

BMS Training missions



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Foreword

The purpose of this manual is to document the new 4.34 training missions. We decided to go back to basics and use a similar building block approach to that used in the original Falcon 4.0 manual training missions. We will develop about 25 missions, divided into 5 main groups:

- Basic handling and navigation.
- Advanced handling and avionics.
- Weapon employment.
- Advanced navigation (BMS Comms and Nav book).
- Naval Operations (BMS Naval Ops manual).

You will fly various F-16 models, with different avionics and capabilities, including the F-16B block 15, F-16D block 40, F-16C block 52 and F-16C block 52+. Naval operations will feature the F/A-18 Hornet.

**This document is not intended to explain how the BMS aircraft systems work.
The F-16 and its systems are explained in the BMS Dash-1 (TO-BMS1F-16CM-1) manual.
Weapon employment procedures are explained in the BMS Dash-34 (TO-BMS1F-16CM-34-1-1).**

**These documents should ideally be read before flying the training missions.
The purpose of this document is to link both -1 & -34 with specific scenarios, tying all the documentation together.**

Whenever appropriate we will refer to both the Dash-1 and the Dash-34 in this document to streamline your information input and avoid duplication of content available elsewhere.

We will similarly refer to the F-16 checklists that are also available in your Docs folder. We suggest you print them out or put them on your tablet, so you have them handy when you first start to fly BMS.

Note:

1. Whenever you need to stop the mission to read part of this document (or any other document) use the freeze mode (except in TRN 9). The difference between pause and freeze is the ability to use the avionics while in freeze mode; you can't when you are in pause mode. The downside is that the clock continues ticking. So if you need to meet a time sensitive objective avoid freeze mode.
2. We will not always refer to keystrokes as you may not be using the default keyfile. Therefore it is the responsibility of the reader to correlate the function with the relevant keystroke.
3. We will assume that you use a realistic HOTAS layout; we will refer to HOTAS functions where appropriate by their name on the F-16 throttle and stick: TMS, DMS, CMS etc and not the keystroke.
4. Some settings of your aircraft at mission start depend on your callsign.ini file. These settings cannot be controlled by the TE designer. To overcome this issue we use scripts at the beginning of training missions which start in the air. Some aspects such as your MFD setup can't be set by the scripts. Therefore you will have to set up some avionics on your own using your best judgement. The training scripts are automatically applied and transparent for the user. You do not need to enable the 'Enable Training Script' checkbox in order to get them to work.
5. Different air forces have different SOPs (Standard Operating Procedures) and therefore what you will read here is only one method of learning the jet. What you know may differ and that is accepted. The goal here is to document one method; we are sure some people know better.

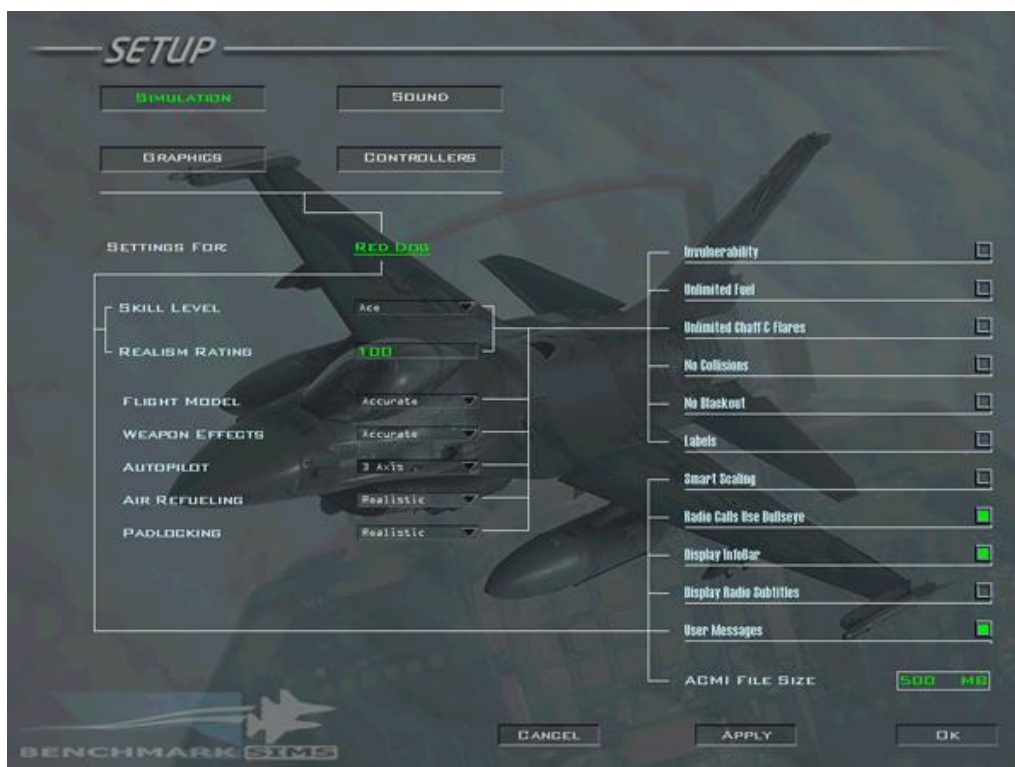
Setting up BMS for the training missions

The training missions are accessed through the Tactical Engagement (TE) part of the BMS user interface (UI). By default the leftmost tab named TRAINING is selected so you will see the list of missions available. Click on a mission and more windows will appear on the right side of the user interface. The bottom right corner windows give a very short summary about the selected TE. Click the COMMIT button to launch the TE.

The mission may be single ship or multiple ship and include other flights that are not F-16s. Your pilot will automatically take the first seat available, the flight lead's position, but you can take any seat according to the mission setup. **Choose the F-16 flight.** The missions will start with a stopped clock. As most of the training missions start in the air, that will leave you plenty of time for flight planning. When you are ready simply click the TAKEOFF button on the bottom right of the UI to launch to 3D.

You may need to setup BMS correctly for the training missions to work as intended. From the UI select the SETUP button. It defaults to the SIMULATION tab which is what we need. Confirm that your pilot is selected. We believe that you should train the way you intend to fight. Therefore we suggest you select ACE skill level and ensure that the following options are checked:

- Flight model: Accurate (mandatory)
- Weapon effects: Accurate
- Autopilot: 3 Axis
- Air refuelling: Realistic
- Padlocking: At your discretion
- Invulnerability: At your discretion
- ACMI file size: 500 MB recommended (see below)



Invulnerability can be a very useful training aid. Don't feel bad about enabling it for training purposes. It will lower your realism rating but that is really not a problem. You didn't come here to get medals... yet.

We advise you to record all your training flights with the onboard ACMI. When you get into the cockpit your first action should be to start an ACMI recording. To do so use the relevant keystroke (f) or your mouse to switch the AVTR on. The green indicator will turn on confirming you are recording. At the end of the training flight you can review your flight with either the built-in BMS ACMI reader or [Tacview](#), which is available for free and compatible with BMS. Some add-ons for Tacview are also available on the [BMS forum](#), which provide additional tools for reviewing your training mission objectives.



Please note 4.34 introduced a pilot model in the cockpit. The leg and torso of the pilot may prevent you from seeing all the cockpit switches easily. For the purpose of the training mission we advise you to deactivate the pilot model from the GRAPHICS page of the SETUP UI (option PILOT MODEL) under CANOPY CUES.

Also if you have trouble understanding English ATC, we advise you to enable subtitles from the SETUP UI.

PART 1: BASIC HANDLING

You will fly a series of 3 training missions around Kunsan airbase in Korea in an old F-16B block 15. It's a dual seat F-16 and you will be in the front seat.

You can fly these 3 training missions one after the other without leaving the cockpit. Although there are 3 different missions which you can select (Ground Ops, Navigation & Landing), the 3 training missions all use the same TE, but just start in different places. When you complete the content of the first part (Ground Ops) you can continue to the second part (Navigation) without going back to the UI. The training scenario will end at the end of Mission 3 (Landing), when you land the F-16 back at Kunsan.

Alternatively you can concentrate on just one at a time, then quit and continue later on from the next section. The 3 missions have the same initial setting:

AIRBASE: Kunsan RKJK –RWY 18/36 - 075X – ATIS: 120.225 – Ground: 273.525 – Tower: 292.3 – Departure & Approach: 292.65

CALLSIGN: Goblin 2-1 (single ship)

AIRCRAFT: F-16B block 15 (Pratt & Whitney engine). Clean configuration, 2 AIM-120B on wingtips.
 GW: 24174 lbs
 Fuel: 5898 lbs
 Drag Factor: 9.0
 CAT I
 Max G: +9/-3
 Max speed: VNE

WEATHER brief: RKJK INFO: B 010955LT ILS RWY36 TRL140 320/12 KT 9999 FEW050 18/08 Q1009 NOSIG.

FAIR weather, few clouds at 5000 feet, winds 320°/12 knots, temperature 18°C, dew point 08°C, altimeter 1009 (2980), NO SIGNificant changes.

GOAL:

Mission 1: Ramp start, taxi and take-off.

Mission 2: Master the basics of navigation: INS and TACAN.

Mission 3: Land and shut down the jet.

MISSION 1: GROUND OPS

TAKEOFF OPTION: Select RAMP

Please note: you need to select the F-16 flight in the left window of the UI. By default the system will put you in the first seat available when you commit to 3D. Since F-5s are taking off earlier than this training flight you will end up sat in an F-5. Ensure you take a seat in the **F-16** training flight instead.

LOCATION: Wolfpack flow Kunsan airbase

CONDITION: Aircraft cold, canopy open. You have just been strapped in the jet by your Crew Chief.

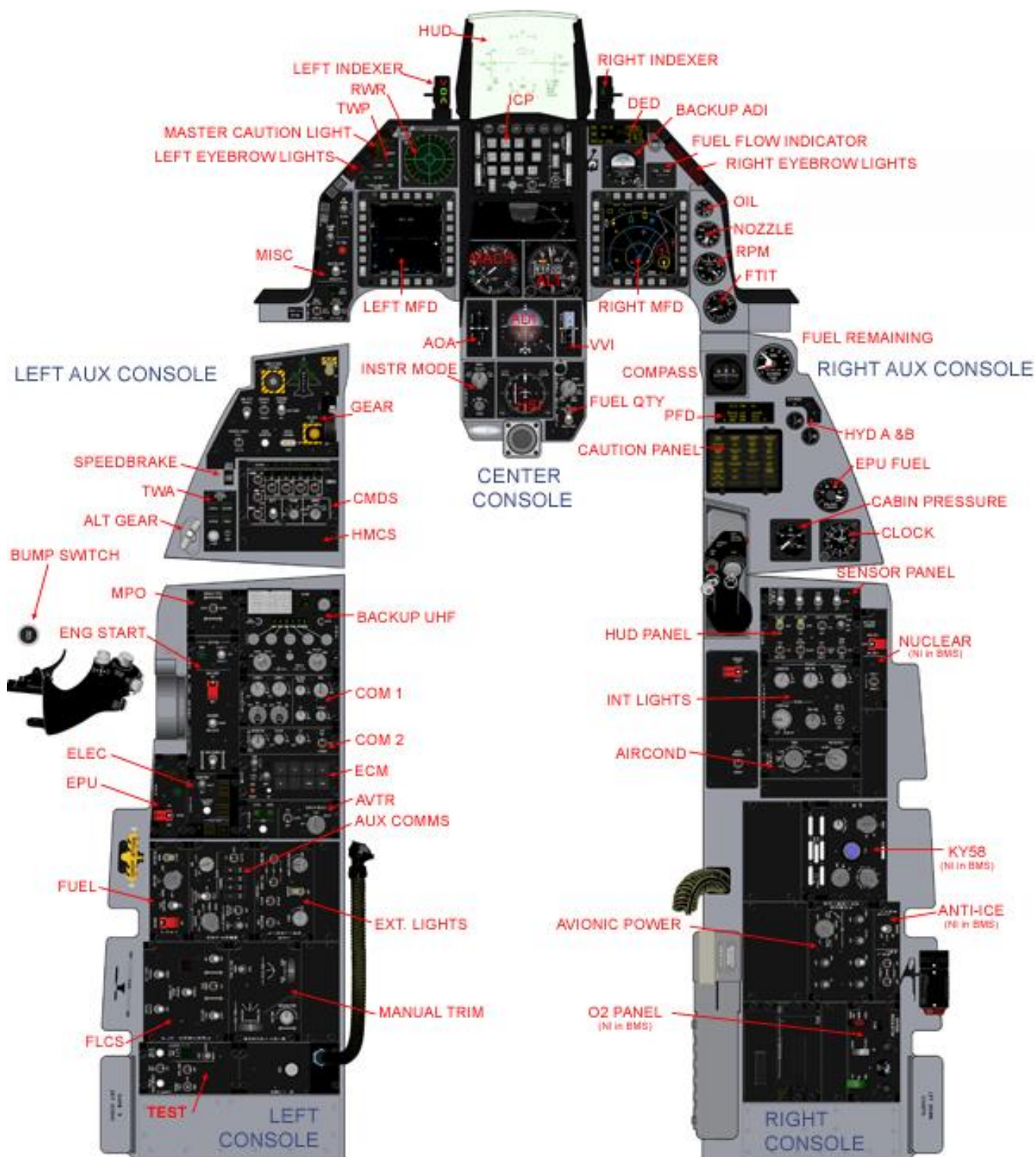
GOAL: Prepare the jet for taxi by conducting a full ramp start. Taxi out to the EOR. Line up and take off. Level out at 5000 feet.



The Block 15 has no EGI, no IDM, no digital FLCs and no coloured MFDs so the procedure to start up the jet although similar has some details different from the Dash-1 Section II Chapter 1: RAMP START in 3 SWEEPS.

You may be familiar with the procedure because you have been mastering it in 4.33.

May we suggest you go through it again anyway to spot the improvements in fidelity which 4.34 brings?



F-16 block 50/52 cockpit layout and panels

1.1. 1st Sweep: Before starting the engine

Looking towards the back of the left console, we start by setting the systems correctly, so they begin working from the moment that main generator power is received.

Looking towards the back of the left console, we start by setting the systems correctly, so they begin working from the moment that main generator power is received.

1. On the EXT LIGHTS panel we set the MASTER LIGHT switch to NORM, ANTI-COLLISION OFF, POSITION to STEADY and WING/TAIL & FUSELAGE switch to BRIGHT. Note that the WING/TAIL & FUSELAGE switches move together as they share a common callback in BMS. The FORM and AERIAL REFUELING knobs are not implemented in the current version of BMS. You won't immediately see the lights come on as the jet doesn't have power yet. The lights will only come on when the main generator comes online during engine start.



2. Moving up we quickly check the AUX COMM panel to check that the CNI knob is turned to BACKUP. We move one step further up and check that the MASTER FUEL switch on the FUEL panel is positioned to MASTER and that the guard is down. These should be correctly set at ramp. The ENG FEED knob though needs to be rotated to NORM to avoid fuel system malfunctions later on in the flight if the fuel pumps are left switched off. The TANK INERTING switch is not implemented in BMS.



3. Battery power is enabled with the MAIN PWR switch to BATT on the ELEC panel. THE ELEC SYS caution light and the FLCS RLY, MAIN GEN and STBY GEN lights (ELEC panel) should come on with battery power enabled. We need to test the battery by moving down to the TEST panel and holding the FLCS PWR TEST switch out of NORM to TEST. Please note when doing this with the mouse you must keep the mouse button depressed on the hotspot to simulate holding the switch or button in position. While doing that the FLCS PMG and the ACFT BATT TO FLCS lights illuminate and the FLCS RLY light goes out (ELEC panel). On the TEST panel the four FLCS PWR lights (ADBC) come on indicating good power output to the FLCC. The MAIN GEN and STBY GEN lights (ELEC panel) remain illuminated during the test.



You can now release the FLCS PWR TEST switch (release the mouse button). The lights reset to their initial state. This check is eye candy and is not mandatory. Leave the MAIN PWR switch in BATT for now; we will start the engines after we have finished the pre-start checks.

4. Let's set the comms so we're quickly ready to use the radio after engine start. Moving forward to the AUDIO1 panel we rotate the COMM1 (UHF) volume knob out of OFF clockwise to the 12 o'clock position and do the same for COMM2 (VHF).

Note that the first step out of the full counter-clockwise position actually represents the ON/OFF switch. Note also that for the backup UHF panel to work the COMM1 volume on the AUDIO1 panel needs to be out of the OFF position.

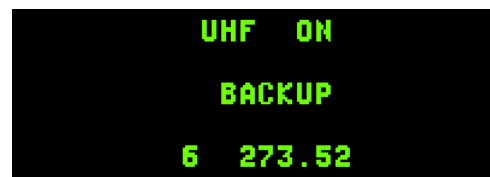


The two mode knobs for COMM1&2 should already be set to SQL and do not need to be moved for ramp start. They have no function anyway with the CNI switch in the BACKUP position. Set the MSL & THREAT volumes to 12 o'clock. These two do not have ON/OFF switches at the CCW position but are very often forgotten, which may cause problems later if you don't notice you've been locked up or fired upon!

Implemented in BMS 4.33 the ILS knob needs to be powered for the ILS system to work. Audio volume for ILS is not implemented; it's just an ON/OFF feature for now. Intercom volume does work, and controls all sounds normally heard in the pilot headset. So this one should always be set to full CW position (default).



5. Moving forward to the backup UHF panel the left function knob should be rotated from OFF to BOTH and the right mode knob set to MNL or PRESET or GRD depending on briefing. MNL configures the backup UHF panel to use the MANUAL frequency you can now set with the 5 smaller knobs. In PRESET the radio is tuned to the selected channel (6 by default) and GRD sets the backup UHF to guard UHF (243.000). Please note that the F-16 only has a backup radio for UHF and not for VHF. The backup UHF radio only works when the CNI switch is in the BACKUP position. It is strongly advised to set the backup radio correctly as briefed such that your lead or any member of the flight is able to communicate if needed. Indeed before switching to CNI the backup UHF radio is your only means of communication. In this case, the ground frequency 273.525 might be entered in the manual frequency window by clicking the relevant knobs. Once set, communication with Kunsan ground will be available in Backup mode. Select the COM1 page of the UFC; it will display the following page: When the UFC will be powered the DED will tell you that the UHF is ON in Backup mode and 273.525 is selected in the MNL window and the active backup preset is channel 6.



6. Since there is nothing to set on the front panel during this sweep we move straight to the right console. If you need internal lighting you can set up the LIGHTING panel accordingly.

PRIMARY INST PANEL (backlighting) and DATA ENTRY DISPLAY (DED and PFD) and FLOOD CONSOLES (all cockpit floodlights) can be rotated clockwise.

The highlighted knobs are not implemented. Please note as the aircraft doesn't yet have main power the lights won't come on when you move the switch; only when the relevant buses receive power.



Note: a spotlight is also available for night ramp starts. This is available as soon as the MAIN PWR switch is moved to BATT, so for night ramp starts using the MAIN PWR switch key callback, followed by the spotlight callback (SHIFT + s) will light up the cockpit, allowing you to continue your ramp start more easily.

7. The final item to check in this sweep is to make sure that the AIR SOURCE knob is set to NORM. Failure to do so will cause an EQUIP HOT caution light as soon as the systems are powered by the main generator, because they will not be being cooled correctly.



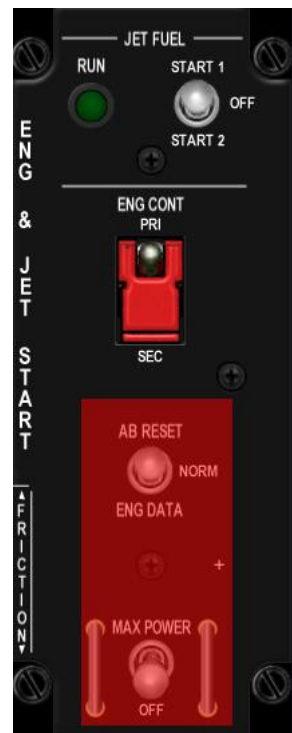
1.2. 2nd Sweep: Starting engine & systems

The second sweep is dedicated to starting the engine and getting all systems online. We start again on the left console.

1. On the ELEC panel move the MAIN PWR switch out of BATT to MAIN PWR. The lights do not change as the generators need the engine running to provide power to the buses. Please note one of the common mistakes is to start the jet in BATT which prevents some systems from coming online later as the main generator is not online and may cause engine start issues. So make sure you start this sweep with the MAIN PWR switch in MAIN PWR.



2. Moving forward you can close the canopy (spider). Ensure it is fully closed before engaging the JFS. Check your throttle is all the way back (in CUTOFF) then move to the ENG & JET START panel. The JFS switch is moved to START2 (right-click **once**); the JFS RUN light comes on after a few seconds and RPM steadily increases to 20%. At that point check that the SEC caution light is off and move the throttle forward if you have the Idle CUTOFF config option ticked, or press the idle detent callback (ALT + i) and monitor engine gauges:



- SEC caution light goes off around 20% RPM (**before** moving throttle).
- FTIT should increase to around 600-650° then decrease to 500° at idle. If you see FTIT rising at an alarming rate or go above 750°C you are encountering a hot start; immediately pull the throttle back to CUTOFF and let the FTIT decrease to 200°C while the JFS is running, before moving the throttle back to IDLE. See also Dash-1 chapter 3.5.3 GROUND EMERGENCIES for more information on this scenario.
- HYD/OIL PRESS light (right eyebrow) goes off between 30 and 35% RPM. If the light stays on and your oil pressure remains below 15 psi you have an oil pressure fault; shut down the engine immediately (pull the throttle back to CUTOFF) and follow the steps in Dash-1 chapter 3.5.4 GROUND EMERGENCIES to recover from this fault.
- FLCS PMG light (ELEC panel) goes off around 40-45% RPM.
- JFS shuts off around 55% RPM (the switch automatically snaps back to OFF).
- ENGINE light (right eyebrow) and STBY GEN light (ELEC panel) go off around 60% RPM and MAIN GEN light (ELEC panel) goes off about ten seconds later.

With the engine running steadily you can check the remaining engine gauges such as fuel flow (700-1700 PPH), nozzle position (greater than 94%) and HYD A & B pressure (at the 12 o'clock position).

With MAIN GEN online all systems receive power and the systems you previously set should come online (lights, radios, etc.) You may already hear the ground traffic comms from your backup UHF radio.

3. Move straight to the AVIONICS POWER panel to quickly begin INS alignment and power up the MMC, ST STA (SMS), MFD, UFC, GPS, DL switches. Note that the MFD & UFC will need a few seconds to boot up after the UFC switch is powered. Once the DED comes online rotate the INS knob from OFF to ALIGN NORM. Newer blocks have EGI (Embedded GPS/INS), decreasing INS alignment time from 8 to ~4 minutes but our Block15 has the older INS system.

Let's sweep back to the other side:

4. Move forward to the SNSR panel, power the FCR and place RDR ALT in STBY. Depending on loadout you can also power the left and right hardpoints. Please note these are the chin stations found on the left and right-hand side of the intake and carry TGP, NVP, or HTS pods. There is no need to power them if you have nothing loaded on those stations. Failure to do so however can prevent any pods from being powered in time as they may require a cool down period before becoming operational, especially the FLIR pod which needs anything between 8 and 15 minutes. As you need to check/boresight it on the ground before take-off this needs to be a priority.

5. Moving to the centre console quickly check that the INS has started aligning; look at the DED which defaults to the INS page and check that the status of the INS is being incremented. Another way is to look at the flags on the ADI. The AUX yellow flag on the ADI disappears 60 seconds into INS alignment.

6. Switch the HUD on with the ICP SYM thumbwheel (up). Click on F-ACK (left eyebrow) to review the PFLD and reset the MASTER CAUTION light (click on it) so you are aware of the next time it comes on. Try to reset the MC light as soon as you acknowledge a fault, so you don't miss the next one, but never reset it without knowing why it came on in the first place. Also clear the MFL (Maintenance Fault List) on the MFD TEST page with OSB 3. The PFLD will display common ramp start faults which will clear as systems come online.

7. Move back to the left console and the AUX COMM panel. Though 4.34 implemented a fully functional IFF system this older jet still has the old style AUX COMM panel (newer jets have an IFF panel). We will come back to IFF later on.

For the moment simply put the IFF MASTER knob in STBY and rotate the CNI switch from BACKUP to UFC so you can start using the primary onboard systems.

With that done the Up Front Controller comes online and it is suggested that you load up the data cartridge into the system before you set up the radios through the UFC. The DTC contains all the information that was set in mission planning. In real life the pilots carry it with them and load into the DTC receptacle on the right console. In BMS we load the DTC by selecting the DTE page on the MFD and selecting the LOAD button (OSB 3). The sequence of highlights of the OSB has changed so do not worry if it takes longer than before.

The reason we load the DTC **before** setting the UFC radios is that since the DTC has a comms section, the presets might be different than the ones pre-briefed. If you load the DTC after setting the UFC radios you might not be on the correct frequency anymore. For more information about the data cartridge refer to the DTC section in the BMS-Manual.

This item is also often forgotten by new BMS pilots and can cause problems later on in the flight.



The COMM PLAN completely changed in BMS 4.34. Airbases now have multiple frequencies for Ground Ops, Ground, Tower and Approach/Departure. By default DTC assigns common UHF presets to these frequencies according to your home airbase. Ground Ops is always preset #1, Ground is always preset #2, Tower is always preset #3 and Approach/Departure is always preset #4. Note: Approach and Departure are often on the same frequency in real-life too.

Nevertheless knowing the actual frequency is advised and these frequencies are published in the usual pilot references (AIP, charts). You can use preset or discrete frequency, whichever you prefer.

The way to communicate with AI or human pilots in your flight also changed with the 4.34 radio code update. The first flight in the package will usually be assigned VHF preset #15, the second #16, third #17 and so on. AI (wingmen, ATC, AWACS, tanker) will **only** be able to communicate with you if you are on the same frequency, just as in real-life.

The briefing will document the new COMM plan. It is now a mandatory item of the flight briefing.

COMM LADDER:				
AGENCY:	BALLSIGN:	UHF [BHNL]:	VHF [BHNL]:	NOTES:
INTRA-FLIGHT:	Goblin2	--	138.750 MHz [15]	Flight Management Comms
GUARD:	None	243.000 MHz	121.500 MHz [13]	Distress / Emergency
COMMON:	None	339.772 MHz [14]	123.500 MHz [14]	Advisory / UNICOM
BASE OPS:	None	304.800 MHz [1]	--	Homeplate Operations
TACTICAL:	None	250.600 MHz [6]	--	Package Comms
DEP ATIS:	Kunsan ATIS	--	120.225 MHz	Departure Airbase
DEP GROUND:	Kunsan Ground	273.525 MHz [2]	--	Departure Airbase
DEP TOWER:	Kunsan Tower	292.300 MHz [3]	126.500 MHz [3]	Departure Airbase
DEP DEPARTURE:	Kunsan Departure	292.650 MHz [4]	--	Departure Airbase
ARR ATIS:	Kunsan ATIS	--	120.225 MHz	Recovery Airbase
ARR APPROACH:	Kunsan Approach	292.650 MHz [4]	--	Recovery Airbase
ARR TOWER:	Kunsan Tower	292.300 MHz [3]	126.500 MHz [3]	Recovery Airbase
ARR GROUND:	Kunsan Ground	273.525 MHz [2]	--	Recovery Airbase
ALT ATIS:	Seosan ATIS	--	130.300 MHz	Alternate Airbase
ALT APPROACH:	Seosan Approach	253.950 MHz [10]	--	Alternate Airbase
ALT TOWER:	Seosan Tower	353.100 MHz [11]	126.750 MHz [11]	Alternate Airbase
ALT GROUND:	Seosan Ground	275.800 MHz [12]	--	Alternate Airbase

As per brief, let's input Uniform (UHF) Ground & Victor (VHF) 15 in the UFC radios:

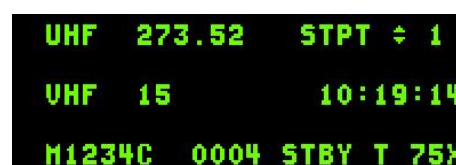
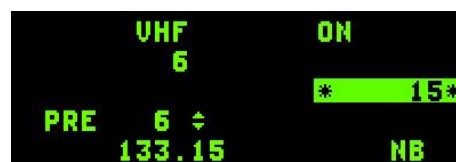
Push COM1 on the ICP and the DED displays the UFC COM1 page. You can either select PRE 2 or enter the ground frequency manually. To select preset #2, either hit "2" in the scratchpad then ENTR or use ICP "up arrow" then ENTR. To enter the manual frequency, enter "27352" in the scratchpad, followed by ENTR.

Note that the last 5 cannot be entered, it does not matter. Remember the Scratchpad is the area between asterisks.

Now do the same with COM2 & Victor, setting it to preset #15.

Upon hitting ICP ENTR and the DED returns to the CNI page where you can see that UHF is now set to 273.52(5) which is the newly assigned ground frequency for Kunsan. And VHF #15 which is the new default intra-flight preset for the first flight in a package.

That's the end of the second sweep. It's a little bit confusing toward the end, but from this point while the INS/EGI does its magic you have some time to check systems, prepare the jet for the mission and set the rest of the avionics up.



1.3. 3rd Sweep: Checks and Avionics setup

1. The TEST panel is the first to be used in this sweep. Press and hold the FIRE & OHEAT DETECT button and check the:

- ENG FIRE warning light is on.
- OVERHEAT caution light is on.
- MASTER CAUTION light is on.
- All lights go off when the button is released.

Press and hold the MAL & IND LTS button and check correct operation of the Voice Message System (VMS) and that all lights are illuminated. If you don't hear any sounds check the INTERCOM knob.

Flip the PROBE HEAT switch to the upper position and check that the MASTER CAUTION light remains off. Move the switch to the lower TEST position and check that PROBE HEAT flashes on the caution panel. Once you are satisfied that the system works correctly you can place the switch to OFF again. We will come back later to test the EPU and the oxygen system.



The TEST panel is mostly eye candy and there are no consequences if the above checks are skipped.

2. Move one panel forward to test the FLCS. Before doing so cycle and check the flight controls (stick and rudder) to assist in warming up the hydraulic fluid and removing air from the system. Very important indeed! More importantly check that all FLCS panel switches are down. If the MANUAL TF FLYUP switch is up for example the FLCS BIT (built in test) will fail.

Flip the FLCS BIT switch. It's a magnetic switch that stays in place for the duration of the BIT. The green RUN light comes on and the flight controls are tested in sequence; progress can be monitored by looking out of the cockpit at the flight controls. Members of your flight are also able to see your flight controls moving. During the FLCS BIT WARN will be displayed in the HUD and the T/O LDG CONFIG warning light may also flash. At the end of the self-test the switch will revert back to its original position and the RUN light will go out. Occasionally the test may fail, and the amber FAIL light will then be illuminated. If that happens the only way to reset it is to perform the BIT again. On later blocks (with a digital FLCS) the status of the FLCS bit is displayed in the FLCS MFD page. The FLCS bit will initiate only if weight is on the main wheels (WOW) and groundspeed is less than 28 kts.



The next check is usually Digital Backup operation, but the block15 doesn't have a digital FLCS so you can't check in this aircraft. For other blocks simply toggle the DIGITAL BACKUP switch up and check that DBU on the right eyebrow is illuminated. Move the flight controls and check them visually for correct operation. Once satisfied return the switch to the OFF position and check that the eyebrow light goes off. Again, the HUD WARN message will be displayed during the DBU check and the FLCS page on the MFD will display DBU. Once FLCS tests are complete ensure all switches are in the DOWN position on the FLT CONTROL panel.

Both the FLCS BIT & DBU checks are eye candy in BMS and bear no consequence if you skip them.

3. Move down to the MANUAL TRIM panel. A good habit is to always check that all needles are centred, especially if you have a real cockpit where knobs might not always be so! Place the TRIM/AP DISC switch in DISC and ensure that stick trim actions do not cause flight control movement or needle deviation. Return the switch to NORM, apply stick trim to check needle deviation and re-centre.

Failure to set the trims properly may cause problems during or immediately after the take-off roll.

These checks may appear like eye candy, but as asymmetric drag is implemented in BMS ensuring proper trim settings before take-off is strongly advised!

4. If your mission could include air-to-air refuelling you need to test the AR system. On the FUEL panel open the AR door by flipping the AIR REFUEL switch to OPEN and check the right indexer for a blue RDY light. Hit the stick DISC button and RDY should be replaced by an amber DISC indication. After three seconds DISC should go out and the blue RDY light should return. Move the AR switch to CLOSE and the blue RDY light should go out.

BMS rarely develops a fault into the AR system so this check might be categorised as unnecessary.



5. As you have noticed BMS 4.34 introduced a new red info message on the top of your screen saying that the EPU safety pin is in place. It is a safety pin to prevent EPU operation on the ground while the engine is starting. Your Crew Chief needs to remove this PIN before the pilot tests the EPU. Instructing them to remove the pin is done via the ATC menu. Open the Ground page menu (t) and select option 1 "Remove/insert EPU pin". The red message will then disappear.

To test proper EPU operation first cycle the EPU to OFF and back to NORM. With the mouse make sure you use a left-click to move it from NORM to OFF; a right-click would engage the EPU (now un-safed) which is to be avoided on the ground. The real reason is of no significance to us; hydrazine is extremely toxic.

Check first that both the EPU GEN and EPU PMG lights are off on the ELEC panel. Testing the EPU is done with the EPU/GEN switch on the TEST panel. Engine RPM needs to be around 80% and the parking brake can't be engaged, so make sure your aircraft is still on chocks and back them up with toe brakes. Move the throttle to 80% RPM, toggle and hold the EPU/GEN switch on the test panel and check lights:

- EPU AIR light on (EPU panel).
- EPU GEN and EPU PMG lights off (ELEC panel).
- FLCS PWR 4 lights on (TEST panel).
- EPU RUN light (EPU panel) comes on after five seconds.

You can then release the test switch and return the throttle to idle. If the green run light fails to come on reinitiate the test with a slightly higher throttle setting.

This check can be omitted as the system will run automatically whenever needed, as long as the EPU switch is in the NORM position. In real-life the EPU test should be done just after starting the engine, before powering the avionics to avoid surges, but that is also irrelevant in BMS... for now.



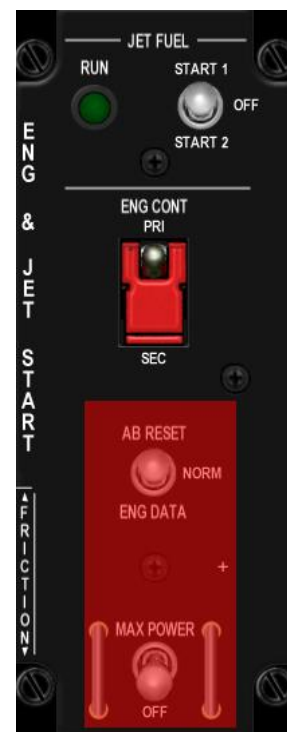
6. Check the ECM panel and toggle the top left switch to OPR. This is the only switch implemented on the ECM panel. While you are there check the AUDIO panels one last time for correct volumes on COMM 1, COMM 2 and INTERCOM. TACAN volume is not implemented and we set the ILS volume earlier. No further action should be required as you set COMM 1 and 2, THREAT and MSL tone volume knobs earlier.

7. SEC check is performed next to ensure that the engine can operate in secondary control mode. SEC mode might be entered automatically in case of an engine damage or malfunction. The pilot thus needs to ensure that SEC mode works correctly. Parking brakes shouldn't be engaged, ensure that the aircraft is on chocks and back them up with toe brakes. Lift the guard and move the ENG CONT switch to SEC. The MASTER CAUTION light and the SEC caution light come on. The engine nozzle closes and should indicate less than 5% on the NOZ POS indicator on the right instrument stack.

In SEC RPM might be lower than in PRI mode. Check smooth RPM operations while in SEC and when satisfied return the ENG CONT switch to PRI and close the guard. The MASTER CAUTION and SEC lights should go out and the nozzle open up to more than 94%.

In multiplayer you can now also check your wingman's SEC test and confirm his nozzle opening and closing.

SEC check is not mandatory to have a ready-to-go jet.



Performing the SEC check, nozzle closing & opening

8. A good idea while in that area is to check proper speedbrake operation. Open the speedbrake with the slider on the throttle and check the SPEED BRAKE indicator on the left auxiliary console. Remember that it takes about two seconds to open and six seconds to close; ensure that it is closed before you taxi.

9. The defence suite power-up starts at the TWA (THREAT WARNING AUX), located on the left auxiliary console. Depress the lower right POWER button and the SYSTEM POWER green light illuminates.



You can then move to the CMDS panel and power up the RWR and JMR pod with both toggle switches to ON. The CMDS has four countermeasure banks but only the CH (chaff) and FL (Flares) are used in the Korean F-16 squadrons. Bank 01 and 02 are not implemented in the F-16 in Korea and as such these two switches can remain OFF. You may need to power them ON with other versions of the F-16.

The PRGM knob can be set to any program (preset through DTC) you like, and you should rotate the MODE knob as desired or pre-briefed. Once all is set correctly (assuming you didn't forget to move the ECM switch to OPR earlier) the GO status indicator should come on, telling you that all systems are ready to be deployed.



You may also power up and check the HMCS at this stage or do it later at FENCE in.

Moving up to the gear panel; quickly set CAT I or III according to your loadout (check the STORES CONFIG caution light) and confirm that all three gear lights are green.

Move up to the TWP (THREAT WARNING PRIME) and run the BIT on the RWR suite. These tests vary according to the F-16 model. The following is relevant to the ALR-56 RWR:

Depress the SYS TEST button and check the indication on the RWR displays. Then check the MSL LAUNCH indicator and AUDIO by depressing the indicator. Once satisfied the system is running normally depress the HANDOFF button. That sets the RWR to diamond float mode.



This item is often overlooked and if omitted will prevent the RWR suite from warning you properly of threats!

10. While you are busy on the centre panel you can set the MFDs and UFC for your mission.

Set A-LOW to the transition altitude in Korea of 14000 feet. Select the A-LOW ICP page, dobber (move DCS) down to move the asterisks from CARA ALOW to MSL FLOOR. Type 14000 with the ICP numeric keys and hit ENTR. From now on Betty will call “ALTITUDE ALTITUDE” whenever you descend through 14000 feet. That is a gentle reminder to input the local pressure (QNH) in your altimeter.



Select the T-ILS page and input a ground TACAN of 75X, which is the frequency & band for Kunsan TACAN located north-west of the runway. When the T-ILS page is selected all you have to do is to input 7 then 5 with the ICP key and hit ENTR. If the Y band is active, enter ICP key 0 in the scratchpad, followed by ENTR to toggle the band back to X. If the TACAN is set to A/A TR mode simply dobber right to set the mode to T/R.



ILS frequency is also set through this page: dobber up until the scratchpad is active (the line where you input 75 for the TACAN) and type the ILS frequency for Runway 36 (110.3). Type 11030 ENTR. The system will recognise that it is a valid ILS frequency and will move the data to the right of the FRQ mnemonic. Please note the ILS ON in the top right corner of the DED. If your ILS knob on the AUDIO2 panel is turned to off the ILS will report OFF and the relevant system will be unavailable.

For this flight set a Joker level of 3000 lbs of fuel. Hit the ICP LIST button followed by ICP key 2 to select the BINGO page: use the ICP keypad to input 3000 and hit ICP ENTR. That will ensure that Betty calls “BINGO BINGO” when the totalizer reads 3000 lbs of fuel (if the FUEL QTY SEL knob is in the NORM position).



Many other settings can be set according to your mission, but they are out of scope for this basic part of the training. Remember, the more you do on the ground the less you will have to do while flying. Expect to be very busy once the wheels leave the ground; make your job a little easier by performing as many tasks as you can during your ramp start.

11. To the right of the HSI you will find the FUEL QTY SEL panel which may be used to check that your remaining fuel is being displayed correctly:

- In TEST check that both needles of the fuel gauge on the right auxiliary console indicate 2000 lbs. The totalizer should read 6000 lbs and both FWD and AFT FUEL LOW lights should be illuminated on the caution panel.
- In NORM; A/L = 2675-2810 lbs, F/R = 3100-3250 lbs.
- In RSVR both needles should read 460-480 lbs.
- In INT WING both needles should read 525-550 lbs.
- In EXT WING both should read 2300-2420 lbs (when carrying 370 gal wing tanks).
- In EXT CTR; A/L = 0 lbs, F/R = 1800-1890 lbs (when carrying a centreline tank).



Always remember to return the knob to NORM after checks because NORM is the only position where you get proper operation of the automatic forward fuel transfer system, trapped fuel warnings and for BINGO fuel warning computations based on fuselage fuel.

In other words you will not get TRAPPED FUEL or BINGO fuel warnings if the knob is not in NORM!

12. Moving to the right AUX console, check the PFLD for any remaining faults you might not already have acknowledged. Depress F-ACK and check the MASTER CAUTION light, the warning light panel and EPU fuel quantity, which should be between 95 and 102%.

13. The final step in this sweep is to confirm that the INS is fully aligned by checking to see if ALIGN is flashing in the lower left corner of the HUD. If so, toggle the INS knob from ALIGN NORM to NAV on the AVIONICS POWER panel. From that moment, all navigation cues will be displayed. The aircraft lights can be set for taxi. Switch your landing light and the anti-collision light on and set the WING/FUS lights to FLASH.

Arm your ejector seat and enable nose-wheel steering; confirm NWS is illuminated on the right indexer. Apply toe-brakes or set parking brakes and ask the ground crew to remove the chocks via the ATC menu (t 2).

The 4.34 ATC menu has been updated with new pages relevant to Ground, Tower, Approach and Departure, Common Carrier and Contingencies (Carrier page has been omitted from the picture below). Pages are toggled with subsequent (t) presses. Available options are highlighted with a corresponding number. Hitting the relevant keyboard alphanumeric keys will select that option and close the ATC menu. The menu can also be closed with the ESCAPE key.



There are a few things left to do to finish this training mission. In order to be ready to taxi and go to the next mission you need to first get the QNH (local pressure setting), the winds and the active runway from the ATC. All this is done through the ATC menu you just opened. You can ask for each item of information separately from the Common page of the ATC menu, or use the ATIS (Automated Terminal Information Service).

Each airbase has an ATIS VHF frequency. Kunsan ATIS is 120.225. Input this frequency in the COM2 radio (VHF) and listen to the automated broadcast. ATIS will give you the name of the airport, the active runway, the wind, visibility and clouds (sky condition if you use [set g_bUseATISColorCode](#)) temperature and altimeter setting. The only information not intuitive is the sky condition given as a colour code (blue, white, green, yellow, amber, red and black). The following table shows visibility and clouds corresponding to each colour code. Black means the airport is closed.

Minimum base of lowest cloud (SCT or more) above aerodrome level:	>= 2500 ft	1500-2499 ft	700-1499 ft	300-699 ft	200-299 ft	< 200 ft
Minimum reported visibility						
>= 8 km	BLU	WHT	GRN	YLO	AMB	RED
5000-7999 m	WHT	WHT	GRN	YLO	AMB	RED
3700-4999 m	GRN	GRN	GRN	YLO	AMB	RED
1600-3699 m	YLO	YLO	YLO	YLO	AMB	RED
800-1599 m	AMB	AMB	AMB	AMB	AMB	RED
< 800 m	RED	RED	RED	RED	RED	RED

1.4. Taxi out

The Crew Chief just removed the chocks and gave you a salute. From now on the jet is yours and you have to bring it back in one piece. Check that the aircraft is all green and you have no warning lights, caution lights or the MASTER CAUTION light on.

The first thing to do is to ask Kunsan ground for clearance to taxi. Open the ATC Ground page and select 'Request Taxi for Departure'. If you set your radio correctly to airport ground frequency the ATC will answer with your clearance and to hold short from the active runway. If other aircraft are in the queue ATC will state your number in the sequence and may instruct you to remain at your position or give way to other aircraft in sequence. When they do that they will re-contact you when it is your time to taxi. If you are on any other airport frequency the ATC will remind you to set the correct frequency.

The initial call is quite important because it places your aircraft in the ATC queue and the ATC will light up the ALS (Airport Lighting System) and keep them on as long as you are in the queue. It's especially important at night if you want some lights to guide you.

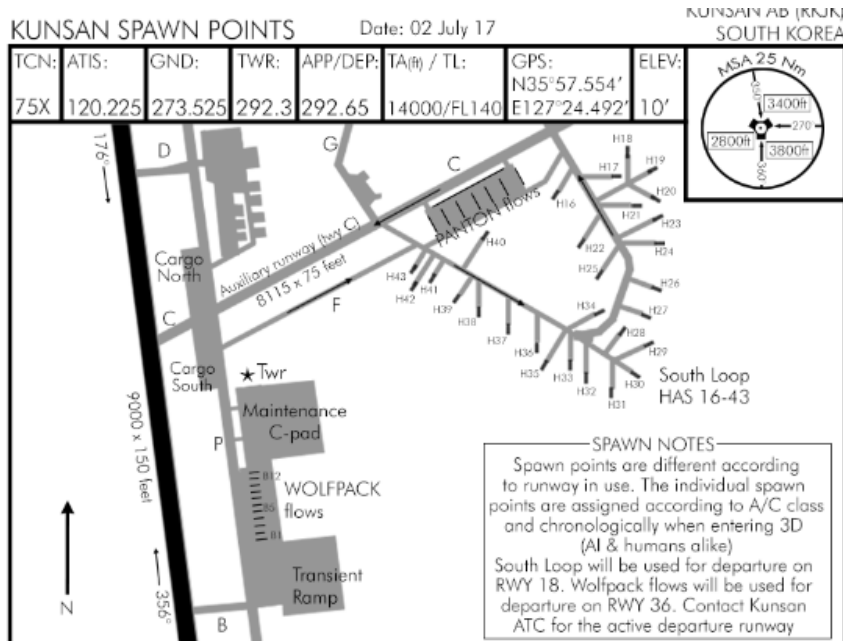
Once you receive ATC clearance to taxi, move the jet forward and out of the blast revetments of Wolfpack flows so we can see the taxiway better. Move the throttle forward a notch to unstick the wheels and once the aircraft is moving pull the throttle back to IDLE. A lightly loaded jet may move forward even at idle power. The first thing to do is test the wheel brakes. Gently tap the toe brakes and confirm the nose dips and the aircraft slows down. The aircraft steers on the ground with the rudder pedals. The Nose Wheel Steering is active as indicated by the green NWS right indexer light. To turn left depress the left pedal, to turn right depress the right pedal. If you do not have a rudder installed you may use the rudder left and rudder right keystrokes (, and .), or there is an option in the CONTROLLER > ADVANCED UI page to allow the sidestick to steer the aircraft on the ground (check the ENABLE ROLL-LINKED NWS).

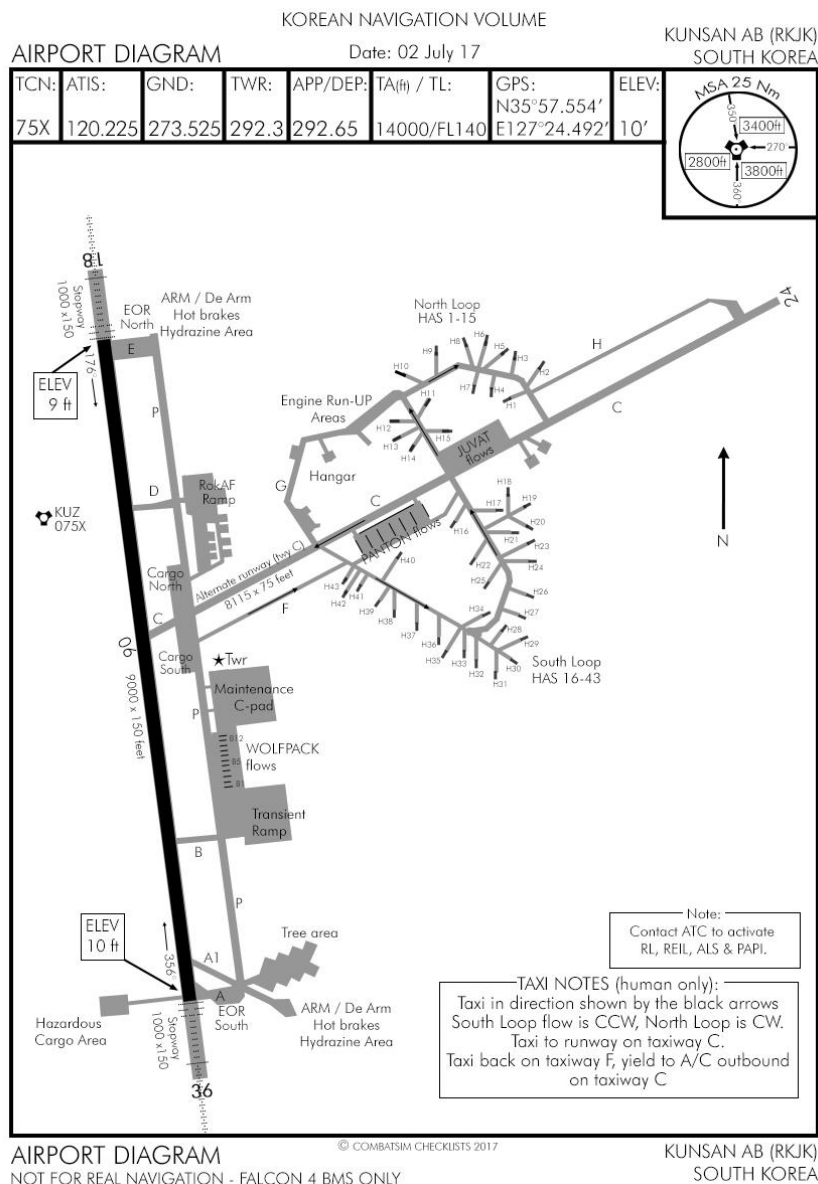
In the early days of training it's not always easy to know where the aircraft will spawn on the airbase and therefore it's not always easy to know which direction to go to taxi to the active runway. The airport diagram should help to plot your route to the holding point.

All the BMS charts are located in the *Docs\Airport Approach & Navigation Charts* folder of your BMS install.

As you see on the chart on the right Wolfpack flows is the line of blast revetments lining up Taxiway Papa and facing the 18/36 Runway. North is to the right; therefore you should turn left on Papa to go to the holding point of RWY 36. Single aircraft should taxi on the taxiway yellow centreline. So turn left on the taxiway and align your nose with the yellow centreline.

In a multi-ship scenario, your lead may instruct you to taxi scattered in order to shorten the taxi sequence. In that case, each aircraft should taxi on opposite sides of the taxiway centreline.





The taxi out to EOR SOUTH, which is the holding point for RWY 36, is not very long. The main challenge of taxiing is to avoid a hot brakes situation. Brakes can become very hot if used extensively and may lead to wheel fires or blown tires. To avoid such situations developing you should taxi slowly and avoid riding the brakes constantly. It's better to manage the throttle correctly rather than to have a too high setting and then needing to brake often. Maximum groundspeed might change from one country to another and according to the peace/war situation, but generally you should stay below 25 kts in straight lines and 10 kts in turns.

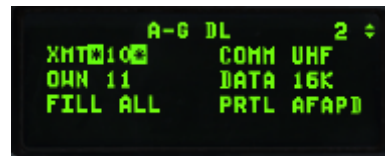
But your HUD tape doesn't change and is stuck at 0 kts? Indeed the system needs air flowing through the pitot tube and probes of the aircraft to give an accurate airspeed reading to the pilot. Taxiing on the ground these probes are ineffective and the HUD cannot display your groundspeed.



The INS page of the DED is the only way to get this information on the ground. Push ICP LIST 6. Your groundspeed is given in the lower right corner of the DED (6 kts in the example). Note the elevation shows as 13 feet, which is not what the chart tells you, but remember that the aircraft probes are not at ground level. There are always a few feet difference.

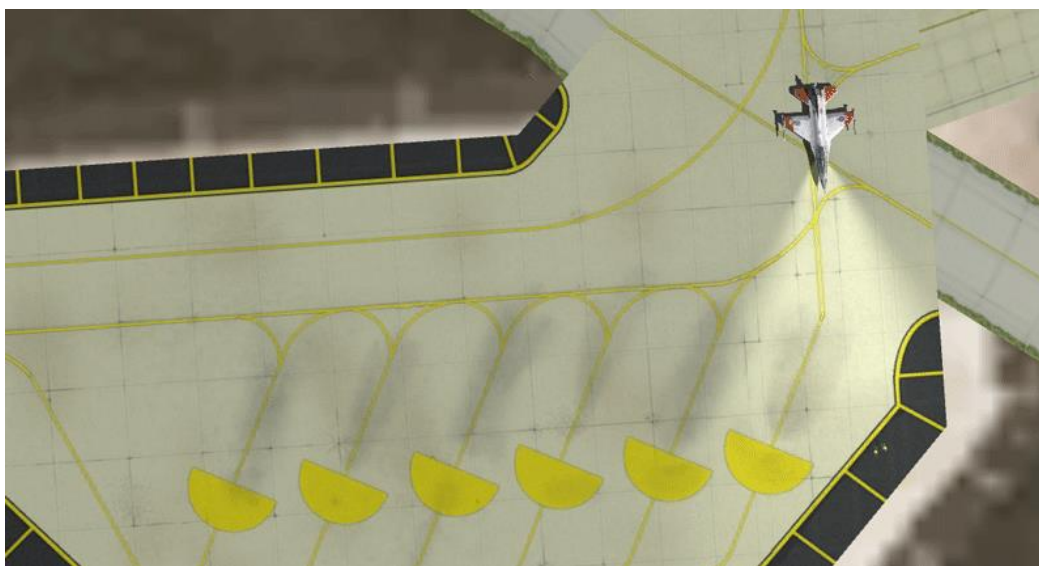
4.34 removed the IDM capability of the earlier blocks. The block 15 we are flying today doesn't have improved data modem (IDM) anymore, unlike in 4.33. With more modern blocks, taxiing out is the moment pilots would check the IDM with the other aircraft in their package. Although not possible to do in this training mission, there is no other place to specifically explain this so let's pretend we still can and use that information for when we are flying other F-16 blocks.

The IDM is set through the UFC DLNK page. Press the LIST ICP button and select subpage DLNK by pressing the ENTR ICP key. The first page displays your flight IDM address (10) and your ownship IDM address (11). Dobber right to enter the second page of the IDM where you can enter the other team member IDM addresses. Since this flight is single ship the IDM only has your own address input. By default all your flight members IDM addresses are entered in the left column and the right column is empty. By dobbering down you can input specific addresses in specific slots. In this example I dobbered down to the #2 position and inputted the IDM address of a virtual wingman (12), then dobbered further down to the first address of the right column (#5) to input the address of the lead of another flight in my virtual package (21).



Once all addresses are input correctly you will have sensor information from these IDM addresses according to the status of your IDM. Taxiing out, the IDM is tested by initiating a single IDM round and checking you can see the icons of the flight members appear in sequence on your HSD. The IDM check is initiated by depressing the throttle COMM switch left for more than half a second. The position of your flight members and eventually the extra package addresses you inputted should become visible on your HSD momentarily. The system has been checked and can be used as required further in the flight.

Arriving at EOR south, park your jet away from the taxiway so you can perform your before take-off checks. Kunsan EOR areas have been modified so that waiting aircraft point away from the airbase, which makes it easier to check the approach end of the runway before lining up. There are 6 parking spots available. As flight lead always pick the closest slot to the runway that is available. This will trigger the ground controller to switch you to the tower controller. If you aren't told to switch you are too far away from the runway.



End of Runway checks might sound superfluous in a simulation, but in an intensive scenario where AI aircraft may slow the taxi-out to the runway it makes sense to taxi early and wait as close to the runway as possible. By taking the parking spots away from the taxiway you allow enough room for the AI to pass without disturbing them. It's also a good spot to complete anything in the checklists that you did not do at ramp, such as setting weapon release parameters, bore-sighting the FLIR, checking the TGP etc.

Upon arriving at EOR the Ground Controller will call you and instruct you to switch to the Tower frequency. You don't have to do it right away; it's at your discretion whenever you are ready. You may elect to first do your EOR checks. Don't forget to engage the parking brake. The parking brake is magnetically held and will remain activated as long as your RPM settings are below 83%. To remove them flick the switch or simply advance the throttle past that limit and retard to Idle, you will hear the switch snap off and the aircraft move.



The aircraft systems are unable to give you the wind speed and direction while the aircraft is on the ground. To plan your take-off properly you should know the surface winds. You had them listening to the ATIS earlier (320°, 14 knots gusting 23 kts) but as illustrated in the picture below, 4.34 also introduced wind socks at each runway end of all airbases. A quick look at these should give you the wind direction and approximate speed. And if that's not enough, the Tower Controller will give you winds when you are cleared for take-off.

Once you have completed your before take-off checks switch to Kunsan Tower (remember you have already been cleared to switch frequency). Input 292.3 or use preset #3 in COM1 and let the Tower know you're ready for take-off via the ATC menu tower page (t t 1).

Tower will then instruct you to hold short runway 36, line up and wait, or clear you to take-off. Gone are the days when we needed to ignore ATC to depart on time. The ATC update has made Falcon BMS way more immersive in 4.34.



1.5. Take-off

Line up on the active runway magnetic heading (referenced on the charts). If you are single-ship like in this flight you will use the centreline; otherwise your position will depend on how many aircraft there are in your flight and on the briefed departure type.

Please note, the new ATC code instructs AI to take-off in 2-ship elements by default, but you may instruct them to line up as a 4-ship with either #3 or #4 in the slot. Your position as lead should always be downwind to avoid the wind pushing your aircraft into the path of your wingmen.

Stop the aircraft with the toebrakes and make a quick final check of engine gauges and for any caution or warning lights. Check the runway QFU (magnetic heading), place the Radar Altimeter switch in the RDR ALT position and the IFF master knob in NORM.

Taking off seems a relatively easy task. All you have to do basically is increase the throttle setting, keep on the centreline and pull gently on the stick once you reach rotation speed. There are a few tricks to it though.

The first one is the gross weight of your aircraft. The heavier you are the longer the take-off roll will be, and things will happen slower. If your aircraft is very light, as is the case in this training scenario, things will happen fast as the aircraft will accelerate very quickly.

The gross weight of your aircraft is given in the arming screen of the UI. Unfortunately your rotation speed is not given. Rotation speed is the speed at which the pilot pulls back gently on the stick to rotate, transitioning from rolling to flying. It is a very important parameter you should know for every take-off.

WDP (Weapon Delivery Planner) is the only tool that will calculate your rotation speed for you. It is strongly advised. Refer to the WDP documentation as it is outside the scope of this manual to document WDP use.



In this training scenario your jet is empty, but for the 2 AIM-120B missiles on the wingtips. It is a very light configuration.

The bottom right box of the arming screen gives you more detail about your jet configuration:

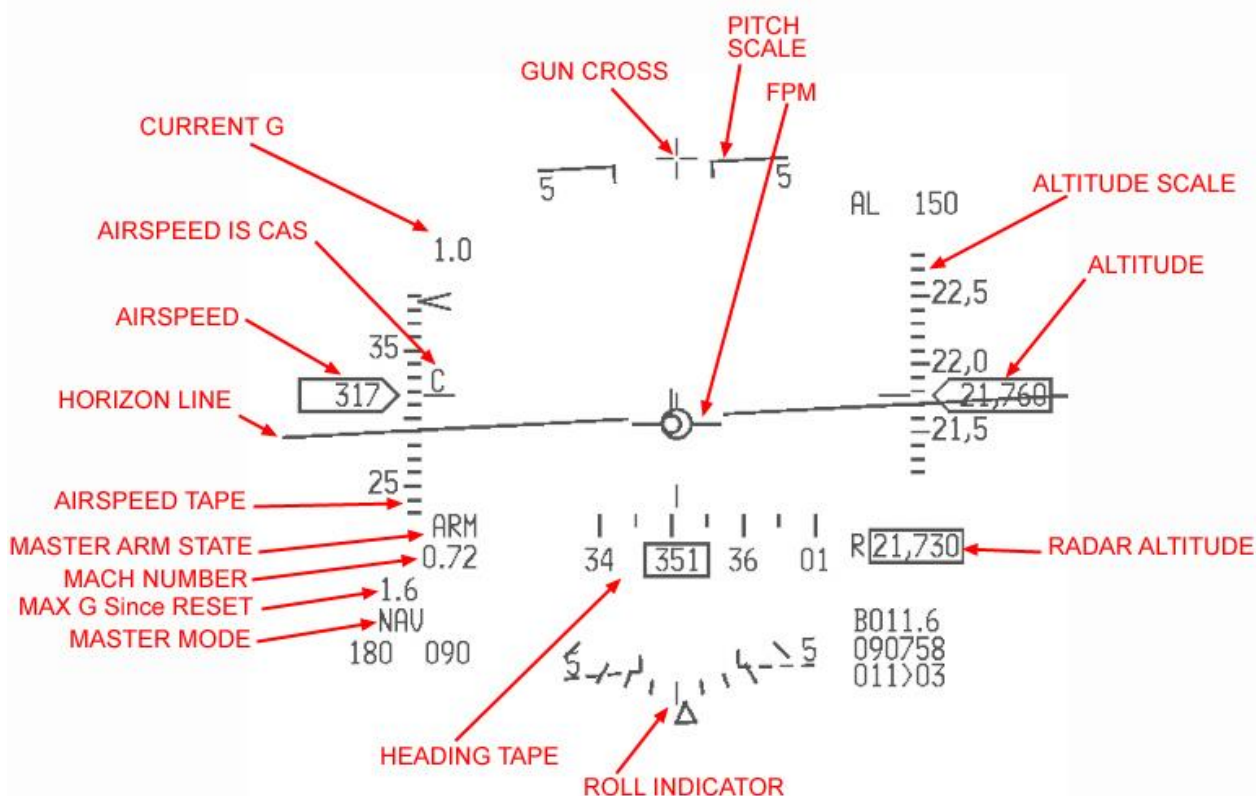
- Clean Weight of 17600 lbs is the empty weight of the aircraft. It is consistent for each aircraft model.
- Munitions gives you the weight of the stores loaded; just 676 lbs in this case.
- Fuel is controlled with the slider and the number on the right is the amount of fuel (in pounds) on board; 5897 lbs this time.
- Gross Weight is the sum of all the first three lines and represents your actual weight at take-off.
- Maximum Weight is the weight limit of the aircraft and changes for a specific F-16 variant; 37500 lbs for this type. You cannot load the aircraft past that limit. If you are heavier, you will need to remove stores or decrease the amount of fuel loaded.
- Drag Factor is a coefficient indicating the amount of drag the current configuration produces.
- Max G and Min G Limit are much more important since 4.33 because the stores loaded will limit the Max and Min G you can pull. If you exceed these limits the stores may become completely unusable or the fuses of bombs which you can still drop may not work. The system will not warn you, so you have to commit these numbers to memory... and respect them.
- Maximum KIAS and Maximum Mach are the maximum speed in knots and in Mach. Since that depends on altitude, the UI refers to AC. Or in other words you should use the VNE line on your Machmeter.
- Load Category will show either CAT I or III. That load category must be set appropriately with the STORES CONFIG switch on the GEAR panel.
- LGB Laser Code is used for LGB delivery and outside the scope of this mission. Basically laser guided weapons loaded on your jet are set with a fixed laser code and the aircraft system must match the weapon laser code for the bomb to guide accordingly. It is a new feature in 4.33, allowing amongst other things buddy lasing to be performed. The arming screen LGB laser code is the fixed weapon code that the user can set according to brief. More on that in the LGB training mission.

The difference between your actual Gross Weight (24174 lbs) and the Max Weight (37500 lbs) tells you how lightly or heavily loaded your jet is. WDP for this configuration gives a rotation speed of 127 kts. That is particularly slow as rotation speed for a combat laden aircraft is usually around 165 kts or more. If you perform an afterburner take-off you will reach that speed before you know it and have very little time to think about anything else.

And the jet will continue accelerating once you are airborne. It will reach the 305 kts gear-down limit in no time, so if you don't disengage afterburner quickly you will find yourself damaging your landing gear

The second trick during take-off is avoiding excessive steering while rolling. When NWS is enabled the nose wheel turns with the rudder; this is something you really don't want to happen at high speed. NWS should be deactivated before you reach 80 kts and used with caution even below that. Remember though that your airspeed scale will not start to move until you reach 60 kts, so your window of action is very small. If you aligned your jet correctly with the nose wheel straight on the centreline you will not need NWS during take-off, so it may be safer to align carefully on the runway and disable NWS before advancing the throttle.

Obviously that means you will not be able to steer the aircraft on the runway with the nose wheel. As your speed increases though so does the air flow on your rudder, increasing rudder authority/effectiveness, and allowing you to steer to compensate for crosswinds.



All relevant information for take-off is displayed on the HUD. For a deeper explanation of the HUD please refer to Chapter 1.5 in the Dash 1 Manual.

The left scale is your airspeed. As the Dash 1 documents in more detail, the airspeed scale can be set to different speeds: calibrated (CAS), true (TAS) and groundspeed (GS). When the gear is down the HUD always displays CAS, ignoring the switch position on the HUD panel (refer to Dash 1, Chapter 1.2.5.3). The reason is you don't care about TAS since you're close to the ground (TAS is CAS corrected for pressure altitude) and you certainly don't want to have a speed corrected for winds (as groundspeed is) because your stall speed is always indicated/calibrated.

You will notice that your airspeed scale remains at zero although you are moving at slow speed. As explained above the probes need airflow to provide information and below 60kts the airflow is not sufficient.

The right scale indicates your altitude. According to the position of the ALT switch on the HUD panel it can display Barometric or Radar or can switch from one to another at 1500feet. The default setting is Barometric so if you did not touch the switch at ramp your HUD should indicate barometric altitude.

The top scale is your heading, which can also be displayed on the bottom of the HUD. This one should indicate the Runway QFU as stated on the charts: 356° for Kunsan RWY36. Remember the better it is aligned, the less steering you will have to do initially.

The centre part of the HUD displays the attitude lines, the Flight Path Marker (FPM), the Great Circle Steering Cue (aka tadpole) indicating the Steerpoint and the gun cross which is the fuselage reference line indicating zero degrees. This is a very important item for take-off as you use it as your climb angle reference.

You are now ready to take-off.

The first step is to keep the brakes firmly engaged and add power to 90% RPM. Once stabilised check engine gauges and if all is good release the brakes and advance the throttle to full military power (aka Buster or MIL), then smoothly forward to engage afterburner.

The jet is now accelerating on the runway. Disengage NWS as quickly as possible (if you haven't already) and steer lightly with the rudder to keep on the runway centreline. Be aware that the wind may push you sideways.

Once you reach rotation speed pull back gently on the stick and place the gun cross on the 10° pitch up line. Please note you place the gun cross on the 10° pitch line (and not the FPM) as the FPM takes AOA into account and the gun cross is the fuselage reference line. Do not climb too steeply and keep under 14° pitch as you rotate, or you may risk scraping the nozzle on the runway. The aircraft will keep accelerating fast.

Continue flying on the runway heading and raise the landing gear. The gear must be in the wells before the airspeed reaches 305 kts. It takes a few moments for the gear to raise so don't wait until 300 kts but do it as soon as you confirm you have a positive climb rate.

While the gear is in transit the gear handle red lollipop light will be ON. The gear is confirmed up when the 3 gear green lights on the gear panel and the lollipop red light are OFF. If the lollipop remains lit you have a gear malfunction and should stay under 300 kts while you attempt to solve it.

Congratulations you are flying.

Once your airspeed reaches 350 kts disengage the afterburner. Maintain buster and pull more on the stick to adjust your climb angle to maintain 350 kts. With a very light jet the climb angle will be steep.

Switch to the Departure frequency (preset 4) and select 'Report Airborne' on the ATC menu Departure page. Departure will probably give you a heading of 355°.

Level out at 5000 ft on runway heading and retard the throttle to maintain 350 kts.

You can now move on to Mission 2: Basic Navigation.

MISSION 2: BASIC NAVIGATION

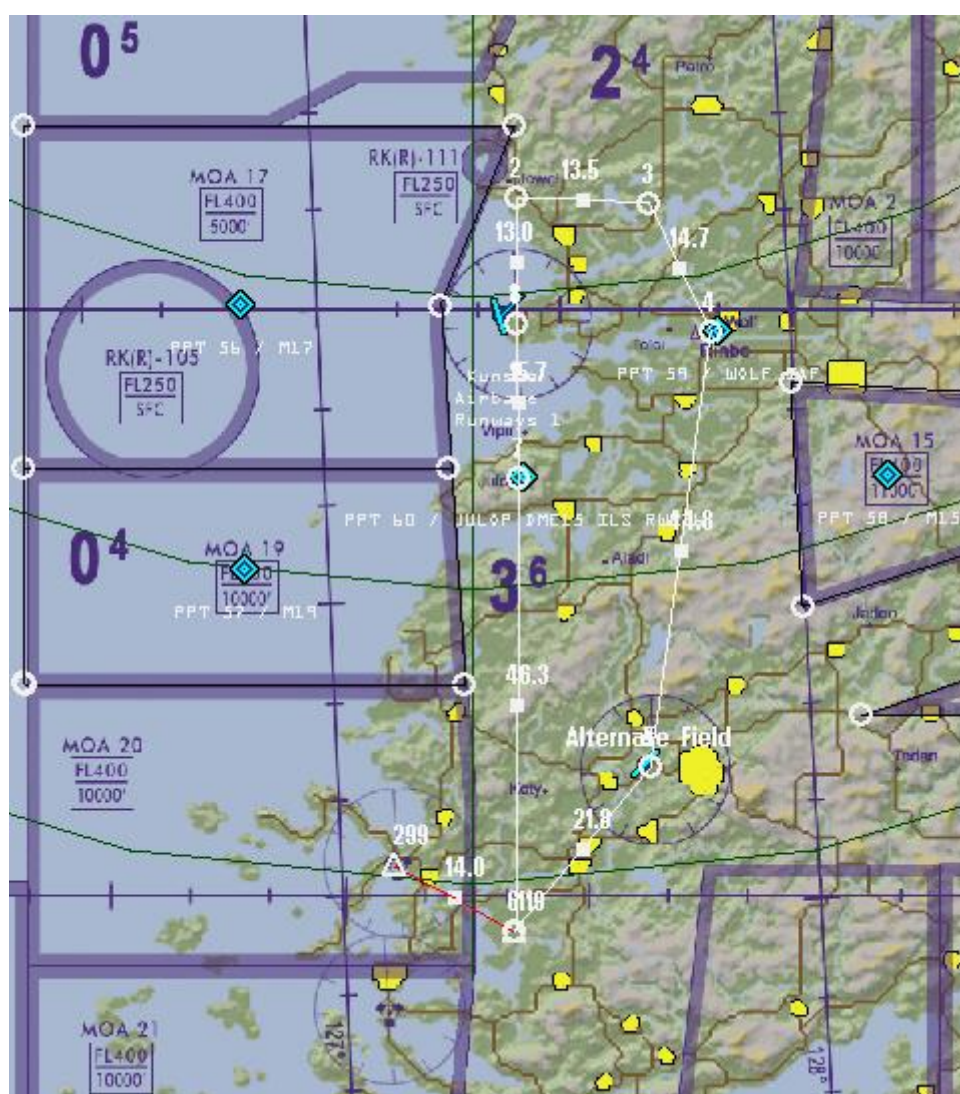
TAKEOFF OPTION: In Flight.

LOCATION: Approximately 5 Nm north of Kunsan.

CONDITION: Aircraft level at 5000 feet - heading 360° - speed 350 kts. Once in the cockpit the training scripts will freeze BMS and setup your systems correctly. Set up your MFDs according to your preference.

GOAL: Follow the INS (Inertial Navigation System) flight plan, train TACAN navigation and come back to the Initial fix for landing at Kunsan.

The key to a successful flight is good planning. Remember the 5 P's: Proper Planning Prevents Poor Performance. Before starting up this training mission let's study our flight plan.



The flight today will bring us south of Kunsan in the area of Kwangju airbase. The training scenario will start somewhere between Kunsan and Steerpoint 2. Steerpoint 4 is WOLF, Initial Approach Fix (IAF) for Kunsan. Steerpoint 5 is the alternate airbase for this flight and Steerpoint 7 is where the training mission will end and the next one (Landing) will start. This route has been plotted on the UI screen using the Tactical Engagement Editor. The INS flight plan is displayed in white, with the steerpoints represented by empty circles.

When the flight plan (or single leg) turns red there is a problem somewhere. Possible causes may be not enough fuel on board for the flight plan distances, timing problems, or steerpoint problems. When you build your own TE's you will have to correct these issues to ensure your flightplan is white before flying the mission.

The distance in Nm is displayed between two INS steerpoints. You can also display any distance between 2 points by enabling the UI Ruler. Simply right click anywhere on the UI map and select Ruler. A line 20Nm in length will be displayed between 2 triangles and you can move either of the two triangles to specific points on the map to calculate distances between these points. It is a very handy feature of the mission planning screen. Note that in our flight plan the ruler was set to calculate distance from Steerpoint 6 to Muan VORTAC (TACAN channel 65X). The ruler also displays the corresponding headings for the leg. In this case: 299° if flying from Steerpoint 6 to Muan and 119° if flying from Muan to Steerpoint 6.

