FALCON BMS

TRAINING MANUAL

Benchmark Sims

Ver.: BMS 4.37.4.1

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FOREWORD

The purpose of this manual is to document the training missions in BMS 4.37. The 33 training missions are divided into 6 main groups:

- Basic handling and navigation.
- Advanced handling and avionics.
- Weapon employment.
- Advanced navigation.
- Naval Operations.
- Air to Ground Operations.

You will fly various F-16 models, including F-16CM block 50, F-16CM/DM block 52 and F-16C block 52+. Naval operations will feature the F/A-18C Hornet. In addition, we added the F-15C for the AAR mission.

This document is not intended to explain how the BMS aircraft systems and in-game functions work in detail. For that purpose, you have **four** important document sources**:**

1. The F-16 and its systems are explained in the **TO BMS 1F-16CM/AM-1** (Dash-1)
(/Docs/02 Aircraft Manuals & Checklists\01 F-16).

2. Non-Nuclear Weapons and Avionics are explained in the **TO BMS 1F-16CM/AM-34-1-1** (Dash-34)
(/Docs/02 Aircraft Manuals & Checklists\01 F-16).

3. Navigation procedures are explained in the **BMS Comms-Nav-Book** *(/Docs/00 BMS Manuals).*

4. The BMS User Interface is explained in the **BMS User Manual** *(/Docs/00 BMS Manuals)*.

The purpose of the BMS Training Manual is to link those four documents mentioned before with specific training scenarios, tying the documentation together with the amount of knowledge you need to master each training mission.

Whenever appropriate, we will refer to those documents to streamline your information input and avoid duplication of content available elsewhere.

If you are 100% new to Falcon BMS, please check the "WELCOME" document *(/Docs)* **first** to achieve the optimal learning experience and guideline.

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

Since BMS 4.36 we reworked and revised much of the content and modified most of the training missions. Readers familiar with the document versions prior to and including BMS 4.35U3, will notice that some content has been deleted/heavily edited/completely reworked and/or is 100% new. The rationale for these revisions is that this content is already part of the other BMS documents mentioned above. These revisions reduced some chapter sizes resulting in a streamlined learning experience.

The Falcon BMS 4.37 changelog presented to you on the Falcon BMS website gives a good overview about all new features. Even for experienced users it is worth to read through all documentation again and re-fly all training missions.

Note:

1. Whenever you need to stop the mission to read part of this document (or any other document), use the freeze mode (except in TRN 9 and TRN 17B). The difference between pause and freeze is the ability to use the avionics while in freeze mode; you can't when you are in pause mode. The downside is that the clock continues ticking. So, if you need to meet a time sensitive objective avoid freeze mode.

2. We will not always refer to keystrokes as you may not be using the default keyfile. Therefore, it is the responsibility of the reader to correlate the function with the relevant keystroke.

3. We will assume that you use a realistic HOTAS layout; we will refer to HOTAS functions where appropriate by their name on the F-16 throttle and stick: TMS, DMS, CMS etc and not the keystroke.

4. Some settings of your aircraft at mission start depend on your callsign.ini file. These settings cannot be controlled by the TE designer. To overcome this issue, we use scripts at the beginning of training missions which start in the air. Some aspects such as your MFD setup can't be set by the scripts. Therefore, you will have to set up some avionics on your own using your best judgement. The training scripts are automatically applied and transparent for the user. You do not need to enable the 'Enable Training Script' checkbox to get them to work.

5. Different air forces have different SOPs (Standard Operating Procedures) and therefore what you will read here is only one method of learning the jet. What you know may differ and that is accepted. The goal here is to document one possible method.

6. All changes in this document coming with 4.37.0 are marked with a **black** line.
7. All changes in this document coming with 4.37.1 are marked with a **blue** line.
8. All changes in this document coming with 4.37.2 are marked with a **red** line.
9. All changes in this document coming with 4.37.3 are marked with a **green** line.
10. All changes in this document coming with 4.37.4 and 4.37.4.1 are marked with an **orange** line.

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MULTIPLAYER FLYING AND TRAINING

To get the most out of Falcon BMS, we recommend you to fly with other humans in a multiplayer environment after you made your first experiences in single player with the BMS training missions to get a feeling for the simulator.
The following 33 training missions are a great way to start your BMS journey and learn F-16 avionics, weapons and basic tactics.

Where Falcon BMS shines is the multiplayer experience and the BMS community itself which is always helpful and interested to on board new users and bring them in shape.

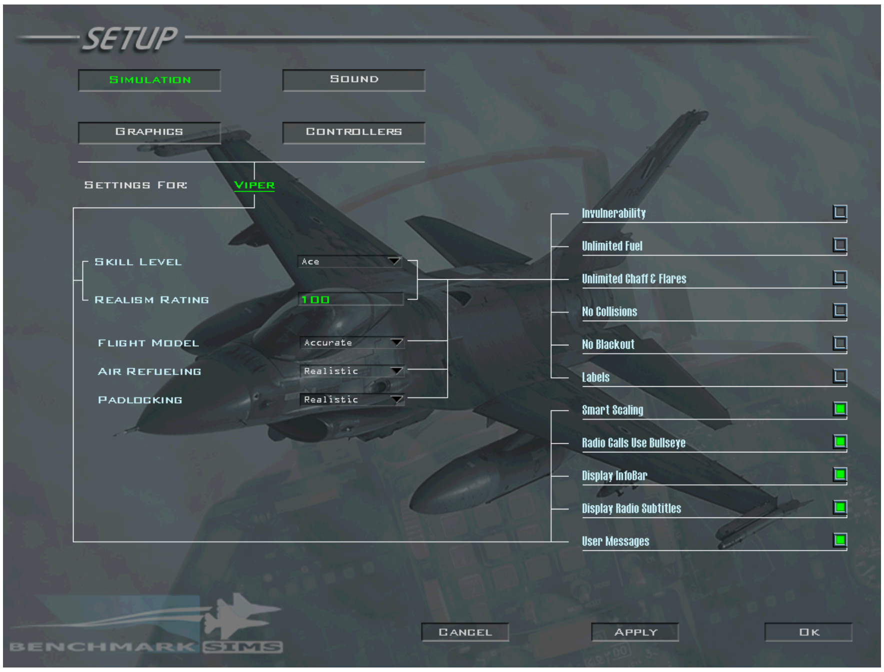
Besides hundreds of BMS online squadrons (click here for a squadron overview) there are also other non-squadron communities like Falcon Lounge, Falcon Online , Veterans Gaming or Falcon Events where you will find people you can learn from and fly with.

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 resume the clock on the top right corner and 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)
- Air Refueling:
  Realistic
- Padlocking:
  At your discretion
- Invulnerability: At your discretion

Invulnerability can be a very useful training aid. Don't feel bad about enabling it for training purposes. It will lower your realism rating but that is not a problem.

We advise you to record all your training flights with the on-board ACMI. When you get into the cockpit your first action should be to start an ACMI 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.

Please note that BMS has a pilot model in the cockpit. The leg and torso of the pilot may prevent you from seeing all the cockpit switches easily. For the purpose of the training mission, we advise you to deactivate the pilot model from the GRAPHICS page of the SETUP UI (option PILOT MODEL) under CANOPY CUES. Alternatively, you may leave it activated in the UI but toggle it ON and OFF in the cockpit with the relevant keystroke.

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

Keymapping and Keyfile

Please read chapter 3.4 of the BMS User Manual (*Docs\00 BMS Manuals)* to learn the process about to setup your keyfile. Since U4 it is possible to setup and update the keyfile in 3d. See chapter 3.4.2 in the User Manual.

Once you are now familiar how to setup BMS, it is time to start your BMS Training!

PART 1 : BASIC HANDLING

You will fly a series of 3 training missions around Gunsan airbase in Korea in a F-16DM block 52.
It's a twin seater F-16 and you will be in the front seat.

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

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

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

CALLSIGN/ PACKAGE: Goblin 2-1 (single ship) / Package 2065

AIRCRAFT: F-16DM block 52. Clean configuration, 1 AIM-9M + AN/ASQ-T50 on wingtips.
GW: 26531 lbs
Fuel: 5898 lbs
Drag Factor: 9.0
CAT I
Max G: +9/-3
Max speed: AC

WEATHER brief: RKJK INFO: B 010055Z 320/5KT 9999 FEW050 9/ -1 Q1010 NOSIG.

FAIR weather, few clouds at 5000 feet, winds 320°/13 knots, temperature 18°C, dew point 02°C, altimeter 1010 (2983), no significant changes.

LEARNING OBJECTIVES:

Mission 1: Ramp start, taxi and take-off.
Mission 2: Basics of navigation: INS and TACAN.
Mission 3: Land and shut down the jet.

MISSION 1: GROUND OPS *(TR_BMS_01_GroundOPS)*

TAKEOFF OPTION: Select RAMP

Please note: you need to select the F-16 flight in the left window of the and take the seat with a left click on the aircraft symbol so your callsign appears (refer to the picture on the right). By default, the system will put you always in the first seat available. In this case, there is only one flight in the list. Make always sure you are seated correctly when multiple flights are listed.

LOCATION: “Wolf Pack Flows”, Gunsan Airbase, Parking position 0

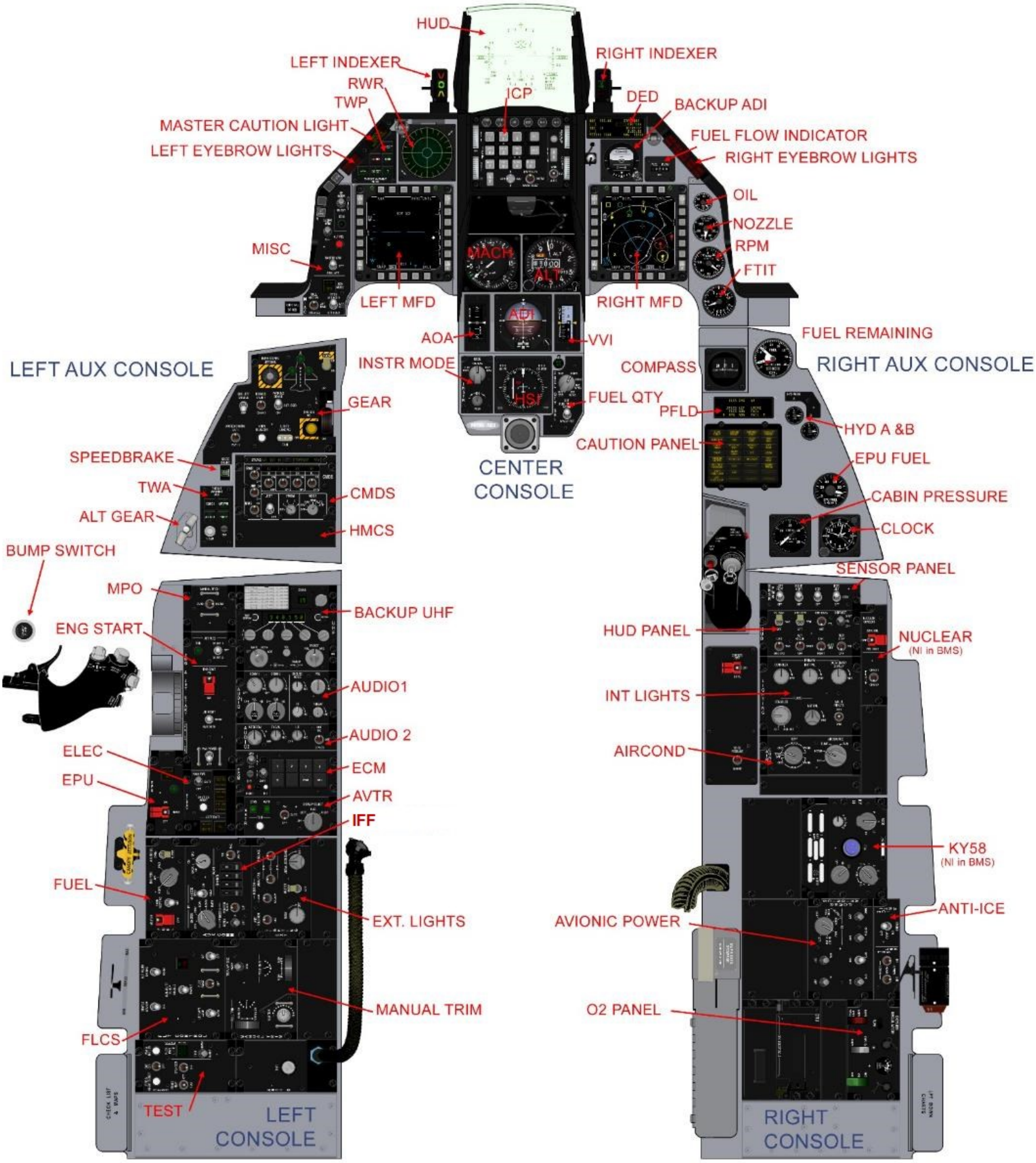
CONDITION: Aircraft cold, canopy open. You have just been strapped in the jet by your Crew Chief.

