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**AVIONICS AND NONNUCLEAR WEAPONS DELIVERY FLIGHT  
MANUAL**

**FALCON 4 / BMS SERIES AIRCRAFT**

**F-16C/D & A-MLU**



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## FOREWORD

### PURPOSE AND SCOPE

This manual contains data describing the aircraft weapons system updates. It is not intended to replace the Falcon 4.0 manual, the SP3 manual or the BMS 2.0 manual; only to supplement them. This manual is a work-in-progress and will evolve over time. The change symbol, as illustrated by the black line in the margin of this paragraph, indicates changes have been made in the current issue.

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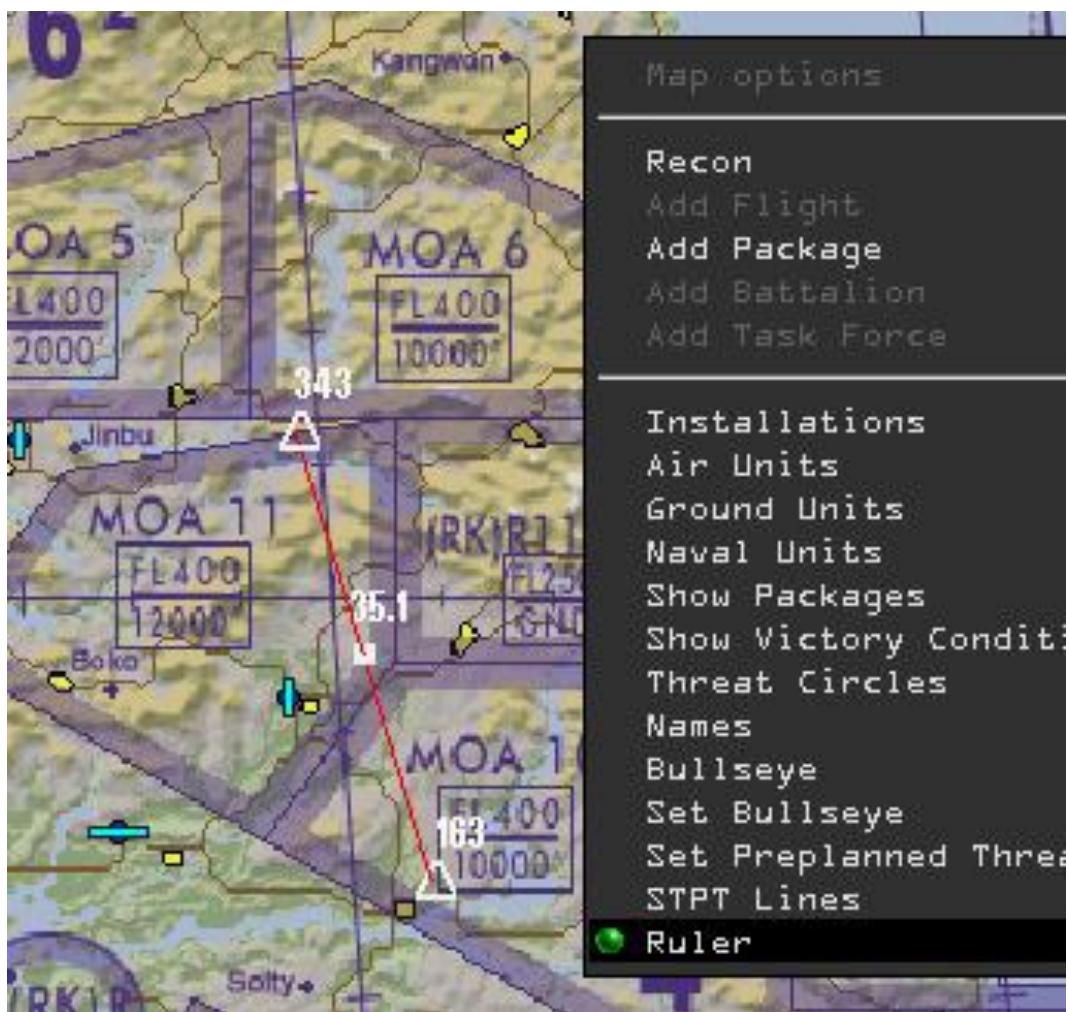
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# User Interface



## Ruler Tool

A ruler tool has been added to the UI map for measuring distance and bearing. Enable and disable the ruler from the right-click context menu in the map area. The ruler can be moved around over the map by use of a left-click and hold on the center white square and dragging the mouse. The triangles at each end of the ruler can also be dragged with a left-click to alter their position and relative placement. The number above the center square represents the length of the line.

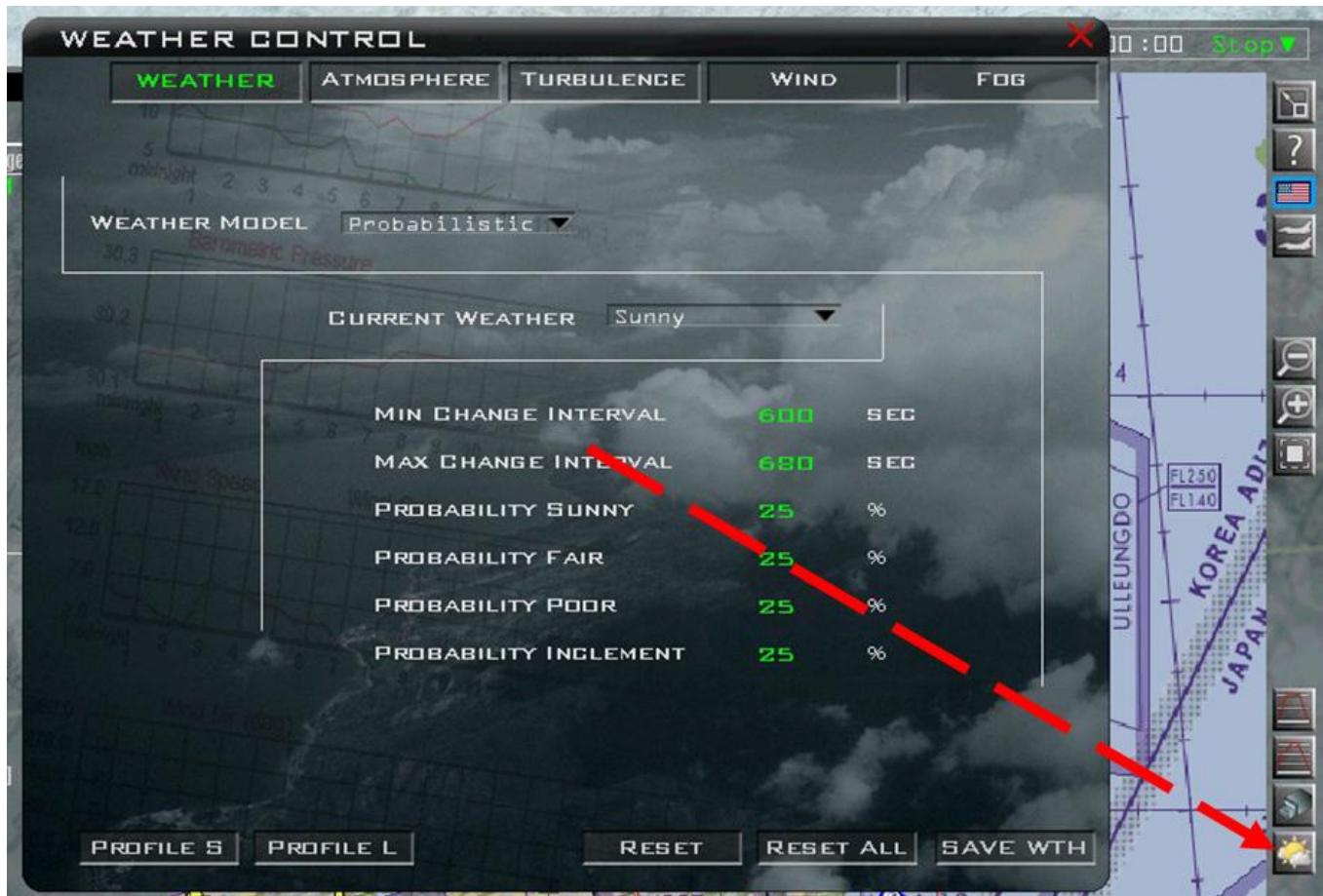


# Weather Control

Weather types of deterministic or probabilistic have been coded. The TE maker can control atmosphere (temperature & pressure), turbulence, wind and fog. The weather is saved in a new file "<TE\_name>.twx" in the same location as other files saved for TE missions. Default weather can be saved in a new log profile "nickname.dat". Clouds are now shared in multiplayer which means that all players should see the same cloud cover throughout the theater.

Click on the icon below the DTC icon to bring up the Weather Control

The altimeter setting can be obtained by calling the tower (ATC menu page 2 - QNH, QFE, QNE calls are available) and can be dialed in on the altimeter. `g_bCalibrationHg` in the .cfg file makes the altimeter call in InHG otherwise it is in MB. A complex atmosphere with 2 adiabatic layers and one isotherm layer has been coded. Interpolation of temperature and ground pressure changes the values depending on the Time of Day (now minimum temp is at Sunrise and max is at 4 pm).



# COMMS / Phone Book

The Phone Book has been redesigned and now includes the following features:



Refer to the section on Aircraft Radios for additional details about the updated voice communication systems.

## **Server Name**

This is a text string that you can choose as a way to remember the collection of settings that you enter below this one to describe the connection to a particular host. Normally this would be the host system name or the name of the player who is hosting a game that you would like to join perhaps.

## **Connect to IP Address**

This is the routable IP address of the host system to which you would like to connect. This address must be routable from your system. Typically this is the WAN address of the router of the remote player or server who will host your game. It is possible to use a non-routable address such as one on your local LAN if you are not using the internet for connectivity.

## **Connection Bandwidth**

For the time being you must enter a value in this box (future versions may automate this). Unfortunately there isn't really a hard and fast rule for what to put here. The value is used to help manage network traffic on your connection to avoid flooding while keeping the throughput as high as practical. As a general rule of thumb, enter the upload speed of your connection minus 25% in kilobits. For example, if you upload capacity is 1000 kilobits per second then you would enter 750 in this box.

Please refer to our web site articles for more specific guidance on this topic, particularly as it relates to hosting games.

## **Dedicated Voice Server IP**

This field holds the address of the voice server that you will use for IVC in this game. The field accepts IP addresses. For example, if you are hosting the voice server on your local system, you can use “127.0.0.1” to provide the correct address.

Please note: older versions of Falcon4 that had IVC systems used a convention of “0.0.0.0” in the voice server field as the means of both starting the voice server on your local system and connecting your game to it locally. This NO LONGER SUPPORTED.

Leaving this field blank with no valid IP address or hostname will result in an error.

## **Dedicated IVC Password**

Some voice server hosts may choose to implement a password to access their server. If required, enter the password in this field to complete your credentials before connecting.

## **IVC Enabled**

Turns the integrated voice comms on/off. Please refer to the Aircraft Radios section for more detail on the Integrated Voice Comms system.

## **IVC Automatic Gain Control**

Turns on and off the automation of gain control for the microphone you have connected and are using for the IVC system.

## **Hosting Scenarios**

These are three of the more common scenarios for making network connections with IVC support. [Others are possible. In some cases, it *may* be possible to mix WAN and LAN clients on the same host but this is router/NAT implementation dependent and there's no guarantee that this will work for you.]

- 1) Pilots are using a separate dedicated IVC server and the pilot with the most bandwidth / fastest machine is game host: All pilots enter the host's IP in the “Connect to IP Address” field and the voice server IP or hostname in the “Dedicated IVC Server” field and then click Connect. This scenario will be used the majority of the time.
- 2) Separate voice comms server not available – one pilot is hosting voice comms and another is hosting the actual mission. The pilot hosting voice comms should be the initial game host. He starts the voice server locally before entering the game. Then at the COMMS screen he puts “0.0.0.0” in the “Connect to IP Address” field and “127.0.0.1” in the “Dedicated IVC Server” field and clicks Connect. All other pilots put his IP address in the “Connect to IP Address” and “Dedicated IVC Server” fields. Once all pilots are in the Lobby, the mission host puts up the TE/Dogfight/Campaign and the pilots join.
- 3) Separate voice comms server not available – one pilot is hosting both voice and the actual mission. (This is not recommended for large missions with lots of clients unless the host has a smoking fast machine and lots of bandwidth). The host starts the voice server locally before entering the game. Then at the COMMS screen he enters “0.0.0.0” in the “connect to IP Address” field and “127.0.0.1” in the “Dedicated IVC Server” fields. All remaining pilots input the host's IP address in the “Connect to IP Address” and “Dedicated IVC Server” fields and connect. This host also brings up the TE/Dogfight/Campaign mission and pilots join.

# Data Transfer Cartridge

In previous versions of Falcon 4.0, the pilot was able to set up his cockpit the way he wanted it – similar to how the real F-16 can be configured with the Data Transfer Cartridge (DTC), but this system was more basic, that is until now.

The “cockpit saved state” as it is called, saved numerous options that the pilot could set and then save so that he would not have to re-accomplish his own personal setup each and every time he flew. These options were saved in a text file named `callsign.ini` stored in the [Your Falcon BMS dir]\User\Config directory. Some of the options that can be saved are:

- **EWS & Chaff/flare settings** (Burst qty, burst interval, salvo qty, salvo interval, BINGO, REQJAM)
- **Default Mastermode**
- **MFD primary/secondary/tertiary setup per Mastermode** (A-A, A-G, NAV, DGFT, MSR OVRD)
- **Bullseye Mode** (on/off)
- **UHF & VHF preset channels**
- **HUD Setup** (HUD color, scales setup, FPM/pitch ladder, DED info, velocity and Alt setup)
- **Laser Start Time**
- **Master Arm selection**
- **Default cockpit view**

To accomplish this, the pilot would set up his cockpit to his liking and then hit Alt C, S to save it. To load it, he would hit Alt C, L. These keystrokes still accomplish this, but a new way to also accomplish this is through the DTE MFD page via the LOAD button. Each label on the DTE page will highlight briefly (this is purely graphical eye-candy) and then the cockpit setup will load.

In this updated version, the number of things stored to the `callsign.ini` has increased. New options that are also saved now are:

- **Target steerpoints** (stored in STPTs 1-24)
- **LINES steerpoints** (stored in STPTs 31-50 – 4 groups of 5 STPTs each)
- **Preplanned threats** (stored in STPTs 56-70)
- **EWS VMU FDBK** (EWS Voice Message Unit feedback)
- **UHF frequency presets 1-20**
- **VHF frequency presets 1-20**

The `callsign.ini` format is not very user-friendly when it comes to wanting to change your cockpit setup before a mission. To ease setup outside of the cockpit and/or before a flight, a virtual Data Transfer Cartridge has been developed for use in the User Interface (UI). Not all options listed above are configurable via the DTC UI, but most of the more important functions can be changed and stored. There is however, one other option for managing the DTC information and that is to use an external program to edit the files. You could do this with a text editor but note that mistakes in the file may result in errors or crashes when the game runs so do this with great care. A far better alternative exists in the shape of the Weapon Delivery Planner (WDP) program (found at <http://www.weapondeliveryplanner.nl/home.html>) which manipulates everything in the DTC safely and effectively; along with many other useful tricks!

The list of DTC elements you can edit using the in-game UI includes:

- **EWS & Chaff/flare settings** (Burst qty, burst interval, salvo qty, salvo interval, BINGO, REQJAM)
- **Default Mastermode**
- **MFD primary/secondary/tertiary setup per Mastermode** (A-A, A-G, NAV, DGFT, MSR OVRD)
- **UHF & VHF preset channels**
- **Target steerpoints** (stored in STPTs 1-24)
- **LINES steerpoints** (stored in STPTs 31-50 – 4 groups of 5 STPTs each)
- **Preplanned threats** (stored in STPTs 56-70)
- **EWS VMU FDBK** (EWS Voice Message Unit feedback)
- **UHF frequency presets 1-20**
- **VHF frequency presets 1-20**

To be on the safe side, if it is your first time using the DTC or you attempted to use it in an earlier exe, it is recommended you browse to the config folder of your Falcon installation folder and delete the `callsign.ini` where “callsign” is your callsign. I.e., [Your Falcon BMS dir]\User\Config\Yourcallsignhere.ini. If you are unable to see the file extension, accomplish the following:

1. Double-click “My Computer”.
2. Go to Tools→Folder Options→View tab. Click the radio button next to “Show hidden files and folders”.
3. Uncheck “Hide extensions for known file types”
4. Click “OK”.

You will be able to rebuild your chaff/flare set up within the UI with the DTC and anything else in the 3d world so don’t worry about deleting this file.

There is also a special new .ini file that stores **only** Target steerpoints, Preplanned threats, and LINES steerpoints. This .ini file is built while in the TE module and once saved, is stored in the [Your Falcon BMS dir]\Data\campaign\SAVE directory (where TE missions are also stored). The name of this .ini file is the same as the TE’s. The section below describes this new file and how it is created in detail.

## DTC Operation

After opening a TE or campaign mission, stop the clock. On the right-hand side of the UI map, there is a new button, , which opens the DTC. There are 4 tabs as seen below. Note that the DTC window can only be opened while you’re in a TE or campaign mission and **not** in the TE Editor. As mentioned above a special new .ini can be created within the TE module [as if you were going to fly] (**not** the TE Editor). After building a TE and saving it, the pilot exits back to the main UI, and reenters the TE like he was going to fly. He stops the clock and then builds any Target steerpoints, Preplanned threats and LINES (as described below) he wishes for the mission to have as defaults. After building the points, he opens up the DTC and hits the Save button. This will store those values into the `TEmissionname.ini` file that will be stored in the \Falcon4\campaign\save directory. See the Important Notes subsection below for more details.

## Common Buttons

There are 3 common buttons on all the DTC tabs. Clear, Load and Save. Clear does the obvious – clears all of the `callsign.ini`. Load loads the `callsign.ini` and Save saves it. If you select Load, and then move to a different tab and it appears that the fields (let’s say the MFD Modes) did not load, hit the Load button again and the fields should populate. Next to the Clear button is a status message. After bringing the DTC up for the first time, it will say “Ready”. After loading it, it will say “Loaded OK”. A save will show “Saved OK”.

## Targets

The Targets tab is a feature that allows the pilot to assign a recon target to a specific steerpoint. The pilot may only use steerpoints 1 through 24, which is plenty for most situations. There are two ways the pilot can go about using this feature depending on the pilot's needs and the needs of the mission.



### **One Pass, Haul Ass**

If the mission has only one target (for example a SAM site), generally the (TE) mission builder or the campaign ATO manager will have one TGT-type steerpoint in the flight plan at the target area. Let's assume you are part of a 4-ship assigned to destroy this site. The SAM site has its associated radar (in this case, a Straight Flush) and a number of TELs (Transporter Erector Launchers) that will be targeted by each member of the flight. After choosing targets, using the Targets feature makes it a snap for each pilot to get an accurate lat/long of their individual target without having to write down the coordinates and reprogram their TGT-type steerpoint in the jet. The following procedures are used to accomplish this.

1. Close the DTC if it is open and then recon the target area. Let's assume that STP 5 in your flight plan is the TGT-type steerpoint at the SAM site.



TARGET LIST		
TARGET	CONDITION	VALUE
SA-2	No damage	Very high
SA-2	No damage	Very high
SA-2	No damage	Very high
SA-2	No damage	Very high
Fan Song B	No damage	Very high
ZPU-2	No damage	Very high
ZPU-2	No damage	Very high
ZPU-2	No damage	Very high

2. Select the target you are assigned—in this case, the Fan Song B. Below the red arrow, use the decrement/increment ( $\triangleleft \triangleright$ ) arrows to select STPT# 5. Press the Accept button to put the exact LAT/LNG of the Fan Song into steer point 5 for your jet. The highest you can select is STPT 24.



3. Open the DTC once again. Using  $\triangleleft \triangleright$  arrows next to the “Targets Steerpoints” text, increment until you hit STPT 5. It should list the target you assigned to it along with the exact coordinates.
4. Next, to save the assignment hit the Save button. Now you have a very precise lat/long of your specific target and no reprogramming of a steer point in the cockpit is required.

### Multiple Targets, Multiple Passes

If the mission has more than one target and/or you are required to make multiple passes on a target, the following technique can be used to assign the targets. For this example, let's assume you are on a search and destroy mission looking for ground movers and your flight route has a total of 9 steer points total. Steer point #10 is probably the alternate recovery base. Depending on how the TE mission was built or how the ATO went about setting up the steer points may vary. The campaign ATO probably set up two TGT-type steer points separated by some distance. We will assume you see some targets in the vicinity of these two steer points which leaves you with some options. You may click and drag one or both of your STPTs to get closer to these targets and then use the method described above to reprogram those two steer points so they are more accurate. Alternatively, you can leave your two TGT-type steer points alone and assign another steer point or two independent of your flight plan (of which the two TGT-type steer points are a part).

As discussed, the mission had 10 total steer points (9 plus the alternate base) so we want to use steer point number 11 and/or higher for the target assignment. This method has some benefits. The first is it does not require you to move the flight plan steer points and all the members of your flight will have these for common reference (as opposed if you

reprogrammed them, each flight member would have these on their individual targets). Once you got to your area of responsibility, you would simply call up whatever steer point(s) you assigned and then attack your target(s).

What it boils down to is that using the first method will make a steer point that is part of your flight plan more precise to your individual target. If everyone in the flight does this for the TGT-type steer point in the flight plan then everyone will have slightly different locations for that steer point once everyone is in their own aircraft. The second method assigns a steer point that is not part of your flight plan to a target. This leaves all flight members with the exact same flight plan steer points but allows more flexibility for each pilot to have one or more specific sets of coordinates for reference or attack that can quickly be called up via the ICP/DED using the STPT page. Which method you use will be dependent on the mission and how the flight or package lead wants to assign the targets.

## EWS

The Electronic Warfare System allows the pilot to set up his ALE-47 CMDS to meet the threats expected. It is important to have a full understanding of the CMDS described in the Electronic Warfare section. There are two drop-down menus on the EWS tab. The first is for setting up a Chaff or Flare program and the second is for the specific program in which you are making the assignment. Remember each chaff/flare program (1-6) may dispense chaff or flares, or both. A good rule of thumb is to program each of the 6 for a specific purpose with maybe even some overlap in case you have a particular program selected designed to counter only a radar threat but then an IR threat emerges suddenly.



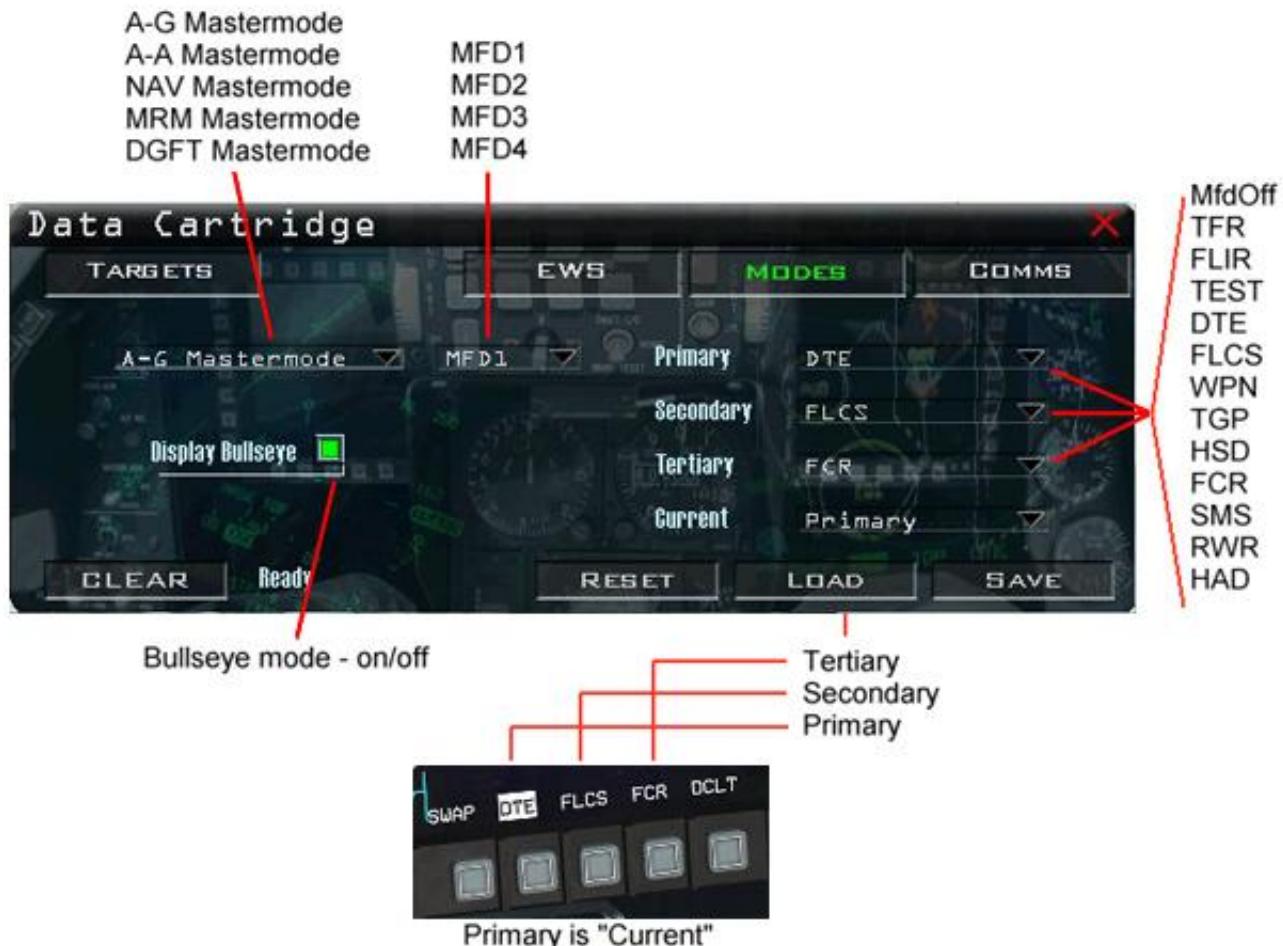
For example, Program 1 could be a chaff only program designed to counter a radar threat (SAM or AI). Program 2 could be designed to counter an AI radar threat as well as any IR missiles that may come your way. Program 3 could be used to counter a radar SAM with chaff only and Program 4 could be used to counter both a radar SAM and IR SAM threat. Program 5 (slap switch) could be used to counter both radar SAM/AI and an IR threat and Program 6 could be something like a flare-only air-to-air merge program designed to defeat an IR missile during the visual merge. The bottom line is the pilot should come up with programs that meet his needs.

After programming all 6 programs (if desired), hit the Save button to write the changes to the `callsign.ini` file.

## Modes

The Modes tab allows the pilot to customize his MFD setup for each Mastermode. To accomplish this:

1. Choose the mastermode from the first drop-down menu, then select for which MFD you are configuring. MFD1 is the left MFD and MFD2 is the right MFD. MFDs 3 & 4 are for use in the “1” view with 4 MFDs on the screen and possibly for use with non-F-16 cockpits. If you rarely use the “1” view, it is recommended to not even set MFDs 3 & 4.
2. As in the picture above, select each MFD page you want for the Primary, Secondary and Tertiary slots for each mastermode and MFD. Most of the labels are self-explanatory. MfdOff is a non-utilized MFD page slot (i.e., blank).
3. Select a different mastermode and go back to MFD1 (or you could leave it on MFD2, it does not matter – just make sure you remember to set MFD1) and repeat the process.
4. Program all mastermodes as desired. Once completely done, hit the Save button.



## Comms

The Comms tab allows the pilot to set up the UHF and VHF radio presets. A full understanding of the Aircraft Radios section is required to use the Comms tab to its fullest capabilities.



### Buttons and Menus

Working left to right, the “Band” drop-down menu selects the radio you want to configure – UHF and VHF. The “Preset #” has numbers 0 through 20. Preset #0 for both UHF and VHF is direct frequency entry if designated as default via “Default” checkbox. In other words, preset 0 is a placeholder for the radio to set up entered frequency when you enter the 3d world when you also flag preset 0 as the default; put another way, you can put a frequency in preset 0 and make that the default and thereby have the radio pre-tuned to something other than one of the normally selectable presets (i.e. 1-20) as you enter the 3D world. For example, the picture above has Preset #0 set frequency 349.00. The “Default” checkbox selects the current preset as the default that is loaded into the aircraft upon entry into the 3d world and/or when a DTE load is accomplished (if necessary). The “Frequency” field allows the pilot to manually type in a valid UHF or VHF frequency to be assigned to a given preset. It is important to understand what constitutes a valid frequency as discussed in the Aircraft Radios section.

The “Reset” button will reset all presets in both bands to their default frequencies. The “Print” button will print your UHF and VHF presets/frequencies to the printer. The “Set Tower” button will attempt to lookup the tower frequency of the airbase out of which you are flying. When this happens, the “No Comment” field will be replaced with the name of the airbase. Also for presets 1-20 (note 0 is not included), the “No Comment” field may be erased and replaced by whatever text the pilot wants associated with that preset. For example, he could select preset 1, delete the text in that field and designate preset 1 as “DCA Primary”. This can be useful for complex communication plans as mentioned in the Aircraft Radios section. After making a text assignment, use the  $\leftarrow$   $\rightarrow$  arrows to select a different preset in order to store the text in memory *before* you hit the Print button. If you do not, the text will still say “No Comment” on your printout.

Similar to the other DTC procedures, after changing a frequency or setting a tower, a Save should be accomplished. It should be noted that unless the pilot has a very specific reason or need to change the default frequencies (like for Force on Force), it is recommended to use the defaults. See the Aircraft Radios section for more information.

## Preplanned Threats

Previous versions of Falcon had a major inaccuracy in how the Horizontal Situation Display (HSD) dealt with threats (SAMs, AAA and Search radars). Threats would “auto-magically” appear on the HSD when the pilot’s aircraft was near SAMs, etc. Aircraft fraged for A-G missions would have their HSDs even more cluttered with these symbols. These threats were fed in real-time (and instantaneously) to the HSD with no pilot action needed. While it is believed

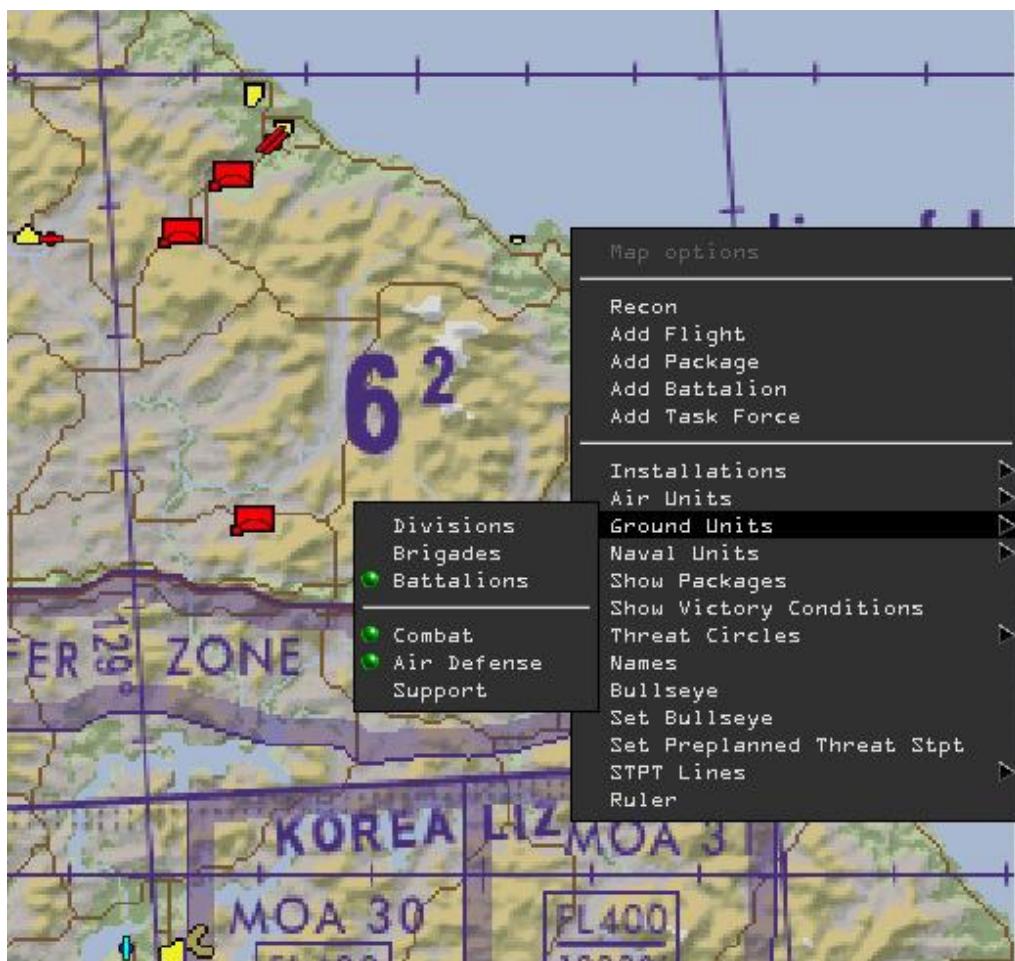
that this method was an attempt at a generic datalink with assets such as AWACS, JSTARS and Rivet Joint (even if they are not in the mission!), it does not correctly model preplanned threats mechanization in the F-16. These symbols would also be removed automatically if, for example, a SAM site's radar was destroyed –which is also incorrect.

This automatic and inaccurate method has been stripped from the HSD code and now pilots have the capability and flexibility to assign only the threats they want to be displayed that will or could be a factor to their aircraft, route of flight, area of responsibility (AOR) or other assets of interest to them.

As the name implies, Preplanned Threats (PPTs) are exactly that—threat systems the pilot plans for during mission planning that could be of harm to him. PPTs are effectively steer points with additional information associated with them. This information includes latitude, longitude, elevation, threat system (i.e., 2 for SA-2) and a maximum effective range for that threat in nautical miles. Since PPTs are steer points, the pilot may select a PPT and navigate to it. Up to 15 PPTs can be used at one time and they are stored in steer points 56-70. The UI map and DTC are used to store and load PPTs prior to committing to a mission.

### **How to set PPTs**

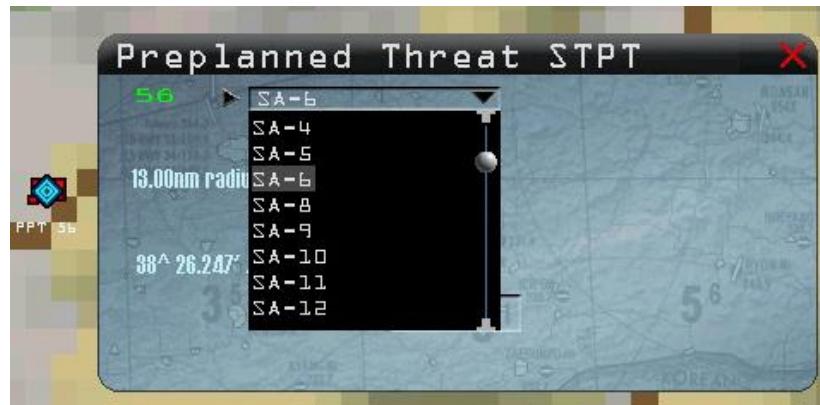
- 1) First, it is important to set up the DTC options (EWS, Comms, etc) the way you want them using the methods described above. After you have done this, you should not have to change them very often (for things like EWS settings for example).
- 2) Next, turn on Ground Units→Air Defenses to see what SAM systems are out there that you may want to assign a PPT to. Right-click on the map somewhere and browse to the following:



- 3) As seen above, several air defense systems popped up on the map. The system to the west of STPT 4 is an SA-6 system. We will assign it as a PPT. To the Northwest is an SA-3 and to the North-Northwest is an SA-2. This example will use the SA-6.
- 4) Right-click on the map in the vicinity of the SA-6 (not directly on it or you won't get the correct menu) and select "Set Preplanned Threat Stpt". A blue diamond-looking symbol should appear with the PPT number below it. The picture on the right is a zoomed in view. You will want to zoom in as much as possible and drag the PPT over the top of the SA-6.



- 5) After dragging the PPT over the SAM, right-click on it and choose "Status". A box will pop up. This allows you to choose what kind of threat it is, in this case, an SA-6.



- 6) Select the threat and hit Accept. It will report the threat's radius and lat/long. It will also draw a red range ring on the UI map and label the PPT icon.



- 7) If you make a mistake or you want to change this PPT to another threat, you may again right-click on it and choose Status. Change it to the threat of your choice. Be aware that if you are zoomed out too far and/or you place the threat right on top of the SAM, you may have a little difficulty doing a Recon on it. If you position the cursor just right, you should be able to do a Recon, or just do a Recon very close to it and you should be able to select the SAM. It is recommended that you do a Recon before assigning a PPT as to avoid this little hassle.
- 8) Repeat the above process as necessary for any other threats. Remember you don't have to go crazy and assign every SAM you see with it, but choose the ones that you think will be a factor to you. You only have 15 slots so use them wisely.
- 9) After assigning all your PPTs, open the DTC back up and hit the Save button. This will save the PPTs to the `callsign.ini` file (if you're in the campaign module) or to the `TEmissionname.ini` (if you're in the TE module) and they will remain there until you overwrite them.

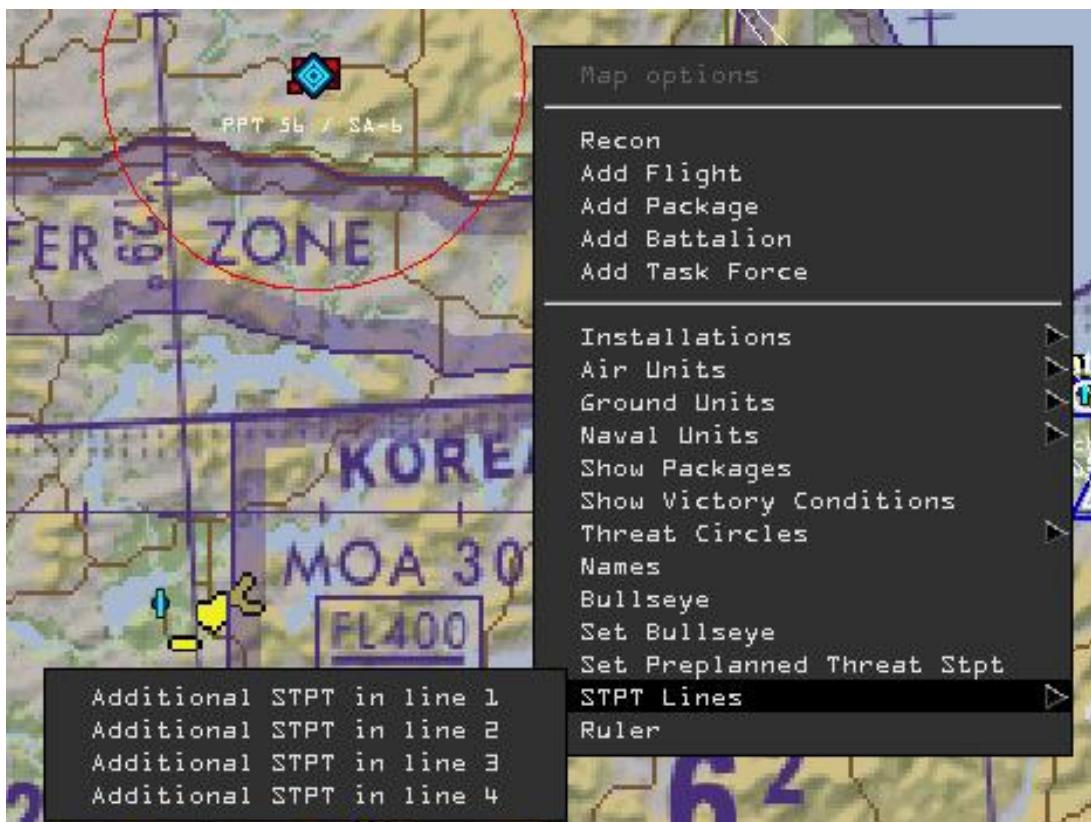
Another benefit of being able to assign PPTs rather than have them automatically appear is that you may assign only one or two PPTs for a given area. For example, let's assume your target is in a populated city that has 6 different SA-2 and 3 SA-3s. Unless you are trying to take them all out (SEAD or DEAD), there is no real need to assign 6 PPTs for all 6 SA-2 and 3 PPTs for all 3 SA-3s. You could use only 2, if the SAMs are in proximity to each other and avoid an HSD clutter nightmare. Another capability that can be used to maximize training missions is that you are able to "make up" threats at a given location even if there are no threats there.

## Lines

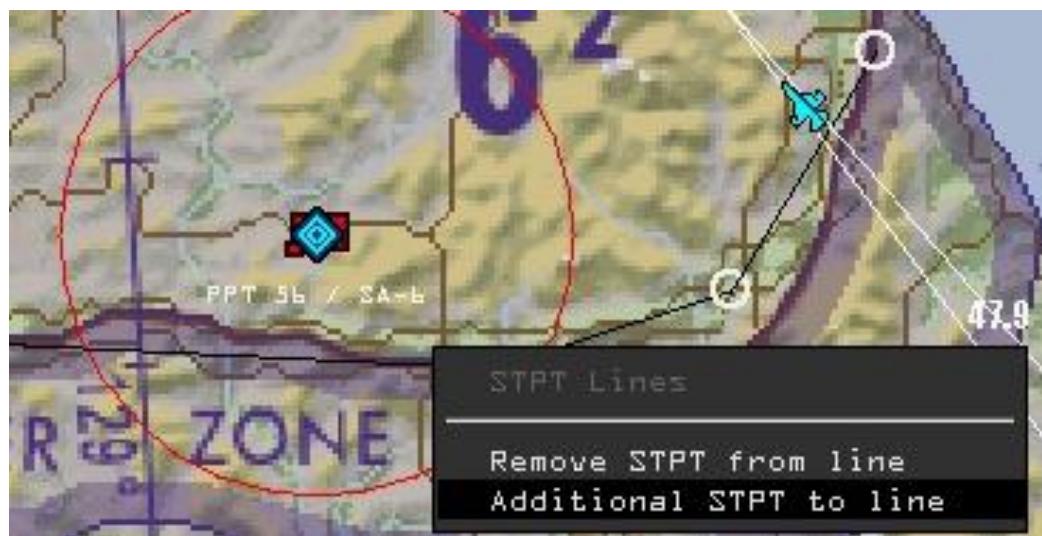
The last function of the DTC is the capability of being able to draw geographic lines on the UI map which appears on the HSD. Up to four lines can be drawn on the HSD (LINE1, LINE2, LINE3, and LINE4) using steer points 31-50. Each LINE series contains up to 5 steer points that can be used to define a forward edge of battle area (FEBA)/Forward line of troops (FLOT), geographic border or battle container (CAP AOR, kill box, location of friendlies, etc). The lines in the HSD are dashed lines drawn between the steer points. If any of the lines are partially off the HSD, the partial line is displayed. The campaign engine will also no longer automatically draw the FLOT (which normally wound up being very jagged looking and not very useful). The pilot must draw the FLOT manually using the LINES feature if it is desired.

### How to Draw Lines

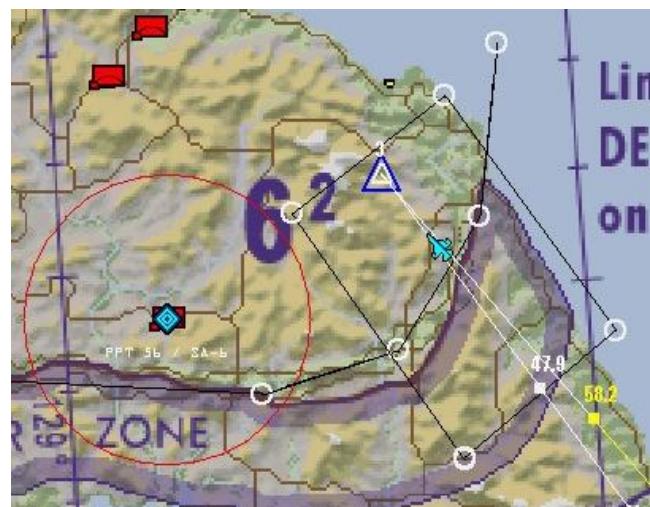
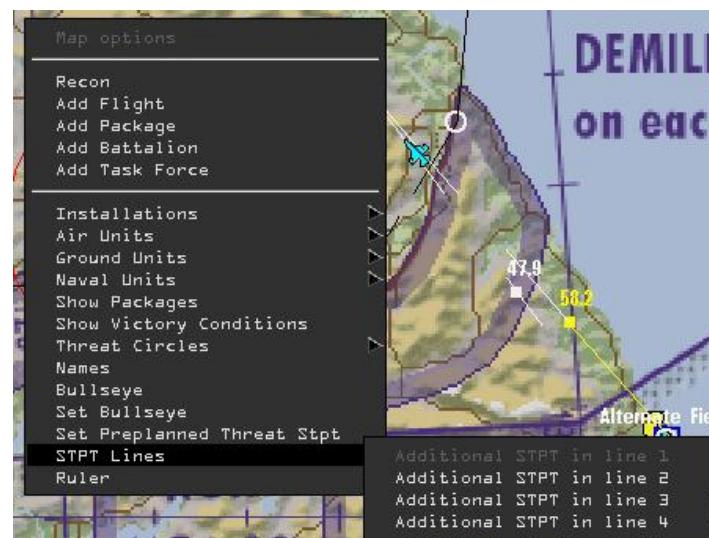
1. Right-click on the UI map at the location you want to start drawing a LINE, select STPT Lines → Additional STPT in line 1. A small white circle will appear.



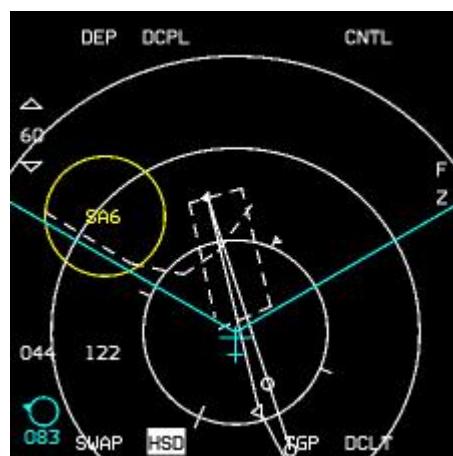
- Drag the circle to the desired location. To add another point (and thus make a line), right-click on the circle and choose “Additional STPT to line”. This second circle will appear exactly on top of the first. Left-click and drag it away and you will see the line drawn between the two. Alternatively, you may also right-click away from the first circle and choose “Additional STPT in line 1” like the picture above and it will draw another circle with a line attaching the two. As shown below, “Remove STPT from line” will remove a steer point from a LINE section.



3. After adding all 5 steer points to a LINE section, you will see “Additional STPT in line 1” greyed out. If desired you can create additional LINE sections using the same procedures.



4. After creating all your LINES, open the DTC back up and hit the Save button. This will save the LINES to the callsign.ini file (campaign module) or to the TEmissionname.ini (TE module) file and they will remain there until you overwrite them.



LINEs and PPTs in the cockpit

## Set Bullseye

This is new feature which allows the pilot to move the bullseye to a location that is useful to him. In order to use this, the “Floating Bullseye” in the Config Editor must be turned off. A pilot may move the bullseye in a multiplayer session before takeoff and the position change will propagate visually on all clients in the session as well as in each pilot’s navigation system. To move the bullseye, simply right-click on the area where you want to move it to, and select “Set Bullseye”.

## What about Multiplayer? How can these features be used in MP?

Since the pilot has the ability to save an .ini file associated with his TE mission, using the data in multiplayer is a piece of cake. All the pilot has to do is send each pilot the **TEmissionname.ini** file that will be used. Each pilot copy/pastes the .ini file into the **Falcon4\campaign\save** directory. It is not necessary for each pilot to have a copy of the actual TE mission. The code is smart enough to recognize the name of the TE and will load the .ini file associated with it.

The following are the procedures for using the TGT STPTs/LINES/PPTs in MP if the mission builder desires all pilots to have the same information:

### **For Tactical Engagements**

1. Build your TE as normal. Save the TE and then exit back to the main UI screen. Open the TE as if you were going to go fly it. Stop the clock. Build TGT STPTs/LINES/PPTs as described in the above paragraphs.
2. Upon completion, open the DTC and hit the Save button. This will write an .ini file that has the same name as the TE. So if you saved your TE as “4shipOCA”, the associated .ini file will be called “4shipOCA.ini”. Again, it resides in the **\Falcon4\campaign\save** directory.
3. Distribute this file to the pilots flying. They will copy/move the file into the same directory.
4. Upon entering the TE module, all pilots should see the TGT STPTs/LINES/PPTs.
5. Each pilot *may* manipulate the information in the UI (add threats, additional lines, or target STPTs), but only he will see those changes. He must hit Save in the DTC if he wishes to keep the changes.

### **For Campaign Missions**

1. Open the campaign module and stop the clock. Build TGT STPTs/LINES/PPTs as described in the above paragraphs.
2. Upon completion, open the DTC and hit the Save button. This will write the information to the **callsign.ini** file. Upon entering the 3d world, the pilot will see the data on the HSD.

Unfortunately, due to technical reasons, each pilot will have to create/build the data they want to see in the cockpit in the campaign screen right before committing to 3d, since it is not possible to share it via normal means like with TEs. See points 3 and 5 in the Important Notes paragraph above.

## Advanced Techniques

Armed with the knowledge above, you can now get creative. If you’re not fully comfortable using the system, reread the section and use it a few times. Once you are comfortable, there are some additional things a mission builder can do to really customize DTC information.

First, a TE builder can build a **TEmissionname.ini** like above but tailor it to a specific mission. He can copy this file to a safe location and then go back into the TE module (in the same TE) and build different information tailed to another specific mission. Again he saves the DTC and winds up with another .ini file with the same name. He can keep these two (or more) files separate from each other (they have the same file names) and distribute one file to one group of pilots (let’s say an OCA) and another file to another group of pilots (let’s say a SEAD flight). All pilots will

copy the file into the \campaign\save directory, but they will have different information in the UI map. How creative you get is up to you, the needs of the pilots and the needs of the mission.

Again, it is worth noting that some of these advanced techniques may be more readily accomplished with an external program such as the Weapon Delivery Planner – highly recommended!

## Format of the TEmissionname.ini

```
[MISSION]
title=TEmissionname
[STPT]
target_0=0.000000, 0.000000, 0.000000, -1
target_1=0.000000, 0.000000, 0.000000, -1
target_2=0.000000, 0.000000, 0.000000, -1
target_3=0.000000, 0.000000, 0.000000, -1
target_4=0.000000, 0.000000, 0.000000, -1
target_5=0.000000, 0.000000, 0.000000, -1
target_6=0.000000, 0.000000, 0.000000, -1
target_7=0.000000, 0.000000, 0.000000, -1
target_8=0.000000, 0.000000, 0.000000, -1
target_9=0.000000, 0.000000, 0.000000, -1
target_10=0.000000, 0.000000, 0.000000, -1
target_11=0.000000, 0.000000, 0.000000, -1
target_12=0.000000, 0.000000, 0.000000, -1
target_13=0.000000, 0.000000, 0.000000, -1
target_14=0.000000, 0.000000, 0.000000, -1
target_15=0.000000, 0.000000, 0.000000, -1
target_16=0.000000, 0.000000, 0.000000, -1
target_17=0.000000, 0.000000, 0.000000, -1
target_18=0.000000, 0.000000, 0.000000, -1
target_19=0.000000, 0.000000, 0.000000, -1
target_20=0.000000, 0.000000, 0.000000, -1
target_21=0.000000, 0.000000, 0.000000, -1
target_22=0.000000, 0.000000, 0.000000, -1
target_23=0.000000, 0.000000, 0.000000, -1
ppt_0=0.000000, 0.000000, 0.000000, 0.000000,
ppt_1=0.000000, 0.000000, 0.000000, 0.000000,
ppt_2=0.000000, 0.000000, 0.000000, 0.000000,
ppt_3=0.000000, 0.000000, 0.000000, 0.000000,
ppt_4=0.000000, 0.000000, 0.000000, 0.000000,
ppt_5=0.000000, 0.000000, 0.000000, 0.000000,
ppt_6=0.000000, 0.000000, 0.000000, 0.000000,
ppt_7=0.000000, 0.000000, 0.000000, 0.000000,
ppt_8=0.000000, 0.000000, 0.000000, 0.000000,
ppt_9=0.000000, 0.000000, 0.000000, 0.000000,
ppt_10=0.000000, 0.000000, 0.000000, 0.000000,
ppt_11=0.000000, 0.000000, 0.000000, 0.000000,
ppt_12=0.000000, 0.000000, 0.000000, 0.000000,
ppt_13=0.000000, 0.000000, 0.000000, 0.000000,
ppt_14=0.000000, 0.000000, 0.000000, 0.000000,
lineSTPT_0=0.000000, 0.000000, 0.000000
lineSTPT_1=0.000000, 0.000000, 0.000000
lineSTPT_2=0.000000, 0.000000, 0.000000
lineSTPT_3=0.000000, 0.000000, 0.000000
lineSTPT_4=0.000000, 0.000000, 0.000000
lineSTPT_5=0.000000, 0.000000, 0.000000
lineSTPT_6=0.000000, 0.000000, 0.000000
lineSTPT_7=0.000000, 0.000000, 0.000000
```

```
lineSTPT_8=0.000000, 0.000000, 0.000000
lineSTPT_9=0.000000, 0.000000, 0.000000
lineSTPT_10=0.000000, 0.000000, 0.000000
lineSTPT_11=0.000000, 0.000000, 0.000000
lineSTPT_12=0.000000, 0.000000, 0.000000
lineSTPT_13=0.000000, 0.000000, 0.000000
lineSTPT_14=0.000000, 0.000000, 0.000000
lineSTPT_15=0.000000, 0.000000, 0.000000
lineSTPT_16=0.000000, 0.000000, 0.000000
lineSTPT_17=0.000000, 0.000000, 0.000000
lineSTPT_18=0.000000, 0.000000, 0.000000
lineSTPT_19=0.000000, 0.000000, 0.000000
```

Note that flight plan waypoint coordinates shown on the UI map also get exported to this ini file as TGT STPTs, except if an explicit TGT STPT was defined for a waypoint's index. In this case the user-defined assigned using the recon UI one is saved into the file in place of the default coordinate set from the flight plan steer point for the given index.