The alternate runway is displayed in the flight plan as the last INS steerpoint. In this case our INS flight plan starts at Kunsan (STPT 1) and ends at Kunsan (STPT 8) therefore the alternate runway (Kwangju airbase) will be Steerpoint 9. Incidentally in this flight plan it is also Steerpoint 5.

There is no indication of TACAN channels or airport information on the UI map. This extra information would overload the map. Yet that information is important and must be planned for the flight. There are multiple tools to help you do that. WDP and its data card will layout the relevant navigation information. Alternatively you can also use the relevant interactive maps on combatsimchecklist.net.

Here is the required information for this flight:

- Kunsan: TACAN 075X - RWY 18/36 - ILS RWY 36: 110.3 – Elevation: 10 feet -
ATIS: 120.225 - Ground: 273.525 – Tower: 292.3 – Departure & Approach: 292.65
- Kwangju (Alternate): TACAN 091X – RWY 02/20 (L&R) – ILS RWY02&20: 111.1 – Elev: 110 feet -
ATIS: 128.875 - Ground: 275.8 – Tower: 254.6 – Departure & Approach: 268.0
- MUAN VORTAC: 065X
MOKPO VORTAC: 049X
- MOA 15 active: 11000' to FL400
MOA 17 active: 5000' to FL400
MOA 19 active: 10000' to FL400
(these are restricted to you as other aircraft train in these areas).

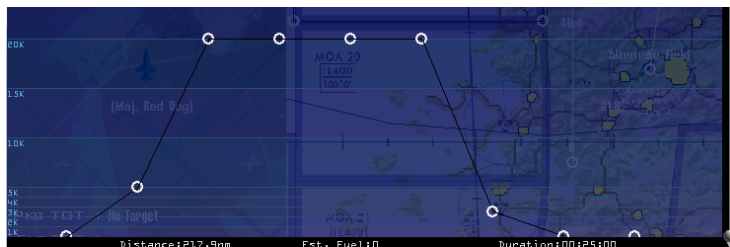
The mission planning map also displays relevant areas or specific points. These are Lines and PPTs. They are activated by right clicking on the UI map and selecting 'Set STPT Lines' or 'Set Pre-planned Threat Stpt'.

Lines are used to mark specific areas such as FLOT lines, CAP boxes, AAR boxes, AOR, Kill boxes, etc. PPTs are used to identify specific points like IAF, entry points, rendezvous points, push points, etc. They can also be used to label boxes you have created with Lines, like the MOA in this training scenario. Lines and PPTs are fully customisable and can be labelled as you prefer using WDP or by editing the PPT.ini file directly.

MOAs 15, 17 & 19 are lined and labelled and PPTs are also placed on WOLF IAF for Kunsan and JULOP fix for ILS RWY36. All these lines & PPTs will be visible on your HSD MFD page if you have loaded your DTC.

The map also displays MEF (Maximum Elevation Figures) in each box created by one degree of latitude and one degree of longitude. The MEF are the highest known point of elevation in each box. They are given in hundredths of feet, with the large number being thousands and the smaller number being hundredths of feet. For instance 5² indicates 5200 feet. To stay safe from hitting the ground (in bad visibility for instance) you should stay above that reference by at least 500 feet. MEF + 500feet = MSA (Minimum Safe Altitude), unless you are on a published SID or approach chart which will keep you safe from the terrain.

The altitude of your flight plan can be checked as well: Obviously the first and 2 last steerpoints (departing airbase, arrival airbase and alternate) are at ground level. The altitude of the other steerpoints is displayed in two different graphics which you can enable or disable with the 2 graphic buttons on the right side of the UI screen. The total distance of the flight plan is 218 Nm and the ETE (Estimated Time Enroute) will be 25 minutes.

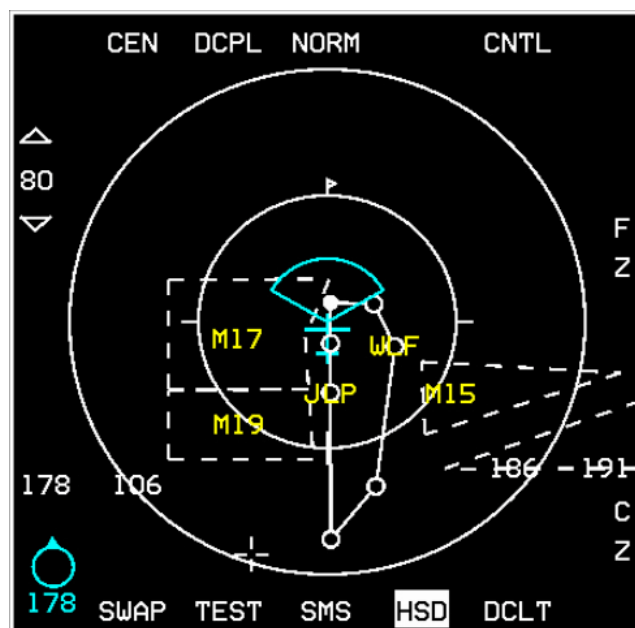


More information can be found for each steerpoint if you click on it. A new window will open up with steerpoint information:

- Flight callsign: Goblin 2-1.
- Steerpoint number.
- Time over Steerpoint (TOS).
- Altitude required for steerpoint passage.
- True Airspeed passing the steerpoint.
- Calibrated airspeed.
- Formation required.
- Type of action at Steerpoint. If type is defined, then the Option box below will be filled in with relevant information.



All this information will be available once you are in the cockpit. Besides the main flying instruments the most important tools for INS navigation are your HUD and your HSD MFD page. The Horizontal Situation Display page is a god's eye view around your aircraft. It can be zoomed from 5 to 240 Nm and displays your INS flight plan, PPTs and lines as illustrated below. Both the HUD and the HSD are explained in the Dash 1.



The pictures above are taken at the starting point of the Navigation training mission. You are between Kunsan airbase and Steerpoint 2, level at 5000 feet QNH. Calibrated airspeed is 350 kts.

If STPT 2 is not selected press the ▲ arrow on the ICP and notice the top right corner number in the DED switching to STPT 2. When selected as the active steerpoint the circle in the HSD turns solid. A steerpoint diamond is also displayed in the HUD if the steerpoint is within the HUD FOV. If not, as in this example the diamond is displayed with an X through it at the edge of the HUD nearest the direction of the steerpoint.

The HUD indicates the direction of the selected steerpoint with the Great Circle Steering Cue (aka tadpole), right of the FPM. Distance and ETE to the selected steerpoint are displayed in the bottom right block of the HUD. Steerpoint 2 is ~6.3 Nm away and at this speed you will need ~65 seconds to reach the steerpoint.

Zoom out the HSD to 80 Nm to display the whole flight plan. And set HSD to CEN (OSB 1) option so ownship is centred in the HSD. The FCR search cone, lines, PPTs and flight plan are all displayed. You can zoom in/out with OSB 19 and OSB 20, or alternatively you can make the HSD SOI and move your cursors to the top or bottom edge to increase or decrease the HSD zoom level.



Initial conditions of this training scenario. Kunsan is in the background

Steer towards Steerpoint 2 by placing the tadpole inside the FPM as illustrated on the right. Try to maintain 5000 ft by keeping the FPM on the horizon line (0° pitch line in the HUD).



The aircraft can automatically switch to the next steerpoint as you approach the active steerpoint (default off). Select the ICP STPT page with the STPT button and DCS right. The DED will toggle from MAN to AUTO. DCS left to return to the CNI page and note that the steerpoint number is now followed by an A, indicating Automatic mode is active. When reaching Stpt 2, the system will automatically switch to the next steerpoint.

While on the CNI page moving DCS right will display wind direction and speed, used to show how much you are drifting. In this case the wind is from 319° at 14 kts. We are flying 360° so the wind is pushing us to the right. This is also illustrated by the slight offset of the FPM, tadpoles and the pitch lines. If you look closely the FPM is not in the centre of the HUD but slightly to the right indicating a right drift because of the winds. A significant crosswind component and higher wind speed will push you off track even more.

UHF	292.65	STPT ÷ 2A
		319° 14
VHF	15	10:35:54
M1234C	7630	TIM T 75X

In some parts of the mission the FPM drifting in the HUD may be an annoyance, so it can be deactivated by placing the ICP DRIFT switch in the DRIFT C/O position. The FPM will then remain centred in the HUD. Just ensure you replace the switch in NORM before landing.

Upon reaching Steerpoint 2 the HUD will switch symbology to STPT 3. Turn the aircraft to the right, maintaining level flight until the steerpoint diamond in the HUD becomes visible. Align it with the FPM and ensure the tadpole is vertical. You are now flying directly to STPT 3.

The flight plan calls for a climb to FL200 (20000 feet on QNE (29.92)). Climbing to altitude can be achieved by pulling gently on the stick. The aircraft will climb, and airspeed will decrease.

In this training scenario we will learn to perform a climb to altitude in a fuel efficient way. Fuel is always a concern, so everything possible should be done to conserve fuel. One fuel efficient climb profile is to climb at a set speed and adjust your climb angle to maintain that speed. Advance your throttle to buster (MIL power), wait for 350 kts and then pull the stick and adjust the climb angle to maintain 350 kts throughout the climb. As you climb, your airspeed may drop below 350 kts, in which case simply decrease your climb angle to stabilise your airspeed and accelerate back to 350 kts.

Passing 14000 feet set your altimeter to QNE: 1013 Mb or 29.92 inHg. That is the standard pressure for flights above the transition altitude in KTO (Korean Theatre of Operations). From now on altitude will not be called in feet, but in Flight Levels expressed in hundredths of feet. e.g.: FL150 is 15000 feet. Before reaching FL200 decrease your climb to level out at your assigned altitude. Depending on your gross weight you may also need to retard the throttle a bit to maintain 350 kts.

Now is a good time to check your fuel. Fuel remaining and fuel imbalance problems should be one of your main concerns. Fuel remaining is checked by looking at the fuel gauge on the right AUX console. Fuel imbalance is checked for by looking for any red portion of the needles visible on the fuel gauge. If you don't see red your fuel load is balanced. If you do see red then you should start to fix the situation immediately, most probably by checking the position of the ENG FEED switch. Refer to chapter 1.7.7 in the Dash 1.

Passing Steerpoint 3, the avionics will switch to STPT 4 and your HUD should show information related to STPT 4. Steerpoint information can also be displayed on the Horizontal Situation Indicator (HSI) located on the centre console. This instrument is explained in the BMS COMMS and NAV book in your Docs folder.

Depending on the position of the INSTR MODE knob the HSI will indicate navigation information related to the active TACAN station (TCN & TCN/ILS positions) or the active steerpoint (NAV & NAV/ILS positions). Move the knob to TCN and notice the bearing indicator pointing to KUN TACAN moving to the three o'clock position as illustrated on the left screenshot below. The DME window on the top left of the instrument indicates 19(.5) Nm and once centred with the CRS knob the CDI indicates the bearing to Kunsan is 248°.

The HSI pictured below is slightly different and more accurate than the normal HSI as it is the EHSI extracted with MFDE (MFD Extractor), third party software that extracts gauges for multi-screen and cockpit use.

If you move the INSTR mode to NAV the HSI will change and display information relevant to the active steerpoint (4). The bearing indicator rotates to the 12 o'clock position, indicating that the steerpoint is straight ahead. The DME window will indicate 9(.3) Nm which is the same distance displayed in the HUD. Note that the Course Arrow is still set to 248° as before. The CDI can be used to intercept radials relative to NAVAIDS or steerpoints, as explained in the BMS COMMS and NAV book.



As we overfly WOLF IAF (STPT 4) we check the INS coordinates against the IAF on the Kunsan approach charts. WOLF is R090° DME 20 from Kunsan TACAN. Coordinates are N35°57.990' E127°50.029'.

Select the ICP STPT page while STPT 4 is active. The LAT and LONG lines give the coordinates of INS STPT 4. You will notice the coordinates are slightly different. Without going into too much detail 1° of latitude (measured on a great circle meridian) is 60 Nm. The difference between WOLF on the chart and Steerpoint 4 is about 1 minute in latitude and 0.15 minutes in longitude. When translated into Nm that equates to just under 1 Nm difference. A slight inaccuracy we have to live with in Falcon.



```

STPT 4 ÷ AUTO
LAT N 35° 56.982'
LNG E 127° 49.879'
ELEV 9700FT
TOS 10:39:33

```

Coordinates can be changed in the INS using the STPT page. Let's adapt the current coordinates to the ones displayed on the chart.

Move DCS down until the scratchpad is around the latitude line. Since 4.33 we first have to start the coordinate input with one of the cardinal direction symbols




```

STPT 4 ÷ AUTO
LAT N 35° 57.990'
LNG E 127° 49.879'
ELEV 9700FT
TOS 10:39:33

```

(N E S W) that are indicated on the 2, 4, 6 and 8 ICP buttons. Failure to do so will prevent any numbers from being entered in the scratchpad.

Hit 2 for North then 3, 5, 5, 7, 9, 9, 0 and ENTR. The latitude lines will change to the new coordinates and the scratchpad will move down to the longitude line. Hit 6 for East then 1, 2, 7, 5, 0, 0, 2, 9 ENTR and longitude will change to the new coordinates; the scratchpad will move to the elevation line. You can change it as well if you so desire.



```

STPT 4 ÷ AUTO
LAT N 35° 57.990'
LNG E 127° 50.029'
ELEV 9700FT
TOS 10:39:33

```

It is not really noticeable in this example because the distances are so short but the solid steerpoint on the HSD also moved to its new location.

Autopilot can also be used to fly the aircraft while the pilot is busy with other tasks. The autopilot of the F-16 is very reliable and features different modes of operation: PITCH HOLD, ATT HOLD, ROLL HDG SEL and STRG SEL. The autopilot is documented in chapter 1.14 of the Dash 1.

The mode that is interest to us for this training mission is the STRG SEL mode that will follow the INS route. It must be used in conjunction with the AUTO steerpoint toggle we discussed before, so the AP is able to steer to the next steerpoint when the current one is reached. Failure to use the AUTO mode will result in the aircraft circling the current steerpoint when reached until the pilot switches to the next steerpoint manually.

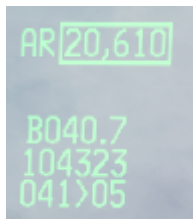
Autopilot needs a few conditions to be enabled. These are also documented in the Dash 1:

- Gear is not down.
- AR door is not open.
- ALT Flaps switch is not in EXTEND position.
- AOA is not greater than 15°.
- DBU is not engaged.
- MPO switch is not held in OVRD.
- There is no A/P failure or FLCS failure PFL message (STANDBY gains would be active).
- TRIM A/P DISC switch is not placed in DISC.
- Stall Horn is not active.

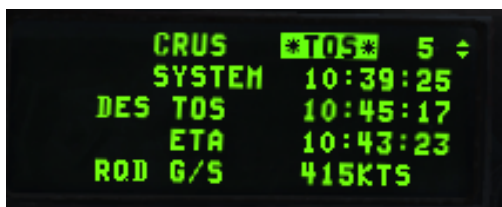
Move the LEFT AP switch to STRG SEL and move the right AP switch to ALT hold. The autopilot will engage (if the above conditions are met) and fly the aircraft. At any moment you can take control over the AP simply by moving the stick but be aware that if you exceed any of the above limitations the autopilot will disengage and WARN will be displayed in the HUD.

Note: there is no auto throttle on the F-16 so the throttle always has to be controlled by the pilot.

With the AP in STRG SEL the aircraft will steer towards the HSI bearing pointer the. It will also compensate for winds. Approaching STPT 4 the system will switch to STPT 5 and the AP will fly the jet to the steerpoint (because AUTO STPT was selected earlier. When MAN is selected the AP will circle round the steerpoint waiting for pilot input). We can concentrate on the avionics while keeping an eye on the airspeed.



Let's look at the lower right block of information on the HUD. STPT 5 is selected and is 40.7 Nm away. The ETA is 1043 and 23 seconds Falcon time. This line can display ETE or ETA according to the status of the TOS subpage. Let's select the CRUS page with button 5 of the ICP. DCS right to review all available sub modes: TOS (Time over Steerpoint, RNG (Range), HOME (self-explanatory) & EDR (Endurance). Select the TOS page. Depending on the TOS page being mode selected or not the HUD will display ETA or ETE to the selected steerpoint. Note that when TOS is mode selected it is highlighted in green.

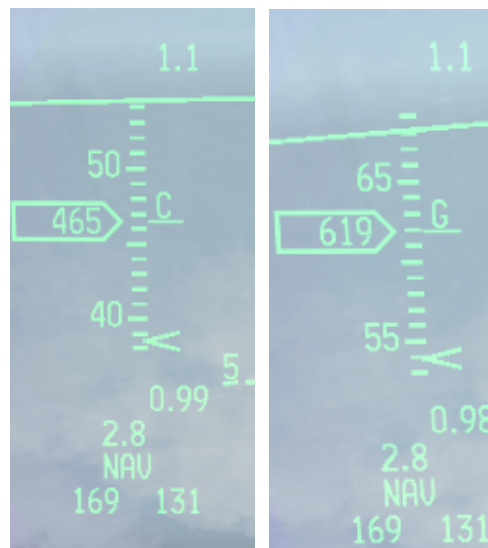
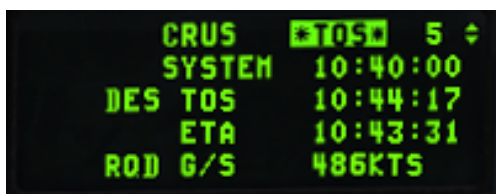
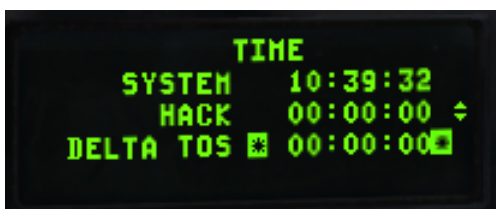


When not mode-selected only the asterisks of the scratchpad are highlighted. Here it is highlighted and the HUD displays ETA. The DED TOS subpage also provides current time (10:39:25), DES TOS (10:45:17) which is the planned time over steerpoint, ETA (10:43:23) which is our estimated time over steerpoint based on current speed and required Ground Speed (415 kts) needed

to reach the steerpoint at the planned time.

Current speed is 465 CAS. Let's switch the HUD speed scale to GS with the relevant switch on the HUD panel (right console). Our actual groundspeed is 619 GS: 204 kts too fast. Notice the TOS airspeed caret at the bottom of the HUD airspeed scale. To fly TOS the caret must be aligned with your current airspeed mark; we should slow down. Rather than slowing down to 415 kts GS we will adjust all steerpoint times by minus 1 minute with a Rolex call. Rolex is a time difference for all INS steerpoints. It is used when the flight is early or late and all steerpoint times need to be adjusted at once. It is done using the TIME page.

Return to the CNI page with DCS left and select the TIME page by pressing the ICP 6 button.



Dobber down to the DELTA TOS page and enter 0, 1, 0, 0, ENTR. The first zero actually inputs a minus sign. 1, 0, 0 is for 1 minute and ENTR enters the data into the system.

Return the UFC to the CRUS TOS page and notice the DES TOS has shifted to 10:44:17; 1 minute earlier than before. We are still a bit too fast, but we can now reduce speed to 486 kts groundspeed and fly the caret on the HUD airspeed scale.



The 3 pictures on the left illustrate flying the caret. The left one is taken just after DES TOS was adjusted. We are flying GS 602 kts, too fast to arrive at the steerpoint at the ETA.

In the middle one groundspeed was reduced to GS 474 kts on the caret. The HUD airspeed switch is then replaced in CAS.

The aircraft is flying at 350 KCAS and will arrive at the steerpoint on TOS, as long as the caret remains on the airspeed mark.

Passing Steerpoint 5 the aircraft, still on Autopilot, steers towards Steerpoint 6. It is now time to switch from INS navigation to TACAN navigation. As we planned before the flight, we know that we are flying close to both newly implemented VORTAC stations. We decided to call them VORTAC to differentiate them from the airbase-collocated TACAN stations, but basically they behave in the same way as TACANs in BMS.

Muan and Mokpo are 2 VORTAC stations with a limited range of 40 Nm. Let's fly direct to Muan. Select the T-ILS page and enter Muan channel: 065X in the scratchpad. Check that the INSTR MODE is set to TCN and look at your HSI. The OFF flag is not displayed, indicating that Muan is in range. The bearing pointer is approximately 257° and distance shows 23(4) Nm.

The autopilot is still flying the aircraft in STRG SEL mode, so let's move the heading roll bug on the station bearing with the left HSI knob and switch the AP from STRG SEL to ROLL HDG SEL.

The aircraft will immediately start a right turn to align with the HDG bug on the HSI (the yellow captain bars on the right screenshot). You may need to refine the HDG bug alignment with the bearing pointer to overfly the station.

At a distance of 4 Nm from the station the bearing pointer will start drifting to the side. Remember we are flying at FL200 which is a bit more than 3 Nm in altitude.

The DME (Distance Measuring Equipment) indicates slant range and therefore at this altitude station passage will happen at around 3.5 Nm. That is the reason why the bearing pointer will switch to the 6 o'clock position on the HSI with a DME still indicating 3 or 4 Nm.



It is now time to RTB (Return to Base). Fuel is not an issue in this flight, but it is good to get into the habit of checking your remaining fuel often.

Remember that the MOAs West of Kunsan are active so we should avoid them. Disengage the autopilot by moving the right AP switch to A/P OFF and fly heading 090° to get back on our initial route, staying clear of MOA19.

Once established back on track select STPT 7 (JULOP) which is the last steerpoint of this mission. The TACAN is still set to Muan so we need to switch back to KUN TACAN 75X and check the HSI, which can remain in TACAN mode.

We can now start our descent, so we overfly JULOP at 2800 feet.

Descending is even easier than climbing. Retard the throttle to IDLE and the FPM will pitch down slightly.

Let the aircraft descend while taking care not to let her accelerate too fast. Aim for 350-400 KCAS in the descent. The hardest thing to know is when to start your descent. With the landing steerpoint selected and its diamond visible in the HUD, wait until the diamond is about 7° below your horizon ghost line. That's your cue to start descending.



Switch the UHF radio back to Kunsan Approach 292.65 using the COM1 page (if it was changed) and request QNH using the ATC menu (or listen to ATIS on VHF) as you descend through the transition layer of FL140. Once you have the QNH, input it in the pressure window of the altimeter and continue your descent to 2800 ft.



Congratulations, you are now able to navigate using the INS and TACAN stations.

MISSION 3: LANDING

TAKEOFF OPTION: In flight.

LOCATION: Approximately 15 Nm south of Kunsan.

CONDITION: Aircraft level at 2500 feet over JULOP fix - heading 360° - speed 420 kts. Fuel level just hit Bingo. Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly. Set up your MFDs according to your preferences.

GOAL: Land on Kunsan RWY 36 Straight-in or Overhead.

This mission starts over JULOP fix 15 Nm south of Kunsan airbase. Your airspeed is around 420 kts and you cover 7 Nm in a minute. You will be on the ground in about 3 minutes.

This training mission will be used as a starting point for different scenarios. We will start by explaining the landing procedure with a long straight-in approach. We will explain the nuts and bolts of a good approach and how to manage the jet to land safely. This part will mostly be a copy & paste of the relevant chapter of the Dash 1 manual.

Then we will explain other landing procedures such as the overhead or the ILS approach. In these chapters we will consider that how to land the airplane has been mastered and concentrate on the specific approach procedures.

A good landing starts with a good approach. Configure your jet early enough with all the information you need for landing:

- Correct altitude. If your glideslope is too steep you will not be able to decelerate enough to lower your landing gear and even if you do, your final approach speed will be too high.
- Correct airspeed. The faster you are the more distance you will need to get down to landing speed.
- Know the weather. Display winds in your DED (DCS right on CNI page) so you are always aware of the wind component according to the runway heading: that will help you compute your wind drift. The F-16 has a maximum crosswind component of 25 kts. If the crosswind is stronger than that, you should find a better-oriented runway to land on (the airbase might be closed). Obviously you are aware of the current visibility and can plan your approach accordingly.
- Know your landing weight to have a rough idea of your on speed AOA for landing and know the runway. Although the F-16 is able to land on any runway in Korea the landing speed and the landing roll will depend on your gross weight at landing. GW computation can be done by taking empty weight + weight of stores remaining + weight of fuel remaining. That said, if you follow the AOA cues you will always fly the correct on speed AOA for approach.
- Always place the DRIFT C/O switch in NORM so the FPM drifts with the wind. That way you will automatically compensate for drift by placing the FPM on your desired touch down point.
- Listen to the ATC to build situational awareness of the traffic around the airport. In 4.34 each airbase has multiple frequencies: Ground, Tower and Approach/Departure which share a common frequency. ATC is also able to tell you which runway is active for departure and arrival. At night, the ALS (Airport Lighting System) will be off unless you initiate contact with ATC and will remain lit as long as aircraft are in the landing queue. If you don't make contact with the ATC and there are no other aircraft taking off or landing the ALS will remain off.

3.1 Landing straight-in

A straight-in landing is a long, controlled descent to the runway; usually beginning at a distance between 6 to 9 nautical miles. The landing phase will start aligned with the runway axis; you can use the airbase TACAN to do that, but it can be done visually as well. Altitude should be 2000 feet and airspeed less than 300 knots for safe extension of the landing gear.

Since we are 15 Nm out at 2500 feet and 400 kts, we have a few miles to adjust parameters for the straight-in. You should see Kunsan Runway 36 in front of you. Adjust your line up, descend to 2000 feet and reduce speed to 300 kts. Due to the low drag nature of the F-16 speed brakes may need be opened to reduce speed.

Let's initiate contact with ATC by requesting unrestricted approach. ATC will insert us into the landing queue, light up the approach lights and at the same time give us some flexibility for this scenario. Open the ATC menu Approach page by pressing 't t t 4'. Approach will instruct us to continue inbound and give us QNH.

From this point on we will no longer refer to airspeed but instead use Angle Of Attack (AOA). The optimal approach airspeed depends on your gross weight and the best way to be 'on speed' is to forget all about airspeed and think 13° AOA for landing.

First lower your landing gear (double-check your airspeed: it must be below 305 kts). Doing so will automatically deploy leading and trailing edge flaps and the FLCS will switch to take-off and landing gains. The drag caused by dirtying up your aircraft configuration will further decrease your airspeed and pitch the nose down a bit.

The HUD symbology will also change; notably an AOA bracket will be displayed. This symbol is used in conjunction with the flight path marker and the Indexer lights as your main cues for controlling the approach.

At 10 Nm Kunsan approach will call you to switch to Tower frequency. Input preset #3 or 292.3 into the COM1 radio and 'Request Landing' at initial contact with the tower with 't t 2'. Tower will clear you to continue inbound and ask you to "Report on Final".

The glide slope is 3° down to the runway. By placing the FPM on the -2.5° dashed line or slightly below you should fly a correct profile for your descent to the runway.

Most runways in BMS are equipped with a visual landing aid system called Precision Approach Path Indicator or PAPI. It consists of four equally spaced lights situated to the side of the runway. The lights will be seen as white or red according to the position of the aircraft with respect to the optimal glideslope.

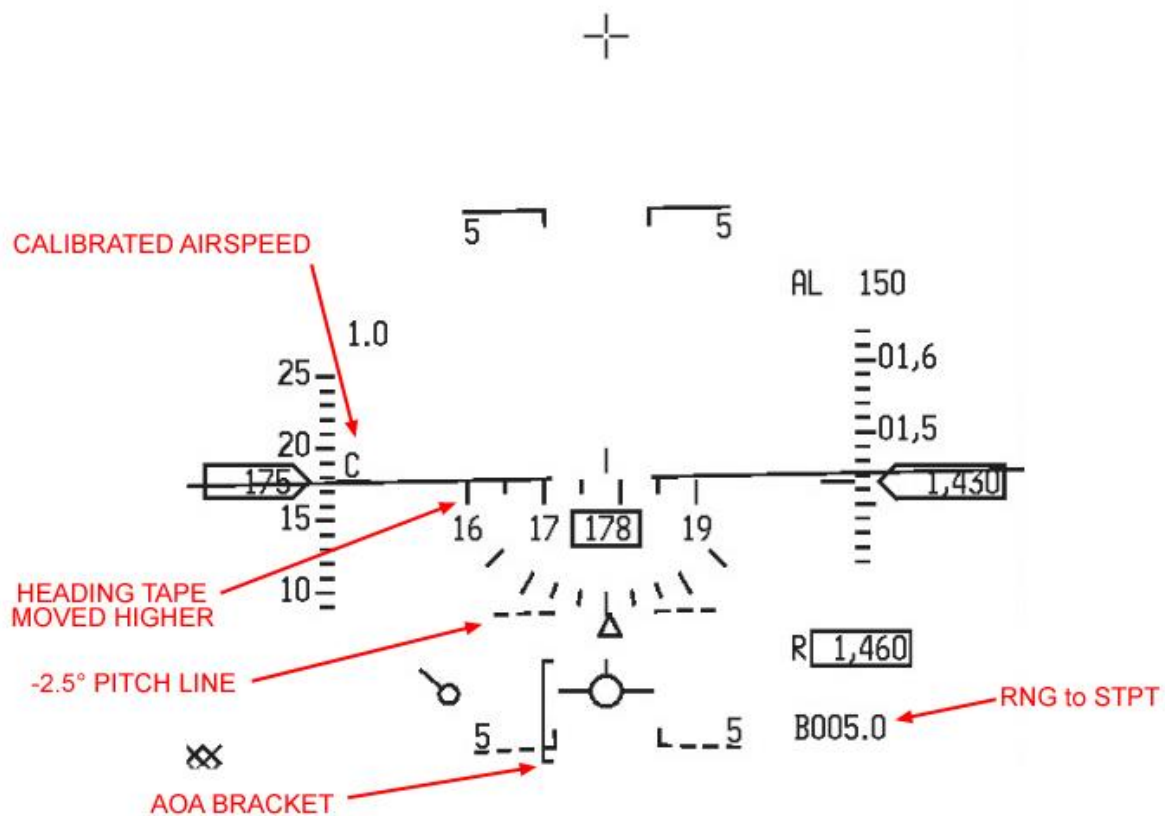
The more red lights visible from the landing aircraft the lower you are on the glideslope.

The more white lights seen from the aircraft the higher you are above the glideslope. The optimal glide slope is thus flown when 2 red and 2 white lights are seen.

A rule of thumb to remember:
Red is dead!

So there you are with the runway and PAPI visual at around 6 Nm, aligned correctly with the centreline at 2000 feet, gear down and flying around 250 knots.





You know that you have to place the FPM on the runway threshold to land.

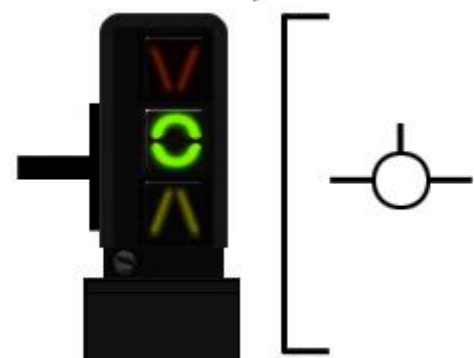
You also know that to maintain two red and two white lights on the PAPI you have to fly a 3° glideslope to the runway; the FPM has to be around the -2.5° dashed pitch line. This is done with the sidestick controller.

All you have left to do is to understand angle of attack and how to control it with the throttle.

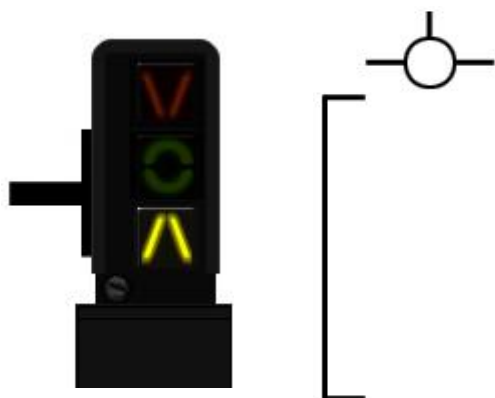
AOA is the angle between the aircraft wing chord line (equivalent here to the airframe longitudinal axis) and the relative vector of motion of the aircraft. Basically it's the angular difference between where the aircraft is pointing and where it is going.

The optimal touch down AOA for the F-16 is 13° AOA; corresponding to when the flight path marker is in the middle of the AOA bracket. At this moment, the AOA indexer located on the left of the HUD will show the middle green doughnut illuminated.

The top of the HUD AOA bracket indicates 11° AOA and the bottom mark of the HUD AOA bracket indicates 15° AOA. The bracket therefore corresponds to 5° AOA: from 11 (top) to 15° (bottom).

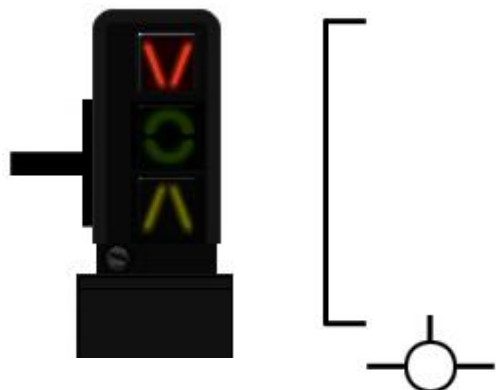


AOA is controlled by the power setting. Increasing power decreases AOA. (The FPM moves up while the nose remains steady) Reducing power increases the AOA (The FPM moves down in the HUD while the nose remain steady)



Knowing that, if the FPM is above the bracket ($AOA < 11^\circ$), you know you will have to decrease power setting to increase the AOA and lower the FPM inside the bracket.

You are too fast.



If on the other hand the FPM is below the bracket ($AOA > 15^\circ$), you will have to increase power to decrease AOA and bring the FPM up inside the AOA bracket.

You are too slow.



The approach is made around 11° AOA (FPM at the top of the HUD AOA bracket) on a $2.5^\circ - 3^\circ$ glideslope to the runway with speed brakes opened and landing gear (obviously) deployed.

The FPM should be just on the runway threshold and the PAPI should indicate two red and two white lights. The picture on the left depicts the situation although the AOA is a bit too low and fast. The throttle was then pulled back to increase AOA and lower the FPM to the top of the bracket.

From there the power setting is used to maintain the FPM on the runway threshold and on the top of the bracket.

'Report Final' to the Tower Controller via the ATC Tower menu 't t 4'. Tower will then give you surface winds and clear you for landing.

The next phase will be the flare just prior to touch down. The F-16 does not require much flare. The idea here is to transition the FPM from the top of the AOA bracket (11° AOA) to the centre of the bracket (13° AOA), with the green doughnut illuminated on the left indexer.

Decreasing power is usually all it takes to transition to 13° AOA. Once there, maintain it until the wheels kiss the ground and pull the power back to idle. If you land with the correct on-speed AOA the aircraft will not bounce off the runway and will not want to fly again unless you increase power.

Maintain aerobraking by keeping the FPM in the middle of the AOA bracket and the green doughnut illuminated in the left indexer. Since you are rolling and not flying anymore that is done by pulling gently on the stick. Beware that pulling too much will scrape the exhaust nozzle or the airbrakes and damage the aircraft. You can maintain directional control with the rudder during the landing roll; rudder efficiency is greater at higher speed and will decrease as your speed decays.

Around 80-90 knots the nose gear will drop to the runway; gently cushion it by pulling the stick.

Wheel braking can then be initiated, being careful to avoid causing a hot brakes condition; nosewheel steering can be engaged once you are below control speed (70-80 knots) to steer the aircraft on the ground. Congratulations, you just made your first solo landing.

3.2 Overhead landing

Overhead landing is the preferred method for landing because it allows multiple aircraft to land in the minimum amount of time. Since 4.34 AI are able to perform overhead landings under certain conditions. Similarly requests for an overhead approach will only be granted to humans under certain circumstances:

- Flight conditions must be VFR.
- No aircraft are already in the landing queue, except those on base or final.
- All aircraft in the flight must be within 15 Nm of flight lead at time of initial request.

As with all the other approaches, the type of approach is requested on the Approach ATC menu. In this case, as soon as the training mission starts 'Request Overhead Approach' with: 't t t 3'.

10 Nm from the airbase, approach will request a frequency change to Tower. Once the frequency is inputted into the radio make initial contact as before with 'Request Landing' on the Tower ATC page: 't t 2'. It is important to make this initial contact before the break point. Tower will clear you inbound and request you to "Report on Final". The flight should be in a wingtip or echelon-close formation. The side of the formation is opposite the direction of the break, e.g.: left break for RWY 36 = flight lead left and wingmen in right echelon. Speed is 300 kts, altitude 1500 ft AGL and the flight aligned with the runway axis.

The last 5 miles are used to fine tune the formation, so the landing looks good. Aircraft fly a constant airspeed level altitude until overhead the runway. If you fly with AI wingmen all the humans must declare their break with the 'Report Overhead Break' option on the Tower ATC menu: 't t 5'. This is the only indication for the AI to time their own break. If you are alone or only flying with humans you do not need to do this step.

From there aircraft will break in sequence, gain separation and fly the downwind leg; bleeding airspeed and lowering the gear. At base, the jet will turn towards the runway and start descending to land in sequence.

In this training scenario you are single ship, so you don't have to take other aircraft into account. The idea is to lay out the procedure so you can then join a 2- or 4-ship and perform your landing in sequence.

From JULOP you already have the runway in sight. Descend gently to 1500 ft AGL and reduce your speed to 300 kts, aligning your heading with Runway 36 QFU (356°).

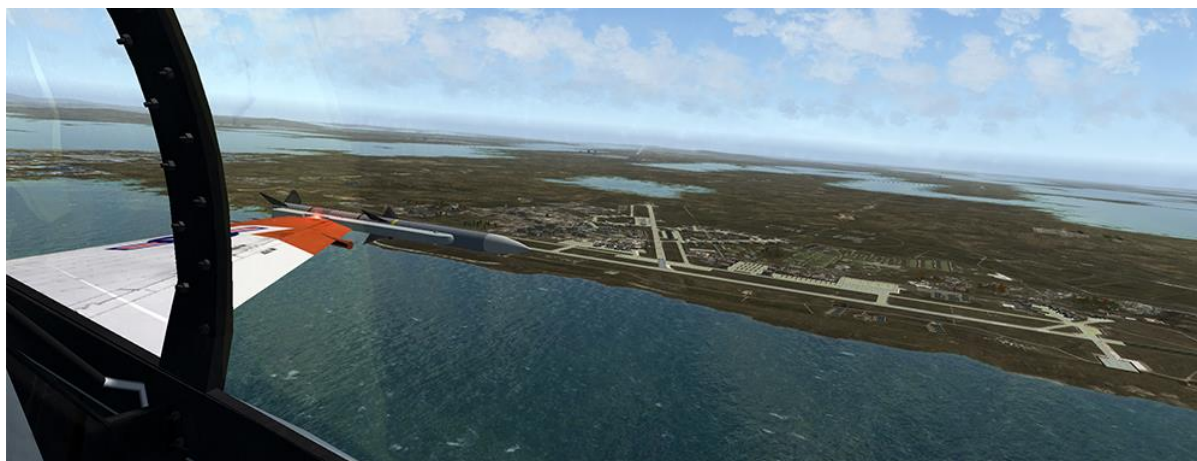
You should be within parameters at least 5 Nm from the runway threshold. Continue straight & level until you overfly the runway. Timing the break turn depends on how many aircraft there is in your flight and on how long you want your downwind leg to be. Obviously the sooner your break, the shorter your downwind leg will be. A good cue for single-ship training is to wait for the opposite landing threshold (RWY 18 in this case) to disappear under your aircraft's nose. In a 4-ship scenario, lead has the shortest downwind and should start his break much sooner (like the beginning of the runway) to allow the rest of the flight to break before overflying the opposite end runway threshold.

The direction of the break may be published on the airport visual charts or stated in the airport SOPs. Let's say that at Kunsan all the breaks are over the water to avoid overflying populated areas. Landing on RWY 36 the water is on the left side so the break will be to the left.

The break turn is a manoeuvre that will turn 180° level. While turning you will be bleeding airspeed and once established on the downwind leg (356-180=176°) you can lower your landing gear immediately.

The turn will define how wide your lateral separation with the runway will be.

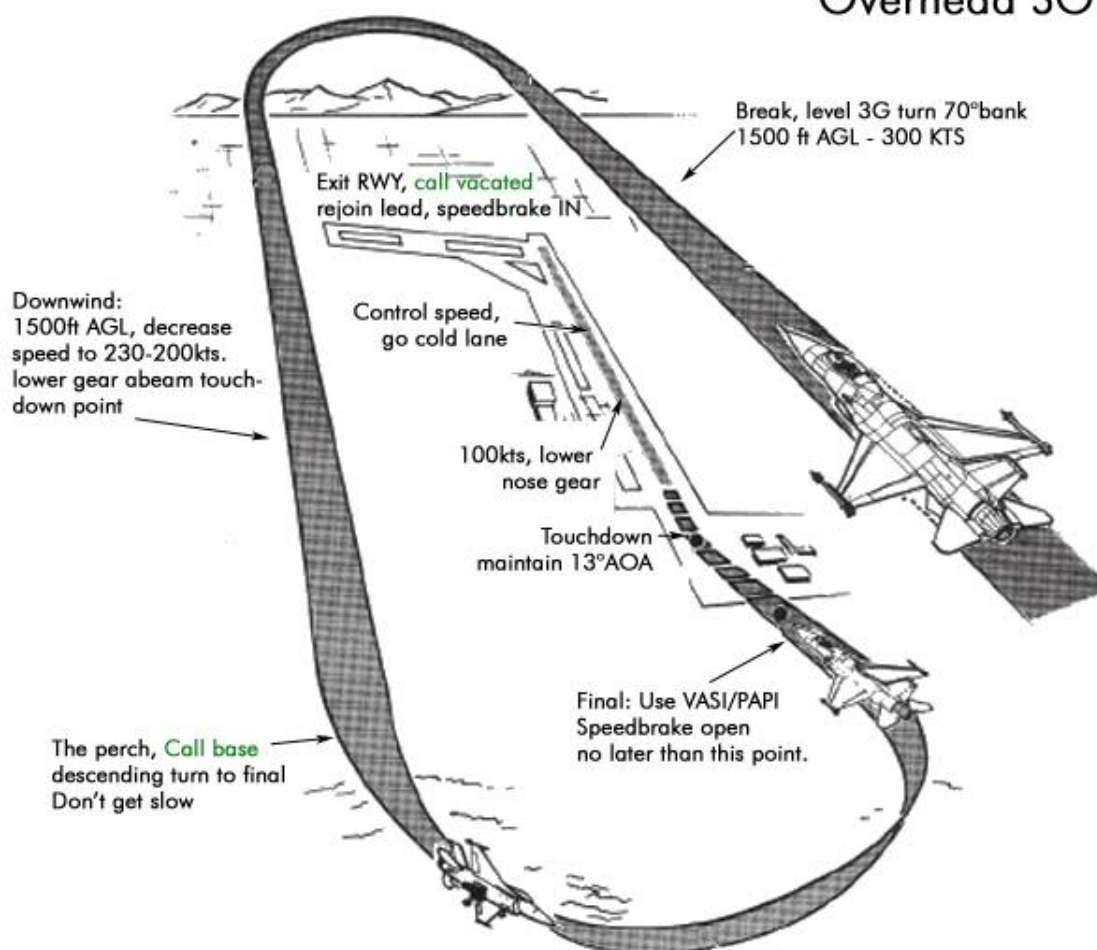
The idea is to fly the downwind leg with the wingtip on the runway. If the runway is inside your wing the break turn was too tight; if the runway is outside the missile rail then your break was too wide. Judging the correct lateral separation is the first challenge of the overhead recovery. It will come with experience and it will soon be second nature. You may also need to adjust for crosswinds blowing you towards or away from the runway.



The downwind leg is flown at 230 to 200 kts - 1500 feet until you reach the Perch. That's the point where you will turn toward the runway and start your descent. Judging that point is the second challenge of the overhead. A good visual cue is when the front of the wingtip touches the runway threshold.

Retard the throttle (or deploy speed brakes) and start a left descending turn towards RWY 36. Keeping the runway in sight throughout the turn is very important. Avoid slowing down too much in the turn. Try to fly 11° AOA (FPM at the top of the bracket). The low speed warning horn comes on at 15° AOA. An occasional horn is ok but do not get in the habit of hearing the horn all the way around the final turn.

Overhead SOP



Final approach is when you are aligned with the runway. Use PAPI as a landing aid and maintain on-speed AOA or just a tad above (yellow triangle) as explained in the straight-in landing section.

Don't forget to 'Report On Final' through the Tower ATC page as instructed earlier by Tower. The Tower Controller will then give you surface winds and clearance to land. The clearance is given for the whole flight entity, so wingmen do not need to report final. They are cleared automatically when the flight lead is cleared to land. Basically the only thing wingmen need to do is call out their 'break' if they have AI in the flight.

Speedbrakes should be deployed on final if they weren't deployed earlier. The reason speedbrakes are needed is to overcome the slow spooling time of the engine, particularly the older models. An engine at low revolutions may need a certain time to accelerate to go around setting. While the engine spools up, the aircraft will sink and may hit the ground. To keep engine revolutions high without accelerating, speedbrakes are used.

In case of a go-around the speed brakes are retracted and the engine spool time will be faster since the setting was higher than without use of the speedbrakes.

Touch down on centreline and maintain aerobraking as explained in the section above.

3.3 Taxi back and shutdown the jet

Once at control speed (less than 80 kts) with 3 wheels on the runway you can enable NWS and use the wheel brakes as necessary. Exit the runway at the first available taxiway to the right and once past the runway hold lines retract your speed brakes.

ATC will automatically ask you to switch to the Ground frequency as you exit the active runway. Set Ground (preset #2) and 'Request Taxi Back to Ramp' on the Tower ATC page: 't 4'.

You may park your aircraft in any parking spot you want but to conclude this training scenario we will taxi back to where the mission started in Wolfpack flows, south of the tower. Taxi on Taxiway Papa all the way to the transient ramp and turn left behind Wolfpack flows. Select one emplacement and roll into it. Once parked, 'Install / Remove chocks' on the Ground ATC menu: 't 2' and then save the EPU: 't 1'.

Shutting down the jet is not really necessary. If you want to, shut down all avionics before placing the throttle in CUTOFF (or use the idle detent callback). Open the canopy and then place the POWER switch on the ELEC panel to OFF.

You can breathe again and exit the aircraft with the ESC key.

PART 2: ADVANCED HANDLING

Having mastered the basic course, you will now fly a more advanced F-16 blocks 40 & 50 for the Advanced Handling Course made of 6 independent training flights.

Mission 4: Night ILS Landing Clear Weather.

Mission 5: Air to Air Refuelling.

Mission 6: Bad Weather ILS Landing.

Mission 7: Simulated Flameout Landing.

Mission 8: Terrain Following Radar and FLIR.

Mission 9: In-flight Failures.

MISSION 4: NIGHT ILS LANDING

TAKEOFF OPTION: In flight.

WEATHER: RKJK INFO: B 010355LT ILS RWY36 TRL140 320/5 KT 9999 FEW050 12/02 Q1007 NOSIG.

LOCATION: Approximately 15 Nm south of Kunsan.

CONDITION: Night time - Aircraft level at 2500 feet over JULOP fix - heading 360° - speed 420 kts. Fuel level just hit BINGO. Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly. You may have to set your MFDs according to your personal preferences.

GOAL: Land on Kunsan RWY 36 ILS.

The setup is the same as the landing training mission but at night. The weather is clear, and this is a good opportunity to use the ILS on RWY 36 at Kunsan. The next ILS scenario will be in bad weather.

The initial setup of an ILS approach is similar to a straight-in approach starting at an approach fix at a set altitude and speed. The difference is that we will guide the aircraft using instruments to the runway minima.

The principles of ILS are explained in the BMS COMMS & NAV book. Basically it's a double radio emitter with a limited range (18 Nm) and azimuth (3-6°). The first emitter is vertical and called the localizer. It guides aircraft to the runway centreline. The localizer is represented in the cockpit by a vertical bar in the HUD, ADI and HSI.

The second emitter is horizontal and guides the aircraft on the optimal glide path to the runway (3° in BMS). It is called the glide slope and is represented in the cockpit by a horizontal bar in the HUD and the ADI.

Both emitters create a microwave path ending at the runway threshold allowing aircraft to be guided in bad weather until the pilot can see the runway. To follow the ILS pilots need to place their aircraft in the centre of both cones and stay there until minimum. The ILS symbology in the instruments then displays a centred cross created by both the glideslope and the localizer.

Two distance beacons are placed on the approach track: usually around 6 Nm and 0.5 Nm from the runway threshold. They are called the outer marker and inner marker. They provide audio and visual feedback when overflown: the marker light next to the HSI will flash at different frequencies (low frequency for outer marker and high frequency for inner marker). Besides providing distance information (and therefore altitude) the markers are good cues for specific points along the approach: the outer marker is usually where the landing gear is lowered, and the inner marker is close to minima (usually 200 feet above the ground), where the pilot should have the runway in sight and be able to transition to visual for the final seconds of the approach.

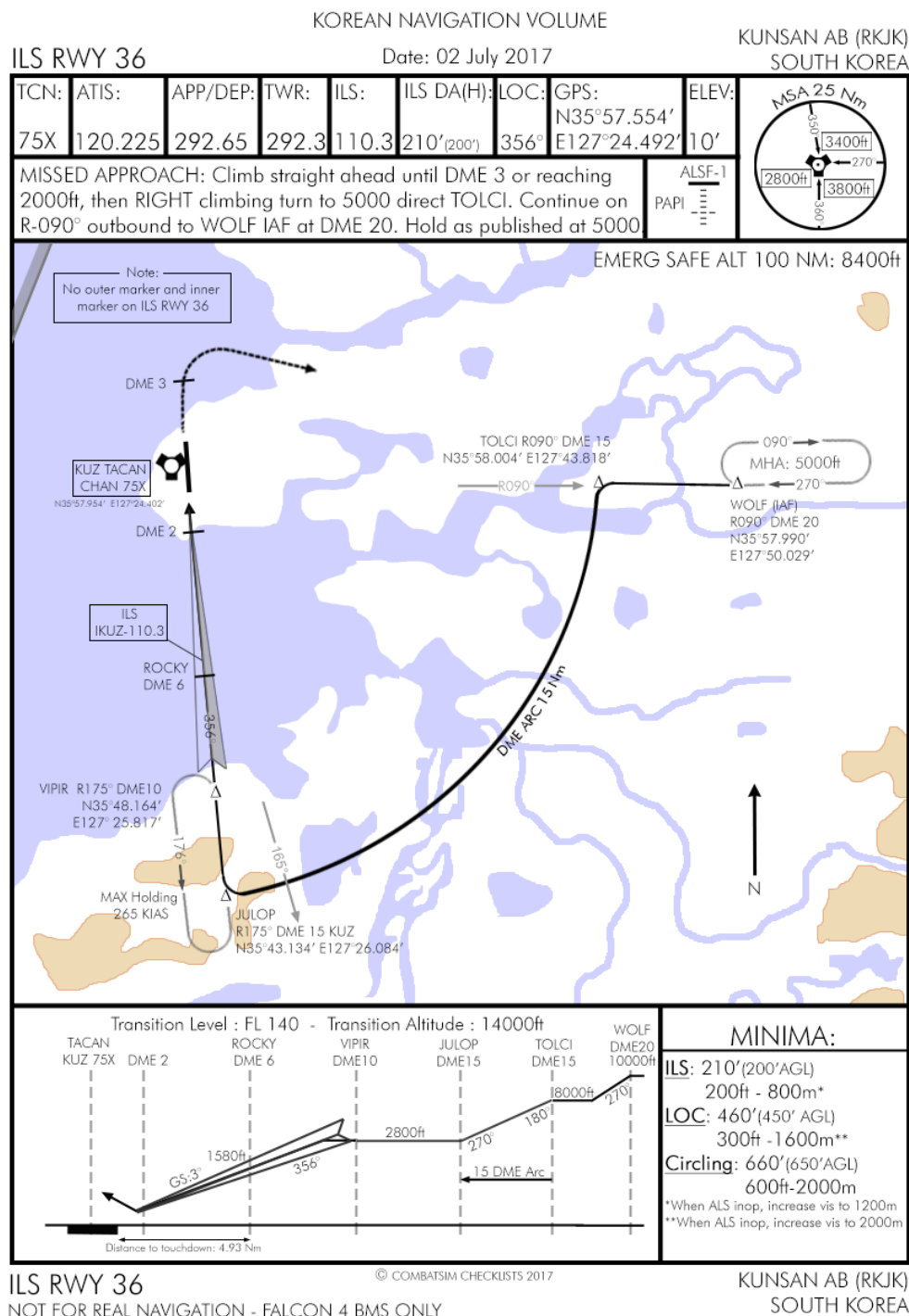
Unfortunately Kunsan does not have these beacons because the approach is over water. We will demonstrate their use though in the next ILS training mission.

ILS approaches are made using relevant approach charts. Since visibility may be reduced, the aircraft is flying in proximity to the ground sometimes lower than mountains and the MEF, navigation must be accurate and you must follow the published approach tracks closely.

Charts for BMS airbases are in the Docs folder of your BMS install. You will need ILS RWY 36 for Kunsan for this mission.

The charts give plenty of relevant information about the ILS approach. Most important is the ILS frequency (110.3), localizer heading (356°) and minima (210 feet). But also relevant information about the runway such as the type of ALS (ALSF-1 and PAPI left), the elevation (10 feet) and the Tower frequency (292.3).

The approach track is represented with IAF, AF, holdings, radials, missed approach path. An elevation view at the bottom of the chart displays the height at which the approach track should be flown. Refer to the BMS COMMS & NAV book for further information about the Falcon charts.



The training scenario starts at JULOP fix 15Nm from Kunsan which you can see on the chart. ILS interception should happen no later than ROCKY fix at 6 DME.

Contact Kunsan Approach immediately to request an approach. Unfortunately we can't request an instrument approach from this point because the ATC would send us back to the IAF, even though we are already in the ILS cone. Open the ATC menu at the Approach page and select "Unrestricted Approach" 't t t 4'. Approach will clear you to continue inbound, give you the latest QNH and at a certain point will ask you to switch to Tower.

Intercepting the ILS is done in two steps. The first is to intercept the localizer and therefore align the aircraft with the runway centreline. The second is to intercept the glidepath and therefore follow the optimal glideslope to the runway. The glidepath is always intercepted from below by flying a level altitude and letting the glideslope horizontal bar descend in the centre of the instrument. Once it is centred the landing gear is lowered and the increased drag usually suffices to slow down and pitch the aircraft down onto the glide path.

Let's start by retarding the throttle to give us more time and to slow down to approach speed. We then have a few moments to set the ILS correctly. Select the T-ILS UFC page and set it to Kunsan TACAN 75X. By now you know how to do that. The next step is to select the ILS frequency (110.3) for RWY 36, which can be taken from the chart header.

Entering the ILS frequency is done the same way as you just did for the TACAN. The system will be able to differentiate a TACAN channel from an ILS frequency. Enter 1 1 0 3 0 in the scratchpad and hit ENTR. If you entered the wrong frequency you will see ILS red LOC and GS flags on the ADI.

Once the ILS frequency is set the scratchpad moves to the CRS setting. This course is independent of the HSI CRS and should allow the HUD Command Steering Cue to work correctly in relation to the ILS radial. The course for Runway 36 is 356° so input 3 5 6 ENTR.

The scratchpad then moves to the CMD STRG line which you can mode-select or not. When mode-selected a steering cue will be displayed in the HUD showing you your course for optimal intercept of the ILS. It is very similar to a flight director in commercial aircraft. If you do not wish to use it simply un-mode-select CMD STRG with the 0 M-SEL button.

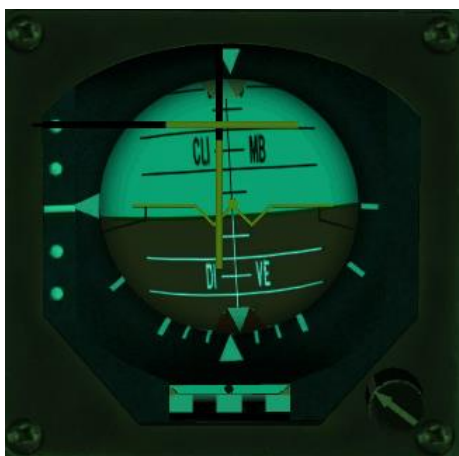
Finally, check the top right corner of the T-ILS page to check if the ILS system is ON or OFF. Symbology will be displayed if it's on. If it is off you need to turn the ILS knob on the AUDIO 2 panel clockwise to turn it on.

Move down to the EHSI. F-16s have been upgraded and all now have the Electronic HSI (EHSI). The INSTR MODE panel has been replaced with a blank panel. To change instrument mode you now have to press the M button on the EHSI. Press the M button till PLS/NAV or PLS/TCN is displayed in the EHSI: the ILS symbology will then be displayed in the HUD and ADI. The EHSI will only display the localizer.



You could select PLS/NAV rather than PLS/TCN; the distance information in PLS/NAV is related to the active steerpoint, as opposed to the selected TACAN in PLS/TCN mode.

Please note: BMS does not feature ILSDME, so distance is never to the ILS, but to the TACAN or the active steerpoint.





Looking at the screenshots above, the localizer is slightly to the left and the CMD STRG cue is to the left indicating a left turn is required. The glideslope is dashed because we are outside parameters, but it is above us so that's good.

The ADI gives us the same localizer and glideslope information. Further to displaying the ILS bars the ADI gives an angular reference to the position of the glideslope. Each dot on the left side of the ADI represents an angle of 2.5°. The glideslope is more than 5° above us. That is the reason why the glideslope in the HUD is dashed.

The EHSI displays not only the localizer but also the distance to the TACAN (14 Nm) in the DME window and gives an angular reference to the localizer. In ILS mode each dot is 2.5° (in TCN or NAV mode they are 5°). The current localizer is less than half a degree to the left.

The EHSI CRS is set to 000 so 4° offset from the ILS course. It is good practice to set the ILS course in the EHSI as well. Although it will not impact the localizer deviation it will make your situational awareness better as it points straight along the ILS approach track. You could do it at a 90° off angle and still fly a perfect ILS approach, but it is making life more complicated for nothing.

While setting all the systems your airspeed dropped to 350 KCAS. Let's slow down further to 300 kts and turn just a bit to get back on the localizer. Unlike a radial intercept you do not take an angle of 30° on the localizer past initial interception. In this case let's simply turn until the FPM is on the CMD STRG cue.

We will turn and then the CMD STRG cue will guide us towards the localizer.

Around 10 Nm from the airfield Approach will switch you to the Tower frequency. Switch your radio accordingly and initiate contact with Tower by requesting landing: 't t 2'. Tower will clear you inbound and ask you to "Report on Final".

A good idea is to check the winds. You can ask ATC, but it is preferable to display the winds in the DED with DCS right. With the winds displayed you have a good idea of your drift which is emphasised by the FPM in NORM, which is offset from the centre of the HUD indicating a crosswind.

All the approach will be made flying the needles and the CMD STRG cue. The CMD STRG cue will guide you horizontally and vertically once you are within 5° of the ILS cone. If you place the cue into your FPM you will fly a perfect approach. As we approach the airbase maintaining our localizer centred the glideslope will start to move down towards the centre of the HUD.

When the glideslope is within 5° (2 dots on the HSI) the pitch cue will appear on the CMD STRG cue. It's a large vertical bar on top of the circle.

When it is displayed the CMD STRG cue will provide vertical guidance on the glideslope as well. You may see the cue go up or down in your HUD.

Look at the picture (on the left) of the ILS bars. Each bar has 5 marks; each represents 2.5°. The optimum position is both bars centred at their middle mark.



In the picture the glide slope is still 2.5° above us, illustrated by the glideslope bar being one mark above the centre mark of the localizer. The localizer is centred on the middle glideslope mark; we are aligned but drifting left (as the CMD STRG cue is on the right).

Continue flying level on the localizer and ensure your airspeed is below 300 kts. When the glideslope hits the centre of the localizer lower the landing gear and extend the speed brakes. The added drag will pitch the aircraft down, which is usually more than enough to start the descent along the glide path. We should be 6-9 Nm from the TACAN.

The HUD symbology will change when the gear is down (right picture). The AOA bracket and the minus 2.5° dashed pitch line will be displayed. The heading tape will move to the top of the HUD.



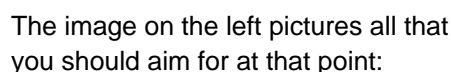
Don't forget to 'Report on Final' with the Tower ATC menu: 't t 4'. The Tower Controller will then clear you to land and give you surface winds.

From that point just apply the techniques you learned in the straight-in training mission; slowing down to place the FPM on top of the bracket at 11° AOA and also staying centred on both the localizer and the glideslope.

Note also the **v** on the heading tape. 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 centred on the heading tape, your nose should be crabbed into the wind just the right amount to maintain ground track along the approach course centreline to the runway.

About 200 feet from the ground you will reach the ILS minima. At that point you must have the runway in sight, and you can transition your landing from instruments to visual.

For this first exercise we had good visual with the runway throughout the whole ILS approach. It will change once we start adding adverse weather to the training scenario. The feeling you will get when you reach that spot perfectly aligned with the runway and see the runway lights is unique and very rewarding.



2 white & 2 red on the PAPI.

Localizer & glideslope centred.

Heading on runway QFU (356°).

All that's left to do is flare the aircraft gently as explained before and kiss the runway.

Congratulations, you just graded your first ILS night landing in clear weather.

We mostly used the HUD for the ILS, but you can also perform ILS approaches without the HUD by staying in the head down view. You then scan the main flight instruments (ADI, HSI,

Machmeter, Altimeter, AOA and VVI) without looking up until minima, where you transition to visual and look for the runway to land.

It is suggested you try the same mission in heads-down view.

MISSION 5: AIR TO AIR REFUEL

In this training mission you have two scenarios to master. The first one is a typical post-attack refuelling with a relatively light aircraft. The second one is a pre-target refuelling with a fully loaded aircraft.

Both happen in daylight at the usual refuel altitude and speed with the F-16B block 15 or F-16D block 40. The light scenario takes place on the east coast of South Korea with a KC-10 and the heavy scenario happens on the west coast of South Korea with a KC-135. The techniques for AAR are the same and will be explained once for both scenarios. The main difference will be the sluggish response from the heavily loaded F-16 and the tanker legs that are longer in the low gross weight scenario which makes the AAR easier for novice pilots with less turns from the tanker.

TAKEOFF OPTION: both scenarios: In flight.

CONDITION:	Low Gross Weight AAR	High Gross Weight AAR
	KC-10: Camel1 - A-A TCN: 29Y – U301.85	KC-135: Canteen1 - A-A TCN: 63Y –U:292.87
	Long tanker orbit legs	Short tanker orbit legs
	Package 4977	Package 4980
	Callsign: Goblin 2-1 (F-16B block 15)	Callsign: Goblin 3-1 (F-16D block 40)
	GW: 23786 lbs	GW: 35900 lbs
	Fuel load: 2500 lbs	Fuel load: 2500 lbs
	6 Nm trail on tanker, entering AAR box	3 Nm trail on tanker, entering AAR box

GOAL: Refuel your aircraft in the air. Top off at full.

5.1. Setting up and finding the tanker

Air to air refuelling is not an easy task and requires formation skills, concentration, control over yourself and good preparation, just like the real thing. Matter of fact some say AAR in a simulator is harder than in reality.

Both scenarios start far enough away from the tanker to allow a bit of time to setup. Rest comfortably in your seat and ensure your throttle is loose enough to allow precision settings. Select the BNGO page on the DED (LIST 2) so you can monitor fuel transfer and disconnect from the tanker at the prebriefed top off (in this case 9000 lbs). Open your AAR door with the AIR REFUEL switch on the left console FUEL panel.

Once open, the right indexer RDY top light will illuminate in blue and the external fuel tanks (if carried) will depressurise a bit, allowing fuel to enter the external tanks. The drop of pressure prevents the fuel in the external tanks being transferred to the internal tanks. If the AAR door remains open for too long though the depressurised external tanks may create a trapped fuel situation as they contain fuel not being transferred into the main tanks. So don't open your AAR door too soon. And don't forget to close it when you're done.

Finding the tanker can be done with your FCR or with A-A TACAN. If an AWACS is airborne you can also ask for vectors to the nearest tanker on the tactical frequency (preset 6); in this flight your radios are preset to that frequency. Open the AWACS menu with the 'q' or 'a' key, depending on your keyboard layout. Press q (or a) again to display the second page of the AWACS menu and select the 'Request Vector to Tanker' option; the controller will reply with the callsign, position, TACAN channel and UHF frequency of the closest tanker.

You can also contact the tanker on UHF on his assigned frequency via the Tanker menu using the 'y' key and 'Request Fuel'. Outside 10 Nm the tanker will give you a heading and a distance for rejoin. You can find the tanker frequency in the briefing (if there's a refuel point assigned to your flight it will be Preset 13), in the ATO or just hover over the tanker icon on the map. Note: the same callsign *always* has the same frequency.

Snap to the heading provided and set your radar antenna elevation to cover airspace around FL200/FL240. Look for the tanker contact on your FCR.

Input the correct UHF frequency or the preset into the UHF page and the given TACAN channel in the T-ILS UFC page, ensuring you set the correct band and TACAN mode.

- TACAN band is toggled by inputting 0 (zero) in the scratchpad and hitting ENTR.
- TACAN mode is toggled using DCS right. The mode will toggle from TCN T/R to TCN A-A.

Depending on which scenario you chose you may (not) have bearing information to the tanker. The KC135 A-A TCN only provides distance information, the bearing pointer will spin around the HSI at a set frequency. The KC-10 A-A TACAN provides distance and bearing information, therefore the bearing pointer of the HSI will point to the direction of the A-A TACAN emission.

Once you are close to the refueller (less than 10 DME) open the Tanker menu: 'y 1' to 'Request Fuel'. The tanker will clear you to pre-contact position and lower the boom. Before concentrating on rejoin open your air refuelling door with the AIR REFUEL switch on the FUEL panel located on the left console. Confirm it is open with the right indexer blue RDY light. That will give time for the fuel system to depressurise the external tanks so fuel can flow into them. The speed limit for opening the AR port is CAS 400 kts / Mach 0.85 (whichever is lower) and flying with the AR receptacle open is CAS 400 kts / Mach 0.95 (whichever is lower).

Display the BNGO UFC page with LIST 2. It is easier to look at the total fuel on the DED rather than on the fuel gauge on the right auxiliary panel. You can also repeat the DED in the HUD with the DED DATA switch on the HUD panel. When you have the tanker visual place the FCR in STBY before you get close to avoid bombarding the tanker crew with microwaves at close range.

A good rejoin is a good start to the refuelling procedure. Once the tanker is ready to give fuel he flies around 300-305 kts. Knowing his speed you can set your own overtake speed with the following rule:

Over 2 Nm = 100 kts overtake, then decrease overtake speed by 10 kts for every 1000 ft closure, so 6000 ft = 60 kts, 5000 ft = 50 kts etc. Within 1000 ft do not exceed 10 kts overtake.

Judging closure from 6 o'clock is difficult so you may offset your rejoin to the left side of the tanker to better judge your closing rate. Depending on your position in the flight you will go straight to pre-contact (if single-ship or flight lead) or observation left position on the left wing of the tanker. The Quick-flow procedure is explained in chapter 2.2.2 of the Dash 1 manual.

5.2. Pre-contact

Before taking fuel you will need to establish a stable pre-contact position. This position needs to be held for a few seconds to be recognised by the boomer. You'll need to be 50 feet below at 30° down from the tanker.

The best method to get that position correctly is to use the gun cross and the boom. The position of the boom tip gives you the location of the pre-contact position. Just follow the lower part of the boom by aligning the gun cross with it. The HUD side mounts are also a good cue. Align them with the engines of the refueller (inboard engines for the KC-135).

Mind the tanker speed and try to minimise the amplitude of your stick and throttle movements.

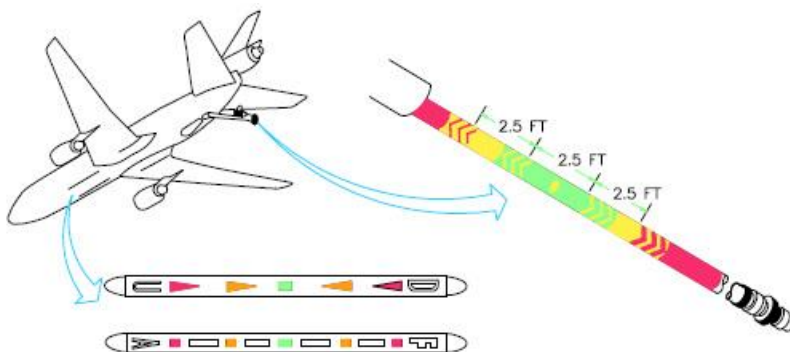


Very often pilots tend to get stiff on the controls. It doesn't help so try to relax your death-grip on the stick and throttle and you will find it easier to fine-tune your stick and throttle control. You should fly the refuelling as you fly a fingertip formation. **Don't look at your HUD cues, look at the aircraft you are flying formation with** and match his attitude and position. At first you may even find it helps to turn the HUD off to avoid being too focused on it, as the lag inherent in the HUD means you often end up chasing your tail, either see-sawing up and down, or yo-yoing back and forth.

Be advised there are no director lights at this stage. You just need to hold position a few feet behind the boom. When the boom operator is happy with your stabilised position he will call: "*call sign, cleared to contact position*". At that point the red director lights **F** (Forward) and **U** (Up) will switch on to give further positional guidance. Start to move **slowly** towards the boom. The boom operator will offset the boom left or right to let your aircraft slide into the contact position.

5.3. Getting fuel

To move into contact position advance the throttle slightly for a few seconds and retard the throttle to its pre-contact position. As the refuelling point is behind the cockpit on the F-16 you will lose sight of the boom as you move forward. Concentrate on the director lights on the belly of the tanker. When moving into contact position only the Forward and Up lights are illuminated; steady for correction and blinking for fine tuning. Follow them until you stabilise in the contact position. When the lights go off you're in the correct position and the boom operator is flying the boom into your F-16's AAR receptacle. Maintain your position, wiggle your fingers and toes and breathe.



"CONTACT"

Once contact has been made the yellow and green lights will become active as well; these will help you to adjust your position to stay connected with the boom. When the boom connects, the blue RDY light on the right indexer shuts off and the green AR/NWS light comes on signalling fuel transfer, which can be checked on the UFC BNGO page.

The next difficult thing is to maintain your position while the fuel is being transferred. Hopefully the tanker will maintain a straight leg for your initial refuelling training, but it might turn too. Whatever happens try to keep the same sight picture on the tanker as you saw when you first hooked up and/or keep an eye on the director lights which will continue to guide you to the correct position.

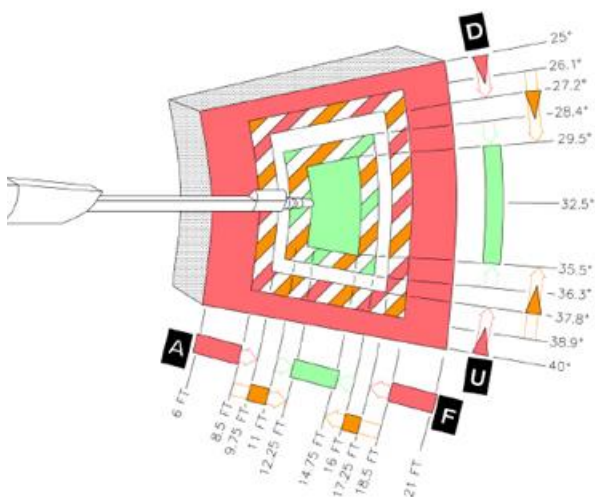
The director lights are slightly different from the KC-10 to the KC-135 but work along the same principles. They are made up of 2 lines with different symbols.

The left line is relevant to your height from the contact position and features letters U for Up, D for Down and different coloured arrows.

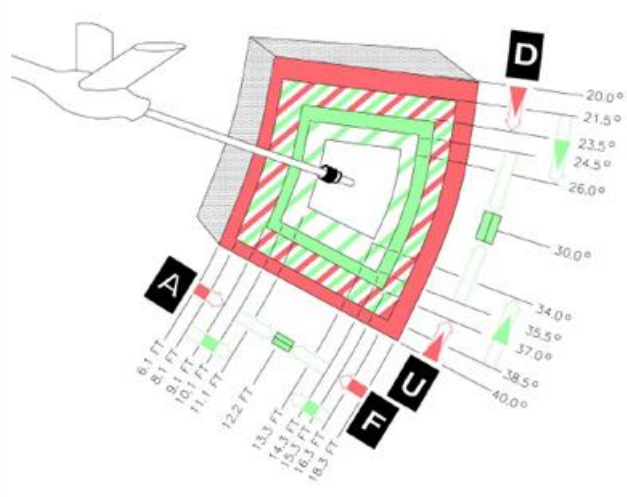
The right line is relevant to your longitudinal position from the contact position and features the letters F for Forward and A for Aft and other coloured position symbols.

The colour of the symbols depends on how far you are from the reference contact position. Red is the furthest away. Yellow is close to the reference position and green is the ideal contact position. The colour code will help you adjust your throttle & stick inputs accordingly. The shape of the symbols also varies from one tanker to another, but their position and colour is more important than their shape. On both tankers the contact reference position are squares (green on KC-135 and yellow on KC-10).

