

# BMS Training missions



Author: Red Dog  
Version: BMS 4.33.1  
Date: 04. 2016

## Index

<b>Copyrights Statements .....</b>	<b>5</b>
<b>Foreword .....</b>	<b>6</b>
<b>Setting up BMS for the training missions .....</b>	<b>7</b>
<b>PART 1: BASIC HANDLING.....</b>	<b>8</b>
MISSION 1: GROUND OPS .....	9
1.1. 1 <sup>st</sup> Sweep: Before starting the engine .....	11
1.2. 2 <sup>nd</sup> Sweep: Starting engine & systems.....	13
1.3. 3 <sup>rd</sup> Sweep: The final sweep.....	15
1.4. Taxi out .....	21
1.5. Take-off.....	25
MISSION 2: BASIC NAVIGATION .....	29
MISSION 3: LANDING .....	38
3.1. Landing straight-in.....	39
3.2. Overhead landing .....	42
3.3. Taxi back and shutdown the jet.....	44
<b>PART 2: ADVANCED HANDLING.....</b>	<b>45</b>
MISSION 4: NIGHT ILS LANDING.....	46
MISSION 5: AIR TO AIR REFUEL .....	52
5.1. Setting up and finding the tanker.....	52
5.2. Pre-contact .....	53
5.3. Getting fuel.....	54
MISSION 6: ILS IN BAD WEATHER .....	57
6.1. Calculating the crosswind component .....	61
MISSION 7: FLAMEOUT LANDING .....	62
MISSION 8: LOW LEVEL NAVIGATION (TFR – FLIR) .....	69
8.1. MAN TF check .....	73
8.2. AUTO TF FLY-UP check.....	74
8.3. TFR LET DOWN CHECK .....	75
8.4. TFR SWIM CHECK.....	75
MISSION 9: IN-FLIGHT FAILURES .....	78

<b>PART 3: WEAPON EMPLOYMENT .....</b>	<b>83</b>
MISSION 10: AIR TO GROUND GENERAL PURPOSE BOMBS .....	84
10.1.    The weapons .....	84
10.2.    Delivery methods .....	85
10.3.    The mission .....	85
MISSION 11: LASER GUIDED BOMBS.....	93
11.1.    Laser guided bombs – What there is to know? .....	93
11.2.    Single ship LGB release .....	95
11.3.    Buddy Lasing .....	103
11.4.    Laser Spot Tracker (LST).....	104
MISSION 12: AGM-88 HARMS.....	105
12.1.    POS mode.....	107
12.2.    HAS mode.....	111
12.3.    HAD mode .....	113
12.4.    SEAD / DEAD in BMS .....	117
MISSION 13: AGM-65 MAVERICKS .....	118
MISSION 14: AGM-65 MAVERICKS (CAVOK) .....	129
MISSION 15: INERTIALLY AIDED MUNITIONS.....	130
15.1.    JSOW .....	130
15.2.    JDAM .....	137
15.3.    Other IAMs .....	142
MISSION 16: Man In The Loop (MITL).....	143
MISSION 17: IR MISSILES.....	143
MISSION 18: RADAR MISSILES.....	143
MISSION 19: GUNS GUNS GUNS .....	143
MISSION 20: HMCS.....	143

<b>PART 4: NAVAL OPERATIONS.....</b>	<b>144</b>
MISSION 21: F/A-18 HORNET - Carrier Takeoff.....	145
21.1 TAXI.....	145
21.2 On the Cat.....	146
21.3 Carrier Details .....	147
MISSION 22: F/A-18 HORNET - Carrier Landing .....	148
MISSION 23: F/A-18 HORNET - Night Carrier Landing .....	150
MISSION 24: AGM-84 HARPOON .....	150
<b>To be continued... .....</b>	<b>151</b>
<b>BIBLIOGRAPHY .....</b>	<b>151</b>
<b>ACKNOWLEDGMENT .....</b>	<b>151</b>

## Copyright Statements

Falcon BMS is a community mod developed and published by Benchmark Sims for use with licenced copies of Falcon 4.0. Unauthorized rental, sales, arcade use, charging for use, or any commercial use of this mod or part thereof is prohibited. This mod is for non-commercial use only. This mod was created by Benchmark Sims with permission from Tommo Inc. and Retroism.

This mod and all included content are in no way affiliated with Tommo Inc. and Retroism.

© 2003-2016 Benchmark Sims. All rights reserved.

Falcon Collection and Falcon 4.0 are trademarks or registered trademarks of Tommo Inc. Falcon Collection and Falcon 4.0 are published by Retroism.

© 2016 Tommo Inc. All rights reserved.

The BMS training manual is published by Olivier “Red Dog” Beaumont. Unauthorized rental, sales, charging for use, or any commercial use of this manual or part thereof is prohibited. This manual is for non-commercial use only. No reproduction of this manual or part of this manual is allowed without the written permission of the author. © 2014-2016. All rights reserved.

## Foreword

The purpose of this manual is to document the new 4.33 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 4 main groups:

- Basic handling
- Advanced handling and avionics
- Weapon employment
- Naval Ops

While going through the four main mission groups you will fly several different F-16 models, with different avionics and capabilities. You may find yourself at the controls of an F-16B block 15, F-16D block 40, F-16C block 52 or F-16C block 52+. Naval operations will feature the F/A-18D 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 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 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 whenever you 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. As a reminder, 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 time 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 one. 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. Finally, there are multiple ways to operate the aircraft. Different airforces 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.

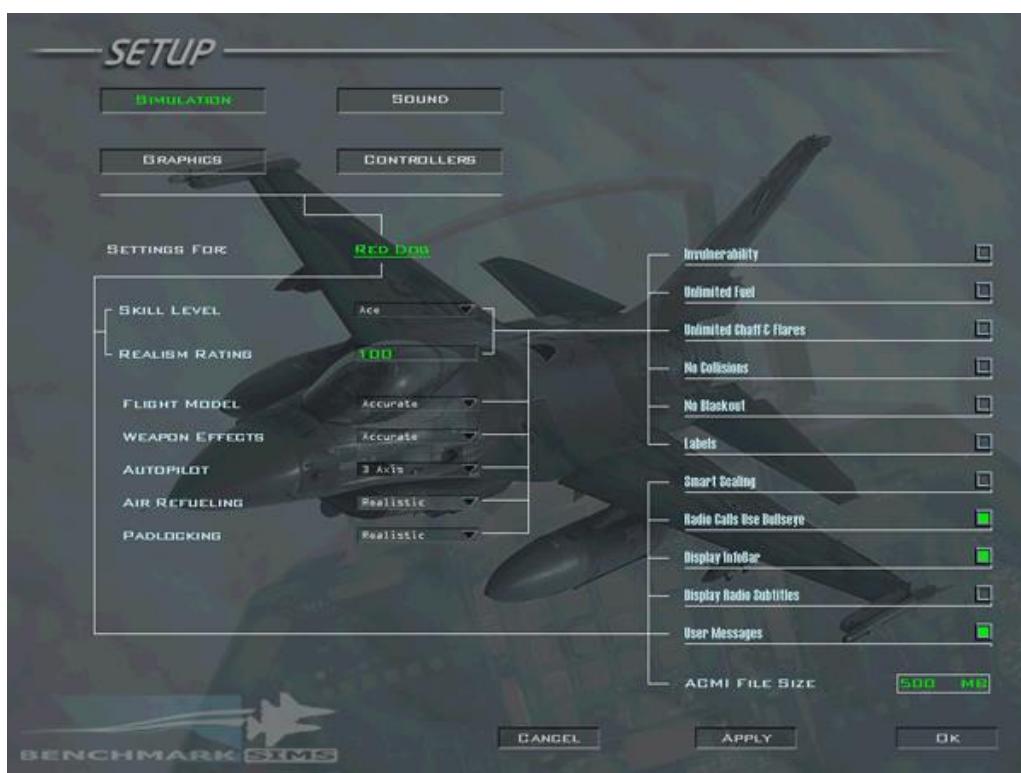
## Setting up BMS for the training missions

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 might be a very useful learning tool. 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 or use your mouse to switch the AVTR to 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.



## PART 1: BASIC HANDLING

You will fly a series of 3 training missions around Kunsan airbase in Korea in an 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 (.trn files) you can select (Ground Ops, Navigation & Landing) the 3 training missions use the same TE but just start in different places, so 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, quit after each mission and continue later on from the next section.

The 3 missions have the same initial setting:

- AIRBASE: Kunsan RKJK –RWY 18/36 - 075X – 292.3
- CALLSIGN: Goblin 2-1 Single ship
- AIRCRAFT: F-16B block 15 (PW engine). Clean configuration, 2 AIM-120 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: 0955LT ILS RWY36 TL140 320/02KT 30SM FEW080 28/23 A2991 NOSIG.

FAIR weather, scattered clouds at 8000 feet, winds 320°/02 knots, temperature 28°C, dew point 23°C, altimeter 2991, NO SIGnificant changes.

- GOAL:

- Mission 1: Ramp start, taxi and takeoff.
- 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 A-10s are taking off earlier than this training flight you will end up sat in an A-10. 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.

**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.

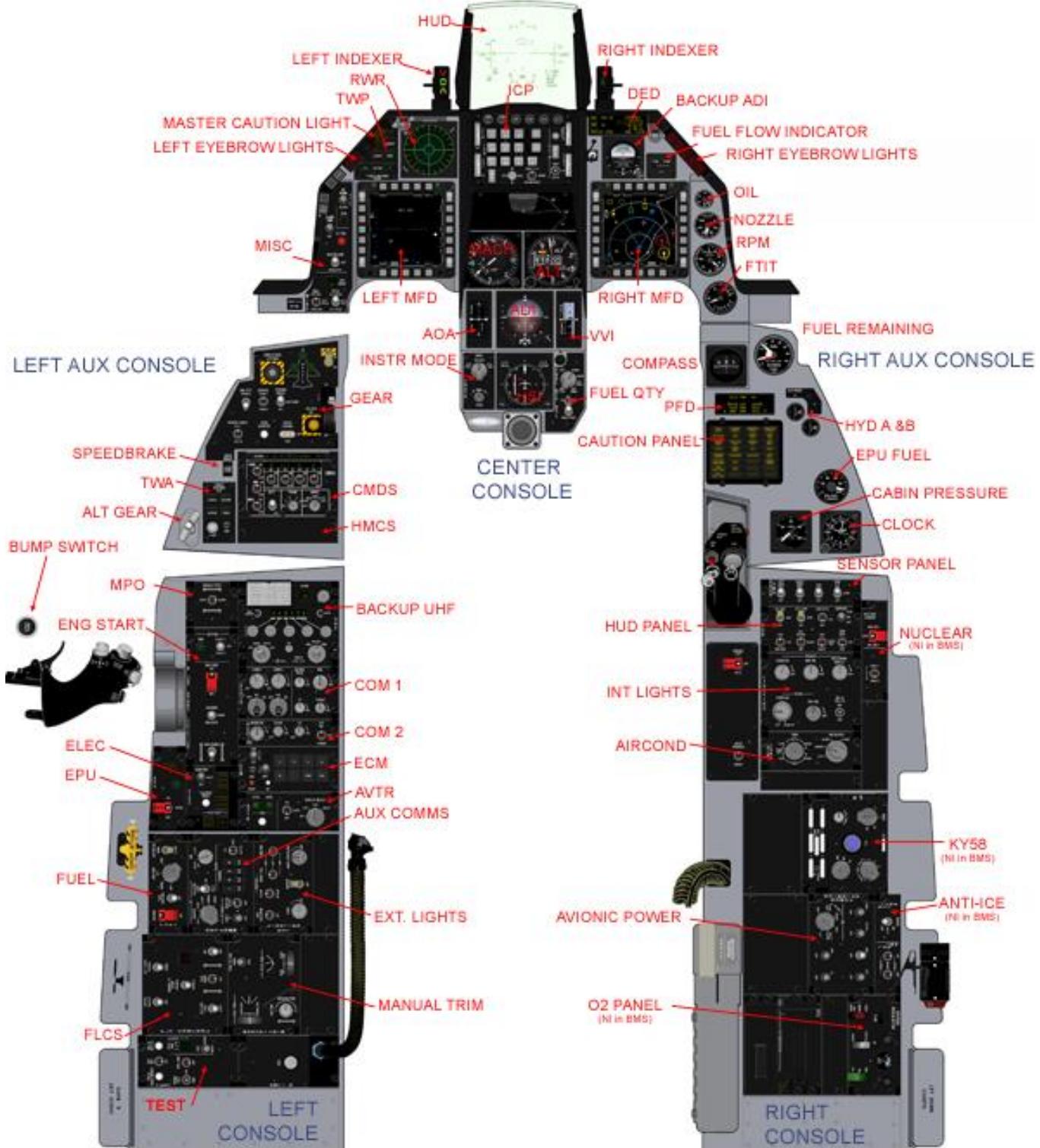


Although the Block 15 has no EGI and no coloured MFDs the procedure to start up the jet is just the same as in the Dash-1 Section II Chapter 1: RAMP START in 3 SWEEPS.

You may be familiar with the procedure because you have been mastering it in 4.32.

May we suggest you go through it again anyway to spot the improvements in fidelity which 4.33 brings?

The paragraph below is a copy of the relevant chapter from the Dash-1:



F-16 block 50/52 cockpit layout and panels

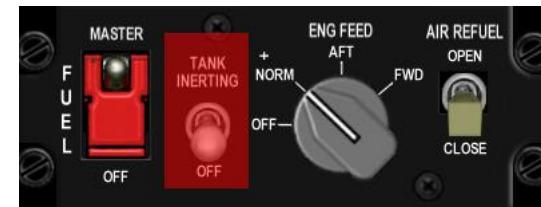
## 1.1. 1<sup>st</sup> Sweep: Before starting the engine

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.

- 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.



- 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.



- 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 on the hotspot depressed 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.



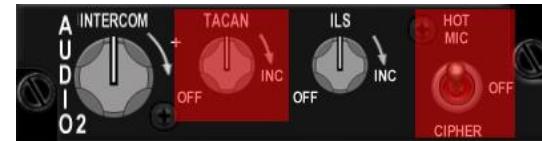
You can now release the FLCS PWR TEST switch (releasing the mouse button). The lights reset to their initial state. This check is eye candy and is not mandatory. Leave the MAIN PWR switch to BATT for now we will start engines shortly.

- 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 to the fully-clockwise 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. Bear in mind 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!**

Newly implemented in BMS 4.33 the ILS knob now 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 tower frequency 292.3 might be entered in the manual frequency window by clicking the relevant knobs. Once set, communication with Kunsan tower 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 292.3 is selected in the MNL window and the active 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&PFD) and FLOOD CONSOLES (all cockpit floodlights) can be rotated fully 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 but rather 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 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 AIRSOURCE knob is set to NORM. Failure to do so will cause a EQUIP HOT caution light as soon as the systems are powered by the main generator because they will not be cooled correctly.



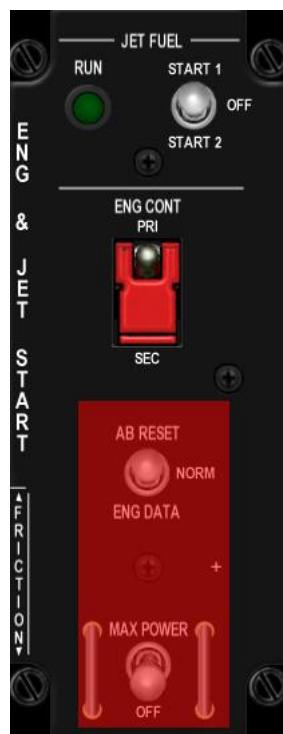
## 1.2. 2<sup>nd</sup> Sweep: Starting engine & systems

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. So make sure you start this sweep with the MAIN PWR switch to MAIN PWR.



2. Moving forward you can close the canopy (spider). Do so before engaging the JFS. Move on 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 increases steadily 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) and monitor lights and engine gauges:



SEC caution light goes off around 20% RPM (before engaging the throttle).

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.

HYD/OIL PRESS light (right eyebrow) goes off between 15 and 70% RPM.

With the engine running steadily you can check the engine gauges such as fuel flow (700-1700 PPH), oil pressure (min 15 PSI), nozzle position (greater than 94%), FTIT (below 650°C) 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. You can now proceed to set the next ones.

3. Move straight to the AVIONICS POWER panel to quickly begin the INS alignment.

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. In 4.33 newer blocks have EGI (Embedded GPS/INS), decreasing 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. As you will notice the PFLD will display common ramp start faults which will clear as systems come online.

7. Move to the left console 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 reason we do this **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.***

Let's input Uniform (UHF) Tower & Victor (VHF) 1 in the UFC radios:

Push COM1 on the ICP and the DED displays the UFC COM1 page. The Scratchpad is the area between asterisks and is currently empty. That is where you input the frequency with the ICP numeric keys: 29230

Hit ICP ENTR and the DED returns to the CNI page where you can see that UHF is now set to 292.30.

Alternatively, if you set DTC preset 15 as the tower frequency in the UI you can simply set COM1 by using that DTC preset. Select the COM1 ICP button again and just type 15 followed by ICP ENTR.

Now do the same with COM2 & Victor, setting it to preset 1.

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. 3<sup>rd</sup> Sweep: The final sweep

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!

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. 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 would be the Digital Backup operation, but the block15 doesn't have a digital FLCS so you can't execute the check for 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 takeoff 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.** Move to the EPU panel and 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 which is generally avoided on the ground. The real reason is of no significance to us; hydrazine is extremely toxic to ground crews, but we don't have them in Falcon.

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. Some will also argue that 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.*

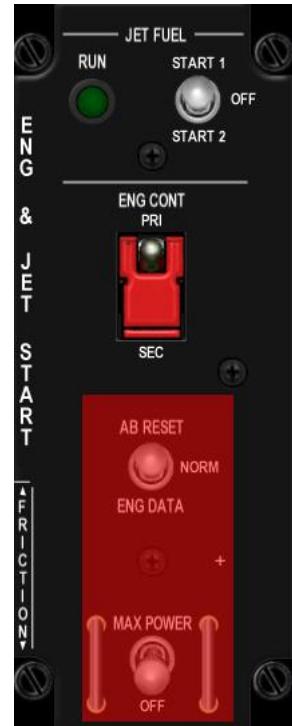
**6.** Check the ECM panel and toggle the top left switch to OPR. This is the only switch implemented on the ECM panel. While you are there check the AUDIO panels one last time for correct volumes on COMM 1, COMM 2 and INTERCOM. TACAN volume is not implemented and we set the ILS volume earlier. No further 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 second 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 squadron F-16. 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 do it later at FENCE in.



or

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 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!**

is

**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, dobbert (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 dobbert right to set the mode to T/R.



ILS frequency is also set through this page: dobbert 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. Plan on being 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).



Always remember to return the knob to NORM after checks because NORM this 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.

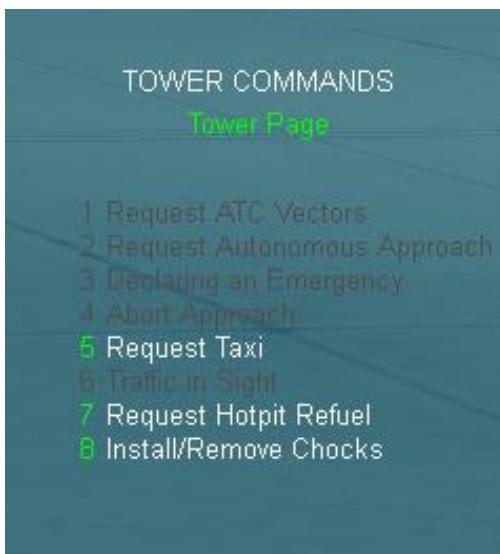
**In other words you will not get TRAPPED FUEL or BINGO fuel warnings if the knob is not in NORM!**

**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.

You are now almost ready to taxi. Arm your seat and enable nose wheel steering; confirm NWS is illuminated on the right indexer. Apply toe brakes or set parking brakes and ask the Tower to remove the chocks through the Tower ATC menu (displayed by pressing T on the keyboard). The Tower menu has multiple pages that 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 Tower 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 Tower menu you just opened. Select T-T-1 to request QNH from the ATC. Write it down or enter the value directly in the pressure window of your altimeter.

Reopen the Tower menu second page and hit 6 for Takeoff Runway. The tower will tell you which runway is assigned for departure. It might sound pointless here at Kunsan because you know that if the wind is from the north that runway 36 will be used for departure, but on parallel runway airbases it is handy to know which runway is active for departure and for recovery, before you start to taxi.

Finally reopen the first page of the Tower menu and press 8 to Remove Chocks. The red text CHOCKS IN PLACE will disappear and your jet is now free to move.

You are now ready to taxi.

## 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.

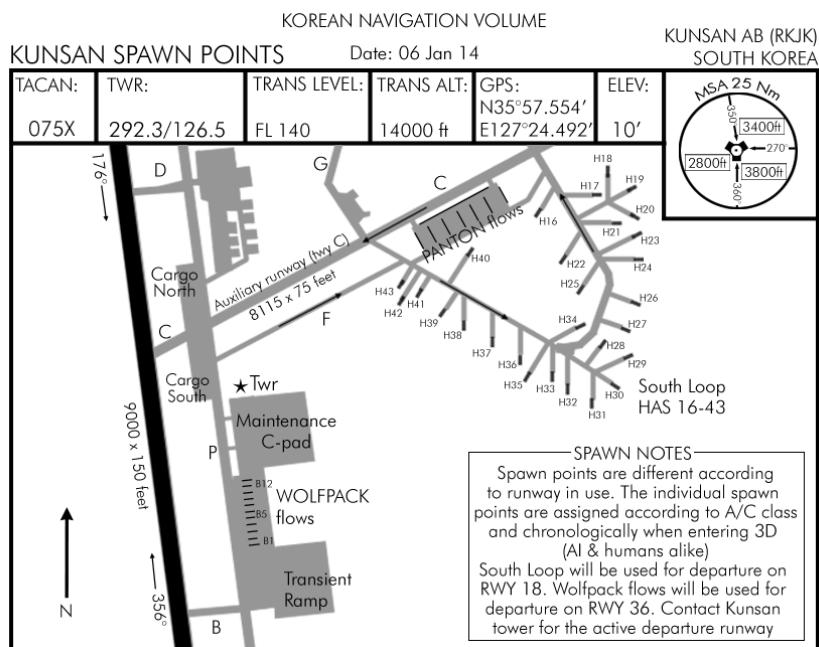
The first thing to do is to ask Kunsan tower for clearance to taxi. Open the ATC menu and select 5 Request Taxi. The tower will answer with your clearance and to hold short from the active runway. If other aircraft are in the queue ATC will state your number in the sequence. This call is quite important in 4.33 because it places your aircraft in the ATC queue and the tower 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.

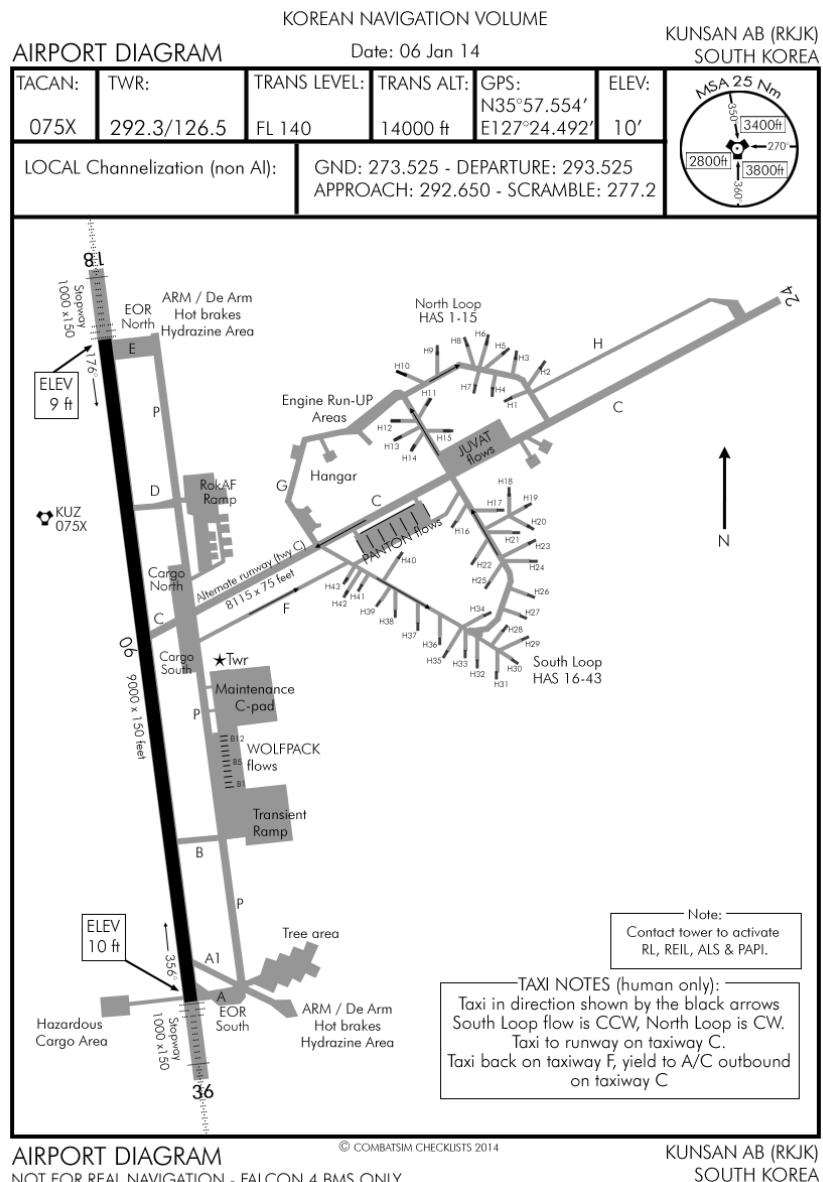
Let's move the jet forward and out of the blast revetments of Wolfpack flows so we can see the taxiway better. Move the throttle forward a notch to unstick the wheels and once the aircraft is moving pull the throttle back to IDLE. A lightly loaded jet will move forward even at idle power. The first thing to do is test the wheelbrakes. Gently tap the wheelbrakes 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, or there is an option in the CONTROLLER > ADVANCED UI page to allow the stick 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 25kts in straight lines and 10kts in turns.

But your HUD tape doesn't change and is stuck at 0kts? Indeed the system needs air flowing through the pitot tube and probes of the aircraft to give an accurate airspeed reading to the pilot. Rolling 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 on the right). 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.



While taxiing out you won't have much time to enjoy the Kunsan scenery. It might be a good time to check your IDM for instance. The IDM is the Improved Data Modem which connects you to your flight members or package members depending to your settings.

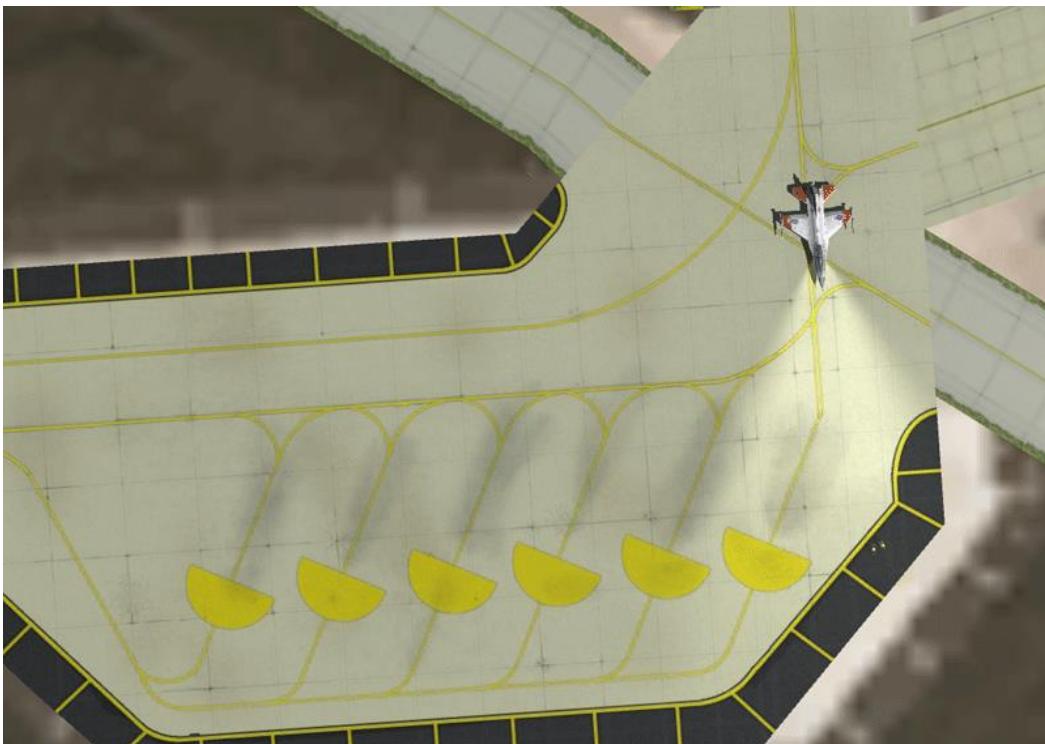
THE IDM is set through the UFC DLNK page. Press the LIST ICP button and select subpage DLNK by pressing the ENTR ICP key. The first page displays your flight IDM address (10) and your ownship IDM address (11). Dobber right to enter the second page of the IDM where you can enter the other team member 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).

XMTW10	A-G	DL	2
OWN 11	COMM	UHF	
FILL ALL	DATA	16K	
	PRTL	AFAPD	

XMT 10	INTRAFLIGHT	2
#1 11	#5	COMM UHF
#2 12	#6	DATA 16K
#3	#7	OWN 11
#4	#8	LAST #2

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 on your HSD. The IDM check is initiated by depressing the throttle COMM switch to the 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 takeoff checks. The engineers at Kunsan have modified both EOR so the waiting aircraft points away from the airbase, which makes it easier to check the approach end of the runway before lining up. Before 4.33 the EOR positions were towards the airbase. There are 6 parking spots available. You can pick any one of them for this flight but when you are part of a larger flight you should of course take parking spots according to your position in the flight.



End of the 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: setting weapon release parameters, boresighting the FLIR, checking the TGP etc.

Don't forget to place the chocks with the Tower menu or use 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 so to plan your takeoff properly you should request a wind check from the tower before leaving EOR. Open the Tower menu, hit 'T' again to display the second page and then select 4 Wind Check. The tower will give you the wind direction and its speed in knots.

The tower will automatically clear your flight to take off at your takeoff time. Obviously if you are still in the EOR position you will be late taking off which might be a problem in time sensitive TEs. Keep your TOT in mind and try to line up 2 minutes – 90 seconds before your takeoff time. Obviously keep looking at the approach path of the runway and listen to the tower frequency to build your Situational Awareness.

If you take the active runway too soon the ATC will yell at you to clear the runway. There's nothing you can do to avoid that since if you do as instructed you may be late. Switching to a fake departure frequency or the tactical briefed frequency is one of the solutions but then you will lose the airport traffic SA. That is the solution I prefer, but then I don't lose time on the runway.

## 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 shoot for the centreline; otherwise your position will depend on how many aircraft there are in your flight and on the briefed departure type. Stop the aircraft with the toebrakes and make a quick final check of engine gauges and for any caution / warning lights. Check the runway QFU (magnetic heading) and place the Radar Altimeter switch in the RDR ALT position.