In order to distinguish a flight plan waypoint from a user-assigned TGT STPT an additional integer is exported, which is -1 in case of an undefined or TGT STPT (if undefined x,y & z coordinates will be 0), otherwise this integer is the WaypointClass::Action member, a positive integer representing the action for the waypoint (LAND, TAKEOFF, etc.).

Keep in mind that flight plan waypoints previously stored in the ini file will not be loaded into the DTC when you use the LOAD button in the DTC UI page (this would not make sense anyway). Other details from old .ini files should be loaded correctly of course.

## Important Notes

There are some additional notes about TGT STPTs, LINES, and PPTs the pilot needs to be aware of. The first involves the nature of the `callsign.ini` and `TEmissionname.ini`. They work as follows:

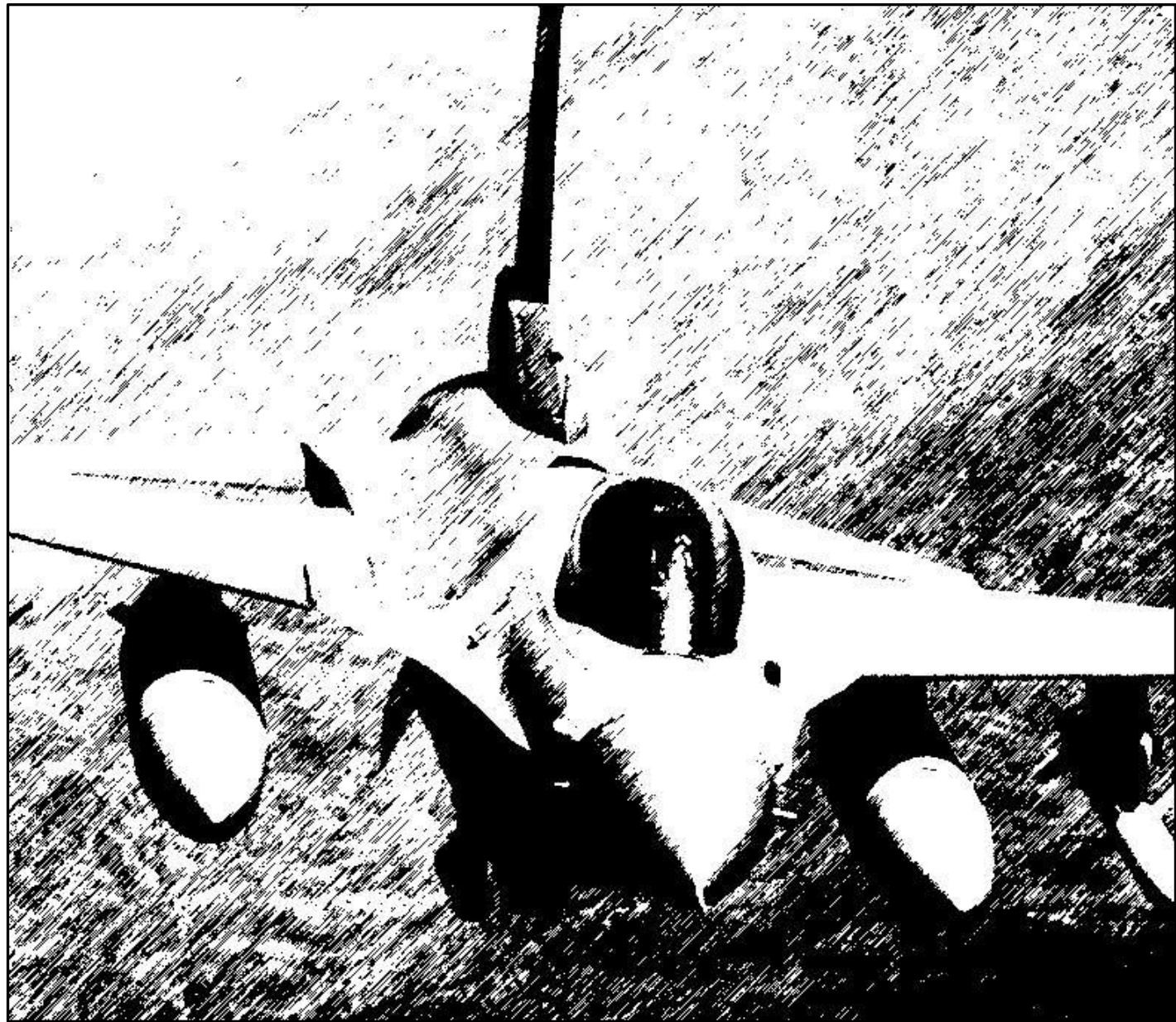
1. Upon application startup and changing the pilot (via logbook) the MFD/EWS/Radio information (everything in the `callsign.ini`) gets loaded.
2. Upon loading a TE, the `TEmissionname.ini` file gets loaded, if it exists. This loads TGT STPTs/LINES/PPT info *on top* of the MFD/EWS/Radio info. If no `TEmissionname.ini` exists, TGT STPTs/LINES/PPT get set to the defaults.
3. Upon loading a campaign mission, TGT STPTs/LINES/PPT (in the `callsign.ini`) gets reset to the defaults (i.e., they are deleted).
4. Upon saving the DTC in the TE module, TGT STPTs/LINES/PPT info gets saved to *both* `callsign.ini` and `TEmissionname.ini`.
5. Upon saving the DTC in a campaign mission, TGT STPTs/LINES/PPT info *only* gets saved to `callsign.ini`. This is due to technical reasons.
6. TGT STPTs/LINES/PPT info gets saved to `callsign.ini` in both the TE module and campaign module so the code in the 3d world only needs to know about the `callsign.ini` file.

The second is that they are totally “local” to each pilot’s computer—meaning that while each pilot may have the `TEmissionname.ini` in their `\campaign\save` directory and see the same TGT STPTs/LINES/PPTs, changing any one of these will *only* affect that pilot that made the change. The changes will not propagate to the other pilots inside the context of the game.

The third note relates to the loading of the DTC. The `callsign.ini` is loaded into memory automatically upon program start up (launching Falcon from the desktop) and also if a new logbook is selected/created. In other words, after a pilot creates LINES, TGT STPTs, and PPTs for a mission, hits the Save button in the DTC and then exits the sim (completely), it is not necessary to open the DTC and hit the Load button when he re-launches Falcon and wishes to fly using the elements he created. He should see them in the cockpit automatically.

Finally, a couple of variables to control behavior of DTC info load have been added. Set g\_bLoadDTCForTrns to 1 for the DTC to be loaded in training missions as well as other missions types; off by default which is the original behavior – no player ini file load for trn missions. Set g\_bNoDTCForRampStart to 1 to suppress loading of the DTC ini file content when the player selects RAMP starts. This implies they will have to load this up from the MFD interface (or key command if they are being lazy) manually as part of the jet start up sequence; off by default which is the original behavior (i.e. always load automagically).

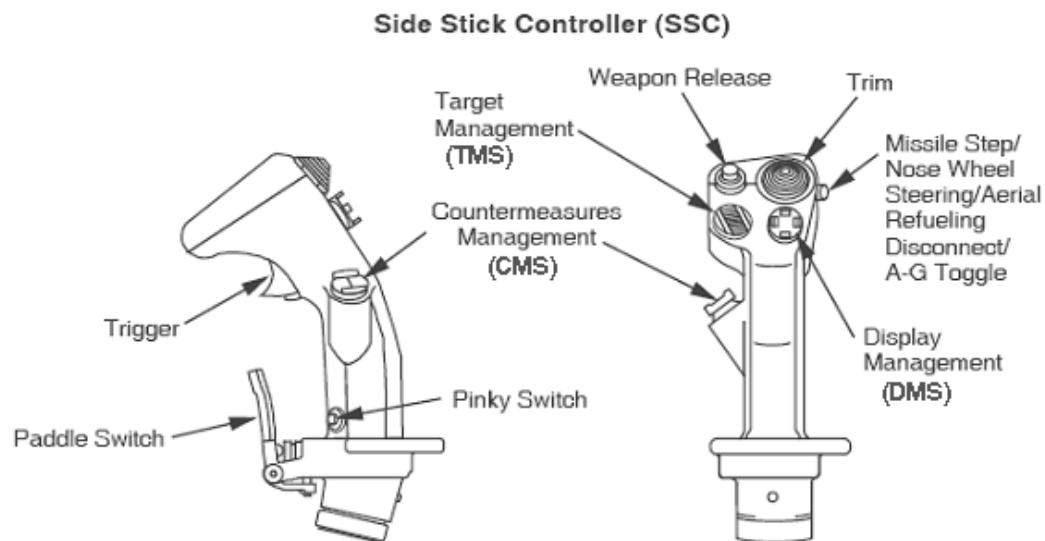
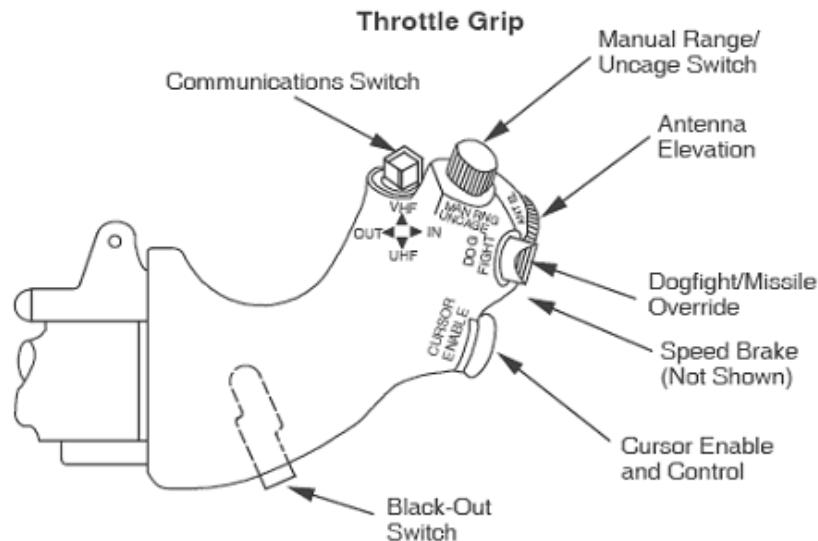
# Flight



# Hands-on Controls

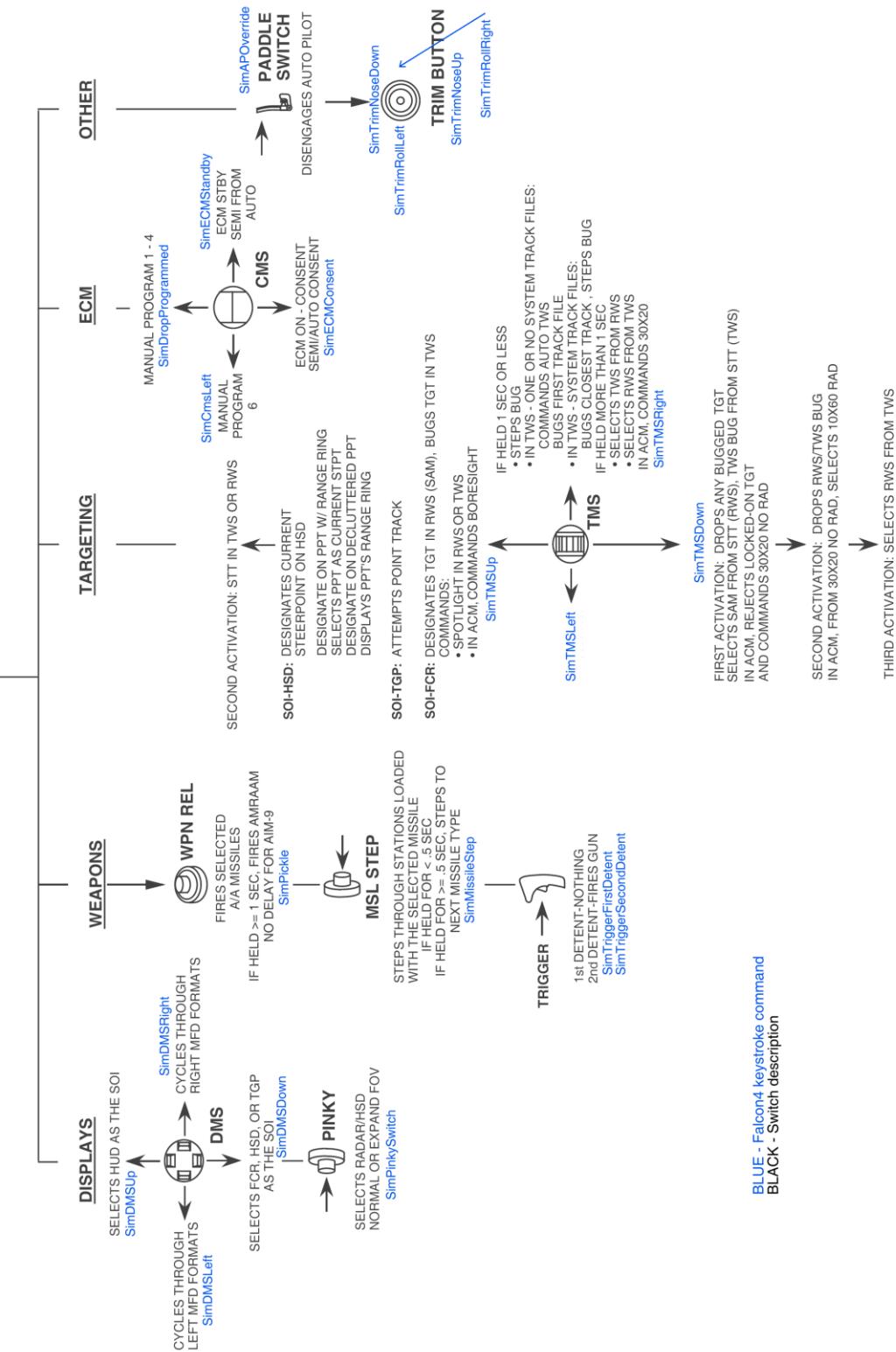
The following diagrams illustrate the typical F-16 HOTAS control grips and the various functions assigned to them. With the exception of the black-out switch (HOBO), all HOTAS functions are modeled in the game.

The sections which follow illustrate the function of the various controls in AA and AG modes and provide the names of the key file callback names that are typically mapped to each switch position on the stick and throttle grips.

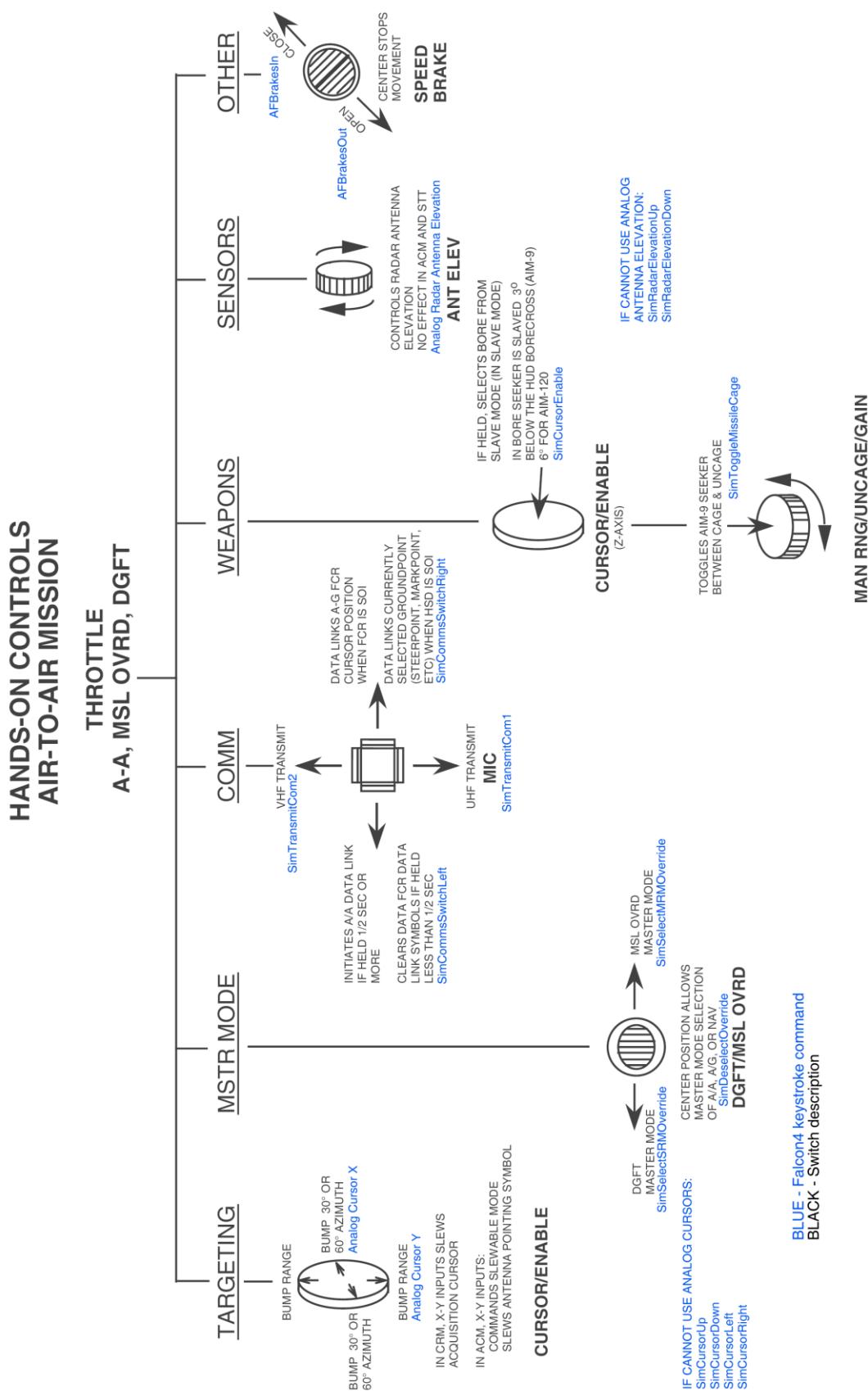


# Air-to-Air Mission, Stick

**HANDS-ON CONTROLS  
AIR-TO-AIR MISSION**  
**SIDE STICK CONTROLLER  
A-A, MSL OVRD, DGFT**



# Air-to-Air Mission, Throttle

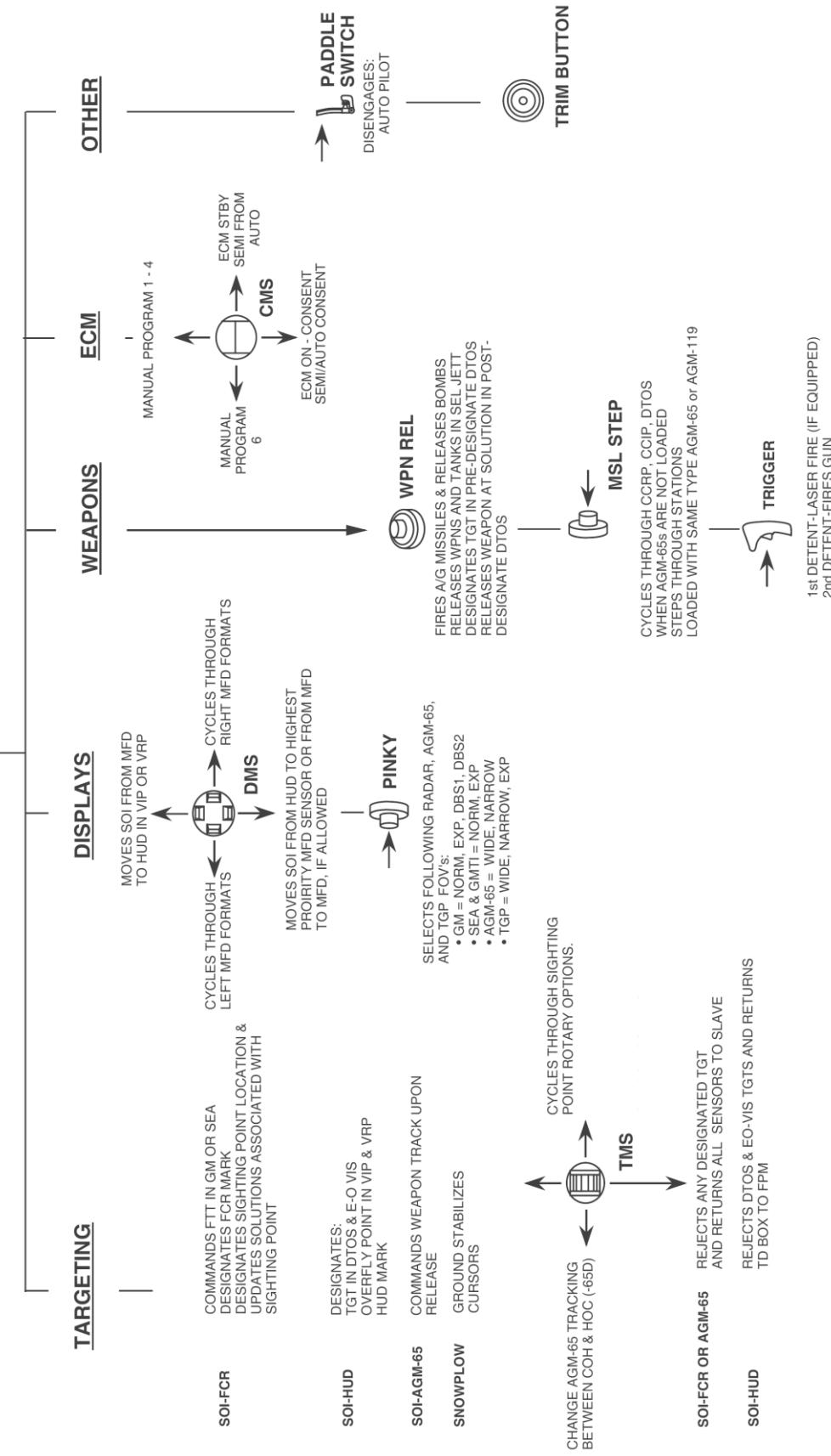


BLUE - Falcon4 keystroke command  
BLACK - Switch description

# Air-to-Ground Mission, Stick

## HANDS-ON CONTROLS AIR-TO-GROUND MISSION

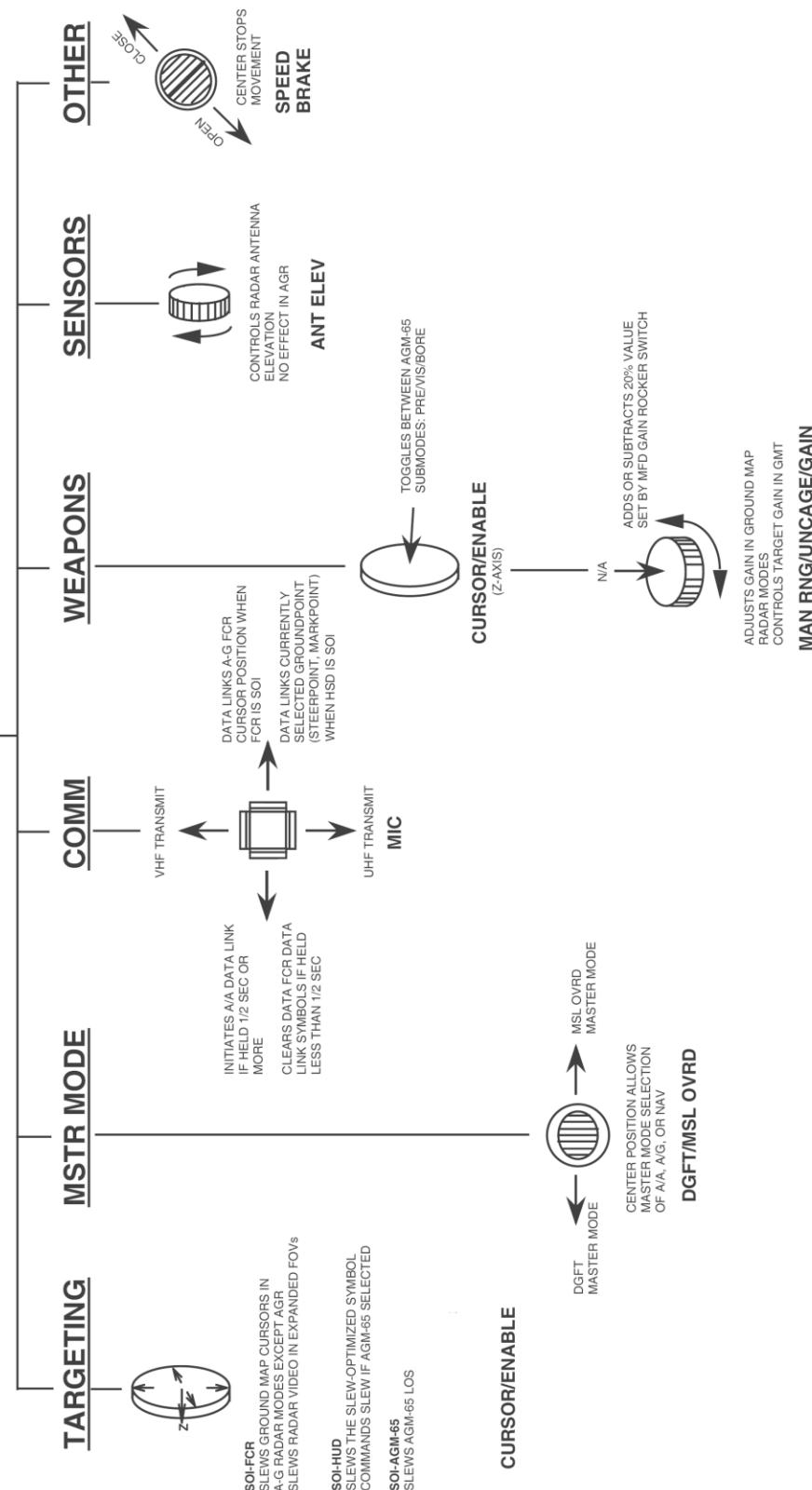
SIDE STICK CONTROLLER  
A-G MASTERMODE



# Air-to-Ground Mission, Throttle

## HANDS-ON CONTROLS AIR-TO-GROUND MISSION

### THROTTLE A-G MASTERMODE



## Fuel Management

New fuel code for internal tank F2 is now coded. External wing tanks now have three compartments and the fuel transfer is 100% accurate. All data set for a 100% accurate evolution of CG with fuel consumption. Be extra careful with your CG evolution now as an increased chance of departure from controlled flight is possible if fuel gets out of balance.

A Fuel Slider has been added in the Loadout screen to allow the pilot to select less than a full load of gas. If using this feature in MP, move the slider only when all players are in the TE/camp/etc. to ensure consistent updates.

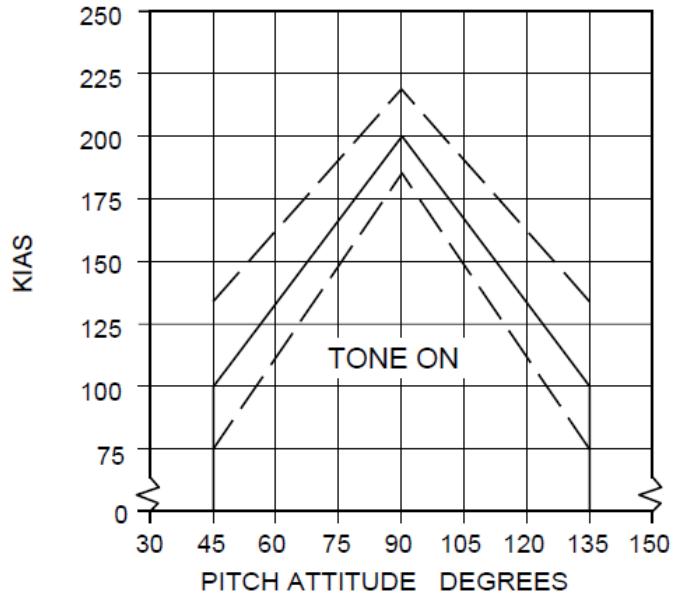
F-16 Home Mode BINGO check now only applies to F-16's. Normal BINGO (as set via DED/ICP LIST -> 2 page) fuel check still applies to all aircraft however. This should prevent unwanted "BINGO" messages from Bitchin' Betty for non-F-16 aircraft.

## Low Speed Warning Tone

The F-16 Low Speed Warning Tone Schedule is now correctly coded according to the chart shown below.

### NOTES:

- LG handle in UP and ALT FLAPS switch in NORM.
- Dashed lines indicate airspeed tolerances for low speed warning tone activation.



## Limit Cycle Oscillation

Complex buffeting & stores flutter (Limit Cycle Oscillation) code has been added to the Flight Model. These are both based off real-world F-16 studies & technical papers.

A limited amplitude constant frequency oscillation (commonly referred to as limit cycle oscillation or LCO) may occur with certain stores loadings. The LCO (typically 5-10 cycles per second) may occur in level flight or during elevated g maneuvers. The LCO may appear as buffeting or turbulence similar to that experienced during normal transonic buffet, but the buffeting is a constant frequency, lateral acceleration from side-to-side or, in some cases, vertical

accelerations up and down. The magnitude generally increases with increasing airspeed and/or load factor. Other cues of LCO include significant vertical movement of the forward area of wing stores, especially wingtip launchers and missiles; this motion is typically up and down, but may also follow a circular pattern. In addition, cockpit instruments may become difficult to read as the LCO amplitude increases from moderate to severe. Within published carriage limits, LCO is not detrimental to the aircraft. LCO susceptible loadings include air-to-surface and air-to-air loadings and associated downloadings. If LCO is encountered and is uncomfortable or distracting, reduce airspeed and/or load factor. The flutter happens in a small band around each of the lines depicted below in the second graphic.

Configuration	LOADOUT PYLONS										Flutter
	1	2	3	4	5	6	7	8	9		
1	any	any	any	0	any	0	any	any	any	any	NO
2	any	any	AGM	Full ext / GB / GPB	any	Full ext / GB / GPB	AGM	any	any	any	YES
3	any	any	AGM	Half ext / AGM	any	Half ext / AGM	AGM	any	any	any	YES
4	any	any	AGM	Empty ext	any	Empty ext	AGM	any	any	any	YES
5	any	any	GPB	Full ext / GB / GPB	any	Full ext / GB / GPB	GPB	any	any	any	YES
6	any	any	GPB	Half ext / AGM	any	Half ext / AGM	GPB	any	any	any	YES
7	any	any	GPB	Empty ext	any	Empty ext	GPB	any	any	any	YES
8	any	any	GB	Full ext / GB / GPB	any	Full ext / GB / GPB	GB	any	any	any	YES
9	any	any	GB	Half ext / AGM	any	Half ext / AGM	GB	any	any	any	YES
10	any	any	GB	Empty ext	any	Empty ext	GB	any	any	any	YES

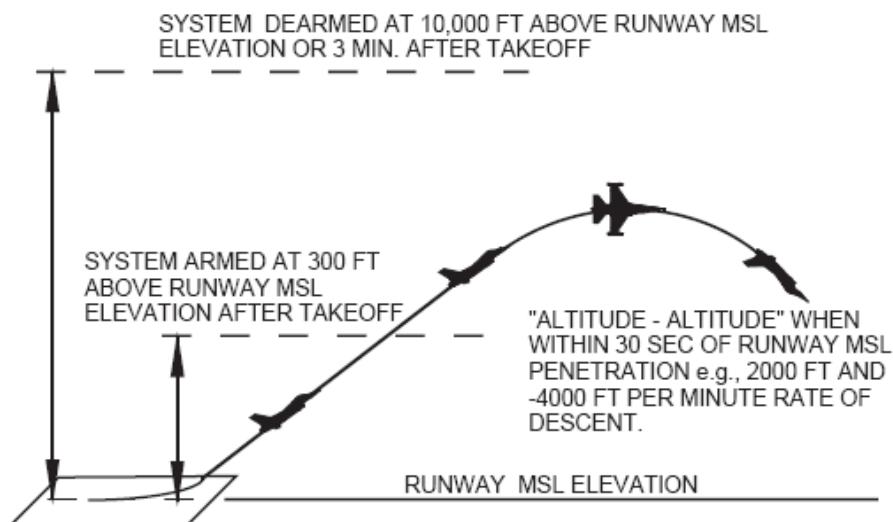


# Decent Warning After Takeoff (DWAT)

Decent Warning After Takeoff (DWAT) provides an audio warning of an unintended dive or descent during the departure phase of flight. The Voice Message Unit (VMU) descent warning advisory, "Altitude, Altitude," will occur when all the following conditions are met:

- The landing gear handle is up.
- The time from takeoff is less than 3 minutes.
- The aircraft has climbed at least 300 feet above the runway elevation referenced to Mean Sea Level (MSL) but not yet gained 10,000 feet above runway elevation.
- There is a descent rate present such that the aircraft will descend to the runway MSL elevation within the next 30 seconds.
- The DWAT message has not previously occurred since takeoff.

NOTE: Selecting ENABLE on the GND JETT ENABLE switch starts the DWAT 3 minute timer.



To implement the DWAT, significant changes related to radar altitude management were required. Fixes for radar altimeter so that the warm up period is executed properly and that you can turn the gadget on and off in flight with requisite warm up delays each time. Radar altimeter now stores an actual radar altitude reading for use by various other systems.

In addition, the CARA ALOW code has been rewritten so that it behaves more like the real one. Specifically, the "AL <alt>" label will flash when you are below the selected <alt> value as measured by height AGL. If you descend through the ALOW limit, you get the VMS warning one time unless and until there is a CARA reset. Resets happen for going back above the limit altitude, or if the RALT reading is lost (like when you roll inverted and the radar can't see the ground). A reset also occurs if your rate of climb *as measured by the radar altitudes* exceeds 1200 feet per min (previously terrain variation was not taken into account at all). Note this last one means that you can hear the VMS message even when flying along in level flight or even climbing if the terrain below you has sudden significant down slope. Normally though you should only hear one VMS altitude warning per trip below the limit value.

## Brakes

Brake Energy Limits have been modeled. The limits are based on gross weight, temperature, pressure altitude and airspeed at which the abort was initiated. It assumes idle thrust, maximum braking, speedbrakes are open, TEFs are down and applies to all drag indexes. It is now possible to experience:

- Blowing tire fuse plugs – tire(s) go flat which causes much more longitudinal friction and less lateral friction.
- Brake hydraulic pressure line failures – amortization / brake reaction is reduced.
- Main gear tire fire, hydraulic fluid fire, exploding tires & gear failure – the affected gear fails completely.

The four zones are modeled on a per-brake basis in the following manner.

Zone 1 : **Green**: Normal zone – 0-11.5 million ft-lbs, nothing happens

Zone 2: **Yellow**: Caution zone – 11.5-15 million ft-lbs, 30% chance something bad happens

Zone 3 : **Red**: Danger zone – 15–24.5 million ft-lbs, 90% chance something bad happens

Zone 4 : Over 24.5 million lbs: Danger zone + immediate braking failure

It takes 5 – 9 minutes (random) for the brake energy / heat to build up after braking. During this time period is when one of the following problems can occur as described above, based on how much energy was built up. Brake energy is also continually monitored and built up during taxiing (when the brakes are applied obviously). Build up from taxiing is at its greatest with low gross weights and long taxis because the brakes must be used more often in order to control taxi speed. Taxiing with a gross weight of 20,000 lbs at 10 knots over a distance of 20,000 ft yields ~4.3 million ft-lbs of energy absorbed per brake. Heavier weight and increased speed uses less energy over the same distance (speed within reason of course). Heat and energy also dissipate over time. A rejected (aborted) takeoff with maximum braking followed by another rejected takeoff will likely put the aircraft in the danger zone or worse (all depending on the a/c gross weight, speed at which the brakes were applied, etc).

Related to this feature is the way the aircraft is taxied – this has been made more realistic. Like most aircraft, the aircraft may have enough thrust at idle power to start rolling (and accelerate), depending on gross weight. Therefore, unless the pilot holds the brakes or sets the parking brake, the aircraft will start rolling (again, depending on gross weight). If the aircraft is heavy enough, some thrust must be applied to start moving, and then idle thrust should be sufficient to keep the aircraft moving. Real world F-16 taxi and braking technique now applies which is:

- Taxi speed in clear areas should not exceed 25 knots.
- To reduce tire wear, slow to 10 knots when making sharp turns.
- Do not ride the brakes.
- Correct braking technique allows taxi speed to increase to approximately 25 knots, and then apply moderate braking to slow to 15 knots. Release the brakes, allow the speed to increase back to 25 knots and repeat the process.
- Ground speed is available on the INS page (List 6).

## **Speed Brakes**

The speed brakes now have separate values for opening and closing rates. The defaults are specific to the F-16. It takes ~2 seconds to open them to 60 degrees and ~6 seconds to close them. These values were derived from multiple video examinations.

The default timings are configurable via the aircraft dat file with two new rate variables that factor the rate of motion normalized to a rate of 60 degrees per second as the unit value: “airbrakeOutRateFactor”, default is 0.5, fraction of 60 degrees per second that it takes the air brake to open; 0.5F default means 2 secs to open air brakes going from zero to 60 degrees. “airbrakeInRateFactor”, default is 0.1667, fraction of 60 degrees per second that it takes the air brake to open; 0.1667F default means 6 secs to close air brakes going from 60 degrees to zero.

## **Chocks**

The pilot now has the ability to “install” and “remove” chocks to prevent the aircraft from rolling on the ramp without using toe brakes or the parking brake. All “Ramp” starts will spawn the aircraft with the chocks installed. Similar to

the Hot Pit refueling feature, chocks are installed and removed via the Tower menu. This requires the pilot to be on the Tower UHF frequency in order to install/remove them.

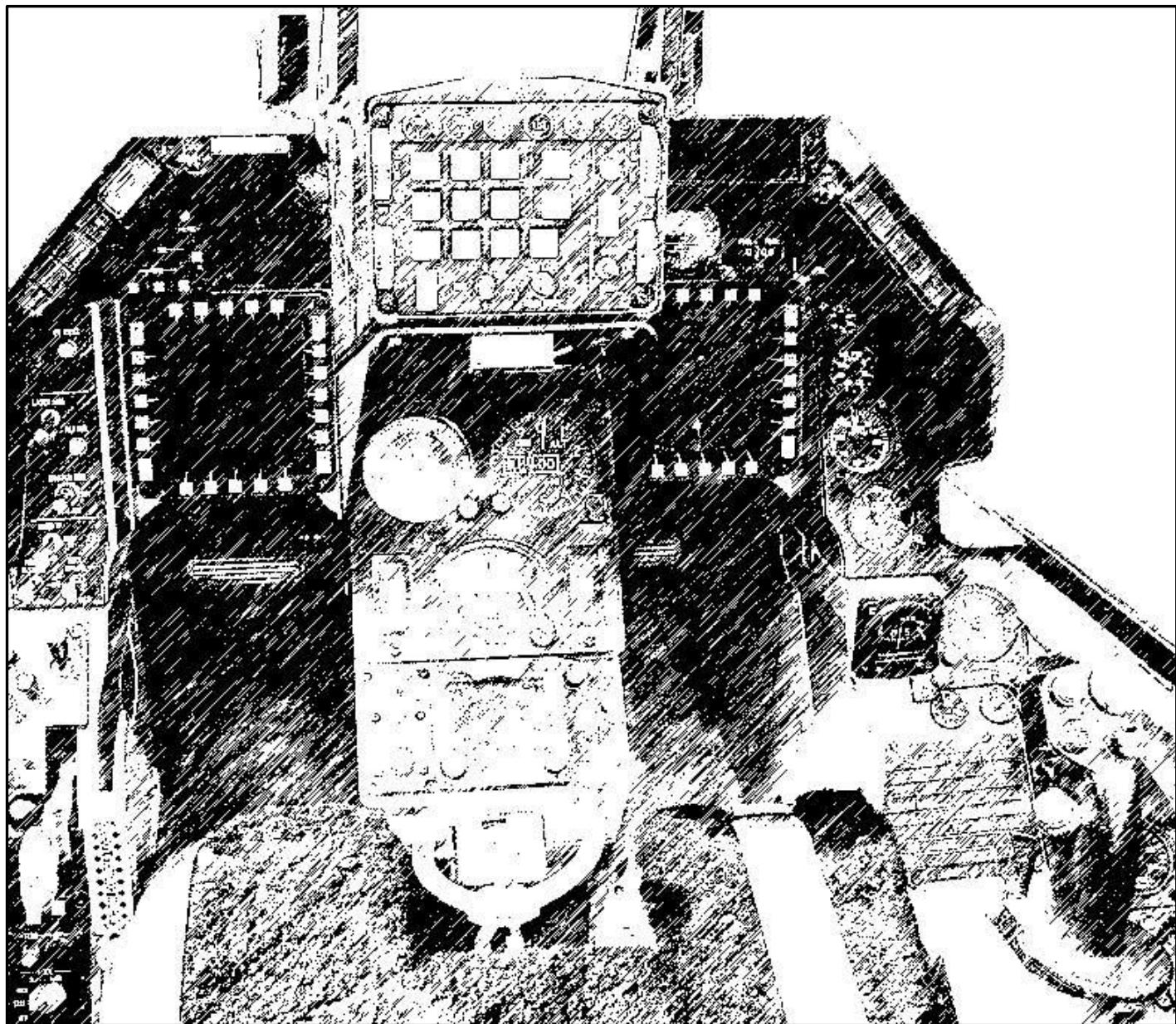
Although a crew chief or maintenance personnel would perform this action in the real world at specific locations (parking spots and End-of-Runway [EOR]), the pilot has the flexibility of being able to accomplish this anywhere on the airfield except the runway.

## ***Flight Model***

Oh, and there's one more flight related thing we should mention. There is a completely new flight model that is we believe unprecedented in PC game flight simulators. This one is based on a full physics model for air and ground operations. This is complemented by an implementation of the F-16 flight control system that is a faithful model of the actual system used in current inventory jets. Combined, these models create a completely different feel from any prior version of the F-16 in the Falcon franchise (or any other equivalent for that matter). There are a whole series of articles available on the web by the author of the code for these models and interested readers are invited to dig in to that. For everyone else, jump into the jet and enjoy! Force sensor joystick controllers are highly recommended to get the most out of this system.

Four flight model selections are now available in the UI: Accurate activates the full Advanced Flight Model (AFM); Moderate invokes AFM without lateral asymmetry; Simplified gives you the player flight model based on the Original Microprose "accurate" Flight Model (OFM); Easy gives you the original simplified flight model.

# Avionics



# Navigation

There are some significant changes to the navigation system and the Up-front Controls (UFC) that control it. The DED pages now operate realistically and are much more intuitive.

The navigation system has been updated. There are now 1-99 possible steer points (STPTs). They are broken down as follows:

<u>STPT#</u>	<u>Usage</u>
1-24	Navigation route/general flight planning
25	Automatically assigned as the “campaign” bullseye
26-30	Ownship MARK points – small “x”
31-50	HSD LINES (see DTC, LINES section)
51-55	Open
56-70	Preplanned threats (see DTC, PPTs section)
71-80	Flexible Datalink steerpoints – large “X” (see IDM, DL STPTs section)
81-99	Open

Numbers 1-25 are regular flight planning ones for use in the Campaign or TE mission planning screen for an aircraft's flight plan. Numbers 26-30 are for ownship MARK points. The campaign bullseye (BE) is filled into slot #25. The pilot may go to the BE DED page(LIST→0→8) and select any one of 1-25 as the aircraft's BE point. However, the “normal” campaign/TE bullseye is stored in STPT 25 by default. If the pilot chooses another STPT other than #25, AI aircraft and AWACS will *still* continue to use the BE as set by the campaign engine (i.e. the coordinates in STPT 25). Being able to select whatever STPT as your BE is more for TE missions with human pilots involved (like Force on Force). Note also that since all STPTs can be edited in the STPT or DEST DED pages, you can overwrite your copy of the campaign BE—be careful! Also for similar reasons, **do not** make flight plans with more than 24 STPTs—bad things will happen. STPT AUTO mode no longer wraps at the last STPT that is designated as part of your flight plan. The increment/decrement arrows on the ICP will get you to any STPT from 1-99 as opposed to just those on your flight plan as per the old behavior. Cycling to STPTs not assigned to something will be all 0's in the lat/long fields. MARK point handling is completely revised and works properly now for more than one MARK. OFLY and FCR marks are implemented; HUD and TGP MARKs are to-be-determined. See the Navigation section for more details.

## Steer Point Page



Punching “4” on the ICP brings the pilot to the Steer point (STPT) page. The scratchpad asterisks will initially be at the top as seen above. The pilot may punch another number (4, Enter) to select a different steer point as the current steer point. All steering cues will update to reflect the new selection (#4 in this example). The pilot may “dubber” down with the Data Control Switch (DCS) to each individual field on the page and edit it as desired –latitude, longitude, elevation and Time On Station (TOS). Note that while editing the lat/long, the pilot will see immediate feedback from his steering cues (tadpole, STPT diamond, ETE/ETA, bearing/distance, etc) in the HUD and in heads-

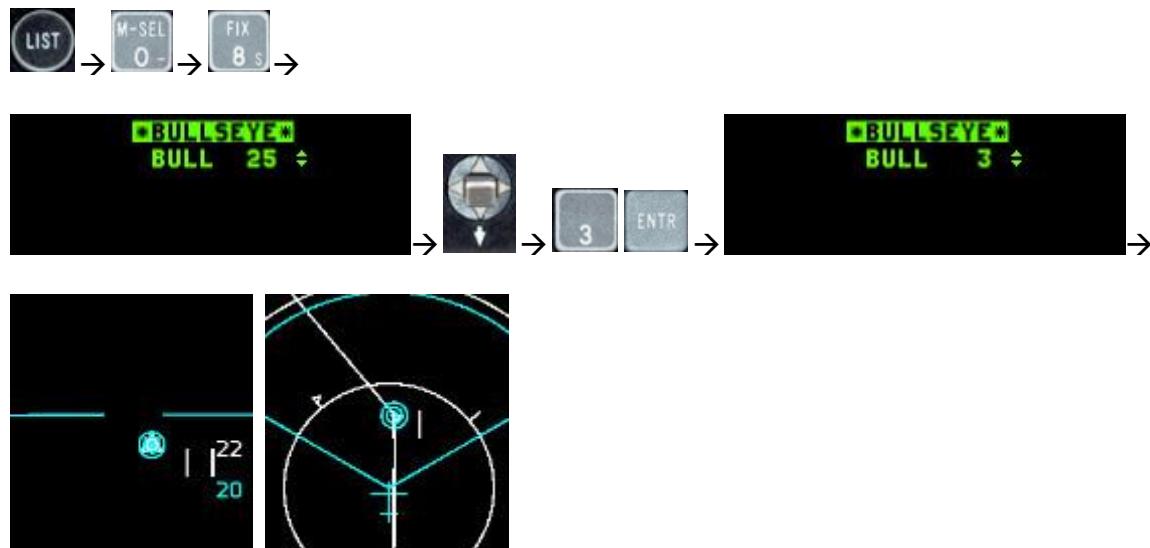
down displays since the STPT he is editing is his current steer point. Elevation may be edited as well, but it does not function like the real aircraft. In the real aircraft, the elevation is the MSL elevation of the steer point at ground level. In the Falcon 4 world, this elevation field is the MSL elevation that the aircraft was designated to fly at to this steer point as directed by the campaign/TE flight plan generator. The pilot may also toggle auto steer point sequencing (AUTO) on and off (MAN) by dobbing right to SEQ on the steer point DED page. With auto steer point sequencing, the system will automatically increment the steer point when the aircraft is within 2 miles of the steer point and the range is increasing. Auto steer point sequencing is indicated on the CNI page with a letter "A" displayed next to the current steer point. Nothing is displayed when in manual sequencing.

## Destination Page



The Destination (DEST DIR) DED page is nearly identical to the STPT page. The only difference between the two is that the DEST page must be used to observe and/or change coordinates of a particular steer point without affecting navigation to the current steer point.

## Bullseye Page



As was mentioned above, the bullseye's default steer point is #25. The BE can be changed to any steer point. In this example, the BE is changed to STPT 3 and the pilot sees STPT and BE co-location on the FCR and HSD. Recall that the AI and AWACS will only use the location that is stored in STPT 25 and that the pilot has the possibility of overwriting this location so be careful.

## Time Page



Hitting 0- designates a negative value.

Original TOS	New TOS
9:33:33	9:38:33
9:38:15	9:43:15
9:44:21	9:49:21
9:46:18	9:51:18
9:49:44	9:54:44
9:51:37	9:56:37
9:55:45	10:00:45
9:58:55	10:03:55
10:00:00	10:05:00

The Time page includes the system time, a hack clock time and a delta time on station. The hack clock may be started



or stopped by using the INC/DEC switch . The DELTA TOS value allows you to adjust all destination TOS with one entry to accommodate changes in takeoff and/or rendezvous times. By dobbing down to the DELTA TOS field, enter the delta time to any steer point. If required, press the 0- key prior to your entry to designate it as a negative value (i.e. you want to arrive earlier at all steer points). Press ENTR to apply the DELTA TOS to all TOS.

## MARK Points

The MARK mode rotary will cycle through the 4 existing modes in this order: HUD, TGP, OFLY, FCR.

When entering DED MARK page (ICP 7 button) the MARK mode will be set automatically according to the master mode and relevant sensors state.

- If the system is in NAV or AG master modes, the FCR is in AG mode (not AGR), the FCR is the SOI and the FCR is designating something, MARK mode will be automatically set to FCR. When entering MARK page at this state, a FCR MARKPOINT will be automatically recorded.
- If the system is in NAV or AG master modes, the TGP is in AG mode, the TGP is the SOI and ground stabilized, MARK mode will be automatically set to TGP. When entering MARK mode at this state, a TGP MARKPOINT will be automatically recorded.
- If the system is in NAV or AG master modes and conditions are not sufficient to set FCR or TGP modes, MARK mode will be automatically set to HUD.
- If the system is in AA master mode, MARK mode will be automatically set to OFLY. When entering MARK mode at this state, an OFLY MARKPOINT will be automatically recorded.

**MARK HUD functionality:** When the system is in NAV or AG master modes and the MARK mode is set to HUD, an HMC (HUD MARK Cue) will appear in the HUD. The HMC is a 12mr circle with a 1mr aiming dot inside it. There are 2 states for MARK HUD mode, pre-designate and post designate. In pre-designate mode the HMC will appear on

the FPM, The cue then can be slewed to the desired position and a TMS-Forward will ground stabilize it. At this stage the position of the actual MARK may be refined using the cursors, then a second TMS-Forward will mark the point.

When the cue is ground stabilized, a TMS-AFT will cancel the stabilization and return to pre-designate mode and the HMC will be again placed on the FPM. Note that if trying to ground stabilize or mark with TMS-Forward when the cue is not on the ground, nothing will happen.

If setting with the ICP sequence (SEQ) button a MARK mode which does not match the current system and sensors state (for example setting FCR mode when the system is in AA master mode) and trying to mark, an OFLY MARKPOINT will be recorded.

**IMPORTANT:** ICP ENTER button is not used anymore to set a MARKPOINT. Instead of that, use TMS-Forward (in all modes).

When at MARKPOINT DED page and the current MARKPOINT is valid (has positional data) then M-SEL button (ICP 0) is used to set the MARKPOINT as the current active steer point.

When at MARKPOINT DED page and pressing one of the 1-9 ICP buttons, a MARK mode change will happen (just like using the sequence button).

Just like any other steer point, a recorded MARK point can be sent to another aircraft via the IDM.



## Sighting Options

Aircraft sensors are pointed along a common line-of-sight (LOS) to a specific point on the ground for air-to-ground sighting known as the System Point-of-Interest (SPI). The following sighting options and cursor position features are available:

- STP/TGT – Steerpoint and Target Direct Aimpoint sighting
- OA1/OA2 – Offset Aimpoint sighting
- IP – Visual Initial Point sighting
- RP – Visual Reference Point sighting
- SP – Snowplow sighting

The STP/TGT, OA1/OA2, IP, and RP sighting options are selected via the sighting point rotary on the MFD GM FCR page (OSB 10). Additionally the sighting point options are selectable via TMS right. Offset (OA1/OA2), initial point (IP) sighting, and reference point (RP) sighting are used for aim points where positions are known or estimated to be near specified steer points. Bearing from true north, range, and elevation data are entered via the upfront controls.