To stay in contact fix one problem axis at a time as smoothly and gently as you can. If both longitudinal and height positions are off fix one first then address the other. Trying to fix both at the same time is more complicated and will create more problems unless you are experienced at Air to Air Refuelling. Try to relax by wiggling your fingers and toes.



Director lights envelope of the KC-10



Director lights envelope of the KC-135

If you fly your jet outside the boom envelope the boom will retract and disconnect. You will have to fly in contact position and wait for the boom to hook you up again. Once in position it is relatively easy to maintain formation with the tanker if you don't use your instruments. This is particularly important when the tanker starts turning. Concentrate on the perfect sight picture and try to maintain it. Ignore everything else.

The pilot of the tanker will give you a heads up call before turning. Stay focused on the tanker and turn with him. He will bank exactly 30° for a 180° turn for the opposite leg of his racetrack pattern. Stay in position and match his attitude. You may have to add a bit of throttle while turning. It's easier said than done and will require a lot of practice. A manual can't help you with that, but the best advice really is just to focus on the aircraft you are flying formation with, remember what the sight picture looks like when you're in the perfect position and to relax your body. You will get tense trying to get into and maintain position and consciously thinking about relaxing will definitely help. Practice, practice and more practice!

Once you have the desired amount of fuel offloaded you can disconnect manually from the boom by pressing the A/R DISC button on your stick. The right indexer amber DISC light will come on momentarily and the green AR/NWS light will turn off and be replaced by the blue RDY light, signalling that the AR door is open.



"DISCONNECT"

Retard the throttle a notch to separate from the tanker and initiate a gentle right slide to the right wing of the tanker. You must tell the tanker that you are done refuelling. Use the Tanker menu: 'y 3' 'Done Refuelling'. This removes your aircraft from the queue; only after you have done this will the tanker clear your wingmen to pre-contact.

In multiplayer ownership of the tanker is transferred from one player to the next at this point and you may encounter a small bandwidth hiccup when the tanker may appear jumpy, slow down or start to turn. Be prepared to react accordingly.

According to the quick flow procedure the fuelled aircraft fly formation with the tanker on its right wing while the rest of the flight refuels. Once you are in position close your AR door and check that the right indexer has no lights illuminated. You can reset your UFC to the CNI page and place the FCR out of OVRD. Before going on with your mission check the fuel gauge on the right auxiliary console to ensure that your fuel load is balanced. You can now switch out of the Tanker refuel frequency and back to AWACS tactical (preset 6).

Congratulations, you just succeeded at one of the most difficult tasks in BMS: Air to Air Refuelling. Use this training mission often as practice will help you fly formation better as well as refuel easier and this is really an aspect of flight simulation that is both demanding and rewarding.

MISSION 6: ILS IN BAD WEATHER

TAKEOFF OPTION: In flight.

LOCATION: Approximately 10 Nm north of MIKKI IAF for ILS landing at Taegu.

CONDITION: Day time - Aircraft level at 15000 feet - heading 180° - speed 350 kts. Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly. You may have to set your MFDs according to your personal preferences.

WEATHER: RKTN INFO: B 010825FT ILS RWY32 TRL140 240/13KT 1200 BR RA OVC010 22/21 A2935
Wind 240° at 13 kts, Visibility 1200m, Mist & Rain Overcast 1000 feet. Altimeter 2935. No significant changes.

GOAL: Land on Taegu RWY32 ILS.

Taegu Elevation: 353 feet
Taegu TACAN: 125X

Taegu Approach: 346.3 - Tower: 365.0 – Ground: 275.8
ILS RWY 32: 108.7 (Minimum 553 feet – Localizer 320°)

This training mission is technically the same as Mission 4 but this is the real thing. Visibility is very low and cloud coverage is total up to the minima. You will see the runway only during the final stages of the approach. **This training mission is difficult on purpose;** you had the chance to train ILS in good weather, now it's time to try it in real ILS conditions.

The approach starts before you reach the IAF on top of the cloud layer. It's very bright and you may not see the HUD clearly enough. Lower your visor (SHIFT + CTRL + ALT + v) to decrease your light blindness.

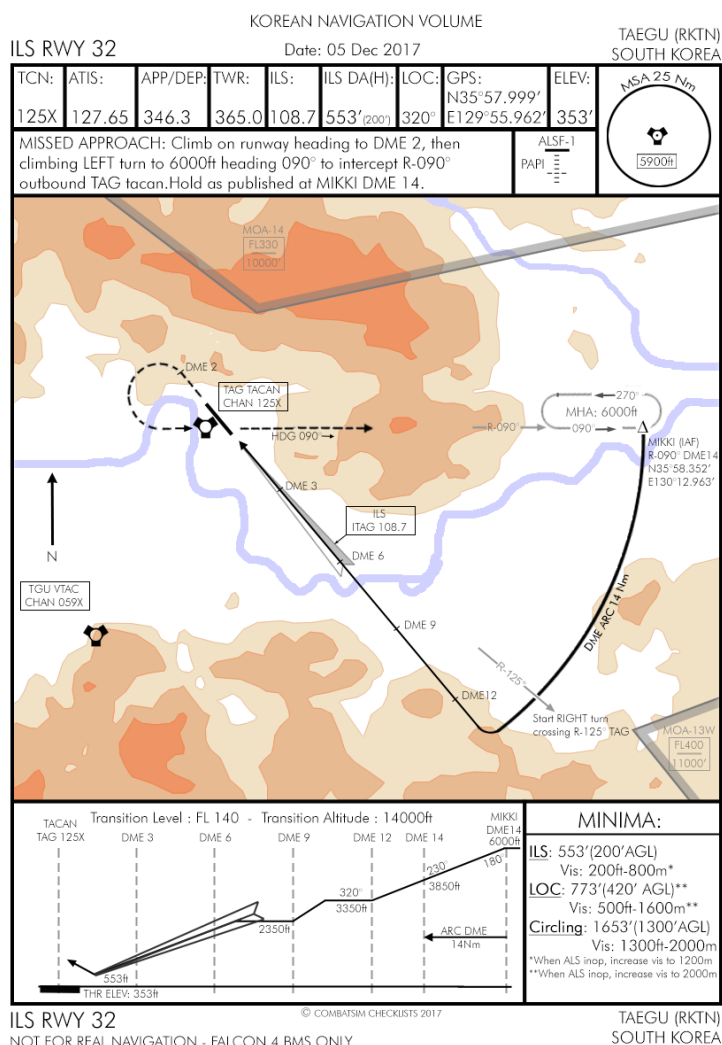
You will need the TAEGU ILS RWY 32 chart to fly the published approach. The airport is surrounded by mountains and you will need to stay on the published route to avoid crashing. The chart is in you \Docs\03 KTO Charts\01 South Korea\Taegu folder.

The approach will be made in two steps. The first will be to fly the ARCDME until you cross Radial 125° and then we will turn to intercept the ILS on RWY32.

Your TACAN is already set to 125X and the HSI mode is set to TCN. The HSI therefore points to TAG (Taegu TACAN). The ILS is ON, Taegu Approach is set to COMM1 and the QNH is set for approach.

4.34 introduced a completely new ATC system and one of the highlights is that the ATC will try to vector you in bad weather using the published RADAR approach chart when available, which is the case for Taegu.

Radar and ILS reporting points may be different though and therefore the vectors given by the ATC will not suit this ILS approach. Therefore fly this training mission simply requesting an unrestricted approach.



The first action you should do in this training scenario is contact Taegu Approach and 'Request Unrestricted Approach' through the ATC Approach menu: 't t t 4'.

Upon contacting Approach, ATC will give you the altimeter setting (QNH) and clear you for the option. You need to start your descent immediately to 6000 ft and fly to the MIKKI fix.

You should also display the wind direction and speed in your DED (DCS right on the CNI page). The wind should always be displayed for landing but in these conditions it is really important.

You will have to set your ILS frequency to 108.7 using the T-ILS page of the UFC. Input 10870 into the scratchpad and press ENTR. The scratchpad moves to the ILS CRS. Input 320 and ENTR which is the localizer course for Taegu ILS 32. The scratchpad moves up to CMD STRG which is mode-selected; command steering will be available.



As the weather briefing reported the wind is from 270° at 10 kts and the initial heading is 180°. The wind is stronger at 6000 ft. The UFC reports the wind at this altitude at 24 kts. Don't be surprised that the FPM, pitch lines and tadpole are offset to the left as the wind is pushing the aircraft to the left. Blame the weatherman!

The mission starts 10 Nm north of the IAF. After contacting Approach, descend to 6000 feet and reduce your speed to 300 kts. MIKKI is on R-090° 14 DME from TAG TACAN.

As you see on the right picture TAG is on our right at 15 DME. We are flying 185° and the HSI in TCN mode is set to CRS 090°. The bearing pointer is not yet 90° to the right of our heading, but as we fly south it will drift there.



As the bearing pointer drifts down the CDI (Course Deviation Indicator) will move towards the centre of the instrument. When both the CDI is centred, and the bearing pointer is 90° from our heading we will overfly MIKKI and the approach will start.

Flying the ARC DME is explained in the BMS COMMS & NAV book in your Docs folder.

The principle can be summarised as simply keeping the TACAN bearing pointer on the HSI (set to TCN) 90° offset from your heading. In this case to the right as the airbase is on our right and the ARC turns right. Place the bearing pointer a bit before 90°.

Maintain your heading and let the pointer drift slowly to 90° and past it. Once a few degrees past the reference point turn right slowly and replace the bearing pointer in front of the 90° mark and resume the process.

Doing so you will fly a series of straight legs and small right turns. If you have the home plate selected as your steerpoint of interest (STPT 7) your tadpole in the HUD should mimic the bearing pointer behaviour and point 90° to the right.



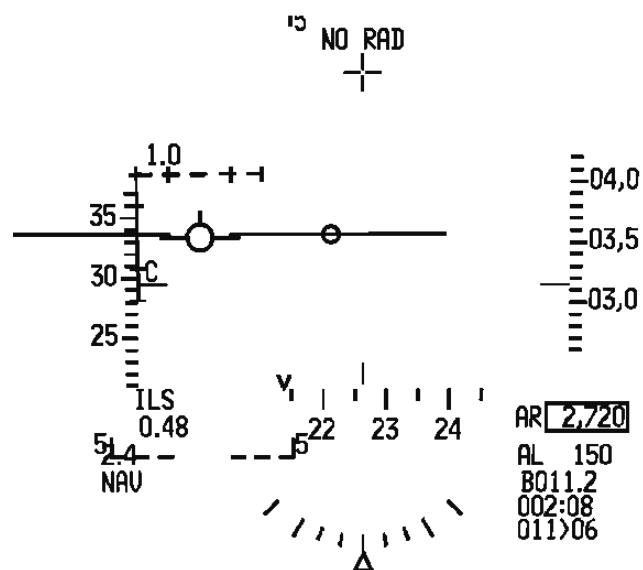
On top of all this you also have to descend from 6000 to 3350 feet as required by the published approach and pay attention to the wind, which will constantly push you away from the ARC, increasing your DME value.

Passing MIKKI turn 10° to the right and start a gentle descent. You're on the ARC. Maintain focus on your speed, which should remain at or below 300 kts, the bearing pointer of your HSI to maintain that 90° offset angle and of course your attitude with a slight rate of descent.

The next reference point is passing R-125° from TAG. Set the HSI CRS to 125° so you are ready for the next step when the CDI will centre on R-125° but continue to fly the descending ARCDME. Level your altitude when reaching 3350 feet.

When the CDI centres on R-125 your heading should be around 220 - 230° with the bearing pointer still pointing 90° right and a DME of 14 Nm. As you can see on the picture I didn't correct enough for wind and I drifted my ARC out to 15 DME! Better avoid that as there might be mountains outside the published approach track. Once the CDI centres immediately switch the HSI to TCN/ILS mode and start a right turn towards 320°.

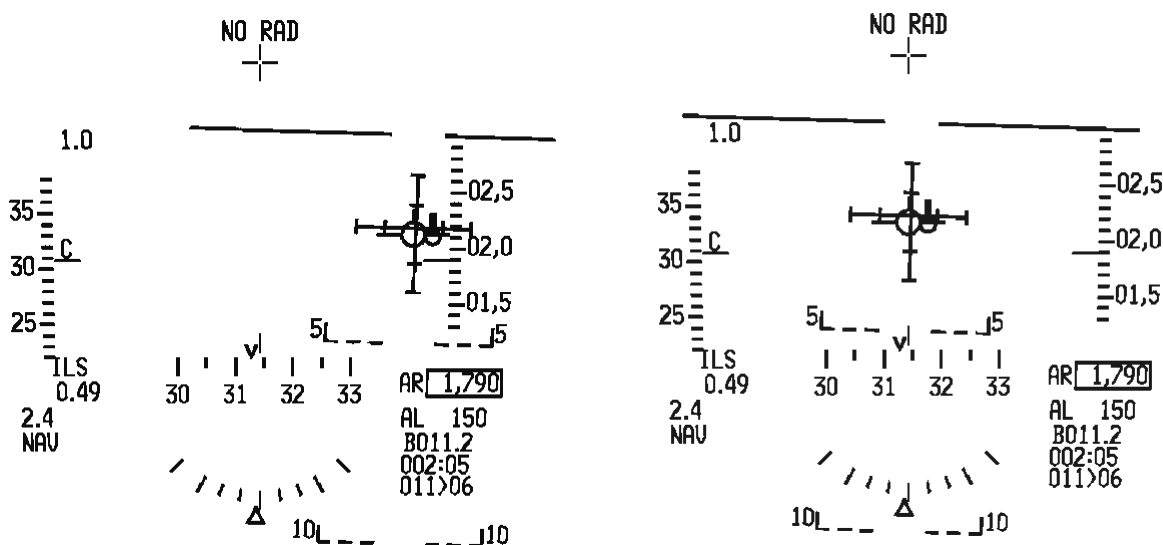
While turning, the localizer visible on the ADI and the HUD are offset to the left and will move towards the centre, indicating that the 320° localizer course is approaching. Alternatively just follow the command steering caret in the HUD to smoothly intercept the localizer. The CMD STRG cue is offset to the right of the FPM, indicating the need for a right turn for optimal intercept. Follow the cue until you intercept the localizer.



You should be fully established on the localizer at 12 Nm on heading 320°, level at 3000ft with an airspeed of 300 kts. At that point the localizer is centred, and the glide slope is above your FPM. The next step is glide slope intercept around 6 Nm from the runway at 2000 feet. Descend to 2000 feet while maintaining localizer course and still with the glide slope above. Mind your speed which should remain below 300 kts. At this point slow to 250 kts to give yourself a bit more time.

Somewhere between 9 and 6 Nm Approach will tell you to switch to Tower (365.0). Switch your radio but delay the 'Request Landing' call a bit until you overfly the outer marker. That's usually around 6 Nm and the perfect distance to call the Tower (and lower your landing gear).

The next two pictures are taken somewhere around 6 Nm. The left one is offset to the right because of the wind and the DRIFT C/O switch in NORM and the right one is taken at the same moment but with the DRIFT C/O switch in DRIFT C/O. It is easier to fly the approach with the DRIFT in NORM, but it is more complicated to look at the HUD because of the offset.



Around 6 Nm from the TACAN we will overfly the outer beacon and the MRK BCN in the cockpit located right of the HSI will flash with an accompanying sound. Incidentally it is also the moment where the glide slope should centre making a nice centred cross with the localizer on the ADI.

You are on localizer, on glide slope so it's time to lower the landing gear and check for 3 greens. 'Report on Final' on the Tower frequency using the ATC Tower menu: 't t 4'.

Tower will clear you inbound. They might not clear you to land straight away as you're still 6 Nm out. Don't worry, the call will come later.

Note on the right picture that the CRS of the HSI has no influence on the CDI. In TCN/ILS mode the CDI moves according to the localizer of the ILS and not the course set in the instrument. The only drawback in this case is simply an unnecessary offset of the instrument by 10 degrees. Not much of a problem but it is more serious when the offset angle is 90°. Therefore it is better practice to set the CRS as the localizer.



Keep both localizer and glide slope bars centred and you will descend along the ILS track to the published minima. With your gear down drag increases and your aircraft slows down. As with any landing, place the FPM on top of the AOA bracket to fly the correct approach speed for your current gross weight. The descent will be bumpy, so a bit extra speed won't hurt.

Open speed brakes to decrease engine spooling time in case you need to go around. Without speed brakes the engine will need a longer time to go from 70 to 100% RPM and you may sink for too long. Using the speed brakes decreases that risk. Somewhere during that descent Tower will clear you to land on Runway 32 and give you surface winds.

Maintain your instrument scan and include the ILS bars. You will overfly the inner marker around 2 Nm from the TACAN. The MRK BCN in the cockpit will flash and sound again, this time at a higher frequency.

That is usually the cue for minima 200 feet above ground level. You should have the runway lighting in sight to continue the approach and land on the runway. If you don't you should go around and try again or find another place to land your jet.



Now that you have the runway in sight you can land visually. Be ready for turbulence close to the ground. Welcome back. You can be proud of your success; it is not an easy exercise.

Upon exiting the active runway Tower will instruct you to switch frequency to Ground 275.8 (preset 2). Switch your radio and select 'Request Taxi Back to Ramp' on the Ground frequency.

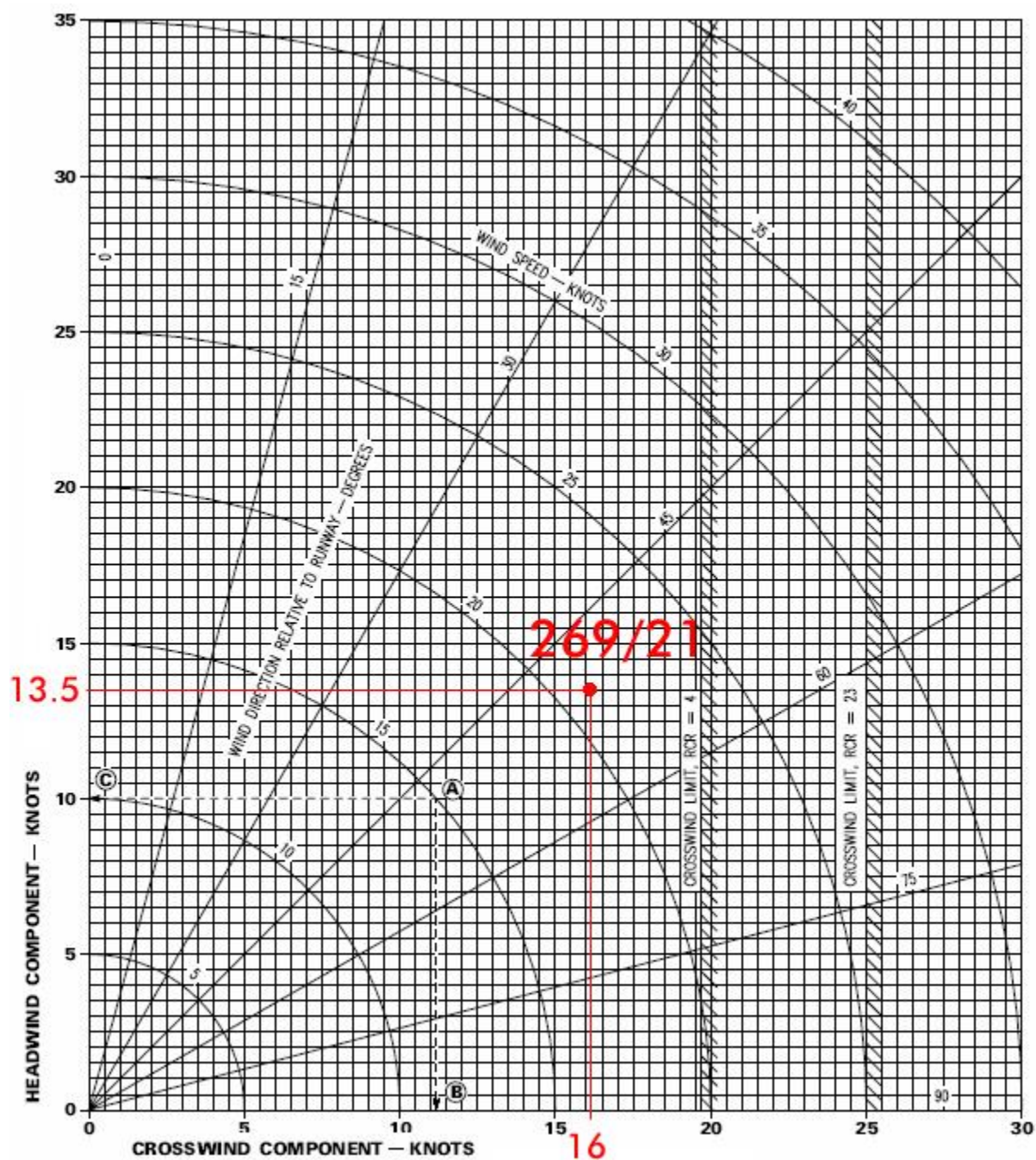
Now you have practised flying the ARCDME you can refly this mission using ATC radar vectors instead. You will find the TAEGU RADAR RWY 32 chart in your `\Docs\03 KTO Charts\01 South Korea\Taegu` folder. Select 'Request Vectors for Instrument Approach' when you initially contact ATC on the Approach menu page and follow ATC instructions to arrive on the runway heading safely and then continue your ILS approach as before.

6.1. Calculating the crosswind component

The maximum crosswind component on take-off and landing depends on the runway conditions (RCR). In BMS whatever the weather the RCR are always optimal and can be assumed to be 23. Therefore the maximum crosswind component of the F-16 is 25 kts. As you see from the graph below, there are actually two limits for the F-16: one at RCR 4 (worse): 20 kts and the other at RCR 23 (optimal): 25 kts.

To compute the headwind and crosswind component enter the graph at the intersection of the concentric wind indicating wind speed and the straight line that represents the angle between the runway heading and the wind direction: RWY heading: 320° - wind reported in DED: 269° / 21 kts $\Rightarrow 320 - 269 = 50^\circ$.

Locate the 45° and 60° angle on the map and the curve for speed of 21 kts and place a reference dot. By reporting the position on both axes we calculate the headwind component to 13.5 kts and the crosswind component to 16 kts. This training scenario is well within the limits of the F-16.



MISSION 7: FLAMEOUT LANDING

LOCATION: Approximately 13 Nm south of Osan airbase.

CONDITION: Barrel 1, In flight - Engine out - Aircraft level at 21000 feet - heading 270° - speed 300 kts.
GW: 21300 lbs with stores – 19700 lbs without stores (Fuel at 0 lbs).

Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.

AIRBASE: OSAN RKSO –RWY 09/27 L/R - 094X – Ground: 253.7 – Tower: 308.8 – Approach: 306.3

WEATHER: RKSO INFO B 010425LT RWY09 TRL140 100/4kt 9999 12/2 Q1034
Sunny, clear skies, wind 100° at 4 kts, temperature 12°C, dewpoint 2°C Altimeter 1034 hPa

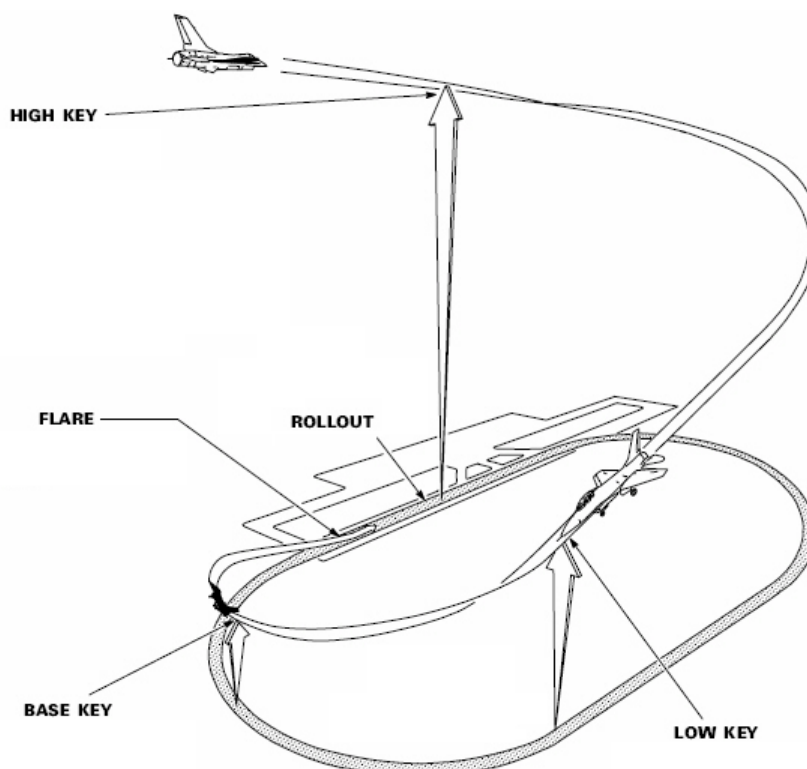
GOAL: Land the aircraft with no engine on RWY 09 Osan airbase.

Although simulated flameouts should be practiced as often as possible we will train real flameout due to fuel starvation. There are two basic types of flameout approaches: direct (straight-in) and overhead. The direct approach may look simpler but provides no extra room for error. The overhead pattern is by far the safest as it provides good visual cues against known references (if you know them by heart). This is the approach we will demonstrate here.

7.1 The overhead approach

The overhead flameout approach is made up of 3 distinct points called HIGH KEY, LOW KEY and BASE KEY. Each key is associated with a minimum altitude, ensuring that the flameout approach can be concluded with a safe landing. The pattern can be entered at any point provided the next key altitude can be reached:

- HIGH KEY: 1/3 down the landing runway at 7000 – 10000 feet.
- LOW KEY: abeam rollout point on final at 3000 – 5000 feet.
- BASE KEY: midpoint of the turn from downwind to final no lower than 2000 AGL.



Some Numbers

There are a few parameters you should know before attempting a flameout procedure. Your aircraft is powerless and many systems will be running on emergency power as you fall towards earth. Gliding speed will obviously depend on your Gross Weight: 200 knots for a GW of 20000 lbs and 205 knots for 21000 lbs. Add 5 knots per 1000 lbs of additional GW. For reference an F-16 block 30 empty of fuel and having jettisoned stores (with a centreline pod & A-A missiles) weighs around 20000 lbs or 19000 lbs without an ECM pod.

Best glide speed is thus typically set to ~200 knots; with landing gear down just subtract 10 knots (~190 kts).

A useful tip to find out your best glide speed in any configuration is to just fly a 7° AOA attitude.

The real Dash 1 manual says that the F-16 will go 7 Nm over the ground for every 5000 feet of altitude loss. That's a glide ratio (or "finesse") of 8.4. You will cover 8400 feet for every 1000 feet of altitude you lose.

This can make gliding calculations tricky in an emergency so just use a glide ratio of 1:1 giving a finesse of 6, i.e.: 1000 feet altitude loss for every nautical mile (6000 feet) distance. It is an approximate rule, but it is handy to quickly estimate your range when deciding which available runway to use and whether you can make it.

Optimum bank angles are 50° for gear up and 55° gear down. Anything above optimum bank angle causes a significant loss of altitude per degree of turn.

Another consideration for long glides to the runway is how much EPU fuel you have left for hydraulics and emergency power. Once hydrazine is depleted the EPU will shut down, hydraulic pressure will fall and the F-16 will be as controllable as a brick. At that point your only way out is to eject. The EPU will run for about 10 minutes on hydrazine, so don't plan for a glide and flameout landing taking more than 10 minutes!

Let's review the numbers for this training scenario:

- Best glide speed gear up: 200 kts (7° AOA)
- Best glide speed with gear down: 190 kts
- Increase all airspeeds by 5 kts per 1000 lbs of fuel/stores
- Glide ratio at best glide speed: 5/7 (finesse 8.4)
- Max bank angles gear up: 50°
- Max bank angles gear down: 55°
- EPU fuel autonomy: 10 minutes
- Altitude High Key: 7000 - 10000 feet (7000ft + 500 ft for each 1000 lbs fuel/stores)
- Altitude Low Key: 3000 - 5000 feet (3000ft +250 ft for each 1000 lbs fuel/stores)
- Altitude Base Key: No lower than 2000 feet AGL

The above numbers should be committed to memory.

7.2 The training mission:

You are on a routine test flight around Osan airbase in an F-16C block 30 aggressor. The jet has been freshly painted at Kunsan and is being prepared for its long ferry flight to Alaska. The aircraft is fresh out of the paint shop and you are clearing the jet for operational use. It is dawn and you are enjoying the rising sun, but the situation is about to get less peaceful... you just lost your engine. You are 13 Nm south of the runway with plenty of altitude and speed. You decide to attempt a flameout landing on RWY 09.

The most urgent thing is to clean the aircraft to extend your range as much as possible. Perform an emergency jettison to get rid of the excess drag created by the wing tanks. Emergency Jettison is done by pushing the white EMER STORES JETTISON pushbutton on the GEAR panel.

Turn north towards Osan and let your speed decrease to best glide speed while maintaining level flight. When you reach best glide speed start a descent to maintain that airspeed. You are now gliding with an AOA close to 7°.

The engine provides electrical power and hydraulic pressure to the aircraft system through the main generator. When the engine died the main generator went offline and most of your systems shut off. The emergency buses powered by the Emergency Power Unit (EPU) took over, powering up critical systems so you can land the aircraft.



The EPU can run solely on air if wind-milling engine RPM is sufficient but will use hydrazine fuel if not. The status of the EPU can be checked on the EPU panel on the left console. The green light indicates that the EPU is running. If the AIR indicator is lit it means the EPU is running on air and if the HYDRZN light is illuminated it means that the EPU is using up the limited supply of hydrazine and you have maybe 10 minutes to get down safely.

Hydrazine quantity can be checked on the right auxiliary console. The EPU FUEL gauge is labelled from 0 to 100% and has already started to decrease, indicating hydrazine consumption.

Once the EPU runs out of hydrazine the FLCS will no longer be powered and the aircraft cannot be controlled. You will have to eject. Check that EPU FUEL gauge often.

MFDs, EWS and the DED will be off but your main instruments and the HUD will be usable. Speedbrakes are available as well, but the gear handle will not work. You will have to use the ALT GEAR HANDLE.

The UFC is not available, so you need to switch the CNI knob on the AUX COMM panel to the BACKUP position. A good habit is also to squawk emergency with the IFF by moving the IFF knob to EMER. As you are gliding to Osan input the Tower frequency (308.8) in the manual frequency of the Backup UHF panel, then move the right knob to MNL. That makes the manual frequency you've just entered active, instead of the preset channel. You will now be able to communicate with Osan ATC to request an emergency landing.

Another very important aspect to consider is the wind. It influences your flight when the jet is powered, but when gliding the wind may throw all your parameters out the window and make you fall short or go long. Unfortunately you can no longer rely on the UFC to display winds. You will have to 'Request Wind Check' from the Common ATC menu page. In this training mission we planned to land on RWY 09 at Osan so we could expect a wind from the east. The wind will push you on downwind and slow you down on final, increasing your sink rate further. Something critical to consider!

By now you should have Osan airbase visual, slightly to your right. Depending on EPU fuel remaining and winds it might be preferable not to fly direct to the runway but to maintain a slight offset so you can maintain visual better. If you fly direct to the runway you will lose it under your nose and judging overfly is trickier. Of course in situations where EPU fuel is running low you might not have that luxury. Maintaining visual with your runway is critical though.



If you don't have enough altitude left you can decide to go for a straight-in at this point. But it shouldn't be the case if you managed your glide speed correctly. Remember the overhead flameout pattern is flexible and you can enter it at any point, depending on your altitude or energy state. If you're too low for high key but almost good for low key enter the pattern at low key. The main concern of the procedure is to reach high key, low key or base key above the minimum required altitude.



Monitor your EPU FUEL gauge and continue to fly to high key. You should reach it between 7000 and 10000 feet above the runway and have at least 30% of EPU fuel remaining. In this particular scenario the jet is very light so 10000 feet should be possible, giving you extra margin.

It is not easy to judge the perfect position for high key since you may lose sight of the runway. It is not critical to be at the perfect spot 1/3 down the runway. Pick a visual aim point outside the airbase grounds to help you keep oriented and mind your altitude more than your relative position.

Departing high key, concentrate on executing a successful landing in a similar way to a normal overhead landing. Keep computing the wind action on your ground track (tailwind) and execute a 50° bank descending turn to downwind (270°) while maintaining 200 knots in the descent, aiming for low key.



Low key is usually 1 Nm out from the runway centreline. It's the point where you start your final 180° turn towards the runway and should be reached between 3000 and 5000 feet AGL. Execute a 50° bank angle descending turn towards the runway, still maintaining best glide speed towards base key. Do not lower your landing gear until you are confident of reaching base key.

Base key is the mid-point of the turn and should be reached no lower than 2000 feet AGL. At that point the gear should be down. The gear handle alone will not work. You must execute an alternate gear extension. Start by lowering the regular gear handle and then use the ALT GEAR handle further left on the auxiliary console to 'blow' the gear down..

Continue your descending turn towards final. If you're too fast you may extend the speed brakes to bleed off excess altitude, but don't overdo it as you cannot get that energy back.

Wings level on final there is a tendency to slow down below optimal airspeed; this increases your sink rate and should be avoided. Keep your aim point on the runway threshold and make note of the steep final.

Open the ATC Tower menu page and 'Report on Final' if you have time, though the Osan Tower Controller will clear you to land anyway if you are in position. Osan was modernised in 4.34 and now features parallel runways. Plan on landing on 09L, as instructed by ATC.

Once your landing is assured shift your aimpoint short of the intended touchdown point and control your airspeed with your speedbrakes.



Allow the aircraft to flare but remember the higher the airspeed, the longer the float will be in the flare. The float from best glide speed (190 kts) will be approximately 3000-4000 feet in a no wind situation; shorter in this case as we have a 10 kts headwind. Touch down at the usual 11-13° AOA.



On landing aero-brake as normal and when the nose wheel is on the ground apply full aft stick, fully open the speedbrakes and engage wheel brakes as necessary. Wheel brakes remain available in BMS even though their availability in the real jet depends on if you used the JFS to assist the EPU in the air.

NWS is not available so use differential braking (if you have it on your flight controls) once you start to slow down and your rudder authority becomes less effective. Congratulations, you've made it back in one piece.

MISSION 8: LOW LEVEL NAVIGATION (TFR – FLIR)

LOCATION: Kunsan Airbase Ramp.

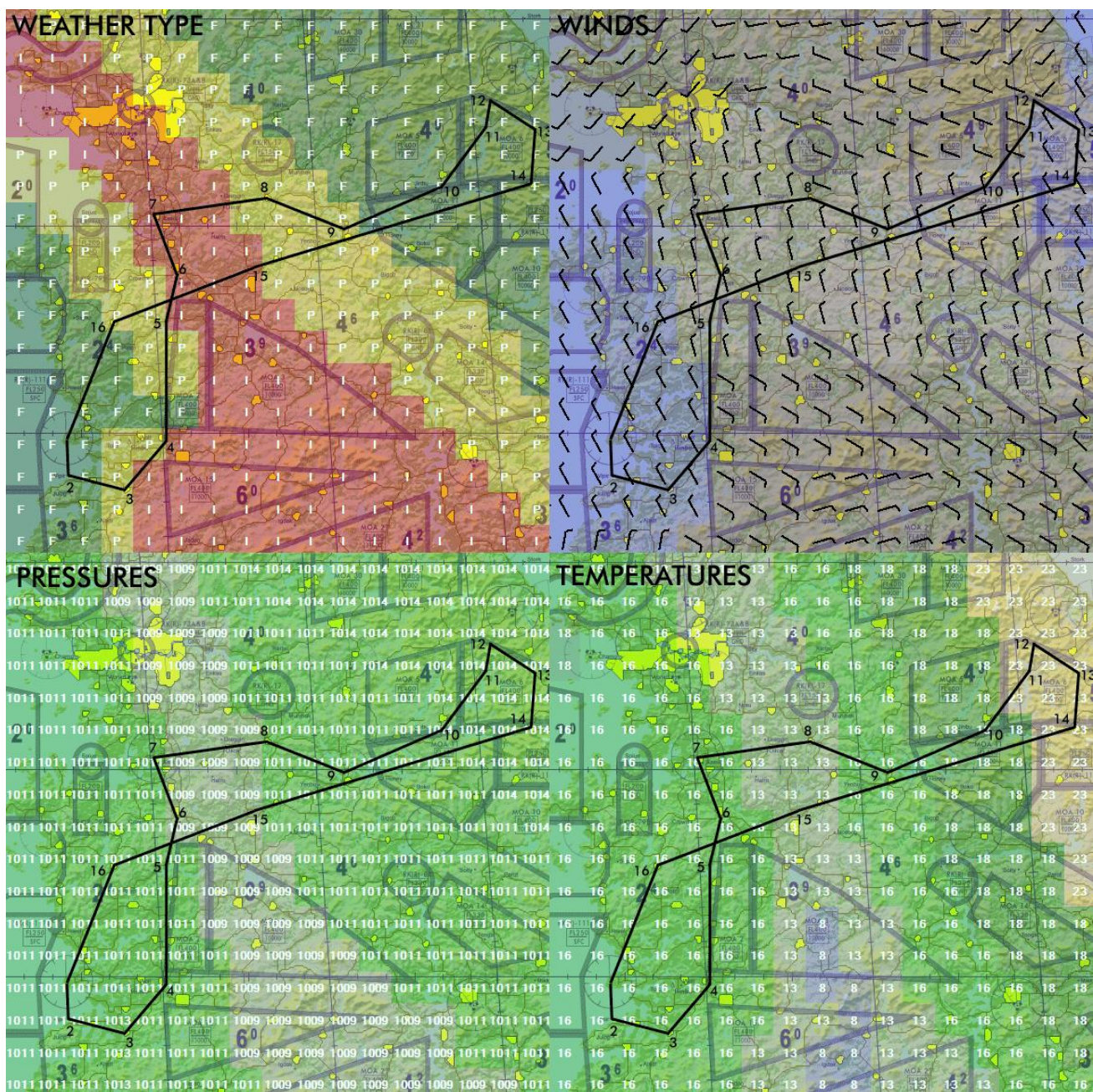
CONDITION: ROKAF F-16 block 52 – Flight of 2 - Callsign Sherpa 2.

GW: 39280 lbs. 4 GBU-12 & both LANTIRN pods. Max G: 5.5/-2.0 Max speed: 550 kts / 0.95 Mach.

WEATHER: This Training TE uses a Map Model weather map (Fmap). Users can now create realistic weather patterns according to GRIB data (refer to the BMS-Manual and Technical manual for more information).

The following images will give you an overview of the weather situation for this flight. The top left image shows the kind of weather expected at specific locations: green = FAIR; yellow = POOR; red = INCLEMENT.

The top right image shows wind speed and direction. The bottom left image shows QNH and the bottom right image gives temperatures.



Looking at the chart we can expect an RWY 36 departure due to the wind coming from the North and we can expect to fly through a weather front from STPT 3-4 up to STPT 8-9 where the weather should clear, allowing us time for target practice at KOTAR (which is not part of this training mission).

GOAL: Low level (500 feet) navigation to the target area (KOTAR, STPT 14) at night and in bad weather.

This mission will demonstrate use of the LANTIRN (Low Altitude Navigation & Targeting InfraRed for Night) system. LANTIRN consists of two pods carried on the chin pylons of the F-16, the AN/AAQ-13 Navigation Pod mounted on the left chin hard point and the AN/AAQ-14 Targeting Pod loaded on the right chin hard point.

Please note: TFR and (particularly) FLIR displays are FPS intensive. If your framerate is too low try reducing tree and grass density on the SETUP > GRAPHICS UI page.

Operational use of the LANTIRN suite is documented in both the BMS1F-16CM-1 and BMS1-F16CM-34-1-1 manuals, which should be read before attempting this mission.

The training mission starts at the ramp as the TFR and FLIR need to be checked on the ground and in-flight soon after take-off before operational use. We will demonstrate the required checks and fly low level in weather to the target area. The training will then stop at IP and the bombing part of this TE is not relevant to this training mission. Nevertheless you can choose to pursue your flight and practise LGB runs on targets at KOTAR. If you do, don't forget to make a note of the bomb code in the LOADOUT screen before entering the aircraft.

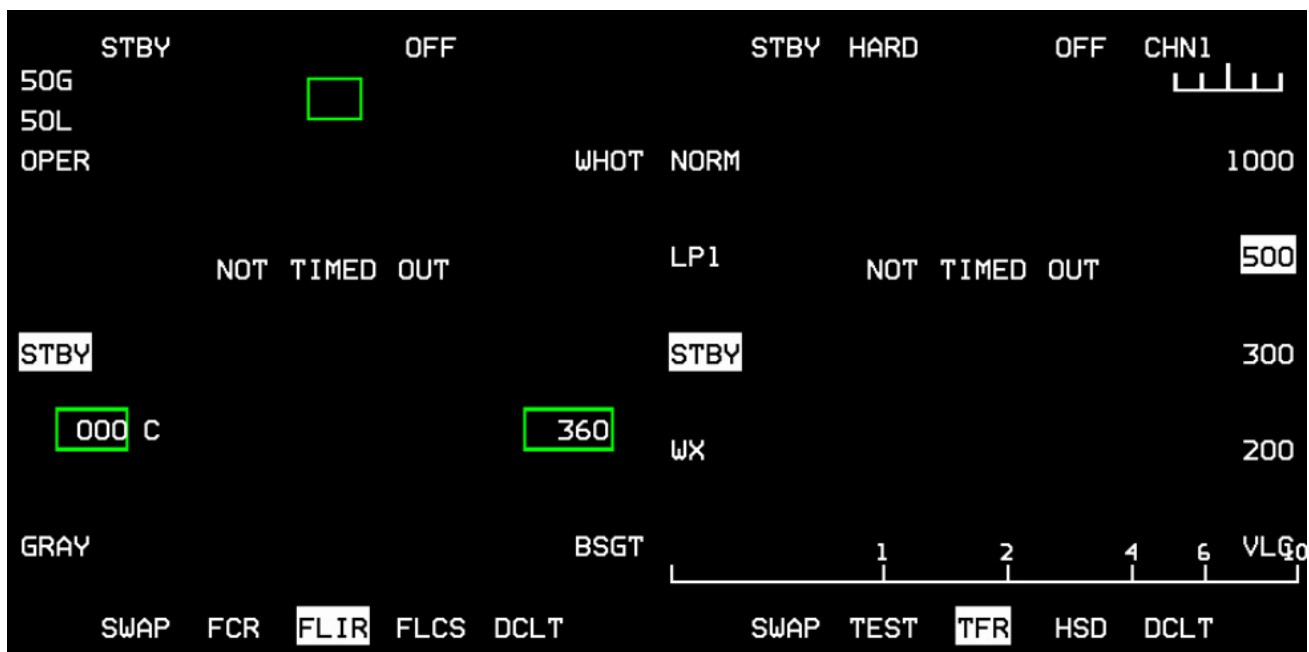
Obviously we will not document the ramp start procedure already explained in Mission 1. We will document only the necessary TFR and FLIR aspects of the checks. You will need to include them in your ramp start routine.

The chin pylons on the F-16 are not powered by default, so your first step is to switch on the LEFT HDPT and RIGHT HDPT switches on the SNSR PWR panel. This is usually done at the same time as powering on the FCR.



Immediately select the FLIR MFD page and place the FLIR in STBY (OSB 18). The NOT TIMED OUT message will display as the FLIR needs between 7 and 15 minutes to cool down. It is a long time and since you may want to boresight the FLIR afterwards you should perform these steps as early as possible in your ramp start procedure.

Next select the TFR page on the MFD and place the TFR in STBY as well; the same NOT TIMED OUT message appears. The TFR will need about 3 minutes to warm up. the NOT TIMED OUT message will disappear when it is ready.



The RF switch position on the MISC panel will determine the modes of operation available to the TFR (see BMS1-F16CM-34-1-1). In SILENT the TFR will be in standby and cannot be used. In QUIET the TFR will work only in WX (Weather) or LPI (Low Probability of Intercept) modes. For the TFR checks ensure the RF Switch is in NORM, allowing the TFR to operate in all its modes (NORM, WX, LPI and VLC).

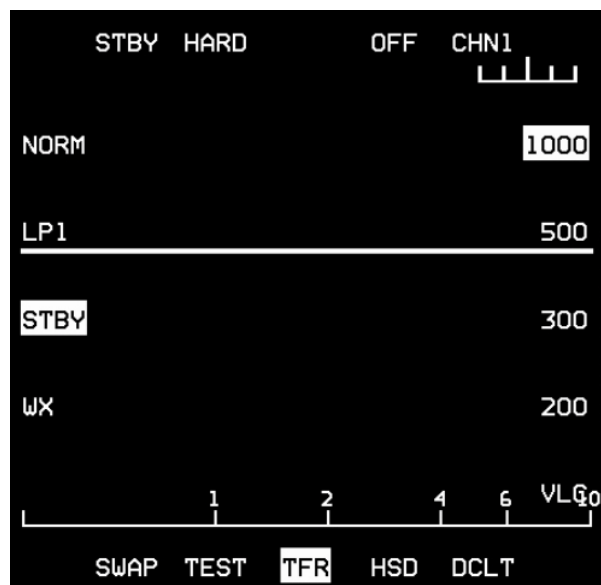
Obviously we will need to have the radar altimeter operating as well. It is now in STBY and we will turn it on as usual at runway line-up.

The MANUAL TF FLY UP switch on the FLCS panel needs to be placed in ENABLE. A good habit when checking the FLCS panel switches is to ensure they are all placed in the down position.

The ENABLE position of the switch ensures that in MAN TF (Manual TFR) there is the same automatic fly-up protection as in AUTO TFR. If the switch was left in DISABLE the pilot has to initiate the fly-up manoeuvre.

When the TFR is ready the NOT TIMED OUT message will disappear and the Flight Path Reference Line will be displayed. We can now set the TFR according to the first in-flight checks we will need to perform:

- SET SCP (Set Clearance Plane) to 1000 feet (OSB 6).
- SET RIDE type HARD (OSB 2).
- Select the A-LOW UFC page and set CARA ALOW to 900 feet (i.e. SCP – 10%).
- The TFR ADV line is an altitude the pilot can set, above which the AAF (Attitude Advisory Function) is disabled.



From this point, except for the RALT switch still in STBY, the TFR has been ground checked and is ready for in-flight use. The FLIR is still cooling down and may still need another 10 minutes, so we will resume checks at EOR. Concentrate on finishing your ramp start and taxi to the assigned holding point of the active runway.

When the FLIR is ready press OPER (OSB 20) and display the FLIR image on the HUD with the ICP BRT wheel (bottom left wheel). You can set the required GAIN level on the displays using the up and down arrows in the FLIR section on the ICP.

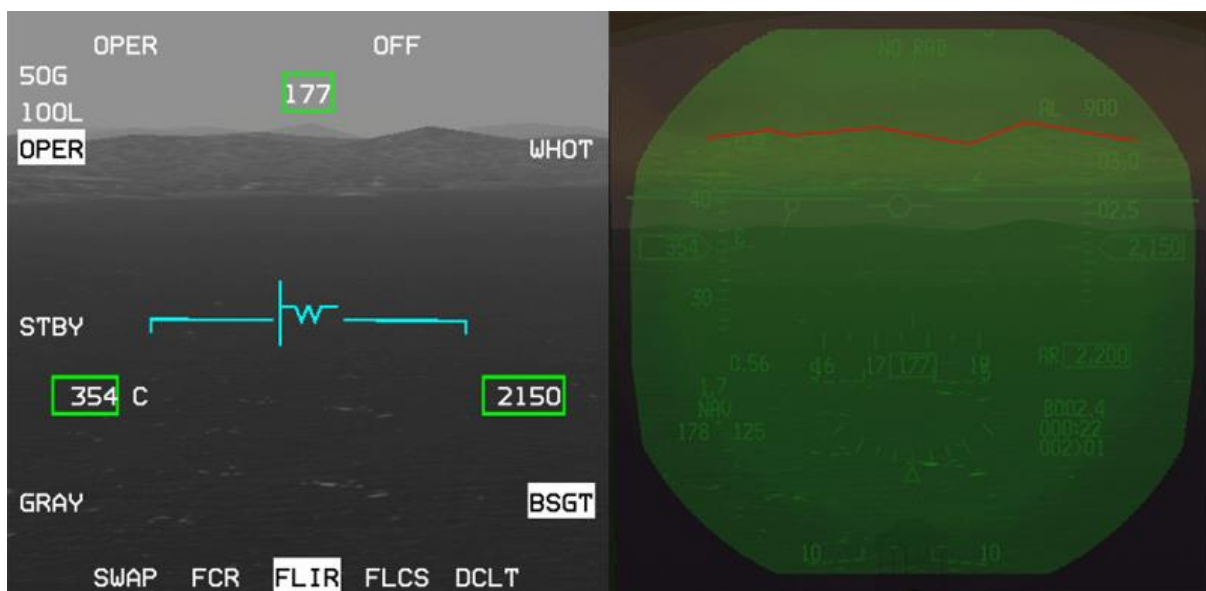
The FLIR image on the HUD should be correctly aligned with the HUD image. But in case of misalignment it is possible to boresight the FLIR image on the HUD. We will do so immediately after we get airborne.

You don't need the FLIR displayed in the HUD for ground operations so place the FLIR in STBY. The pods have been ground checked; let's see how they behave in flight.

Taking off on RWY 36 we turn 180° to STPT 2 and once established on that heading we have some useful mountains on the horizon to boresight the FLIR on. Level out, zoom in on the HUD, place the FLIR in operate and press BSGT (OSB 10). The mnemonic of the OSB highlights and the FLIR image on the HUD can then be moved with the cursors so it matches the item you see on the HUD. Align the FLIR HUD terrain on the mountains you have visual with the cursors. Once satisfied exit the boresight mode by pressing BSGT again (BSGT is not highlighted anymore) and turn the FLIR back to STBY for now.

The screenshot shows the FLIR MFD on the left and the HUD image on the right. The darker mountains in the lower part of the HUD are what you see and as you can see the FLIR image is too high (on purpose).

Move the FLIR image down with the radar cursors until they are perfectly aligned with the terrain at the distance you want to focus at. Needless to say it is better for flight safety to use a correctly boresighted FLIR.



Before using the TFR in flight we need to ensure that the systems are reliable. This is done with a series of checks that take less than 2 minutes. The leg between Steerpoint 2 and 3 is designed for LAN (Low Altitude Navigation) checks. We'll test Manual TFR (MAN TF), Auto TFR (AUTO TF), FLYUPS and the RALT.

Once confident that the TFR can be used safely we will set the system to mission parameters and start our low level ingress to the target.

8.1. MAN TF check

- Accelerate to 350 kts and climb above 1000 feet AGL. We will test that the TFR LIMITS warning works properly.
- Select the TFR MFD page and place the TFR in NORM. Since we are flying below the airspeed limit of 360 kts the TFR will display multiple warnings:
 - HUD:** LIMIT displayed and speed scale flashing – verify also the MAN TF box is displayed.
 - MFDs:** a yellow TFR LIMITS square is flashing.

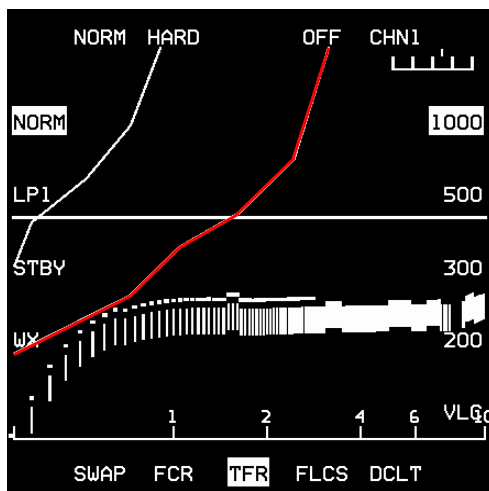


- Accelerate to 400 kts and check that the LIMITS disappear past 360 kts.
- Bank past 60° and verify:
 - MFDs:** yellow TFR LIMITS square flashing.
 - HUD:** LIMIT flashes and the MAN TF box disappears if the bank is held for more than 2 seconds. The airspeed scale does not flash because the limiting factor this time is not airspeed but bank angle.
- Roll wings level and verify that all LIMITS have disappeared and that the MAN TF box reappears.

8.2. AUTO TF fly-up check

If possible make the following checks over low terrain. We will check the behaviour of the TFR in automatic mode and push it past its limits to check the automatic 2G fly-up:

- Activate AUTO TF with the ADV MODE switch (AMS) on the MISC panel. Once activated the green indicator ACTIVE will be illuminated signifying that the TFR is now in AUTO TF mode. The aircraft will gradually descend to the programmed SCP (1000 feet).
- Verify that the AUTO TF LINE is displayed in the HUD (it replaced the MAN TF command box).
- Verify that NO TER is displayed in the HUD (No Terrain) and verify ground return on the TFR MFD.
- Monitor automatic level off at SCP (1000 feet).
- Push stick forwards to commence a shallow dive.
 - Verify aural “ALTITUDE – ALTITUDE” at A-LOW (900 feet AGL).
 - Verify fly-up occurs at 750 feet AGL (75% of SCP).
 - Verify LO TF is displayed in the HUD, LIMITS in both MFDs and aural “PULLUP – PULLUP”.
- Allow the fly-up to level altitude at 1000 feet and once there depress and hold the paddle switch to cancel the fly-up. Verify STBY light on AMS indicator.
- Press the AMS switch until both lights are off to cancel AUTO TF and release the paddle switch.
- You are now back in MAN TF, check the MAN TF command box is displayed in the HUD.



Fly-ups are automatic manoeuvres commanded by the FLCS to avoid the terrain. They will occur in AUTO TF (and in MAN TF only if the MANUAL TF FLYUP switch is placed in ENABLE).

A normal fly-up will occur at 75% of SCP with an incremental 2G climb. That curve is visible on the TFR MFD page. It is the second line path as illustrated on the screenshot.

If more than 2G is necessary to clear the terrain the TFR will issue a G-LIMIT warning and commence a 3G incremental fly-up.

If more than 3G is necessary the TFR will issue an OBSTACLE warning and initiate a 4G fly-up. In both cases a break X will be displayed on the MFDs.

It is important to note that fly-ups will not level your aircraft. They are terminated at 300 knots or 45° pitch attitude to prevent a possible stall. Pilots should take over at or before this point to avoid departure from controlled flight.

The pilot can interrupt fly-ups by depressing the paddle switch. It is however recommended to continue the manoeuvre until a safe altitude or attitude has been reached. When depressing the paddle switch the green ACTIVE light on the AMS indicator is replaced by the amber STBY light indicating pilot override.

8.3. TFR letdown check

We will now test the more aggressive 3G and 4G fly-ups in MAN TF by inducing an obstacle clearance:

- From SCP 1000 feet in MAN TF push the stick until approximately 500 feet AGL.
- Verify G-LIMIT and OBSTACLE warning fly-up occurs.
PULLUP is displayed on the HUD.
Flashing break X is displayed on both MFDs .
VMS is issuing an aural “PULL UP – PULL UP”.
- Allow the fly-up to occur and depress and hold the paddle switch when reaching 1000 feet SCP. While still holding the paddle switch set a new mission SCP of 500 feet. You can now release the paddle switch and follow the MAN TF command box in the HUD to mission altitude.

8.4. TFR SWIM check

There is one last check to make. We need to ensure that automatic roll to wings level and fly-up will occur if the radar altimeter fails for any reason:

- Roll to 15 – 30° of bank.
- Select the MFD TEST page and press OSB 7 for RALT BIT.
- Verify the following:
 - MAN TF box disappears.
 - Aircraft automatically rolls to wing level and fly-up occurs.
 - Aural “PULL-UP”.
 - WARN displayed on the HUD and TF FAIL warning light on (left glareshield).
 - TF FAIL PFL on PFLD (if below 4500 feet AGL).
- Press and hold the paddle switch and level out at SCP. Once the RALT BIT is complete you can release the paddle switch and resume MAN TF operation.
- Press F-ACK to acknowledge the SWIM PFL. The MASTER CAUTION and TF FAIL lights will go off.

All TFR systems have been checked and our level of confidence in the TFR is high so we can continue with the mission.

The SCP is now set to 500 feet. A-LOW should be reset to 10% below SCP: 450 feet. Ride is set to HARD and the TFR is set to MAN TF. We want to ingress to the target in AUTO TF though, so depress the AMS switch and check that the AUTO green light is illuminated and that the MAN TF box in the HUD has been replaced by the AUTO TF line.

Remember that the TFR in AUTO TF is only commanding pitch to the aircraft (unless in blended mode). The pilot remains in control of roll and airspeed.

It's getting darker so select the MFD FLIR page, press OPER so the FLIR image is displayed on the HUD and proceed to Steerpoint 4.

Rain is a problem for the TFR because it degrades the radar

Before we terminate this training session there are two small things left to cover regarding FLIR operations: LOOK-INTO-TURN (LIT) and SNAPLOOK.

LIT will be commanded if the bank angle is more than 5° and DMS Up is held. The FLIR LOS will move the FLIR image in the direction of the turn. When releasing DMS the FLIR will revert to boresight.

[illegible]

Flying in AUTO TF you let the TFR manage your altitude (set at SCP) as long as you ensure that you fly the aircraft within the TFR limits (360 to 600 kts - max bank angle 60°). Whenever a fly-up occurs let the TFR climb back to altitude but terminate the fly-up with the stick paddle. Check the AMS indicator amber yellow light and level the aircraft. Once in parameters release the paddle and AUTO TF will resume.

If you don't override fly-ups they will terminate at a pitch angle of 45° (or if you slow down to 300 kts). The TF will FAIL and pitch authority will be given back. If you don't take proper action, you may depart controlled flight.



Obviously if the idea was to stay low avoiding detection letting the fly-up climb the aircraft at 45° pitch up is a bad idea. Stay low and fast and override fly-ups as soon as you are in a safe position to do so.

You can proceed low level to STPT 14 or further, or you can move to the LGB Training Mission that will start at IP1 (STPT 6) of this flight.

The BMS Avionic Checklists located in your *Docs* folder contains a section on the TFR and FLIR; much handier for in-flight reference than this manual for your usual flights.

As you will not use TFR and FLIR on most of your flights, you will need to practise them from time to time to remain competent with these systems.

MISSION 9: IN-FLIGHT FAILURES

LOCATION: In flight above the Korean Straits between Japan and Korea.

CONDITION: F-16 block 42 – Single ship - Callsign Magnet 4-1.

GW: 28500 lbs. 2 370 Gal Fuel tanks, standard A-A loadout. Max G: 7/-2.0 Max speed: 600 kts / 1.6 Mach.

WEATHER: RJFF INFO A 011255LT ILS RWY01 TRL140 340/5KT 9999 30/20 Q1040

Fair weather turning Poor, Winds 340/5 kts. Visibility over 10 km. Temperature 30°C, dewpoint 20°C, Altimeter 1040hPa

GOAL: Manage the in-flight malfunctions and land the aircraft safely.

Do not use Freeze mode in this Mission – if you need to interrupt the training use Pause!

In this training flight you will encounter successive aircraft malfunctions that you will have to deal with in sequence. None of them will prevent you from landing the aircraft safely unless you screw up fixing or stabilising the emergency.

The in-flight failures are a glimpse of the new malfunction system in BMS. The whole PFL and other warning and caution systems were re-written much more realistically in 4.33. Unfortunately or fortunately depending on your point of view BMS in-flight malfunctions can only happen at the moment as a result of battle damage or pilot negligence. It hardly ever happens randomly as it would in real life (or because the jet's systems weren't properly checked during the ramp start).

Yet working on this training mission project I felt compelled to add a small training chapter about these great new features in BMS.

The BMS Dash-1 and Dash-34 go into more depth about the mechanisation of Caution, Warning and Fault analysis. As usual these documents should be read and understood before trying to solve this in-flight emergencies Training Mission.

If you read this chapter in full before flying the training mission you will spoil all the fun of it.

We suggest you don't read the following pages but fly first and try to manage the emergencies with the help of the emergency checklists located in your Docs folder. If there are issues you do not understand, or you couldn't solve then come back to this chapter and read the following pages.

As you enter the cockpit you are flying in the Korean Straits inbound to a US Navy carrier group. Your home plate is Fukuoka airbase (57X) in Japan and your alternate is Pusan (87X) on the Korea peninsula.

You are getting ready to play with the 2 F-14 Tomcats that are protecting high value targets such as the Growler and the Hawkeye currently in flight.

As usual before the action you quickly check all aircraft systems, gauges, caution panel, PFLD. All is normal.

Then suddenly...

1st fault:

Suddenly the MASTER CAUTION light comes on and the MFD reports the FCR and MMC are off. The VHF radio is off as well and the altimeter shows the PNEU flag, indicating that it is running on pneumatic power. Electrical power is lacking. The PFLD is blank but the caution light has the ELEC SYS light on, confirming the source of the problem.

The aircraft electrical system is managed through the ELEC panel on the left console so naturally you must check the panel and look at the light status. The MAIN GEN light is ON, indicating a problem with the main generator.

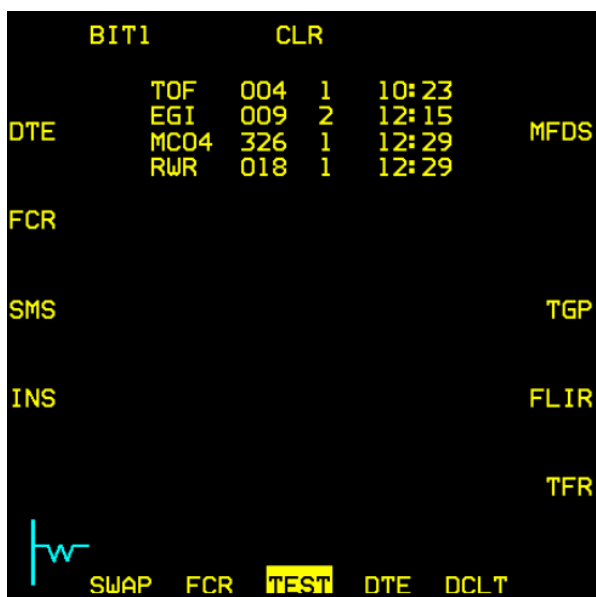
You're on standby power now, which is why only the essential systems are powered. The EPU is able to provide electrical power but has not started yet. That indicates the STBY GEN is working fine so far, hence you are suffering from a single generator failure in flight.

You may try to reset the MAIN GEN by switching the MAIN PWR switch to BATT then back to MAIN PWR to see if that restores electrical power, but doing so the STBY GEN will shut down (the STBY GEN light will turn on) and the aircraft will be on battery power. More systems will then shut down. The EPU will then activate and depending on your RPM situation you will use air or start to use hydrazine.

Move the MAIN PWR switch back to MAIN. The STBY GEN restarts but the MAIN GEN light is still on indicating the problem with MAIN GEN wasn't solved. As you have a good engine the EPU is able to run on AIR only. You can shut it down for now. Make sure you replace it in NORM; you may need it later in the flight.



The checklist recommends you press the ELEC CAUTION RESET pushbutton to reset both generators. Luckily in this case it resets the main generator and the MAIN GEN light goes off. Power is restored but the PFLD lists all the faults that happened. All PFL pages must be acknowledged with successive presses of the F-ACK button on the left glare shield. Once all faults are acknowledged they disappear from the PFLD and the MASTER CAUTION light extinguishes. If faults were still present then they would quickly reappear on the PFLD. Luckily it is not the case here.



The TEST MFD page though still lists all the systems that encountered a fault during the main generator failure.

The aircraft is back on normal status but as the FCR was shut off it is normal for the FCR to perform a BIT. Monitor the BIT on the left MFD as usual.

The checklist recommends you land as soon as practicable. There is obviously something wrong with the electrical system, the failure might occur again, and we may not be able to clear it next time.

We need to turn for home or the alternate now and abort the mission. It's time to say goodbye to the Tomcats.

2nd fault:

The left MFD has failed. Nothing much you can do about this. Acknowledge the fault with the F-ACK button. The fault will disappear from the PFLD, but the AV mnemonic will remain lit, indicating that there is a fault condition in the avionics. If at any point you recall the fault list, the left MFD fault will be displayed. You have the right MFD to manage your flight. You can access any MFD page from the MENU base page or you can also use OSB 15 SWAP to swap the MFD displays.

**3rd fault:**

The first indication of the next malfunction is the HYD/OIL PRESS warning light on the right glare shield. Betty will call that to your attention by repeating the word “WARNING”. Automatically you should check both HYD PRESS gauges on the right auxiliary console. The hydraulic system is made of two independent hydraulic systems: A and B, each providing hydraulic power to different aircraft systems. In normal operation both needles should point to the 12 o'clock position. In this scenario the HYD A system needle points to zero. You are suffering from a single hydraulic (A) failure.

The PFLD also reports an ISA ALL FAIL message and the FLCS FAULT caution light is illuminated. This is typical of hydraulic malfunctions. You could have tried to reset the FLCS with the FLCS panel FLCS reset momentary switch, but it wouldn't have reset.



In such situations it is critical to know which systems are affected by the failure. The checklist reports that System A failure in BMS affects the speedbrakes and the automatic fuel distribution (balancing). System B failure on the other hand would render the following equipment inoperative: Landing Gear, Wheelbrakes, Nose Wheel Steering, Air Refuelling door and the gun.

There is nothing you can do to fix hydraulic system A in flight. But you really don't want system B to fail now as well, so monitor the B HYD PRESS gauge closely. The checklist also recommends you land as soon as practicable (we are already on our way), to make smooth inputs to the controls and to plan for a straight-in approach (without speedbrakes).

Don't forget to monitor your fuel balance and take necessary action should the fuel load becomes unbalanced. Keep a close watch on the fuel totalizer gauge on the right auxiliary console. Whenever the red portion of the needles is visible an imbalance condition exists.

To fix the imbalance simply select the AFT or FWD position on the ENGINE FEED knob of the FUEL panel rather than the NORM position (auto balancing). Select AFT to pump fuel from the aft reservoir and select FWD to take fuel from the forward reservoir according to your actual imbalance.

The ISA ALL FAIL and FLCS cautions are related to servos and the autopilot. If you were on autopilot at the time of the hydraulic failure you may have noticed that the A/P disengaged. As long as a single or dual hydraulic failure condition exists the FLCS can't be reset and the A/P can't be engaged. It is also recommended that you keep airspeed under 400 kts.

4th fault:

The GPS bus failed and while you could reset the GPS switch on the AVIONICS POWER panel it won't fix itself. Losing the GPS isn't a major problem as long as the INS/EGI is working but it will decrease INS/EGI reliability. Fortunately your flight will be short, so you probably will not notice any INS drifting.

5th fault:

The HUD failed and you obviously don't need any fault indication or VMS message to tell you that. Acknowledge the fault with the F-ACK button anyway. As usual with these specific bus failures there is nothing you can do to fix them in flight. The challenge in this case will not be to manage the fault but to manage the final navigation and the landing with no Head Up Display.

Do not underestimate the malfunction of the HUD. Depending on the decisions you made earlier in this flight it could happen at a certain distance from your home base or in the middle of the approach. Losing the HUD means you lose the FPM. You will not compensate drift intuitively as you would by placing the FPM on the runway threshold. You also lose speed and altitude and the AOA bracket. All are very important settings or cues for landing the aircraft.

Now you must look at the main heads down instruments to get your speed and altitude. The left indexer gives your AOA. Remember shoot for a yellow just above the green on approach and touch down with green AOA. The trick is to judge the deviation from yellow to green to red.

But the most troublesome aspect may be the correction required for wind drift. It will be much harder to judge and to correct. Remember it's better done before you drift so ensure the wind is displayed in the DED and correct your heading before you start drifting.

6th fault:

You contact Fukuoka Tower on 225.5 and 'Declare Emergency'. Tower clears you for an emergency landing on RWY 33. (Since it's an emergency you can bypass Approach). As you need to turn all the way around to land on RWY 33, better plan for an SFO pattern. If not done already, squawk emergency by placing the IFF master switch to EMERG.



UHF ÷ 2	STPT 1
	341° 3
UHF 15	14:15:12
H	EMER T 57X

Coming in for high key overhead Fukuoka airbase, enter downwind by turning right on a 150° heading with your throttle in IDLE. The SFO pattern allows you to land the airplane dead-stick if the engine dies at any point during the approach. You time your last 180° turn onto final according to your energy levels and the wind. Established on a long straight-in approach you lower the gear, but nothing happens. No green gear lights. Quick check of the HYD B gauge: all good. But no gear. You must quickly lower the gear with the alternate landing gear handle. First ensure that your main landing gear handle is down and decrease speed to 190 kts, then pull the alternate gear handle. Monitor the gear lights and pray all three will turn green. You can now land normally. Just be aware that Nose Wheel Steering will be unavailable after an alternate landing gear extension, so plan to stop straight ahead on the runway after the landing roll.

As an extra safety feature – although completely unnecessary currently in BMS – you could lower the hook.

Next faults:

The final faults of this training scenario are meant for the pilots who didn't make the right decisions in the flight (i.e. not aborting earlier). They are supposed to happen after landing for the safe pilots, but if you didn't follow the checklists then they may happen in flight. The MAIN GEN will fail definitely and the EGI/INS will fail. Once that happens the pilot will be in a jet unable to navigate, as part of the electrical system is down and the essential navigation systems have failed as well. No EGI/INS, no TACAN, no HSI, etc. Hopefully you have the runway in sight when both these faults happen, or you have very good situational awareness and you can navigate until you see Fukuoka airbase. But the weather is turning sour as well...

If the above happened to you, we hope that next time you will consider aborting and returning to base as soon as practical... as the checklists advised!

Conclusions:

The mechanics to system failure analysis are always the same:

- First the aircraft will let you know that there is a caution or a warning present.
If it is a warning, WARN in the HUD will be displayed and Betty will call: “WARNING – WARNING”.
If it is a caution, the relevant caution light will illuminate on the caution panel and a few seconds after that the MASTER CAUTION light will come on. Betty will call: “CAUTION – CAUTION”.
- You should then check the relevant warning lights or caution lights.
The pilot fault display should be checked as well as it may give more information about the failed system, especially the first line mnemonic that will lead you to specific aircraft systems, i.e. engine, FLCS, avionics.
- From the information above look at the specific panel or gauge and take action to clear the failure condition, if it is possible.
A quick look at the MFD MFL (Maintenance Fault list) on the MFD helps tracking the faults as well.
- If the fault has been fixed acknowledge the fault with the F-ACK, the MASTER CAUTION or the HUD WARN RESET. If the fault wasn't cleared the process will start again.

BIT1		CLR		
DTE	TOF	004	1	10:23
	EGI	009	2	12:15
	MC04	326	1	12:29
	RWR	018	1	12:29
FCR	MFDS	168	1	13:56
	FLCS	036	1	14:23
	GPS	003	1	16:08
	HUD	003	1	21:08
SMS	INS	003	1	23:08
INS				FLIR
				TFR

If the fault can't be fixed the MASTER CAUTION and HUD WARN can be reset but the PFLD will keep the first line mnemonic illuminated to tell you the fault is still present.



PART 3: WEAPON EMPLOYMENT

You know how to fly the jet and use its systems. It's now time to learn how to fight in the aircraft.

Part 3 of this Training Manual will cover weapon employment and procedures. You will fly different F-16 blocks with modern avionics in 10 independent missions.

Mission 10: GP bombs - CCRP, CCIP and DTOS.

Mission 11: LGBs - level, loft and buddy lasing.

Mission 12: SEAD & DEAD: AGM-88 - HAD, HAS, POS.

Mission 13: AGM-65 Mavericks (advanced pilots).

Mission 14: AGM-65 Mavericks CAVOK (same as mission 13) but easier thanks to clear skies.

Mission 15: Inertially aided Munitions (JSOWs & JDAMs).

Mission 16: SPICE bomb.

Mission 17: A-A IR missiles (& Baseline Intercept).

Mission 18: A-A Radar missiles (& CAP).

Mission 19: Guns & HMCS.

Mission 20: Harpoons & TASMO.

MISSION 10: AIR TO GROUND GENERAL PURPOSE BOMBS

LOCATION: North of KOTAR.

CONDITION: F-16 block 50 – Single ship - Callsign Stud 1.

GW: 36550. 12 BDU-33. Max G: 5.5/-2.0 Max speed: 550 kts / 0.95 Mach.

Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.

WEATHER: RKTY INFO: B 010755LT ILS RWY26 TRL140 200/15KT 9999 FEW050 28/18 Q1013 NOSIG

GOAL: Strike the target with general purpose bombs using different types of delivery at KOTAR.

10.1 The weapons

This training mission will teach you how to strike targets with General Purpose bombs. GP bombs are unguided and may be low drag (LD) or high drag (HD) and of varying weights. Low drag munitions are slick weapons that fall ballistically. High drag weapons are retarded munitions that allow the aircraft to exit their frag envelope, allowing delivery from low level.

In BMS these weapons are:

- Mk-82 LDGP: 500 lb Low Drag General Purpose munition.
- Mk-82 AIR: 500 lb High Drag General Purpose munition.
This is a Mk-82 fitted with a BSU-49 high drag tail assembly.
- Mk-82 SE (Snake Eye): retarded High Drag General Purpose munition.
- Mk-84: 2000 lb Low Drag General Purpose munition.
- You may also encounter Mk-81 (250 lb) and Mk-83 (1000 lb), but they are less commonly used than the Mk-82 and 84s, especially by F-16s.

