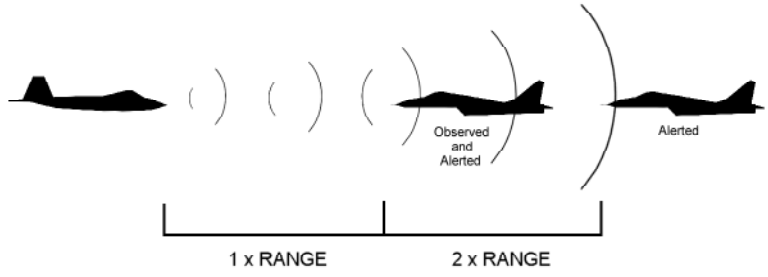
Remember to keep a close eye on your MFDs and HUD while using accelerated time. Events can happen very quickly at 8x normal time. *i*F-22 Raptor automatically switches to normal time when a missile is launched at your aircraft, so you'll have time to take evasive actions.

Sensors

Sensors onboard the F-22 include active and passive radar, an IFDL (In Flight Data Link) system, and an automatic IFF (Identify Friend or Foe) system. It is very important to understand that the MFD radar displays show integrated data from all available data sources. This means that if your active radar is off and your passive radar is destroyed, you may still see objects on your radar-related MFDs—the F-22's avionics package processes sensor data from current air and ground IFDLs. To detect and engage targets, it may not be necessary to have your active radar on and give yourself away to any enemies you scan or "paint."

Active radar

The active radar system projects radar energy from the nose (up to 70 degrees off either side of the nose) of the aircraft and then records the energy that bounces off objects and returns to the F-22. To toggle your active radar on and off, press the **R** key.



The F-22's maximum radar range is 120 miles. Your maximum radar range represents the farthest range at which your radar signal can travel, strike an object, and bounce back to your aircraft with enough energy to be useful. This means that your radar signal can actually hit a target at twice its maximum range with enough energy to alert the target that it has been struck, but it then lacks sufficient energy to return back to your aircraft. Since all aircraft use passive radar sensors to alert them to enemy radars, you should minimize the use of your radar. To decrease your radar's range, press the **[** key (open bracket); to increase it, press the **]** key (close bracket).

The radar on the F-22 is primarily an air search-and-track radar. However, it can distinguish ground objects such as buildings and vehicles up to 25 miles in front of your aircraft.

Finally, your radar-related displays constantly show aircraft and buildings within five miles of your aircraft to simulate that you, the pilot, and all of your wingmen are always searching the skies for targets. Because it's more difficult to do this in a simulator than in the actual aircraft, we have made this adjustment.

Passive radar

Passive radar works not by sending out radar energy but by collecting and processing all radar energy that is directed at the F-22. This system is extremely useful to a stealthy plane because it lets you know when other planes, SAM/AAA sites, and radar sites are looking in your direction with their radar. You can detect radar-emitting objects at twice the distance they can detect you because they have to emit enough enough so that the signal can bounce back to them. Outside their maximum range, you can detect their radar emissions, but they do not get a return signal.

Your passive radar sensors operate constantly unless they are damaged.

IFDL pseudosensor

Your IFDL system can be thought of as both a communications and sensor system. All planes linked by IFDLs share their sensor data. This means that an AWACS IFDL transmits the locations of all friendly and enemy aircraft it can see to the F-22. The AWACS, through direct links to Rivet Joint and JSTARs, also transmits the locations of all ground units and buildings within 25 miles of your F-22. Therefore, your IFDL is probably your most useful sensor for stealth. Because your plane's avionics package integrates sensor data from all sources into one set of data, you can target and get information on objects that your plane couldn't possibly see. For that reason the IFDL is called a pseudosensor.

Laser designator

The F-22 does not have laser targeting capabilities. However, the F-22 can carry laser-guided munitions, such as a GBU-16B Paveway, by using a forward air controller (FAC) to designate the target for the bombs. Without a FAC designating a target, a laser-guided bomb falls exactly like a unguided iron bomb, such as the Mk83. FACs are only available on Close Air Support (CAS) missions, so you should use only laser-guided munitions while flying CAS. To use laser-guided bombs, select a CAS mission on the mission selection screen. Fly within 25 miles of your target, contact the FAC using your UHF radio (**U** key), and let the FAC know that you're in the area and ready to drop your ordinance by requesting an IFDL. After replying, the FAC uses a laser designator to guide your bombs to the targets you specify. All you need to do is drop your bombs so that they can be steered to their intended target, so wait for your "DROP" cue, and let 'em have it!

IFF check

An Identify Friend or Foe (IFF) check is a radar-related signal that goes out to an aircraft that you currently have on a radar display. The signal "interrogates" the target and determines if it is a friend or a foe. Your avionics constantly updates your MFDs with IFF information, but in a heated dogfight, you may not be able to look down at them. For this reason, you can do a manual IFF check on your current target by pressing the **I** key.

If you hear a buzzing sound, your current target is a friendly aircraft. If you hear nothing, then your target is an enemy.

Communications

In *i*F-22 Raptor, there are four types of communications:

UHF—both audio and text are received by everyone on your current frequency (see"UHF" on page 61)

IFDL— stealthy text-only communications are received by everyone currently in your IFDL list (see "IFDL" on page 61 and "IFDL list" on page 62)

Guard channel—audio and text communications are received by everyone in the simulation and that should only be used for general and emergency messages (see "Guard" on page 62)

Chat messages—messages typed by the user that are directed to other players (see "Chat" on page 62)

For a complete list of pre-scripted communications messages, see Appendix C, "Pre-scripted Communication Messages."

UHF

As stated earlier, the recipients of UHF (Ultra High Frequency) communications are frequency-dependent. To initiate a UHF message, first ensure that your radio is on by either looking at the Communications/Navigation MFD Mode or the Com1/UHF Frequency setting on the HUD controller, which should be on (lighted). If your UHF radio is off, press the **Y** key to turn it on. To initiate an UHF message, press the **U** key, the appropriate menu item, or appropriate MFD button and follow the instructions in "Chat line" on page 19. The only recipients available for IFDL messages are those who are on the same UHF frequency as you. Scripted messages transmitted on this channel are audio and text messages, while user-typed messages are text-only.

Frequency

To change the UHF frequency, use the arrows to the right and left of the frequency displayed on the HUD controller. The range for UHF frequency is 225.0 through 400.0.

IFDL

In Flight Data Link (IFDL) is a stealthy communication system that lets the F-22 communicate with everyone in its IFDL list (described in "IFDL list" on page 62). Certain types of information are automatically communicated between everyone in the IFDL list. The main function of the IFDL is to collect and disseminate sensor information such as passive and active radar information, which allows the F-22 to operate in hostile territory without using its own radar and broadcasting its location to everyone in range. The F-22 gathers all information from everyone in the IFDL list and displays it in MFDs as if the F-22 detected it with its own radar.

Another use of IFDL is passive weapons launch. If the F-22 is receiving target information from an AWACS, it can launch an AIM-120 AMRAAM missile, which uses the AWACS radar to track on the target. The result

is the F-22 only breaks its stealth by launching the missile. The AWACS sends target location update data to the missile until it becomes active and uses its own radar to hit the target. The target is usually completely surprised because a missile appears on its tail with little or no warning.

A final use for IFDL is a stealthy text-only communication. To send an IFDL message, press the **K** key or the appropriate MFD button and follow the instructions in the "Chat line" on page 19. The only recipients available for IFDL messages are those with which you have an IFDL link. Scripted and user-typed messages transmitted on this channel are text-only messages.

IFDL list

You can find the IFDL list in the Communication/Navigation MFD Mode. IFDL links are automatically made between your F-22 and your wingmen. To make IFDL links with AWACS and FACs, contact the AWACS or FAC by using UHF or Guard channel and request an IFDL link.

Guard

The Guard channel on your radio is monitored by all friendly aircraft and ground control units within the combat area. This channel is used for general and emergency communications only. To initiate a Guard message, press **Ctrl-G** or the appropriate MFD button and follow the instructions in "Chat line" on page 19. Scripted messages transmitted on this channel are audio and text messages, whereas user-typed messages are text-only.

Chat

Chat messages are user-typed messages that can be sent to other players during a multiplayer simulation session. Only human players understand user-typed messages, so don't try to send them to the computer-controlled wingman. To initiate a chat message, press the ' key (single quote) or appropriate MFD button and follow the instructions in "Chat line" on page 19. Chat messages (and therefore the ' key) are disabled in single-player sessions.

Navigation

*i*F-22 Raptor, like the real F-22, uses waypoints to navigate around the battlefield during missions. Waypoints are points along your mission flight path that correspond to changes of direction and possibly activity, which includes speed, altitude, and current mission task. This section addresses the use of waypoints during flight and landing operations (see "PDA: Mission Planning" on page 43 for detailed descriptions of each waypoint type).

Your primary display for waypoint information is the Tactical MFD mode (see "Tactical mode" on page 75). In this display, you are presented with a graphical representation of your waypoints with lines connecting them that show the exact paths you should fly. The current waypoint (the waypoint you are flying toward) is outlined in white. When you get near your current waypoint, the next waypoint in the list is automatically selected. You can manually step forward through your waypoints by pressing the **O** key or step backward through them by pressing **Shift-O**.

Your mission waypoints are displayed while you are on the ground or in the air, unless you turn your Instrument Landing System (ILS) by using the / key (slash), in which case landing points are displayed.

The Communications/Navigation MFD mode displays a list of your waypoints (mission or landing) and highlights the current waypoint. At the bottom of the display is the recommended altitude in thousands of feet and

speed in knots for this waypoint leg (see "Communications/Navigation mode" on page 81).

Your Heads-Up Display (HUD) Navigation mode (see "Navigation mode" on page 65) displays current waypoint information only. It displays a waypoint "tadpole" that slides right and left to indicate the direction to your current mission waypoint. The tadpole also rotates to indicate the degrees right and left to your current waypoint. While flying toward your target waypoint, the tadpole is replaced by an Azimuth Steering Cue.

Finally, the ILS HUD mode displays waypoints similarly to the Navigation HUD mode, but it also displays ILS "needles" when the ILS system is activated (see "ILS Mode" on page 71). After you line up with the runway, fly the landing points until you reach the middle marker; the ILS needles guide you down to the runway by giving constant altitude and heading corrections. The waypoint tadpole does not work when you are using landing points.

Fuel Consumption

Even with the exceptionally low drag characteristics of the F-22, its two engines, each delivering over 35,000 lbs of thrust, consume fuel. Your aircraft's maximum fuel capacity is 25,000 lbs, which lasts around three hours under normal operating conditions. Since most missions in *i*F-22 Raptor are an hour or less in duration, you won't need a full tank or "bag" of gas to complete them. Therefore you should limit the amount of fuel you take, because the lighter an aircraft is, the more maneuverable it is.

Each mission in *i*F-22 Raptor has a recommended fuel amount on the Mission Planning window under the Payload option. The recommended fuel estimate is prepared by calculating the required fuel to fly your current waypoints at the specified speeds and altitudes, adding 2,000 lbs of fuel for takeoff and landing operations, and then multiplying the total fuel amount by 1.3 to give you extra fuel for fighting. You can manually increase your fuel load, but cannot reduce it below the recommended fuel amount.

Your aircraft burns fuel at around 8,000 lbs per hour at moderate speeds and medium altitudes. As you fly lower and faster (full military power or 100 percent engines without afterburners) the fuel consumption rises to around 12,000 lbs per hour. With afterburners on, you burn fuel at the alarming rate of 36,000 lbs per hour. Needless to say, you should avoid extended use of your afterburners. To help manage your fuel during a mission, your aircraft warns you when you have consumed half of your fuel with an audio and text "Bingo" message.

During missions, you may want to dump your fuel to lighten your load. Press **Ctrl-D** to begin dumping your fuel at a rate of 3,000 lbs per minute. You can stop dumping fuel at any time by pressing **Ctrl-D** again. Fuel dumping automatically ceases when your remaining fuel reaches 2,000 lbs.

Heads-Up Display

The Heads-Up Display (HUD) is a transparent display device that gives a pilot critical information on the status of the aircraft. The HUD is divided into two areas: the HUD controller and the HUD glass or "the HUD." The HUD controller contains buttons and displays that you use constantly, while the HUD glass has a number of modes for different sets of information.

A simple automatic mode-changing routine is built into the HUD. This routine attempts to predict what HUD mode you want based on

key presses and buttons selections and works as follows:

Weapons mode—The HUD automatically changes to Weapons mode when you prepare a shoot list (**S**) or target the object nearest to the center of your HUD (**L**).

Navigation mode—The HUD automatically changes to Navigation mode when you toggle through your waypoint list (**O** or **Shift-O**).

ILS Mode—The HUD automatically changes to ILS mode when you toggle your ILS system on/off (**/** key).

HUD controller

The HUD controller has a number of buttons and one display area:

Soft buttons—Changes the HUD text/graphics color.

Declutter (DC)—Toggle that removes (and returns) a number of nonessential items from the HUD display. See each HUD mode description for specific items that are removed by Declutter.

Weapons Mode (WM)—Changes the HUD to display Weapons mode information. See "Weapons mode" on page 68.

Navigation Mode (NM)—Changes the HUD to display Navigation mode information. See "Navigation mode" on page 65.

ILS Mode (IM)—Changes the HUD to display ILS mode information. See"ILS Mode" on page 71.

IFF Check (IC)—Performs an IFF check on your current target.

Send Com1 (S1)—Initiates a Com1/UHF communication. See "UHF" on page 61.

Send Com2 (S2)—Initiates a Com2/IFDL communication. See "IFDL" on page 61.

Send Guard (SG)—Initiates a Guard communication. See "Guard" on page 62.

Com1 UHF frequency window—Current UHF frequency. See "Frequency" on page 61.

Com1 UHF left arrows—Changes the UHF frequency by +1 (up arrow) and -1 (down arrow). See "Frequency" on page 61.

Com1 UHF right arrows—Changes the UHF frequency by +0.1 (up arrow) and -0.1 (down arrow). See "Frequency" on page 61.

HUD controller

Navigation mode

The Navigation HUD mode displays the following HUD information for flying your aircraft and navigating waypoints:

Heading indicator—Displays the compass heading or direction of travel in degrees.

Pitch Ladder—Displays the pitch angle between the fuselage (tail to nose) of your aircraft and the horizon. The pitch is read as the angle to the right and left of the watermark (see below). The climb and dive angle is read as the angle to the right and left of the flight path marker (see below).

Bank indicator—Displays the roll angle between your wings and the horizon.

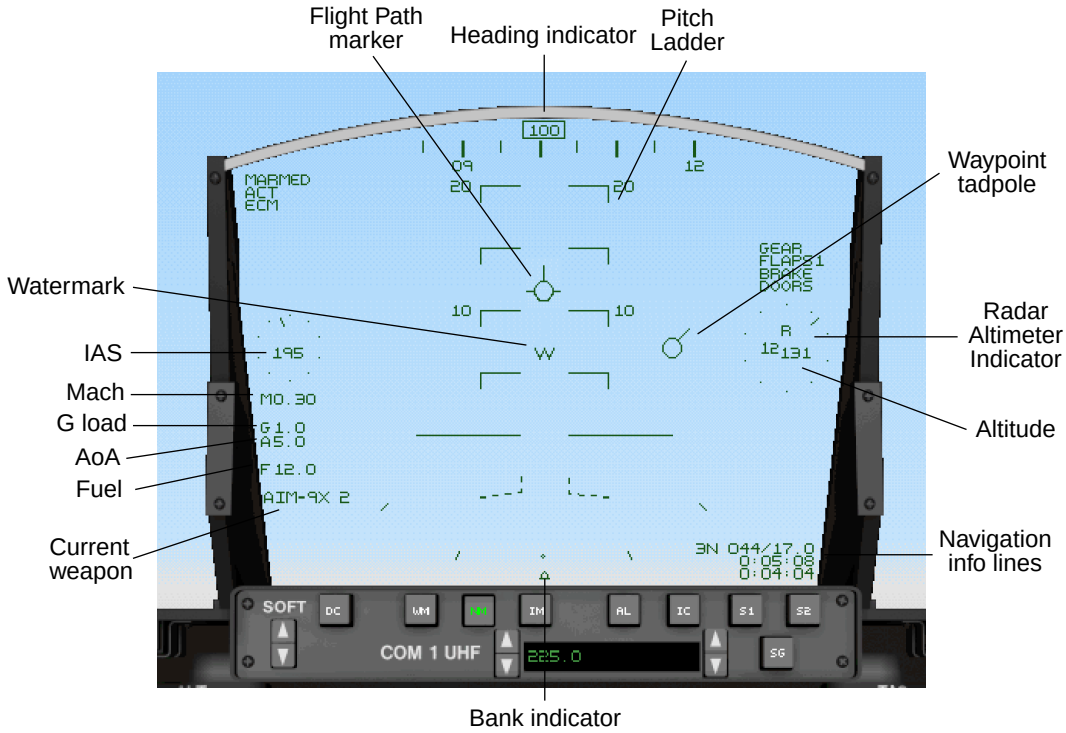
Iron Gun Cross—Displays where your gun rounds hit at a range of 2,250 ft. if you are flying straight and level.

Watermark—Indicates the direction of the nose of your aircraft.

Flight Path marker—Indicates the true direction of flight, which is almost always different from the watermark.

Waypoint tadpole—Displays the direction to your next waypoint. The icon slides right and left parallel to the pitch ladder to indicate course corrections of up to 30 degrees. It also rotates to indicate the actual course correction of up to ±180 degrees.

Azimuth Steering Cue—Replaces the waypoint tadpole while your aircraft heads toward your target waypoint and displays the direction to your target waypoint. It is represented by a line perpendicular to horizon extending the height of the HUD. The line slides right



and left parallel to the pitch ladder to indicate course corrections of up to 30 degrees.

Indicated Air Speed (IAS)—Your current indicated air speed in knots. The circle graphic with a caret shows the indicated air speed tendency (increasing or decreasing).

Mach indicator—Your current indicated air speed as measured against the speed of sound.

G Load indicator— The current G-load of your aircraft.

Angle of Attack (AoA) indicator—The angular difference between the watermark (where your nose is pointed) and the flight path marker (current direction of flight). If you are using the realistic flight model and the AoA limiter is on, an "L" is displayed after the readout.

Remaining fuel—Remaining fuel in thousands of pounds.

Currently selected weapon—Your currently selected weapon and the number of weapons of that type remaining.

Current altitude—Your current barometric altitude in feet (altitude measured from mean sea level). The circle graphic with a caret indicates the altitude tendency (increasing or decreasing). A small R indicates that you are using the radar altimeter that measures your altitude above the ground (this altimeter is not stealthy), and a small L indicates you are using the laser altimeter that measures altitude above the ground (it does not function through clouds).

To change your altimeter press **Shift-A.**

Armed indicator—Indicates that your current weapon is armed. A "MARMED" indicator is displayed in the upper left corner of the HUD if the Master Arm switch is on, which means that all weapons are automatically armed when selected.

Afterburner indicator—Indicates that your afterburners are activated; an "AB" indicator is displayed immediately above the Indicated Air Speed indicator.

Airbrake indicator—Indicates that your airbrake (differential rudder) is activated; a "BRAKE" indicator is displayed immediately above the Altitude indicator.

Wheel Brakes indicator—Indicates that your wheel brakes are engaged; a "WBRAKE" indicator is displayed above the altitude indicator.

Flaps indicator—Indicates that your flaps are extended; a "FLAPS1" or"FLAPS2" indicator is displayed immediately above the Altitude indicator.

Gear indicator—Indicates that your landing gear are extended; a "GEAR" indicator is displayed immediately above the Altitude indicator.

Bay Doors indicator—Indicates that your bay doors are open; a "DOORS" indicator is displayed immediately above the Altitude indicator.

ECM indicator—Indicates that your ECM gear is on; an "ECM" indicator is displayed above the IAS display.

Navigation Information Line 1—Current waypoint number and type:

S	Start
N	Navigation
P	Patrol
IP	Initial Point (Bomb Run)
T	Target
C	CAP
C1	CAP Leg 1
C2	CAP Leg 2

R Rendezvous

L Landing

Landing Points

OM Outer Marker

MM Middle Marker

TP Touchdown Point

Bearing to waypoint in degrees off your nose right (+) and left (-), and three-dimensional distance to waypoint in miles.

Navigation Information Line 2—Time to waypoint in *minutes:seconds*.

Navigation Information Line 3—Difference between actual and scheduled time to target (TOT) in *minutes:seconds*. For best mission results, keep the Estimated TOT value at or near 00:00.

When the HUD Declutter button is selected, the following items disappear from this mode:

- Iron Gun Cross
- G Load indicator
- AoA indicator
- Remaining fuel
- Currently selected weapon
- Armed indicator
- Airbrake indicator
- Flaps indicator
- Gear indicator
- Navigation Information Line 2
- Navigation Information Line 3

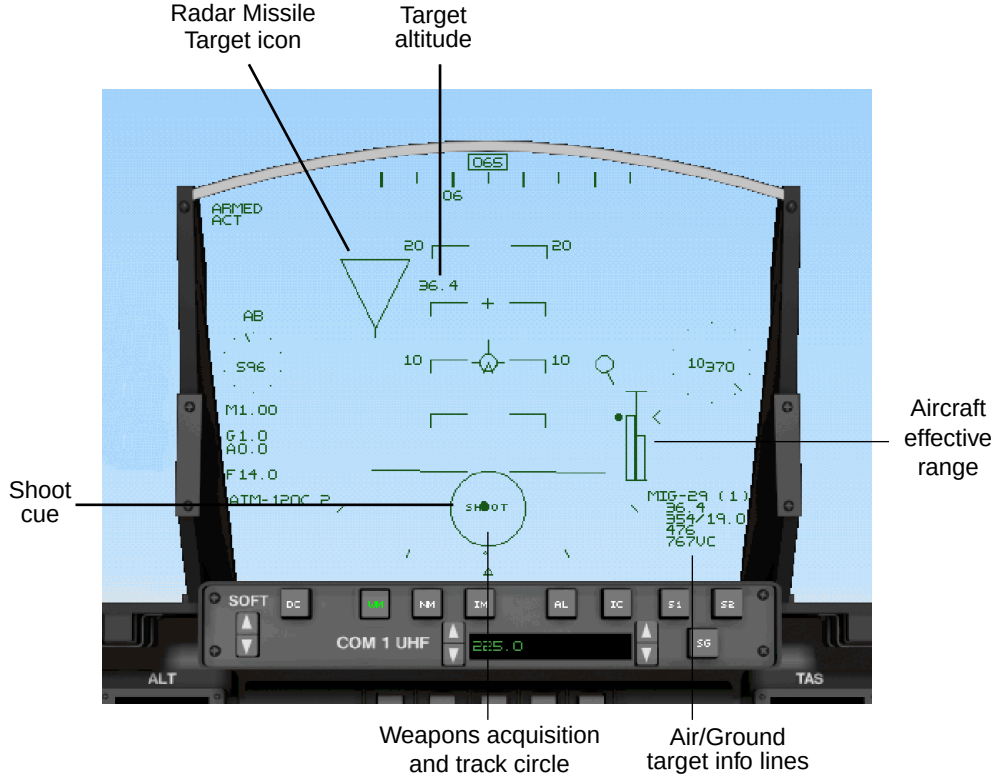
Weapons mode

The Weapons HUD mode displays information for flying your aircraft and attacking targets. Many of the items in this mode are the same as in the Navigation mode (see "Navigation mode" on page 65). Other items in the Weapons mode are as follows:

Air Weapon Effective Range indicator—Displays the maximum possible range (the top of the bracket) and the effective range (the bar) of your currently selected weapon. A filled dot represents your current target to the left of the display and slides up and down to indicate the target's range relative to your weapon's range. The right scale represents the maximum range of your current target's best air-to-air weapon. Your aircraft is represented as a caret (<) to the right of the scale, with the bar representing 50 percent of the target's maximum range.

Ground Weapon Range Indicator—Displays the maximum (top of bracket) and minimum (bottom of bracket) effective range for your currently selected air-to-ground weapon. Above the bracket is the factory maximum weapon range (dash) and below is the factory minimum range. Above the factory maximum weapon range is the range to target is miles. To the left of the display is a filled dot representing your current target, which moves up and down to show the range to target relative to your weapon range.

Weapon Acquisition and Track Circle—Displays the view/track cone of your currently



selected weapon with a filled dot representing your current target.

Air/Ground Target Information Line 1—Aircraft type, mission target designator if applicable (*), and target or shoot list number: for example, Mi-24 (*2).

Air/Ground Target Information Line 2—Target's altitude in thousands of feet.

Air/Ground Target Information Line 3—Bearing to target in degrees (right +, left -), and the three-dimensional distance to target in miles.

Air/Ground Target Information Line 4—Target's true air speed in knots.

Air/Ground Target Information Line 5—Velocity closure (VC) with target in knots.

Target icons—Targeted aircraft are represented by triangular outlines. The current targeted aircraft is represented by a large triangle for radar missiles, a large dashed triangle for guns, a large circle for infrared-guided missiles, or a large square for air-to-ground munitions; to the right of each aircraft icon is the aircraft's altitude in thousands of feet. Other targets in your shoot list are displayed as small triangles, regardless of the weapon selected.

SHOOT cue—When the targeted aircraft is within your effective weapon range and is within your weapons acquisition and tracking cone, the word "SHOOT" is displayed above the bank indicator in the bottom of the HUD.

DROP cue—When the targeted ground object is within your effective weapon range and is within your weapons acquisition and tracking circle (see "Tactical mode" on page 75), the word "DROP" is displayed above the bank indicator in the bottom of the HUD.

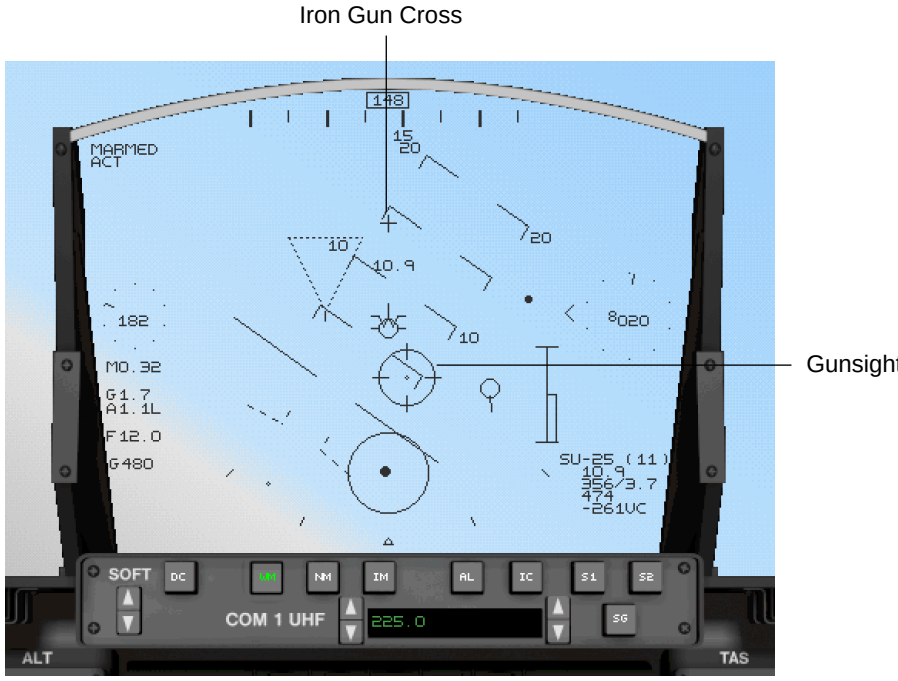
Gunsight—When your M61A2 20mm gun is selected and armed, a Historical Lead Computing gunsight appears roughly in the center of the HUD. The sight displays where your bullets hit at 2,250 ft. away from your aircraft. As your maneuver your aircraft, the gunsight

Ground Weapon Range indicator

moves to display where your gun rounds will hit.