NOTE: For simplification, entering “0” for elevation places offsets at ground level, regardless of terrain MSL altitude. Thus, pilots should normally enter “0” for altitude.

**Direct Aimpoint Sighting (STP/TGT).** Direct sighting can be used in any bombing mode. All sensors are pointed at the selected steer point. Slewing the cursor via the cursor control may be required to place the steer point position over a desired aim point more precisely. Slew corrections may be zeroed via the cursor zero OSB.

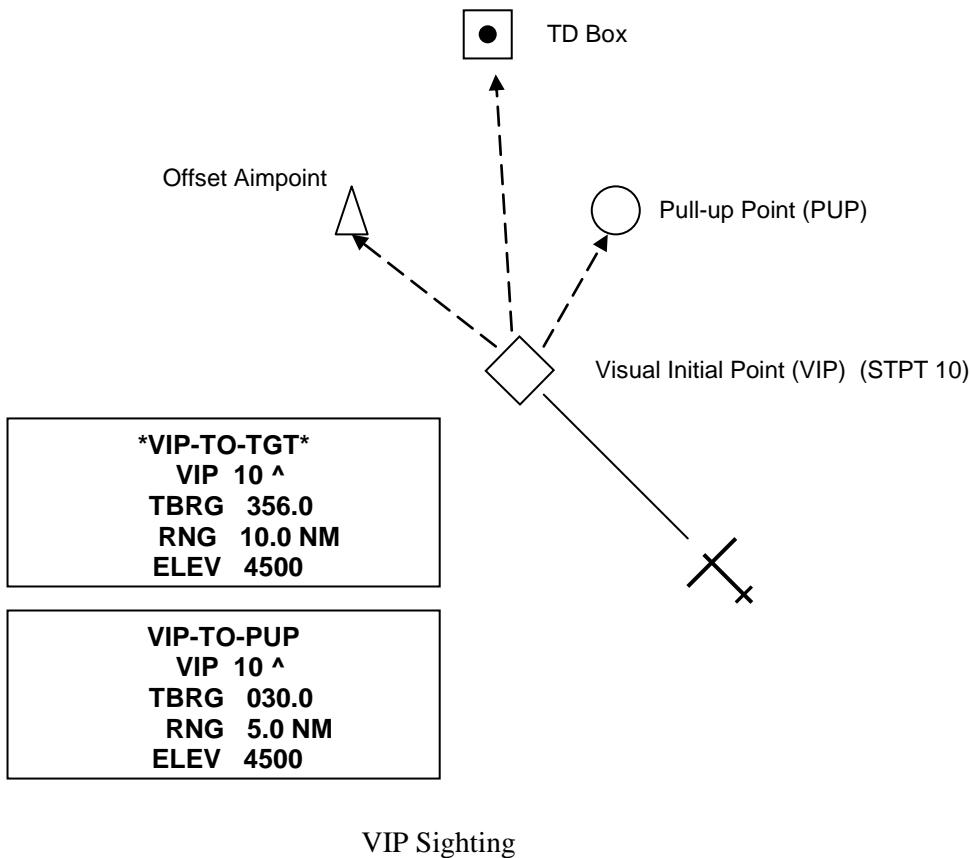
**Offset Aimpoint Sighting (OA1/OA2).** Steer points may have up to two offsets, each defined as a true bearing and range from the steer point and each with a separate elevation. If an offset aim point has zero range, it is skipped in the sighting point rotary. If OA1 or OA2, all sensors are pointed to the offset position; however, the steer point defines the target location. As a result, weapons may be delivered against a target that presents a poor radar return by aiming at a radar-significant object. Offset aim point sighting is provided in preplanned submodes (CCRP in this case, since LADD and ULFT are not implemented) only. The OA symbol is an isosceles triangle 12 mr high and 6 mr wide. It is displayed in NAV and A-G mastermodes.

Offset aim point selections are remembered by the system through master mode and steer point changes.

**Visual Initial Point Sighting (VIP).** Visual initial point (VIP) sighting is used in preplanned submodes to plot a target on the HUD at a true bearing and range from a visually identifiable overfly point. Overfly updates to the SPI and HUD slews are not implemented at this time.

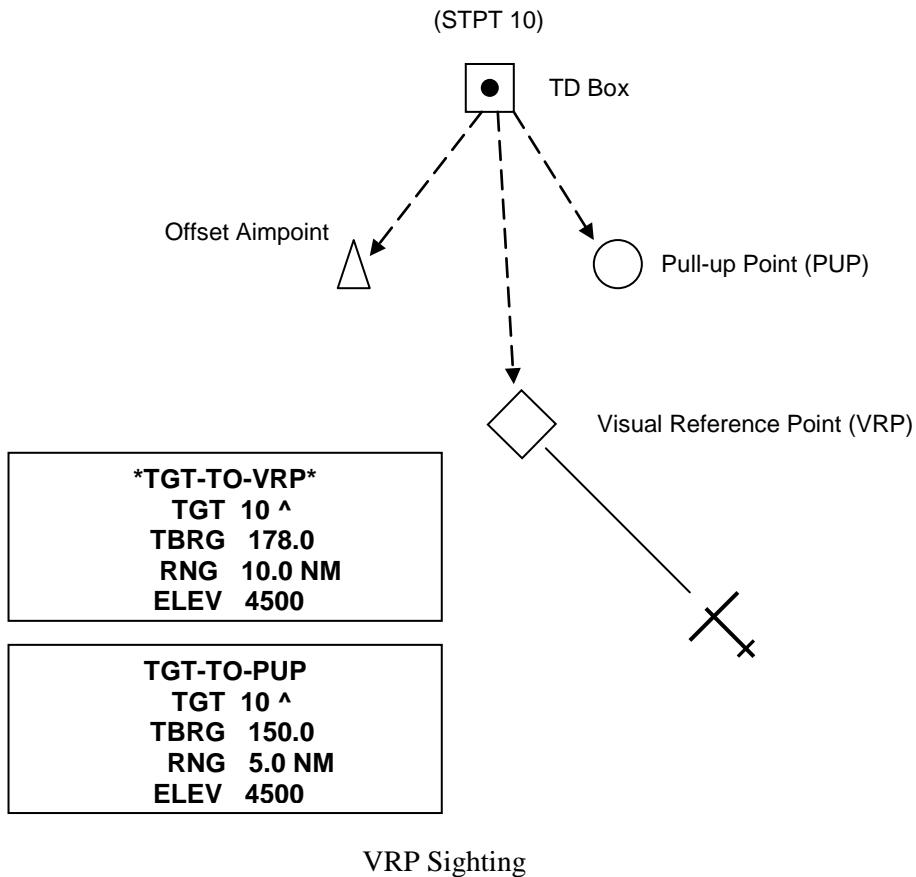
The VIP sighting mode also allows for an unknown target position to be referenced from a known position (steer point) during a mission. By preplanning the IP, bearing, range, and elevation can be entered while airborne to define the target.

While in VIP, navigation steering to the IP is provided via the HSI and the azimuth steering line to the target on the HUD. Cursor zero reverts the system solution back to the original navigation solution if cursor slews are made. Bearing, range and elevation data for the IP may be entered by pressing LIST→3 on the ICP. VIP is mode-selected by placing the scratchpad asterisks on “VIP-TO-TGT” and pressing “0” to mode select. Offset aim points and IP sighting may be used simultaneously.



**Visual Reference Point Sighting (VRP).** Visual reference point (VRP) sighting mode is used in preplanned submodes to plot a reference point on the HSI as a true bearing and range from the target. This allows the utilization of a known, visually identifiable position, or RP point, to initiate an attack. Again, overfly updates to the SPI and HUD slews are not implemented at this time.

While in VRP, navigation steering is provided to the target via the HSI and via the azimuth steering line on the HUD. Initially, the sighting point rotary is on TGT. While in VRP, the steer point defines the target and the RP is defined as a bearing and range from the target and an elevation (remember, use "0"). Bearing, range and elevation data for the RP may be entered by pressing LIST→9 on the ICP. VRP is mode-selected by placing the scratchpad asterisks on "TGT-TO-VRP" and pressing "0". Offset aim point and RP sighting are available simultaneously.



**Pop-Up Point (PUP) Cue.** The pop-up point (PUP) is entered via the VIP-TO-PUP or VRP-TO-PUP page of the DED. DCS right (SEQ) to select the PUP page from the VIP or VRP pages. When the PUP is limited in the HUD FOV, an X is superimposed over it.

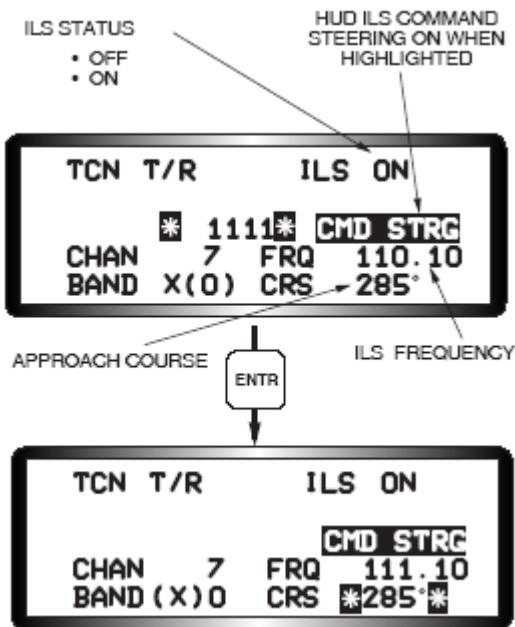
**Final IP and RP Notes.** Note how aim points and PUPs are defined in both VIP and VRP (they are always off the steer point—the VIP is a steer point while the VRP is not). Careful study of the geometry in both modes will ease understanding and help the pilot make the decision in which mode would be best utilized. Target type, location, terrain features and delivery methods may also be factors to consider when using one mode or the other. VIP and VRP may not be used simultaneously. Mode-selecting one will de-mode-select the other. It is not advisable to try and use both modes for one steer point as OA and PUP geometry will change if one mode is selected but the offsets were intended for (or entered in) the other.

**Snowplow (SP) Sighting.** Depress OSB 8 next to the SP mnemonic in GM/GMT to select the snowplow option. The mnemonic highlights indicating that you are in the SP mode. SP sighting directs each sensor line-of-sight straight ahead in azimuth, disregarding any selected steer points. In the GM, GMT, and SEA modes, the ground map cursor will be positioned at half the range selected, i.e., the center of the MFD. The cursors remain at this range while the ground map video moves, or "snowplows," across the MFD. At this point, there is no SOI, and the cursors cannot be slewed. The cursors can be slewed to a target or aim point with the CURSOR/ENABLE switch **after** you **ground stabilize** them by using **TMS forward**. TMS forward establishes the radar as the SOI and enables cursor slewing. TMS forward again over a target to command single target track. All cursor slews in SP are zeroed when SP is deselected. After ground stabilizing, the point under the cursors at the time of stabilization effectively becomes your steer point. All NAV and weapon delivery steering and symbology, including great circle steering, will be referenced to this "pseudo steer point." Displays return to the previously selected sighting point when SP is deselected. For example, SP can be used to accomplish an FCR mark on a point 5 nm in front of your position when the steer point selected is 40 nm away. It may often be used with IR Mavericks where target coordinates are not known in advance. Another application of SP is for weather avoidance (not implemented).

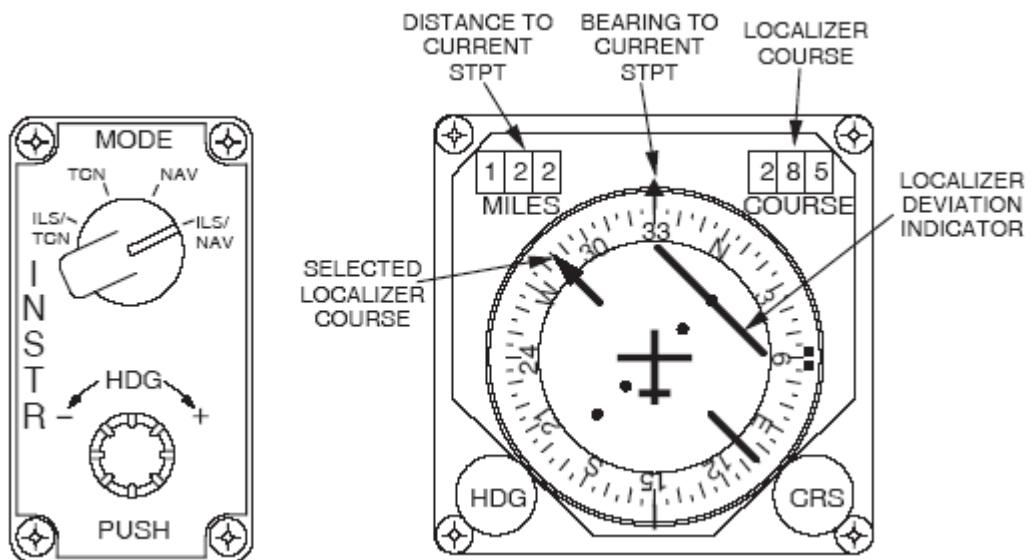
# Instrument Landing System (ILS)

The ILS has been almost totally rewritten and now is true to life. It includes proper operation of the localizer and glideslope bars, ILS course caret, command steering symbol as well as the real limits of the ILS localizer/glideslope signal have been coded. The DED (Data Entry Display) has been updated to reflect proper operation of the controls.

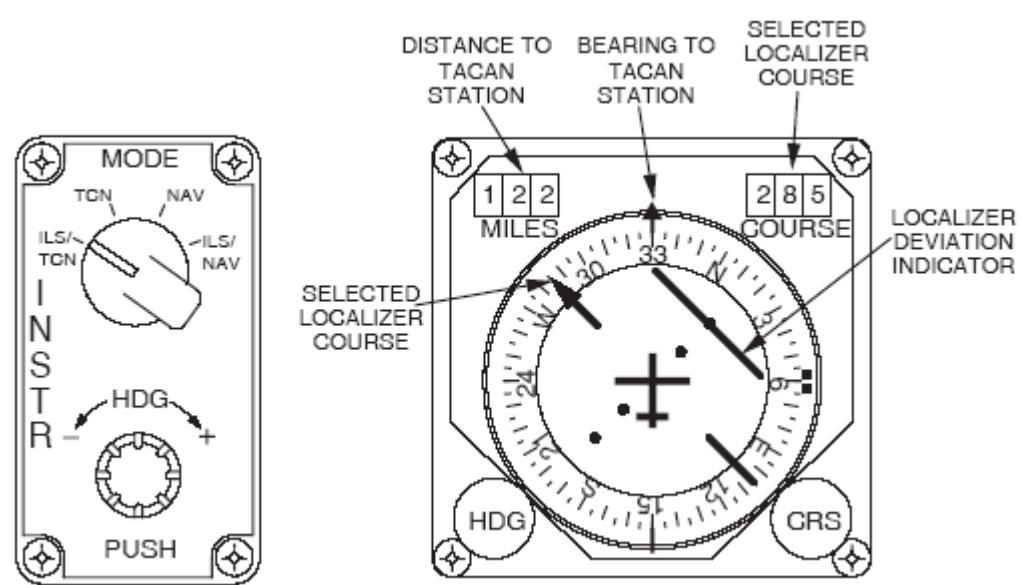
The ILS is used to perform precision instrument approaches using azimuth (localizer) and vertical (glideslope) approach cues in the cockpit independent of any airport precision radar. The system operates on VHF frequencies of 108.10 to 119.95 MHz. The ILS is turned on and off using the ILS volume control knob on the Audio 2 Panel on the left console. The system is controlled from the T-ILS DED page, which is accessed using the T-ILS button (1) on the ICP. Command steering (CMD STRG) is automatically mode selected on FCC/MMC power up, but may be deselected/selected by positioning the asterisks around CMD STRG and pressing the M-SEL button. The pilot tunes the ILS by entering the desired four- or five- digit ILS frequency in the scratchpad and presses ENTR. The system recognizes that an ILS frequency has been entered and the asterisks step to the Course (CRS) window. The pilot then keys in the course with the ICP keys and presses ENTR. The CRS setting in the DED is not connected to the CRS setting on the HSI. For consistent ILS display, the ILS approach heading should be set at both the DED and the HSI.



ILS cueing is presented on the HUD and the HSI. When the instrument mode selector is positioned to ILS/NAV, ILS cues are displayed on the HUD and selected STPT distance and bearing information is shown on the HSI.



When the instrument mode selector is positioned to ILS/TCN, ILS cues are displayed on the HUD and TACAN distance and bearing information are shown on the HSI.



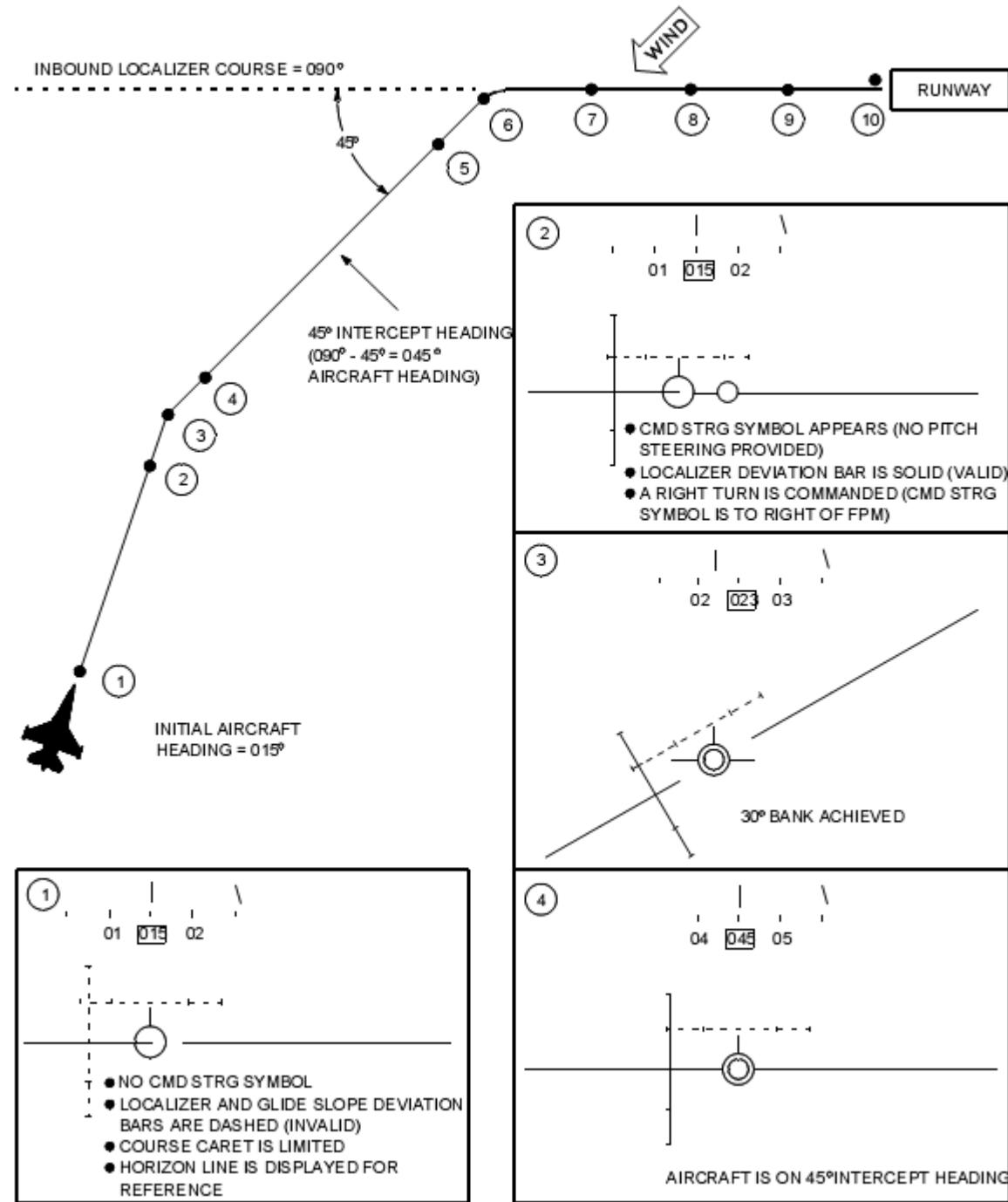
It is important to note that ILS localizer raw data is displayed both on the HUD and on the HSI, but command steering cueing (when selected on) is displayed only on the HUD. The command steering cue is a circle similar to the great circle steering cue (tadpole), but it has no tail. When the glideslope is intercepted, a short tail appears on the command steering cue and the cue moves up and down to indicate corrections required to intercept and maintain the glideslope. The pilot flies the FPM to the command steering cue to intercept and maintain the localizer course and the glideslope for an ILS approach.

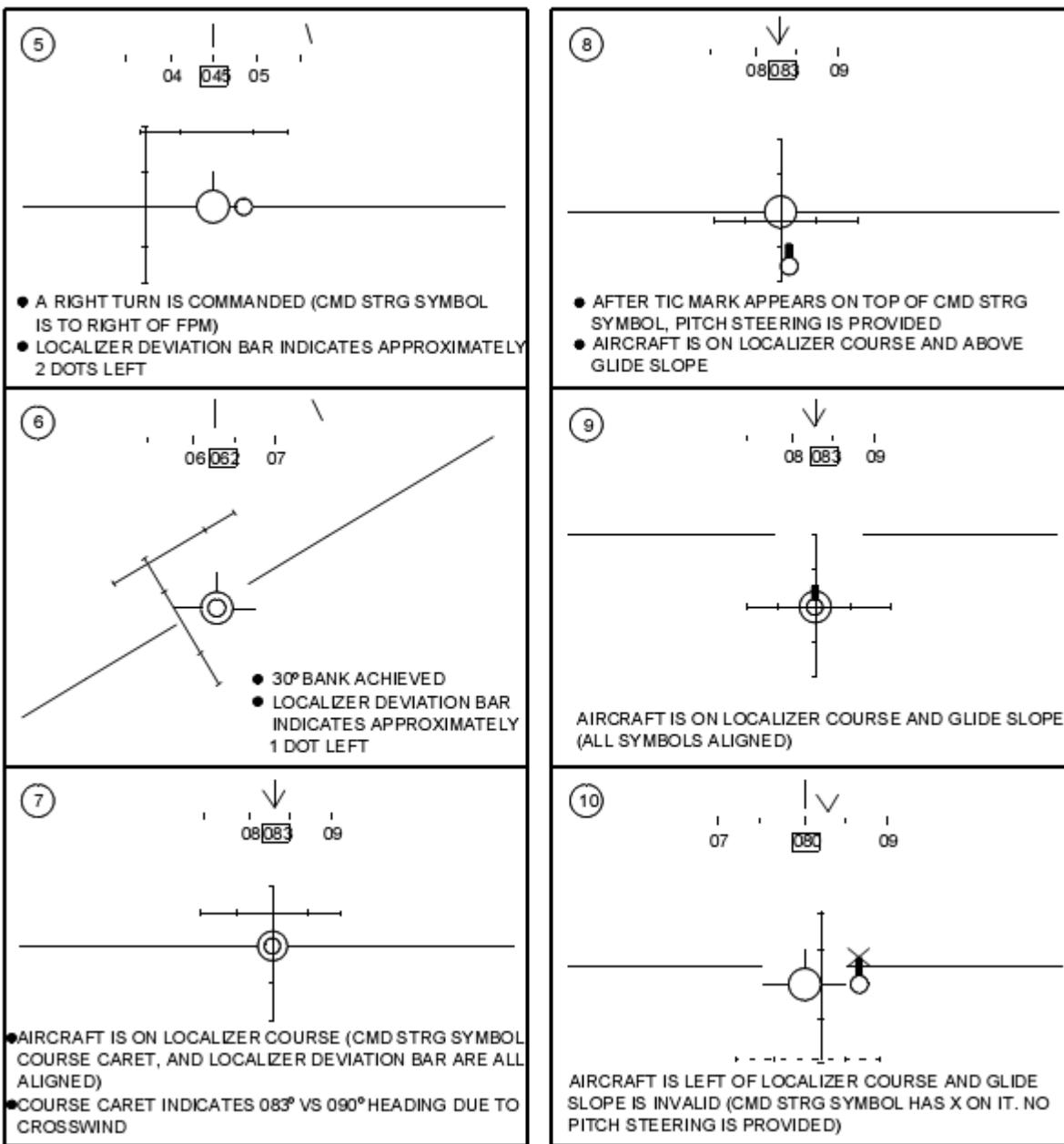
Below is a table summary of the function of the INSTR Mode Select Panel.

IMSP	HSI					ADI		
INSTRU-MENT MODE SELECTED	RANGE INDICATOR	COURSE ARROW & COURSE SELECTED	COURSE DEVIATION INDICATOR	TO – FROM INDICATOR	BEARING POINTER	ATTITUDE SPHERE	LOCALIZER DEVIATION BAR	GLIDE SLOPE DEVIATION BAR
ILS/TCN	RANGE TO TACAN STATION OR DME NAV AID	MANUALLY SELECTED LOCALIZER COURSE	LOCALIZER DEVIATION	OUT OF VIEW	BEARING TO TACAN STATION	INS ROLL AND PITCH ATTITUDE	LOCALIZER DEVIATION	GLIDE SLOPE DEVIATION
TCN		MANUALLY SELECTED COURSE	DEVIATION FROM SELECTED COURSE	IN VIEW			OUT OF VIEW	OUT OF VIEW
NAV	RANGE TO INS DESTINATION	MANUALLY SELECTED LOCALIZER COURSE	LOCALIZER DEVIATION	OUT OF VIEW	BEARING TO INS DESTINATION	INS ROLL AND PITCH ATTITUDE	LOCALIZER DEVIATION	GLIDE SLOPE DEVIATION
ILS/NAV		MANUALLY SELECTED LOCALIZER COURSE	LOCALIZER DEVIATION	OUT OF VIEW	BEARING TO INS DESTINATION		OUT OF VIEW	OUT OF VIEW

The following two pictures describe and show the typical sight picture the pilot sees when flying an ILS approach. These were taken straight out of T.O. GR1F-16CJ-1 (the *Dash One*).

## ILS HUD DISPLAYS





If you're still scratching your head a little bit over the technical mumbo-jumbo you just read, here is a description of the system in plain English.

## ILS Nuts and Bolts

The coverage zone for the localizer is considerably different now. It mirrors the USAF instrument manual description (AFMAN 11-217 VOL 1). That is: there's a relatively narrow 18nm radius pie wedge shaped coverage zone centered on the extended runway centerline. There is a second fatter pie wedge of radius 10nm similarly centered.

The ATC vectoring procedures in real life are designed to get you roughly in the neighborhood of the localizer at or around 2000' AGL (given roughly flat terrain in the vicinity of the base). From there you are vectored into the coverage zones as appropriate. Now, if you have the CMD STRG mode selected (read: highlighted in the DED page), when you cross into the coverage zone, a CMD STRG cue pops up. This is a plain small circle that is tied to the HUD horizon line. It moves back and forth across that line to guide you to a 45 degree intercept of the extended runway centerline that the localizer transmits along.

The cue is fixed to the horizon line because the idea is that you fly level at ~2000' to intercept the glideslope (GS) from below. Of course what's really going on is that you are too far out from the GS transmitter to get any reasonable pitch steering cues so the system assumes ATC is controlling your altitude and that ATC wants you in level flight.

So you are driving along on the 45 and start to get within 2-3 degrees of the localizer centerline. At this point the localizer deviation bar (HUD and HSI) should start to come alive and the CMD STRG cue will start to swing you onto the approach course.

As you continue inbound you'll get to within 2-3 degrees of the GS centerline. When you do the pitch deviation bar will start to come alive. Depending on exactly where you are in the approach course, around this time or shortly thereafter you will be close enough to the GS centerline to get pitch steering. The CMD STG cue will unglue from the horizon line and will grow a fat "tick" on top of it (the tick means: you have pitch steering now in case you forget!).

The main thing now is to center the deviation bars and get the FPM and the bars and the CMD STRG cue to line up, more or less.

One other thing about the CMD STRG cue: if you start to drift above the GS centerline after you have once intercepted it and drift to the point that you risk losing pitch steering, the fat tick will have an "X" superimposed over it. This is your cue to pull back on power and/or drop the nose as appropriate.

Another new toy is the CRS setting. This is active in the T-ILS page now -- be sure to put CRS headings and ILS freqs in the right scratchpad fields to avoid confusing yourself! What the T-ILS CRS setting does is allow you to dial in the course that you want to use during an ILS approach; usually the runway heading. When you do this, you get a "V" cue on the heading tape in the ILS HUD. This cue gives you the wind corrected heading you need to steer to maintain the desired approach course. So if you have the CMD STRG cue under the FPM and the "V" centered on the heading tape, your nose should be crabbed into the wind just the right amount to maintain ground track along the approach course centerline to the runway. Note: the CRS setting in the DED is totally separate from the one for the HSI now—no relationship whatsoever in the avionics suite.

Two more things to add...

With the gear down and the ILS HUD up, there is a declutter option that removes some of the symbology on the HUD to give you a cleaner look at your aim point on the runway. I can only assume this is a "hands on" shortcut for changing NAV mode for when you break out of the clouds and get a visual on the runway and transition to visual approach or some such.

Anyway the trick is the UNCAGE button on the HOTAS throttle. If in the conditions mentioned above you press this button, the ILS bars and a few other pieces declutter so you can see the FPM and the AoA "staple" and the runway a little more clearly. The declutter cancels again with WoW or a mode change or cycling the gear if you don't proactively toggle the declutter off again yourself.

The last thing you'll recognize, which isn't directly related with ILS but is with landing, is how various symbology in the HUD now move in coordination with the FPM. This movement was noticed during review of many HUD videos. The heading, speed, and altitude tapes, G meter, ALOW setting and radar altimeter altitude all move up and down in the HUD based on the FPM. Some symbology can fall completely off the HUD, but the airspeed and altitude boxes will always remain visible. Our logical guess is that this allows consistency in the distance between the FPM and the altitude/airspeed boxes and also serves as a visual cue of low airspeed/high angle of attack during an approach or in the pattern.

# Aircraft Radios

## Introduction

The radio in this version of BMS Falcon has undergone significant changes. These changes include differences from previous versions of Falcon in both the single player and multiplayer environment. This section will talk about how the underlying components of the voice communication system work and then describe the in game radio interface.

## Purpose & Implementation Overview

Like many other features of Falcon4 BMS, realism is one of the driving reasons for the radio changes. Along with this, the Internal Voice Communications (IVC) for multiplayer, which was first introduced as a feature of SuperPAK 3, has vastly grown in flexibility and realism.

The current implementation in the game code is based on use of an external voice client program run by each player and a remote voice server program that may either be hosted by one player or resident on a separate server system.

There are a number of potential candidates for the client and server voice programs and the code inside the game is designed to be agnostic to the choice of voice client in particular while still offering the ability to control the client from within the game, using the realistic radio and HOTAS controls. This is accomplished by use of a shared memory structure for the game code to provide status to the client program. Any client modified to read the shared memory state and in theory be used to deliver a good voice communication solution.

To make things a little simpler, one such client/server program combination is provided as part of the game install. We are very much indebted to TeamSpeak Systems GmbH/Triton CI Associates for permission to use the TeamSpeak 3 SDK for this development work.

In essence, the voice system implemented for Falcon4 BMS includes therefore three components:

1. The voice server program, based on the TS3 SDK; and
2. The voice client program, also based on the TS3 SDK; and
3. Code in the game designed to provide command and control to the local client program.

If you are wondering about the former IVC implementation that was based on the Microsoft DirectPlay Voice system, this has been removed from the game. Since Microsoft withdrew support for this system some time ago and it wasn't possible to make it work on Windows 7 or newer versions of the operating system, we needed a new approach and that is what you see in the TS3 SDK based programs.

One important note up front: the client and server programs based on the TS3 SDK are NOT – repeat – *NOT* compatible with the normal TeamSpeak client and server programs available from the TeamSpeak web site. The SDK programs have a different enough implementation that you can't mix-and-match components. In effect, the client and server programs included with the Falcon4 BMS install are only usable with other copies of the exact same programs. Please don't ask how to change this so your existing TS3 (or TS2 for that matter) server or client can participate in the voice communication systems – it's not possible.

The folks at TeamSpeak/Triton have really done us a good turn with the licensing on this code now. You may all use it with Falcon4 BMS – we can theoretically have as many copies running at one time as we like. We can run the server as long as we like and as often as we like. Obviously Triton intends for us to be able to get what we need from this tool set to support Falcon4 BMS. If we abuse this Triton has the ability to revoke the license...so please, be wise with the privilege for all our sakes.

- Do NOT decompile or otherwise reverse engineer the client or server exe's

- Do NOT decompile or otherwise reverse engineer the dll's that come with the exe's
- ONLY use the client and server code in concert with Falcon4 BMS
- Do NOT try to use the client with a standard TS3 server – this won't work anyway
- Do NOT try to use the server with standard TS3 clients – this won't work anyway
- Virtual squadrons may run voice servers 24x7 but please run as few as practical
- Don't start the server exe yourself unless you really need to do that
- If you do run your own voice server standalone for a game, please terminate it when you finish your mission
- There is a 32 player limit on any one voice server at any one time

Every one of you has a responsibility to the others in our community...just one of you can screw this up for everyone else with a few moment's selfishness or thoughtless behavior...just be wise, please, and we should have no problems.

## **Enabling Internal Voice Comms (IVC)**

To use the IVC system `set g_bVoiceCom 1` must be set in the `falconbms.cfg` file. The option to enable it is in the Config Editor.

## **Using the Voice Server Program**

It's actually dirt simple. All you really need to know about running the server is that you start it and you are done. At this point it's ready and waiting for clients.

When you start the server exe, a cmd/DOS box pops up. That's mostly there to show status. It has a small set of "commands" that you can enter in the box. Unless you need to for some reason, the best advice is to leave those alone – they come from the TS3 SDK example server code and we left them for possible use in debug. We haven't tested them other than to discover that at least two of the options `_will_` crash the server exe.

By default, the voice server uses 3 UDP IP ports: 9987, 9988 and 9989.

If you run the exe on a machine that has a fully qualified domain name or an IP address that is routable (e.g. a machine that is direct connected to the internet) no other preparation is required – just give that IP address to your prospective flying partners for them to use as the voice server address and let them connect.

If you run the server exe on a system that is behind a NAT router you will have to forward the 3 ports above to the LAN address of the system running the server exe. The code uses only UDP so there is no need to forward TCP. Failure to forward the ports will render the server accessible to LAN clients only. Assuming that you have correctly set up port forwarding, tell your prospective flying partners the WAN IP of your NAT router and tell them to use that as the voice server IP address. Usually that address is one that's routable, given to you by your ISP, and most often delivered via DHCP when your router connects to the ISP (but not always, YMMV).

The only other "feature" to know about the server is that it does support code word access. This is a supplemental password that you can customize to your server and that all clients would then need to present in order to connect. To set an access code word, start the server exe with a single word command line argument. That word can be arbitrary length but only the first 8 characters are considered. It is possible to use non US/English characters in the code word but results may be mixed so it's recommended that you stick to the ASCII printing characters a-z,A-Z,0-9 and punctuation marks for best interoperability.

Easiest way to do this is to make a shortcut to the server exe and put the command line argument code word in there. I did one like this:

```
"c:\FalconBMS\Bin\x86\ivc\IVC Server.exe" mysecret
```

When I start the server exe, the cmd/DOS window pops up and this is what it should say if it's working correctly:

```
TeamSpeak Server 3.0.0-beta6 [Build: 11633] SDK
(c) TeamSpeak Systems GmbH

Logging to file started (no console logging on Windows)
Server running
Server lib version: 3.0.0-beta6 [Build: 11633] SDK
Create virtual server using keypair ''
Create virtual server with 32 slots
Create virtual server using keypair ''
Create virtual server with 32 slots
Create virtual server using keypair ''
Create virtual server with 32 slots

Falcon BMS IVC Server commandline interface

[q] - Quit
[h] - Show this help
[v] - List virtual servers
[c] - Show channels of virtual server 1
[l] - Show clients of virtual server 1
[n] - Create new channel on virtual server 1 with generated name
[N] - Create new channel on virtual server 1 with custom name
[d] - Delete channel on virtual server 1
[r] - Rename channel on virtual server 1
[m] - Move client on virtual server 1
[C] - Create new virtual server
[E] - Edit virtual server
[S] - Stop virtual server

Enter Command (h for help)>
```

I have done nothing other than start the server via the shortcut to get the above output. I don't type in any commands once the window appears. The server is now open for business. There are 3 virtual servers running in the context of this one exe – one virtual server each for UHF, VHF and GUARD radio frequency sets.

Notice, no mention of the code word in the output there....you'll have to keep track of whether you started the server with one or not.

For the list of command line interface commands the ones that list states are probably safe. The ones that change the state of the server you should avoid. At least for now. The exception to this rule of course is "q" which you are encouraged to use as soon as practical once you have finished using the server in order to shut it down.

The person with the most bandwidth and fastest machine should be the voice host, and maybe even the mission host as well depending on the clients. In large missions with humans, running a voice host and the mission can induce quite a load on the host machine and lower fps can be expected. When possible, have one person with a lot of bandwidth and

CPU power host voice and another with bandwidth/CPU power host the mission. Ideally, the best way to use IVC is with a separate dedicated voice server system.

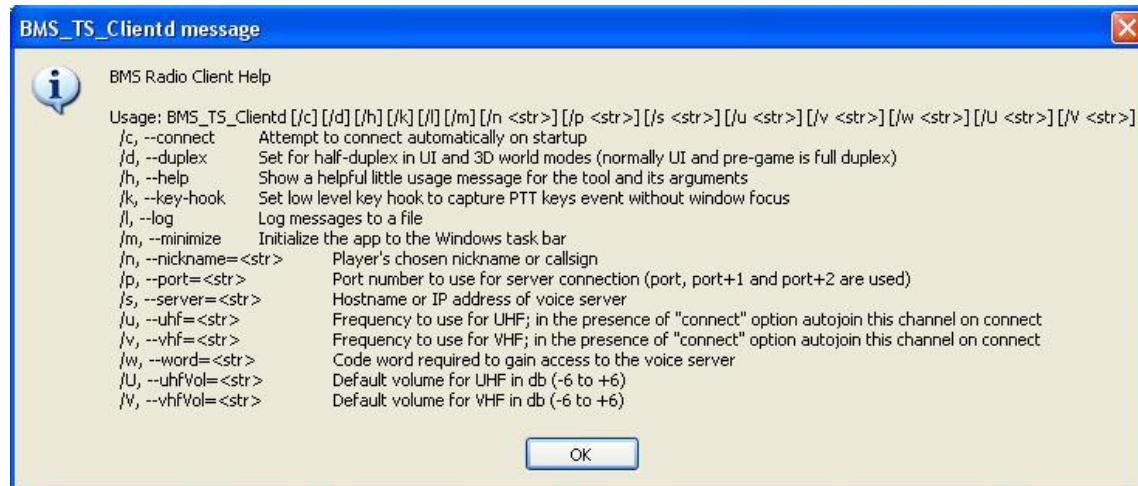
## Using the Voice Client

### **Command Line Switches and Options**

The IVC client includes some new capabilities. In particular I have added a number of command line switches and options that you can use. These are useful for one time configuration of the client but as I hope you will imagine, saving sets of appropriate command line strings as part of a shortcut to the client applet will allow you to parameterize the startup operation in a pretty flexible way.

For instance, a virtual squadron may have a couple of different voice servers in various parts of the world at some point. To that end, I will probably have two shortcuts that auto-connect me to each one separately with the appropriate frequencies pre-selected and set up so I do no more than launch the client and then start mashing the PTT to talk to the other pilots.

So, how's this all going to work you ask?? Good question! Here's a picture of the usage/help text dialog:



[Note: this picture was taken with a debug exe of the client so the first thing is the program name has a "d" on the end – yours will not...it will just be "BMS\_TS\_Client.exe"]

You can enter command line options either by launching the applet from the cmd prompt or by setting the command line string in a Windows shortcut.

You can use any or all of these switches and options in combination; a few have interactions with each other as will be noted.

You can use the "/<letter\_name>" syntax or the longer --<switch\_name> choice but note that with the slash version you just follow with space and a string for the switches that require an option <str> to be present whereas the --<switch\_name> form requires the "=<str>" (no space) construction so far as I know (latter not tested much because frankly I think the / notation is easier). I did discover by accident that -<letter\_name> seems to work too, by the way.

If you put in a switch that is not recognized, fail to provide an option <str> where one is required or otherwise mangle the command line so the applet can't figure out what you meant, then you get the above dialog box and the client will exit immediately after you click on the OK button.

Case *IS* significant for these options. Be careful as some are upper case now in addition to the lower case ones.

Here's a longer description of the available choices:

/h or --help: this one is special...you can put it anywhere in the command line and all other options and switches WILL BE IGNORED. This causes the usage dialog box to show and from there the program will exit. Do not pass "GO!" do not collect 200 local currency units, no soup for you!

The rest of the switches and options act alone or in combination provided there is no /h... You can enter switches and their option strings (if required for a switch) in any order you like...order is not significant.

/c or --connect: if present, this will cause the client applet to attempt to connect immediately the program starts. Be careful using this one alone because by default your nickname is "noname" and the server address entry isn't either a legitimate ip address or translatable hostname. In other words, expect this to fail unless you use the other appropriate options as well as this one.

/d or --duplex: if present this causes the client to operate on half duplex basis in all modes, pre-game, Falcon4 BMS UI and 3D world. If not present, the client operates on full duplex basis for pre-game and Falcon4 BMS UI but you get half duplex in 3D world. Half duplex means that when you transmit, all incoming sound is muted. Full duplex is like the telephone: you can talk over each other if you want. Half duplex is how the radio should work for the 3D world to model the real thing. The sound effects follow this option too – if you enable it for pre-game for instance, then you get mic clicks and ambient noise mixed in with all transmissions.

/k or --key-hook: if present this option causes the applet to install a low level Windows key hook. This will gobble up all key presses of F1, F2 and F3 keys into the applet. It will do this regardless of which window/application has focus at the time. What this means is that you can minimize the client or put it in the background and the PTT keys will still transmit when you press them. So for instance, many applications in Windows respond to F1 as the "help" key – if the key hook option is present for the radio applet, F1 will not be delivered to any application other than the radio applet so you won't be able to use it for opening help for other applications. Another useful property of doing this is that it means you can start the client, connect and start talking all the way into the Falcon4 BMS UI and on into 3D without interruption... Without the hook, when you start Falcon4 BMS (especially in full screen mode; or if you click on some other application and give it foreground focus) you can't transmit again until the COMMS->connect operation completes successfully. With the hook, the PTTs make the client transmit regardless of what window has focus...at the expense of stealing F1/F2/F3 from any and all other applications. One extra note: when you go through COMMS->connect and reach the connection established dialog box, the low level hook is removed if it's active at this point...that allows you to still use F1/F2/F3 for normal avionics key bindings in the 3D world. For the avoidance of doubt the hook is set when the applet is launched and remains in place until the applet closes (yes, it's active even after Falcon4 BMS closes because the applet resets the hook when you leave Falcon4 BMS...so no F1/F2/F3 in other apps if you don't also close the applet but it will release the keys back to Windows if you then close the applet as well as Falcon4 BMS).

/l or --log: primarily a debugging option so most of you won't need it unless we run into problems. Using this

switch forces the applet to write a text file called "radio-log.txt" into the ivc sub-directory in your Falcon4 BMS install. It's full of boring spooge about what the client library and server are up to behind the scenes and there really isn't a lot of interest in there for regular pilots. It's mostly there in case I ask you to enable it to help debug problems at some point. Note: the log file is one-shot so every time you start the applet any previous content is deleted. Keep this in mind if you are asked for log files to match specific game circumstances.

/m or --minimize: this launches the applet to the taskbar instead of showing the full window on the screen. The BMS code launches the client this way when it auto-launches for you and that's mostly why the option exists but when used in concert with other options you can get the effect of being magically connected to the voice server and talking away all while the client UI is tucked away out of sight. NOTE: I was trying to get the auto-launch of the client by the Falcon4 BMS code to be silent/background but this doesn't always work properly yet. When Falcon4 BMS auto-launches it does minimize the client *but* it may also alt-tab away from the Falcon4 BMS window. Good news is that alt-tab is fixed to work properly now so the remedy is just to alt-tab back to the Falcon4 BMS window and you should see the game UI again (no more blackscreen/partial screen paints). If this behavior offends your sensibilities you can either: a) educate me how to do this kind of launch from a full screen DX application so that it doesn't alt-tab; or b) if you can't do a) then I recommend just pre-launching the client anyway.

/n <str> or --nickname=<str>: this switch causes the string you supply to be used as the content for the "nickname" field in the applet's UI – this is the equivalent of your logbook name for Falcon4 BMS purposes. So for example enter "/n Viper" on the command line. Note this is different than "/n viper" – logbook names *are* case sensitive. Oh and don't put a string that is longer than 60 characters. No really, don't put in any long strings.

/p <str> or --port=<str>: This switch causes the numeric value of <str> to be used as the base IP port address for the client to use in trying to talk to the server. The client uses 3 ports so this one <str> number is the first and the others are one and two more than that respectively. So if I put in "/p 8086" the client will use ports 8086, 8087 and 8088 to reach the voice server (it may also transport your hardware to somewhere between 1978 and 1979 and reduce your system to 8-bit processing mode...don't say I didn't warn you!). In general there is presently no way to change the ports that the server binary listens on anyway so you are best off ignoring this option anyway...it's there for future growth. The string you enter must be a decimal number made up of the characters zero through 9 inclusive.

/s <str> or --server=<str>: this switch causes the applet to use <str> to fill into the server box in the applet UI. This string can either be a routable IP address or a fully qualified domain name. It is possible to use a more local name so long as it is routable by your system. If you happen to be running a server binary on your system own you must still enter the address for it -- you can use "localhost" or "127.0.0.1" and that should work in that case. This option is useful in combination with /c because in that case it will launch the applet and go ahead and attempt a connection to the server you specify with this /s option in the <str> field. FQDN's must be less than 60 chars long also.

/u <str> or --uhf=<str>: this makes the applet fill <str> into the UHF frequency box in the applet UI. This option is useful in combination with the /c and /s options because it will cause the applet to auto-connect to the server specified with the /s option and then auto-join the UHF channel specified with the /u option [for you TeamSpeak users, all channels are type "temporary" so they are created and torn down for you, no server side management required]. The <str> in this case can be anything but keep in mind that the game universe uses 6 digit decimal integers to represent frequencies -- essentially the MHz value times 1000 to remove the decimal – Osan tower is 308.800MHz so the <str> to use so you can hear players on that frequency is: "/u

308800". By the way, if you leave this option off and still use /c and /s, you are connected and the UHF radio ends up tuned to a channel imaginatively called "Default channel". Channel name <str> values must be 60 characters or less.

/v <str> or -vhf=<str>: this makes the applet fill <str> into the VHF frequency box in the applet UI. This option is useful in combination with the /c and /s options because it will cause the applet to auto-connect to the server specified with the /s option and then auto-join the VHF channel specified with the /v option. The <str> in this case can be anything but keep in mind that the game universe uses 6 digit decimal integers to represent frequencies -- essentially the MHz value times 1000 to remove the decimal. By the way, if you leave this option off and still use /c and /s, you are connected and the VHF radio ends up tuned to a channel imaginatively called "Default channel". This is NOT the same as the UHF default channel...they are separate radios don't forget! Channel name <str> values must be 60 characters or less.

/w <str> or --word=<str>: Use this option to specify a password that is required by some servers to gain access for connection. Only the first 8 letters of this string are used (if 8 or more are provided, less is OK if that's what your server needs). If you need a null password for some server you can explicitly add that with /w ""

/U <str> or --uhfVol=<str>: Use this option to change the default volume level for the UHF radio channel. This also affects the GUARD receive channel as well. The range of usable values is +6 to -6 (yes, you can put the '+' and '-' symbols in <str>). The default volume, which the TS code sets to "normal maximum", is accomplished by either leaving out this option or explicitly using it and providing '0' as the option string. Note: this means that a value of +6 actually amplifies the incoming voice level so it's LOUDER than normal...mind your ears. Minus values reduce the volume below the norm. [NB: this range of adjustment in the minus area is less than the range that can be commanded via control in the game -- disagreements on volume levels with pre-game options and in-game levels can result in jumps in volume level as you move from one environment to another...it's up to you to manage this if you don't want the jumps!]. For the technically minded these are interpreted to be a decibel value...which is why minus means quieter and so on.

/V <str> or --vhfVol=<str>: Use this option to change the default volume level for the UHF radio channel. The range of usable values is +6 to -6 (yes, you can put the '+' and '-' symbols in <str>). The default volume, which the TS code sets to "normal maximum", is accomplished by either leaving out this option or explicitly using it and providing '0' as the option string. Note: this means that a value of +6 actually amplifies the incoming voice level so it's LOUDER than normal...mind your ears. Minus values reduce the volume below the norm. [NB: this range of adjustment in the minus area is less than the range that can be commanded via control in the game -- disagreements on volume levels with pre-game options and in-game levels can result in jumps in volume level as you move from one environment to another...it's up to you to manage this if you don't want the jumps!]. For the technically minded these are interpreted to be a decibel value...which is why minus means quieter and so on.

One useful way to use these is with shortcuts. Perhaps make a folder of shortcuts for each of the voice servers you expect to work with. Let's assume that I want to auto-join the server and use the same UHF/VHF frequencies that BMS is set up to use by default in the game UI chat/mission screens. Given the server address we are using as an example I'd make a shortcut that has this command line:

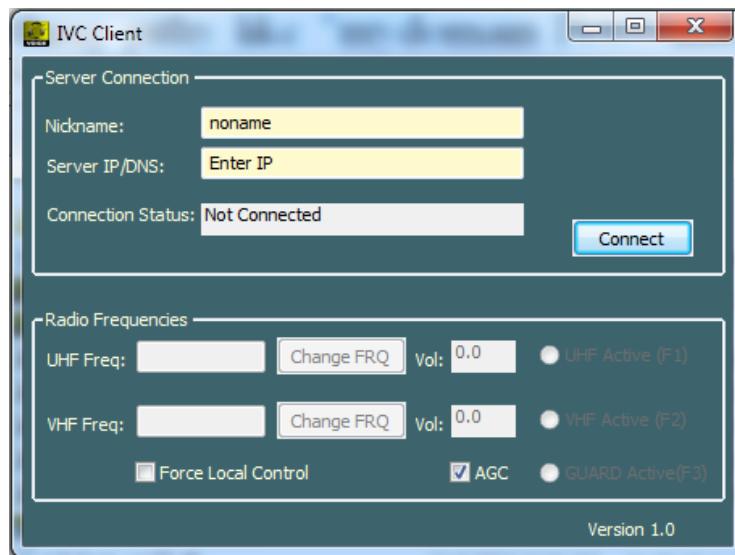
```
"c:\FalconBMS\Bin\x86\ivc\IVC Client.exe" /c /k /n Viper /s ivc.mydomain.org /u 307300 /v 1234
```

I could add a /m in there as well to have it launch to the task bar instead of opening a window initially as well perhaps. I'd probably rename the shortcut to something pithy like "mydomain IVC" and call it good from there.

I know a number of folks asked for ini files for this sort of thing but when it came down to it what I think

would be most useful is profiles of connection parameters and providing command line options like this allows you to store a profile as a "launch-able" target right from the windows desktop. That felt to me like it was at least equivalent to profiles stored in an ini file and faster to use in that you select without having first to start the applet. Oh and it doesn't hurt that adding command line switches and options like this was very little actual code (there's a sweet wxWidgets library that does the work!) to write so I could give you all something I hope will be useful without it being a major coding project.

## **Client User Interface**



If you start the client applet with no command line arguments, you should see a window like the one above as a result. Focus first on the Server Connection group of controls.

In the Nickname box fill in your callsign or equivalent. Note that when you get into a multiplayer game this field is overwritten with the name that matches your logbook as selected in the game configuration. It's going to be less confusing if you enter the same name (case sensitive) here as the one you use for your Falcon BMS logbook. "noname" is the default nickname pre-entered for you if you don't change this field's content.

In the Server IP/DNS box you type in the routable IP address of the target voice server or a fully qualified domain name for that server. Note that for a server running on the same system as the client applet, you can enter 127.0.0.1 or "localhost" – either choice will work to connect you in that case.

The connection status box is informational. As shown above you begin in not connected state unless you use some of the command line options listed above to automate an initial connection.

Beside the status box is the connect button. Press this to initiate a connection. Note that you will only get a useful response if the server box contains the correct address or hostname for a system running the voice server. Pressing connect before entering the address will cause an error.

You will notice that the Radio Frequencies group of controls is greyed out when the applet starts. These controls become active once a successful server connection is initiated. If you had used command line options to pre-fill the radio frequencies, you should see those values in the boxes but they are still greyed out until a connection is made to a valid server.