Mk-82s are usually loaded on stations 3 & 7 and may be loaded on TERs (Triple Ejector Racks), allowing 6 weapons to be carried in total. The inner station of the TER is usually not loaded as the weapon may conflict with the external wing tanks when carried. That restriction is not relevant to BMS and the TER can be fully loaded. Stations 4 and 8 in BMS can also carry A-G weapons, although we will not use that capability here. Mk-84s are much heavier and can only be loaded singly on pylons.

Beside the GP bombs BMS offers a wide range of other types of munitions that fall ballistically like the GP munitions. They are CBU (Cluster Bombs Units) and penetration weapons such as the BLU-107 Durandals. Releasing these weapons is very similar to the GP bombs, so this training scenario is valid for these types of weapons as well. We will use GP bombs for illustration, but the methods are the same for CBU and BLU. CBU though will need an extra setting in the SMS CNTL page: Burst Altitude (BA).

Finally, BMS offers the possibility to load practice bombs known as the BDU-33. They have the same ballistic characteristics as the Mk series but are smaller and don't explode on impact. They simply emit smoke for easy spotting of the impact. They can be carried on TERs (up to 3 units), or in a specific SUU-20 container that is loaded up automatically on the LOADOUT page when you try to load more than 3 BDUs on a single station. A SUU-20 can carry 6 BDUs.

These are the weapons we will use in this training scenario. Our aircraft is loaded up with 12 BDU-33 - 6 in each SUU-20 on stations 3 and 7. We will release these weapons in pairs, allowing us to practise 6 different delivery patterns.

10.2 Delivery methods

There are many ways to deliver GP bombs. Most often used are Continuously Computed Impact Point (CCIP) and Continuously Computed Release Point (CCRP), but there are also Dive Toss (DTOS), Low Altitude Drogue Delivery (LADD) and Manual mode (MAN).

CCIP is a visual mode that does not need target designation. Its symbology displayed on the HUD shows where the bombs will hit if released at any specific moment. If the bombs would fall outside the HUD field of view the piper switches to a delayed mode; more information on this later. In CCIP the FCR switches to Air to Ground Ranging (AGR) mode automatically and is unavailable to the pilot. CCIP is typically used when the target is easy to acquire visually, with the aircraft in a dive, so the target remains in the HUD field of view and the bombs can be dropped with maximum accuracy. The pilot places the piper on the target and pickles.

CCRP computes the release point, not the impact point. The target needs to be designated by one of the on-board sensors (FCR, TGP) and CCRP HUD symbology guides the pilot to the optimal release point. CCRP can be used level, in a slight dive or even for lofting the bombs, usually at pre-planned targets.

DTOS is a mix of visual target acquisition and computed release point. The target will be visually designated with the HUD as SOI (Sensor of Interest). Once designated, the HUD symbology will switch to CCRP and the pilot will be guided to the release point. Although, as the name implies, DTOS can be used to toss the bombs on to the target it's mostly used in a dive to allow visual target acquisition, but where the pull out of the dive happens before bomb release (because of proximity of the target).

LADD is a low altitude mode mostly used with air-burst weapons (CBU). These weapons need to detonate above ground level, potentially at or above the altitude at which the aircraft is flying. The delivery method consists of a 45° climb during which the weapon is released and an egress manoeuvre. It is not practical to demonstrate this type of delivery as the training scenario doesn't load CBUs. In any case LADD in BMS is not fully implemented.

MAN mode is completely manual and uses backup manual or standby reticules. It is essentially the same bombing method that was used in WW2 and hardly ever used in modern jets, except as a backup system.

10.3 The mission

The training mission starts in the air about 20 Nm from the Korean Tactical Range (KOTAR). You are approaching the IP (STPT 5) and will turn 90° to the right to fly towards the target. We will illustrate different methods of releasing GP bombs at different targets on KOTAR. After each pass you will have to fly back to the IP and then follow the instructions for the next delivery method.

Obviously you should set your aircraft systems appropriately before attempting to strike a target:

- Select A-G Master Mode by pressing the A-G button on the ICP.
- Select the SMS MFD page and select GP weapons (BDU-33), set correct weapons settings and select the correct bombing mode.
- Set MASTER ARM to ARM (or SIM but then the bombs will not release so it won't be quite as productive in a simulator as you will not see where the bombs would have landed).
- Check HUD release cues match the bombing mode you selected.

First pass: CCIP

The first pass will be used to illustrate a CCIP release of 2 BDU-33 on a marked target on the range. While you fly inbound to the target you can check the KOTAR QNH by contacting the Range Controller on the KOTAR UHF radio frequency (233.8). Simply use the ATC Common page menu to 'Request QNH' as normal.

SET A-G mode and ensure MASTER ARM is set to ARM. Select the SMS page on the right MFD (DMS right), ensure that BDUs are selected and set them to release in PAIRS (OSB 8). Enter the CNTL page (OSB 5) and select AD1 (OSB 19) and enter a standard GP bomb arming delay of 4.58 seconds. Exit the CNTL page by pressing CNTL (OSB 5) again.

Finally press OSB 2 to select the CCIP sub-mode. Alternatively you can press the MSL STEP button on your HOTAS, which will toggle the bombing modes from CCRP to CCIP to DTOS and so on.

Don't lose time setting the systems as KOTAR is in front of you and you don't want it to disappear under your nose, so maintain your visual scan to acquire the range.

Maintain your altitude until IP2 which is a PPT placed on your INS flight plan as a close reference point for the target. Dive gently to the range and acquire the targets visually.

Remember that your Max negative G with this loadout is -2G. If you overstress the aircraft you may cause system failures.

You cannot place the piper directly on your intended target unless you are very close. Place the target on the bomb fall line and let the piper walk through it. Once the piper is on the target pickle the bombs. It is a good habit to keep the pickle depressed for a longer time, especially if you ripple multiple weapons, to ensure they all are released. While the pickle is kept depressed the FPM will flash.

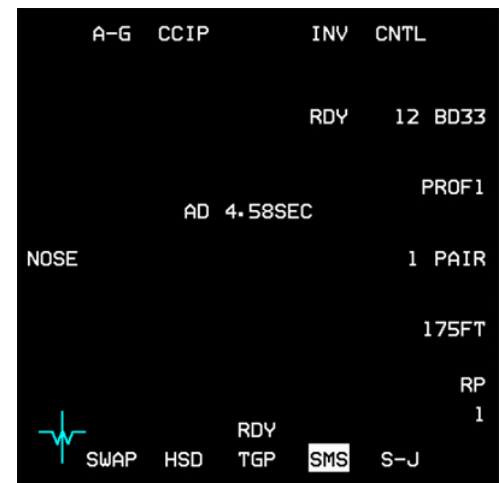
A quick note about ripple in CCIP. When you ripple bombs in CCIP, the piper shows the centre of the bomb stick so you need to aim at what you want to bracket. Ripple is different than dropping bombs in pairs. In that case each pair release 2 bombs simultaneously (no ripple spacing).

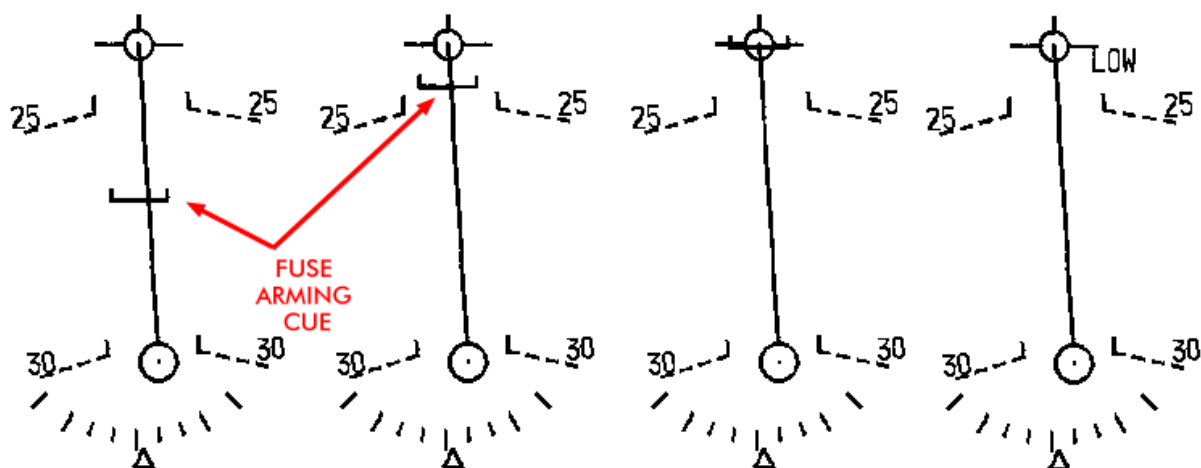
Once the bombs have cleanly separated execute a Climbing Safe Escape Manoeuvre (CSEM). It's a 5G pull in 2 seconds to the horizon followed by a 20-30° climb. This is then followed by a turn in whichever direction is appropriate. In this case make a left turn towards IP1. Level out at 14000 feet and fly back to the IP.

While we are flying outbound setting up for the next pass let's discuss fuses and arming delays. As you noticed there is a fuse arming cue on the bomb fall line (see screenshot on the next page).

The fuse arming cue provides anticipation as the aircraft approaches minimum altitude for arming by moving upwards closer to the FPM. If it reaches the FPM, LOW will be displayed to the right of the FPM. If bombs are released at this moment their fuses will not have time to arm. They will hit the ground and make a hole but will not explode. We call them duds.

You must therefore ensure that the fuse arming cue is always below the FPM when releasing bombs.



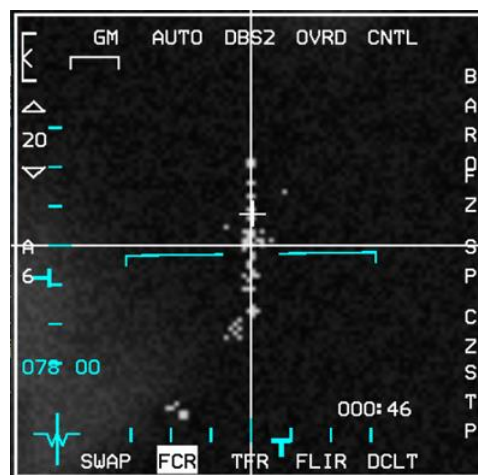


Second pass: CCRP

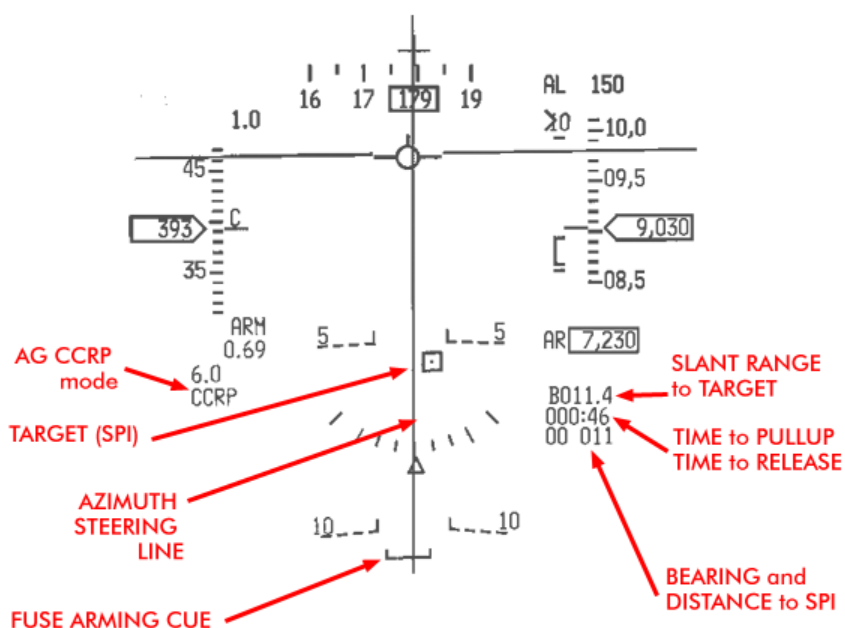
Approaching IP1 turn back towards the range and concentrate on using the FCR to acquire the target. Select the target steerpoint (STPT 6) and zoom the FCR into DBS2 mode with OSB 3. The structures should be clearly recognisable. Designate a target with TMS up.

Ensure the right MFD shows the SMS page and select CCRP, or press the MSL STEP button on your HOTAS until you see CCRP.

CCRP provides azimuth steering and distance information to the target. Place the FPM on the azimuth steering line to fly directly towards the target. As you approach the target the HUD symbology will change. CCRP has two solution cues. The first one is the left solution cue; the second one is the level solution cue.



Although we are set to release bombs in pairs, CCRP ripple is different in behaviour than CCIP ripple. When you ripple bombs in CCRP, the piper shows where the first bomb will impact. (CCIP ripple shows then centre of the stick).



The first solution cue depends on the release angle set in the SMS CNTL page. It will be dynamically adjusted for the value entered as the intended release angle. By default it is set to 45°.

As you approach the target a horizontal line will appear at the top of the azimuth steering line and start descending towards the FPM. That's the first solution cue (loft). The counter indicates the time to pull up if you intend to loft the weapon. As the solution cue approaches the FPM a large circle will appear steady on the HUD. It's the Pull Up Anticipation Cue (PUAC). It appears 2 seconds before pull up.

When the counter reaches zero the first solution cue is on the FPM, the PUAC flashes and the pilot should pull 4G in 2 seconds to the intended release angle and give release consent by depressing and holding the weapon release button. When the next solution cue hits the FPM the bombs should be released automatically. If they are not, the parameters weren't met, and the system inhibited release.

The LOFT cues are a bit off in BMS and it is advised to ignore them and rather start the pull at a planned distance and speed from the target (usually 4.5 - 5.6 Nm and 550 kts).

Alternatively the loft solution cue can be ignored and CCRP made in level flight, which is what we will demonstrate here.

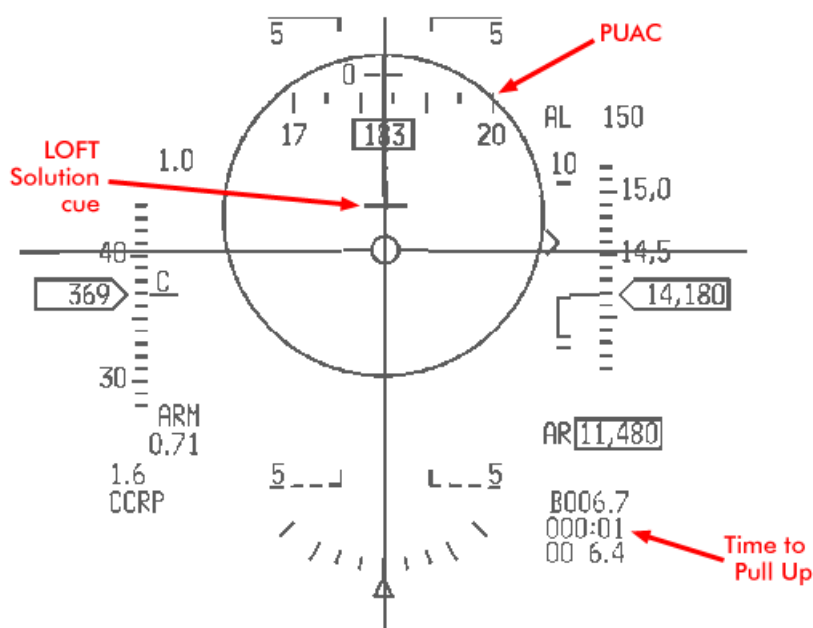
After the first solution cue passed through the FPM the timer resets to Time to Release for the second solution cue. The flashing PUAC disappears and a second solution cue appear on the azimuth steering line, again descending towards the FPM. This is the level solution cue. As the solution cue approaches the FPM depress and hold the weapon release button to give release consent. When the counter reaches zero and the solution cue is on the FPM the bombs will drop. It is important in BMS not to depress the pickle too long in advance to ensure that the command is not disrupted by any other factor. Try to give consent just a few seconds before the drop point. It is also sometimes better to fly a slight dive to ensure a good consent.

If the weapon didn't drop the solution cue will climb away from the FPM and you will have to reset for another try. Let's fly back to IP1 and reset for the next pass.

Third pass: DTOS

When you reach Steerpoint 5 turn back again towards the range and select DTOS on the SMS, or with the MSL STEP button on your stick. When DTOS is enabled the HUD is Sensor of Interest (SOI) as illustrated by the asterisk in the top left corner of the HUD.

Dive Toss is a delivery method where the target is acquired visually and designated in the HUD with the TD box, which is slaved to the FPM initially. When you are far from the target you may have it in sight (in the HUD FOV) but it may be difficult to acquire the target precisely. As you near the target area maintaining level flight, the target will disappear under your nose.



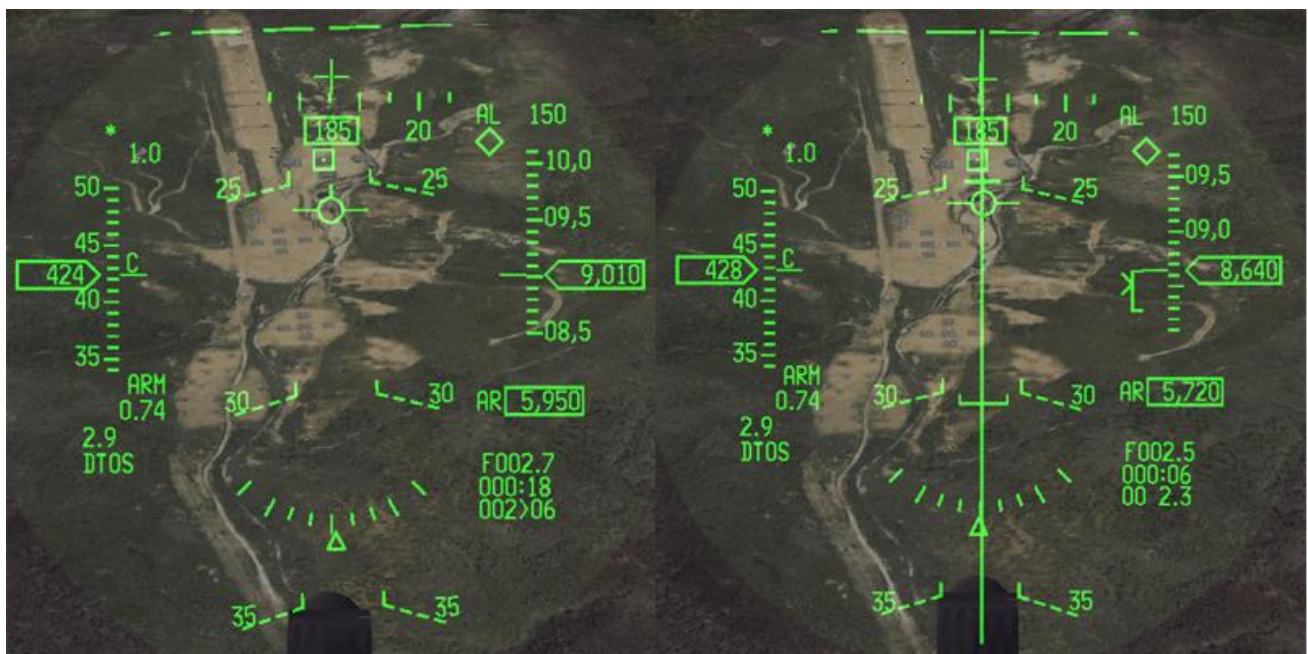
So usually a good target acquisition is made at short range in a slight dive, so that the target remains within the HUD field of view.

The target is designated by superimposing the TD box over the target structure and pressing TMS up. Placing the TD box over the target can be done in two ways:

1. Manoeuvre the aircraft to place the FPM on the target. The TD box is slaved to the FPM upon entering DTOS. Designate the target with TMS up.
2. Slew the TD box within the HUD FOV with the cursors. Move the TD box over the target and press TMS up to designate (left screenshot).

Once the target is designated, the HUD symbology will change to CCRP style delivery (right screenshot).

Keep the FPM on the azimuth steering line. Pull out of your dive and as you pull the release cue will descend towards the FPM. Give consent by depressing and holding the weapon release button. The bombs will separate when the release cue is on the FPM, as you pull out of your dive.



The above images show the dive to the target in DTOS mode. The left image is pre-designate: the HUD is SOI and the TD box was moved up with the cursor on the centre target, and then designated with TMS up.

The right image is post-designate. The CCRP symbology appears once the target has been designated. By pulling out of the dive, the FPM will move up and meet the release cue. The bombs will release.

If at any moment you are not happy with the designated target press TMS down and the HUD will revert to pre-designate mode and slave the TD box to the FPM again. You can then designate another target.

Egress the target area back to Steerpoint 5 for the next pass.

Fourth pass: Popup

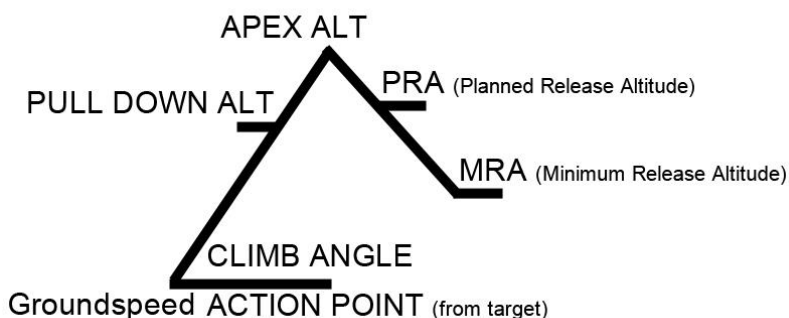
This is where things get interesting. Let's descend to low altitude while we egress to IP1 again. The next pass will be a popup with a 30° offset from the action point.

A popup is a manoeuvre that allows the strike aircraft to approach the target area at low altitude and climb to a safe release altitude to strike the target. After bomb release the strike aircraft will descend low level again to minimise exposure to air defences.

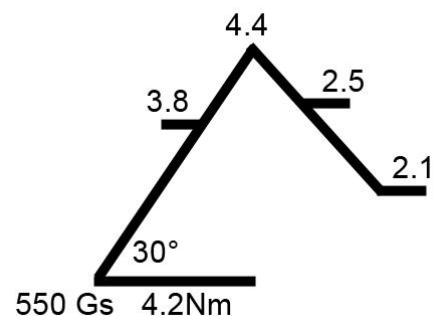
Pop-ups can be computed through the VIP-VRP pages of the UFC and the HUD will provide symbology for relevant points in the pop-up. What we will do here is fly a popup manoeuvre by the number, without relying on HUD symbology. To execute a pop-up you need to know some parameters:

- The first one is the type of attack defining the dive angle. In this example we will do a 20LALD (20° Low Altitude Low Drag).
- The Dive Angle is used to calculate the climb angle. It is Dive Angle + 5° for less than a 20° dive and Dive Angle + 10° for a dive of 20° or more; so in this case 30°.
- The Action Point is the distance in Nm from the target that the manoeuvre starts: 4.2Nm. Ground speed at the action point is also given: 550 kts. The Offset is not mentioned but in this case we'll turn 30° left before climbing.
- Pull-down Altitude is the altitude at which the pull down to the target is initiated: 3800ft AGL.
- Apex is the maximum altitude reached while pulling down to the target: 4400ft AGL.
- PRA (Planned Release Altitude) is the altitude at which the bombs should be released: 2500ft AGL.
- MRA is the Minimum Release Altitude: 2100ft AGL. If you haven't dropped before MRA, come off dry.

ATTACK TYPE (dive angle)



20 LALD



All altitudes given are AGL (above ground level) and therefore do not take target elevation in consideration. The reason is that these pop-ups diagrams are valid for an attack type and not only one target. Since KOTAR elevation is 2854 feet you need to add this to all numbers given in the pop-up diagram to calculate MSL.

Commit these numbers to memory because you will have no time to refer to the diagram during the pop-up.

Since MRA (+ target elevation) is a very important altitude it is set as the MSL FLOOR of the A-LOW UFC page. This ensures Betty will call ALTITUDE when reaching MRA. We don't use the CARA ALLOW because the radar altimeter will most likely blank during a pop-up due to its operating limits being exceeded.

Reaching IP1, turn towards the range and accelerate to GS 550 kts at 500 feet. Select CCRP mode and fly inbound to the action point.

The reason we use CCRP is because CCIP doesn't provide directional cues to the target. During a pop-up it's easy to get disorientated and lose sight of the target, especially during the pull-down phase. The target steering line in CCRP mode ensures we always know where the target is. It's an invaluable aid in the pop-up. CCRP also provides an accurate range to target, which is used for the action point.

Just before reaching the action point at 4.2 Nm from the target execute a hard level turn 30° left (top picture). KOTAR is just visible behind the mountain. As soon as you're established on a 150° heading pull 3-4G to the 30° pitch line. If the target is defended with SHORADs you would now initiate release of a countermeasures program designed to protect your aircraft during the most vulnerable phase of the pop-up. The target steering line is to the right of the HUD indicating the direction of the target. The TLL (Target Locator Line) originating from the gun cross is pointing to the target and is a great help during the diving turn.

When the altitude reaches 6650 feet, roll 110° inverted and pull towards the target (2nd & 3rd pictures). Monitor your apex altitude and dive towards the target area. This is a tricky part because it is very easy to get disorientated and too slow to pull down, or too fast in the dive. As you see on the third picture my apex was 7900 feet rather than the planned 7200 feet. Note the radar altimeter blanking in the HUD because we are outside its operating limits. Pull your throttle back mid-range in the dive to avoid over-speeding the jet.

Once you have the target visual switch to CCIP mode, roll back wings level in a 20° dive and let the target walk through the CCIP piper. The correct technique is to push the stick forward slightly to hold the dive angle in a straight-line and avoid a 'banana pass' curved dive as the F-16 FLCS attempts to maintain 1G. It also slows the CCIP piper track rate, making it easier to be accurate as you pickle at the base of the target.

Bomb release should happen close to PRA: 5350 feet if you respected the pop-up numbers. As seen in the last picture the intended target was still ahead of the piper at PRA. Since we have a 400 feet buffer to MRA we can press the attack and pickle. In this case it happened at 5100 feet, which is above MRA. If you can't pickle before MRA (4950 feet), don't release; come off dry and go around for another pass.

Once the bombs have separated execute your escape turn away from the target while returning to the safety of low level. Release countermeasures as desired and egress back to Steerpoint 5.

Pop-up planning is the key to success. Studying the terrain around the target will help you decide the attack direction, the required offset and the exit heading. When the target is well defended you want to stay hidden as long as possible behind terrain and you want to get back into hiding as soon as possible after you release, while respecting the frag envelope.

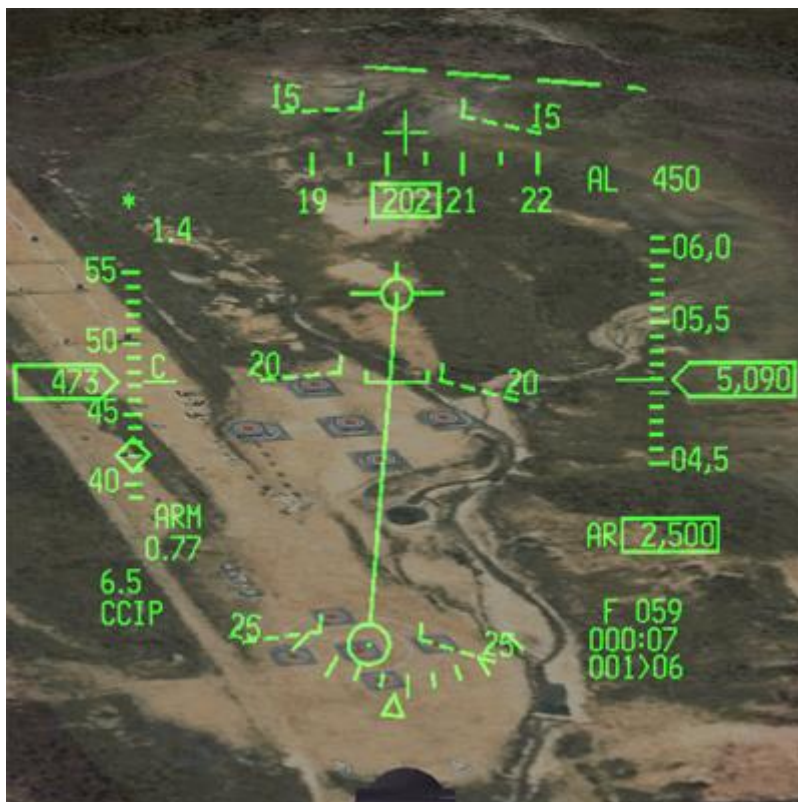


The most common errors during pop-ups are failure to commit the numbers to memory (bad planning) and flying approximate numbers, ending up out of parameters.

Navigation accuracy may also be an issue, such as incorrect initial altitude, or speed, or even missing the action point.

Failure to find the target comes next, especially when the target was not designated correctly, or when the pilot is disorientated, rolling into the target without proper HUD cues.

Recognising these errors as soon as possible helps the pilot to correct and adjust the manoeuvre accordingly.



Bombs on the way

We will not cover LADD and MAN deliveries. You have 4 BDU-33 left and you can make a couple more practice deliveries on the range before terminating this training mission.

MISSION 11: LASER GUIDED BOMBS

There is no longer any need for a ground start to this mission, as bomb codes in 4.34 are saved with the TE. Therefore this mission can now start in the air with the correct 1511 & 1512 bomb codes already assigned.

LOCATION: In flight somewhere inside DPRK West District airspace.

CONDITION: KF-16 block 52 – Flight of 2 - Callsign Vandal 3.

GW: 39400. 4 GBU-12. Laser code: 1511/1512. Max G: 5.5/-2.0 Max speed: 550 kts / 0.95 Mach. Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.

GOAL: Strike Pupo-ri Naval base with pinpoint accuracy to avoid collateral damage.

WEATHER: RKSS INFO B 011825LT ILS RWY32L TRL140 360/15KT 9999 FEW 120 28/18 Q1013 NOSIG Clear skies, winds 360 at 15 kts few clouds at 12000feet. Visibility over 10km. No Significant changes in the next 2 hours.

This training scenario can be flown in single- or multiplayer to enjoy the full suite of new TGP capabilities. Flying this mission with a human wingman will allow you to test buddy lasing, the Laser Spot Tracker (LST) and the IR Pointer. Since the AI is not able to coordinate these systems if you fly this mission as single-player you will only be able to learn the basic LGB release procedures with the first two bombs. The next two bombs will be used for buddy-lasing and MP specific procedures.

To perform successful LGB drops knowledge of the TGP is mandatory. The TGP is extensively documented in the TO-BMS1F-16CM-34-1-1 located in your Docs folder. We will only cover the aspects of the TGP we need in this training scenario to successfully release laser guided munitions.

11.1 Laser guided bombs – what is there to know?

Dropping laser guided weapons implies that the target is designated with a laser beam. That laser beam can come from the dropping aircraft, another aircraft or a ground based designator. In BMS we only have both airborne laser options available. Prior to 4.33 the dropping aircraft was always the designator as well.

Laser beams are categorised by a frequency. For a weapon to guide it needs to be set to the same laser frequency as the designator. That translates to a 4-digit numeric code:

- The weapons have a code which is set in the UI LOADOUT screen prior to flying. That code is inalterable in flight (it is set in the bomb itself) and **must** be set correctly for each flight member **before** hitting the FLY button. Please note since 4.34 it is saved with the TE.
- The TGP code is set with the ICP on the LASER page (LIST 0 5). You can set the code to guide your bombs or your human wingman's bombs if you're flying multiplayer. If the TGP code doesn't match the weapon code the bomb will not guide.
- A bomb will only guide on a Combat laser. Change from TRNG to CMBT by pressing any ICP key with the scratchpad on the A-G line.



```

LASER 7
TGP CODE 1511
LST CODE 1511
A-G: [CMBT] A-A: TRNG
LASER ST TIME 20 SEC
  
```

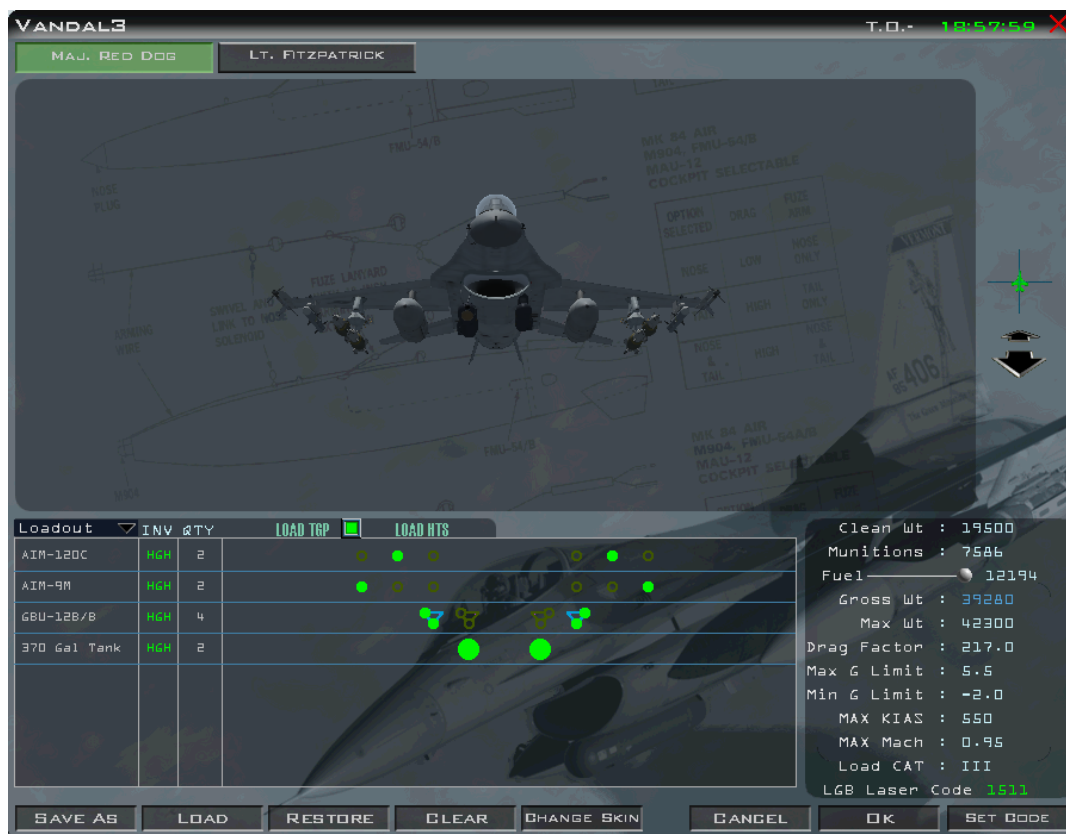
The LOADOUT screen can be tricky when you have to set different configurations for different flight members. By default when you enter the LOADOUT screen all flight members' names/tabs are green. That means they are all selected. If you want to unselect one you need to click on a name. That name/tab then turns grey and that flight member is not active. To select a single flight member you should then un-select all the other flight members and then make the relevant changes, which will be applied only to the green name/tab.

In a 4-ship flight you should assign a specific weapon code to each flight member. For instance: 1511, 1512, 1513 and 1514 for #1 to #4 respectively.

In 4.33, weapon codes were not saved with the TE. This has been addressed with 4.34 and now TE designers can set specific weapon codes for all aircraft of the flight. It is nevertheless good practice to check them before going into 3D as it is too late to change them once you have hit TAKEOFF.

By default laser codes are set to 1688. Although it is no longer necessary to change them for this mission, this is how you would change them and assign specific codes to specific aircraft:

Go into the LOADOUT screen, un-select the wingman and check that only the flight lead is displayed in green. Click on 'LGB Laser Code' and enter 1511. Click the SET CODE button to apply your change. Then un-select lead and select the wingman; only the wingman is now displayed in green. Change to 1512 and click the SET CODE button to apply changes. Exit the LOADOUT screen by clicking the OK button to save any changes.



Laser guided munitions are general purpose bombs fitted with a laser guidance kit, allowing them to track a laser spot and guide the bomb to hit it. The bomb does not track the laser for the full drop. The weapon is released using CCRP mode and falls ballistically at first towards its target. While falling, it looks for a relevant laser reflection. If no matching laser is detected the bomb acts as a ballistic general purpose bomb, albeit it will fall long as the fins help it fly further than a standard GP bomb. When it detects a laser spot on the correct frequency it will guide the bomb to the illuminated spot on the ground, if physically possible.

There are two ways to fire the laser from your cockpit. The first is manual lasing by depressing the first trigger detent on your sidestick (if the stick programming is set correctly).

The second way is automatic; the TGP will fire the laser at a specified time before predicted weapon impact. That time can be changed in the LASER page by selecting the LASER STart TIME. By default it's 16 seconds, but you can set it to a realistic setting of 10 seconds for Paveway II bombs now, as the code has been much improved in 4.34. For Paveway III bombs you can manually lase earlier, especially for moving targets.

In both occurrences the L symbol in the HUD and on the TGP page will flash when the laser is firing. For this to happen, the LASER switch in the cockpit (MISC panel) must be in the ARM position.

11.2 Single ship LGB release

As with any strike mission recon the target carefully before flying. The target today is a large North Korean port facility at Pupo-ri situated at Steerpoint 7 of the flight plan. The main target will be the two loading cranes. These targets are easily identifiable, but not so easy to hit due to the surrounding buildings. The first target will be the yellow crane, the second target the red loading crane.

To recon the target right-click Steerpoint 7 and choose Recon in the menu. The recon and target list windows will be displayed. Select Pupo-ri Naval Base in the target list and click on the first loading crane (yellow). It will turn green in the list and the Recon window will show the selected crane in the centre.

On the right of the recon window you can move the point of view and change the attack heading. From the flight plan the IP to target heading is 256° . Click on the small arrows to change heading to 256° and zoom out a bit with the large arrows. That will provide a view similar to the TGP view as you approach the target.



The steerpoint is not usually placed perfectly on your DMPI (Desired Mean Point of Impact) but will be in the general vicinity of the target. To set a precision steerpoint for your DMPI select it in the target list, as we just did, and click on the ► arrow to the right of the DESIGNATE AS TRG STPT # box to increase the number to the same as the target steerpoint (7). Click on the ACCEPT button and target Steerpoint 7 will be placed exactly on your DMPI. This will ensure your sensors are looking at this point when STPT 7 becomes active.

You can also note down the coordinates of the target which are displayed at the top left of the recon windows. This is more useful when you have to strike 2 targets but have only one target steerpoint in the flight plan – just as in this scenario. Write down the coordinates for the second loading crane in the list (red): $N37^\circ 48.440'$ $E126^\circ 14.747'$ and find a suitable attack heading, e.g.: 360° .

Once the first target is destroyed we will change the coordinates of target Steerpoint 7 to the ones we wrote down and make another run from the south.

The in-flight scenario training flight starts about 10 Nm from the IP (STPT 6), which is 15 Nm from your target. Weapon loadout is 4 GBU-12 Paveway II 500 lbs bombs loaded on TERs on stations 3 and 7.

We will use the flight to IP to configure the jet correctly. Fence in, set MASTER ARM to ARM and select A-G mode. We would normally turn the exterior lights off but it is a training mission so that is left to your discretion.

In A-G master mode with the FCR page displayed on the left MFD and the HSD on the right one, make sure you have the TGP set up on another Direct Access Button on the left MFD and quickly check it is operational. When initially selecting the TGP page it will be in STBY mode. Depress the A-G mode and the TGP should be looking at the currently active steerpoint (IP), which is over water.

If the North pointer is not enabled, hit OSB 5 for the CNTL page and press N/M (OSB 18). This will display the coordinates of the TGP cross, the meterstick distance and a North Pointer. Exit the control page by pressing the highlighted CNTL next to OSB 5. Move the left MFD back to the FCR page. On the right MFD quickly check the SMS page is set for GBU-12, single release and standard arming delay of 4.58 seconds.

Next let's check the UFC LASER page (LIST 0 5). The first line TGP Code is where you can change the laser code emitted by your targeting pod. To guide a specific weapon you must ensure that the TGP code matches that weapon's code. DCS up until the TGP code is highlighted by the scratchpad and enter the relevant 4-digit code (1511 if you're lead or 1512 if you are flying wingman) then hit ENTR. The second line is the Laser Spot Tracker (LST) code. This will allow your TGP to detect and track another TGP's laser spot, e.g. your wingman.

A-G laser can be set to TRNG (Training) or to CMBT (Combat) mode. A weapon will only guide on a combat laser, so ensure that the A-G LASER in the UFC page is set to CMBT. Select that line with the DCS; once highlighted press any ICP key to toggle it to CMBT. It will flash for a few seconds before displaying CMBT.

The A-A laser cannot be toggled to CMBT and the A-G laser can remain in TRNG for simulated drops.



```

LASER 6
TGP CODE 1511
LST CODE 1512
A-G: CMBT A-A: TRNG
LASER ST TIME 12 SEC

```

Finally we can change the default auto-lase time. Dobber (DCS) down to that line and enter 10 seconds. That will ensure that the laser will fire for final guidance of the bomb 10 seconds before predicted impact.

The last thing we now need to ensure is that the MISC panel LASER switch is set to ARM. If left to OFF it will prevent the laser from firing and the bombs will just fall ballistically and not guide. Laser status can be double-checked in the TGP and the HUD near the master arm indication. A solid L means the Laser is armed. A flashing L means the laser is firing. A solid T means the laser is armed in Training mode. A flashing T means the laser is firing in Training mode.

By this time we should be close to the IP. Select the target steerpoint and turn inbound to the target. As planned our attack heading should be close to 256°.

When you selected the target steerpoint all on-board sensors switched to that spot as well. SPI (System Point of Interest) greatly improves multi-sensor correlation (FCR, TGP) but can be confusing at first if you don't understand the consequences of slewing the cursor away from the default position. Cursor slew is now consistent between *non-tracking* sensors. That means that if you slew the cursor on the FCR (no tracking state) the same cursor slew will be applied on the TGP (no tracking state). If one sensor is tracking and the other is slewed then the slew is local and has no impact on SPI.

It is important to realise that the slew creates an offset from a default position, which is applied to all sensors and all steerpoints.

Basically if you slew your TGP cursor 2 Nm from its default position and forget to zero your cursor slew afterwards, all your flight plan steerpoints will have the same 2 Nm offset. Or worse, if you have to attack a secondary target at another steerpoint the offset will still be active when trying to locate the next target and you might miss it, because your sensors are not looking at the target, but at the target + the same 2 Nm offset.

It gets even more confusing, as HUD cues will point differently to either the original steerpoint or the SPI, according to which master mode you are in. The steerpoint diamond may still be on the steerpoint but the tadpole may be pointing to the SPI in NAV mode for instance.

It is **very important** therefore to cancel any cursor slews with **Cursor Zero (OSB 10 – highlighted when a slew exists on newer blocks)** whenever the slew is no longer required.

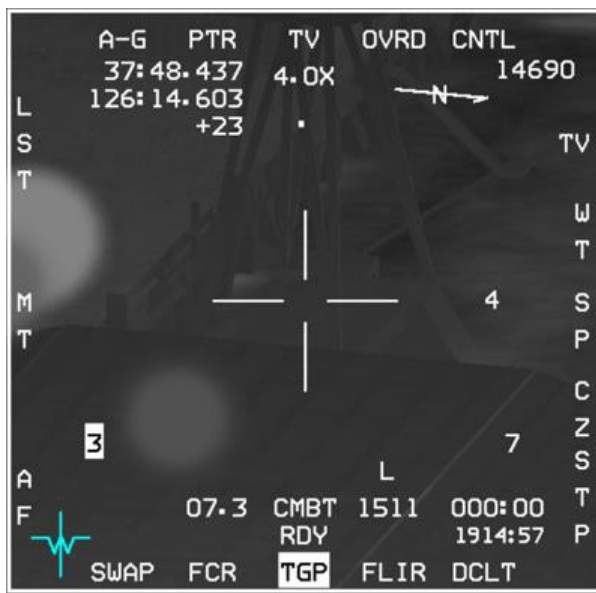
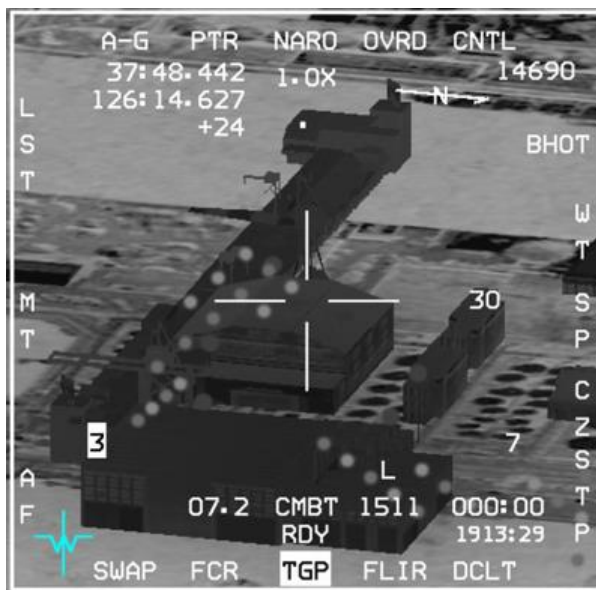
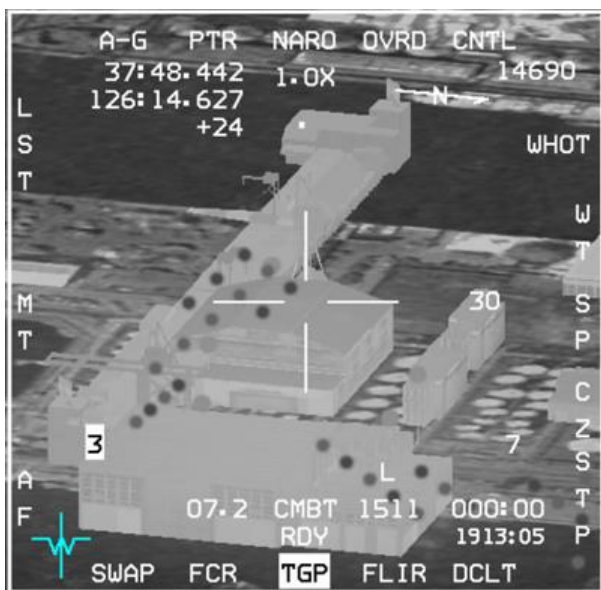
Add it in your fence check or IP routine to avoid any problems. We will come back to this egressing from our first target. More information can be found in the SPI MANAGEMENT chapter of the BMS1F-16CM-34-1-1.

It is a **must read**.

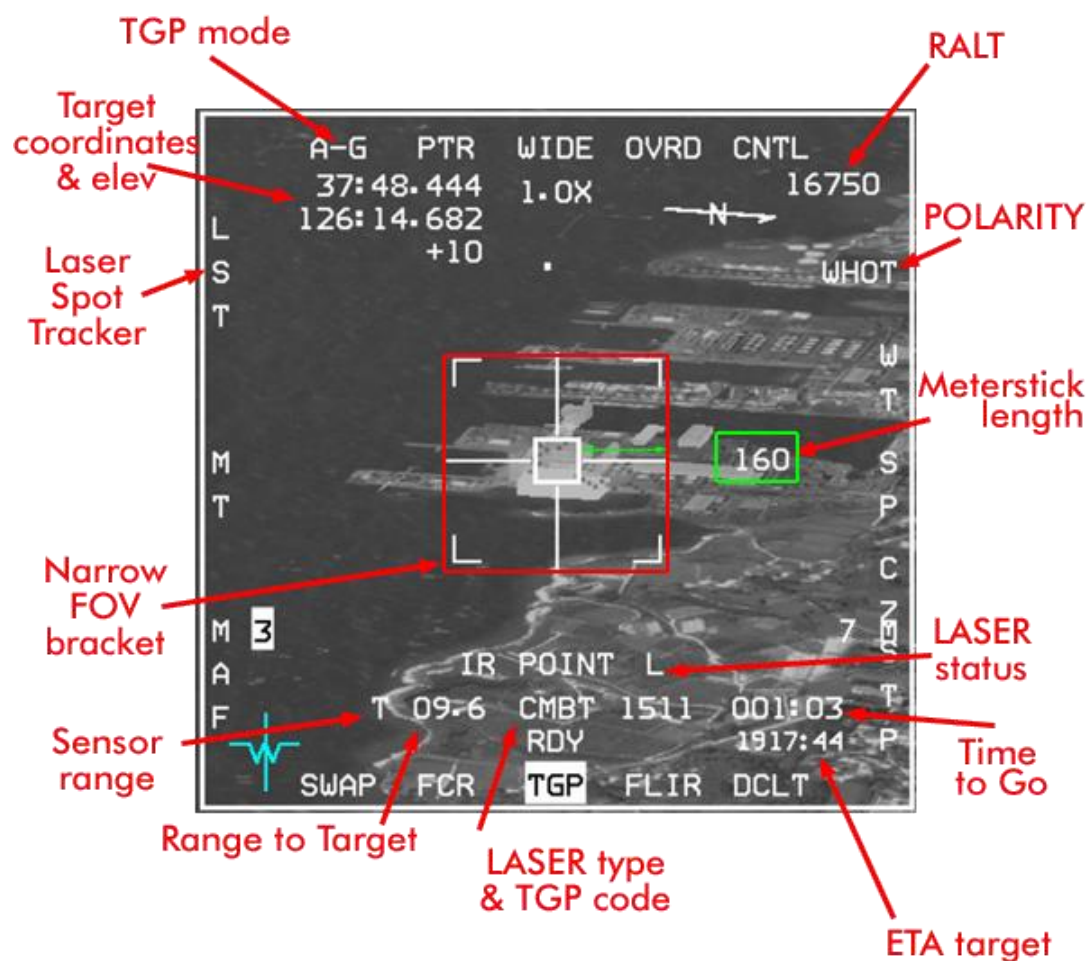
Switch the left MFD to the TGP page with DMS left, or by depressing the relevant OSB on the base page of the MFD. If TGP is not Sensor of Interest (SOI), DMS down to make it SOI and ground-stabilise the TGP with TMS up. The laser will only fire if the TGP is SOI.

By default the TGP is in WIDE field of view and WHOT (White = HOT targets). We are still 15 Nm away, so depress OSB 3 to switch to NARO (narrow) field of view, to have a better view of the target area.

The TGP has three display options: WHOT, BHOT (Black = HOT) and TV. Toggle with OSB 6.



As you can see from the above 4 images, BHOT and WHOT are FLIR modes, picking up targets according to their temperature and usable day and night. TV is a daylight mode that offers greater zoom capability using the MAN RNG knob on your throttle (if set up correctly).



The TGP page displays a great deal of information that is explained in detail in the TO-BMS1F-16CM-34-1-1. Let's concentrate on the items that are relevant to us for this training scenario:

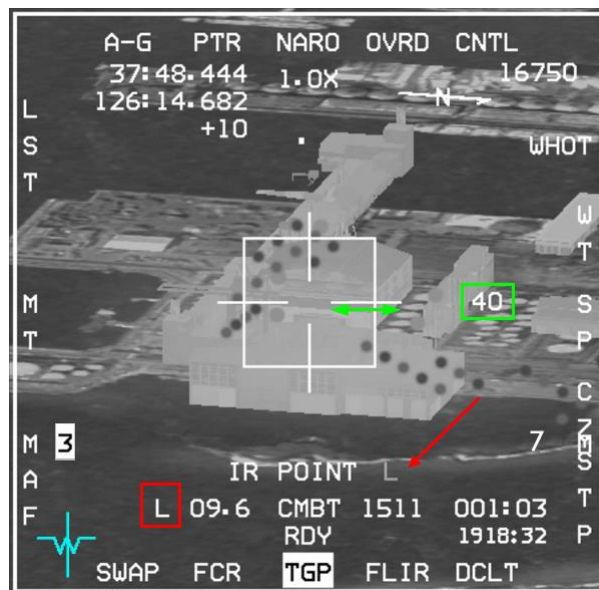
- The Narrow FOV brackets show the area you will see magnified when you switch to NARO FOV.
- The LASER status is the same as the one in the bottom left corner of the HUD. L means laser is set to Combat and T means laser is set to Training. Flashing means the laser is firing. CMBT is also repeated on the bottom of the TGP next to the laser code. When the laser is set to Training the laser code is not displayed.
- The range to the ground-stabilised TGP cursor is preceded by a mnemonic indicating the sensor that is ranging. T indicates that the TGP is passively ranging, L indicates the laser is ranging. To range the target with the laser, depress the first stage trigger to manually fire the laser. Besides giving more accurate ranging, firing the laser checks correct laser operation before bomb release and ensures that the target is not obscured by clouds for instance.
- After bomb release a flashing L does not specifically mean that the bombs are guiding; it only confirms that the laser is firing. But it could fire through clouds and dissipate, preventing the weapon from guiding. This is especially true with 4.34 where the impact of clouds is much more realistic than before. If you see clouds over the target, expect to lose laser track due to humidity. You may need to descend under the cloud base (FL150 in this training mission).

- The only valid indication that the target is actually being lased correctly is when the range is valid and preceded by the L mnemonic. So although not strictly required, manually ranging the target with the laser before delivery is definitely advised.

When you pickle (bombs) the laser fires automatically to more accurately range the target. Laser ranging happens as long as the pickle button is depressed.

As you can see in the right picture the laser is being fired manually. The range to target is preceded by the L mnemonic and the L next to IR POINT is flashing, indicating the laser is firing.

There are two more settings that are not that relevant to this training scenario, but we will illustrate them briefly:



- As we discussed earlier the target coordinates, the north pointer and the meterstick are only displayed if the N/M option is selected in the CNTL page (on by default). Meterstick length was 160 meters in the WIDE FOV picture on the previous page and it is much shorter in NARO FOV (40 meters) above. The meterstick shows the distance of each horizontal line of the crosshair (due to perspective issues, the distance is only accurate in the horizontal).

Meterstick distance is useful when you need to coordinate distance from SPI between different pilots, especially for Close Air Support (CAS) missions, where a FAC(A) could transmit target coordinates and then direct aircraft to attack at a specific distance and bearing from the given coordinates. In such occasions the meterstick and the north pointer are invaluable tools.

- Another useful setting in the CNTL page is the FRAG pattern that can be displayed as an ellipse on the TGP display. It is set through the MENU (OSB 2), available on the TGP CNTL page. When OSB 2 is depressed a small menu opens in the TGP window. You navigate in the menu using TMS left & right and use TMS up to select an option. A line is selected when the > symbol is in front of it.

If you TMS up on the FRAG ON line a sub-menu opens to the right, which allows you to toggle display of the frag pattern on the TGP page on or off. The next line allows you to change the size of the RADIUS; when selected this opens a third menu on the right with distances from 95 m to 1609 m. The next line toggles distance from METER to FEET. And the last line allows you to exit the submenu.



Both options are extremely useful when doing CAS if you know the Risk Estimate (Danger Close) Distances for your weapon(s). You can then display distance from SPI and the relevant frag pattern on the TGP and ensure that friendly troops or off-limit targets stay outside the weapon envelope.

Anyway we are not doing CAS for now, so let's go back to the task at hand...



As we expected our target is obstructed by a large building. We will drop the bomb and as we near the target fine-tune the TGP cursors to the crane location past the warehouse. The target is now captured, so we can switch our attention to the HUD and CCRP release cues.

We are not lofting the LGB, so we can ignore the first CCRP release cue and continue flying straight until the level cue nears the FPM. The pickle button is pressed and one GBU-12 is released.

Stores create drag and drag decreases lift. When a single bomb is released, the aircraft is loaded asymmetrically. Drag is not balanced anymore from one wing to another and lift becomes asymmetrical. As one wing produces more lift than the other your aircraft will roll towards the heavier wing. To counter this asymmetrical store situation trim will need to be applied.

Trims are accessible with the trim hat on your sidestick or manually on the MAN TRIM panel. The easiest way to trim for in-flight asymmetrical conditions is with the trim hat on your sidestick. The up and down part of the trim hat controls pitch trim; left and right regulates roll trim, which is what we need in this scenario.

Note: rudder trim is only available on the MAN TRIM panel.

So whenever you drop a single bomb and need to compensate for an asymmetric load simply move the trim hat on your sidestick *towards* the wing where the bomb was released.

Knowing from which side the bomb will be released is therefore very useful and this can be easily checked in the TGP page by looking at the highlighted station number. In the example above station 3 is highlighted so the next bomb will drop from the left wing. At bomb release, if the loadout becomes asymmetric, the aircraft will roll towards the heavier right wing and a little left trim will be needed to stay level.

The TGP pod is on the right chin pod. A right-turn after bomb release may mask the TGP against the airframe, as the TGP needs to look left for lasing the target and the airframe, also left of the TGP, will at some point probably enter its field of view. A left turn is therefore often the better option, particularly at lower altitudes, as the TGP can look right towards the target, which will remain unobstructed for longer.

In our example a further addition of left trim is not harmful as we want to initiate a gentle left turn after release.

The bomb is now falling ballistically towards the target. As we approach the target the TGP cursors can be moved to the base of the crane as the warehouse is not obstructing our target anymore. When the Time To Go indicates 10 seconds the L will start to flash, indicating the laser is firing. The bomb acquires the laser spot and guides on it to the target.

TGP cursor position can still be moved while the bomb is guiding. How far you can move from the original cursor position depends on how much energy the bombs have left before impact. If the pilot moves the cursor too far away from the original position the bomb may not have enough time or energy to guide to the new spot. In this example we will maintain the cursor position on the crane until bomb impact.

After bomb impact turn back towards the South and fly 20 Nm from the target. Next we will loft the LGB from low level. But first take a few seconds to trim the aircraft and ensure that the next bomb release will happen from the opposite wing to cancel the asymmetric condition.

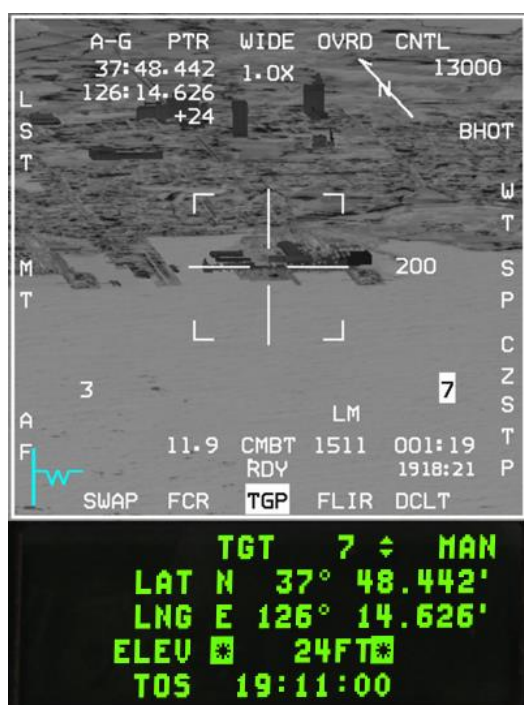
Remember: SPI remains where you last moved the cursors. You always want to cancel any unwanted cursor slew and reset SPI back to the original steerpoints. To do this you must perform the following routine:

- **TMS down** (to cancel any tracking state or ground stabilisation).
- **Wide Field of View** (to cancel any sensor zoom if set).
- **Cursor Zero** (CZ - OSB 10 - to reset SPI to original INS steerpoints).

The problem with flying low level is that the TGP does not have altitude to see the target, preventing capture from long distance. In a low level LGB loft manoeuvre target capture often happens *after* bomb release. Because the bomb is lofted, bomb fall time is usually longer than a level release from medium altitude, allowing more time for target capture and designation.

To maximise the chance of capturing the target it is advised to know the target coordinates and enter them accurately in the INS. Our target will be the red loading crane, which we looked at on the Recon page during flight planning. The coordinates are N37°48.440' E126°14.747'. Enter these in the UFC Steerpoint page for Steerpoint 7, not forgetting to start with the 'N' (ICP 2) and 'E' (ICP 6) symbols, otherwise you will not be able to enter numbers for the coordinates.

If your TGP is looking back at the target area you will be able to see the TGP cross move from the old target to the new target once the coordinates are entered correctly. The left picture below is the original target and the right picture the new target. Note the matching coordinates in the DED and TGP.



At 20 Nm from the target turn inbound and descend to 500 feet. Accelerate to 500-550 kts, as we will need the speed for the loft manoeuvre. As expected, while we are descending to low level the TGP image flattens, making it harder to identify targets from a long distance. Ground-stabilise the TGP cursors anyway.

The Time to Go in the TGP display counts down time to the next event. In this case the first TTG is the loft release cue. Once past the loft release cue the TTG will count down to the level release cue and after that it will count down to the time of impact.

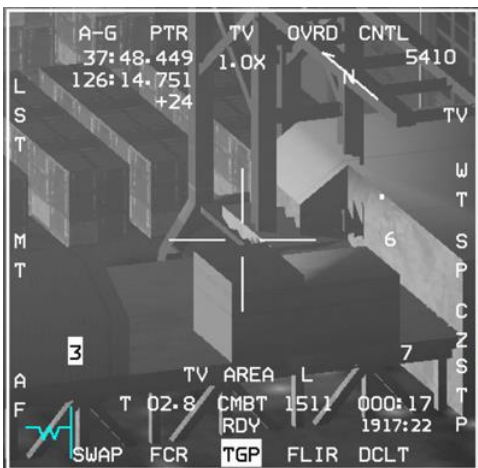
The loft release cue in BMS is set to a 45° loft by default. When following such a release pattern the aircraft usually ends up high and slow, which is not a condition you would want to enter in a high threat environment.

We could decrease the release angle in the SMS CNTL page to 30°, but in this scenario we will just wait until we are 5 Nm from the target to pull up. That will maximise our P_k (probability of kill) and simplify bomb release.

To ensure bomb release using the default 45° loft cue all parameters have to be spot on, because it is the maximum distance possible from the target, which makes the loft very susceptible to any fluctuations in speed, G and angle. It is not uncommon to miss release parameters when following the default 45° loft cue.

After the first release cue, wait until the PUAC stops flashing and don't pull up until the distance to target is 5 Nm. This is the action point.

At the action point pull 4G in 2 seconds to 40-45° and give bomb release consent by depressing the pickle button. Stay on the azimuth steering line and the bomb will separate from the aircraft as you are climbing. Start your gentle egress turn 90° left and start a gentle descent back to low altitude. You have plenty of time to stabilise your aircraft in a safe attitude and away from the threats while the bomb is flying ballistically to its



target. Don't get fixated on the TGP because you are afraid of missing the target. If you do while your aircraft continues its climb dead ahead towards the target you will most likely end up in the air defence engagement zone and get shot down.

Once attitude is under control switch your attention to the TGP display and refine the cursor position at the base of the red crane.

When the counter hits 10 seconds from impact the laser will fire. The range will be preceded by an 'L' and the laser status will be a flashing 'L'. The bomb is now guiding on the laser spot from your targeting pod. There is nothing more you can do but to enjoy the feeling of a job well done as you watch the bomb hit the target.

Once the target is destroyed cancel any cursor slew with: TMS down, Wide Field of View, Cursor Zero. This procedure needs to be practised until it becomes second nature.

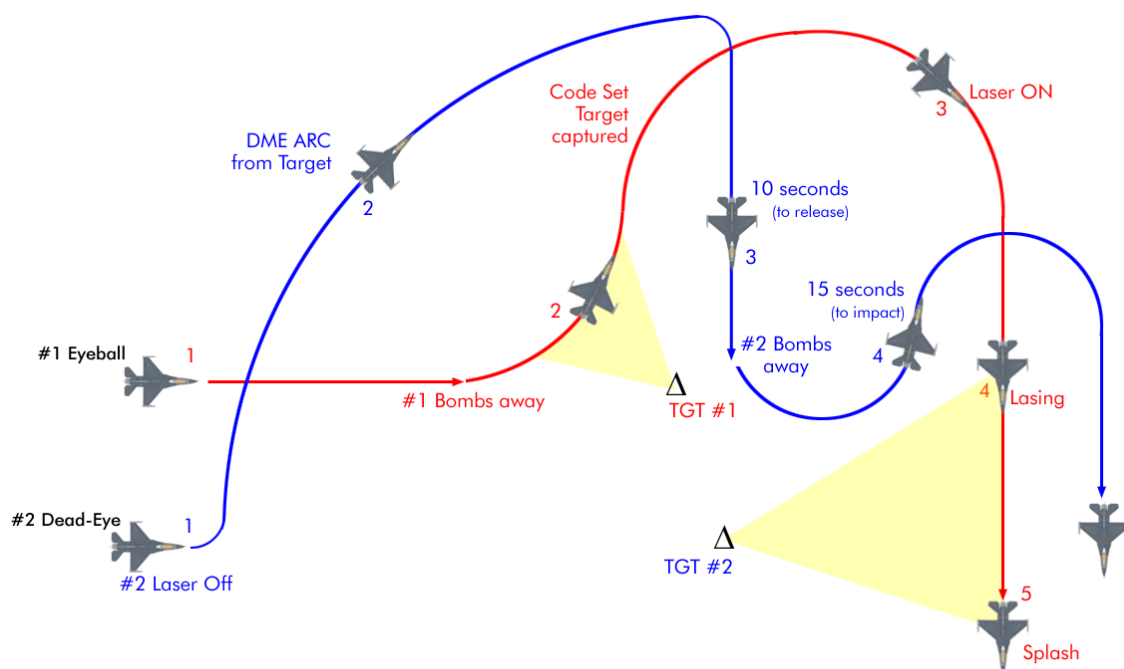
You have two more bombs to release. If you are training in single player, practise some more GBU releases on the target. If you are training in multiplayer let's see how we perform buddy-lasing in BMS.



11.3 Buddy Lasing

Lasing for another platform can be useful in many different situations. Your wingman may have a malfunction and has lost his TGP capability. You may have another F-16 flying as a FAC(A), lasing or pointing out targets for you. This is especially useful when engaging SAMs, when the lasing aircraft can remain just outside its WEZ at high altitude and the striker lofts LGBs from low altitude, behind terrain, inside the air defences WEZ.

There are multiple ways to perform buddy-lasing. If both aircraft have a TGP with a different laser code care must be taken to avoid lasing multiple targets with the same code, as it will obviously confuse the bombs. In this scenario it is advisable to have one aircraft turn LASER ARM off and use eyeball/deadeye procedures.



This is a buddy-lasing tactic where one aircraft is unable to lase, but two targets need to be destroyed within the same target area. The manoeuvre starts in spread formation at any altitude. In the scenario above lead will be eyeball (laser on) and the wingman will be dead-eye (laser off). This is only one way to do it.

At the action point the wingman turns the LASER ARM switch to OFF and turns into his lead, arcing around the target. To do that initiate your 90° turn and simply keep the tadpole at 90° off in the HUD, or the station bearing pointer in the HSI at 9 o'clock (with the target steerpoint selected and any cursor slew cancelled).

Lead ingresses the target and drops his bombs on the target as usual. At bombs away he turns left 90° and supports his own bombs with his TGP laser.

Immediately after his bomb hits, lead changes his TGP laser code to his wingman's bomb code (1512 in this case) and captures the wingman's target on his TGP. He calls: "Vandal 3-1, code set 1512 - captured".

That's the cue for the wingman to turn directly towards the target. When he reaches 10 seconds before his release cue he calls: "Vandal 3-2, 10 seconds". Lead confirms his laser is armed: "Vandal 3-1, laser on".

The wingman calls "bombs away" and monitors his time to impact. When it reaches a pre-briefed time before impact, in this case 15 seconds but it could be longer, he calls it on the radio: "Vandal 3-2, 15 seconds".

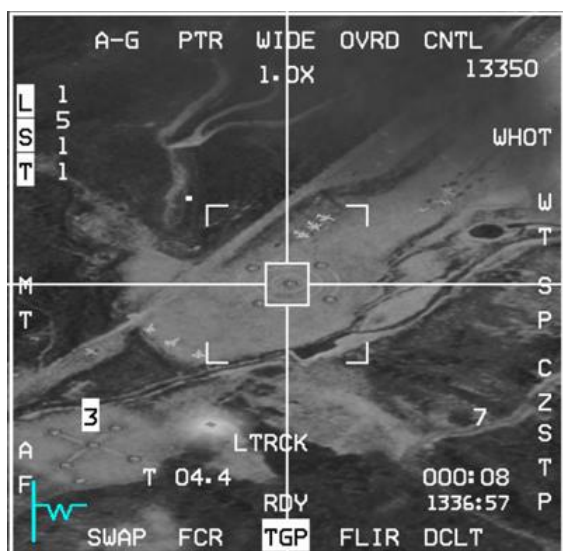
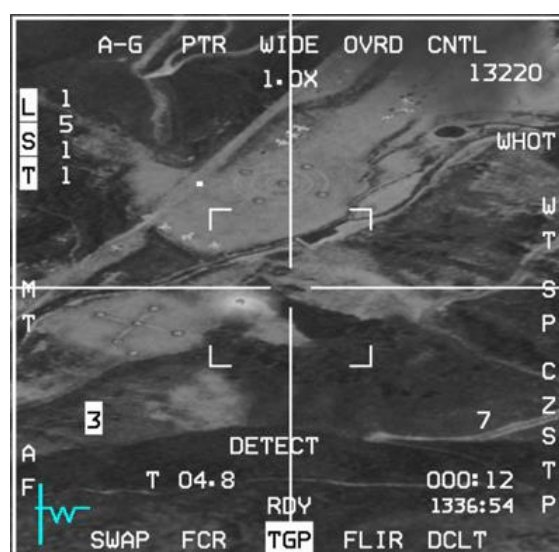
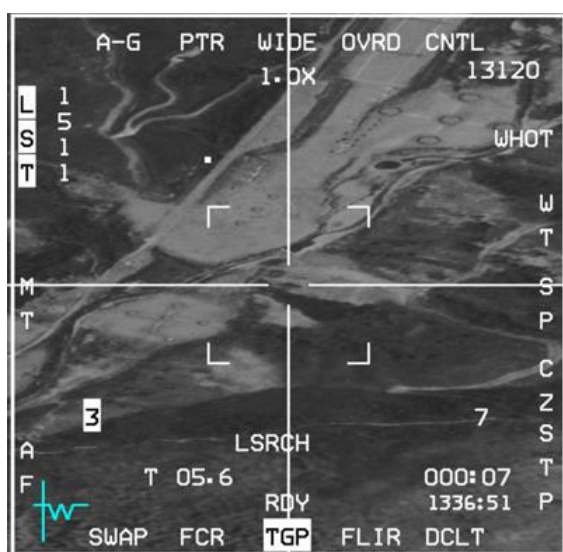
Lead manually lases the target with the first trigger detent and refines his aimpoint if necessary until impact.

11.4 Laser Spot Tracker (LST)

The Laser Spot Tracker can detect and track laser spots being designated by other aircraft in BMS. It is very convenient when you want to know which target your wingman, or a FAC(A) is lasing. To enter LST on your TGP first ensure that your LASER UFC page has the correct laser code entered on the LST code line. In this example let's use 1511, which is the flight lead's laser code.

The pilot can select LST mode hands-off via OSB 20, or hands-on by pressing the MAN RNG/UNCAGE knob. The LST mnemonic highlights and the laser code entered in the LST CODE line is added next to it (OSB 20). The TGP enters LSRCH (Laser SEARCH) mode and looks for a laser spot matching the code you entered. Your wingman's laser might not be firing yet, so it might not be visible immediately.

Once he fires his laser your TGP will switch to DETECT mode for a few seconds. If the laser remains valid it will then switch to LTRCK (Laser TRACK) mode and your TGP cross will move to the target currently being lased by your lead.



As soon as the others aircraft's laser stops firing the TGP will revert to normal operation and LST will no longer be highlighted.

Initiate a track (AREA or POINT) with TMS right or up to point the TGP permanently at the LST detection spot. Otherwise the TGP will revert back to your current SPI.

MISSION 12: AGM-88 HARMS

LOCATION: In flight somewhere inside DPRK South East District airspace.

CONDITION: F-16 block 50 – Flight of 2 - Callsign Weasel 3.

GW: 38672. 2 AGM-88 HARM missiles, HTS pod, Sniper pod. Max G: 6/-2.0 Max speed: 600 kts / 1.2 Mach. Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.

GOAL: Destroy SAMs Radar.

WEATHER: Few clouds at 8000 feet, visibility 10 km or more, Winds from the North at 10Kts QNH 1009.

The AGM-88 is an anti-radiation missile capable of high speed and long range. It tracks radar emissions and targets the source of the electromagnetic waves. It is used for SEAD (Suppression of Enemy Air Defences) or DEAD (Destruction of Enemy Air Defences).

The HARM has multiple modes of operation and can be used as a stand-alone weapon in POS (Position Known) and HAS (HARM as Sensor) modes. The third standalone missile mode: DL (Datalink) is not currently implemented in BMS.

Another targeting system is available only when the AN/ASQ-213 HTS (Harm Targeting System) pod is loaded on the left chin pylon: HAD (Harm Attack Display). Not all F-16 models are able to load the HTS pod. In BMS only US block 50/52 and block 40 F-16s can carry it and therefore use HAD mode.