When the HUD Declutter button is selected, the following items disappear from this mode:

- Waypoint tadpole
- AoA indicator
- Remaining fuel
- Airbrake indicator
- Flaps indicator
- Gear indicator
- Weapon Acquisition and Track Circle
- Air/Ground Target Information Line 4
- Air/Ground Target Information Line 5



ILS Mode

Many of the items in the ILS HUD mode are the same as in the Navigation mode (see "Navigation mode" on page 65). Other items in the ILS HUD mode are as follows:

Optimum Air Speed—This is the suggested air speed for your position along the glide path.

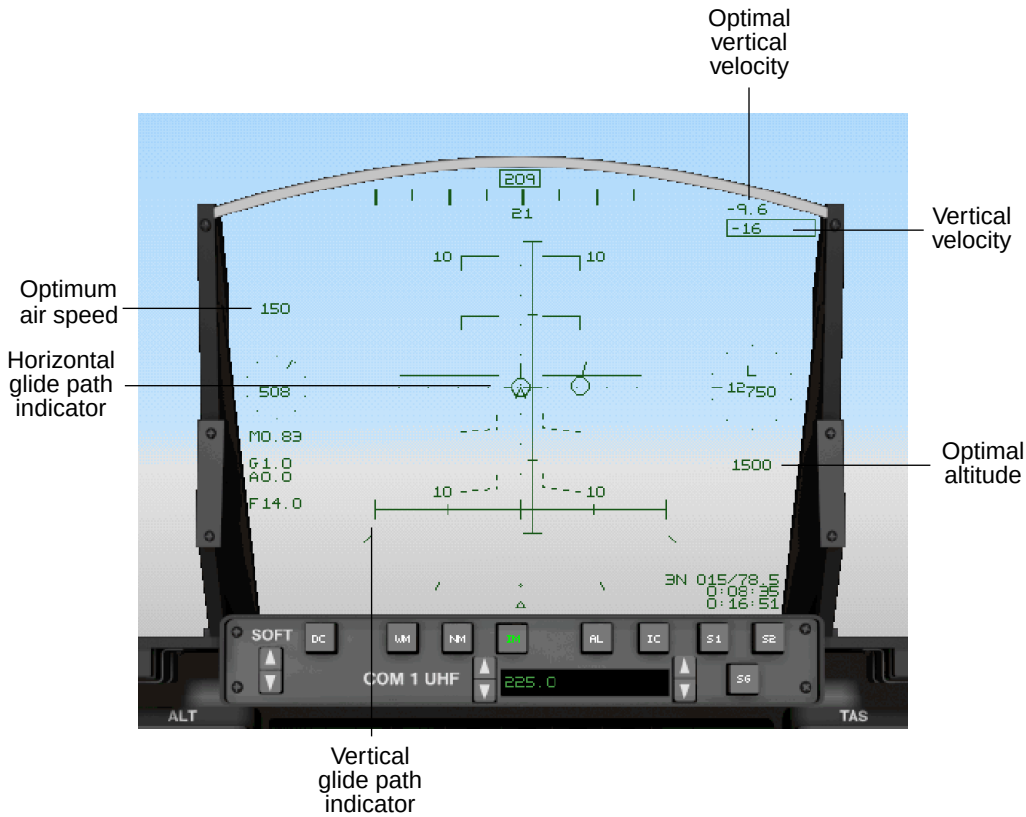
Optimum Altitude—This is the suggested altitude for your current position along the glide path.

Vertical Glide Path indicator—This line moves up and down in the HUD to indicate that you are above or below the glide path for an optimum landing; for an optimum landing it should line up with the Horizontal Glide Path Indicator in the center of the HUD.

Horizontal Glide Path indicator—This line moves right and left in the HUD to indicate that you are to the right or left of the glide path for an optimum landing; for an optimum landing it should line up with the Vertical Glide Path Indicator in the center of the HUD.

Vertical Velocity—This is your vertical velocity in feet per second (- is losing altitude)

Optimum Vertical Velocity—This is the suggested vertical velocity for your current position along the glide path.



When the HUD Declutter button is pressed the following items disappear from this mode:

- Iron Gun Cross
- Waypoint tadpole
- Optimum Air Speed
- Mach indicator
- G Load indicator
- Currently selected weapon
- Optimum Altitude
- Navigation Information Line 2
- Navigation Information Line 3

Multifunctional displays

The F-22 cockpit is dominated by four large full-color multifunctional displays (MFDs). The displays are referred to as the left, center, right, and bottom MFDs. One of the four displays is always active and can be identified by a white outline just inside the MFD. Here's a list of basic MFD options:

Select next MFD—**N** key

Select previous MFD—**Shift**-**N**

Next MFD mode—M key

Previous MFD mode—Shift-M

Increase MFD/radar range—] key

Decrease MFD/radar range—[key

Set MFDs to Combat modes—**Insert** key; sets MFDs to the following modes:

- Left—Defense
- Center—Tactical
- Right—Attack
- Bottom—Stores Management

Set MFDs to Status modes—**Home** key; sets MFDs to the following modes:

- Left—Damage
- Center—Tactical
- Right—Stealth
- Bottom—Stores Management

Set MFDs to Navigation modes—**Page Up** key; sets MFDs to the following modes:

- Left—Communications/Navigation
- Center—Tactical
- Right—Flight Ball
- Bottom—Damage

Set MFDs to Dogfight modes—**Delete** key; sets MFDs to the following modes:

- Left—Tactical
- Center—Dogfight
- Right—Defense
- Bottom—Stores Management

Set MFDs to Landing modes—**End** key; sets MFDs set to the following modes:

- Left—Tactical
- Center—Flight Ball
- Right—Communications/Navigation
- Bottom—Damage

You can change the MFD modes associated with the five preset MFD sets by using the Configure MFDs window (see "Configure MFDs" on page 32).

Icons and targeting text within the MFDs are color-coded based on their alliance or side of the conflict:

- Red—Enemy
- Green—Friendly
- Blue—Wingmen

Some icons break the normal rules and deserve special attention:

- White—Friendly missiles and missile track lines
- Yellow—Non-civilian buildings (military targets including EWRs)

- Light blue—Civilian buildings (non-military targets)

There are several icons displayed in radar-related MFD modes:

Aircraft—Filled circles with lines denoting the direction of travel. The lines also indicate the velocity class of the aircraft:

- Short—Less the Mach 1.0
- Medium—Between Mach 1.0 and 1.49
- Long—Mach 1.5 and greater

In Defense mode, hollow triangles are projected off the nose of enemy aircraft when they search in your direction with active radar, indicating their detection range versus your aircraft's current stealth state.

Ground vehicles—Filled circles without lines.

Radar SAM sites—In Defense mode, they appear as hollow pentagons that change to filled when the radar is on and facing your direction. Each SAM site has a large hollow circle denoting the SAM's detection range versus your aircraft's current stealth state. In other MFD modes, they appear as small filed circles.

Buildings and structures—Filled circles.

Waypoints: Initial Point or Bomb Run—Filled green squares.

Waypoints: Target—Filled green triangle.

Waypoints: All other types—Four pointed, filled green stars.

Waypoint connecting lines—Green lines.

Missiles—Small filled circles with a line leading from the missile to its target

Current target—Displayed with a thick white circle around it.

Other targets in your shoot list—Displayed with thin white circles around them.

Wingman targets—Displayed with a dashed white circle around them.

Clicking on objects in your MFDs has the following effects:

- On nontargeted object—Adds object to your shoot list as the current target
- On a noncurrent target in your shoot list—Makes that target the current target in your shoot list
- On your current target—Removes target from your shoot list

Right-clicking on an object in your MFDs displays crosshairs over the object and information about the object for five seconds in the Tactical and Dogfight MFD modes and in the HUD.

Defense mode

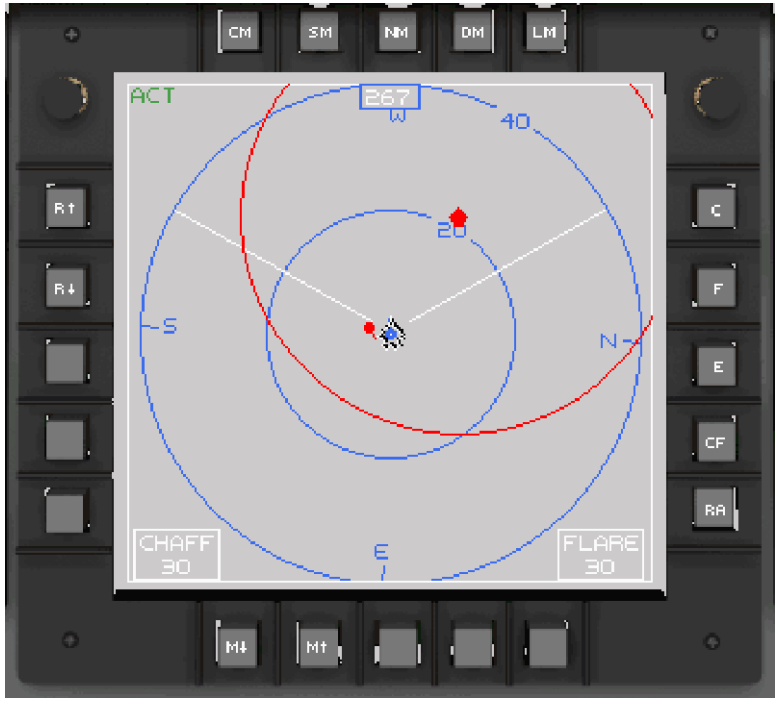
The Defense MFD mode is your primary way of remaining alive and unseen. In the center of the display is an F-22 icon representing your aircraft with two lines indicating the search/track angle of your radar. If you turn your radar on, everyone within those two lines receives your signal and is alerted to your presence. The number at the top of the display is your current heading, and the two large circles represent ranges. This display shows all radar contacts that are a threat to your F-22, with threat being defined as physical threats and threats to maintaining your stealth.

There are two displays at the bottom of the MFD: remaining chaff and remaining flares. The Defense MFD mode is the only display that shows radar ranges of SAM sites and aircraft. As your RCS and IRCS increase, the radar circles around SAM sites, and radar cones from aircraft increase in size to reflect their detection ranges. Your best chance for remaining unseen is to keep the small white dot inside the F-22 icon outside of all enemy radar detection circles and cones.

There are two status indicators in the Defense MFD mode: “ACT” indicates your active radar is on, and “ECM” indicates your ECM is on.

Maximum display range for the Defense MFD mode is 160 miles, while the minimum is five miles. The following buttons are along the edge of any display that contains the Defense MFD mode:

CM	Set MFDs to Combat modes
SM	Set MFDs to Status modes
NM	Set MFDs to Communication/Navigation modes



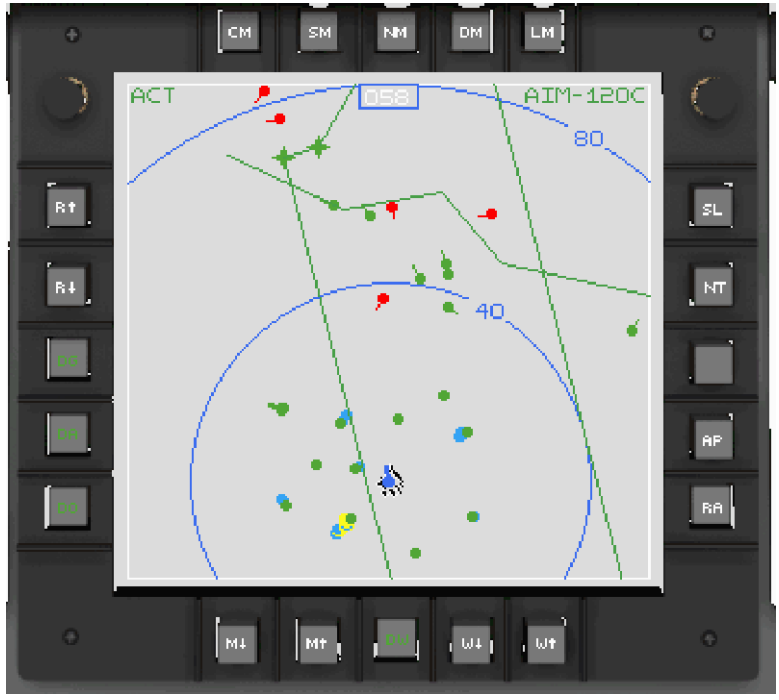
DM	Set MFDs to Dogfight modes
LM	Set MFDs to Landing modes
Up arrow R	Increase radar range
Down arrow R	Decrease radar range
Up arrow M	Previous MFD mode
Down arrow M	Next MFD mode
C	Fire chaff
F	Fire flare
E	Toggle ECM
CF	Auto dispense chaff and flare
RA	Toggle active radar

Tactical mode

The Tactical MFD mode is your primary map display and contains information on all ground and air contacts, target information, waypoint information, and heading information. The Tactical mode is also the primary display for delivering air-to-ground munitions. The number at the top of the display is your current heading, and the two circles represent ranges. This display contains an F-22 icon that is near the bottom of the display.

The target information display is identical to the one on the HUD Weapons mode (see "Weapons mode" on page 68).

When you have air-to-ground munitions selected and armed, you see either a small white dot and white circle indicating the possible impact points of the weapon. When your currently selected ground target is under the



dot or circle, a “DROP” cue is shown at the bottom of the display, indicating that your weapon is likely to hit the target.

The ACT status indicator denotes that your active radar is currently on.

Your current weapon and the remaining number of that type of weapon are displayed in the upper right corner of the display. Maximum display range for the Tactical MFD mode is 160 miles, while the minimum is five miles. The Tactical MFD mode has the following buttons:

CM	Set MFDs to Combat modes
SM	Set MFDs to Status modes
NM	Set MFDs to Communication/Navigation modes
DM	Set MFDs to Dogfight modes
LM	Save MFDs to Landing modes
Up arrow R	Increase radar range
Down arrow R	Decrease radar range
Up arrow M	Previous MFD mode
Down arrow M	Next MFD mode
Up arrow W	Previous waypoint
Down arrow W	Next waypoint
DG	Toggle display ground objects
DA	Toggle display air objects
DO	Toggle display other items; when selected, the FEBA (green line) is not displayed
DW	Toggle display waypoints
SL	Prepare auto shoot list
NT	Select next target
AP	Toggle autopilot
RA	Toggle active radar

Attack mode

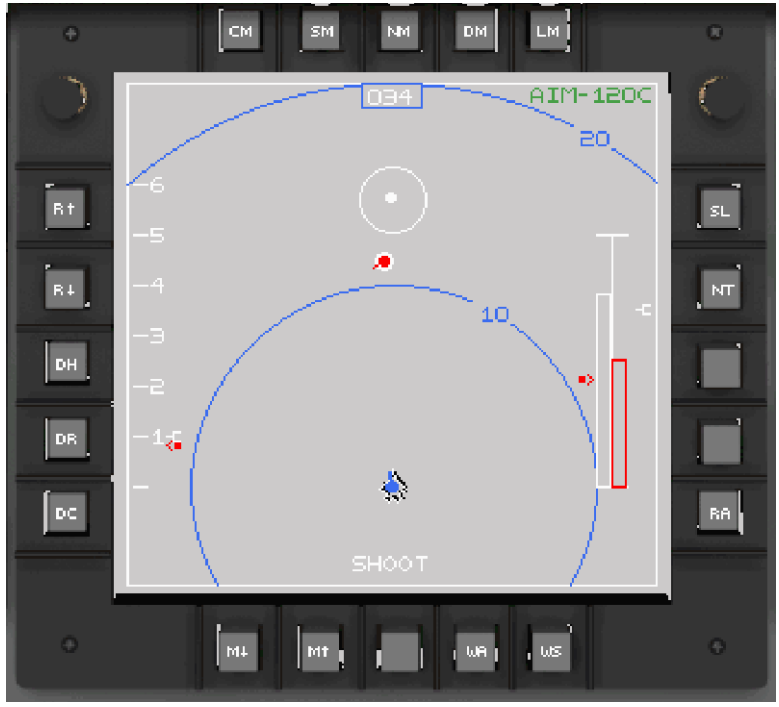
The Attack MFD mode displays radar information for your currently selected weapon. If you have an air-to-air missile selected, only air targets are displayed, while only ground targets are shown for air-to-ground munitions. The number at the top of the display is your current heading, and the two circles represent ranges. This display contains an F-22 icon representing your aircraft near the bottom of the display.

The altitude display (left) shows altitudes in increments of ten thousand feet from 0 to 60,000 feet. Your aircraft is represented as a white bracket to the right of the scale. Your current target is represented as a red caret or less than sign (<) with a red square. The square is hollow until you fire at the target, in which case it is filled completely red.

The Weapon Range Indicator (right) consists of two side-by-side weapon range scales and operates identically to the one in HUD Weapons mode (see "Weapons mode" on page 68).

The weapon acquisition and track circle (top center) is only available for air-to-air weapons. It operates identically to the one in HUD Weapons mode (see "Weapons mode" on page 68).

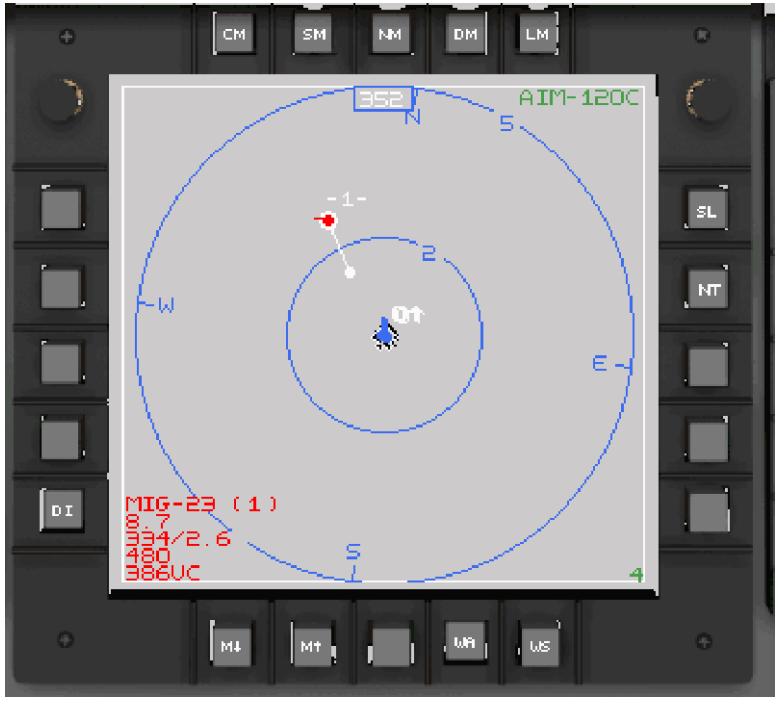
Your current weapon and the remaining number of that type of weapon are displayed in the upper right corner of the display. Maximum display range for the Attack MFD mode is 160 miles, while the minimum is five miles. The Attack MFD mode has the following buttons:



CM	Set MFDs to Combat modes
SM	Set MFDs to Status modes
NM	Set MFDs to Communication/Navigation modes
DM	Set MFDs to Dogfight modes
LM	Set MFDs to Landing modes
Up arrow R	Increase radar range
Down arrow R	Decrease radar range
Up arrow M	Previous MFD mode
Down arrow M	Next MFD mode
DH	Toggle display altitude scale
DC	Toggle display weapon aim circle
DR	Toggle display weapon range scale
WA	Toggle arm weapon
WS	Select next weapon
SL	Prepare auto shoot list
NT	Select next target
RA	Toggle active radar

Dogfight mode

The Dogfight MFD mode increases your situational awareness in close-up dogfights. The radar in this mode shows all aircraft up to 10 miles from your aircraft, regardless of your radar's current status. The box at the top of the display is your current heading, and the two circles represent ranges. This display contains



an F-22 icon representing your aircraft in the center of the display.

Above each aircraft icon is a number and a trend indicator:

Number—Difference in altitude between target aircraft's altitude and your altitude in thousands of feet. If it is positive, the target is above you; a negative number indicates the target is below you.

Trend indicator:

- A dash (–) indicates that the aircraft is neither climbing nor diving.
- An up arrow indicates that the aircraft is climbing.
- A down arrow indicates that the aircraft is diving.

The Dogfight mode shows target information identical to the information displayed on the HUD in Weapons mode (see "Weapons mode" on page 68). Your current weapon and the remaining number of that type of weapon are displayed in the upper right corner of the display.

Maximum display range for the Dogfight MFD mode is ten miles, while the minimum is one mile. The Dogfight MFD mode automatically sets the display range according to your current target. This mode has the following buttons:

CM	Set MFDs to Combat modes
SM	Set MFDs to Status modes
NM	Set MFDs to Communication/Navigation modes
DM	Set MFDs to Dogfight modes
LM	Save MFDs to Landing modes
Up arrow M	Previous MFD mode
Down arrow M	Next MFD mode
DI	Toggle display target information
WA	Toggle arm weapon
WS	Select next weapon
SL	Prepare auto shoot list
NT	Select next target

Stores Management mode

The Stores Management mode displays the current status of your weapons, engines, and countermeasures. At the top of the display are engine thrust indicators that show information regarding each engine:

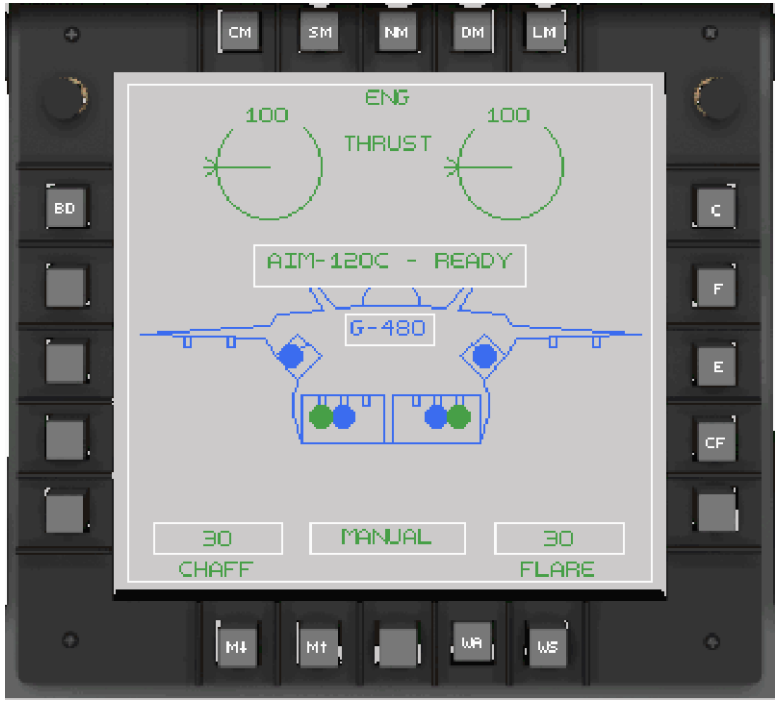
Current thrust setting—“>“ symbol

Current thrust indicator—“__” symbol and number; “0–100” for military power and “140” for afterburner

In the center of the display is a box showing your currently selected weapon and its status, which is “Ready” if the weapon is armed.