LEARNING OBJECTIVES: 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.

Goblin 2-1

1.1 Preparation

Before entering the cockpit, make sure you have a rough overview about the cockpit arrangement and avionics. The Dash -1 (Systems) and Dash -34 (Avionics) *(/Docs/02 Aircraft Manuals & Checklists\01 F-16)* will provide you all information needed to become sufficient in handling the F-16. It will take time to understand the details and capabilities of all systems. Do little steps, one after another and try to avoid to get (task) saturated. BMS has a steep learning curve. Things will come together.



F-16 block 50/52 cockpit layout and panels

In addition to the Dash documents we recommend to use the Block 40-52 F-16 checklist under *(/Docs/02 Aircraft Manuals & Checklists\01 F-16/F-16 Checklists*) for all procedures. Those checklists have the purpose to make sure you are handling the F-16 in a technically correct manner to avoid system failure or unsafe conditions.

Execute your ramp start as described in the BMS Checklist (Blk40-52). Use the pages in the Section N for the Block 52 (Engine: PW229). To get familiar with the checklist layout, you find a "README_Checklist" file in the aforementioned folder.

You may be familiar with the ramp start procedure because you mastered it already in a previous version of BMS. But with every new release, additional features may have been introduced that require different inputs or procedures. Again, we suggest you to read through all documents and checklists and scan for changes (all changes are marked in the document with colored lines). Fly the following training missions again to appreciate the improvements to fidelity incorporated in the latest BMS version.

1.2 Loading the DTC (Data Cartridge)

Once you have selected your desired flight and seat in the UI, there is one last step necessary before joining the 3d world.
This step is taking care about your DTC (Data Cartridge).
The purpose of the DTC is to provide all data created during mission planning and load it into the aircraft systems.
Please refer to the User Manual (Chapter 5) for all information about the DTC.

The following procedure (also called "Click Dance") is valid for all missions and campaigns, either in single player or multiplayer:

1. Open the DTC Tab in the BMS UI (User Interface).

2. Click the "Comm" tab.
3. Click "Comm Plan".

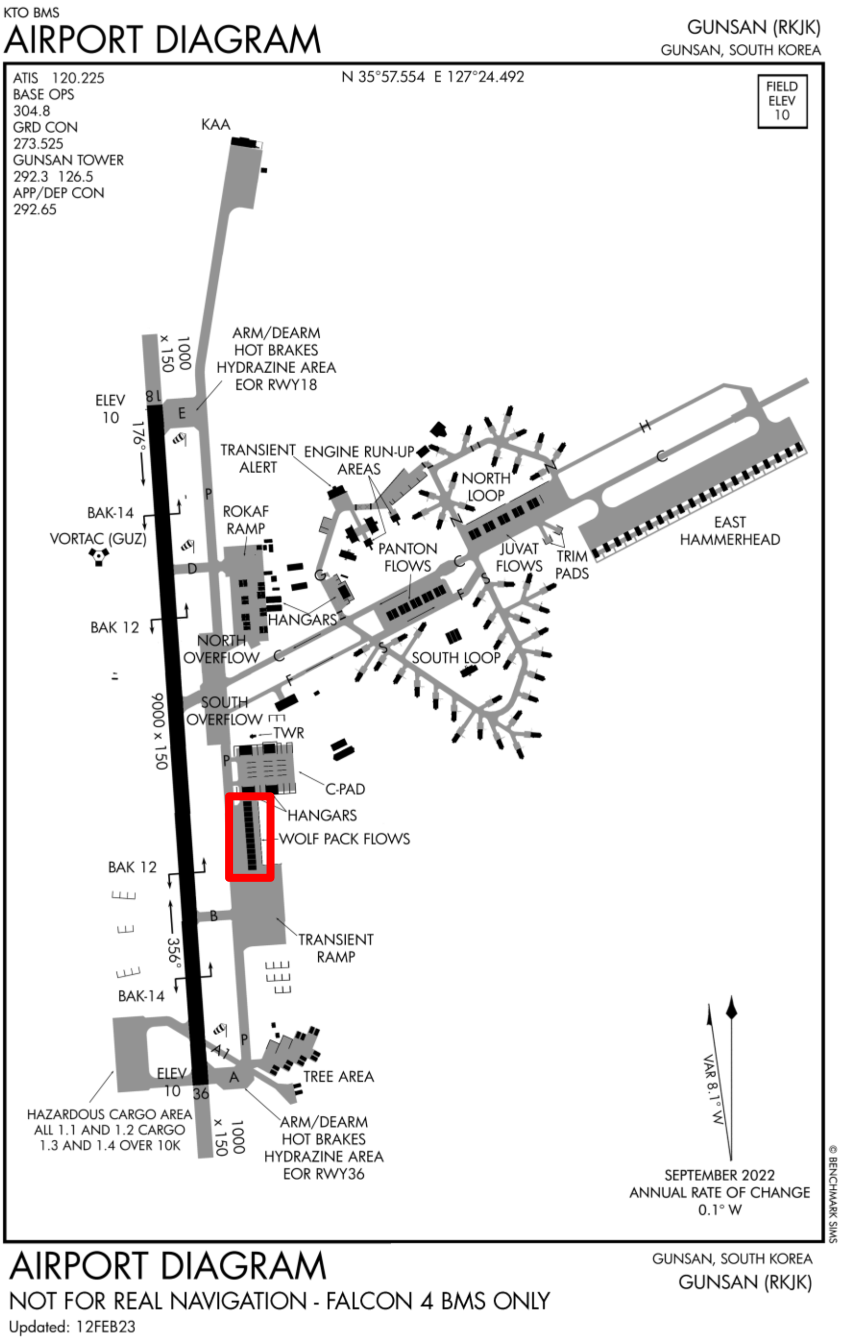
4. Click the "IFF" Tab.
5. Click "IFF Plan".
6. Click "Save"

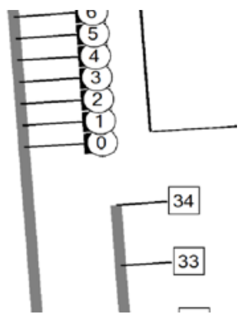
Ignore the L16 Tab for now. This will be part of other trainings.
Now you are set and ready for the mission. Click on "Takeoff" in the lower right corner and wait till the clock is running to "T-00:20:00". BMS will always start each mission 20 minutes before takeoff time by default (if not set otherwise).

1.3 Welcome to Gunsan!

Once you are in 3d, you will find yourself in a shelter at Gunsan airbase. Gunsan is located in the western hemisphere of South Korea and is the home of the 8th Fighter Wing, also called the "Wolf Pack".

You will be spawned at the "Wolf Pack Flows". For better orientation, you find the Airport chart for Gunsan airport in the */Docs/03 KTO Charts/01 South Korea/Gunsan* folder. Let's have look on the chart:





As you can see above, the "Wolf Pack Flows" is located south of the airport (red marking). You will be spawned at parking position 0. The active runway is 36. To verify where you are located exactly, use the Airport Parking chart for RWY 36 ("Gunsan_APC_RWY36.png") to find your spawning point.

1.4 Warning, Caution Light and Pilot Fault System

Since BMS is an in-depth simulator, certain systems are modelled not only to be functional, but also to have a malfunction and effect other subsystems. Before starting the engine/systems, we need to have some ground school done first.

Remember that the given information in this document doesn't contain all information about systems, avionics, procedures, etc. We focus on the most practical knowledge to improve your experience in BMS. The Dash-1, Dash-34 and the BMS checklists accommodated the ultimate data about all F-16 related aspects.

When faced with emergencies, it is crucial to exercise sound judgment in determining the most appropriate course of action. When feasible, communicate your issues and proposed corrective actions to your fellow flight members.

There are three fundamental rules to be applied in all emergency situations:

- Maintain aircraft control
- Analyze the situation and take corrective action
- Land as soon as the situation dictates

The warning/caution system comprises various subsystems:

- Warning lights: Amber lights on the eyebrows.
- MASTER CAUTION: Press to reset the amber light on the left eyebrow.
- Caution lights: Yellow lights on the right auxiliary console caution panel.
- PFLD (Pilot Fault List Display): A small screen on the right auxiliary console managed with the F-ACK button on the left eyebrow.
- Maintenance Fault List: Found on the MFD Test page.
- VMS (Voice Message System – aka Bitching Betty): Audible warnings.
- HUD messages: Visual information on the Head-Up Display.

1.4.1 MASTER CAUTION light

The MASTER CAUTION light activates shortly after any individual light on the Caution Panel illuminates (excluding IFF). It does not activate simultaneously with the warning lights.

The MASTER CAUTION light can be reset by pressing it, unless the triggering caution light is the ELEC SYS light.

It is advisable to reset the light promptly to enhance the visibility of other triggering events. If not reset, the MASTER CAUTION light will persistently remain illuminated as long as the individual caution light stays on. In essence, if the caution light goes out (indicating the fault is cleared), the master caution light will also extinguish.

1.4.2 CAUTION lights

Situated on the right auxiliary console, the caution light panel accommodates 32 indicators, with the majority being fully functional in BMS.

Resetting the ELEC SYS caution light cannot be accomplished using the MASTER CAUTION light. Instead, it requires the use of the ELEC CAUTION RESET push button on the ELEC panel, although reset may not be possible in certain situations.

Lights like AVIONICS FAULT, ENGINE FAULT, and FLCS FAULT can be reset using the F-ACK button (PFLD message).

FLCS FAULT	ENGINE FAULT	AVIONICS FAULT	SEAT NOT ARMED
ELEC SYS	SEC	EQUIP HOT	NWS FAIL
PROBE HEAT	FUEL/OIL HOT	RADAR ALT	ANTI SKID
CADC	INLET ICING	IFF	HOOK
STORES CONFIG	OVERHEAT	NUCLEAR	*
ATF NOT ENGAGED	EEC ————	————	CABIN PRESS
FYD FUEL LOW	BUC ————	————	————
AFT FUEL LOW	————	————	————

A FLCS fault is detected. Refer to the PFL display 1.4.4. See chapter 7.1.3 in the Dash-34 and B-2 (Checklists).