The other F-16 models can either load the HARM missile as a standalone weapon or cannot carry the HARM at all. When the F-16 carries the missile without an HTS pod, only POS and HAS modes are available.

The main operational differences between the HTS/HARM combination and HARM alone are:

- With HTS the pod is the main sensor. The HAD page is able to display which mode the air defence radar is using through coloured or flashing symbols. You can then be more confident the radar is emitting before firing your missile (though it may still switch off after). The pod sensor is also still usable after all your missiles have gone. HTS detects all threats and is not limited to threat tables.
- Without the HTS the sensor is the missile itself and therefore will not be available once all missiles have been fired. Targeting is done through the WPN page. The two modes available in BMS: HAS and POS are limited to specific threats, which need to be pre-selected to be visible on the WPN page.

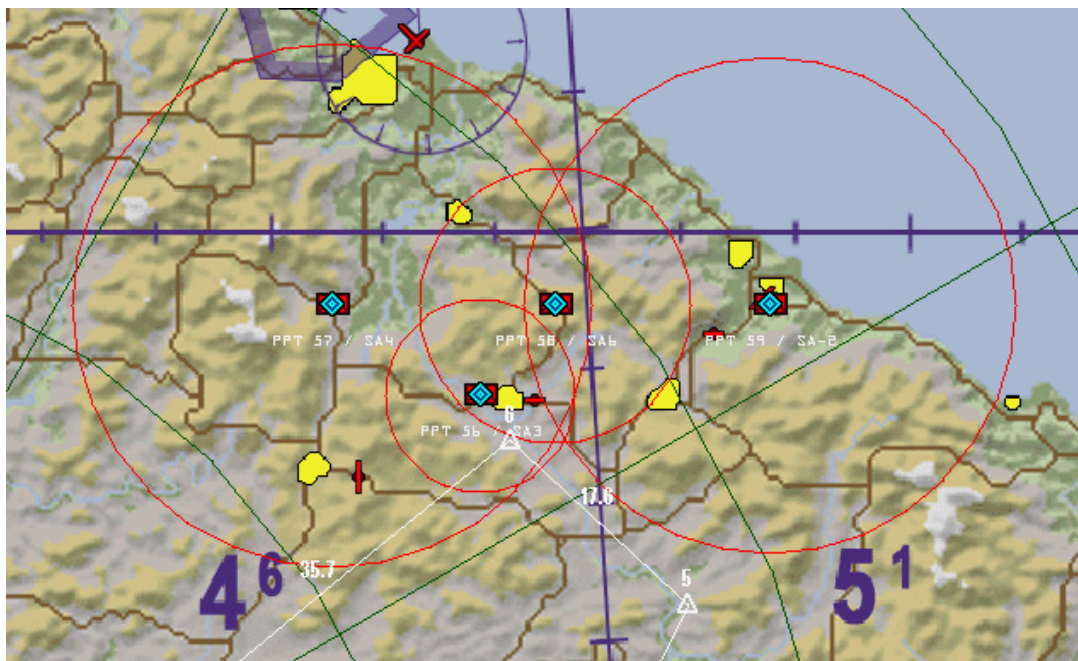
This training mission will document all three modes, but we only have two missiles onboard. We will direct the AI wingman to fire his HARMs at our designated targets.

As a SEAD or DEAD flight lead your responsibility will be to protect the strike package or to destroy enemy air defences, but to be able to do that you need to have a good idea of where the threat will be located. Let's start with a recon of the target area for this flight.

We have two target points at Steerpoints 5 and 6. Multiple air defence radars are marked on the map with PPTs (Pre-Planned Targets) and their associated WEZ (Weapon Engagement Zone):

- PPT 56: SA-3 (fixed) Flat Face search ('S' on RWR) and acquisition & Low Blow missile guidance ('3')
- PPT 57: SA-4 (mobile) Long Track search ('S') and acquisition & Pat Hand missile control radar ('4')
- PPT 58: SA-6 (mobile) Flat Face search ('S') and acquisition & Straight Flush missile control radar ('6')
- PPT 59: SA-2 (fixed) Spoon Rest search and acquisition ('S') & Fan Song missile guidance ('2')

BMS 4.34 introduced significant changes to the way SAM systems work. The most obvious change though is the fact that all SAM battalions now have both a Search and Acquisition Radar and a Fire Control Radar. To render a SAM site ineffective the FCR must be destroyed.



We need to differentiate fixed from mobile SAM systems. If we intend to fire a HARM in POS EOM mode we need to be certain that the radar will be close to the steerpoint we'll use during the firing procedure (most of the time a PPT). If the SAM moves away from that location the missile will certainly miss. As a rule of thumb we will use POS mode only for known, fixed targets (the SA-2 and SA-3 in this scenario).

The SA-4 & SA-6 are tracked vehicles that may move from one point to another to defend different objectives. These are better targeted using HAD or HAS mode.

Steerpoint 5 will be used as our attack point for the fixed SA-2 radar at PPT-59. We will attack in POS EOM mode. We will turn then towards STPT 6 and direct the wingman to engage the SA-3 at PPT 56 and then we will hunt the mobile SA-4 & SA-6 SAMs in HAD mode.

Once you enter the cockpit set up your systems according to preference as usual. Select A-G master mode, place MASTER ARM to ARM and power up your AGM-88 missile with OSB 7 on the SMS page. When PWR ON is selected all of the missiles loaded on the aircraft (of the selected type) are simultaneously powered up. Missiles remain powered up until PWR OFF is selected, or a change is made to the current weapon inventory. There is no time restriction on the power of the HARM missiles in BMS.

Since we are going to deal with SAM radar and use the RWR extensively it is advised to turn on the SEARCH capability of the RWR so we can see the search radar symbols as well. These might not tell you which SAM is looking for you but by correlating the information with your HSD and PPT you can deduce important bits of information and build SA. Depress the Search button on the TWA located on the left auxiliary console.

Each AGM-88 missile carried can be programmed differently within the SMS by stepping between loaded stations (with the HOTAS MSL STEP button). The avionic system remembers the parameters selected for that particular station and will initialise to the last known parameters when returning to that station.

Although HARMs are air to ground missiles and need to be fired in A-G master mode you don't need your FCR in A-G mode to fire them. It's much better therefore to switch the FCR to CRM or any A-A mode to keep an eye on any air threats and build situational awareness while you do your SEAD/DEAD work. If any of them become a factor to your flight/package you can quickly switch to MRM override mode and deal with the threat.

12.1 POS mode

POS stands for POSition known. As the name implies it is a mode that is used when the position and the type of the SAM site is known with high confidence, making it a pre-planned attack mode.

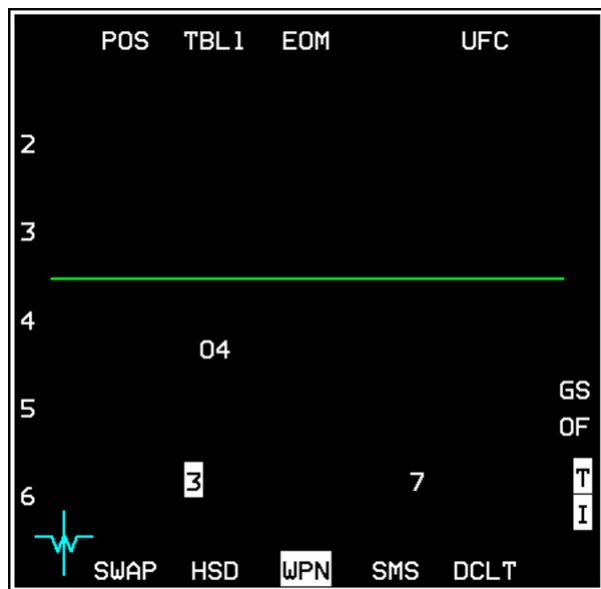
In POS mode the missile is not fired at a radar, but at a **steerpoint**. It is programmed to start looking for a *specific radar type* at a certain distance from the steerpoint and if the radar is emitting the missile will target it. If the radar is not emitting the missile will hit the coordinates of the steerpoint it was fired at. When using POS mode the pilot has no way of knowing from the WPN page if the radar is actually emitting or not. Using the RWR may provide clues about the state of the SAM radar.

POS is mostly used in a SEAD scenario where killing the SAM is not the primary objective; preventing it from firing its missiles during the time frame that the strike flight is vulnerable is enough to fulfil mission objectives.

POS mode is accessed from the WPN page as the sensor is in the missile. It has three sub modes: EOM, PB and RUK. OSB 3 provides hands-off sub mode selection; the HOTAS pinky switch on the stick will provide hands-on sub mode selection when the WPN page is SOI.

Each mode controls at which point the missile will activate its seeker and what the FOV of the seeker will be. They all use the same WPN page symbology:

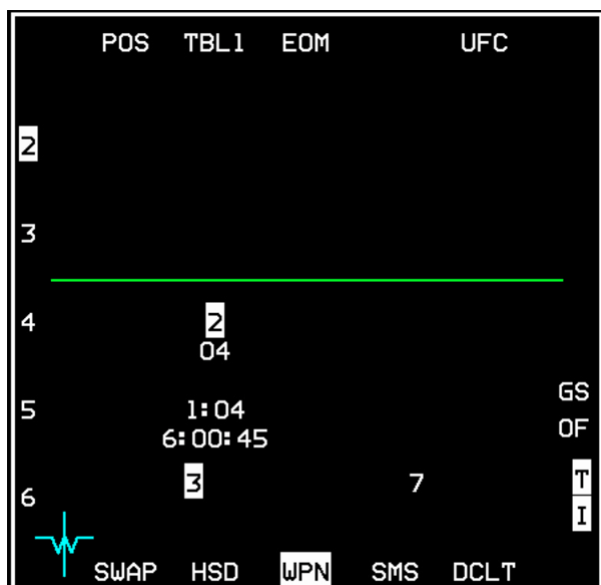
- **EOM** (Equations of Motion) is the most accurate POS sub-mode. The seeker is activated with a narrow 40° field of view 5 Nm from the known threat position. This mode should only be used when the location of the emitter is well known (i.e. collocated to a steerpoint).
- **PB** (Pre-Briefed) mode is used for long range delivery with high confidence of the target location. The seeker will activate 15 Nm from the steerpoint with a wide FOV of 120°.
- **RUK** (Range Unknown) is a degraded EOM mode where confidence in range of the target is very low. The seeker will activate 20 Nm from the steerpoint with a 120° FOV.



The WPN page in POS mode is divided into two parts by the green launch status divider line (LSDL). Pre-launch information will be displayed below the LSDL and post-launch information will be displayed above the line.

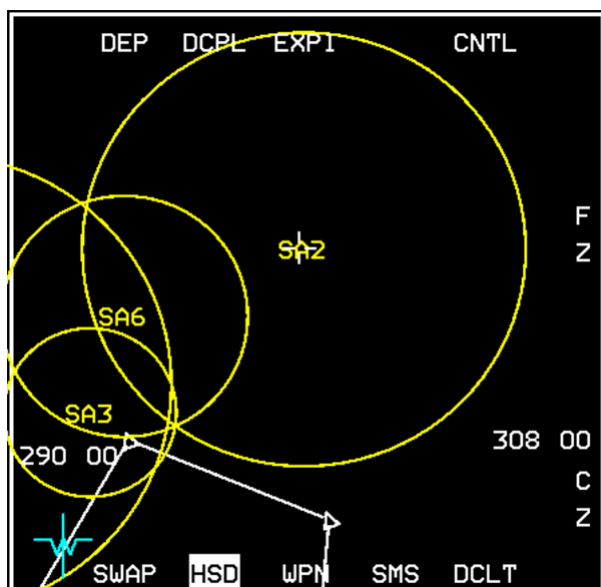
As said above POS needs a steerpoint and a threat type. The steerpoint is by default the current steerpoint of interest (04 in this case as we just entered the training mission and we are flying inbound to Steerpoint 4).

Threat types must be selected according to the mission. OSB 2 accesses 4 different tables of threat types. According to the threat table selected OSB 16-20 will allow selection of a radar type. TBL1 is selected in the left picture and contains SA-2, SA-3, SA-4, SA-5 & SA-6, which is perfect for this training mission. TMS left when the WPN page is SOI to toggle between threat tables.



Depress OSB 20 to handoff SA-2 threat type to the missile, or toggle through the threat types with TMS right. The threat type will be added below the LSDL, above the steerpoint. Missile time of flight and the time of impact are also displayed. Should the missile be fired now it would go to Steerpoint 4, fly for 1 minute and 4 seconds, activate its seeker 5 Nm from STPT 4 and look for radar emissions from a Fan Song radar.

Missiles will remember their handed off threat types, but the steerpoint is always the currently selected steerpoint. We can step the missile and select the other AGM-88 on station 7 with the MSL STEP button and handoff a SA-3 threat type. Stepping through the stations will then toggle between a SA-2 and a SA-3 ready POS page. But the selected steerpoint will still be the active UFC steerpoint.



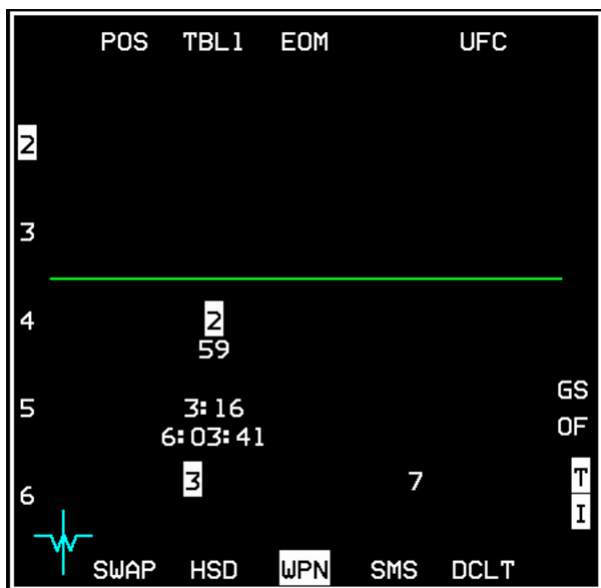
It's important to remember this because you rarely fire two missiles at two radar types at the same location.

Although you may pre-program each missile with a threat type you must change the UFC

```
STPT 59 ÷ MAN
LATEN 38° 54.412'E
LNG E 129° 16.286'
ELEV -0FT
TOS 00:00:00
```

steerpoint before firing the second missile.

There are multiple ways to change the active steerpoint. If you remember the PPT number of your target just use the STPT page of the UFC and enter the PPT number. If you don't remember it select the HSD page, make it SOI and move the cursor to the intended target at the centre of the threat ring. With the cursor just above the threat symbol press TMS up. That will make it the active steerpoint of interest. The relevant PPT number will also be displayed on the DED.

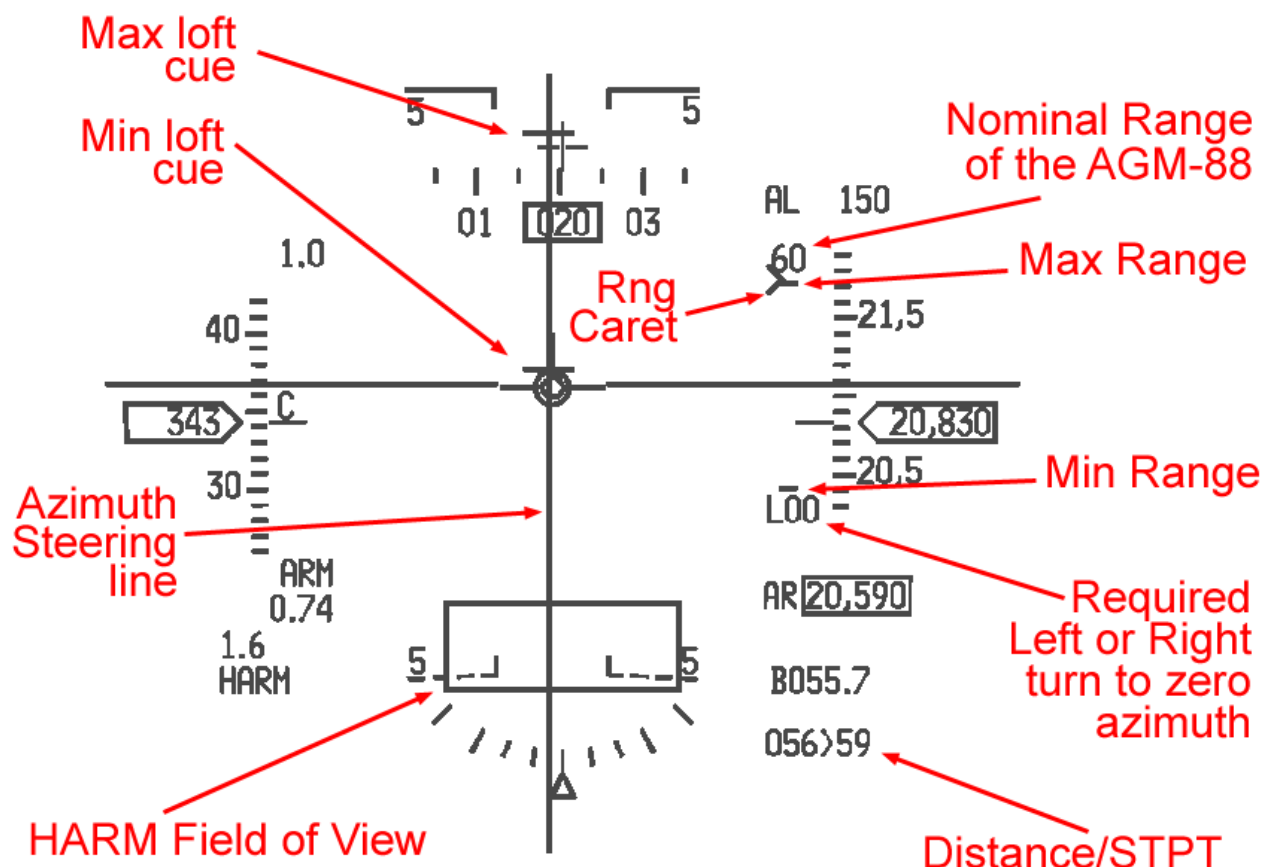


Remember that all your other sensors are pointing to that steerpoint now, including your INS. If you are flying with the autopilot in steering mode the aircraft will immediately turn to the new steerpoint. In the WPN page the Steerpoint, TOF (Time of Flight) and TOI (Time of Impact) are updated accordingly.

The HARM missile is capable of Mach 3+ speeds, has a missile motor burn time of about 45 seconds and a range of up to 60 Nm in BMS. This is longer than any SAM engagement zone in Korea (the SA-10 is 50 Nm and the older SA-5 is 53 Nm).

Using the time of impact timers you can also coordinate attacks on specific threats at specific times. If your SEAD flight carries 4 HARMs and you need to protect a strike

package entering the SAM WEZ for 1 minute you will plan for a HARM impact every 15 seconds to suppress the air defences in the area (these are Pre-Emptive Targeting (PET) shots).



The HUD provides cues according to missile mode. The Missile FOV box will be different in POS/EOM than in PB and RUK sub-modes. In EOM the FOV is 40°; in PB and RUK it is 120°. The HUD HARM FOV will be larger in PB/RUK. The above picture shows the POS/EOM shot we are about to take on the SA-2 at PPT59.

The range of the missile depends on the launch aircraft's altitude, speed and loft angle. The more energy the missile has, the longer its range. Judging efficient AGM-88 range is tricky in BMS as the missile is shown in the HUD with its nominal range of 60 Nm (displayed on the top of the range bar right of the HUD).

Although 60 Nm is sufficient to beat any BMS SAM engagement zones (PPT threat rings) you can still have valid shots at longer ranges than 60 Nm. Be warned though if you fire too soon the missile will self-destruct in the air when its battery runs out. So if you want to ensure best hit probability wait for the HUD in-range cues, but be aware you might have a bit more margin if needed.

A valid shot happens when the range caret is within the max and min range. The HARM FOV will flash indicating the missile is in range. If the azimuth to the target is not 0° then the HARM missile will need to manoeuvre, which will decrease its range. The ASL is similar to the CCRP steering line and the HUD also provides indication of any left or right turns needed (in tens of degrees) to zero the azimuth.

The SA-2 is still 56 Nm away and we are way outside its threat circle. We will close a little bit more, tempting the SAM operator to turn his Fire Control Radar on. Having the SAM radiating greatly increases the chance of our missile killing the radar. If you see a 2 on the RWR, fire your missile. If the Fan Song doesn't turn on, fire before entering the SA-2 threat ring and fly towards it; hopefully the SAM site will engage you.

AGM-88 missiles are heavy and as soon as one missile is away the aircraft will enter an asymmetrical store condition with one heavy wing. Be ready to add roll trim to counteract this.

While we close with the target let's have a quick look at the other two POS sub-modes:

RUK (Range Unknown) can be selected with OSB 3 on the WPN page, or the pinky switch on your HOTAS if the WPN page is SOI. Obviously timers on the WPN page will not be displayed in RUK, as range is unknown.

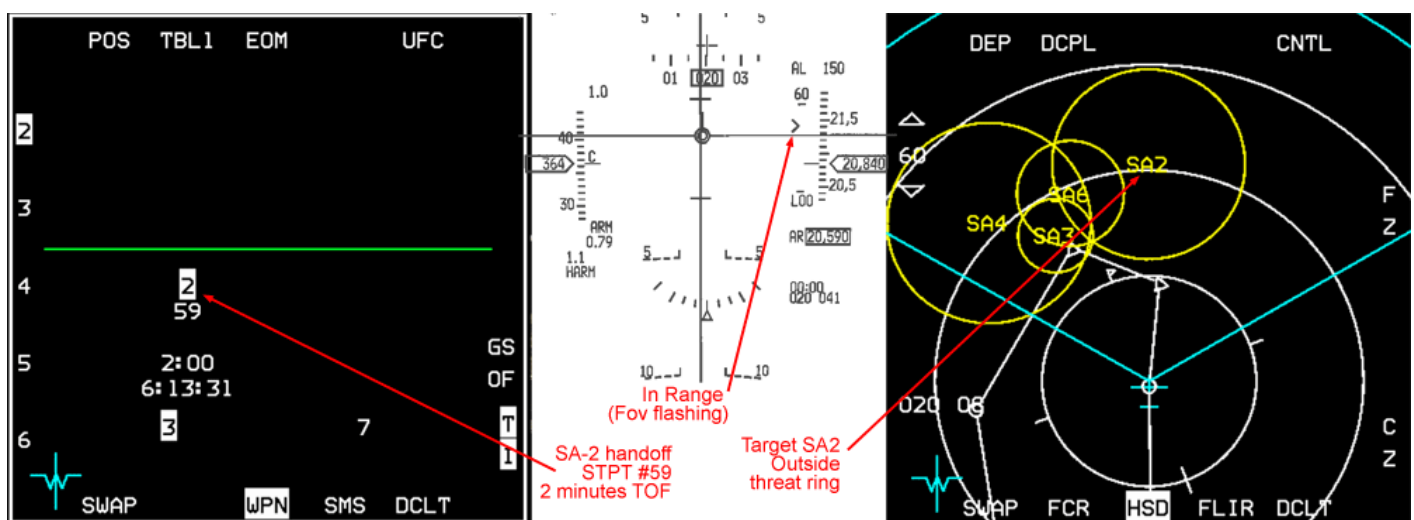
The HUD cues are the same as in EOM, but the HARM FOV box is wider as it represents 120°. The range and loft cues are not displayed. The seeker of the AGM-88 will activate 20 Nm from the steerpoint and look for the pre-set handoff threat (in this case a Fan-Song) with a 120° FOV. RUK is simply a degraded EOM mode.

A further press on OSB 3 or the pinky switch selects PB (Prebriefed) mode. The seeker will activate 15 Nm from the active steerpoint with a FOV of 120°. The WPN page is identical to the EOM sub mode.

The HUD cues display the larger HARM FOV and an optimal loft cue is displayed within > < carets. POS PB may be used at long range when you have good confidence in the target location.

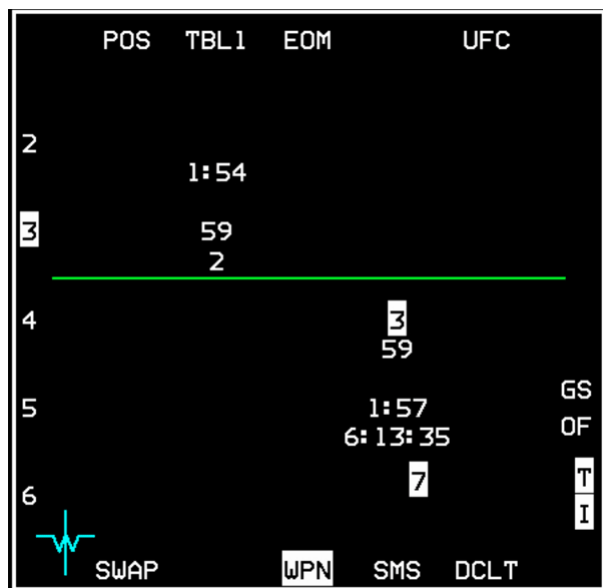
Both PB and RUK POS sub-modes are not optimally coded in the current BMS version and the most accurate POS mode remains EOM at this time. I would advise you stick to POS EOM until the other two sub-modes are optimised. Neither mode offers much over EOM.

Let's switch back to POS EOM. The SA-2 is now 40 Nm away and we are well within range, if we haven't fired already.



Press the pickle button and keep it depressed until the missile is away. A radio call on UHF is required, to alert any aircraft in the vicinity: "Weasel 3-1, Magnum PET Alpha 2 minutes".

Post launch missile information will appear above the LSDL on the weapon page with the handed off threat, the steerpoint the missile was fired at and the time remaining before impact. This counter is very useful for coordination with other flights. When the timer reaches zero it will remain displayed for 5 more seconds; the pilot should announce it on the radio: "Weasel 3-1, PET Alpha timeout".



The second HARM was handed off a SA-3 threat earlier in the flight. After firing the first missile on station 3 the second one on station 7 becomes active and remembers the previous handoff. Steerpoint 59 is still active and we need to change it to the location of the SA-3, which is PPT 56. You are now ready to fire at the SA-3 in POS EOM, even before the first missile hits its target.

When the WPN page is SOI you can switch from POS to HAS with the CURSOR ENABLE button on your throttle. We will cover HAS later in this training mission, but toggling is an easy way to know if a SAM radar is emitting or not before firing at targets of opportunity within the selected threat table.

When the counter reaches zero the missile will impact the Fan Song radar (we'll assume it was radiating).

The SA-2 site is now harmless and its threat ring can be removed from the HSD with a TMS down on its PPT.



12.2 HAS mode

HAS mode is the second mode that is available to F-16s which have no HTS pod loaded. Like in POS the HARM missile is the sensor and provides data for the WPN page.



HAS mode is selected from the WPN page by pressing OSB 1 and selecting HAS (OSB 19) on the menu, or as mentioned above with the CURSOR ENABLE button from the POS WPN page when it is SOI.

The WPN page displays the ALIC which is the HARM WIDE field of view ahead and down by default. Up to 10 emitting radars from the selected threat table will be visible as symbols within the ALIC area.

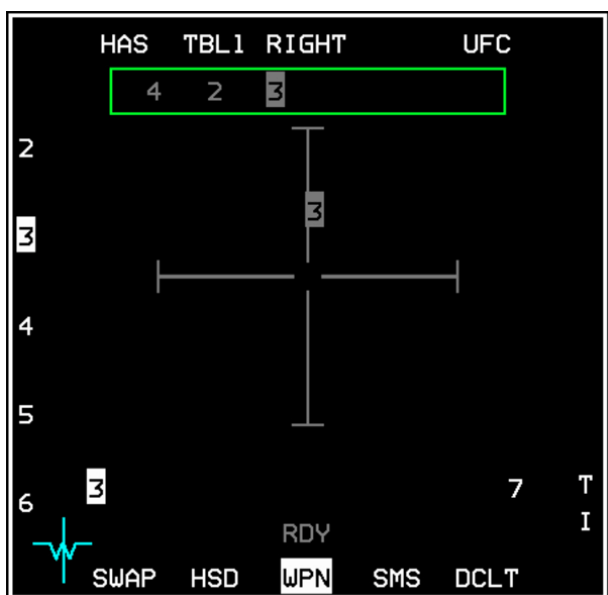
Like POS mode threat types must be preselected through one of the 4 available tables, which can be toggled with OSB 2. The threats within each table are displayed on the left OSB row of the MFD. Unlike POS modes all threat types within the selected table will be displayed if emitting. The DTSB (green rectangle on the top of the WPN page) lists detected threats.

OSB 3 allows you to narrow the missile field of view. When OSB 3 is depressed CENTRE will replace the WIDE mnemonic and the missile FOV is halved. A further OSB 3 press switches the missile FOV to the left (LT) and another OSB 3 press shifts the missile FOV to the right (RT). When changing FOV the HAS resets and any previously displayed threats disappear until they are detected again. A further OSB 3 press resumes WIDE FOV. Hands on FOV switching can be made with the pinky switch when the HAS is SOI.

OSB 4 labelled SRCH brings up the search filter page. It allows removal of certain threat types from the table. It is useful when there are more than 10 threats emitting within the same table. As the ALIC is only able to display a maximum of 10 threats we need to delete some threat types to ensure we see all threats from the relevant types. Depressing OSB 4 displays a menu page with the threat types corresponding to the selected table. They are all highlighted meaning they are all active. To deactivate a threat type simply depress the relevant OSBs. In this case we will deactivate SA-4, SA-5 and SA-6 from the detection pattern. It can be done to other tables as well by first selecting them with the OSB 2 TBL button. Once selection is complete depress OSB 1 (HAS) to return to the HAS page. The SA-4 is now absent from the detection pattern of the ALIC. Obviously the SA-4 is still a threat to us in this case, but it is no longer visible in the HAS WPN page.



Threats must be handed off to the missile before firing. The WPN page must be SOI, so the cursors can be moved to the selected threat. Handoff is initiated with TMS up. When a threat is handed off the display will change to the missile boresight view. Only the handoff threat is now visible in the display, but the DTSB still shows all the emitting threats. Handoff can take up to 5 seconds. When the threat is correctly handed off RDY appears above the WPN page mnemonic (OSB 13). If a missile is fired before handoff is complete it will miss.



In this case we handed off the SA-3 to the missile. The handoff is complete as RDY is displayed.

Note that the OSB 3 mnemonic still informs us that the HARM is looking right as we handed off the threat from the RT side of the HAS display. Although not visible on the MFD the SA-2 and SA-4 radar are still emitting.

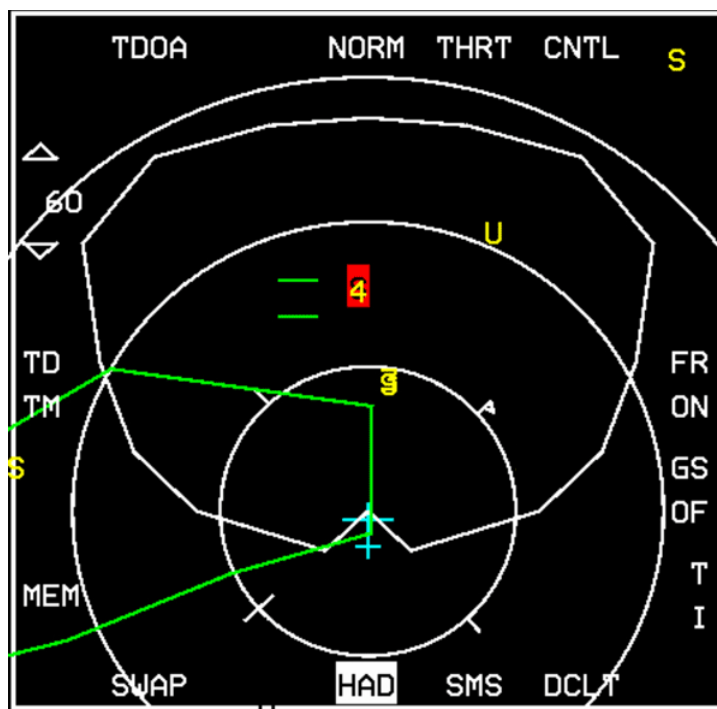
HAS mode does not provide HUD in-range cues as the missile is unable to compute range to the radar. We know that the HARM missile has a range of 60-65Nm in BMS so range must be deduced from the HSD and PPT threat rings.

As we have only one missile left we will lose POS/HAS symbology if we fire. TMS down to unselect the SA-3 and switch to HAD mode.

12.3 HAD mode

HAD mode is only accessible when the aircraft carries a HTS pod on the left chin pylon. Obviously the pod needs to be powered with the LEFT HDPT power switch on the SNSR panel. If the hard point has no power the HAD page will display HTS OFF.

The HAD page is accessible from the MFD menu via OSB 2. It can then be displayed in any master mode, but A-G master mode must be selected to be able to fire the AGM-88.



HAD page mechanisation is very similar to the HSD, but can also display radars in different colours according to their status.

HAD is forward looking only (about 120-180° forward sector).

HAD range can be changed with OSB 19 & 20 or with cursor bumping, as you would do with the HSD. FOV can be changed from NORM to EXP1 and EXP2 with OSB 3.

The HARM WEZ footprint, which depends on the launch aircraft's speed and altitude is also displayed on the HAD page. As you can see from the left picture it is just short of 60 Nm in the forward quarter at our current attitude.

The WEZ is dynamic and will react to speed and altitude changes. Any emitter within the missile footprint is nominally in range.

If HARM WEZ is greater than the HAD range being displayed, the footprint will be dashed, indicating that all visible threats are in range.

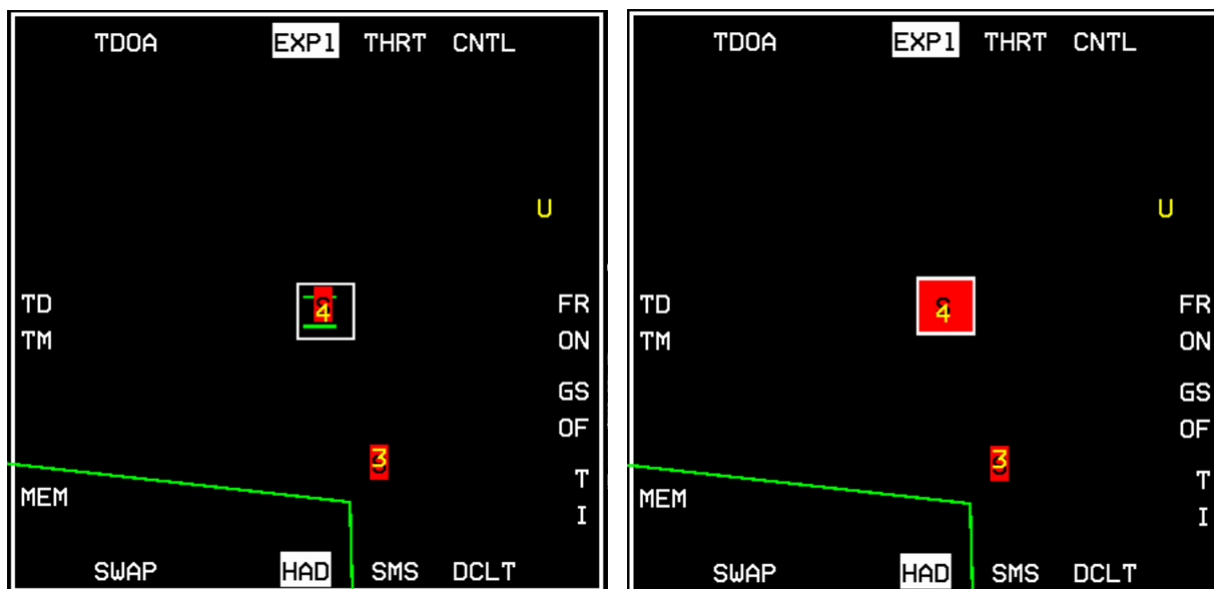
The INS flight plan is displayed in green. Unfortunately the HSD PPT and their threat rings are not displayed on the HAD page. Toggling quickly between the HAD and the HSD pages can therefore be useful for SA.

The displayed symbols change colour according to their emitting state:

- Steady GREEN:
 1. Radar (previously detected by sensors or intel) in HTS pod FOV but currently not radiating, or
 2. Radar outside HTS pod field of view and status cannot be determined.
- Steady YELLOW: Radar is emitting in scanning mode (search).
- Steady RED: Radar is tracking (acquisition).
- Flashing RED: Radar is guiding a missile (launch).

As planned we'll use our last remaining HARM on the SA-4 radar. The SA-4 is protected by a SA-3 short range SAM. Task your wingman to take it out. If your wingman is AI designate the SA-3 on the HAD page, open the wingman radio menu with 'w' or 'z' and select the 'Attack my Target' option '1'. The AI wingman will break away and fire one HARM at the Low Blow radar.

Note how both the SA-3 and SA-4 have a double-symbol displayed on the HAD. Both have an 'S' symbol almost superimposed on the '3' or '4' symbol. The S stands for Search and is the search and acquisition radar of the SAM site; a Flat Face for the SA-3 and a Long Track for the SA-4 SAM site. The search radar cannot guide missiles, so destroying the search radar will not prevent the SAM site from firing; it will only decrease its range and probably reaction time. Your target should be the Pat Hand radar, displayed with a '4' symbol.



Use EXP mode (OSB 3) to zoom in and ensure that you designate the Pat Hand and not the Long Track. In the pictures above the search radar is tracking but the Pat Hand FCR is not. It's the same for the SA-3.

When you designate with TMS up, a white box surrounds the target. If the threat is tracking, that box is filled with red. If the target is emitting but not in a tracking state then the inside of the box remains empty. It is clearly visible in both pictures above. The left has the Pat Hand (4) designated, but it's not tracking. The right picture shows the Long Track in tracking mode and designated. Both are valid shots but only the right scenario will (probably) render the SAM site harmless.

It is therefore important to know the capabilities and the configuration of the enemy air defence battalions before engaging them. The left most TGP image shows the Low Blow SA-3 FCR seconds before being destroyed by the wingman. The other picture shows the Flat Face SA-3 search radar: a truck with a rotating antenna on top of it.



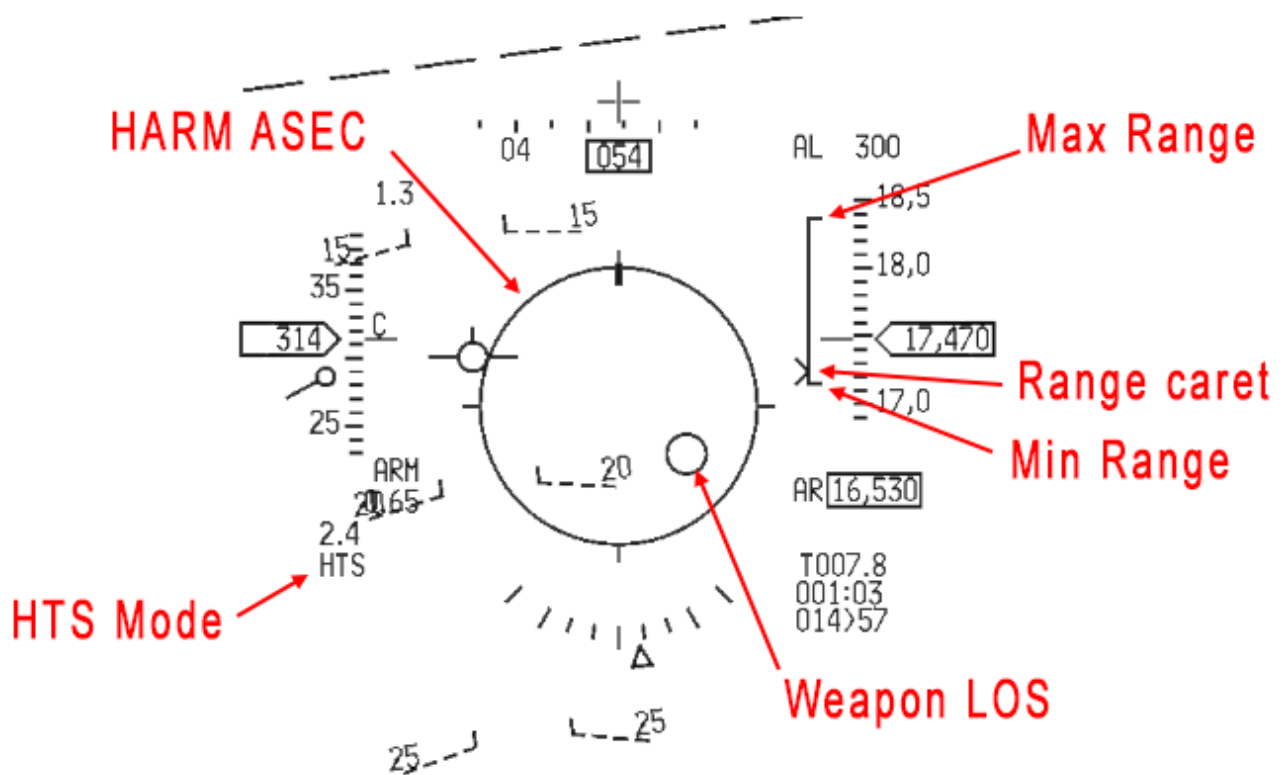
Although quite large, it is hard to see, making it difficult to spot at long range, as there are other trucks without antennas in the battalion.

The Low Blow blows up before we enter its WEZ and we can now concentrate on the SA-4.



The search radar of the SA-4 (Long Track) has a large rotating antenna on top of a tracked vehicle (centre picture). The Pat Hand FCR has a solid antenna mounted on a tracked vehicle as well (left picture). The SAM site has 3 launchers with 2 missiles each (right picture).

We designate the Pat Hand on the HAD page and we will confirm its destruction using the TGP. Once designated, the HUD provides in-range and targeting cues: the SA-4 was well within the missile footprint displayed in the HAD, so the HUD flashes the ASEC to confirm the target is in range. Fire the missile by depressing the pickle button. As always with missiles you must keep the pickle depressed for a few seconds for the missile to release.



The Pat Hand is quickly destroyed and we can remove the SA-3 and SA-4 threat rings from the HSD. We are ARIZONA, meaning that we have no HARMs left. The wingman still has one that can be used on the SA-6.

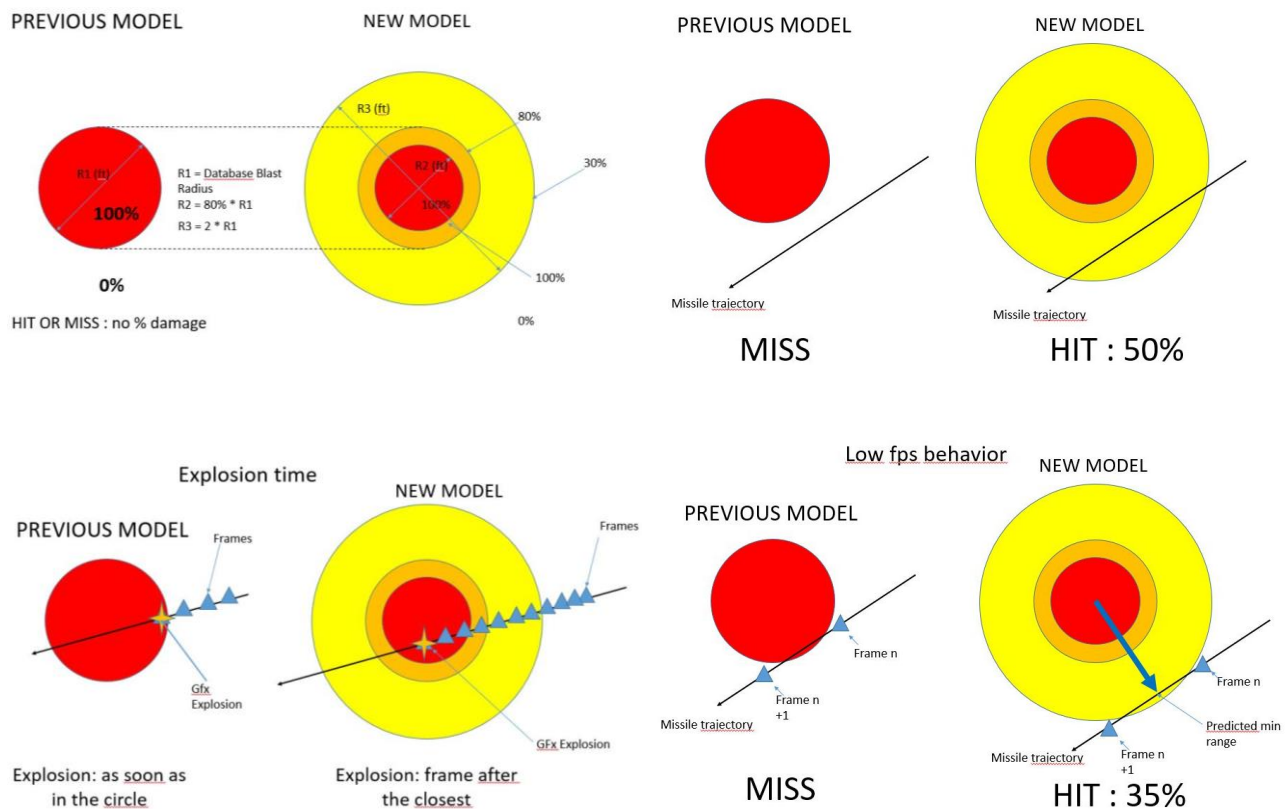
The SA-6 is mobile and moving and therefore harder to find. The advantage of having the HTS pod is that we can still designate the Straight Flush FCR, even after having fired all our anti-radiation missiles.

Once designated with the HAD page, instruct your wingman to attack with the 'Attack my Target' command from the wingman menu.

12.4 Missiles in BMS

Missile mechanisation has been updated as well in 4.34. It's not exclusive to SAMs, but the same updates were done for all missiles (including air to air). Missiles now have a proximity fuse.

Before 4.34 missiles were either hit or miss. You survived, or you were hit, exploded and out of commission. With the new damage model and failures more manageable from the cockpit, 4.34 needed more occasions for degraded operations. Missile behaviour was changed to provide the possibility of damaging aircraft rather than just destroying them every time they were hit. The following graphics illustrate the comparison from the old model (left side) and the new model (right side).



You thus have now more chances to survive a missile hit, but also bear in mind bigger missiles will yield bigger damage, and some of these SAMs are quite big, so stay sharp!

12.5 SEAD / DEAD in BMS 4.34

In real life there is a clear distinction between SEAD (Suppression of Enemy Air Defences) and DEAD (Destruction of Enemy Air Defences).

This distinction has not always been so easy to make in BMS.

In 4.32 mission types were either SEAD Escort or SEAD Strike.

In 4.33 these mission types were replaced with SEAD and DEAD, though essentially remained the same.

In real life, good SAM operators are smart and cautious if they value their life and their mission. In previous BMS versions they were not particularly (artificially) intelligent and didn't have the same priorities. They hardly ever switched their radars off, providing easy targets for anyone carrying anti-radiation missiles. As a result most HARM shots were kills and SEAD was almost impossible to carry out, as it usually turned into DEAD after the first AGM-88 was fired.

4.34 changes that quite a bit. SAM operators are still artificial intelligence, but are much smarter than before. They have become more cautious and now play a much better game of cat and mouse. They have dedicated EWRs (Early Warning or Search radars) and FCRs (Fire Control Radars). Both are now completely separate entities, so destroying a Search radar will not prevent a SAM system from engaging you, but it might force the Fire Control Radar to stay on longer, allowing you to target it next. Destroying the FCR will prevent the SAM site from firing a missile, but its Search radar will remain active and can still radiate, cluttering up your RWR.

In 4.34 more HARM shots will miss their target because the radar they were homing on suddenly went silent. For now, the balance of power has shifted and the HARM will not always be your weapon of choice when you go out to duel with canny SAM operators.

SEAD finally makes sense in certain scenarios and you *will* need to upgrade your tactics to suppress or destroy SAM sites in 4.34, especially at higher skill levels.

Get ready to play bait to tempt the radar to stay on while your wingman kills the SAM radar.

SEAD / DEAD work is much more interesting and rewarding in 4.34. You will not always win.

MISSION 13: AGM-65 MAVERICKS

NOTE: You may want to disable trees by moving the tree density slider full left on the SETUP > GRAPHICS page. Consider this mission as three-part training. The first part is mainly focused on bore-sighting the Mavericks, the second part is the ingress at low altitude using TFR (see TRN 08 for TFR use) and the last step is the actual strike against the ZSUs under a low cloud ceiling. Part 2 & 3 are for advanced users.

LOCATION: In flight over the East Sea inbound North Korea.

CONDITION: KF-16 block 52 – Flight of 2 - Callsign Boxer 2.

GW: 36600. 2 AGM-65D – 2 AGM-65G – 1 centreline tank, Navigation and Targeting pods.

Max G: 7/-2.0 Max speed: 600 kts / 0.95 Mach.

Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.

GOAL: Destroy 2 ZSU-23 at STPT 7 and Tangch'on bridge at STPT 11.

WEATHER: RKND INFO: F 0725L ILS RWY26 TL140 360/17KT 9999 RA OVC 010 22/17 Q994 NOSIG

There are four types of Mavericks in the BMS database. The older A and B models (white) and the more advanced D (green) and G (grey) models. We will concentrate on D and G models. The earlier models are only carried on older blocks and the D/G models are standard on all modern F-16 blocks in BMS.

The lighter AGM-65D, with a range of 15 Nm is optimised for use against armoured vehicles and small hard targets. The heavier AGM-65G is optimised for use against larger target structures and has a range of 20 Nm. Obviously it can be used against smaller targets as well. Earlier A and B models have a range of 10Nm.

In BMS the A, B and D models are carried on LAU-88 triple ejectors, or LAU-117 single pylons and the G models are only carried on the single missile LAU-117 pylons. The triple missile launcher is in reality never used operationally on the F-16 and has only been seen in flight on weapon test airframes.

In this scenario we will carry a pair of AGM-65Ds on stations 3 and 7 and a pair of G models on stations 4 & 6.

Mavericks are fire and forget missiles. They will guide themselves to correctly tracked targets. Mavericks became much more realistic with 4.33 and now require a more realistic workload from the pilot to attain a successful track prior to launch.

Both missiles have many operational limitations. You have to keep these limitations in mind when you carry the missiles, as the potential problems may really happen now in BMS.

1. Time limitation

Missiles need a 3 minute gyro spin up time before use.

The maximum power on time is 60 minutes in power-on mode with video off. The maximum full power mode (when video is visible) is 30 minutes. These times are cumulative over the mission timeframe.

Therefore it is strongly advised to power off the missiles whenever you don't need them and ensure that you use the video only when you need it. Don't fly around with the WPN page showing missile video (or you'll not be able to use them when you need to, and it will hurt your FPS too).

Automatic POWER ON is accessible by pressing CTNL on the WPN page. This allows automatic powering of the missiles when you pass North/East/South/West of a selected steerpoint.

2. Ground use

Maverick video is inhibited when the MASTER ARM switch is OFF. On the ground, video is inhibited unless the GROUND JETTISON switch is placed in the ENABLE position. Ground boresight is not possible in BMS.



3. Launch restrictions

The AGM-65 missile is always hot. Even if out of range or outside parameters pressing the pickle button will fire the missile. A Maverick launched outside these limits will miss:

- Maximum launch speed: Mach 1.2
- Maximum gimbal offset angle: max 10° azimuth and 15° elevation (keyhole)
- Maximum dive angle: 60°
- Maximum bank angle: 30°
- Maximum roll rate: 30°/s
- Maximum load factor: 3G
- Minimum load factor: 0.5G

4. Structural restrictions

Stores restrictions are listed as usual in the arming screen. Mavericks are cleared for 7G / -2G and a max speed of 600 kts or Mach 0.95. Over-speeding/stressing the jet may damage the missiles or the pylon and cause a hung missile upon firing. It's important to realise that you may not detect the problem until you try to fire the weapon. To avoid problems fly within the store restriction envelope. The condition may be visible on the station number when a missile is selected, or you try to fire it. If you see F, D or H replacing the station number the missile may have Failed, be Damaged or Hung.

The AGM-65D and G Mavericks can be fired in 3 different modes:

- **PRE** for pre-planned delivery (CCRP type). Initial target selection is made with other onboard sensors, such as the FCR or TGP. The LOS of the missiles needs to be boresighted to the LOS of the sensors.
- **VIS** for visual mode (DTOS type). Target selection is made with the TD box with the HUD as SOI. Since 4.34 VIS mode can be boresighted as well.
- **BORE** for boresight. Allows firing on targets of opportunity. Target selection is made by placing the target within the HUD boresight cross and using the WPN page to refine cursor position.

The selected mode can be changed with OSB 2 on the WPN page or with the CURSOR ENABLE button on the throttle when the WPN page is SOI. The mode is also displayed in the HUD.

This training mission's goal is to locate and destroy the air defence vehicles at steerpoint 6. The target is a HQ battalion that will be attacked by A-10s later in the day. We need to locate 2 ZSU-23s and destroy them with 2 AGM-65Ds. The battalion is at the extreme range of a SA-10 battery, so attack from high altitude is not an option. Our secondary target is a multi-span bridge at steerpoint 11. We want you to destroy two different spans with both your AGM-65Gs.

The weather is not going to make this mission easy. Visibility is reduced and there is extensive cloud cover. The ingress will be made at low level through the valleys, where visibility should be acceptable. Both target areas are in mountainous terrain and we will ingress using the terrain following radar in autopilot blended mode. Trust your TFR and you will be able to let the system fly the airplane while you concentrate on firing the Mavericks.

This mission is very challenging. When you are first learning to employ Mavericks you may wish to use the next mission to begin with, especially the boresight part. It is the same mission but with clear skies and no wind, really demonstrating just how much of a difference the weather can make in BMS.



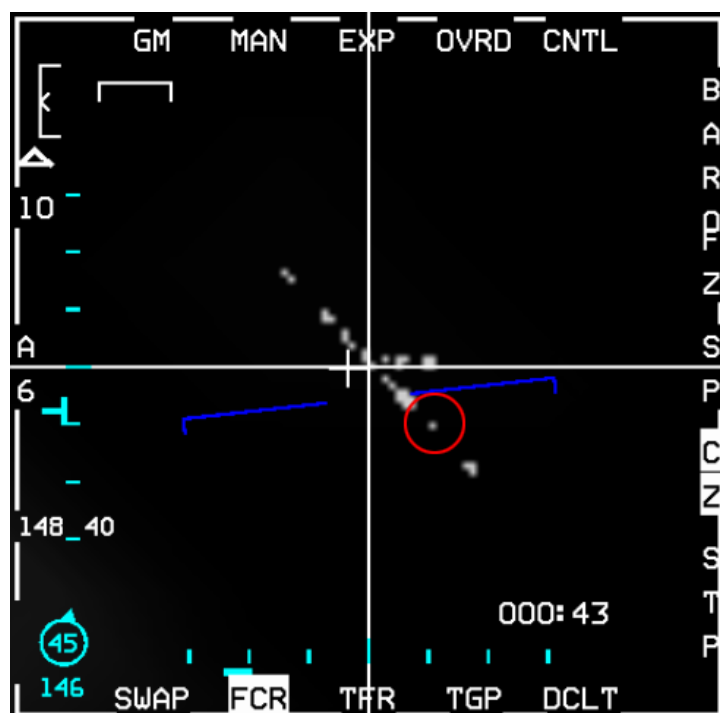
In 4.34 pods are handled like any other stores, so pod loading is at the user's discretion (pods are in the "Other" group of stores on the LOADOUT screen). This TE loads both a Navigation and a Targeting pod.

The real challenge of this training mission will be to quickly locate, target and destroy 2 ZSU-23s located near Steerpoint 7. The target is in high mountainous terrain (around 5700 feet elevation) and the low ceiling and visibility will greatly reduce your search capability and ability to pace your attack.

Intel reports suggest that both AAA are located very close to the village on the eastern side. It is valuable information, as it should decrease your search time.



They may be moving, but at least you know you will have to search right and close to the buildings for the air defence vehicles. The picture below shows the A-G FCR scan of the target area. The ZSUs are circled in red.



Ceiling and clouds will be your other problem. If you fly too high you may enter clouds and have zero visibility on the IR sensors. You will have to stay low, which is a good thing when you consider the SA-10 coverage, but a bad thing for your standoff range from the ZSUs.

Staying at 500 feet SCP on the TFR may not provide enough time for targeting. 1000 ft SCP might be preferable, but if you fly above mountain peaks rather than staying in the valleys the TFR might fly in clouds, spoiling the attack run. You will have to override the autopilot to stay in valleys under the overcast as much as possible.

To maximise chances of success you must ensure quick targeting and firing. Weapon LOS will have to be boresighted to the TGP beforehand and both targets will have to be designated within a single pass.

The slightest delay will force a miss. Nobody ever said the training missions had to be easy. They are harder as the syllabus gets near the end. There is no shame in not being able to cope with such a situation, it's hard on purpose. Remember you have the CAVOK version of this mission that makes it much easier.

Entering the cockpit in flight over the East Sea we need to power on the Mavericks immediately so their gyros can spin up. Do your fence checks, select A-G master mode and access the SMS page. Press OSB 7 to power on all AGM-65s. After boresighting them we will turn them off to save their battery. To avoid having to turn them back on manually we will activate AUTO POWER ON West of Steerpoint 5.

Enter the CTNL page and press OSB 20 until WEST OF is displayed. Press OSB 19 to select the steerpoint. A new page opens; select STPT 5 with OSB 16, then ENTR (OSB 2) which takes you back to the CNTL page. Press AUTO PWR ON with OSB 7. Exit the CNTL page with OSB 5 and note the A mnemonic next to OSB 7, confirming that AUTO POWER ON is activated.



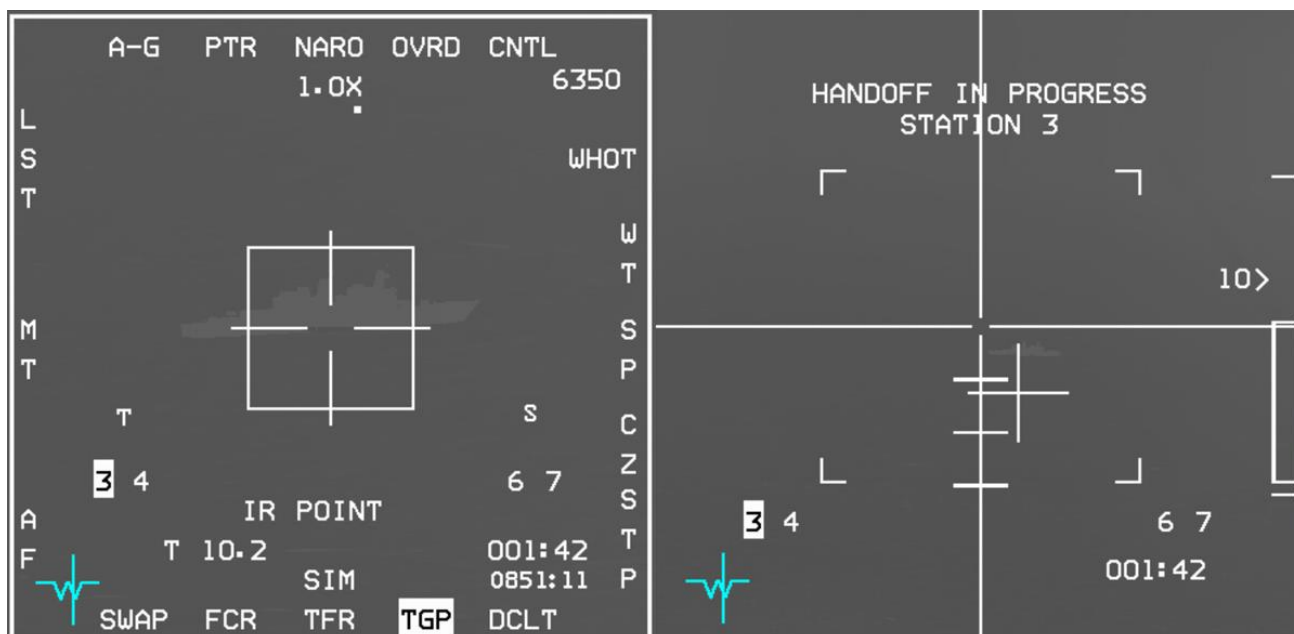
Loading the missiles on their launch rails causes alignment errors that will be visible between the aircraft sensors' LOS and the missile LOS. This misalignment may cause problems when using the Mavericks in PRE mode, where their LOS is slaved to the SPI. To overcome this issue the pilot must ensure that both missile and sensor LOS match. This is best done in flight, using both the TGP and the WPN page, to ensuring both sensors are looking at the same spot. This must be done once per station/launcher (i.e. with 3 missiles on a triple LAU-88 pylon you still only need to boresight that station once).

In this training scenario we plan on using the D models in PRE mode on the moving vehicles and the larger G models on the bridge using VIS mode. At the very least therefore the D models must be boresighted. There is a US destroyer near Steerpoint 4 which we can use to boresight the missiles. Select AGM-65D on the SMS page (stations 3 & 7), switch to the WPN page, set MASTER ARM to SIM to prevent accidental missile release on the friendly ship and engage the autopilot in ALT HOLD.

Descend to 6000 ft (override A/P with the stick paddle) to search under the weather for the friendly destroyer and reduce speed to ensure you are still at least 10 Nm away from Steerpoint 4 when the missiles become available (NOT TIMED OUT disappears from the SMS/WPN page). 85% RPM should do the trick. With the AGM-65D the WPN page will remain blank for each missile until you blow the protective dome cover off with the MAN RNG/UNCAGE button on your throttle.

Around 10-12 Nm from the STPT you should be able to find the destroyer with the FCR in SEA mode. If you designate it, SOI will be transferred to the WPN page on the right MFD. Transfer SOI to the TGP and look for the destroyer, which should be moving on a north-easterly heading. Minimise the time between finding it on the FCR and switching to the TGP or you may lose it. If that happens, switch back to the FCR and acquire it again. There is no need to designate with the FCR; simply move your SPI with the radar cursors just in front of the destroyer's path and then switch to the TGP (SPI position is automatically shared between sensors) to pick it up visually on the TGP. Go NARO field of view to zoom in and obtain point track with TMS up. You can also practise boresighting on one of the buildings on the coast; though if you do this remember to pick one that is separate from the others, so you can be confident you are boresighting on the correct building.

The WPN page then shows HANDOFF IN PROGRESS STATION x. During handoff the TGP is trying to give the target position to the selected missile. Unlike 4.33, the handoff fail will not cause a fault.



Ignoring the handoff in progress message for now move SOI to the WPN page, zoom in to EXP FOV with OSB 3 / pinky, then slew the cursors to the same target as the TGP. Press TMS up to track the target. The handoff in progress message does not mean the WPN page can't be used. When the missile is successfully tracking the target BSGT will appear next to OSB 20. Press it to boresight the station. BSGT will momentarily highlight. Missile LOS on that stores station is now looking at the same spot as the aircraft sensors.

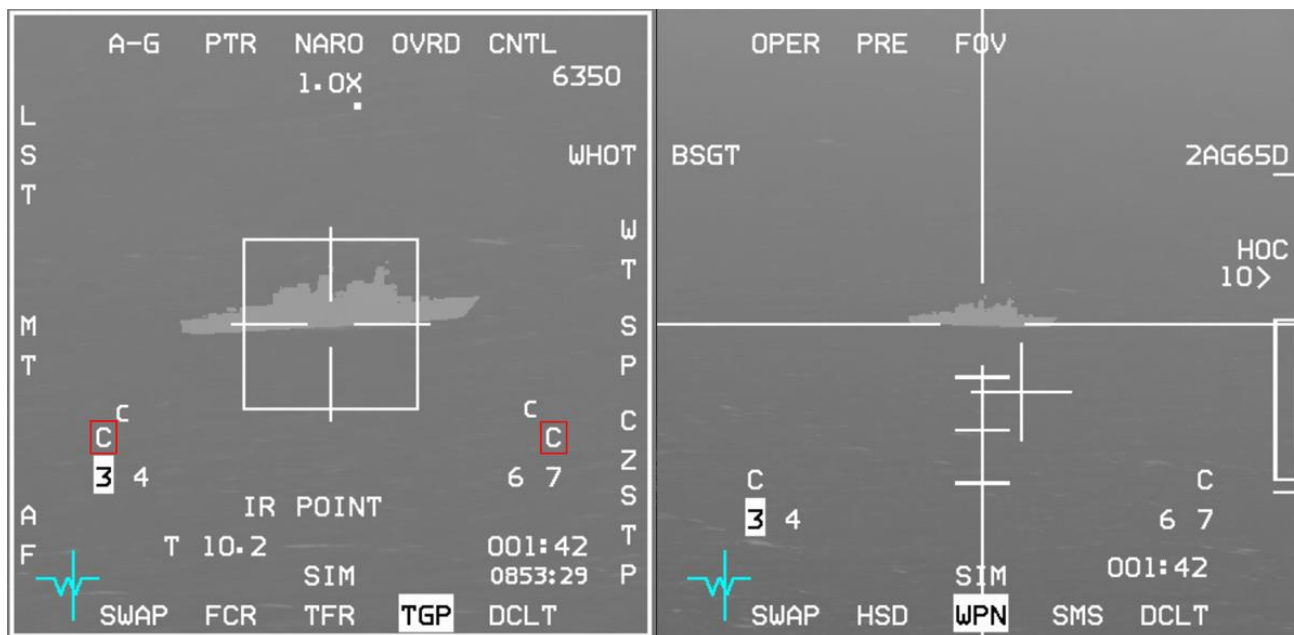
We must do the same procedure for the other pylon. Step the missile with MSL STEP on the sidestick until Station 7 is selected. Uncage the missile seeker head if you can't see any video. The WPN page may still show the cross on the target but do not designate now. First move the cursors and you will notice that the cross will move away from the target. Place the cursors back on the target, zoom in to EXP FOV and then designate with TMS up. When the track is valid and BSGT appears press OSB 20 to boresight this station.



It is a good idea to handoff the TGP target to the missile again to ensure the boresight was done correctly. The quickest way to start afresh is to cancel all locks by switching master mode. Select MRM mode, then cancel it to go back to A-G mode. The TGP is SOI on the left MFD and the WPN page is on the right MFD.

Obtain POINT TRACK on the destroyer in NARO FOV. Handoff this time will be successful. The WPN page will be looking at the same spot on the destroyer as the TGP page. To confirm handoff is complete the TGP page will display a “C” above the stores station number.

If you did get any faults during this process they may still be displayed on the PFLD but will clear now with a press of the F-ACK button. Have a quick look at the TEST page and you may also clear the MFL with OSB 3.



You may have noticed that there are different symbols appearing over the station number on the TGP and WPN pages. These symbols give the handoff status:

- I for Incomplete handoff.
- C for Complete handoff.
- S for Slave (the missile is not tracking).
- T for Track (track mode has been commanded).

We don't *need* to boresight the AGM-65G because we will use them in VIS mode to attack the bridges, though boresighting them (since 4.34 VIS mode can be boresighted too) is a good idea if you have time, as it ensures they are looking exactly where you expect, minimising the time you have to spend fine-tuning your aim on the WPN page after designating the target on the HUD (or FCR).

Bridges are not point-trackable in BMS, so they can't be handed off to the WPN page.

It is always advisable to boresight missiles, as it ensures the missile will be looking where your system point of interest (SPI) is looking, saving you valuable time, but it is only critical when targeting point-trackable targets with the TGP.

Now that the AGM-65Ds are boresighted we can power them down to conserve battery life. They will power on west of Steerpoint 5. The weather isn't getting any better and we are approaching feet dry. We'll ingress in AUTO TFR set at 500 feet SCP. Select the TFR page, set the SCP and don't forget to engage weather mode (WX) as soon as you see rain which will clutter the TFR display. Engage AUTO TFR and let the aircraft descend to its SCP. A/P STRG SEL can be blended with TFR but exit A-G master mode if you want to enable auto steerpoint as it does not work (on purpose) in A-G mode. If you choose to stay in A-G mode you will have to change steerpoints manually.

But first let's reset SPI with the usual routine of TMS down, Wide FOV, Cursor Zero. Remember, if you don't do that the SPI offset/delta (from boresighting the Mavericks) will remain active for all steerpoints, including the target, which will make finding and targeting the ZSU-23s even harder. Also change the FCR from SEA back to GM (Ground Map) mode. Once all that is done set A-LOW to 10% less than SCP.

The TFR is a huge help in these situations. It will fly the aircraft for you at low level while you concentrate on the upcoming attack. All you have to do is monitor the TFR and keep your attitude and airspeed within the TFR limits. Do not hesitate to override the AUTO TFR with the paddle whenever you want to steer around mountain peaks. While doing so the MAN TFR box will be displayed in the HUD, as will LIMITS if your bank angle is excessive. Don't push the LIMITS too far and resume AUTO TFR when steering is no longer required.

After passing Steerpoint 5 check on the SMS page that the Mavericks powered back on as planned. Set your cockpit: A-G master mode, MASTER ARM to ARM, MFDs set up as above, fuel & switches checked.



The target area is located on a plateau and you are coming up the valley at low altitude. Clouds are random; especially the cumulus, so you can expect to have only a limited amount of time to acquire the targets. Increase SCP to 1000 feet and A-LOW to 900 feet. As you do, your RWR may start chirping with AAA noises.

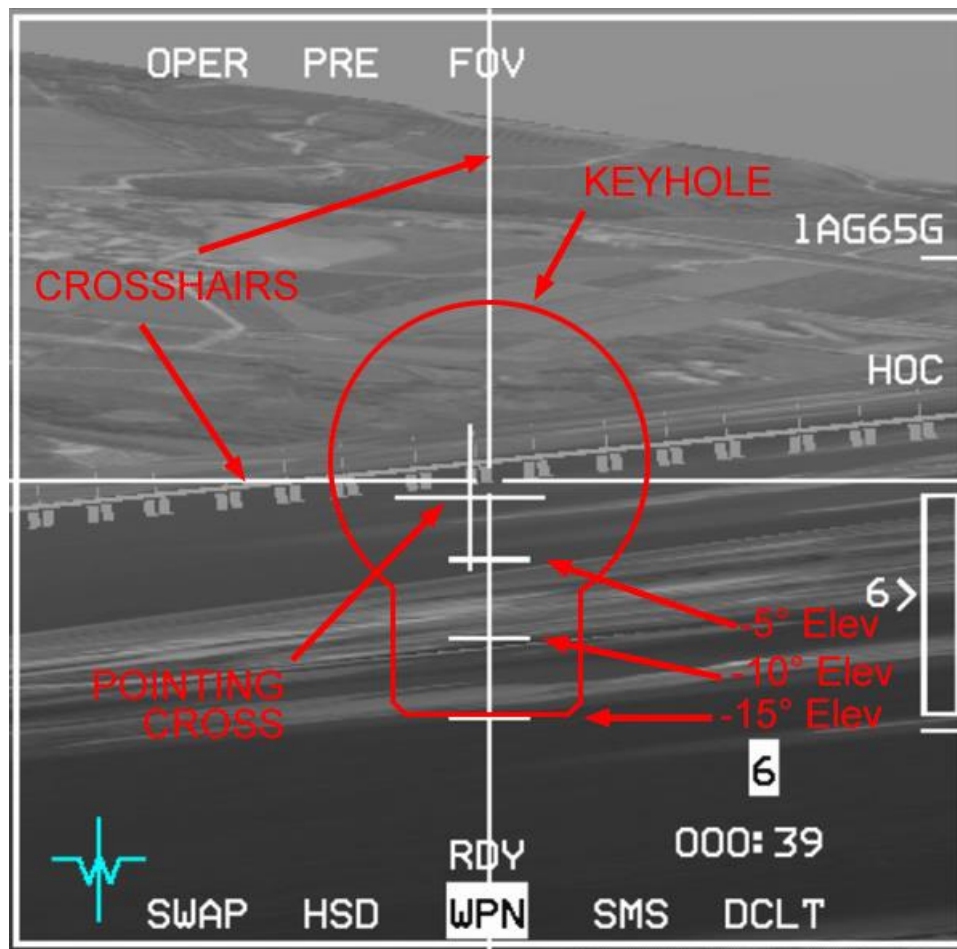
First let's discuss the requirements for a valid Maverick shot:

- In range (caret must be within Missile Launch Envelope staple (MLE) in HUD and on WPN page).
- Weapon Pointing Cross steady (i.e. it must not be flashing).

Checking the range is pretty straightforward; most Maverick misses are caused by pilots firing when there is a flashing pointing cross in the WPN page. There are a number of conditions for the pointing cross to be steady, signifying a valid missile track.

Obviously all the launch restrictions documented earlier in this chapter must be respected: speed less than Mach 1.2, bank angle max 30°, dive angle max 60°, roll rate max 30°/s, max load factor 3G, min load factor 0.5G and last but not least the weapon LOS must be within missile gimbals.

The Maverick gimbals are 10° in azimuth and 15° in elevation. The 5, 10 and 15° down elevation limits are displayed as horizontal tick marks in the WPN page (for D or G models) but the azimuth gimbals are not. The gimbal LOS of the missile is actually shaped like a keyhole centred on the WPN page crosshairs.



To ensure a valid missile track after launch the pointing cross must be within that imaginary keyhole. If it is not it will most likely flash, indicating an invalid track and the missile will almost certainly miss.