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

The first one is the gross weight of your aircraft. The heavier you are the take-off roll will be longer 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 actually calculate your rotation speed for you. It is strongly advised to use that planning tool for your TE. 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-120 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:

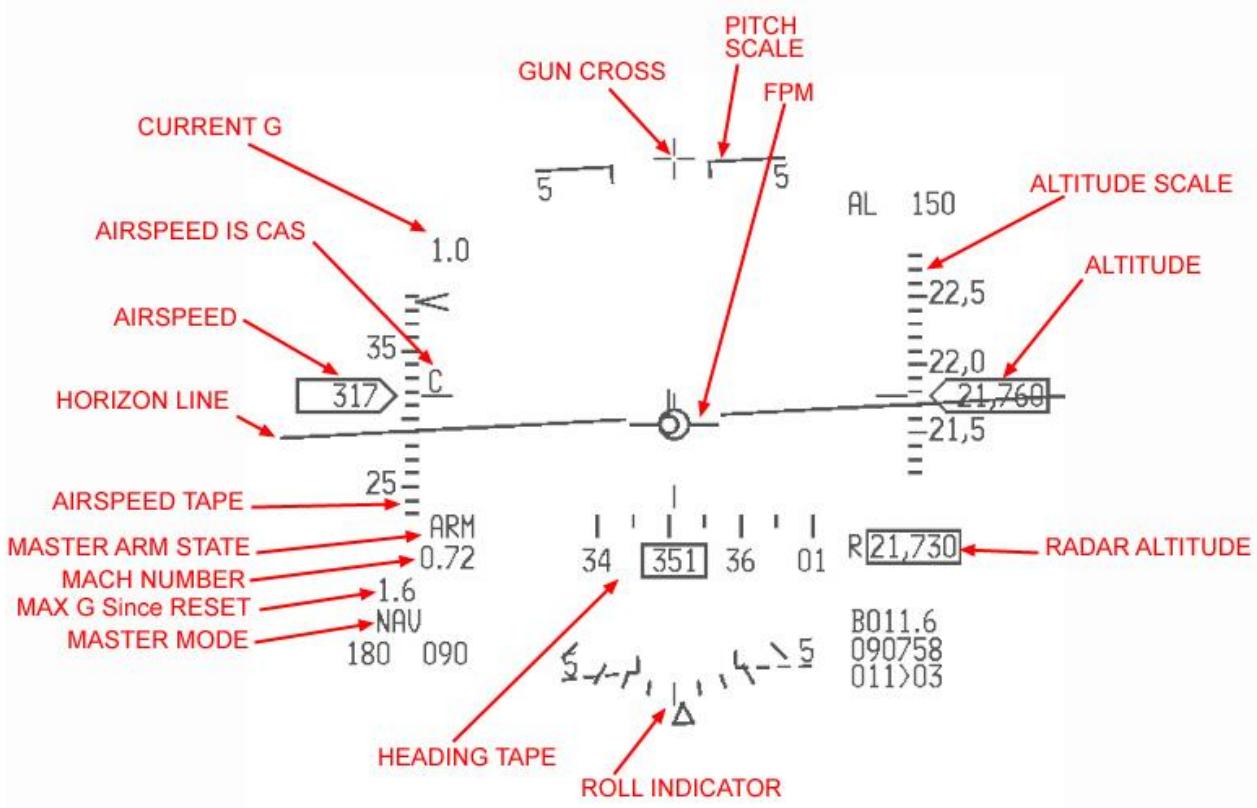
- Clean Weight of 17600lbs is the empty weight of the aircraft. It is consistent for each aircraft model.
- Munitions gives you the weight of the stores loaded; just 676 lbs in this case.
- Fuel is controlled with the slider and the number on the right is the amount of fuel (in pounds) on board; 5897 lbs this time.
- Gross Weight is the sum of all the first three lines and represents your actual weight at takeoff.
- Maximum Weight is the weight limit of the aircraft and doesn't change 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 in 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 the 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 takeoff 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 limit in no time and if you don't disengage afterburner quickly thereafter you will find yourself over 550 kts in no time. But more on that later

The second trick during take-off is avoiding excessive steering while rolling. As you know, 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 get to 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 takeoff, so it is usually safer to align carefully on the runway QFU 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 gross 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 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 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.

Level out at 5000ft 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

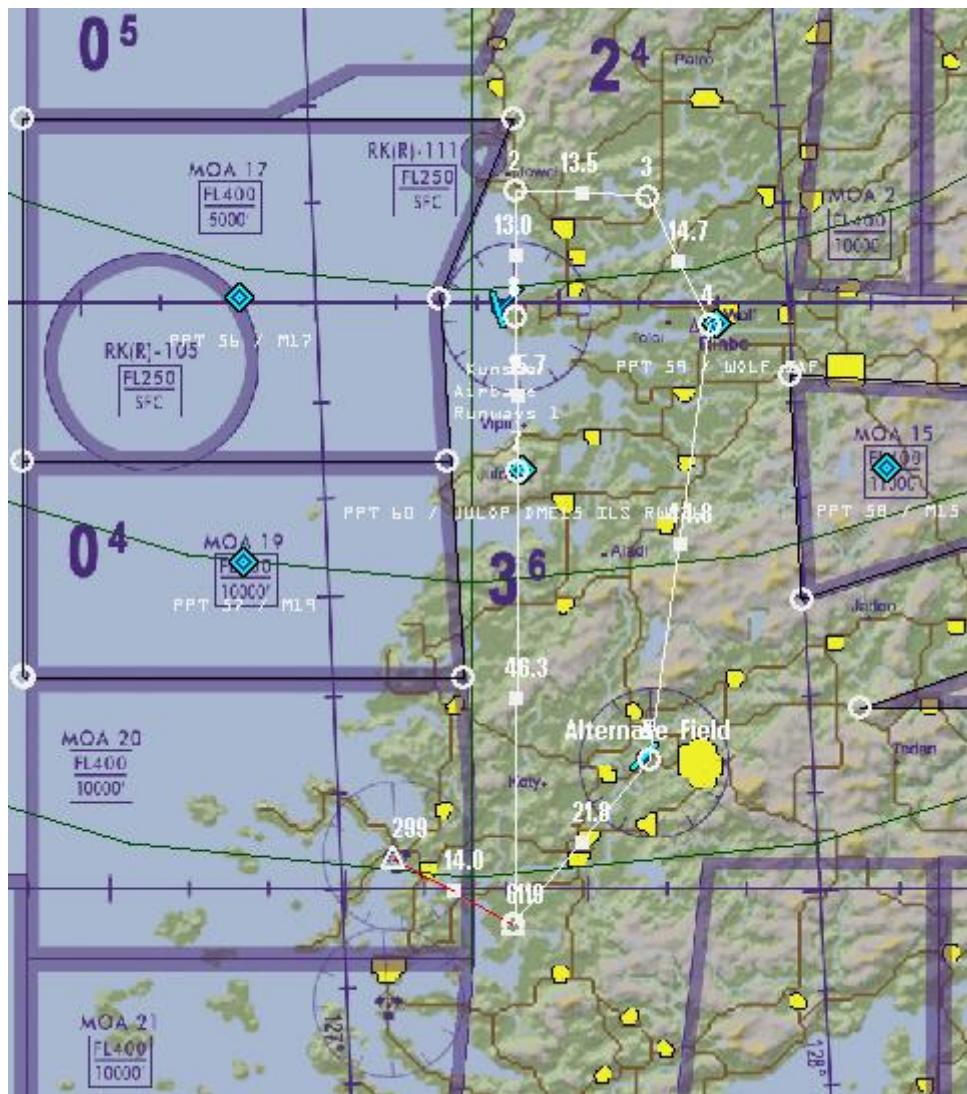
**TAKEOFF OPTION:** In Flight.

**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 5P rule: 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, the Initial Approach fix 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 will start (Landing). 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 flight plan 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](http://combatsimchecklist.net).

Here is the required information for this flight:

- Kunsan: TACAN 075X – Tower UHF: 292.3 - RWY 18/36 - ILS RWY 36: 110.3 – Elevation: 10 feet
- Kwangju (Alternate): TACAN 091X – UHF: 254.6 – RWY 02/20 (L&R) - ILS: 111.1 – Elev: 110 feet
- 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 Preplanned Threat Stpt'.

The Lines are used to mark specific areas such as FLOT lines, CAP boxes, AAR boxes, AOR, Killboxes, etc. The 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. The Lines and PPTs are fully customisable and can be labelled as you prefer using WDP or by editing the PPT.ini file directly.

In this TE 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 and PPTs will be visible in 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 1 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 5<sup>2</sup> 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:



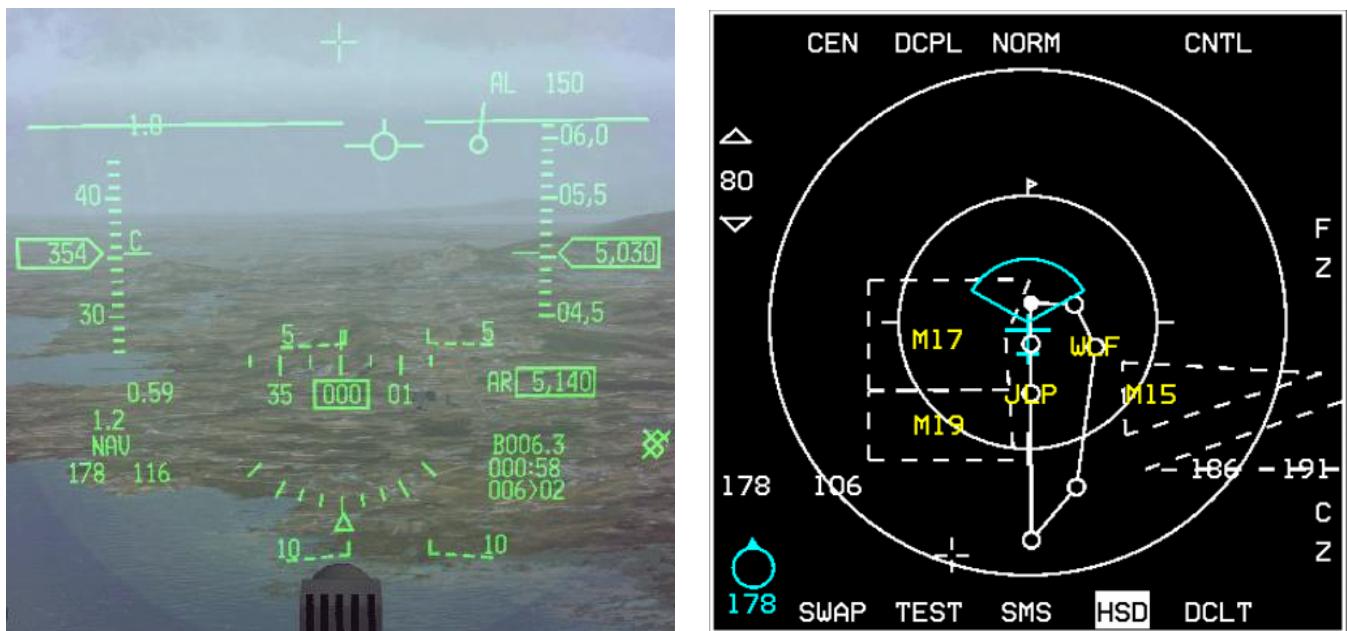
Obviously the first and 2 last steerpoints (departing airbase, arrival airbase and alternate) are at ground level. The altitude of the other steerpoints is displayed in two different graphics which you can enable or disable with the 2 graphic buttons on the right side of the UI screen. The total distance of the flight plan is 218Nm 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.
- Calibrated airspeed passing the steerpoint.
- True 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 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 ~58 seconds to reach the steerpoint.

The HSD has been zoomed out to 80 Nm to display the whole flight plan. Note that it has been set to the CEN (OSB 1) option so ownership 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.



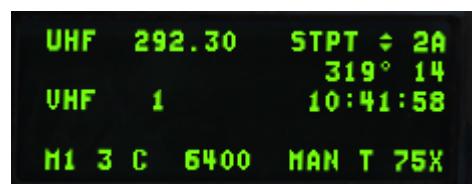
Initial conditions of this training scenario. Kunsan is in the background

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

While on the CNI page moving DCS to the right will display the 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.



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 direct to STPT 3.

The flight plan calls for a climb to FL200 (20000 feet on QNE). Climbing to altitude can be very easily done by pulling gently on the stick. The aircraft will climb and the 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 (military power - no afterburner), wait for 350 kts and then pull the stick and adjust the climb angle to maintain 350 kts throughout the climb. Doing so, you will continue to steer towards STPT 3. As you climb, your airspeed may drop below 350 kts, in which case simply decrease your climb angle to stabilise your airspeed or 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 are not well balanced and should start to fix the situation, most probably by checking the position of the ENG FEED switch. Refer to chapter 1.7.7 in the Dash 1 for more information about fuel imbalance issues.

Passing Steerpoint 3, the avionics will switch to Steerpoint 4 and your HUD symbology should indicate information related to Steerpoint 4. Steerpoint information can also be displayed on the Horizontal Situation Indicator (HSI) located on the centre console between the pilot's legs. This instrument is explained in the Chart Tutorial 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 Chart Tutorial.



As we overfly WOLF IAF (STPT 4) we check the INS coordinates against the 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 the INS STPT 4. As 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 0.150 minute in longitude. When translated into Nm that equates to approximately just under 1 nautical mile 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. In 4.33 we first have to start the coordinate input with one of the cardinal direction symbols (NESW) 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.



```

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

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

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

```

Hit 2 for North then 3557990 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 12750029 ENTR and the longitude will change to the new coordinates as well and the scratchpad will move to the elevation line. You can change it as well if desired.

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.

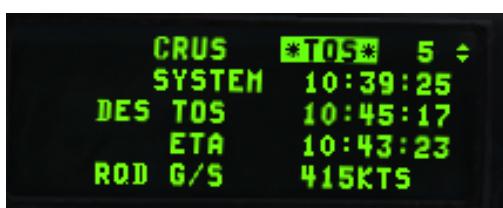
Move the LEFT AP switch to STRG SEL and move the right AP switch to ALT hold. The autopilot will engage (if the above conditions are met) and fly the aircraft. At any moment you can take control over the AP simply by moving the stick, but be aware that if you exceed any of the above limitations the autopilot 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 mode the aircraft will steer automatically towards the bearing pointer of the HSI. It will also automatically compensate for winds. Approaching STPT 4 the system will switch to STPT 5 and the AP will fly the aircraft to the steerpoint. We can concentrate on avionics while keeping an eye on the airspeed.

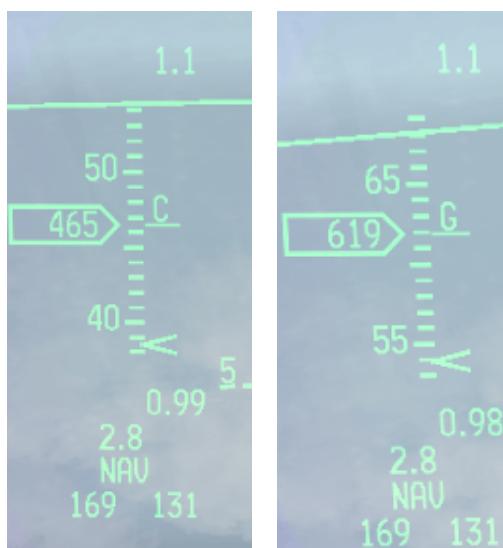
**AR 20,610**  
**B040.7**  
**104323**  
**041>05**

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 submodes: 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. In this case it is highlighted and the HUD displays ETE.

As you can see on the DED the TOS subpage also provides current time (103925), DES TOS (104517) which is the planned time over steerpoint, ETA (104323) which is our estimated time over steerpoint based on current speed and required ground speed (415) to reach the steerpoint at the planned time.



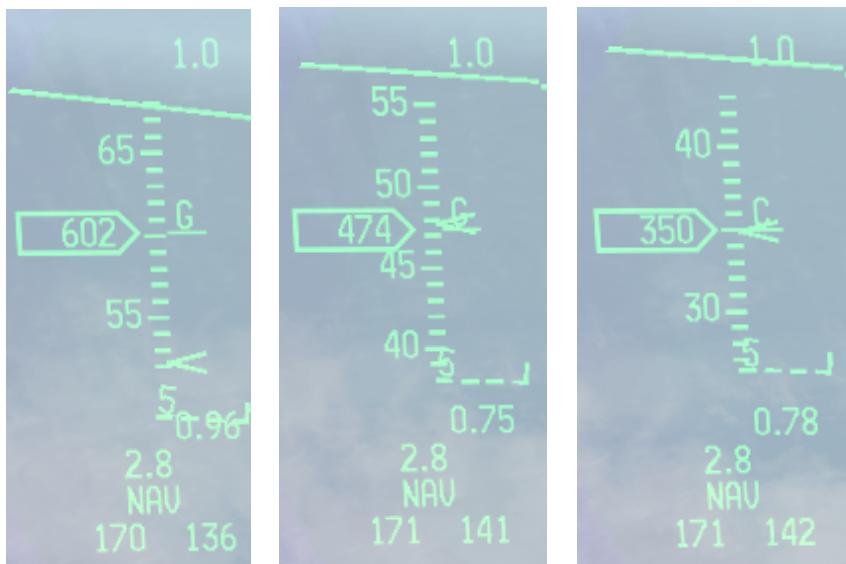
Current speed is 465 CAS. Let's switch the HUD speed scale to groundspeed with the relevant switch on the HUD panel (right console). Our actual groundspeed is 619 GS: 204 kts too fast. Notice the TOS airspeed caret at the bottom of the HUD airspeed scale. To fly TOS the caret must be aligned with your current airspeed mark; we should therefore 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 DES TOS page and enter 0 1 0 0 ENTR. The first zero is actually inputting a minus sign. 1 0 0 is for 1 minute and ENTR to enter the data into the system.

Return the UFC to the CRUS TOS page and notice the DES TOS shifted to 104417: 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 most one is taken just after DES TOS was adjusted. We are flying 602 kts groundspeed, too fast to arrive at the steerpoint on the ETA.

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

The aircraft flies 350 KCAS and will arrive on the steerpoint on TOS for as long as the caret is maintained 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 exact 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 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 Tower 292.3 using the COM1 page (if it was changed) and request QNH using the ATC menu 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 feet.



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 2800 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 preference.

**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. 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 tower frequency to build situational awareness of the traffic around the airport. In 4.33 the tower 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 the tower and will remain lit as long as aircraft are in the landing queue. If you don't make contact with the tower 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 six to nine 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 2800 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 speedbrakes may be opened to reduce speed.

From this point on we will no longer refer to airspeed but instead to 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 takeoff 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.

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.

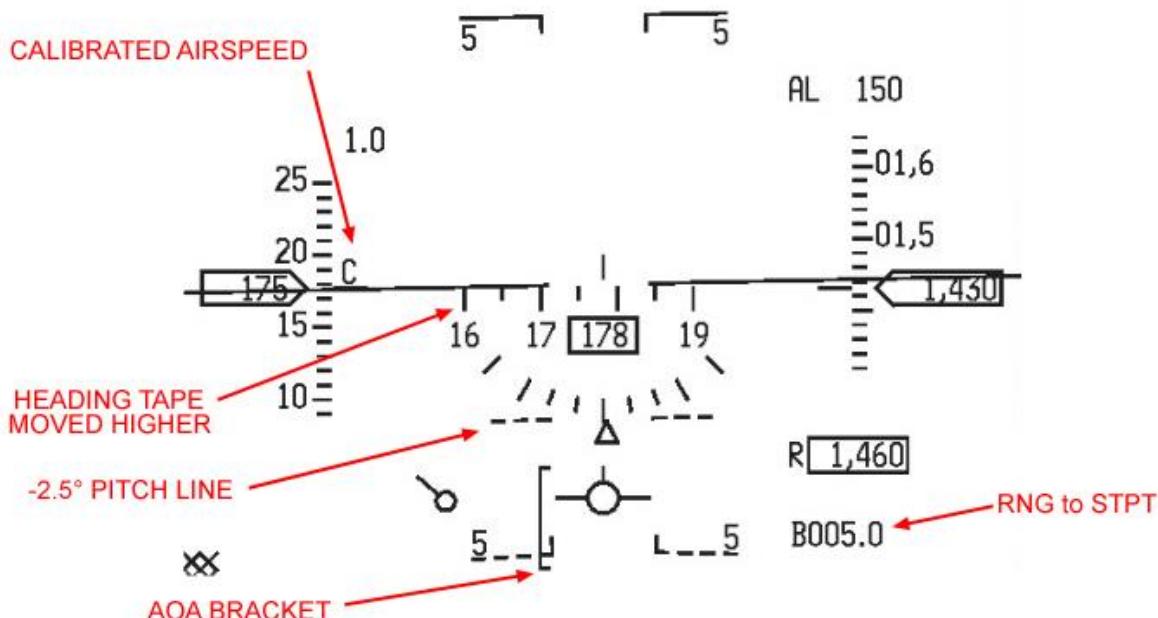
Most runways in BMS are equipped with a visual landing aid system called Precision Approach Path Indicator or PAPI. It consists of four equally spaced lights situated to the side of the runway. The lights will be seen as white or red according to the position of the aircraft with respect to the optimal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

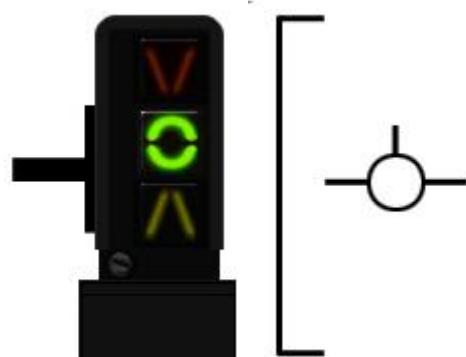
You also know that to maintain two red and two white lights on the PAPI you have to fly a  $3^\circ$  glideslope to the runway; the FPM has to be around the  $-2.5^\circ$  dashed pitch line. This is done with the sidestick controller.

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

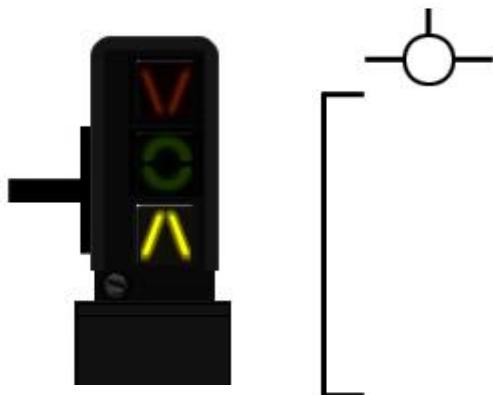
AOA is the angle between the aircraft wing chord line (equivalent here to the airframe longitudinal axis) and the relative vector of motion of the aircraft. Basically it's the angular difference between where the aircraft is pointing and where it is going.

The optimal touch down AOA for the F-16 is  $13^\circ$  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  $11^\circ$  AOA and the bottom mark of the HUD AOA bracket indicates  $15^\circ$  AOA. The bracket therefore corresponds to  $5^\circ$  AOA: from  $11^\circ$  (top) to  $15^\circ$  (bottom).

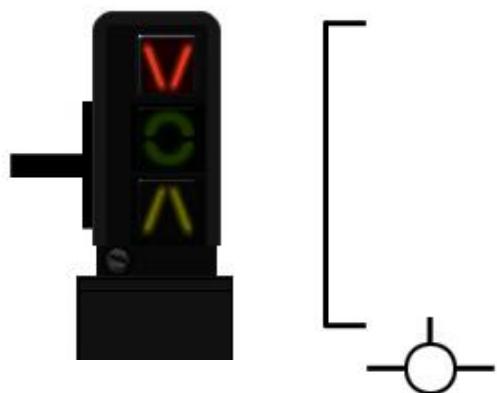


AOA is controlled by the power setting. Increasing power decreases AOA. (The FPM moves up while the nose remains steady) Reducing power increases the AOA (The FPM moves down in the HUD while the nose remain steady)



Knowing that, if the FPM is above the bracket ( $\text{AOA} < 11^\circ$ ), 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 ( $\text{AOA} > 15^\circ$ ), 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  $11^\circ$  AOA (FPM at the top of the HUD AOA bracket) on a  $2.5^\circ - 3^\circ$  glideslope to the runway with speedbrakes 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.

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 ( $11^\circ$  AOA) to the centre of the bracket ( $13^\circ$  AOA & green doughnut illuminated on the left indexer).

Decreasing power is usually all it takes to transition to  $13^\circ$  AOA. Once there, maintain it until the wheels kiss the ground and pull back the power 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 rudders 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 and nosewheel steering can be engaged once 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

The overhead landing is the preferred method for landing because it allows multiple aircraft to land in a minimum amount of time.

Please be aware that different squads or even airforces may have different procedures to perform overhead landings. What is illustrated here is only one method and there are other equally valid ways to do it.

The flight lead announces his flight at initials (usually 5 nautical miles from the runway threshold) in a wingtip or echelon formation. The side of the formation is opposed to the direction of the break. Speed is 300 kts, altitude 1500 feet AGL and the flight is already aligned with the runway axis.

The last 5 miles are used to fine tune the formation so the landing looks good. The aircraft fly a constant airspeed level altitude until overhead the runway. From there the aircraft will break in sequence providing 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 the landing in sequence.

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

You should be within parameters at least 5 Nm from the runway threshold. Continue 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 (RWY18 in this case) to disappear under your aircraft nose. In a 4-ship scenario, lead has the shortest downwind and should start his break much sooner to allow the rest of the flight to break before overflying the opposite end 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 RWY36 the water is on the left side so the break will be left.

The break turn is a maneuver 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.

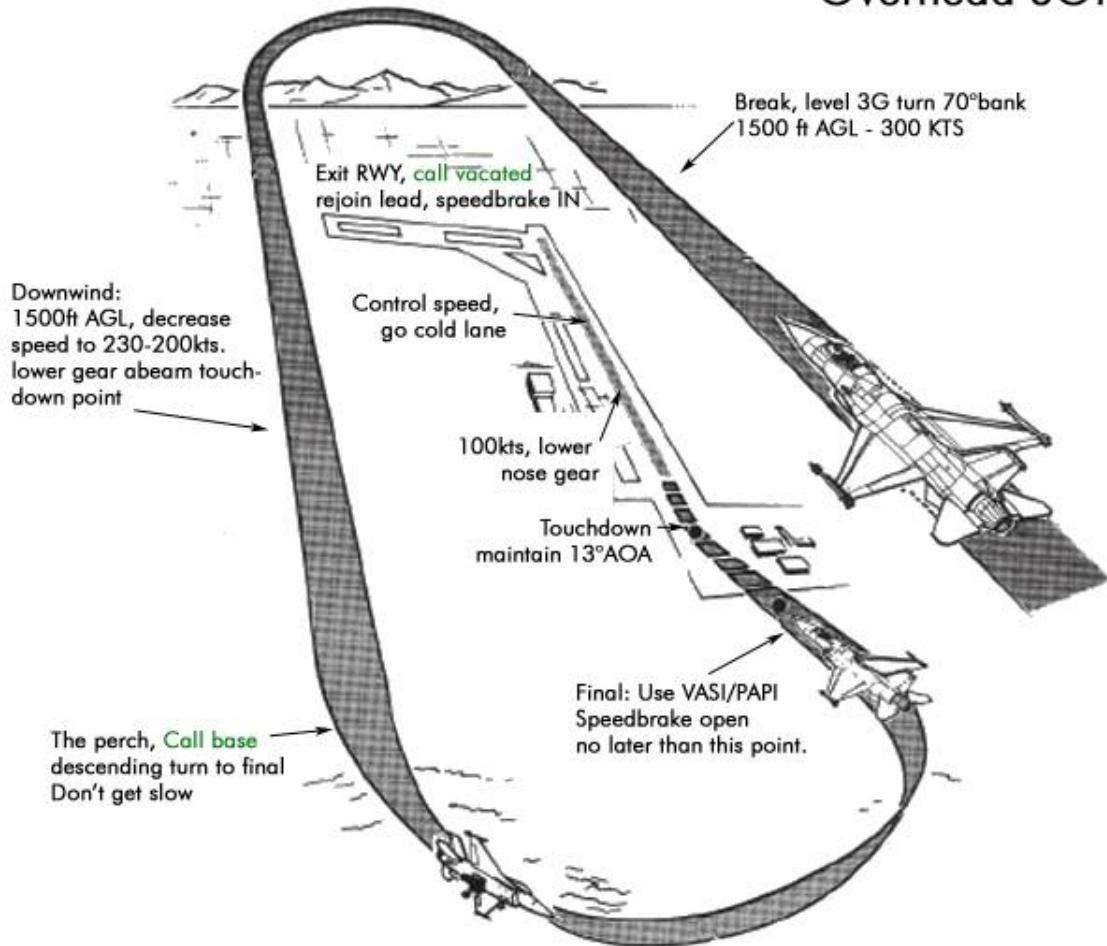
The turn will define how wide your lateral separation with the runway will be.

The idea is to fly the downwind leg with the wingtip on the runway. If the runway is inside your wing the break 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.

The downwind leg is flown at 230-200 kts - 1500 feet till 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 recovery. A good visual cue is when the front of the wingtip touches the runway threshold PIX.

Retard the throttle (or deploy speedbrakes) and start a left descending turn towards runway 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 around the final turn.

## Overhead SOP



Final approach is when you are aligned with the runway. Use the 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.

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 higher without accelerating, the speedbrakes are used. In case of a go-around the speedbrakes 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) on the runway you can enable NWS and use the wheel brakes accordingly. Exit the runway on the first available taxiway to the right and once past the runway hold lines retract your speedbrakes. 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, request chocks through the Tower menu (t 8).

Shutting down the jet is not really necessary. If you do, 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 block 40 & 50 for the Advanced Handling Course made of 6 training flights independent of each other.

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.

**LOCATION:** Approximately 15 Nm south of Kunsan.

**CONDITION:** Night time - Aircraft level at 2800 feet over JULOP fix - heading 360° - speed 400 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 Chart Tutorial (Chapter 3.1). Basically it's a double radio emitter with a limited range (18Nm) 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 path 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 and 0.5Nm from the runway threshold. They are called the outer marker and inner marker. They provide audio and visual feedback when overflow: 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 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 in the next ILS training mission.

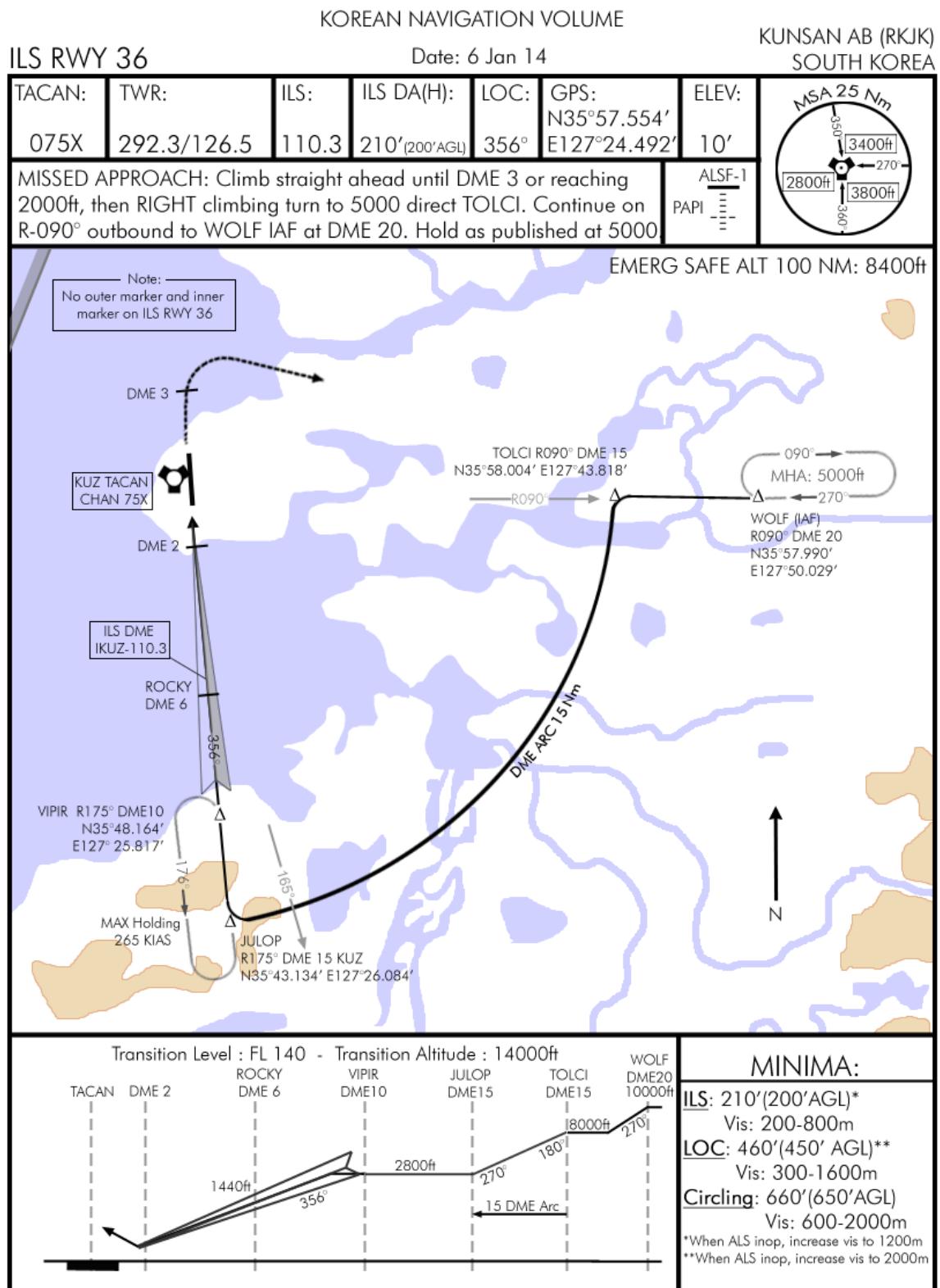
Flying ILS approaches are made using relevant approach charts. Since visibility may be reduced, the aircraft is flying in proximity to the ground and sometimes lower than mountains and the MEF, navigation must be accurate and you must follow the published approach tracks.