At the bottom of the display are three countermeasure displays. The first shows the number of chaff packets remaining. The second display shows the current dispensing method—Manual or Auto. The third shows the number of flares remaining. This mode has the following buttons:

CM	Set MFDs to Combat modes
SM	Set MFDs to Status modes
NM	Set MFDs to Communication/Navigation modes
DM	Set MFDs to Dogfight modes
LM	Set MFDs to Landing modes
Up arrow M	Previous MFD mode
Down arrow M	Next MFD mode
BD	Toggle bomb bay doors for current weapon
WA	Toggle arm weapon
WS	Select next weapon



C	Fire chaff
F	Fire flare
E	Toggle ECM
CF	Auto dispense chaff and flare

Communications/Navigation mode

The Communications/Navigation MFD mode contains detailed information on the status of your communication systems and a list of your mission waypoints. It lists:

- The status of COM1 and your current UHF frequency
- Your current COM2/IFDL links

This MFD mode displays a list of your mission waypoints including waypoint number, UTM zone, X coordinate, Y coordinate, and the waypoint action type. Your current waypoint is highlighted in this list (see "Waypoints" on page 47). The suggested speed in knots and the suggested altitude in thousands of feet are displayed for the current waypoint leg at the bottom of the screen. This mode has the following buttons:

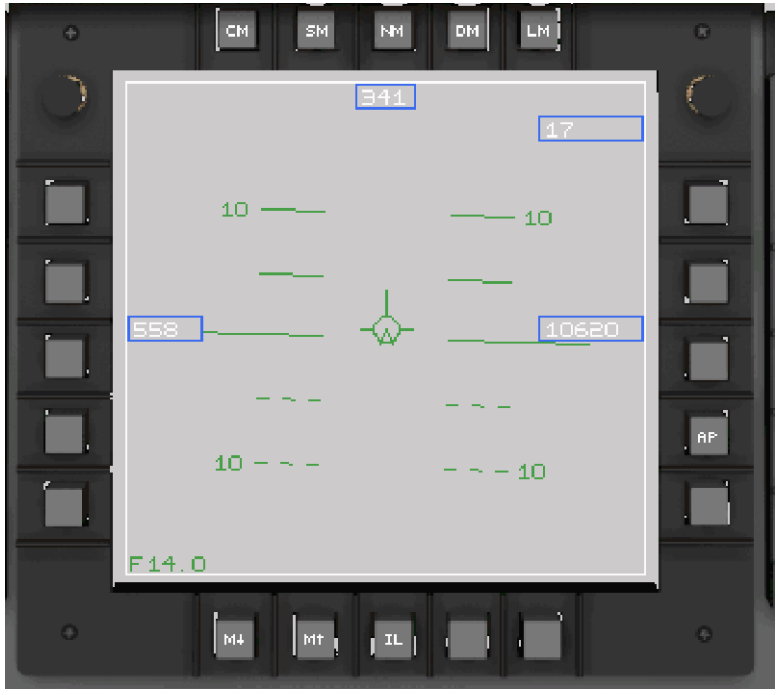
CM	Set MFDs to Combat modes
SM	Set MFDs to Status modes
NM	Set MFDs to Communication/Navigation modes
DM	Set MFDs to Dogfight modes
LM	Set MFDs to Landing modes
Up arrow M	Previous MFD mode
Down arrow M	Next MFD mode
Up arrow W	Previous waypoint

Down arrow W	Next waypoint
C1	Toggle Com1/UHF
S1	Send Com1/UHF communication
S2	Send Com2/IFDL communication
SG	Send Guard communication

Flight Ball mode

The Flight Ball MFD mode is basically a backup system for your HUD. It displays the pitch ladder, IAS in knots, altitude in feet, ILS information, remaining fuel in thousands of pounds, and vertical velocity in feet per second in the upper right corner. This mode has the following buttons:

CM	Set MFDs to Combat modes
SM	Set MFDs to Status modes
NM	Set MFDs to Communication/Navigation modes
DM	Set MFDs to Dogfight modes
LM	Set MFDs to Landing modes
Up arrow M	Previous MFD mode
Down arrow M	Next MFD mode
IL	Toggle ILS
AP	Toggle autopilot



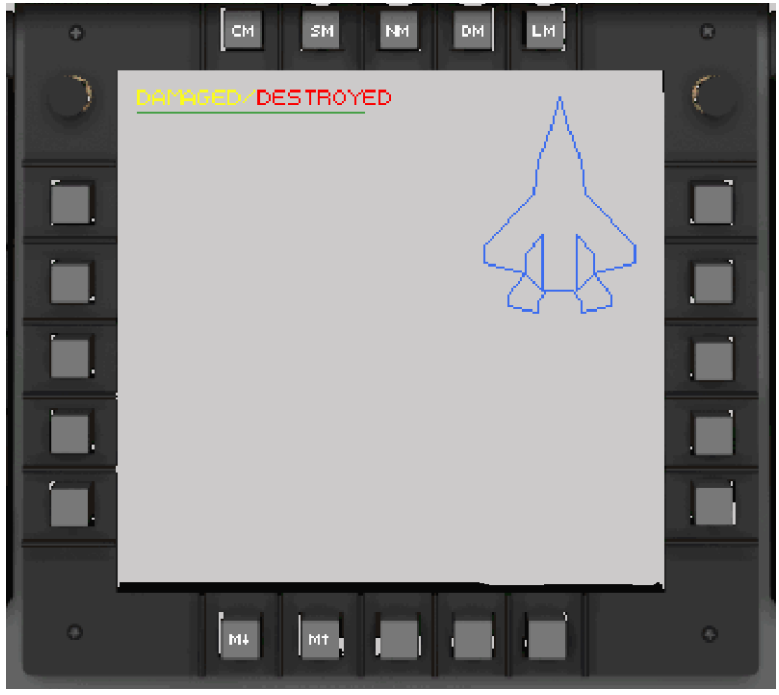
Damage mode

The Damage MFD mode displays F-22 systems that have been damaged (yellow) or destroyed (red). It also contains a graphic representation of the F-22, which is color-coded according to the total amount of damage sustained by the aircraft. It provides quick feedback about your F-22's flight worthiness:

- Blue: 0–20 percent damaged
- Light Blue: 21–40 percent damaged
- Yellow: 41–60 percent damaged
- Orange: 61–80 percent damaged
- Red: 81–90 percent damaged
- Flashing Red: 91–100 percent damaged

This MFD mode has the following buttons:

CM	Set MFDs to Combat modes
SM	Set MFDs to Status modes
NM	Set MFDs to Communication/ Navigation modes
DM	Set MFDs to Dogfight modes
LM	Save MFDs to Landing modes
Up arrow M	Previous MFD mode
Down arrow M	Next MFD mode



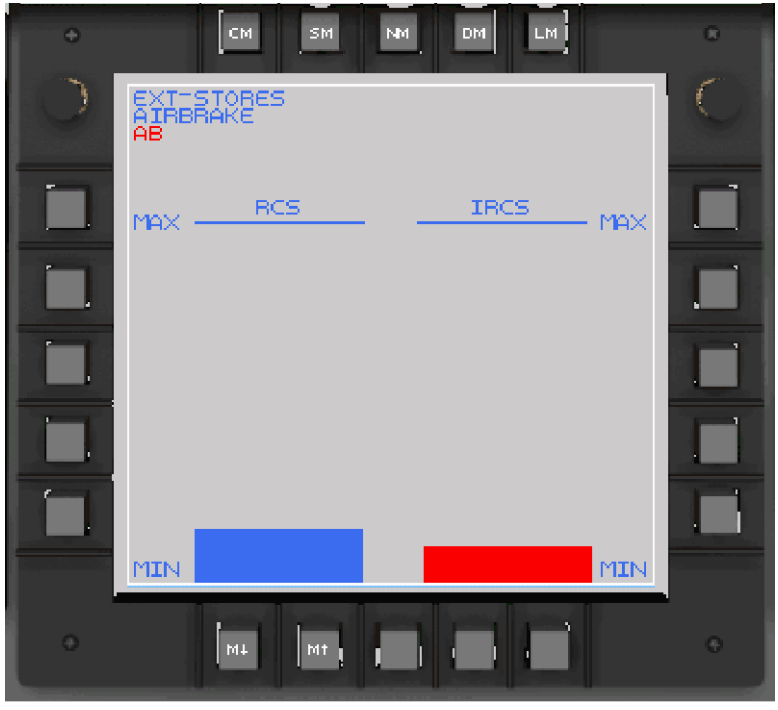
Stealth Status mode

The Stealth Status MFD mode displays your aircraft's current stealth state, both Radar Cross Section (RCS) and Infrared Cross Section (IRCS). The two bar graphs expand and contract in sync with your aircraft's stealth state. The smaller the graphic, the stealthier your aircraft is. Above the graphics are all the items that contribute to your RCS (blue) and IRCS (red). This mode has the following buttons:

CM	Set MFDs to Combat modes
SM	Set MFDs to Status modes
NM	Set MFDs to Communication/Navigation modes
DM	Set MFDs to Dogfight modes
LM	Set MFDs to Landing modes
Up arrow M	Previous MFD mode
Down arrow M	Next MFD mode

Instrument panels

The instrument panels are described in the following sections.



LCD displays

There are three instrument areas of your aircraft. The first area is immediately above your MFDs and contains four display instruments. Looking from left to right, you have an **UTM** coordinate indicator that displays your aircraft's current location in the world by *UTM Zone:X coordinate in hundreds of meters:Y coordinate in hundreds of meters* (DF:235:001).

The next instrument is your current barometric or above sea level altitude (**Alt**) in feet. The third instrument is your True Air Speed or "ground speed" in knots. The final instrument is the current simulation **Time** in *hours:minutes:seconds.*

Bottom right panel

The bottom right instrument panel contains the F-22's critical switches. There are three switches that have a safety cover to prevent accidental activation: **Master Arm**, **Fuel Dump**, and **Jettison Stores** (external only). There are three states to each of these buttons: cover down and off, cover up and off, and cover up and on. To open or close the cover, click on it, but remember that when the cover is down, the switch is automatically shut off.

To flip any switch, click on it, or click on the cover to shut the cover again.

The remaining two switches on this panel are your right and left engine on/off switches. Click on these switches to change their state.

Also in this view is the flight stick, which has three buttons and two hat switches that have two modes each:

Top thumb button	Fires your currently selected weapon (space bar)
Trigger	Fires your gun (**Shift**-space bar)
Bottom thumb button	Arms or de-arm your currently selected weapon (**Back-space**)
Left hat switch up	Selects your next weapon (**Enter**)
Left hat switch down	Selects your previous weapon (**Shift-Enter**)
Right hat switch up	Fires a chaff packet (**C** key)
Right hat switch down	Drops a flare (**F** key)

Bottom left panel

The bottom left instrument panel contains takeoff/landing and general in-flight switches. There are two three-position turn knobs. The first knob is the **Wheel Brake** knob with **Off**, **On**, and **Park** positions. The second knob is the **Land/Taxi Light** knob with **Off**, **On**, and **Landing** settings (this function is not implemented).

On the far right of the panel is the **Landing Gear** lever with **Extended** and **Retracted** positions. When the landing gear is retracted, the three landing gear lights are gray. When the landing gears are extended, each gear light is either green for functioning or red for malfunctioning.

The **Flaps** switch is either in the **Extended** or **Auto** position. In the **Auto** position, the aircraft's flight control system automatically manipulates the position of the flaps to keep the F-22 in the air. The last switch on this control panel is the **Air Brake** switch. The F-22 does not have a standard air brake but uses differential or opposite rudders to produce drag that slows the aircraft. The air brakes are either **Extended** (on) or **Retracted**.

Below the control panel is the throttle. The long red button prepares a shoot list. The small red button selects the next target in the shoot list. The black thumb switch removes the current target from the shoot list.

Weapon systems

The following sections explain weapon system controls.

Weapon management

Weapons management includes selecting, arming, and firing weapons from aircraft hardpoints. You can select weapons in a number of ways:

Select next weapon or next weapon type—Press **Enter**; click the select next weapon (**WS**) button on the Dogfight, Attack, or Stores Management MFD modes; or flip the left hat switch up on the flight stick in the down and right view.

Select previous weapon—Press **Shift-Enter** or flip the left hat switch down on the flight stick in the down and right view.

When selected, weapons are automatically unarmed unless the **Master Arm** switch is on. You can arm or unarm weapons in a number of ways:

Master arm toggle—Press **Ctrl-A**; double-click on the **Master Arm** switch located on the right instrument panel (see "Instrument panels" on page 84).

Arm weapon toggle—Press **Backspace**; press the **Arm** button on the Dogfight, Attack, or Stores Management MFD modes; or the press the lower thumb button on the flight stick in the down and right view.

When you arm an AIM-9 Sidewinder, there is approximately a one-second delay before the weapon is extended into the airstream to search for targets because the F-22 has no infrared search-and-track capabilities. During this delay, you won't see an "ARMED," "MARMED," or "SHOOT" cue. Each time a Sidewinder is readied, you get the same delay.

After the current weapon is armed, you'll see "ARMED" or "MARMED" (**Master Arm** is on) in the upper left corner of the HUD and in the Tactical, Dogfight, Attack, or Stores Management MFD modes (a "Ready" cue is displayed next to the current weapon instead of the usual "ARMED").

You can fire weapons in the following ways:

Fire gun—Press **Shift**-space bar or the trigger button on the flight stick in the down and right view.

Fire selected weapon—Press the space bar or the upper thumb button on the flight stick in the down and right view.

When you launch a weapon from an internal weapons bay, there is a noticeable delay before the weapon is released because of the operation of the bay doors and the weapon ejection system. Expect a delay of approximately one second before it leaves the weapons bay. Each weapon is given its target upon launch, not upon command to launch. Therefore, if you press the button to launch a weapon at target A, immediately switch to target B, and press the launch button again, two weapons are launched, and they track toward target B because it was the active target when the weapons actually left the bays. The only exception to this is the AIM-9 Sidewinder. It immediately launches and tracks its target, but as mentioned previously, it has a one-second arming delay.

Weapon Launch G Limitations

To launch a weapon, you must have sufficient gravitational and/or centrifugal forces (Gs) on your aircraft. To launch a bomb you must have Gs between 0.5 and 6, while to launch a missile your G limits are 0 to 8.

Shoot list

A shoot list is a computer-prepared list of targets based on your current weapon and potential targets. When the computer prepares a shoot list, it looks at your currently selected weapon and scans for appropriate targets (air, ground, or ground-based radar, as with a

HARM missile). Each potential target is prioritized according to distance away from your aircraft and its angle off your nose. The computer then prepares a shoot list of up to *x* targets, where *x* is the number of weapons of the currently selected type. The name of each target is followed by its shoot list number and possibly an asterisk (*) if it is a mission target.

The current target in your shoot list is represented by a larger filled white circle behind the target icon in your MFDs. The remaining targets in your shoot list are represented by hollow white circles behind the target icons. There are dashed hollow white circles behind shoot list targets of your wingmen.

Targeting

Here's how you can select and deselect targets in *i*F-22 Raptor:

Prepare a shoot list—Press the **S** key; select the prepare shoot list button (**SL**) in the Tactical, Dogfight, or Attack MFD modes; or press the long red button on the throttle in the down and left view.

Select next target in shoot list—Press the **T** key; select the next target button (**NT**) on the Tactical, Dogfight, or Attack MFD modes; click on any target in the Defense, Tactical, Dogfight, or Attack MFD modes; or select the small red button on the throttle in the down and left view.

Select previous target in shoot list—Press **Shift-T** or click on any target in the Defense, Tactical, Dogfight, or Attack MFD modes.

Deselect current target—Press **Shift-D**; click on the current target in the Defense, Tactical, Dogfight, or Attack MFD modes; or press the black thumb switch on the throttle in the down and left view.

Selecting targets using your mouse—Click on any object in your MFDs and one of the following events occurs:

- If the target in not in your shoot list, it becomes the current target in your shoot list.
- If it is in your shoot list but is not the current target, it becomes the current target.
- If it is the current target in your shoot list, it is untargeted and removed from your shoot list.

NOTE: If you click on a ground object icon, a shoot list is prepared with all the vehicles or buildings associated with the group of ground objects.

Select target nearest to the center of your HUD—The **L** key locks onto the nearest target of the type designated by your current weapon.

Getting information on targets using your mouse—Right-clicking on any object in the Defense, Tactical, Dogfight, or Attack MFD modes displays crosshairs and target-related information around the target for five seconds.

Maintaining target lock

Selected targets remain in your shoot list as long as you maintain radar contact with them. Maintaining radar contact simply means that you can see them in your MFDs, so it could be that your radar is off, but your wingman's radar is on and you have an IFDL with the wingman that lets you see the bogey (enemy aircraft). Try to keep all targets in front of you so either you or your wingman's radar can maintain contact.

Countermeasures

F-22 countermeasures, which operate similar to those of other aircraft, are as follows:

Fire flare— Press the **F** key; select the **Flare** button on the Defense or Stores Management MFD modes; or the flip the right hat down on the flight stick in the down and right view.

Fire chaff—Press the **C** key; select the **Chaff** button the Defense or Stores Management MFD modes; or the flip the right hat up on the flight stick in the down and right view.

ECM on/off toggle—Press the **E** key, or select the **Flare** button on the Defense or Stores Management MFD modes.

Auto launch chaff and flares—Press the **V** key, or select the **Auto Chaff/Flare** button on the Defense MFD mode.

View systems

The internal and external views are described in the following sections.

Internal

There are 20 internal views, not including the Padlock view, which cycles through the available views while keeping a lock on your current target. The internal view system is based on fixed views that change in 45 degree increments in the horizontal and vertical plane. Accordingly, there are eight views on the horizontal or eye level plane, eight views on the up 45 degree plane, a top view (up 90 degrees), and three down 45 degree cockpit views. F-22 also lets you to snap your view instantly to five critical internal views. To change your current view, use the following commands:

Snap view front and level—Press **5** on the keypad or **F1**.

Snap view rear and level—Press **0** on the keypad.

Snap view right and level—Press **3** on the keypad.

Snap view left and level—Press **1** on the keypad.

Snap view top—Press **7** or **9** on the keypad.

Right 45 degrees— Press **6** on the keypad.

Left 45 degrees—Press **4** on the keypad.

Up 45 degrees—Press **8** on the keypad.

Down 45 degrees— Press **2** on the keypad.

Toggle between Padlock and Front view—Press **.** on the keypad or **Del**.

Padlock view—Press **F3**.

Cockpit graphics on/off—Press **F2**.

You can also change internal views by clicking your mouse when a transparent view arrow is displayed on the window. To display the view arrows, move your cursor toward the edges of the window, avoiding active cockpit elements such as buttons and MFDs.

External

In *i*F-22 Raptor, there are seven external views, which are accessed as follows:

Player Chase view—Press **F4**.

Target Chase view—Press **F5**; not available until range is less than 40 miles.

Missile/Bomb view— Press **F6**.

Tactical view— Press **F7** (looking from your aircraft to the target aircraft).

Reverse tactical view— Press **F8** (looking from the target aircraft to your aircraft); not available until range is less than 40 miles.

Fly-By view—Press **F9** (looking head-on at F-22 changing to tail-on as F-22 flies past the camera).

Down view—Press **F10** (looking directly out of the bottom of the bomb bay).

Satellite view—Press **F11** (looking from 1,000 feet above your aircraft).

You can manipulate any external view, such as zooming and rotating your viewing angle, by using the following keys:

Zoom view—Press **.** key or **Ctrl-.**.

Unzoom view— Press **,** key or **Ctrl-,**.

Rotate view up— Press **Ctrl**-Up Arrow.

Rotate view down— Press **Ctrl**-Down Arrow.

Rotate view right— Press **Ctrl**-Right Arrow.

Rotate view left— Press **Ctrl**-Left Arrow.

Toggling views with the view function keys (F1 and F3 through F11)

The view function keys are unique because they act as a toggle to your previous view. The first time you hit a key, it switches your view to the requested view. For example, you switch from the Front Cockpit view (keypad **5** or **F1**) to Player Chase view by pressing **F4**. If you press **F4** again, the view toggles back to the Front Cockpit view. Press it again, and you're back in the Player Chase view. You can toggle this feature on and off by pressing **Ctrl-F1**.

Aircraft damage

Like the real F-22, the *i*F-22 Raptor aircraft can take considerable damage before being destroyed. Each time your aircraft is hit by a weapon, it sustains damage to the overall airframe and one or more subsystems. To view you current damage status, switch one of your MFDs to the Damage Mode (see "Damage mode" on page 83), which identifies each damaged and destroyed system.

Certain systems on your aircraft are critical systems, which means that your aircraft will not stay airborne if they be destroyed. Critical F-22 systems are:

- Engines
- Airframe
- Fuel cells
- Computer

Also, if your aircraft receives enough damage, regardless of the affected systems, it is not likely to stay airworthy. On the Damage MFD mode, there is an overall damage indicator, which changes color from blue to red as your aircraft receives damage. When it's red or blinking red, your plane may explode, so consider punching out (ejecting).

Using your wingmen

Wingmen in *i*F-22 Raptor do exactly what you tell them. After takeoff they fly off your wing until they are attacked, at which time they defend themselves, or you tell them to do something. To order your wingmen use your UHF (see page 61), IFDL (see page 61), or Guard (see page 62) communication systems, but not the Chat system. For example, to get your wingmen to attack someone simply target the object and tell your wingmen to "Attack my target." For a full list of wingman communications see Appendix C, "Prescripted Communication Messages." Many mission require the use of wingmen in order to achieve the mission objectives, so don't forget they exist.

Multiplayer sessions

In multiplayer sessions, the game concepts pause and accelerated time lose their meaning and have therefore been disabled.

Operations

This section describes basic operations such as taking off and dogfighting.

Taking off and landing

Take off

You can begin a mission either on the runway or in the air. When beginning on the runway, return your throttle to the idle position by pressing the **1** key above the keyboard or by pulling the throttle all the way back, and then turn on your engines (right and left) by pressing **Ctrl-R** and **Ctrl-L**.

With your aircraft lined up in the center of the runway, release your wheel brakes (**W**), and increase to maximum throttle—afterburners are not required. Use gentle rudder control to stay on the runway while you accelerate. When you reach approximately 150 knots, pull back on the stick to get airborne. At this point, look at the mission waypoints displayed in the Tactical mode and then turn toward the active waypoint. You're off and running!

Landing

To land your aircraft, fly to your last waypoint and turn the ILS system on by pressing the **/** key. In the Tactical MFD mode, your mission waypoints are replaced by landing points for the nearest airfield. The landing points consist of a point directly under your aircraft and three points lined up with the runway: outer marker point (OM) approximately 10 miles from the touchdown point, inner marker point (IM) approximately 5 miles from the touchdown point, and touchdown point (TP). The ILS system also switches your HUD modes to ILS mode and displays the ILS needles. Press **Shift-A** until a small R appears above you, which indicates that you are using your radar altimeter (which measures your altitude above the ground).

The outer marker, inner marker, and touchdown point form a straight line ending on the runway. Fly your waypoint path in the MFDs to the outer marker and descend to altitude 1,500 ft., a speed of 150 knots, and set your flaps to "FLAPS2" by pressing the **H** key twice. Do not fly the ILS needles until you reach the inner marker. Try to stay exactly on the line between the outer marker and inner marker. At the inner marker, you should start to descend using the ILS needles. Extend your landing gear by pressing the **G** key. As you approach the touchdown point, drop your speed to 135 knots.

Just before you touch down, drop your speed to about 120 knots and pull your nose up a little so the first thing to hit the runway is your back gear. As soon as your back gear touches down, cut your engines and apply your wheel brake by pressing the **w** key. You can also use your airbrake to slow down, but its effectiveness diminishes as your speed decreases.

Congratulations! You just landed your aircraft, which is undoubtedly one of the harder things pilots master. While on the ground, you can end your mission at any time by pressing **Ctrl-Q** without penalty.

There are two things to remember about landing in *i*F-22 Raptor. First, at about 225 knots, your aircraft automatically retracts landing gear and flaps to avoid damaging them. Second, in the realistic flight model, your flaps are not only automatically retracted but are also automatically extended by the flight control system to aid in controlled flight of the aircraft.

Dogfighting: air-to-air attacks

Air-to-air combat is divided into two phases: beyond visual range (BVR) and visual engagements.

BVR engagements

In BVR engagements, the only contact you have with the enemy is your radar MFD modes and HUD. Select your medium range (5–30

miles) AIM-120A and AIM-120C AMRAAMs by pressing **Enter** until they appear in the lower left corner of the HUD. Lock onto a target by preparing a shootlist (**S** key), selecting the target nearest to the center of your HUD (**L** key), or by clicking on an air target (a red circle with a line extending from it) in an MFD. Turn toward your target by following the target line extending from the center of your HUD. When the target is in your HUD, a large triangle appears around it with a line extending from it.

For your missile to be able to hit your target, you need a "SHOOT" cue displayed in the bottom of you HUD. To get a "SHOOT" cue, two parameters must be met. The first is that your target must be inside of your weapon's effective range, which is displayed on the right side of the HUD and the Attack MFD mode. The effective range of your weapon is displayed as the left bar with your target represented by a small dot that slides up and down the to the left of the bar. The right bar depicts 50 percent of your target's maximum weapon range, with your aircraft depicted as a less-than sign (<) that slides up and down to the right of the bar.

To bring your target into effective weapon range, you need to maximize the velocity closure between you and your target (displayed in the lower right of the HUD) by turning directly at your target. When the dot representing your target is to the left of the bar, your target is inside your weapon's effective range.

Your weapon must also be able to track its intended target. The weapon acquisition and track circle located in the bottom of your HUD and the top of the Attack MFD mode depicts your weapon's field of view as a circle and your target as a small dot. If the dot is inside the circle, your weapon can track it. If it is not in the circle, steer your aircraft until the dot is within the circle.

When the target is within your weapon's effective range and acquisition and track circle, you're ready to fire. If your weapon is not armed ("ARMED" or "MARMED" in the upper left of the HUD), arm it (**Backspace** key) and fire away (space bar)! There is a one-second delay between pressing the fire key and when the weapon is launched due to the bay doors opening and the weapon being extended from weapons bay.

Remember that your aircraft is extremely stealthy, so you should be able to shoot before the bad guy even knows you're there. But when your doors open to launch the missile, your stealth is reduced and you may become visible if you are within the target's radar cone. Try to be off to a side or behind the target before firing.

Visual engagements

Within 5 miles, select AIM-9M and AIM-9X Sidewinders (1–5 miles) because AMRAAMs don't have enough acceleration and maneuver time to be effective. Because your aircraft has no infrared targeting mechanism, a Sidewinder missile is extended from the weapons bay to search for targets after it is selected and armed. Target an enemy aircraft and try to get it into your HUD, where a dashed and solid circle appears around the enemy.

To get a "SHOOT" cue, you need to get the target within the Sidewinder's effective range and its field of view. For the AIM-9M, the field of view is 45 degrees to the right and left of your nose, while the 9X can see 70 degrees to either side of your nose. Therefore, you don't necessarily have to see the target to get a "SHOOT" cue, although the hit probability of your missile increases as the target nears the center of the HUD.

If you can close within a half mile or less, your Sidewinders become less effective, so you

should switch to your 20mm gun. You have two sights available for your gun, a historical lead predicting gunsight and an iron gun cross. The historical lead predicting gunsight predicts where bullets you fire now will be after they have traveled 2,250 ft. This means you must start firing your gun just before the target passes into the gunsight. The iron gun cross shows where your bullets would hit at 2,250 ft. if you were flying straight and level. Because you will almost never be flying straight and level in a dogfight, this sight is only useful if *you* are a good lead predictor.

There are a couple of things to remember about visual engagements. First, because you are in visual range, your stealth advantage is negated and you must outperform the enemy in order to win the engagement. Second, you should keep your eye on the velocity closure reading in the lower right corner of the HUD. If you close in too rapidly on the target, you risk an "overshoot" or passing the enemy, which puts the target in prime firing position—the hunted becomes the hunter!

In the realistic flight model, your aircraft is capable of high angle-of-attack maneuvers at low speeds, which enables you to snap your nose around to get quick missile and gun shots. But beware—at low speeds, it's easy to pull too much angle-of-attack and lose control of your aircraft.

Bombing: air-to-ground attacks

To make an air-to-ground attack, press **Enter** to select an air-to-ground weapon, such as the GBU-32 JDAM (see "US-built air-to-ground weapons" on page 151). Lock onto a target by preparing a shootlist (**S** key), selecting the target nearest to the center of your HUD (**L** key), or by clicking on an air target (red dots for enemy vehicles and yellow dots for buildings, friendly and enemy) in an MFD. Turn toward your target by following the target line extending from the center of your HUD. When the target is in your HUD, a large square appears around it.

The F-22 is not designed to perform dive bombing or low level bombing, so level out your aircraft once you've turned toward your target. In the Tactical MFD mode, there is a white circle with a dot in the center of it. The dot shows the ballistic or unguided impact point of your currently selected weapon. This is the only bombing aide that appears in your MFD when you use Mark 82, 83, and 84 unguided iron bombs or if you use laser-guided bombs without a FAC to guide them. The white circle represents the area to which your weapon can be guided, given your current altitude, speed, aircraft attitude, and the steering limits of your weapon.

Displayed on the right side of the HUD and the Attack MFD mode is the effective range scale for your bomb. It is depicted as a right bracket with your current target shown as a filled dot to the left of the bracket. The range to target (in miles) is above the bracket.

Fly until the target icon on the MFD is inside the white circle and the dot representing the target in the HUD is to the left of the bracket. When these parameters are met, a "DROP" cue appears in the bottom of the HUD and Tactical MFD mode, indicating that your weapon can be guided to your designated target. The closer your target is to the ballistic impact point of the weapon (dot inside the white circle) and to the center of the bracket in the HUD, the better chance your weapon has of hitting it.

As your aircraft climbs, the circle and the bracket get larger and move farther away from your aircraft, while they shrink and move closer when you dive. When you release an unpowered weapon, it assumes your speed,

heading, and altitude. All of these things determine the fall time of the bomb, which in turn dictates the area in which targets can be hit. The higher the altitude, the longer the fall, and the more time your weapon can steer toward your target.

Deep Strike, stealthy infiltration

Deep Strike missions are unique missions because it is more important to remain unseen than to engage enemies other than your mission targets. Because all Deep Strike missions are scheduled with only one aircraft, there are no wingmen to give away your position. It's completely up to you to survive alone and deep behind enemy lines.

The key to remaining unseen is staying clear of enemy aircraft and ground units with radar and infrared detection capabilities. Use the **RCS** and **Alt** options on the Mission Planning window (see "PDA: Mission Planning" on page 43) to plan a set of mission waypoints that steer clear of all known threats. Assume a stealthy RCS and stay at relatively high altitudes (30,000 ft. and above) to avoid small SAM and radar sites. Use the Payload screen to make sure you don't have any external weapons because they greatly increase your RCS. If necessary, lose some self-defensive weapons and move your mission-specific weapons to internal hard points in order to remain stealthy. If the enemy can't see you, they can't kill you!