If the pointing cross is outside the keyhole you must turn your aircraft more towards the target and designate your target only when the pointing cross is within the keyhole. On the same note if you are outside the launch limits explained above at the time of lock up then the pointing cross will also flash, and the missile will miss.

If you do not have a valid track on the target TMS right (with TGP SOI) to reject the handoff target and TMS up again to acquire a valid track and handoff to the Maverick missile when you are able.

Having a steady pointing cross is critical to a valid missile track and therefore a good target hit!

The crosshairs are reaching up to the designated target. They will blank around the target to avoid confusing target recognition. The size of the blank depends on target size.

Please note crosshairs, weapon pointing cross and elevation tick marks also change colour. They can be either white for Hot on Cold (HOC) when the WPN page tracks only white targets or black for Cold on Hot (COH) polarity where the WPN page will only track black targets. Polarity can be changed hands on with TMS LEFT for the AGM-65G.

Missile gimbal limits should not be a factor in this scenario though, as we are approaching the target from head on and the pointing cross will be in the keyhole.

If the cloud situation allows, you may choose to force the TFR to fly higher so you can acquire the target earlier and then let the TFR descend back to 1000 feet SCP. You may choose to acquire targets on the FCR first or just use the TGP according to your proficiency level and your knowledge of the target location in the convoy. ZSU-23s are quad barrel AAA guns mounted on a tracked vehicle. They should be easily identifiable from the rest of the trucks and BMPs in the column. Remember they are on the right (east) of the village.

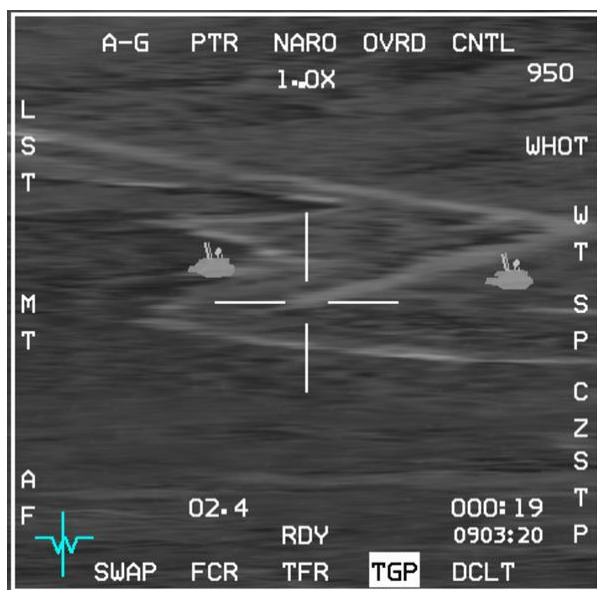
Quickly designate the first ZSU on the TGP with TMS up to command Point Track. Notice HANDOFF IN PROGRESS on the WPN page and a couple of seconds later the handoff will be complete with the crosshairs centred on the designated ZSU and a 'C' above the weapon station. Check for a steady pointing cross. The first missile is ready to fire.

Now for the second missile. Hit MSL STEP to select the next missile, then command Point Track on the second ZSU with the TGP and wait for handoff complete on the WPN page. Check again for a steady pointing cross. Now both missiles are ready to be fired.

Of course you don't really need to designate both and then fire both. You can designate – fire - designate - fire. But ripple fire is very rewarding and firing the Mavericks at the same time (or in very quick succession) avoids the IR bloom from the first missile's rocket blinding the seeker on the second missile.

Note that after bore sighting you no longer need to reacquire the target on the WPN page, it is automatic. Target acquisition and track is made on the TGP and handed off to the missile. All you have to do on the WPN page is check for a steady pointing cross to confirm valid track and make sure you're in range before firing.

When the missiles are slewed or tracking the HUD shows both missiles LOS as 10 mr (milliradians) circles. The TD box is also displayed and points at the SPI. If The TD box and AGM LOS are both at the same position only the TD box will be displayed as it has display priority. This is the case in this example: the TGP is still looking at the latest locked target: the first missile to be launched will destroy that target. The next station was handed off earlier and is the next to shoot missile. It is no longer being looked at with the TGP; its missile LOS is drawn with a 2 on the HUD. The 2 means it's the second missile to shoot.



A 1 next to the LOS circle would indicate it would be the first missile to shoot. You would see this if the TGP was moved away from the AGM LOS. You can use MSL STEP to toggle the firing sequence. Note: the square symbol underneath the 10 mr circle indicates a completed handoff.

Ripple fire the missile by pressing the pickle button twice quickly and then immediately turn away from the target before the AAA shreds your aircraft. If you set the SMS page Ripple option to 2 a single press of the pickle button will send both missiles away, whether they have a valid track or not, so be careful when using this option.



If you couldn't fire at the ZSU in time, break off the attack and try again if you want, but remember the surprise is gone now and the AAA (and possibly manpads) will be waiting for you when you return. Expect to be greeted with a deadly stream of tracers and shoulder launched missiles if you get too close. Start the mission from scratch if you prefer, after analysing what went wrong. The challenge is hard, but it is doable.

If you managed to locate and destroy the AAA though, congratulations. The convoy is now all but defenceless and the A-10s will make short work of them in the afternoon. Hopefully the weather will clear for them.

We still have a bridge to destroy, so let's reference Steerpoint 8 and remember to stay low, as the area is still being protected by that long range SA-10 battery.

Reset SPI as usual with TMS down - Wide FOV – Cursor Zero and reset the TFR to 500 SCP and the A-LOW to 450 feet. Approaching Steerpoint 10 you should overfly a large river leading to the target bridge located at the river estuary. Follow the river to your target at Steerpoint 11.

The target is a multi-span bridge and the idea is to destroy two different spans with the two G Mavericks in VIS mode. Select the two remaining AGM-65Gs with the SMS page and select VIS mode with OSB 2.

The HUD is made SOI by default, indicated by the asterisk in the top left corner and the TD box is placed on the FPM. You can move the TD box in the HUD with the cursors. Place it on the outer left span of the bridge. TMS up to ground-stabilise the TD box and SOI automatically transfers to the WPN page.

Refine the cursors if necessary and once you are happy, designate with TMS up to command track. The missile LOS will then be displayed in the HUD as a 10 mr circle as before.

Check the pointing cross; if it's steady fire the missile.

The picture on the next page illustrates the HUD with the TD box, the steerpoint diamond and the AGM LOS as the aircraft flown by AUTO TFR is approaching the target. Notice the lack of the small square under the HUD missile LOS as the Maverick wasn't handed off from the TGP (the bridges aren't point-trackable).

Note: always go to EXP FOV (OSB 3) before commanding track. It *significantly* increases the chances of a steady pointing cross.



When you command a missile track from the WPN page the missile doesn't always lock at the exact same spot you commanded the lock. It may move LOS slightly because of the centroid track mode of the missile.

To force the missile to track the exact spot you designated you must use the force correlation track mode, only available with the AGM-65G. This mode is very useful when you want to target specific parts of a larger target such a building door, a bunker entry or even an aircraft parked inside a hardened aircraft shelter. To illustrate this feature we will target the third bridge span from the right with the last missile.

Move the cursors to the right of the bridge and select the third span. Designate when ready and notice how the centroid mode tracks the 5th span (bottom left picture). TMS down to reject the track and press OSB 7 to cycle options until AREA is displayed, to select force correlation mode. Move the cursors to the third span. Aim for the lowest possible spot on the span and designate with TMS up. When lock-on occurs the crosshairs will close and the missile will track the intersection of the crosshairs. Check for a steady pointing cross and if in range let the last missile go. It will hit the exact spot your weapon page was tracking.



As you may have noticed this training mission isn't an easy one. There are a lot of things to manage: TFR, weather, avionics, weapons; all at the same time. Accurate planning, knowledge of the avionics and proper system configuration are all necessary for the success of this mission. We don't expect you to succeed the first time you fly it.

The weather makes this mission particularly difficult (but incredibly immersive). The weather is now so powerful in BMS that it brings an element of randomness and a completely new perspective to regular TE's.

We understand that this training mission might be too much of a challenge for initial Maverick training. That is the reason we decided to provide the same training mission with sunny skies and calm winds. Without the ceiling, turbulence and clouds you will have much more time to acquire the target, work the avionics and pace your attack to achieve successful missile launches and build your proficiency, before challenging yourself to do all of that while coping with the worst that the weather can throw at you.

Note also that the unpredictability of the weather will mean on different flights you may encounter weather that will throw your best plans out; low cloud near the target area giving you no time to acquire the target or low cloud/fog in the valleys making your approach totally reliant on your TFR when you fly through cloud at very low level and can't see a thing, just like in real-life. ☺

We hope you will realise how much more important a factor the weather can be now, not just in planning and flying TEs, but also if you create your own.

Maverick HOTAS summary:

Throttle:	UNCAGE:	Blow dome cover (AGM-65A, B and D).
	CURSOR/ENABLE:	Change E-O delivery mode when WPN is SOI (PRE – VIS – BORE).
	Cursors:	Move cursor on SOI (HUD, FCR, TGP, WPN).
Sidestick:	TMS up:	Command track on SOI.
	TMS down:	Reject track on SOI.
	TMS left:	Change polarity (AGM-65G only).
	TMS right:	Reject handoff target (TGP SOI). Toggle AREA/Polarity (AGM-65G WPN SOI).

MISSION 14: AGM-65 MAVERICKS (CAVOK)

Same mission as 13, but without the weather. Use chapter 13 for mission description.

MISSION 15: INERTIALLY AIDED MUNITIONS

LOCATION: Inbound YangYang VORTAC 43X (STPT 4) on the east coast of South Korea.

CONDITION: F-16 block 50 – Flight of 2 - Callsign Sparky 3.

Lead: GW: 42166 lb. 4 AGM-154A JSOW - 2 wing tanks – TGP and A-A missiles.

Max G: 5.5/-2.0 Max speed: 550 kts / 0.95 Mach.

Wingman: GW: 40800 lb. 2 GBU-31(v)1/B - 2 wing tanks – TGP and A-A missiles.

Max G: 5.5/-2.0 Max speed: 550 kts / 0.95 Mach.

Once in the cockpit the training scripts will freeze BMS and setup your systems as usual.

GOAL: Attack & Destroy HQ battalion and Mech battalion just North of the DLZ.

Air defences: AAA & SHORAD and SA-3 at target, SA-4 north of target.

WEATHER: RKTY INFO: B 011755L RWY08 TRL140 360/20KT 9999 OVC 040 25/15 Q995.

Inertially Aided Munitions (IAMs) are INS or GPS guided bombs providing standoff capabilities for Air to Ground attack. Since BMS 4.33 they have been correctly implemented as JDAM (Joint Direct Attack Munition), LJDAM (Laser Joint Direct Attack Munition), JSOW (Joint Stand Off Weapon), WCMD (Wind Corrected Munition Dispenser) and SDB (Small Diameter Bomb).

For a full explanation about IAMs, please refer to the TO-BMS1F-16CM-34-1-1 in your Docs folder.

This training scenario will document JSOW and JDAM procedures. Sparky 3-1 will be the JSOW shooter on both HQ and Mechanised battalions and Sparky 3-2 is loaded with JDAMs to destroy the Dalsan bridges. The training mission can be flown single-ship in either of the positions, or multiplayer by alternating roles.

15.1 JSOW

For this section, select the flight lead position of the training flight.

JSOWs are gliding cluster weapons that guide to their target using INS/GPS coordinates. Their range varies according to release altitude. The ideal range is usually around 20 Nm from 25000 feet. Since they use INS/GPS to guide they can be used in zero visibility and unlike laser guided munitions they are not impacted by moisture and clouds. Two AGM-154 versions are available in BMS: the AGM-154A is most effective against soft targets; the AGM-154C is best used against hard targets. In this training mission we will drop the AGM-154A version against vehicles. The interesting fact about A model JSOWs is that the pilot can program their final heading and altitude to best match the target geometry to cause maximum damage.

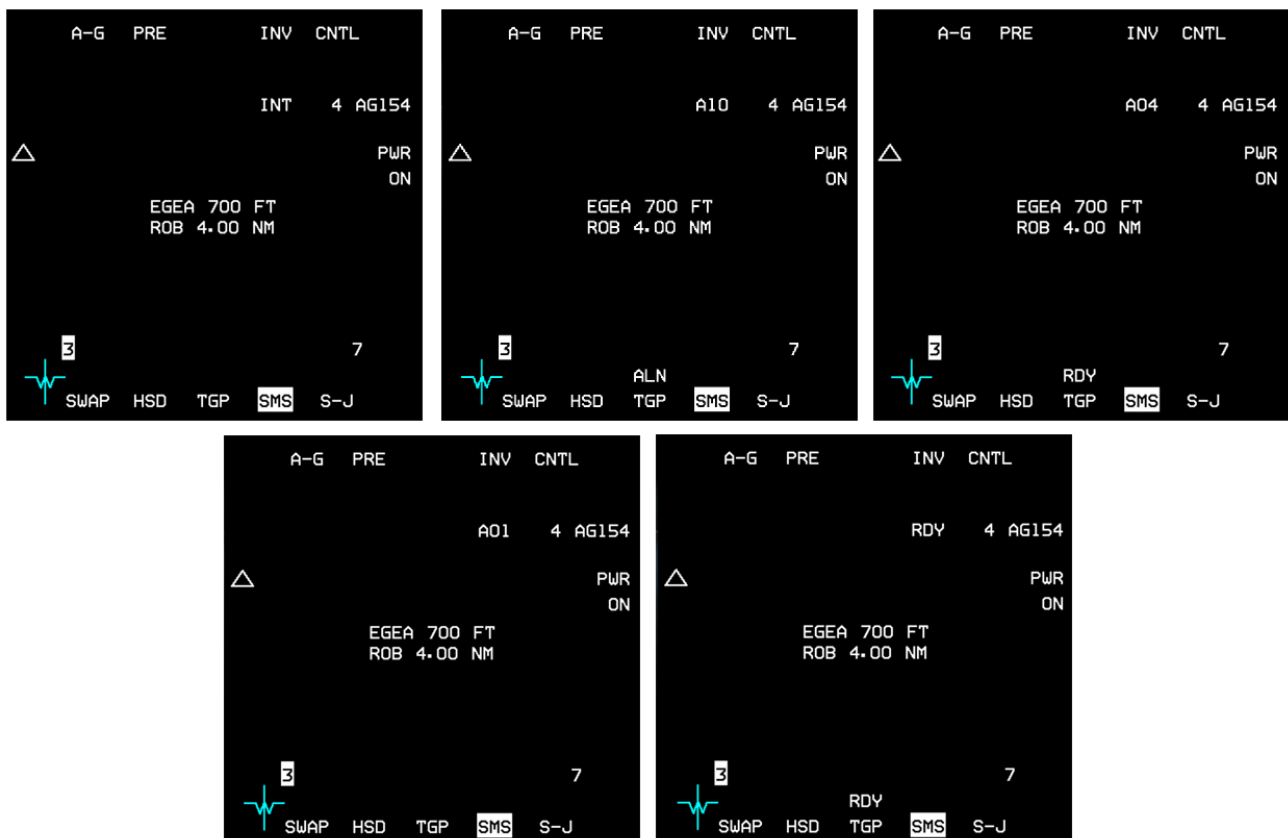
This training scenario reflects the early days of a BMS campaign where HART site targeting is executed to soften up enemy artillery as allied armour progresses against enemy lines. We will target Dalsan HART site, where reconnaissance flights spotted enemy HQ and Mechanised battalions earlier in the day.

JSOWs are heavy weapons usually carried in pairs on stations 3 and 7. Each weapon weights 1520 lbs. When carrying 4 don't expect your jet to react swiftly, so plan your flight accordingly. You'll be slow and will need a lot of time to get to high altitude. Don't even think about air to air combat with 4 pigs under your wings.

The training mission starts enroute to Yang Yang VORTAC 043X. Altitude should be ~ 24000 feet. You can select AP Steering and Pitch altitude mode. JSOWs need a bit of time to align their INS, so the first thing you should do is to select the SMS page and power on the JSOWs. You don't need to power all 4 weapons individually.

The initialisation sequence (Mass Data Transfer) of the weapon will show various mnemonics in the SMS page. After initial power up the weapons will first initialise (left picture), then start their alignment process (centre picture). While alignment is in progress the ALN mnemonic is displayed above OSB 13 and the INT mnemonic left of the weapon type is replaced by the alignment status counting down from A10 to A01 to RDY, which is fully aligned. The weapon reports sufficient alignment from A04. At that point the ALN mnemonic above OSB 13 will be replaced by RDY if the MASTER ARM switch is in ARM, or by nothing if the MASTER ARM switch is in SAFE (see picture 4 below) and by SIM if the switch is in SIM.

Note: Any weapon release before A04 status has a high probability of miss as the alignment is marginal.



The whole alignment process up to A04 takes about 95 seconds. A full alignment to A01 then RDY takes about 140 seconds. In general you should plan for a 3 minutes alignment time requirement.

In this training scenario the weapons should be aligned and ready no later than overflying the VORTAC at Steerpoint 4.

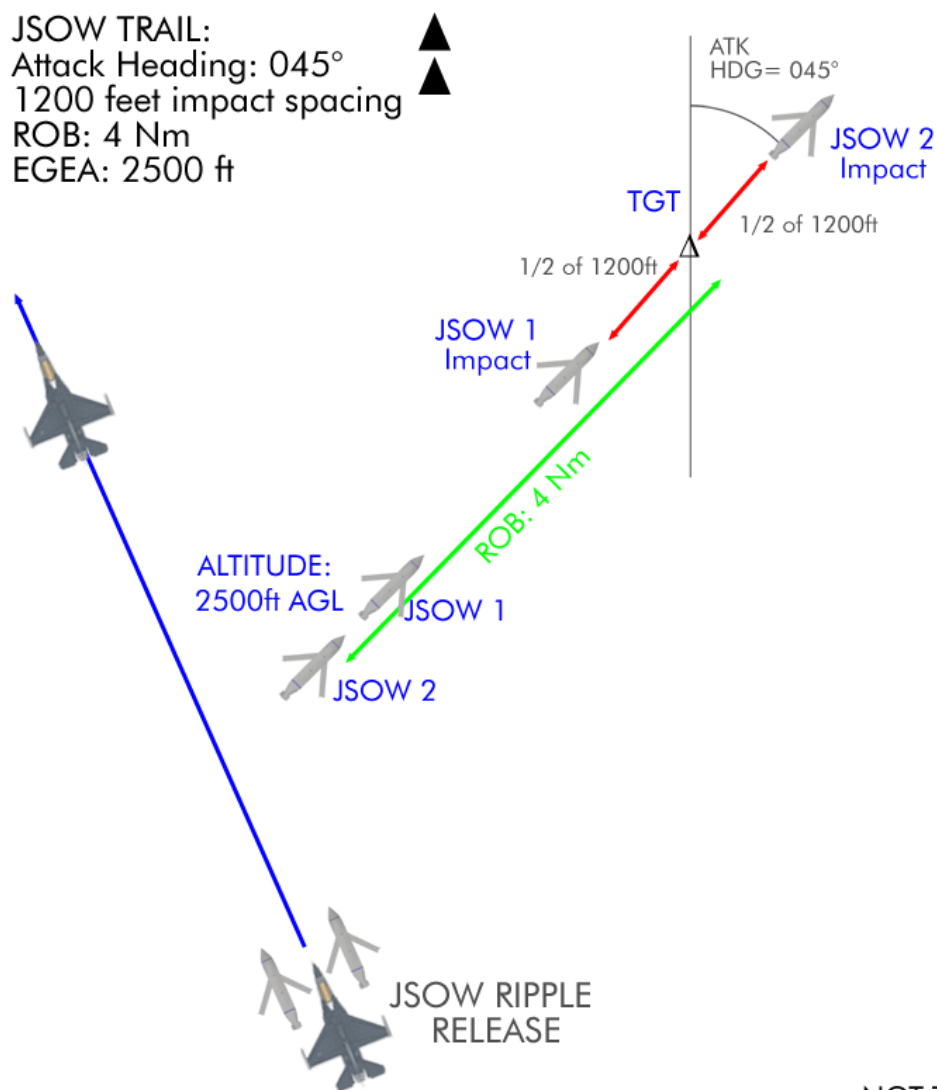
While the INS/GPS of the JSOWs align you can setup your attack parameters. OSB 19 displays \triangle which represents a JSOW. In this configuration a single JSOW is programmed for release. If you press OSB19 the \triangle will be replaced by $\triangle\triangle$ indicating 2 JSOWs side by side release and a further press of OSB 19 sets a trail/tandem formation of 2 JSOWs. The symbols are then stacked on top of each other. OSB 19 therefore sets the ripple mode of the weapon. When either side by side or trail/tandem is set a further spacing option appears next to OSB 18 on the SMS page.

Press OSB 18 to set spacing between the two glide bombs. A new page will be displayed where the spacing can be input and entered in the system with OSB 2 ENTR.

Upon returning to the SMS page the spacing will be displayed next to OSB 18.

When $\triangle\triangle$ side by side is selected the JSOW will fly in a spread formation spaced by the distance entered in the SMS page. The left bomb will hit a point left of the target at half the distance spacing; the right bomb will hit right of the target at the same half spacing distance. The target therefore lies at mid-point between the two impact points.

When trail/tandem is selected the JSOW will follow each other separated by the distance entered in the SMS page. The lead bomb will hit the short point (before the target) at half spacing distance and the trailing bomb (second released) will hit the long point (past target) at the same half spacing distance. The target therefore lies at mid-point between the two impact points.



The choice between options will depend on the target geometry, as we will see later on. If we are able to align the JSOWs final heading with the axis of the target, trail formation will provide a better result. If on the other hand the JSOWs attacks the target at a 90° angle, side by side will be more effective.

Determining the best spacing is also dependent on target geometry and the ripple option. If the target is long, like the vehicle column in this training scenario, spacing will be important. If the target is condensed in a small area, spacing can be tighter. You may use the TGP meterstick or frag pattern to evaluate distances.



Passing steerpoint 4 the JSOWs should report RDY, although they may not yet be fully aligned.

Set course to Steerpoint 6 (approx. 295°) and let the AP fly the aircraft, while you manage the systems.

The CNTL page of the SMS allows you to set ATK AZ (Attack Azimuth), EGEA (End Game Entry Altitude) and ROB (Range on Bearing). These parameters allow you to set the final heading and altitude the JSOW should fly at from a certain distance from the target. Obviously the azimuth serves to align the weapon course with the target geometry and the altitude sets the height at which the JSOWs will release their bomblets, and therefore defines the footprint of the impact zone on the ground. As with any other CBU in BMS the burst altitude should actually be called burst height, as it is a distance from the ground and not an altitude. ROB sets the distance at which the weapons should be aligned with their target axis.

To be able to choose the best options we first need to have a good picture of the target geometry. So we need to get closer to the targets and paint them on radar before deciding how to attack. In some cases it could be done at flight planning when the target is spotted and visible on the UI map. Recon the target to determine the best weapon heading and attack settings.

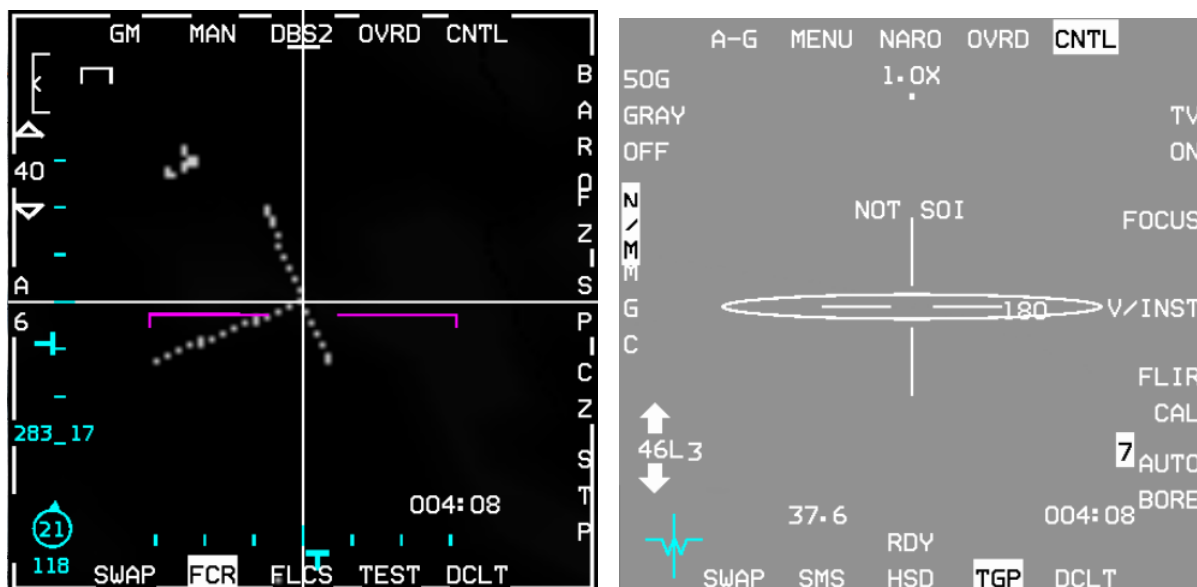
The target is about 35 Nm away and you know the optimal launch envelope for the JSOWs at this altitude is around 20 Nm. We have 10-15 Nm to define target geometry and plan our attack.

Set A-G FCR to a 40 Nm scope and ensure the TGP is set to A-G and the N/M (North/meterstick) option is active on the TGP CNTL page. The target should be visible on the FCR, but we need to get a clearer view by going into Expanded DBS2 mode. We now clearly see two different vehicles columns in the target area.

The FCR vertical line is representative of our current heading: 295°. As you can see the first column is angled about 10-15° to the left and the second column is angled about 60° to the right. We can now estimate the axis of the first column to 270° and the axis of the second column to 360°. We will set an attack azimuth of 270° and attack the right column (270°) with two JSOWs in trail, then attack the left column (360°) with a 270° attack azimuth, but this time with two JSOWs side by side.

The TGP is useless because of the weather conditions at this distance. The frag pattern has been selected to 1280 feet and displayed through the menu (OSB 2) of the Control page (define the options with TMS).

This draws an ellipse on the TGP 600 feet around the target. Once the target becomes into view, the side of the ellipse should give us an estimation of the JSOW separation at impact.



It's best to fire JSOWs at INS steerpoints rather than cursor positions, so we need to mark both centres of the columns and use them as our attack INS steerpoints. As both attack axes are different, we'll also have to set the first two bombs for the 270° column, (right one, almost vertical) ripple the first two JSOWs, then program the SMS for the next column axis (360° - left one – almost horizontal) before releasing the last 2 bombs.

As you ingress, keep an eye on that SA-3 right of your route. Don't trespass its WEZ.

First designate the centre of the right column on the FCR.

Select the ICP MARK page and hit TMS up to create Markpoint 26.

As the FCR was tracking, the MARK page defaulted to FCR MARK. When the Markpoint is created, press M-SEL to make it the active steerpoint.

```

MARK * FCR *
MKPT 26
LAT N 38° 26.274'
LNG E 129° 08.387'
ELEV 1092FT

```

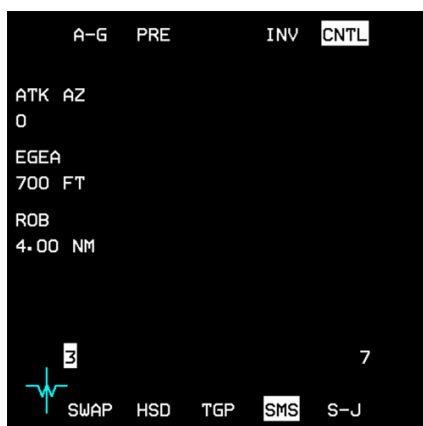
Un-designate the A-G FCR, cancel slew by hitting Cursor Zero (CZ) and move the cursors to the centre of the left column. Ensure the MARK page is still active and press TMS up to create Markpoint 27 for the second column axis. Note this doesn't designate on the FCR as the MARK page has ownership of the TMS. Cancel all slews by hitting CZ (OSB 9) on the FCR. This is critical to avoid any unwanted cursor slews. Both your attack INS steerpoints have been created.

```

MARK * FCR *
MKPT 27
LAT N 38° 27.217'
LNG E 129° 08.467'
ELEV 1372FT

```

Markpoint 26 is selected as the current steerpoint; that's our first target: the right column with an axis of 270°. Let's select the SMS CNTL page and enter 270° as ATK AZ, 2500 feet for EGEA and 4 Nm ROB. 2500 ft AGL seems a good altitude for cluster munitions and ROB is left at the default of 4.0 Nm.





Exit the SMS CNTL page and check the JSOW settings and RDY status:

- JSOW set to ripple trail.
- 1200 feet spacing.
- Attack Azimuth of 270°.
- End Game Entry Altitude: 2500 ft AGL.
- Range On Bearing: 4 Nm.
- JSOW status: RDY.

The JSOWs are ready to be released. We just need to wait until the HUD reports JSOW in Zone (JIZ), around 20-22 Nm from the target steerpoint. The JIZ indication will be blanked for altitudes above 40000 ft, airspeeds below M0.6 or above M0.95, pitch or bank angles greater than 30° and when target bearing exceeds 60°.

When JIZ is displayed, press and hold the pickle button; IAMs need about 1.6 seconds weapon release consent. As you are rippling two, make sure you keep the pickle depressed for at least 3.2 seconds. Failure to keep the pickle depressed long enough may result in hung weapons.

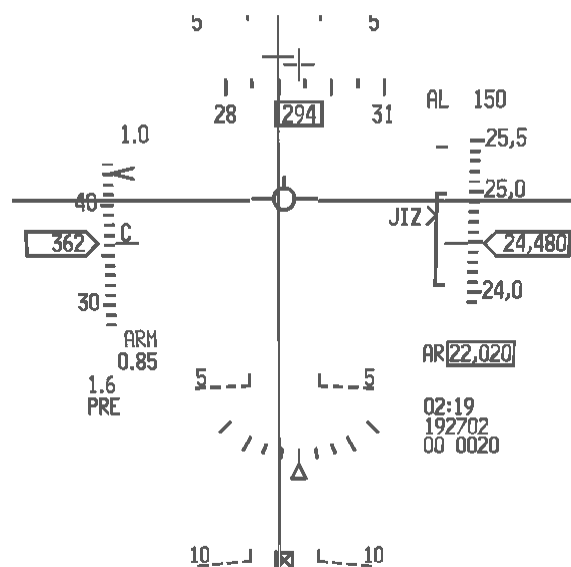
As the bombs release the FPM will flash and the RDY status will be replaced briefly by REL for release.

When both of the first pair of JSOWs have been released select STPT 27 for the second column. Don't forget, or you will send the second pair to the same location as the first!

We will keep the same attack azimuth of 270°, but set the ripple to side by side. As the column is oriented 360°, 90° off side by side will provide the best attack geometry. Leave spacing at 1200 ft.

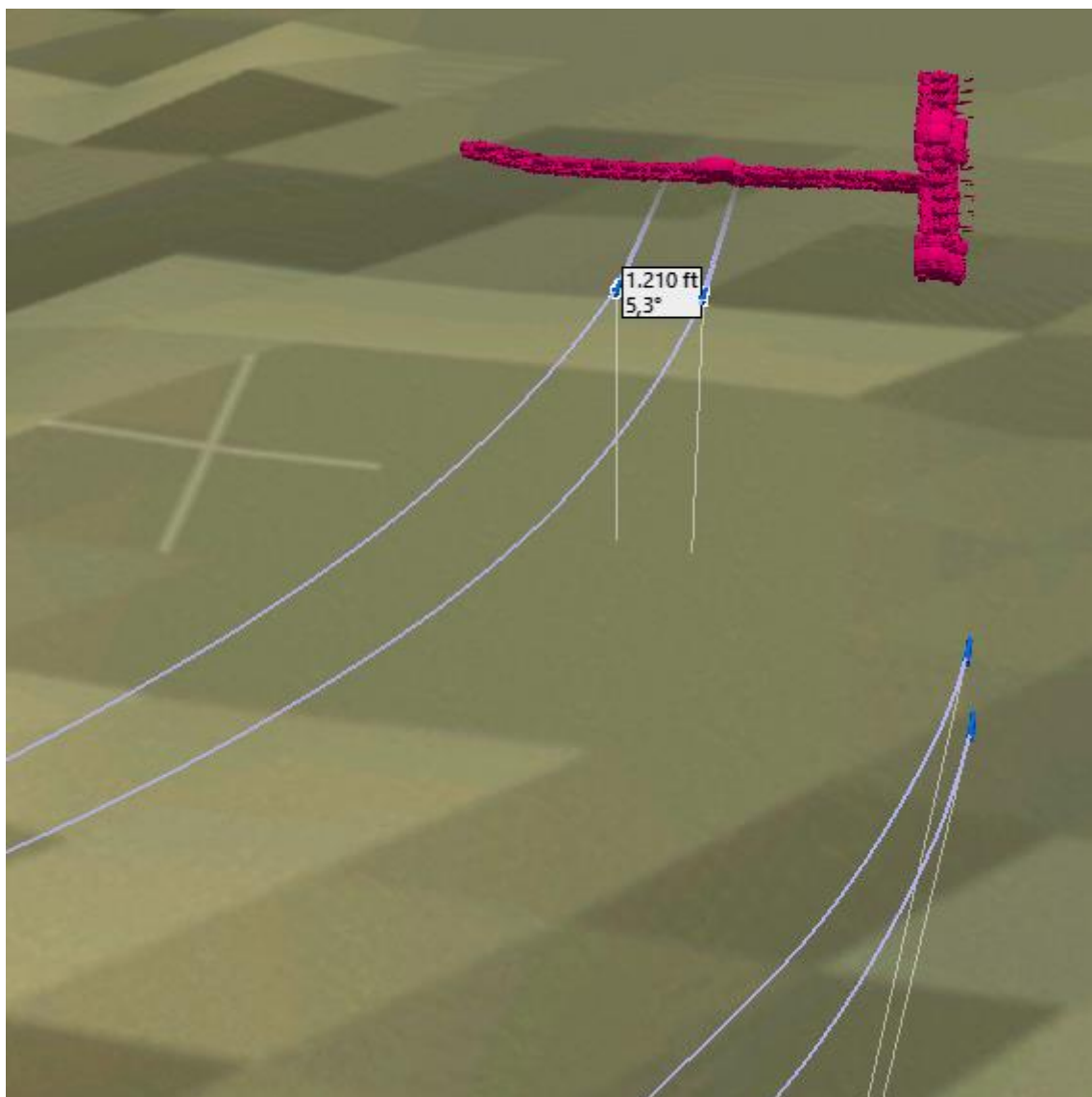
Once you are confident that settings are correct and JIZ is displayed in the HUD DLZ depress and hold the pickle again for just over 3 seconds and monitor the JSOWs release.

After weapon release your CAUTION light will come on indicating a CATI/III mismatch. Switch to CAT I with the relevant switch on the left auxiliary console.



Don't fly too close to the columns as there is another SA-3 protecting them!

If any weapon fails, the station number will be replaced by either H for Hung, D for Degraded or F for Failed. That weapon will be unusable for the remainder of the mission.



The second side by side pair (released last) will hit the 360° column first, perpendicular to the column axis. The first pair released (right on the picture above) is flying in trail and aligned with the 270° column. JSOWs are unpowered, so very slow and will take quite a bit of time to get to their target.

The first rippled weapon in a trail formation hits the short point. The second weapon hits the long point. The cluster munitions will cause a huge amount of damage in both enemy vehicle columns, but looking at the result with the ACMI, 1200 feet spacing could have been increased to 2000 ft. There is your excuse to restart this training mission with a better spacing.

As soon as all 4 JSOWs are gliding towards their target turn your aircraft away from the enemy air defences. Select steerpoint 6 to exit the target area, staying out of the SAMs pre-planned circles.



Follow your INS flight plan back to Yechon. Congratulations on a job well done.

15.2 JDAM

For this section, select the wingman position of the training mission. As you fly wingman you may hear your AI lead giving instructions to attack his target. Ignore him or change your VHF frequency away from preset #15, so you can concentrate without his constant calls.

JDAMs are conventional bombs fitted with a GPS/INS kit. They fall ballistically and don't have the standoff range of gliding bombs like JSOWs or SDBs. In BMS the F-16 can carry the GBU-31(v)1/B based on the Mk-84 2000 lb bomb, the GBU-31(v)3/B based on the 2000 lb BLU-109 penetration bomb and the smaller GBU-38B based on the 500 lb Mk-82 bomb.

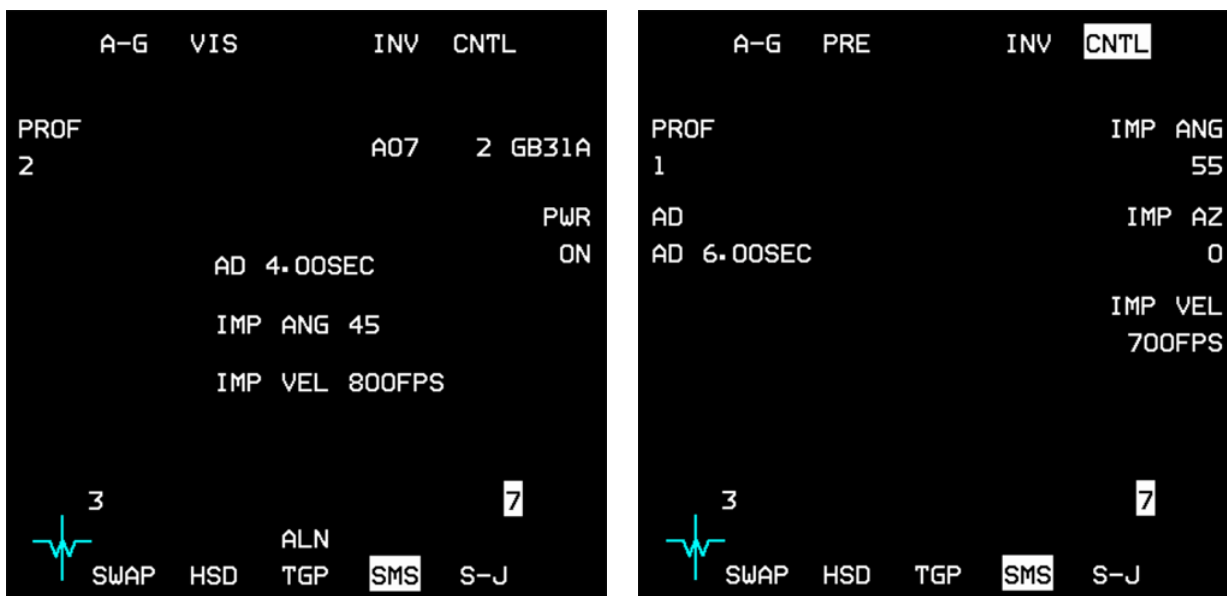
In this training scenario the wingman is tasked to destroy bridges with 2000 lb GBU-31(v)1/B bombs, loaded as with all IAMs, on stations 3 and 7.

JDAMs are primarily meant to be used on INS target steerpoint coordinates. TGP might be useful to designate and drop JDAMs, but it is not mandatory. As you have checked the weather briefing you know you can expect a cloudy situation in the target area and TGP target identification might be limited. Luckily the targets coordinates were clearly identified before the flight in the Recon screen:

- Dalsan (South) bridge: N38°21.463" E129°34.837" Elevation 1573 feet (275°/095°).
- Dalsan (North) bridge: N38°23.466" E129°34.298" Elevation 1895 feet (265°/085°).

JDAMs need to be powered up and aligned like other IAMs, so as soon as you enter the cockpit power them up on the A-G SMS page. While they align we can set additional options on the CNTL page.

JDAMs allow the pilot to set 4 different profiles, accessible with OSB 20 on the A-G SMS page. Each press will toggle between 4 profiles, containing settings for: Arming Delay (AD), Impact Azimuth (IMP AZ), Impact Angle (IMP ANG) and Impact Velocity (IMP VEL). The last two are not implemented in BMS at this stage.



Since we have two different targets to destroy we will create two distinct profiles, so we can quickly swap settings between the two bomb drops. Profile 1 will be used on the Dalsan South Bridge (first target STPT 5) and Profile 2 will be used on the Dalsan North Bridge (STPT 6). This will be quicker than going to the CNTL page and changing the impact azimuth between the two bomb releases.

Choosing the right impact azimuth is not easy and requires careful planning. Obviously it depends on the target situation, but also from where you intend to drop the bomb. If the impact azimuth requires impossible turns for a ballistic bomb the weapon will override the impact azimuth and fly direct to the target. If you are too close to the limit you may never see the correct HUD Launch Acceptable Region (LAR) indication and fail to release the bomb in the right envelope. Once again planning is the key and the relation between aircraft heading, impact azimuth and target position must be considered to ensure a release allowing the bomb to fly the impact azimuth.

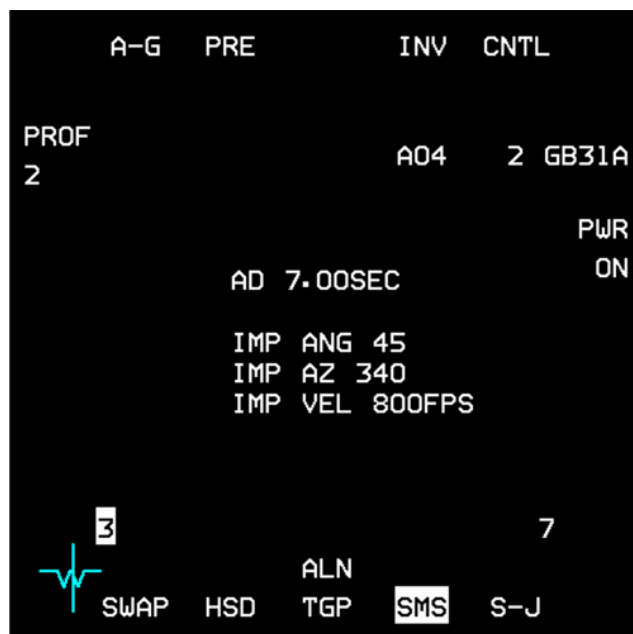
In this case our flight approaches the target from the South East on a 300° heading. The targets are slightly right of the route and oriented east/west. In that configuration, if you request an impact azimuth of 090° for instance, the bomb would have to turn 150° to the right to comply. That will seriously decrease your range, preventing the LAR2 from being displayed in the HUD and will almost certainly force the bomb to override the settings and fly direct to the target. To ensure a good envelope you must try to plan for an offset of no more than 60° from the target bearing. In this scenario we will set an impact azimuth of 350° for the 1st target (Dalsan South Bridge) and 340° for the second target (Dalsan North Bridge).

Enter the SMS CNTL page and check that PROF 1 is selected. All changes made to this configuration will only be made for the selected profile.

Ensure delivery mode is set to PRE and press OSB 19 to set an arming delay of 9.00 seconds. When you hit ENTR (OSB 2) the SMS will return to the CNTL page. Press OSB 7 to set an impact azimuth of 350° and press ENTR. The last two options (impact angle and velocity) can be left at default.

Next, select PROF 2 with OSB 20 and enter the following settings: Delivery mode: PRE. Arming delay: 7.00 seconds. Impact Azimuth: 340°. Impact Angle and Impact velocity left at default.

Once done, exit the control page and check the different options are displayed for Profiles 1 and 2 in the centre of the SMS page by toggling OSB 20.



You will notice that impact azimuth is not available when the release mode is set to VIS (PROF 4 for instance). In such cases the weapon will fly direct to its INS target. JDAMs set in PRE mode with an impact azimuth of 0 will also fly direct to their target.

Your IAMs are all set and you are probably close to Steerpoint 4. If you haven't done so already you may engage steering autopilot so you can concentrate on the avionics.

As we have two targets and no attack steerpoints defined, we must input the target coordinates into the INS system. We will assign the closer target (Dalsan South Bridge) to STPT 5 and Dalsan North Bridge to STPT 6.

We could do this directly from the STPT page, but to prevent changing the active steerpoint, while we are in autopilot, we will use the DEST page instead.

Select the UFC DEST page (ICP LIST 1) and choose STPT 5, either by pressing ICP 5, or by using the ICP arrows until 5 is displayed.

Ensure the scratchpad is on the Latitude line and enter the Latitude of Dalsan South Bridge by starting with ICP 2 for North, then 3821463 and press ICP ENTR.

The scratchpad moves down to Longitude. Start your input with ICP 6 for East and type 12934837 ENTR. Remember, you must start coordinate input with the cardinal symbol N and E.

Bomb accuracy is highly dependent on target elevation. In BMS 4.34, target elevation is not yet part of the bomb accuracy code, so although the steerpoint elevation in the DED has been updated (from 4.33, where it was indicating the flight plan altitude) to ground elevation in 4.34, changing the 1377 ft elevation to the target elevation of 1573 ft is not required, but advisable to do anyway (good practice for the future). You will notice Steerpoint 5 moved to the new coordinates in your HSD.

Toggle the DEST page to STPT 6 and place the scratchpad on the Latitude line. Start entering the full coordinates for the other bridge: N3823466 E12934298, elevation 1895 feet and check that STPT 6 moved position on the HSD.

Attack steerpoints are set; weapons are set. All we need to do now is to monitor the HUD for LAR, release the first bomb, toggle to Profile 2, select STPT 6 and drop the second JDAM.



Exit the DEST page back to the CNI page, select STPT 5 and monitor the autopilot turning the jet towards the first target. Time for FENCE checks: MASTER ARM to ARM, STPT 5 (first target) selected in UFC, master lights switch OFF, Cursor Zero, SMS set to PROF 1, IAMs status RDY.

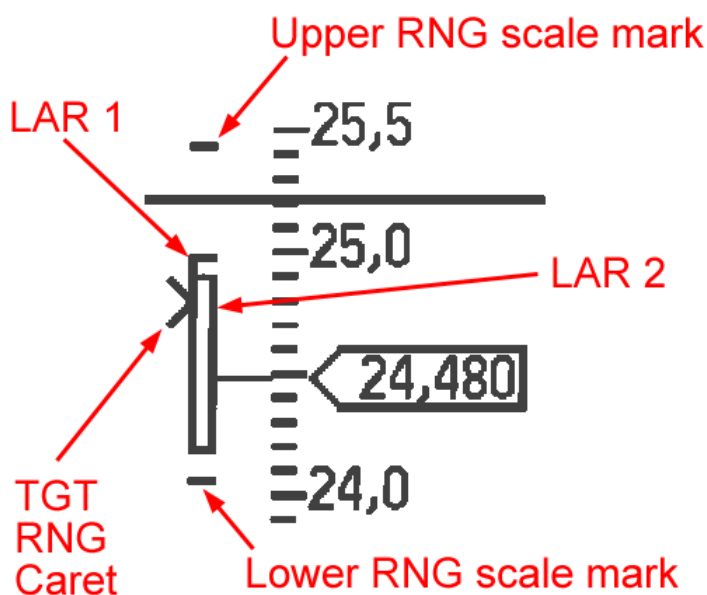
Airspeed is within M0.5 and M1.5, Target bearing within 60°, pitch and bank are less than 60° - all these conditions ensure that the HUD displays DLZ, LAR1 and LAR2.

The target is defended with a SA-3 but we should be able to remain outside its WEZ. If needed, switch the autopilot to heading mode and turn left a notch to stay just outside the SA-3 WEZ. You may turn towards the target later by flying round the SA-3 WEZ. Let's close up while monitoring the LARS.

LAR1 is displayed as [and has RMAX1 and RMIN1 marks extending to the right. RMAX 1 is at 70% of the IAM kinematic range (which depends on the aircraft flight conditions). The Upper range scale mark is the maximum range of the IAM. JDAM release is inhibited until the target range caret is within RMAX1 and RMIN1, but releasing within RMAX1 & RMIN1 may not ensure the weapon has enough energy to meet the current end game (impact azimuth) settings.

LAR2 is displayed as] and has RMAX2 and RMIN2 marks extending to the left and ensures that weapon release between these two marks has enough energy to meet the SMS CNTL settings, such as impact azimuth.

LARs are the equivalent of the JIZ indication for the JSOWs and allows the pilot to ensure the JDAM is in its optimal launch envelope.



If LAR1 is not displayed it is because your aircraft attitude is not within limits, MASTER ARM is SAFE, or target bearing is more than 60° offset. In that case, a turn indication will be displayed in the HUD as Rxx or Lxx for right or left turn and xx representing the required turn in degrees to place the target within 60°.

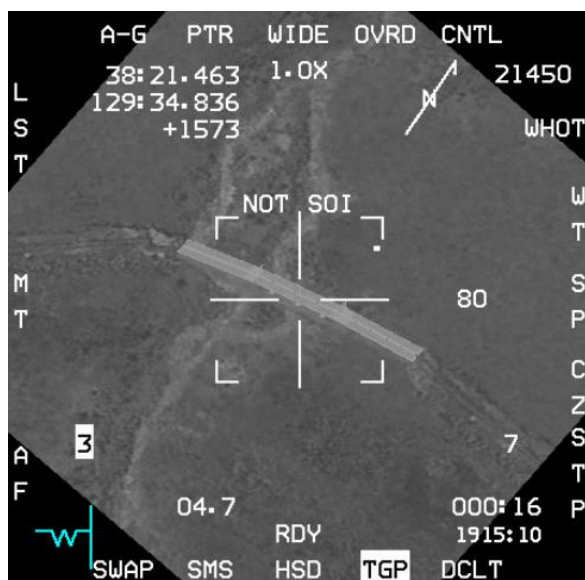
If LAR2 is not displayed, the currently set impact azimuth can't be met and the weapon will fly direct to target.

Time until next Cue
Time at next cue
TGT bearing & Range

The top line of the data blocks under the DLZ provides different counters: the first counter is time to loft (caret on upper range tick mark), then time to RMAX1 (caret on RMAX1) then time since RMAX1 (amount of seconds past RMAX1 as you wait for the weapon caret to meet RMAX2).

After bomb release the timer gives time to impact.

The second line provides the actual time when the next counter will reach 0: time at loft, time at RMAX1 and time of impact. The third line gives target bearing (00°) and Range (22 Nm).



As the weapon caret descends from the upper range to RMAX1 have a glimpse at the TGP to confirm we have the right target designated. You may have to turn slightly back towards the target. When the weapon caret hits RMAX2 give release consent by holding the pickle button for about 2 seconds. The first JDAM will release and you will have to compensate for the wing drop.

Quickly select STPT 6, switch SMS to PROF 2 and adjust course to keep the weapon release cue displayed.

Wait for the weapon caret to hit RMAX2 before releasing the second JDAM on the North Bridge. The sequence should be very quick and since JDAMS can't be rippled is the correct procedure for releasing multiple JDAMs in one pass.

After the second bomb release select STPT 7 to turn away from the target and air defences. Switch to CAT I and MRM to defend yourself against possible air threats.

Both JDAMs will destroy the bridges as your flight lead attacks the movers with his/her 4 JSOWs. You can now return to base and compliment yourself once again on a job well done.



15.3 Other IAMs

There are other types of IAMs in the inventory:

- SDB are GBU-39 Small Diameter Bombs, most effective against soft skinned static targets, such as air defence sites, radars, fuel tanks etc. The F-16 can carry 8 on special pylons on station 3 and 7.
- WCMD are Wind Corrected Munitions Dispensers, i.e. CBUs fitted with an INS tail kit allowing them to take the wind into consideration when releasing their bomblets. WCMDs are CBU-103 (based on CBU-87), CBU-104 (based on CBU-89 Gator) and CBU-105 (based on CBU-97 sensor fused weapon). To be honest WCMD do not provide increased targeting capabilities in BMS as the winds aloft are still disabled to ensure AI can hit their targets with GP bombs. Nevertheless you can use them on stations 3 and 7 of the F-16.
- LJDAMs are GBU-54 500 pound JDAMs fitted with both a GPS/INS and laser guidance kit. They provide increased flexibility, as the laser kit can track the coordinates of the laser spot, making them suitable for either stationary or moving soft-skinned targets.

None of these 3 IAMs are documented in this training manual as the release procedures are very similar to JSOWs and JDAMs. Please refer to the TO-BMS1F-16CM-34-1-1 located in your Docs folder for further information about these IAMs.

MISSION 16: SPICE

LOCATION: Inbound Ongjin DPRK Airbase on the South West coast of North Korea.

CONDITION: KF-16 block 52 – single ship - Callsign Falcon 1.

GW: 35000 lb (Fuel state 6.4, dry). 2 SPICE 2000 - 2 wing tanks – TGP and A-A missiles.

Max G: 5.5/-2.0 Max speed: 550 kts / 0.95 Mach.

GOAL: Attack & Destroy installation at Ongjin airbase defended by SA-11 and SA-17 while remaining outside the SAM weapon engagement zones.

WEATHER: RKJK INFO: B 010755LT ILS RWY36 TRL140 360/15KT 9999 FEW050 28/18 Q1013 NOSIG

Recently ROKAF acquired modern Israeli weapons, such as the SPICE (Smart Precise Impact Cost Effective) designed by Rafael industries. BMS 4.34 reflected that change and the ROKAF block 52 can now use the Israeli glide bomb.

SPICE in BMS comes in 4 versions: 2000 lb (Mk-84) or 1000 lb (Mk-83), both with either a high-explosive or penetration (BLU-109) warhead. SPICE1000 is the 1000 lb bomb and SPICE1000P is the 1000 lb bomb with the penetration warhead (BLU-109). SPICE 1000 has less punch, but a longer range and features deployable wings to increase their range further. ROKAF F-16s in BMS can only carry the SPICE 2000 & 2000P; they can't load the SPICE1000 & 1000P, although the Israeli blocks in 4.34 can.

16.1 SPICE bomb

SPICE in BMS is considered as an IAM. Actually it's an electro-optical GPS glide bomb but the electro-optical part is not implemented in BMS; only the GPS is.

Using SPICE is very easy as it's a true fire and forget weapon. Being a glide bomb its range will depend on the altitude and speed of the launching platform and it may take a while to reach the target.



As a rule of thumb you may consider that the SPICE can glide 1 Nm for every 1000 feet of altitude at launch. A launch at 20,000 feet will give an approximately range of 20 Nm.

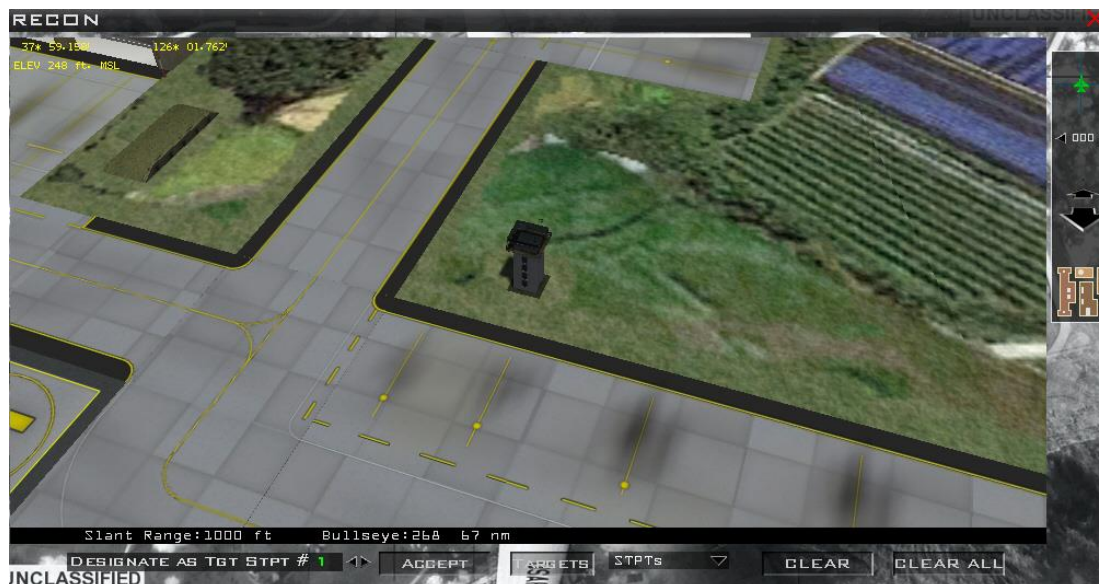
Being GPS guided it is only suitable for fixed targets. SPICE cannot attack targets of opportunity as it cannot be reprogrammed in flight. Targeting needs to be assigned on the Recon screen.

The real challenge of deploying SPICE weapons is setting up the avionics during pre-flight planning. So don't go straight to 3D as you need to set up a few things first in the UI. Make sure you stop the clock if it's running.

In this training scenario you are tasked to destroy the Control Tower and the SSR radar at Ongjin airbase. This shouldn't be a problem even for dumb Mk-84 bombs. Unfortunately, the airbase is very well protected by SA-11 and SA-17 batteries, forcing you to use standoff weapons, unless of course you're feeling suicidal as the SA-11 and SA-17 are lethal air defence systems in BMS.

16.2 Strike Planning

Ever wondered what the WPN TGT box purpose is in the Recon window of the UI? Well it is specifically for SPICE targeting. SPICE bombs are pre-programmed on the ground with a bank of 99 possible target coordinates. It is important to note that these target waypoints are totally independent from the DTC. They are a little bit confusing to set up, so we'll go through how to program the weapon in the UI. Let's recon a target; in this case Ongjin airbase. Open up the list of targets under Ongjin airbase and select the Control Tower.



Usually when you want to assign a specific target to a steerpoint, you need to know your steerpoint number for the target and use the first box labelled as “DESIGNATE AS TGT STPT #X” with X being your target INS steerpoint. You increment/decrement the steerpoint number with the 2 small arrows placed on the right and hit the “ACCEPT” button once the correct steerpoint is selected. This actually changes your DTC, by assigning the precise coordinates of the target to your target INS steerpoint. But have a look at the second drop down box further to the right. It is set to STPT for steerpoint. That is the reason that when you select a waypoint with the first box, it is an INS steerpoint.

What we want to do here is totally different than setting up your DTC steerpoints.

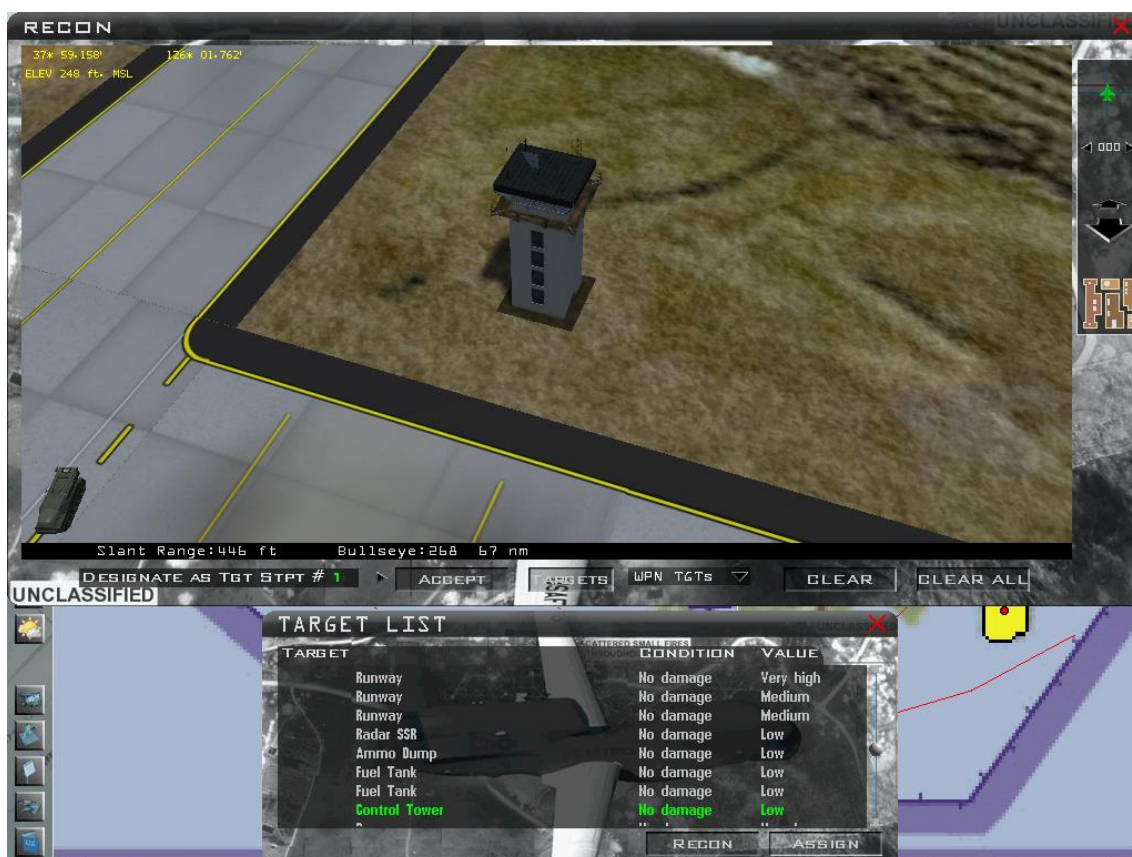
We need to assign weapon targets, not steerpoints. See the difference? A steerpoint is an INS waypoint, to which you as the pilot steer to. A weapon target is specific to a weapon, in this case, only the SPICE. To assign weapon targets you need to change the second drop menu to WPN TGT, rather than STPT. Open the drop-down menu and click on WPN TGTs.



But you still have to assign them; that is still done with the first box and the 2 small arrows left of it. Unfortunately the label of that box did not change and it is still named: “DESIGNATE as TGT STPT”.

It would be much less confusing if that box was simply labelled “DESIGNATE AS” and leave the confusing STPT or WPN labels out of it – and have the further box on the right tell the user if the assignment was meant for steerpoints or weapon targets. Unfortunately clearing user confusion is not always a high priority in a complicated UI design workflow.

Let’s come back to our SPICE targeting. WPN TGT is set on the right box; Control Tower is selected in the Recon view. We have two SPICE bombs loaded, so we need to set up at least 2 weapon targets. We could set up more targets in case they were needed; up to a total of 99. Check that STPT 1 is selected and that WPN TGT is active and hit ACCEPT. The Control Tower has been assigned as the first weapon target.



Select the SSR radar in the target list of the recon window, increment STPT to 2, cross check that WPN TGT is active and hit ACCEPT to assign the SSR radar coordinates to the second weapon target.

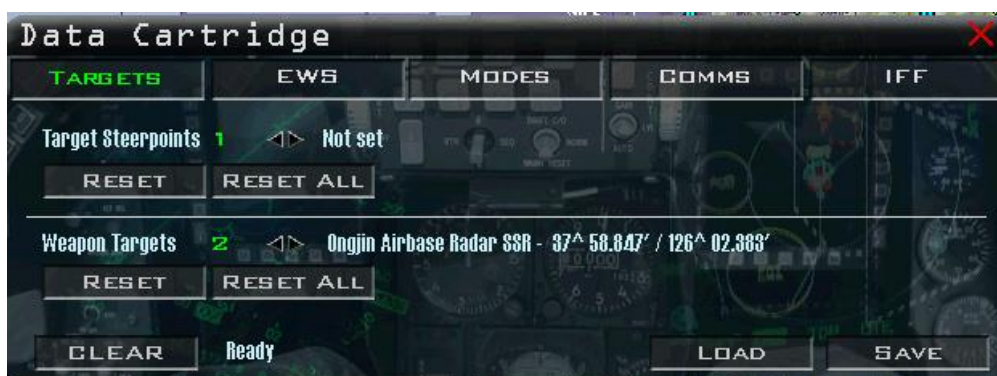
I know it took a while to explain, but due to the confusing way it is implemented I had to spend extra time making sure there could be no possible confusion. The danger, if you don’t understand what you are doing, is that you actually change your INS steerpoints rather than assigning weapon targets for the SPICE and you will not see the changes on the UI map, but it will create a mess on your HSD after having loaded your DTC. As you will be in 3D by then, it will be impossible to fix without restarting the mission.

Just remember the difference between steerpoints and weapon targets; how to switch from one to another and learn to cross check before hitting the ACCEPT button

Luckily, there is a way to check before stepping to the aircraft. If you open the DTC you can check your steerpoints and you can also check any weapon targets you have assigned.



As you can see TARGET STEERPOINT 1 is not set (meaning Steerpoint 1 is the regular flight plan steerpoint) and WEAPON TARGET 1 is assigned to Ongjin airbase.



Depressing the right arrow next to the weapon target will select the second weapon target, which is correctly assigned to the SSR radar.

So whenever you assign SPICE targets, cross check your DTC before flying. Needless to say, if no targets are assigned to the SPICE the weapon will be useless, as you cannot assign coordinates to them in flight. You are now ready to go flying.

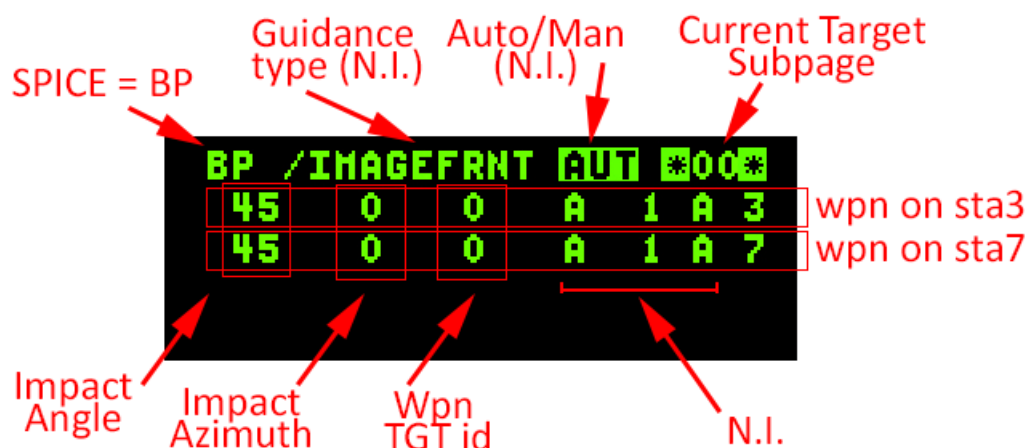
16.3 In flight

Like all GPS weapons, SPICE needs to align. Alignment starts automatically upon weapon power up and will last approximately 3 minutes. As soon as you enter the training mission select A-G master mode and display the A-G SMS page on the MFD. Power up the weapon with OSB 7. The SMS page will go through different statuses during alignment until displaying RDY when the weapon is ready to be launched.

Set Master ARM to ARM on the MISC panel. If you want to make your life easier, engage autopilot in steering mode while you set up your avionics.

Assigning targets and flight parameters for each bomb is done through a dedicated DED page. Select LIST on the UFC and then zero for the MISC page. Select the specific SPICE page with ENTR.





- BP is the mnemonic for IAM in BMS and you can't change it.
- IMAGEFRNT is specific to each bomb and is one of three options for guidance type: IMAGEFRONT, IMAGETOP and GPS. As mentioned earlier, the BMS SPICE is GPS only. Although you can toggle the options, with the M-SEL button when the asterisks are around the guidance type box, it is not implemented in BMS and regardless of the chosen option the guidance type will always be GPS.
- AUTO/MANUAL is not implemented and cannot be toggled. SPICEs are always in AUTO in BMS
- The current target subpage displays which DED subpage you are looking at. As more than 4 weapons cannot be loaded on a F-16 (max. 2 on KF-16 and max. 4 on Israeli models) you will never use another subpage, since the primary page can display settings for 4 bombs.
- The SPICE DED page will display one line for each weapon loaded. You can select each bomb line by moving DCS up and down to the relevant bomb line you want to set. By default the WPN TGT box will be selected. To select further options for the same bomb, use DCS SEQ to toggle through all remaining options.
- Impact Angle is not implemented in BMS and by default is set at 45°. Although you can change the option to any value, the impact angle will always remain at 45°. The impact angle setting is displayed in the SMS MFD page.
- Impact azimuth can be changed to the heading you want the bomb to strike its target. It is implemented but will obviously decrease the bomb's glide range. Zero inputted in this box means that the weapon will fly directly to its target. When an impact azimuth is set, it will be displayed in the SMS MFD page and the DLZ with LAR2 will be displayed in the HUD (more on this later).
- Weapon Target ID is the weapon target number assigned to this bomb. This is the weapon target that you assigned in the UI at flight planning. You need to assign a target to each weapon before firing.
- A 1 A never changes in BMS. The last A is the position of the bomb in case you are carrying multiple bombs on the same station, but this is never the case with SPICE bombs in BMS.
- The last number is the station number where the bomb is loaded.

In this case we have 2 bombs loaded on station 3 and station 7, we therefore have two lines in the DED page, one relevant to the bomb loaded on station 3 and the other relevant to the bomb on station 7. You can switch from one bomb to the other with DCS down or up. When selecting a weapon line, the scratchpad defaults to the WPN TGT ID entry. Enter the weapon target ID that you set at prestrike planning. In this case, we will input 1 then ENTR to set weapon target 1 for Ongjin Control Tower.

Once done, cross check the SMS page. The target ID we just assigned is relevant to the bomb loaded on station 3. So make sure that the SMS is set to the station 3 SPICE. This is done by depressing the MSL STEP button on the HOTAS; the relevant station number in the SMS page will highlight. The target ID set in the DED will be displayed on the bottom left of the SMS page. As you can see the SMS reports that the weapon loaded on station 3 is targeted at the Ongjin airbase control tower.

Please note, although the SMS system is RDY (above OSB 13), the weapon on station 3 is still aligning, as reported by the weapon status (A03) left of the SP20 mnemonic (OSB 6).

DCS down on the ICP will select the bomb on station 7, assign WPN TGT 2 for the SSR radar and cross check the station 7 SMS. We will also assign an impact azimuth of 330° for this bomb. Press DCS SEQ until the scratchpad is on the impact azimuth box and input "3 3 0 ENTR".

The SMS page when set to display station 7 will then report the correct target ID (Ongjin SSR radar), the default impact angle (45°) and the set impact azimuth (330°).

Be aware that assigning an impact azimuth will decrease the bomb glide range, since you force it to manoeuvre. In our training mission it is critical since you may have to wait longer for the second bomb to be in range and trespass the SAM threat rings. To avoid the problem, carefully chose your impact azimuth to minimise the effect on weapon range. Our heading at bomb release will be close to North so setting an impact azimuth of 330° creates an angular difference of 30°, which should have a minimal effect on range, allowing us to release before trespassing the SAM rings.

Please note, unlike the bomb on station 3, this one is now fully aligned. Both RDY statuses are displayed.

A quick note about the Ripple function (OSB 9). SPICEs can be rippled from the same weapon pickle, but in that case the DLZ will use an average between different target assignation ranges. In this case, because we have one bomb set with an impact azimuth, it is better not to ripple them. If both were direct to target, they could be rippled together as both targets are very close and the average DLZ should remain accurate.

That is all you have to do to set up the SPICE weapons. You may set other options in the DED pages, but those are eye candy and will not change bomb behaviour in BMS. Remember you select the line weapon with DCS up/down and then toggle through options for this weapon by moving the scratchpad with DCS SEQ.

By now you should be close to Steerpoint 4. Your avionics are set up correctly and you may start hearing chirps on your RWR from the SA-11 and SA-17. These missiles systems are not to be underestimated. Treat them with respect and be fully aware that trespassing their threat rings is very dangerous, even at low level; a luxury you do not have when deploying glide bombs that need high release altitudes. Speaking of which, check that you are flying around 18000 - 22000 feet for release. The higher you are the longer the range of your weapons. Remember the glide ratio of the SPICE2000: about 1 Nm for every 1000 feet.

Your IP is Steerpoint 5 and before you get there you need to think about what you're going to do after weapon release. The BMS SPICE is a true fire and forget weapon, so you could turn tail and egress right after bomb release. If you do that you may seriously increase the distance between you and the target and create bubble issues, which can be a problem with long range standoff weapons. If you drop 20 Nm from your target, by the time the bomb has glided the distance, you may be very well 35-40 Nm away from your drop point, thus around 60 Nm from your target. In the case of structures, it is not a real problem, but it might become an issue in some cases. Although it is of no particular relevance in this training mission, it is important to remain aware of this limitation when using standoff weapons. To avoid the issue one possible scenario is to offset 90° from the target and wait until impact, just like you would do with weapons that you need to guide to impact. Doing this you may also monitor your target with your TGP.

Before reaching the IP, it might be a good idea to switch back to MRM mode to assess the air picture in front of you and towards the target area. We have been in A-G mode, setting up the systems for quite a while. Normally you fly in an air to air mode, ready to react to any threat. Always keep that in mind when you're flying an air to ground mission. The Dogfight/MRM switch on the throttle is the easiest way to easily switch from A-A to A-G in such scenarios. When you are confident there is no immediate A-A threat to you, centre the switch on your throttle to cancel MRM and the system will revert to A-G, if it was the last master mode you were in.