Once the frequencies group does activate, you can enter channel values and begin transmitting. As in the jet there are three receivers. Unlike the jet which has only two, there are three transmitters in the applet as well. If there are no command line options used, you will initially be connected to the server and each of your radios placed in a frequency called “Default channel” (UHF and VHF transceivers both have separate default channels so you have to transmit on the right radio to talk and be heard; GUARD’s default is separate too but it is called “243000” and thus places you on the UHF guard frequency by default). Thus you should be able to speak to other people who started the applet the same way without entering any explicit frequency information.

In the UHF Freq box you can type in any string value. When you click on the Change FRQ button to the right of that box, you will be connected to the channel on the voice server named by the string. Choice of string is completely up to you but the most useful way to use the applet is to enter strings that represent entries in the radio frequency domain that you can use inside the game. To do that, enter a string with six digits that represent the MHz frequency multiplied by 1,000. For example, if you wanted to dial in Osan tower in your UHF channel, enter the string 308800 to represent 308.800 MHz. You must click on Change FRQ for a newly entered string to put you in a new channel. Hitting ENTER after typing the string moves the window focus from the text box to the Change FRQ button so you can type “308800”, ENTER then ENTER again and that will be a shortcut for clicking on the Change FRQ button as well. The UHF band frequencies are from 225.000-399.975 MHz in 25 kHz stepping, just like the real thing.

The VHF box and Change FRQ button operate exactly the same way but the recommended frequency range to use is different. The VHF band frequencies used in the game are from 116.000-151.975 MHz in 25 kHz stepping.

The volume boxes allow you to enter numeric values to a maximum of 6.0 either side of zero. These are decibel values that modify the radio output volume. Zero is the default sound level. Plus 6.0 is the maximum amplification above the default (caution: sound may overdrive and clip depending on your hardware). Minus 6.0 attenuates the volume level significantly. Note that the UHF volume also controls the volume of the GUARD transceiver – these cannot be modified separately.

The three radio buttons to the right of the control group are informational. These activate when you press and hold one of the push to talk keys, F1, F2 and F3 for UHF, VHF and GUARD transceivers respectively. Oh and let me forestall one thing right away: there is no way to change the PTT keys for the applet – F1/F2/F3 is all you get. The Falcon4 precedent rules!

There is also a checkbox for Automatic Gain Control – this is enabled by default and seems to work reasonably well most of the time. Being able to turn this off for the applet may help some users so the option is there if you end up needing it.

The last gadget in the applet UI is a “force local control” check box. Most people should stay away from this. The purpose of it is to prevent the applet code for looking for Falcon4 BMS and hence to prevent the client from being slaved to the Falcon4 BMS code. Useful in debug, probably not useful to most everyone else but since it’s there, now you know what it’s supposed to do...if you click it while Falcon4 BMS runs, then all bets are off...not sure what will happen...use at your own risk: you have been warned!

### ***Interactions Between the Client and the Game***

In practice there are two ways to start voice comms to use with the game. You can either launch the applet before the game starts or the game can start the client applet for you. Only one instance of the voice client applet can run on your system at any one time.

The launcher gives you the opportunity to start the voice client applet separately. This allows you to connect for voice communications in advance of starting the game and making a multiplayer connection. Among other things, this may be useful to talk players new to multiplayer through the process of making a connection.

Alternatively if you enable voice communications and the client applet is not running as you press the Connect button then the applet is launched for you automatically in the background. In some cases an alt-tab may be required to bring the game UI to the foreground again once the applet has launched. This mode more closely resembles the operating model of the earlier DirectPlay voice system and may be more comfortable for some players.

If the client is running before the game then it runs independently up until the “connect” button in the COMMs UI page in the game is pressed to initiate a multiplayer game. At that time, provided the local control gadget in the client applet is not checked, the applet will slave itself to the Falcon4 BMS code. When the applet is slaved the local user interface controls are disabled and all parameters are driven from the game. Among other things, this means that if the COMMs UI dialog has any different parameters from those used to start the applet (such as logbook name or voice server address), then the applet is directed to disconnect and then reconnect with the settings from the game UI.

There is some amount of error recovery built in to the voice system so if for some reason the connection to the voice host is lost or dropped, then attempts are made to re-establish communications. Absent any error though, the connection is maintained as long as the game runs. When you exit Falcon4 BMS, the connection to the voice host is terminated and local control is returned to the UI for the client applet.

## Radio Sound Effects

This revision of the code includes four wav files that provide crude sound effects.

There's a wav for mic clicks on start and finish of a transmission. Some folks don't like the idea of the lead-in click – if that's you, simply rename or remove that file and the sound won't be played.

There is a 'noise' wav file that is played as a loop mixed with the incoming audio stream. This has the effect of some static or ambient radio noise to dirty up the sound a little so it's not quite so pristine. This is provided for you when there is one and only one person transmitting on a channel that you are listening to.

There is also a 'block' wav. This one is LOUD and sort of obnoxious by design; before you ask it is taken from a real radio clip. This one is played with more than one person is transmitting on the frequency you are listening to and represents co-transmission interference. Obviously you can only run into this one if more than two people are on the frequency.

Note that these noise and blocking sounds interact with the half-duplex transmit mode that is also included in this update: when any person transmits all incoming sound on the frequency is muted. Thus in the case of two folks talking over each other now, they hear nothing but everyone else on the channel gets an earful. Be careful what you wish for!

At present there is no side-tone implemented in the radio applet intrinsically. You can however get something of that effect by using the Windows sound mixer to feed in a little of your out-going microphone audio back into the sound output on your local system.

# Radios in the Falcon4 World

## Differences – The Old

From SP3 on, only 15 communications channels were possible. These “channels” were name-based, and then later changed to a more realistic-looking preset name-based in BMS 2.0. The table below shows BMS 2.0 preset names and their name/function in SP3.

BMS 2.0 “preset”	Falcon 4 Channel Function
1	Flight1
2	Flight2
3	Flight3
4	Flight4
5	Flight5
6	Package1
7	Package2
8	Package3
9	Package4
10	Package5
11	From Package
12	Proximity
13	Guard (but is actually Team)
14	Broadcast
15	Tower

Both COM1 and COM2 can “tune” to any one of these channels. Channels Flight2-5 and Package2-5 are more for multiplayer to split up communications on multiple channels but otherwise these behave the same as Flight1 and Package1 respectively.

## Differences – The New

The new radios now behave much more like the real thing and exceed any 3<sup>rd</sup> party voice comm software out there in terms of flexibility, capability, controllability and realism. COM1 and COM2 (UHF and VHF) both have 20 presets available to them and each preset can be assigned a valid frequency within its respective band range. There are separate up-front and backup control sets for the UHF radio (ICP/DED-based and UHF control head respectively) and the backup radio has only 19 presets available.

### UHF

The UHF band frequencies are from 225.000-399.975 MHz in 25 kHz stepping, just like the real thing. Since 25 kHz stepping applies, the 5<sup>th</sup> digit of a 6-digit freq must end with 0, 2, 5, or 7 and the 6<sup>th</sup> digit must end in 5 or 0. Examples of valid freqs: 371.075, 377.10, 271.6. Examples of invalid freqs: 339.11, 271.14. It should be noted that the pilot may only input freqs using 5 digits *and* he will only see 5 digits in the Upfront Controls (UFC, i.e., the DED), but it is possible to assign preset freqs with 6 digits. Although this capability will rarely be used in the game world, it is possible by using the DTC and will always be *required* if entering frequencies direct into the voice client applet.

### VHF

The VHF band frequencies are from (AM mode) 116.000-151.975 MHz in 25 kHz stepping. The FM mode (30.000-87.975 MHz) is not implemented. The rules regarding digit input are the same as those which apply to the UHF band.

## What about the AI? How do they fit in?

Working with existing code and keeping the AI aircraft in the loop was a little tricky since there were a few possible ways to do it. The way chosen was a tradeoff for playability, continuity and required the least amount of work as far as rewriting/changing existing code. It's also the easiest for you to learn. Here is how it works.

Again, each radio (COM1/2) has 20 presets. With the CNI switch in BUP (Backup) UHF has only 19 presets. The VHF radio has no backup controls. The AI still use the well-known “channels” for their communication—i.e., Flight1, Package1, “Guard”, etc. But now, instead of these communication channels being a specific preset or channel function name, it is a frequency. Since each AI channel function is assigned a specific frequency, the pilot can program this frequency into ANY preset he desires and the function remains the same. To reduce the workload on you the pilot, we have already compiled a default list of presets and matched them up according to their function.

Note: In a multiplayer game, humans can talk on any of the presets/frequencies. The trick is that 14 of the default frequencies are *also* assigned to the AI, so that humans hear the AI as well. The AI **only** knows the default frequency list and they are assumed to be able to “follow” when you set any one of the frequencies in that list. What this means is that AI members of your flight will be able to hear you and communicate back on any one of frequencies which are assigned to presets 1-14. AI package members will only hear you on the freqs that correspond to Package1-5 (unless the package members are also members of your flight). AWACS and tankers are “smart” like your flight members. They can communicate on any of the 14 well-known default frequencies. Prox will limit transmission to jets close by. Broadcast/Guard sends to all AI in your team.

The Team frequency is a special one. When using IVC in multiplayer from the game UI (i.e. before or after flight), the “F1” key transmits on the Team frequency. In a force-on-force scenario, red and blue forces can set different Team frequencies in their `falconbms.cfg` file (described below) to allow communication in the user interface (UI) with ONLY members of their team. This allows them to brief/review their plan before committing to 3d without the other team listening in. Another feature of this is someone (a human AWACS controller or a shot down pilot <grin>) in the UI can communicate with someone in the 3d world over the team freq (provided the person(s) in the 3d world are tuned to it). The AI on their team can also communicate with human pilots in the 3d world over this frequency provided it is configured to be one of the presets that the AI use.

Naturally, if both sides (teams) do not have different Team freqs, everyone will hear one another as if they were on the same team. In a MP environment, F2 is by default ONLY used for the UI and *everyone* in the UI can hear transmissions on it. By default F2 can never be heard from the 3d world because it uses a frequency outside the range you can select once you are in the jet. F2 is intended for everyone to coordinate and to synchronize launching to 3d, briefing any “global” type things like rules of engagement, any special procedures, or just BS’ing before you fly. However, it is now possible to change the frequency that is used for F2 from the UI so if you want you can reconfigure it so both F1 and F2 are tunable in the 3D world as well. Depending on your needs you have considerable flexibility to separate teams or have multiple “control agencies” on separate frequencies or the like. More discussion on force-on-force and setting the Team freq can be found below.

Below is the table of default frequencies/presets and their functions in regard to the AI.

AGENCY	UHF	PRESET	VHF
Flight 1	297.50	1	138.05
Flight 2	381.30	2	138.10
Flight 3	275.80	3	138.20
Flight 4	294.70	4	126.20
Flight 5	279.60	5	134.25
Package 1	349.00	6	133.15
Package 2	377.10	7	132.35
Package 3	292.20	8	126.15
Package 4	264.60	9	132.875
Package 5	286.40	10	132.325
From Package	354.40	11	132.575
Proximity	269.10	12	121.20
Team**	307.30	13	119.50
Broadcast/Guard	377.20	14	120.10
Open	354.00	15	134.10
Open	318.10	16	126.80
Open	359.30	17	120.00
Open	324.50	18	141.80
Open	339.10	19	123.70
Open	280.50	20	121.70

You will notice that “Tower” is missing. Pay special attention to this change. In order to communicate with a tower, you must punch in its frequency by manually tuning it (i.e., just punching in the frequency in the COM1 or 2 override DED page) or you may assign it to any preset (an open one is recommended) and then punch in the preset number, which tunes your radio to the frequency in the preset. Procedures on how to operate the radios are listed later on in this text.

Communication with your wingman is similar. You must be tuned to a frequency that your AI wingman can talk to you on (one of the freqs that are listed in the table of default preset frequencies). If you are not, you will neither be able to give him commands, nor will you hear any transmissions he makes, nor will you hear yourself calling the AI wingman. Your first clue that you aren't on a frequency the AI can hear you on is pressing “W”, “1” and not hearing your own voice make the call (if you have Pilot Voice on in the Sound setup). Typical radio use in the real F-16 is UHF is normally used to communicate with external agencies: ATC--ARTCC, ground, towers, approach/departure, etc. and in war-time or exercises, controlling agencies like AWACS (DCA, Strike, etc), JSTARS or other command and control agencies. VHF is normally used for intra-flight communications but some frequencies may double as a coordination net as well depending on the purpose. What does this mean to you? Since the above are the typical set ups, we recommend talking to Towers, AI packages, or humans in other flights or packages on UHF and keeping intra-flight communications on VHF.

So, in single-player your radio set up may be:

UHF 6 (preset 6 for Package) and change UHF to the tower freq for airfield ops when taxiing, takeoff and landing.  
VHF 1 (preset 1 for Flight)

In a multiplayer (MP) environment, with say 2 flights of 4 aircraft, all humans, the above configuration would not work. Why? Because if both flights were tuned to VHF 1, which is what you wanted to use solely for intra-flight comms, everyone in both flights would hear each other since they are all tuned to the same frequency. This is important. Using the old code, each flight could be on “Flight1” (or preset 1) and not have to worry about hearing other non-flight members. Not so in the new code because the only thing that matters is what frequency you are tuned to on the radio. You will hear everything said on a given frequency you are tuned to and the same goes for anyone else

tuned to that frequency also. During the planning before your MP flight, both flights should coordinate which VHF presets/freqs they're going to use for deconfliction. The first flight could use preset 1 on VHF and the second flight could use preset 2. If both flights only had humans, you could use another preset, like 19 or 20.

## Setting the UI Radio Frequencies

To change the team frequency, open up the `falconbms.cfg` file in the root Falcon4 directory with a *plain text editor* like Notepad. Add the following to either the top of the file or the bottom, it does not matter.

```
set g_nF1TeamUiFreq 307300
```

As you can see, referencing the default frequency table above, 307300 is 307.300 MHz. That number is the default if `set g_nF1TeamUiFreq` is not set in the `.cfg` file. To change the Team freq, add a 6-digit number that complies with the rules mentioned in the UHF section regarding frequencies or keep it simple. Good examples: 236800, 377800, 253700, 229025, 141325, 139000, 143925. The team freq can either be a valid UHF or valid VHF frequency.

**IMPORTANT NOTE:** The team freq *does not* have to be a valid UHF or VHF frequency but there's a catch. It *can* be any 6 digit number, but we are *strongly recommending* using a valid UHF/VHF frequency otherwise the pilot in the 3d world WILL NOT be able to tune to that number unless it is a valid frequency. So while the number you choose will work for the UI, it will not for the 3d world. So, just ensure you're using a valid frequency and be done with it!

The same configuration trick works for the F2 frequency as well so you can change it as well as that used for F1. In this case the name of the variable to set the frequency is: `g_nF2TeamUiFreq`

## Changing the default frequency list in the Callsign.ini File

It is recommended that the pilot use the DTC to change the default freq list only if absolutely necessary, as described in the DTC Comms section. If you **must** change the defaults manually, here is how to do it:

To change the default frequency presets (**not recommended for single player or the inexperienced**), you must open the `callsign.ini` file with a *plain text editor* like Notepad. Find the [Radio] section.

```
[Radio]
UHF_n=XXXXXX
VHF_n=XXXXXX
```

“n” is the preset number you wish to change (1-20), and XXXXXX is frequency. Example:

```
[Radio]
UHF_13=236800
```

This would set preset 13 to 236.8MHz. Again, you can change any preset frequency you wish, although we *highly discourage* changing the entire UHF and VHF lists. One exception is that UHF values in the ini file only affect the UFC COM1 controls. The default freq list (i.e., the list used by the AI) is permanently set in the BUP COM1 radio controls. Numbers must be valid frequencies for UHF and VHF or the code will discard it and use the default values. If you were to set completely different frequencies you will not be able to hear any AI players at all, except for AI flight members on Team freq. Probably one of the only times you would actually want to change the entire list (and this really isn't likely) is if ONLY human players are involved in the entire mission or force-on-force scenario and you wanted to have a robust, complex communications plan. But even in this situation, just changing presets 15-20 should be sufficient and you do not have to worry about the AI freqs.

## Tying It All Together

So, let's say you're in the blue force and your mission commander directs all blue force members to set 236800 as the Team frequency. You would open up falconbms.cfg and add:

```
set g_nF1TeamUiFreq 236800
```

And save/close the file.

And he also directs you to change preset 13 to the same. Do so by using the DTC. If you want to do it manually, open callsign.ini and change preset 13:

```
[Radio]
```

```
.....
```

```
UHF_13=236800
```

And save/close the file.

An additional thing to think about is that since communications are frequency based and there is no Have Quick or Secure Voice (encryption), when you are developing comm plans for force-on-force, realize that if you are using a default frequency/preset and so are the human enemies, you will hear them, and they will hear you. You will not, however, be able to hear their AI. It is best for Red and Blue forces to come up with comm plans where if this should happen in the mission, the mission commander or any other person flying can initiate "chattermark" procedures to get all the forces on his team to "roll" to a different, briefed frequency. The official definition of Chattermark is "begin using briefed radio procedures to counter communications jamming." It can also be applied to a situation like this in Falcon. Blue and Red force commanders can also work together in planning to deconflict frequencies. Just remember, all comms are in the clear, so using brevity and code words can now actually be very important in force-on-force. You never know who is listening.

As you can see, communication in Falcon has the potential to get very complex, but at the same time it is also very flexible and easily controlled within the sim. In the real world, 99% of the time communications plans are very complex and take a lot of study to know what frequencies to talk on, who is on what, and when you need to talk to whom.

This table is a rundown of the Blue Airbases which includes Tacan channel, UHF/VHF freq, runways available and the ILS frequencies. Only Korea has been built at this time.

## Blue Forces

AIRFLD	TCN	UHF	VHF	RUNWAY	ILS (RWY)
Osan	94X	308.80	122.10	26/08	111.3 (26/08)
Seoul	46X	237.10	126.20	19/01/18/36	110.9 (19)
Suwon	22X	366.00	126.20	34R/16L/34L/16R	108.5 (34L)
Kimpo	83X	240.90	118.05	14R/32L/14L/32R	110.1/108.3/109.9/110.7
Mandumi	1Y				
Pyeongtaeg	19X	257.80	122.50	16/34	108.5 (34)
Seosan	52X	353.10	136.755	20R/02L/20L/02R	111.5 (02R)
Kunsan	75X	292.30	126.50	16R/34L/16L/34R	110.3 (16R/34L)
Kwangju	91X	254.60	126.20	20/02	111.1 (20/02)
Kadena	57X	225.50	126.20	01/19/33/15	109.7 (01),108.7 (19)
Kimhae	117X	233.30	118.10	16/34	109.5 (34)
Punson	87X	232.40	118.10	14/32	109.5 (32)
Taegu	125X	365.00	126.20	14/32	108.7 (32)
Pohang	72X	236.60	118.05	08/26	110.9 (08)
R601	6Y				
Yechon	26X	269.50	124.35	08/26	109.3 (26)
Choongwon	5X	230.15	126.20	16R/34L/16L/34R	111.3 (34R)
Kangnung	56X	334.90	126.20	08/26	111.5 (26)
Sachon	37X	305.40	130.20	23R/05L/23L/05R	108.1 (23R),111.5 (05L)
Chongju	42X	250.20	118.70	05R/23L/05L/23R	111.7 (23R)

## Red Forces

<Not built at this time>

## UHF Radio Communication

The ARC-164 UHF radio operates using either manually entered UHF frequencies or any one of 20 preset channels (19 available in Backup operations). Also included in the UHF radio is a dedicated, selectable, auxiliary guard receiver that operates on the standard 243.0 MHz guard frequency. Back-up manual control of most UHF radio functions is provided by the UHF Radio Control Panel (Figure 1-43) during engine starts with only battery power, or whenever the UFC is inoperative. The UHF control panel, which is located on the left cockpit console, is operative when the IFF Panel Communication and IFF (C&I) switch (AUX COMM panel) is in BACKUP and the Audio 1 Panel Communications (COM)1 volume control switch is out of OFF. UHF transmissions are initiated by holding the COMM switch aft on the throttle. This causes the UHF mnemonic on the CNI and COM 1 DED pages to highlight, indicating that the microphone has been keyed and the radio is active. Mnemonic highlighting is only available in the MP environment using In-game voice comms (IVC).

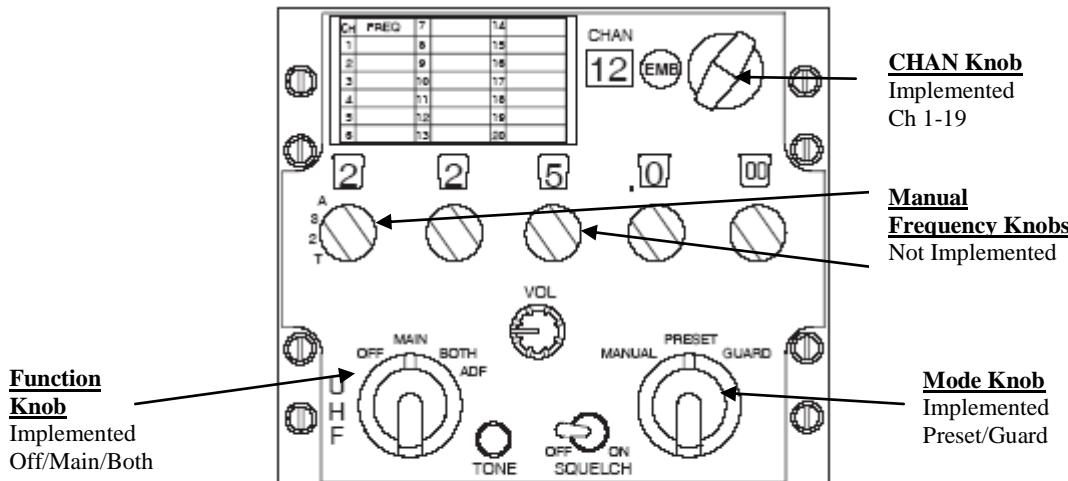


Figure 1-43 UHF Radio Control Panel

### Audio Panel

The AUDIO 1 Panel (Figure 1-44) provides power to the radios and controls other less frequently used communications and audio functions. The COMM 1 switch controls UHF radio power and volume. Rotating the switch clockwise out of the OFF position applies power to the radio and increases UHF radio volume. The 3-position rotary knob directly below the COMM 1 switch disables the auxiliary guard receiver, and automatically tunes the main receiver and transmitter to guard frequency in Guard (GD). Only 2-positions are implemented—SQL (squelch) and GD. SQL is the normal position.

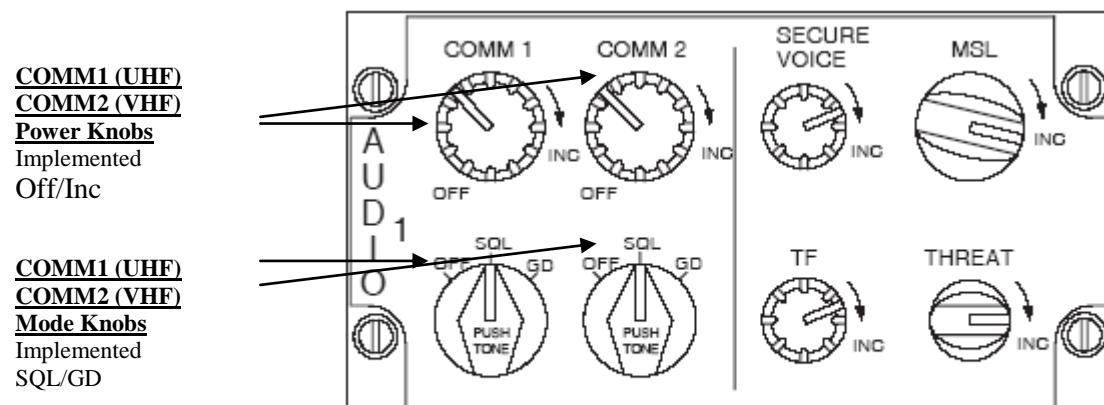


Figure 1-44 Audio 1 Panel

### Normal Radio Control

Normal UHF radio control is provided by the UFC. After the engine is started and the aircraft is on internal power, the UFC switch on the Avionics Power Panel is switched to ON. When initially powered-up, the DED page will display “BACKUP” in large letters to indicate that the Communications and IFF systems are in the BACKUP control mode. Moving the AUX COMM Panel C&I switch from the BACKUP to UFC allows normal UHF

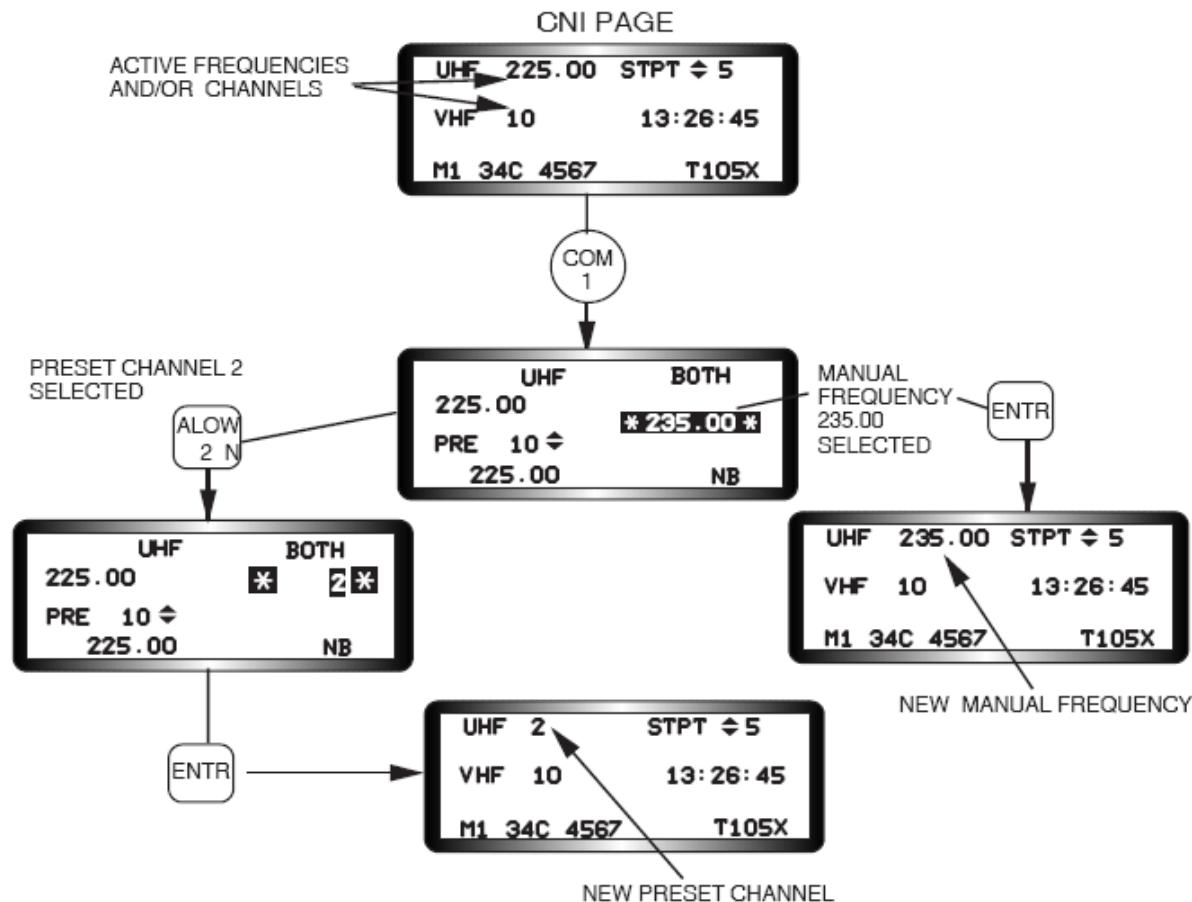


Figure 1-46 Manual Frequency and Preset Channel Selection Procedures

control of communications and IFF systems and causes the CNI page to be displayed on the DED. Depressing the COM 1 pushbutton on the ICP accesses the UHF COM 1 Control page on the DED (Figure 1-45). The pilot selects the data he wants to enter on the control page by placing the asterisks in the desired area with the dobor (DCS – Data Control Switch) switch. Data entry areas include the scratchpad, receiver band, preset channel number, and preset channel frequency. Not included in Figure 1-45 below is a “TOD” label below the SCRATCHPAD. It is for receiving HQ Time-of-Day and is not implemented. Hitting ENTR with the scratchpad cursors on it will cause it to highlight for 60 seconds (it is purely cosmetic). Receiver band has no function in the simulation.

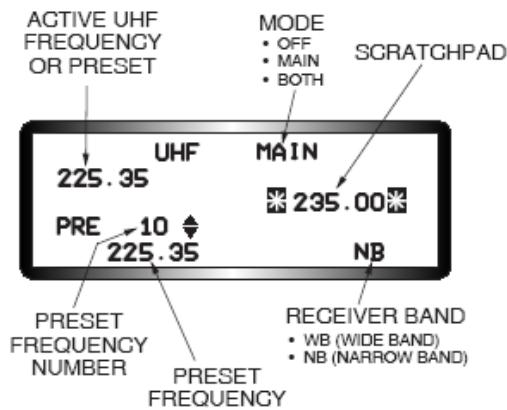


Figure 1-45 COM 1 Control Page

## **UHF Mode**

OFF indicates that the UHF radio power is off. MAIN indicates that only the UHF receiver/transmitter is selected. BOTH indicates that the UHF receiver-transmitter and auxiliary guard receiver are both selected. The radio initializes to BOTH at power up. Placing the “dobber” switch to SEQ rotaries between the MAIN and BOTH settings.

## **Scratchpad**

The pilot changes preset channels or manual frequencies using the scratchpad (Figure 1-46). Channels are changed by keying in the one- or two-digit channel and ENTR. Manual frequencies are selected by keying in the appropriate five-digit number and ENTR. The pilot does not need to key in trailing zeros for manual frequencies. For example, the pilot keys in the three digits 2,5,5, and depresses the ENTR button to select 255.00 MHz. The system automatically places the decimal and trailing zero(s) in the proper positions.

## **Auto Exit Feature**

The UFC provides an “auto exit” feature when valid manual frequency or channel changes have been entered through the scratchpad. The feature automatically returns the DED to the page that was in use before the COMM 1 override button was depressed to access the UHF DED page. Attempted entry of invalid frequencies or channels will cause the scratchpad to flash until valid data is entered. After a channel or frequency has been entered, the scratchpad will display the preset channel or frequency that was in use prior to the currently selected channel or frequency. This feature allows the pilot to conveniently return to a previously selected channel or frequency when radio contact cannot be made on the currently selected channel or frequency.

## **Preset Frequencies**

The frequency programmed for the displayed preset channel is shown directly below the PRE mnemonic. Frequencies associated with each preset may be reviewed, without affecting the currently active preset number, with the increment/decrement switch and viewing the preset frequency associated with each preset channel. The frequency associated with each preset number may be changed by incrementing/decrementing to the desired channel, positioning the asterisks about the frequency, entering the desired value, and depressing the ENTR button.

## **Receiver Bandwidth**

The UHF receiver has two possible bandwidths: Wide (WB) and Narrow (NB). The active bandwidth setting is changed by placing the asterisks around the bandwidth mnemonic and depressing any ICP key 1 through 9. This does nothing in Falcon 4.

# **VHF Radio Communication**

The VHF radio provides two-way voice communication in the FM bandwidth (30.000 to 87.975 MHz) and AM bandwidths (116.000 to 151.975 MHz). Again, FM mode is not implemented as well as the receive-only range from 108.000-115.975. VHF transmissions are initiated by holding the COMM switch on the throttle forward. This causes the VHF mnemonic on the CNI and COM 1 DED pages to highlight indicating that the microphone has been keyed and the radio is active. There is no similar indication when the VHF radio is receiving a VHF transmission from another VHF radio.

## **Normal Radio Control**

Normal VHF radio control is very similar to the UHF radio. The VHF DED page (Figure 1-47) is accessed by depressing the COM 2 override button on the ICP. Data entry procedures for changing manual or preset frequencies are the same as UHF. Except as noted below, the COM 2 portion of the AUDIO 1 Panel (Figure 1-44) and the UFC serve the same control functions for the VHF radio as COM 1 does for UHF.

- VHF radios have no “backup” controls in the event of UFC failure.
- The COMM 2 GD switch automatically tunes the VHF receiver and transmitter to the VHF guard frequency (121.5 MHz) and causes a dedicated VHF GUARD DED page to be displayed (Figure 1-48). The asterisks default around the receiver band portion of the VHF GUARD DED page. Depressing any ICP key 1 through 9 rotates the band selection between the AM and FM bands (Not Implemented).

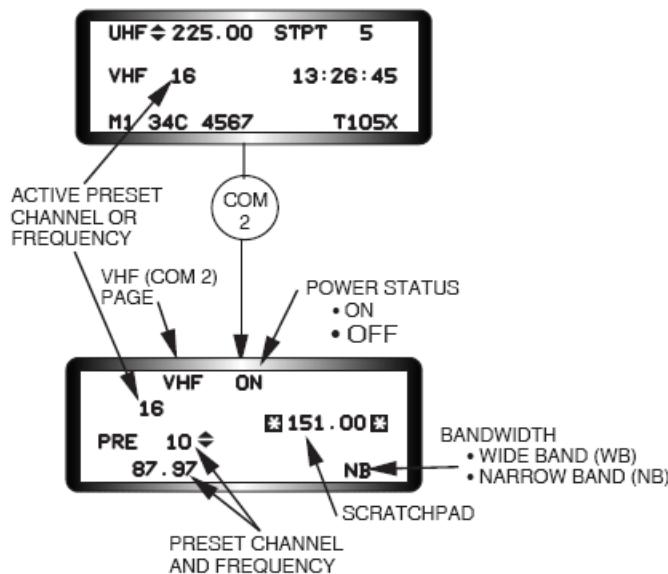


Figure 1-47 COM 2 DED Page

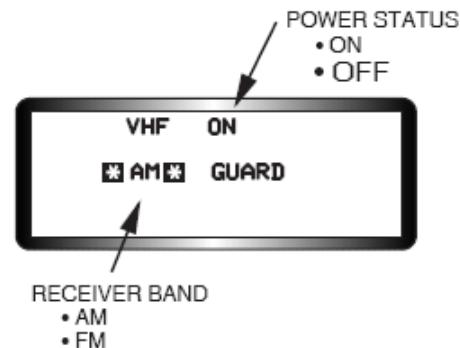


Figure 1-48 Dedicated VHF Guard Page

## Special Notes and Limitations

You will find later in this text that, just as in real life, the new comm code also has the guard frequencies implemented—243.0 and 121.5. With the UFC set to “BOTH” (in CNI UFC) you will hear any transmissions made on 243.0 regardless of UHF frequency you are on. This is because the UHF radio has a dedicated guard receiver. The VHF radio however does not have a dedicated guard receiver so the only time you can hear transmissions on 121.5 is if you are tuned to it or you have the COM2 (VHF) Mode Knob (SQL/GD) in GD (guard) which will auto tune the VHF transmitter and receiver to 121.5.

As previously mentioned, there is no AM band support for the VHF radio. There is also no radio range modeling, no Have Quick support or secure radio support but the new features that are implemented should keep us all busy. So in Force-on-Force games each side will need to make sure and keep their communications plan/comm cards secret or the opposing forces could eavesdrop. All comm is in the clear! Develop communication/chattermark plans. Use code words!

## Head Up Display (HUD)

A variety of changes have been made to code for the Head Up Display that make it that much closer to the real thing in terms of display capability and presentation.

Fixes for the HUD speed tape caret. Previously the KIAS value was always used to place the caret even with GND or TAS scales selected on the HUD control panel. Obviously this led to bogus placement of the caret since it was not scaled. These changes make sure that the desired speed is scaled correctly for the current speed-type setting so now you can follow the caret and get the proper result (TOS or whatever) for GND and TAS settings as well as CAS speed-type setting.

The EEGS funnel has been rewritten to move about the HUD (with a valid FCR track and range less than 2 miles) in order to help get the pilot to maneuver to get in-plane with the target and establish the proper lead-angle needed for a gunshot. NOTE: The funnel may look/react funny on a non-maneuvering target. You should primarily aim with the gun cross in these situations.

The pull-up cue (break X in HUD and MFDs) has been adjusted to trigger when a 4g pull-up should be initiated instead of a 7g pull-up to clear the terrain.

Multiple fixes for various HUD window fields - The Mach, MaxGs, Mastermode/Submode, Fuel warning/Bullseye, Slanrange and Time-to-go are all blanked when the landing gear is down and aircraft velocity is greater than 80 knots. If the gear is raised, they will all reappear. Likewise, if the aircraft slows below 80 knots w/ gear down (i.e. landing rollout), they will reappear. NOTE: The radar altimeter and ALOW box and distance/stpt# are never blanked regardless of gear position or speed. Also, the ILS modes (TCN/ILS and ILS/NAV) were incorrectly blanking the slant range and Time-to-go fields. This was fixed.

The Horizon Line is drawn FULLY across the HUD, even with extreme yaw movements.

Fixed the PUAC (Pull-up Anticipation Cue) for CCIP post-designate, CCRP, and DTOS post-designate. Previously, the PUAC was set too far low in the HUD due to the viewport not being initialized properly.

Added a point in the middle of the AG TD box (CCRP, DTOS). Added a point in the middle of the CCIP post-designate circle.

Fixed the TLL (Target Locator Line) for AG modes (CCRP, DTOS, etc) and Maverick modes. In AG modes, the relative bearing to the target does not take pitch into account like AA mode does. Fixed this for CCRP, DTOS post-designate, and Maverick modes. Also the TLL only updates in 10s, i.e., 10, 20, 30, 40, etc. Also several small fixes to TD boxes / sizes.

Fix to the NAV HUD: Now if the CRUS TOS function is mode selected then you get the ETA in the lower left of the HUD. If any other CRUS mode is mode selected or CRUS TOS is not mode selected you get a TTG instead of ETA. This change matches the real jet so it only works with realistic avionics. TTG is shown as MMM:SS format and ETA is shown on the HUD as HHMMSS.

The "X" symbol that is drawn over the FPM was still being drawn at the FPM's location, even if the INS was off/failed. It no longer draws now when the INS is off/failed.

"X SRM" or "X MRM", where "X" is the number of missiles for that type, is now drawn in missile override mode (instead of "MSL"). "MSL" is a display thing of BLK 30 F-16s and lower (i.e., mainly older software tapes).

Mach number and max g's windows are now not drawn in the HUD when in Dogfight override. The "SpeedText" – speed (in KCAS) required to reach the current steerpoint on time) field is now not drawn in the HUD when in Dogfight override. This was never realistic.

Attack symbology (missile reticles, ASEC, ASC, DLZ, timers, etc) are blanked on the FCR/HUD when the master arm switch is in OFF (i.e., weapons safe).

In the slant range window in the HUD, "F" and "B" were reversed. FXXX.X is now displayed when the player has a target bugged or locked up (indicating that the radar [FCR - that's why it's an F and not an R] is providing the ranging information). BXXX.X is now displayed to the current steer point indicating barometric altitude (triangulated with INS range) is providing the slant range information. The position of slant range, time-to-go and distance/stpt# markings were adjusted.

Target Altitude in HUD. The target altitude (two digit number in thousands of feet) replaces the ALOW setting on the HUD when the FCR is in an A-A mode and data concerning the bugged target and system altitude are valid. The

ALOW altitude setting is moved above the altitude scale. If there is no bugged target, the window is blanked. It is turned on with “set g\_bMLUM2TAinHUD 1” in the cfg file and defaults to on.

Fix for the TD circle in DF mode. With the target outside of the HUD FOV, it should not draw a regular circle (w/ an X in the middle), but rather the same arc(s) (and in-range cue) that are drawn when the target IS in the FOV.

Added the FCR min/max search altitude numbers to the ACM Slewable cross in the HUD.

Updated the EEGS In-range cue to be positioned at the 8 o'clock position on the TD circle (this reflects extended range PGU-28 rounds). It also disappears when tgt rng < 8000 ft so as to avoid being confused with the Level V pipper.

Made the small AIM-9 missile diamond flash when you are in range (Rmax1). Previously only the large, uncaged diamond did this. When you are within the maneuver zone (Rmax2 to Rmin2), the missile reticle flashes as well.

Added the missing BATR (Bullets at Target Range) circle for EEGS. It is a 6-mil circle displayed after the trigger squeeze and the bullet travels the target's range. It disappears after the last bullet passes the target range (well actually it disappears 1 second after the trigger is released--that is good enough for the time being). The BATR is nothing more than a record of where the gun cross has been pointed (corrected for gravity drop). BATR is turned on with the “SCOR ON” OSB label.

The EEGS funnel will now disappear when the trigger is pulled and reappear 1 second after trigger release. FEDS bullets also now work correctly. They are turned on with the “SCOR ON” OSB label.

DED text inversion for “DED in HUD” has been removed and made more realistic. Any text in the “DED in HUD” that is highlighted on the normal DED will use a slightly larger font than the surrounding text. For example, transmitting on one of the IVC radios will cause the UHF or VHF label to use the larger font. When the transmission stops, the label will go back to normal font size.

Multiple HUD symbology sizing fixes. The pitch ladder has been adjusted and better matches current MLU and US F-16 software. The negative portion of the ladder consists of 4 tic marks and the angle for each line is  $\frac{1}{2}$  the pitch angle of that line. The horizon line is now 253.5 mr long on either side of the gap in the middle. The HUD now has the correct dimensions for width of the pitch ladder (86 mr), the size of the center gap (34 mr). Corresponding adjustments have been made to placement of digits relative to the ladder pitch lines and the dimensions of the dashes of the negative pitch lines. The Level V pipper and BATR have been changed to use their correct mr size – 4mr and 6mr respectively. Visually they look the same as the old values. Changed the 1G and 9G pippers values to use MRTohudUnits. Sizes now match real life values of 4mr. Fix for numeric value formatting on the altitude HUD tape for barometric reading scale.

The scale labels and the box value for current altitude should now match the real thing better. Scale values are XX,X format with leading zeros as required. Current altitude box value uses blanks ahead of the comma if the altitude is less than 10k (one blank then a digit then the comma) or less than 1k (two blanks then the comma). The heading tape was moved up a little bit in the low position so that it is more accurately placed compared to the real thing. Changed the heading tape so that outside the current heading box 2 digit values are used (tens of degrees in other words). Also fixed the code so we have more vertical ticks on the tape scale. Both of these changes should make it look more like the real thing. Made the altitude and airspeed tape tics a little bit better, based on HUD tapes & HUD pictures. Minor changes to get the appropriate number of tic marks on the airspeed and altitude tapes.

Blank the attitude awareness arc in DGFT override if the gear is down.

Corrected the hard-coded numbers for the FPM sizing. Sizing is now the proper mil sizing (10 mr circle w/ 10 mr wings and 5 mr tail). The result is the FPM circle is slightly larger, but matches HUD videos/pictures better.

Update to EEGS TD circle symbology. TD circle is now the correct size of 35mr. As the arc decreases, dots are shown. Also, an aspect caret is on the perimeter of the circle similar to the missile reticles. In-range cue moved to ~4 o'clock position and its size was adjusted.

Multiple fixes to RADAR AUTO mode for the HUD altitude scale. The 1,000-1,500 foot area is now correctly proportioned and has correct tick sizing and the thermometer tape scales for that region of the display properly (instead of reading linear with the rest of the scale below it). ALOW "T" on the thermometer tape better proportioned. AUTO scale now scrolls down the HUD when the gear is down with the FPM and airspeed scales. Erroneous "R" marking removed from thermometer tape. AL digital readout moved back below the altitude tape for AUTO mode in low case with thermometer shown (instead of overwriting the tape). In general, should look more like the footage you see in the LANTIRN HUD shots that show this altitude tape style now. Also, both airspeed and altitude tapes have the appropriate number of tic marks. The HUD VVI is now visible when using the ILS with the scales switch to VV/VAH. A-A TD box is now visible when using the ILS if a target is bugged.

Major overhaul to the pitch ladder drawing code. Most of this is aimed at making it easier to understand and maintain. However, it includes revised code for getting the ladder properly centered on the FPM regardless of drift mode selection, plus code to ensure the horizon line is always drawn on the horizon regardless of beta angle, better negative pitch line rendition, and improvements to the ghost horizon line. Also, the heading scale in the low position is pushed down the HUD by the FPM with Drift C/O engaged as well as in NORM mode now.

## AMRAAM Dynamic Launch Zone (DLZ) Updates

The appearance and terminology of the AMRAAM DLZ has changed if the M2-style AMRAAM DLZ option is selected. The following is a summary:

**R<sub>aero</sub>** – Raero (Range Aerodynamic) (small triangle) represents the maximum kinematic range of the AMRAAM and is the longest possible shot that a pilot can take and have a chance of hitting the target. It assumes the target will not maneuver and that the missile is perfect. It currently does not take optimum loft conditions into account (which should further increase range).

**R<sub>opt</sub>** – Ropt (Range Optimum) (small circle) represents the maximum launch range with some buffer to offset any target turns. It is 85% of Raero. It currently does not assume the shooter will achieve optimum steering and pitch.

**R<sub>pi</sub>** – Rpi (Range Probability of Intercept) is 75% of Raero and is a range that has a higher probability of hitting the target.

**R<sub>tr</sub>** – Rtr (Range Turn and Run) replaces Rmax2 and represents the maximum range shot assuming that the target performs a turn-and-run maneuver at launch. Technical calculations are described on pg 106.

**R<sub>min</sub>** – Rmin replaces Rmin1 and Rmin2 and represents the minimum launch range. It is based on Rmin1 calculations.

**AMRAAM Loft Solution Cue** – A loft cue was added to aid the pilot achieve a lofted shot. It is above the Raero caret on the HUD and MFD and consists of a one or two-digit number representing the appropriate climb angle. When the DLZ target range cue reaches Raero the loft angle provides the conditions required to achieve an Raero shot (target range between Raero and Ropt) or an Ropt shot (target range between Ropt and Rpi). For either shot, center the Attack Steering Cue (ASC) in azimuth relative to the Allowable Steering Error Circle (ASEC) and execute a smooth pull-up to the indicated loft angle placing the ASC in the center of the ASEC. The loft solution cue counts down (every 5 degrees) from the total required angle as the pilot pitches the aircraft up to the MMC-specified loft angle. When the angle is reached, the cue will read "0" (zero) degrees to indicate that the pitch has been achieved. The loft cue is removed when the target range is less than Rpi. The loft cue does not take into account aircraft AOA while the display of the ASC does. This can result in a situation where the ASC is in the center of the ASEC (dot in the hole), but the loft solution cue is indicating a required loft angle. The greater the AOA is the greater the difference between the

positioning of the ASC and the display of the required loft angle. The pilot should center the dot in the hole in this case. In addition there is a two digit value above the target closure value which represents a Digital Maneuvering Cue (DMC). This is an angle value sort of representing how much turn a target would have to make to significantly degrade probability of achieving a missile intercept.

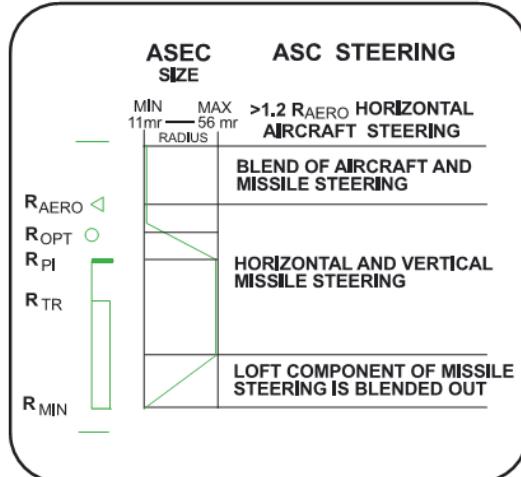
**AIM-120 Boresight Reticle** – When the selected AIM-120 sighting option is Bore, or the selected sighting is Slave and there is no bugged target, the AIM-120 boresight reticle (262mr diameter circle) is displayed on the HUD (the Bore reticle is not displayed on the MFD).

**AIM-120 Missile Diamond** – The missile diamond flashes when the target is in range (Raero or less).

**Allowable Steering Error Circle (ASEC)** – The ASEC is a variable diameter circle displayed on the HUD and MFD when an AIM-120 is the selected weapon, sighting option is Slave, and a bugged target exists. The weapon status must be RDY or SIM (Master ARM in ARM or SIM) in order for the ASEC/ASC and DLZ to appear. If there is no bugged target, the AIM-120 Boresight reticle will be displayed. The ASEC is an aid for positioning the attack steering cue in order to take the best shot possible based on the steering. At target ranges from outside Raero to Ropt, the ASEC is its smallest size, 11mr radius. At Ropt, the ASEC begins to grow in size until target range reaches Rpi where it reaches its maximum size (the ASEC represents 45 degrees of allowable steering error at Rpi). From Rpi to mid-point Rtr, the ASEC remains its largest size, at which point it begins to shrink again until it reaches minimum size at Rmin. The ASEC flashes when the target range is within the maneuver zone. The ASEC's variable radius varies from 11mr to 56mr with a slaved target. For a bore shot, the radius is static at 131mr (262mr diameter). The ASEC on the MFD is identical in function.

**Attack Steering Cue (ASC)** – The ASC (8 mr diameter circle in the HUD, 10 pixel radius circle on the MFD) provides several types of steering: horizontal aircraft steering, a blend of aircraft and missile steering, optimal missile steering (with horizontal and vertical missile steering), or Rmin steering (shortest LOS to the target). The type of steering provided is a function of range to the target. Horizontal aircraft steering is provided against targets beyond 1.2 X Raero (where Raero is the maximum kinematic range of the missile) and is based on the limits of the ASEC and a 45 degrees LOS to target limit. Blended aircraft and missile steering is provided for target ranges between 1.2 Raero and Raero. Inside Raero, the steering provides optimal horizontal and vertical missile steering. Once inside mid-point Rtr (half-way in the maneuver zone), the ASC provides Rmin steering. The pilot follows the ASC cue by rolling until the cue is on the HUD centerline above the center position of the ASEC and then pulls the aircraft (if commanded) to put the ASC in the center of the ASEC. When the target range is greater than Raero, a limit cross (X) is displayed inside the ASC to indicate that an AIM-120 shot does not exist even if the pilot performed a loft maneuver. The limit cross will also be displayed when the required lead angle exceeds 60 degrees, even if the target is nominally in range. Neither the ASEC nor ASC are displayed on the HUD in DGFT mode.

The following diagram sums ASC/ASEC relationship to the DLZ and the type of steering provided.



**A/F Pole Cues** – A-Pole (ownship to target range when AMRAAM goes active with MPRF) and F-Pole (ownship to target range at missile impact) ranges were added to the DLZ. A-Pole or F-Pole range indications, for the missile on the rail, were added to the DLZ below the Target Range Cue caret and Closure Rate indication. Indications are in NM with an M suffix for A-Pole (A is not used to avoid confusion with AMRAAM active indications) and an F suffix for F-Pole.

A-Pole or F-Pole range indications for the missile in-flight are added immediately below the DLZ. Post-launch cues are relative to winning Missile-Of-Interest (MOI, the missile aimed at the bugged target with the longest time remaining until impact) for the current bugged target. Changing the bug in TTS or TWS will provide A/F pole cues for the MOI for each if missiles are in flight to both.

Time remaining indication for the in-flight MOI is still displayed in the second field below the DLZ. This can show one of several prefixes: "A" (time to HPRF), "M" (time to MPRF), "T" (time to intercept) or "L" (time to termination; basically missile time of flight remaining). Note that this timer is more persistent than before. It's dynamic for bugged target and a winning MOI. For a winning missile where you lost track or snipped, the count becomes a simple stop watch. One note of caution: it's not a bug that the timer doesn't count down in linear fashion for a bugged target with an active DL missile. The time to intercept is calculated dynamically and takes target maneuver into account so it's perfectly reasonable for that count to *increase* even in some cases.

Missile datalink has been fixed to allow you to support up to six missiles in flight. These may be fired on up to two targets (TTS) or up to six targets (TWS). You can get A/F pole and time remaining data for all six missiles if you have six in flight and provided that their intended targets are still present on the FCR as track files.

HUD, HMS and FCR displays all include updated A/F pole cues.

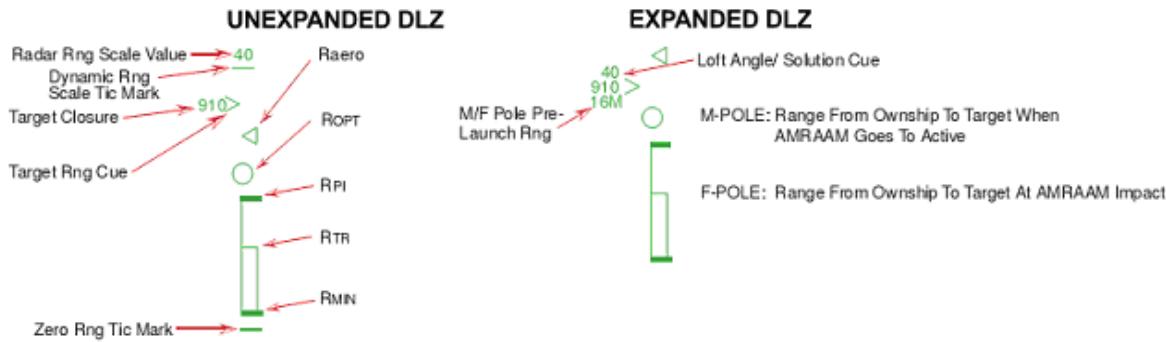
The radar model for AMRAAMs now includes HPRF (Husky) mode for favorable target geometries. The missile will activate the seeker well before the normal MPRF (Pitbull) range and attempt to track. HPRF is better at tracking high aspect targets with high closing range rate. Datalink guidance will continue up to MPRF unless the pilot commands a snip (drops the radar track) before that time. During HPRF with host DL guidance, the missile will use the best tracking solution available (either seeker or host DL guidance). HPRF and MPRF activation are now entirely based on range to target (used to be time-to-run based). Ranges coded are rough guesses for the AIM-120B. Other (active radar) missiles will need specific dat file edits (the AA-12 has been done already).