Charts for BMS airbases are in the Docs folder of your BMS install. You will need ILS RWY 36 for Kunsan for this mission (*\Docs\Airport Approach & Navigation Charts\South Korea\Kunsan*).

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 Chart Tutorial document 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. Intercepting the ILS is made 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 glideslope and therefore follow the optimal glide path to the runway. The glideslope 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 down the aircraft 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 tune in 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 taken from the chart above.

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 CRS is independent from 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 let's input 3 5 6 ENTR.

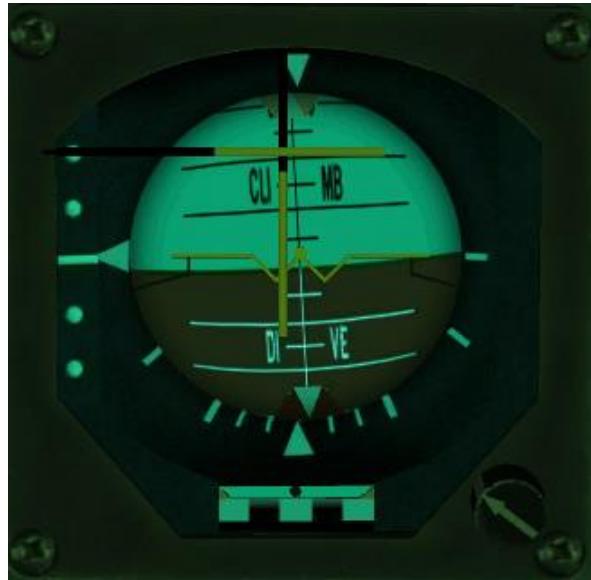
The scratchpad then moves to the CMD STRG line which you can mode select or not. When mode selected a steering cue will be displayed in the HUD showing you your course for optimal intercept of the ILS. It is very similar to a flight director in commercial aircraft. If you do not wish to use it simply un-mode select CMD STRG with the M-SEL 0 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 to the INSTR MODE panel and select TCN/ILS; the ILS symbology will then be displayed in the HUD and ADI. The HSI will only display the localizer.

You could select NAV/ILS rather than TCN/ILS; the distance information in NAV/ILS is related to the active steerpoint, as opposed to the selected TACAN in TCN/ILS 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 HSI displays not only the localizer but also the distance to the TACAN (13Nm) 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 the dots are 5°). The current localizer is less than half a degree to the left.

The HSI CRS is set to 000 so 4° offset from the ILS course. It is good practice to set the ILS course in the HSI as well. Although it will not impact the localizer deviation it will make your situational awareness better as it points straight out to the ILS approach track. You could do it at a 90° off angle and still fly a perfect ILS 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 left 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 left until the FPM is on the CMD STRG cue.

We will turn left and then the CMD STRG cue will drift back right and will guide us towards the localizer.

The Kunsan area is in sight as the night is clear but we cannot see the runway. In BMS 4.33 the runway lights are not always illuminated at night. ATC will light up the airbase only when an aircraft is in the traffic queue.

Let's contact the tower and tell them we are landing. BMS 4.33 introduced a new option in the Tower menu. You are now able to request an autonomous approach. Basically that lets ATC know that you do not require vectors and you will land on your own. This is particularly handy when you are following a published approach or performing a visual approach like an overhead pattern and don't want to receive conflicting vectors from ATC. Open the Tower menu with t and press 2 for Request Autonomous Approach. The tower will switch the ALS on, monitor your progress and clear you to land when you are final.

A good idea is to check the winds. You can ask the tower 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 emphasized 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 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 on 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 that 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 switch to the top of the HUD.

#### TOWER COMMANDS

##### [Tower Page](#)

- 1 Request ATC Vectors
- 2 Request Autonomous Approach
- 3 Declaring an Emergency
- 4 Abort Approach
- 5 Request Taxi
- 6 Traffic in Sight
- 7 Request Hotpit Refuel
- 8 Install/Remove Chocks



From that point you must 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 but you also have to stay centred on both the localizer and the glideslope.

A cross may appear on the pitch cue of the CMD STRG cue if you drift too far away from the very narrow cone of the glide path (it becomes narrower as you approach the runway). The cross indicates that the pitch command is unreliable and deactivated. As you fly back within the cone the X will disappear and the pitch command will become reliable again.

Note also the inverted 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.

In such situations the HUD can become crowded with information. You can declutter it with the UNCAGE button on the throttle. It will remove some of the symbology on the HUD to give you a cleaner look at your aim point on the runway. The problem in this training scenario is that it will also remove the ILS bars so you can see the FPM and the AoA staple and the runway a little more clearly. The declutter will cancel itself with Weight On Wheels if you don't proactively toggle the declutter off again yourself.



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 start seeing nothing but the runway lights is unique and very rewarding.

The image on the left pictures all that you should aim for at that point:

- FPM on top of the AOA bracket, aimed at the touch down point
- 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, Machmeter, Altitude, HSI, 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 usual post target 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

KC-10: Camel 1 - A-A TCN: 29Y  
 Long tanker orbit legs  
 Package 4977  
 Callsign: Goblin 2-1 (F-16B block 15)  
 GW: 25500 lbs  
 Fuel load: 5900 lbs  
 6 Nm trail on tanker, entering AAR box

High Gross Weight AAR

KC-135: Canteen 1 - A-A TCN: 63Y  
 Short tanker orbit legs  
 Package 4980  
 Callsign: Goblin 3-1 (F-16D block 40)  
 GW: 35900 lbs  
 Fuel load: 5900 lbs  
 3 Nm trail on tanker, entering AAR box

**GOAL:** Refuel your aircraft in the air. Top off at 9000 lbs.

### 5.1. Setting up and finding the tanker

Air to air refuelling is not an easy task and requires good 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. I can't compare but I'll test anytime.

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 enough precision. 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 depressurize 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 depressurized 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 either. And don't forget to close it when you're done.

Finding the tanker can be done with your FCR or with the A-A TACAN. If an AWACS is airborne you can also ask for vectors to the nearest tanker. The AWACS menu is opened with the 'a' or 'q' key depending on your keyboard layout. Press a (or q) again to display the second page of the AWACS menu and select 'Request Vector to Tanker' and the controller will reply with the Bullseye position and the TACAN channel of the tanker.

If no AWACS are airborne contact the tanker directly via the Tanker menu using the 'y' key and 'Request Fuel'. If you are outside 10 Nm AWACS will give you a heading and a distance for rejoin.

Snap to the heading provided and set your radar antenna elevation to cover airspace around 20000 feet. Look for the tanker contact on your FCR. That should help the rejoin or intercept.

Input 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 by using DCS right. The mode will toggle from TCN T/R to TCN A-A.

Depending on which scenario you chose you may or may not have bearing information to the tanker. The KC135 A-A TACAN provides distance information only, the bearing pointer will turn 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 enroute to intercept the tanker you need to set the radios to be able to communicate correctly. Although it is not really mandatory to do in BMS because the AI does not follow the UHF/VHF frequency logic, it is good practice to always select a specific radio frequency for refuelling. Most virtual squads use preset 12 (Proximity) to ensure we can talk to the tanker and that is what we will use in this training mission. Select COM 1 on the UFC and set the UHF radio to preset 12. For the record the 'y' Tanker radio menu works whatever your frequency is set to.

Once you are close to the refueller (less than 10 DME) open the Tanker menu with y and press 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 open with the right indexer blue RDY light. That will give time for the fuel system to depressurize the external tanks so fuel can flow into them. The speed limit in 4.33 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 at 20000 feet. Knowing his speed you can set your own overtake speed with the following rule:

**Over 2Nm (12000 feet): 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 document. In this training scenario you are single ship and we will not document the quickflow procedure again.

## 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 recognized 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 minimize the amplitude of your throttle movement.

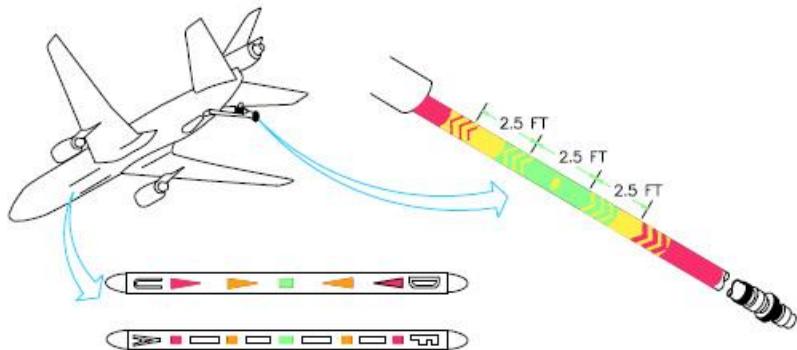


Very often pilots tend to get stiff on the controls. It doesn't help so try to relax your grip on the stick and throttle and you will find it easier to fine tune your stick and throttle control. You should fly the refuelling as you fly a fingertip formation. Don't look at your HUD cues, look at the aircraft 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 all lights go off that means the boom operator will plug the boom into the F-16 AAR receptacle. Maintain your position, wiggle your fingers and toes and lower your breathing rate.



"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 .

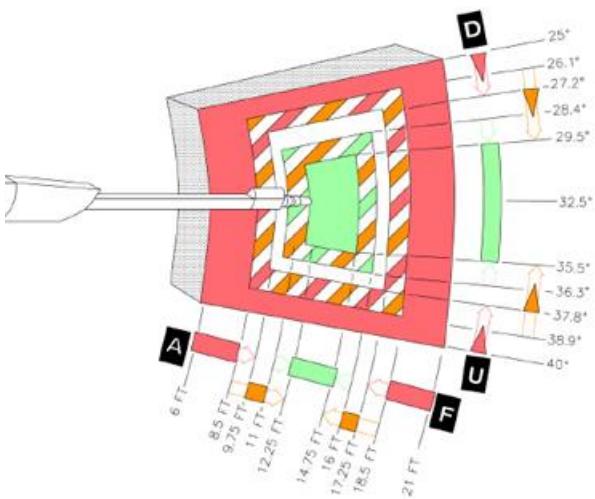
The director lights are slightly different from the KC-10 to the KC-135 but work along the same principles. They are made up of 2 lines with different symbols.

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

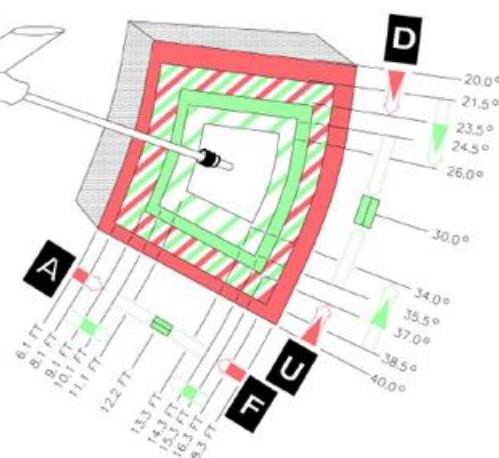
The right line is relevant to your longitudinal position from the contact position and features the letters F for Forward and A for Aft and other coloured position symbols.

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 'y' menu and press 3 Done Refueling. It is only after you have done this that the tanker will clear your wingmen to pre-contact. In multiplayer the tanker ownership is transferred from one player to the next 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 quickflow 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.

Congratulations, you just succeeded at one of the most difficult tasks in BMS: Air to Air Refueling. Use this training mission as often as you need as practice makes perfect and this is really an aspect of flight simulation that requires a lot of practice.

## MISSION 6: ILS IN BAD WEATHER

**TAKEOFF OPTION:** In flight.

**LOCATION:** Approximately 2 Nm north of MIKKI IAF for ILS landing at Taegu.

**CONDITION:** Day time - Aircraft level at 6000 feet - heading 180° - speed 400 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: F 0825FT ILS RWY32 TL140 270/10KT 1.1SM FG RA OVC010 NOSIG Wind 270° at 10 kts, Visibility 1.1 mile, Fog & Rain Overcast 1000 feet. No significant changes.

**GOAL:** Land on Taegu RWY32 ILS.

Taegu Elevation: 353 feet

Taegu TACAN: 125X

Taegu Tower: 365.0

ILS RWY 32: 108.7 (Minimum 553 feet – Localizer 320°)

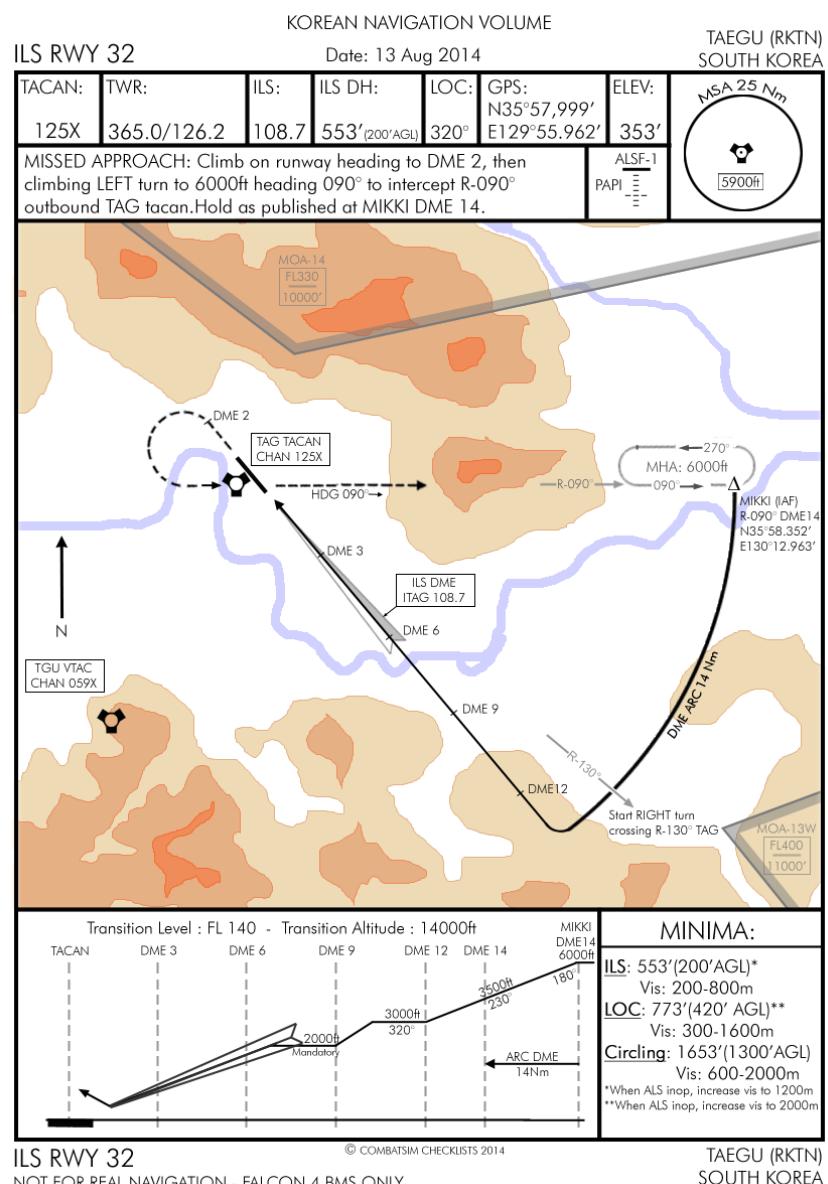
This training mission is technically the same as the mission 4 but this is the real thing. The visibility is very low and cloud coverage is total up to the minima. You will see the runway only at the very final stage of the approach.

The approach starts at the IAF and 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 available in your Docs folder.

The approach will be made in two steps. The first will be to fly the ARCDME until you cross Radial 130° 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 tower is set to COMM1 and the QNH is set for approach.

You should 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.

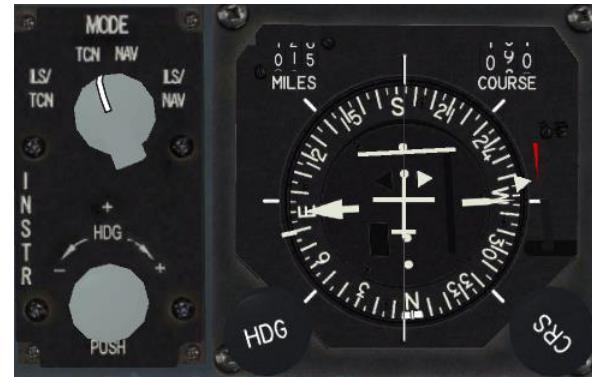


You will have to set your ILS frequency to 108.7 using the T-ILS page of the UFC. Input 10870 into the scratchpad and press ENTR. The scratchpad moves to the ILS CRS. Input 320 and ENTR which is the localizer course for Taegu ILS 32. The scratchpad moves up to CMD STRG which is mode selected; command 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 feet. 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 2 Nm north of the IAF. First 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 Chart Tutorial in your Docs folder. The principles can be summarised to simply keep 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 pass 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 as the ARCDME. 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.

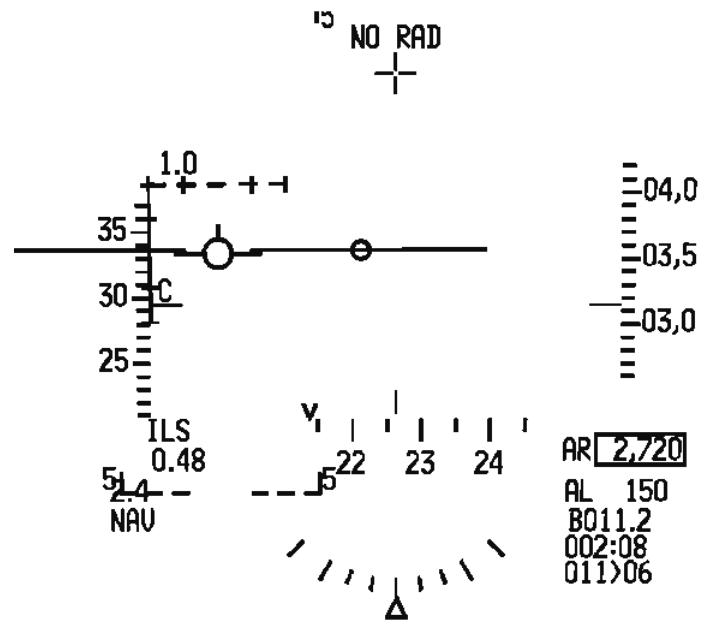
On top of all this you also have to descend from 6000 to 3000 feet as required by the published approach and pay attention to the wind, which will constantly push you away from the ARC, increasing your DME value.

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-130° from TAG. So set the HSI CRS to 130° so you are ready for the next step when the CDI will centre on R-130° but continue to fly the descending ARCDME. Level your altitude when reaching 3000 feet.

When the CDI centres on R-130 your heading should be around 220 - 230° with the bearing pointer still pointing 90° right with a DME of 14 Nm. As you can see on the picture I didn't correct enough for wind and I drifted my ARC 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.

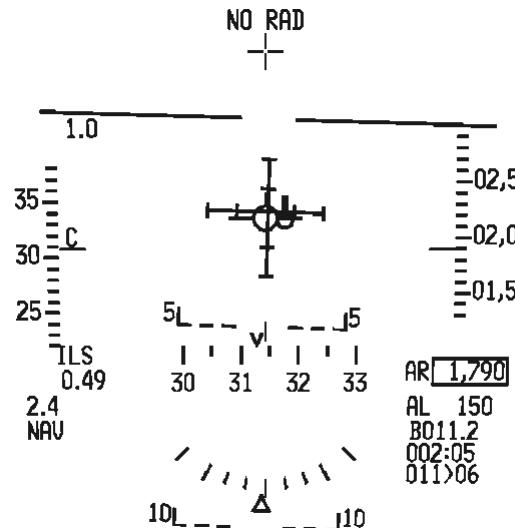
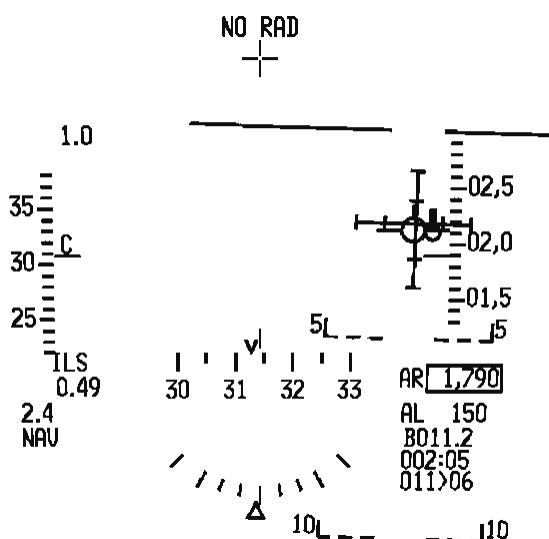




You should be fully established on the localizer at 12 Nm on heading 320°, level at 3000ft with an airspeed of 300 kts. At that point the localizer is centred and the glide slope is above your FPM. The next step is glide slope intercept around 6Nm from the runway at 2000 feet. Descend to 2000 feet while 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.

You should contact the tower no later than this point to get your ticket in the landing cue. Select Request Autonomous Approach from the Tower menu. If you are not in the landing queue the airport lights will not be turned on and in bad weather you *really* need them.

The next two pictures are taken somewhere close to 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 and it's time to lower the landing gear and check for 3 greens.

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 to set the CRS as the localizer (320° or at least 140°).

Keep both localizer and glide slope bars centred and you will descend along the ILS track to the published minima. With your gears down the 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 speedbrakes the engine will need a longer time to go from 70 to 100% RPM and you may sink for too long. Using the speedbrakes decreases that risk.

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. If you forgot to contact the tower the ALS will be off and your chances of landing will be dramatically decreased.

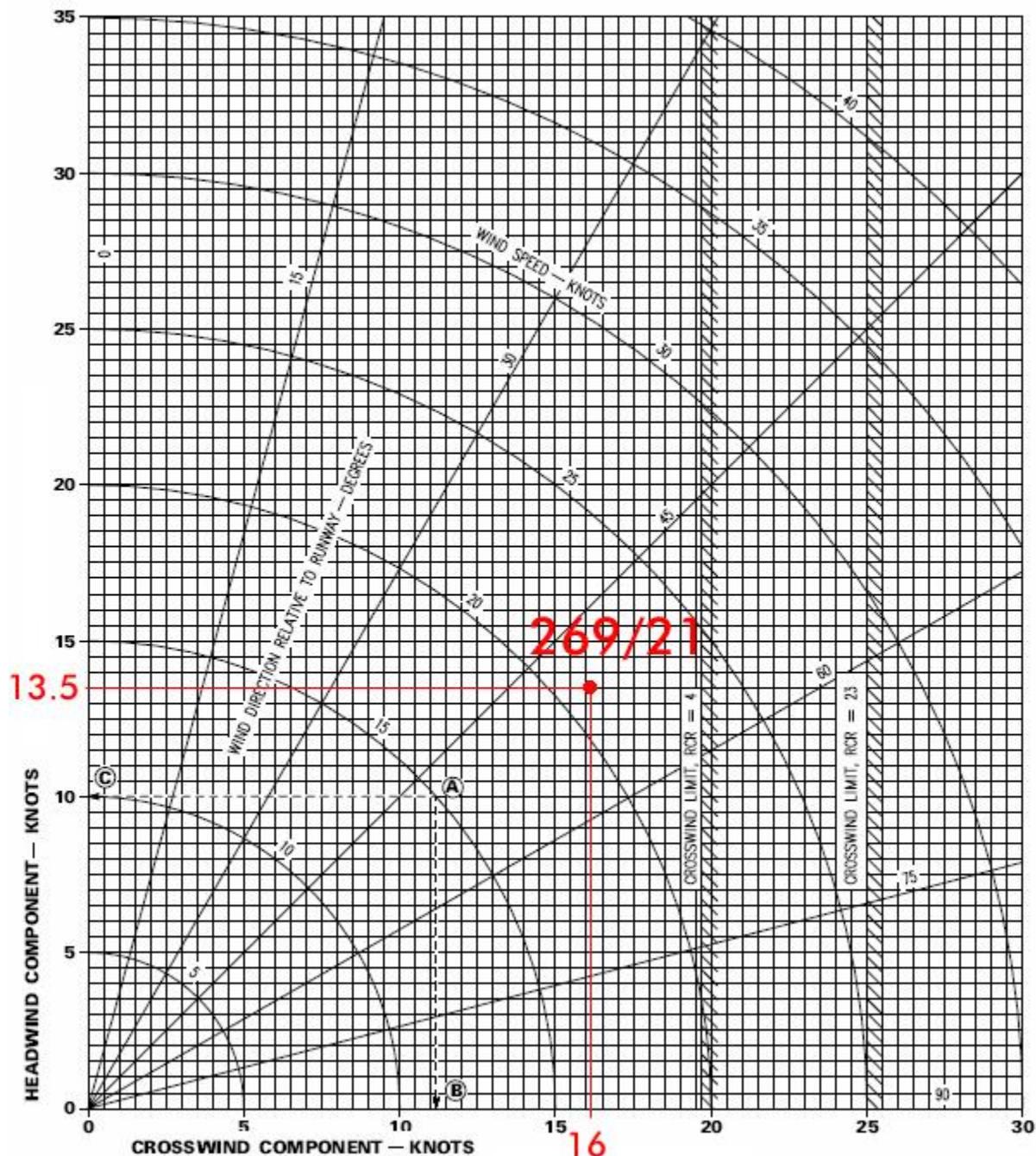


Now that you have the runway in sight you can land visually. Pay attention to the turbulence close to the ground. Welcome back. You can be proud of your success; it is not an easy exercise.

## 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 below graph, 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:  $320^\circ$  - wind reported in DED:  $269^\circ / 21$  kts  $\Rightarrow 320 - 269 = 50^\circ$   
Locate the  $45^\circ$  and  $60^\circ$  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 cross wind 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:** 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.

**WEATHER:** Sunny, clear skies, wind 100° at 6 kts.

**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.

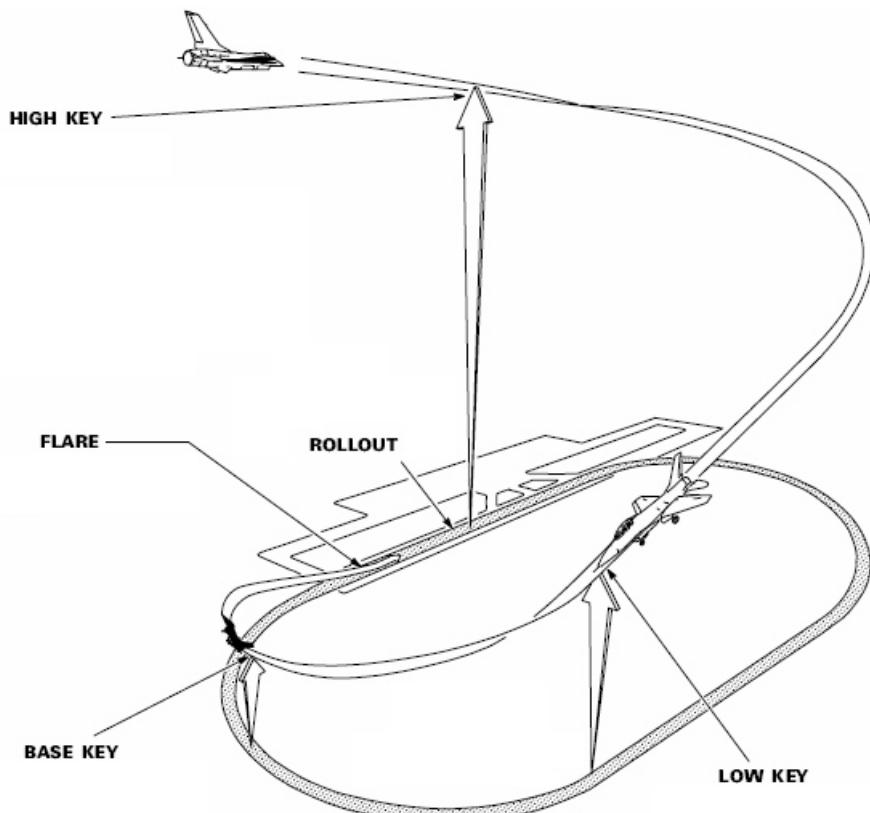
### The overhead approach

The overhead flameout approach is made up of three distinctive 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 limited emergency power and you glide towards earth at a certain glide ratio. The gliding speed will obviously depend on your Gross Weight: 200 knots for GW of 20000 lbs and 205 knots for 21000 lbs GW. 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 the centreline ECM pod.

The best glide speed is thus typically set to 200 knots. Best glide speed with gear down is 10 knots less than gear up best glide speed (190 kts). To find out your best glide speed in any configuration 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 ft of altitude you lose. That is a fineness of 8.4. You will cover 8.4 Nm for each 1000 feet of altitude loss.

This makes gliding calculations tricky in an emergency so just use a glide ratio of 1:1 giving a fineness of 6: 1000 feet altitude loss for each Nm (6000 feet) distance. Granted it is an approximate rule but it is very handy to estimate your range when deciding which available runway to use and whether you can even 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 EPU fuel for hydraulics and emergency power. Once hydrazine is depleted the EPU will shut down, hydraulic pressure will drain out and with no hydraulic pressure the F-16 will be as controllable as a brick. At that point your only way out is to eject. The EPU has about 10 minutes running 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

(fineness 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.



### 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's 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 bags. 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 quit 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 windmilling 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 autonomy of maybe 10 minutes. 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 not be powered anymore and the aircraft can't be controlled. You will have to eject. Check that EPU FUEL gauge often.

MFDs, EWS suite and 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. 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 the tower.

Another very important aspect to consider is the wind. It already influences your flight when the jet is powered but when gliding the wind may very well throw all your parameters out the window and make you fall short or long. Unfortunately you can't rely on the UFC to display winds. You will have to ask the tower with the Tower menu (t t 4). 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 therefore increasing your sink rate 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.



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 gliding speed correctly. Remember the overhead flameout pattern is flexible and you can enter at any point depending on your altitude or energy. So 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 and 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. Now might be a good time to request an emergency landing (t 3), so the airport lights are switched on and traffic cleared.

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 unless you're 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 down and then use the ALT GEAR handle further left on the auxiliary console.

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. 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.



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 at 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. But that feature is not yet available in BMS, so wheel brakes and differential braking are available on roll out.

NWS is not available so your only option to steer on the ground is 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.