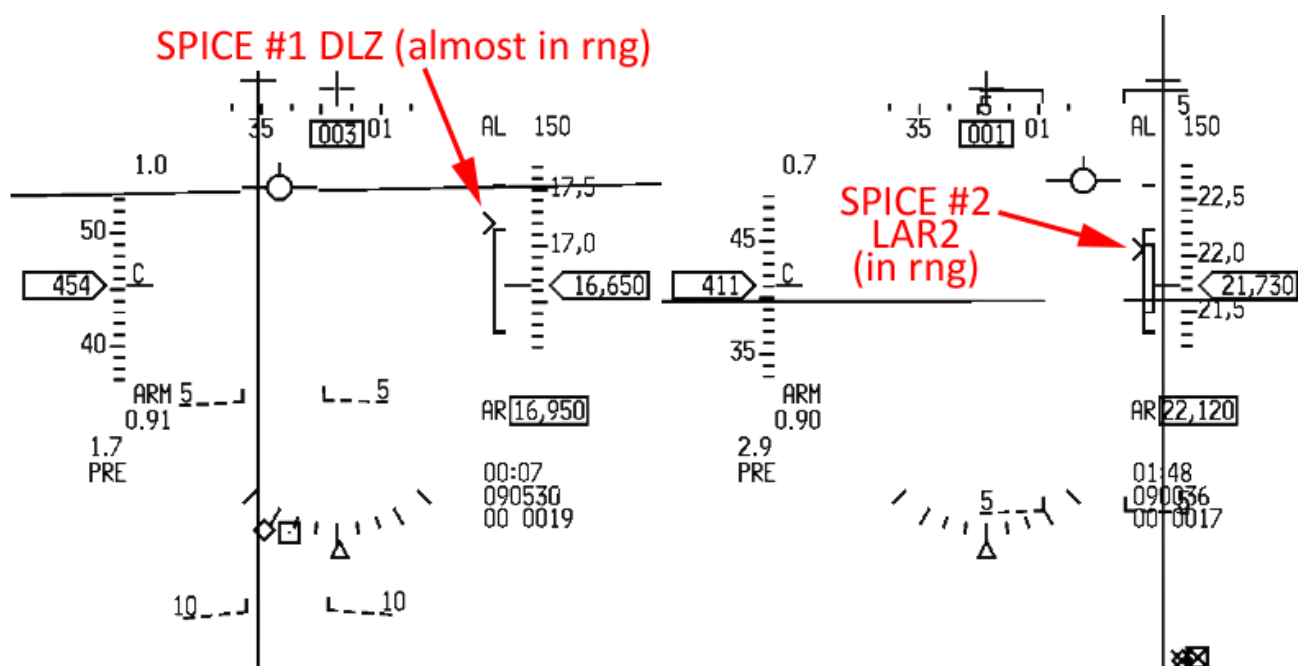
At IP, turn towards the target. Check your switches before bomb release; everything is going to happen fast now. Another good habit to develop if you have the chance is to check the target. We have a targeting pod and although we don't need it for releasing the SPICES, nothing prevents you from using it.

As you can see on the TGP image, it's too bad the SPICE can't be reprogrammed in flight. That said, you could have planned up to 99 weapon targets at preflight, so nothing prevented you from assigning much more than what you need and then reassigning the weapon from the DED page before release. Obviously these Su-7s will not stay very long on the active runway.



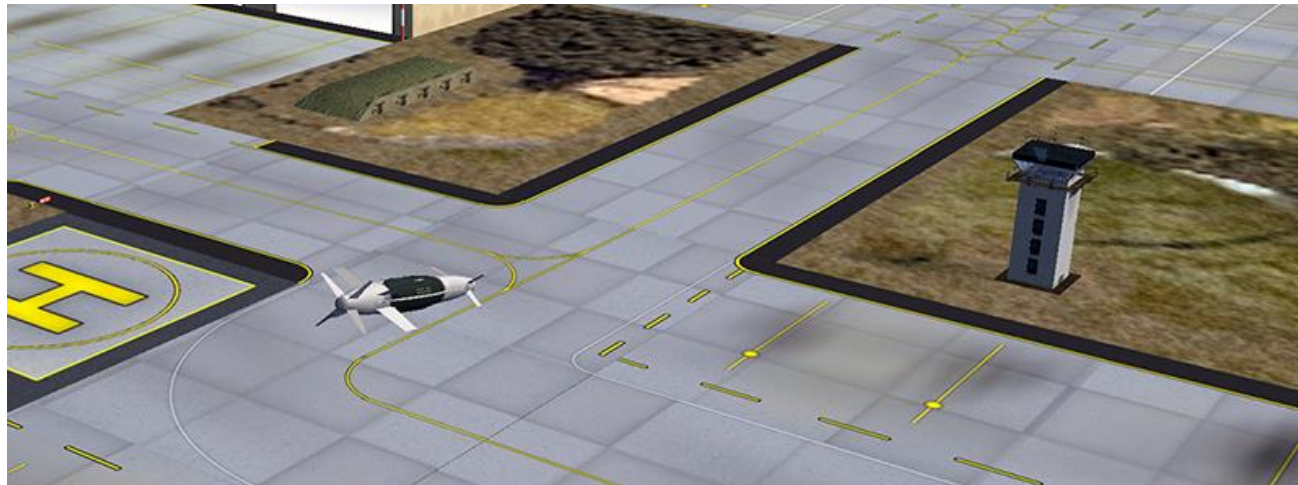
SPICE HUD symbology is the same as other IAMs in BMS and therefore you have a DLZ (LAR1) on the right side of the HUD. If your bomb is set to glide direct to the target you will have a simple DLZ (LAR1). This is the case of the SPICE on station 3. If you set an impact azimuth, you will have a DLZ with a LAR2 inner scale, which is the case for the SPICE loaded on station 7. Refer to the IAM training mission if you need further information about LAR.

For the first bomb, assigned to the Control Tower, you must wait until the range cue hits the top of the DLZ. At that moment the bomb is in range and you can pickle. For the second bomb, you need to wait for the range cue to hit the top of the LAR inner scale before releasing. Monitor the threat rings as you wait for the second bomb to be in range and pickle as soon as possible. Should you need to pickle before reaching the top of the LAR, the bomb will fly straight to the target and ignore the impact azimuth. By the way, it's never a good idea to release a glide bomb in a dive!



Once both SPICE bombs are released, turn west to beam the target and switch back to MRM mode.

Remember, you saw a flight of 4 aircraft taking off just before you attacked the airbase. Be ready in case they want to play with you (and if you get shot by the SAMs trying to engage them don't tell me I didn't warn you).



MISSION 17: IR MISSILES

LOCATION: MOA 18.

Please note, make sure you select the F-16 flight from the mission window, if you select the first flight without checking you will end up piloting a C-160 Transall, a military transport aircraft.

CONDITION: F-16 block 50 – Single ship - Callsign Falcon 1.

GW: 30500 (fuel 6.6 dry). 2 AIM-9M, 1 AIM-9P, 2 wing tanks, 1 ACMI pod and 1 Sniper targeting pod.

Max G: 7.0/-2.0, Max speed: 600 kts / 1.6 Mach.

Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.

WEATHER: RKJK INFO B 010755LT ILS RWY18 TRL140 140/13KT 9999 FEW080 25/15 Q1013 BCMG 0109/0110 1500 BR OVC040 (Basically FAIR turning POOR)

GOAL: Destroy the aircraft in MOA18 with infrared missiles. RoE (Rules of Engagement) require VID (Visual Identification) before firing.

17.1 The infrared Sidewinder missiles

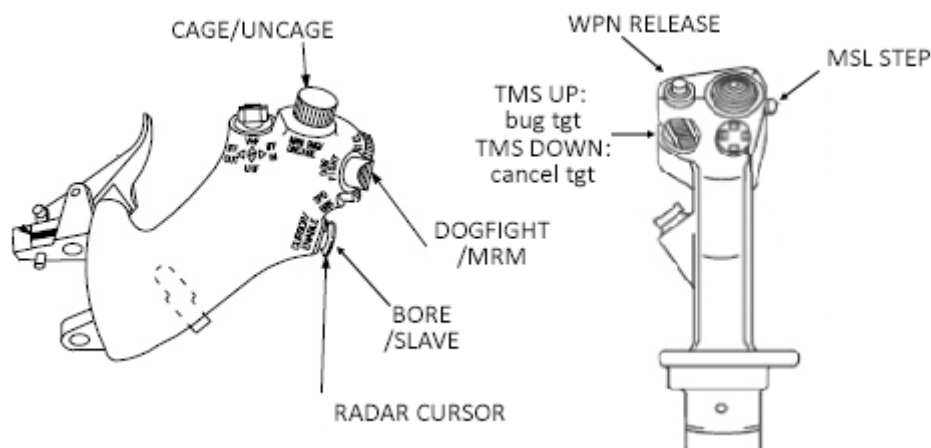
The F-16 in BMS is able to carry 3 types of infrared missiles:

- AIM-9P an older rear-aspect only short range missile.
- AIM-9M an all-aspect short range missile.
- AIM-9X a modern high-angle off-boresight (HOBS) short range missile.

All infrared missiles are relatively short-range missiles because they guide on heat emissions and heat dissipates quickly in the atmosphere, especially in clouds, so if you are tracking an aircraft which flies into clouds you will notice your missile seeker will often lose track; if you've already fired, you may have wasted a missile. Obviously an aircraft engine generates a lot of heat, but the surfaces of the aircraft travelling through the air generate heat by friction as well. Newer missiles are unsurprisingly better at detecting this:

- The AIM-9P seeker can only detect heat from the engine and so must be fired from behind an aircraft to have a view of the engine exhaust. It has a max range of about 3-4 Nm and a FOV of 3 degrees.
- The AIM-9M seeker is more sensitive and is able to guide on the heat generated by the friction of the aircraft moving towards you, so it can be fired regardless of the aspect of an aircraft if it has a good track. It has a range of about 6-10 Nm depending on aspect and a field of view of 3 degrees.
- The AIM-9X seeker is significantly more advanced and the missile more manoeuvrable with less drag. It is often used with the HMCS and so will be covered later in the HMCS Training Mission.

HOTAS controls for IR missiles



The MAN/RNG rotary has a push down function to UNCAGE or CAGE AIM-9 missile seekers. Uncage the missile to allow its seeker to move and track a target; press the button again to re-cage the seeker head.

The DOGFIGHT/MRM override switch is a three position slider that overrides the master mode. Left position (outboard) is for Dogfight, right position (inboard) is for MRM (Medium Range Missile) override mode. The centre position cancels the override mode and reverts to the previous master mode. Dogfight gives quick access to the gun and short-range missiles (if you're carrying them). It also sets the FCR to ACM (Air Combat Mode) and stops it radiating. MRM provides access to missile mode (long range or short range).

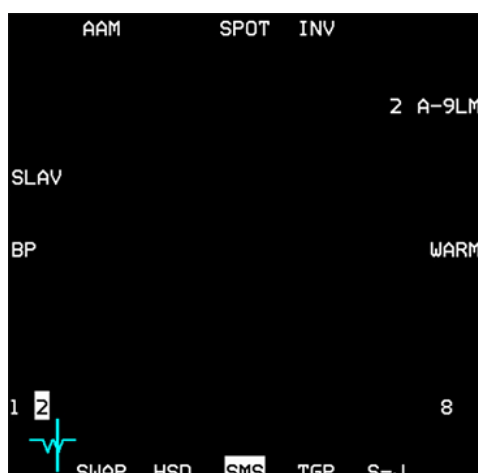
The RADAR CURSOR moves/slews the ACQ (acquisition) cursor (aka captain's bars) on the FCR. It also has a push down function ENABLE that allows you to toggle momentarily from SLAVE to BORE (see SMS display below) while the button is pressed/held in.

The WPN RELEASE (aka pickle) button must be held down to fire a missile and is always hot for IR missiles.

MSL STEP selects the next available missile of the same type.

TMS up is used to bug (track) a target on FCR, once the captain bars have been placed over it. TMS down cancels the track.

SMS display for IR missile



OSB 6 displays which weapon is active. In this case the AIM-9M. The AIM-9P has its own SMS page but there are no options on it.

OSB 8 is a two-position rotary that commands cooling the AIM-9M seeker head with argon gas. Options are WARM and COOL.

In WARM the seeker head is not cooled and RDY status is not achieved. IRL missile wouldn't fire but in BMS you only have a degraded track and a lower efficiency of the missile.

In COOL the seeker head is being cooled with argon gas and you will notice the missile audio tone will change to indicate this. RDY status is achieved. Cooling in BMS will last for 90 minutes until the virtual argon gas bottle is empty.

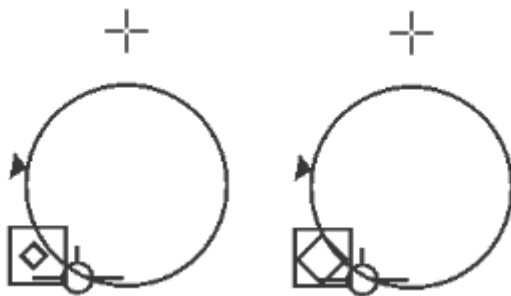
OSB 18 is a two-position rotary labelled TD (Threshold Detection) or BP (Bypass). When set to TD the missile automatically uncages when it finds a valid heat source. When set to BP the missile needs to be uncaged manually by the pilot.

OSB 19 toggles SLAVE or BORE. In SLAVE the seeker head is slaved to the radar line of sight. In BORE the missile seeker head is fixed 3° below the gun cross. In that case, the pilot must manoeuvre to place the target aircraft within the field of view of the seeker head in order for the missile to see the target. The missile can then be uncaged to command it to track.

OSB 3 is a two-position rotary labelled SPOT/SCAN. If SCAN is selected the seeker head scans on its own and increases its field of view slightly until a heat source is detected or the seeker head is uncaged; at which point the seeker head reverts to its nominal size. In SPOT the seeker head does not scan, and the field of view stays at its usual size.

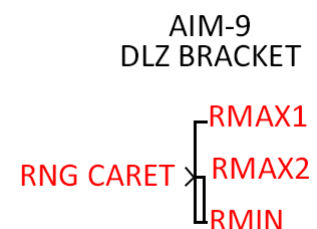
HUD symbology for Infrared missiles

There are a few HUD symbols specific to Sidewinders that you should know. First the missile diamond will be displayed in the HUD to tell you where the missile seeker is looking. The missile diamond changes in size, according to its caged or uncaged status. When caged, the missile diamond is half the size as it is uncaged. In the following example the missile diamond is within the TD box, as we have a radar lock, but it is the same behaviour (without the TD box) when the radar does not have a valid lock.



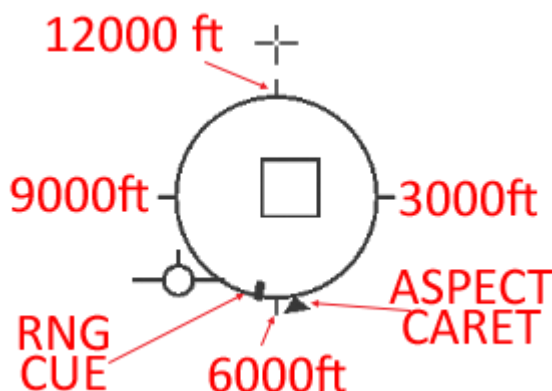
The left image shows the missile diamond with radar contact when caged. The right image shows the increased sized missile diamond after uncaging.

When a contact is radar designated a Dynamic Launch Zone (DLZ) is displayed on the right side of the HUD. This bracket tells you if you are in range for a missile shot. A range cue caret slides along the DLZ to signify the range. When the cue is at RMAX1, the missile is at maximum range. If the target manoeuvres, it will probably miss. When the cue is at RMAX2, you are within manoeuvring range; the missile circle and diamond will start to flash. RMAX2 is a more reliable max range, because even if the target starts manoeuvring, the missile will still have a good chance of hitting it anyway.



When the cue hits RMIN (there are actually RMIN1 & RMIN2) you are too close for a missile shot and a large break X will appear on the HUD.

Once within 2 Nm or 12000 feet of the target the seeker head field of view will change and display 4 range marks; respectively for 12000, 9000, 6000 & 3000 feet. A range cue moves along the inner missile field of view circle to give an indication of range. The aspect caret is a triangle moving around the circumference of the circle and indicates the aspect angle of the bugged target.



Left shows the display for the AIM-9M, above is the display for the AIM-9P.

In addition to the HUD symbology, sidewinders will emit an audio tone providing feedback on the quality of the missile track. If the tone is faint, the track is faint. If the tone is loud, the track is solid. Trust the heat tone as range is one thing but never forget an infrared missile needs a heat source to guide on. Tone will also change according to CAGED / UNCAGED status.

17.2 Positional geometry

Before getting into air to air there are a few academic subjects that need to be covered. Aerial combat is by far the most difficult aspect of flight to understand and master. We can only begin to scratch the surface of this complicated subject in this manual, so you are strongly advised to also read the AIR-TO-AIR chapter of the BASIC EMPLOYMENT MANUAL Vol 5, located in your \Docs\05 Other Documentation\Real Manuals folder.

One such topic is how to describe the spatial relationship between two or more aircraft manoeuvring against each other. You need to be familiar with terms like: aspect angle (AA), range, angle-off (HCA), antenna train angle (ATA) and different pursuit curves.

Range

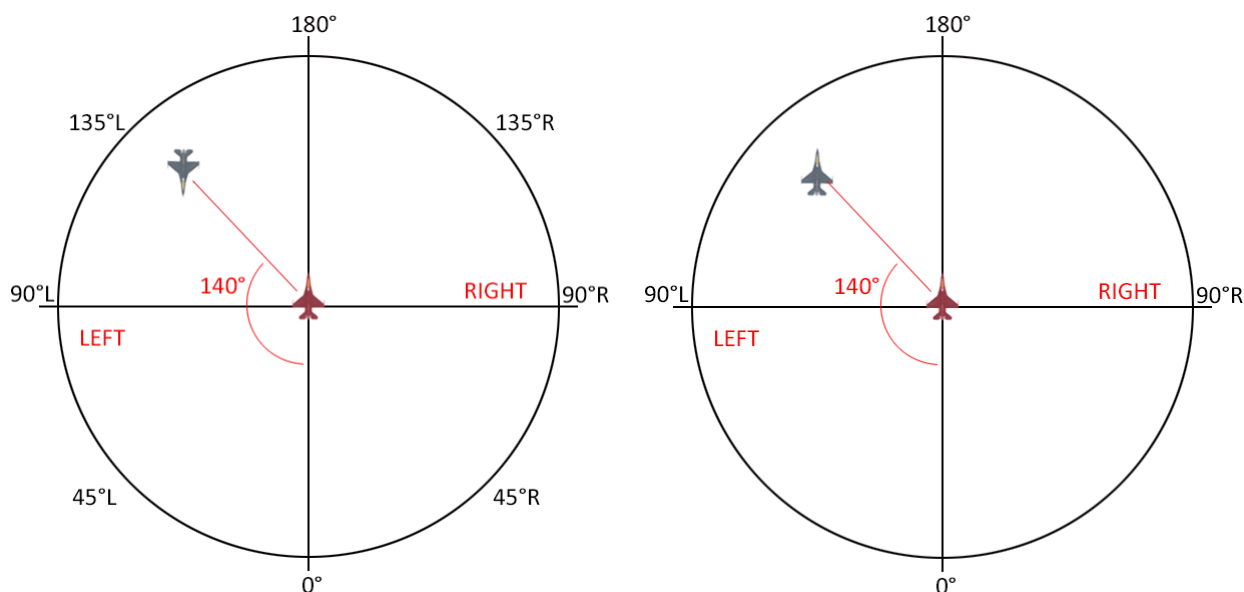
Range is easy. It is the distance between you and the target. It's measured in nautical miles or feet, depending on how close you are from one another. 1 Nm is 6000 feet. Distance is given at multiple places in your avionics depending on your configuration. With a bugged target, the range is given in your HUD under the altitude scale. Range can also be determined from the A-A FCR MFD page.



Aspect angle

Aspect angle is the number in degrees measured from the tail of the target to your aircraft. It usually has a suffix for left (L) or right (R).

Please note: aspect angle has nothing to do with your heading, as you will see below. It is simply a description of your position *in relation to the bandit's tail*.



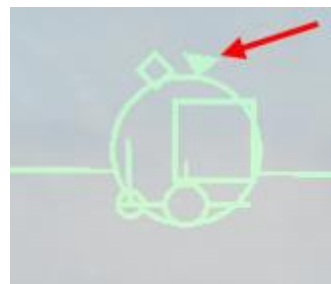
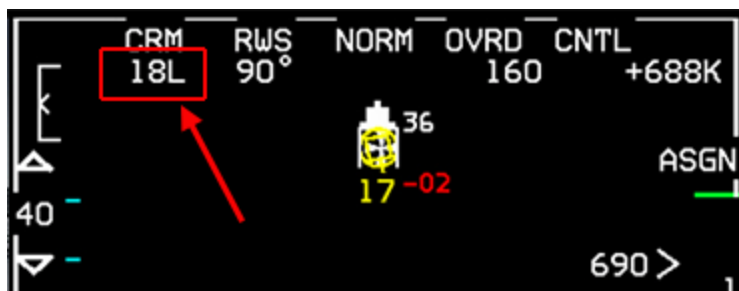
The aspect angle concept must be burned into your brain before proceeding further. Some typical scenarios should be easy enough to memorise:

When you are face to face with your enemy, your aspect is 180° if none of you gets turning room (the aspect will then decrease) you will pass canopy to canopy on a head on pass.

When you are perfectly at your enemy's six o' clock, waiting to fire, your aspect is 0°.

It is your position on the *bandit's* left or right side that determines left or right aspect. It is not which side of your nose the bandit is. Both circles above display 140L aspect, but in the left diagram the bandit is on your left side, in the right diagram the bandit is on your right side. In both cases, however, you are *left of the bandit*, hence 140 *left*.

Aspect angle is visible in the FCR and your HUD in any A-A mode once you have bugged a contact.



On the FCR, the aspect angle is displayed in the top left corner in 2 digits plus the L or R suffix. 18L means 180° Left aspect. It's rounded to the nearest 10 degrees. On the HUD, there is a caret on the SRM reticle (representing the missile seeker field of view) identified with the red arrow above. The caret moves around the circle to indicate aspect. When the caret is at 12 o'clock, aspect is 180° (like in this scenario). When the caret is at 3 o'clock, aspect is 90°R. When the caret is at 6 o'clock, aspect is 0°.

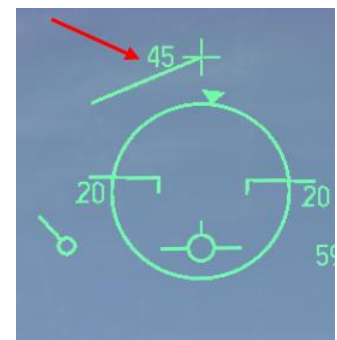
Angle-off or Heading Crossing Angle (HCA)

This angle tells you relative fuselage alignment. It's the angle between your heading and the bandit's heading. A HCA of 0° tells you that you are flying a parallel course with the bandit. A HCA of 90° tells you that you are flying perpendicular to the bandit.

Antenna Train angle (ATA)

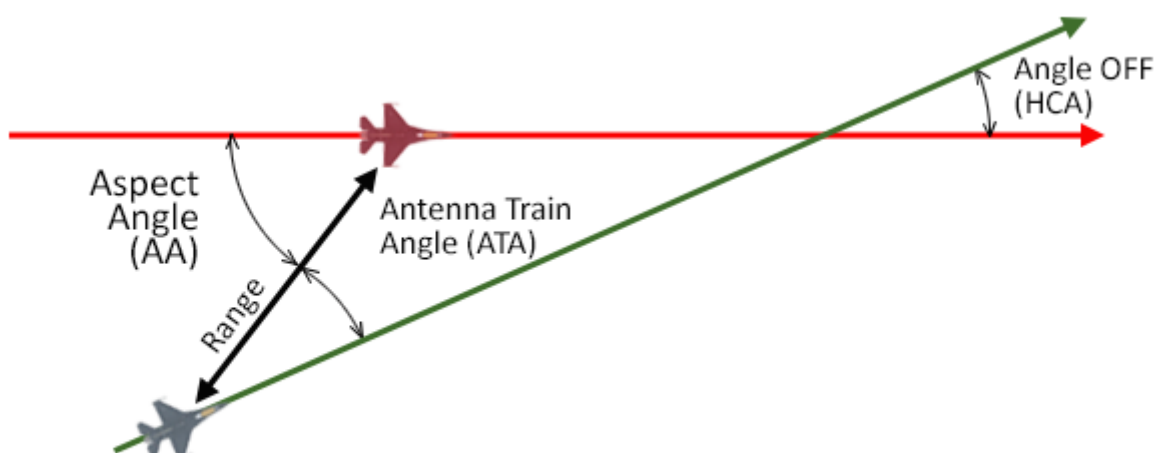
The ATA is the number of degrees the defender is off-boresight of the attacker. This angle is very important because it will tell you when your FCR is about to lose track because the contact exits your FCR scan limits (around 55°).

ATA is displayed next to the TLL (Target Locator Line) on the HUD, which becomes visible as soon as the TD box exits the HUD field of view. It is a concept used often in both BVR and WVR when you want to keep a contact as close as possible to the radar gimbals.



How it all works together?

The following image should give you an idea of how these aspects all work together:



Pursuit Courses

When you manoeuvre in the same plane of motion as the bandit, your velocity vector determines your pursuit course. This is displayed by the flight path marker (FPM) in the HUD.

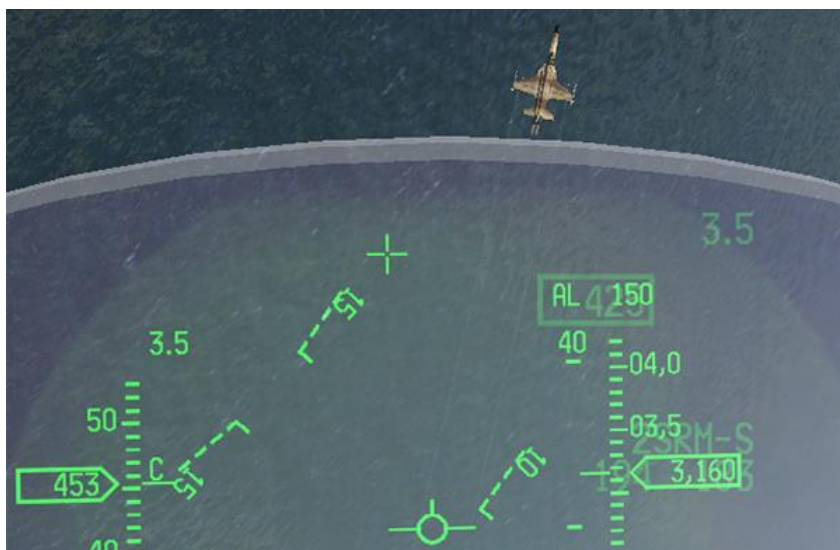
FPM on the bandit, you're flying a pure pursuit course and will collide with the bandit.



FPM in front of the bandit; you are flying a lead pursuit course and will pass in front of the bandit.



FPM behind the bandit; you are flying a lag pursuit course and will fall behind the bandit.



17.3 The baseline intercept

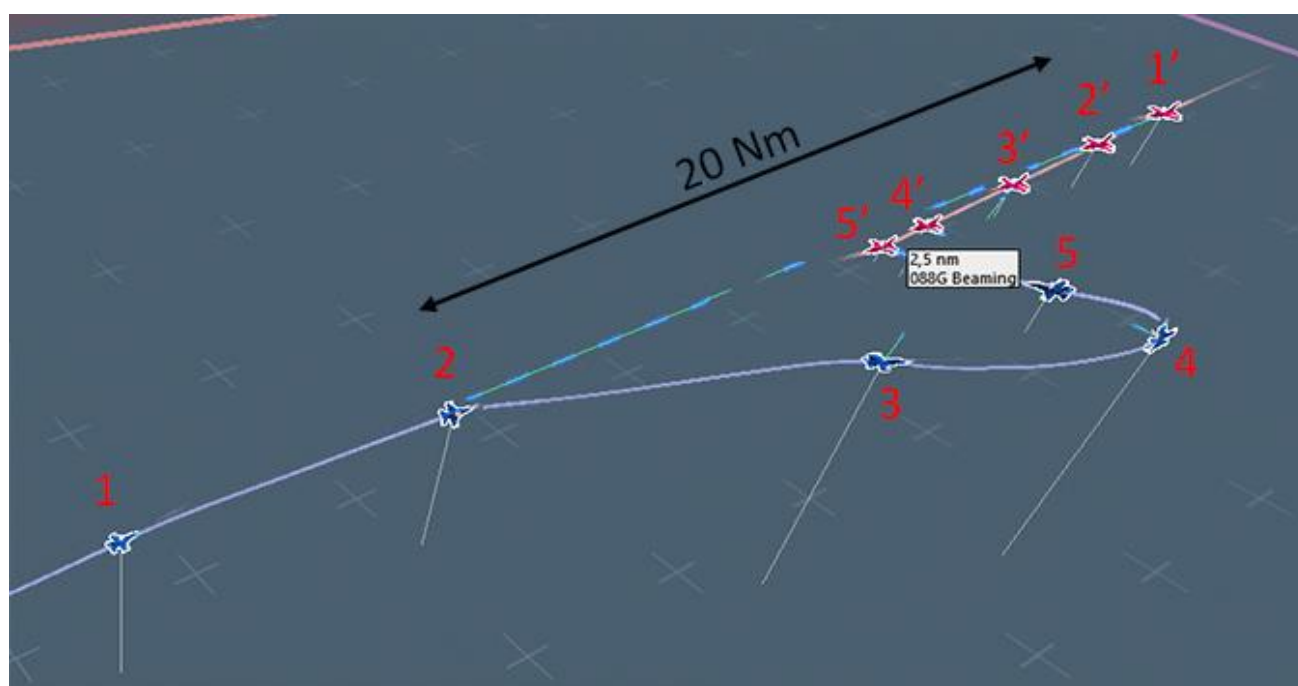
This training mission starts with a contact off the nose at 40 Nm with a requirement that you visually identify (VID) the bogey before shooting. If you keep the contact on your nose you will end up in a head on pass. You probably will have time to identify the type of aircraft as you flash past, but by the time you have done that you will not be in a good position to shoot it out of the sky anymore.

If the bandit continues straight on course, you now need to turn back towards him and then chase him down before you can actually engage the bandit with your weapons. This all wastes time and fuel.

To avoid this situation, we fly intercept profiles. There are many types of intercept profiles. The most common are the baseline intercept and the single side offset. They are basically the same profiles. The SSO is made from further away to minimise the enemy's capability to target you with its radar, if so equipped. The baseline intercept is usually made on non-maneuvring non-fighter aircraft.

The baseline intercept profile is made up of 5 steps:

1. Detect and close on the target, gain speed and altitude advantage.
2. Offset for manoeuvring room.
3. Monitor aspect and range.
4. Go pure pursuit.
5. VID & shoot.



Gain radar contact with your target and assess its speed, altitude, range and initial aspect angle. Increase speed to close the gap quicker and gain altitude separation to make it harder for your opponent to track you.

Around 20 Nm from your target offset to one side to gain lateral turning room. But which way do you turn? First determine which side of the target's flight path you are on by looking at its aspect angle. This is the side you will want to stay on, and will want to turn toward later, since it's the shortest path to the bogey's six o'clock and avoids you flying across its nose. So if the MFD shows *right* aspect, turn (opposite what it shows, i.e. to the left) to keep the contact on the *right* side of the MFD. If it gives you a *left* aspect, turn (right) to place the contact on the *left* side of the MFD. If the contact has an aspect of 180° it doesn't matter which way you turn.

Once you have decided which way to turn, you need to determine how much to turn. The higher the aspect, the more turning room you will need to create; if aspect is lower, you will need to create less turning room. For higher offsets try to keep the radar contact near the side of the MFD, but be careful not to lose it by exceeding (gimballing) the FCR antenna limits.

Continue to monitor aspect angle, antenna train angle and range. If your target continues flying straight, seemingly unaware of your presence, aspect angle will decrease, ATA will increase, and you may have to turn into the contact to avoid losing FCR track. Use the TLL in the HUD and don't let it go above 50°. Range to the target will obviously decrease. If you notice aspect angle start to increase, the bogey has probably detected you and is turning toward you to deny you turning room.

When the aspect angle reaches 120° it is time to go pure pursuit on the bogey. Usually that happens around 6-8 Nm. No matter the aspect, go pure no later than 5 Nm. Use the TLL to help bring the bogey into the HUD field of view and try to VID the aircraft. Upon positive hostile identification you can release an infrared missile. To fire a Mike you don't have to be behind the bandit and pure pursuit will probably bring you within valid shot parameters. To fire a Papa, you may need to manoeuvre behind the target during your conversion turn.

17.4 The mission

This mission starts in MOA 18 at around FL150. You have 2 AIM-9M and 1 AIM-9P Sidewinders and a full load of 20 mm cannon shells for your gun.

A contact will appear on your FCR at around 30 Nm in front of you. You will make a baseline intercept on that contact, identify it as a military transport plane and shoot it with one of your infrared missiles.

First get set up. Fence in as usual, making sure you don't forget anything: A-A or MRM master mode, FCR set to 40 Nm on the left MFD, ACQ cursor and ANTenna ELEVation wheel centred, TGP in A-A mode and HSD and SMS on the right MFD. Weapon selected: AIM-9P and MASTER ARM set to ARM.

And don't forget to record your flight, analysing your ACMI will prove invaluable in air to air situations.

Let's make a quick remark about MRM or Dogfight override modes here. The advantage of MRM or Dogfight override modes is that you can quickly access them with just a flip of the switch on the throttle. In an air to ground mission, you are not in A-G master mode all the time. You fly in and out of the target area in A-A and switch to A-G just before striking the target. If you switch to A-G too early, or stay in A-G master mode too long, you may get intercepted by enemy aircraft you were not aware of.

A good habit is to select A-G master mode at fence in, then after you have checked your A-G setup is correct, immediately switch to MRM override mode. That way you stay on top of the air to air picture. Should you need to assess the A-G situation, a swift re-centring of the DOGFIGHT switch on the throttle cancels MRM and puts you back in the previous master mode you were in, in this case A-G.

Another advantage of Dogfight mode is that your AIM-9M (and newer IR missile seekers) are automatically cooled when in this mode, which is not the case in MRM or A-A mode, where you have to cool them manually.

We don't use Dogfight mode in this training scenario initially as the intercept starts at 35 Nm. We use the FCR in CRM or TWS at first to assess the target. Switching to Dogfight mode at the end is optional if you want to gain access to the gun.

Back to the mission...

A radar contact should start to appear around Steerpoint 5. If not, check that your antenna is set to scan a volume around 17000 feet at 30 Nm.

Immediately bug (track) that contact by placing the ACQ cursor (captain's bars) over the blip and depressing TMS up once. You do not want to hard lock the guy, by depressing TMS up a second time, because you would go STT on him and if he is equipped with an RWR it will scream at him notifying of your impending attack. So a single TMS up is enough to track the contact in RWS-SAM (Situational Awareness Mode).



After bugging the target, the top of the FCR will provide more information, such as: target aspect angle (18R), target heading (090°), target velocity (160 knots KCAS) and target closure rate (724 kts TAS). From the airspeed you can deduce that the contact is *probably* not a fighter. The contact is at 17000 feet, as are we and it's always better to avoid remaining co-altitude. So start climbing to 20-21000 feet to make you more difficult to detect on radar now, or visually later. You could accelerate, but you already have quite a speed advantage.

You now need to close up on the contact. The FCR displays a 'steering cross' (visible in the screenshot below right - to the right of the bugged target) called the CATA (Collision Antenna Train Angle). When you want to fly to most direct route to a bugged target, centre the CATA symbol in the middle of the MFD. In this case, we are already flying a collision course and the CATA is centred already.

At 20 Nm it is time to offset for manoeuvring room (below left). I decided to turn left and placed the contact on the right side of my MFD. Although the aspect still reports 17L (below right taken moments after my turn), I am clearly on the *right* side of the bandit, so that's a small bug (now corrected) at the time of writing; the aspect angle should be 17R by now. Decrease FCR range to 20 Nm to keep the contact in the top half of the FCR page.



Once the contact is on the side of the MFD, it is easy to lose track and let it drift outside FCR scan limits. To avoid that use the HUD TLL. It displays a line pointing towards the contact outside your HUD field of view and the ATA in degrees. Don't let it go above 50° (55° max). Anytime you come close to 50°, make a check-turn towards the contact to bring ATA back to 45-50°. That will ensure the contact stays within your FCR scan volume. Continue to monitor target aspect angle.



If the adversary pilot is unaware of your intercept, his aspect angle will steadily decrease as you get closer to his six o'clock. If you see the aspect suddenly increase back towards 180°, then he's probably detected/seen you and turned into you, negating your turning room offset. If the aspect angle suddenly decreases rapidly to zero, then the aircraft has turned away from you and is trying to escape.

It is easy to ignore these scenarios at this time, because the target in this mission is totally unaware and continues to fly straight and level. Bear in mind though that a fighter, or a human opponent, will not play the game according to your rules; he will fight back. Paying attention to any aspect angle changes will help keep you in charge of the intercept, provided you know what to do to react to any sudden change.

Range is also decreasing fast and once aspect angle hits 120° (12R) turn towards the contact by flying pure-pursuit. As you can see on the following picture, the contact is now 5.3 Nm at 51° off-boresight to the right.



An aggressive turn to the right brings the TD box into the centre of your HUD and you can try to identify the bogey visually. It's definitely a twin engine transport but if you need a better tool at VID, the TGP is your friend. It's a Transall C-160. The TGP will track the same A-A contact as the FCR provided it was setup in A-A mode.



let it go!

As a cloud, chances are that the Papa

use of sidewinders.





Nice view but don't celebrate yet, more aircraft are coming to you and these might fight back. Reset your systems and turn to the North, scanning the skies ahead of you. Check your fuel and weapons remaining. Fuel should be ok and you should have 2 AIM-9M all-aspect sidewinders and some cannon rounds left.

Reset MRM mode, the Mikes are selected automatically. Reset your FCR to 40 Nm range and centre the antenna for good measure. HSD and SMS reset on the right MFD. Scan the airspace in front of you for bogeys.

As said earlier the AIM-9M needs to be cooled. A warm missile seeker will not be as efficient and may fail to track correctly. To cool the missile seeker press OSB 8, labelled WARM. The mnemonic will change to COOL and the tone will become higher pitched after a short while. Missile status will also change to RDY. Remember, DOGFIGHT mode does this automatically.

Continue to scan north and after a while you will paint a two-ship MiG-19 flight. They are line abreast and fly around 20000 feet on a 200° heading. They are armed with AA-2 (R-13D) Atoll, which are a reverse-engineered early model sidewinder.



Perform an intercept on these two guys, trying to sneak behind them without them noticing you. Do the same procedure as before, but pay attention to your speed and altitude advantage, and monitor aspect closely to detect immediately if they manoeuvre. Remember that you perform intercepts from further away on fighters.

I suggest you start offsetting at least 35-40 Nm from them. They don't have a radar as powerful as yours (if any), so although they are a bigger threat than the Transall, they should still be an easy target for you.

You have two missiles left and two targets. The first one you will bug on the FCR for the intercept; your last missile should be fired without radar lock, or in DOGFIGHT override mode. After successful dispatching the MiGs, you can recover at Kunsan airbase to analyse that ACMI tape of yours.

Good luck and good hunting.

MISSION 18: RADAR MISSILES (CAP)

LOCATION: North of demilitarised zone

Please note, make sure you select the F-16 flight (BARCAP) from the mission window; if you select the first flight without checking you will end up piloting an AWACS.

CONDITION: F-16 block 52 – Two ship - Callsign Falcon 1.

GW: 36702. 1aim-9X, 5 AIM-120C, 2 wing tanks, 1 ECM pod and 1 Sniper targeting pod.

Max G: 7.0/-2.0, Max speed: 600 kts / 1.2 Mach.

Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.

WEATHER: RKSM INFO: B 011225LT RWY01 TRL140 360/15KT 9999 FEW050 28/18 Q1013 NOSIG

GOAL: Prevent red air from trespassing your AOR during your CAP patrol time of 30 minutes.

18.1 Combat Air Patrol

When you fly any type of CAP your task is to assume your station on time and prevent enemy from passing through your Area of Responsibility (AOR). You will mostly fly a racetrack pattern at a relatively high altitude.

Racetracks are made of 2 parallel legs with 180° turns between them. The hot leg and the cold leg are usually 20-30 Nm long, but mileage may vary according to the tactical situation. The definition of hot versus cold leg is mainly defined by where the enemy side is. When you're on the hot leg you are facing the enemy and actively searching for contacts, and will engage any hostiles within your AOR. When you are on the cold leg, you are typically flying back to your initial CAP point with the enemy at you back.

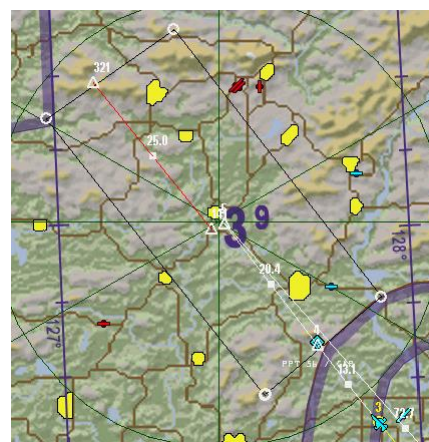
Most CAP flights are made with contra-rotating elements; so that while one element is hot, the other is cold. Elements coordinate their turns so that there is always one set of radars scanning the AOR in the primary threat direction. And elements cover each other; when one element turns cold, the hot element takes over responsibility of the engagement, aka a 'Grinder', and engages the enemy while the cold element resets. Depending on how the engagement develops, turns can be made when necessary to ensure mutual support.

Speed and altitude are important. BVR combat doesn't happen in the dense, lower layers of the atmosphere. Most BVR missiles are powered by rockets that burn for a very limited part of their flight time. Once that burst of initial propulsion ends the missile starts to slow down, so higher altitudes with thinner air will slow missiles down less quickly, than air nearer the ground, extending their range.

The launch aircraft's speed also provides the missile with kinetic energy and its altitude provides potential energy. Therefore, flying high and fast when launching is definitely desirable for extending missile range.

Knowing when to engage a contact or leave it depends on its position relative to your AOR. That is the reason most CAPs are flown with a box on your HSD, drawn with lines during mission planning.

The risk is to be baited by a decoy flight, leaving your element without support; or even worse, leaving your AOR unprotected while you go off chasing bandits far away from the area you were supposed to protect. Good CAP planning must have clear Commit Criteria to avoid confusion about when and how to engage the enemy.



In this training scenario you are single-ship, because we will focus on what happens in your own cockpit. The mission has the engagement timed in to avoid the need for mutual support. Your AOR is clearly marked on your HSD and your simplified single commit criterion is any enemy aircraft that enters your CAP box. Fly your hot leg, investigate any contacts. Commit only if you can conclude the engagement without being dragged away. Turn cold to maintain your CAP geometry. It's harder to do in single-player but hopefully you will learn things in the process.

18.2 The AIM-120 AMRAAM missile

The primary BVR missile of the F-16 is the AIM-120 AMRAAM (Advanced Medium Range Air-to-Air Missile). It is an Active Radar Homing (ARH) missile with launch-and-leave capability. This means the missile's own radar can find and track a target at a specific point during the missile's TOF (time of flight).

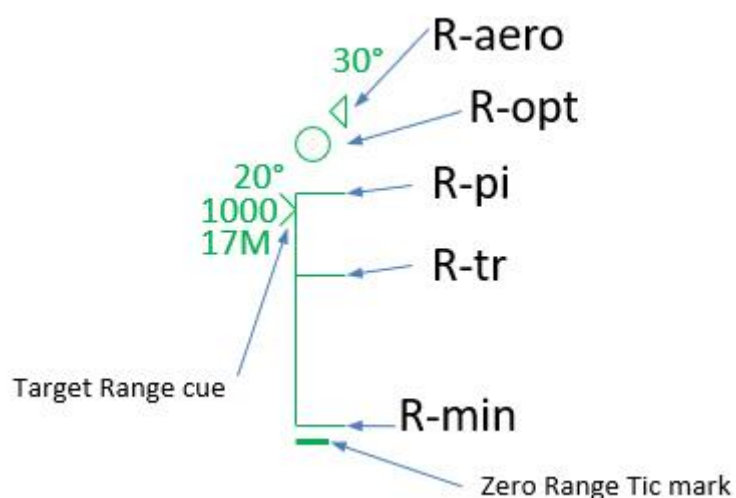
Because of the relatively small missile cross-section its on-board sensors are rather small and its radar range is limited. Therefore the missile is supported via datalink from the launching aircraft, which continues to track the target using its own, more powerful radar, until the missile is close enough for its own radar to take over. Once the missile becomes active, you can decide to continue supporting it (for better accuracy), or snip it by dropping the track on your aircraft's radar to let the missile continue its intercept autonomously.

In BMS both the AIM-120B and AIM-120C are modelled. The differences are slight, with the newer block lighter with slightly longer range. Basic HUD symbology is explained in the Dash-1 (HUD chapter) and AMRAAM usage in more depth in the BMS1-F16CM-34-1-1, so we will not cover all the tiny details, but rather stick to what is really important in this training scenario.

18.2.1 DLZ

What is the range of the AIM-120? Well if you look at the right side of the HUD, or on the right side of the FCR when the AIM-120 is the selected weapon, there is what we call a Dynamic Launch Zone (DLZ). The reason why is called Dynamic should answer your question. There is not a fixed range for missiles; it depends on many factors that the human cannot compute. So the avionics system does it for us and presents it as the DLZ and its range cue.

To be able to measure range the system must have a reference: the bugged contact on the FCR. Once a contact is bugged and MASTER ARM is in ARM or SIM, the missile symbology will be displayed. The Target Range Cue on the DLZ gives you information about missile range.



The AMRAAM DLZ consists of five ranges:

- **R-aero:** (Range aerodynamic) represents the maximum kinematic range of the missile. When the target range cue is next to the R-aero symbol, you could fire the missile and it *may* hit if the target is not manoeuvring at all *and* if you make a perfect shot by following the attack steering cue and lofting the missile. A missile fired at R-aero range will always terminate in nominal termination.
- **R-opt:** (Range optimal) is the same as R-aero but the missile will terminate in high termination criteria. *Termination criteria* are used to describe the kinetic energy and manoeuvrability potential the missile has to successfully intercept the target and destroy/damage it. It can have **High Termination Criteria** or **Nominal Termination Criteria**. The latter means the missile will have less energy/ manoeuvrability thus less probability to hit the target.
- **R-pi:** (Range probability of intercept) represents the maximum range shot with high probability of intercept given *current* steering; that is to say without following attack steering or optimal loft cues. We still assume a non-maneuvring target though. The missile diamond flashes at R-pi.
- **R-tr** (Range turn & run) represents the maximum range assuming that the target turns away from you to a tail aspect at launch. The ASEC flashes at R-tr.
- **Rmin** - represents minimum launch range based on missile kinematics and current steering.

If there is only one thing you can remember from this page: the highest probability of kill (P_K) is at R-tr when the ASEC flashes. You're also closer to the target though, who may be firing back at you!

18.2.2 The ASEC (Allowable Steering Error Circle) and ASC (Attack Steering Cue)

The ASEC is a variable diameter dynamic circle centred on the FCR and HUD. The ASEC can be used as an aid for positioning the ASC, which helps you to steer your aircraft into the best position to launch your missile to maximise missile energy and therefore range.

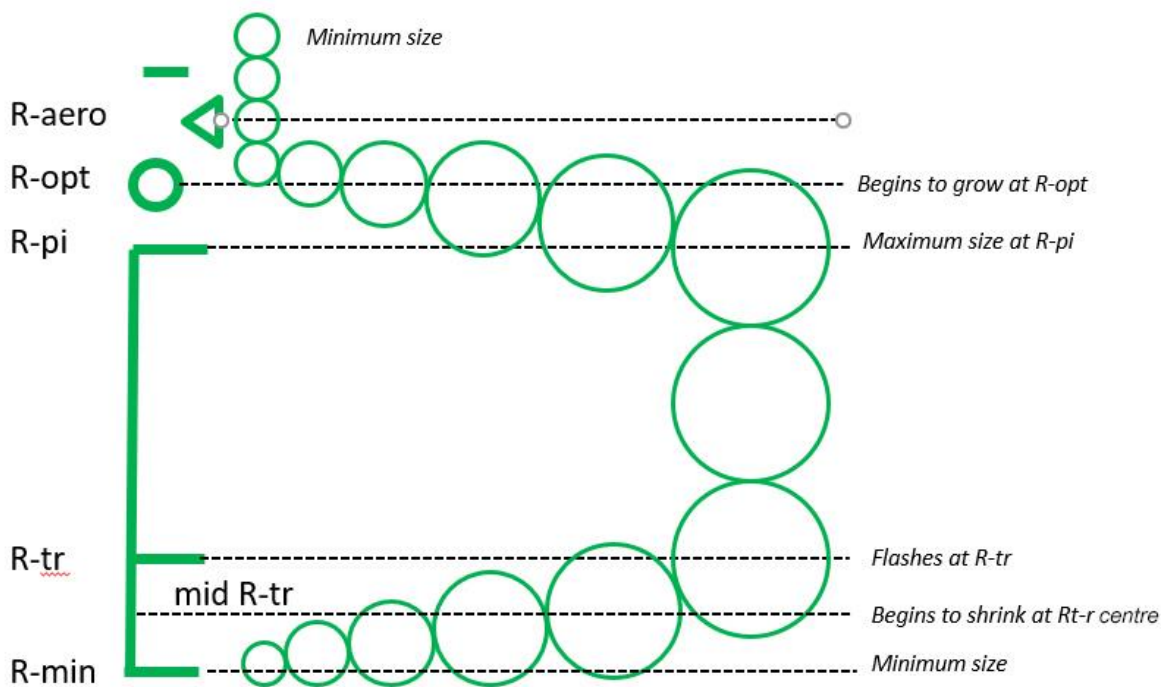
For the ASEC to be displayed a target must be bugged, the AIM-120 selected as the active weapon and MASTER ARM needs to be set to ARM or SIM.

At target ranges from outside R-aero to R-opt, the ASEC is set to a minimum size of 11 milliradians.

At R-opt the ASEC begins to grow until the target range reaches R-pi, where it reaches its maximum size of 56 mr. At R-pi the ASEC represents 45° of allowable steering error. The ASEC remains at maximum size until the target range reaches the centre of the Manoeuvre zone, at which point it begins to shrink until it reaches its minimum size again.

The ASEC will flash when target range is between R-tr and R-min and within missile LOS limits.

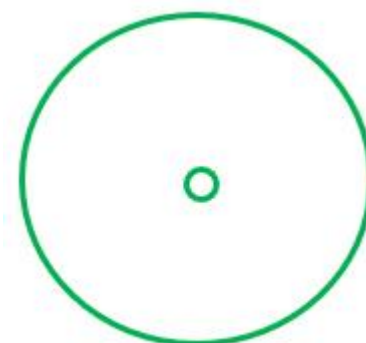
The larger the ASEC, the higher the P_K . The smaller the ASEC, the lower the P_K .



The ASC (Attack Steering Cue) is a 8 mr diameter circle in the HUD and a 10 pixel radius circle on the FCR. It provides a reference for guiding the aircraft to the target. If the target is outside the range of the DLZ, the ASC represents the required course for the aircraft to maximise closure rate on the target. Once within range of the DLZ, the cue indicates the optimum course for the AIM-120 to intercept the target.

Flying the cue to the centre of the ASEC before firing will give the missile the best kinematic advantage, making the ASEC grow as large as possible.

For the best shot possible, place the ASC at the centre of the ASEC.



Optimal Missile Steering

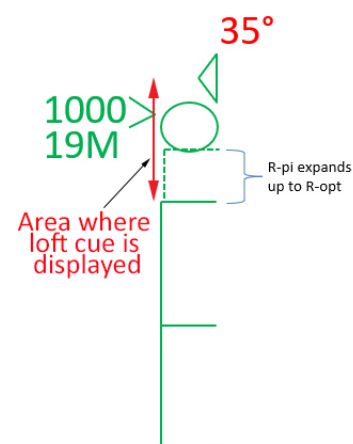
18.2.3 Loft Solution Cue

The loft solution cue is displayed when the target range cue is between R-aero and R-pi. At that range the ASC provides horizontal steering only. The Loft solution cue provides vertical steering optimisation. The loft angle is shown in 5° increments and illustrated in red in the picture on the right.

Once the AMRAAM leaves the rail, it will loft on its own, but by pulling your aircraft up into a climb you reduce the energy the missile will need to use to loft itself, thereby increasing its range.

Lofting at R-opt will expand R-pi up to R-opt, thus increasing missile range.

To follow the loft cue in the example right, simply accelerate and nose up to the 35° pitch line before depressing the pickle button.



18.3 BVR

What is BVR? BVR means Beyond Visual Range and therefore consists of manoeuvres to optimise your radar missile shots and at the same time preventing the enemy from doing the same to you.

It is the art of modern long-range air combat centred on pressing the pickle button, but the hard parts are actually happening before and after having pressed that button.

Many users complain about the huge amount of abbreviations or specific vocabulary used in an F-16 combat flight sim. Well, it's about to get a whole lot worse. If you continue reading this chapter, be prepared to get completely overloaded with acronyms and weird words that don't mean much when taken out of their context; and this is very much a simplified version of what real pilots have to understand. You have been warned!

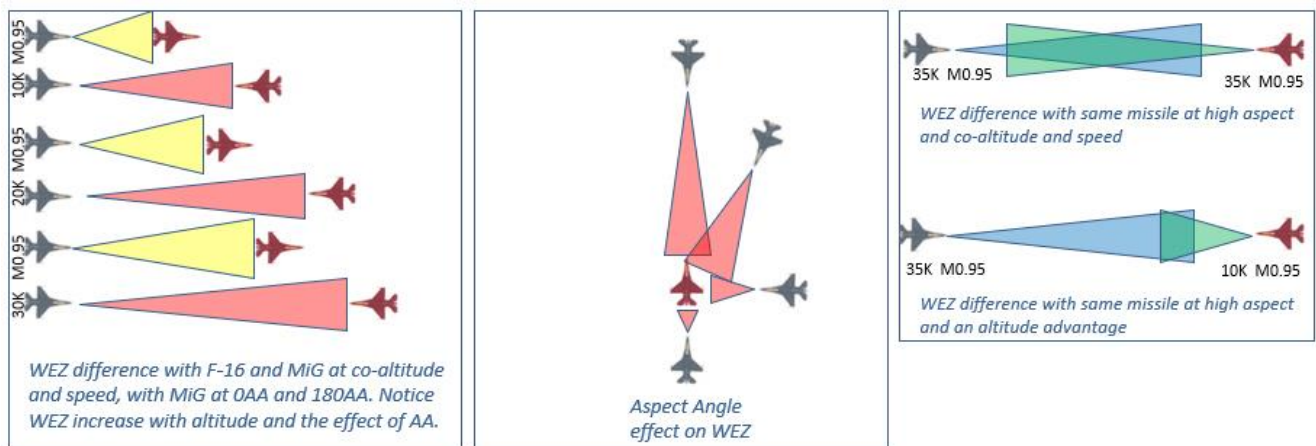
Still here? Okay, here goes...

18.3.1. WEZ, WEZta & MAR

As we have discussed earlier, we cannot consider missile ranges because these ranges are dynamic and change constantly, depending on many factors such as: speed, altitude, aspect etc.

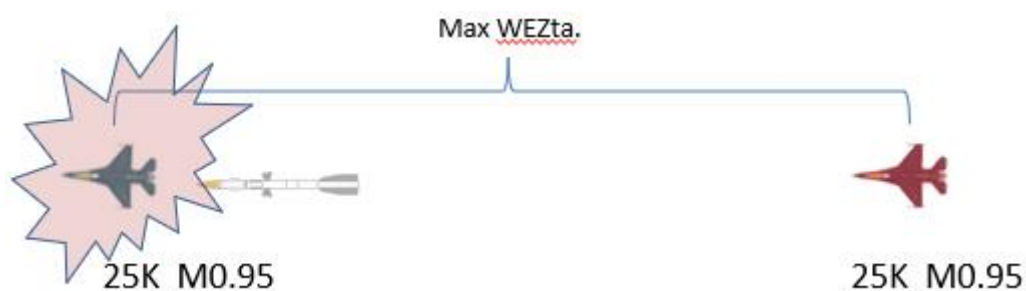
We will use the term WEZ (Weapon Engagement Zone) instead of range.

Here are some examples:



And since it is usually a bad idea to continue towards a missile launched at you, and smarter to turn tail and try to outrun the missile, we will define WEZta (WEZ tail aspect), which is the weapon engagement zone for a missile fired at a zero aspect (tail chase) target which is co-speed and co-altitude.

WEZta is the maximum range that a missile will hit a target when fired from a 0° AA (stern) position.



WEZ and WEZta play a significant role in BVR. Knowing the adversary's missile WEZ helps determine your execution ranges. You must be aware of the adversary's WEZta at low, medium and high altitudes, for they change dramatically as illustrated above.

Your goal is to get the best parameters for shooting a missile and kill the target, while staying out of your target's WEZ.

Where do you get that WEZ-ta value at different altitudes? Legitimate question, but it is beyond the purpose of this training manual to provide you this data. I suspect that in real life this data is classified. I would even venture that in a BMS VFW, the data extracted with long test sessions are in some way classified as well. I hardly see a VFW which has spent hundreds of hours at each release of BMS to test these ranges to simply give them away to the next VFW, one that they could one day fight against in a TvT campaign.

So this data is indeed hard to get, and I will not give any away either! My hands are full writing these documents for BMS and I have no time to create tests protocols to come up with WEZta tables to supplement this manual.

In a typical engagement though you don't start in a tail chase. Often aspect is 180° with each party charging towards the other. Both are usually fast, and both are usually as high as possible. Why? Because both parties understand that the higher and the faster the launching platform is, the longer WEZ they'll get.

So we need to define the next relevant distance: MAR which stands for Minimum Abort Range, which is the minimum distance at which you can make a 180° turn and outrun a missile that was launched at you. Basically, MAR is Max WEZta + the distance necessary to make that 180° turn away from the bandit.

The quickest 180° turn is probably a Split S where the pilot would roll inverted and pull till he's level again. The problem with that is the altitude loss such a manoeuvre would require. As we have seen before, WEZ changes with altitude. Doing such a manoeuvre to turn tail from a bandit wouldn't be very smart because you would now be at an altitude disadvantage being much lower than the opposing shooting platform, not to mention putting you in the WEZ of any weapons looking up at you from the ground, such as MANPADs, SHORADs and AAA.

Similarly, you do not want to turn so aggressively that you deplete all your energy. Doing so, you would end up at a speed disadvantage which will work against you when there is a missile coming at you.

The basic standard abort turn is a slice manoeuvre to tail aspect using 5G and constant speed. Depending on the F-16's configuration AB may be required.

As a rule of thumb we can define the distance to execute that standard abort turn as between 3 and 5 Nm.

Therefore:

$$\text{MAR} = \text{Max WEZta} + 3 \text{ to } 5 \text{ Nm}$$

Aborting at MAR will defeat the enemy's first shots and ensure you initially remain outside the WEZta.

In a BVR engagement, if you want to stay alive and prevent the engagement from turning into a merge, you need to respect MAR. This range will depend on the type of missile the enemy has, the altitude and speed of your opponent, or rather the difference of altitude and speed between you and your opponent. It is a lot of factors to control, but hopefully basic MARs can be given at your briefing.

18.3.2. CRANK

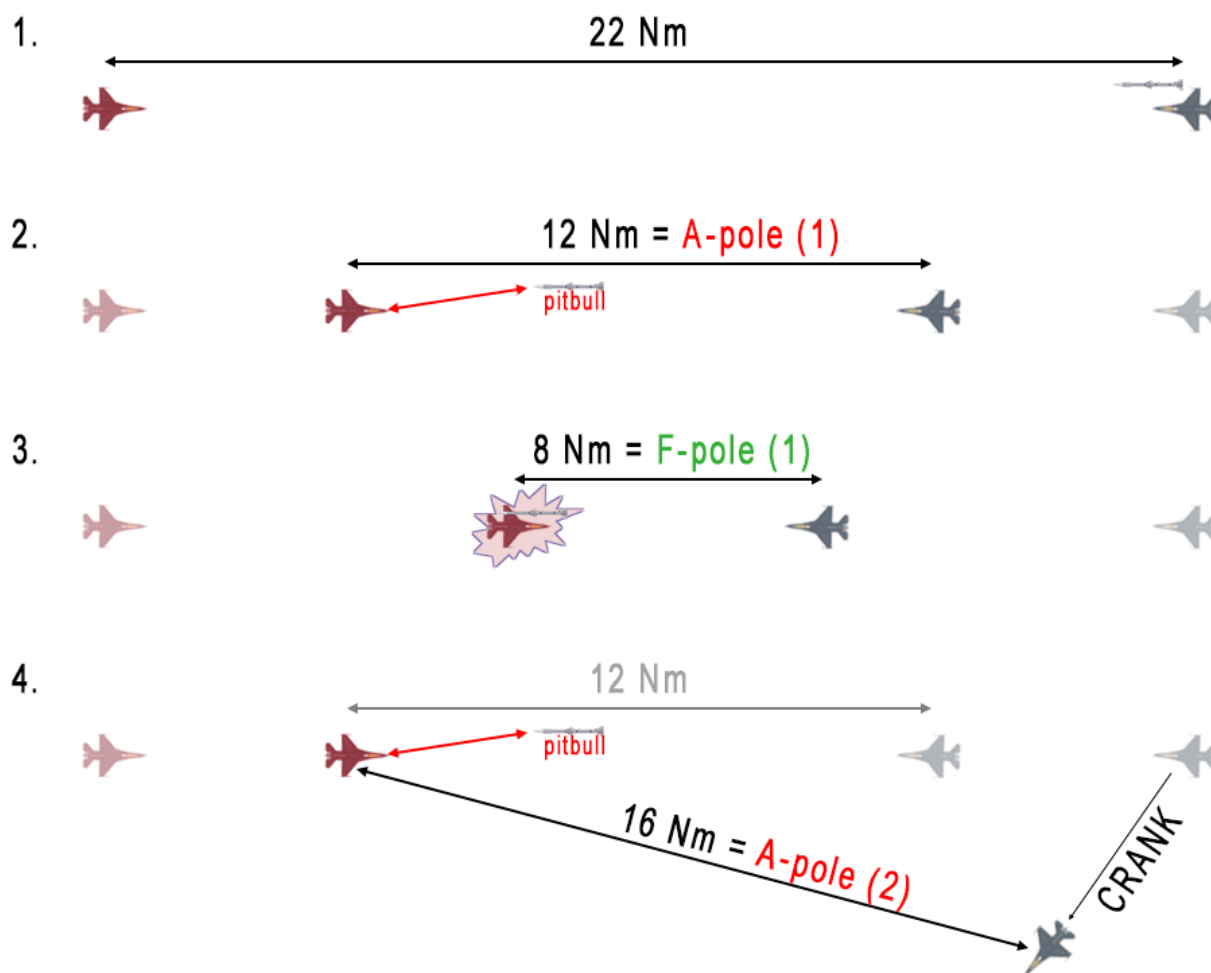
Cranking is a manoeuvre intended to increase the range between shooter and target after missile launch. Indeed once the missile is in the air, there is no tactical advantage at charging in the direction of the opponent and thus decreasing the distance between you and him. Doing so you may lose the range advantage your missiles have and provide your enemy with a firing solution on your aircraft.

Similarly, it's pointless to keep flying fast; but it's dangerous to fly slow too. If you have to react quickly, you need speed. So find a compromise between slow and fast. Slow enough to avoid decreasing your F-pole, but fast enough to maintain enough energy for the follow up of the engagement.

On the other hand, you can't really turn tail and reset for another engagement. As explained earlier you need to keep radar lock on your target to send data-links to support your missile, at least until it is able to continue the intercept on its own.

What is this F-pole we just referred to above?

F-pole is the distance between the Shooter and Target at missile impact.



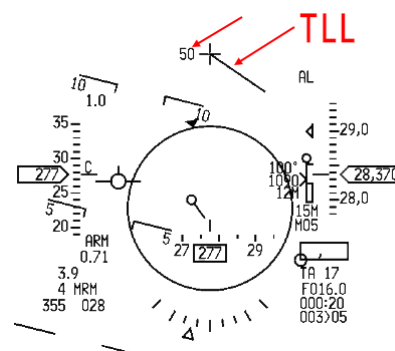
So basically it is a crank manoeuvre to increase your A/F-pole, while still being able to support your missile.

As illustrated by the 4 cases picture above (not drawn to scale):

- Case 1. The blue fighter has FLO (first launch opportunity) and fires its slammer at 22 Nm.
- Case 2. Both fighters continue head on, same speed, same altitude. The slammer goes active when the distance between the 2 aircraft is 12 Nm. That distance is called the A-pole.
- Case 3: Both fighters continue head on, same speed, same altitude. The slammer hits the red fighter when the distance between the 2 aircraft is 8 Nm. That distance is called the F-pole.
- Case 4: After firing its missile, the blue fighter cranks left and puts the target gimbal right at 50°. When the missile goes active, the distance between the 2 fighters is 16 Nm. Compared to case 2 it represents a gain of 4 Nm on the A-pole.

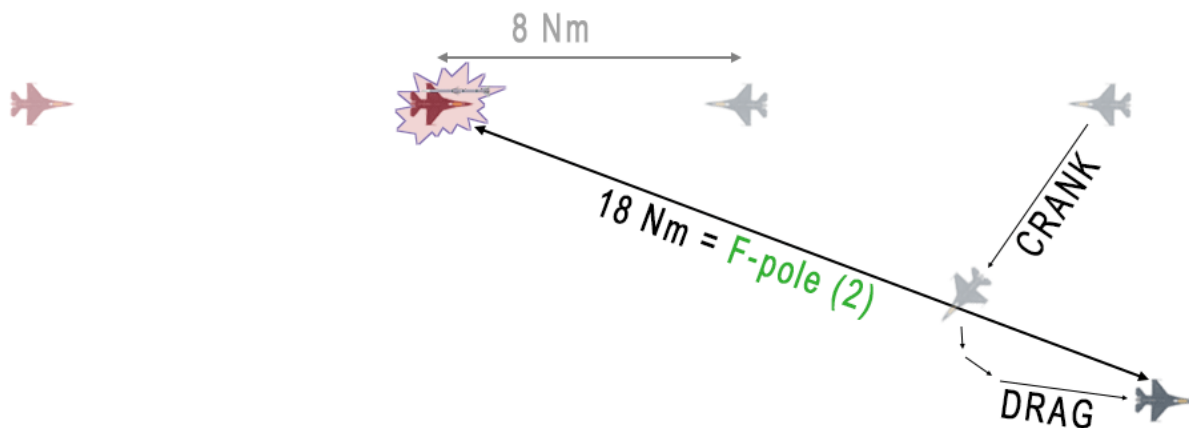
Cranking is made by turning away from the enemy just enough to maintain the radar lock. Doing so you place the radar contact on the opposite FCR gimbals of your turn (turn left, gimbals right and vice versa).

The HUD TLL (Target Locator Line) originating at the gun cross will display the angle-off, which will help you to keep the radar lock. A good reference value is 50°. More than 55° and the FCR may lose lock and the ability to send data-link updates to your missile in flight.



Once your missile becomes active (PITBULL), you may disengage and reposition for the next manoeuvre. There is no point continuing towards your enemy, as the missile is active and does not need updates from your FCR anymore. This is usually a DRAG away from the bandit which further increases F-pole as seen on the case 5. F-pole at Case 3 was 8 Nm and is now 18 Nm at Case 5; a gain of 10 Nm.

5.



This is usually the moment you start your retreat on the cold leg of the engagement and your wingman or element will cover your retreat by being in the hot leg of the engagement, doing the same as you just did with any potential trailing elements or flights.

This illustrated the geometry of how to increase F-pole, but remember that any speed advantage, any altitude advantage and any way you can apply to increase your missile energy at time of launch will also increase the poles: So fly high and fly fast when you loft your slammers.

When firing active missiles, A/F-pole comes in play. The basic concept of an A/F-Pole manoeuvre is to make your AMRAAM in flight go active or timeout prior to an adversary's missile doing the same.

There is way more to be said about BVR and we could write a 200 page manual about it and still only scratch the surface of this topic. But it's outside of the scope of this training mission. The basics have been covered and if you want to learn more the best course of action may be to refer to an online VFW.

18.4 The mission

The training mission is a 2 ship CAP flight north of Seoul. Expected opposition are MiG-23 and MiG-29. The MiG-23 carry R-23R (AA-7) semi-active radar homing missiles and the MiG-29 carry the more advanced R-27R (AA-10A) semi-active radar homing missiles.

Both these missiles are inferior to the AIM-120 AMRAAM (the equivalent in the red team is the R-77 (AA-12), so you should always have first shot opportunity (when co-speed and co-altitude), if you apply the techniques explained earlier to prevent the bandit from trespassing your FAOR (Fighter Area of Responsibility).

The flight will start just before entering the CAP box; AWACS is available on UHF preset 6 and your wingman is on VHF preset 15. Bullseye is at Steerpoint 5, which is the northernmost point of your CAP.

The IFF plan for this engagement is Mode C active at departure and Mode 4 only active once in the CAP; your DTC has been loaded accordingly. 4.34 introduced the IFF system. More information about IFF in BMS can be found in section 1.16 of the BMS Dash-1.

You can fly this mission in multiplayer with a human partner, or with an AI wingman. The latter will require you to issue commands to the AI wingman, which work much better now as AI BVR tactics have been completely rewritten for 4.34. This chapter will consider that your wingman is AI and will cover how to manage him in this scenario.

18.4.1 Getting Ready

Upon entering the jet, the sim will freeze, and some systems will be set for you. Once you get control back, make sure you can communicate with the AI wingman and instruct him to go SPREAD via the Wingman menu ('w' or 'z' depending on your keyboard). If the wingman does not respond, check that your VHF is set to VHF preset 15.

A Communication check with the AWACS might be a good idea as well. Check that the UHF radio is set to preset 6 and 'Request Picture' with the AWACS menu ('q' or 'a' depending on your keyboard). The AWACS should respond with a bullseye call for the first bogey.

Bullseye has been placed at Steerpoint 5, which is the end of your CAP hot leg. There are many ways to place bullseye for CAP flights, this is one of them. Such placement simplifies your commit criteria.

Since you do not want to leave your CAP box unattended, you want to set commit criteria. These will include a distance from a reference point that will trigger you engaging any trespassing aircraft. That reference point is bullseye. The distance in this case is the end of the AOR (Area of Responsibility).

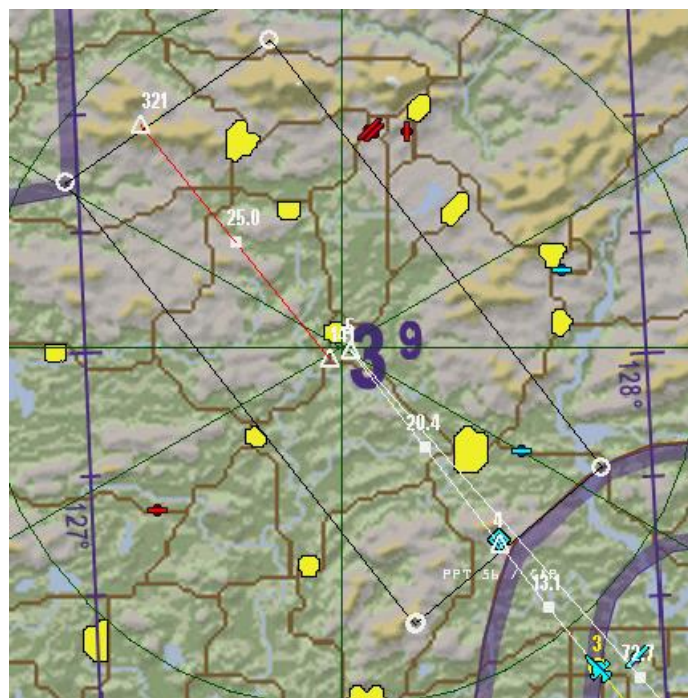
Since bullseye is 25 Nm from the forward edge of your AOR, as illustrated in the following image, your commit criteria should be bullseye + 25 Nm. Any contact reported within 25 Nm of bullseye should be engaged.

Knowing the position of bullseye is vital to understand contact position reports. The CAP box is orientated along a 320° (Hot lane), 140° (Cold lane) axis. Bullseye calls below 320° will be left; over 320° will be right when you are hot. 320° will be dead ahead.