A failure of the electrical system is detected. Check ELEC panel for illuminated light(s) and press the ELEC CAUTION RESET button. See chapter A-2 (Checklists).

Currently, BMS does not include coding for single generator failures. Therefore, if the ELEC SYS caution light illuminates, examine the pertinent ELEC lights, and attempt to reset the fault by pressing the ELEC CAUTION RESET button. If the fault persists, initiate a landing as promptly as possible.

The illumination of the PROBE HEAT caution light signals either a failure in the probe heater or a malfunction in the monitoring system. PROBE HEAT has been comprehensively implemented to address icing conditions. The system's functionality can be verified using the PROBE HEAT switch on the TEST panel. It is advisable to activate PROBE HEAT during flight, particularly in cold and humid weather. In instances where the probes might be contaminated with ice, crucial pneumatic instrument readings, such as the altimeter and machmetre, could exhibit erratic behavior. To rectify this, check the PROBE HEAT switch to reheat the probes if possible. If the issue persists, navigate outside icing conditions (clouds) and plan to land at the earliest convenience.

The C ADC caution light is not implemented in BMS. It does come on during the MAL & IND LTS test though.

The STORES CONFIG caution light on the gear panel (left auxiliary console) is illuminated due to the incorrect position of the STORES CONFIG switch for the current loadout. To resolve this, toggle the STORES CONFIG switch, and the caution light should extinguish.

The caution light associated with Automatic Terrain Following failure is not functional in BMS. While it may illuminate during the MAL & IND LTS test, it does not have any consequences in the simulation.

The FWD FUEL LOW caution light illuminates when the forward reservoir contains less than 400 pounds of fuel (C model) or 250 pounds of fuel (D model).

The AFT FUEL LOW caution light illuminates when the aft reservoir contains less than 400 pounds of fuel (C model) or 250 pounds of fuel (D model). Please note that engine flameout due to fuel starvation may occur, even if the fuel quantity does not indicate empty tanks, especially during negative G pushovers. Fuel gauges are designed to be as accurate (or inaccurate) as they are in real life.

Engine fault(s) have been detected. Consult the displayed Pilot Fault List (PFL) message and reset the ENGINE FAULT caution light by pressing the F-ACK button. Conduct a fault recall with an additional press of the F-ACK button to assess whether the failure condition persists. Refer to Chapter 7.1.1 of the Dash-34 for PFL Analysis.

The SEC caution light illuminates whenever the engine is operating in secondary mode.

Verify the ENG CONT switch's position on the ENG & JET START panel (left console). If the switch is set to PRI, it indicates either an automatic transfer to SEC (not implemented in BMS) or that the switch should be in the SEC position. When in SEC, the nozzle remains closed, and afterburner activation is inhibited.

Temperature of the fuel going to the engine or engine oil is excessive.

The INLET ICING caution light illuminates when the ANTI-ICE system detects ice accumulation in the inlet or detects a failure in the ANTI-ICE protection system. If ice is detected, the caution light remains on for approximately 70 seconds or more, depending on whether the ANTI-ICE protection system successfully melts the ice during that time.

When the ANTI-ICE switch is in the AUTO position, the ANTI-ICE protection system activates to melt the ice. Failure to manage inlet icing properly, such as leaving the switch OFF, may result in engine seizure if a detached block of ice is projected into the engine fans.

In case of ANTI-ICE system failure detection, pilots should navigate outside icing conditions (clouds) and attempt to recycle the ANTI-ICE switch. If the issue persists, it is advisable to land as soon as practicable.

The OVERHEAT caution light comes ON whenever an overheat condition exists in the engine compartment, ECS, EPU bay or MLG wheel wells.

Not used in the real F-16 Block 50 – not used in BMS.

Not used in the real F-16 Block 50 – not used in BMS.

An avionics fault has been identified. Please refer to the PFLD message and press the F-ACK button to reset the AVIONICS FAULT caution light. Perform a fault recall by pressing F-ACK again to assess whether the failure condition persists. For further details, consult Section 7.1.1 on PFL Analysis in the Dash-34.

Insufficient cooling for avionics equipment has been detected. Check the AIR SOURCE knob position immediately. If AIR SOURCE was not in NORM, set it to NORM, and the fault will clear once cooling becomes effective. If AIR SOURCE was already in NORM, anticipate degraded avionic equipment performance and potential FCR shutdown. Reduce throttle to 80% and shut down non-essential avionics. Plan to land at the earliest convenience.

Malfunction of the radar altimeter. Move the radar altimeter switch to OFF. A-LOW will not be available anymore.

The IFF caution light illuminates when conditions prevent Mode 4 operation, such as IFF in standby, Mode 4 disabled, Mode 4 keys zeroed, or RF switch in SILENT. Additionally, the IFF caution light briefly illuminates when the IFF is unable to respond to a Mode 4 query. Depending on IFF settings, an accompanying audio cue may sound simultaneously. Note that this caution light does not trigger a MASTER CAUTION light.

Malfunction in the NUCLEAR control circuitry which is irrelevant in BMS. This caution light is advisory and has no consequence in BMS.

This caution light illuminates whenever the ejection seat lever is up (system safe). If desired simply arm the seat and the caution light will clear.

The Nose Wheel System (NWS) has failed and steering with the nose gear is not possible. Steering can be done with the rudder but will become less effective at low speed. Differential toe brakes can be used at low speeds but beware of hot brake risks.

The ANTI-SKID system is deactivated with the landing gear lever down or is experiencing a malfunction. If the ANTI-SKID switch on the gear panel is in the OFF position, switch it to ANTI-SKID to extinguish the caution light. If the caution light persists and the ground speed is above 12 knots, an ANTI-SKID system failure is detected. In such instances, the brake system transitions to alternate braking, reducing brake effectiveness from 25% to 50%.

When the ANTI-SKID system is set to OFF and the brake channel is on Channel 2, the entire ANTI-SKID system is deactivated. This results in decreased brake effectiveness, and the wheels may lock, increasing the risk of tire blowouts.

The hook is not in the up and locked position. Cable arrestment systems are now operational on non-generic airbases in BMS. Engaging the cables is possible with the hook down, irrespective of ATC notification. To clear the caution light, adjust the HOOK switch on the gear panel.

The OBOGS caution light will light up when the ECS air supply falls below 10 psi, indicating a halt in oxygen production. Anticipate the OXY LOW warning light and initiate a descent to a suitable altitude to prevent hypoxia conditions.

The CABIN PRESS caution light is activated when cockpit pressurization exceeds 27,000 feet. Verify that the AIR SOURCE knob is set to NORM. If the caution light persists, descend below 25,000 feet and limit your speed to a maximum of 500 knots. You can continue the flight below 25,000 feet as oxygen is still available. Since the implementation of hypoxia in version 4.34, failure to descend rapidly enough may result in blackout. If a blackout occurs during descent, recovery will happen upon reaching lower altitudes, unless the aircraft impacts the ground first.

1.4.3 WARNING lights

The warning lights are located on the left and right eyebrow under the glareshields.

ENG FIRE

Upon the illumination of the ENG FIRE warning light, promptly reduce the throttle to idle. This indication typically suggests an engine compartment fire. If additional signs of an engine fire are evident, such as visible smoke or flames, elevated FTIT, an illuminated OVERHEAT light, or unresponsive engine behavior, eject immediately. However, if no other indications of a fire are present, the likely cause may be a malfunction in the fire detection system. In such instances, prioritize landing as soon as possible.

TO/LDG CONFIG

This warning light indicates an incorrect configuration for landing or take-off. On the ground, when the landing gear handle is down, the warning light signals that the Trailing Edge Flaps (TEF) are not fully deployed, which is a rare occurrence in BMS. In such cases, it is advised to abort the aircraft.

In-flight, with the landing gear handle up, the light activates to alert the pilot of an incorrect configuration for landing. The warning light is triggered under the following conditions:

1. Altitude below 10,000 feet.
2. Airspeed less than 190 knots.
3. Descent rate of 250 feet per minute or more.

Simultaneously, the VMS warning horn will sound. To rectify the situation, cease the descent, accelerate, or deploy the landing gear handle if plnning to land.

When the landing gear handle is down in flight, the light signals a malfunction either in the landing gear or the TEF. To diagnose the issue, check the status of individual gear lights. If all three are green, indicating that the gear is fully down and locked, the problem is related to the TEF. In this scenario, execute a landing with a normal Angle of Attack (AOA), approximately 20 knots faster than usual.

If any of the gear lights are not green, it implies that the respective gear is not fully down and/or locked. Consult the "Landing Emergencies" chapter (3.8.3 LANDING WITH GEAR UNSAFE/UP) later in this section for further guidance.

CANOPY

The activation of this warning light signals that the canopy hooks or locks are not secured, or there has been a loss of cabin pressure. Descend below 10,000 feet and initiate a landing at the earliest opportunity.

FLCS

The FLCS warning light illuminates whenever there is a PFL warning message associated with the Flight Control System (FLCS). Please consult the Pilot Fault List (PFL) message for further details.

HYD/OIL PRESS

This warning light indicates a low-pressure condition in one or both hydraulic systems or a low engine oil pressure condition, requiring thorough checks:

1. Check the oil pressure gauge. If the pressure reads normal, the issue is not related to oil pressure. If the pressure is below 15 psi, indicating low oil pressure, limit throttle movement and initiate a prompt landing. Refer to section 2.1.13 on Oil Leak in the in-flight emergency paragraph later in this section. If on the ground, shut down the engine immediately and wait for the RPM to decrease below 20% before attempting a restart.

2. Examine the hydraulic system A & B gauges on the right auxiliary console and verify the pressure:

   - If only system A is below 1000 psi, it indicates a single system A hydraulic failure (refer to System A Hydraulic failure in the EP checklists).
   - If the system B gauge registers under 1000 psi, check the Emergency Power Unit (EPU):
     - If the EPU RUN light is off, there is a single system B hydraulic failure (refer to System B Hydraulic failure in the EP checklists).
     - If the EPU run light is on, inspect the ELEC SYS caution light:
       - If the ELEC SYS light is on, the problem is a PTO shaft failure.
       - If the ELEC SYS light is off, both hydraulic systems A & B have failed (refer to Dual Hydraulic failure in the EP checklists).

If both hydraulic indicators show less than 1000 psi with the EPU switch in NORM or running, indicating a total hydraulic failure, the aircraft will become uncontrollable once the EPU fuel runs out. If a landing cannot be executed before this occurs, ejection is the only viable option.

OXY LOW

The OXY LOW warning light activates when the On-Board Oxygen Generation System (OBOGS) Built-In Test (BIT) identifies a fault or when the regulator pressure drops below 5 psi. Refer to the OBOGS malfunction section for further details.

DBU ON

The DBU ON warning light becomes active whenever the FLCC operates in digital backup mode. In BMS, this occurrence is primarily for visual effect and takes place solely during DBU testing.

TF FAIL

Signals a malfunction in the Terrain Following Radar (TFR) system. Promptly execute a climb to reach a minimum safe altitude.

ENGINE

The ENGINE warning light indicates various engine-related issues such as engine flameout, alternator failure, over temperature, etc.

If the RPM is unusually low but not at zero, it signifies an engine flameout. Retard the throttle to off and initiate an air-start (refer to 2.1.7 Air Start chapter later in this section).

If the RPM is low and reads zero, an alternator failure has occurred.