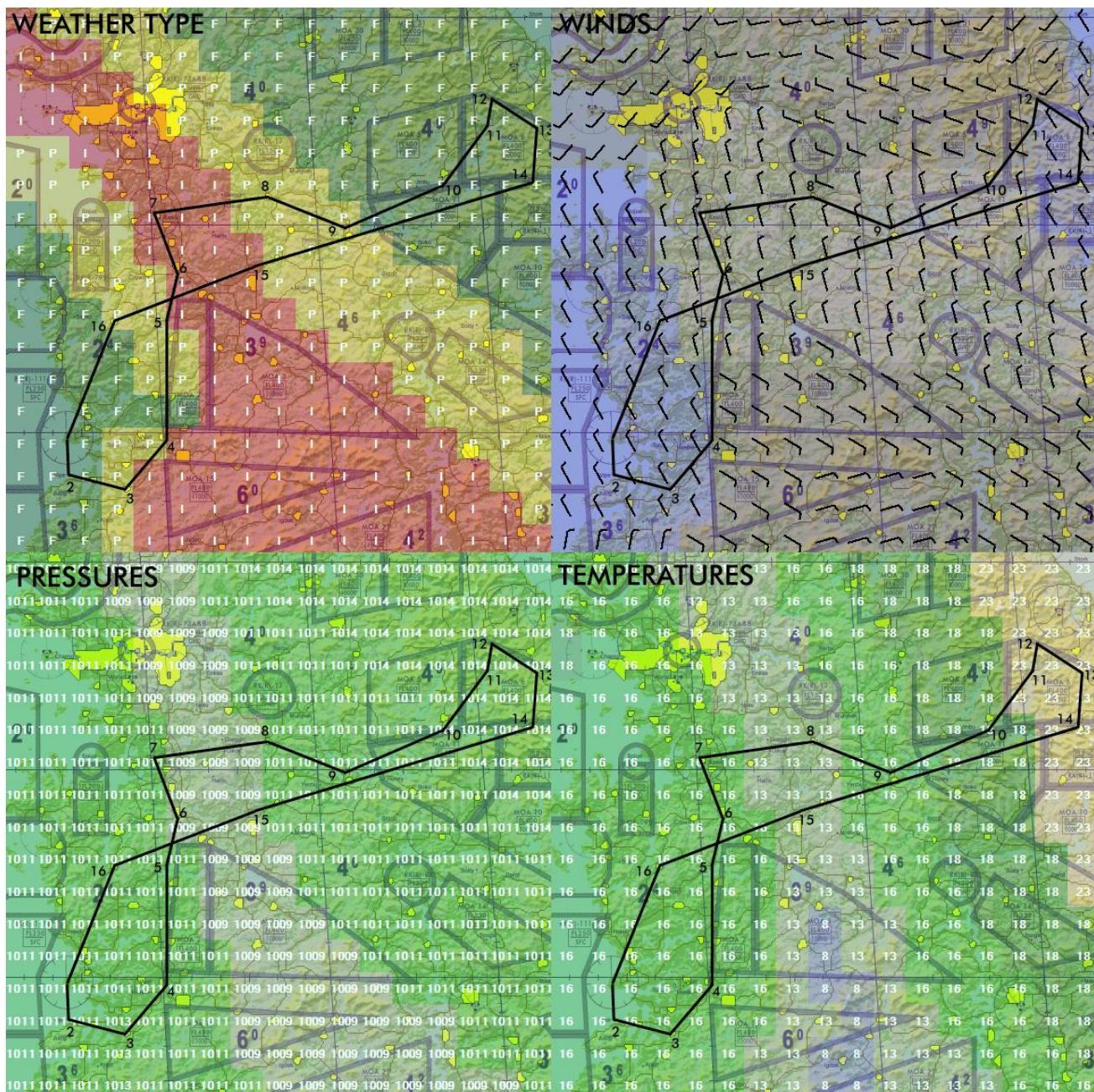
## MISSION 8: LOW LEVEL NAVIGATION (TFR - FLIR)

**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 new feature of 4.33: Weather Maps. Users can now create real weather patterns according to GRIB data (Refer to the BMS-Manual for more information about Fmaps). The following 4 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 a 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 target practice at KOTAR (in another 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 the use of the LANTIRN (Low Altitude Navigation & Targeting Infrared for Night) system. LANTIRN is made of two pods carried on the chin pylons of the F-16, the AN/AAQ-13 navigation pod loaded 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 from the SETUP > GRAPHICS UI page.

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

The training will start at RAMP as the TFR and FLIR need to be checked on the ground and in flight right 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 will be used in the LGB training mission. Nevertheless you can choose to pursue your flight and turn this document to the relevant chapter.

Obviously we will not document the ramp start procedure explained in training 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 to ensure correct pod operation is to power both LEFT HDPT and RIGHT HDPT switches on the SNSR PWR panel. This is usually done at the same time as powering 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 8 and 15 minutes to cool down. It is a long time and since you may need 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, checking the same NOT TIMED OUT message appears. The TFR will need about 3 minutes to warm up and when ready the NOT TIMED OUT message will disappear.



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 we need the NORM position of the RF switch allowing the TFR to operate in all its modes (NORM, WX, LPI, VLC). Ensure the RF switch is in NORM.

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 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.

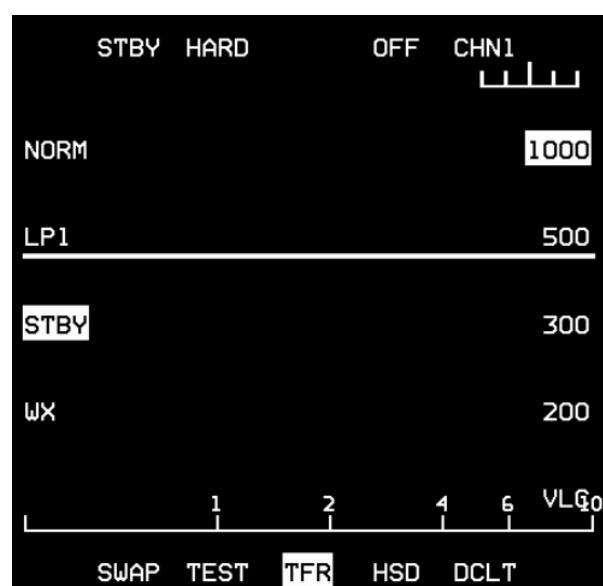
The ENABLE position of the switch ensures than in MAN TF (Manual TFR) there is the same automatic fly-up protection as in AUTO TFR. If the switch was left in DISABLE the pilot has to initiate the fly-up manoeuvre.

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 SCP – 10% = 900 feet.

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 will still need another 10 minutes so we will resume the 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.

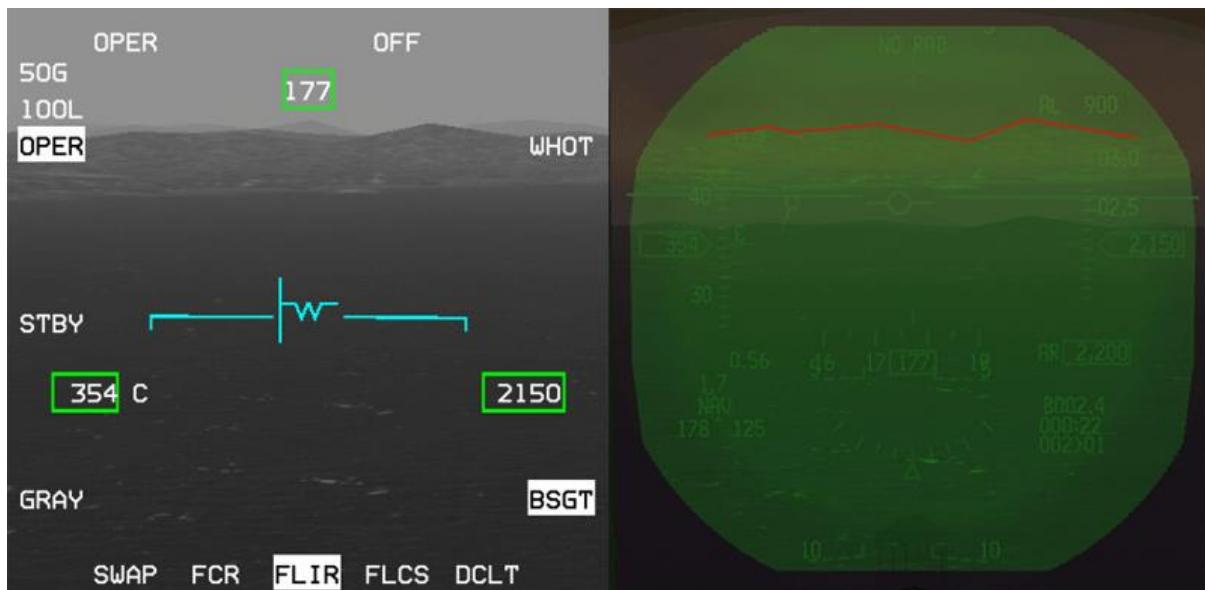
The FLIR image on the HUD should be correctly aligned with the HUD image. But in case of misalignment it is possible to boresight the FLIR image on the HUD. We will do so immediately after we get airborne.

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 nice 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 next 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 in a series of multiple checks that don't take longer 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 limits warning of the TFR 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 limits:  
HUD: LIMIT displayed and speed scale flashing – verify also that the MAN TF box is displayed.  
MFDs: a yellow TFR LIMITS square is flashing.

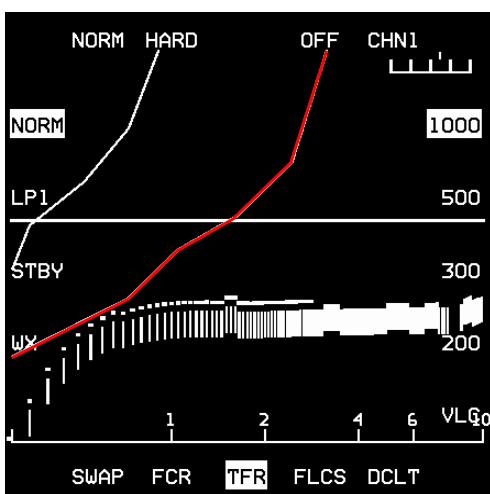


- Accelerate to 400 kts and check that the LIMITS disappear past 360 kts
- Bank past 60° and verify LIMITS again.  
MFDs: yellow LIMIT squares flash.  
HUD: LIMIT flashes and MAN TF box disappears if the bank is held for more than 2 seconds.  
You may have noticed the airspeed scale does not flash because 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 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 of 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 happen in AUTO TF and in MAN TF if the MANUAL TF FLYUP switch on the FLCS panel is placed in ENABLE. A normal fly-up will occur at 75% 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 degrees pitch attitude to prevent a possible stall. Pilots will have to 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's override.

### 8.3. TFR LET DOWN CHECK

We will now test the more aggressive 3 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 warnings fly-up occur  
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 the 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:

- 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 & 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% less than SCP: 450 feet. Ride is set to HARD and the TFR is set to MAN TF. We will ingress to the target in AUTO TF so once established on SCP 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 automatic terrain following is only commanding pitch to the aircraft (unless in blended mode). The pilot remains in control of the 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.

As you may have noticed during your TFR checks the weather has worsened. Kunsan was under FAIR weather but the conditions are now POOR and as you fly to Steerpoint 4 you will go in and out of INCLEMENT weather.

Rain is a problem for the TFR because it degrades the radar conditions and you may start to get fly-ups even before you see the rain. Your first cue of rain when using the TFR will be a weird looking TFR MFD with scattered radar returns like that on the screenshot to the right. Whenever you are in severe weather you should switch the TFR to WX (Weather) mode, either by pressing OSB 16 on the TFR page or simply by pressing the WX button on the ICP. If you don't use the WX mode the TFR will constantly try to fly-up to avoid the rain drops. Once in WX mode the TFR radar return will display the terrain radar return in a fluid curve again and resume normal operation.

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

SNAPLOOK may be selected by holding DMS UP and moving the cursors. The cursors can move the view vertically by 9° from FLIR boresight. Laterally the cursors can move the FLIR image by 25° of the FLIR boresight. This can be used to check the terrain to the left or right of the aircraft prior to turning. When you release DMS the FLIR reverts to boresight.

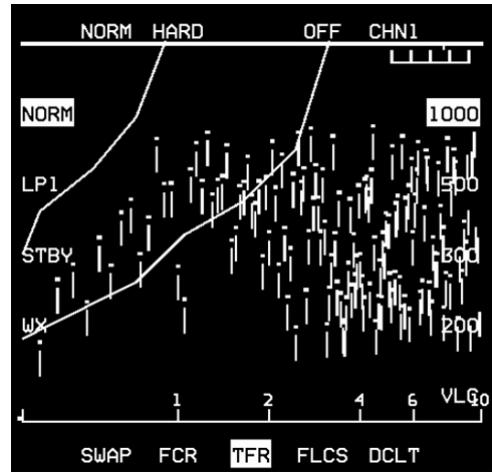
LIT will be commanded if the bank angle is more than 5° and DMS UP is held. The FLIR LOS will move the FLIR image in the direction of the turn. When releasing DMS the FLIR will revert to boresight.

Whenever the FLIR image on the HUD is shifted the FPM will change appearance to a dashed FPM indicating that the image is offset.

Enroute to Steerpoint 5 you are flying low level at night in bad weather. Nobody would like to be alone flying in these conditions but you are and the enemy manning the air defences at target will certainly not expect you.

Flying in AUTO TF you let the TFR manage your altitude (set at SCP) and 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.

The TFR will also indicate the direction of the terrain higher than your SCP when flying around mountains.



If you don't override fly-ups they will terminate at a pitch angle of 45° (or when reaching 300kts). The TF will FAIL and pitch authority will be given back. If you don't take proper action from any of these conditions, 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 & fast and override fly-ups as soon as you are at safe altitude.

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 4.33 Avionic Checklists located in your *Docs* folder contains a section for TFR and FLIR for quick in-flight reference.

## MISSION 9: IN-FLIGHT FAILURES

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

**CONDITION:** F-16 block 42 – Single ship - Callsign Doom 4.

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:** Fair turning Poor, Winds 340/13 kts.

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

**Do not use Freeze mode in this training 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 4.33. The whole PFL and other warning and caution systems have been re-written much more realistically. Unfortunately or fortunately depending on your point of view BMS 4.33 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 4.33.

The BMS Dash-1 and Dash-34 go into more depth about the new 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...

**1<sup>st</sup> 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 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 on 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 thus 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 will use air or 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 draws 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.



BIT1		CLR		
	TOF	004	1	10:21
	MC04	326	2	12:30
DTE	MC13	326	2	12:30
	EGI	009	2	12:30
	IFF	030	2	12:30
	IFF	046	2	12:30
FCR	IFF	131	2	12:30
	IDM	001	2	12:30
	RWR	018	2	12:30
SMS	RWR	021	2	12:30
				14825
				TGP
INS				FINS
RSU				TFR
	SWAP	TEST	SMS	HSD DCLT

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.

**2<sup>nd</sup> 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.

**3<sup>rd</sup> 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. The HYD/OIL PRESS light indicates a problem with hydraulic pressure. 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 at 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 situation 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:  
Gear – Wheel braking – Nose Wheel Steering – AR 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.

**4<sup>th</sup> fault:**

The GPS bus failed and while you could reset the GPS switch on the AVIONIC 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 the INS/EGI reliability. Fortunately your flight will be short and you probably will not notice any INS drifting.

**5<sup>th</sup> 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 always 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 accordingly before you start drifting.

**6<sup>th</sup> fault:**

You contact Fukuoka tower on 125.5 and request QNH and an emergency landing. Coming from TOYOTA IAF you have the choice to shoot a straight-in ILS Runway 19 or 01. Wind is from the north-west so landing on 19 will have a tailwind component. Runway 01 is better for the winds but you have to fly around the airbase, increasing your time airborne. It's your call.

Setting up the ILS you may notice that the TACAN bus failed as well. No problem as we are close to the airbase and the INS works. Even with a TACAN failure the ILS will work.

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 but hopefully 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 take 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 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: 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.
- 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.  
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: Man In the Loop (MITL) Weapons (will be published later)

Mission 17: A-A IR missiles (will be published later)

Mission 18: A-A Radar missiles (will be published later)

Mission 19: Guns Guns Guns (will be published later)

Mission 20: Helmet Mounted Cueing System (HMCS) (will be published later)

## MISSION 10: AIR TO GROUND GENERAL PURPOSE BOMBS

**LOCATION:** North of KOTAR.

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

GW: 36594. 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: F 0755LT ILS RWY26 TL140 200/2KT 9999 FEW080 28/23 Q1013 NOSIG

**GOAL:** Strike 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, therefore 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.

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). We will come back to this later.

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 for up to 3 units or in a specific SUU-20 container that is loaded up automatically by the arming screen 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 9. We will release these weapons in pairs allowing us to train 6 types of delivery patterns.

## 10.2. Delivery methods

There are multiple ways to deliver GP bombs. The most 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 pipper switches to a delayed mode; more information on this later. When in CCIP the FCR is in AGR (air to ground ranging) mode and unavailable to the pilot. CCIP is mostly used when the target is easy to acquire visually and in a slight dive so the target remains in the HUD field of view. The pilot places the pipper 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 in level, in a slight dive or even for lofting the bombs, most of the time at preplanned 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 toss the bombs to the target it's mostly a mode used in a dive to allow visual target acquisition but where the pull out of the dive happens before bomb release (because of the 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 and LADD in BMS is not fully implemented.

MAN mode is fully manual and uses backup manual or standby reticles. It's 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 you will turn 90° to the right to fly to the target. We will illustrate different methods to release the GP bombs at different targets on KOTAR. After each pass you will have to fly back to the IP to follow the instructions for the next delivery method.

Obviously you should set your aircraft systems accordingly 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 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).
- 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 horizontal 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 (306.8). Simply use the Tower menu with t t 1 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 arming delay of 4.58 seconds. Exit the CNTL page by pressing CNTL (OSB 5) again.

Finally press OSB 2 to select the CCIP submode. 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 target and acquire the target.

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 pipper directly on your intended target unless you are very close. Place the target on the bomb fall line and let the pipper walk through it. Once the pipper 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.

Once the bombs have cleanly separated execute a Climbing Safe Escape Manoeuvre (CSEM). It's a 5G pull in 2 seconds to the horizon leading to 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.

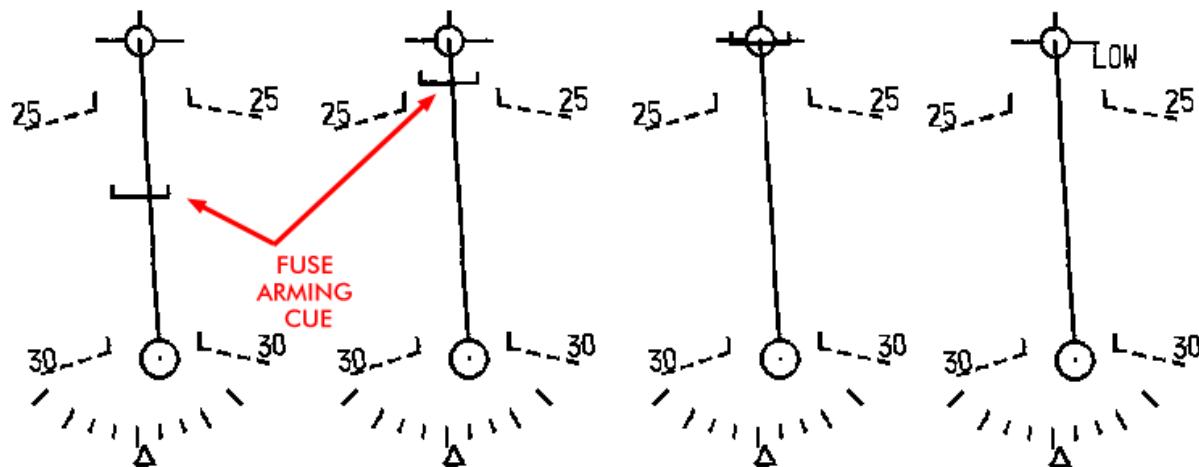
While we are flying outbound setting up for the next pass let's discuss fuses and arming delays. As you noticed there is a fuse arming cue on the bomb fall line (see screenshot on the next page).

The fuse arming cue provides anticipation as the aircraft approaches minimum altitude for proper 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 fuzes 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 dropping bombs.

A-G	CCIP	INV	CNTL
		RDY	12 BD33
		AD 4.58SEC	PROF1
NOSE			1 PAIR
			175FT
			RP 1
SWAP	HSD	RDY	SMS S-J



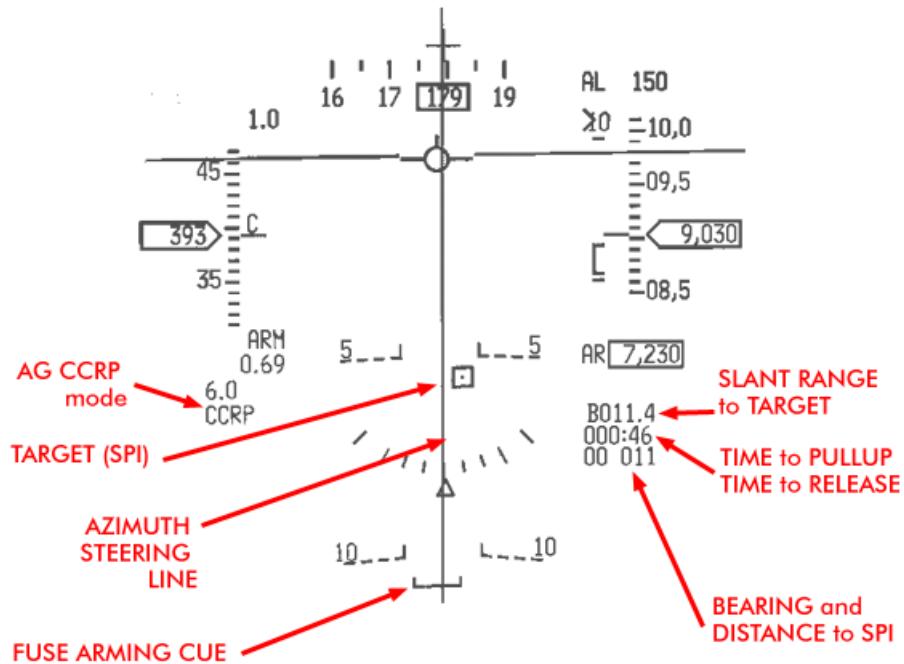
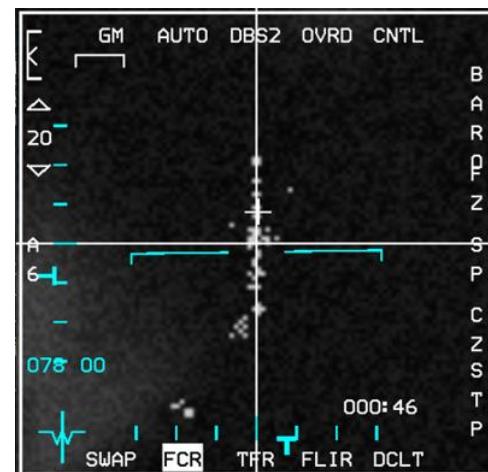


### Second pass: CCRP

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. The structures are now 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 loft solution cue; the second one is the level solution cue.



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°. To ensure consistent release when lofting it is advised to change it to 30° as this is more reliable.

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 automatically released. If they don't, the parameters weren't met and the system inhibited release.

Alternatively the loft solution cue can be ignored and CCRP made in level flight.

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

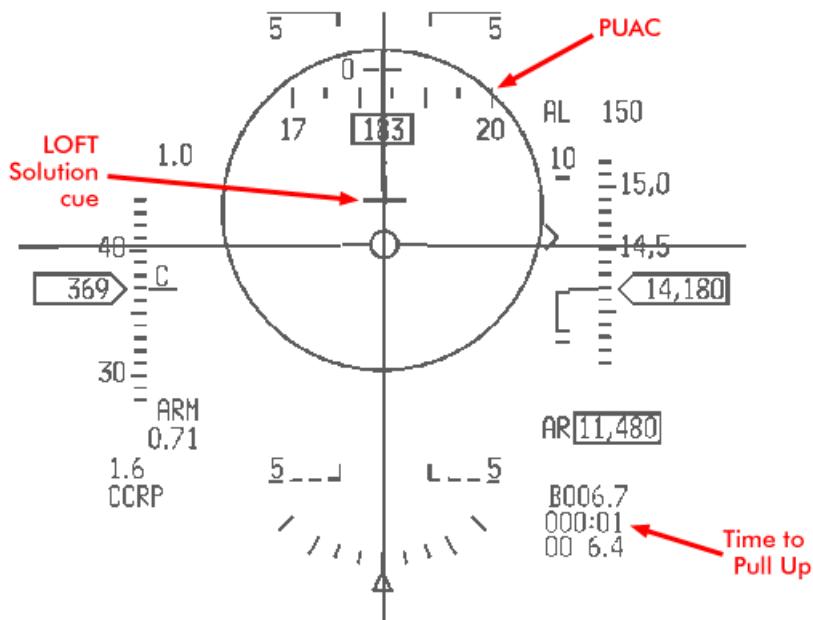
drop. It is important in BMS not to depress the pickle too long in advance to ensure that the command is not disrupted by any other factor. Try to give consent just a few seconds before the drop point. It is also better to fly a slight dive to ensure a good consent.

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 a level flight, the target will disappear under your nose.

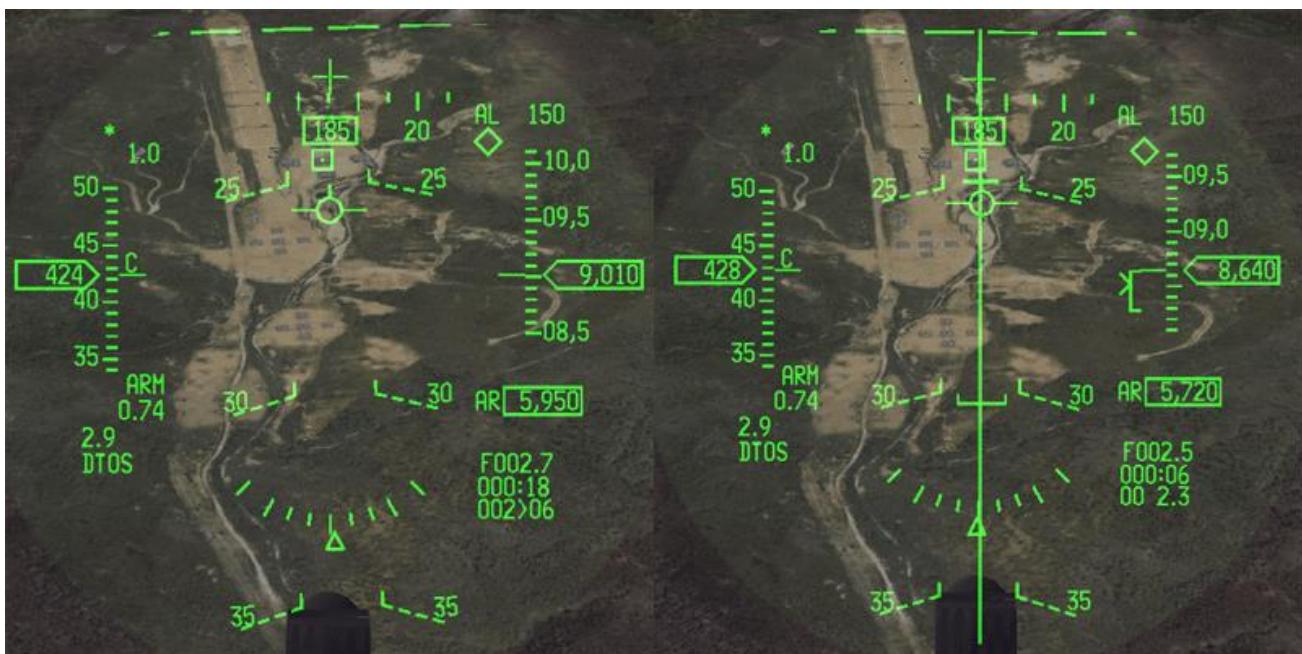


So usually a good target acquisition is made at short range in a slight dive to have the target within the HUD field of view.

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. You can also slew the TD box within the HUD FOV with the cursors. Move your 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). Maintain the FPM on the azimuth steering line. Pull out of your dive and as you pull, the release cue will descend towards your 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 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 drop.

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.

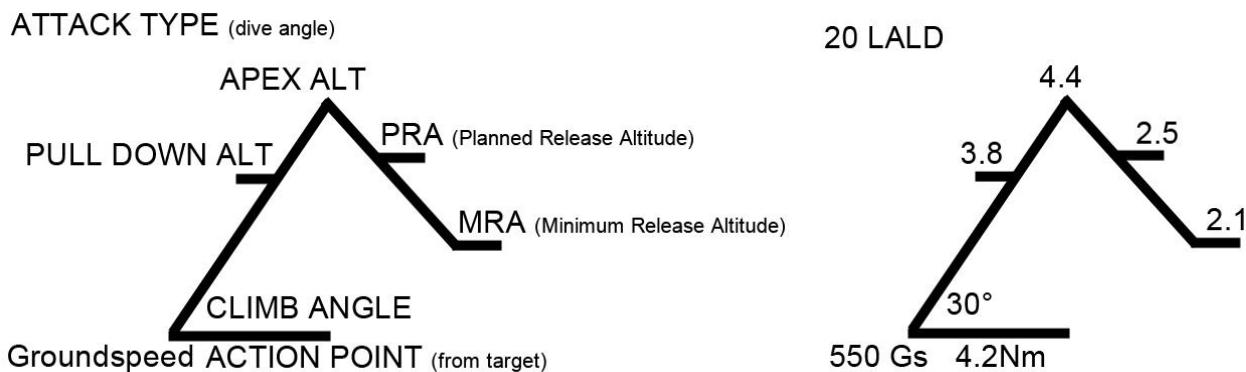
### Fourth pass: Popup

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 minimize 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 without relevant 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 also conditions the climb angle. It is Dive angle +5° for less than a 20° Dive and Dive Angle +10° for a dive of more than 20°. 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 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 by MRA come off dry.



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

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 into the MSL FLOOR of the A-LOW UFC page. This ensures Betty will call ALTITUDE when reaching MRA. We don't use the CARA ALOW because the radar altimeter will most likely blank during a pop-up due to its operating limits.

Reaching IP1, turn towards the range and accelerate to 550 kts GS 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 the target, especially during the pull down phase. The target steering line of the CCRP mode ensures we always know where the target is. It's an invaluable help in the pop-up. CCRP also provides an accurate range to target which is used for the action point.

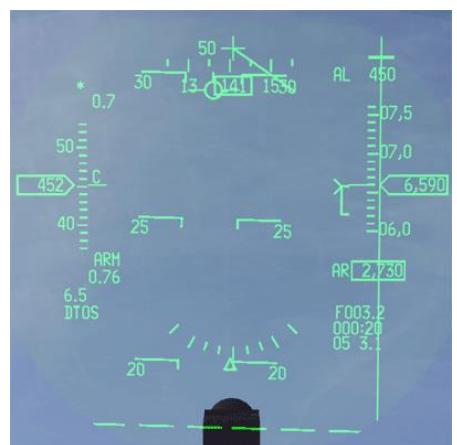
Just before reaching the action point at 4.2 Nm from the target execute a hard level turn 30° left (top picture). KOTAR is just visible behind the mountain. As soon as you're established on a 150° heading pull 3-4G to the 30° pitch line. If the target is defended with SHORADs you would now initiate release of a countermeasures program 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 gross 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 (2<sup>nd</sup> & 3<sup>rd</sup> 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. 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 limit.

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 pipper. 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 pipper 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 draw 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 error during pop-ups is failure to commit the numbers to memory (bad planning) and flying approximate numbers, ending in an out of parameters pop-up.

Navigation accuracy may also be an issue, such as incorrect initial altitude or speed or 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.

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



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 are two versions of this training mission available. The first one starts in flight so laser codes are identical for both aircraft (1688) and can't be altered. The second version starts at Ramp to be able to document different laser weapon codes for different aircraft. The laser weapon codes are set in the LOADOUT screen for all bombs and can't be altered once the flight has departed, just as in real-life.

**LOCATION:** In flight somewhere inside DPRK West District airspace.

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

GW: 39280. 4 GBU-12. Laser code: 1688 (in flight) or 1511/1512 (ramp). 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:** Clear skies, light winds. NOSIG

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, 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 there is 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 4.33 we only have both airborne laser options available. With 4.32 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 numeral code:

- The weapons have a code which is set in the UI LOADOUT screen prior to flying. That code is inalterable in flight and **must** be set correctly for each flight member before hitting the FLY button. Please note it is not saved with the TE so it **always** has to be set manually before the flight.
- The TGP code is set with the ICP on the LASER page (LIST 0 5). That code can be set differently in flight to allow guiding different weapons; your own by inputting your bomb code as the TGP code or any of your wingmen's when you input their weapon code as the TGP code. 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 with the 'M-SEL 0' key.



The arming screen is a bit tricky when you have to set different configurations amongst flight members. You don't really know which one is selected. By default when you enter the arming 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 displayed flight member 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.

Unfortunately weapon codes are not saved with the TE yet so the TE designer cannot pre-set the laser code. As a consequence this procedure always needs to be done before committing to 3D.

If you chose the in-flight option for this training mission the laser code will be the default 1688 for both aircraft and can't be altered. But if you chose the ramp option you will be able to set weapon bomb codes. Your first mandatory step before flying is to click on LOADOUT and setup the laser codes.