When you think you have the perfect mission plan, select the **Takeoff** button to begin your mission. If an AWACS is available, use your UHF radio (**U** key), establish an In-Flight-Data-Link with it while you're still on the ground, and use its radar as your eyes throughout the mission. If no AWACS is available, use your active radar sparingly and rely mainly on your passive radar gear to warn you of enemies attempting to detect you. Any use of your active radar broadcasts your presence to every enemy within your radar cone out to twice your radar's maximum range, or approximately 240 miles. When you do use your active radar, it's a good idea to immediately turn and change altitude so enemy aircraft can't vector in to your position.

Once you are in the air, minimize your exposure to enemy units and aircraft. Because military intelligence isn't always accurate, you'll probably find both enemy aircraft and air defenses in your path. Avoid them at all costs, using your Defense MFD mode to fly around their radar detection envelopes, which should be greatly reduced due to your RCS. Use the Stealth MFD mode to make sure you are as stealthy as you can possibly be. Correct all RCS and Infrared Cross Section (IRCS) violators as soon as possible.

At your mission target, do whatever you have to do to complete your mission. If this means using your active radar, then do so, but avoid making too many bomb passes. From the minute you're detected, enemy ready alert and CAP aircraft start vectoring into your position. After you leave the target area, follow the same procedures you used during your ingress to the target. When you get near the front line or FEBA, you can engage enemies at your own risk. But remember, there is nothing more upsetting than flying a perfect mission for 30 minutes to an hour, only to get killed fooling around on the way home.

Defensive countermeasures

Chaff

Chaff is a small packet of aluminum strips used to fool radars. When a chaff packet is released, the strips disperse in the airstream and create a large radar cross section (RCS),

which may fool radar into believing it is the aircraft. The chaff can fool radar for up to three seconds, but after that, it is too dispersed. Because chaff produces a large RCS, it compromises your stealth.

You can launch chaff at any time to try to fool radar, but you have a limited quantity on board your aircraft. To increase the effectiveness of chaff, combine its release with defensive maneuvers (see "Defensive maneuvers" on page 96). When attempting to fool a radar-guided missile, it's best to launch chaff when the missile is approximately five seconds from impact (1–3 miles). This makes it difficult for the missile to reacquire or lock onto your aircraft before it passes you.

Flare

A flare is a combustible device that burns at a temperature simulating the infrared signature of jet engines. When a flare is released, it ignites behind the aircraft and creates a large infrared cross section (IRCS), which may fool an infrared search and track systems (IRST) for up to three seconds. After that, it no longer burns at the right temperature to create the appropriate IRCS. Because a flare produces a large IRCS, it compromises your stealth.

You can drop flares at any time to try to fool an IRST, but you have a limited quantity on board your aircraft. To increase the effectiveness of flares, combine their release with defensive maneuvers (see "Defensive maneuvers"). When attempting to fool an infrared guided missile, it's best to drop flares when the missile is approximately five seconds from impact (1–3 miles). This makes it difficult for the missile to reacquire your aircraft before it passes you.

ECM

Electronic countermeasures (ECM) is a piece of equipment used to fool radar into believing that your aircraft is somewhere other than where it really is. When activated, ECM captures radar signals directed at your aircraft and, after a varying time delay, transmits them back to the sender. Over three seconds, the ECM system gradually increases your apparent range from the radar system and then begins a new cycle. The net result is that radar systems see your aircraft at incorrect ranges, which can hamper tracking and firing, cause AAA to fire ahead or behind your aircraft, and cause SAMs to overshoot your aircraft. Because ECM deliberately emits a radar signal, it compromises your stealth.

You can use ECM at any time to try to fool radar systems. To increase the effectiveness of ECM, combine it with chaff and defensive maneuvers (see "Defensive maneuvers").

Defensive maneuvers

Once an enemy acquires your aircraft, you have several options to defeat the aircraft or missiles tracking you. As the previous sections explained, the F-22 has sophisticated ECM and chaff to deceive enemy radar and radar-guided missiles. It also carries ejectable flares to decoy infrared missiles. These devices provide the F-22 with the best technology in the world for defeating weapon systems, but they do not provide the maximum protection if used alone.

Maneuvering is the ultimate savior. When a launch occurs, turn to place the missile off your wing. If it's a radar-guided missile, activate your ECM. As it closes in, track it and continue to hold it off your wing by turning into it in an increasingly hard turn. When it is about five seconds from impact (1–3 miles), release your chaff or flares and perform a break turn toward the missile while dramatically pulling up or down as altitude allows. If it is a heat-seeking missile, pull your throttles to idle when this is done. The idea is to make the missile overshoot by dramatically changing your

position in the sky. A missile may be able to pull 20 as opposed to your 9 Gs, but it is traveling at speeds in the Mach 3+ range. This end maneuver is a violent, maximum performance maneuver—you're fighting for your life.

5 Postflight Operations

Postflight operations include saving pilots, locations, and missions for later play.

Ending a mission

To end a mission, press **Ctrl-Q**. Ejecting from your aircraft by pressing **Ctrl-E** also ends a mission, but your aircraft is lost and your pilot has the potential of becoming missing in action (MIA). To get full credit for your missions, do not exit until you've safely landed and come to a complete stop. Exiting at any other time may not give you the rewards for your accomplishments.

Debriefing

PDA: Mission Debriefing

The Mission Debriefing page on the Debriefing window presents mission results specific to you, your flight, and the entire air effort during the last mission. It also displays a brief Pilot Debriefing that lists promotions and awards.

Mission briefing description and abbreviations:

- **FM**—From (message sender)
- **TO**—To (message recipient)
- **SUBJ**—Subject
- **MSN NR**—Mission number

1. Result: Mission result (see "Results" below for more information)
2. Type: Mission type
3. Target: Mission target
4. BDA: Battle Damage Assessment (see "Results" below for more information)
5. Effectiveness: Mission Effectiveness (see "Results" below for more information)
6. TOT: Time on Target
7. T/O: Takeoff time
8. L/D: Landing time
9. Flight: Flight time
10. Amplifying Remarks: Other mission details, including the percent target destroyed
11. Your mission results: Things you personally destroyed

12. Your Entire Flight's mission results: Things you and your flight destroyed
13. Your Flight's mission losses: Destroyed aircraft from your flight
14. Overall Theater losses: Overall losses throughout the theater
15. Joint Rivet threat assessment: Description of actual threats along your waypoint path

Pilot debriefing—Name of pilot who received a decoration or promotion; also lists award type. Name of aircraft and missile type that shot you down, if applicable.

Continue—Exits the Debriefing window.

Results

There are three measures of your mission success:

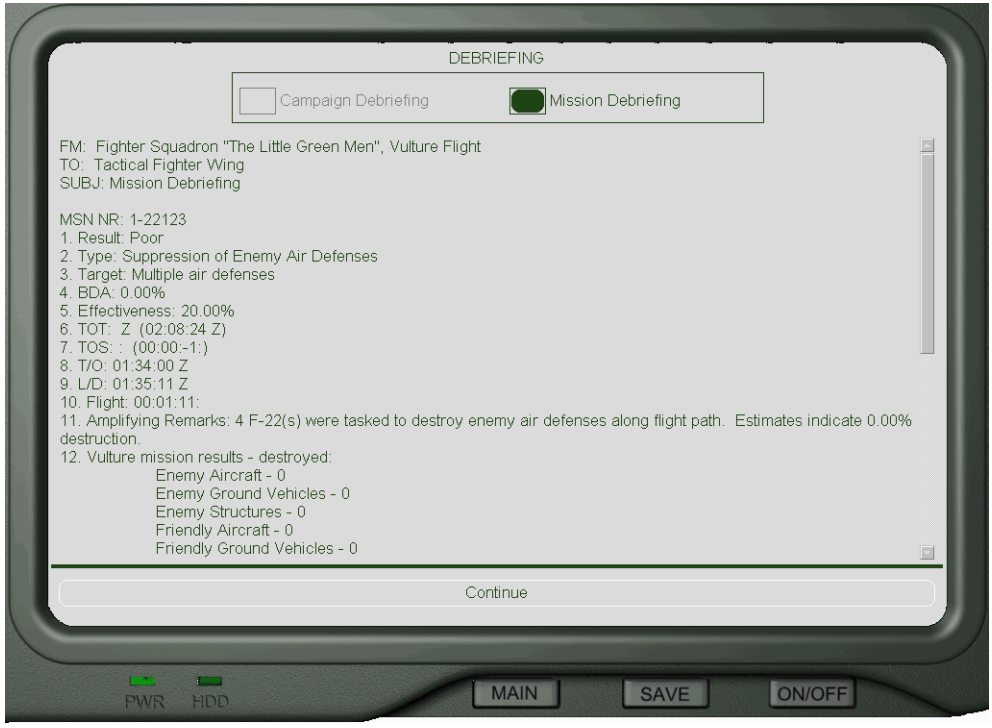
Mission Result—A text measure of your overall mission success, ranging from "Poor" to "Outstanding."

Battle Damage Assessment—Measure of the number of enemy aircraft, vehicles, and structures you and your flight destroyed.

Mission Effectiveness—Measure of your total effectiveness that takes enemy and friendly losses as well as time-on-target into account.

Victory and defeat

*i*F-22 Raptor uses a number of factors to determine the success or failure of each mission. The first factor considered is your time-on-target. Because other people are counting on you to perform your mission on time, you need to be at your target, CAP, or rendezvous waypoint on time. In the bottom right corner of the Nav-



igation HUD mode, there is a timer that displays the difference between your scheduled and actual time-on-target. If the value is negative, you are behind schedule and you should increase your speed until it reads roughly zero.

The second factor considered is the minimization of losses on your side, which includes your flight and any flight you are escorting. The third factor is how many enemies you killed, but destruction of mission targets is also essential. Mission targets for air-to-ground missions appear with an asterisk (*) beside them in the HUD and MFDs. Mission targets for air-to-air missions are simply enemy aircraft.

Campaigns

Your aircraft and flight are just a small part of a much larger campaign that ranges across vast areas (theaters) and that involves many thousands of combatants. Each time you fly a mission, you have the opportunity to affect the overall war effort. Your influence can make the difference between friendly ground forces capturing one area or retreating from another.

PDA: Campaign Debriefing

The Campaign Debriefing page of the Debriefing window presents the state of your squadron and the war effort. It details squadron missions and sorties flown as well as squadron aircraft lost. It also presents the results of enemy and allied ground offensives.

Campaign progression

The current state of the campaign is represented as a front line or forward edge of the battle area (FEBA). This line divides the areas held by both sides and indicates areas where major ground battles are likely to occur. Before, during, and after you fly a mission, both ground combatants and aircraft fight to gain control of areas along the FEBA and therefore expand their area of influence within the theater.

The ultimate objective of each side during a campaign is to control all of the objectives within the theater. Objectives are areas of extreme value, such as major cities, port facilities, road and railroad junctions, bridges, power facilities, and airports. To view the campaign objectives, select the **Objectives** button on the Mission Planning window.

You can directly influence the ground war by flying missions near or at the FEBA. If you want to influence the campaign in general, fly missions over friendly airspace or behind enemy lines.

Resupply and reinforcements

Throughout a campaign, the opposing forces take casualties in personnel, aircraft, ground vehicles, and ordinance. Each force has a rate at which they gain reinforcements and resupply to offset losses. If you inflict numerous losses on the enemy air defense vehicles, they can't put up a sufficient defense network until reinforcements arrive. Similarly, if your squadron has excessive aircraft losses, it can't perform all of the missions necessary to assist the ground forces or maintain air superiority. To find out when reinforcements and resupply will arrive, look at the Campaign Intro/Update window (see page 39).

Ending a campaign

Campaigns end when your side captures the last enemy held objective, the enemy captures the last friendly held objective, or when both sides decide to try peace. To see how close you are to winning or losing a campaign based on the objectives, select the **Objectives** button on the Mission Planning map, which displays how many objectives are currently held by both enemy (red) and allied (blue) forces and which objectives are currently being fought over or are neutral (green).

After a number of missions, the United Nations (UN) steps in and tries to get each side to agree to peace. When this happens, you'll see a UN window asking if you agree to peace talks, which effectively ends the campaign. If you prefer to continue the war, reject the peace overture.

PDA: Campaign Summary

When you complete a campaign (win, lose, or stalemate), the Campaign Summary window is displayed. This window presents the overall results of the campaign and statistics such as

number of enemies you destroyed and number of aircraft your flight has lost.

Pilot statistics, medals, and awards

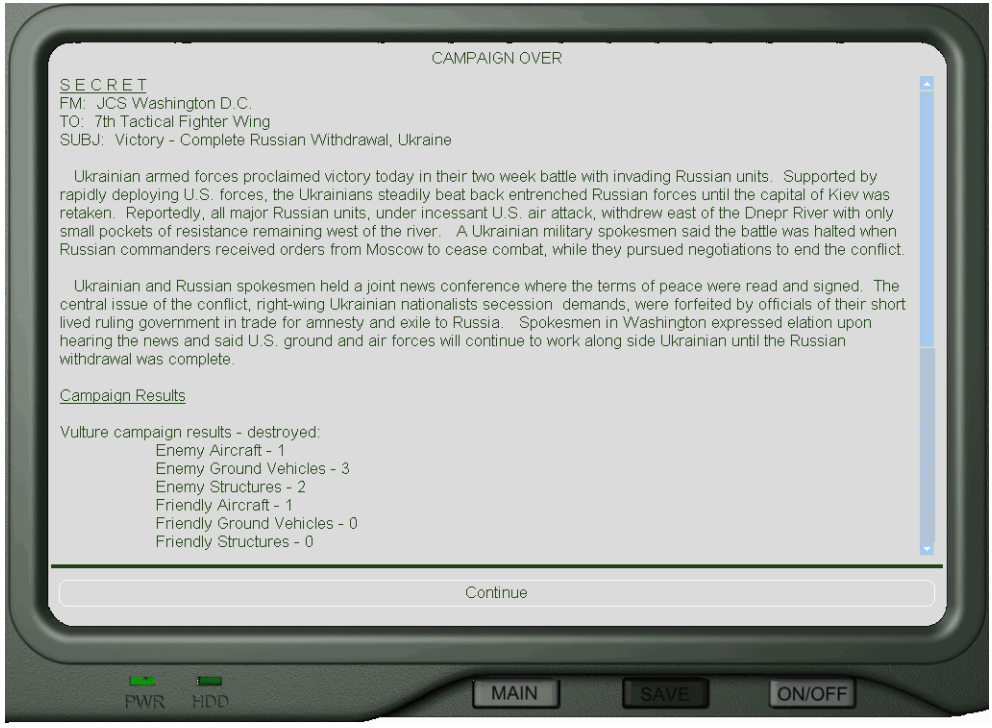
As you complete missions and campaigns, *i*F-22 Raptor keeps track of your results. You earn medals and promotions for successful efforts. There are three type of awards in *i*F-22 Raptor: ribbons, medals, and promotions.

Ribbons are awards that can be achieved by routine feats (such as minor mission successes) and by successfully completing campaigns.

Medals require more heroic feats and are awarded based on one of three categories: unique circumstances, mission success independent of difficulty level, and mission success dependent on difficulty level. The Air Force Achievement Medal, Distinguished Flying Cross, and Air Force Distinguished Service Medal are awarded based on mission success independent of difficulty level.

The Silver Star, Air Force Cross, and Air Force Congressional Medal of Honor—the most coveted medals in the game—are awarded based on both mission success and difficulty level. To be considered for these medals, your difficulty level needs to be 100 percent.

The remaining two medals, the Air Medal and Purple Heart, are awarded based on unique circumstances. The Air Medal is awarded for every ten combat missions flown. Each time you choose to resurrect your pilot, you receive a Purple Heart.



Two Hall of Fame boards show the ten highest mission and overall scores. After completing every mission, *i*F-22 Raptor checks to see if your score deserves a place in the Hall of Fame. If it does, you'll see the appropriate Hall of Fame with your pilot's name and callsign highlighted. Feel free to browse the records and accomplishments of the other pilots in the Hall of Fame by clicking on their plaques.

Death

Each time you bail out and land behind enemy lines, or if your plane is destroyed, your pilot is lost. You have the option of accepting the loss or resurrecting the pilot. If you choose to "accept your fate," then your pilot and all save games associated are lost, but your pilot's record is still available for review via the Ready Room. If you decide to save your pilot, the pilot automatically receives a Purple Heart.

If you use the invulnerability options, your pilot will never receive a Purple Heart and can never be lost. However, it is mathematically impossible to receive the most coveted medals using invulnerability. You must choose between immortality in action or the ultimate medals—you can't have both.

Multiplayer sessions

Multiplayer sessions, except for cooperative single missions, have their own unique scoring systems. For head-to-head dogfight sessions, there is a running total for each player (listed by callsign) in the upper right side of the window. The total shows number of kills each player has scored (the first number) versus the number of times the player has been killed (second number). At the end of the session, the player with the most kills sees a victory window, while all other players view a defeat window.

In head-to-head capture the flag sessions, the sudden death victor is the first team to land their C-17 transport on the neutral airfield, thereby capturing it. At this point, every player on the winning side views a victory window, while the losing team views the defeat window.

Multiplayer cooperative single missions operate identically to regular single missions and therefore end in the same ways.

When you die in multiplayer sessions, one of two things happens. In cooperative single missions, you are reincarnated at your previous waypoint. In capture-the-flag and dogfights, you are reincarnated at your original starting location.

6 General Principles

This chapter describes how the US Air Force organizes its units as well as basic principles of physics that affect flying a plane.

Air Force organizational units

*i*F-22 Raptor uses the standard US Air Force aircraft organization scheme. The smallest organizational element in *i*F-22 Raptor is the flight, which consists of one to four similar planes (all F-15s or F-22s, for example) on a similar mission. Throughout this simulation, you'll play the role of a flight leader for each of your missions.

The next level of aircraft organization is the squadron, which consists of 18 to 24 similar aircraft based at the same air base. At the start of each campaign, your squadron consists of 18 aircraft for which you receive replacement aircraft if you suffer losses.

Groups of two or more squadrons form wings. Wings can be comprised of squadrons made up of completely different aircraft, such as a squadron of A-10s and a squadron of F-22s.

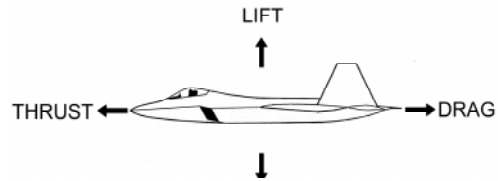
The final level of organization is an air force, which is composed of two or more wings. An example of an air force is the 3rd Air Force located in Mildenhall, England—not the US Air Force.

Flight principles

This section explains the rules of aerodynamics that affect flying, such as lift and drag. It also describes pilot maneuvers.

Basic physics

You don't need to be an engineer to enjoy *i*F-22 Raptor, but a basic understanding of the following aerodynamic principles will help you get the best performance from your aircraft and may keep you out of the dirt:



Lift—Bernoulli's Law says that the faster a body of air moves, the less pressure it exerts along its path. If you look at the cross-section of a wing, you see the upper side of the wing is curved (cambered), while the bottom half is essentially flat. Therefore, the air passing over the wing travels faster than that going under. This creates a lower pressure on top of the wing and allows the higher pressure on the bottom to "lift up" on the wing. If you don't have lift, you don't fly.

Drag—There are two types of drag, which is the resistance that air creates on a moving aircraft. Parasitic drag is caused by the air impacting or passing over the structure of the aircraft and can be affected by changing the physical configuration of the airplane. Lowering the gear and flaps or carrying external stores creates a larger surface area and increases drag. Induced drag is created as a function of lift being created by your wings and the speed of your aircraft. In other words, your drag increases whenever you increase the lift or speed on your F-22. Keeping these effects in mind is very important when maneuvering against an enemy.

Angle of Attack (AoA)—This is the angular difference between the wing and the direction of the airflow striking the wing. You can use it as a measure of the lift being produced by a wing. The lift a wing produces at a given airspeed increases as AoA is increased, but only up to a point. Beyond that point, the wing begins to "stall" or lose lift. Created by the air flow separating from the top of the wing, stalling can cause a loss of control.

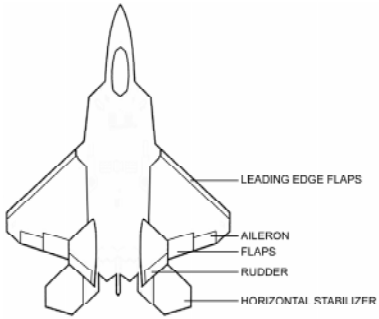
Stall—To rid yourself of the stall, you must reduce the AoA by releasing some or all of the back pressure on your control stick.

NOTE: With its thrust vectoring and advanced fly-by-wire technology, the F-22 is controllable even when the wings are stalled, but you must have a very soft touch on the controls.

Thrust and thrust vectoring—Newton's Law says that for every action, there is an equal and opposite reaction. Therefore, if you inflate a balloon and release it, it jets away from the open end in reaction to the air rushing out of the opening. Jet engines compress air and burn fuel to create a high pressure inside that exits out the exhaust. The force this creates is called thrust. Thrust drives your aircraft in the direction opposite the thrust direction or vector. In most aircraft, the thrust vector is parallel to the fuselage and pushes the aircraft forward. Next generation aircraft (such as the F-22) use a controllable thrust vectoring that can be moved up or down, thereby greatly affecting the aircraft's maneuverability.

Thrust-to-Weight (T/W) ratio—The T/W ratio of an aircraft is found by dividing the thrust of an aircraft by its weight. Modern fighters generally have a T/W ratio greater than 1:1, which indicates a formidable excess of power available to enhance maneuvering and to sustain energy.

Flaps—Flaps are movable devices on the trailing or leading edges of the wings that a pilot moves to increase the surface area and camber of the wing, thereby increasing lift. They also significantly increase drag. The flaps on the F-22 are automatically programmed by the Operational Flight Program and are based on predetermined flight laws.



Aileron—These devices control roll, are hinged to the rear of the wing, and are controlled by the control stick. (Move the stick left and right to roll left and right.) When you move your control stick left, the aileron on the right wing moves down, increasing its camber, which increases the lift of that wing, causing the right wing to rise and roll the aircraft left.

Horizontal stabilizer—These control surfaces, which are controlled by the control stick, are the small wings on the rear end of the aircraft and are used primarily to control pitch. Unlike the main wings, stabilizers are generally symmetrical in shape, thus producing the same amount of force on the top and bottom. To pitch the nose up, pull back on the control stick. Moving the leading edge of the stabilizer down increases lift on the underside and pulls the tail of the aircraft down, pitching the nose up.

Speed brakes—The speed brakes are movable surfaces on an aircraft used to rapidly increase the parasitic drag and quickly slow the aircraft. The F-22 does not have separate speed brakes—it moves its two rudders in opposite directions to create the needed drag.

G-forces—When maneuvering, aircraft generate forces in all axes of flight. Anytime the F-22 changes direction, in any axis, that change creates a force toward the outside of the direction of turn. The amount of this force is measured in Gs, or forces of gravity, with 1G equaling the amount of force exerted by Earth on any object. These Gs increase the apparent weight of all objects changing direction, including the aircraft and you. A *positive G* refers to an increase in the force in a direction from your head downward. A *negative G* is apparent in the opposite direction. All aircraft have structural G limits. If you exceed those limits, your aircraft can fail structurally.

Blackout/Redout—Just as aircraft have G limits, the pilots flying them have limits also. The high performance of today's aircraft places severe physical stresses on the pilots and, in fact, this limit is now considered by many to be the limiting factor in aircraft design. The two primary symptoms caused by G-load are *blackout* and *redout*. These phenomena can completely incapacitate a pilot and cause the loss of an aircraft. Excessive negative Gs push blood into the head, causing the pilot's vision to turn red. Excessive application of negative Gs can result in ruptured blood vessels in the eyes and brain and can cause permanent damage. Positive Gs make it harder for the heart to pump blood to the brain and, if maintained at a high level, can cause the pilot to lose consciousness. When Gs are released, blood returns to the brain, and the pilot regains consciousness but is in a confused state for some time. If you black out in your F-22, you will be a somewhat sloppy pilot for a period of time. Your enemies have the same problems. The F-22 uses a reclining pilot seat, the Advanced Technology Anti-G Suit (ATAGS), and Combined Advanced Technology Enhanced Design G-Ensemble (COMBATEDGE) to minimize these limits. See "Blackouts and redouts" on page 115 for more information on blackout and redout.

Maneuvering

This section explains aircraft controls and how to use them to maneuver.

Flight control system

For years, aircraft were controlled by the pilot controls in the cockpit (throttle, stick, and rudder pedals) that moved cables and rods connected directly to the control surfaces of the aircraft. As speeds and aircraft size rose, the force required to move the control surfaces increased to the point where pilots simply weren't strong enough. Hydraulic actuators were introduced to assist, but these were activated by a physical connection to the cockpit through the same cables and rods.

The fighter technology of today has removed those physical cables and replaced them with electrons and light "cables"; this is called fly-by-wire. In this system, the pilot still makes a control movement to cause the aircraft to perform a maneuver. However, these control inputs are now converted to electrical signals, which are passed through a high-speed computer that determines what control surface changes are needed and then sends signals to electrically activated hydraulic actuators connected to the surfaces. It does this according to preset flight laws in its software. This entire process takes milliseconds. Pilot input for engine performance is handled in the same manner. A throttle movement generates a signal that is sent to a microprocessor controlling the engine. The microprocessor evaluates the signal against factors such as speed, AoA, temperature, pressures, and fuel flows. If the processor determines that the action requested by the pilot is safe, it sends appropriate signals to the engine.

Flight controls

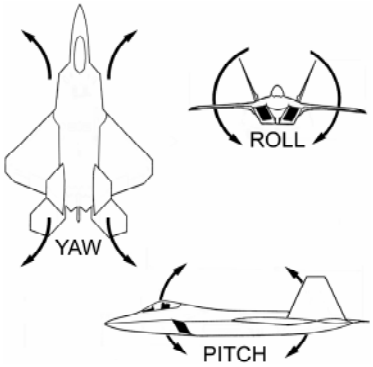
All aircraft can be maneuvered anywhere in the sky through movements in the following three axes. The ability of an aircraft to maneuver in these axes defines its maneuverability or agility.

Roll—The longitudinal axis is defined by a line extending lengthwise from the nose of the aircraft through its tail. Rotation around this axis results in a rolling motion of the aircraft and is controlled primarily by movable surfaces on the trailing edge of the wings called ailerons. The pilot controls roll through left/right movements of the control stick. In addition to the ailerons, the F-22 sometimes uses its horizontal stabilizers and rudders to assist in roll.

Pitch—The lateral axis is essentially defined by a line running from wingtip to wingtip. Rotation around this axis, controlled by the stabilizer, is manifested with movement of the nose up and down and is called pitch. The pilot controls pitch through forward and back movements of the control stick. The F-22 is expected to be the first production aircraft in the world with added pitch control provided by thrust vectoring. In this case, the engine exhaust nozzles move up and down, directing the thrust of the engines at an angle to the fuselage. This adds to the pitching moment of aircraft, particularly during low-speed flight.