If RPM is not unusually low but the FTIT is abnormally high, it indicates an engine over-temperature condition. Land as soon as possible.

If RPM is not unusually low and FTIT is not abnormally high, it may be an engine warning system failure or RPM/FTIT indicator failure. Land as soon as practical.

GEAR LIGHT HANDLE

The red light in the gear handle (lollipop) is also considered a warning light. It signifies a discrepancy in the landing gear or landing gear doors not aligning with the position commanded by the handle, unless the gear is currently in transit.

Under normal circumstances, this light should be illuminated while the gears are in transit.

If the light persists after moving the handle, it indicates a failure.

If the light remains on after raising the gear handle, it suggests that one or more gears has not fully retracted, or a landing door has not closed. Refer to 3.1.2 “LG Extension Malfunctions” in this document.

If the light stays on after lowering the gear handle, it indicates that one or more gears are not fully down and locked. Check the individual gear light to identify the specific one and refer to 3.1.2 “LG Extension Malfunctions” later in this document.

HUD WARN

The HUD WARN message activates whenever any of the warning lights illuminates. Please refer to the corresponding warning light and use the HUD WARN RESET switch on the ICP to reset the HUD.

1.4.4 Pilot Fault List Display (PFLD)

The PFLD, positioned on the right auxiliary console, serves the purpose of displaying a system code to identify the active fault. Two categories of PFLD messages exist:

Warning level PFL:

Associated with the FLCS, warning level PFL triggers the display of the PFL message and FLCS error code on the PFLD. Simultaneously, the FLCS FAULT caution light illuminates, the HUD flashes the WARN message, and VMS Warning is activated (“WARNING – WARNING”).

Caution level PFL:

Caution level PFL prompts the display of the PFL and error code on the PFLD. Additionally, the relevant caution light panel illuminates, and the MASTER CAUTION light is activated. VMS Caution is triggered (“CAUTION – CAUTION”).

To acknowledge and recall PFL, press the F-ACK button on the left eyebrow. It's important to note that multiple faults can occur simultaneously, requiring the use of the F-ACK button to toggle through additional PFLD pages for review.

- Acknowledging a caution level PFL clears it from the PFLD and extinguishes the relevant caution light.

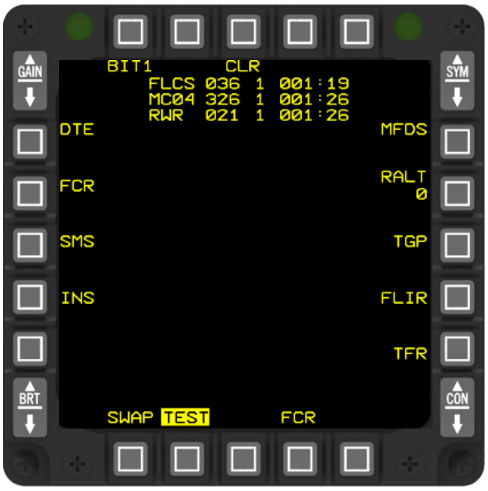
- Acknowledging a warning level PFL clears it from the PFLD, but the FLCS warning light remains ON.

Refer to chapter 7.1.3 and 7.14 of the Dash-34 for more details about PFL.

1.4.5 Maintenance Fault List (MFL)

The Maintenance Fault List (MFL) is a comprehensive compilation of faults accessible through the MFD TEST page. This list encompasses all information reported by subsystems indicating a fault. In comparison to the Pilot Fault List, which focuses on faults relevant to the pilot, the MFL offers greater precision and includes details of interest to maintenance personnel. While primarily designed for maintenance purposes, pilots can utilize the MFL to gather more detailed information about specific components within a failed system.

For a thorough understanding of MFL analysis, refer to chapter 7.1.2 of the Dash-34.



1.4.6 Voice Message System (VMS)

The Voice Message System (VMS) serves as an auditory warning system complementing visual warning and caution cues. To disable VMS alerts, use the VOICE MESSAGE INHIBIT switch on the right console. Adjust the VMS volume using the INTERCOM volume knob on the AUDIO 2 panel, affecting all sounds in the pilot's headphones according to the knob's position.

Follow this method for setting volumes effectively:

1. Adjust your Windows volume and headset/speaker volume as needed outside BMS.
2. Set your BMS UI sound volume to default.
3. Position all volume knobs mid-range and run the MAL & IND LTS test. While the test is ongoing, set your desired master headset volume with the INTERCOM volume knob.
4. Customize COMM 1, COMM 2, MSL, and THREAT volumes based on your preferences.

This approach provides finer control over in-cockpit volumes, avoiding the counterproductive MAX volume setting. With this method, you can fine-tune specific sounds, such as reducing Betty sounds with the INTERCOM volume while increasing relevant COMMS volume.

The "WARNING – WARNING" message activates automatically 1.5 seconds after any warning light illuminates.

The "CAUTION – CAUTION" message activates automatically 7 seconds after any caution panel light illuminates. Resetting the MASTER CAUTION light within 7 seconds inhibits the audio cue.

In addition to the WARNING and CAUTION messages, VMS provides specific voice messages:

- "ALTITUDE – ALTITUDE": Indicates descent after take-off, radar altitude below the CARA A-LOW setting, or barometric altitude below the MSL A-LOW setting.
- "BINGO – BINGO": Played when fuel quantity reaches the set Bingo amount in the UFC, with FUEL QTY SEL in NORM.
- "JAMMER": Played if CMDS REQJAM is activated, advising the use of the jammer and requiring pilot consent.
- "COUNTER": Advises initiating a dispense command in CMDS SEMI mode.
- "LOCK – LOCK": Indicates FCR has locked on a target.
- "PULLUP – PULLUP": Activated when the ground proximity warning triggers, signaling an immediate 4G pull to avoid terrain.
- "CHAFF – FLARE": Advises CMDS initiating a dispense program release (active if FDBK is turned on in the DED CMDS page).
- "LOW": Indicates expendables reaching their bingo level (if turned ON in the CMDS UFC page).
- "DATA": Played when the IDM receives data link information.
- VMS can also produce the LOW SPEED warning tone and Landing Gear warning horn.

VMS is inhibited with WOW but can be tested using the MAL & IND LTS test button, during which each word is heard once in sequence.

1.5 Before starting the Engine

As mentioned before, we recommend you execute all F-16 related starting procedures via the BMS checklists. Those checklists can be found in your documentation folder under *(/Docs/02 Aircraft Manuals & Checklists\01 F-16/F-16 Checklists*). In addition, we have all checklists for normal procedures included in the BMS 3D kneeboards (see in the picture below). There are two hotspots per kneeboard side which you can control with your mousewheel and/or keyfile callbacks:

One smaller area in the upper right corner and one bigger area one in the center of the kneeboard

The default pages featuring “NORMAL PROCEDURES” checklists on the right knee and KTO maps, navigation data and threat tables on the left knee. Before you start with the ramp start, follow the “COCKPIT INTERIOR CHECKS” as a part of your pre-engine startup procedure. When finished, the next step would be the “AFTER COCKPIT CHECK IS COMPLETE–VERIFY” checks. Once finished, move on to the “BEFORE STARTING ENGINE” section. We will go in detail now about this part of the startup procedure.

The pilot model can block some panel views. To deactivate it you can either through use the UI option (SETUP > GRAPHICS) or in 3D with a keystroke associated with a callback (default ALT c then p).

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

1. Note that all external lighting is implemented since 4.36.

You will not see the lights come on until the main generator comes online during engine start.

External lighting settings are as follows:

PROCEDURE	SCENARIO	MASTER COVERT	ANTI-COLL	POSI-TION	WING/TAIL	FUSE-LAGE	FORM(%)	AR (%)
RAMP	DAY – Good weather	NORM	1-4	STEADY	BRT	OFF	100	0

2. Moving up we quickly check the IFF panel to check that the CNI knob is turned to BACKUP. We move one step further up to the FUEL panel and check that the MASTER FUEL switch on the FUEL panel is positioned to MASTER and that the guard is down.

These should be correctly set at ramp. The ENG FEED knob though needs to be rotated to NORM to avoid fuel system malfunctions later on in the flight if the fuel pumps are left switched off. The TANK INERTING switch is not implemented in BMS.

3. Battery power is enabled with the MAIN PWR switch to BATT on the ELEC panel. The ELEC SYS caution light and the FAIL, MAIN GEN and STBY GEN lights (ELEC panel) should come on with battery power enabled. We need to test the battery by moving down to the TEST panel and holding the FLCS PWR TEST switch out of NORM to TEST. Please note when doing this with the mouse you must keep the mouse button depressed on the hotspot to simulate holding the switch or button in position.

While doing that the FLCS PMG and the ACFT BATT TO FLCS lights illuminate and the FAIL light turn off (ELEC panel). On the TEST panel the four FLCS PWR lights (ADBC) come on indicating good power output to the FLCC. The MAIN GEN and STBY GEN lights (ELEC panel) remain illuminated during the test.

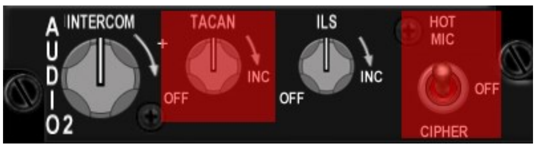
.

You can now release the FLCS PWR TEST switch (release the mouse button). The lights reset to their initial state. Leave the MAIN PWR switch in BATT for now; we will start the engines after we have finished the pre-start checks.

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

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

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



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

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

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

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

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

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

8. Proceed further aft right and place the ANTI-ICE switch to ON. Put it ON and not into AUTO. That is part of the ANTI-ICE TEST sequence.

1.6 Ground Emergencies

Before starting the engine and systems (see chapter 1.8), we need to consider certain failures included in BMS and suitable emergency procedures to avoid unsafe conditions. For further information, please refer to the F-16 checklists section “EP Ground”, Ground Emergencies.

1.6.1 Hung Start / No Start

A hung start occurs when the RPM ceases to increase beyond 25% but before reaching IDLE. However, in BMS, a genuine hung start is not implemented. Nonetheless, instances of NO START can arise, originating from two potential sources in BMS.

If the Jet Fuel Starter (JFS) initiates, but the RPM fails to increase after throttling out of CUTOFF or using the idle detent, this indicates a hardware issue with the throttle (likely improper calibration) or a problem with the idle detent keystroke. In such cases, it is advisable to abort the aircraft and inspect the hardware and configuration settings.

Since version 4.35 and the introduction of the START1 option for JFS, occurrences of NO START are more likely. The START1 option provides a 50/50 chance of JFS start. Failure to start the JFS with START1 is identified by the JFS run light remaining OFF beyond the usual 30 seconds required for it to illuminate and indicate proper JFS operation. Additionally, the RPM needle remains at zero.

In the event of such a failure, return the JFS switch to OFF. The initial attempt discharges only one JFS/Brake accumulator, leaving the second one available and charged. The pilot may choose to make a second JFS start attempt using either START1 or START2, both of which will utilize the last remaining JFS/brake accumulator. If the second attempt succeeds, both JFS/brake accumulators will recharge during subsequent engine operation. However, if the second attempt fails similarly to the first, the only recourse is to request ground crew assistance in recharging the JFS through the ATC menu. This process takes approximately 3 minutes and may incur a cost, typically in the form of a case of beer.

1.6.2 Engine Start In Battery

While not constituting an emergency, it is not unusual to observe virtual pilots attempting to initiate engine startup solely on battery power. A primary indicator of a battery start is the ELEC SYS light on the caution panel persisting throughout the engine start process (it typically extinguishes when RPM reaches 50% in a normal start).