Unselect the wingman and check that only lead is displayed in green. Then click on LGB Laser Code which by default is 1688 and change it to 1511. Click the SET CODE button to apply your change. Then select the wingman and unselect lead. Only the wingman is displayed in green. Change 1688 to 1512 and click the SET CODE button to apply changes. Exit the arming screen by clicking the OK button.

It's important to realise the difference between starting on the ground and starting in the air. The chapter below will assume the ramp option was chosen. If you selected in-flight, just use the default 1688 laser code.



Laser guided munitions are general purpose bombs fitted with a laser guidance kit allowing them to track the 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 first ballistically to 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 method is automatic; the TGP will fire the laser at a specific time before weapon impact. That time can be changed in the LASER page by selecting the LASER STArt TIME. By default it is 8 seconds but it is advised to set it to 16 or 20 seconds for better accuracy. Indeed the sooner the bomb steers towards the target the better chance of target hits, especially if the target is moving.

In both occurrences the L symbol in the HUD and on the TGP page will flash when the laser is firing. The LASER switch in the cockpit (MISC panel) obviously needs to 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 at its 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 never perfectly placed on your DMPI (Desired Mean Point of Impact) but rather the general area 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 the target Steerpoint 7 will be placed exactly on your DMPI. That will ensure that your sensors are looking exactly at this point when Steerpoint 7 becomes active.

You can also note down the coordinates of the target which are displayed at the top left of the recon windows. That 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°48.440' E126°14.748' and find a suitable attack heading, e.g.: 360°.

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

The in-flight scenario training flight starts about 10 Nm from the IP (STPT 6), which is 15Nm from your target. Weapon loadout is 4 GBU-12 Paveway II 500 lbs bombs loaded on TERs on stations 3 and 7. If you selected the ramp start scenario perform your ramp routine and you can set your systems on the way to steerpoint 6.

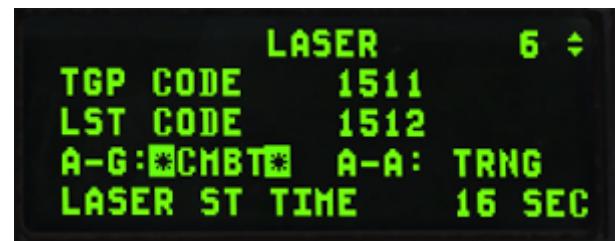
We will use the flight to IP to configure the jet correctly for striking the target. Fence in, set MASTER ARM to ARM and select A-G master mode. We would also normally turn the exterior lights off but it is a training mission so that is left to your own discretion.

With the master mode in A-G the FCR page is displayed on the left MFD and you probably have the HSD on the right one. Make sure you have the TGP setup on another Direct Access Button on the left MFD and quickly check that it is operational. When initially selecting the TGP page it will be in STBY mode. Depress the A-G mode and the TGP should look at the currently active steerpoint (IP), which is overwater. Hit OSB 5 for the control 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 for GBU-12, single release and standard arming delay.

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. As above to guide a specific weapon you must ensure that the TGP code matches the weapon code. Dobber up until the TGP code is highlighted by the scratchpad and enter the relevant 4 digit code then hit ENTR. (1688 if you chose the in-flight TE and 1511 if you're lead of the ramp TE or 1512 if you are flying the wingman of the ramp scenario). The second line is the Laser Spot Tracker (LST) code. This will allow your TGP to detect and track another TGP's laser spot. We can set it to the TGP code of the wingman (1512). We will come back to this later on.

A-G laser can be set to TRNG (Training) or to CMBT (Combat) mode. A weapon will only guide to a combat laser. Therefore before releasing weapons ensure that the A-G LASER in the UFC page is set to CMBT. Select that line with DCS and once highlighted press any ICP key to toggle it to CMBT. Please note 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.



And finally we can also change the default auto laser time. It's normally set at 8 seconds, which is a bit on the short side, so dober down to that line and enter 16 seconds. That will ensure that the laser will fire for final guidance of the bomb 16 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 not guide and just fall ballistically. 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 onboard sensors switched to that spot as well. SPI (System Point of Interest) is now implemented in 4.33. This greatly improves multi-sensor correlation (FCR, TGP) but can be very confusing 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 INS/EGI steerpoints from 1 to 25 (i.e. including bullseye).

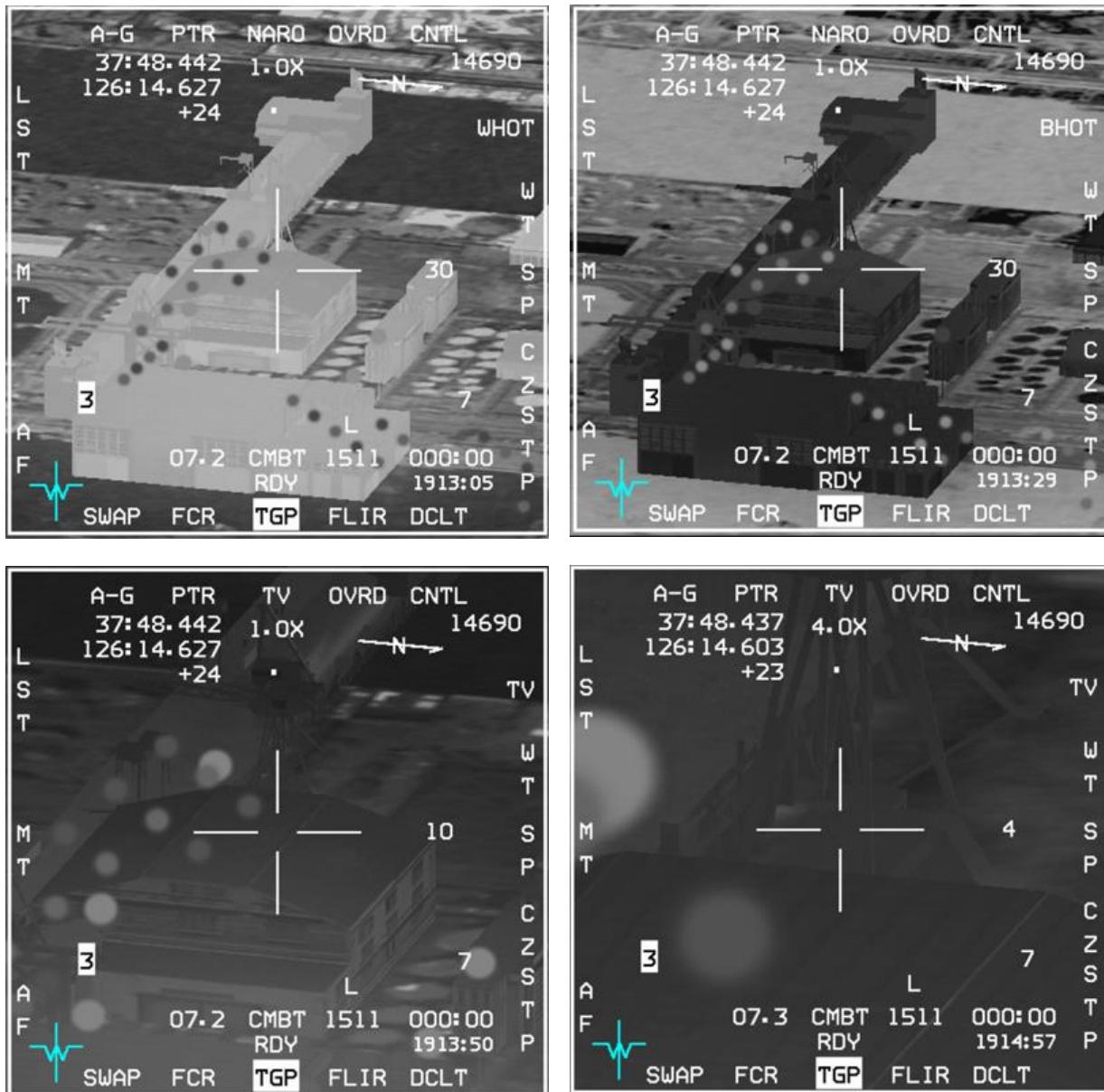
Basically if you slewed your TGP cursor 2 Nm from its default position and forgot to cursor zero, all your flight plan steerpoints will have the same 2 Nm offset. Or worse if you have to attack a secondary target at another steerpoint the offset will still be active when trying to locate the next target 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 the HUD cues will point differently to either the original steerpoints or the SPI according to master mode. The steerpoint diamond may be on the steerpoint and the tadpole may point to the SPI in NAV mode for instance. **It is very important therefore to cancel any cursor slew with Cursor Zero (OSB 10 – highlighted when slew active) when 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 on SPI management in the relevant chapter of the BMS1F-16CM-34-1-1. It is a **must** read.

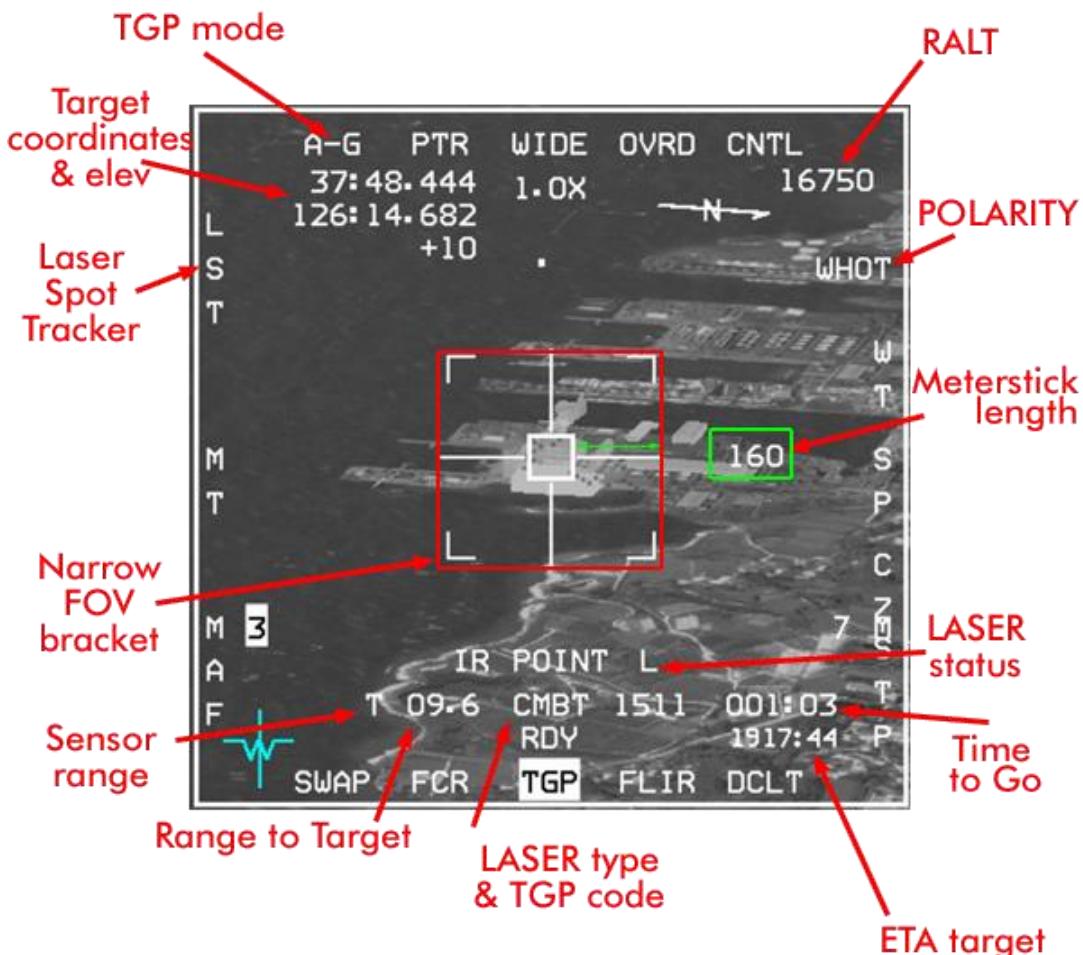
Switch the left MFD to the TGP page with DMS left or by depressing the relevant OSB on the base page of the MFD. If TGP is not Sensor of Interest (SOI) DMS down to make it SOI and ground stabilise the TGP with TMS up. The laser will only fire if TGP is SOI.

By default the TGP is 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 options BHOT and WHOT are Infrared and usable day and night by picking up targets according to their temperature. The TV mode is a daylight mode that offers a greater zoom capability using the MAN RNG knob on your throttle (if set up correctly).

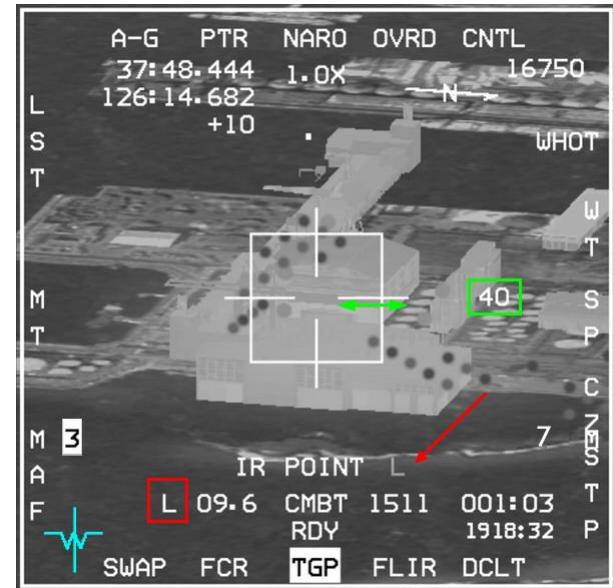


The TGP page displays a great deal of information that is explained in detail in the TO-BMS1F-16CM-34-1-1. Let's concentrate on the items that are relevant to us for this training scenario.

- The Narrow Field of View brackets show the area you will see magnified when you switch to NARO FOV with OSB 3.
- 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. 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 required, manually ranging the target with the laser is always advised. Please note when you pickle the bombs the laser will automatically fire 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. Notice the meterstick length is now 40 meters.



There are two more settings that are not that relevant to this training scenario but we will take a few moments to illustrate them:

- As we discussed earlier the target coordinates, the north pointer and the meterstick distance 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 as you noticed on the earlier pages it is smaller in NARO FOV (60 meters). Meterstick is 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) where a FAC could transmit target coordinates and then direct the strikers to hit something at a specific distance and bearing from the given coordinates. In such occasions the meterstick and the north pointer are invaluable tools.

- Another interesting 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 and when selected opens a third menu on the right with distances from 95m to 1609m.

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 danger close distance of your weapon. You can then display distance from SPI and 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 slightly move 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 the CCRP release cues.

We are not lofting the LGB therefore we can ignore the first CCRP release cue and continue flying level till the level cue nears the FPM. Pickle is depressed 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 heavy 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 and left and right regulates roll trim, which is what we need in this scenario. Please 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 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 asymmetrical, the aircraft will roll towards the heavier right wing and a little left trim will be needed to maintain level flight.

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 is also left of the TGP and at some point may 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 does not obstruct our target anymore. When the time to go indicates 16 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. The offset 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 accordingly. In this example we will simply refine the cursor position on the crane until bomb impact.

After bomb impact turn back towards the south and fly 20 Nm from the target. In the next exercise 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 asymmetrical condition.

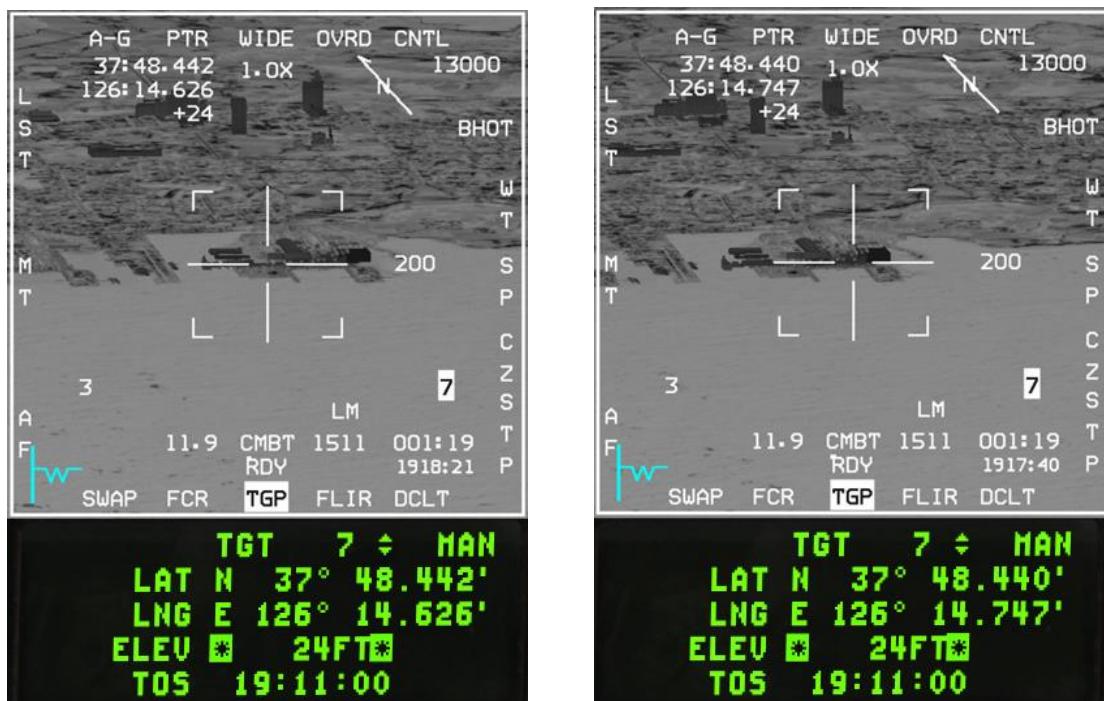
Remember: SPI remains where you last moved the cursors. You always want to cancel any unwanted cursor slew and reset the SPI back to the original steerpoints. To do this you must perform the following routine:

- TMS down (to cancel any lock 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 look at the target, preventing capture from a long distance. In a low level LGB loft manoeuvre target capture may very well happen after bomb release. The good thing is that since the bomb is lofted bomb fall time is usually longer than level release from medium altitude, allowing more time for target capture.

To maximise 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°14.768'. Enter these in the UFC Steerpoint page for Steerpoint 7, not forgetting to start with the ICP '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.

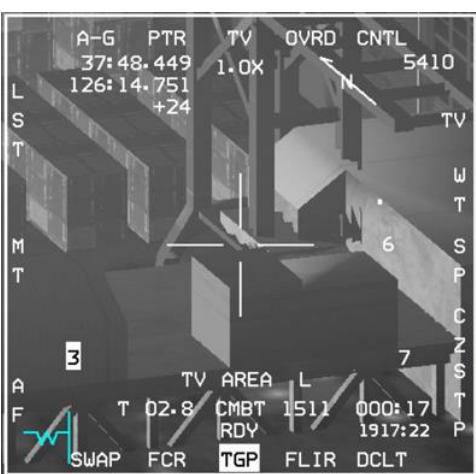
We could decrease the release angle in the SMS CNTL page but in this scenario we will just wait until we are 5 Nm from the target to pull up. That will maximise our Pk (probability of kill) and make bomb release easier.

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. That is what we call 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° off target 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.

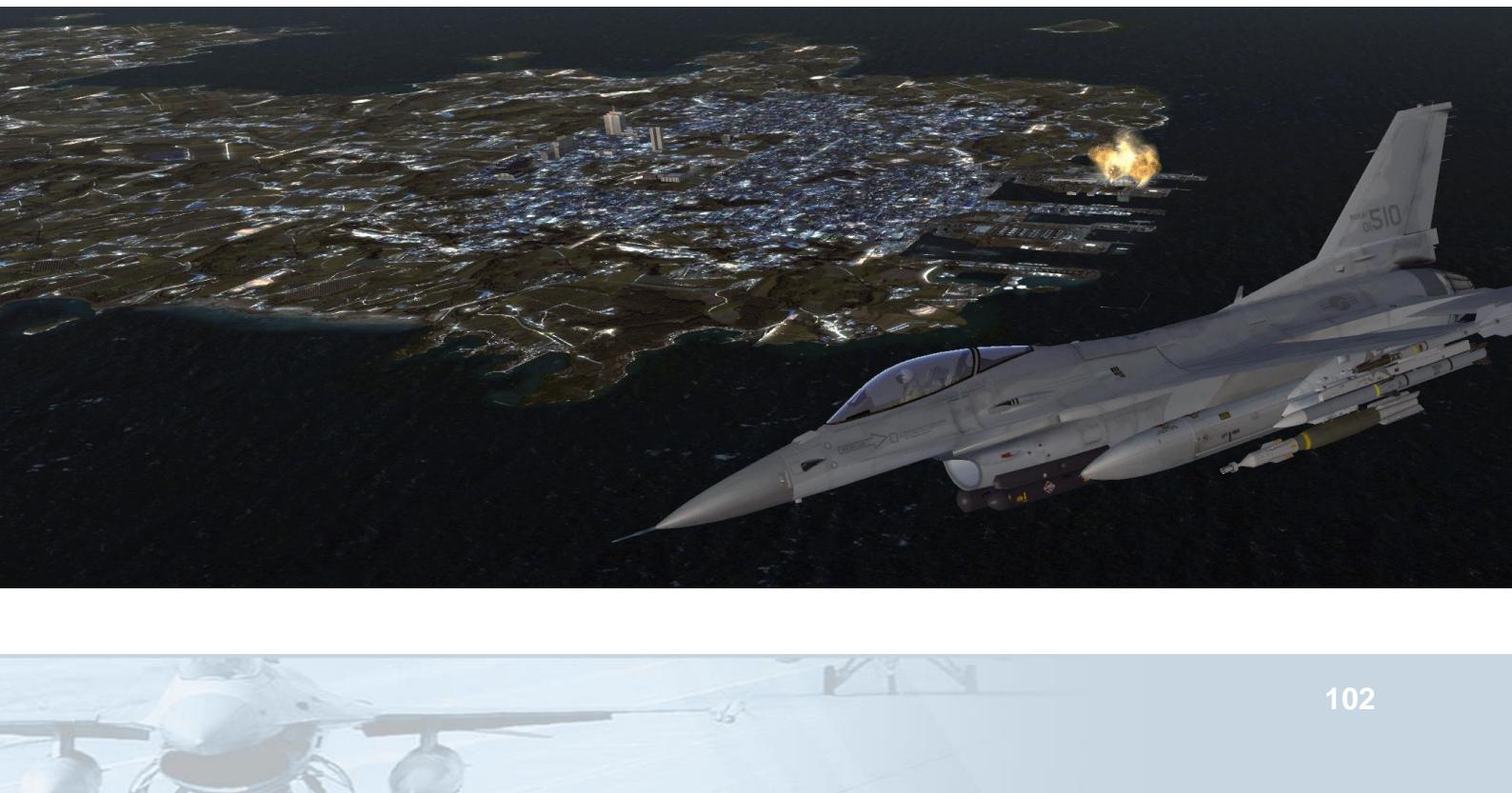


Once attitude is under control switch your attention to the TGP display and refine the cursor position at the base of the red crane.

When the counter hits 16 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 the usual TMS down, Wide Field of View, Cursor Zero. This procedure needs to be practised until it becomes second nature.

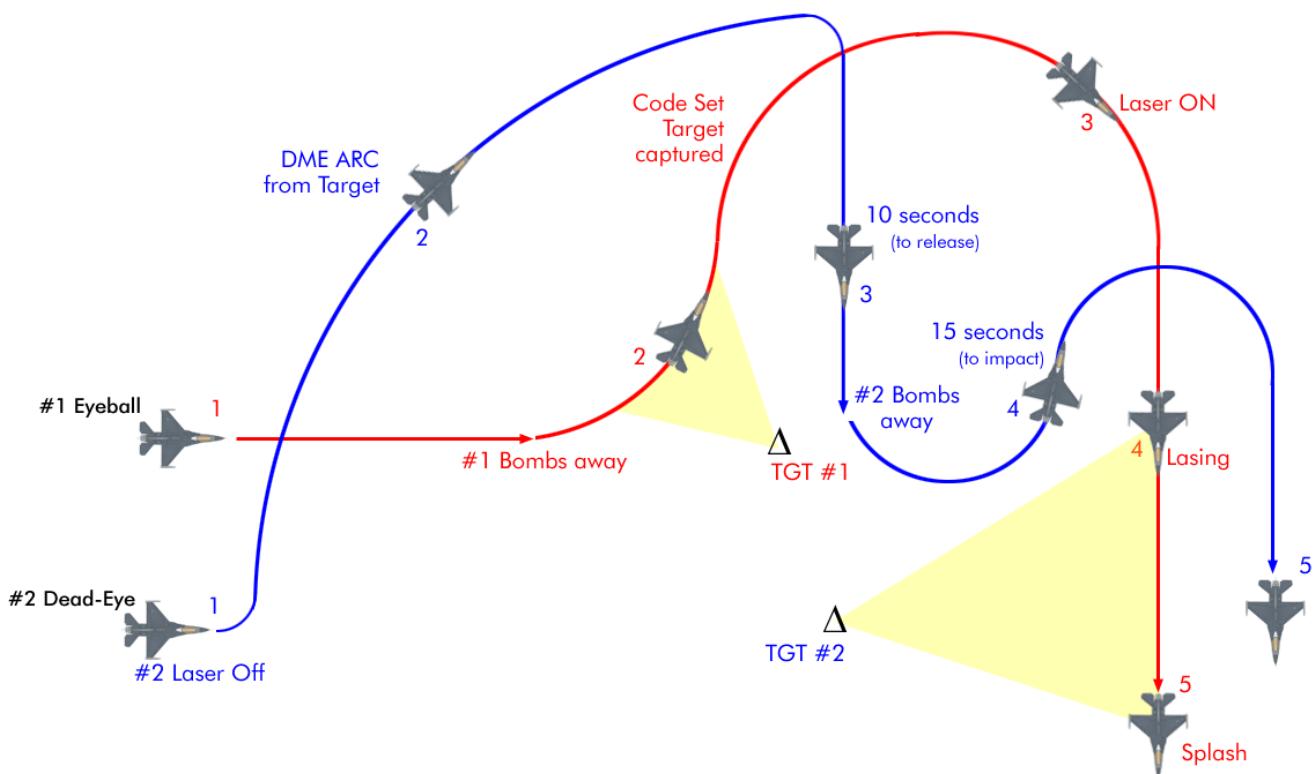
You have two more bombs to release. If you are training in single player practise some more GBU releases on the target. If you are training in multiplayer let's see how we perform buddy lasing in BMS.



## 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 lost yours. You may have another F-16 flying as a FAC (Forward Air Controller), lasing or pointing out targets to your strike flights.

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 such a scenario it is advisable to have one aircraft turn its laser 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 the eyeball (laser on guy) and the wingman will be the dead-eye (laser off guy). This is one way to do it:

At the action point the wingman turns the LASER ARM switch to OFF and turns into his lead, arcing 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 of course). 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 the target lead changes his TGP laser code to his wingman's bomb code (1512 in this case) and captures the wingman target on his TGP. He calls: "Vandal 3-1, code set - 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".

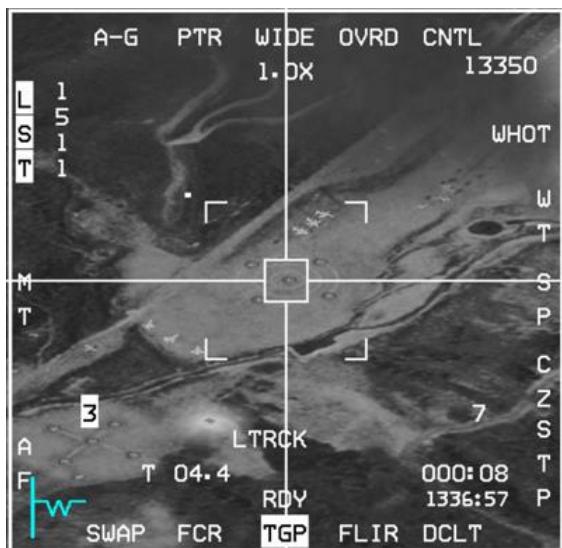
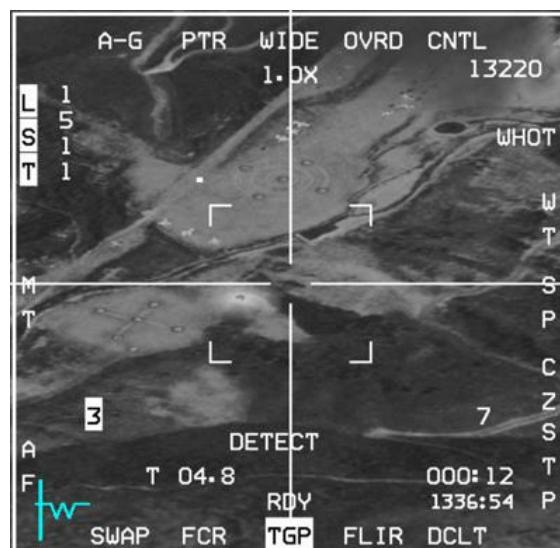
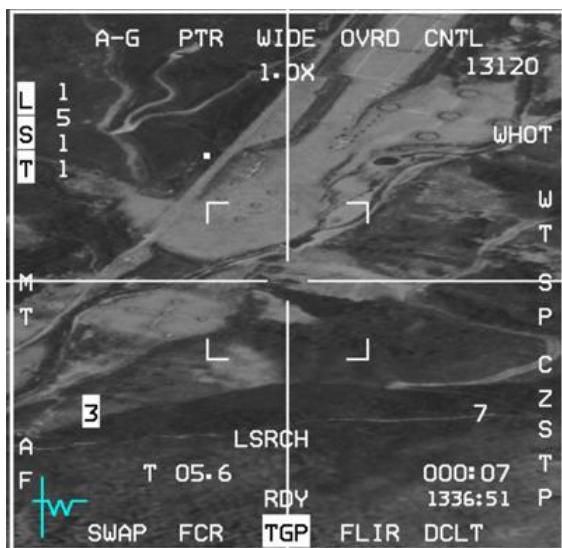
Lead can now start manually lasing the target with the first trigger detent and refines his aimpoint if necessary until bomb impact.

## 11.4. Laser Spot Tracker (LST)

Laser Spot Tracker allows your TGP to search for another station lased target if you know its laser code. It is very convenient when you want to know which target your wingman (or a FAC) 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 laser code.

Then simply press OSB 20, labelled LST on the TGP page. The LST mnemonic highlights and the laser code entered in the Laser Spot Tracker UFC line is added next to the LST mnemonic. The TGP enters LSRCH (Laser SEARCH) mode. It looks for a laser spot corresponding to 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 other's aircraft 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: 38221. 2 AGM-88 HARM missiles, HTS 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:** Clear skies, light winds. NOSIG.

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) mode. 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 block 50/52 and block 40 F-16s can carry it and therefore can use HAD mode.

The other F-16 models can either load the HARM missile as a standalone weapon (F-16 block 42, 52+ (these two because they can carry the LANTIRN pod suite), 30/32 & 25) or cannot carry the HARM at all (F-16 block 15 & MLUs). When the F-16 carries the missile without a HTS pod, only POS and HAS modes are available.

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

- With the HTS the pod is the main sensor. HAD page is able to detect which mode the air defence radar is using through coloured or flashing symbols. You can then be more confident your missile will guide on an emitting radar. 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. The 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 by reckoning the target area for this flight.