Yaw—An aircraft experiences yaw whenever there is a rotating moment about a vertical axis drawn through the center of the aircraft. In simple terms, yaw is the left-right movement

of the nose of an aircraft in the air and is controlled using the rudder pedals.



Control devices

All fixed-wing aircraft have three devices that control movement:

Flight stick—Controls the aircraft roll (left and right stick movement) and pitch (up and down stick movement)

Rudder pedals—Control the aircraft's yaw angle (left and right pedal movements)

Throttle—Controls the aircraft's forward thrust and velocity

Aircraft performance

It's very difficult to say that one aircraft is better than another because performance is made up of so many factors. One plane may prove be far superior in one performance factor but not even compete in another. Also, certain missions require superior performance in some aspects, so a mission-specific aircraft's lack of performance in an area outside the mission's scope is generally considered irrelevant.

A common performance issue for all aircraft is managing the energy of the airplane in any phase of flight. This energy can be potential (altitude is an example), kinetic (speed), or stored (fuel). Maneuvers and decisions you make with your aircraft affect the energy state and will dramatically impact the performance. Keep this in mind when reading about the following performance measurements:

Speed

Speed is life…Israeli Tactics Manual

Acceleration is of key importance and often overlooked…Lt. General Adolph Galland, Luftwaffe

The preceding quotations may sound repetitive, but realize that there are different kinds of speed. If an aircraft accelerates well, it's often called "quick." This is a good characteristic for aircraft involved in classic dogfights, during which the ability of an airplane to gain speed and energy is essential. However, that aircraft doesn't necessarily need an extremely high top-speed or to be "fast." An interceptor needs that high top-speed to enable it to rapidly reach out and touch the enemy far from the base or target it was protecting. The F-22 presents an excellent compromise in this area with its Supercruise capability, which provides a very good top speed (Mach 1.78 without afterburner, near Mach 2.0 with afterburner) and excellent thrust-to-weight ratio.

Turn capability

[The Luftwaffe High Command] were stuck on the idea that maneuverability in banking was primarily the determining factor in air combat.…They could not or simply would not see that for modern fighter aircraft the tight turn as a form of aerial combat represented the exception…
Lt. General Adolph Galland, Luftwaffe

Turning ability can be a critical aspect of fighter design. But like speed, judging the turn capability of an aircraft depends on what type turn capability you need. Turning ability of an aircraft is usually measured in two ways: instantaneous turn rate and sustained turn rate.

The instantaneous turn rate is the maximum rate of turn (in degrees per second) that an aircraft can generate without overstressing the airframe. It is usually performed by executing a break turn, but you will lose speed/energy whenever you execute a break turn. Use this turn to break a missile lock or gun track or to get that nose position for your own shot.

Sustained turn rate is the maximum rate of turn an aircraft can generate without losing energy. It's important to remember that you can maintain a sustained turn rate until you run out of fuel or your body just can't take it any more. The F-22 can maintain higher sustained and instantaneous rates of turn than conventional aircraft because of its unique thrust vectoring capability. But be aware of your body's limitations to handle the incredible forces involved.

Effects of weapon loadouts

The F-22, due to its stealthiness and advanced weapons system, isn't required to carry heavy payloads compared to aircraft such as the F-15. The wings of any aircraft create only so much lift. Adding more weight to the aircraft with weapons or fuel means that more of that generated lift is used to keep the aircraft aloft rather than being available for turn performance. To achieve better performance, don't load your aircraft down with weapons or fuel you don't need.

Similarly, carrying external stores on your wings hinders the roll rate of your aircraft and thus its performance. An even greater penalty is paid by your stealth factor in this case, so carrying external stores is not recommended except in extreme circumstances.

Thrust vectoring

Nearly all aircraft are maneuvered through the use of the control devices mentioned earlier: rudders, ailerons, and horizontal stabilizers. Recently, advanced flight computer programming and design have allowed the use of the rudders and stabilizers to enhance the roll rate of modern aircraft. The latest performance enhancement, however, has been the addition of thrust vectoring, which involves moving the exhaust nozzles of an aircraft to redirect the thrust vector. This imparts a force not directly along the fuselage line of the aircraft and causes it to move the rear end of the aircraft in the direction opposite the new thrust vector. The F-22's thrust vectoring affects the pitch axis of the aircraft by ±20 degrees. This provides it with improved instantaneous and sustained turn capability, improved low airspeed/high AoA control, better Mach 1+ turn ability, and the ability to point the nose of the aircraft more effectively to improve its weapons' effectiveness. The entire vectoring system is fully automated and controlled by the flight dynamics computer. You as a pilot never see the vectoring system working; you see only the result.

Basic fighter maneuvers

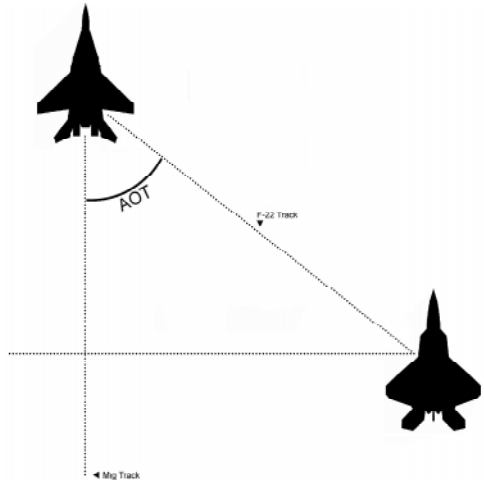
When fighter pilots are engaged in a close-in dogfight, they use a series of maneuvers to gain a positional advantage over their adversary. These maneuvers by themselves are not "magic" and are really are extensions of other maneuvers the pilots have learned since entering flight training. The magic comes with knowing when to perform which maneuvers and integrating these maneuvers, sometimes simultaneously, into a series of actions that result in a superior firing position.

Maneuver factors

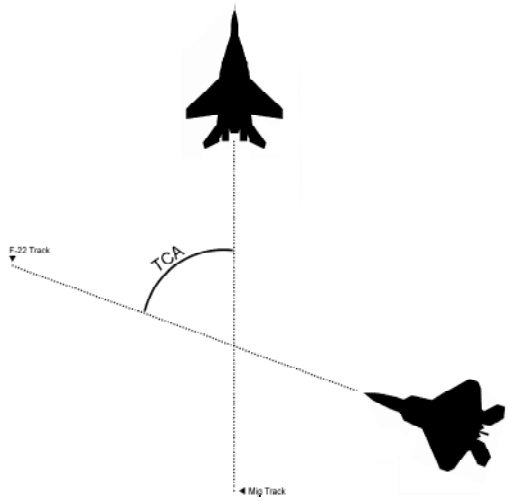
Factors affecting basic fighter maneuvers are as follows:

Angle Off the Tail (AOT)—Measurement of degrees off an enemy's tail. If you are at the six

o'clock position of an aircraft, you are 0 degrees AOT. If you are directly off either wing, the AOT is 90 degrees, and straight ahead is 180 degrees AOT.



Track Crossing Angle (TCA)—Instantaneous measurement of the angular differences in velocity vectors of two aircraft. If your flight path is parallel to that of another aircraft, you have a 0 degree TCA. If you are approaching perpendicular to the flight path, you have a TCA of 90 degrees. A pure head-on pass has a TCA of 180 degrees.



Nose phase—The position of an aircraft's nose. Is it high? Is it low? Going right or left? See the "General rules for fighting" on page 114.

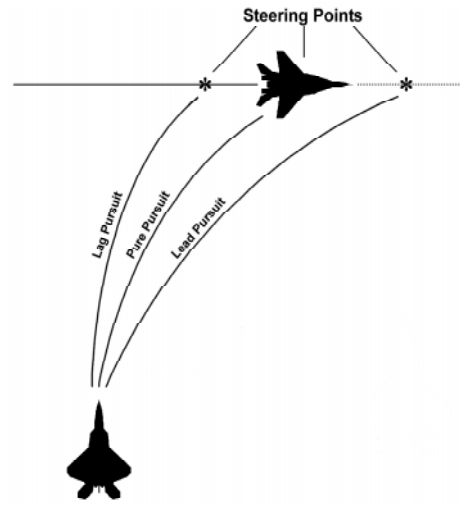
Closure—Measurement, in knots, of how fast you are closing range with another aircraft.

Energy state—The total energy an aircraft has, whether it is speed, altitude, or power. This is the single most important resource to manage during an engagement.

Maneuver definitions

Let's look at some of the basic maneuvers and discuss what each one accomplishes:

Lead pursuit—A method of interception where the nose of the attacking aircraft is positioned *ahead* of the target aircraft to "cut across the circle." This maneuver reduces TCA and increases closure to the maximum rate. Most effective at high AOT, it does cause an increase in AOT initially.



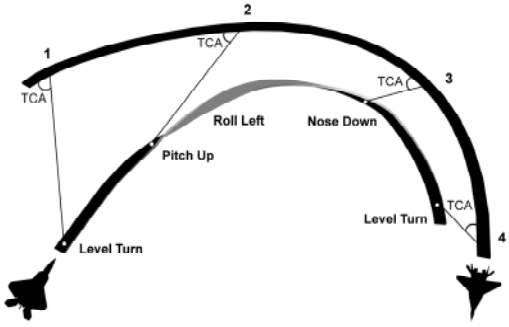
Pure pursuit—A method of interception where the nose of the attacking aircraft is positioned *on* the target aircraft. This maneuver reduces TCA without increasing AOT at the expense of a reduced closure rate.

Lag pursuit—A method of interception where the nose of the attacking aircraft is positioned *behind* the target aircraft. This maneuver reduces AOT at the maximum rate while maintaining TCA and stopping closure.

Hard turn—A maneuvering turn, usually into the opposing aircraft, at a G-force that allows the pilot to *maintain* energy (no loss of speed or altitude).

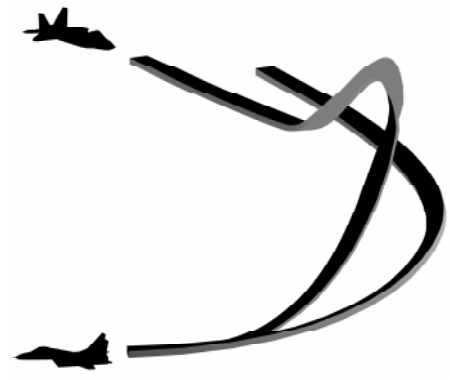
Break turn—A maneuvering turn, usually into the opposing aircraft, that sacrifices energy for maximum turn rate and reduced turn radius.

Lag roll—A maneuver performed by executing a rolling pull-up in the direction outside the turn to decrease closure and prevent overshoot without sacrificing speed or energy. The roll is done against a turning aircraft to roughly maintain the attacker's lift vector on the target's flight path, and G is adjusted to arrive at a point just behind the target. This maneuver is used in situations of high closure and low AOT.



Lag roll

Displacement roll—Similar to the lag roll, this maneuver is used in close-range, low closure situations to reduce AOT and increase range. Again, a rolling pull up to the outside of the turn is performed; however, in this situation, the G is adjusted based solely on nose-to-tail range and angular displacement of the attacking aircraft toward the target aircraft's flight path.



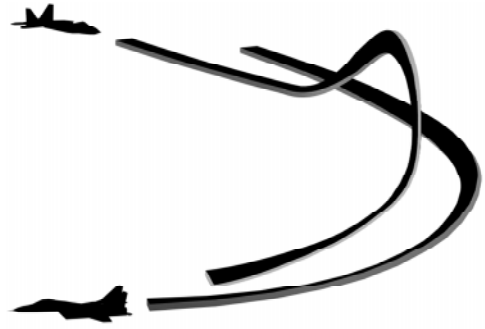
Displacement roll

Barrel-roll attack—Similar to the previous rolling attacks, the barrel-roll attack is executed in the same manner but with the goal being to displace the attacking aircraft in the rear hemisphere of the target aircraft and with an altitude advantage that can be used to further maneuver for the advantage. Effectively, it is a very slow roll with an extended climb that conserves energy and results in an inverted position well above the target aircraft and transitioning to the rear hemisphere. The maneuver is completed to approach the target from above and off to one side.

Barrel roll

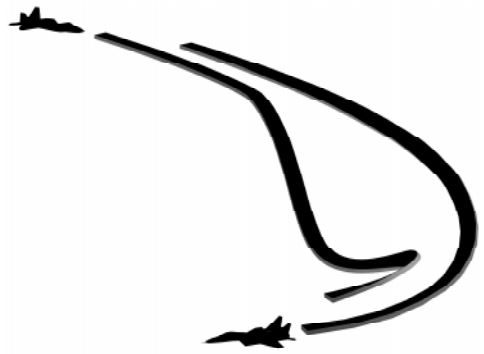
High Yo-Yo—This maneuver is used to prevent overshoot or to reduce AOT in similar-speed situations when excessive lead is not available. The vertical is used to maintain energy while decreasing closure. The wings are rolled level (or nearly), and a pull-up is initiated until a point is reached in the upper rear hemisphere

of the target aircraft with nearly zero closure. The attacking aircraft then rolls into the target aircraft in the appropriate pursuit curve.



Hi Yo-Yo maneuver

Low Yo-Yo—This maneuver is used to increase closure and angular advantage. The nose of the attacker is lowered and the aircraft rolled to place its lift vector in a lead pursuit position ahead of the bogey aircraft. This maneuver increases closure, and range is reduced by cutting across the circle. The attacker then climbs back to a position behind and level with the target aircraft.

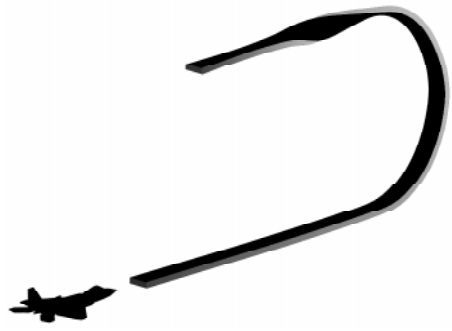


Low Yo-Yo maneuver

Scissors—This maneuver occurs when two aircraft attempt to maintain their lift vectors on one another. An example is an overshoot by an attacker during which the attacked aircraft reverses back into the attacker as it turns back toward the target. This results in another overshoot, and the aircraft then reverses again. This situation continues until a stalemate occurs or one aircraft (usually the slower of the two) gains a favorable advantage. Scissors can be either flat (level reversals on one another), rolling (where both the horizontal and vertical are used), or vertical.

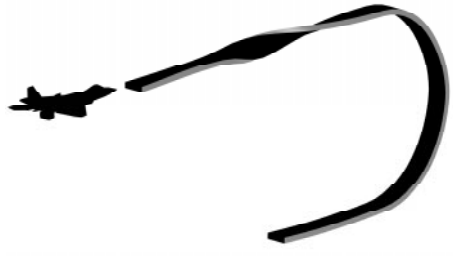
Scissors maneuver

Immelmann—A vertical maneuver used to manage energy and gain an altitude advantage while changing direction. Accomplished by performing a half-loop and rolling wings level on the top.



Immelmann maneuver

Split S—The reverse of an Immelmann where the aircraft is rolled inverted and the last half of a loop performed.



Split S maneuver

Lead turn—This maneuver is used by the attacker when converging on the target aircraft with a very high AOT (from the forward hemisphere). A turn into the target aircraft begins well before the aircraft are abeam. The turn is continued until approaching 0 degrees AOT or a point where a lag pursuit can commence.

Head-on options—These are basically turn direction options afforded aircraft with very high AOT approaches (forward hemisphere) and can be accomplished in the vertical as well as horizontal. They are defined by the resulting relative position *if* the turns are held to conclusion. The first of these turns is the nose-to-nose maneuver, in which both aircraft turn toward the same side. If held, similar performing aircraft will pass nose-to-nose on the opposite side of the circle, 180 degrees from where they began. The second option is the nose-to-tail maneuver, which is accomplished when the merging aircraft turn toward one another at the merge. This option results in similar performance aircraft being widely separated with 0 degrees TCA when the turn has completed 180 degrees. The decision of which of these options to choose is strongly influenced by flight path separation and turn performance.

Bug out and extension—A disengagement maneuver best performed when the flight paths of two aircraft are diverging and one attempts to gain horizontal separation either to exit the fight or to maneuver for reengagement. The goal is to gain maximum energy and speed to affect the separation and establish the aircraft in a more advantageous position from which to reenter the fight. It is best accomplished by "unloading" the aircraft (go to 0 G and full power). This results in maximum acceleration and separation.

General rules for fighting

There are some basic rules to follow to improve your chances of success during fighting:

Match nose phase of bogey—If the enemy's nose starts up/down, move yours in the same direction.

Match lift vector of bogey—Basically, maintain the same roll angle as your enemy.

Maintain range and closure—Control these variables to prevent large swings in the situation.

Put the bogey on your nose—When in doubt, strive to maintain the enemy in your forward hemisphere.

Use the vertical—Don't get stuck in a horizontal turning match. Using the vertical helps you manage your energy and decrease apparent turn radii.

Stalls

*The Immelmann Turn was very successful….But later, when more powerful engines became available, it was a dangerous move, for the lower pilot could climb after the Fokker and attack the enemy when it hung almost motionless in the vertical position, not under full control, and presenting an easy shot…*Air Vice-Marshal J.E. "Johnnie"

Johnson, Leading RAF Ace in Europe, WWII, 38 Victories

As described on page 106, when the AoA of a wing reaches a certain point, the airflow over the top of the wing begins to detach from the surface of the wing, and a loss of lift occurs. This results in an instability in the aircraft and a decrease in the control available.

Because of these problems, it is best to avoid stalling the aircraft if at all possible. A stall can usually be recognized by an airframe buffet and gradually changing control authority. In addition, the F-22's aural warning system will advise you of an approaching stall. However, there are times when you will unknowingly, or purposely, find yourself in a stall but still need to control your aircraft. The F-22's state-of-the-art flight dynamics computer is optimized for this type of flight, and its thrust vectoring lets you fly at AoAs unavailable to most fighters. Be gentle with your controls and avoid large rudder inputs. You can then continue fighting under control when other aircraft are struggling just to maintain controlled flight.

To recover from a stall, pitch your aircraft's nose down to gain airspeed and avoid drastic control stick and rudder movements. When the aircraft gains sufficient airspeed, it should return to normal controlled flight.

Spins

A spin results when factors combine to upset the balance of stable, controlled flight and cause an excessive yaw rate. A spin is actually a balanced (although uncontrolled) state of flight, which means that you should take positive action to unbalance the flight and recover from the spin. The flight dynamics computer of the F-22 recognizes the onset of a spin and attempts to prevent entry.

To recover from a spin, point your aircraft nose down to gain speed and apply rudders opposite of the spin direction (differential rudders). This usually brings the aircraft back under your control, but when all else fails, point your nose down and release the stick. This gives the flight control system full control over your control surfaces, which can greatly aid in spin recovery.

Blackouts and redouts

Your aircraft is capable of sustaining incredible G loads, but you are not! Whenever you pull more than six Gs, you begin restricting the blood flow to your upper extremities. This in turn deprives your brain of much-needed oxygen and can result in loss of consciousness. The rate at which you black out increases as you near nine Gs, your plane's imposed limit.

There are also dire effects for sustaining too many negative Gs. Whenever you sustain negative one to negative three Gs (imposed aircraft limit), you're forcing too much blood into your brain and begin to suffer a redout. As with blackouts, the onset of redouts increases as you sustain more negative Gs.

Neither blackout or redouts are instantaneous effects, so when the screen begin to turn black or red, take measures to counter these effects. To negate the onset of blackouts or redouts, release your flight stick or minimize the G load of your aircraft (bring the G load closer to one).

Ejecting

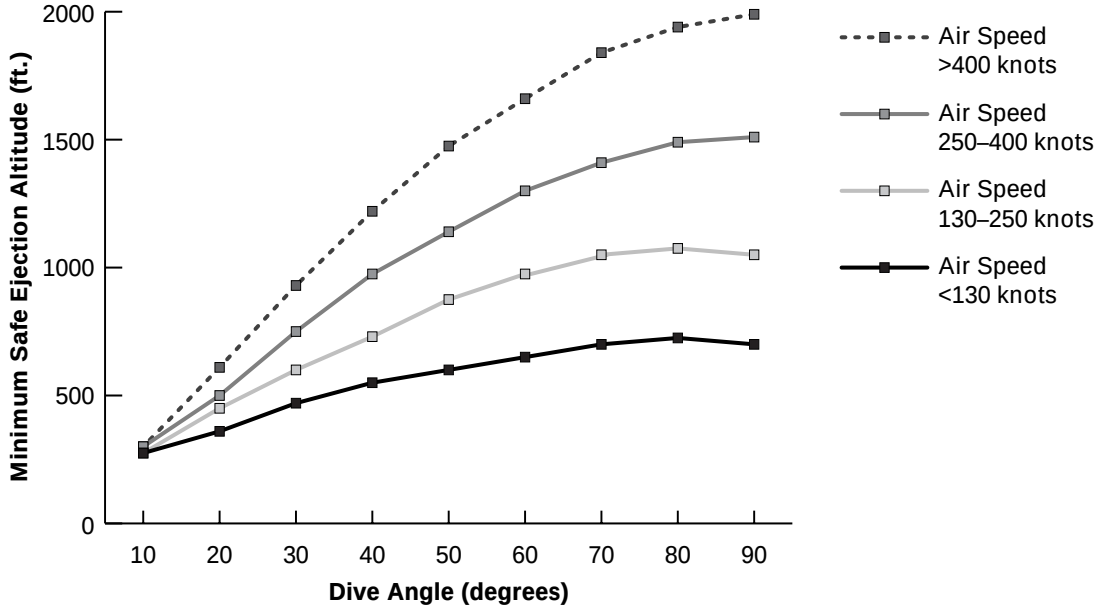
Sometimes, the aircraft is uncontrollable despite your best efforts. When that happens, you have no choice but to save yourself to fight another day. To help you do this, modern fighters are equipped with rocket-propelled ejection seats. The F-22, equipped with the

ACES II seat with the Advanced Recovery Sequencer (ARS), provides you a safe, reliable seat with which to trust your life. When you make a decision to eject and pull the handle, you put into operation a complex but rapid sequence of events that will give you the ride of your life.

With the ACES II seat, you can exit the aircraft through the canopy if it fails to be jettisoned. Canopy breakers located on top of the seat fracture the canopy before you go through it. Upon ejection, the seat snaps to a vertical position and harness restraints pull you upright in the seat to minimize back injury, and it repositions your legs and feet. A gas-generation gun is fired, and the seat begins to travel up the guide rails. Your arms and legs are drawn in to the seat by a restraint system to prevent them from flailing in the windstream and being injured.

As the seat nears the top of the guide rails, small rocket motors in the base of the seat fire, generating approximately 5,000 lbs. of thrust. This lifts the seat out of the aircraft and into the windstream. Once clear of the aircraft, a small parachute deploys to stabilize the seat. At this point, the ARS evaluates the altitude and airspeed to determine what happens next. If the ejection occurred at high altitude, the pilot remains in the stabilized seat until it falls to approximately 11,000–14,000 ft. above sea level, at which point the ARS automatically deploys a drogue chute. The drogue chute slows the seat further and then deploys the main parachute. The pilot's lap belt, leg restraints, and arm restraints are released, and the pilot is pulled from the seat by the main chute opening. At low altitude, this entire process takes less than four seconds.

Refer to the following chart that outlines the general "safe ejection" parameters for the F-22. Please note that increasing dive angle, airspeed, or roll angle decreases the minimum safe altitude.



Stealth principles

He who sees first, lives longest...Unknown

For years, combatants have struggled to avoid being seen by either avoiding the enemy or deceiving the enemy. At the same time, giant strides have been taken toward detecting those that are trying to hide or deceive. Today, detection of the enemy usually occurs through one of four search and track systems.

Types of search and track systems

Search and track systems are as follows:

- Radar
- Infrared Search and Track (IRST)
- Electronic signals
- Mark I eyeball

Radar

Radar works on the principle of time. Electronic pulses, focused by the radar dish, are transmitted in a very narrow beam. The dish then switches into a receive mode and "listens." When the transmitted pulse strikes an object, the signal reflects from that object and returns to the radar, which "hears" it. By calculating the time of the return and the bearing, radar can pinpoint the position of an object. Radar requires that the transmitted signal be reflected strongly enough for the receiver to detect the return. New technologies in aircraft design and radar-absorbent materials have reduced radar reflectivity—the radar cross section (RCS)—of aircraft dramatically. The F-22 is said to possess an RCS one-thousandth that of the F-15, which severely reduces the range at which radar can detect the aircraft.

Infrared Search and Track (IRST)

Aircraft generate a heat "signature" in many ways. Aside from their engines, there are pumps, exhausts, piping, and friction-generated heat on their skin (surface of the aircraft). Infrared Search and Track (IRST) devices detect the heat differences between the aircraft and its background and display the target optically. Special materials, piloting skills, and careful aircraft design can reduce the signature and delay or prevent detection. The F-22 uses all these technologies to reduce its susceptibility to IRST detection.

Electronic signals

Any electronic transmission acts as a beacon to enemy surveillance equipment. The F-22 uses Low Probability of Intercept (LPI) radar and a low-power data link to minimize its electronic signature. However, despite the best of stealth technologies, it is virtually impossible to hide your aircraft if you transmit using radar, radio, or electronic countermeasures. There are times when these transmissions are necessary, but they must be kept to a minimum if the F-22 stealth is to be maintained.

Mark I eyeball

One peek is worth a thousand [radar] sweeps... Unknown

The Mark I eyeball —the pilot's eyes—is still the fighter pilot's last line of defense. A pilot who sees the enemy first will generally win the fight. Modern aircraft minimize their visual signature as well, and a keen eye is necessary to pick out the enemy fighter beyond 5 miles.

Maximizing stealth

I attempt to attack out of the sun. If the enemy aircraft is surprised, he's duck soup, but time is an important factor and it should not be wasted in securing position...Lt. Colonel John C. Meyer, USAAF

The F-22, when operating in stealthy mode, minimizes the need for transmissions by rely-

ing on an integrated system of sophisticated elements received via data link from the E-3 AWACS. This link provides the location of aircraft (determined by AWACS), enemy radar radio sites (determined by Rivet Joint aircraft) and ground targets (determined by JSTAR aircraft). This data is integrated and plotted on the F-22 displays with no transmissions required from the F-22.

If transmissions are required, here are a few hints to minimize your aircraft's exposure:

- Cycle your radar on only to update positions of enemy aircraft or to target them directly with one of your radar-guided missiles.
- Keep radio transmissions under five seconds.
- Don't activate electronic countermeasures unless you are in a high threat area with several radars or are targeted and a missile is on its way.
- Minimize use of your afterburners when there is an infrared threat nearby.
- Don't fly at low altitudes if at all possible. This exposes the F-22 to a variety of optically aimed weapons alerted by sound or sight.
- Don't open the weapon bay doors until necessary. The RCS increases dramatically when these doors are open.

7 Campaign Scenarios

The Bosnian Conflict

History

15 June 2002

Sarajevo, Bosnia—The last UNEIFOR (United Nations Extended Implementation Force) unit, a French paratroop brigade, left Sarajevo this afternoon, ending UN military involvement in the Dayton Accords. The decision to end the peacekeeping mission, rather than extend it for another year, was nearly as contentious as the conflict that the mission was intended to resolve. American NATO and State Department officials, supported by Poland and Bulgaria, felt that "the nations of the former Yugoslavia are still too riven by division...to be left without the stabilizing influence that a United Nations peacekeeping force provides" and unsuccessfully fought to extend the mission over the objections of the French and German governments.