However, numerous virtual pilots overlook this signal, only recognizing the situation when the avionics, including Multi-Function Displays (MFDs), and the Up Front Controller (UFC), refuse to commence. In BMS, a battery start may lead to hot or hung starts. Consequently, it is now imperative to initiate engine starts with MAIN power to avoid such complications.

1.6.3 Hot Start

BMS presents the potential for engine start failure due to pilot error. Prematurely advancing the throttle to IDLE before the Jet Fuel Starter (JFS) has propelled the engine to 25% RPM can result in a HOT START, marked by a rapid rise in FTIT (Fuel Temperature Indicator) exceeding the ground limits of 800°C (PW) or 935°C (GE).

During the engine start process, it is crucial for the pilot to exercise patience, allowing the RPM to reach 25% before transitioning the throttle to IDLE. Continuous monitoring of the FTIT temperature is essential. If the temperature rapidly climbs to 750°C and beyond, indicating a hot start, immediate shutdown of the engine is imperative. Neglecting to interrupt the engine start process can lead to engine damage, potentially resulting in an engine fire with FTIT surpassing 1000°C. The presence of smoke around the aircraft is indicative of engine damage.

Upon returning the throttle to the CUTOFF position (engage the idle detent if necessary), it is recommended to keep the JFS running, as it aids in cooling down the engine. Allow the FTIT to decrease to 200°C before advancing the throttle to IDLE for another engine start attempt.

Furthermore, there exists a slight, random possibility of a HOT START occurring even without pilot error. Hence, it is now mandatory to closely monitor FTIT during the engine start and intervene promptly if required.

Note: The JFS has operational limitations on the ground. After running for 4 minutes, the JFS will begin to overheat, indicated by the JFS light flashing once per second. After 8 minutes, the JFS will fail (light flashing twice per second), rendering the engine unstartable. To prevent this, the pilot should shut down the JFS if necessary to allow it to cool (the light will stop flashing when adequately cooled) and then request the crew chief to spend 3 minutes recharging it through the ATC > Ground menu page.

1.6.4 Oil Pressure

During a ramp start, it is imperative for oil pressure to reach a minimum of 15 psi. If the pressure remains below 15 psi and the HYD / OIL warning light remains illuminated as the engine RPM reaches 35%, take immediate action to prevent engine seizure and/or fire by shutting down the engine (return the throttle to CUTOFF - engage the idle detent if necessary).

To address the fault, attempt to clear it by allowing the engine RPM to drop below 20%. Initially, leave the Jet Fuel Starter (JFS) on to assist in cooling the engine. As RPM approaches 25%, turn off the JFS to facilitate the engine RPM falling below 20%.

Once the RPM has fallen below 20%, you can proceed with recommencing the engine start procedure. If the JFS fails to start, request your crew chief to recharge it through the ATC > Ground menu page.

1.6.5 Anti-Skid Malfunction

The failure of the ANTI-SKID brake protection system is signaled by the illumination of an ANTI-SKID caution light on the ground when the ground speed exceeds 5 knots. This malfunction results in diminished braking effectiveness and an extended stopping distance, with a 50% increase when employing differential braking and a 25% increase when not utilizing differential braking.

To deactivate the ANTI-SKID system and clear the CAUTION light, select BRAKE CHANNEL 2 and set the ANTI-SKID switch to OFF (note that the ANTI-SKID always remains partially active on CHANNEL 1).

In instances where there is uncertainty about the ability to bring the aircraft to a halt due to an ANTI-SKID malfunction and a slippery runway, it is advisable to plan for engaging the arrestor wire and consult the cable arrestment section in chapter 3.2.8

1.6.6 Equip Hot Caution Light

If the EQUIP HOT caution light becomes illuminated during a ramp start, inspect the AIR SOURCE knob to ensure it is set to NORM. If the AIR SOURCE was not in the NORM position, the Environmental Control System (ECS) cannot deliver cooling to the avionics. If the EQUIP HOT caution light persists one minute after adjusting the AIR SOURCE to NORM, deactivate all nonessential avionics and initiate an aircraft abort.

1.6.7 FLCS BIT Failure

The indication of a FLCS BIT failure is signaled by the illumination of the FAIL light on the FLCS panel, accompanied by pertinent information on the FLCS Multi-Function Display (MFD) page and Pilot Fault List (PFL) messages. The sole resolution for a failed Built-In Test (BIT) is to rerun the FLCS BIT. During this process, both the RUN and FAIL lights will be illuminated. Upon completion of the new FLCS BIT, the FAIL condition may potentially clear. Should the FAIL condition persist, execute additional BIT attempts until the issue is resolved.

It is important to note that if any of the FLCS switches were not in the down position before initiating the test, the BIT is likely to fail. With the introduction of version 4.35, a new FLCS fault may occur during the ramp phase, and if not promptly cleared, it has the potential to result in repeated FLCS BIT failures.

1.6.8 NWS Failure

The occurrence of Nose Wheel Steering (NWS) failure is signaled by the illumination of the NWS FAIL caution light. In the event of such a failure, refrain from engaging NWS, as a malfunction may lead to sudden turns, tire skidding, blowouts, and departure from the paved surface. Utilize the rudder and brakes as necessary for ground steering.

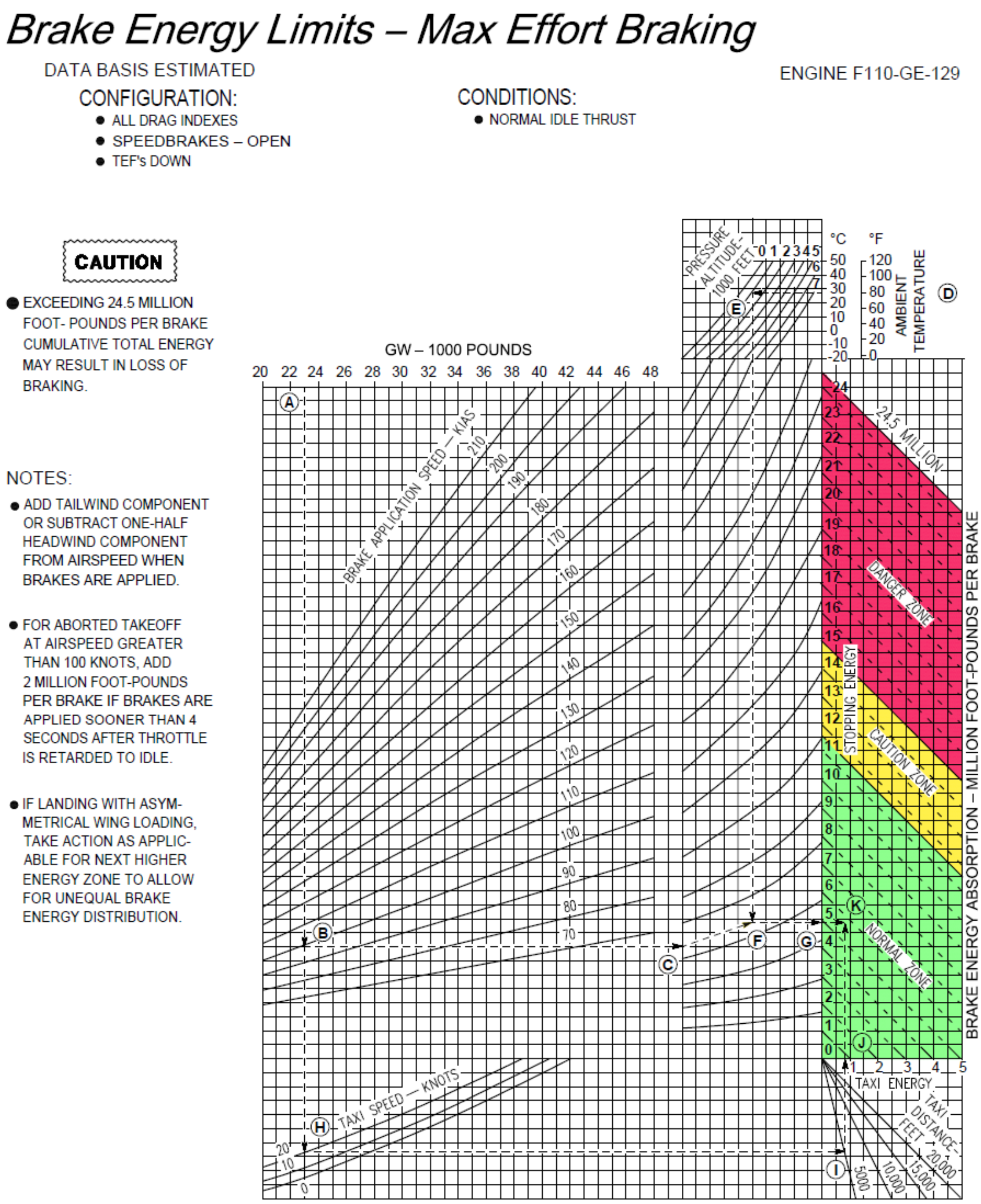
Exercise caution when employing differential brakes for steering, as there is an increased risk of generating excessive heat in the brakes.

Additionally, it is essential to note that NWS should not be employed at speeds exceeding 70 knots. Doing so may result in abrupt turns, tire skidding, blowouts, and departure from the paved surface. Adhering to this speed limit is crucial for maintaining control and safety during ground operations.

1.6.9 Hot Brakes

It is incumbent upon the pilot to ascertain the presence of a hot brake condition. BMS now incorporates precise modeling of actual F-16 brake energy limits, determined by factors such as gross weight, temperature, pressure altitude, and the airspeed at which an abort or landing braking is initiated.

Refer to following the chart for detailed brake energy limits:



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

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

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

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

Following braking, it takes between 5 and 9 minutes (randomly determined) for brake energy/heat to accumulate. Failures stemming from a hot brake condition may occur during this interval, contingent upon the amount of energy accrued.

Continuous monitoring of brake energy occurs during taxiing, with the highest buildup observed during prolonged taxis at lower gross weights, where brakes are frequently applied to control speed. For instance, taxiing with a gross weight of 20,000 lbs at 10 knots over a distance of 20,000 ft results in approximately 4.3 million ft-lbs of energy absorbed per brake. Heavier weights and increased speeds use less energy over the same distance. It's crucial to recognize that heat and energy dissipate over time, and consecutive rejected take-offs with maximum braking may place the aircraft at risk.

If a hot brake condition is suspected, minimize brake usage, attempt to stop, and secure the aircraft in the nearest designated hot brakes area (avoid using the parking brake). Turn off the Emergency Power Unit (EPU), retard the throttle to OFF to shut down the engine (as hot brakes present a fire hazard), and subsequently turn the MAIN Power switch OFF.

A BMS hot brake scenario may lead to various outcomes depending on the amount of energy the brakes absorbed, such as blowing tire fuse plugs causing flat tires, brake hydraulic pressure line failures resulting in reduced or complete loss of brake reaction, and more severe situations like main gear tire fires, hydraulic fluid fires, exploding tires, and complete gear failure.

1.7 MFL management at Ramp Start

It is common to encounter faults during the ramp start sequence, and multiple faults may be reported until all systems are fully operational. These faults will automatically clear as the systems come online or when the pilot activates and checks various systems.

Once the aircraft is prepared for taxi, the pilot can reset the Maintainance Fault List (MFL) by pressing OSB 3 on the TEST page. This action cleans the MFL, facilitating better tracking of any in-flight faults that may arise.