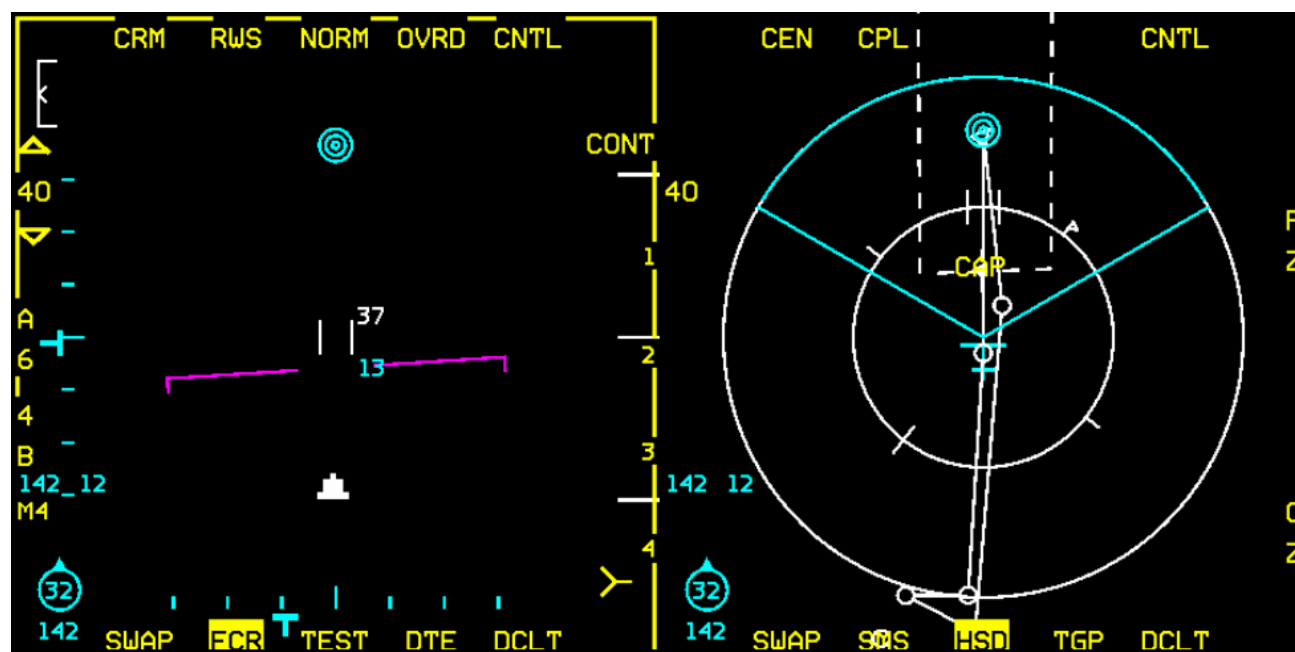
Normally AWACS will switch to BRAA (Bearing, Range, Altitude and Aspect) calls when contacts are within 25 Nm.

You are about 12 Nm from your CAP box; climb to FL260 or even 300 and accelerate to Mach 0.85 before entering the CAP.

The CAP is a 30 minute patrol. In campaigns, leaving the CAP before your station time is over will result in a mission fail. It is best to time your patrol with the HACK timer on the ICP to avoid leaving early. When you reach Steerpoint 4, your first CAP point, start the HACK timer on the ICP TIME page with the up arrow. You may return to the CNI page and the Hack time will still be displayed.



Obviously Fence in before entering your CAP. Kill your aircraft lights, set MASTER ARM to ARM, select MRM mode, ensure the TGP is set to A-A mode, start your ACMI recorder, ensure that your IFF is just Mode 4 and set FCR on the left MFD and HSD on the right MFD with option CEN (Centred) and CPL (Coupled).



The advantage CEN/CPL will bring is that HSD range will automatically change to match the FCR range. It is not mandatory; it's just a bit easier.

Last thing you may want to do is to set FCR OSB 16 to Mode 4 only. That way when you interrogate you will do so in Mode 4 only. If a contact doesn't answer a Mode 4 interrogation on this side of the demilitarised zone, it's *probably* not going to be friendly...

18.4.2 Managing the AI wingman

Before entering the CAP, a small word about managing your AI wingman. In a 4-ship multiplayer flight, a CAP is usually done with contra-rotating elements; while one element is hot, the other is cold. Elements coordinate their turns so that there is always one set of radars scanning the AOR in the primary threat direction. Elements cover each other; when one element turns cold, the hot element takes over responsibility for the engagement, aka a 'Grinder', and engages the enemy while the cold element resets.

With AI, it is a bit more difficult to do this. In a 2-ship scenario with AI, it's best to keep your wingman in spread and on the same leg as you. For more information about managing AI, please refer to Chapter 2.1.2 in the BMS COMMS and NAV book in your Docs folder.

The default state of your wingmen is 'weapons tight'. But he will want to engage much sooner than you as he doesn't care about commit criteria; so you must ensure you keep him on a tight leash.

When the wingman asks you for "permission to engage", you will have to respond to that call. Lack of response on your part will be taken as implied permission after a while. So, if you do not respond, your AI wingman will engage.



If the contact is too far away, select 'Weapons Hold' from the Wingman menu to tell your wingman to wait. Get ready to use that one often.

Default sorting upon issuing an 'Attack Targets' command is: lead sorts lead, wingman sorts wingman.

Using the 'Weapons Free' command instructs the wingman to look around for targets on his own, so no sorting and potential for missile spillage. Alternatively you may place your cursor over the desired contact and instruct your wingman to 'Attack my target'; then acquire you own target and engage it. You do all the work this way and lose precious time.

In my opinion, the best course of action is to use the 'Attack Targets' command and sort accordingly. But bear in mind AI are not as smart as you; always double-check (with IDM) which target your wingman is tracking before sorting yours, to ensure you don't waste precious missiles

After clearing an engagement, always instruct your wingman to 'Rejoin Formation', otherwise he will go off chasing MIGs. At lower skill levels, the AI may fire up to 4 slamers at a single MiG-23 when they get excited, so pay attention to what they are doing at all times and don't let them off the leash.

If you want to monitor the distance from your AI wingman you need to set up your A/A TACAN according to AI default use of A/A TACAN. AI flights always use the same structure:

- 1st flight in a package: Lead: **12Y** - Wingman #2: **22Y** - Element Lead: **75Y** - Wingman #4: **85Y**
- 2nd flight in a package: Lead: **13Y** - Wingman #2: **23Y** - Element Lead: **76Y** - Wingman #4: **86Y**

Up to 5 flights can be supported using the same format.

This training mission is in the first flight of the package, so your wingman's A/A TACAN is **22Y**. To pair with him set **85Y** (22 + 63).

Initiating IDM CONT ensures that you can track your wingman's position and who he is targeting.



As a reminder, that is done by pressing OSB 6 on the FCR until it reads CONT and then initiating an IDM round with a long COMM switch left.

18.4.3 The CAP

You just entered the CAP in SPREAD formation. Ordinarily you would check in with AWACS, but that code hasn't been implemented yet. Start your HACK timer and 'Request Picture' from the eyes in the sky.

Falcon 1-1 Chalice 1 picture is 1 group bullseye 3 2 5 / 3 7 26000 track Southeast hostile

You already have one group dead ahead (325°), outside your commit criteria at 37 Nm but they are flying south-east (135°), so they are approaching. Select Steerpoint 5 (end point of the CAP) and monitor them.

The new AWACS picture calls are a real game changer in 4.34. They really help to build a mental picture of what's going on around you. As a rule of thumb 'Request Picture' when you turn, especially when turning cold. The reply from AWACS will help you time your turns to keep the bandits at bay, for example you don't want to turn cold with a contact only 15 Nm behind you and then have a missile in your face when you turn hot again.

Approaching Steerpoint 5, make another picture request:

The first group is closer (31 Nm) but still outside your commit criteria (25 Nm).

There is a second group coming from the right but he's still 66 Nm away.

You've reached the decision point to

turn cold or commit on the first group. Since it is outside briefed commit criteria turn cold, but be aware that they are a bit close for comfort. Your AI wingman will want to engage; issue a 'Weapons Hold' command.

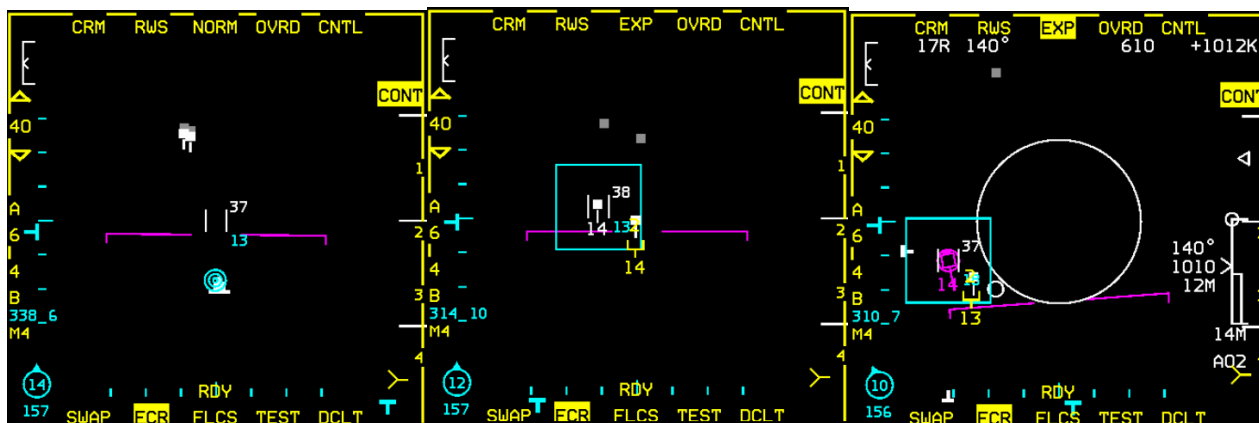
Falcon 1-1 Chalice 1 picture is 2 groups range and azimuth split

Southwest group bullseye 3 2 5 / 3 1 19000 hot hostile

Northeast group bullseye 0 3 3 / 6 6 5000 track Southwest hostile

While you are on the cold let get ready for an immediate engagement when you turn hot. In such a situation, with no friendly element pointing at the enemy the cold leg is your weak point. With the distance reported in this example it is best to turn hot before reaching your usual turning point. The longer you wait the closer they will probably be when you turn hot again.

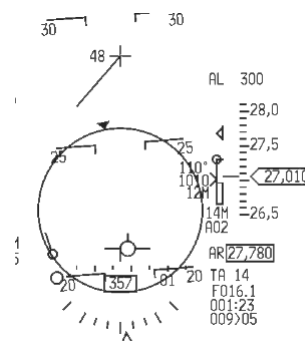
Turning hot again, calling AWACS is not necessary as the first group quickly appears on your FCR and your RWR shows you have MiG-23s at your 11 o'clock.



30 Nm is perfect timing for engaging these guys. You have first shot opportunity and they are within your commit criteria. From here everything goes fast, as illustrated by the three FCR pictures above.

- Left FCR: detection. Initiate a quick IFF interrogation in SCAN mode. No Mode 4 answer.

- Centre FCR: you issue the 'Attack Targets' command to your AI wingman and wait to see his IDM radar cursor appear on your FCR. You expand your FCR to get a better view of who he is targeting. He was supposed to sort the wingman, but he didn't – hence why you should always check.
- Right FCR: you bug the trailer, go AB, loft and fire your first slammer at the bandit. Crank right and monitor the situation, waiting for your slammer to go active. Keep an eye on your wingman DME (A/A TACAN) and position in IDM. Be ready with that leash.



When your wingman calls "PITBULL", issue the 'Rejoin' command. When your missile goes active, drag back to the start/anchor point of your CAP to increase your F-pole even further. Depending on your attack, both MiGs might be destroyed. If not, regroup and finish them off.

Drawing conclusions from the first engagement, you realise that commit criteria of 25 Nm is too close. The MiG-23 engagement was concluded within 15 Nm and the MiGs might have fired missiles back. If they have been more advanced fighters you and your AI wingman would have had to defend against incoming missiles. Learn from your mistakes and extend that commit criteria to bullseye + 40 Nm.

While you let your blood pressure drop, check that your wingman is in spread and fly the CAP as usual, waiting for more trade. It's always a good idea to keep a close eye on your wingman's fuel state and weapons remaining. Ask him for a 'Weapons Check' via the Wingman menu second page. He will give you his fuel state as well.

'Request Picture' whenever you turn in the CAP, there was a second group loitering on the East and you can expect them to try to penetrate your AOR at some point. Monitor your Hack time; your patrol time was set to 30 minutes from 1310 to 1340 LT.

There is no need to guide you in the next engagement; the mechanics will remain the same as the first one. Just bear in mind the distance at which you engage. The more advanced your opponent, the smaller the margins between who has the first launch opportunity will be. Therefore know your opposition, which may be more advanced as this training mission evolves.

The most dangerous opponent (short of a human player with slammers) will be MiG-29 or Su-27 type aircraft carrying the R-77 (AA-12) Adder. The young, bold pilots amongst you (there are no old bold pilots) might stay after their CAP patrol time for some real fun. 😊

A last bit of advice, BMS implemented IFF. Use it, especially in these types of scenarios. You never know when a friendly AI aircraft might enter the fray...

MISSION 19: GUN & HMCS/AIM-9X

LOCATION: Over the demilitarised zone. No AWACS, no tanker in the area.

CONDITION: F-16C block 50 – Single ship – Package 1606 - Callsign Falcon 1.

GW: 31000 lb, 4 AIM-9X, 1 Sniper pod, 1 Centreline tank.

Max G: 7.0/-2.0, Max speed: 600 kts / 1.6 Mach.

Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.

WEATHER: RKSM INFO B 011625LT RWY01 TRL140 360/15KT 9999 FEW050 28/18 Q1013 NOSIG
(Fair weather)

GOAL: Shoot enemy aircraft with the gun and the HMCS & AIM-9X combination.

At mission start your aircraft will be placed in an offensive situation against a Q-5 Fantan. The initial goal is to use the cannon to shoot it down, before other enemy flights enter the area and put you in a defensive situation, where you can use the high off-boresight capabilities of the AIM-9X to defend yourself.

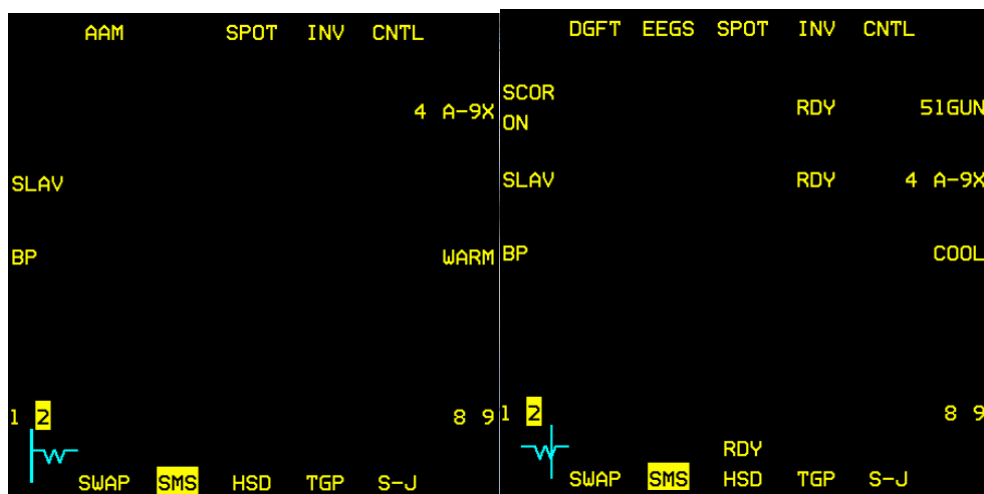
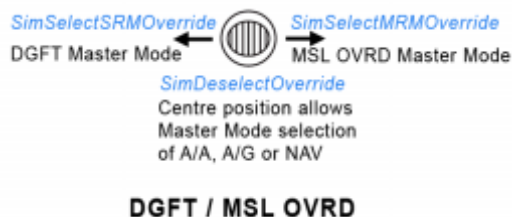
19.1 The Gun

The quickest way to select the gun is to select DOGFIGHT master mode with your HOTAS.

As its name implies Dogfight mode sets your aircraft systems for WVR (Within Visual Range) air-to-air combat; unlike MRM mode which sets your aircraft systems for BVR).

Settings may be customised in your DTC file but default settings for DOGFIGHT are: FCR/ACM (radar off) on the left MFD, SMS on the right MFD with SRM (short range missile) or HOB (high off-boresight) active (if carried) and the gun ready for use.

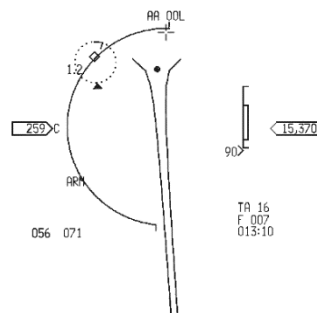
The gun can also be selected from the A-A SMS page by selecting OSB 1 to toggle between missiles and the gun.



The gun in the F-16 has different gunsights according to blocks. There are 4 modes available, depending on your Avionics profiles (for information on the Avionic Configurator, please refer to the BMS Technical Manual).

The gun cross and the enhanced envelope gunsight (EEGS) are the two gunsights used in most F-16s. The primary F-16 gunsight is the EEGS.

- **EEGS**



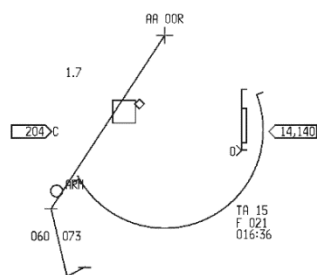
EEGS is the only reliable mode in BMS and represents a funnel and an aiming point at a fixed distance. The size of the funnel depends on the wing span setting entered in the LIST 5 page (MAN). Default is 35 feet which corresponds to a MiG-23 wing span. The perfect solution cue is attained when the funnel touches both wingtips of your target and the core of the aircraft is placed on the dot of the funnel.

```

MAN 7
HSPAN * 35FT*
HBAL
RNG 2000FT
TOF 5.4SEC

```

- **SNAP**

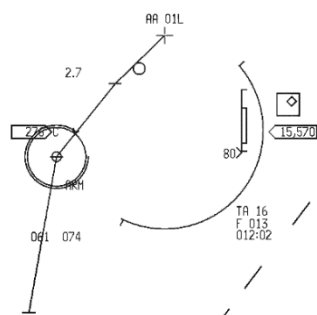


SNAP does not work correctly in BMS.

It presents you with a snake (a few straight lines which are connected to each other) and a marker.

With no radar lock, the marker will correspond to a fixed distance to target, while with a radar lock the marker moves along the snake and gives you a more precise solution.

- **SSLC**

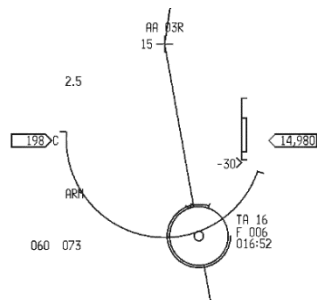


SSLC does not work correctly in BMS.

It should be almost the same as SNAP, but the impact point is the big circle. In BMS it's a full SNAP (with impact marker) and the big circle does nothing.

In real-life the big SSLC circle is adjusted according to target wingspan (just like the EEGS funnel) - but it is not implemented correctly in BMS.

- **LCOS**



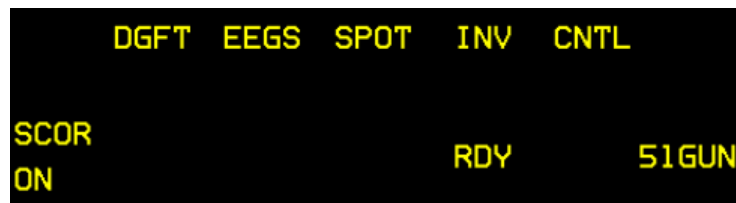
LCOS does not work correctly in BMS.

It does not correct for target range with a radar lock so it will always present you with a solution for the default target range.

As you have noticed only EEGS is reliable in BMS. The other three modes haven't received as much love as EEGS because they are older modes implemented only on a few older F-16 blocks. In BMS, EEGS will be your primary means (and the only one in late blocks) to use the guns.

The EEGS is documented in detail in the Korean BASIC EMPLOYMENT MANUAL F-16C volume 5 in your `\Docs\05 Other Documentation\Real Manuals` folder

When flying a block that features any of the 4 gun modes implemented, they can be toggled with OSB 2 of the A-A SMS page: Pressing the button will toggle the different modes displayed in the HUD. The amount of gun rounds remaining is displayed next to OSB 6 in multiples of 10. 51GUN means 510 rounds remaining.



Once the gun is selected, it's hot if MASTER ARM is in ARM. It may sound obvious, but there is a difference between firing the gun and firing missiles or dropping bombs. Missiles are fired and bombs released using the pickle button; the gun is fired with the trigger.

The F-16 HOTAS has a double trigger detent, so has BMS. The first trigger usually starts the gun camera (or recording), or fires the laser; the second trigger fires the gun.

Therefore you must ensure that you have programmed your HOTAS with the *SimTriggerSecondDetent* callback to ensure your HOTAS trigger will activate the gun.



19.2 Helmet Mounted Cueing System (HMCS)

The HMCS is fully explained in the Dash-34 manual. This chapter will cover its operational use with the AIM-9X loaded in this training mission. HMCS use will be explored after the first gun kill on the Q-5. In the meantime, here is some basic information on how to setup the HMCS in the cockpit.

The HMCS is obviously mounted on top of the pilot's helmet. It must be turned on with the knob on the HMCS panel located on the left auxiliary console. The knob has an ON/OFF button at the beginning of its course and controls HMCS brightness and intensity as well. Once activated, it is an extension of the HUD and both are considered as one SOI (Sensor of Interest).



The HMCS features two DED control pages (LIST – MISC - RCL) to manage different options, such as HUD and COCKPIT blanking (HMCS display will blank automatically when the pilot looks at the HUD and inside the cockpit) and different levels of de-cluttering. These options are set by default and described in the Dash-34.

The use of the HMCS can be passive or active:

- You can use the HMCS to keep basic flight information in your view at all times as you look around. Aircraft airspeed and altitude are displayed on the HMCS and are valuable information when you are looking away from the HUD, keeping a tally on a bandit for instance. The heading is not the aircraft heading, but the bearing you are looking towards, helpful for calling out bandits to your wingmen.
- Uncaged AIM-9 seekers can also be switched from the FCR to the HMCS by depressing CURSOR ENABLE on your throttle. By default, the button has to be kept depressed for the seeker to slave to the HMCS. As soon as you release the button, the seeker will return to the FCR LOS. This behaviour can be changed to a toggle in Avionic Configurator. This allows you to boresight the infrared missiles to the HMCS without using the FCR, for when you want maximum surprise.

- You can also use the HMCS more actively by slaving FCR LOS to the HMCS.

In DOGFIGHT override mode, switch the FCR to ACM BORE (Boresight) sub-mode by pressing and holding TMS up; an ellipse is displayed on the HMCS. Move that ellipse over the target and when you release TMS up, the radar will start to radiate and attempt to acquire/track a target within the ellipse.

Obviously for this to work, the HMCS LOS must be within FCR gimbal limits. When you move the ellipse out of the FCR gimbal limits, the ellipse will stop being displayed on the HMCS centre, but will remain on the side of the gimbal with a X superimposed on it.

These two methods will be documented in detail in the training mission.

19.3 The mission

Timing air to air engagements with AI is not an exact science. The idea in this training mission is to place you in an offensive situation for an easy gun kill against a Q-5 fantan, while a MiG-21 attempts to intercept you. As the mission evolves, more single-ship red aircraft will pop up and each will be a more advanced fighter than the previous one.

Obviously the situation will be very dynamic, and we will consider the engagements one by one:

- Q-5 with guns.
- MiG-21 with HMCS passive AIM-9X (no radar lock) off-boresight.
- MiG-23 with HMCS FCR/HMCS BORE.
- The 4th fighter will be up to you as a bonus.

19.3.1 The Q-5: guns

Entering 3D, you seem all alone cruising lazily above the clouds. Select Air to Air master mode and make an FCR sweep in front of you. You will notice a contact inside 10 Nm in front of you, he's cold meaning flying away from you. Don't wake up the guy by going STT (double TMS UP) on him right away but lock him up with one TMS UP so you can get his speed at least. Quick round of IFF LOS gives no response. You have no AWACS and must close to visually ID the bogey before engaging.

Closing on him, monitor your closure rate with the FCR. Check your switches for Master arm ON and that the HMCS is ON. If contrast against the clouds is a problem, lower your visor.



The left FCR picture on the previous page should be close to your initial lock on the FCR. The bogey is dead ahead, 7 Nm, 16000 ft, aspect 4° left, flying on course 320° at an airspeed of 240 kts.

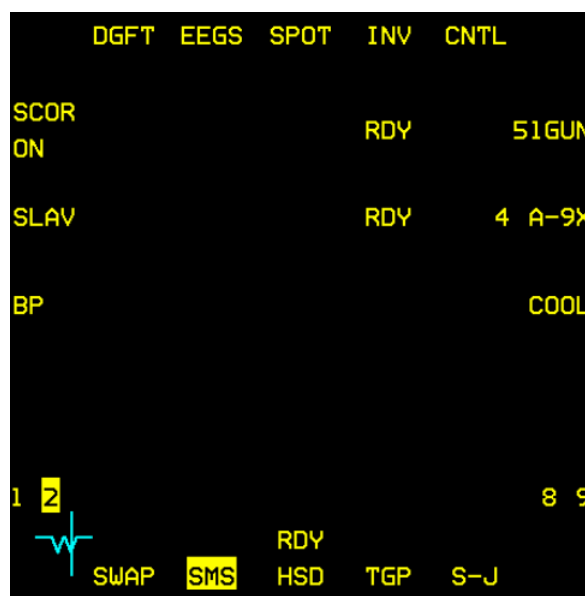
To intercept a radar contact from this position you need to closely monitor your closure, which is identified on the right FCR picture in the top right corner of the FCR. It is currently 360 kts. As you may have noticed, the closure rate is also displayed on the scale on the right of the FCR.

Flying lead pursuit is the quickest way to intercept the contact and that is done by simply placing the CATA in the centre of the FCR, as illustrated in the right FCR picture.

As you close in on the bogey you must obviously adjust your speed. An overshoot would place you in a very awkward situation wouldn't it?

Once you have a tally on the bandit (you classify it as a bandit when you see it as it's a DPRK Q-5 Fantan) and you've got your closure rate under control, switch to Dogfight mode. This will provide many advantages:

- The radar will switch to ACM mode and will snooze (stop radiating) until you select a sub-mode.
- Infrared missiles will be selected and can be fired with the pickle button (note RDY next to AIM-9X on the right SMS picture).
- IR missiles are automatically cooled (if applicable). In A-A master mode, IR missiles need to be manually switched to COOL (OSB 8). If they are not cooled, RDY status may not be displayed; the missile will fire but with degraded seeker efficiency.
- The gun will be selected and can be fired with the second trigger detent (note RDY state next to the GUN on the right SMS picture).



As explained above the F-16 block 50 you are flying today only has the EEGS gunsight. You therefore cannot change it with OSB 2, but you wouldn't want to anyway as it's the best F-16 gunsight.

EEGS displays a funnel and a reference aiming point in the HUD as a solution cue. The funnel should be adapted to the wingspan of your target for better accuracy. This is done through the LIST – 5 page of the ICP.

It defaults to 35 ft for a MiG-23 and the Q-5 has a 31 ft wing-span. It won't prevent you from shooting the aircraft down, but if you want to change the wingspan setting to 31, simply enter '3 – 1 – ENTR' with the ICP with the scratchpad on the WSPAN line.





Now you must manoeuvre your aircraft into a control position behind your target, trying to position the Q-5 on the EEGS dot which is 2000 feet in front of you with the EEGS funnel on its wingtips. Once you get that sight picture (or actually a fraction of a second before) fire a short burst of cannon fire.



If you close too much, an X will superimpose on your HUD. If you fire and hit the aircraft in front of you, you might get damaged by the blast, or debris as you fly through the explosion. Still, that allows you to admire the marvellous new 3D model of this not very well-known aircraft.

The pilot of the Q-5 must be junior, as he's flying slowly and remains unaware of your attack for a long time. Once he detects you he will start to jink, and he will use the sun a lot, hoping to decoy your infrared missiles.

It shouldn't take long for you to saddle up behind the Q-5 and shoot him. But be aware that while you're having fun with the Q-5, a MiG-21 may be manoeuvring behind you; check your six often, or you may see a few tracers flying past your canopy while you are target-fixated on that weird aircraft.

19.3.2 The MiG-21

Although the purpose of this manual is not to teach you how to dogfight, there are 2 basic rules I can refer to:

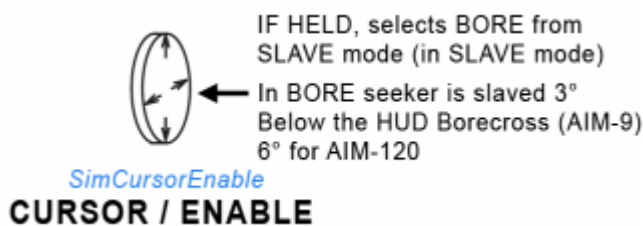
- Don't lose sight of your opponent. Once you lose tally (on the target) you will lose precious time trying to reacquire it. While you are doing that, the target will be manoeuvring into an offensive position.
- Energy management is the key to max-performing the F-16, particularly controlling your airspeed and altitude. Keep your airspeed in the corner velocity window of 330 to 440 knots for maximum turn-rate. Convert altitude into speed and speed into altitude as needed to out-maneuvre the MiG.

Obviously I can't tell you where the MiG-21 will be after the Q-5 engagement. He might be in firing position on your six, he might have flown back to base; he could be anywhere in a block of airspace 40 Nm around you. All I can tell you is that when you spawned he was supposed to come in from your 4-5 o'clock quarter. You'll have to find the MiG with your Mark1 eyeballs or your on-board sensors. First have a careful look around you. If you can't see him and your FCR doesn't auto-lock him in ACM mode, start a wider FCR search by moving the dogfight switch to MRM override mode, which will place the FCR back in RWS mode. Pay attention to your RWR. If he finds you first you may hear the spike and be able to get an idea of his direction from the RWR display. Continue scanning the skies until you spot him.

Once you have radar contact, let's try to sneak up on him and send an AIM-9 up his tailpipe. Once you have tally, go back to dogfight mode, which will snooze the radar, and keep him padlocked. Let's try to get him with a radar-off infrared shot. First uncage the first AIM-9X. The missile diamond seeker in the HUD doubles in size (left picture below).



By default, the missile seeker is pointed 3° under your HUD boresight cross. As we are in off-boresight geometry we need to slave the missile seeker to the HMCS. This is done with the CURSOR ENABLE button on your throttle (press in and hold). The missile seeker will go to the HMCS LOS as long as you keep the button in.



As you see on the second picture, the missile diamond moved from the HUD to the centre of the HMCS display but it didn't acquire the MiG-21, as it's still outside the seeker field of view. The cursor enable switch is not released. If you release it, the missile seeker will return to the HUD. Instead, keep it depressed and place the HMCS missile seeker head on top of the aircraft, then release cursor enable. If the seeker sees the aircraft it will lock up, the growl will change in pitch and you're ready to fire. Last check of the firing parameters and you let fly the sidewinder, which will find its prey as it's climbing, trying to outmanoeuvre you.

For the off-boresight sidewinder to score, the aircraft you are targeting must be in the missile seeker gimbal limits. These limits are greater (for the AIM-9X at least) than the FCR gimbal limits that often become the limiting factor when you try to make an off-boresight shot with a radar lock. The next three pictures are taken looking left of the airplane at about the 3/9 line. The right picture shows the seeker still centred on the HMCS LOS when looking at 006°. When looking further left (346°) the diamond is offset as if becoming stuck on the side of the HMCS. You have reached the missile seeker gimbal limits.



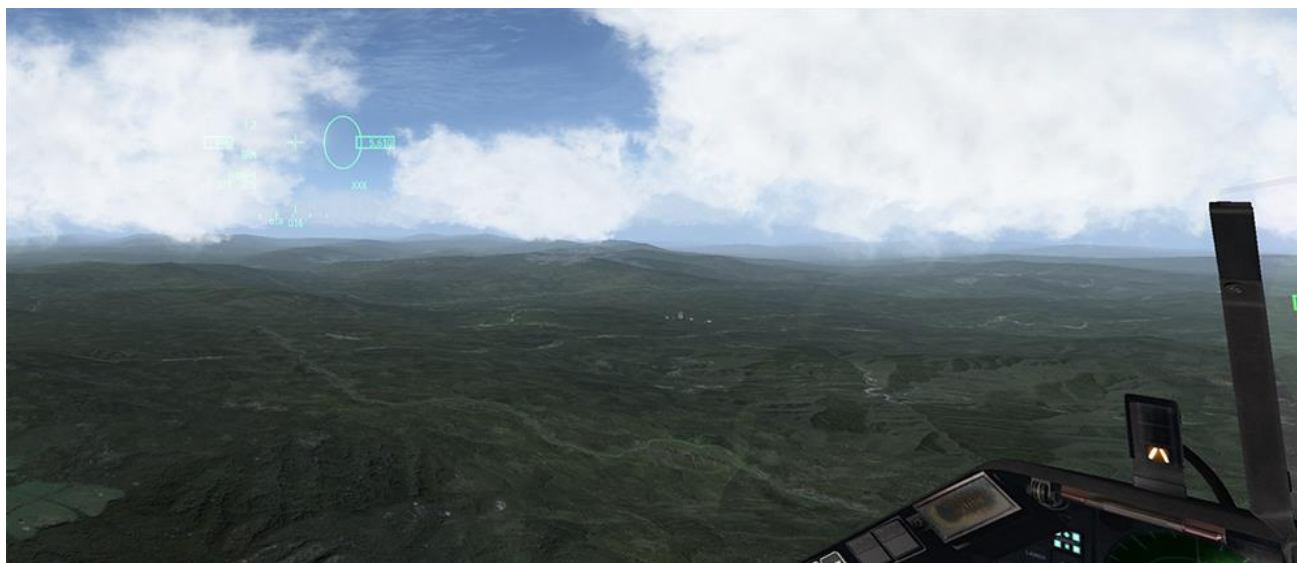
If you look further left at 333° (left picture) the missile seeker head is crossed and stuck at the side of the display, indicating that the boresight limits are outside the HMCS display. It's hard to judge from the pictures above how far off-boresight you can get. With the AIM-9X it's just under 90°; the following picture shows the missile diamond tied on the HMCS just above its gimbal limit, and we're barely looking at our left 9 o'clock.



The FCR has less off-boresight capability, as the following images will show you. The same test was performed looking left, with TMS up to slave the radar in BORE to the HMCS. The right picture shows the FCR BORE ellipse still centred when looking at 032°. Looking further left (016°) the ellipse offsets to the right, it remains stuck at the FCR gimbal limits. If you look further left (009°) on the left picture the ellipse is crossed and stuck on the side of the HMCS display.



As you see the infrared seeker reaches gimbals around 360° whereas the FCR gimbals around 030°, equating to 60° either side of your heading, which obviously corresponds to the 120° scan volume of the FCR. The next picture might give you a better idea of the off-boresight limits using the FCR:



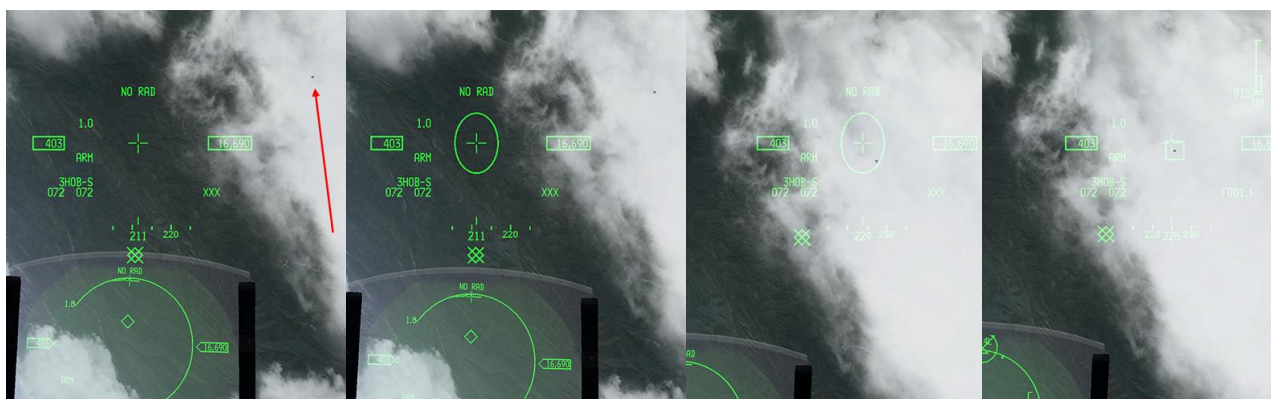
19.3.3 The MiG-23

While engaging the MiG-21 you may have had a glimpse on your RWR of 'nails' from a MiG-23. He is set to come in from the West. Hopefully you were able to deal with the MiG-21 before the MiG-23 finds you.

If you have no indication of his position, start a search to the West and you should find him quickly. As always, don't go STT on the radar contact. You want the bandit to stay unaware as long as possible. Climb to get an altitude advantage, the MiG-23 is a very fast aircraft and you will need all the energy you can get.

We will attack the MiG-23 with an AIM-9X using an FCR lock. As always, use the FCR in CRM mode to start your intercept and get as much information on your opponent as possible: airspeed, altitude, closure, aspect angle etc. Once you have tally, switch to dogfight mode and start using your HMCS.

Slaving FCR LOS to the HMCS is done, within FCR gimbal limits, with TMS up. TMS up actually switches the FCR, when it is in ACM (Air Combat Mode) to ACM BORE. Just like the Cursor Enable button for the missile seeker, it's a dead man press and the FCR will start radiating when TMS up is released. So press and hold TMS up and an FCR Field of View ellipse will be displayed in the HMCS. Place that display over the position of the contact you want to lock and release TMS up. Upon release the FCR will start radiating and any contact within the HMCS ellipse will be locked up.



In the 4 pictures on the previous page, the left most picture is the initial attack on the MiG-23 in the top right corner. Dogfight mode is on, the radar is snoozed. In the second picture, TMS up is pressed and held. The FCR doesn't radiate yet but the FCR LOS ellipse is displayed in the HMCS. In the third picture, the HMCS ellipse is moved over the visual contact and TMS up is released. The FCR starts to radiate, finds the contact and locks it (right most picture).

Upon FCR lock, the MiG-23 reacts, breaks left and tries to run away, popping chaffs and flares. He can run, but he cannot hide. Well, not with a trail of flares like that anyway...



Wait till the sight picture looks better, then uncage and fire your infrared missile.

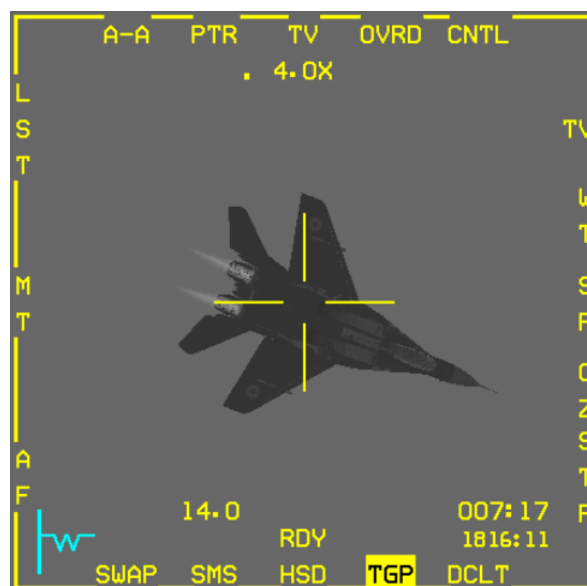
Well done, that's three you're almost ace!!

19.3.4 The MiG-29

The MiG-29 engagement is the icing on the cake. It's where you will apply all you have (hopefully) learned in the previous paragraphs. He's not supposed to be anywhere nearby as you dispose of the MiG-23, but he is taking off from Wonsan for a Sweep in your area. Knowing that, you may therefore manoeuvre into an offensive position on him. Turn towards Wonsan and start a radar search.

You've learnt how to use the gun, short range AIM-9X and the HMCS, so you're on your own now.

Use pause, use freeze, use invulnerability and unlimited gun and missiles as necessary to train as much as you need, until using these systems becomes second nature. Practice is what you need.



Try this mission as often as required and it will play out differently depending on how you manage the first engagements. The situation is obviously very dynamic and may not play exactly as it was documented here. That's not the really important part. Learn these systems regardless of the way the training mission develops. And above all: have fun doing it.

MISSION 20: AGM-84A HARPOON

LOCATION: Over Sokcho airbase close to the DMZ.

Please note, make sure you select the TASMO F-16 flight from the mission window.

CONDITION: RSAF F-16D block 52+ – Flight of 2 – Package 4964 - TASMO - Callsign Falcon 2.

GW: 39000 lb, 3 AIM-120B 1 AIM-9X, 4 AGM-84A Harpoon, 1 TGP, 1 Navigation pod.

Max G: 5.5/-2.0, Max speed: 550 kts / 0.95 Mach.

Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.

WEATHER: RKJK INFO: B 010455LT ILS RWY26 TRL140 360/10KT 9999 FEW050 18/8 Q1009 NOSIG

GOAL: Identify and attack the Russian Carrier Kuznetsov, cruising within its battle group alongside the North Korean West coast. Intel reports its destination is Wonsan harbour.

20.1 TASMO

TASMO stands for Tactical Air Support Maritime Operations; you will be attacking naval targets for a change. BMS 4.34 introduced a lot of new features supporting naval operations. Amongst them is the Russian carrier battle group of the Admiral Kuznetsov, which is currently cruising off the north-east shore towards Wonsan. The Kuznetsov is a formidable weapon and can deploy its air wing of Su-33 fighters. Considering the opposition, your package will be supported by an F-16 escort, AWACS, HAVCAPs and a tanker. Your mission is to identify the carrier from the rest of the naval group and sink it.

The best weapon for the mission is the AGM-84A Harpoon; a sea-skimming anti-ship missile. It is designed to be simple to use and its operational range of 60-70 Nm allows standoff attacks, usually keeping the launching platform out of range of all but aerial retaliation. It can be carried by Korean and Singaporean F-16s in BMS.

The Carrier group around the aircraft carrier Kuznetsov consists of 6 ships; the largest being the carrier itself. It contains the highest threat to attacking forces: its aircraft. Regarding close air defence SAM systems the Kuznetsov is equipped with the medium range SA-N-9 missiles, the equivalent of the SA-15 (Tor). The second largest ship is the Kirov class missile cruiser Peter the Great (Pyotr Velikiy). This nuclear powered cruiser is equipped with the longest range SAM in the carrier group with the SA-N-6 the naval equivalent of the SA-10.

The last 4 ships in the group (unless there are a few submarines underwater) are Sovremenny-class destroyers equipped with SA-N-7 medium air defences, the naval equivalent of the SA-11.

Unfortunately, none of these missile systems in BMS can currently engage the anti-ship missiles fired at them and since the harpoon outranges all of their air defence missiles, TASMO is still a milk run in BMS at the moment. Nevertheless, be on the lookout for shore-based air defences, or the carrier air wing if it launches.



20.2 The AGM-84A missile

Let's review AGM-84A Harpoon employment. Before use each missile needs to be powered up separately. You carry 4 of them for this mission, so you will have to power all 4 on the SMS page. Missiles will power off automatically if A-G mode is exited, or another weapon type is selected (including another A-G weapon).

Power-on time for the harpoon missile is around 20 minutes. Keeping the missile powered up for longer may degrade missile functionality, or at worst render the missile unusable.



Powering the missile is not required for managing the weapon before launch, it is only required for launching it. Therefore you may elect to power the missile just before launch; in fact it is advised to do it exactly like this. Powering up is immediate, but the missile needs approximately 10 seconds to display a RDY state.

With 4 missiles loaded, stepping the missile with OSB 10 or OSB 16 will alternate missile position. For instance if missile on station 4 is selected (left wing) and you want to select the missile on station 7, you will need to press OSB 10 for selecting the next right wing station (station 6), then press OSB 16 to select the next left wing station (station 3) then once more press OSB 10 to finally select the next right wing station which is station 7.

You can't step within the same wing with either OSB 10 or OSB 16; you have to toggle through all 4 stations. This might be confusing when you power on all the missiles together. Do remember to always check the station number to have a clear view of which missile is powered and which is not. Again, it is easier to power them up in sequence just before firing them.

The harpoon can be launched in one of three modes, set through the WPN page:

- RBL (Range Bearing Launch)**
 RBL is the primary launch mode of the missile and is used when the target position is well known – meaning known to the aircraft sensors, which can provide accurate target position to the missile interface before launching. The harpoon will be fired on SPI coordinates and will fly and acquire the target according to the WPN page options.
- BOL (Bearing Only Launch)**
 BOL mode is used when the exact position of the target is not known. It is a slightly degraded mode when target range is not computed (read no sensor on the target) but approximate target bearing is known. There are no search area or priority options available. The pilot can set a defined range for missile seeker activation and missile destruction.
- LOS (Line Of Sight)**
 LOS is a backup mode used only in case of malfunction in the avionics. The missile attitude reference will be established in a self-level mode and the bearing to target will be established by pointing the launching aircraft in the direction of the target. In LOS it is mandatory to maintain straight and level flight for at least 40 seconds prior to weapon release, fire the missile and continue flying the same straight and level attitude for at least 40 seconds after missile launch. The missile seeker will activate automatically shortly after its boresight launch. The search pattern is pre-programmed and cannot be altered by the pilot.

The relevant mode can be selected with OSB 1. Another selection menu will then be displayed where RBL (OSB 20), BOL (OSB 19) or LOS (OSB 18) mode can be selected. Once a mode is selected, the WPN page will revert to its initial state.

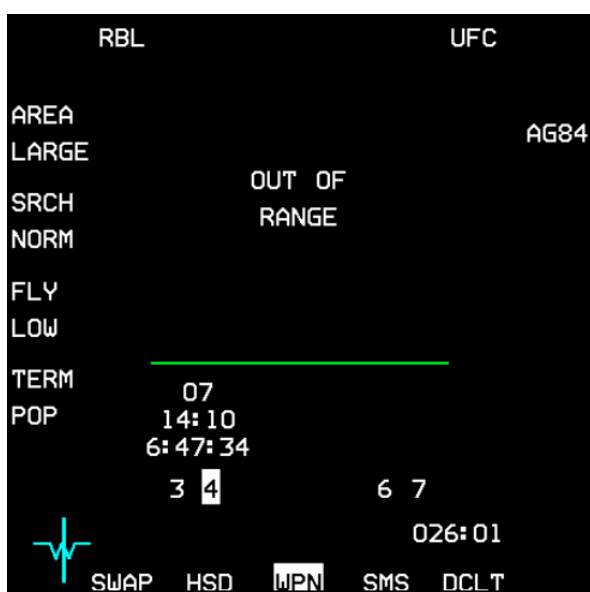


OSB 20 is mode-dependant.

With RBL mode selected (left picture below) it sets the Harpoon Search Area Size. Depressing OSB 20 will toggle between Large, Medium and Small. Large area is default and expands with longer ranges. Small and Medium are fixed area modes (i.e. they don't depend on range) and are mostly used when multiple ships are in the area, or in narrow waterways to avoid the harpoon targeting ground targets. It is not advised to use Small or Medium search area when launching at long range because the target may exit the search area by the time the missile gets to the area.

With BOL mode selected (right picture) it sets the Enable Range (ENBL), which is a distance in nautical miles after the launch point where the missile seeker goes active looking for targets. It is also the set distance from launch point where the missile will descend to a lower altitude (see OSB 18). Depressing OSB 20 enters a sub-menu, allowing you to set the range in nautical miles.

With LOS mode selected, there are no options available for OSB 20.



OSB 19 is also mode-dependant.

With RBL mode selected it sets the Harpoon Search Priority (left picture above). This option is only available with RBL launch mode when the search area is set to LARGE. Depressing OSB 19 will toggle between available options:

- **NORM:** default - the search pattern will start at the centre of the area and extend outward in all directions.
- **NEAR:** will start the search at the bottom of the search area and expand first on the sides (left and right) and move back towards the rear of the search area.
- **FAR:** will start the search at the rear of the search area and expand first on the sides and move towards the front of the search area.
- **LEFT:** will start the search at the left side of the search area, expand front and back and then move to the right of the search area.
- **RIGHT:** will start the search at the right side of the search area, expand front and back and then move to the left of the search area.

The search priority may become handy according to the position of the target you want to attack in a group of different ships.

With BOL mode selected (right picture above) it sets the Harpoon Destruct Range (DSTR). It is a distance in nautical miles from launch point at which the missile will self-destruct. Depressing OSB 19 enters a submenu allowing you to set the range in nautical miles.

With LOS mode selected, there are no options available for OSB 19.

Fly-Out mode

OSB 18 sets the Harpoon Fly-Out Mode. It is available in all modes except LOS mode. If the last part of the missile flight will be at low level to avoid detection the first part of its flight can be set to high or low altitude. Depressing OSB 18 will toggle between these two options.

With LOW selected, the missile will immediately descend to low altitude, which may provide better protection against earlier detection, but may increase the risk of obstacles such as civilian or allied ships cruising close to the launch point. Selecting HIGH will ensure that the missile will remain at higher altitudes during the first part of its flight. The missile will descend to lower altitude at a specific range from the launch point:

- When launched in RBL, the missile will descend 10 Nm from the launch point.
- When launched in BOL, the missile will descend at the set enable range (see BOL paragraph).

Terminal manoeuvre

OSB 17 sets the terminal manoeuvre of the missile. It is available in all modes except the LOS mode. Depressing OSB 17 will toggle between POP (default) and SKIM.

Selecting POP commands the missile to execute a pop-up manoeuvre before impact, to allow the missile to strike the target from above. It is also the option that works best against short-range defences the target may deploy to shoot the missile (which are not implemented in BMS).



Selecting SKIM will command the missile to remain at very low altitude and therefore hit the target closer to the waterline. Smaller ships may be too small, so missiles set to SKIM may fly over their target in such cases.

Launch status divider line (RBL)

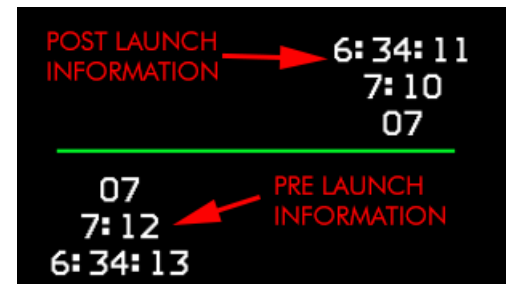
As with all AGM-8x series, the WPN page features the green launch status divider line displayed in the centre of the MFD in RBL mode (BOL and LOS do not have the LSDL). Anything below the green line is pre-launch information and the information displayed above the LSDL is post-launch information.

Post launch information can only display information for 2 missiles. If you fire more than 2 missiles, post launch information of the first missile fired will be overwritten by the second missile fired from the same wing.

Pre & Post launch information (RBL)

Pre-launch information is displayed only in RBL mode and consists of three lines: Target steerpoint – Missile time of flight if fired now – System time of impact if fired now.

Once the missile has been fired the information move above the launch status divider line and changes to: System time of impact – Missile time of flight remaining – Target steerpoint.



Alert (& Priority Alert) messages

The harpoon WPN page is also able to display 2 types of alert messages. The top line is reserved for priority alert messages and the second line may display regular alert messages according to missile mode or status.

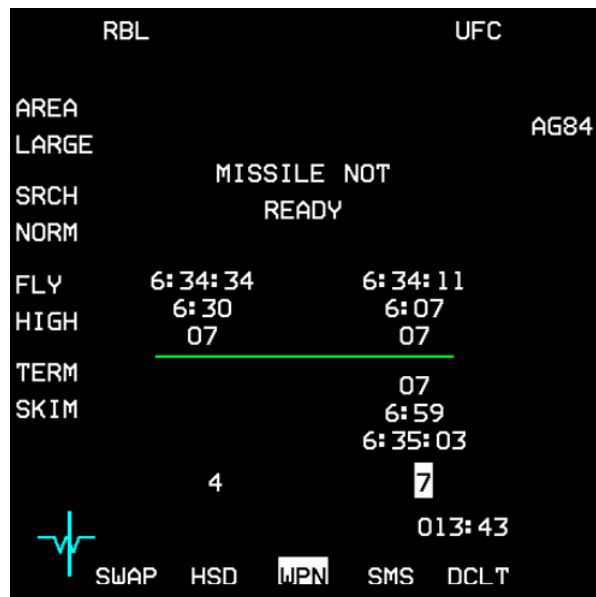
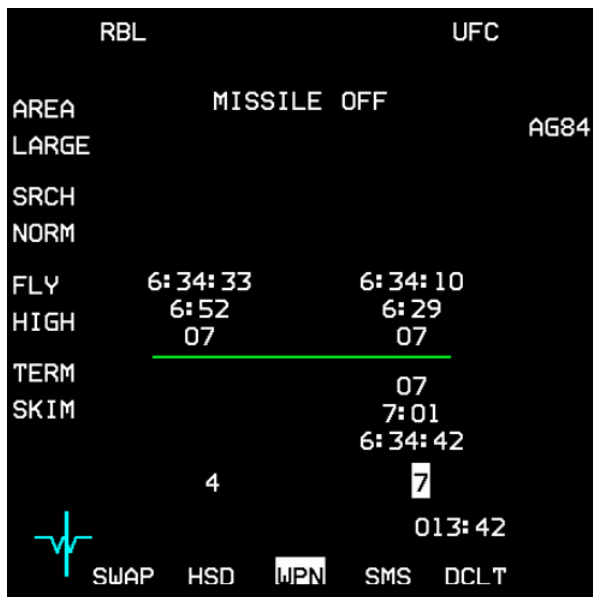
The priority alert messages are common to all modes (RBL, BOL & LOS). They are limited to two priority alert messages:

- **MISSILE OFF** reminds the pilot that the currently selected missile has not been powered up yet. The pilot should go to the SMS page and power on the missile before launching.
- **BATTERY ACTIVE** is displayed after an interrupted launch sequence (pickle button not held long enough) and reminds the pilot that the missile has an activated battery and launch should be executed as soon as possible to avoid the missile running out of power before reaching its target.

The priority messages apply to all modes and are displayed under the priority alert messages. They are mode-dependant and display information about missile status and aircraft parameters that may degrade (or prevent) a missile launch.

Once such a message is displayed the pilot should take corrective action. As soon as the issue is corrected, the alert message will disappear. If the issue cannot be corrected, the pilot needs to either select LOS mode or abort the attack. Examples of alert message include:

- **MISSILE NOT READY** (missile needs power).
- **OUT OF RANGE** (fly closer to attack Steerpoint (67 Nm)).
- **ACTIVE RANGE TOO SMALL** or **DSTR RANGE TOO SMALL** in BOL mode.
- **FLY WINGS LEVEL** (counter) **SECONDS** in LOS.
- **MACH NUMBER OUT OF RANGE** (launching platform is too slow or too fast).



The above pictures illustrate a launch sequence.

The missile on station 6 has been fired at target Steerpoint 7 and will impact at 063410 system time.

The missile on station 3 was fired as well and will impact target Steerpoint 7 at system time 063433.

Both have the post launch information above the LSDL.

The weapon on station 7 is the next one set to fire. In the left picture the missile is not yet powered up as illustrated by the priority alert message "MISSILE OFF", reminding the pilot to power up the missile before firing, which is done with a quick toggle to the SMS page.

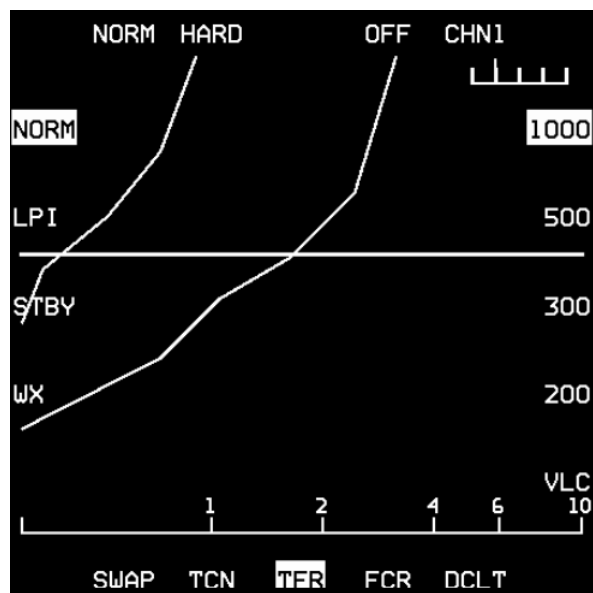
The right picture is taken seconds later while the missile spins up for 10 seconds. Immediate launch is prevented as notified by the alert message "MISSILE NOT READY". As soon as the missiles gyros have spun long enough, the missile sends a RDY state, the alert message is removed and the missile can be fired.

Once fired, the missile information currently displayed under the LSDL will move above the green line, overwriting the information relevant to the missile fired from station 6.

Station 4 remains loaded and will be selected automatically upon firing the weapon on station 7.

20.3 The mission

Your flight starts just as you go feet wet north of Sokcho. The North Korea shores are defended with SA-10 so most of your flight will be over water, close but outside the SA-10 envelope. Keep that in mind when you're manoeuvring and activate the SEARCH feature of the TWA so you can detect search radars earlier. If the SA-10 sites become too interested in your package, don't hesitate to extend away from their WEZ.



You can also decide to go lower on your threat horizon and have less chance of detection. You are still far away from your target area (more than 120 Nm) and the maximum SEA radar range is 80 Nm. You may need to fly high to acquire the target on your onboard sensors, but it's pointless remaining in harm's way so far away from your target – unless fuel is an issue?

Start a descent to stay safe from enemy threats for now. A good way to relieve a bit of pressure is to enable the TFR in blended mode (AP steering). Select the TFR on the left MFD, set SCP at 1000 feet and enable TFR AUTO mode. Once done, set the AP switch to Steering Select and make STPT 7 the active steerpoint (DCS right on the STPT page allows auto-switching of the next steerpoint when you get close to your active steerpoint).

As always when you get in the cockpit, the first thing to do is to setup your jet according to your mission. Select A-G mode and set the left MFD to FCR SEA mode. To do so press OSB 1 which opens a menu of possible sub-modes available (GM – GMT – SEA) and press OSB 8 corresponding to Sea mode. SEA mode is the same as GMT optimised to find ships. It may track movers on the ground as well and may have a hard time finding ships at anchor, or sitting dead in the water. For that purpose GM radar will sometimes be a better choice.

Set the right MFD slots to SMS, WPN and HSD. Since you may be under threat of the carrier air wing, you will need to configure an A-A mode as well. While in A-G mode, select MRM on the HOTAS. Set your left MFD to FCR, 40 Nm range and centre the antenna. Set the right MFD to HSD & TGP.

When you centre the dogfight switch on the throttle, you will immediately revert back to the last mode you were in before selecting MRM, in this case A-G set for TASMO. As always, remember that anytime you do not need the A-G mode you should be ready for an air-to-air engagement in MRM mode.

Fence in, switch off your external lights with the master light switch on the left console, set MASTER ARM to ARM and set your master mode to A-G as we now will setup the missiles. You have 4 missiles and we will try to make different shooting profiles targeting the biggest ship in the enemy battle group. The first 3 missiles will be fired in RBL with an accurate SPI on the Kuznetsov and the last missile will be fired in BOL mode, to simulate not having an accurate fix on the carrier. Once set, the SMS will remember each station settings. As we don't get debrief with training missions, make sure you tape your flight by switching on ACMI.

Select WPN page and select station 4 (left wing). By default RBL mode is active and the search area is set to LARGE. Search priority is set to NORM by default as well. No reason to change that. Set the fly-out mode to HIGH and the terminal attack to POP.

Step weapon to select the missile loaded on station 6 (right wing) and apply the same settings except for the fly-out and the terminal manoeuvre. Set them to LOW and SKIM respectively.

Step weapons once more to select station 3. Keep the search area and search priority default and set fly-out to HIGH and terminal attack to POP.



Step to the last weapon on station 7 and depress OSB 1 (RBL) to access the mode menu and select BOL mode with OSB 19. The default values of BOL mode are seeker activation after 1 Nm and self-destruct range at 95 Nm. We will change that to 40 and 86 Nm respectively.

Depress OSB 20 in BOL mode and a new MFD page allowing you to input a distance is displayed. Hit the relevant OSBs for '4' and '0'. Upon entering a valid range the MFD reverts to the WPN page with the corrected seeker activation range of 40 Nm.

Do the same for the self-destruct range, entering the menu with OSB 19. Input '8' then '6'.

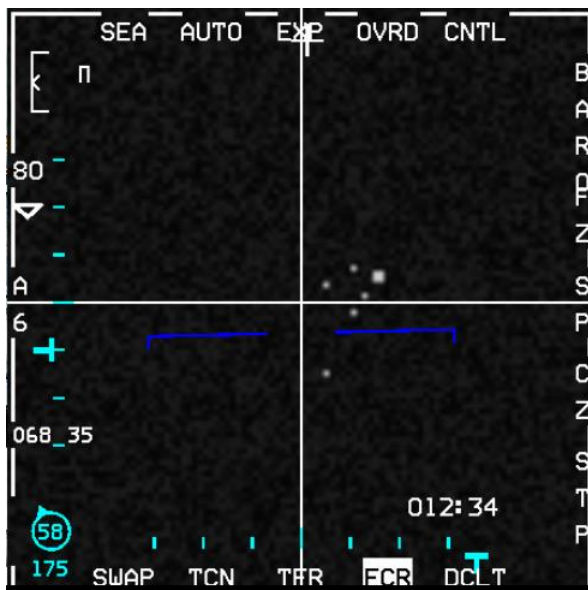


On the WPN page set fly-out to HIGH (OSB 18) and terminal attack to SKIM (OSB 17).

The 4 weapons are set and are ready to fire, except we still need to power them up as we can see by the priority alert message "MISSILE OFF" for each of them. The alert message displayed underneath is normal as we are ingressing low level using TFR. Once your systems are configured for the strike, check your distance to target Steerpoint 7 and switch back to MRM mode, in case you have to fight your way in.

At 85 Nm from the target you need to gain some altitude to be able to spot the carrier group on radar. If you stay too long at low altitude your targets will be below your horizon and you will spot them too late on your sensors, losing the advantage of the standoff capability of your Harpoons. On the other hand it is not necessary to go high further than 80Nm away from your target as your SEA radar has a maximum range of 80 Nm. Normally, once the battle group is spotted on the on-board sensors the strikers would freeze their FCR and go low again, but in this case the distance between acquiring and firing is very small as the harpoon has a range of 67 Nm. The situation might be different if we were inside the battle group's SAM WEZ.

Climbing to FL150, monitor your FCR and start looking for ships. As soon as you see blips on your FCR, go to expand mode. The idea is to try to differentiate the smaller ships from the larger carrier and target the Kuznetsov. As you can see from the SEA radar picture below the carrier has a much bigger return than the



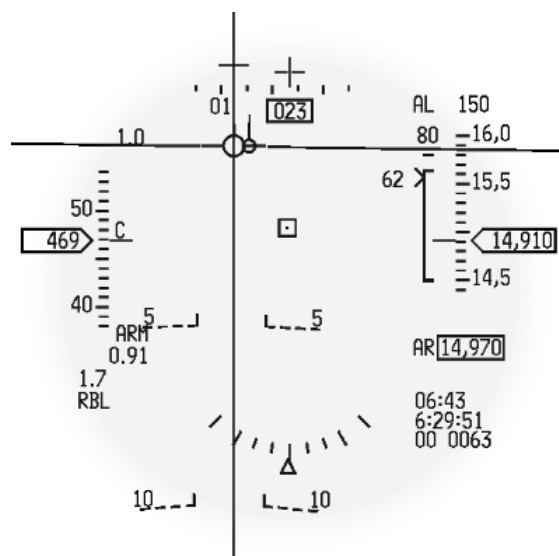
other ships in the formation. It's harder to differentiate the Kirov class missile cruiser from the Sovremenny-class destroyers though. At this distance trying to use the TGP for identification is pointless. So bear in mind that you do not have a precise way to target specific ships within the same group unless there is a carrier.

Place your cursors over the larger contact and designate with TMS up. We are now ready for the RBL mode as bearing and range is inputted into the missile brain.

The HUD in RBL mode has a range scale displayed on the right. A tick mark is displayed at 80 Nm and the dynamic range starts at 67 NM. A caret with the actual range from SPI descends down the scale. When the caret is within the dynamic launch range, the missile is in range and the alert message OUT OF RANGE will disappear.

We can't really ripple the 4 missiles together as we need to power them up in sequence and wait about 10 seconds for the missiles to be ready. So we will use that to our advantage to fire the first three in a common sequence:

- Right MFD to SMS.
- OSB 7 to power that missile.
- Right MFD back to WPN page.
- Wait for the alert message "MISSILE NOT READY" to disappear.
- While waiting for the missile gyros to spin up, open the Wingman comms menu and select option 1 'Attack my target'. This will ensure the enemy carrier group gets 4 more missiles inbound.
- When the alert message has disappeared, press and hold the pickle button until weapon release. Please note Harpoons require a very long pickle. It might take anything between 1 and 6 seconds. Make sure you hold it long enough. The FPM will flash when the missile is away.



- Rinse and Repeat: once the missile is flying the missile information will move up the LSDL and the priority alert message MISSILE OFF will be displayed again as the system selects the next missile, which has not yet been powered up.

Repeat the whole sequence to fire the second and third missile.

As noted above, the Harpoon may need a very long held pickle. It is not uncommon to misfire by releasing the pickle too soon. In that case a priority alert message will be displayed on the WPN page alerting the pilot that the misfired missile has an activated battery. Batteries have a very short lifespan and a battery activated missile may run out of power quickly.

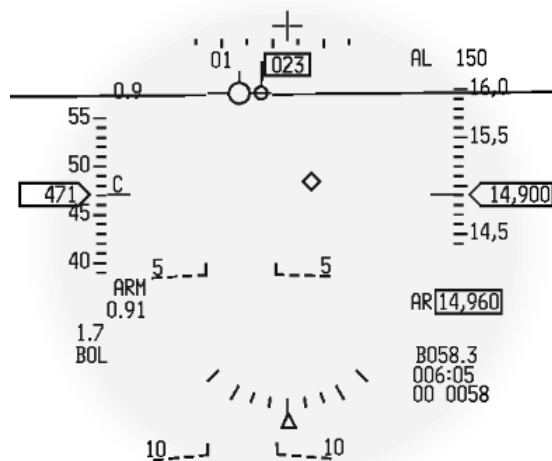
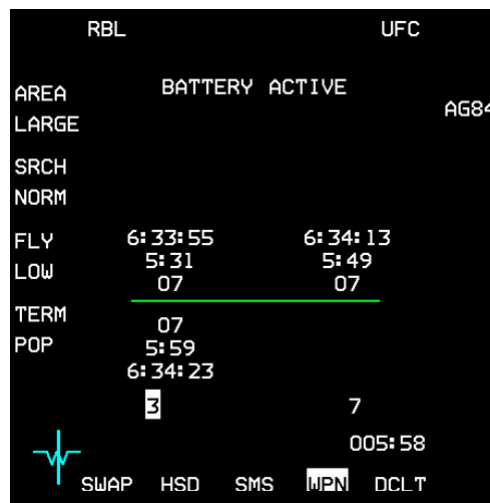
To avoid this, the pilot should reattempt to fire this missile as quickly as possible. In this scenario, the third RBL launch was misfired and a second attempt was made immediately after to send the missile on its way to the target.

The final missile will be fired in BOL mode. It is kind of wasted, but done specifically for training purposes, to see the differences between RBL and BOL modes. The last missile needs to be powered up first through the SMS page and as always we need the missile to be ready before firing.

Since the missile is fired without range information, the HUD symbology will be different. Mainly there is no dynamic range scale (It is the same in LOS mode). The Harpoon mode is displayed in the lower left corner of the HUD and there is no azimuth steering line displayed and no target box obviously.

In this scenario the missile will go on its way and probably target another ship than the carrier. You have no control on the ship priority the missile will target.

Fire the missile anyway and don't forget to instruct your wingman to attack your target one last time.





Your job is done, switch back to MRM and CAT1 in case you need to defend your flights against naval interceptors scrambled against you and dive back for the deck if your fuel state allows it.

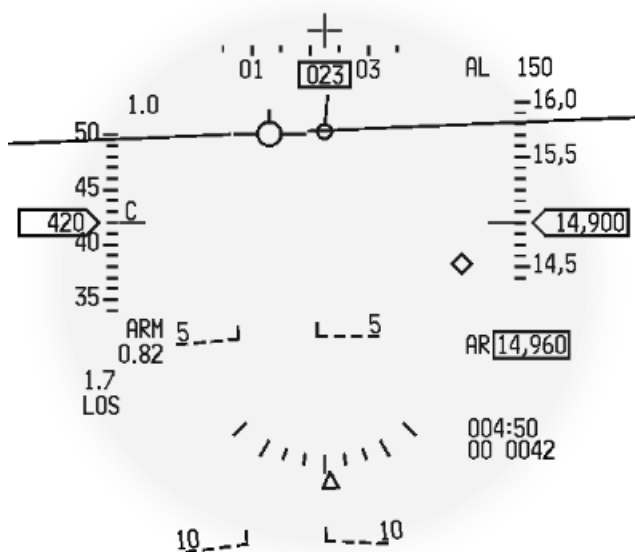
Before succumbing to the temptation to look at your missiles, make sure you select a steerpoint taking you back to friendly lines and reengage the autopilot. You may elect to fly all the way back to Kunsan or divert to Sokcho which is just south of Steerpoint 5.



The missile launched in BOL mode didn't target the carrier but one of the 4 destroyers.

It takes multiple missiles to sink such ships, destroyers need at least 2 Harpoons, the Kirov was sunk with 3 AGM-84A and I am still trying to sink the Kuznetsov ☹️

We didn't use it but there is a third harpoon mode. It does provide targeting possibilities, but is mostly a backup mode used when neither the aircraft avionics nor the missile are working correctly.



LOS needs a very stable launching platform because flight attitude and launch bearing are provided to the missiles according to the launching platform references. This process needs a straight and level flight for 40 seconds prior and post launch.

In LOS the pilot follows the information provided by the alert messages displayed on the WPN page and waits for the countdown from 40 to zero to launch the missile.

After launch the FLY WINGS LEVEL alert message will continue to display.

The HUD LOS mode is similar to the BOL mode with obviously no range scale indication, no azimuth steering line and no target box.



PART 4: OTHER MANUAL TRAINING MISSIONS

The following training missions are not documented in this manual. They are relevant to other very specific manuals and have their own dedicated chapters. They are built and documented in the very same way as the previous 20 training missions.



MISSION 21: NAVIGATION FLIGHT OSAN-TAEGU

This training flight is a ferry flight from ramp to ramp illustrating the new communication protocols and the navigation aspects in BMS 4.34. You are tasked to ferry an F-16 from Osan to Taegu in poor weather. This first part starts at Osan Ramp and can be continued through to shut down at Taegu.

The training flight is completely documented in section 5 of the BMS COMMS and NAV book; a new publication in the manual suite, located in your Docs folder.

MISSION 22: NAVIGATION FLIGHT OSAN-TAEGU: Part 2

This training flight is the second part of Mission 21; it starts just before reaching the top of the descent before the IAF at Taegu and is meant to concentrate on the approach part of the training mission.

As above the training flight is completely documented in section 5 of the BMS COMMS and NAV book.

MISSION 23: CARRIER OPS - Launch (F/A-18D)

This training flight is the first of the three carrier operations missions flown with the F/A-18C from the deck of the USS Enterprise CVN-65 cruising west of the Korean peninsula. It will cover the launch sequence from the catapult of the Enterprise.

The training flight is completely documented in section 5 of the BMS NAVAL OPS volume located in your \Docs\04 Other Aircraft folder.

MISSION 24: CARRIER OPS - CASE 1 RECOVERY (F/A-18C)

After the launch from your catapult you eventually need to land back on the carrier. This training mission documents Case 1 recovery procedures (VFR) for landing on the carrier.

The training flight is completely documented in section 5 of the BMS NAVAL OPS volume located in your \Docs\04 Other Aircraft folder.

MISSION 25: CARRIER OPS - CASE 3 RECOVERY (F/A-18C)

Still flying the Hornet, this training mission will document the Case 3 recovery procedures (IFR) on the carrier.

The training flight is completely documented in section 5 of the BMS NAVAL OPS volume located in your \Docs\04 Other Aircraft folder.

The Future of the training manual

The training manual is now complete and the missing 4.33 missions have been added. Updating this manual for 4.34 I realised that creating the new missions was actually the easy part. Updating the old 4.33 missions to 4.34 standards was actually the time consuming factor. Indeed tracking the minor details that were changed during the long development process of BMS made us check and constantly recheck all missions with every major update.

I hope 4.35 will not be as difficult to manage as far as the training missions have been concerned as this update really stretched my capability to deliver the end product. It is no surprise to me that never before were training missions ported from one update to another; all previous projects have been abandoned by their author. Considering the frustration level I went through doing it, I don't blame any of them.

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- BMS forums & articles
- Training scripts article

ACKNOWLEDGMENT

While writing this manual and designing the training missions I constantly pestered the developers and beta-testers with questions, requests and cries for help.

This training manual became possible only because of the commitment of the entire BMS dev group, coders, other developers and beta-testers alike. I would like to thank all of them.

Special thanks to Mav-jp who provided the content for the Carrier Ops training missions and corresponding chapters. They were almost removed from the training syllabus, but the Case 1 and Case 3 recoveries with full ATC are something never achieved before in any sim and I'm very glad we kept them.

Darkman again did the tedious work of editing and proof-reading. His input was instrumental in creating the finished document.

Leech helped us understand the various avionics systems in the aircraft as usual; without his guidance the manual wouldn't be nearly as comprehensive and useful as we hope you will find it.

Zipgun deserves special thanks for all his help trying to sort out the mysterious issues we encountered while beta-testing, his determination to bring the problems to a solution and his help creating training missions.

Many thanks to all who beta-tested the Training TEs; members of the BMS development group and the ViperDrivers squad.