The variables are:

- AspectSelectorSize – HPRF requires target aspect to be within this many degrees of 180.
- HuskyMinClosure – HPRF will not activate unless range rate is higher than this threshold
- HighAspectBomberHusky – Select LARGE target (AIM120 SMS page) to use this as HPRF range gate
- HighAspectFighterHusky – Select MED or UNKN target (AIM120 SMS page) to use this as HPRF range gate
- BomberPitbull – Select LARGE target (AIM120 SMS page) to use this as MPRF range gate
- FighterPitbull – Select MED or UNKN target (AIM120 SMS page) to use this as MPRF range gate

**Note:** you can select SMALL in the SMS page. Doing so doesn't make a lot of sense in Falcon4 since this is apparently intended for targeting small RCS targets although it might be useful against helicopters. If you do choose small, MPRF ranges are reduced by around a third compared to MED.

Bug fixes relative to older versions of BMS in this general area: fixed bogus clearing of target when you flip between override modes or SMS changes from one missile type to another while you have a bugged target – now the lock is maintained. There is also a fix for datalink – previously last slammer was never provided with any datalink guidance making it significantly worse in performance compared to a missile fired with more of the same (slammer) type left on the rail.



## AMRAAM DLZ Transitions

- 1) Unexpanded AMRAAM DLZ Scale: When the current target range is greater than 125% of Raero, the AMRAAM DLZ is displayed on the HUD in an unexpanded configuration. On the HUD the upper and lower range scale tics are displayed at their static locations and the radar range scale digital readout is displayed above the upper range scale tic. The remaining AMRAAM DLZ parameters (target range caret, Raero, Ropt, Rpi, Rtr, and Rmin) are positioned relative to the upper range scale tic which represents the current radar range scale value and the lower tic that represents zero range.
- 2) Expanded AMRAAM DLZ Scale: The AMRAAM DLZ transitions to the expanded scale when the target range is less than or equal to 125% of Raero. The upper and lower range scale tics and the radar range scale are removed from the HUD when the DLZ transitions to the expanded scale. The upper boundary of the expanded range scale on the HUD is dynamic and represents 125% of Raero. All DLZ parameters are positioned proportionally to the value of the range scale. However, as target range decreases below 125% of Raero, the Raero triangle is always displayed at 80% of the DLZ scale range.

## AIM-9 DLZ Transitions

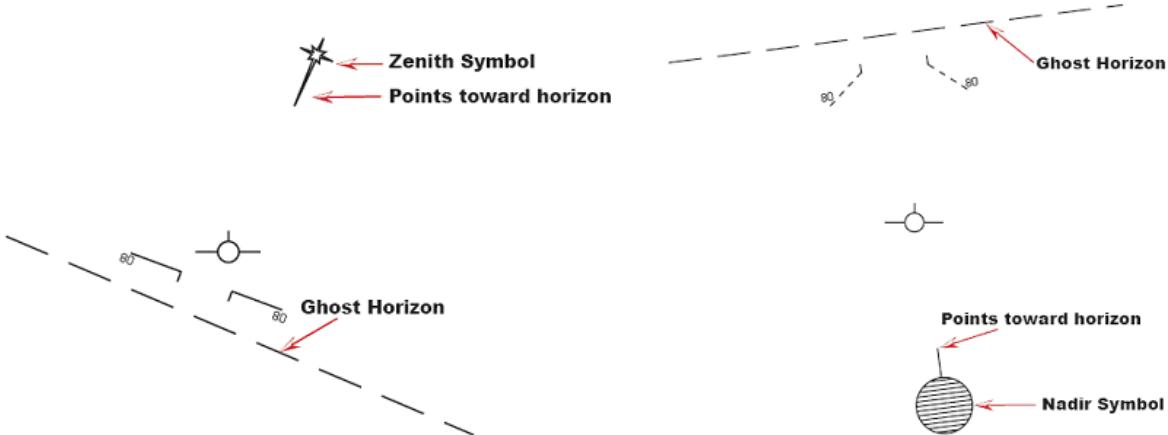
The AIM-9 DLZ also has unexpanded and expanded scales to maintain consistency with the AIM-120, except a value of 110% of Rmax1 is used.

## Attitude Awareness Arc

Attitude awareness in DGFT is provided on the HUD through the Attitude Awareness Arc (AAA) and the Ghost Horizon Line (GHL). The Attitude Awareness Arc provides a global picture of pitch and roll attitude in the form of an arc. Roll is provided by the angle of an imaginary line through the ends of the arc in relation to the HUD. During wings level flight the arc gap is toward the top of the HUD, while during inverted flight, the arc gap is toward the bottom of the HUD and indicates the upright attitude. The arc represents the ground. The attitude arc is not adjusted for winds or aircraft yaw and is roll stabilized about the center of the HUD Total Field Of View (TFOV). The curvature of the arc represents the direction of the ground, and an imaginary line connecting the ends of the arc represents a line parallel to the horizon. In level flight the arc forms a half circle. As the aircraft increases nose-up pitch, the arc length decreases. As the aircraft noses over below the horizon, the arc length increases. The arc is at its smallest length at 87-degrees nose-up and is at its longest length at 87-degrees nose-down. The GHL appears when the aircraft exceeds +/-10 degrees of pitch to enhance attitude awareness in conjunction with the Attitude Awareness Arc.

## Zenith/Nadir symbols

Addition of Zenith/Nadir symbols in the HUD. At  $\pm 90$ -degrees pitch, the Zenith and Nadir symbols are displayed respectively, with arms pointing to the horizon. The Zenith symbol is an elongated star, the longest arm of which points to the horizon line. The Nadir is a 31.4-mr circle with a 15.7-mr line extending from the circle and pointing to the horizon. The Nadir has twelve lines inside the circle that parallel the horizon line to distinguish it from other similar symbology.



## HUD Sampling

If you study enough HUD videos on Youtube, you'll notice there are small delays in numerical data sampling such as airspeed and altitude (either caused by HUD or CADC processing and/or the 'natural' delays in pitot-static systems) and not an instantaneous display of individual numbers. An example is a quick acceleration in airspeed will 'jump' from value to value...i.e., 102, 105, 109, 113. In previous versions of F4, the code would display every single digit through an acceleration/deceleration or changes in altitude. Now that data is sampled. The result is basically identical behavior to real life.

More studying also reveals a "lag" effect in the inertial system and can be clearly seen in the behavior of the aircraft pitch ladder and horizon line (it is slightly behind what the aircraft is actually doing). This effect has also been realistically reproduced. In addition, other symbology such as TD boxes, etc have been properly "lagged" to produce a more realistic HUD representation.

## Stores Management System

The Stores Management System (SMS) in Falcon has received a complete overhaul. Much of this work will be somewhat transparent to the user, but the improvements are there nonetheless. Many of the improvements have been to make the code more consistent, efficient, cleaner, and more "friendly" in terms of playing nicely with other parts of the Falcon code. The following is what the end-user will see, when comparing to previous versions of BMS and Falcon.

A long-standing problem with Falcon and its SMS, was the fact that it was unrealistic in jettison procedures—both selective jettison and emergency jettison. Essentially, when jettisoning stores (weapons), the entire store/pylon assembly was jettisoned from the wings. In reality, the circumstances of what comes off during a jettison greatly depends on what weapon(s) are carried, whether or not the aircraft is carrying racks (launchers) or something like a TER (Triple ejector rack). The basic point is that the wings would essentially be empty of all pylons (excluding AA missile pylons), when the pylons (and the drag!) are actually bolted to the wings and can't be jettisoned. BMS has rebuilt the SMS code to allow such differences amongst a wide-variety of stores and their individual differences. More information about the BMS rack data and how it's built can be found in the Appendix. Since Falcon is primarily an F-16 simulator, BMS focused only on the SMS of the F-16.

## Selective Jettison (S-J)

The first thing the pilot will notice is some graphical differences. The line box drawn around the store/pylon(s) are gone, and now replaced by inverse labels, upon when a station's store/rack is selected for jettison. The S-J page and the S-J mastermode are selected by depressing OSB 11 adjacent to the S-J label on any SMS page. This will allow the pilot to jettison weapons and racks unarmed or unguided from selected aircraft stations. Only jettisonable stores will be displayed for selection. The pilot presses the OSB adjacent to the station displayed on the S-J page. The selected station's bottom-most store is highlighted on the S-J page, indicating that it is selected. If a jettisonable rack is also loaded, it may also be selected on the second depression of the OSB. A third depression will then deselect all stores on that station. The pilot can preselect a selective jettison configuration while in S-J mastermode, which will be remembered during mastermode transitions. The stores are jettisoned using the pickle button when the Master Arm switch is in ARM. After the stores are released, the highlighted stations are removed from the S-J page and the associated weapon quantity reads zero. The S-J mode also bypasses any other weapons settings.

## Using the SMS in Combat

Also related to the SMS, is how it functions in combat. Previously, the SMS did not do a good job at remembering what weapons you called up for a particular mastermode. Now, it should remember the particular weapon type you select. This applies to all the mastermodes—Air-to-Air, Air-to-Ground, NAV, Dogfight, and Missile Override. What this means is the pilot can program the weapons he wants to come up first in a particular mastermode.

## Hands-On Missile Select

Depress and Release (D&R) of the Missile Step switch on the side stick controller provides hands-on selection of a stores station. When in an A-A master mode, D&R of the Missile Step switch for <0.5 seconds selects the next stores station in the rotary with the selected weapon type. The selected station is identified on the SMS Base page by inverse video. Hands-off changes remain the same.

When in an A-A master mode, depress and hold the missile step switch  $\geq 0.5$  seconds to select the next missile type in the A-A weapon selection rotary. The avionics system automatically selects the next missile type in the A-A rotary and displays the newly selected weapon mnemonic adjacent to OSB #7 on the SMS Base page. The missile type (SRM, MRM) will also change on the HUD if the new missile is a different type.

## Gun Related Changes

The gun option was taken out of the weapon rotary. You need to hit OSB 2 to get to the GUN in an AA mode or (easier) just use DOGFIGHT override. This prevents getting to the gun when using the missile step/missile type switch command and not being able to get back to missiles.

There was significant change to the implementation of the gun code.

- Guns now have longer reach.
- Guns have dispersion.
- The code can simulate every round or 1/10th of rounds.

A new config var is available to disable simulating every round: `g_bOneTenthOfBullets` (default false) will simulate 1/10th of the rounds fired. This is similar to the original code.

Bullet dispersion was also added, although this is currently semi hardcoded. It can be altered during run time by issuing the chat line command: `.gundis` (default .34). Values are specified in degrees, with the default being based on the F-16.

# **APG-68 Radar**

## **CRM Range-While-Search Submode (RWS)**

### **Two Target SAM**

TTS simultaneously tracks two targets while maintaining a RWS scan volume centered on the secondary (non-bugged) target.

The following paragraphs provide an overview of CRM RWS operations:

- Designating on an RWS search target changes it to a bugged target and places the FCR in RWS SAM submode.
- Designating on a RWS search target while in SAM will transition the radar to TTS submode. When TTS is entered, the first bugged target remains the primary (currently bugged) target, the second designated target becomes the secondary target, and the scan volume is adjusted to permit dwells on each target as the radar continues to RWS. When both the bugged target and the secondary target are beyond 10 nm, the search volume is fixed at 50 degrees wide by three bars in elevation. The scan pattern is centered in azimuth on the acquisition cursor, and is controlled in elevation via the elevation trim control. TMS-right for less than 1 second will step the bug between the two TTS targets. When either target is within 10 NM, search is suspended and the radar spends full time tracking the bugged and secondary targets (ping pong). When the scan pattern is moved off of both targets in TTS, the scan width will adjust to optimize track versus search time. As the scan pattern is moved away from both targets, the scan width will become narrower. When the bugged target is within 3 NM, the radar automatically drops track on the secondary target and reverts to STT on the bugged target.
- Designating on a bugged SAM target places the radar into STT.
- TMS-forward actions change submodes from RWS to SAM to TTS to STT. TMS-aft changes the submodes back in the same sequence as TMS-forward. For example, if the pilot designates a target and puts the radar in the SAM submode, a subsequent TMS-aft will return the bugged target to a search target and the radar will revert back to CRM RWS submode. TMS-AFT in STT will place the radar in TTS if a secondary target is being extrapolated, or SAM if there is no secondary target. TMS-aft from TTS will place the radar in SAM, and TMS-aft from SAM will place the radar in CRM RWS.
- Depressing TMS-right for more than 1 second, from any CRM RWS mode with or without a tracked target (SAM, TTS, or STT), transitions the radar to TWS and retains any pre-existing bugged targets.
- Commanding TMS right and hold from TWS with a bugged target and system track files will transition the radar into two target SAM. The bugged target in TWS will become the primary (bugged) target in TTS. The TWS system track file to be carried through as the TTS secondary target is based on MMC and FCR prioritization, based on the following:
  - Cursor attach tank target or system track file
  - Target against which an AIM-120 has been launched (active data link) in descending order of time until active (not implemented yet)
  - Target range. (not implemented yet)

## Track While Scan (TWS) / “Twiz”

Previously, the Target Acquisition Cursor attached itself to targets even with radar lock or designation broken, or gimbal limits exceeded. This has now been fixed.

The TWS radar mode has undergone a complete overhaul in how it is mechanized. It should operate much more like the real thing than ever before. This includes the number of targets it can track at once (which was previously unlimited), how it builds and maintains track files, how it dumps them and the azimuth and elevation limits of TWS.

### **Using TWS**

To switch to the CRM-TWS (combined radar mode) sub-mode, the pilot may either hit OSB 2 three times or TMS right to switch from CRM-RWS to CRM-TWS. Upon entering TWS, the radar azimuth will initialize to an “A2” or 50 degree azimuth scan (25 degrees on either side of boresight) and the elevation will initialize to a 3-bar “3B” scan.

### **TWS Mechanization**

As its name implies, TWS tracks multiple targets while searching for others. It is mechanized to begin forming track files (triangles, or hollow squares with a tic if you’re using EPAF radar cues) automatically from RWS search hits (solid squares) when the radar receives two hits (meaning the radar detects something twice) in 6.5 seconds. The radar is able to track 10 targets simultaneously. Since the radar does not pause on the track files while scanning, the track’s positions are extrapolated in between updates (when the radar detects them again). If a target is not updated, i.e., detected in 13 seconds, the radar will dump the track file until the target is detected again upon which it will rebuild it into a track file. A dump could happen for a number of reasons including a target moving out of the radar’s current azimuth scan, elevation scan, or both. Also for example, if the pilot is tracking 10 targets and decides to designate on a search target, the radar will dump the lowest priority track and automatically upgrade the search target into a track file. If the radar has not received a hit on a track on its return scan where the track should be (or rather, where the radar thinks it should be based on the target’s last heading and speed), the track file will turn from yellow to red to indicate this. When the track is detected again, it will turn back to yellow. If a track is no longer detected, it will turn red like previously mentioned and extrapolate for 13 seconds total. The last 5 seconds before the radar dumps the track, the track will begin to flash. Tracks are prioritized by range and the order in which they were built.

Three scan patterns are available in TWS. They are:

- ± 60, 2 bar
- ± 25, 3 bar
- ± 10, 4 bar

Without a bugged target, the azimuth scan centers on the cursors and elevation is controlled manually. When a target is bugged, the azimuth is biased to keep the bugged target in the scan and the elevation is centered on the bugged target. If the antenna elevation is tilted while the pilot has a bugged target, upon dropping the bug, the elevation scan will move according to what the pilot commanded to reflect the position set by the antenna elevation controls.

There are two ways to bug targets. The pilot may either slew the cursors over to a track file (or a search target) and designate or may TMS-right to bug the closest track file. Further TMS-right’s will step the bug to the next highest priority track file. The pilot may enter STT (Single Target Track) by slewing the cursors over the bug and pressing TMS-forward. This will erase all search targets and tracks from the radar, although the tracks will extrapolate for 13 seconds. If the pilot undesignates (TMS-aft) to return to TWS, the extrapolated tracks will reappear and the target will be bugged. If TMS-aft is commanded again, the pilot will drop the bug and the radar will continue to TWS. If TMS-aft is commanded a third time, the radar will dump all tracks and begin rebuilding tracks automatically. If TMS-aft is commanded a fourth time, the radar will go back into CRM-RWS.

Targets are detected in TWS as they are in RWS, and search detection symbols (small filled squares) are displayed at the target range and azimuth. Search detections may be either manually or automatically acquired and tracked. Search detections whose ground speed along the radar line of sight is greater than 200 knots will automatically be acquired and tracked by the radar as described above. Targets whose speed is slower than 200 knots can be acquired manually by placing the acquisition cursor over the target and designating. The speed gate prevents using a track slot for a low threat target or a potential false alarm.

## Spotlight Scan

Depressing and holding the TMS to the designate (up or forward) position for longer than 1 second will command the radar to spotlight scan ( $\pm 10$  degrees azimuth by 4 bars elevation). Spotlight scan is initially centered about the acquisition cursor and antenna elevation knob setting and can be slewed. The radar attempts to acquire and track the target within the acquisition cursor at release of the designate position of the TMS.

Spotlight scan in TWS is similar to spotlight scan in RWS. The TWS spotlight search volume is initially centered about the cursor. The spotlight search volume is not biased by the TWS track files, but is controlled through the use of the cursor and the elevation thumbwheel. In other words, the pilot can override the TWS bug priority in azimuth and elevation. Spotliting outside the TWS priority scan volume will help establish track files on groups outside the previous TWS scan volume. Track updates on the target of interest (TOI) and targets with AIM-120 missiles in flight will only occur if spotlight scan volume includes these targets.

## Hot lines

Hot lines provide in a graphical format, the component of the targets' ground speed along the antenna line-of-sight. Hot lines pointing up the display indicate tail aspect targets, while hot lines that point down indicate potentially higher threat targets on a head aspect. Pilots need to be aware that near beam targets at 100° right/left aspect will show a head vector, or 80° right/left aspect will show a tail vector. Hot lines are shown for RWS search targets.

## GM Snow Plow Mode

Air-to-Ground GM SnowPlow mode has received a significant overhaul to be more realistic. The following is a brief description of its changes and how it functions. Pay special attention on how to enable cursor slewing.

Depress OSB 8 next to the SP mnemonic to select the snowplow option. The mnemonic highlights indicating that you are in the SP mode. SP sighting directs each sensor line-of-sight straight ahead in azimuth, disregarding any selected steer points. In the GM, GMT, and SEA modes, the ground map cursor will be positioned at half the range selected, i.e., the center of the MFD. The cursors remain at this range while the ground map video moves, or "snowplows," across the MFD. At this point, there is no SOI, and the cursors cannot be slewed. The cursors can be slewed to a target or aim point with the CURSOR/ENABLE switch **after** you **ground stabilize** them by using **TMS forward**. TMS forward establishes the radar as the SOI and enables cursor slewing. TMS forward again over a target to command single target track. All cursor slews in SP are zeroed when SP is deselected. After ground stabilizing, the point under the cursors at the time of stabilization effectively becomes your steer point. All NAV and weapon delivery steering and symbology, including great circle steering, will be referenced to this "pseudo steer point." Displays return to the previously selected sighting point when SP is deselected. For example, SP can be used to accomplish an FCR mark on a point 5 nm in front of your position when the steer point selected is 40 nm away. It may often be used with IR Mavericks where target coordinates are not known in advance, for example. Another application of SP is for weather avoidance (not implemented).

The OSB 8 (SP) button on the GM FCR page is now a toggle to get in and out of SP mode. The pilot can also exit SP mode by switching to any A-A mode FCR page or by changing steer points (after you have ground stabilized SP only – pre-designate changes of steer point have no effect); or by selecting any A-G visual modes (CCIP, DTOS, STRAFE, EO-VIS). That leaves out only a couple of the more esoteric real conditions. There are also a couple of TMS changes associated with this. TMS aft will now only drop a ground target lock placing the cursor at the same point it was before a lock attempt was made; it will no longer clear slews and remove ground stabilization. You must use the CZ

(OSB 9) to zero slews and clear ground stabilization now. These changes also fix certain ICP presses that would undo ground stabilization and reset SP mode unexpectedly.

Additionally, the GM range AUTO bumping function is revised in this version. It works more intuitively now with the range bumping up if the cursor is at 95% of the way up the MFD and bumping down if the cursor is at 42.5% of the way up the display or less. Note the bump will only happen if and when the cursor is not being slewed! As a final note, TTG (Time-to-go) has been added to the GM radar scope when you are in STP mode or SP mode with a ground stabilized aim point.

## AMRAAM FCR Symbology

The symbology on the Bscope when an AMRAAM is in flight is now stored when the pilot bugs another contact. TWS mechanization: The pilot fires on a track and the normal AMRAAM symbology is displayed. The pilot may then bug another track or TMS right and fire on another track. The first track's symbology will be retained and the track will turn magenta in color. The pilot may bug additional tracks and shoot missiles. The AMRAAM missile timing information will be retained for all missiles in flight for their respective track files and shown for the current track.

### Air-to-Air FCR Symbology



## Other Radar Changes

Fixed the ACM slewable scan search altitude display numbers to show negative numbers and red when negative. Fixed the spacing between them so they're not scrunched up together. Make the BORE and SLEWABLE ACM crosses bigger in size - based on HUD videos. Also a fix for the slewable circle in the HUD to go to the edges of the slewable cross. Fix for altitude coverage numbers in Bscope. They should have been based off a 5 NM range, but instead were based off of the RWS/TWS cursor ranges which lead to erroneously large altitude coverages.

The bar scans (the number of bars in the scan, rather) was incorrect for both ACM 30x20 and ACM Slewable. 30x20 was corrected from a 5B to a 4B and Slewable was corrected from a 3B to a 4B.

DBS1/2 modes will now scan from outboard to inboard. For example if the target is 20 degrees off the left side of the nose, the antenna will sweep from left to right, then reset to the left and repeat the process. The variables to configure the DBS scan rate factors are no longer needed and have been removed from the Config Editor. The DBS scanning now very closely mimics real life. Also, if the pilot is in any of the expanded modes and then changes the range selection, the radar will come out of the expanded mode and change to the commanded range scale.

Various additions to the AG Freeze (FZ) mode—the lat/long of the cursors are now displayed on the upper right of the scope, and the target bearing/range are displayed in the lower left. Changing the range selection, the OSB next to FZ, or changing FOVs will exit FZ mode.

## ACM-One Switch Action to NO-RAD:

1. Any ACM radiating submode, TMS aft enters ACM 30x20 NO-RAD.
2. From 30x20 NO-RAD, TMS aft enters ACM 10x60 radiating submode.

TMS aft is the only switch action that commands a break lock from an ACM track mode.

What this means is in any radiating ACM mode, whether BORE, 30x20, Slew, or 10X60, the TMS aft command will drop the current radar track if there is one and command 30X20 and snooze the radar. If TMS aft is commanded again, the radar will switch to 10X60 and radiate. A further TMS aft will again switch to 30X20 and snooze the radar. With a track in any of the ACM modes, switching to another mode (with the exception of 10X60) will not drop the current track, but only switch modes, i.e., in BORE mode → TMS right → 30X20.

Cursor area of effect is now larger. Default 105% of the size of the captain's bars symbol “| |” as you see it on the screen this means that you get SAD display a little sooner than before as the cursor moves very close to but not quite over a blip on the display. This should greatly improve sorting capability because of the larger area of effect and the way the code now differentiates targets that are very closely drawn on the display. For example, sorting the trailer in a lead-trail group – Move the cursor up to the upper side of the group and TMS fwd. The larger cursor area will allow you designate the trailing contact without having to super-precisely put the cursor right over the contact.

Rewrote the logic for radar target history management. Formerly, anytime the target was painted and detected or extrapolated, the history state was updated, meaning that it was possible to get very large numbers of "history" entries in a single radar frame. This was the underlying cause of the blips dribbling down the MFD at speed when being extrapolated (painted but not detected lately). Now the history is only pushed down once per frame so multiple hits in one frame refine the top of the history stack updating the position data if it's changed (simulating improved track quality) but such updates don't overwrite history data from previous radar frames any longer. This makes display of history work much better.

Extrapolation code for SAM rewritten completely. Extrapolation is no longer applied to search hits in any mode (that was bogus apparently, especially in RWS which does no extrapolation at all now). An expert asserts that the actual radar computers are VERY good at extrapolating target position in three dimensions so the old scheme of just adjusting range only is gone in favor of near perfect (well OK, actual) position updates. The main difference now between added history and extrapolated is that extrapolated history doesn't update the last radar hit time so the track will start degrading if the radar doesn't pick it up again within some reasonable time frame (pattern dependent of course). If the radar has not detected the bug/track target lately (like in the last 5 paints where the beam passes over the target aircraft but doesn't get a strong enough return) and the radar is coasting (4 seconds since the last actual hit) extrapolation continues. After the coast time the symbol will flash to indicate imminent loss of track status; sometimes you won't even see this depending on where the target was in the scan pattern...either way the bug/track will shortly disappear unless you get a paint and detection almost immediately.

SAM mode entry antenna steering modified. Previously there was a call to ChangeMode() that resulted in the radar antenna being "homed" as part of the mode change from RWS to SAM. The time taken to home the antenna and then start scanning again was often taking just longer than the pattern time for SAM. This in turn caused the target to be lost for one frame by the radar resulting in the SAM bug disappearing right after being designated. To fix this now, the ChangeMode() code does NOT home the radar antenna for changes into SAM mode. Also, on transition from RWS to SAM (via TMS fwd on a track), the radar antenna shifts direct to the bugged target for the standard SAM mini-scan dwell time and only then resumes scanning pattern. This behavior is realistic. Combined with the removal of the homing of the antenna on mode switch, this appears to fix the problem with the prematurely disappearing bug symbol.

SAM AUTO independent azimuth and elevation implementation completed – previously the antenna elevation was always manually trimmed. The seeker center management was completely rearranged into one spot in the code to rationalize it as part of this fix. For some reason it was scattered all over the place and pretty hard to follow as a result. Upon ST (single target) SAM entry, the acquisition cursor is positioned over the SAM target and follows it. The azimuth of the scan pattern will move to stay centered around the SAM target until the ACQ cursor is moved. If the

acquisition cursor is slewed, auto AZ is terminated and the acquisition cursor no longer follows the tracked target. Search elevation is centered at the elevation selected by the ANT ELEV knob.

Several fixes to mode transitions for history marking such that you should see less "incorrect" symbol types for the mode you are entering (e.g. when entering SAM, you get a Bug symbol right away and leaving STT you get a bug not a track and then a bug etc.). In general the symbology should surprise you less as you change modes between RWS, SAM, TTS and STT.

Search history is now never drawn for track or bug symbols. It was previously but this effect was less obvious because the history insertion was broken and the colors for the history paints were so weak. Now those problems are fixed, incorrectly drawing history for track/bug would really stand out as wrong.

Fixed minor display bug where the SAD display for a blank target (yes, the real radar does this same thing, doing this is not in and of itself a bug) would be drawn in green: now it's the same color as a standard search hit (yellow at present).

Bug fix for SAM and TWS given the revised scheme for managing radar frame history. The old code here simply did bad things for SAM and TWS when trying to correlate paints to previous hits. It failed to check the actual position against the projected position and then did not take into account the time since the last history was recorded versus the time between the last histories used to project new position. New function added to re-factor the projection code so it can work for both SAM and TWS. Checks to see if the target is roughly where we'd expect him to be using radar history to project the current position (compared to actual position). For track-while-scan modes like SAM and TWS the radar may lose the track if the target returns don't correlate with the previous sets of history data.

Added EXP FOV to RWS.

The lower and upper numbers of the cursor altitude coverage show negative numbers. The numbers are drawn in red when they are negative.

## ***Sniper Advanced Targeting Pod (ATP)***

### **Background**

The Targeting pod (TGP) has received a number of enhancements. The pod can track air-to-air (A-A) and air-to-ground (AG) targets. The slewing controls that interface with you the pilot have been rewritten and as a result controlling the TGP should be much smoother and intuitive. The TGP should no longer randomly jump to targets as in previous versions and tracking a target behind you does not "swap" the controls (i.e., to slew the TGP left, you had to move your cursors right). Tracking techniques include Point Track (based on a high-contrast edge – i.e., a vehicle like a tank), Area Track (which is a tracking mode for large area targets like buildings), and Computed Rates Track (based on the last known angular rate of change for the target). The TGP may operate in all mastermodes (NAV, A-A, A-G, DGFT & MSL OVRD). The TGP has two optical Fields of View (FOV), wide (+/-4 deg.), narrow (+/-1.0 deg.) and one electronic expansion (EXP) FOV (0.334x0.334) when selected (mimicking Sniper, but XR features are not implemented). The TGP has a laser ranger that can be fired at a target for very accurate ranging data.

Control of the TGP is available both hands-on and hands-off. For hands-on control the TGP must be the sensor of interest (SOI). The SOI is moved to the TGP via DMS Down (or AFT). Hands-off controls are via the MFDs TGP Base page, the A-A Mode Menu page and the A-G Mode Menu page. Selecting the TGP mnemonic on the Master Format Menu page will access the TGP Base page. The TGP OFF page is displayed if there is no power applied to the targeting pod. Power is applied to the targeting pod by placing the right Hard Point (HDPT) switch on the sensor power panel to the RIGHT HDPT position. When power is first applied, the TGP is placed in Standby (STBY) mode while the system cools and "NOT TIMED OUT" is displayed in the upper center of the TGP Base page. After the Forward Looking Infrared (FLIR) system has cooled, "NOT TIMED OUT" is removed from the display and the pod

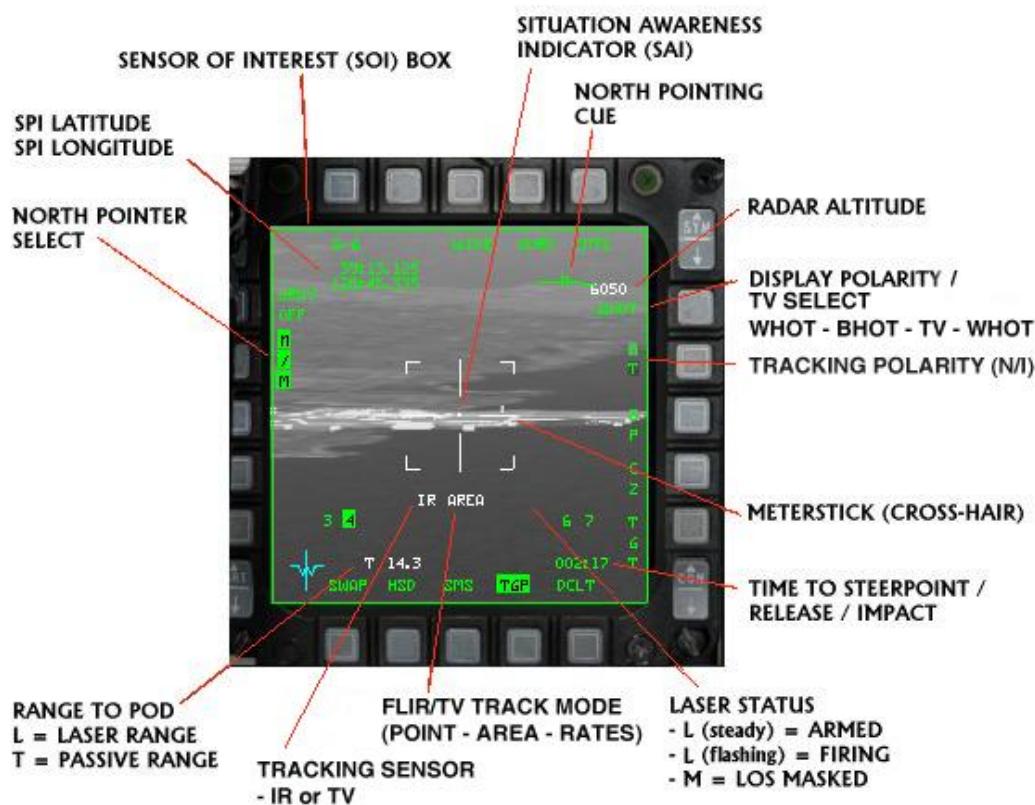
transitions to the commanded submode (A-G, A-A or STBY). The pod FLIR sensor normally takes 8 to 10 minutes to cool.

Note also that the targeting pod can be loaded on the jet from the munitions UI page even if LGBs are not carried as part of the loadout.

## TGP Base Page

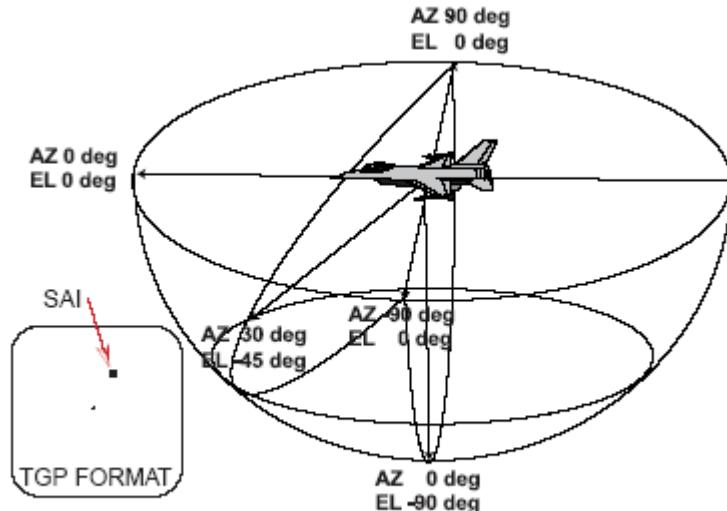
### *Modes of Operation*

- 1) TGP Operating Mode (OSB #1): Displays the current operating mode and the OSB accesses the Mode Menu page. Operating mode selection is Master mode dependent; for the A-A Master mode, the TGP may be in A-A or STBY; for the A-G Master mode, the TGP maybe in A-G or STBY; and for the NAV Master mode, the TGP may be in A-A, A-G, or STBY.



- 2) FOV Select (OSB #3): Displays the current FOV and the OSB toggles between WIDE and NARO. With WIDE selected, the narrow FOV indicator is displayed. The FOV can also be changed hands-on by making the TGP the SOI and Depressing and Releasing (D&R) the pinky switch to toggle the options.
- 3) Standby Override (OVRD) Select (OSB #4): Commands the TGP to STBY mode and “OVRD” highlights. With OVRD highlighted, “STBY” is displayed at OSB #1 for all Master modes.
- 4) Radar Altitude: Radar altitude is displayed above the OSB #6 mnemonic.
- 5) Display Polarity Select (OSB #6): Alternates between White-Hot (WHOT) and Black-Hot (BHOST) or WHOT, BHOST, and TV depending on which TGP is loaded (a combination of features from Litening II & Sniper / Pantera are modeled). With BHOST selected, hot objects appear as black on the display; with WHOT selected, hot objects appear white.

- 6) Snowplow (SP) Sighting (OSB #8): When selected the TGP is slaved to  $\frac{1}{2}$  the selected FCR range until the selected waypoint is ground-stabilized via TMS forward. “SP” is highlighted when selected. This does not currently work correct in Falcon4 and should not be used.
- 7) Time to Steerpoint/Release/Impact: Time to steerpoint, release, or impact is displayed in the lower right corner of the TGP page depending on the master mode and whether a weapon has been released. In NAV master mode, this display indicates time to steerpoint. In A-G master mode, this display indicates time to weapon release, then displays the estimated time until impact.
- 8) SPI Range: The SPI (System Point of Interest) range is displayed in the lower portion of the TGP format. If the range is determined by the TGP laser, an L precedes the range. If the TGP determines the range, a T precedes the range. If any other sensor provides the range, only the range is displayed.
- 9) Situation Awareness Indicator (SAI): A small square appears on the TGP format indicating TGP Line-of-Sight (LOS) in azimuth and elevation. The square is positioned around the center of the display at its azimuth relative to the nose of the aircraft, and its position from the center of the display indicates its elevation with the center representing -90 degrees elevation and the edge 0-degrees. Some examples may help clarify this scheme: The 12-o'clock position at the top of the display indicates 0-degrees relative azimuth and 0-degrees elevation; the 3-o'clock position at the right edge of the display indicates 90-degrees azimuth and 0-degrees elevation. A position half way between the edge and center of the display indicates -45-degrees elevation; and the center of the display indicates -90-degrees elevation. The 6-o'clock position half way between the center and bottom of the display indicates 180-degrees azimuth and -45-degrees elevation. Figure 4-3 shows TGP LOS positions relative to the aircraft.



**Figure 4-3 TGP LOS Positions Relative To The Aircraft**

- 10) The North Pointer has been added to the TGP base page. The label at OSB 19 (N/M) is used to toggle it on/off. It consists of the letter N with an arrow, displayed on the top right corner of the TGP base page. The arrow points to magnetic north relative to the TGP LOS (crosshairs). Added lat/long SPI (system point of interest) information on the upper left side of the TGP base page. Elevation is not yet included. It is turned on with the North Pointer (“N/M” OSB 19 label).

## Additional Hands-On Controls

Using TMS-Left 2x times in less than 0.5sec will toggle the current sensor. If switching to TV, then the IR FOV and polarity are stored and will be put back to use when switching back to the IR sensor. IR mode has 2 FOVs (Wide/Narrow) while TV mode has only 1 FOV and it can't be changed (trying to change FOV in TV mode will do nothing). If in TV sensor mode the OSB #3 will have "TV" label on it.

TMS-left under IR mode will change polarity between WHOT/BHOT, under TV mode TMS-Left will not change anything. Added a TV FOV variable that is used for the TV sensor and can be read like the other TGP FOVs from TGPDATA.dat. Changes in FOV values: IR Wide FOV = 3.6 (changed from 4.0); IR Narrow FOV = 1.0; TV FOV = 0.5.

Mechanization also includes a manual zoom capability that can be used regardless of current sensor/FOV choice. Manual zoom is operated by the MAN RNG control on the throttle grip – this works either with the analog axis mapping or the equivalent key stroke mappings for that control. The zoom offers between 1.0 and 4.0 times magnification of the image presented on the MFD with the current sensor and FOV choices.

## TGP Mode Menu Page

The TGP Mode Menu page (Figure 4-5) provides switching between the TGP modes. Depressing OSB #1 on the TGP Base page accesses the TGP Mode Menu page. The TGP Mode Menu page only displays the modes available for the selected Master mode. In the NAV Master mode, the TGP may be commanded to A-A, A-G, or STBY.



TGP Mode Menu page in NAV MM



TGP in Standby

## TGP Tracking

The TGP includes processing that performs as an automatic tracker. The tracker operates in three modes: POINT, AREA, and Computed RATES. Tracker mode information is imbedded in the TGP video. During any tracking mode, the cursor is used to reposition the LOS (Line of Sight). When cursor inputs stop, the TGP returns to the mode it was in prior to applying the cursors. This allows fine tuning of the tracked point.

### **POINT Track**

The TGP POINT Track mode is capable of tracking single targets. The targets require well-defined edges – like vehicles. When POINT Track is established, a box grows from the center of the crosshairs until the edges of the target

are enclosed in the box. “POINT” is displayed below the crosshairs, indicating that track has been established. Designating with TMS-forward and hold, when the TGP is the SOI, commands AREA track to stabilize the LOS. Releasing TMS-forward commands POINT Track. TMS-aft commands the TGP to break track and return to the SLAVE mode—meaning it is slaved back to the radar LOS. If the target cannot be POINT tracked because the target does not have sufficient edge detail, the TGP automatically defaults to AREA Track. Once the TGP has changed to AREA Track, it will not return to POINT unless a new POINT Track command is initiated. It is important to realize that you can drop munitions on a target if you are in AREA or POINT track. The TGP tracker continuously updates the tracker box such that, when the aircraft is maneuvered, the tracker box changes to the new viewing aspect of the target. NOTE: Buildings cannot be POINT tracked in this version – only objects like vehicles and aircraft.

## **AREA Track**

The TGP AREA Track mode tracks targets that are not POINT trackable – like large buildings and structures. Large targets, scenes that do not contain targets with well-defined edges are examples of situations where POINT Track might not maintain a stable track. AREA Track may also be used for targets that are point trackable but where AREA Track is desired (e.g., to place the center of the LOS at a particular point). When in AREA Track, “AREA” is displayed on the TGP format below the crosshairs. AREA Track can be accessed in two ways: 1) TMS forward and hold, or 2) TMS right. AREA Track is commanded as long the TMS-forward is held. When TMS forward is released, POINT Track is commanded. The benefit of commanding AREA Track is that it stabilizes the scene and makes establishing POINT Track easier. The second method of commanding AREA Track allows AREA Track to be commanded without the TMS being held.

## **Computed RATES Track Mode**

Computed RATES is entered automatically when the POINT and AREA trackers lose target track. This happens most often when the aircraft structure or stores mask the target. The Computed RATES Track mode enables the LOS to remain ground stabilized at the last point tracked. The TGP accomplishes this by using aircraft attitude information and information about the last point tracked. When the masked condition clears, the TGP LOS will be close to the last target tracked. The pilot must manually reacquire the target.

“RATES” is displayed below the crosshairs when the TGP is in Computed RATES Track. Computed RATES is not pilot selectable. A special consideration about RATES Track is that as the TGP is in RATES, you will see the TGP cursors slowly drift off of your target so you must slew the cursors back to your target and refine your aiming. As this is a degraded mode of tracking, this is normal.

## **TGP Masking**

Since the combat mode laser is not eye-safe (in the real world), even for scattered/reflected energy, it is imperative that the laser beam not strike the aircraft. To accomplish this safety consideration, the TGP determines if it is looking at the aircraft structure or stores. When the TGP LOS is pointed at the aircraft, laser fire is inhibited. The mask zone blocks off the area surrounding the wing tanks on stations 4 and 6 and a LANTIRN navigation pod on station 5L. All other stores are blocked by the wing tanks. Indications of a masked condition includes an “M” on the TGP format next to the L-mnemonic in the bottom right portion of the MFD and “MASK” adjacent to the flight path marker on the HUD. There is a warning zone outside of the actual mask zone which alerts the pilot that a mask condition is approaching. When in the warning zone, the TGP crosshairs flash and MASK flashes on the HUD. When conditions warrant for a MASK condition, MASK is displayed steadily on the above mentioned displays.

## **Navigation**

In this version, the TGP cannot be used for navigation updates, fix taking or TGP Marks. However, as mentioned earlier, either TGP modes can be used in NAV Master mode.

## **TGP A-G Mode**

The A-G mode is used against preplanned targets as an aid for identifying, locating, and acquiring ground targets. In the A-G mode, A-G or STBY are the only TGP modes available.

When dropping LGB's, the laser fires automatically at the entered laser start time and continues four seconds after the computed weapon impact time.

## **Attitude Advisory Function (AAF)**

If the TGP is in A-G mode, TGP format is displayed and the aircraft exceeds any of these defined attitudes:

- a) Bank > 75 deg; Pitch < 0 deg.
- b) Pitch < -20 deg

A flashing red rectangular box with a double set of words "CHECK ATTITUDE" is displayed on both MFDs (all formats).



## **TGP A-A Mode**

The TGP A-A mode provides visual target identification and tracking of A-A targets. In A-A the TGP is initially commanded to the FCR LOS if the FCR is tracking an A-A target. When the TGP is not the SOI and the FCR is not tracking a target, the TGP LOS is positioned to 0 degrees azimuth and -3 degrees elevation. The TGP can track and maintain an A-A target independent of the FCR LOS, resulting in two A/A TD (target designator) boxes/TLL's (target locator line). Once the TGP has been commanded to track, the TGP LOS and the FCR LOS are independent. The TGP LOS is shown as a dotted 50-mr A-A TD box in the HUD. If the TGP LOS is outside the HUD field-of-view, a dotted TLL and target angle are displayed. The FCR A-A TD box is a solid 50-mr box.





## TGP Tutorial – How do I use it?

With the above knowledge in your hip pocket, you can begin to learn how to use the enhanced capabilities of this new targeting pod. It will take some practice to get used to the system and its quirks and to become proficient. The following should get you started off in the right direction. First, we'll look at air-to-ground operations.

### Air-to-Ground

We'll start off with a typical scenario that you the pilot have started off in Taxi or Takeoff mode. All of your systems are up and running, including the TGP. This means you will not have to wait for the system to cool down before you can use it as would be the case if you did a Ramp start.

You are safely airborne and on your way to your target. The first thing you will want to do is call up Air-to-Ground (AG) mastermode (mm). On your left MFD, you probably have the AG GM radar up and sweeping. On your right MFD, you will want to call up the TGP base page. If you have the WPN page in one of the MFD slots and don't have any weapons that require its use (e.g., Mavericks), then replace that page with the TGP base page (I typically run with HSD, SMS and TGP as my set up on the right MFD). Hit the OSB (option selection button) under "WPN" to switch to that page (if you're not already on it), then hit that same OSB again to switch to the main MFD menu. Hit the OSB next to "TGP". You should now see the TGP is STBY mode, waiting for you to select the operating mode. Next, hit OSB 1 (upper left) above "STBY". Next select the OSB next to "A-G" (OSB #6). That commands AG mode for the TGP. At this point the TGP page may still be blanked. If it is, select Master Arm on (if you're actually getting ready to attack or just want to arm the laser) and that will bring the video to life. *NOTE: At this point in time, to arm the Laser, you must be in Master Arm on. So, arm up the laser.* If you're not going to be attacking a target, select Master Arm Simulate.

From here, you will want to decide what FCR radar mode and submode you will need to use which is dependent upon your target. Are you hitting a building or looking for a column of tanks? Is the building at a steer point of mine? Is the column moving or holding their position? Does the target(s) require continuous lasing or can I use delayed/automatic lasing? All of these are questions you should think about while you are still planning your mission so you will know prior to getting to the target what modes you will need to call up. We'll run through two examples.

## **Scenario 1 – Fixed Target, One Pass**

In the first example, we will be hitting a nuclear plant with 2 GBU-10s rippled in pairs from 22,000 ft and we have precise lat/longs for the target entered into our STPT 5. We have our LASR page set to start automatically lasing the target 20 seconds prior to impact. We will want to leave our radar in GM mode with STP/TGT (steer point/target) mode selected. That will allow our GM radar to point/aim at the selected steer point when we switch to it making it easy to find our target. We're 20 nm from the target and we've acquired the plant on the radar. We've locked it up in GM STT. Next, DMS (display management switch) down/aft to get the sensor of interest (the big box on the outside of the MFD) on the TGP MFD.

With the SOI box on the TGP page, TMS forward (or TMS right) to ground stabilize the TGP in AREA track. You should see the target and now can refine your slew to the target you desire to hit. Select Master Arm on, make sure the laser is armed and ensure you've got the proper munitions selected that you're going to drop on the target. Follow the normal delivery cues as necessary and drop the munitions. Be careful not to maneuver too aggressively and mask the target or make the TGP go into RATES tracking. If it does, you will have to refine your slew again. A good technique is to make a gentle turn away from the target toward your egress direction to keep it more off to the side rather than underneath your jet. But there shouldn't be a problem with over flying the target either if that is what is required. You're eyeballing your TGP while also looking outside clearing for threats. Thirty seconds prior to impact your laser should fire and provide terminal guidance to the bomb. Impact. You can now TMS aft to break AREA track and command the TGP to the FCR line-of-sight (LOS). You can exit AG mm and egress.

## **Scenario 2 – Moving Targets, Multiple Passes**

In this example, our target is a column of T-62 tanks that are rapidly moving south and we need to stop them. Our loadout is 4 GBU-12 which we will be dropping in singles. We've positioned our TGT STP 5 around in the vicinity of where we expect the column to be when we arrive on target but we've kept in the back of our mind that they may not be there.

After safely airborne and en route to the target, we begin the administrative tasks of checking our systems out in AG mm. Again we call up the TGP base page and select A-G mode of operation. This time, we've planned to initially use STP/TGT submode in the GMT mode. Thirty to 25 miles out we begin looking for movers at our STPT 5—nothing so far. Ten miles from the STPT we pick up some movers 5 miles to the north of our STPT. Since there are no friendlies around for miles, we know this is our target. They appear to be heading toward our STPT. We switch into SP (Snowplow) mode in GMT. This mode is better suited for looking for our targets not at our steer point. With the SOI on the GM scope, we TMS forward to enable us to slew the radar cursors around. We slew over to the movers and lock one up. Next we DMS down to switch the SOI to the TGP. Next, command TMS forward to stabilize the TGP and enable slewing. We use the pinky switch to change the field of view (FOV) to EXP so we can get a good visual. At last we see some tanks moving. We slew over to one of them, cease slewing, and then TMS forward and command POINT track. We begin a shallow dive and release. We manually lase the mover with our trigger to ensure the bomb will hit. Shack!

*NOTE: It is important to cease slewing before commanding a POINT track or the cursors will “jump” off the target as you’re trying to lock up the mover (very frustrating!). You can practice this and see exactly what happens. It is also important NOT to make any slew inputs while in POINT track as it will also make the cursors jump off and away of what you were tracking, unless you are intentionally wanting to break POINT track. The cursors jumping off is a bug. As you can guess, this can make getting a POINT track on a mover a challenge. It is best to lead the mover and let him drive into your cursors and then command POINT track. Also note that you may likely need to be in narrow or expanded FOV to get a POINT track, as the size of the object is important in if the TGP can get a track on it. Also if you are too far away, POINT track may not be able to get a lock. Aggressive maneuvers or a MASK condition can break a POINT track.*

We plan to conduct multiple passes until all of our bombs are off. This can be accomplished a couple of ways. After the first pass, we can leave our TGP in AREA track and make small slews to follow the column as they move and as we reposition for another attack. You can also choose to TMS aft and command the TGP to slave to the GM FCR

LOS. Either works and depending on the situation, you may want to use one over the other. If you TMS aft, the TGP will be slaved to the radar and you will have to conduct another search similar to how you set up the first pass. Another thing you can do (on the first or another pass) is after slewing the radar cursors to the column, since you don't have a STPT at that exact location, you can hit 7 (MARK) on the ICP and then SEQ Right until you get to "FCR", then hit ENTR to take a mark point on where the column is. Then you can switch to that MARK STPT (#26) to aid in navigation and delivery, or you can just use it as a reference on the HSD as to where the column is. Realize if they're moving, they may not be in the same place as the Mark. Take that into consideration for your aiming and even take another Mark point if desired on another pass. Another important consideration is to ensure you give yourself enough time and spacing to conduct another pass without having to rush it or make a sloppy delivery. This may mean getting as far away as 10 miles (or more) before turning back into the target. With practice, experience and know-how, you can narrow this distance down and stay closer to the target between each pass. But initially, you should give yourself plenty of time to work the sensors for each pass, otherwise you'll wind up off dry and what did you accomplish? Nothing except a miss, a dry pass, or just burned more of your gas down—not to mention maybe even got shot at unnecessarily. Pacing and patience is important as you're learning this new system. Also keep in mind aggregation and deaggregation of ground units in the back of your mind. You may not see a target until you are pretty close to them (5-6 miles away even). There may need to be some work on deaggregation of units that will allow better and more realistic employment opportunities. There are many methods, techniques and procedures that one can do to effectively employ this new system. Practice is the biggest key and trying new ways in training missions can pay off in learning new or better ways to employ.

### Air-to-Air

The TGP can be a great asset in the A-A role. Its advanced optics and IR capabilities can see much farther than the Mark I eyeball, making it an excellent ID tool for BVR or near-BVR ranges. As stated above, it can be slaved to the radar or also work independently of it, just like in A-G. This allows the pilot the ability to monitor or track a target with the TGP, but use his FCR to continue searching or tracking other targets. The pilot can set the TGP in one of the MFD page slots in MSL OVRD, DGFT and/or NAV modes and switch the SOI to the TGP to command expanded FOVs for ID purposes. Take the following example: The pilot bugs a contact at 10nm on the radar. The A-A mode of the TGP is called up and the pilot sees the target as the TGP is slaved to the radar. Switching the SOI to the TGP and commanding expanded FOV to get a better picture of the target, the pilot then TMS forwards to command a POINT track on the target. Recall that just like in A-G modes, POINT tracks on targets far away may not be possible. If the TGP drops a POINT track, a TMS aft *with* the SOI on the TGP may be necessary to re-slave the TGP to the FCR. Remember, display polarity selection is also available. At range, the TGP may display a better picture in WHOT compared to TV mode, for example. With the SOI on the TGP, TMS left will cycle display polarity options (WHOT – BHOT – TV) or OSB 6 may also be pressed to cycle it. Using the TGP effectively in combat takes switchology practice to gain proficiency, but once learned can be a valuable tool.