Clearing the MFL initiates a comprehensive assessment of all existing malfunctions, identifying and reporting persistent faults within the system. If a fault persists after MFL clearing, it will be displayed again on the TEST page. If the affected system has been shut down, the fault cannot be reported, and the TEST page will not display that specific fault report.

After take-off, when the aircraft reaches 120 knots with the gear up, a pseudo fault called "TOF" is generated to record the take-off time. It's important to note that if the MFL is cleared during flight, the TOF pseudo fault will be replaced by the mission time at the moment of MFL clearing.

If the flight proceeds without any malfunctions, the next pseudo fault generated will be the landing fault (LAND), recording the landing time when the airspeed drops below 80 knots with the gear down.

1.8 Starting the 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 require a running engine to provide power to the buses. Please note one of the common mistakes is to start the jet in BATT which prevents some systems from coming online later as the main generator is not online and may cause engine start issues. So make sure you start this sweep with the MAIN PWR switch in MAIN PWR.

2. Moving forward you can close the canopy. The canopy features a motor switch to lower or raise the canopy and a switch guard commonly referred to as the "yellow spider" that locks and seals the canopy in place and start the pressurization.

Both are now functional in BMS. To lower the canopy right click on the canopy switch (and hold it) until the canopy is completely lowered. Please note: Its downward movement can be stopped at any time if the switch is replaced in its center position.

With the canopy down, you must lock and seal it which is done by moving the yellow spider outboard. Once the spider guards the canopy motor switch, you will hear the ECS starting and the CANOPY warning light on the right glare shield will extinguish.

3. Ensure the canopy is fully closed before engaging the JFS. Closing canopy during JFS operation may result in a failed JFS start or premature JFS shutdown due to a reduction in electrical power available to the JFS. Check your throttle for its correct position (cut-off) then move on to the ENG & JET START panel. The JFS switch is moved to START2 with a right-click or START1 with a left-click. START1 will use only one JFS/Brake accumulator and provide a 50% chance of engine start. START2, normally used in cold weather condition gives a better chance of engine start as it uses both JFS/brake accumulators simultaneously to start the engine. The benefit of using START1 is that in case of failure, you have another 50/50 chance of engine start by reusing START1 which will then use the remaining JFS/Brake accumulator. In case of depletion of both JFS/Brake accumulators, the JFS must be manually recharged (which is possible through the ATC menu) the JFS RUN light comes ON after a few seconds and engine RPM increases steadily to 25%. At that point check that the SEC caution light is off and move the throttle forward to your IDLE detent (or click the idle detent) and monitor lights and engine gauges:

- SEC caution light goes off around 20% RPM (**before** moving throttle).
- HYD/OIL PRESS light (right eyebrow) goes off between 30 and 35% RPM. If the light stays on and your oil pressure remains below 15 psi you have an oil pressure fault; shut down the engine immediately (pull the throttle back to CUTOFF).

- FTIT should increase to around 600-650° then decrease to 500° at idle. If you see FTIT rising at an alarming rate or go above 750°C you are encountering a hot start; immediately pull the throttle back to CUTOFF and let the FTIT decrease to 200°C while the JFS is running, before moving the throttle back to IDLE. See also Dash-1 chapter 38.3 GROUND EMERGENCIES for more information on this scenario.

  In a good engine start FTIT increases steadily with engine RPM: 40%RPM=400°C FTIT, 50%RPM=500°C FTIT, ... Experienced pilots can detect a hot start very early as the rate of FTIT increase is not proportional to RPM but much faster.

- FLCS PMG light (ELEC panel) goes off around 40-45% RPM.

- JFS shuts off around 55% RPM (the switch automatically snaps back to OFF).

- ENGINE light (right eyebrow) and STBY GEN light (ELEC panel) go off around 60% RPM and MAIN GEN light (ELEC panel) goes off about ten seconds later.

With the engine running steadily you can check the remaining engine gauges such as fuel flow (700-1700 PPH), nozzle position (greater than 94%), FTIT (usually below 650°C but never above 800°C), HYD A & B pressure (at the 12 o'clock position) and 3 green gear lights.

4. Move back to the TEST panel and test PROBE HEAT, FIRE and OHEAT detection and MAL&IND Lights system.

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 as advertised you can place the switch to OFF again. We will come back later to test the EPU and the oxygen system.

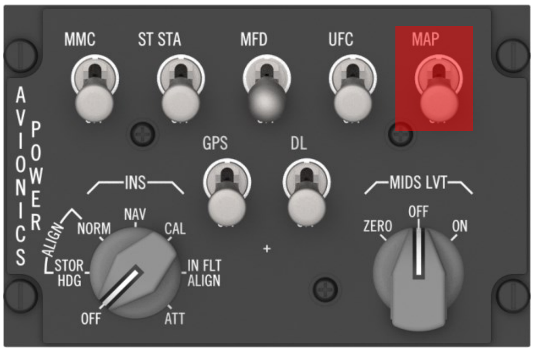
5. Before powering up sub-systems, it is recommended to check the EPU operation.
EPU testing may provide a surge in the electrical system and is best done before providing power to the avionics.
The EPU is safed during engine start to prevent automatic EPU start up.
Before testing the EPU, the ground crew must remove the EPU safety pin.
This is done after engine start through the ATC menu (Ground page). Please note you must be on the ground ATC frequency.
Once the crew chief has removed the EPU pin the status message in the top right corner of your screen will disappear.
Once the EPU pin is removed, move to the EPU panel and cycle the EPU to OFF and back to NORM. With the mouse make sure you use a right-click to move it from NORM to OFF; a left-click would engage the EPU which should be avoided on the ground. The real reason is of no significance to us; hydrazine is toxic to your ground crew 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 just above 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 second

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.

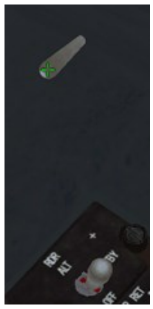
This check can be omitted as, with the EPU switch in the NORM position, the system will run automatically whenever needed.



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

For this training, please ignore the MIDS LVT knob and keep it in the OFF position. L16 will be part of training TR 17C. Let's sweep back to the other side:

7. 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. In this training mission the chin pods may remain unpowered.



8. The up/down position of the pilot seat can be adjusted with a switch on the right-side wall just outboard the SNSR PWR panel.
You may adjust the position at any time but this is a good moment to set it as desired. Normally real pilots place their fist over their helmet and raise the seat until their fist touches the canopy.

9. Moving to the center 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.

10. 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.

It is common to have an FLCS fault at engine start because the FLCS detects a low pressure and assumes the ISA failed. Some pilots automatically reset the FLCS after engine start, even before the PFLD is able to report the FLCS fail message. Others may wait till the PFLD is powered and starts to report this fault. Either way you may need to reset the FLCS to clear the fault.
Also clear the MFL (Maintenance Fault List) on the MFD TEST page with OSB 3. The PFLD will display common ramp start faults which will clear as systems come online.

11. Move back to the left console and the IFF panel.
Simply set the IFF MASTER knob in STBY and rotate the CNI switch from BACKUP to UFC so you can start using the primary onboard systems.

With that done the Up Front Controller comes online and it is suggested that you load up the data cartridge into the system before you set up the radios through the UFC. The DTC contains all the information that was set in mission planning. In real life the pilots carry it with them and load into the DTC receptacle on the right console. In BMS we load the DTC by selecting the DTE page on the MFD and selecting the LOAD button (OSB 3).

The reason we load the DTC **before** setting the UFC radios is that since the DTC has a comms section, the presets might be different than the ones pre-briefed. If you load the DTC after setting the UFC radios, you might not be on the correct frequency anymore.

You might actually load the DTC, even before switching the C&I switch to UFC. For more information about the data cartridge refer to the DTC section in the BMS User Manual.

Airbases have multiple frequencies for Ground Ops, Ground, Tower and Approach/Departure. By default, DTC assigns common UHF presets to these frequencies according to your home airbase. Ground Ops is always preset #1, Ground is always preset #2, Tower is always preset #3 and Approach/Departure is always preset #4. Please note: Approach and Departure are often on the same frequencies in real-life too.

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

The way to communicate with AI or human pilots in your flight also changed with the latest radio code update. The first flight in the package will usually be assigned VHF preset #15, the second #16, third #17 and so on. AI (Wingmen, ATC, AWACS, Tanker, JTAC) will **only** be able to communicate with you if you are on the same frequency, just as in real-life. If you see a wingman comm menu entries not highlighted, you're not on the correct frequency to communicate with them.

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

COMM LADDER:

AGENCY:	CALLSIGN:	UHF [CHNL]:	VHF [CHNL]:	NOTES:
INTRA-FLIGHT:	Goblin2	330.700 MHz	136.350 MHz	Flight Management Comms
GUARD:	None	243.000 MHz	121.500 MHz	Distress / Emergency
COMMON:	None	339.750 MHz [14]	119.500 MHz [13]	Advisory / UNICOM
BASE OPS:	None	304.800 MHz [1]	--	Homeplate Operations
TACTICAL:	None	337.800 MHz	--	Package Comms
DEP ATIS:	Gunsan ATIS	--	120.225 MHz	Departure Airbase
DEP GROUND:	Gunsan Ground	273.525 MHz [2]	--	Departure Airbase
DEP TOWER:	Gunsan Tower	292.300 MHz [3]	126.500 MHz [3]	Departure Airbase
DEP DEPARTURE:	Gunsan Departure	292.650 MHz [4]	--	Departure Airbase
ARR ATIS:	Gunsan ATIS	--	120.225 MHz	Recovery Airbase
ARR APPROACH:	Gunsan Approach	292.650 MHz [4]	--	Recovery Airbase
ARR TOWER:	Gunsan Tower	292.300 MHz [3]	126.500 MHz [3]	Recovery Airbase
ARR GROUND:	Gunsan Ground	273.525 MHz [2]	--	Recovery Airbase
ALT ATIS:	Seosan ATIS	--	130.300 MHz	Alternate Airbase
ALT APPROACH:	Seosan Approach	253.950 MHz [10]	--	Alternate Airbase
ALT TOWER:	Seosan Tower	353.100 MHz [11]	126.750 MHz [11]	Alternate Airbase
ALT GROUND:	Seosan Ground	275.800 MHz [9]	--	Alternate Airbase

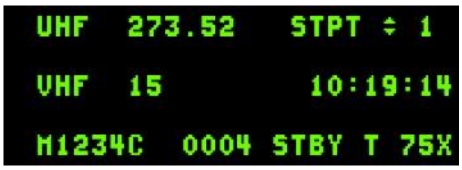
As per brief, let's input Uniform (UHF) Ground & Victor (VHF) 15 in the UFC radios:

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

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

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

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



1.9 Checks and Avionics setup

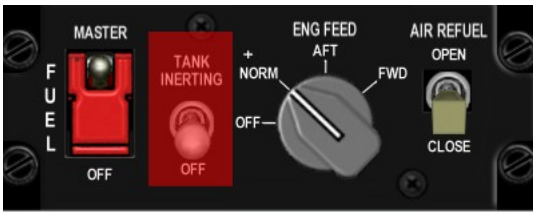
1. Start again at the far left of the cockpit with the FLCS BIT on the FLCS panel. Before doing so cycle and check the flight controls (stick and rudder) to assist in warming up the hydraulic fluid and removing air from the system. Check that all FLCS panel switches are down. If the MANUAL TF FLYUP switch is up for example the FLCS BIT (built in test) will fail.

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

The next check is usually Digital Backup operation. 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.