12 December 2003

Beograd, Serbia—Today, Biljana Plavsic was sworn in as the new President of Serbia, capping an incredible political comeback. After serving as Vice President to Slobodan Milosovic, Plavsic became an outspoken opponent of the Serbian government and its attempts at reconciliation with the west. An ardent nationalist, she championed Serbian "ethnic self-fulfillment" during the recent election campaign, striking a chord within a Serbian population that has suffered from years of hyperinflation and economic turmoil.

News of Plavsic's election in October was greeted with celebration in the streets by ethnic Serbs in neighboring Bosnia and Croatia, who have claimed to be victims of unfair treatment and racial prejudice since the final withdrawal of UN forces in 2002.

22 December 2003

Beograd, Serbia—At a press conference today, Serbian government officials announced that Serbia was "interested in the welfare and well being of Serbs everywhere," and that they would begin collecting information on the abuse of ethnic Serbs in neighboring Bosnia and Croatia. If warranted, the data would be presented to the World Court in The Hague, and Serbia would ask for the formation of a tribunal to investigate the claims.

Both the Bosnian and Croatian governments have denied any wrongdoing, and in a joint statement, called the action "a thinly veiled political ploy... [to] draw attention from the blood on Serbia's hands."

6 April 2004

Tuzla, Bosnia—Since the beginning of the year, incidents between ethnic Serbs and government security forces in Bosnia have become an increasing source of tension between the Serbian and Bosnian governments. Ethnic Serbs demonstrating against a lack of access to government jobs or health care, as well as alleged abuses by the Bosnian government's internal security troops, have increasingly been met by police and Bosnian army troops in riot gear. Bosnian officials have repeatedly charged that the demonstrations are being orchestrated by Serbian agents, although no firm evidence has been provided for these accusations.

The Serbian government has denied any role in the disturbances but has indicated that it "cannot stand idly by as our brothers are beaten in the streets."

8 April 2004

Foggia, Italy—US intelligence sources revealed today that Serbian forces have been gathering along the borders with Bosnia and Croatia for the past week. It is unclear whether this is merely saber-rattling by Serbia, or actual preparation for war.

Bosnian and Croatian forces have been put on alert, but despite the efforts of successive American presidents to increase their effectiveness, both are generally considered inferior to the Serbian forces they are facing. American troops in Italy and Germany have been put on high alert and are said to be preparing for any contingency, including direct intervention by American ground troops in the former Yugoslavia.

Administration officials have both publicly and privately warned Serbian representatives that a renewal of the conflict in Bosnia would "not be acceptable" and would almost certainly lead to a direct confrontation with American forces.

The Serbian government has denied that it is preparing for war and has described the troop deployments as a reasonable precaution against a "spillover" of tensions from neighboring Bosnia and Croatia.

18 April 2004

Osijek, Croatia—Protests by ethnic Serbs turned violent today as demonstrators stormed government offices, looting and burning before being scattered by security forces backed up by Croatian army tanks. Additionally, car bombs were detonated in a crowded marketplace in Bijeljina, and in front of a government office in Slavonska, injuring dozens in these predominately ethnic Serb towns.

When police and ambulances arrived to cordon off the areas and tend to the injured, they were met by angry crowds demanding to be "protected from these attacks" and threatening "if you won't protect us from this, perhaps we should find someone who will."

This marks the sixth straight day that bombs have exploded in ethnically Serb towns, and their toll is mounting. No person or organization has come forward to take credit for the attacks.

20 April 2004

Sarajevo, Bosnia—Serbian tanks rolled across the Bosnian and Croatian borders yesterday, in response to continuing terrorist attacks on ethnic Serbs.

In an open radio broadcast, Serbian President Biljana Plavsic declared that Serbian forces were entering Bosnia and Croatia in order to protect the lives of the endangered Serbian minorities in both countries and would only

remain as long as was necessary to guarantee their safety and well-being.

Heavy fighting has been reported in some areas as Serbian columns advanced across the countryside, but in most cases, initial Bosnian resistance has been swept aside. Croatian forces have fared better, although they are also reportedly giving ground to the advancing Serbs.

21 April 2004

Zagreb, Croatia—Interpol claims to have captured three Serbian intelligence agents in Austria, who reportedly confessed to planting the car bombs in Bijeljina and Slavonska at the behest of the Serbian government. They also supplied the names and descriptions of more than 20 others, still in Bosnia and Croatia, who they say have been engaged in similar activities.

The Serbian government hotly denied the charges, calling them "obvious lies." It referred to the supposed agents as "Croatian dupes" and "a weak propaganda ploy that should be obvious to all."

However, these accusations have caught the attention of the international community, which has largely stood on the sidelines as this new conflict has unfolded, despite American efforts to organize new sanctions against Serbia and provide military aid to the Bosnians and Croatians.

24 April 2004

Washington, DC—In a televised address last evening, the President announced that American forces would be entering Bosnia and Croatia to "help put an end to this bloody war of aggression…perpetrated by the Serbian government against the people of Bosnia and Croatia. We must now, once again, enter into a conflict that we did not start, but because of our own strong sense of moral duty and integrity, must end."

Objectives

Allied objectives are to:

1. Establish air superiority over the battlefield
2. Halt the further advance of Serbian troops into Bosnia and Croatia
3. Liberate Serbian-occupied territories
4. Continue to prosecute the war until the Serbian government capitulates

Allied forces

American ground forces entered Bosnia and Serbia via overland railroad routes and the Adriatic coastline, joining the Bosnian and Croatian forces already there. Despite American attempts to mold the Bosnian and Croatian armies into capable fighting forces (including equipping them with American equipment), the armies are generally regarded as inferior to the Serbian army they face.

American air forces operate primarily out of airbases in Italy, although the Italians have not themselves committed forces to the conflict. Likewise, neither have America's other major NATO allies. Neither Bosnia nor Croatia has significant air forces.

Allied forces in the Bosnian Conflict

Tanks	**Air Defense**	**Aircraft**
M1A2	BSFV	AH-64 Apache
APCs	IHAWK	UH-60 Blackhawk
M2	Patriot	A-10 Warthog
Artillery	Shoulder Launched	F-15 Eagle
M109	• FIM-92 Stinger	F-16 Fighting Falcon
MLRS		F-22 Raptor
		E-3A AWACS
		C-17 Globemaster III
		B-52 Stratofortress

Enemy forces

Since the signing of the Dayton Accords in 1996, the Serbian military has spent its time expanding and rearming to maintain its position as the pre-eminent military power among the former Yugoslavian republics. Russia, who has traditionally taken a great interest in the affairs of other Slavic peoples such as the Serbs, supplied them with surplus equipment and military advisors, even during the Serb-West détente at the turn of the century.

The Serbian air force is moderately sized and represents a good balance between air superiority and ground attack capabilities. MiG-23 Flogger, MiG-29 Fulcrum, and Su-25 Frogfoot aircraft form the backbone of the Serbian air force and are the most likely to be encountered. Also present is a small squadron of MiG-31 Foxhound interceptors, whose powerful radar and long-range AA-9 Amos missiles could present a significant threat to air operations.

Serbia makes use of many mobile SAM systems, including the SA-13 Gopher and SA-15 Gauntlet systems. The most common long-range SAM system is certainly the SA-11 Gadfly.

Enemy forces in the Bosnian Conflict

Tanks	Air Defense	Aircraft
T-72	S60—57mm AAA	Mi-24 Hind
T-80	ZSU-23-4 Shika	MiG-23 Flogger
APCs	SA-10 Gumble	MiG-29 Fulcrum
BMP-2	SA-11 Gadfly	MiG-31 Foxhound
BRDM-2	SA-12 Gladiator	Su-25 Frogfoot
Artillery	SA-13 Gopher	Su-27 Flanker
2A61	SA-15 Gauntlet	An-12 Cub
2S19	Shoulder Launched	
Uragan	• SA-16 Gimlet	
	• SA-18 Grouse	

Maps (ONCs and TPCs)

The following is a complete list of ONCs and TPCs needed to cover this theater:

- ONC F-2 (1:1,000,000)
- ONC F-3 (1:1,000,000)

and/or

- TPC F-2B (1:500,000)
- TPC F-2C (1:500,000)
- TPC F-3A (1:500,000)
- TPC F-3D (1:500,000)

These maps can be purchased from:

NOAA Distribution Division, N/ACC3
National Ocean Service
Riverdale, Maryland 20737-1199
Toll Free (in the US): 800-638-8972
Telephone: 301-436-8301
Fax: 301-436-6829

NOTE: See "Map disclaimer" on page iii.

The Russo-Ukrainian War

History

5 January 2003

Kiev, Ukraine—In rescheduled elections, Oleksandr Moroz was elected governor of the eastern Ukrainian Oblast (state) of Sumska. Moroz, 82, chairman of the Socialist Party of Ukraine and former Chairman of the Supreme Rada, ran a campaign stressing return to the collective ideals of the disestablished USSR. Western election observers, denied access to election centers, say that rumors of voter fraud and vote tampering, while unconfirmed, appear to be valid. The results of national elections last June were thrown out when massive fraud and corruption of the process were revealed.

"The moral decay of the West has permeated our country and soiled our ideals," Moroz said in a post-election statement issued at Socialist Party headquarters in Sumy, the capital of Sumska. "Their capitalistic infiltration of our economy has brought with it the stain of sin and the destruction of our ethnic culture. This

election is a mandate to return our country to the roots of its people."

Sumska is one of eight Oblasts in eastern Ukraine where ethnic Russians make up the majority of the population. Though composing only 22 percent of the country's total population, ethnic Russians held enormous power under the old Soviet system. Together with Communist strongholds in the Crimea and Dometsk, they form "Little Russia," and their ambiguous loyalties have created concern in the halls of the Supreme Rada in Kiev.

31 March 2003

Sumy, Ukraine—Oleksandr Moroz**,** Governor of Sumska, has called for the formation of a regional alliance among the Russian majority Oblasts of eastern Ukraine and the Crimea. "The Dupes of Kiev continue to suckle at the breast of the West while our people go hungry," Moroz said at the Oblast Economic Cooperation Council meeting in Symferopyl, capital of the Crimea. The call for a regional alliance has revived the fears of western and central Ukrainians who, while moving toward a centrist, capital-based government, have yet to coalesce into a truly united group of states.

Andriy Pyziur, Professor of Eastern European Studies at Georgetown University, believes that Moroz's reference to hunger actually refers to the agricultural problems in Russia. Moroz, swept into office two months ago on a platform of reversion, has increasingly shown his disdain for the central Ukrainian government and its free market economy and has worked to strengthened ties with Russia. While Russian agriculture has continued to suffer from depressed harvests, outdated farming techniques, and gross mismanagement, the Ukrainian agricultural sector has quickly adopted Western technology and agricultural techniques. Once known as the "Breadbasket of Europe," Ukrainian farms suffered immeasurably under the collective process of the USSR. However, since gaining independence in 1991, Ukraine became agriculturally self-sufficient in 1999 and began to export agricultural foodstuffs in 2001, mainly to the Balkans and the Mideast. Moroz has been critical of agricultural export out of the CIS rather than "humanitarian transfer" of the crop excesses to Russia.

12 April 2003

Sumy, Ukraine—Today at a press conference, the governors of the Ukrainian states known as "Little Russia" announced the formation of the Eastern Ukraine Democratic Alliance, "a cooperative association intended to advance economic, political, and social issues peculiar to its member Oblasts." It was also announced that Oleksandr Moroz would function as acting Chairman until an election could be held.

The Ukrainian Supreme Rada quickly denounced the EUDA as "a government within a government" and called for its immediate dissolution.

1 May 2003

Kiev, Ukraine— In a pre-dawn lightning strike, Russian forces crossed the eastern border of the Ukraine today. Armored forces met virtually no opposition as they moved across the border and took up positions in key locations throughout eastern Ukraine. Ukrainian forces appeared to be caught completely off-guard and fell back in disarray before the invading troops, although the Ukrainian Air Force has been able to evacuate some aircraft to bases west of the Dnepr River. No reports of damage or casualties have been released.

Russian President Vladimir Zhirinovsky issued a statement declaring the foray into Ukraine was undertaken by "invitation" and with the assistance of "cooperative forces" loyal to the newly formed Eastern Ukraine Democratic Alliance. Neither Moroz nor EUDA spokespeople were available for comment. US Chief of Mission in Ukraine, William Miller, called the action "unprecedented, perilous and abominable." Both UN and

NATO spokesmen said their organizations would be meeting in emergency sessions immediately. Presidential spokesperson Dylan Rogers said that the US was "most disturbed" by the action and called for the immediate withdrawal of Russian forces from Ukraine. He also reported that the President was already meeting with national security advisors to discuss the American response to the situation.

2 May 2003

Kiev, Ukraine—Ukrainian Armed Forces trapped east of the Dnepr River rallied for counterattacks today against Russian military units. In violent clashes throughout the east, Ukrainian forces fought to regain lost territory, but reports indicate that they have met with little success, and eyewitness reports describe the large-scale withdrawal of Ukrainian forces across the Dnepr River and the call-up of reserve forces. Other reports depict valiant efforts by the outnumbered Ukrainian Air Force against increasing numbers of Russian aircraft.

Both NATO and UN councils met in Executive session today and condemned the Russian invasion as a "crime against the free people of Ukraine." Further discussions outlining possible military options were underway.

2 May 2003

Washington, DC—The President, having met with leaders of Congress and the Joint Chiefs of Staff, has issued a stern warning to Russian President Vladimir Zhirinovsky. "The people of the free world cannot allow the tyranny of oppression to rear its head again in Eastern Europe…. The United States and our allies will not allow the despicable acts of aggression taking place in the Ukraine to continue." Presidential spokesperson Dylan Rogers said that contact with European allies, while not resulting in any concrete military assistance, indicated that they strongly supported US efforts to support the Ukrainian government. Pentagon sources indicate that US Army and Air Force units have been put on alert both in the US and Europe.

6 May 2003

Washington, DC—The President today announced the deployment of US Army and Air Force units to Ukraine. "At this very moment, select elements of the United States Army and Air Force are on the ground in Ukraine to support the elected government there. These forces are provided to assist Ukrainian forces in the defense of their homeland." Pentagon sources indicate that the US forces consist primarily of armored ground forces and a variety of aircraft. Unconfirmed reports indicate that the newly introduced F-22 air superiority fighter is among those assets being deployed.

Objectives

Allied objectives are to:

1. Protect currently friendly airbases in the Ukraine
2. Establish air superiority over the Ukrainian battlefield
3. Support joint American/Ukrainian ground forces
4. Conduct air operations against key objectives to reduce Russian force effectiveness
5. Continue operations until Russian forces are pushed east of the Dnepr River

Allied forces

Aside from US forces, allied forces consist of Ukrainian air and ground forces. No other

allied forces are expected to participate in these operations.

Long a part of the USSR, Ukraine forces use armaments common to the Russian forces. Because of this, great care must be taken to positively identify targets prior to engagement to prevent fratricide. Rules of Engagement (ROE) will reflect this requirement.

American forces include ground and air forces from European commands as well and CONUS-based forces. The President, through the Secretary of Defense and Joint Chiefs of Staff, has authorized a force strength equal to the required tasks and removed all non-nuclear restrictions concerning force structure.

US forces in the Russo-Ukrainian War

Tanks	**Air Defense**	**Aircraft**
M1A2	BSFV	AH-64 Apache
APCs	IHAWK	UH-60 Blackhawk
M2	Patriot	A-10 Warthog
Artillery	Shoulder Launched	F-15 Eagle
M109	• FIM-92 Stinger	F-16 Fighting Falcon
MLRS		F-22 Raptor
		E-3A AWACS
		C-17 Globemaster III
		B-52 Stratofortress

Ukrainian forces in the Russo-Ukrainian War

Tanks	**Air Defense**	**Aircraft**
T-72	S60—57mm AAA	Mi-24 Hind
T-84 (Ukrainian built T-80 tank)	SA-10 Gumble	MiG-23 Flogger
	SA-12 Gladiator	MiG-29 Fulcrum
APCs	SA-15 Gauntlet	Su-25 Frogfoot
BMP-2	SA-17 Grizzly	Su-27 Flanker
BDRM-2	SA-19 Tunguska	MiG-31 Foxhound
Artillery	Shoulder Launched	An-12 Cub
S19	• SA-16 Gimlet	Tu-22M Backfire
Uragan	• SA-18 Grouse	

Enemy forces

The armed forces of the former USSR have undergone a near implosion since that nation dissolved in 1991. The once mighty military machine is a shell of its former self, its formerly unified forces now diluted by their divi-

sion among the 14 independent former Soviet Republics. Despite this dilution however, the Russian military still remains one of the world's most formidable forces.

The Russian air forces still retain some of the most advanced combat aircraft in the world today, and research has continued to produce state-of-the-art innovations for the aircraft. Among the combat aircraft "standards" are the MiG-23 and MiG-29 as well as the Su-25 and Su-27. Development of these and other aircraft have resulted in variants such as the MiG-31, MiG1-42, Su-34, Su-35, and Su-37. Though in limited production, these variants provide a deadly addition to the Russian air forces.

Russian ground combat forces underwent the same debilitating reductions as the air forces. As with the air forces, they continue to maintain their highly capable weapon systems and can still field the largest attack force in Europe. Maintaining their focus on armor as the backbone of their forces, Russian commands have access to the some of the most modern armored weapon systems in the world. Tanks include the T-72, T-80s, and T-90s. Ground weapons development, while not pursued as aggressively as the air side, has continued to march forward as Russia looks to establish itself as the premier supplier of weapons on the world market.

Russia continues to place emphasis on its air defenses and has one of the world's most modern inventories. This inventory includes the new SA-17 Grizzly and the SA-19 Tunguska in addition to the older systems. This integrated force provides a formidable defense against any aircraft.

Enemy forces in the Russo-Ukrainian War

Tanks	**Air Defense**	**Aircraft**
T-72	S60—57mm AAA	Mi-24 Hind
T-90	SA-10 Gumble	MiG-23 Flogger
APCs	SA-12 Gladiator	MiG-29 Fulcrum
BMP-2	SA-15 Gauntlet	MiG-31 Foxhound
BRDM-2	SA-17 Grizzly	MiG1-42 Felix
Artillery	SA-19 Tunguska	Su-25 Frogfoot
2A61	Shoulder Launched	Su-27 Flanker
2S19	• SA-16 Gimlet	Su-34 Fastback
Uragan	• SA-18 Grouse	Su-35 Flasher
		Su-37 Freefall
		A-50 Mainstay
		An-12 Cub
		Tu-22M Backfire

Maps (ONCs and TPCs)

The following is a complete list of ONCs and TPCs needed to cover this theater:

- ONC E-3 (1:1,000,000)

and/or

- TPC E-3C (1:500,000)

These maps can be purchased from:

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Riverdale, Maryland 20737-1199

Toll Free (in the US): 800-638-8972
Telephone: 301-436-8301
Fax: 301-436-6829

NOTE: See "Map disclaimer" on page iii.

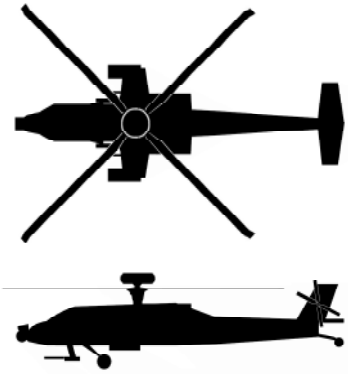
A Aircraft, Vehicle, and Weapon Reference Data

This appendix lists statistics for the aircraft and other military equipment appearing in this simulation.

Aircraft data

US-Built aircraft

AH-64 Apache



Crew	2
Type	Helicopter gunship
Max. Speed	162 mi/hr
Max. Altitude	13,000 ft.
Height	15.5 ft.
Length	55.5 ft.
Wingspan	45.8 ft.
Engines	2 x 1265 kW turboshafts
Combat Range	253 mi
Armament	30mm cannon with 1200 rounds

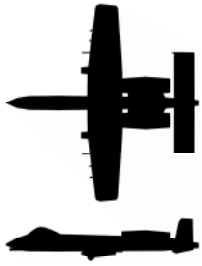
The AH-64 Apache is the US Army's front-line attack helicopter. Using Hellfire guided missiles in the anti-armor role, it has developed into a premier multipurpose ground attack platform whose capabilities have been highlighted in Operations Just Cause and Desert Storm, as well as other peacekeeping deployments and operational exercises.

UH-60 Black Hawk

Crew	3 (+11 passengers)
Type	Utility helicopter
Max. Speed	184 mi/hr
Max. Altitude	9000 ft.
Height	16.1 ft.
Length	61.8 ft.
Wingspan	51.2 ft.
Engines	2 x 1151 kW turboshafts
Combat Range	373 mi
Armament	none

This replacement for the venerable UH-1 Iroquois (Huey) has now become the most numerous helicopter in the US inventory. Consistent with its origins as a utility helicopter, it has been adopted to transport, ASW, ASUW, SAR, special operations, MedEvac, and ELINT roles.

A-10A Warthog



Crew	1
Type	Close air support aircraft
Max. Speed	425 mi/hr
Max. Altitude	35,000 ft.
Height	14 ft.
Length	50.9 ft.
Wingspan	54.9 ft.
Engines	2 x 40.3 kN turbofans
Combat Range	290 mi (with 2 hour loiter)
Armament	30mm cannon with 1350 rounds

Entering service in 1976, the A-10 was the first purpose-built American ground attack aircraft. Although capable of carrying 16,000 lb. of guided and unguided munitions, its real charm lies in its seven-barreled, 30mm GAU-8/A “Avenger” cannon, capable of killing tanks from as far as five miles away. The A-10 combines simplicity, ruggedness, and lethality in a single devastating package

F-15E Strike Eagle

Crew	2
Type	Multirole combat aircraft
Max. Speed	Mach 2.5
Max. Altitude	59,000 ft.
Height	17.62 ft.
Length	60.8 ft.
Wingspan	40.8 ft.
Engines	2 x 79.2/129.4 kN turbofans
Combat Range	790 mi
Armament	20mm cannon with 512 rounds

The F-15 was the most capable air-superiority fighter in the world when it entered service in 1976. It features excellent radar and avionics for BVR (Beyond Visual Range) engagements and surprising agility for dogfighting. The F-15 has since been developed into an excellent multirole aircraft. By 2010, the F-22 will replace the F-15 in the air superiority role, although the Strike Eagle variant will retain its front-line role.

F-16C Fighting Falcon

Crew	1
Type	Multirole combat aircraft
Max. Speed	Mach 1.8
Max. Altitude	52,500 ft.
Height	15.9 ft.
Length	47 ft.
Wingspan	31.3 ft.
Engine	76.8/128.9 kN turbofan
Combat Range	850 mi
Armament	20mm cannon with 511 rounds

Originally conceived as a small, clear-weather day fighter, the F-16 has developed over the past 15 years into a multirole, adverse-weather, day/night fighter. Renowned for its agility and dogfighting capability, the F-16 has been a popular export item, in service with 18 foreign countries and produced under license in both Europe and Asia.

F-22A Raptor

Crew	1
Type	Air superiority fighter with secondary ground attack capability
Max. Speed	Mach 2.4
Max. Altitude	60,000 ft.
Height	15.7 ft.
Length	59.2 ft.
Wingspan	42.4 ft.
Engines	2 x 155 kN turbofans
Combat Range	Over 1500 miles
Armament	20mm cannon with 480 rounds

The F-22 is the first of the “next generation” fighters, combining incredible performance with low-observable technology to create an aircraft capable of killing its opponents before they even know it’s there. While other aircraft were forced to sacrifice performance and mission capabilities in exchange for their stealthy characteristics, the F-22 has been able to mold the two together, greatly enhancing both. Able to deploy both air-to-air as well as air-to-ground munitions, the F-22 will serve as the backbone of the United States Air Force well into the 21st century.

E-3C Sentry

Crew	20
Type	AWACS
Max. Speed	530 mi/hr
Max. Altitude	27,700 ft.
Height	39.8 ft.
Length	145.9 ft.
Wingspan	139 ft.
Engines	4 x 93.4 kN turbofans
Combat Range	1,000 mi
Armament	none

As an AWACS aircraft, the E-3C Sentry provides American and Allied commanders with the all-weather surveillance, command, control, communication, and coordination capabilities in modern air war. Built on a modified Boeing 707 commercial airframe, the most important feature of the Sentry is its 30-foot diameter, 6-foot thick rotating radome mounted above the fuselage, which allows it to detect, identify, and track targets at a range of more than 200 miles.

C-17 Globemaster III

Crew	3
Type	Heavy cargo transport
Max. Speed	402 mi/hr
Max. Altitude	42,900 ft.
Height	52.6 ft.
Length	166 ft.
Wingspan	162 ft.
Engines	4 x 181 kN turbofans
Combat Range	3,105 mi
Armament	none

Entering service in 1993, the C-17 is capable of transporting a wide variety of loads (including AH-64 helicopters and the M1 main battle tank) to main operating bases as well as to austere airfields near the front line.

B-52H Stratofortress

Crew	5
Type	Heavy bomber
Max. Speed	630 mi/hr
Max. Altitude	52,200 ft.
Height	38.8 ft.
Length	152 ft.
Wingspan	176.5 ft.
Engines	8 x 75.6 kN turbofans
Combat Range	4,800 mi
Armament	20mm cannon with 1200 rounds (tail)

Originally delivered to SAC in 1959 as a strategic nuclear bomber, most Big Ugly Flying "Fellas" (BUFFs) are older than the crews that fly them. Able to carry a huge load of guided, unguided, conventional, and nuclear weapons over vast distances, the B-52 is the classic heavy bomber, and it will remain in service into the 21st century.

Russian-Built aircraft

Mi-24E Hind

Crew	2 (+8 passengers)
Type	Helicopter gunship
Max. Speed	208 mi/hr
Max. Altitude	14,000 ft.
Height	20.3 ft.
Length	66.8 ft.
Wingspan	54.1 ft.
Engines	2 x 1633 kW turboshafts
Combat Range	2,240 mi
Armament	12.7mm machine gun (undernose turret)

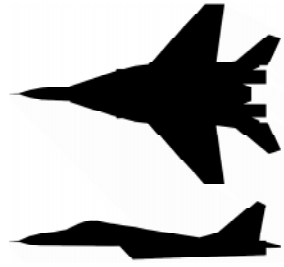
Since its introduction in the early 1970s, the Mi-24 Hind has been one of the most feared helicopter gunships in the world. It has been described as a flying tank because of its large size and heavy weapons load. While its stepped, tandem crew seating and its employment of stub-wings to increase weapon hardpoints are typical of helicopter gunship arrangement, the Hind's ability to transport up to eight troops to the front lines and then assist them in a fire support role is unique.

MiG-23 Flogger

Crew	1
Type	Fighter/interceptor
Max. Speed	Mach 2.35
Max. Altitude	58,000 ft.
Height	15.1 ft.
Length	49 ft.
Wingspan	43.7 ft.
Engine	83.8/127.4 kN turbojet
Combat Range	1,211 mi
Armament	23mm cannon with 200 rounds

Introduced in 1969, the Flogger uses variable geometry wings ("swing wings") to enhance its performance. In addition to this design innovation, it was also the first Soviet aircraft with a BVR missile capability as well as long-range navigation systems that enable it to operate independently of ground control in some situations. Although it has a high "dash" speed, it suffers from relatively poor maneuvering performance and is clearly now a second-rate fighter.