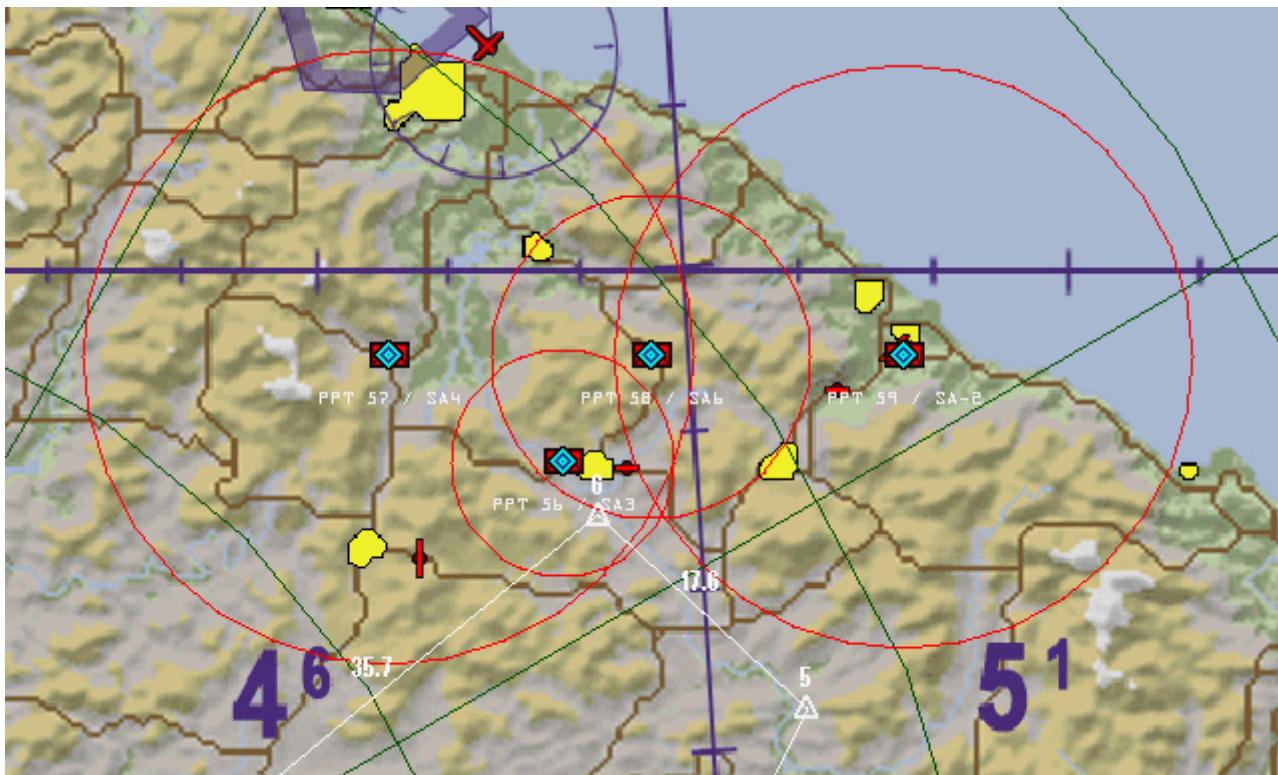
We have two target points at Steerpoints 5 and 6. Multiple air defence radars are marked on the map with PPTs (Pre-Planned Targets) and their associated WEZ (Weapon Engagement Zone):

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) Straight Flush search, acquisition & missile control ('6')

PPT 59: SA-2 (fixed) Spoon Rest search and acquisition ('S') & Fan Song missile guidance ('2')



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 fixed targets (the SA-2 & 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 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 (HOTAS MSL STEP). 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 well known, making it a pre-planned attack mode.

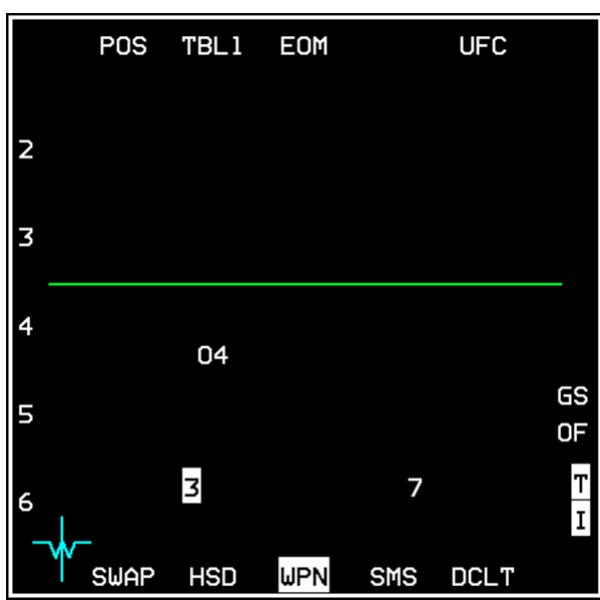
In POS mode the missile is not fired at a radar but at a steerpoint. It is programmed to start looking for a specific radar type at a certain distance from the steerpoint and if the radar is emitting the missile will target it. If the radar is not emitting the missile will hit the coordinates of the 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 onboard RWR may provide cues 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 submodes: 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.

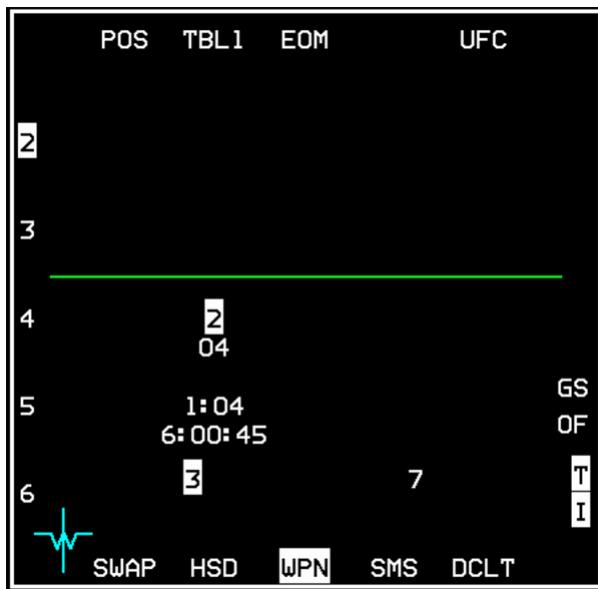
- Equations of Motion (**EOM**) is the most accurate POS submode. The seeker is activated with a narrow 40° field of view 5 Nm from the known threat position. This mode should only be used when the location of the emitter is well known (i.e. collocated to a steerpoint).
- Pre-Briefed mode (**PB**) is 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°.
- Range Unknown (**RUK**) is an opportunistic and self-defence mode. The seeker is activated straight after launch with a 120° FOV. Used when range is unknown in self-defence from specific threats.



The weapon page in POS mode is divided in two parts by the launch status divider line (LSDL – green line). Pre-launch information will be displayed below the LSDL and post launch information will be displayed above the green 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 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 threats but the steerpoint is always the UFC selected steerpoint.

We can step the missile and select the other AGM-88 on station 7 with the MSL STEP button and handoff an SA-3 threat type. Stepping through the stations will then toggle between an SA-2 and an 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 steerpoint before firing the second missile.

There are multiple ways to change the active steerpoint. If you remember the PPT number your target is assigned to; simply use the STPT page of the UFC and enter the PPT number.

**STPT #59# MAN**  
LAT N 38° 14.927'  
LNG E 128° 54.390'  
ELEV 22000FT  
TOS 06:00:22

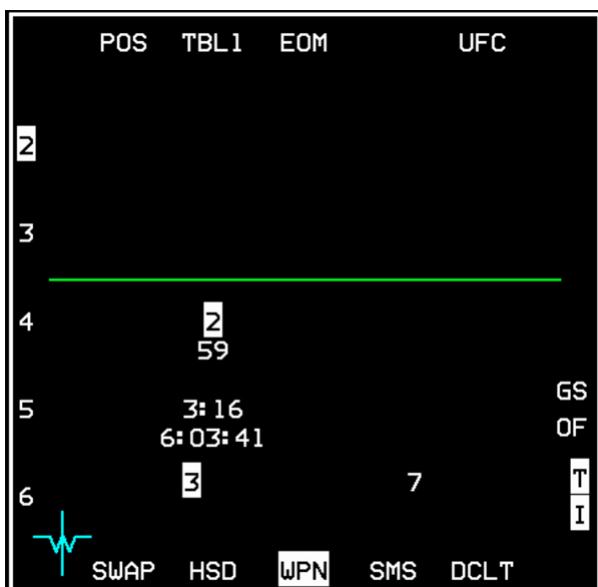
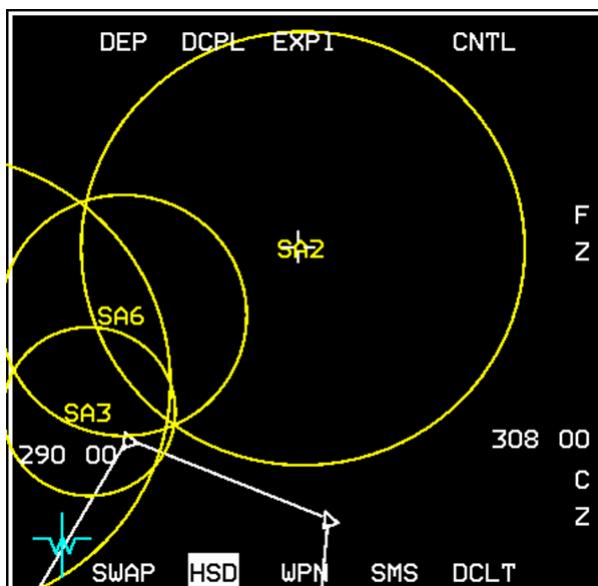
If you don't remember it select the HSD page, make it SOI and move the cursor to the intended target at the centre of the threat ring. With the cursor just above the threat symbol press TMS up. That will make it the active UFC steerpoint. The relevant PPT number will be displayed on the DED.

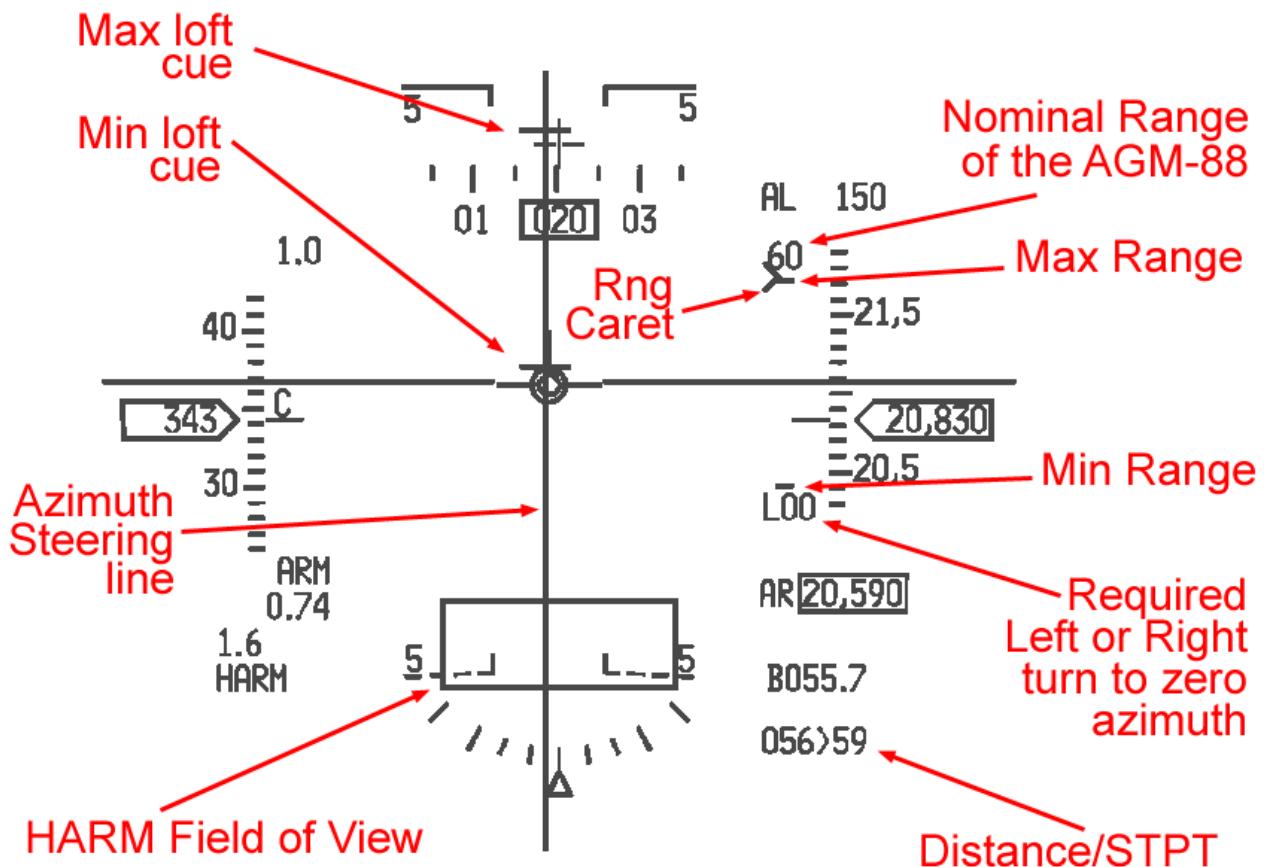
Remember that all your other sensors are pointing to that steerpoint now, including your INS. If you are flying with the autopilot in steering mode the aircraft will immediately turn to the new steerpoint.

In the WPN page the Steerpoint, TOF (Time of Flight) and TOI (Time of Impact) are replaced accordingly.

The HARM missile is capable of Mach 3+ speeds, has a missile motor burn time of about 45 seconds and a nominal range of about 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 submodes. In EOM the FOV is 40°; in PB and RUK it's 120°. The HUD HARM FOV will be larger in PB/RUK. The above picture illustrates the POS/EOM shot we are about to take on the SA-2 at PPT59.

The range of the missile depends on the launcher aircraft 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 documented to have a nominal range of 60 Nm (displayed on the top of the range bar right of the HUD). Although 60Nm 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 necessary.

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 zero degrees then the HARM missile will need to manoeuvre and that will decrease its range. The ASL is similar to the CCRP steering line and the HUD also provides indication for left or right turns in tens of degrees to zero the azimuth should it be necessary.

The SA-2 is still 56 Nm away and we are way outside its threat circle. We will close a little bit more, wait for a missile time of flight of two minutes and fire the HARM.

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 submodes:

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 directly after launch and look for the pre-set handoff threat (in this case SA-2) with a 120° FOV.

RUK is a self-defence mode when you expect specific SAMs to be along your route. There is no point using POS/RUK when you do not know which SAM may pop up along your flight path as the missile will only look for the threat type that was handed off.

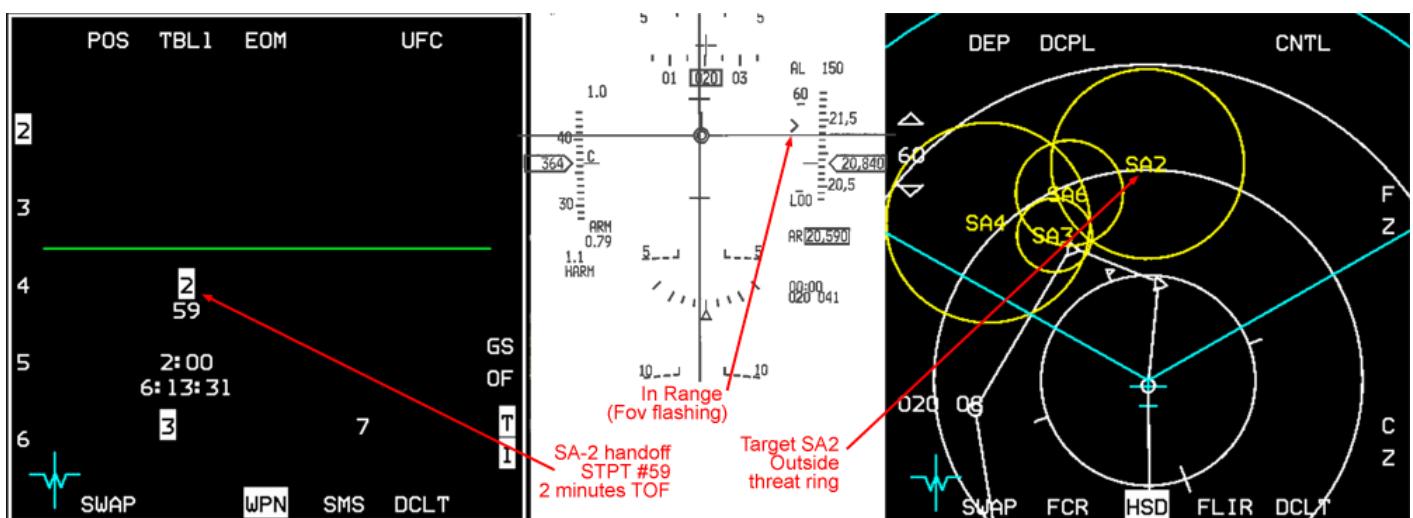
A further press on OSB 3 or the pinky switch selects PB (Prebriefed) mode. The seeker will activate 15Nm from the active steerpoint with a FOV of 120°.

The WPN page is identical to the EOM submode.

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 of the target location.

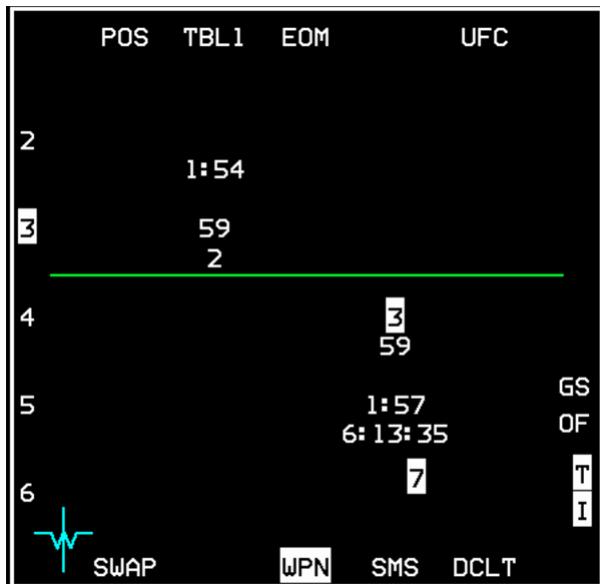
Both PB and RUK POS submodes are not optimally coded in the current BMS version and the most accurate POS mode remains EOM at this time. I would advise you stick to POS EOM until the other two submodes are optimised. The PB mode doesn't offer much over EOM and RUK mode is incomplete as if you want to be ready for unexpected SAM popups you want a self-defence mode that is not limited to a single threat type.

Let's switch back to POS EOM. The SA-2 is now 40 Nm away and we are well within range.



Press the pickle button and keep it depressed until the missile is away. A radio call on UHF is required: "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 an 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 at PPT56. 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 (assuming it is radiating). The SA-2 SAM 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 to the weapon 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.

As in 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.

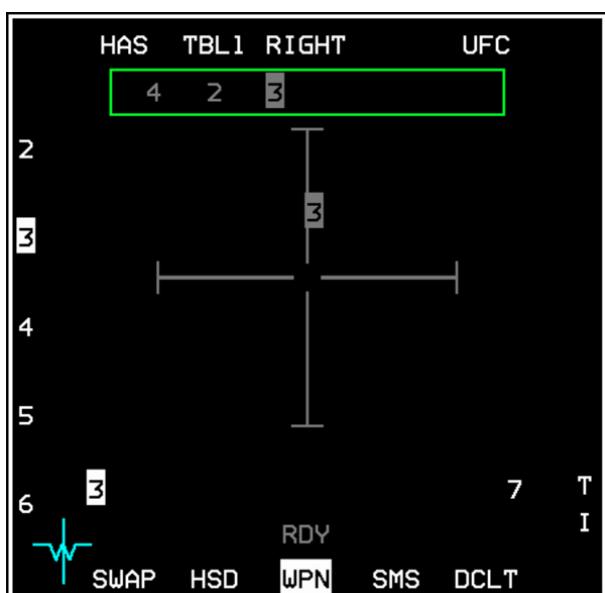
The DTB (green rectangle on the top of the WPN page) lists detected threats.

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 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 the selection is complete depress OSB 1 labelled 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 DTB 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.



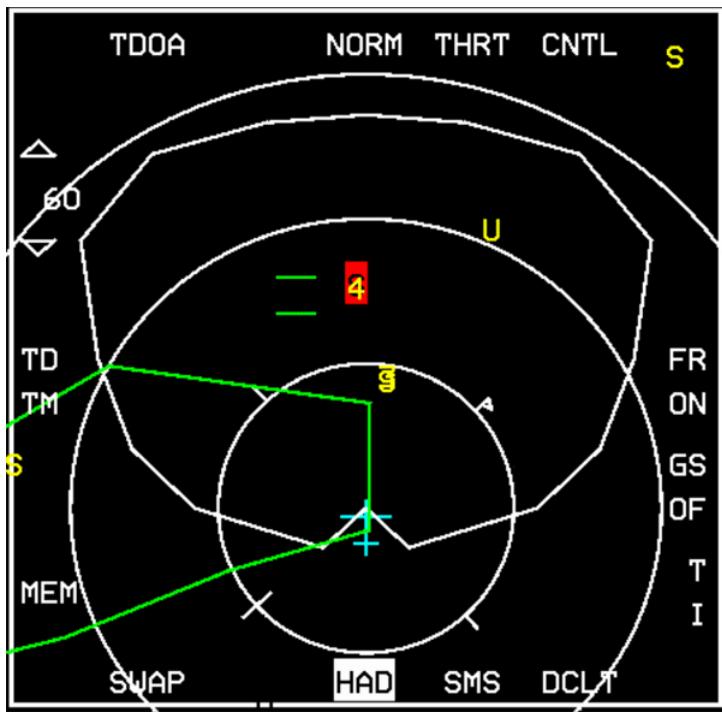
In this case we handed off the SA-3 to the missile. The handoff is complete as RDY is displayed. Note that OSB 3 mnemonic still mentions that the HARM is looking right as we handed off the threat from the RT side of the HAS display. Although not visible on the MFD the SA-2 and SA-4 radar are still emitting.

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 in range must be deduced from the HSD and PPT threat rings. As we have only one missile left if we fire we will lose POS/HAS symbology. 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 the 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.

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.



The HAD page looks similar to the HSD but has the capability to display radars in different colours according to their status.

HAD range can be managed with OSB 19 and 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 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 in range.

If the HARM WEZ is greater than the HAD selected range the footprint will be dashed, indicating that all visible threats are in range.

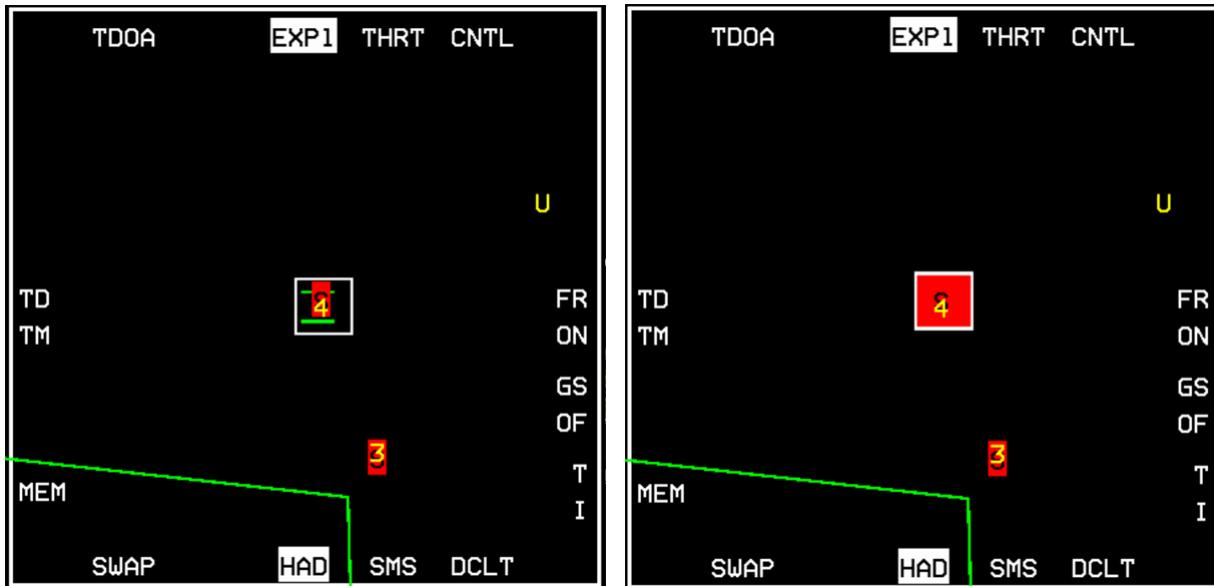
The INS flight plan is displayed in green. Unfortunately the HSD PPT and their invaluable threat rings are not displayed in the HAD page. Quick toggling between the HAD and the HSD page can therefore be useful.

The displayed symbols change colour according to their emitting state:

- Steady yellow: Radar is emitting in search mode.
- Steady red: Radar is tracking (acquisition).
- Flashing red: Radar is guiding a missile (missile launch).
- Grey: Radar is not emitting.

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' and select option '1' Attack my Target. The AI wingman will break away and fire one of its HARMs at the Low Blow radar.

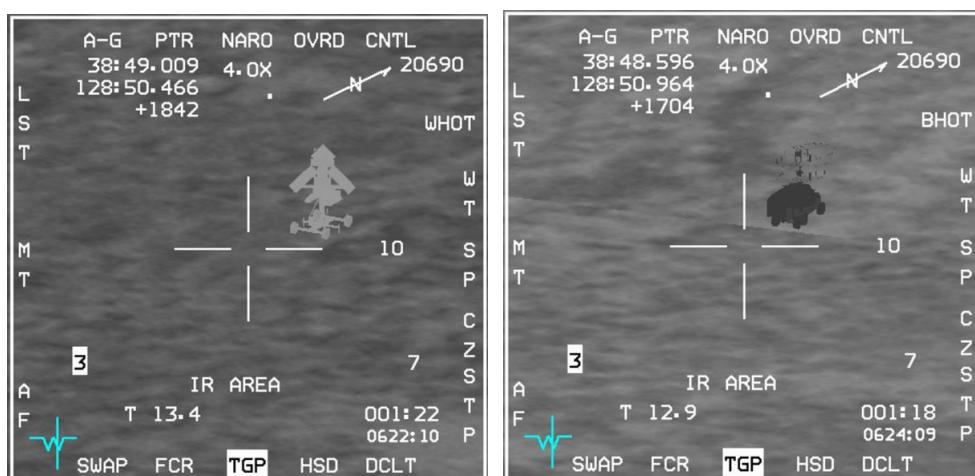
Note how both the SA-3 and SA-4 have a double symbol displayed on the HAD. Both have an 'S' symbol almost superimposed on the '3' or '4' symbol. The S stands for Search and is the search and acquisition radar of the SAM site; a Flat Face for the SA-3 and a Long Track for the SA-4 SAM site. The search 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 with 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 is not. The SA-3 is in the same configuration.

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 has the Long Track in tracking mode and designated. Both are valid shots but only the right scenario will render the SAM site harmless.

It is therefore important to know the capabilities and the configuration of the enemy air defences battalion before engaging them. The left most TGP image shows the Low Blow SA-3 radar seconds before being destroyed by the wingman. The other picture shows the SA-3 search radar: Flat Face.



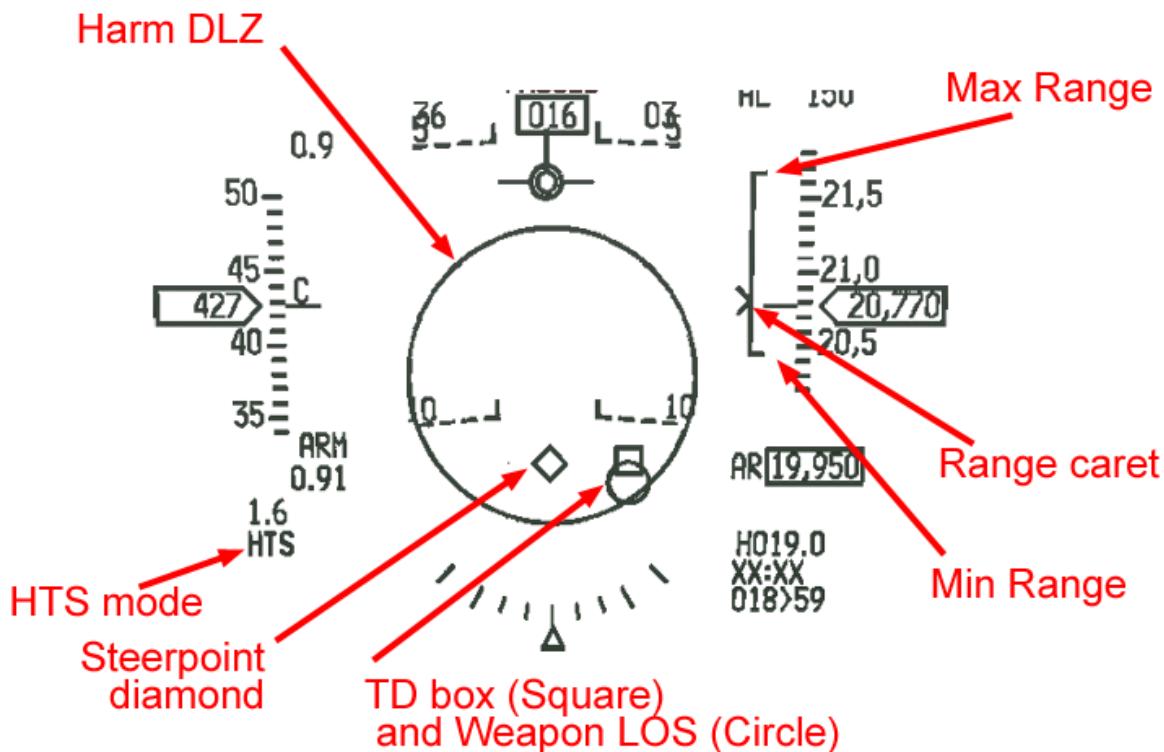
It's a truck and the rotating antenna on top of it, although quite large, is hard to see making it difficult to find at long range as there are other similar trucks without the antenna in the battalion.

The Low Blow blows up before we enter its WEZ and we can now concentrate on the SAM-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 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 with 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 SA3 and SA4 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 radar even after having fired all our anti-radiation missiles. Once designated with the HAD page, the HUD will display the TD box, marking the position of the moving radar.



If you select the TGP and move the SPI the steerpoint diamond will move in the HUD as well. To find the SA-6 radar with the TGP place the steerpoint diamond (SPI) on the HUD TD box (HAD lock). This is very useful if you need to pass target coordinates to other flight members or direct attack with other weapons on a target.

In this scenario designating the SA-6 radar with the HAD and instructing your wingman to 'Engage my Target' would have been sufficient to target it with the remaining HARM.

Unfortunately we were too close and too slow and the SA-6 fired. It's time for another training mission: Missile Evasion!



## 12.4. SEAD / DEAD in BMS

Real life makes a huge distinction between SEAD (Suppression of Enemy Air Defences) and DEAD (Destruction of Enemy Air Defences).

This distinction is not so easy to make in BMS. In 4.32 mission types were either SEAD escort or SEAD strike. In 4.33 these mission types have been replaced with SEAD and DEAD.

In real life, SAM operators are smart and cautious if they value their life and their mission. In BMS they are artificial intelligence and don't have quite the same priorities. They will hardly ever switch their radar off to prevent a rain of anti-radiation missiles on them. Still they are somewhat smarter than before thanks to the efforts of BMS coders. But in 4.33 most HARM shots find their targets making SEAD impossible and DEAD arguably too easy.

POS is clearly made for SEAD while HAD is better suited for DEAD missions (in BMS), but suppression of enemy air defences in BMS is more a simulation within a simulation until the AI SAM operators are made more intelligent. Hopefully that will be one of the big improvements in BMS 4.34.

The BMS team is aware of the compromises with the current version in this aspect but time constraints did not allow them to solve these issues without a complete overhaul of other equally important and related aspects of the simulation.

## MISSION 13: AGM-65 MAVERICKS

**LOCATION:** In flight over the East Sea inbound North Korea.

**CONDITION:** KF-16 block 52 – Flight of 2 - Callsign Rocket 2.

GW: 35572. 2 AGM-65D – 2 AGM-65G – 1 centreline tank. 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 carried only on older blocks and the D/G models are standard on modern F-16 blocks.

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 carried only 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. That means that you can forget all about the missiles once they are in the air. They will guide themselves to correctly tracked targets. Mavericks became much more realistic with 4.33 and now require more 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 wander 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.

### 3. Launch restrictions

The missile is always hot. Even if not in range or outside locking parameters pressing the pickle button will fire the missile. A Maverick launched outside these limits will miss:

- Launch speed: above 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 or be Damaged or Hung.

The AGM-65D and G Mavericks can be fired in 3 different modes:

- PRE for preplanned 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 in the HUD as SOI.
- BORE for boresight. Allows firing on target 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 an 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 we have extensive cloud coverage. 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, as it is the same mission but with clear skies and no wind.