2. Move down to the MANUAL TRIM panel. A good habit is to always check that all needles are centered, especially if you have a real cockpit where the knobs might be in a different position. 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-center.
Failure to set the trims properly may cause problems during or immediately after the take-off roll.
These checks may appear like eye candy, but as asymmetric drag is implemented in BMS ensuring proper trim settings before take-off is strongly advised!

3. If your mission could include air-to-air refueling 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.



4. 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.

5. 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.

Performing the SEC check, nozzle closing & opening

6. The next step is to check proper speedbrakes operation. Open the speedbrakes with the slider on the throttle and check the SPEED BRAKE indicator on the left auxiliary console. Remember that it takes about two seconds to open and six seconds to close; ensure that it is closed before you taxi.

7. The defense 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.

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

The PRGM knob can be set to any program (preset through DTC) you like, and you should rotate the MODE knob as desired or pre-briefed. Once all is set correctly, the GO status indicator should come on, telling you that all systems are ready to be deployed.

9. Moving up to the gear panel; quickly set CAT I or III according to your loadout (check the STORES CONFIG caution light), check brake channel set to channel1, brake switch to ANTI-SKID, gear handle down and confirm that all three gear lights are green.

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

Depress the SYS TEST button and check the indication on the RWR displays. Then check the MSL LAUNCH indicator and AUDIO by depressing the indicator. Once satisfied the system is running normally depress the HANDOFF button. That sets the RWR to diamond float mode. This item is often overlooked and if omitted will prevent the RWR suite from warning you properly of threats.

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

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

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

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

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

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

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

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

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

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

13. 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%.

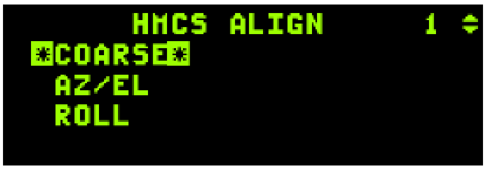
14. The next step in this sweep is to confirm that the INS is fully aligned by checking to see if ALIGN is flashing in the lower left corner of the HUD. If so, toggle the INS knob from ALIGN NORM to NAV on the AVIONICS POWER panel. From that moment, all navigation cues will be displayed. The aircraft lights can be set for taxi. Switch your taxi light and the anti-collision light on and set the WING/FUS lights to FLASH. Please note, taxi/landing light is now correctly implemented. You have two different positions on the LIGHTS switch.

15. The ANTI-ICE system needs to be checked. Remember the ANTI-ICE has been put to ON earlier in your ramp start sequence and is therefore now running since engine start. ANTI-ICE operation decreases performances and increase FTIT temperature. To check that the ANTI-ICE was running properly we will set it OFF and check that the FTIT decreases by at least 10°. In BMS it translates to a temperature difference of about 40° which is quite visible and perfect for checking proper ANTI-ICE operation. Once you can confirm that the FTIT decreased a bit after turning OFF ANTI-ICE you know that ANTI-ICE was operating normally. Now put the switch to AUTO to ensure automatic ICE accumulation detection and automatic ANTI-ICE protection whenever needed. Please note the image on the right shows 500°/540°C but the FTIT may vary, so check the temperature variation rather than the actual temperature.

16. The second to last Item to check is Oxygen / OBOGS proper operation. This has to be delayed until the engine has run IDLE for at least 2 minutes but that is the case here.

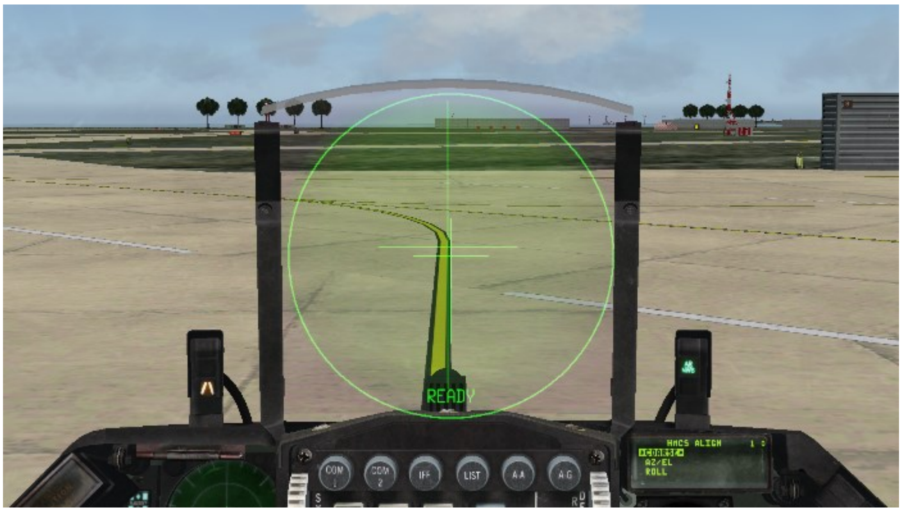
Move the OBOGS TEST switch to BIT on the TEST PANEL (far left) and check that the OXY LOW warning light on the right glare shield comes ON for 10 seconds and then extinguishes. Normally the pressure dial would be checked, and the red and white lever would be placed to NORM but in BMS only the green lever is implemented. Placing it to ON activates oxygen supply in the mask (and activates pilot breathing sounds) and prevent hypoxia when the pilot remains for a long time at high cabin pressure altitude. It may also help with pilot’s G tolerances.

17. The final step is to power up, align and check the HMCS. Power on your HMCS on the HMD panel on the left auxiliary console. Simply turn the symbology knob clockwise and change the brightness to your taste and external conditions.
Since 4.36 you have to align the HMCS to use it properly and get accurate HUD information. If able, a 15-minute warm-up is required for optimal alignment. This alignment process must be redone constantly during the flight (every 15-20 minutes) and after certain conditions like heavy G maneuvers, etc. The offset between HUD and HMCS data can be significant when the alignment process is not executed properly. After the recommended warm-up time open your HMCS Align page on the DED (LIST->MISC(0)->HMCS->SEQ). There are three alignment modes available. We start with the COARSE mode. When mode select (M-SEL) is depressed with the asterisks around the COARSE label, COARSE ALIGN boresight is entered and the following occurs:



• COARSE label is highlighted on the DED.
• HMCS shows READY.
• HMCS displays the coarse boresight cross.
• HUD displays an aligning cross in the center total field of view.
• SOI disappears.

Move your head to match the HMCS cross with the HUD cross. Press "TQS: RDR CURSOR - Cursor Enable" to start the alignment process.



The HUD indicates “Aligning”. Hold your head position so both crosses are matching as close as possible.

When the alignment is successfully done, the HUD will show “Align OK” or “Align Fail” if not successful.

Press M-SEL again to de-highlight and exit the COARSE mode after your alignment.

The other two alignment modes are used for fine-alignment. This is especially important when using the HMCS for A-G operations (creating A-G markpoints is possible since 4.36).

When M-SEL is depressed with the asterisks around the AZ/EL label, the AZ/EL boresight mode is entered and the following will occur:

• AZ/EL label highlights in the DED.
• HMCS displays FA DX DY.
• HMCS shows two alignment crosses along with four edge-of-display segments.
• HUD displays an aligning cross in the CTFOV.
• SOI goes away (cursor slew affects boresight only).
• HMCS display stabilizes on the HUD.

Deflection of the cursor (X/Y) slews the two crosses to align them on the HUD borecross.

Press M-SEL again to de-highlight and exit the AZ/EL mode after your alignment.

When M-SEL is depressed with the asterisks around the ROLL label, the ROLL boresight mode is entered, and the following occurs:

• ROLL label highlights.

• HMCS displays FA DROLL.

• HMCS displays two alignment crosses along with 4 edge-of-display segments.

The cursor action for DROLL is left and right. Cursor inputs to the left move the lower fine alignment cross to the left, resulting in clockwise rotation and cursor inputs to the right move the lower fine alignment cross to the right, resulting in counterclockwise rotation.

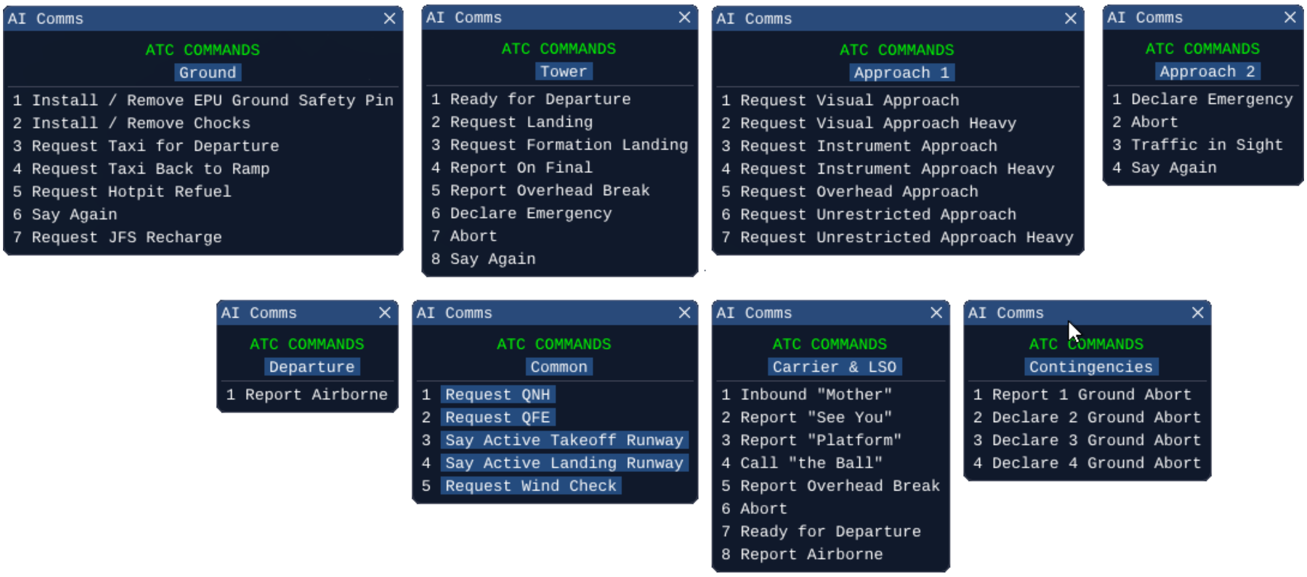
Press M-SEL again to de-highlight and exit the ROLL mode after your alignment.

Note that it is recommended to execute the COARSE alignment pre take-off and the AZ/EL + ROLL fine alignment post take-off. Fine alignment needs to be executed every 15-20 minutes.

The ramp start is now complete.

Arm your ejector seat and enable nose-wheel steering; confirm NWS is illuminated on the right indexer. Apply toe-brakes or set parking brakes and ask the ground crew to remove the chocks via the ATC menu (t 2). The ATC menu has 7 pages relevant to Ground, Tower, Approach and Departure, Common Carrier and Contingencies. Pages are toggled with subsequent (t) presses. Available options are highlighted with a corresponding number. Hitting the relevant keyboard alphanumeric keys will select that option and close the ATC menu. The menu can also be closed with the ESCAPE key.

Note that since 4.36 the comms windows can be now positioned anywhere on your 3D window using your mouse.