MiG-29 Fulcrum



Crew	1
Type	Air superiority fighter with secondary ground attack capability
Max. Speed	Mach 2.3
Max. Altitude	56,000 ft.
Height	14.8 ft.
Length	54.2 ft.
Wingspan	35.6 ft.
Engines	2 x 49.4/81.4 kN turbo-fans
Combat Range	1304 mi
Armament	30mm cannon with 150 rounds

First fielded in 1985 after a long development program, the Fulcrum replaced the MiG-21, MiG-23, Su-15, and Su-17 in front-line units. Despite its relatively short range, the MiG-29 is a premier tactical fighter with excellent performance and maneuverability. MiG-29 pilots can also take advantage of a helmet-mounted target designation system to effectively engage "off boresight" aircraft.

MiG-31 Foxhound

Crew	2
Type	Interceptor
Max. Speed @ SL	Mach 1.23
Max. Speed @ altitude	Mach 2.83
Max. Altitude	64,000 ft.
Height	19.2 ft.
Length	71 ft.
Wingspan	42.1 ft.
Engines	2 x 151.9 kN turbofans
Combat Range	745 mi
Armament	23mm cannon with 260 rounds

Derived from the MiG-25 Foxbat, the MiG-31 provides enhanced capabilities against low-level threats and was intended to guard the Soviet Union's long borders. Important changes include a strengthened air frame (allowing supersonic performance at low altitude) and an electronically scanned phased array radar (the first of its type in service) that enables the MiG-31 to track ten targets simultaneously in excess of 200 km. The Foxhound's primary armament is the AA-9 Amos long range air-to-air missile.

MiG-1-42 Felix

Crew	1
Type	Low-observable, multi-role combat aircraft
Max. Speed	?
Max. Altitude	?
Height	?
Length	?
Wingspan	?
Engines	?
Combat Range	?
Armament	?

Also known as MFI (mnogofunktsionalnyy istrebityel—multipurpose fighter), the MiG-1-42 is similar to the F-22 in many ways. Just as stealth technology has been incorporated in the design of the F-22 from the start, so has it been in the MiG-1-42, although not to as great an extent. Similarly, the MiG-1-42 has thrust-vectoring engine nozzles and uses internal weapon stowage. Also, while it has a ground attack capability, it is primarily an air superiority fighter. All of these features combine to make it a worthy adversary of the F-22.

Su-25 Frogfoot

Crew	1
Type	Close air support aircraft
Max. Speed	605 mi/hr
Max. Altitude	21,900 ft.
Height	15 ft.
Length	48.6 ft.
Wingspan	44.9 ft.
Engines	2 x 44.18 kN turbojets
Combat Range	465 mi
Armament	30mm cannon with 250 rounds

Fulfilling the same close air support role as the A-10, the Su-25 embodies many of the same attributes. The Frogfoot—a relatively slow, heavily armored, twin-engine, and single-seat ground attack aircraft—is intended to loiter over the battlefield and search for targets. Survivability and payload are of paramount importance, and both of these attributes have been tested in Afghanistan and Chechnya. With its full scale introduction in 1984, the Su-25 became the primary Soviet close air support aircraft.

Su-27 Flanker

Crew	1
Type	Multirole combat aircraft
Max. Speed	Mach 2.35
Max. Altitude	56,000 ft.
Height	18.6 ft.
Length	68.7 ft.
Wingspan	44.9 ft.
Engines	2 x 74.5/122.6 kN turbofans
Combat Range	931 mi
Armament	30mm cannon with 149 rounds

Originally designed as a deep penetration fighter/interceptor to surpass the F-15, the Su-27 has developed into what some consider to be the most capable multirole aircraft in the world. Its incredible agility (as exemplified by the Cobra maneuver), large payload (up to ten air-to-air missiles), and off-boresight targeting ability (via a helmet-mounted targeting system) make the Flanker a formidable opponent.

Su-34 Fastback

Crew	2
Type	Theater bomber
Max. Speed	Mach 1.8
Max. Altitude	?
Height	?
Length	?
Wingspan	?
Engines	2 x 137.3 kN turbofans
Combat Range	2,485 mi
Armament	30mm cannon with 149 rounds

Unofficially nicknamed “Platypus” by its crews (due to its wide, flat nose), the Su-34 is a member of the Su-27 family. Major design modifications include a redesigned forward fuselage to accommodate side-by-side seating for the pilot and copilot, a galley and toilet behind the cockpit, and an extended tailboom housing a rear-facing radar. The Su-34 also carries specially modified, rear-firing AA-11 missiles to be used in self-defense.

Su-35 Flasher

Crew	1
Type	Multirole combat aircraft
Max. Speed @ SL	Mach 1.15
Max. Speed @ altitude	Mach 2.35
Max. Altitude	56,000 ft.
Height	19.9 ft.
Length	69.5 ft.
Wingspan	46.9 ft.
Engines	2 x 137.7 kN turbofans
Combat Range	2,485 mi
Armament	30mm cannon with 149 rounds

Formerly known as the Su-27M, the Su-35 is an advanced development of the highly successful Su-27. The Su-35 features more powerful engines, improved radar and avionics, integral ECM pods, two-dimensional thrust vectoring, and a rear-facing radar similar to that in the Su-34. Also, like the Su-34, the Su-35 can carry specially modified, rear-firing AA-11 missiles in addition to more conventional munitions.

Su-37 Freefall

Crew	1
Type	Multirole combat aircraft
Max. Speed @ SL	Mach 1.15
Max. Speed @ altitude	Mach 2.35
Max. Altitude	58,800 ft.
Height	20 ft.
Length	69.5 ft.
Wingspan	46 ft.
Engines	2 x 142.2 kN turbofans
Combat Range	2,050 mi
Armament	30mm cannon with 149 rounds

The Su-37 is a further evolution of the Su-35 Flasher and has the single-seat, multirole, all-weather air superiority role of its predecessor. However, the Freefall incorporates important improvements in avionics and maneuvering capability by taking advantage of the first three-dimensional thrust-vectoring system in a serial production aircraft.

A-50 Mainstay

Crew	15
Type	AWACS
Max. Speed	530 mi/hr
Max. Altitude	48,500 ft.
Height	46.2 ft.
Length	145.8 ft.
Wingspan	158 ft.
Engines	4 x 117.7 kN turbofans
Combat Range	4,534 mi
Armament	none

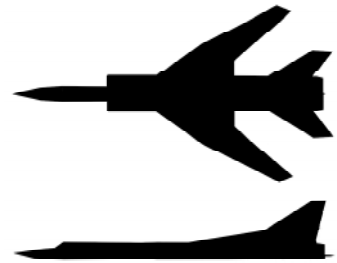
A derivative of the Il-76 transport, the A-50 Mainstay has become the primary Russian AWACS aircraft since its introduction in 1984. With its dorsally-mounted, rotating radome, the Mainstay resembles other AWACS aircraft, such as the American E-3C Sentry, although its performance is generally inferior. In their battle management role, AWACS aircraft are a central component of a coordinated air defense, and as such, are a high-value target.

An-12 Cub

Crew	6
Type	Transport
Max. Speed	480 mi/hr
Max. Altitude	31,900 ft.
Height	32.9 ft.
Length	103.6 ft.
Wingspan	118.9 ft.
Engines	4 x 2942 kW turboprops
Combat Range	2,236 mi
Armament	2 x 23mm cannon (tail)

An outgrowth of the An-8 Camp transport, the An-12 Cub entered Soviet service in 1959. A simple workhorse aircraft, the Cub has since been exported to numerous client states, and a reverse-engineered version is still in production in China under the designation Y-8.

Tu-22M Backfire



Crew	4
Type	Medium bomber
Max. Speed	Mach 1.88
Max. Altitude	41,600 ft.
Height	34.6 ft.
Length	132.9 ft.
Wingspan	107.3 ft.
Engines	2 x 245.2 kN turbofans
Combat Range	1,149 mi
Armament	2 x 23mm cannon (tail)

A long-range, variable-geometry medium bomber for low-level penetration of enemy air defenses, the Backfire is in many ways similar to the USAF B-1B Lancer. A versatile aircraft, it is capable of nuclear and conventional strikes as well as reconnaissance and maritime attack with missiles, bombs, and mines. The Backfire is most commonly armed with AS-16 Kickback ground attack missiles, providing it with a standoff attack capability that further enhances its survivability.

Anti-Aircraft vehicle data

US-Built anti-aircraft vehicles

Bradley Stinger Fighting Vehicle (BSFV)

Type	Mobile SAM system
Crew	5
Armor	Medium
Armament	25mm cannon, 7.62mm MG, 8xStinger

The BSFV accompanies friendly forces and provides them with local, low-level air defense. Originally conceived as a standard M2 Bradley IFV with a two-man Stinger air defense team that could dismount to engage air threats, the BSFV has evolved into a fully integrated mobile SAM system based on the Bradley chassis. However, it contains numerous modifications that enable the crew to identify and engage air threats without leaving the vehicle.

Improved HAWK Launch Platform (IHAWK)—M192 Launcher

Type	Static SAM system
Crew	0
Armor	None
Armament	3xIHAWK

First entering service with the US Army in 1960, the HAWK (Homing All the Way Killer) SAM system has gone through so many improvement programs that little of the original systems remain in the current-generation IHAWK. The M192 Launcher itself is little more than a towed IHAWK rack, lacking any sensors and receiving all target information from other battery resources. A typical IHAWK battery includes a command post, an acquisition radar, a tracking radar, and three IHAWK launchers.

Patriot Launch Platform (M901 Launcher)

Type	Static SAM system
Crew	0
Armor	None
Armament	4xPatriot

This successor to the venerable HAWK missile series is the current state-of-the-art American SAM system, including both Anti-Tactical Missile (ATM) as well as traditional anti-aircraft capabilities. Its configuration is similar to the IHAWK's—a towed missile rack that gets all of its information from external sources—and like any other towed system, lacks any real tactical mobility. Because of this, Patriot systems tend to be clustered around high-value fixed positions and do not operate in direct support of troops on the frontline.

Man-portable missiles

The Stinger missile itself is considered by many to be the best man-portable SAM in the world, and it has proven its worth in many conflicts, most notably in the hands of Mujahedin soldiers during the Soviet occupation of Afghanistan.

Russian-Built anti-aircraft vehicles

S-60 57mm Anti-Aircraft Artillery (AAA)

Type	Towed AAA system
Crew	7
Armor	None
Armament	1x57mm gun

Originally introduced in 1950 as a division-level air defense asset for the Red Army, the S-60 was replaced in the mid-1970s by the SA-8 missile system as air defense roles were taken over by SAMs. Despite using old technology, AAA can still play a role on the modern battlefield, especially when used in conjunction with radar fire-control equipment. Today, these "flak" guns are found almost exclusively in third-world armies, surrounding important, stationary targets.

ZSU-23-4 Shilka

Type	Mobile AAA system
Crew	4
Armor	Light
Armament	4x23mm cannon

Replaced in Russian combat units by the SA-19 system, the Shilka is used by many countries and has a guaranteed long service life due to its simplicity, ruggedness, and high firepower. An excellent point defense weapon, the Shilka can fire as many as 4,000 rounds per minute, with predictable effects on anything it hits.

SA-10 Grumble

Type	Mobile SAM system

SA-10 Grumble

Crew	4
Armor	None
Armament	4xSA10 missiles

Introduced in 1980 in response to American advances in cruise missile technology, the SA-10 missile system was able to hit targets as low as 25 m while still retaining the ability to intercept aircraft at much higher altitudes. The upgraded SA-10c missile now allows the system to engage targets as low as 10 m in altitude. An all-weather system, the SA-10 can engage up to six targets simultaneously at all altitudes, including ballistic missiles. Grumble systems, with their long range and large warheads, are often deployed to defend high-value targets and areas.

SA-11 Gadfly

Type	Mobile SAM system
Crew	n/a
Armor	Light
Armament	4xSA-11 missiles

The SA-11 Gadfly is a medium-range air defense system for engaging targets at all altitudes. A typical SA-11 battery contains a command post, a target acquisition radar (TAR), and six SA-11 self-propelled mounts (SPM), and such a formation would be found near high-value targets. The SA-11 SPM can also operate independently of other vehicles, using its own integral radar to detect and track targets. The SA-11 Gadfly is being replaced by the

SA-17 Grizzly in many Russian and ex-Soviet units.

SA-12a Gladiator

Type	Mobile SAM system
Crew	n/a
Armor	None
Armament	4xSA-12

The SA-12 system became operational in the mid-1980s and was the world's first operational Anti-Tactical Ballistic Missile (ATBM) system. The SA-12a is a dual-role system, capable of engaging aircraft as well as tactical ballistic missiles. Naturally, compromises must be made when designing such a system, with the result being that the SA-12a cannot engage targets below 250 m (900 ft.) altitude. SA-12 batteries are normally assigned to protect important targets such as airfields and command centers because of their long range and high lethality.

SA-13 Gopher

Type	Mobile SAM system
Crew	3
Armor	Light
Armament	4xSA-13

The SA-13 Gopher is a short-range, mobile SAM system that accompanies advancing forces and provide them with local air defense. Although often paired with Dog Ear radar vehicles, the SA-13 missile is not radar guided and instead uses an all-aspect IR guidance scheme to track its targets.

SA-15 Gauntlet

Type	Mobile SAM system
Crew	3
Armor	Light
Armament	8xSA-15

An evolution of the Russian Navy's Kynshal air defense system, this division-level medium-range SAM uses the same chassis as the SA-19 Tunguska. However, to provide the fastest reaction time to targets in any direction, the missiles are stored and launched vertically from a magazine within the turret and hull of the vehicle. Although this general configuration has been used in other Russian SAM systems, this is the first time the missiles have been stored and launched internally.

SA-17 Grizzly

Type	Mobile SAM system
Crew	n/a
Armor	Light
Armament	4xSA-17

One of the newest air defense systems in the Russian arsenal, the Grizzly was first used by the Russian Army in 1995. The SA-17 uses a configuration similar to the SA-11 Gadfly that it is intended to replace, but it improves upon its predecessor in all respects.

SA-19 Tunguska

Type	Mobile SAM/AAA system
Crew	4

SA-19 Tunguska

Armor	Light
Armament	2x30mm cannon, 8xSA-19 missiles

The Tunguska is a short-range, integrated air defense system carrying a pair of 30 mm cannon as well as eight SA-19 missiles. These missiles are IR-guided, with a maximum effective range of approximately 8 km. Target acquisition is handled by a "Hot Shot" radar mounted on the turret roof, and target tracking by a separate system on the front of the turret. In addition, optical sights are provided for use in high-ECM environments.

Man-portable missiles

The SA-16 and SA-18 missiles are all-aspect, IR SAMs that are similar to the Stinger in many respects. The missiles themselves come in a disposable fiberglass launch tubes that must be attached to grip stocks to be launched. Targets are acquired and tracked visually by the gunner prior to launch.

Ground combat vehicle data

US-built ground combat vehicles

M1A2 Abrams

Class	Main Battle Tank (MBT)
Crew	4
Weight	125,740 lb
Max. Speed Road	41 mi/hr
Max. Speed Country	30 mi/hr
Main Armament	120mm smoothbore gun

Although its early design and development was marred by controversy, the M1 has developed into arguably the best tank in the world—a formidable blend of protection, mobility, and firepower unequaled on the battlefield. Its Chobham/depleted uranium mesh armor is highly resistant to all types of munitions; its gas turbine engine, admittedly a gas guzzler, provides it with the speed and mobility of much lighter tanks; and its 120mm smoothbore Rhinemetall gun is capable of defeating the armor of any opponent it will meet on the battlefield.

M2A2 Bradley

Class	Infantry Fighting Vehicle (IFV)
Crew	3 + 6
Weight	66,000 lb
Max. Speed Road	41 mi/hr
Max. Speed Country	30 mi/hr (water speed 4.5 mi/hr)

M2A2 Bradley

Main Armament	25mm chain gun

The M2A2 Bradley provides considerable armor protection for an IFV (including optional reactive armor) while still retaining enough speed and mobility to keep pace with the fast-moving M1A2s it is accompanying. Its 25mm chain gun can be elevated up to 60 degrees to allow fire at slow moving aircraft and helicopters, and it has an effective range of 2.5 km against both air and ground targets. Advanced targeting and stabilization systems, similar to those on the M1A2, even allow it to fire extremely accurately while on the move.

High Mobility Multipurpose Wheeled Vehicle (HMMWV)

Class	Troop transport/reconnaissance vehicle
Crew	1
Weight	4,950 lb (payload—3,520 lb)
Max. Speed Road	65 mi/hr
Max. Speed Country	48 mi/hr
Main Armament	None

The US Army's basic utility/transport vehicle and replacement for the Willis Jeep of WW II fame. The HMMWV has been adapted for reconnaissance, anti-air, and anti-tank roles, among others.

Heavy Expanded Mobility Tactical Truck (HEMTT)

Class	Troop transport/general utility
Crew	1
Weight	(payload—22,000 lb)
Max. Speed Road	55 mi/hr
Max. Speed Country	40 mi/hr
Main Armament	None

The HEMTT provides heavy transport capability for the resupply of combat vehicles and weapons systems. HEMTT variants include fuel carrier and wrecker versions in addition to the original cargo carrier system.

155mm M109A6 Paladin Self-Propelled Howitzer (SPH)

Class	Artillery
Crew	4
Weight	63,600 lb
Max. Speed Road	40 mi/hr
Max. Speed Country	30 mi/hr
Main Armament	155mm Howitzer

This latest version of the venerable M109 family is a typical SPH with a turret-mounted high caliber gun capable of a high angle of elevation (75 degrees) as well an internal crew compartment and ammunition stowage. It integrates a slew of enhancements, including an Automatic Fire Control System (AFCS), similar to that used in the M1 MBT series, and upgraded ballistic fire control computers. The Paladin has a maximum range of up to 30 km

and can fire up to four rounds per minute for extended periods of time.

227mm Multiple Launch Rocket System (MLRS)

Class	Artillery
Crew	3
Weight	55,440 lb
Max. Speed Road	40 mi/hr
Max. Speed Country	30 mi/hr
Main Armament	227mm rockets

The MLRS is a typical multiple rocket launcher, with an armored cab to the front and traversable rocket pods to the rear. Its chassis is based on the M2 Bradley IFV, although it has been extended to accommodate the larger MLRS's weight and length. The MLRS carries two rocket pods of six rockets each and can hit targets up to 45 km away. Available rocket warheads include blast-fragmentation bomblets and anti-tank mines. The MLRS is currently in service with a dozen countries.

Ukrainian-built ground combat vehicles

T-84

Class	Main Battle Tank (MBT)
Crew	3
Weight	101,200 lb
Max. Speed Road	37 mi/hr
Max. Speed Country	25 mi/hr
Main Armament	125mm smoothbore gun

The Ukrainian version of the T-80 MBT, the T-84 includes enhanced armor (including reactive armor) and the capability to fire both standard munitions and AT-11 Sniper infrared missiles from its main gun. The T-84 uses a fuel-efficient diesel engine, offering an extended range of operation, but at the cost of reduced speed when compared to the T-80.

Russian-built ground combat vehicles

T-72

Class	Main Battle Tank (MBT)
Crew	3
Weight	97,900 lb
Max. Speed Road	37 mi/hr
Max. Speed Country	26 mi/hr
Main Armament	125mm smoothbore gun

A typical Soviet tank, the T-72 is relatively light in weight (compared to contemporary Western tanks) and features a ballistically rounded tur-

ret, offering excellent protection for its thickness and weight. Because the turret is so small, the T-72 makes use of an auto-loader rather than having a crew member perform that task. Unfortunately, this auto-loader has a reputation for snagging crew members' clothing and attempting to load their arms into the barrel.

T-80

Class	Main Battle Tank (MBT)
Crew	3
Weight	101,200 lb
Max. Speed Road	43 mi/hr
Max. Speed Country	30 mi/hr
Main Armament	125mm smoothbore gun

The T-80 retains the same basic platform and low silhouette that characterizes Soviet tanks. The largest difference between the T-80 and its predecessors is that the T-80 was the first Soviet tank to be powered by a gas turbine engine, similar to the American M1 series.

T-90

Class	Main Battle Tank (MBT)
Crew	3
Weight	102,300 lb
Max. Speed Road	37 mi/hr
Max. Speed Country	26 mi/hr
Main Armament	125mm smoothbore gun

Developed from late-model T-72s, the T-90 offers a host of improvements, including the Shtora-1 infrared jammer, intended to defeat incoming IR-guided missiles, and second-generation explosive reactive armor (ERA) for better protection against HEAT and APFSDS weapons.

BMP-2

Class	Infantry Fighting Vehicle (IFV)
Crew	3 + 6
Weight	31,460 lb
Max. Speed Road	40 mi/hr
Max. Speed Country	30 mi/hr (water speed 4.5 mi/hr)
Main Armament	30mm gun

The BMP-2 offers increased armor protection over the BMP-1 and mounts a 30mm gun. In addition to its main armament, the BMP-2 carries an AT-5 Spandrel anti-tank missile in a traversable roof mount. Some BMP crews also carry SA-16/18 shoulder-launched SAMs for local air defense against low-level targets.

BRDM-2

Class	Amphibious scout car
Crew	4
Weight	15,400 lb
Max. Speed Road	62 mi/hr
Max. Speed Country	43 mi/hr (water speed 6.2 mi/hr)
Main Armament	14.5mm machine gun

With its light armament and armor, this vehicle uses its excellent speed to lead the main formation in the reconnaissance role. Former Soviet Tank and Motorized Rifle Divisions were issued 28 BRDM-2s, allotted to various

battalions and regiments, to carry out reconnaissance duties.

Truck (ARS-12)

Class	Troop transport/general utility
Crew	1
Weight	-
Max. Speed Road	-
Max. Speed Country	-
Main Armament	None

A basic utility/transport vehicle representative of an entire class of cargo carriers.

152mm 2A61 Towed Howitzer

Class	Artillery
Crew	8
Weight	15,400 lb
Max. Speed Road	-
Max. Speed Country	-
Main Armament	152mm Howitzer

A lightweight towed Howitzer partially based on the D-30. The 2A61 is capable of firing up to eight rounds per minute and has a maximum range of 24 km.

152mm 2S19 Self-Propelled Howitzer (SPH)

Class	Artillery
Crew	5
Weight	92,400 lb
Max. Speed Road	37 mi/hr
Max. Speed Country	26 mi/hr
Main Armament	152mm Howitzer

Based on the T-80 tank chassis, the 2S19 can provide battlefield support for front line units up to 24 km away with its formidable 152mm gun. In addition to more conventional munitions, the 2S19 can also fire the Krasnopol guided round, which uses inertial guidance and semiactive laser homing to hit targets illuminated by forward observers.

220mm BM9P140 Uragan Multiple Rocket Launcher (MRL)

Class	Artillery
Crew	4
Weight	44,000 lb
Max. Speed Road	40 mi/hr
Max. Speed Country	28 mi/hr
Main Armament	220mm rockets

With a maximum range of 35 km, the Uragan can saturate areas with up to 16 rockets equipped with high explosive, bomblet, antitank, or anti-personnel mine warheads. A full salvo of 16 rockets takes 20 seconds to fire and has an area of effect between 20,000 and 460,000 m^2, depending on the type of warhead used.

Weapons data

US-built air-to-air weapons

AIM-120 Advanced Medium-Range Air-to-Air Missile (AMRAAM)

Guidance	Active radar
Weight	345 lb
Warhead	48.4 lb HE directed fragmentation
Max. Range	31 mi
Min. Range	4.4 mi

The AIM-120 AMRAAM development program began in 1975. Designated as the successor to the AIM-7 Sparrow, the AIM-120A entered service in 1991. An advanced version, the AIM-120C, with an improved active radar seeking head and a compressed carriage that allows internal stowage by the F-22, entered service in 1993. The F-22 can hold up to six AIM-120Cs in its central internal weapons bay.

AIM-7P Sparrow missile

Guidance	Semiactive radar homing (SARH)
Weight	506 lb
Warhead	85.8 lb HE blast/fragmentation
Max. Range	28 mi
Min. Range	0.8 mi

A venerable BVR missile, the Sparrow has gone through numerous versions since it entered service in 1956 and has served as the template for the Sea Sparrow (US), Sky Flash (UK), and Aspide (Italy) missile families. Recent developments have included enhanced capabilities in heavy ECM environments, improved discrimination of low-level targets, and the addition of a data link similar to that in the AIM-120 AMRAAM.

AIM-9M/X Sidewinder missile

Guidance	IR
Weight	191 lb / 185 lb
Warhead	25 lb HE blast/fragmentation
Max. Range	5 mi
Min. Range	0.3 mi

The AIM-9 development program began in the late 1940s, with the first operational flight of the AIM-9B in 1953. Considerable enhancements have been made throughout the years, with the most recent addition of enhanced flare rejection circuitry in the AIM-9M. The AIM-9X, expected to enter service around the year 2000, will be significantly more capable than its most advanced predecessors. It will enable over-the-shoulder target designation in conjunction with helmet-mounted target designation systems now in development. Normally, the F-22 carries two AIM-9M/X missiles, one in each side bay, although more could be carried in the central weapons bay and on external hardpoints.

US-built air-to-ground weapons

This section details US-built air-to-ground weapons that can be carried by your F-22. No comparable section for Russian built air-to-ground weapons is available because those

weapons do not have a direct impact on you or your aircraft.

Mark-82 bomb

Targets	General purpose
Guidance	Unguided
Weight	530 lb
Warhead	196 lb

Mark-83 bomb

Targets	General purpose
Guidance	Unguided
Weight	983 lb
Warhead	444 lb

Mark-84 bomb

Targets	General purpose
Guidance	Unguided
Weight	1,966 lb
Warhead	942 lb

The Mark 80 family of low drag, general purpose bombs has become the standard for the US armed forces and many other countries. Although they have been steadily improved since their introduction in the 1950s, these bombs have generally undergone minor modifications to fuses and filling, not significant design changes. They have also served as the basis for many other munitions, such as the AGM-62 Walleye, the Paveway series of laser-guided bombs, and the AGM-154 JSOW.

AGM-154 Joint Standoff Weapon (JSOW)

Targets	General purpose
Guidance	INS/GPS
Weight	1,065 lb
Warhead	185 lb (BLU-111 variant of Mark-82 unitary warhead)
Max. Range	19 mi

Having evolved from Advanced Bomb Family studies by the US Navy and Air Force in the late 1980s, the JSOW is an unpowered glide bomb fitted with folding wings that deploy after release. These wings greatly extend the JSOW's range, allowing it to be launched from beyond the range of many air defenses. Guidance is by a combination of internal inertial navigation system (INS) and satellite-based Global Positioning System (GPS), improving accuracy and increasing resistance to jamming. Because of the bomb's large size, the F-22 can carry the AGM-154 JSOW only externally.