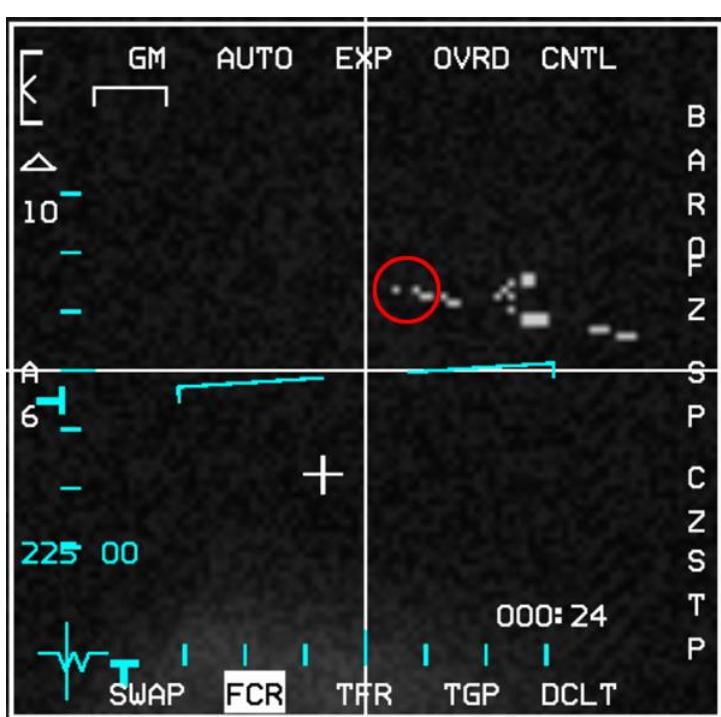
With 4.33 the TGP will automatically load when mavericks are carried. On KF-16 loading the TGP is actually loading both the LANTIRN navigation and targeting pods.

The real challenge of the training mission will be to quickly locate and ripple fire 2 Mavericks at the ZSU-23s at 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 west of the target village. 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 left of the target 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.

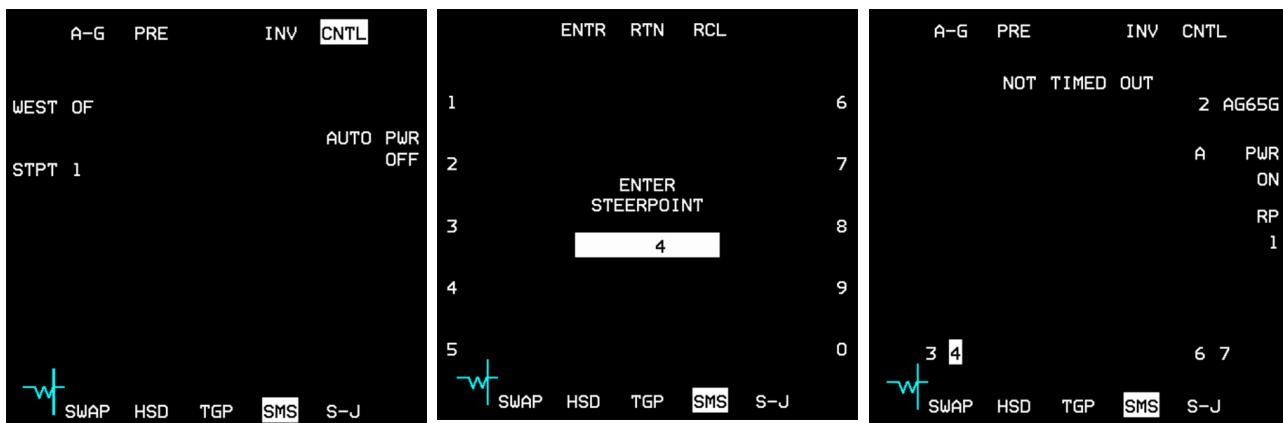
Staying at 500 feet SCP on the TFR may not provide enough time for targeting. 1000 ft SCP might be preferable, but if you fly above mountain peaks rather than staying in the valleys the TFR might fly in clouds, spoiling the attack run. You will have to override the autopilot to stay in valleys under the overcast as much as possible.

To maximise chance 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.

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 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 brings 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 is activated.



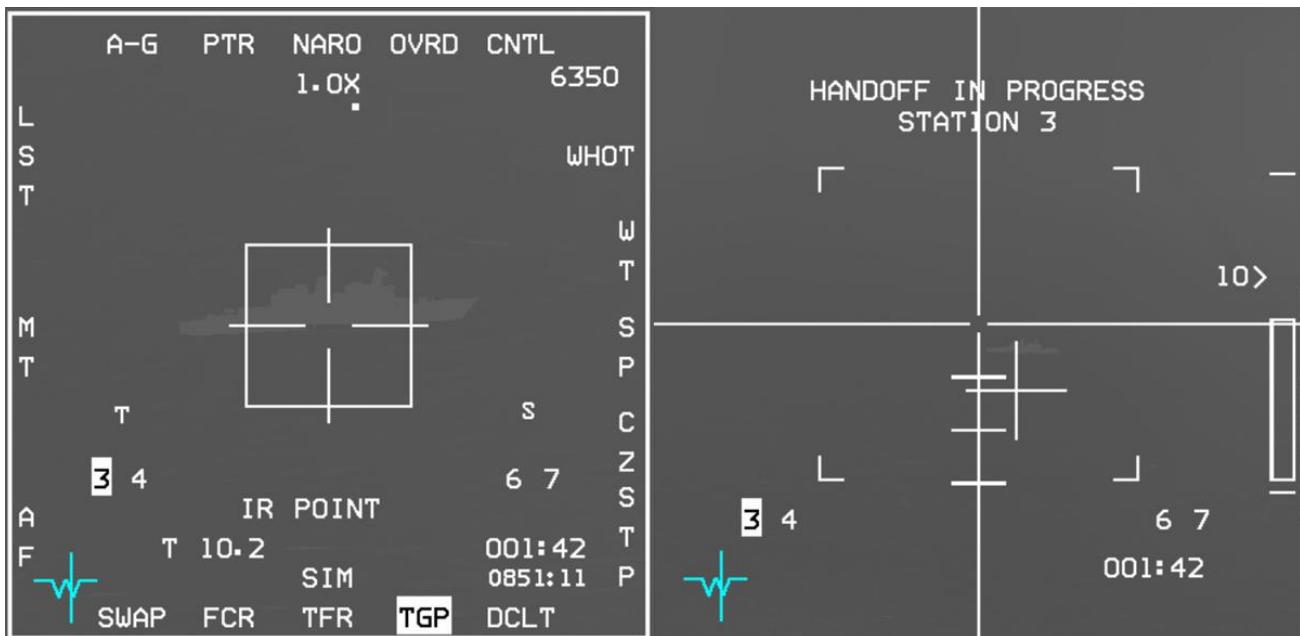
Loading the missiles on their launch rails causes alignment errors that will be visible between the aircraft sensors' LOS and the missile LOS. This misalignment may cause problems when using the Mavericks in PRE mode, where their LOS is slaved to the SPI. To overcome this issue the pilot must ensure that both missile and sensor LOS match. This can be done on the ground at ramp or in flight using both the TGP and the WPN page by ensuring both sensors look at the same spot. This must be done once for each station (i.e. with 3 missiles on a triple LAU-88 pylon you still only need to boresight that station/launcher once).

In this training scenario we plan on using the D models in PRE mode on the moving vehicles and the 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 dome cover 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 the 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 quite fast on a north-easterly heading. Minimise the time between FCR lock up and TGP acquisition or you may lose it. If that happens cancel FCR lock and acquire it again. The better solution is to not 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.

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. The initial handoff will fail because of the alignment error as the TGP and the WPN LOS are not yet pointing at the same spot. The Pilot Fault List will display an AV (Avionic) fault: TGP HANDF FAIL. The MASTER CAUTION light will illuminate soon after.



Ignoring the handoff fault for now move SOI to the WPN page and slew the cursors to the same target as the TGP. Press TMS up to track the target. The fault does not mean the WPN page can't be used, it just means that the handoff from the TGP did not work. When the missile is successfully tracking the target BSGT will appear next to OSB 20. Press it to boresight the missile. BSGT will momentarily highlight. Missile LOS on that stores station is now pointing 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 and you can then designate with TMS up. When the track is valid and BSGT appears press OSB 20 to boresight the second missile.



We must now try to handoff the target from the TGP to the missile again to ensure it works correctly. The quickest way to start fresh is to cancel all locks by switching master mode. Select MRM mode.

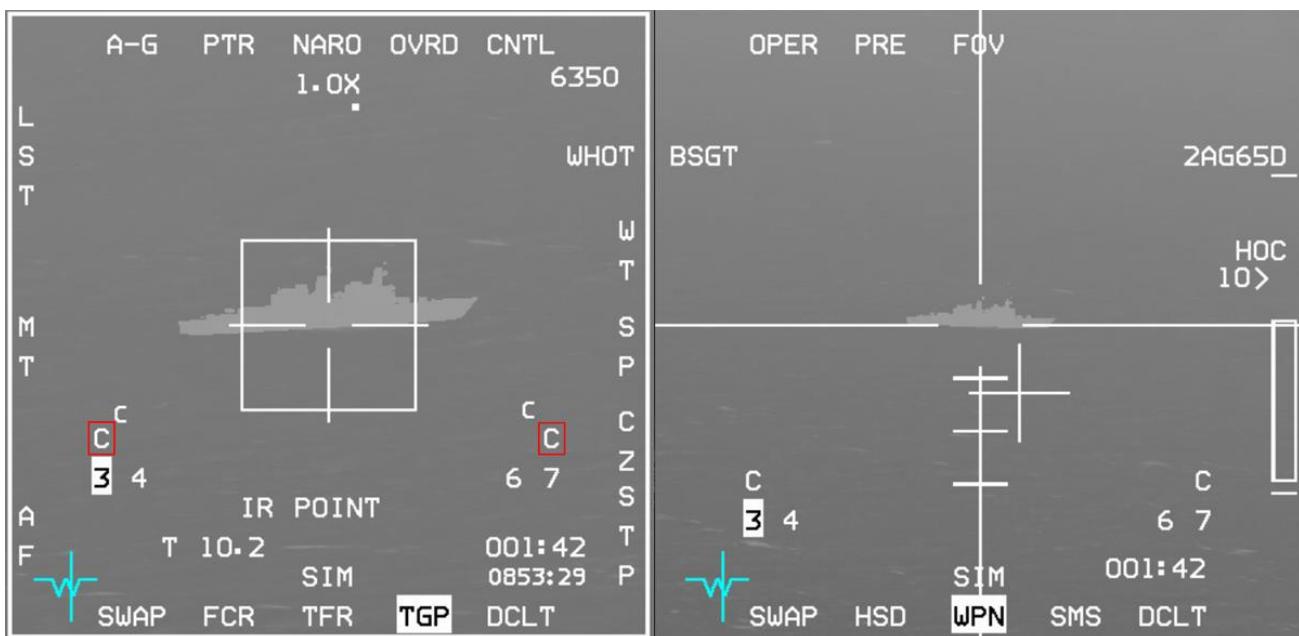
BIT1	CLR	
TOF	004 1	20:12
TGP	018 1	24:39
DTE	TGP 019 1	24:39
		MFDS
FCR		RALT 6358
SMS		TGP
INS		FINS
RSU		TFR
	SWAP HSD TGP TEST DCLT	

Press F-ACK to acknowledge the earlier handoff fault. It will not clear yet as handoff is still in a failed state (it will be until a successful handoff is complete). The PFLD will blank except for the AV mnemonic.

Cancel MRM 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. The 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 complete the TGP page will display a "C" above the stores station number.

As handoff is successful the fault 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. 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 their battery. They will auto 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). 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 and 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 monitor the SMS page and check that the Mavericks powered back on as planned. Set your cockpit for attack: 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.

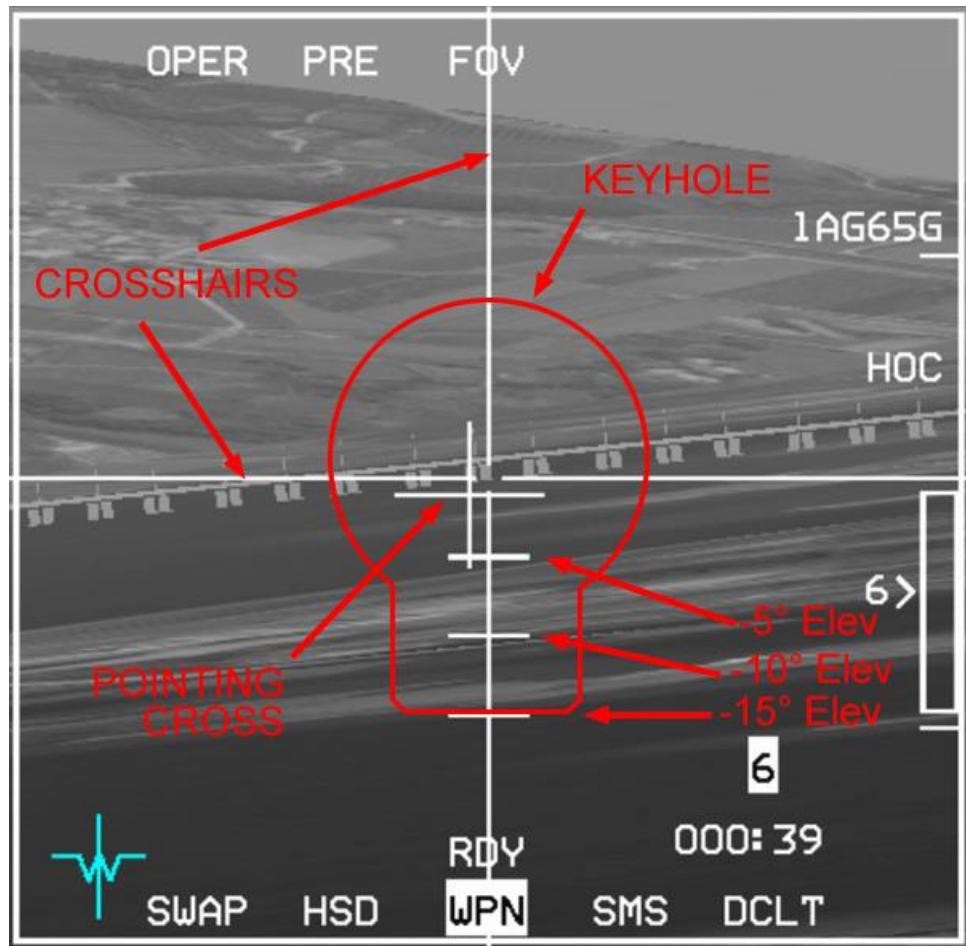
First let's discuss the requirements for a valid Maverick shot:

- 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 after launch.

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.

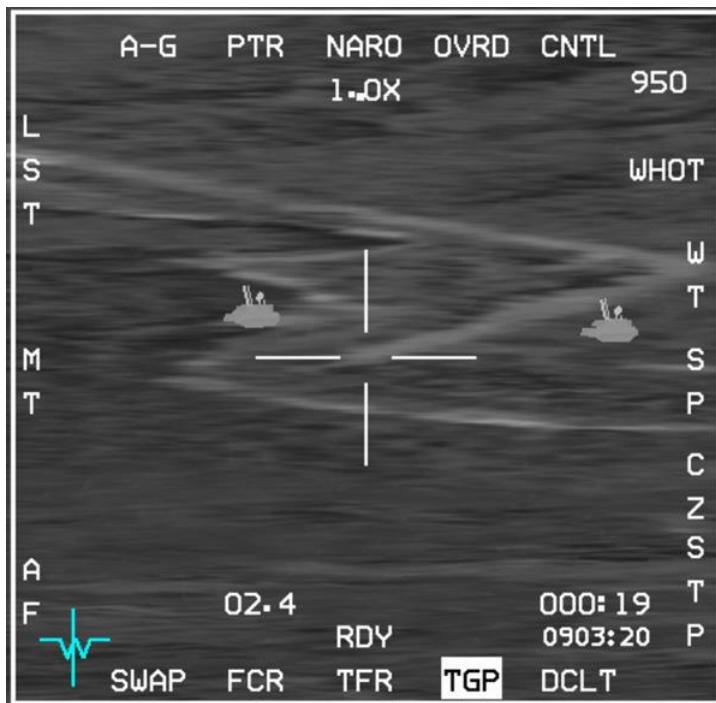
**Having a steady pointing cross is critical to a valid missile track and therefore a good target hit!**

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.

Outside missile gimbal limits should not be a factor in this scenario as we are approaching the target from dead 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 left (west) of the convoy.



Quickly designate the first ZSU on the TGP with TMS up to command Point Track. Notice HANOFF 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 on the sidestick 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.

What is really important here is to note that after boresighting you no longer need to reacquire the target on the WPN page, it is automatic. Target acquisition and lock up 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.

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 destroys 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 however, congratulations. The convoy is now 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 model Mavericks in VIS mode.

Select the two remaining AGM-65Gs with the SMS page and select VIS mode with OSB 2.

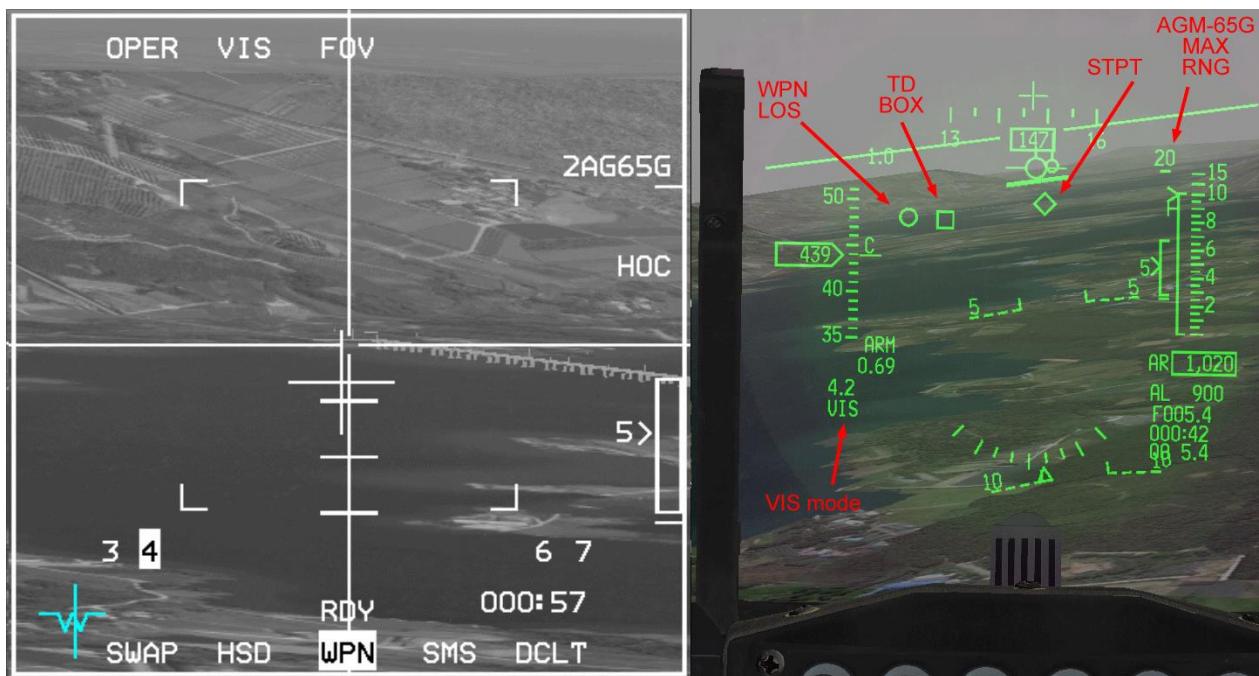
The HUD is made SOI by default, indicated by the asterisk in the top left corner and the TD box is placed on the FPM. You can move the TD box in the HUD with the cursors. Place it on the outer left span of the bridge. TMS up to ground stabilise the TD box and SOI automatically transfers to the WPN page.

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 and 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).

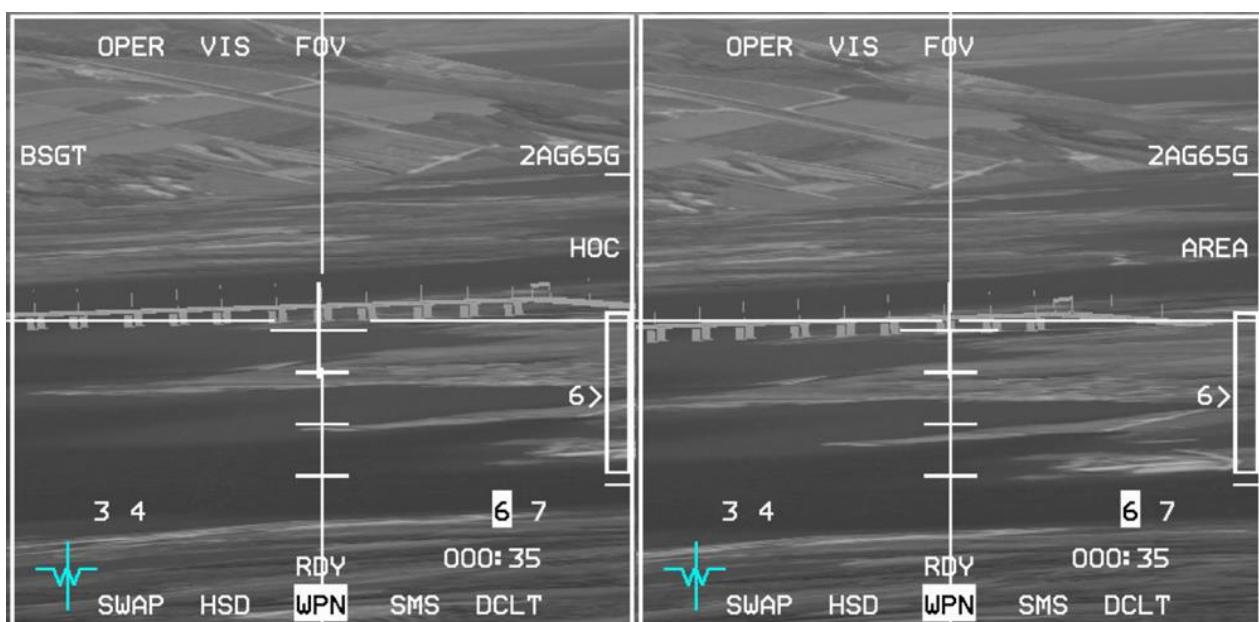
Note: always go to EXP FOV (OSB 3) before commanding track. It significantly increases the chances of a steady pointing cross.



As you have noticed 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 on. Sometimes it may switch LOS slightly because of the centroid track mode of the missile.

If you want more precision and to be able to force the missile to track the exact spot you designated you must use the force correlation track mode available only with the AGM-65G. 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.



This mode is very useful when you want to target specific parts of a larger target such as a building door, a bunker entry or even an aircraft parked inside a hardened aircraft shelter.

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 TE's, 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:	Changes polarity (AGM-65G only)
	TMS right:	Rejects handoff target (TGP SOI) Toggles 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: 42141 Lbs. 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: 40773 Lbs. 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 located at Dalsan HART site at STPT 6.

Air defenses: AAA & SHORAD and SA-3 at target, SA-4 north of target.

**WEATHER:** RKY INFO: B 1825L RWY08 TL140 068/20KT 9999 OVC 070 25/15 Q995.

Inertially Aided Munitions (IAMs) are INS or GPS guided bombs providing standoff capabilities for Air to Ground attack. In BMS 4.33 they are now 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 TO-BMS1F-16CM-34-1-1 located 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 Mechanized 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 mission.

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 4.33: the AGM-154A is most effective against soft and moving 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 Mechanized battalions earlier in the day.

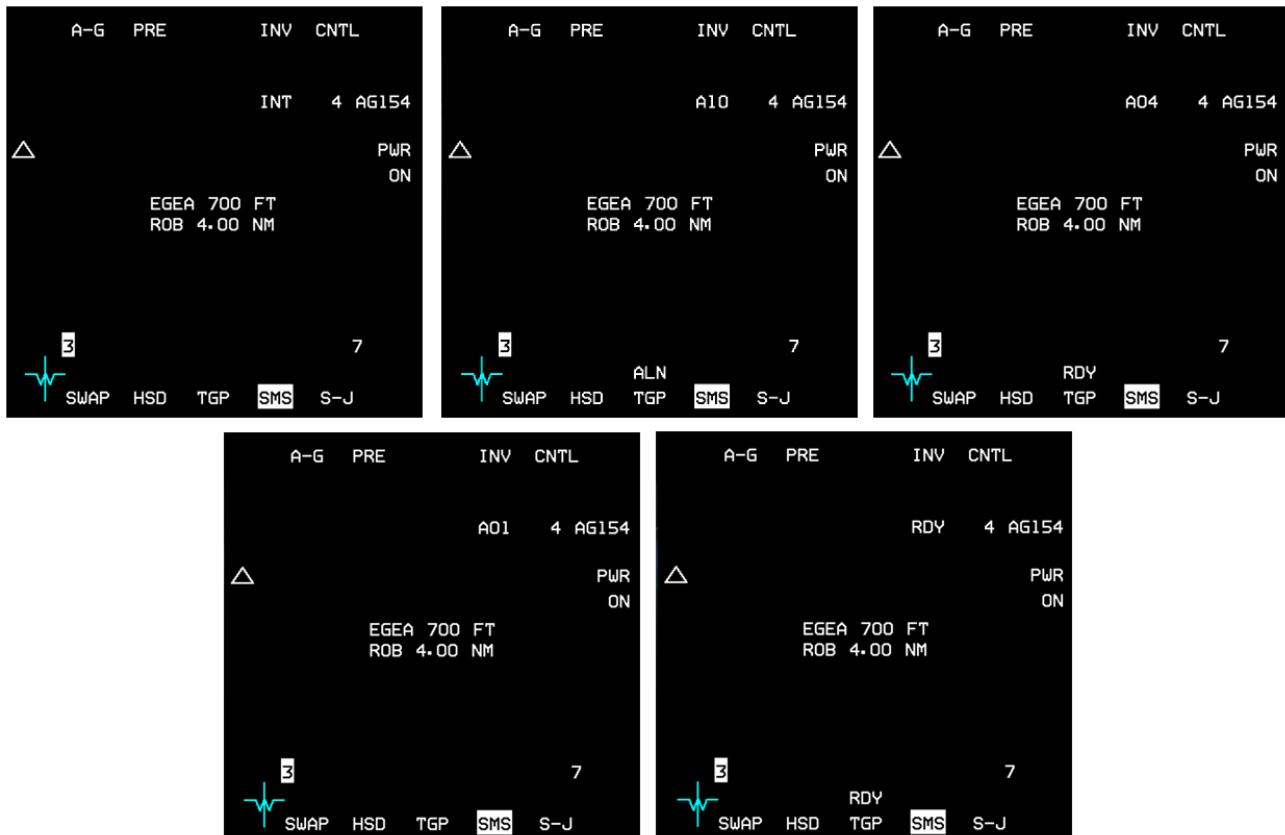
JSOWs are heavy weapons usually carried in pairs on stations 3 and 7. Each weapon weights 1520 Lbs. When carrying 4 don't expect your jet to react swiftly and plan your flight accordingly. You'll be slow and will need a lot of time to get to high altitude. Don't even think about air to air combat with 4 pigs under your wings.

The training mission starts enroute to Yang Yang VORTAC 043X. Altitude should be close to 24000 feet. You can select AP Steering and Pitch altitude mode. The 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 different 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 △ which represents a JSOW. In this configuration a single JSOW is programmed for release. If you press OSB19 the △ will be replaced by △△ indicating 2 JSOWs side by side release and a further press of OSB19 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 are 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.

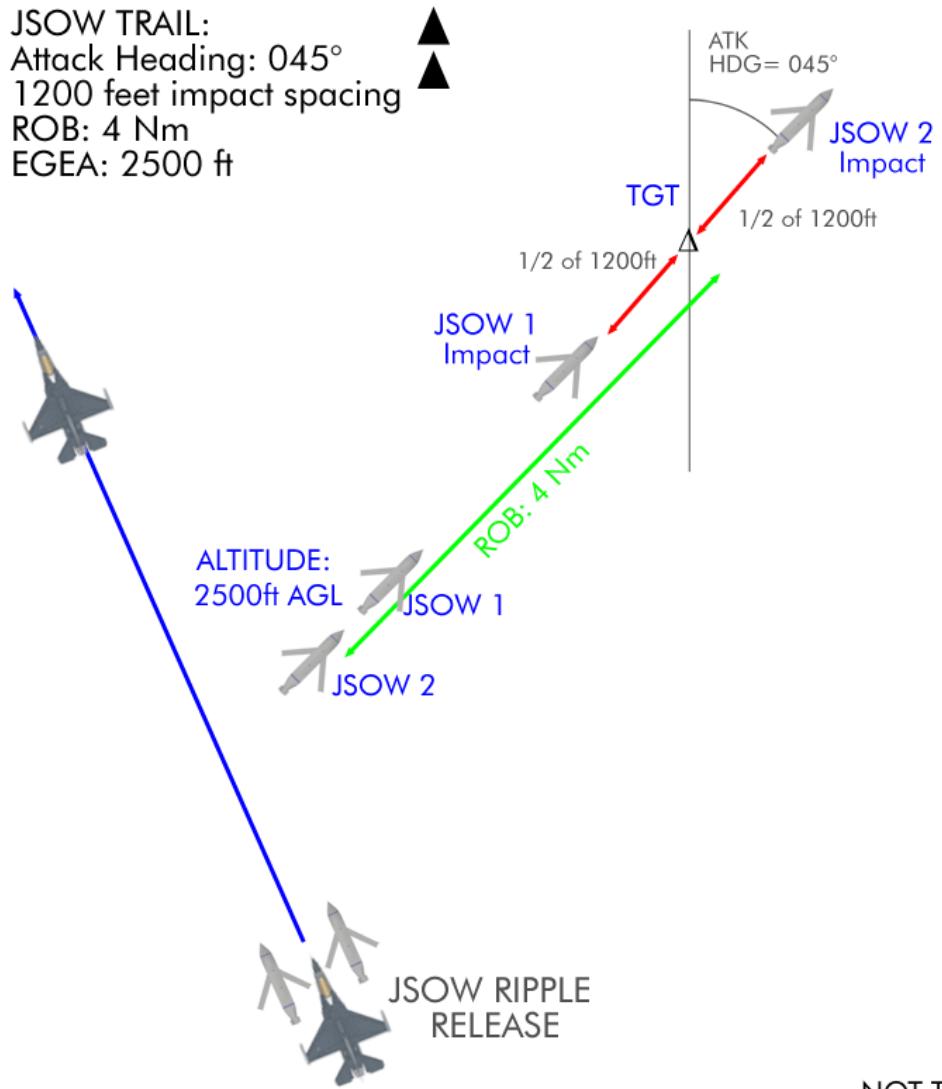
Upon returning to the SMS page the spacing will be displayed next to OSB 18.

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.

#### JSOW TRAIL:

Attack Heading: 045°  
1200 feet impact spacing  
ROB: 4 Nm  
EGEA: 2500 ft



NOT TO SCALE

The choice between one or the other option 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 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 a vehicle column as in this training scenario spacing should be important. If the target is condensed in a small area, spacing can be smaller. You may use the TGP meterstick to evaluate distances.

A-G	PRE	INV	CNTL	ENTR	RTN	RCL
			A06 4 AG154	1		6
△ OFT			PWR ON EGEA 700 FT ROB 4.00 NM	2	RTN IMPACT SPC	7
				3	*	8
			7	4		9
				5		0
3  SWAP	HSD	ALN	TGP	SMS	S-J	

Passing steerpoint 4 the JSOWs should report RDY, although they may not be fully aligned.

Set course to target 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 CBUs 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.