POINT tracking an F-16 independent of FCR

**New Feature:** Sniper ATP changes: Added Sensor mode variable telling which sensor is currently in use for the TGP – options are IR or TV. Using TMS-Left 2x times in less than 0.5sec will toggle the current sensor. If switching to TV, then the IR FOV and polarity are stored and will be put back to use when switching back to the IR sensor. IR mode has 2 FOVs (Wide/Narrow) while TV mode has only 1 FOV and it can't be changed (trying to change FOV in TV mode will do nothing). If in TV sensor mode the OSB #3 will have "TV" label on it. TMS-left under IR mode will change polarity between WHOT/BHOT, under TV mode TMS-Left will not change anything. Added a TV FOV variable that is used for the TV sensor and can be read like the other TGP FOVs from TGPDATA.dat. Changes in FOV values: IR Wide FOV = 3.6 (changed from 4.0); IR Narrow FOV = 1.0; TV FOV = 0.5. Manual zoom can be used regardless of current sensor/FOV and will zoom in/out as usual.

# HARM Attack Display (HAD)

The HARM Targeting System (HTS) page has received an overhaul. Note also that the HTS pod can be loaded on the jet from the munitions UI page even if HARMs are not carried as part of the loadout.

The MFD display for using HTS is now called the HARM Attack Display (HAD). The previous HTS page was embedded into the HARM's SMS MFD page. This was incorrect. The HARM SMS page and main MFD menu page are depicted below.

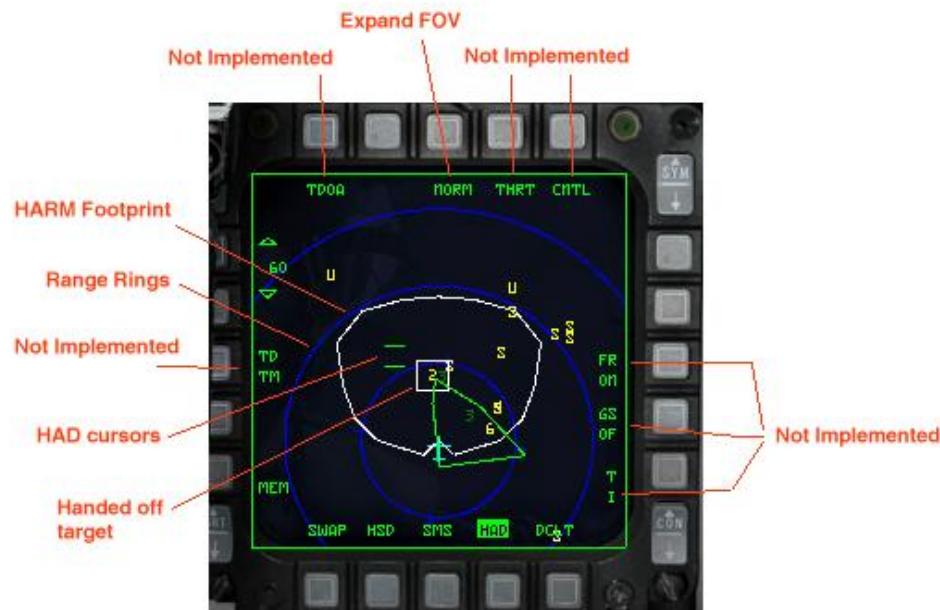


HARM SMS Page



Main MFD page

The HAD is selected from the main MFD menu by pressing OSB 2 (HAD label). The HAD may be selected in any mastermode but it can only be operated in A-G mastermode with HTS and AGM-88s loaded. Selection of the HAD page without AGM-88s loaded will yield a BLANK MFD page. Operation is very similar to the previous HTS page, but the HAD shares many common display features as the HSD. HAD cursor movement and expanded FOV (OSB 3 or pinky switch) options are similar to the HSD as well. The pilot may select the HAD range (HAD as the SOI) by slewing the cursors up and down the display to bump range or by pressing OSBs 19 and 20.



The HARM WEZ/Footprint is based on Rmax of the AGM-88 and will increase/decrease in size according to your speed and altitude. If the HARM WEZ is greater than the selected display range, the lines will be dashed.

Detected emitters are colored as follows:

Yellow = emitter active

Red = emitter tracking

Flashing Red = emitter launching

Green = emitter not active

## HARM modes

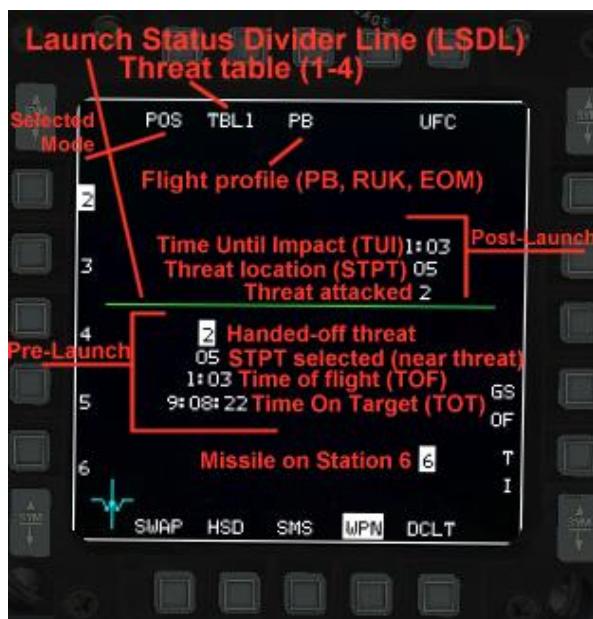
The AGM-88 HARM can now be employed by using the previously coded HTS (for HTS capable F-16s) or via the HARM WPN page for HTS or non-HTS capable aircraft. Two modes are available for employment: Position Known (POS) and HARM As a Sensor (HAS). The third mode, Data Link (DL) is not implemented (at this time).

**POS mode:** In POS mode, aircraft attitude and target position are passed to the HARM. After launch, the missile flies to the near reported position of the emitter and then activates its seeker to search for the handed-off threat. POS mode has 3 flight profiles available:

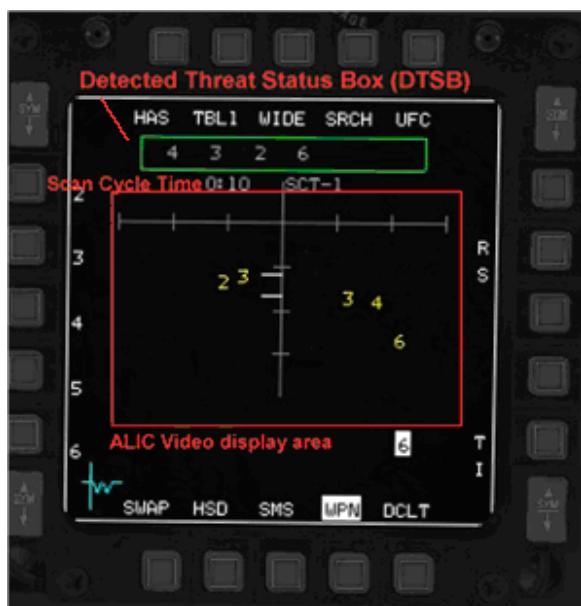
- 1) Equations of Motion (EOM): Provides threat specific off-axis capability with a narrow FOV when the seekerhead is activated.
- 2) Range Unknown (RUK): Provides threat specific off-axis capability with a wide FOV. Used when target confidence is low. (Degraded state of EOM).
- 3) Pre-briefed (PB): Provides location specific, on-axis capability with a wide FOV. PB is used for long range delivery with high confidence target location.

**HOTAS Controls:**

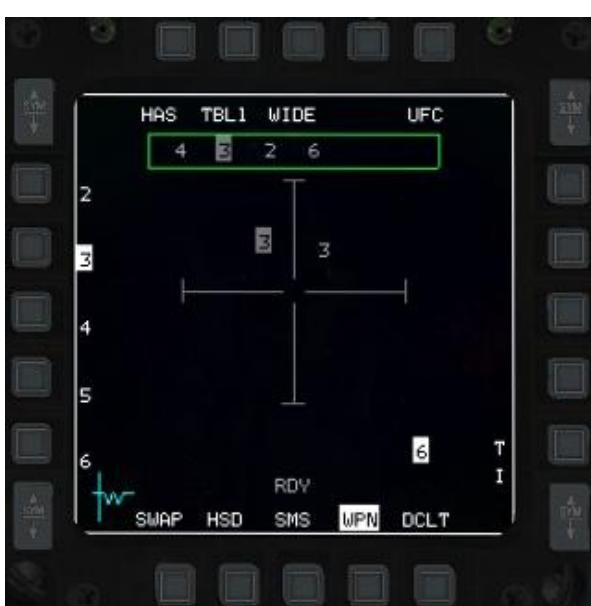
- Cursor enable – toggles between POS and HAS modes.
- TMS Right – Selects first valid threat, a 2<sup>nd</sup> TMS Right steps to the next threat
- TMS Left – Toggles between threat tables
- Pinky Switch – POS Mode cycles the POS flight profile; HAS Mode cycles the FOV
- TMS Aft – Deselects the currently selected threat



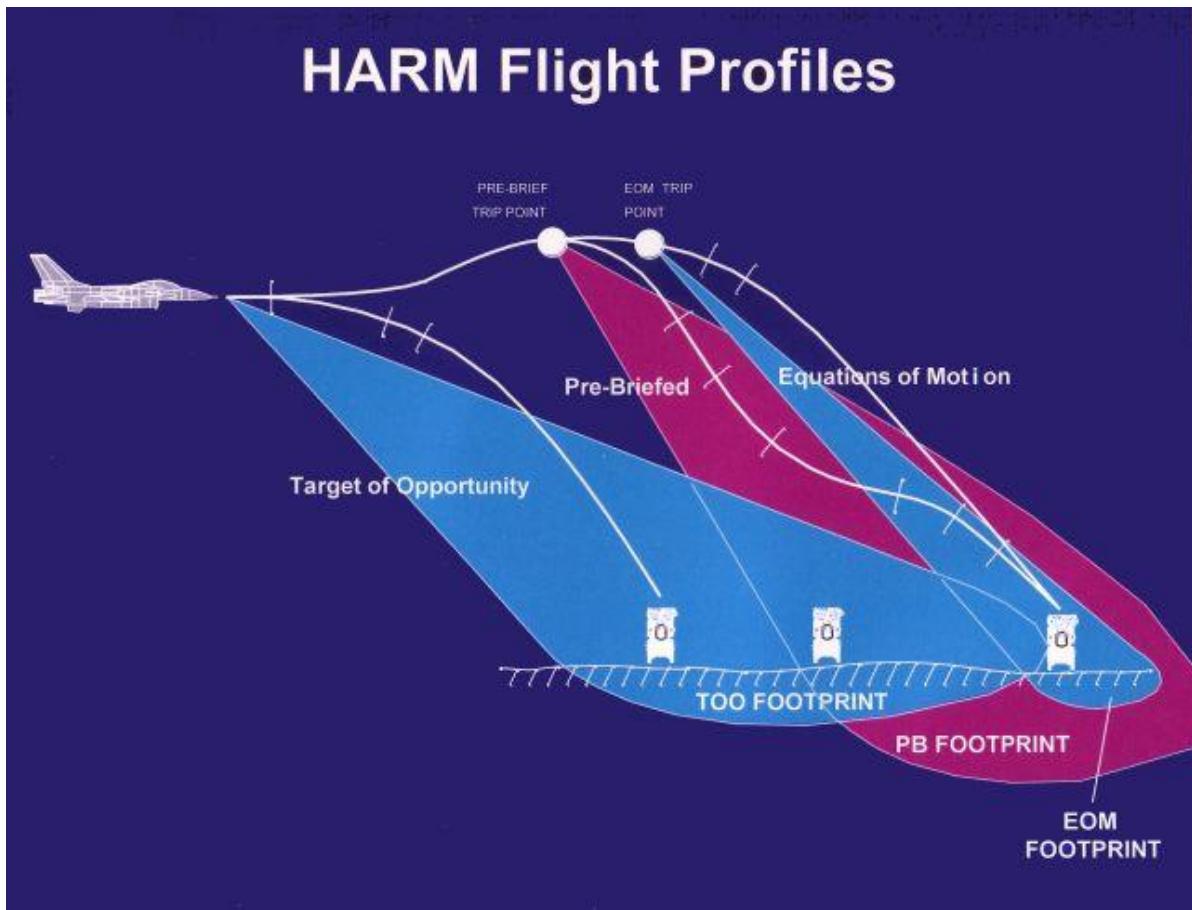
Position Mode



HAS Mode



HAS Mode – ALIC Video After Hand Off



The POS Mode HARM Flight Profiles

There are 3 Position Known (POS) flight profiles: EOM, PB, and RUK (aka Target of Opportunity – TOO). Each mode control at which point the missile will activate its seeker and what will be the FOV of the seeker. The most

accurate mode is EOM. It will activate the seeker at 5NM from the handed off steerpoint with a 40 deg FOV. This mode should only be used when the location of the emitter is well-known—i.e., emitter position collocated with a steerpoint. In PB mode, the seeker will activate at 15NM from the handed off steerpoint with a 120 deg FOV. This mode should be used when the position of the emitter is relatively close to the steerpoint. In the last mode, RUK, the seeker is activated immediately after launch with a 120 deg FOV. This mode is used for self-defense as the range is completely unknown.

In HAS mode, the pilot uses the HARM seekerhead to detect threats. Detected threats are displayed left to right in the Detected Threat Status Box (DTSB). The pilot uses the cursor enable to slew the cursors and designate/hand-off a threat to the HARM. After a threat is handed-off to the missile, the display changes to represent missile boresight and the threat video responds to aircraft pitch, roll and azimuth changes. “RDY” is displayed after hand-off is complete.

**Operational Notes:** HAS search mode will use the currently selected threat table to detect threats. The threats of the current table will appear on the left side of the MFD (next to each OSB). HAS delay timer will now be affected from all threats and not only the ones detected (simulating real system delay for sorting all emissions). HAS search mode will not show more than 10 threats. Search filter page (OSB #4 in the search page) will show the current table’s threats on the left side. Clicking on the corresponding threat’s OSB will select/deselect that threat from being detected and will reset the HAS timer and of course affect the search time. HAS FOV (OSB #3 in the search page) will now cycle through all modes – Wide (default), Center, Left and Right. The selected FOV will force the HARM to detect threats accordingly. Wide will search to a certain range (dependent on altitude) in all directions, Center will search at half of that range, Left and Right modes will search only Left/Right sides accordingly. Each time the FOV is changed the HARM timer will reset and all threats will blank (new search parameters). Hand-off time takes 5 seconds and will now affect missile tracking. Missiles fired before the threat was handed-off will probably miss, so wait for the "RDY" text to show-up after hand-off. HAS hand-off page will show up to 4 threats of the same type as the handed-off threat.

## ***Other HAD Page Fixes***

Fix for HAD display. It used to flicker sim type symbol markers when there was a JSTAR in the mission. Turns out there were a selection of code bugs around this that date back to SP3. Now the code will update ground emitter target lists without blanking useful data about emitter status that were gathered by your on-board HTS pod. The JSTAR updates are staggered now also so that not every friendly in theater processes the emitter list in the same frame; minor performance improvement not likely noticeable in the grand scheme of things.

Now you should be able to use the EXP1 and EXP2 modes as intended -- the coloration on the symbols should be correct and it should be possible to take and sustain a target lock from the expanded modes. This same fix does both those things and it also fixes a problem with locks not being dropped properly when you did manage to get one in an expanded mode but then the target fell out of view of the HTS package.

HAD page should now more correctly show threats and the modes of operation those threat radars are using. For example, target locks are not erroneously flagged at long ranges and when a SAM system is guiding more than one missile the HAD page will continue the flashing red cue for the duration of the launch event (previously it timed out after 2.5 seconds every time for some reason – unsure why it was coded this way). As a result the HAD page should be more useful.

Note that some SAM systems don't go for lock until you are quite close to their firing criteria so you may not see steady red squares (target lock on to you) before it transitions to flashing red for a launch. It is doing the lock registration but with some systems, the AI locks and fires very quickly. Behavior of the HAD for aggregated units and deaggregated units should also be more uniform now.

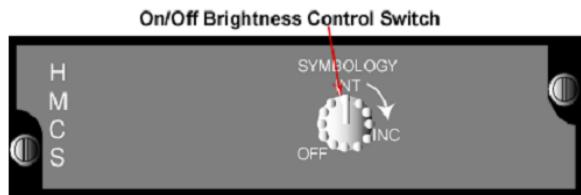
Also, target lock is possible with the HAD page after all ownship HARMs have been fired. This extends also to allow you to direct your AI wingmen to attack based on either a lock on your HAD page or hovering over a threat with the HAD page cursor provided the HAD page is the current SOI.

# **HELMET MOUNTED CUEING SYSTEM (HMCS)**

The Helmet Mounted Cueing System (HMCS) is an Electro-Optical (E-O) device that serves as an extension of the HUD by displaying weapon, sensor, and flight information to the pilot. Combined with high off-boresight missiles, the system gives first look, first shot, first kill capability in the visual arena.

The HMCS is only available in aircraft in the database that have the “Has HMS” flag option selected. The HMCS is controlled via HMCS symbology rheostat (OFF/ON & brightness control) in the 3d pit or with keystrokes:

```
SimHmsSymWheelUp -1 0 0XFFFFFFF 0 0 0 1 "HMCS Brightness Up"
SimHmsSymWheelDn -1 0 0XFFFFFFF 0 0 0 1 "HMCS Brightness Down"
```



The HMCS is basically an extension of the HUD, and as such, it teams with the HUD to provide a single display of the outside world. The HUD and HMCS are considered as one SOI (e.g., they share the same hands-on-control switchology). The HMCS FOV is defined as a 20-degree diameter circle centered on the HMCS LOS. Wherever the pilot looks within the HMCS field-of-regard (FOR), appropriate symbols from the aircraft are accurately displayed, based on the current HMCS LOS.

The HMCS performs different functions:

1. Off boresight marks (not implemented yet)
2. A-G target cueing (N/I yet)
3. Off boresight target designation - dive toss (DTOS) and electro-optical visual (EO VIS) (N/I yet)
4. Off boresight slaving of FCR in the A-A Mode
5. Off boresight slaving of AIM-9 missiles
6. Ownship performance information and status

## **Control Pages**

The HMCS has two DED control pages. The first is accessed by pressing LIST→0. The second can be accessed by pressing SEQ on the ICP. The first allows HUD and cockpit blanking, which allows the HMCS to turn off with the pilot looks either towards the HUD or down in the cockpit. The HMCS and HUD share many symbols, which tend to visually conflict with one another when looking through the HUD and an HMCS. Forward (HUD) blanking is a display declutter feature that removes all HMCS symbols (in A-A or A-G mode) when the HMCS LOS (borecross) is within the inside edge of the HUD instantaneous FOV. The HUD blanking region applies when the difference between the HMCS LOS and the CTFOV of the HUD is less than +10° in azimuth and +10° in elevation.

## **HUD Blanking**

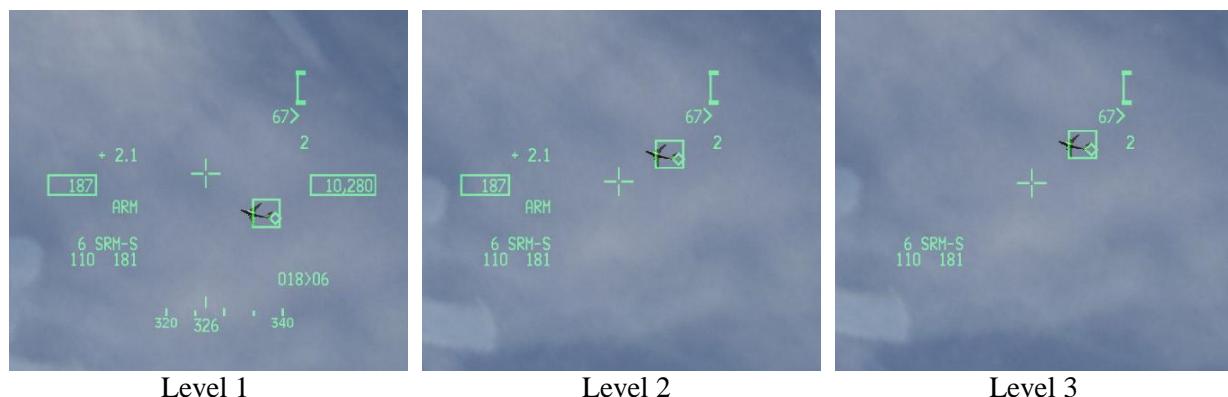
The HUD blanking feature is controlled from the DED HMCS DISPLAY page by placing the asterisks around HUD BLNK and depressing M-SEL on the ICP. When mode selected, HUD BLNK highlights and remains highlighted until deselected, and the asterisks auto step to cockpit blanking (CKPT BLNK). HUD blanking is deselected by placing the asterisks around the highlighted HUD BLNK and depressing M-SEL. Invoking HUD BLNK has no impact on the ability to slave missiles to the HMCS LOS.

## Cockpit Blanking

The cockpit blanking (CKPT BLNK) feature is a selectable display declutter feature that removes all HMCS symbols except the missile diamond, steerpoint diamond, aiming cross, ACM bore symbol, and TD box from the display when the HMCS LOS is below the cockpit canopy rails. The HMCS aiming cross, target locator line, and TD box will stay displayed on the HMCS when cockpit blanking is enabled and the HMCS LOS is in the cockpit blanking region. Cockpit blanking reduces eye clutter when performing head-down (in-cockpit) tasks. Cockpit blanking is controlled in a manner similar to HUD blanking.

## Declutter

The HMCS has 3 levels of declutter available. To rotary through the levels, position the asterisks around DECLUTTER and depress any key 1-9. LVL1 is the lowest declutter state and declutters nothing. LVL2 declutters the following: altitude, range to steerpoint, and helmet heading scale. LVL3 declutters the following: altitude, range to steerpoint, helmet heading scale, airspeed, normal acceleration, and ARM status window.



## Hands-On HMCS Blanking

The display management switch (DMS) enables and disables HMCS display. A DMS-aft and hold for  $\geq 0.5$  seconds toggles the HMCS between displaying symbology and not displaying symbology. This feature is independent of the HUD or CKPT blanking states. Hands-on-control blanking overrides all other blanking including the HUD blanking feature and cockpit blanking feature until the HMCS display is redisplayed via a second DMS-aft for  $\geq 0.5$  seconds. When the symbology is being blanked, the system behaves as if a helmet is not in the avionic system and returns to baseline ACM operation and baseline missile bore operation.

## HMCS Dynamic Aiming Cross

The HMCS dynamic aiming cross is designed to allow the pilot to more easily slave weapons to the HMCS LOS during high G, high look-up angle conditions. The cross moves linearly in elevation only from the center of the HMCS FOV to plus 168-mR head elevation changes from +30 degrees to +80 degrees.

## Air-to-Air Operations

The HMCS A-A mechanization provides the capability to slave the AIM-9 A-A missiles to the HMCS aiming cross LOS when the missile is in the BORE LOS mode. In addition, when the FCR is placed in ACM BORE, the FCR is commanded to the HMCS LOS when the following conditions are met:

- 1) ACM BORE mode is selected
- 2) FCR is SOI

The HMCS populates its windows with data and position symbols based on the same conditions and requirements for displaying data and symbols on the HUD.

### **AIM-9 Missile BORE Operation**

When an AIM-9 missile is selected with HMCS and the missile LOS is BORE (cursor-z depression), the avionic system slaves the missile LOS to the HMCS aiming cross LOS (Figure 46). Note that when the AIM-9 missile is uncaged, the enlarged missile diamond is displayed on the HMCS. If HMCS is not on, the missile diamond is displayed only on the HUD.

When SLAVE is selected with a TOI, the avionic system slaves the missile to the FCR LOS and the missile diamond is displayed at the FCR LOS on the HMCS. With SLAVE selected and no TOI, the missile seeker points three degrees down from the HUD borecross.

#### **Note**

The missile diamond will be displayed in the center of the HMCS up to 28 degrees from boresight. Beyond 28 degrees, the missile diamond will move from the center of the display until it reaches the edge of the HMCS display.

Upon reaching this point, an X is displayed over the missile diamond.

### ***Slaving FCR ACM BORE without a TOI (FCR Not Locked On)***

When ACM BORE is selected and TMS-forward is held, the radar is slaved to the HMCS aiming cross LOS in a non-radiating state. The FCR ACM BORE ellipse is displayed on the HMCS at the FCR LOS. The radar is commanded to radiate when TMS-forward is released. The radar automatically attempts to acquire a target in the ACM BORE ellipse when TMS-forward is released. Note that if the HMCS LOS is moved past the FCR gimbal limits, the avionic system continues to try to slave the FCR LOS to the HMCS LOS even though the FCR gimbal limits have been reached. In this case, the FCR ACM BORE ellipse remains displayed over the HMCS aiming cross, even though the FCR is at its limit and can no longer attain the actual HMCS LOS.

### ***Slaving FCR ACM BORE with a TOI (FCR Locked On)***

If there is a valid TOI upon entry into ACM, the avionic system controls the ACM submodes per baseline.

### ***BORE/SLAVE Toggle***

Changing the BORE/SLAVE option on the SMS base page for either the AIM-9 or AIM-120 will simultaneously change BORE/SLAVE status for both missile types (master mode dependent). The cursor-z axis can also be used to change to the opposite state as long as the switch is held. Upon release of the cursor-z axis, the state returns to the original state (“dead-man” function). The HMCS will indicate SRM-S or MRM-S for SLAVE, and SRM-V or MRM-V for Visual BORE.

## ***Improved Data Modem (IDM)***

### ***Introduction***

The IDM in the F-16 is a very capable and important piece of equipment to the pilot. It allows the flight lead and his wingmen increased situational awareness (SA), the ability to pass positional information about each jet in the flight to all flight members, to target flight members onto air-to-air or air-to-ground targets, to easily execute tactics that go beyond the visual arena and regain visual mutual support should a flight member become a “lost wingman”. The data link in this version of Falcon has been greatly enhanced over previous versions. Previously, the data link was more automated and completely hands-off – although an extremely useful tool. While it resembled the “Continuous” mode

of the following text, that is just one of several air-to-air (A-A) modes that are now available. Air-to-ground (A-G) functions have also been added. Each of these modes open new doors in realism, situational awareness, team work, targeting and ultimately laying down ordnance on the enemy.

There are two new keystrokes associated with the data link that you will want to add to your keystrokes file (if not already included). These are the defaults (Control O and Control P, respectively):

```
SimCommsSwitchLeft -1 0 0X18 2 0 0 1 "Comms Switch Left"
SimCommsSwitchRight -1 0 0X19 2 0 0 1 "Comms Switch Right"
```

For HOTAS Cougar users, SimCommsSwitchLeft (used for A-A operations) should be programmed to the “IFF OUT” switch and SimCommsSwitchRight (used for A-G operations) should be programmed to the “IFF IN” switch. For other joystick users, it is highly recommended to have these programmed as well to allow easy hands-on control.

## Real IDM Background

The data link system consists of the Improved Data Modem (IDM) Line Replaceable Unit (LRU), the Datalink (DL) power switch on the Avionics Power Panel, and a 1553 mux bus avionics communications interface. Existing UHF and VHF radios and antennas complete the data link system. The improved data modem links the aircraft avionics subsystems with the UHF and VHF radio to provide digital data communications with other users that have an IDM. The IDM converts digital data to audio data for UHF or VHF radio transmission. When data are received from other users, the IDM converts the audio data to digital data and sends it to the avionics system for display in the cockpit.

## Data Link Operation Overview

The data link system allows up to 8 IDM equipped aircraft to transmit and receive intraflight data link messages. (IDM in Falcon 4 is *not* tied to the UHF or VHF radios like they are in real life) Data link transmissions are initiated using the 4-position COMM switch on the throttle. Depressing the COMM switch inboard transmits air-to-ground information and COMM switch outboard transmits air-to-air information.

Transmitted air-to-air information consists of own-ship position, altitude, velocity, magnetic ground track, flight member number, and the position of the own-ship’s bugged target. Air-to-ground data link information consists of the selected steerpoint which may be a mark-point, a “regular” navigation steerpoint, or the FCR air-to-ground cursor position. Air-to-air and air-to-ground data link information may be selected for display on the HSD MFD format by selecting ADLINK (OSB 16) and/or GDLINK (OSB 17) on the HSD Control page (Figure 1-55). When ADLINK is selected, intraflight member’s ownship positions and the locations of their bugged targets are displayed on the HSD. This same symbology is also displayed on the FCR provided the FCR is in one of the air-to-air radar modes. When GDLINK is selected, data linked steerpoint (or mark-point) and FCR air-to-ground cursor positions will be displayed on the HSD (Figure 1-56).

## Data Link Symbology

The data link symbology displayed on the HSD is shown in Figures 1-55 and 1-56.

- Data Link Friendly. Wingmen are displayed on the HSD by a half circle with a line projecting from the top of the half circle. The symbols are oriented on the HSD based on ground track. Flight member number is displayed at the top of the symbol and altitude is displayed at the bottom of the symbol.
- Data Link Unknown. Ownship and wingmen’s bugged targets are depicted as half squares with a line projecting from the top half of the half square. Flight member assignment number and target altitude are displayed at the top and bottom of the symbol, respectively.

- Data Link Targets. Outside the HSD FOV. Data link friendly or data link unknown targets which are outside of the HSD field-of-view are indicated by an arrow pointing in the direction of the target positioned on the outer range ring of the HSD.
- Data Link Steerpoints. Are stored in steerpoints 71-80. Ownship Markpoints are shown as a big yellow X. Data link steerpoints are shown as a small yellow x.
- Data Link FCR A-G Cursor Position. The data link A-G cursor position is displayed on the HSD as an asterisk with the sending flight member's number above it.

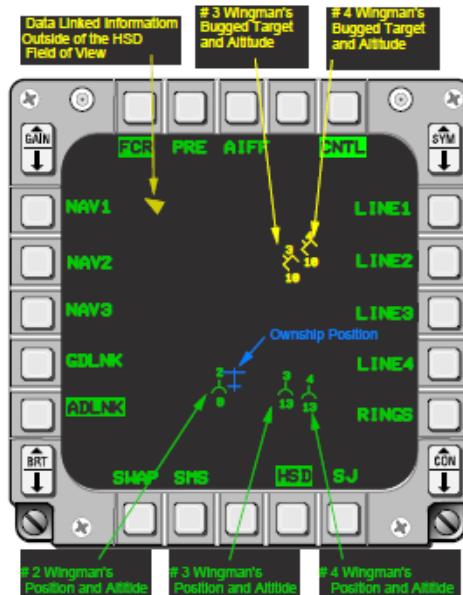


Figure 1-55 HSD ADLINK Data Link Symbology

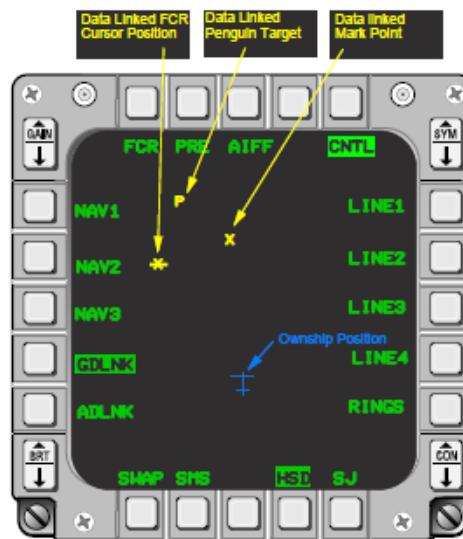


Figure 1-56 HSD GDLINK Data Link Symbology

## IDM Cockpit Initialization

In order to effectively exchange information, each participating datalink user must have compatible parameters initialized into his respective IDM terminal. In Falcon 4, initialization parameters are automatically fed into the IDM – to an extent. Ownship Team Address number and other flight member's team addresses are done for you. These addresses are for your (up to 4) intraflight members. The additional team addresses 5-8 are not filled in and must be keyed in manually based on the pilot's needs or a package commander's needs. This will be discussed later. IDM initialization through the DTC is not implemented. Using the (Up-Front Controls)UFC, the pilot may confirm and manually change only a select number of IDM parameters. In Falcon 4, the pilot may not change his team address.

The first step in initializing the data link system is to position the data link power switch located on the Avionics Power Panel to the DL position (Figure 1-57).

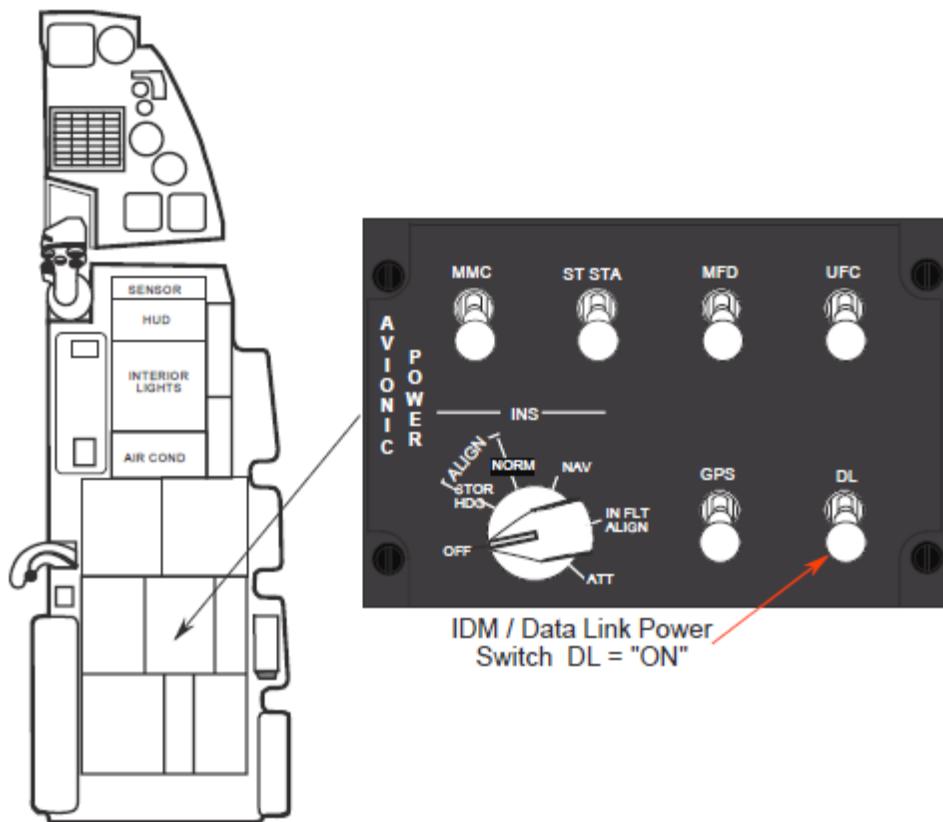
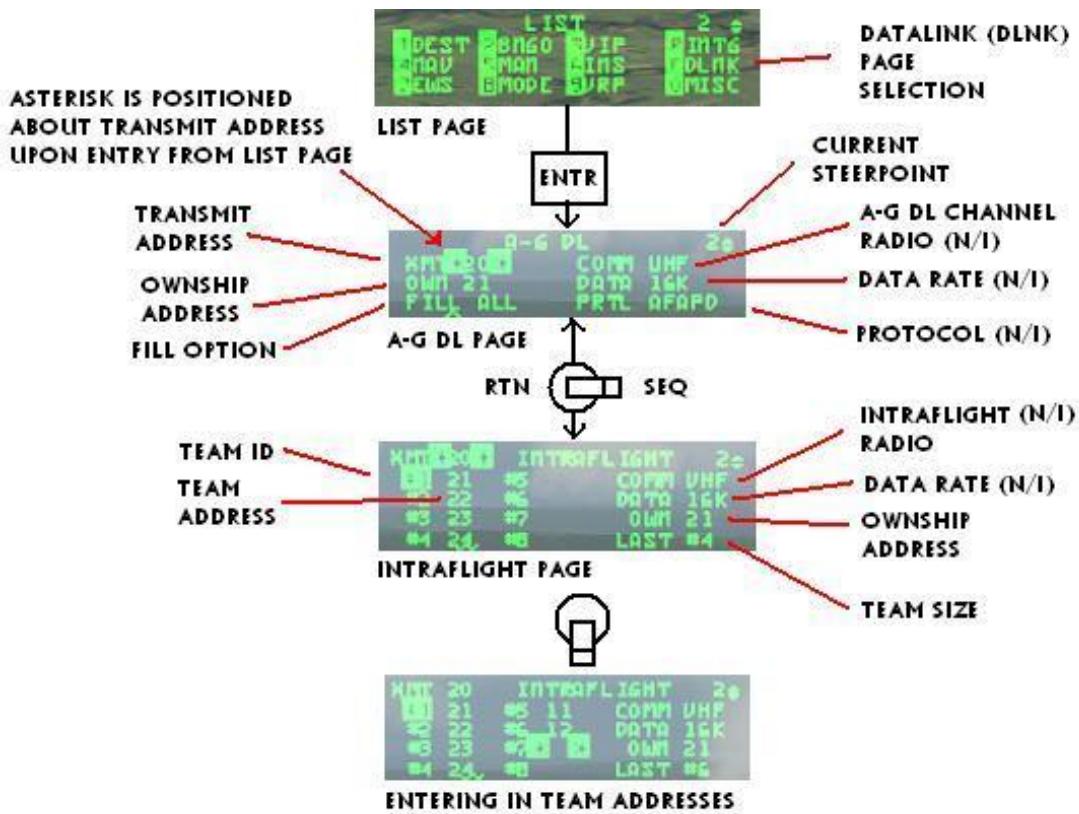


Figure 1-57 Data Link Power Switch



As seen in the diagram above, LIST->ENTR gets the pilot to the A-G datalink page. The only two selectable options in this page are the Transmit Address and the Fill option. The Fill option determines whether the system stores (ALL) or ignores (NONE) all received datalink steerpoints (71-80). When ALL is selected, the system will store the first message in STPT 71 and fill each subsequent STPT until it hits 80, upon which it will wrap around to the oldest location (71) and overwrite the data. When NONE is selected, no HUD or VMU (Voice Message Unit) messages are provided for these messages. In most cases, Fill ALL is normally used. The Fill option has no impact on A-A intraflight or A-G cursor messages—they will be processed normally. Sequencing right (SEQ) changes to the INTRAFLIGHT page where up to 7 team addresses can be reviewed and changed (ownship address cannot be changed in Falcon4).

# Air-To-Air Intraflight Data Link

The A-A intraflight data link operates in three modes selectable by the pilot to assist in situational awareness and employ coordinated support and targeting of airborne targets: Continuous (CONT), Demand (DMD), and Assign (ASGN). For the pilot in single player (SP), using the system will (or can be) fairly hands off and does not require any coordination. For the multi-player (MP) environment, there will need to be some coordination in the briefing prior to launching to ensure all flight members understand what mode will be used.

For the data link system to be operable, the pilot must:

- 11) *Position IDM power switch to DL (data link).* This will already be done for you in a Taxi, Takeoff or mission already airborne, as in previous versions of Falcon.
- 12) *Verify display of data link mode on A-A FCR format.* The system defaults to ASGN mode.

## **Modes of Operation**

### **Demand Mode Operation**

The Demand (DMD) and Assign (ASGN) data link modes allow a team member to obtain a “one-shot” team situational awareness update (an intraflight transmission round) on an as needed basis. The DMD and ASGN modes also enable the option to make assignments to other flight members. When the IDM is in DMD or ASGN mode and is commanded to transmit, the IDM transmits an A-A Request message to the intraflight team (up to four jets in a flight). The request message contains current aircraft position, heading, and velocity. If an FCR target of interest (TOI) is available at the time of transmission, the position, heading, and velocity of the TOI is also sent in the request message. Each receiving aircraft then transmits an A-A Reply message (in turn based on their sequential order requested by the request message). The A-A Reply message contains ownship and TOI data similar to the request message. The messages transmitted allow each member to see the positions and headings of other members and their bugged target on the HSD format (like previous versions of Falcon) and FCR format (new feature). Both A-A Request and A-A Reply messages are snapshots in time. For example, once the pilot’s IDM receives A-A Reply messages, the wingmen team symbols (cyan-colored) and their bugged targets are extrapolated for 8 seconds. Once this extrapolation period ends, the symbols will disappear and another data link round must be initiated by a team member (unless CONT mode is used). If moderate or heavy maneuvering occurs during an extrapolation period, the receipt of the next transmission round may result in wingmen symbols and their bugged target symbols jumping on the displays (HSD and FCR) to their new location.



#2's receipt of an A-A Reply message with #1's bugged target and rest of team member's positions.

The following applies to the initiation and verification of a successful data link transmission round:

3. Depress (option selection button) OSB 6 on the A-A FCR adjacent to data link mode mnemonic; verify data link mode DMD or ASGN is displayed.
4. Depress COMM switch left for >0.5 sec on the throttle (if you have programmed them there on the Cougar, else “control o” or whatever keystroke you have them assigned to); verify DMD or ASGN mnemonic is highlighted for 2 seconds.
5. Verify display of intraflight data link symbology (i.e., your wingmen team members) on the HSD when the reply messages are received from team members.
6. Verify display of intraflight data link symbology on the A-A FCR format when the replying team members are in front of ownship.
7. To declutter A-A intraflight data link symbology on the FCR format, depress COMM switch left for <0.5 sec. The decluttered state will remain until you depress COMM switch left for <0.5 sec again.

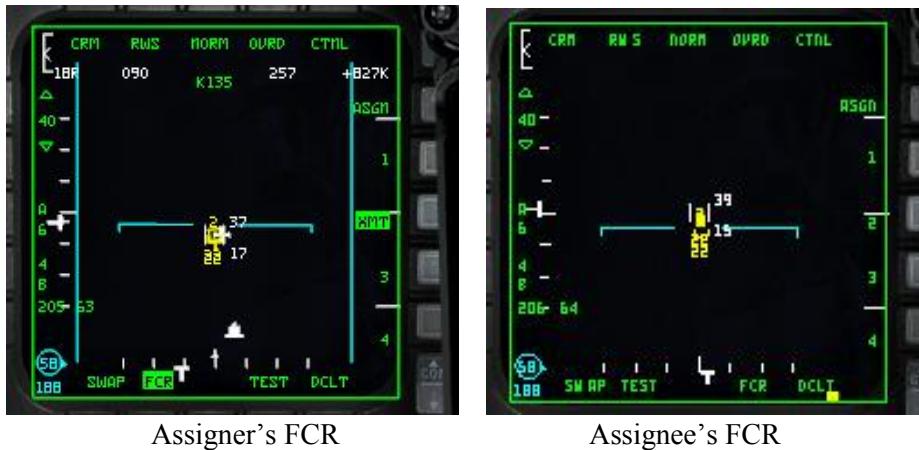
The following applies to making a data link A-A Assignment:

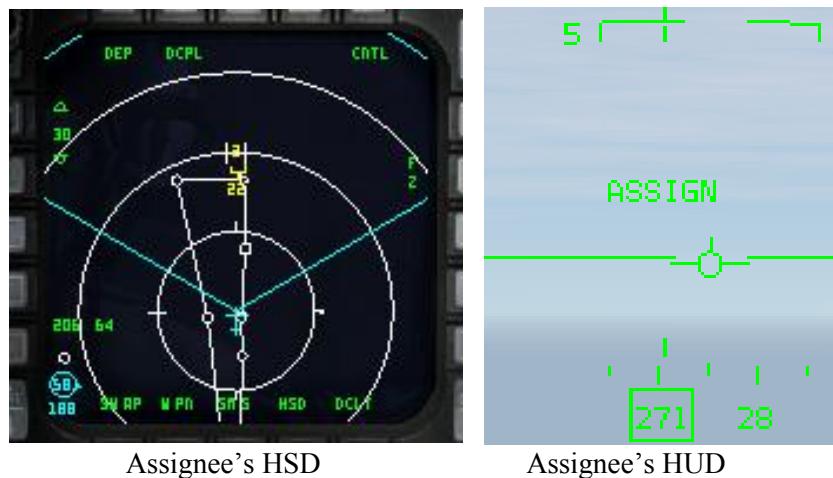
1. Ensure the system currently has a FCR TOI.
2. Depress the OSB (7 through 10) adjacent to the ID associated with the assignee team member (1, 2, 3, or 4); verify assignment ID is replaced by highlighted XMT mnemonic for 2 seconds.
3. Verify display of the team member ID above the FCR target symbol on the FCR format. The ID is displayed until the FCR track is no longer valid or a different target is assigned to the same team member.

Received messages are extrapolated and displayed on the HSD for 8 seconds. (Data link messages are displayed on the HSD when ADLNK has been selected on the HSD Control page.) During this period, the data link ignores any A-A Request command (COMM switch left >0.5 sec).

The following applies to assignment operation for receiving aircraft. Reception of an assignment message is independent of data link mode. The following process describes the reception of an assignment message:

1. Upon reception (indicated by the tone in the headset), verify display of “ASSIGN” in the upper middle part of the HUD. The ASSIGN cue is displayed for 8 seconds or until depression of WARN RESET on the ICP.
2. Verify VMU (Voice Message Unit – a.k.a., Bitchin’ Betty) message “DATA” in the headset if ownship was the assignee.
3. Verify display of data link assignment symbol on the HSD format and FCR format.





Data link assignment target positions are extrapolated and displayed for 8 seconds similar to other A-A data link symbology. The data link system will maintain 4 different slots for reception of assignment messages of the 4 team members. For example, if the flight lead assigns targets one after another (including one to himself), it is possible for team members' displays to contain 4 different assignment symbols (with different ID's) indicating the assigned targets of each team member.

#### **SPECIAL CONSIDERATION FOR TARGET ASSIGNMENT**

During the 2 seconds that XMT is displayed, another FCR target can be selected as the TOI; however, another assignment cannot be made until XMT is removed. The data link system also allows an assignment to be made to oneself by depressing and releasing the OSB adjacent to ownship member number. This message is transmitted to all teammates similar to other assignments.

Although a data link assignment message is broadcast to all members of the intraflight team (up to 4 members currently – in the future this may expand to 8), assignments can only be made to members within the 4-ship flight; hence, assignment ID's 1-4 on the A-A FCR format.

#### **CONTINUOUS MODE OPERATION**

The Continuous (CONT) mode allows the pilot to request continuous update of request and reply intraflight messages. This mode will most often be used amongst Falcon4 pilots. This is the mode that also requires coordination amongst flight members if you are flying in the multiplayer environment, as only one aircraft needs to be in CONT mode and initiates the CONT data link round. All messages are broadcast to the intraflight team. The CONT loop starts when a team member (most likely the flight lead) transmits an A-A Request while in the CONT mode. The CONT label is highlighted to show the aircraft is the controller of the CONT round. The request message from the network controller is followed by the replies of team members and a time delay. The sequence of the team member replies are dependent on the sequence of replies requested by the controller. The aircraft automatically selects the reply sequence and it is not pilot changeable. This time delay (CONT mode delay), loadable from the DTE, allows a time window for transmissions of other non-A-A messages. After the delay period has expired, the controller aircraft automatically resends the request message. The CONT loop ends when the pilot of the controller aircraft deselects the CONT mode.

Received data link A-A Request and Reply messages are displayed on the HSD and FCR similar to DMD and ASGN modes. Assignments of air targets can also be done in the CONT mode similar to DMD and ASGN modes using the "1, 2, 3, 4" labels next to OSBs #7-10.

### Special Considerations for A-A Intraflight Data Link Operation

#### **System Master Mode Versus A-A Intraflight Data Link**

The ability to initiate an A-A Intraflight data link loop and to automatically reply is independent of system master mode and data link mode. When A-A data link has been selected for display using the HSD Control page, all valid A-A data link symbols are displayed on the HSD (when within the HSD FOV) independent of system master mode and data link mode.

This is consistent with the gods eye situation awareness philosophy for the HSD. The radar format displays A-A data link symbols only when the radar mode is one of the A-A modes.

#### **Fcr Declutter**

The A-A FCR scope may be decluttered of IDM symbology by a comms switch left <.5 secs. The display will remain decluttered until comms switch left <.5 secs is toggled again.

#### **Air-To-Ground Intraflight Data Link**

The A-G intraflight data link function allows the transmission of data associated with the currently selected steerpoint or the A-G radar cursor position which can then be used by flight members to “walk” their sensors (AG radar cursors, TGP, etc.) onto a target or point of interest.

#### **AIR-TO-GROUND DATA LINK STEERPOINT**

A-G steerpoint data link is accomplished hands-on using the HSD as an SOI. The HSD can be selected as the SOI using the DMS (Display Management Switch) aft position upon which the MFD SOI (Sensor of Interest) box (on the MFD perimeter) is placed on the HSD. Hands-on selection of the steerpoint location is done by placing the HSD cursor on the desired steerpoint and designating with TMS foward. Transmission of the A-G data link message is accomplished by depressing the COMM switch right while the HSD is the SOI, and also annunciates an audible tone in the headset. A highlighted XMT will also be displayed adjacent to OSB 6 on the HSD base page. Alternatively, the pilot may select the steerpoint he wants to data link via the UFC (Up-Front Controls – ICP), switch the SOI to the HSD and then depress COMM switch right (Control “p” as the keystroke default). Data link steerpoints shows up as a large yellow X symbol on the HSD and are stored in steerpoints 71-80 which allows multiple DL steerpoints to be retained by the navigation system. Once they are all filled up, #71 will be overwritten and subsequent DL STPTs will overwrite the other numbers.



Assignee's HSD showing DL STPT



Assignee's HUD

## **Special Considerations for A-G Intraflight Data Link Operation**

The transmit address may be changed before transmitting a STPT or A-G cursor position (A-G cursor position is described below). The system default is your team's broadcast address (a number ending in "0", i.e., 20). Transmitting to this broadcast address will send the data to individual groups or teams with the same first digit in their ownership address: e.g., transmit address 20 will transmit to address 21-24. If, for example, the flight leader of four F-16s wants to data link a mark point to all members of his flight and their addresses are 21 through 24, he would enter a transmit address of 20 in the XMT field and initiate data link transmission with SimCommsSwitchRight (Control P). The data linked mark point would be displayed on the HSDs of all flight members in the intraflight link. Likewise, if his 4-ship is apart of a package of 8 aircraft, and the other flight's broadcast address was 10, he could enter 10 and transmit A-G data to the other flight of four.

A transmit address not ending in zero is directed to a single respective aircraft. For example, if a pilot wanted to send a mark point to only his #3 wingman, and the wingman's team address is 13, the pilot would have to enter 13 (the wingman's address) in the transmit address field on the AG Data Link page. When the pilot transmits the message only wingman #3 will receive the message and have the markpoint displayed on his HSD. Entering in a specific transmit address is only for A-G operations and does not affect A-A intraflight data link. As described in the paragraph above, transmission of data to a single aircraft can be done to a member outside of your immediate 4-ship team. In other words, if you were address 21, and there was a flight of 4 with addresses 11-14, and you wanted to transmit a mark point to only the leader of that flight, you would enter 11 as the transmit address and initiate the data link transmission.

## ***Air-To-Ground Cursor Position Data Link***

The A-G cursor function provides a hands-on transmission of A-G FCR cursor position. This function is available independent of system master mode while the FCR is in ground map (GM), ground moving target indicator (GMT), or SEA modes and requires the FCR to be the sensor of interest (SOI) for transmission. It also provides A-G cursor data link reception independent of any data link mode.

### ***Transmitting A-G cursor position***

Transmitting ownership A-G cursor coordinates is accomplished hands-on by making the FCR the SOI and slewing the radar cursor with the CURSOR/ENABLE control to the point-of-interest and then depressing COMM switch right on the throttle (Control "p" as keystroke default). An audio tone is audible in the headset and the mnemonic XMT is highlighted for two seconds adjacent to OSB 6 on the HSD. The pilot will not see his own A-G cursor position data link symbol, which is a yellow asterisk (\*) symbol.

### ***Receiving A-G cursor position***

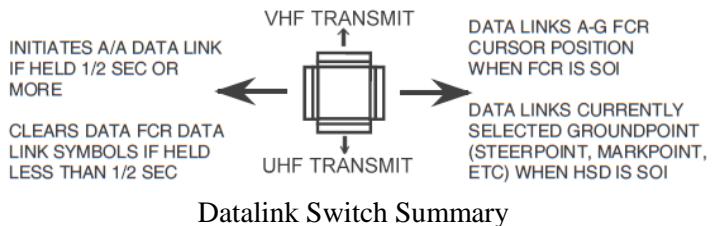
Reception of A-G cursor data link message is independent of the current data link mode. Several cues are provided by the avionics system to indicate reception of a data link message. An audio tone is activated followed by the aural VMU message "DATA" in the headset and the HUD message, "CURSOR" and "DATA", in the middle of HUD. This HUD message remains until the DRIFT C/O switch is positioned to WARN RESET on the ICP or the data is no longer valid (i.e. 13 seconds has elapsed since cursor reception). After reception of an A-G cursor message, the HSD and/or FCR (if it is in one of the three ground-map modes – GM, GMT, SEA), display the data linked A-G cursor symbol (\*).