AGM-88 High Speed Anti-Radar Missile (HARM)

Targets	Radar-emitting structures or vehicles
Guidance	Passive radar/INS
Weight	794 lb
Warhead	145 lb
Max. Range	15 mi
Min. Range	3 mi
Max. Speed	Mach 3

Successor to the AGM-45 Shrike and AGM-78 Standard, the AGM-88 HARM is an anti-radar missile used to attack opposing air defenses,

most often as part of Suppression of Enemy Air Defenses (SEAD) missions. The HARM can be launched with or without a valid target. If it has a target, it uses its passive radar tracking capabilities to guide itself to the target, and if the target shuts off its radar while the HARM is in flight, the HARM engages its backup inertial navigation system (INS) and guides itself to its target's last known position.

GBU-12B Paveway bomb

Targets	General purpose
Guidance	Passive laser
Weight	495 lb
Warhead	196 lb (Mark 82 general purpose unitary warhead)

GBU 16B Paveway bomb

Targets	General purpose
Guidance	Passive laser
Weight	999 lb
Warhead	444 lb (Mark 83 general purpose unitary warhead)

GBU 24A Paveway bomb

Targets	General purpose
Guidance	Passive laser
Weight	1,980 lb
Warhead	942 lb (Mark 84 general purpose unitary warhead)

GBU 24A/B Paveway bomb

Targets	Hardened targets such as bunkers and hardened hangers
Guidance	Passive laser
Weight	1980 lb
Warhead	528 lb (BLU 109/B penetration warhead for hardened targets)

An outgrowth of the Mark 80 series of general purpose bombs, Paveway bombs reflect a modular design concept. They are Mark 80 bombs modified by the addition of bolt-on subassemblies. To convert a Mark 80 bomb into a GBU, a laser guidance unit is added to the nose, and a stabilizing tail unit is added to the rear. The laser guidance unit detects the laser designation spot and guides the bomb towards it by manipulating its control surfaces. The tail assembly plays no role in bomb guidance. Target designation can be by the parent aircraft, another airborne designator, or ground-based systems.

GBU-31A Joint Direct Attack Munition (JDAM)

Targets	General purpose
Guidance	INS/GPS
Weight	1980 lb
Warhead	942 lb (Mark 84 general purpose unitary warhead)

GBU-31A/B JDAM

Targets	Hardened targets such as bunkers and hardened hangers
Guidance	INS/GPS
Weight	1980 lb
Warhead	528 lb (BLU 109/B penetration warhead for hardened targets)

GBU-32 JDAM

Targets	General purpose
Guidance	INS/GPS
Weight	999 lb
Warhead	444 lb (Mark 83 general purpose unitary warhead)

Another product of the Advanced Bomb Family studies, the JDAM system consists of bolt-on subassemblies that can be added to standard Mark 84, BLU-109B, and Mark 83 bombs to increase their accuracy. The tail assembly consists of the GPS and INS guidance units as well as the control surfaces. It is this assembly that guides the weapon to its target after release. The nose unit is a set of stabilizing fins and plays no role in weapon guidance. Because of the bombs' size, the F-22 must carry the GBU-31A and GBU-31A/B externally, but the GBU-32 can be carried within the main weapons bay.

US-Built ground-to-air weapons

Stinger missile

Guidance	IR
Weight	22 lb
Warhead	7 lb HE fragmentation
Max. Range	2.8 mi
Min. Range	0.1 mi
Max. Altitude	12,500 ft.
Min. Altitude	0 ft.
Max. Speed	Mach 2.2

Improved HAWK (IHAWK) missile

Guidance	Semiactive radar homing (SARH), proportional navigation
Weight	1,379 lb
Warhead	165 lb HE fragmentation
Max. Range	25 mi
Min. Range	1 mi
Max. Altitude	59,000 ft.
Min. Altitude	200 ft.
Max. Speed	Mach 2.7

Patriot missile

Guidance	Command, TVM semi-active homing
Weight	1,540 lb
Warhead	161 lb HE blast fragmentation
Max. Range	99 mi
Min. Range	2 mi
Max. Altitude	78,720 ft.
Min. Altitude	200 ft.
Max. Speed	Mach 5.0

Russian-Built air-to-air weapons

AA-7 Apex missile

Guidance	IR and semiactive radar homing (SARH) versions
Weight	473 lb/517 lb
Warhead	66 lb HE fragmentation
Max. Range	12 mi
Min. Range	.6 mi

The Apex is the first Russian BVR missile, developed for use on the MiG-23 Flogger, and is available in both IR and SARH versions. Soviet production ended in 1985, but it was exported to many countries and is likely to be found anywhere MiG-23s or MiG-29s are found.

AA-8 Aphid missile

Guidance	IR
Weight	143 lb
Warhead	86 lb expanding rod
Max. Range	3 mi
Min. Range	0.3 mi

The Aphid is a short-range, all-aspect, IR-guided dogfight missile similar to the American Sidewinder family of missiles. The standard close-in weapon since the 1970s, it can be carried by almost all Russian aircraft and helicopters but is now being replaced by the AA-11 Archer.

AA-9 Amos missile

Guidance	Semiactive radar homing (SARH)
Weight	1078 lb
Warhead	103 lb HE blast/fragmentation
Max. Range	62 mi
Min. Range	12 mi

The AA-9 Amos is a long-range air-to-air missile primarily for use against bombers and cruise missiles, and is similar to the American AIM-54 Phoenix missile in many ways. It is the primary armament of the MiG-31 Foxhound, and together with the Foxhound's long range radar, is a formidable weapons system.

AA-10 Alamo missile

Guidance	IR and semiactive radar homing (SARH) versions
Weight	559 lb/770 lb
Warhead	86 lb expanding rod
Max. Range	25 mi/47 mi
Min. Range	0.3 mi

The AA-10 was developed for use on the MiG-29 and Su-27 and as a replacement for the AA-7 Apex used on the MiG-23 Flogger. Fast, extremely maneuverable, difficult to jam or decoy, and resistant to ground-clutter effects, the AA-10 Alamo is a potent weapon.

AA-11M1/M2 Archer missile

Guidance	IR
Weight	231 lb/242 lb
Warhead	16 lb HE fragmentation
Max. Range	12 mi/19 mi
Min. Range	0.2 mi

Developed as a replacement for the AA-8 Aphid, the Archer is possibly the best dogfight missile in the world. Its high maneuverability and ability to track targets as much as 60 degrees off boresight (80 degrees for the M2 version), combined with the helmet-mounted targeting capabilities of modern Russian aircraft, make any aircraft carrying Archers a dangerous foe.

AA-12 Adder missile

Guidance	Active radar
Weight	385 lb
Warhead	66 lb HE directed fragmentation
Max. Range	31 mi
Min. Range	0.2 mi

The most interesting feature of this new air-to-air missile is its rear control surfaces, which have a unique trellis structure. The potential advantages of this design over more conventional layouts include greater maneuverability at high angle of attack, enhanced maneuverability for any given fin deflection angle, and lighter weight. The Adder's rear control surfaces also fold down, which has led to speculation that it can be carried internally by some aircraft.

Russian-Built ground-to-air weapons

SA-10c missile

Guidance	Targeted-via-missile
Weight	3,256 lb
Warhead	32,316 lb HE fragmentation
Max. Range	93 mi
Min. Range	?
Max. Altitude	94,000 ft.
Min. Altitude	31 ft.
Max. Speed	Mach 6.0

SA-11 missile

Guidance	Semiactive radar homing (SARH)
Weight	1,518 lb
Warhead	154 lb HE fragmentation
Max. Range	20 mi
Min. Range	1.9 mi
Max. Altitude	69,000 ft.
Min. Altitude	31 ft.
Max. Speed	Mach 2.5

SA-12a missile

Guidance	Semiactive radar homing (SARH), inertial
Weight	5,280 lb
Warhead	330 lb HE focused fragmentation
Max. Range	47 mi
Min. Range	4 mi
Max. Altitude	94,000 ft.
Min. Altitude	780 ft.
Max. Speed	Mach 5.0

SA-13 missile

Guidance	IR
Weight	92 lb
Warhead	9 lb HE fragmentation
Max. Range	3 mi
Min. Range	0.1 mi
Max. Altitude	10,950 ft.
Min. Altitude	31 ft.

SA-13 missile

Max. Speed	Mach 2.0

SA-15 missile

Guidance	Command guidance
Weight	363 lb
Warhead	33 lb HE fragmentation
Max. Range	7.5 mi
Min. Range	1 mi
Max. Altitude	18,800 ft.
Min. Altitude	31 ft.
Max. Speed	Mach 2.5

SA-17 missile

Guidance	Semiactive radar homing (SARH), inertial, datalink
Weight	1,584 lb
Warhead	154 lb HE fragmentation
Max. Range	31 mi
Min. Range	2 mi
Max. Altitude	78,200 ft.
Min. Altitude	31 ft.
Max. Speed	Mach 3.5

SA-16 Gimlet/SA-18 Grouse missiles

Guidance	IR
Weight	24 lb
Warhead	2 lb
Max. Range	3 mi
Min. Range	0.3 mi

SA-16 Gimlet/SA-18 Grouse missiles

Max. Altitude	10,950 ft.
Min. Altitude	31 ft.
Max. Speed	Mach 2.3

SA-19 missile

Guidance	IR
Weight	70 lb
Warhead	6 lb HE fragmentation
Max. Range	5 mi
Min. Range	0.3 mi
Max. Altitude	19,100 ft.
Min. Altitude	31 ft.
Max. Speed	Mach 1.8

B Ribbon and Medal Historical Data

This appendix lists all of the ribbons and medals available in *i*F-22 Raptor. They are listed in order of importance, from easiest to hardest to obtain.

Air Force Training Ribbon

This ribbon was established on October 12, 1980, and is awarded to Air Force personnel that complete flight training.

Air Force Recognition Ribbon

This ribbon was established on October 12, 1980, and is given to Air Force personnel in recognition of special accomplishments.

Bosnian Conflict Victory Ribbon (fictional)

This ribbon was established immediately following the Bosnian Conflict and is awarded to all armed service personnel who served in that theater.

Russo-Ukrainian War Victory Ribbon (fictional)

This ribbon was established immediately following the Russo-Ukrainian War and is awarded to all armed service personnel who served in that theater.

Air Medal

This medal was established on May 11, 1942, and is given to armed services personnel who distinguish themselves by meritorious achievement while participating in aerial flight or for sustained distinction in the performance of duties.

Air Force Achievement Medal

This medal was established on April 20, 1980, and is given to Air Force personnel for outstanding achievement, meritorious service, or acts of heroism.

Purple Heart

This was established by George Washington in 1782 and is awarded to armed service personnel wounded in action. It is also awarded posthumously to persons killed from wounds received in action.

Distinguished Flying Cross

This medal was established on July 2, 1926, and is awarded to armed services personnel

who distinguish themselves by acts of heroism or meritorious achievement while participating in aerial flight. This medal was first awarded to Captain Charles Lindbergh for his solo flight across the Atlantic.

Air Force Distinguished Service Medal

This medal was established on July 6, 1960, and is awarded to Air Force personnel who distinguish themselves through meritorious service while serving in a position of great responsibility.

Silver Star

This medal was established on July 9, 1918, and is awarded to armed services personnel for gallantry in action, but not of a degree warranting a Air Force Cross or the Congressional Medal of Honor.

Air Force Cross

This medal was established on July 6, 1960, and is awarded to Air Force personnel for extraordinary heroism not justifying a Congressional Medal of Honor. The first award of this medal was made posthumously to Major Rudolf Anderson Jr. for actions during the Cuban Missile Crisis.

Air Force Congressional Medal of Honor

This medal was established on July 6, 1960, and is awarded to Air Force personnel who distinguish themselves by gallantry and intrepidity at the risk of their lives, above and beyond the call of duty. The first award of this medal was made to Major Bernard Fisher on January 19, 1967.

C Pre-scripted Communication Messages

This appendix lists the contents and possible recipients of pre-scripted messages. You can still type a chat message to any of these recipients, but computer-controlled objects won't understand them. When you initiate a communications message, a list of recipients is displayed. To choose a recipient, press the corresponding number, and a list of messages available for that recipient is displayed. To send one of the messages, press its corresponding number. For example, to tell your flight to cover you, initiate a UHF communication by pressing the **U** key, then press **1**, followed by **1**.

1: Your flight (recipient)

1—Cover me

2—Engage my current target

3—Engage my current target from formation

4—Engage remaining targets

5—Engage remaining targets from formation

6—Radio silence

7—End radio silence

8—Abort mission and return to base

9—Disengage and form on my wing

0—Check in

2: Wingman 2 (recipient)

Same as messages available for "1: Your flight (recipient)."

3: Wingman 3 (recipient)

Same as messages available for "1: Your flight (recipient)."

4: Wingman 4 (recipient)

Same as messages available for "1: Your flight (recipient)."

5: AWACS (recipient)

1—Request IFDL

2—Disconnect IFDL

3—Request Bogey Dope

6: FAC (recipient)

1—Inform that you are in the area

2—Inform that you are "In Hot"

3—Request IFDL

4—Disconnect IFDL

5—Inform that you are leaving area

7: Ground (recipient)

1—Listen to ATIS airport information

2—Request flight route clearance

8: Tower (recipient)

1—Request permission to take off

2—Request permission to land

9: General messages (recipient)

1—“Roger” last transmission

2—Send a “Mayday” call

3—Request “Steers” from nearest command and control unit

4—Request “Launch the air base attack!” (only in multiplayer head-to-head capture the flag)

0: Escorting flight (recipient)

Same as messages available for “1: Your flight (recipient).”

Glossary

AAA. Anti-Aircraft Artillery.

AAR. Air-to-Air Refueling.

AAW. Anti-Air Warfare.

ACC. Air Component Commander.

ACE. Airborne Command Element (such as AWACS or ABCCC).

ACM. Air Combat Maneuvering.

ACT. Air Combat Tactics.

AFAC. Airborne Forward Air Controller.

AGL. Above Ground Level.

AGM. Air-to-Ground Missile.

AI. Air Interdiction or Air Intercept.

ALO. Air Liaison Officer.

AoA. Angle of Attack.

AOB. Air Order of Battle.

ARCP. Air Refueling Control Point. A point on the ART at which receiver aircraft should be prepared to initiate refueling.

ARIP. Air Refueling Initial Point. A point on the ART at which receiver aircraft should enter the track.

ARM. Anti-Radiation Missile.

ART. Air Refueling Track. A preplanned track flown by tankers for aerial refueling.

ASL. Above Sea Level. Used to indicate an altitude measured from sea level.

ASM. Air-to-Surface Missile.

ASOC. Air Support Operations Center.

ASUW. Anti-Surface Warefare

ASW. Anti-Submarine Warfare.

ATO. Air Tasking Order. The official document assigning all aspects of missions in a given period of time. Also known as a *frag*.

AWACS. Airborne Warning and Control System. The USAF's E-3 Sentry.

BAI. Battlefield Air Interdiction.

BDA. Bomb Damage Assessment. Post-strike evaluation of enemy targets.

BFM. Basic Fighter Maneuvers.

BRA. Bearing, range, and altitude of target.

BREAK AWAY. Call given by a tanker or receiver to indicate an immediate separation, usually due to an emergency.

BZ. Buffer Zone. Airspace adjacent to a combat operating area where special restriction apply.

BZ. Bravo Zulu. A naval term indicating a job well done.

BVR. Beyond Visual Range.

CAP. Combat Air Patrol. An anti-air patrol anchored to a particular position or ground feature.

CAS. Close Air Support.

CBU. Cluster Bomb Unit.

CCA. Command and Control Agency.

C2. Command and Control.

C3. Command, Control, and Communications.

C3I. Command, Control, Communications, and Intelligence.

Chaff. Aluminized plastic strips used to deceive or block radar transmissions.

Clock Code. Position system used in aviation to locate objects outside the flight. Twelve o'clock references the nose of the aircraft; three o'clock, the right wing; six o'clock, the tail; and nine o'clock, the left wing. May combine with high/low level to indicate elevation.

Comm Jamming. Intentional disruption of communications.

CONUS. Continental United States.

CSAR. Combat Search and Rescue.

DCA. Defensive Counter Air.

ECM. Measures taken to minimize the effectiveness of electronic emissions, such as radar, generally through jamming or deception.

ECCM. Electronic Counter-Countermeasures. Measure taken to counter electronic countermeasures. For example, enemy radar locks up your aircraft. Your countermeasure is to jam that frequency. The enemy's counter-countermeasure is to change frequency.

EID. Electronic Identification. Identifying a target through electronic means.

ELINT. Electronic Intelligence.

EMCON. Emission Control. Preplanned means of reducing electronic emissions. Usually set up with four levels, EMCON 1 through EMCON 4, with 4 being the most stringent (no emissions).

EO. Electro-Optical.

EOB. Electronic Order of Battle.

ETA. Estimated Time of Arrival.

EW. Electronic Warfare or Early Warning.

FAC. Forward Air Controller.

FEBA. Forward Edge of the Battle Area.

Frag. Fragmentary Order. Same at ATO (Air Tasking Order).

FSCL. Fire Support Coordination Line.

GBU. Guided Bomb Unit.

GCI. Ground Controlled Intercept.

GOB. Ground Order of Battle.

GPS. Global Positioning System.

HARM. High Speed Anti-Radiation Missile. The AGM-88.

Have Quick. A jam-resistant radio system used in aircraft.

HUD. Heads-Up-Display.

IADS. Integrated Air Defense System.

IFF/SIF. Identification, Friend or Foe. System used to electronically identify radar located aircraft as either friendly or enemy.

ILS. Instrument Landing System.

IMC. Instrument Meteorological Conditions.

IR. Infrared.

JFACC. Joint Force Air Component Commander. The Commander of the aviation units involved in a joint operation.

JFC. Joint Force Commander. The Commander of all units involved in a joint operation.

LANTIRN. Low-Altitude Navigation and Targeting Infrared for Night. Detachable system used to give aircraft night and precision targeting ability.

LCC. Land Component Commander. Ground equivalent of the JFACC.

LGB. Laser-Guided Bomb.

MedEvac. Medical Evacuation.

MFD. Multifunctional Display.

MSL. Mean Sea Level. Used to indicate that the preceding altitude was measured from sea level as opposed to the ground. ASL equivalent.

Mutual Support. Two or more aircraft supporting one another through tactics.

NCA. National Command Authority. Direction of the Secretary of Defense or higher.

NORDO. Term used to indicate aircraft has no working radio.

ONC. Operational Navigation Chart.

PDA. Personal Display Assistant.

Pk. Probability of Kill (P-sub-K). The probability of killing a target based on a defined number of defined weapons delivered in a defined manner. For example, the Pk of a heavy tank with one Mk-82 500 pound bomb delivered in a 10(daylight dive at 500 knots by an A-10 is less than 10. (less 10 percent).

POPEYE. Flying in an area of reduced visibility.

Rockeye. MK-20, Cluster Bomb Unit.

ROE. Rules of Engagement. Limitations or rules placed on aircrew performing their mission. Implemented as a control mechanism.

RWR. Radar Warning Receiver. System including cockpit indicator to warn pilots of radar signals sweeping the aircraft.

SA. Situation Awareness.

SAM. Surface-to-Air Missile.

SAR. Search and Rescue.

Scramble. Immediate launch of aircraft to counter a particular threat.

SEAD. Suppression of Enemy Air Defenses.

SHRIKE. AGM-45 Anti-Radiation missile.

TAC-A. Tactical Air Coordinator, Airborne. A person designated to coordinate air operations while airborne. Usually in AWACS.

TACC. Tactical Air Control Center. A ground-based facility used to control air operations and make tactical decisions.

TACP. Tactical Air Control Party. An element usually found with ground combat units to control air assets assigned to that unit.

TACS. Tactical Air Control System.

TOT. Time Over Target. A time assigned to arrive/attack a target.

TPC. Tactical Pilotage Chart.

Vc. Velocity, Closure. The speed of closure between two airborne targets.

VID. Visual Identification.

VMC. Visual Meteorological Conditions. Weather with a ceiling greater than 3,000 ft. and visibility better than 5 miles.

Wild Weasel. Aircraft dedicated to locating and destroying enemy radar.

Designer's Notes

Project History

The "F-22 project" began in mid-1995 when "Wild" Bill Stealey decided that he wanted to create a state-of-the-art flight simulation based on the F-22, the winner of the Air Force's Advanced Tactical Fighter (ATF) competition to replace the F-15 as America's premier air superiority fighter. Preliminary project planning began with Joe Rutledge and Doug Kubel outlining resource requirements and personnel needs. Game Designer Bruce Milligan performed preliminary research into the experimental YF-22 and then proposed design changes necessary to produce the F-22. By January of 1996, game designers Michael McCoy and Michael Chen were assigned to the project full-time. James Harler came onboard in April. By now a core team of programmers and artists had been assembled and a brief preliminary design document was prepared.

By April of 1996 full-scale coding began, coinciding with the first draft of the detailed design document. The team reached the Alpha milestone, defined as having all major elements in the game and working to some degree, in January of 1997. April 1997 marked the Beta milestone meaning all coding was complete with only bug and crash fixes remaining. Finally, after almost two years, *i*F-22 Raptor was completed in June of 1997.

With its ability to "assimilate" anyone who came near it, the project became known as the "F-22 Collective." Head of the "Collective" was our Vice President of Engineering and Technology, Doug Kubel, who not only led and coordinated the team, but also contributed to programming tasks. Throughout the project, valuable game design assistance and experience was provided by Arnold Hendrick. James Harler, a retired Marine Corps A-6 bombardier/navigator, provided an invaluable, although sometimes unsolicited, anchor to "reality."

The outstanding programmers of the "Collective" (in order of assimilation) are Elliot Kim, Chris Tector, Dr. Yates Fletcher, Mitchel Soltys, Malcolm Harwood, Chris Cottrell, Tracey McQuillen, Mike Dickheiser, Rick Campbell, Jay Thrash, Kevin Anderson, and Marcus Nordamstam. Artists Allison Britt, John Dupree, Marco Garcia, and David Knox provided the

excellent artwork and models you enjoy in *i*F-22 Raptor.

I-Magic contracted Numerical Design, Ltd. (NDL) to help develop our 3D rendering system, and DEMON-1, Science Applications International Corporation (SAIC) to assist with the complexities of realistic flight modeling. Mark Finch at NDL and, Bruce Hildreth and David Gingras at SAIC merit special mention for their extraordinary efforts throughout this project. Information Integration and Imaging (I3) provided the satellite photography and digital elevation mapping data for the terrain. Throughout the game both Lockheed-Martin and Pratt and Whitney provided us with immeasurable assistance.

Finally, many thanks to the families and friends of the development team for their understanding and support of our efforts. Without them, none of this would have been possible.

Feature Decisions

Throughout development we made many feature decisions. A number of the feature decisions/discussions became quite heated as members of the team couldn't agree, while other features were deemed desirable yet impossible to implement due to time and resource restrictions. The following is an attempt to clarify some of the feature decisions the we made.

Since the F-22 is first and foremost a medium-to-high altitude air superiority fighter, and we wanted to provide the most realistic experience possible, the team decided to use satellite photography textures mapped onto real world elevation data. The result is spectacular out-of-the cockpit views of real terrain, with every feature in its place, just as a pilot would see. As with anything, there are compromises. The data sets are large, requiring CD storage, and the terrain may be blocky at low altitude.

Initially, it was proposed that players be able to choose between flight leader (commanding only one flight: up to four aircraft) and squadron commander (commanding the entire squadron: up to 18 aircraft) levels of control in the game. After much debate we decided that, at least for our first simulation, squadron commander access was too ambitious a goal. For future flight sims we have put this item near the top of enhancement list.

One of the key features in *i*F-22 Raptor is the "active" cockpit where every button and switch moves and operates the aircraft. To move your view around the aircraft we decided on a fixed rather than "free" or "virtual" view system. Virtual cockpit systems were deemed to demand too much memory to operate well and still maintain the active cockpit and terrain system. The question of whether or not to create a virtual cockpit view system was a hotly debated one. In all probability, its inclusion in future sims will be decided by the reaction to its exclusion from iF-22 Raptor.

The two theaters provided in iF-22 Raptor present different areas of the world in which to fly and fight different opponents. The Bosnian Conflict is based upon a hypothetical eruption of hostilities in the now quiet Bosnia-Serbia conflict, while the Russo-Ukrainian War is based on a hypothetical invasion by Russian forces in support of an ethnic Russian minority. These choices were not intended to imply anything about any nationality, religious or ethnic group. They simply portray plausible future scenarios that might require the deployment of American forces in support of U.S. interests.

Unlike most other flight simulations, iF-22 Raptor uses a dynamic mission/campaign generation system so that no two missions are

alike. Every mission you fly puts you in a truly "alive" world with full air and ground wars being conducted by both sides. This feature took considerable effort and is not without its flaws. Since it is truly dynamic, there is no way to guarantee that you'll always intercept aircraft when you're on a mission. At times we've seen friendly aircraft and SAM units destroy aircraft you were sent out to intercept, leaving you with no targets. Other times, the player may feel compelled to abort his mission and return to base due to the presence of unforeseen, and overwhelming, enemy resistance. This is a feature, not a bug, and forces the player to be as cunning and inventive as a real pilot needs to be.

In *i*F-22 Raptor we have included a form of multiplayer play called capture the flag. While this style of play is common among first-person "shoot 'em ups", it's relatively new to the flight simulator world, and offers a fresh alternative to the "deathmatch multiplayer rut" found in so many other titles.

Throughout the design of the game we reviewed as many unclassified sources as we could for information about the real F-22. Most of the information discovered was incorporated directly into the game; however, some was not. Many sources quoted the F-22s top speed to be Mach 1.78, which to us seemed far too slow. After talking with SAIC, we decided to make our F-22 capable of Mach 2.4, which we feel is closer to the real F-22s top speed. We also found that the F-22 has less than one-thousandth of the radar cross section (RCS) of an F-15. While this number is probably accurate for the real F-22, it does not make for good gameplay, so we have deliberately understated the F-22's stealth capabilities. It's just no fun to fly around and never be seen or attacked.

Any company dealing with modern military affairs needs an information policy. It is both my practice and the policy of Interactive Magic to never seek classified information. If material is classified, we simply don't want to see it. We'd rather make our own estimates and avoid all the limitations that come with knowing Defense Department secrets. This game represents our best estimates at this time, and we'll keep on looking for new data for future games. Actually, it's amazing how much information you can get from unclassified sources, provided you know where to look and how to interpret the statistics.

This product is the first in a series of 20th-century aircraft simulations from I-Magic. We're interested in your suggestions for future games and scenarios. The best way to contact us is via the Internet; just visit our web site

http://www.imagicgames.com

and look for the discussion groups we maintain there.

We hope that you will enjoy playing *i*F-22 Raptor as much as we have enjoyed making it for you.

Michael McCoy Jr.
Lead Designer
iF-22 Raptor

Credits

Executive Producers	Doug “Leadfoot” Kubel
	Joe “Warden” Rutledge
Simulation Design	Michael “Toolman” McCoy
	Michael “Spectre” Chen
	Jim “Weasel” Harler
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	John “Blibdool” Dupree
	Marco “Caveman” Garcia
	Dave “Noodle” Knox
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	Mike “Dragon” Dickheiser
	Malcolm “Mage” Harwood
	Elliot “Raven” Kim
	Mitch “Twister” Soltys
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	Tracy “ImTigger” McQuillen
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Multimedia Production	Robert “Prez” Stevenson
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Newscasters	Lynne “LAB” Beaman
	Paul “Spellbound” Spelman
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	Scott Minnier
	Thomas Spann
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	Robert Hodge
	Barry “4th Horseman” Spikes
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