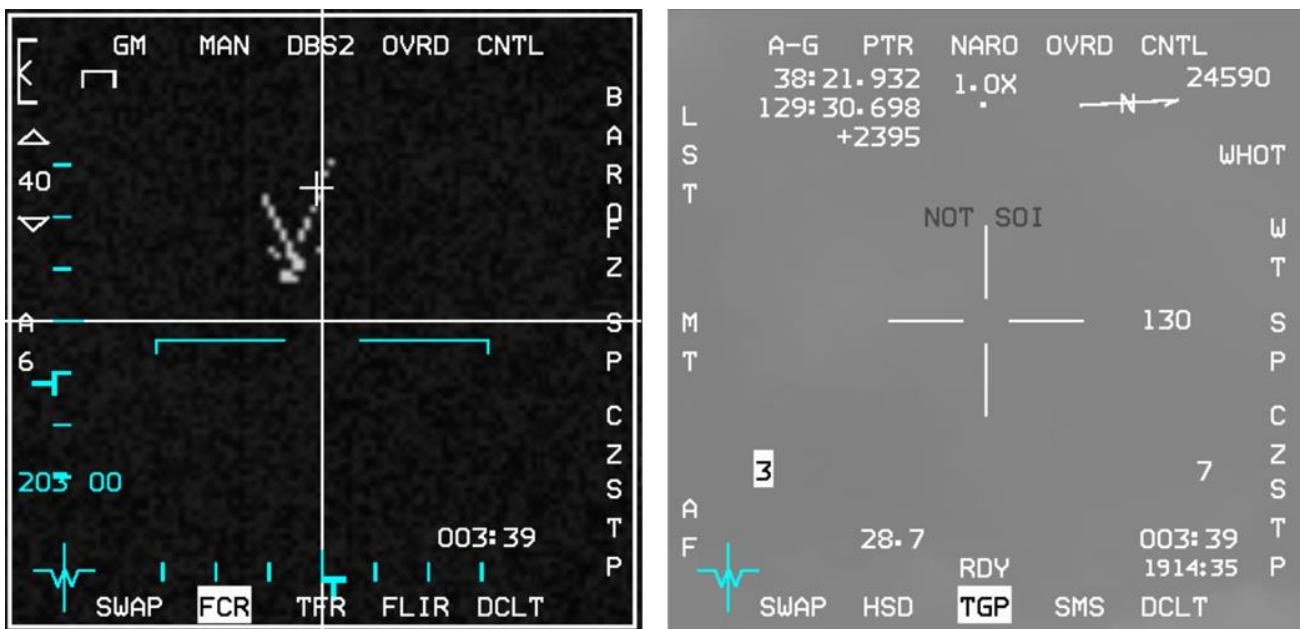
To be able to choose the best options we first need to have a good picture of the target geometry. So we need to get closer to the targets and paint them on radar before deciding how to attack. In some cases it could be done at flight planning when the target is spotted and visible on the UI map. Reconning the target then allows you to determine the best weapon heading and attack settings. Unfortunately in this case the targets were not spotted on the map so we couldn't Recon them.

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 40 Nm scope and ensure the TGP is set to A-G and the N/M (North/meterstick) option is selected 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 20-25° to the left and the second column is angled about 20° to the right. We can now estimate the axis of the first column to 270° and the axis of the second column to 315°; these will be our JSOW attack azimuths.

The TGP is useless because of the weather conditions, so there's no way for us to estimate distance at this time. We'll have to improvise and keep the 1200 feet spacing we inputted earlier.



We're planning to attack each column with a pair of JSOWs in trail. 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 315° column, ripple the first two JSOWs, then program the SMS for the next column axis before releasing the last 2 bombs.

Let's get ready as we approach the 20 Nm mark from target:

First designate the centre of the right column (315°) on the FCR.

Select 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° 22.165'  
LNG E 129° 29.735'  
ELEV 2395FT

Undesignate the A-G FCR and move the cursors to the centre of the left column (270°). Ensure the MARK page is still active and press TMS up to create Markpoint 27 for the second column axis. Note you don't designate on the FCR as the MARK page has ownership of the TMS.

**MARK FCR**  
MKPT 27  
LAT N 38° 21.930'  
LNG E 129° 29.697'  
ELEV 2395FT

Cancel all slews by hitting CZ (OSB 9) on the FCR. This is critical to avoid any unwanted cursor slew.

Markpoint 26 is selected as the current INS steerpoint – that's our first target: the right column with an axis of 315°. Let's select the SMS CNTL page and enter 315° 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 315°.
- 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 needs about 1.6 seconds weapon release consent.

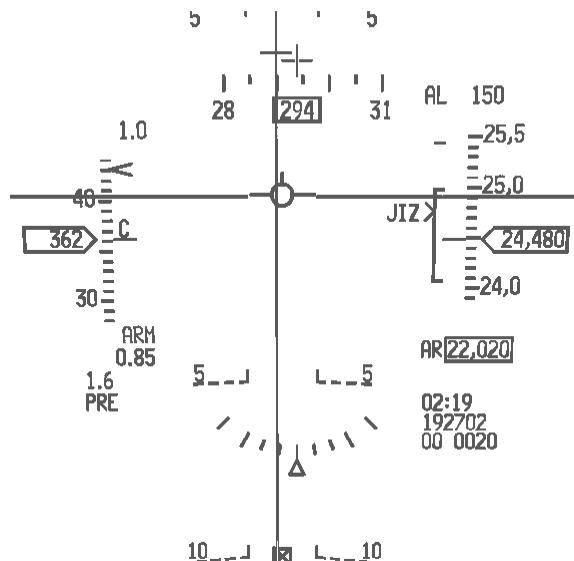
As you are rippling two you must ensure you keep the pickle depressed for at least 3.2 seconds. Failure to keep the pickle depressed long enough may result in hung weapons.

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 attack.

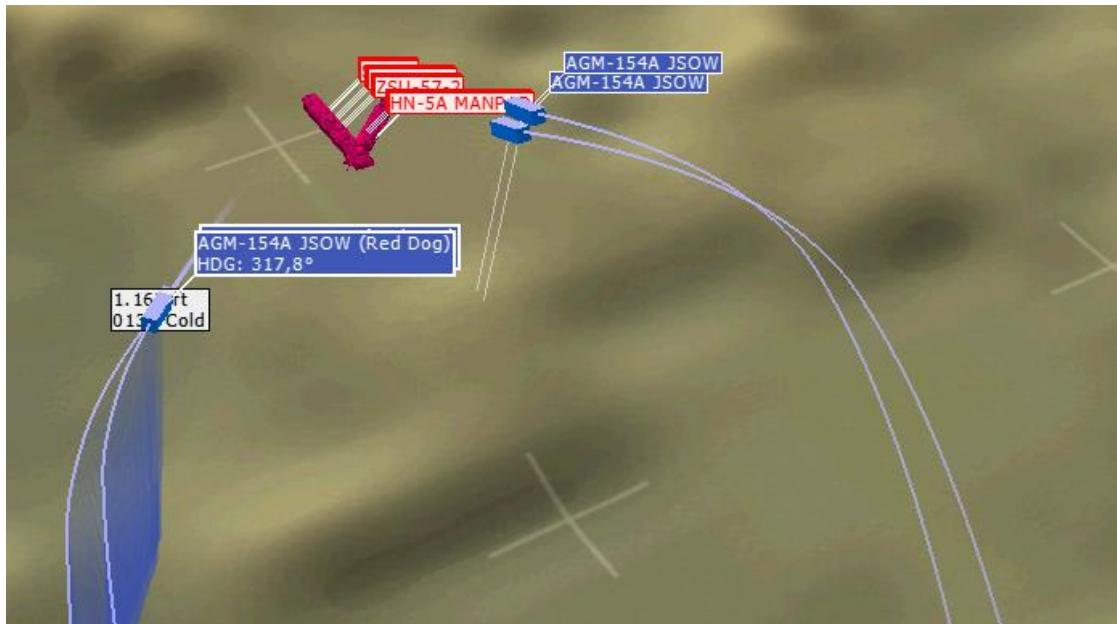
Enter 270° as ATK AZ in the SMS CNTL page and check weapon settings for the second pair of JSOWs. Once you are confident that settings are correct and JIZ is displayed in the HUD DLZ depress and hold the pickle again for just over 3 seconds and monitor the JSOWs release.

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.

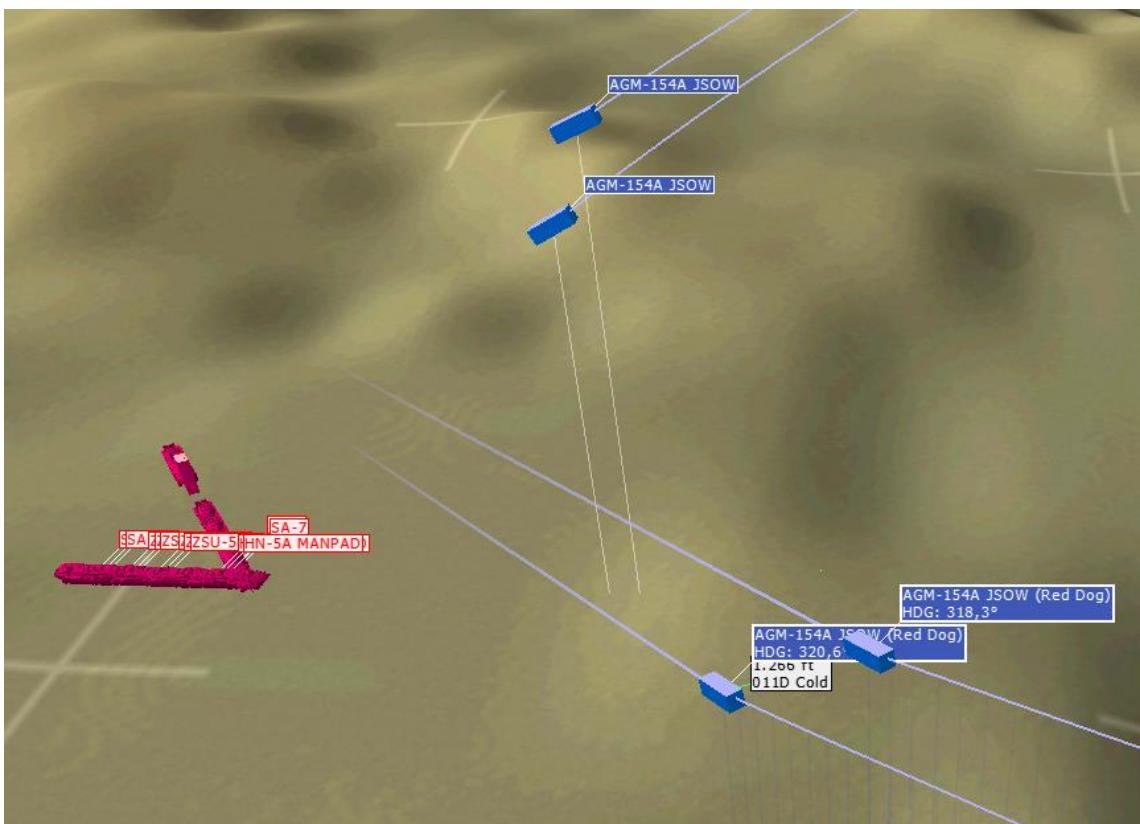


The second pair of JSOWs have been released closer to the target and will hit first as JSOWs are unpowered, so slow down as soon as they are released. They will turn left towards their attack azimuth of 270° and be established 4 Nm from target. The first pair were released earlier and have a longer distance to cover. They will turn right to align with their target and strike the 315° column.

The change of heading are obvious in the following pictures:



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.



As soon as all 4 JSOWs are gliding towards their target turn your aircraft away from the enemy air defenses. Select steerpoint 7 to exit the target area. You can now switch master mode to A-A or MRM and be ready for potential enemy fighters.

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.

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 4.33 the F-16 can carry the GBU-31(v)1/B based on the Mk-84 2000Lbs bomb, the GBU-31(v)3/B based on the 2000Lbs BLU-109 penetration bomb and the smaller GBU-38B based on the 500Lbs Mk-82 bomb.

In this training scenario the wingman is tasked to destroy bridges with 2000Lbs GBU-31(v)1/B bombs loaded as with all IAMs on stations 3 and 7.

Although selecting JDAMs automatically loads the TGP in BMS, they are primarily meant to be used on INS target steerpoint coordinates. TGP might be used to designate and drop JDAMs, but 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 are clearly identified before the flight in the Recon screen:

- Dalsan bridge: N38°21.463" E129°34.837" Elevation 1573 feet (275°/095°).
- Unho-Ri bridge: N38°23.466" E129°34.297" Elevation 1895 feet (266°/086°).

JDAMs need to be powered up and aligned like all IAMs, so as soon as you enter the cockpit power them up on the A-G SMS page. While they align we can set further options on the CNTL page.

JDAMs allow the pilot to set 4 different profiles, accessible from a single push of 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.

A-G	VIS	INV	CNTL	A-G	PRE	INV	CNTL
PROF		A07	2 GB31A	PROF		IMP ANG	
2				1		55	
			PWR ON	AD		IMP AZ	
		AD 4.00SEC		AD 6.00SEC		0	
						IMP VEL	
						700FPS	
3			7				
 SWAP	HSD	ALN		 SMS	TGP	 S-J	

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 Bridge (first target) and Profile 2 will be used on the Unho-Ri Bridge. 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 orientated East/West. In that configuration, if you request an impact azimuth of 090° for instance, the bomb will have to turn 150° to the right to comply. That will seriously decrease your range from target, 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 1<sup>st</sup> target (Dalsan Bridge) and 340° for the second target (Unho-Ri 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.

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 different options are displayed for Profiles 1 and 2 in the centre of the SMS page by toggling OSB 20:

A-G	PRE	INV	CNTL	A-G	PRE	INV	CNTL
PROF 1		A05	2 GB31A	PROF 2		A04	2 GB31A
		PWR ON			PWR ON		
	AD 9.00SEC				AD 7.00SEC		
	IMP ANG 55				IMP ANG 45		
	IMP AZ 350				IMP AZ 340		
	IMP VEL 700FPS				IMP VEL 800FPS		
3		7		3		7	
 SWAP	HSD	ALN	TGP	 SMS	S-J		

You will notice that impact azimuth is not available when the release mode is set to VIS (PROF 4 for instance). Indeed 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 steerpoint defined, we must input the target coordinates into the INS system. We will assign the closer target (Dalsan Bridge) to STPT 5 and the Unho-Ri Bridge to STPT 6.

We could do this directly from the STPT page but to prevent changing the active steerpoint we will use the DEST page instead.

Select UFC LIST 1 page (DEST) and choose STPT 5 either by pressing ICP 5 or by using the ICP arrows until 5 is displayed.

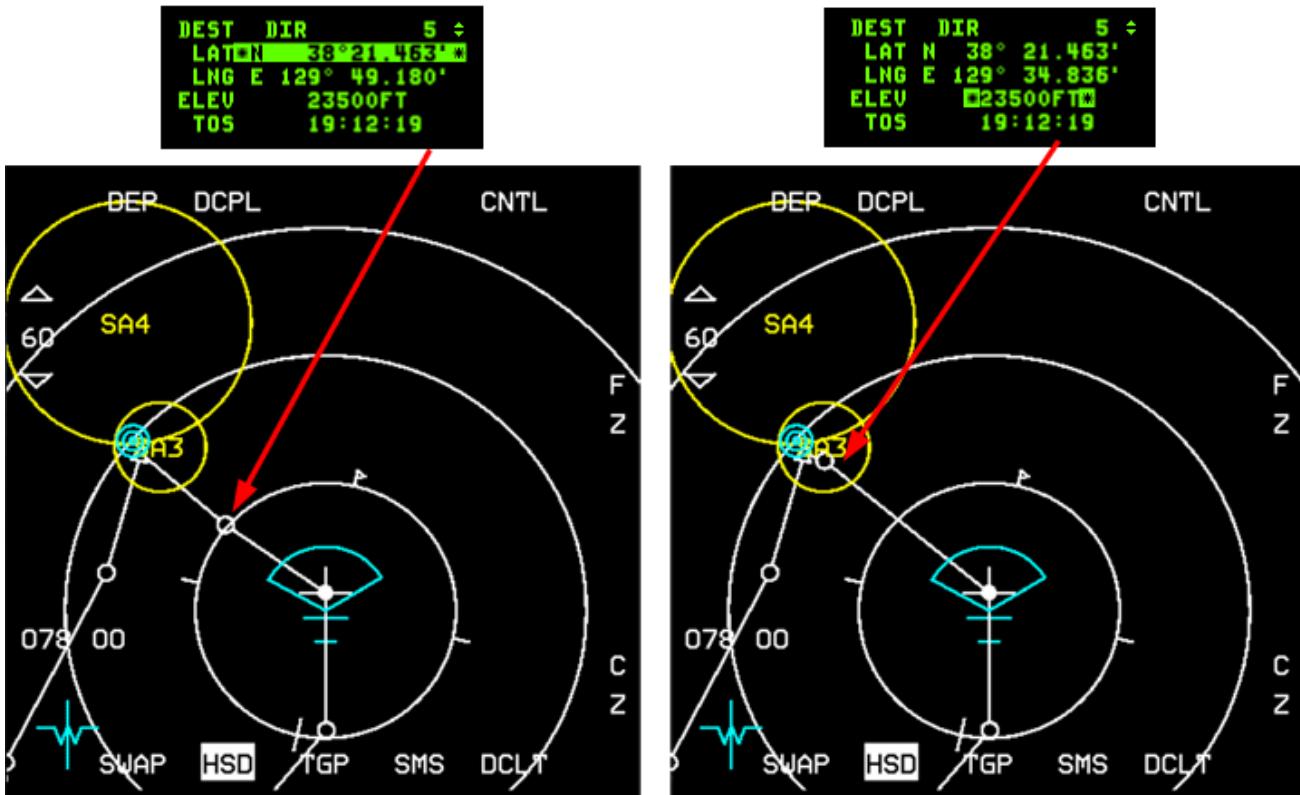
Ensure the scratchpad is on the Latitude line and enter the Latitude of the Dalsan Bridge by starting with ICP2 for North, then 3821463 and press ICP ENTR.

The scratchpad moves down to the Longitude. Start your input with ICP 6 for East and type 12934837 ENTR. In BMS 4.33 you must start the coordinates input with the cardinal symbol N and E.

In the real jet you must also enter the target elevation for accurate positioning but that is not yet implemented in BMS as the steerpoint altitude reflects your INS flight plan altitude. 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 Unho\_Ri Bridge: N3823466 E12934297 and check that STPT 6 moved position on the HSD.

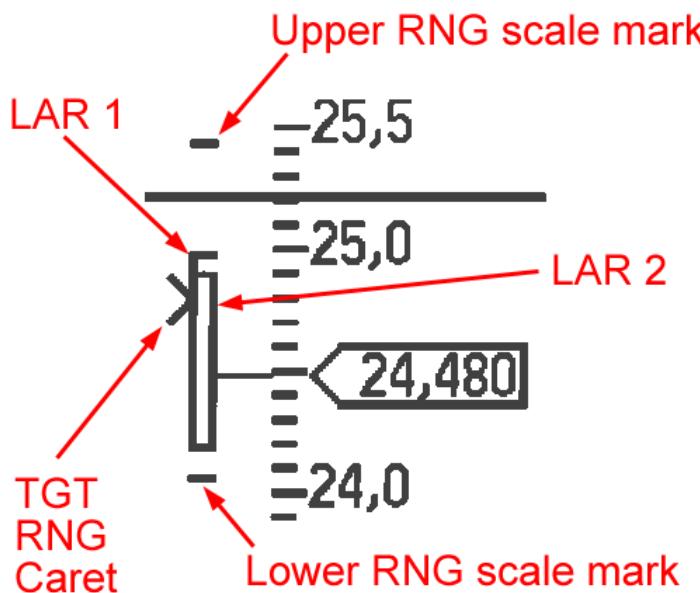
Attack steerpoints are set, weapons are set. All we need to do now is to monitor the HUD for LAR, release the first bomb, toggle to Profile 2, select STPT 6 and drop the second JDAM.



Exit the DEST page to CNI and 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 an SA-3 but we should be able to remain outside its WEZ, let's close up while monitoring the LARS.



LAR 1 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 settings (impact azimuth).

LAR2 is displayed as ] and has RMAX2 and RMIN2 marks extending to the left and ensure that weapon release between these two marks have 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 the optimal launch envelope.

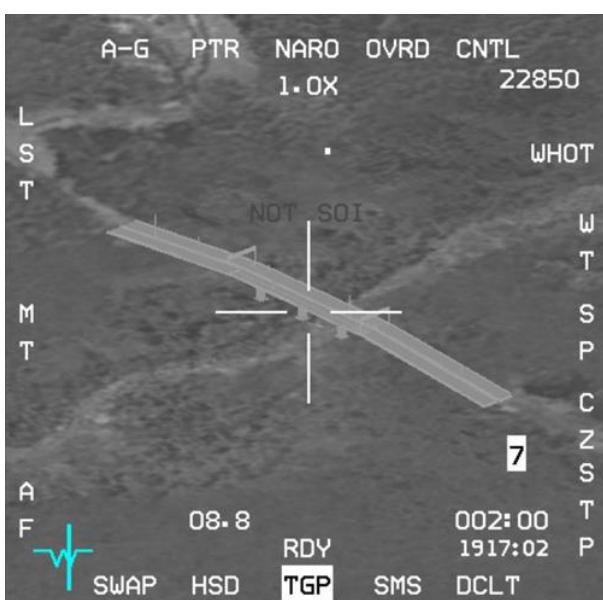
If LAR1 is not displayed it is because your aircraft attitude is not within limits, MASTER ARM is SAFE, or target bearing is more than 60° offset. In that case a turn indication will be displayed in the HUD as Rxx or Lxx for right or left turn and xx representing the required turn in degrees to place 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**  
**001:32**  
**191436**  
**00 022**  
**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 (22Nm).



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. When the weapon caret hits RMAX2 give release consent by holding the pickle button for about 2 seconds. The first JDAM will release and the autopilot will compensate for the wing drop.

Quickly select STPT 6, switch SMS to PROF 2 and wait for the weapon caret to hit RMAX2 before releasing the second JDAM on the North Bridge. If you have time, you can switch to the TGP to confirm the second bridge is designated. 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 defenses. Switch to CATI 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

BMS 4.33 introduced other types of IAMs in the inventory:

- SDB are GBU-39 Small Diameter Bombs most effective against soft skinned static targets, such as air defense 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 4.33 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 Laser 500 pound JDAMs fitted with both a GPS/INS and Laser guidance kit. They provide increased accuracy, as the laser kit tracks the coordinates of the laser spot. They are suited for either moving or stationary 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: Man In The Loop (MITL)**

Post initial release

## **MISSION 17: IR MISSILES**

Post initial release

## **MISSION 18: RADAR MISSILES**

Post initial release

## **MISSION 19: GUNS GUNS GUNS**

Post initial release

## **MISSION 20: HMCS**

Post initial release

## PART 4: NAVAL OPERATIONS

BMS 4.33 introduced better naval operations with new aircraft carrier models. Naval operations are mostly performed with the F/A-18 aircraft as it features a full 3D cockpit and AFM (Advanced Flight Model), albeit not as detailed as the F-16. The following chapters and corresponding training missions were made by Sting. The last mission of the Naval Ops chapter is an anti-ship (TASMO) F-16 mission for Harpoon training.



## MISSION 21: F/A-18 HORNET - Carrier Takeoff

**PREAMBLE:** This training mission assumes you are familiar with the basic operation of the aircraft and its communications systems. It is important to note that while there are some small customisations, the Hornet in BMS essentially uses the Viper's avionics.

**LOCATION:** 35 West of Kunsan Airbase - South Korea

**CONDITION:** Parked on the CVN-65 USS Enterprise as part of the 1027th Carrier Present Task Force. You will be with the 4958th Squadron flying an F/A-18D.

**GOAL:** Successfully taxi to the catapult and launch the aircraft.

### 21.1 TAXI

Select the single ship F/A-18D Hornet in Package 4965. As always check the mission briefing for weather and other NOTAMS. Also ensure you have the communication frequencies for the Carrier Tower. You can commit to either RAMP or TAXI, for this training mission we will commit to TAXI. The AI jets are able to taxi on the carrier and will follow taxi points like on land.



Upon entering the cockpit the aircraft will be hot and chocked with the wings folded in the upright position. Due to confined space on the deck it is preferable to leave the wings in the upright position until just before you are ready to enter the catapult zone.

As the carrier needs to steam into the wind (single-player only – in multiplayer it is stationary) to launch and recover aircraft get into the habit of contacting the Tower early to allow the ship enough time to turn into the wind while you finish your pre-flight checks.

Once your cockpit is set up as you briefed you can request removal of the chocks. Ensure you have either your parking brake engaged or your feet on the brakes, as the aircraft will lurch forwards once the chocks are removed. Once you have ensured the flight line is clear (i.e. no landing aircraft) taxi to the left catapult at the bow of the ship. All four catapults can be used, depending on traffic and parked aircraft. The lead aircraft should always use the left catapult.

Once you are at the point illustrated below it is time to unfold the wings (Wing Fold Switch) and lower your flaps to the HALF setting. Note there are no other indications in the BMS Hornet cockpit of the position of the flaps, only the position of the flaps switch.



## 21.2 On the Cat

Approach at low speed and lined up with the catapult centreline. Continue at slow speed until the aircraft enters into the catapult. There is no need to stop the aircraft; if you are aligned and slow the aircraft will stop and 'catch' the catapult. Once on the catapult the nose of the aircraft will automatically be compressed.



Once in position, the carrier blast doors will automatically be raised. Once you have completed your standard pre taxi off checks and are ready for launch, advance the throttle to full afterburner.

Once your engines are up to speed and the pressure is built in the catapult (steam coming from the deck will be your visual cue) the carrier will automatically fire the catapult and you will be launched from the carrier deck.

Note: you will need to apply aft pressure on the stick to ensure a positive rate of climb. Once a positive rate of climb has been achieved retract the landing gear and set the flaps to AUTO.

Proceed as per standard navigation procedures.



### 21.3 Carrier Details

CARRIER	TCN	UHF	VHF
VINSON	010X	226000	116000
ROOSEVELT	011X	226100	116100
TRUMAN	012X	226200	116200
WASHINGTON	013X	226300	116300
LINCOLN	014X	226400	116400
STENNIS	015X	226500	116500
IKE	016X	226600	116600
KENNEDY	017X	226700	116700
KITTY HAWK	018X	226800	116800
CONNIE	020X	226900	116900
AMERICA	021X	227000	117000
MIDWAY	023X	227100	117100
INDEPENDANCE	024X	227200	117200
RANGER	025X	227300	117400
SARATOGA	027X	227400	117500
ENTERPRISE	028X	227500	117600

## MISSION 22: F/A-18 HORNET - Carrier Landing

**PREAMBLE:** This training mission assumes you are familiar with the basic operation of the aircraft and its communications systems. It is important to note that while there are some small customisations, the Hornet in BMS essentially uses the Viper's avionics.

**LOCATION:** 14miles west of CVN-65 USS Enterprise.

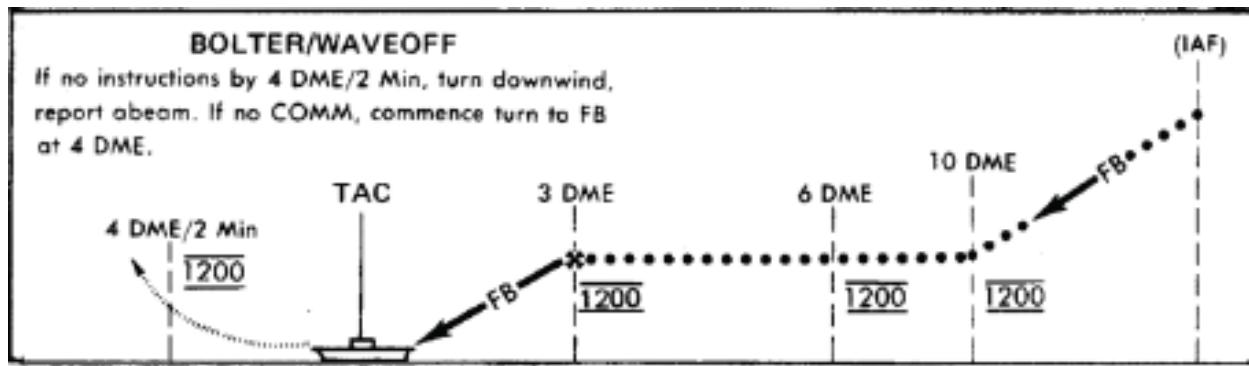
**CONDITION:** 3000 feet, 350 knots, heading 090, 08:25hrs.

**GOAL:** Successfully trap the aircraft on the Carrier.

Select the single ship F/A-18D Hornet in Package 4965. As always ensure you check the mission briefing for weather and other NOTAMS. Also ensure you have the communication frequencies for the Carrier Tower.

Upon entering the cockpit, the aircraft will be approximately 3,000 feet at 350 knots heading 090. You will be just over STPT 9. Select STPT 10, contact the Carrier Tower and request an Autonomous Approach (t 2). As the carrier will always move the ship into the wind (single-player only) when launching and recovering it is a good idea to request the wind (t t 4) as well from the carrier, as the reading you receive will be the runway heading. For this mission we have set the wind to 090 to make it easy for you (i.e. your current heading).

At 10 DME you should have the aircraft at 250 knots, 1,200 feet, heading 095 degrees. The reason for the offset heading is to allow for the angled landing zone on the carrier. Continue your descent towards the carrier as per the following chart:



At 3 DME you can configure the aircraft for landing by lowering the Hook and the Gear and setting the flaps to the FULL position. Reduce to landing speed and begin your final descent towards the carrier. You will still be heading approximately 095 with the carrier in view just to the left of the HUD.



At around 1.3 DME your view should be similar to the following picture. Your speed should be between 140 to 160 knots, depending on weight and the FPM should be located near the landing zone. It is recommended to aim to the right of the landing zone as the carrier is constantly moving away from you. Continue your approach adjusting as required and aiming for the 3rd wire.



Once you hit the deck apply full afterburner in case you missed the wires and have to relaunch the aircraft, otherwise known as a 'Bolter'. If you do catch the wire it will be released from the aircraft very quickly so be ready to apply the brakes and reduce the engines to idle. Once the aircraft is stationary complete the following checklist items:

- Raise the hook
- Set flaps to AUTO
- Fold the wings
- Engage NWS

The BMS Hornet has been given a very high rate nose for carrier deck operations. The turning radius is much higher than what you will have experienced in the Viper, so be mindful when you apply steering input, it turns on a dime.

And that's it. Find your parking spot and contact the tower to engage chocks.



## MISSION 23: F/A-18 HORNET - Night Carrier Landing

**PREAMBLE:** This training mission assumes you are familiar with the basic operation of the aircraft and its communications systems. It is important to note that while there are some small customisations, the Hornet in BMS essentially uses the Viper's avionics.

**LOCATION:** 12miles west of CVN-65 USS Enterprise.

**CONDITION:** 3,000 feet, 450 knots, heading 090, 22:25hrs.

**GOAL:** Successfully trap the aircraft on the Carrier at Night.

Once you have mastered the day time trap, you can challenge yourself with the night time mission. Follow the same procedure as the daytime mission. Good Luck!

## MISSION 24: AGM-84 HARPOON

Post initial release

## To be continued...

Working on the BMS 4.33 suite of manuals our time was very limited. We knew right from the start we couldn't do all that we wanted in the time that we had, but we wanted to provide enough missions and training material to keep both new pilots and 4.32 veterans busy until the next update.

Our plan is to provide more training missions and chapters soon after the initial release of BMS 4.33. These missions will cover more weapons system such as MITL and Harpoons and basic Air to Air weapons employment.

As always with BMS this manual is a work in progress and will be continued soon.

## BIBLIOGRAPHY

- BMS1-F16CM-34-1-1
- BMS1F-16CM-1
- BMS Checklists
- Falcon 4.0 Original manual
- Falcon 4.0 Strategy guide
- BMS forums & articles
- Training scripts article by Revientor

## ACKNOWLEDGMENT

While writing this training manual and designing the training missions I constantly pestered the developers and beta testers with questions, requests and cries for help. The support I got was outstanding and it ended up in one gigantic forum thread with new ideas, questions and corresponding answers from the entire group. The initiative turned into a great team effort which drove us all forward.

This training manual became possible only because of the commitment of the entire BMS dev group, coders and testers alike. I would like to thank all of them. I was a pain I know, but I enjoyed working with all of you on this and the other projects.

Special thanks to Sting who provided the Carrier Ops training missions and corresponding chapters. This was an invaluable help to me as my experience in this domain is very limited.

Darkman again did the tedious work of editing and proof reading. His ideas and advice were also instrumental in creating the finished document.

Leech helped us understand the various avionics systems in the aircraft as usual and without his guidance the manual wouldn't be nearly as comprehensive and useful as we hope you will find it.

Many thanks to all though who beta tested the Training TEs: members of the BMS development group and the ViperDrivers squad.