However, this symbol is blanked on the FCR if either FZ is selected or the radar is in FTT (fixed target track). The symbol is displayed with an ID (1-4) which represents the message source (team member 1-4) or displayed as a 2-digit number representing the IDM address of another member of the 8 ship team that is not members 1-4). This symbol remains on screen for a total of 13 seconds and begins flashing during the last 5 seconds if it is within the display FOV. If ground data link has been decluttered (via OSB 17) on the HSD control page, no A-G cursor symbol will be displayed on the HSD. The system stores and displays a maximum of 3 different data linked cursor positions simultaneously, subsequent receptions overwrite existing locations in a rotary fashion. The data linked cursor position is not stored in a steerpoint.



Assignee's FCR, HSD and HUD. Assigner sent cursor data that happens to be collocated with a steerpoint.

A new AI wingman/element command can be found by pressing “w, w” or “e, e”, respectively. “Datalink Ground Target” is a new command that will request the AI to datalink his A-G FCR cursor position of his target of interest as described above. Note that this command only works if you are either a flight lead or an element and have an AI wingman under your command.



### **Transmitting DL Steerpoints – SP vs STP**

There is an important consideration the pilot must be aware about when it comes to transmitting steerpoints, particularly when it deals with the A-G radar. In SP mode, after TMS forward and slewing around, the pilot is actually slewing his current steerpoint around. This is important to know because the pilot can slew to a target using this mode, DMS down to transfer the SOI to the HSD, and then SimCommsSwitchRight (Control P) and transmit a STPT (i.e., the position of his cursors *as a steerpoint*) to a team member(s). The reason why he can do this is because in SP mode, after TMS forwarding, the pilot is creating a pseudo steerpoint. If the pilot TMS afts, it will zero out the slew and the steerpoint will go back to its original location and the FCR cursors will be in the middle of the scope. Currently, in STP mode slewing around *does not* slew the current STPT around in the same manner (in RL it should). So attempting to slew in STP mode, DMS down to move the SOI to the HSD and then transmitting a DL STPT will transfer the current steerpoint you have selected, not the position of your cursors (as a steerpoint). For more information on SP mode, see the BMS 2.0 manual (search for “pseudo”).

## **IDM Tutorial**

With the above knowledge you are ready to learn some basics in using the IDM in the tactical environment. We will discuss A-A operations and A-G operations.

### **Air-to-Air**

You are the flight lead of a 4-ship of human wingmen in a multiplayer OCA mission. Your role is to conduct a sweep to clear the airspace of enemy fighters before the strikers behind you bomb their target. Armed with AIM-120s, AIM-9s and your trusty IDM, you're ready to deal with any enemy groups that come your way. After getting safely airborne, your wingman, element leader and his wingman gain visual and join up in fluid 4. You briefed your flight

that you the flight lead would be the IDM controller for Continuous mode. You initiated the IDM “round” with “comms switch left >.5 secs” right after takeoff and have been receiving data link rounds from your flight ever since. After fencing in and getting ready for combat, your formation has two groups split in azimuth 10 miles apart – it looks like both groups are two-ships. They are hot and have moved into factor range and decide to commit on them.

Knowing that you can assign targets in CONT mode (even without the wingman labels showing on the FCR), you bug the eastern group lead contact, and hit OSB 9 on the FCR and transmit an assignment for #3 to target that group followed by a radio call to your #3, “Viper13, target group bullseye 090/20, twenty thousand, data”. “3!” Number 3 does almost the identical steps as you have done and targets his wingman, #4, onto the second contact in his group.

Next you slew your radar cursors to the group you intend to target, bug the second contact in that formation and hit OSB 8 followed by a radio call to your wingman, “Viper12, sort group bullseye 090/10, twenty thousand, data”. Number two sees the IDM assignment and quickly calls “2, sorted”. Lastly you lock up the lead contact in your group and hit OSB 7 to send an assignment to your flight indicating your targeting. Since you’re in CONT mode, from here on out, your flight member’s bugged targets remain updating on the HSD and FCR every 8 seconds, along with their ownership positions, ensuring everyone has situational awareness on both groups and each other. Soon, AIM-120s are screaming to their targets – It’s a quick kill on all four.

### **Air-to-Ground**

In today’s tasking, you’ve been assigned to hit a column of T-62 tanks that are on their way towards the border that have the intent on attacking friendlies. You’re the flight lead of a 2-ship of BLK 40 F-16s. You’re armed with 2xCBU-87 and 2xGBU-12 and a targeting pod. Prior to taking off you brief to your wingman that you will be the IDM net controller and will be using CONT mode. After takeoff you “comms switch left” for >.5 secs and begin initiating a continuous round. Your wingman uses 5 nm scope in RWS and sees your IDM team member symbol along with his radar contact and begins a quick rejoin. After fence in and getting closer to where the tanks are expected to be, you begin searching in GMT for the column. You pick up a line of movers 5 nm north of your steerpoint. You switch to SP mode, TMS forward and slew up to the movers. You “comms switch right” with the radar as the SOI and send your GMT radar cursor position to your wingmen. Bitchin’ Betty gets his attention aurally as well as a message in the HUD. He’s got your GM cursor symbol (\*) on his HSD and FCR both and slews to its position. Next, you decide to take a Mark point at the location of the column. You hit 7 on the ICP, SEQ Right to select “FCR”, then mash ENTR. You’ve got a mark. You select RTN and next you hit 4 on the ICP, then punch in 26, ENTR to switch to the Mark point as your current steerpoint. From there, you switch the SOI to the HSD and hit comms switch right again. This time it sends a datalink steerpoint to your wingman, which is a more permanent means for him to maintain SA on the position of the column. He then switches to STPT 71 as his current navigation steerpoint and gets more useful navigation information. After positively ID’ing the column, you and your wingman begin a high wheel attack on the column and lay down some serious punishment.

With the background text and two examples, you should have a good working idea of the capabilities of IDM and how useful it can be in the tactical environment. Practice and experimentation will lead to understanding and developing proficiency with this valuable tool. Good luck and check six.

## **Final Considerations**

There are a few last considerations you need to know about the IDM system in Falcon. During mission planning/mission building, when you are building a package of aircraft, the first flight (in this case a 4-ship) in a package will be assigned addresses 11-14. The next flight will be 21-24 and so on. If during planning you adjust takeoff times so that, for example, the first flight you created takes off later than another flight in the package, the first flight you created will *still* use addresses 11-14. This is important because your IDM addresses may be different than what you thought they were going to be if you were not familiar with the order in which the flights within the package were created. A good technique is to check your team addresses when you get into the cockpit and then reference the kneeboard in the 2d cockpit for the other flights in your package. It will/should list them in the order in which they were created. This can help you select the right transmit addresses for another flight in your package (if there are several flights in the package and you want to “play” specifically with one of those flights).

Another consideration is the flexibility of the IDM. For example, you are 2-ship of DCA and apart of a package that has 4 flights total. You are addresses 11-12. In your IDM you will have 11 and 12 already plugged in. You decide that you want to maintain situational awareness on only the flight leads of the other flights. You can enter 21, 31, and 41 in the IDM and receive their positions on the HSD.

The last consideration involves contingency planning. Normally the flight lead would be the net IDM controller of a flight. If he is shot down, another flight member (normally #3) will have to take over and set CONT mode and reinitiate the DL rounds.

## ***Electronic Warfare – ALE-47 Countermeasures Dispenser Set (CMDS)***

The ALE-47 Countermeasures Dispenser Set (CMS switch and controls) and electronic warfare system (EWS) has been rewritten. There are now 6 chaff/flare programs: Manual programs 1-4, selected one at a time on the CMDS control panel, activated with CMS forward, manual program 5 activated via the cockpit slap switch, and manual program 6, activated with CMS left. The CMS keystroke names are:

SimDropProgrammed

SimECMConsent

SimECMStandby

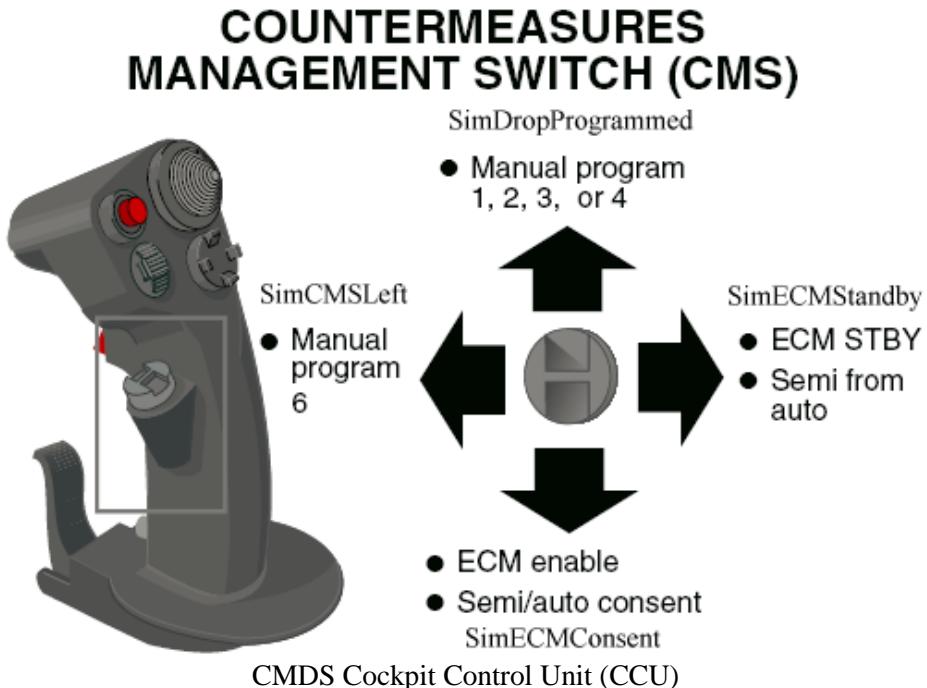
SimCmsLeft

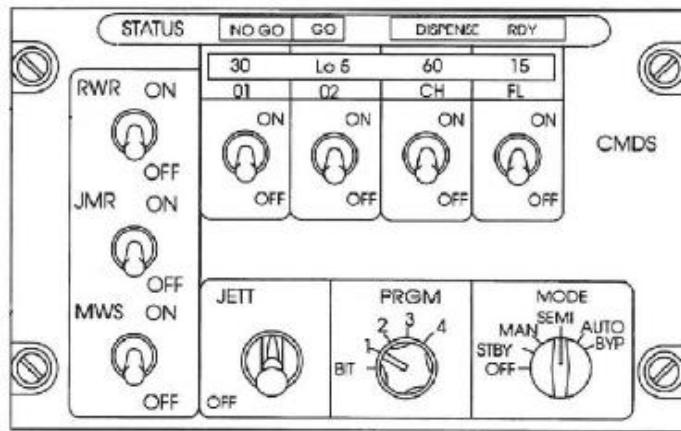
SimSlapSwitch

SimEcmPowerOff

SimEcmPowerOn

See below for a complete description of each keystroke. To program your HOTAS to operate most realistically, the switch layout is as follows:





There are two significant modes of interest selectable with the Mode knob on the CCU that differs from previous versions of Falcon – Automatic and Semi-automatic. For automatic (AUTO), consent once given is assumed until it is explicitly canceled with a CMS right. For semi-automatic (SEMI), consent allows the CMDS to run the program one time only. If the system determines that the threat persists after that (or another has appeared) then it will prompt you for consent again (COUNTER voice message). Note that for SEMI and AUTO, the consent state is tracked even if the CMDS is not yet in SEMI/AUTO. What that means is that in the presence of a threat if you have previously done a CMS aft (consent) and then you switch the mode to AUTO, the CMDS will start dispensing right away based on the previous consent. It is recommended to make sure that you inhibit release prior to entering SEMI or AUTO so you won't inadvertently spew countermeasures. If the CMDS thinks it should be dispensing in SEMI and AUTO and you haven't yet consented, it will always prompt you (COUNTER).

The way SEMI and AUTO modes work now is sort of analogous to the difference between semi-automatic and automatic weapons. For AUTO, when you press the consent (CMS aft), the CMDS unit will keep on dispensing, i.e., rerunning the program over and over until the threat ceases. For SEMI, however, the CMDS unit will not dispense until you hit consent (CMS aft) and then it will run exactly one program run through. If more are warranted after that first one, in SEMI, the "COUNTER" VMS message plays again to prompt you for consent.

All of that affects the programs that you select with the program knob; programs 1-4.

## Programs 1-4

Well, with the MODE knob in Manual (MAN), SEMI or AUTO, the CMS fwd (run program) command will manually activate the program currently selected via the PROGRAM knob (i.e. 1-4). Note that this manual activation will override any automated-initiation dispense program that may be running (if any). Programs 1-4 are also run when consent is given and a threat (i.e. missile launch detected) is present –one shot for SEMI, continuous for AUTO. If you are in AUTO and there is a threat and a program is running and then you mash CMS fwd, the manual program will run immediately (i.e. the program that the AUTO was running is stopped and a fresh run is started – it's the same one because CMS fwd activates the same program(s) that SEMI/AUTO use). If after running the manually commanded program run, and the threat is still there, AUTO will once again commence running programs for you.

## Programs 5 and 6

There are separate controls that allow you to run these at any time you want. Direct access keys/commands if you will. Program 6 is activated via CMS left. Program 5 is activated by the slap switch; in the real jet this is a big button that lives on the cockpit wall just outboard of and above the throttle grip. The useful thing about these is that it means you have one-touch control over manual activation of three separate programs without changing the knob(s) on the CMDS panel. For example a pilot could have things set that the 1-4 program selected is general purpose ch/fl combo while 5 is chaff only, optimized for radar missile defense and 6 is flares only for low level MANPAD defense or for the merge.

The BYP position of the MODE knob just means that you get exactly one chaff and one flare for any dispense that you command manually (there is no automated or semi-auto dispense in BYPASS). This may be useful when you hit the BINGO values for ch/fl and maybe you want to go to a mode where you are really careful with how many consumables you dump overboard. This gives the pilot pretty fine grain control without reprogramming #1-6 via the ICP/DED.

**NOTE:** There are also two new keystrokes that are used to control electrical POWER to the jammer.

SimEcmPowerOff  
SimEcmPowerOn

These may be used as necessary if the pilot wanted to give consent to dispense chaff/flares, but not jam a threat. Note that above for the CMS switch “ECM Stby” means the ECM will not radiate (jam a threat). “ECM enable” means the ECM will jam a threat. If SimEcmPowerOff is selected, you will not be able to jam any threats and “ECM Stby” and “ECM enable” will have no effect since the jammer is off. They will however, still change the dispenser mode (semi from auto, consent).

## Callbacks and Keystroke Technical Descriptions

### New Switch callbacks:

CBEEcmPower, #259 : A two state switch. 0 = OFF, 1 = OPR

This is for the power control of the ECM Jammer, ECM control head, left console. Note that the STBY position is not currently implemented so this one goes direct from OFF to OPR.

CBEEwsJett, #260 : A two state switch, 0 == OFF, 1 == JETT

This is the ALE-47 Jett switch on the CMDS panel

### Modified switch callbacks:

CBEEWSPGMButton, #159 EWS Program select. This one now has one extra state for 5 -- which is the BYP position of the knob.

### New key callbacks:

USER\_FUNCTION(SimEWSModeByp): This command sets the PGM knob on the CMDS panel to the BYP position. In BYP mode, normal dispense programs both manual and SEMI/AUTO are replaced with release of exactly one chaff and one flare (if expendables of each type remain).

USER\_FUNCTION(SimEcmPowerOn): This command sets the power switch on the ECM panel, left console to the OPR position which is in effect the power ON switch for the jammer pod (if present). Note that the JMR control on the CMDS panel just controls whether the ALE-47 can operate the ECM in AUTO mode now -- that control does not affect the jammer pod power at all; use this new one instead for power control!

USER\_FUNCTION(SimEcmPowerOff): This command sets the power switch on the ECM panel, left console to the OFF position which is in effect the power OFF switch for the jammer pod (if present). Note that the JMR control on the CMDS panel just controls whether the ALE-47 can operate the ECM in AUTO mode now -- that control does not affect the jammer pod power at all; use this new one instead for power control!

USER\_FUNCTION(SimSlapSwitch): This command operates the slap switch dispense button that is mounted on the cockpit wall outboard of and a little above the throttle handle. When operated, this control causes the ALE-47 to dispense manually program number 5.

USER\_FUNCTION(SimCmsLeft): This command should be mapped to the countermeasures management switch on

the F-16 control grip (aka H4 on Thrustmaster joystick controllers) in position CMS left (H4L). When operated, this control causes the ALE-47 to dispense manually program number 6.

**USER\_FUNCTION(SimEwsJett)**: This command corresponds to the JETT switch on the CMDS control panel. When operated this command causes any remaining flares to be jettisoned.

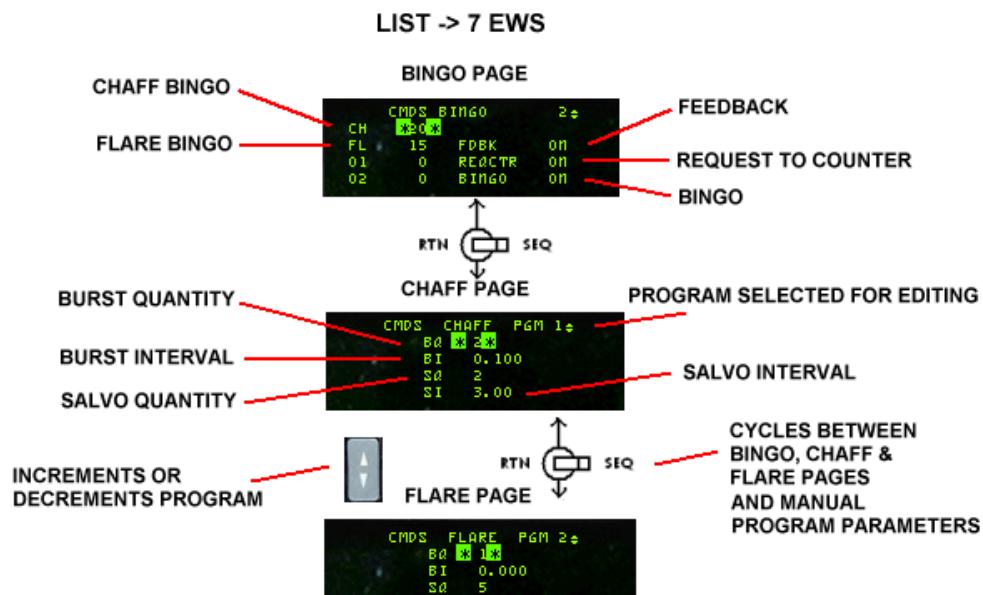
### **Modified key callbacks:**

**USER\_FUNCTION(SimECMStandby)** : This command should be mapped to the countermeasures management switch on the F-16 control grip (aka H4 on Thrustmaster joystick controllers) in position CMS right (H4R). When operated, this control disables consent for the ALE-47. In effect this prevents the SEMI and AUTO modes from dispensing until a consent is noted. The control is now dual purpose in that if the ECM pod is powered on, it will also cease any jamming emissions from the pod.

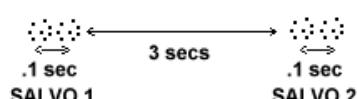
**USER\_FUNCTION(SimECMConsent)** : This command should be mapped to the countermeasures management switch on the F-16 control grip (aka H4 on Thrustmaster joystick controllers) in position CMS aft (H4D). When operated, this control enables consent for the ALE-47. In effect this allows the SEMI and AUTO modes to dispense. For the AUTO mode, if consent has been given (note: even if that was before the AUTO mode was entered!), the the ALE-47 will dispense the currently selected program (determined by the PRGM knob) and will repeat that program as long as a missile threat is present. For SEMI mode, the ALE-47 will dispense the current program exactly once per consent, so to release the program a second time if the threat remains active, the pilot must consent a second time by activating this control. The control is now dual purpose in that if the ECM pod is powered on, it will also start jamming emissions from the pod.

For completeness, remember to map **USER\_FUNCTION(SimDropProgrammed)** to CMS fwd (H4U) for a complete mapping of the CMDS controls to your HOTAS.

## **Ded Upfront Controls**



Example from CHAFF page above: 2 chaff @ .1 sec



The CMDS DED upfront controls are located on the EWS BINGO page and CMDS PGM pages. The BINGO page is accessed from the LIST page by depressing button 7 on the ICP.

The bingo quantities for expendables are DTC loadable and can be changed via the UFC. These values can only be changed when the CMDS CCU mode knob is in STBY.

The REQCTR (request to counter) option enables/disables the counter VMU message used to indicate that the EWS has determined that expendables should be dispensed and manual consent is requested.

The BINGO option enables both the LOW VMU message used to indicate that an expendable has reached the bingo quantity and the OUT VMU message is used to indicate that an expendable is depleted. The bingo quantity can be set to a value between 0 and 99.

The FDBK (feedback) option enables/disables the CHAFF FLARE VMU message used to indicate that an expendable program has been initiated.

The CMDS PGMs can be changed when the CMDS CCU mode knob is in STBY. Positioning the DCS to SEQ selects the expendable category (CHAFF or FLARE) for the manual program number in the upper right corner. The manual program being displayed/changed is selected via the INC/DEC switch. Positioning the DCS up or down moves the asterisks among the manual parameters (burst quantity, burst interval, salvo quantity, and salvo interval). The manual program parameters can be changed to any value within the following limits:

Burst Quantity – 0 to 99

Burst Interval – 0.020 to 10.000 seconds

Salvo Quantity – 0 to 99

Salvo Interval – 0.50 to 150.00 seconds

## **Radar Warning Receiver (RWR)**

Significant changes and bug fixes have been made in the operational modes of the RWR. Spurious RWR sounds without symbology should no longer be heard by the pilot. The function of the HANDOFF button and RWR modes encompasses the majority of the improvements made.

In all previous versions of Falcon, the HANDOFF button was a one-click or one-press button. In this version, depending on how long the button is pressed determines what operating mode the RWR is under. The following describes the button operation:

Short push = less than 1.0 second.

Long push = more than 1.0 second.

**NOTE:** Short push and long push are general RWR “control” terms and apply to using both a keystroke as well as using the mouse to click the 2d/3d pit art. However, using these controls vary a little bit when using a keystroke versus the mouse.

## HANOFF Modes

There are 4 operational modes of the RWR. They are: normal, diamond float, transient and latch modes.

### ***Normal***

Using the HANOFF button controls how each of these modes are entered and controls the function of the diamond symbol on the display. In normal, the diamond symbol is inhibited and threat audio is limited to “new guy” (or new threat) alert and missile launch audio. New guy audio is 3 bursts of sound in 1.5 seconds of that emitter. New guy alert is also seen visually by symbols alternating between normal size and 1.5 times normal size for the first 4 seconds of display. Normal mode will yield a fairly quiet RWR.

### ***Diamond Float***

Diamond float mode is entered via a short push of the HANOFF button. In this mode the diamond symbol on the HANOFF button illuminates and the diamond on the display floats to the highest priority symbol. Sound for that emitter is heard continuously. Another short push of the HANOFF button will deselect this mode and go back into normal mode. This mode is recommended for maximum SA and is the default mode.

### ***Transient***

Transient mode is entered by pressing and holding the HANOFF button. In this mode the diamond symbol steps from the highest priority symbol to the next highest in descending priority order. The diamond will continue stepping for as long as the HANOFF button is held and audio is played as the diamond enhances the symbol. Releasing the button changes the mode to latched.

### ***Latch***

In latched mode the diamond symbol remains on the last symbol it was on when the HANOFF button is released. Sound for that emitter is heard continuously. If the symbol times out (emitter no longer detected), the RWR will go back to diamond float mode.

## Using HANOFF

The HANOFF button may be actuated with a keystroke or with the cockpit art. For simplicity, it is recommended that pilots map a keystroke to the keyboard or HOTAS as the short and long pushes are modeled correctly as stated above. For 2d cockpit, clicking the mouse works as follows:

Left-click = short push

Right-click = long push; then to “release” a long push, either left or right click

BUTTON LEGEND	LAMP	2D ART CB#	LAMP OPERATION DESCRIPTION	BUTTON PRESS FUNCTION
HANDOFF	diamond	21	On only when a HANDOFF mode is engaged (FLOAT, TRANSIENT or LATCH). Off otherwise.	See description of HANDOFF function above.
	H	5	On full time but only when power is present to the RWR.	
MODE	PRI	22	On provided there is power to the RWR and the PRIORITY mode is engaged. Mutually exclusive with the OPEN lamp. This lamp will also flash at 4Hz when in PRIORITY mode and the RWR is currently tracking more than 5 radar sources painting ownship.	Press to toggle between OPEN and PRIORITY mode. OPEN mode shows up to 12 tracks normally or 16 when UNKNOWN mode is engaged. PRIORITY mode shows only the most lethal 5 tracks that the RWR currently tracks.
	OPEN	168*	On provided there is power to the RWR and the PRIORITY mode is NOT engaged. Mutually exclusive with the PRI lamp.	
LAUNCH	MISSILE	20	Red. On provided there is power to the RWR and if a radar missile is being guided on ownship. Flashes at a 4Hz rate when "on".	No button function implemented.
	LAUNCH	20	Red. On provided there is power to the RWR and if a radar missile is being guided on ownship. Flashes at a 4Hz rate when "on".	
T	TGT SET	25	On provided there is power to the RWR and the target separate function has been selected by the player.	Pressing this button will spread out the currently displayed emitter symbols for 5 seconds whereupon it returns to normal display without further player action.
	TGT SEP	5	On full time but only when power is present to the RWR.	
SYS TEST	ON	N/I	Not implemented.	No button function implemented.
	SYS TEST	5	On full time but only when power is present to the RWR.	
ship symbol	U	23	Can only be on if there is power present to the RWR and one of the following conditions is true: a) UNKNOWN mode has been selected by the player (lamp on full time in this case); or b) UNKNOWN mode is not engaged but the RWR detects unknown type radars painting ownship (in this case the U flashes at 4Hz rate).	Press to toggle between UNKNOWN mode on and off. When unknown mode is on, the display will show up to 16 emitter symbols including any that are in the list of unknown type.
	ship	24	On if power is present to the RWR and the NAVAL mode has been selected by the pilot.	
	UNKNOWN	169*	On if there is power to the RWR and UNKNOWN mode has been selected on by the player.	
SEARCH	S	2	Can only be on if there is power present to the RWR and one of the following conditions is true: a) SEARCH mode has been selected by the player (lamp on full time in this case); or b) SEARCH mode is not engaged but the RWR detects search mode radars painting ownship (in this case the S flashes at 4Hz rate).	Press to toggle between SEARCH mode on and off. When search mode is on, the display will show S symbols for emitters that are detected as being in an air search radar mode.
ACT/PWR	ACTIVITY	3	On when there is power to the RWR and the RWR detects missile activity (guide or tracking modes).	No button function implemented.
	POWER	5	On full time but only when power is present to the RWR.	
ALTITUDE	LOW	4	On when there is power to the RWR and the player has selected LOW altitude threat preferences.	Press to toggle between LOW and HIGH altitude threat assessment biasing. SAM dat files assign relative threat for a given SAM radar's base lethality score for both LOW and HIGH cases which the RWR uses in assessing relative threat in real time.
	ALT	5	On full time but only when power is present to the RWR.	
POWER	SYSTEM	5	On full time but only when power is present to the RWR.	Press to toggle between RWR power on and off.
	POWER	5	On full time but only when power is present to the RWR.	

The 3d cockpit (as it stands now) is ONLY capable of producing a long push, therefore it is not recommended to use the 3d cockpit HANOFF button.

SimRWRHandoff is callback for the HANOFF button.

## Noise Bars and Cycle Timer

The RWR scope also consists of four noise bars located around the center circle at 6, 9, 12 and 3 o'clock. They indicate the status of noise in the bands 0, 1, 2, and 3 respectively; however this is not implemented and is graphical only. There is a cycle timer on the left end of the band 3 noise bar. This is a vertical bar that moves up and down. As the RWR becomes saturated with signal activity the cycle timer moves progressively slower. With no signal activity, it moves up and down in 1 second. With full RWR activity, it moves up and down at a rate of 2.6 seconds.

## RWR Control Head Buttons

This section describes the function of the buttons and the illumination pattern of the associated legends for the THREAT PRIME and THREAT AUX control heads that are used to manage the RWR in the F-16.

All lamping should show green legends when illuminated and dark when not illuminated unless otherwise noted.

All button legends are white and visible when power is both on and off. The ship symbol is the only odd man out here because it can also illuminate green if NAVAL mode is engaged.

All art callbacks are two state OFF = 0 and ON = 1 unless otherwise noted. Callbacks shows with a “\*\*” are new in this version of the code.

## Surface-to-Air (SAM) and RWR related changes

Fix for beam riders to make sure that the illumination sound is heard on the RWR with more than one missile in the air even if the first misses (previously a miss would silence the RWR even with a second missile being guided).

SAMs should no longer drop lock early with missiles in flight if a better target comes along. Now they will continue to guide on the first target; they do still switch targets just less frequently now making missiles in the air already more of a threat.

Fix for looping beam rider missiles. Now if the missile overshoots the target and goes beyond lethal blast radius the guidance from the parent unit is cut for SAMs. This also indicates to the launcher that it can/should shoot again – watch out, missile batteries appear much more aggressive as a result!

The missile launch sound will play every 15 seconds as long as the RWR has some missile launch activity continuing.

There have been additional changes to support multiplayer RWR using more accurate radar scan cone tests to see if other aircraft should show up on the ownship RWR. A new variable was added: g\_nRdrScanConeThreshold. This variable is on by default. Zero value is off which uses the old behavior that considers the remote jet scan cone to be 120 degrees in azimuth (AZ) and elevation (EL). A value above zero turns on transmission of scan cone parameters for extent and centers to other sessions as the player changes pattern and modes. The value is used as a threshold for sends. Current default is 5 degrees and change in AZ center point of more than that trips a send via dirty data to the remote sessions.

# TACAN

The primary (and only traditional) navigation aid in Falcon 4 have always been TACAN stations. Very early in Falcon, all airbases and airstrips had their own TACAN channels. Over the years, only the larger airbases kept their navigation aids. Today, navigation in BMS Korea should be pretty close to the real world navigation if one accepts the usual Falcon compromises.

TACAN means TACtical Air Navigation and is primarily a military navigation aid. It essentially combines two navigation systems (but with differences) from the civilian air navigation: VOR (VHF Omni directional Range) and DME (Distance Measuring Equipment). Often, a VOR and a TACAN can be combined into a unique system called a VORTAC. Usually, only military airbases are equipped with TACAN but since it is the only navigational aid we have in Falcon, civilians VORDMEs & VORTACs in the real Korea have been associated with TACANs in Falcon.

TACAN is a radio signal (UHF 960-1215 MHz) and as such depends on Line of Sight. That means that if a mountain is between your aircraft and the TACAN station, your instrument will not be able to receive the signal and will be flagged. This feature was not implemented in Falcon but is correctly implemented in BMS. You will get longer TACAN range when flying at hight altitude. When down in the weeds the TACAN signal might be degraded because of the limited line of sight.

TACANs are set with a channel (from 0 to 126) and a band (X or Y) (252 channels total) and an operating mode, air-to-ground or air-to-air (T/R or T/R AA). The F-16 has two ways to set the TACAN system: One primary and one backup. The backup system is set through the AUX COMM panel where the channel, band and mode are set and will work as long as the CNI switch is set to Backup. In the early days of Falcon, this was the only way to set the TACAN system.



The Aux Comm Panel, items in red are not implemented.

The primary way though is the UFC (Up Front Controller) and is used as soon as the CNI switch is set to UFC. From the ICP T-ILS sub-page, enter the channel in the scratchpad, enter zero in the scratchpad to toggle the band (X or Y) and use DCS right to toggle the mode (T/R or T/R AA).



The T-ILS (TACAN-ILS) DED page.

## Air-to-Ground Modeling

TACAN can be used in both air-to-ground (A-G) and air-to-air (A-A). A-G obviously is used for tuning a ground navigation station and using it to navigate your airplane to/from a fixed ground location. Currently in BMS all ground stations are in the X TACAN band. Refer to the Korean Navigation volume for airbases channels. To tune in a ground station, simply input the TACAN channel and band into your navigation system and set your HSI to TACAN mode. If the TACAN is in range and within line of sight, all relevant information on the instrument will be relative to that ground station. Most Falcon pilots are very familiar with this.

## Air-to-Air Modeling

Aircraft are also equipped with TACAN emitters as in real life. Depending on the type of aircraft, only distance information or both distance and bearing are transmitted. In Falcon, only the KC-10 has both and the other aircraft (F-16 included) are only able to transmit range information.

A-A TACAN is a little bit more complicated than A-G. The channels between the two coupled aircraft need to be 63 apart. The maximum allowed channel is 126, one way or another. That means that if you want to tune in another aircraft that is set on channel 11, you need to input channel  $11+63=74$ . If the other aircraft is set on channel 80, you will have to set channel:  $80-63=17$ . You can't set  $80+63=144Y$  as that's over the 126 limit. In A-A mode, band can be X or Y but the mode needs to be set to T/R AA.

When two aircraft are tied with A-A tacan, the DME information appears in the DME window of the HSI and on the lower right corner of the DED if the A-A TACAN signal is valid. The bearing pointer on the HSI (set to TCN) will spin at  $30^\circ/\text{second}$  when no bearing information is received, or will point to the direction of the emitter when receiving bearing information (KC-10 only).

In addition, regardless of HSI mode selection, if you put the TACAN in T/R AA mode, the DED CNI page will show you DME to the aircraft your TACAN is locked on to if one exists (either as XX.X if less than 100nm range or XXX miles if greater). If you see "----" instead, then you have selected a channel that has no partner aircraft to lock on to.

Humans can select any TACAN channel and any band for A-A TACAN. If more than one receiver is tied, only the closest one information will be displayed.

Let's consider the following example: Flight of three with #2 in Fighting Wing and #3 in spread. Fighting wing is a visual formation and #2 does not really need an A-A TACAN. The guy in spread might use an A-A TACAN though, especially in a simulated environment where judging distance on a flat screen might be a problem. So lead sets an A-A TACAN of 10Y and transmits that information to his flight members. If both #2 and #3 sets their TACAN to  $10+63=73Y$ , both will get the distance from their lead but lead will only get the distance from the closest tied aircraft. Obviously, that's #2, where he does not need to know the distance from his immediate wingman. To avoid that, lead and element lead tie can together and wingmen can tie together as well on a different TACAN. It can be one channel apart or even better one band apart but on the same channel: Lead on 10Y, element lead on 73Y. Wingman #2 on 73X and wingman #4 on 10X. That way, leads are tied together and wingmen are tied together as well, but by simply changing the AA TACAN band (X, Y), they can quickly make a check on their respective lead.

If humans can select any channel and band, AI (Artificial Intelligence) aircraft are using fixed TACAN channels all in the Y band. AI first flight is set on 12, 22, 75 & 85Y. The next AI flight is the same structure but one number higher: 13, 23, 76 & 86Y. And the BMS code can support up to five flights of AI with this system. That means that you can always find the AI controlled aircraft in the first 5 flights.

Refueling aircraft also works with fixed TACANs. The first tanker in the TE is assigned to channel 92Y. That's the most "logical" tanker channel to use (although most all refueling tracks in the United States have assigned TACAN channels) because the reciprocal channel is easy to find:  $92-63=29Y$  – the digits are simply reversed in that case. If there is more than one tanker in the TE, then the next one defaults to 126Y, then 125Y. So to tie on them, pilots will

have to set 63Y, 62Y, etc. You can always ask AWACS (if available) for the tanker channels, but bear in mind that the operator in the AWACS will always give you the tanker channel that you need to enter in your controls in order to get a lock.

Finally note that you can operate the up-front controls (ICP/DED) TACAN settings and those will govern the operation of your on board TACAN as long as the AUX COMM panel CNI switch is in “UFC”. If instead the CNI switch is in “BUP” then the TACAN settings on the AUX COMM panel will be used for TACAN operation. This may come in handy if you want to switch quickly between locks on two separate aircraft. Regardless though, there is only one TACAN transceiver available.

## **Electrical System**

The ELEC panel coding was redone in concert with an underlying model for the primary electrical buses in the F-16. At the present, the A/B systems are not modeled separately so for instance emergency bus 1 and emergency bus 2 are modeled as a single bus. However, many avionics systems will work only when they should work based on the power level found in the various buses, which in turn is derived from proper modeling of engine states, generator states and EPU activity. External ground power is not implemented so battery starts are always assumed.

The backup ADI is now correctly hooked up to battery power (was erroneously on non-essential power); spin up energy code model fixed so it actually works (was previously never running out of energy so far as I could tell).

The backup battery for the Ring Laser Gyro in the Inertial Navigation Unit is now modeled. This battery can supply power to the RLG for one minute keeping the RLG state and alignment intact. Outputs from the RLG are only fed to the HUD/HSD/MMC etc. while emergency power is present. If emergency power fails INS indications will be lost even though the RLG will continue to function for a minute. The good part about that is that if emergency power is restored within one minute, the INS indications return with the previous alignment state. You will notice this effect when the engine flames out in flight and the MAIN and STBY generators go offline. In this case the emergency bus is unpowered until the EPU spins up (approx 2 sec), provided of course the EPU was in AUTO and armed to fire. During the EPU spin up time therefore, you lose HUD indication and ADI/HSD cues based on INS. They will return if the EPU comes on line.

Random error injections that break the electrical generators are now resettable. You'd have to enable random errors (cfg file or use of the key callback will do the job) to see this effect. If the MAIN gen lamp comes on again after engine start other than in the case of deliberate or damage driven flame out then you can try to reset it which may succeed. A reset is accomplished by pressing the CAUTION RESET button on the ELEC panel. You can also perform this reset by moving the MAIN power switch to BATT and then back to MAIN. If you do this however note that the EPU will spin up because moving the switch removes STBY generator power so the EPU in auto mode will spin up. If you perform the reset using the main power switch, recall that you need to cycle the EPU switch through OFF and then to NORM to secure the EPU from running and set it back in ready-to-run (ARMED) mode. If the STBY generator light comes on in similar circumstances then the only way to try and reset that is with the ELEC panel CAUTION RESET button. A new key callback has been added for this function is:

```
SimElecReset -1 0 0xFFFFFFFF 0 0 0 1 "ELEC-Electrical RESET"
```

This operates as a momentary pushbutton type (i.e. press-release in a single callback).

Gear down lights are now tied to the emergency bus as they should be. This is player relevant because during the start up sequence the dash one advises you to watch for those lights to come on with the STBY generator and before the MAIN generator as a signal to you that the emergency bus is getting power correctly. The SEAT NOT ARMED caution lamp functions the same way for this check purpose.

There are a number of related updates for RAMP start devotees with extended support for hardware cockpit builders.  
NOTE: None of these checks are required when ramp starting.

Changes to shared memory header and related code:

- Added OXY LOW eyebrow lamp support (split face now separate from canopy)
- Mechanized EQUIP HOT caution (pay attention to avoid unpleasant side effects!!!)
- Added FLCS A|B|C|D power test lamp (TEST panel)
- ALT fault and OBS bits removed since they weren't ever used.

Near complete model of OBOGS (OnBoard Oxygen Generating System) that includes dependency on electrical and engine bleed air power to keep the supply going. Also models reserve plenum. This is used to drive caution cell (re-legended to OBOGS) and the OXY LOW right eyebrow element of the split face lamp (other half is CANOPY which is mechanized separately).

Updated cabin pressure detection code (RAM air faults also).

OIL and HYD lamps are now combined as they are in the real jet – this warning lamp is NOT a split face.

TEST panel:

- FLCS power test mechanized
- FIRE/OHEAT test mechanized (includes CSFDR MFL entry)
- OBOGS BIT test mechanized (think OXY QTY position for older jets)
- Probe heat test mechanized, PH On position mechanized (could be hooked to weather code one day...)
- EPU GEN test mechanized

The EPU code has been completely re-written so it works properly according to the dash one. It consumes hydrazine at the proper time but will also run fine on AIR alone if there is engine rpm to provide bleed air (it didn't do that before). EPU GEN test now works as per the ramp start checklist. EPU AUTO mode priming will work properly regardless of RAMP, TAXI or air start in the game. All EPU related code re-factored to its own class.

ELEC panel updated so the lamp indications actually match what should happen for RAMP start check list items and jet power up sequence. FLCS PMG light mechanized. FLCS RLY and TO FLCS lamps corrected. EPU GEN and EPU PMG lamps function with the EPU and EPU GEN test functions.

Environmental Control System (ECS) modeled to back up the AIR COND updates and OBOGS and equipment cooling functions. Read the dash one for more on what this unit does and how it provides power/control for onboard oxygen and air cooling systems. OXY LOW warning now mechanized for right eyebrow (see dash one for operating criteria).

Added keystroke callbacks:

- SimProbeHeatOn – places probe heat switch in the up position
- SimProbeHeatOff – places probe heat switch in the center position
- SimProbeHeatTest – places probe heat switch in the down position
- SimProbeHeatMoveDown – move probe heat switch down one position; no wrap.
- SimProbeHeatMoveUp – move probe heat switch up one position; no wrap.
  
- SimObogsBit – press to initiate OBOGS bit
- SimEpuGenTest – press-and-hold callback for EPU power test
- SimFlcsPowerTest – press-and-hold callback for FLCS power test
  
- SimOverHeat – press-and-hold button on the TEST panel that corresponds for the FIRE and OVERHEAT TEST function.

# Flight Control Panel

A more complete implementation of the flight control panel and associated logic was added.

New key callback: `SimDigitalBUPOff` complements the older `SimDigitalBUP`. Now both are active and work to correspond to placement of the switch on the FLT CONTROL panel. At present the FLCS implementation of backup modes is not present so for now this is mostly there to help complete checklist functionality.

Some new callbacks are: `SimManualFlyupEnable` and `SimManualFlyupDisable`. These really only make the bat switch move in the 3D pit for now since the BLK5X jets don't have a real function behind this control.

`SimFLCSReset` now performs a flight control reset – this may clear FLCS faults in some damage situations. The control clears FLCS warnings and cautions flags and the CADC fault. If the underlying fault conditions return, so will the faults however.

`SimFLTBIT` now performs the flight control BIT. The control in the jet is a spring-loaded to off solenoid-held switch. The callback puts the switch to BIT and commands a BIT to commence. The switch bat latches and the RUN lamp illuminates if there is power to perform the test, the WoW switches are closed and the jet is at less than 28 knots ground speed at the wheels. Absent those conditions, the switch returns to OFF. The BIT takes approximately 45 seconds. If the BIT fails during the run (yes, it can fail, not often but it can) the FAIL lamp will illuminate, the RUN lamp will go out and the switch bat will return to OFF. This failure causes an FLCS WARNING so you will see the right eyebrow FLCS lamp light and also WARN indications the HUD. This warning is not resettable (meaning FLCS Reset switch does you no good in this case). However, you *can* rerun the BIT -- just operate the BIT switch again and the RUN lamp should illuminate again along with the FAIL lamp being still on. If on this subsequent run the BIT completes, both lamps will go out and the bat switch will return to OFF. In this implementation, BIT failure is never a hard failure – rerun and it will succeed; yes it can fail multiple times before succeeding but chances are very slim that you will see one failure much less two or more in a row. The BIT test can be visually seen (even in multi-player) as it commands the control surfaces to move. Pilot inputs are locked out during the BIT.

The above mentioned callbacks have all been added to the 3dbuttons.dat file and are clickable in the 3d cockpit. They may be added as assignable keystrokes by coping/pasting the following in the user's .key file and then assigning an open keyboard shortcut. Again, note the last four in the list are non-functional and will only move a switch (if present).

```
SimFLCSReset -1 0 0xFFFFFFFF 0 0 0 1 "FLT CONTROL-FLCS RESET"
SimFLTBIT -1 0 0xFFFFFFFF 0 0 0 1 "FLT CONTROL-FLCS BIT"
SimDigitalBUP -1 0 0xFFFFFFFF 0 0 0 1 "FLT CONTROL-Digital BACKUP"
SimDigitalBUPOFF -1 0 0xFFFFFFFF 0 0 0 1 "FLT CONTROL-Digital BACKUP OFF"
SimManualFlyupEnable -1 0 0xFFFFFFFF 0 0 0 1 "FLT CONTROL-Man Flyup On"
SimManualFlyupDisable -1 0 0xFFFFFFFF 0 0 0 1 "FLT CONTROL-Man Flyup Off"
```

Added DBU warning lamp as separate from FLCS warning. At present the only way to get this warning to trip is to flip the DBU switch on the FLT CONTROL panel. 3D pits are not updated for this as yet so you may not see it until the models catch up, unless you are using shared memory to drive external lamps. The 3D pit switch mask for this lamp is #235. The shared memory bit for this is in lightBits3:

```
DbuWarn = 0x8000, // Right eyebrow DBU ON cell; was Shoot light cue; non-F16
```

FIRE/OVERHEAT button on the TEST panel should now correctly generate a MASTER CAUTION as well as lighting the caution panel lamp cell.

Reworked the FLCS warning and caution code. The system now correctly shows FLCS problems as WARNING type rather than caution type to power the eyebrow lamp correctly. Lesser faults may still show up as cautions (PFL has NOT [yet??] been updated to match these changes however!). The bogus LEF caution was removed – that's an FLCS WARNING if you manually lock the LEFs in place now as per the real jet.

Fix for HYD/OIL eyebrow lamp – broke that inadvertently with earlier changes so that it didn't work properly for 3D pit or shared mem during ramp starts. It should operate correctly now. Also the bogus engine fault condition that would previously light this one up was removed and made sure that it comes on at the correct electrical power level only.

## **Horizontal Situation Display Changes**

There was a significant rewrite to the Horizontal Situation Display (HSD) code to fix bugs and make the code more efficient and readable.

The HSD bearing tics and North arrow have been properly scaled in size.

Ownship bugged target symbols are now displayed only when the aircraft is in an Air-to-Air mastermode (versus any) and the FCR has a bugged target.

Ownship mark points show up as yellow X's in any mastermode.

Freeze (FZ) mode now works correctly. With FZ selected, all ground stabilized data/symbology is frozen on the display and the ownship/wingmen symbols move about the display. The top of the HSD is oriented to the aircraft heading when FZ was selected. When the HSD is not the Sensor of Interest (SOI), depress and release of FZ (OSB #7) freezes the HSD about the ownship position. Upon entering freeze, the HSD utilizes the centered format to ground-stabilize the instantaneous ownship position at the center of the display. When the HSD is selected as the SOI, D&R OSB #7 (FZ) on the HSD Base page, freezes the HSD about the cursor position. Upon entering freeze, the HSD utilizes the centered format to ground stabilize about the cursor position at the center of the display. The aircraft symbol can be flown off the frozen map or can disappear due to different range scales selected with respect to the ground-stabilized center of the display format. HSD cursors, if available, can also be slewed on the map to control the Bump Range capability. The Increment/Decrement (INC/DEC) Range symbols are displayed in HSD FZ page at OSBs #19 and #20. Bump Range is available in Freeze only when the HSD is the SOI (HSD cursors are displayed). When Freeze is entered and the HSD is not the SOI, the HSD can be selected as the SOI and the HSD cursors will initialize in the center of the display format.

The pilot has the ability to set HSD Control page options for each mastermode. When the pilot sets the display parameters on the HSD Control page in the aircraft, these parameters are retained as last left upon reentering the mastermode in which they were set. Any items, which are decluttered on the HSD Control page, are saved by mastermode.

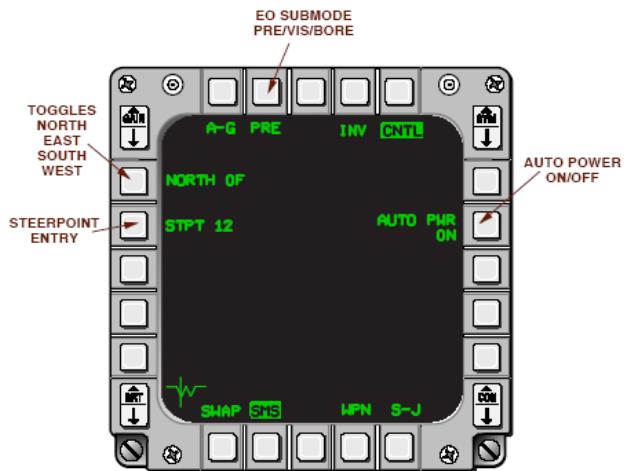
Changes to the HSD NAV point drawing code so that STPT course line and all DL and MARK points are always drawn regardless of "NAV" mode.

When using EPAF radar cues, HSD ownship bugged target symbols are now squares instead of triangles.

SAM threat rings can now be individually decluttered using the TMS aft command with the HSD as the SOI. If the threat ring is shown (by default it is), the pilot may switch the HSD to SOI, move the HSD cursors over the threat symbol and TMS aft to declutter the ring. Likewise, a TMS fwd on the threat will display the threat ring again. There may be slight difficulty if the threat is right on top of a steerpoint.

## Maverick Auto Power On

Maverick missile auto power on has been implemented in the Maverick control page. The pilot can select the cardinal direction and the steerpoint number he wishes for the Mavericks to power up at. The pilot must be within 2 nm and in the quadrant he selects in order for power to be applied automatically. For example, if the pilot is cruising west toward STPT 2 and has "WEST OF" "STPT 2" and AUTO PWR "ON", upon passing STPT 2, providing his a/c is within 2 nm of the stpt, auto power up will begin.



# Procedures



## Air Refueling

A major revision to the tanker queue management code now makes things work a little better for multiplayer. In particular, any player can call for fuel now, regardless of whether they are the host or even a flight lead. Any player calling for fuel will enqueue their *entire* flight. Enqueuing goes in #1, #2, #3 and then #4 order, skipping over any aircraft slots that are not populated (i.e., if wingmen are shot down or have landed). This follows current doctrine to give wingmen a little more fuel than flight/element leads since wingmen inherently use more fuel during “formation keeping” and should be proof against any ordering problems with KIA or aborted aircraft in a flight.

Once members of a flight are in the queue, they will be called in order without further action. Human players must call “done” (y-3 command) when they are topped off to tell the tanker it can call the next in line; AI do this automatically. Any time the next aircraft in the queue is not local to the same player session as the tanker entity, the tanker is transferred to the session that owns the next aircraft in the queue. The transfer includes the entire queue of aircraft that are waiting to take fuel as well as the queue of aircraft that have fueled but are waiting for other flight members. It also transfers the state of the tanker’s selected track pattern so that the pattern once begun continues as long as there are aircraft in the queue ready for fuel (previously each time a new player was up for fuel the tanker would start a new track pattern from scratch). Any given aircraft can be on the queue only once. Any aircraft not on the queue will be added if and when any member of its flight calls for fuel. Thus you can get some odd end cases: #1 and #2 complete fuel loading and #3 and #4 are still in the queue; #1 calls for fuel again and he and #2 only are then added to the end of the queue again since #3 and #4 are already on the queue and can’t be added a second time. Not likely to get used much but that would work if you want.

Pilots may now manually disconnect from the tanker with the NWS/A/R DISC/MSL STEP button if topping off fuel tanks is not desired. The tanker will call “disconnect” and disconnect from the receiver. The pilot may choose to hook back up to the tanker in one of two ways. The first and recommended way is to hit y-2, to tell the tanker you are ready to take fuel again. This will reinitialize the tanker boom “tractor beam” and allow you to “feel” the boom connecting (as normal). The second way is the pilot may not make any radio calls and fly into the contact position. The boom will connect and transfer fuel, but the pilot must fly precise formation in order to keep contact. This method is not recommended. The pilot *should not* use y-1 in this situation as this will add any of his AI wingmen who have already refueled (if the human is not the lead aircraft) back into the tanker queue. Upon completion of refueling, the pilot calls done (y-3) as instructed above.

To avoid problems with players in separate bubbles from the tanker while being the same flight as receivers currently queued, the tanker will assume that any jet more than 10nm from the boom tip is a no-show and that jet will be removed from the queue at the time when it would have been called to pre-contact. Note that this means you will normally want to keep a flight together so that when you call for fuel in the first place all the flight members you intend to have refuel are inside 10nm range from the tanker as well as the caller.

AI can now hook up to the tanker in the turn. They will also use the appropriate bank angle when flying formation off the tanker (see Quick Flow section). Lastly, note that if you want to terminate fueling early, any jet can call done (y-3) at any time and the tanker simply moves on to the next or moves everyone else in the list up if the caller isn’t top of the list. For AI that are on the queue, you can tell them to rejoin and that will remove them from the queue (they tell the tanker they are done if they are on the queue when you tell them to rejoin).

Summary of MP refueling procedures for a 4-ship with all human or a mix of AI aircraft:

- 1) Flight lead (generally) calls the tanker for gas. The tanker clears #1 to the pre-contact position. The tanker will clear #1 to contact position once he’s stabilized in pre-contact. Once topped off or no more fuel is desired (manual disconnect), pilot calls “Done” with y-3 command. If the pilot wants more fuel after a manual disconnect, call tanker with y-2. Upon completion, call done.

- 2) Tanker automatically clears #2 to the boom for gas if he is in the proper On-Deck position, otherwise cleared to pre-contact position. Tanker entity/ownership automatically transfers to that pilot (if he is human). Pilot calls done when topped off or desires no more fuel (if he is human).
- 3) Tanker automatically clears #3 to the boom for gas if he is in the proper On-Deck position otherwise cleared to pre-contact, again with tanker entity/ownership automatically transferred (if human). Pilot calls done when topped off or desires no more fuel (if human).
- 4) Tanker automatically clears #4 to the boom for gas if he is in the proper On-Deck position, otherwise cleared to pre-contact, again with tanker entity/ownership automatically transferred (if human). Pilot calls done when topped off or desires no more fuel (if human).

A further feature is that another flight that wants gas may call the tanker for fuel and his flight will be added to the queue. Upon when the flight currently getting gas finishes, the flight lead of the next flight will be automatically cleared to the boom for gas, as will his wingmen when it is their turn, since they are in the queue.

Real-world pre-contact positions have been added for realistic mode. Player pilots must stabilize (reduce closure on the boom tip to near zero) in the pre-contact position before being cleared by the boom operator to contact position (the Forward light will activate and a radio call will be made). This position is approximately 2 feet below the tip of the boom and 10-50 feet back from the boom tip, centered in azimuth. Notice the tip of the boom is approximately in between the 5° pitch line and the boresight cross. The position of the HUD indexers and/or HUD frame relative to the tanker's inboard engine nacelles can be used to judge the range from the boom tip. Imagine the HUD frame extending vertically bisecting the KC-10s nacelles, and just inside the center for the KC-135.



**KC-135**



**KC-10**

The best technique for moving from pre-contact to contact is to move ahead slowly, think of moving at walking pace relative to the tanker, directly at the boom tip. Do not be concerned about running into the boom tip. The boomer places the tip at the heart of the range of motion for the boom as a guide. So as you approach, think of the placement of the boom tip as marking the perfect spot for you to park under the tanker to get fuel. As you close on that ideal spot the boomer will fly the boom tip up and around your cockpit and up over the spine of your jet to reach the refuel slip way. In so doing the boomer makes it possible for you to fly the simplest course direct to the contact point and he does all the hard work to move the boom to you.

## Boom Envelope Limits

Real-world boom envelope limits have been added for both the KC-10 and KC-135. See the figures below. Preface each light with “Go”, thus an “F” means go forward, a “U” means go up, etc. The boom ‘tractor beam’ code has been re-coded from scratch and the boom now uses a critically damped spring model. Pilots will feel like they are less ‘clamped’ to the boom and now they have the freedom of flying around inside the boom envelope. The director lights

on both KC-10 and KC-135 have been redone (both in code and 3d models) and provide guidance to stay in the envelope. Note the boom operator will not use much verbal communications during A/R as this was unrealistic.

The director lights have a couple of different uses now. First, once you are cleared to contact, the boom operator can manually flash the red lamps at the end of the light bars. These are coarse grain instructions for you to follow to the correct contact position. Again, prefix the name of the light with “go” and that tells you what to do to approach the contact spot where the boomer can plug you.

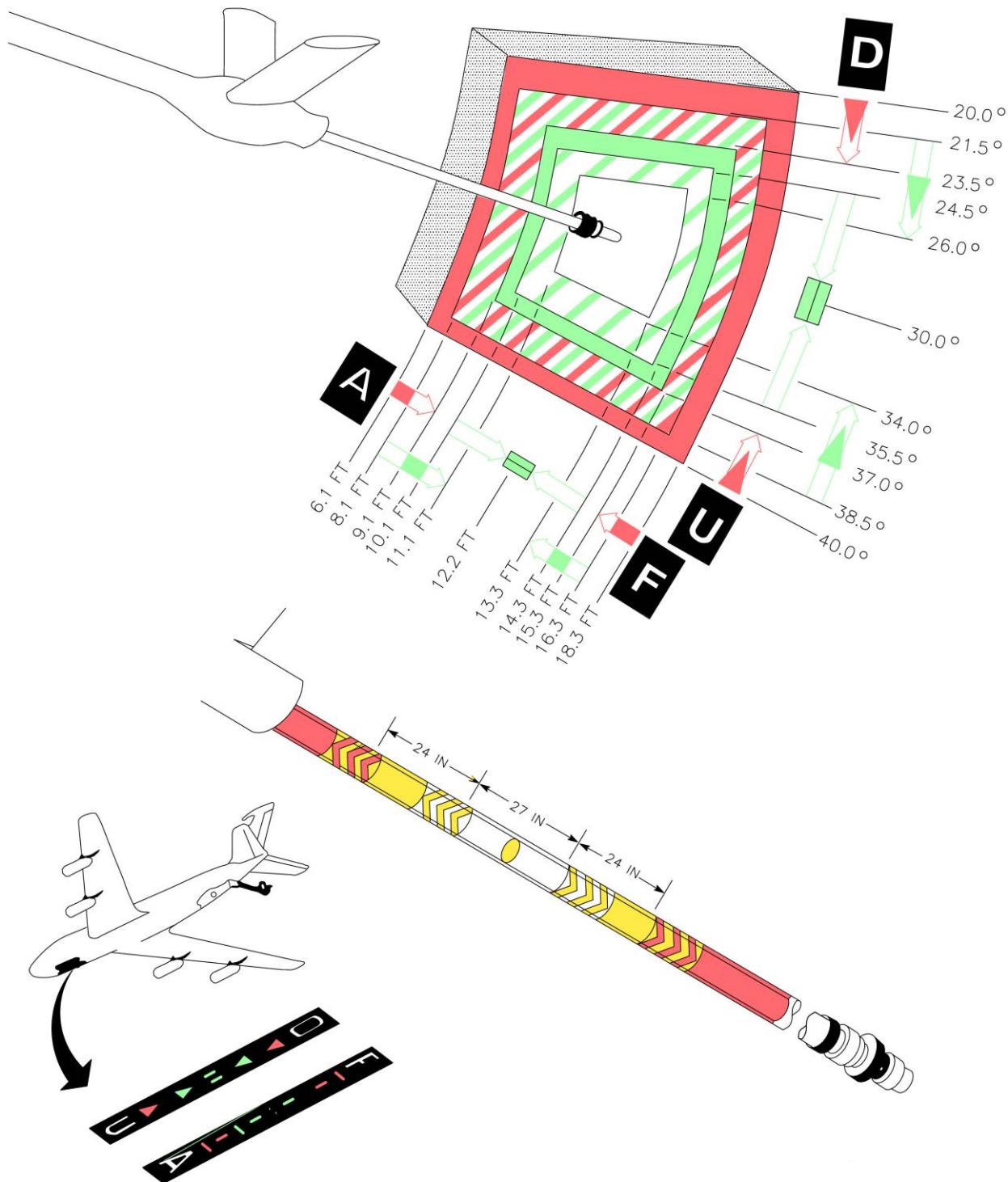
Second, if you have followed the red flashes and reached the correct position, the boomer stops flashing the lights and will start to drive the boom to your refuel slip way (assuming you stabilize in position). So when the lamps stop flashing you are in the right place...hold steady there while the boomer flies the boom to you. With luck the next thing you hear is “Conact!” and fuel will begin to flow.

Once you are connected, the lamp array gives you real time indication of where you are in the envelope of the boom range of motion. Use the “go” thought to help you get to the center of the envelope which is indicated by green bars on the left and right lamp arrays. The big tip here is to fix one of these at a time. So adjust fore and aft and then up and down or vice versa rather than trying to fix both at once. Left and right orientation is generally less of an issue since it’s relatively easy to align your fuselage with the tanker’s.

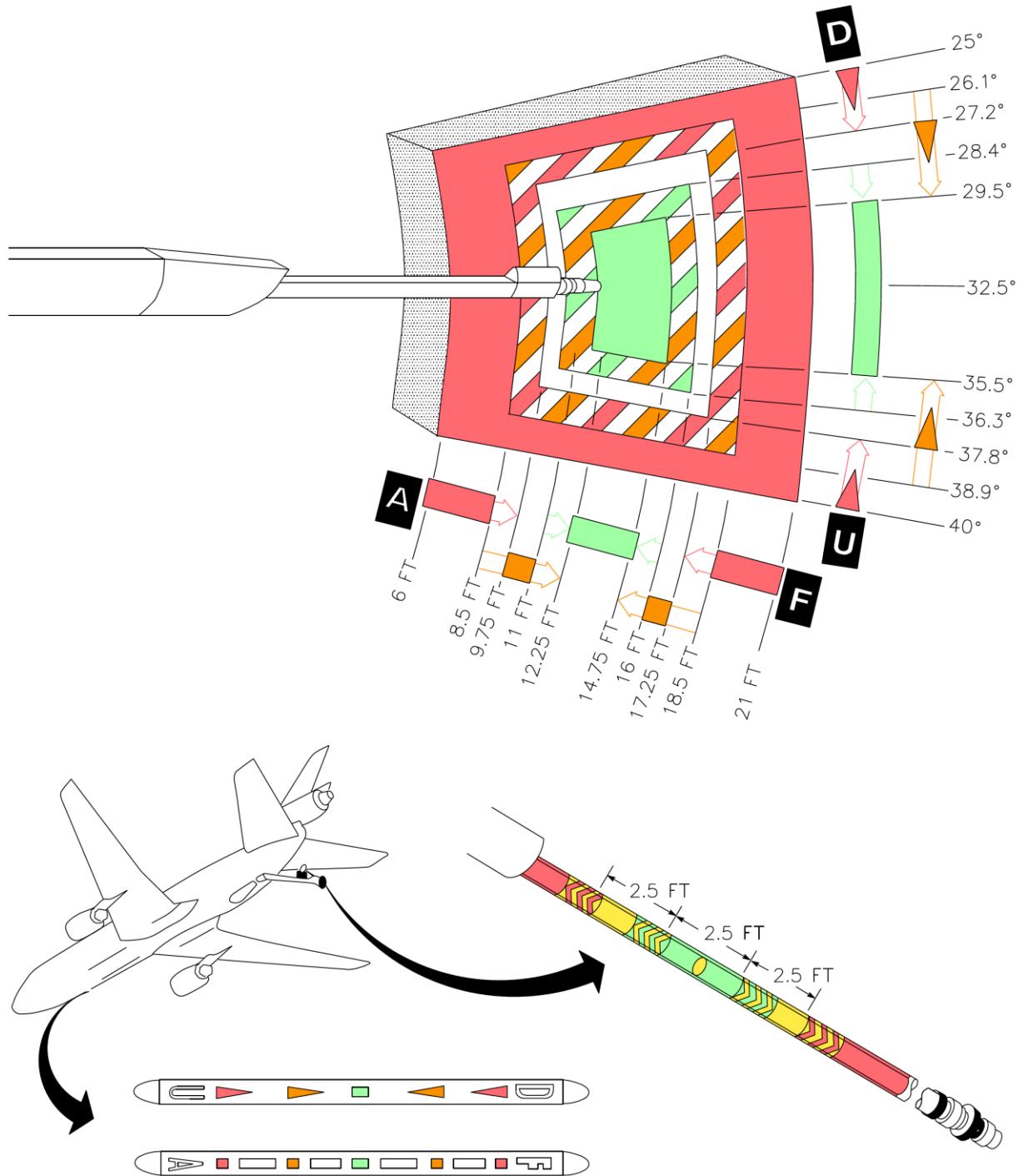
The tanker also now flies a realistic 30 degrees of bank during refueling when making turns instead of 15 degrees and uses a smooth onset of roll rate when rolling into and out of turns. When receivers disconnect from the boom, a fuel spray effect is shown.

## Procedures and Diagrams

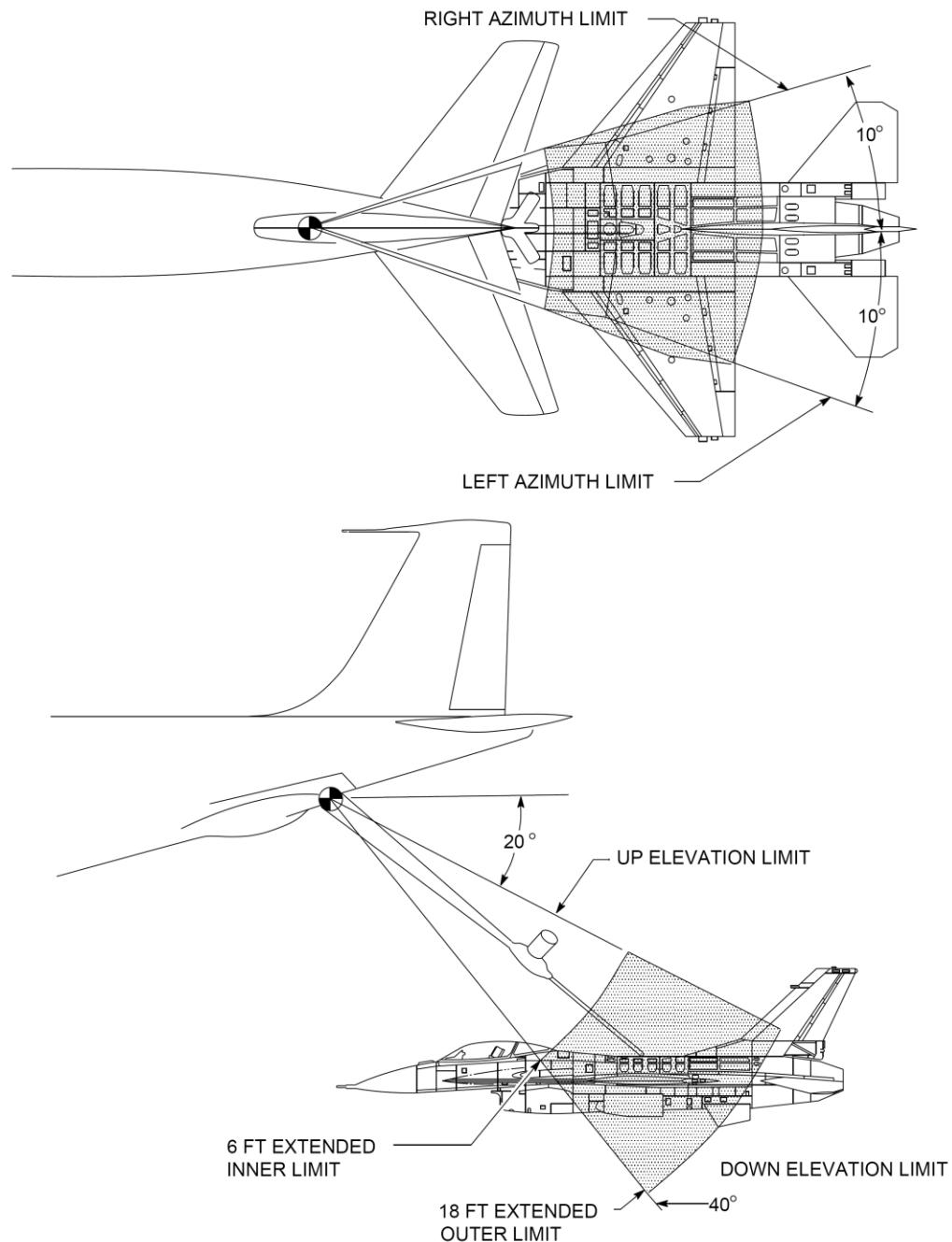
### *Receiver Director Lights (KC-135)*



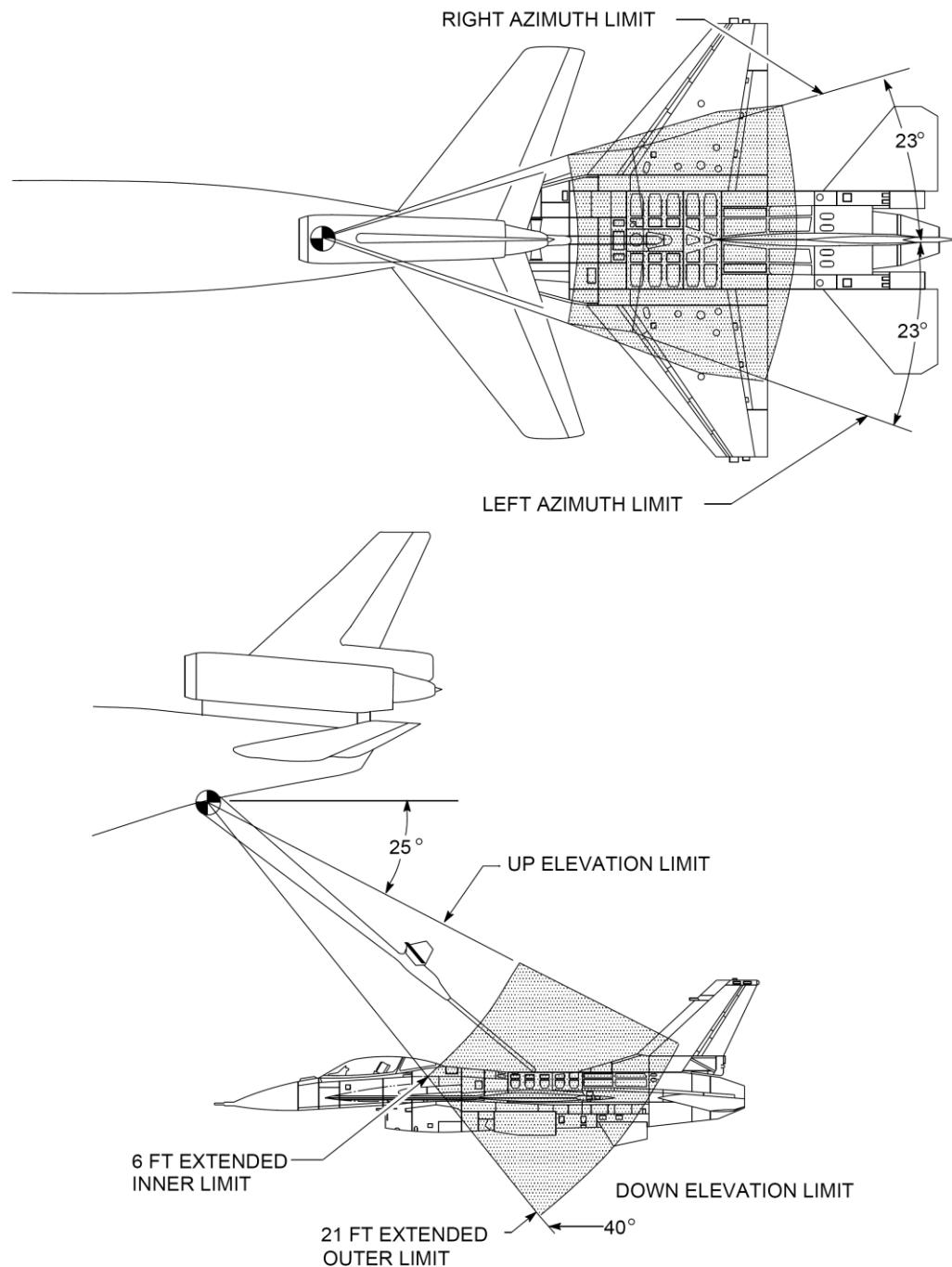
# *Receiver Director Lights (KC-10/KDC-10)*



## Boom Envelope Limits (KC-135)



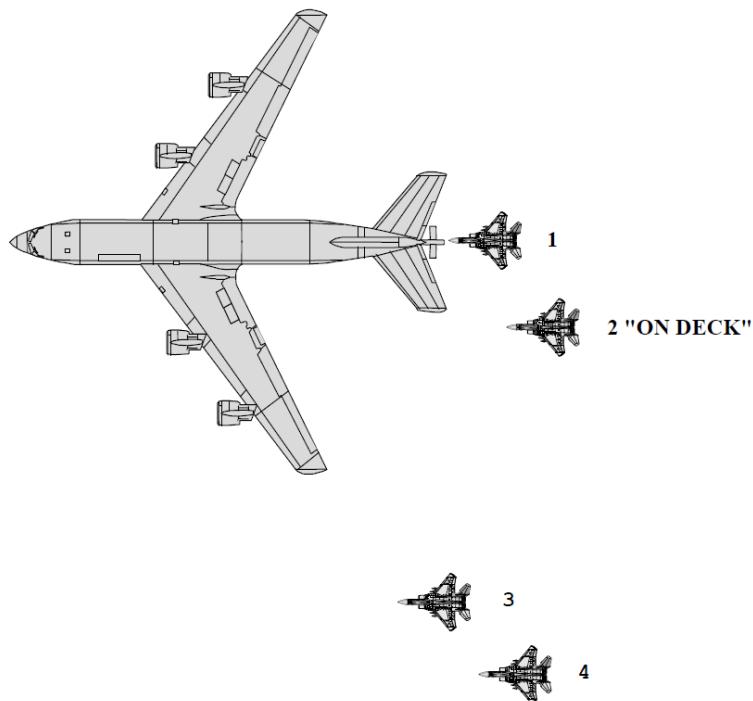
# *Boom Envelope Limits (KC-10/KDC-10)*



## Quick Flow Air Refueling Procedures

Quick Flow procedures have been implemented to expedite air refueling operations. Quick Flow allows receivers to minimize refueling time with maximum fuel transfer. The code uses left echelon formation. The receiver flight will join on the tanker with the flight lead moving to the pre-contact position. Remaining aircraft will proceed to the left observation position. Once the flight lead commences refueling, the second aircraft in the air refueling sequence should move to the On-Deck position. The On-Deck position is normally flown as a route formation with approximately 10' spacing. The third and fourth receivers will go to the observation left position. When the lead jet completes refueling that aircraft moves to an observation position on the tanker's right wing. The second receiver moves from the On-Deck position to the pre-contact or contact position as directed by the tanker. With three or more receivers, the third receiver moves to the On-Deck position. The left to right flow continues until all fighters have refueled. Additional receivers arriving prior to the first flight completing refueling operations will remain in trail position until there is space at the left tanker observation position. There will only be a maximum of three jets waiting at left observation (including the On-Deck spot) at any one time any others waiting will be in trail until there is room for them to move up.

For departure from the tanker, the aircraft at left observation will descend 1000' and take up a loose echelon left formation with each jet stepped down 100' progressively to allow the outside jets to maintain sight. The aim point for this clearing maneuver is 1000' below the tanker's present altitude and 1 NM to the right of the tanker's horizontal position. Once the flight is approaching this aim point they will be cleared to return to waypoint mode.



## Tanker Operating Procedures

All AI aircraft loitering were capped to altitudes between 5k and 20k MSL. Since tankers normally hover above the top of this cap range if they got into a loiter mode they'd often appear to dive sharply. The loiter altitude range top cap is now 26,000 feet MSL which should remove this issue.

Default tanker altitude was set pretty low...absent any other orders they seek to fly around at 10k MSL. This too can apparently make the tanker suddenly drop like a rock. Default altitude is now 22k MSL but other changes make it a lot less likely that this default will ever be needed (in theory!).

Tankers are ONLY open for business when they are shuttling between their two target waypoints. If you call one for fuel before he reaches his first target waypoint or after he departs his track station for the flight to his home base you will hear the 'unable' response. If you are doing TE design or ATO adjustment, make sure that you set tanker Time-on-Target at the first target waypoint anchor and his station time so that your tactical flights get what they need when they need it!

Tankers de-aggregated in 3D world will now fly a two minute holding pattern anchored on their first target waypoint when there are no receivers in their refuel queue. At typical speed/alt for tanker flight plans this is probably a 15-18nm oval from apex to apex. As a result the tanker should most of the time be closer to that first target waypoint where he will anchor in the holding pattern until receivers come along at which point he will fly the full track pattern.

A significant change from older Falcon4 versions is that the tanker target waypoints define the complete extent of the refuel track that they will fly. In other words, the first target point is where he anchors for holding while waiting for receivers and the second target waypoint is the exact location that he will turn inbound to the first target point again when he's flying the full track length.

Tankers in 2D world do NOT fly anchor holding patterns, they simply go from target waypoint to target waypoint back and forth. This is required presently to make 2D refueling work it seems.

Since the aggregated tanker flies the full track length all the time in 2D world, it is possible that when he de-aggregates for your flight that he's not in the holding pattern. If he has no receivers in tow he will try to enter the hold if you don't get there and ask for fuel before he reaches the anchor turn point. This may be useful to you depending on the geometry: it may be more efficient to fly an intercept on the tanker's anchor point and only call him for fuel once he enters the hold. Certainly if you join and call for fuel as he turns outbound again from the anchor point you will have the longest straight and level segment of his track to try and grab fuel before he turns again.

Note: don't place tanker target waypoints closer than the length of the typical two minute holding oval (recommend no less than 25nm separation of target waypoints for safety). If you do put the target waypoints close together, the tanker will likely get confused.

The default flight plan for tankers has been changed. Previously the flight plan would use LoiterTurnDistance (seems to be '25' for default Korea) from the falcon.aii file. The units for this are grid, which in Falcon4 world means roughly a half mile per unit. Thus target point to target point ended up around 13nm...from the above implications you will note that this is a Bad Thing(tm) so the code was changed to consult a new falcon.aii file variable called TankerTrackLength. This var has a default of 100 grids for a net track length of just over 50nm. [Note to campaign data owners: this default is in the code, if you want to override it then add that var to the data file for your theater.] 50nm was suggested as a decent default tanker track length by active duty USAF personnel in case you are wondering about that. Both the campaign ATO generator and the TE editor use this default for planning support flights with tankers – caution: old TE's probably are screwed up in this regard.

The altitude that the tanker flies at is determined by two factors:

1. When there are no receivers in the queue, the altitude set as part of the tanker flight plan is used. [The only exception to this would be for loitering in which case the flight plan altitude is used unless it is greater than 26k MSL, in which case 26k MSL is used, or less than 5k MSL, in which case 5k MSL is used.]; or
2. When receivers are in the queue, the altitude used is the one supplied by the flight plan or the one specified by the setting in the aircraft dat file and whichever of those two values is lower is the one selected. This allows for lower working altitudes for aircraft like A-10's that are loaded for bear and have a hard time making refuel altitude and speeds normally used by vipers.

One special note about track length: it is sometimes useful to assign tankers to ferry missions where you want them to fly a long path with receivers in tow able to take fuel at any and all times along the way. If you set the tanker target waypoint separation to 100nm or longer the tanker will skip holding at his anchor point and assume this is a ferry mission so he flies the entire track length for as long as station time remains. In this case, I recommend you set appropriate station time to cover just the duration of the flight between the two target waypoints. While not strictly necessary to make it exact, by making the duration at least the time it takes to transit and setting the tanker's en route speed to the same speed as receivers take fuel you can ensure that he flies the full route intended.

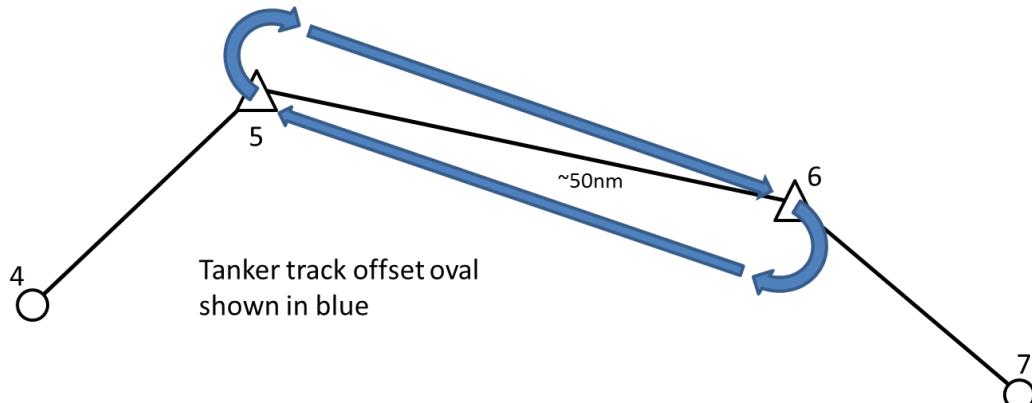
One quick point about station time: as the end of station time approaches the tanker is not required to reach the second target waypoint before departing for the next higher numbered waypoint in his flight plan. That is, if he's half way between target waypoint #3 and target waypoint #4, heading for either one and his station time expires then he will turn immediately for waypoint #5 and be closed for business at that time. This isn't a bug, it is deliberate but you should be able to accommodate that with proper flight planning (read: worst case is he turns to #5 direct from #3...if that path overflies a SAM ring...it's the TE designer's fault when the tanker is lost!).

There are a few points of additional advice for TE mission designers that may help get the most out of adding a tanker to the plan.

Set the two target waypoints to the same altitude value. While you can set them high and have the tanker conserve fuel for its own station time, usable fuel load isn't typically a problem for the KC-10 or the KC-135. Thus I'd recommend 22k MSL for the altitude -- this is the typical refuel altitude for vipers assuming default data file content.

As for speed setting at target waypoints, the ATP-56B NATO AAR operations document seems to indicate that 275KCAS is a fairly typical speed. Again, you will want to set this same speed for both target waypoints for best effect.

The actual over the ground track for the tanker as it flies between the target waypoints is sort of oval shaped.



What happens is that the steer points are used as the aim point for the long straight and level portions of the track. When the tanker reaches one of these, he initiates the turn. This turn is approximately 180 degrees and ends up with the

tanker aimed at the reciprocal target waypoint. If you think about it, what this means is that as the tanker completes the 180, he aims at the next waypoint but not from the waypoint he just reached, he's offset by one turn diameter to the side.

This means that his over the ground track to the waypoint is to one side of the ground track that joins the two target waypoints directly one to the other. Furthermore, it means that as he reaches the next steer point he does so with the previous steer point just a little to one side of his own nose-to-tail axis line.

Now, the AI being pretty simple always turns shortest way to the next waypoint. If you draw this out on paper you will see that it means that the tanker always ends up turning the same way at each target waypoint. Furthermore, the direction of that turn, left or right is directly influenced by the direction that he reaches the first target waypoint when he's inbound from the preceding waypoint.

Hopefully as a result of knowing this, TE designers can more effectively place target waypoints for tankers to get the effect they want and receivers can predict ahead of time which way tankers will turn as they perform both holding patterns and full track length traversals.

## **Tanker Radio Calls**

There are relatively few radio calls that you will hear from the tanker. This section presents a list of those and the meanings for them.

1. Unable: this means that the tanker is not yet on station or has left his station (RTB). In the case that the tanker is not yet on station, if you call again later he may reply one of the things below if he's reached his station. In the case that he's already RTB, all you will ever hear from him is "unable". Your flight is NOT queued when you hear "unable" and won't be unless you hear something other than "unable".
2. Vector to tanker: this means the tanker is on station but you aren't close enough. Get your flight within 10nm of the tanker and call again. I recommend that all jets you want to refuel in your flight be within 10nm of the tanker when you call again to ensure they all get queued properly.
3. Thirsty-11 Cleared to pre-contact: this means you as Thirsty-11 and the flight you are in are queued and the tanker expects you to join and take fuel. There is no need to call again or for any other players in your flight to call for fuel again at this point...the whole flight is queued and you should all just follow quick-flow formation procedure.
4. Cleared to contact position: this happens in two possible situations:
  - I. When you have already heard cleared to pre-contact and have successfully closed to that position and stabilized there (i.e. you are at the pre-contact position more or less stationary relative to the tanker -- boomer wants to see that you are stable and in control and not likely to ram him); and
  - II. When there is a jet ahead of you on the boom, he tops off and clears and you are presently at the on-deck position and stable. Serious bonus points for any player that can FRAPS themselves hand flying the on-deck position well enough to get cleared direct to contact...I've only managed it one time and never in a turn. The AI flies formation well enough that they routinely get clear direct to contact.
5. Roger: this means you are queued. This can happen if you call and there's at least one jet from another flight ahead of you or if you are already in the queue. I don't recommend hitting y-1 a lot once you hear #3 above for your flight but should you happen to do that, the roger confirms that you are in line.

## AI Behavior Around the Tanker

Previously the AI would get within `g_fAIRefuelRange` nautical miles (default 10nm) of the waypoint that has the refuel action and then immediately call for fuel. Most of the time this worked because the default tanker track length was 13nm and most TE designers would put the receiver refuel waypoint on or between the tanker's station waypoints. However, basic math tells you that this won't work if the tanker is now flying with receivers in tow and is at the far end of the default racetrack pattern that is 50nm long (tanker had better be deagged when sim vehicles call for fuel or Bad Stuff(tm) happens).

New behavior: at `g_fAIRefuelRange` nm from the refuel action waypoint, the AI will start looking for the tanker assigned for the flight. Two possible results can happen at this point: the tanker is in range and the AI calls for fuel or, the tanker is "far" and the AI will close.

The range for the AI to call for fuel is now set to one third of `g_fAIRefuelRange`. By default this means the tanker must be deagged and within ~3.5nm away before the AI will do the equivalent of y-1 "request fuel" call.

In almost all cases the AI will not be within 3.5nm of the tanker when it starts looking 10nm short of its refuel waypoint (again assuming default for `g_fAIRefuelRange` value, the code just divides that cfg value by 3 for this one). As a result, most of the time what the AI does is figure out where the tanker is and it flies a baseline intercept on the tanker to close to one third of the `g_fAIRefuelRange`...then it calls for fuel.

[aside: I rewrote the AI Baseline Intercept (BLI) code from scratch for this update. I needed to do that to get the AI to a) find the tanker at all (old BLI...didn't intercept so as you'd notice) and b) not shoot it down (old BLI only worked on 'targeted' things where the new one does that and friendly intercepts if needed). AI BVR might be quite a different experience now they can mirabile dictu at least on that one profile find their way out of the proverbial paper bag. This area of the code needs more serious attention still so consider BVR combat oddities a "known issue" for now.]

Now back to the tanker side of things. When receivers call for fuel they must now be within `g_fAIRefuelRange` to successfully make it onto the queue for fuel. Yes, the AI waits until one third of that range but I figure players aren't going to be as precise so you have a (default) 10nm radius to call instead.

If you call and the tanker is not on station (meaning specifically that it has not started to shuttle between the two "target" waypoints assigned to its flight plan which is also to say it has passed the first of those at least one time), then you will hear "unable" as the response.

If you call for fuel outside a 10nm (default) radius of the tanker, then he will ignore you completely. However! If there is an AWACS in the TE/campaign it will take pity on you and reply for the tanker with a vector to tanker. So please don't be surprised: if you call y-1 for "Request fuel" and hear "Vector to tanker camel 1-1 bearing 030 15 miles tacan channel 29Y" this is not a bug – you are simply calling from too far out, use the vector to help you get closer and call again when you are in range.

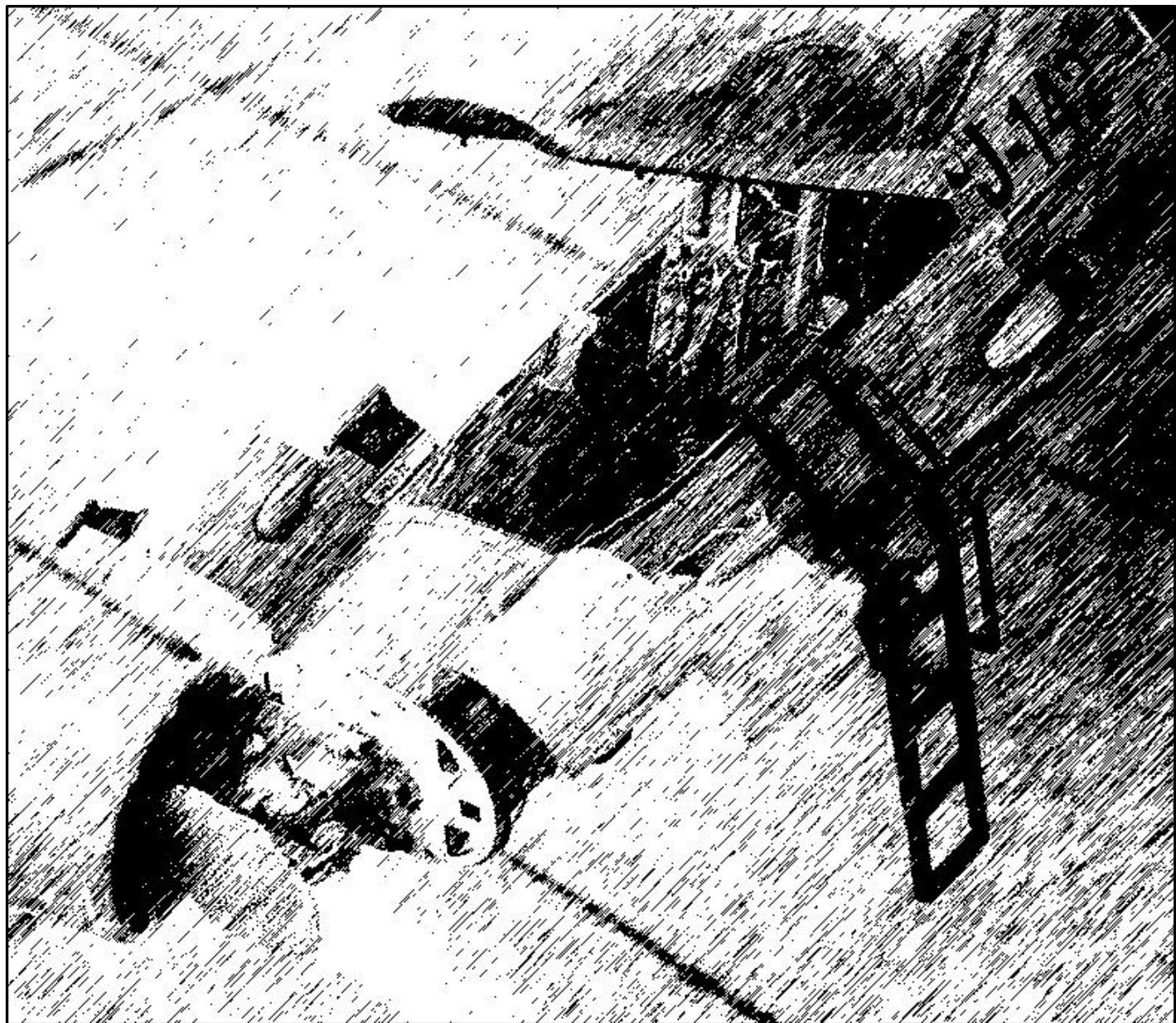
Finally, when the AI flight completes the refuel evolution it will slide out and down towards a position 1nm abreast of and 1000' down from the tanker's position. As it approaches this point, the lead AI will change waypoint to the next point after the one designated for the refuel action. This is a change because previously there was some significant chance that they'd fly back to the refuel waypoint instead before moving on. You may not see the impact for this but in terms of timing for TE mission planners at least you know what to expect now.

In case you are wondering, players must clear the tanker to at least one half nautical mile range after refueling before you can call for fuel and rejoin the queue. Especially around a busy tanker the exit corridor that the AI uses (right and down from post fuel observation) is recommended.

One other comment about TE planning and tanker flight plans in particular. The AI will perform a pretty reasonable looking intercept. However, if you have heavily laden receiver jets (set for ground attack or what-have-you) then you will need to consider their reasonable top speed at MIL throttle settings for the assigned refuel altitude. Put another

way, don't have tankers flying their transit to station (for receivers timed to arrive as the tanker arrives on station) or anchor orbits at break neck speed -- doing that will simply make the receivers work harder and be less time efficient about tanker rendezvous. Something in the 250-280kt range for transit or station loiter ought to give receivers an opportunity to generate reasonable overtake.

# Miscellaneous



## External Display Support

The ability to create additional windows for rendering cockpit displays has been added. These windows can be moved to another display head on an extended desktop configuration.



To enable this option, set `g_bUseExternalWindows 1` in the config file. There is also a new tool, the BMS External Windows Editor (`ExternalWindowsEditor.exe`), which allows you to change the position, size, rotation and the borders of the window. Also, the position of the windows are saved if you move them around while you are in the 3d world and then exit the game.

A limitation to this feature is that the main 3d window cannot be full-screen. However, another cfg variable has been added to remove the window borders of the main window. Use `set g_bMainWindowBorders 0` to remove the borders. This makes the main view appear to take up the entire display.

There can be little to no FPS decrease with this feature depending on your video card and hardware. Careful selection of display components can significantly affect performance for this feature so players are advised to seek out experts amongst the BMS Test Team for current best advice.

## Multiplayer Relevant Changes

### Network Transport

The code includes a completely rewritten interface layer for network transport to allow use of a commercially tried and true network transport provider. We are greatly indebted to Jenkins Software for permission to use the RakNet networking engine as part of the game. Please refer to the website for more information about this networking solution stack (<http://jenkinssoftware.com/>).

### Shared Configuration Settings

Multiplayer settings transfer. To prevent players using different multiplayer settings a new MP message type has been added which transfers the HOSTS critical multiplayer related settings to all players during the join of a game. Transfer happens after the OK button is hit when joining TE or Campaign. This will hopefully give more MP stability.

The following settings are transferred (and more will likely be added later):

`g_nTaxiLaunchTime`, `g_npercentage_available_aircraft`, `g_nminimum_available_aircraft`, `g_nReagTimer`,

g\_nDeagTimer, g\_bIDMDatalink, g\_bManualRadioTuning, g\_bEnableABRelocation

## Player Position in 3D World

Positional updates in multiplayer have been vastly improved. Closer/tighter formations are now possible. Turns/hard turns will also not yield big warps as in previous versions. Likewise, weapons coming off the rails should be smoother as well. Wing root vortices will also show across the network if the aircraft pulling Gs exceeds a threshold. RWR/HTS should also respond better for all a/c.

The Dead Reckoning code which compensates for network lag was completely rewritten with military-grade simulation techniques applied (your tax dollars funded much of the research these code changes depend on). Extremely close formations are now possible with completely fluid missiles, chaff/flare and butter smooth roll and pitch updates in addition to fixing the “cockpit perspective position bug” (that has been around since 1998!) completes the package.

## Campaign ATO Control

“Add Package” is now available in campaign mode. Multiplayer is now refreshed when changing a flight via the flight plan page. You can change the formation, altitude, mission, target assignment, etc. It will be updated for all players. It is also possible to enable/disable the automatic generation of flights for each squadron. Go to the squadron status page to set this (there is a new set by HQ button). Also, fix for the creation of packages after 1d 23:59:59.

## Changes to Artificial Intelligence

Fix for AI eyeball acuity. Chances to spot jets should be higher by eye if the target jet has lights on—more at night and in bad weather than in mid-day sun. There was code in there for this idea but it wasn't working because of confusion over light state flags. This should be fixed now so AI should be less oblivious at night in WVR scenarios.

The AI wingmen's bugged target now only uses information from his radar. This prevents bugged targets from being drawn clearly outside the wingmen's FCR field of view and acted as a cheat for determining where enemy a/c were in relation to your flight. It also means that, for example, if you assign your wingmen a target that is outside his FCR FOV, there will be a potential delay before his bugged target is drawn on your HSD as he turns to bring the target into FOV, searches for it, and then bugs it as he begins his engagement.

AI will now use the appropriate amount of bank in turns instead of yawing their way around turns. This should lead to the AI being better at keeping position in formation. Multiple fixes to get the AI speed control consistent have improved things but their use of throttle is still a little odd sometimes; more work anticipated on this one.

## AI Route of Flight Course Tracking

Two new config file variables are now available:

```
boolean g_bSimpleFMIncludesWind, default true;
```

Setting this value to true means that all AI jets flying the simplified flight model have the effects of wind added into their motion in flight. Setting this value to false removes the wind effect from the simplified FM calculations. Note: wind effect was first added to make the tanker move properly relative to player aircraft to ensure closure rates allow for smooth refuel boom hook up; if you set this variable to false, expect tanking to be more difficult if not impossible in all but the best weather. The config value is added at this stage to enable comparative testing of AI performance in other flight regimes (ground attack etc.) with the wind factored in or out.

```
boolean g_bWindCorrectAIFlying, default true;
```

Setting this value to true makes the AI consider wind direction and velocity in planning their course tracking. Among other things this should make them fly final approach to landing more accurately and line up bombing runs etc. with better accuracy in the case that the simple FM does include the wind in calculations of motion (i.e. with g\_bSimpleFMIIncludesWind set to true). The presence of the config file variable should also allow testing options to see how the AI does with and without wind correction.

Note: these two variables are settable independently to give you maximum flexibility for testing. However, as you can imagine, setting the g\_bSimpleFMIIncludesWind to off (0) while leaving the wind correction for course tracking set true will produce odd results...the AI will plot a heading that compensates for wind that they are not affected by. Thus in testing, it probably makes most sense to have either both on or both off. Note further though, that setting g\_bSimpleFMIIncludesWind to on and g\_bWindCorrectAIFlying to off replicates the behavior of 4.23 and earlier executables so you can baseline against what you expect from recent experience.

In case that alone is not enough fun for you, there are also some new command line options that you can use to play with the above items in real time when you are in the 3D world. As usual, bring up the chat line (shift T by default) and type in: ".<keyword> <value>" replace <keyword> with one of the ones below and <value> with something appropriate.

keyword: wd

effect: sets direction that the wind is blowing towards

range: integers in the interval of 0-359 inclusive

keyword: ws

effect: sets the strength of the wind in KPH (don't ask me why that instead of knots, I don't know :P)

range: integers in the interval of 0-MAXINT...I'd recommend keeping the numbers reasonably low though

keyword: swind

effect: this turns on and off the short wind turbulence (i.e. g\_bWindShortChange)

range: 0 for off, any positive integer for on but 1 is recommended

keyword: sfmw

effect: this turns on and off the effect of wind on the simple flight model (i.e. g\_bSimpleFMIIncludesWind)

range: 0 for off, any positive integer for on but 1 is recommended

keyword: wcai

effect: this turns on and off the wind correction for AI course tracking (i.e. g\_bWindCorrectAIFlying)

range: 0 for off, any positive integer for on but 1 is recommended

Some notes about g\_bWindShortChange: I had not realized and others may not also...while this feature was implemented in support of the AFM flight model code, if the variable is true/on, any and all calculations that use wind speed and direction are apparently affected. Thus AI flight performance (as above) and even dumb bomb flight paths are affected by the shifts in wind speed and direction that are present with g\_bWindShortChange.

With this in mind, notes that from the above chatline selections, wd and ws are only effective when g\_bWindShortChange is false/off (it is off by default).

In addition to complement the above changes.

Adjusted the short final logic for AI landings so that the tracking point stays a bit further out in front of the AI jet. What this does is avoid the tendency of the AI to chase the lineup in close to the touchdown point with ever more radical bank turns as the ground track error increases more rapidly with shorter distances between the nose and the track aimpoint. The net effect is that the AI will appear to be a bit more steady in their bank control close in and should be a lot less likely

to scrape wingtips and/or ground loop on landing.

Tankers will now no longer make impossible turns except when they need to fudge the turns in order to land. This “ex-F-15 driver” 7-g turn was very noticeable in multiplayer—the tanker would yaw through the turns. After each human took on gas and finished, the tanker would execute this turn back to his first track point when ownership of the tanker transferred to the next human, thus making the entire flight chase him down again. Now, the tanker may turn slightly, but the entire flight should be able to stay with him while ownership is transferred.

## ***Support for External Mission Planning Software***

Adding integration for external WDP utility style VIP/VRP/OA data in the ini file (DTC). The DTC load code now looks for a NAV OFFSETS area in the player ini file and reads VIP/VRP mode select (0 = neither, 1 = VIP 2 = VEP), VIP (stpt, brg, rng, alt), VRP (stpt, brg, rng, alt), VIPUP (stpt, brg, rng, alt), VRPPUP (stpt, brg, rng, alt) and OA1-n and OA2-n (brg, rng, alt). In all cases brg is bearing float value from 0-359.9999 interpreted as degrees; rng is int value greater than zero interpreted as feet; alt is int value greater or equal to zero interpreted as feet.

NB: you really want the STPT numbers to agree for VIP/VIPUP and VRP/VRPPUP pairs -- the code doesn't enforce that and unexpected results may ensue if the ini file content isn't consistent there. All offset points may be defined for any stpt from #1 to #24. Only one each of VIP/VRP/VIPUP/VRPPUP entries is supported. You may have OA1 and OA2 defined for all stpts in the range 1-24 if you wish.

Sample ini file section:

```
[NAV OFFSETS]
Modesel=2
VIP=4,228.3,1988427,150
VIPPUP=4,227.6,1986817,150
VRP=5,228.3,1988427,150
VRPPUP=5,227.6,1986817,150
OA1-4=313.2,20103,2061
OA2-4=313.2,20103,0
OA1-5=228.0,1980154,6748
OA2-5=228.0,1980154,0
```

Additional items have been added to the <callsign>.ini file for support of programs like WDP. These do not normally need to be added manually by the pilot unless the features are desired. WPD incorporates the necessary front-end to use the data easily. The new content items include:

```
TACAN Channel=29
ILS Frequency=10900
ILS CRS=0
TACAN Band=1
TACAN Domain=0
```

For TACAN entries, X Band = 0, Y Band = 1. TACAN Domain is AG = 0, AA = 1.

```
[FCC_AIM]
AIM-9_Spot/Scan=0
AIM-9_TD/BP=0
AIM120_TargetSize=0
[FCC_AGM]
Maverick_AutoPwr=0
Maverick_AutoPwrDir=1
Maverick_AutoPwrWpt=1
[FCC_AGB]
Profile1_Submode=8
Profile1_Fuze=1
Profile1_SGL/PAIR=0
```

```
Profile1_Release_Spacing=175
Profile1_Release_Pulse=0
Profile1_Release_Angle=45
Profile1_C1_AD1=400.000000
Profile1_C1_AD2=600.000000
Profile1_C2_AD=150.000000
Profile1_C2_BA=500
Profile2_Submode=7
Profile2_Fuze=2
Profile2_SGL/PAIR=0
Profile2_Release_Spacing=25
Profile2_Release_Pulse=3
Profile2_Release_Angle=45
Profile2_C1_AD1=200.000000
Profile2_C1_AD2=300.000000
Profile2_C2_AD=455.000000
Profile2_C2_BA=650
```

## **TrackIR Axis Customization**

Added support to swap TIR axes around. You may zoom in with the yaw axis, map pitch to x; whatever you want.

.cfg file entries:

```
g_nTrackIRYawMapping
g_nTrackIRPitchMapping
g_nTrackIRRollMapping
g_nTrackIRXMapping
g_nTrackIRYMapping
g_nTrackIRZMapping
```

Map to these constants:

```
TIR_YAW = 0
TIR_PITCH = 1
TIR_ROLL = 2
TIR_X = 3
TIR_Y = 4
TIR_Z = 5
```

So, to swap pitch and yaw you'd write:

```
set g_nTrackIRYawMapping 1
set g_nTrackIRPitchMapping 0
```

Do not include these lines if you do not want to change anything, or use -1 (which means the exe ignores this line). None of these entries appear in the Config Editor: approach with caution!

# **Various Bugfixes, Features and Enhancements**

**New Feature:** Added new config file var: g\_nF2TeamUiFreq

This one does much the same as g\_nF1TeamUiFreq but affecting the second radio channel usually bound to F2. The effect is that you can now control the channel frequency for both F1 and F2 key presses in the 2D UI. Default behavior is the same as before so if you don't add this var to your config then when you press F2 everyone hears that is in the UI and no one in 3D can hear what's said. If you want folks in the UI to have ability to talk to two separate freqs that are both tunable in the 3D world then add this var to the cfg file and set it to a legal value for a radio freq in the UHF or VHF bands (UI transmissions are not subject to any range limitation regardless of band choice). See the radio section for legal freq ranges but recall that the config file stores this as an integer number of kHz so 243.000MHz (UHF GUARD) would be entered in the file as 243000. Final reminder, this is player local setting so be sure everyone changes it if you all intend to use a specific freq other than the default for F2.

**Bug Fix:** Updates to boom AAR code to make pre-contact position for fighter and fighter-bomber types consistent with real world procedures. In particular the Viper is supposed to stabilize about 2 feet below the tip of the boom and 10-50 feet back from the boom tip, centered in azimuth (AR section has been updated with this information). All fighter and fighter-bomber types are now required to find this pre-contact spot in order to get cleared on to contact position. The tanker will place the boom at the heart of the boom motion envelope as you approach. When your nose gets close to the boom as you move from contact to pre-contact, the boomer will fly the boom tip around your canopy to reach the refuel slipway. Note: you must be flying slow and steady for this to work (no more than 3 knots closure) or the boomer will judge you as being too reckless and will haul the boom up out of the way for safety. Further note: for realistic settings, there is no longer a way to bypass stabilizing at pre-contact. The loophole in the code there has been closed. You must stabilize at pre-contact or the tanker will never clear you to contact and if you aren't cleared there is no way to get gas. On the upside, the pre-contact spot should be easier to find now since the HUD frame and gun cross make excellent steering references. The sight-pictures have been updated in the AR section. Fix for CTD if you call for fuel in a mission where there is no tanker. Now you will hear yourself call if you have pilot voice on but when there is no one home to answer that is all you hear (and no CTD of course).

**Bug Fix:** Fix for UHF radio GUARD overrides. The GD position on the AUDIO 1 panel should only affect the UFC UHF radio tuning and the UHF control head GUARD knob position should only affect the backup radio tuning. In both cases though, moving the knobs should set the correct state when the corresponding radio is made active again. These changes should implement that behavior correctly now (previously changing either knob overrode the current radio tuning regardless of which was selected which isn't how the real things work).

## **Known Issues**

**IVC:** When connecting to a multiplayer session in the Comms window, using DNS names for the IVC host will currently not work. Please use IP addresses only here.