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

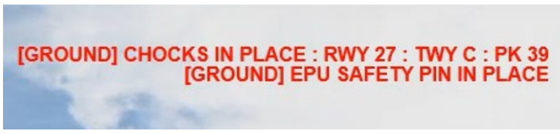
Each airbase has an ATIS VHF frequency. Gunsan ATIS is 120.225. Enter this frequency in the COM2 radio (VHF) and listen to the automated broadcast. ATIS will give you the name of the airport, the active runway, the wind, visibility and clouds (sky condition if you use *set g_bUseATISColorCode*) temperature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

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

1.10 Taxi

Your ramp-start is completed, and you are ready to taxi. ATC will provide information about the expected taxi time on UHF 2. This is an informal message and does not require confirmation by the flight lead on UHF. This call doesn't indicate that you have clearance for taxiing yet. Always wait for ATC to give you clearance. Normally you should be ready no later than 6 minutes before the fragged take-off time.

Since 4.37 you get detailed information where you are located at each airbase when you are entering 3D.



You get information about the parking spot number (see on the right: "PK 39") as well as the taxiway you are located at ("TWY C") and which runway is active ("RWY 27"). Use the Airport Parking Chart "APC" to verify where you are located. Please note that this info is only visible when you installed your chocks.

The Crew Chief just removed the chocks and gave you a salute. From now on the jet is yours and you must 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 Gunsan ground for clearance to taxi. The ATC usage is explained in the BMS Comms-Nav-Book. Refer to: *Part 1: The BMS Air Traffic Control.* We recommend having your charts for Gunsan handy as well. The chart usage is explained in the BMS Comms-Nav-Book. Refer to: *Part 4: Falcon BMS Chart Review.*

Set your nose gear light to: TAXI. External lighting settings are as follows:

PROCEDURE	SCENARIO	MASTER COVERT	ANTI-COLL	POSI-TION	WING/TAIL	FUSE-LAGE	FORM(%)	AR (%)
TAXI	DAY – Good weather	NORM	OFF	FLASH	BRT	OFF	100	0

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

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

In the early days of training, it is 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.

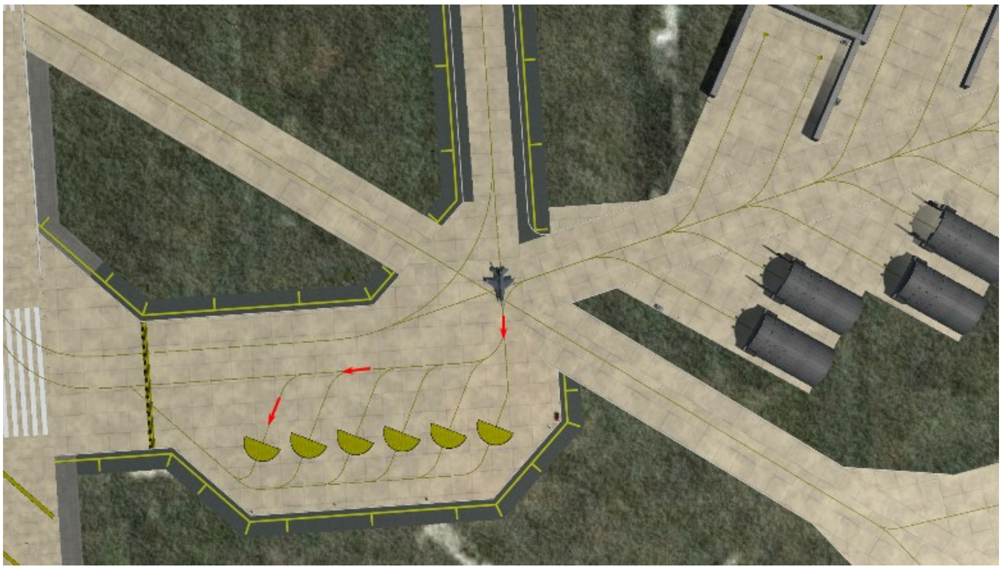
All BMS charts are located in the *Docs\03 KTO Charts* folder of your BMS install.

As you see on the chart, the 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 centerline. Turn left on the taxiway and align your nose with the yellow centerline.

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

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 overused. This may lead to wheel fires or blown tires. One should taxi slowly and avoid constant brake use. It's better to manage the throttle correctly rather than to have a too high setting and then needing to brake often. Maximum groundspeed might change from one country to another and according to the peace/war situation, but generally you should stay below 25 kts in straight lines and 10 kts in turns.

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



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

Once arrived at the EOR (see picture above: red arrows marking your taxi route), set your nose gear light to: OFF. External lighting settings at EOR are as follows:

PROCEDURE	SCENARIO	MASTER COVERT	ANTI-COLL	POSI-TION	WING/TAIL	FUSE-LAGE	FORM(%)	AR (%)
EOR	DAY – Good weather	NORM	OFF	STEADY	BRT	OFF	100	0

The correct parking position for each aircraft at the EOR (if available) is shown below. The nose wheel touches the edge of the EOR. The yellow area is the arm/de-arming area for the ground crew. Since 4.37, we have detailed EOR procedure charts in your docs folder which shows you the arm- and de-arming route for each EOR.

Upon arriving at EOR, the Ground Controller will call you and instruct you to switch to the Tower frequency. You don't have to do it right away; it's at your discretion whenever you are ready. You may elect to first do your EOR checks.

The aircraft systems are unable to give you the wind speed and direction while the aircraft is on the ground. To plan your take-off properly you should be familiar with surface winds. Monitor local conditions by listening to the ATIS (319°, 13 knots gusting 22 kts) but as illustrated in the picture below, look at the windsocks at each runway end of all airbases (their location are marked on the airport charts as well). A quick look at these should give you the wind direction and approximate speed. The Tower Controller will also advise you of wind conditions when you are cleared for take-off.

Once you have completed the "before take-off" checks, switch to Gunsan Tower (remember you have already been cleared to switch frequency). Input 292.3 or use preset #3 in COM1 and let the Tower know you are ready for take-off via the ATC menu tower page (t t 1).

Tower will then instruct you to hold short runway 36, line up and wait, or clear you to take-off.

Once you are leaving the EOR and taxiing to hold short, set your nose gear light to: LANDING.
External lighting settings at EOR are as follows:

PROCEDURE	SCENARIO	MASTER COVERT	ANTI-COLL	POSI-TION	WING/TAIL	FUSE-LAGE	FORM(%)	AR (%)
LINEUP	DAY – Good weather	NORM	1-4	FLASH	BRT	OFF	100	0

Those settings remain the same till you are land in mission 3 and entering the EOR again.

1.11 Takeoff Emergencies

Before taking off (see chapter 1.12), we need to consider certain failures included in BMS and suitable emergency procedures to avoid unsafe conditions. For further information, please refer to the F-16 checklists section “EP Takeoff”, Takeoff Emergencies.

1.11.1 Abort / Rejected Takeoff

Typically, with the F-16's short take-off distance capability, aborting a take-off should not pose a challenge unless there is an issue with directional control, such as a blown tire. Optimal outcomes result from making an early decision to abort. Whether aborting before or after rotation, careful consideration of multiple factors is essential: remaining runway length, runway conditions (wet or dry), availability of barriers, and the aircraft's gross weight, among others. In many cases, it may be preferable to proceed to a high or low key position after rotation and address the emergency during flight. Contemplation of aborting after rotation should occur only if reaching a key position in flight is not feasible.

During an abort, throttle should be retarded to idle, and maximum ANTI-SKID wheel braking should be applied with full pedal pressure while maintaining directional control. Once the nose wheel is on the ground, apply maximum braking effort, including full aft stick, fully opened speedbrakes, and maximum wheel braking. Nose Wheel Steering (NWS) should only be engaged if maintaining directional control becomes problematic.

If the runway is equipped with arrestment cables, deploy the hook and engage the cable as close to the runway centerline as possible.

It is advisable to follow the hot brakes procedure after any abort, as taxiing post-abort increases the likelihood of hot brakes.

1.11.2 LG Fails To Rectract

If the landing gear handle warning light persists after moving the handle up, it indicates that the landing gear or landing gear doors are not fully retracted. In BMS, this may be a result of overspeeding the jet with the gear down (>305 knots). In such a case, promptly reduce speed to below 300 knots and return the gear handle to the down position.

If the landing gear deploys normally, prioritize landing as soon as possible. Avoid attempting to retract the gear, as this may cause additional damage and hinder further gear extension.

In the event that the landing gear does not indicate down, further reduce speed to below 190 knots and utilize the alternate gear extension handle. Note that Nose Wheel Steering (NWS) is not available after an alternate gear extension.

Once the gear indicates it is down and locked, seek visual confirmation (if flying multiplayer) and proceed with a normal landing. Utilize differential braking for directional control if available.

If the gear still indicates it is unsafe, apply alternating G forces (-1.0 to +3.0G) to attempt to free the locked landing gear.

Consider landing with the landing gear unsafe or up, or opt for ejection. If landing is inevitable, divert to a runway with minimal crosswind, retain wing fuel tanks (if carried), jettison all armament and centerline stations (if possible). Ensure wing fuel tanks are empty and reduce gross weight by burning fuel. If immediate landing is necessary and wing fuel tanks cannot be emptied, jettison them after depressurizing the wing tanks by opening the AR door.

Switch off the FCR, ST STA & HDPT power, and ECM power. Extend alternate flaps, place the EPU to ON, and execute a low-angle approach at 13° AOA, setting the throttle to CUTOFF immediately before touchdown.

If the gear handle will not raise, a WOW switch failure may be the cause. The gear handle can be mechanically bypassed using the DN LOCK REL button. Depress the button and immediately attempt to raise the handle.

It is crucial to keep the handle position synchronized with the actual gear position. A gear handle UP position restricts BRAKE CHANNEL 1 functionality, with only BRAKE CHANNEL 2 available for braking.

If the landing gear handle has been raised, attempt to lower it when ready for landing. The DN LOCK REL button may need to be used again if the handle does not lower. If the landing gear handle still does not lower, select BRAKE CHANNEL 2 and extend the ALT FLAP switch. Note that ANTI-SKID may not be available upon landing, and wheel braking will only function if Channel 2 is selected.

Important note: In the Block52 PW engine F-16, the nozzle remains closed during landing, resulting in higher-than-normal landing thrust. This behavior is implemented in BMS since version 4.35. The nozzle of the Block50 GE engine F-16 is not affected by the landing gear handle position.

1.11.3 Blown Tire On Takeoff

Identifying a blown tire condition can be challenging, as the loss of directional control may be mistaken for crosswind effects.

Choosing to abort take-off may present greater risks than continuing, especially if the aircraft's speed is already considerable. If the decision is made to continue the take-off, refrain from retracting the landing gear, reduce the gross weight, and plan to land at the earliest practical opportunity (see Chapter 3.2.1 on “Landing with a Blown Tire” later in this section).

In the event of an aborted take-off, make every effort to maintain directional control using rudder, differential braking (if available), and Nose Wheel Steering (NWS) when at control speed. Bring the aircraft to a stop straight ahead and proceed to shut down the engines. Avoid further taxiing unless it is an emergency situation.

1.12 Takeoff

Line up on the active runway magnetic heading (referenced on the charts). If you are a single ship like in this flight, you will use the centerline, otherwise, your position will depend on how many aircraft there are in your flight and on the briefed departure type. Normally, the flight lead lineup on the 'downwind' side of the runway.

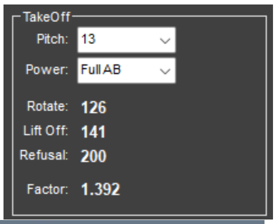
Please note: the ATC code instructs AI to take-off in 2-ship elements by default, but you may instruct them to line up as a 4-ship with either #3 or #4 in the slot. Your position as lead should always be downwind to avoid the wind pushing your aircraft into the path of your wingmen.

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

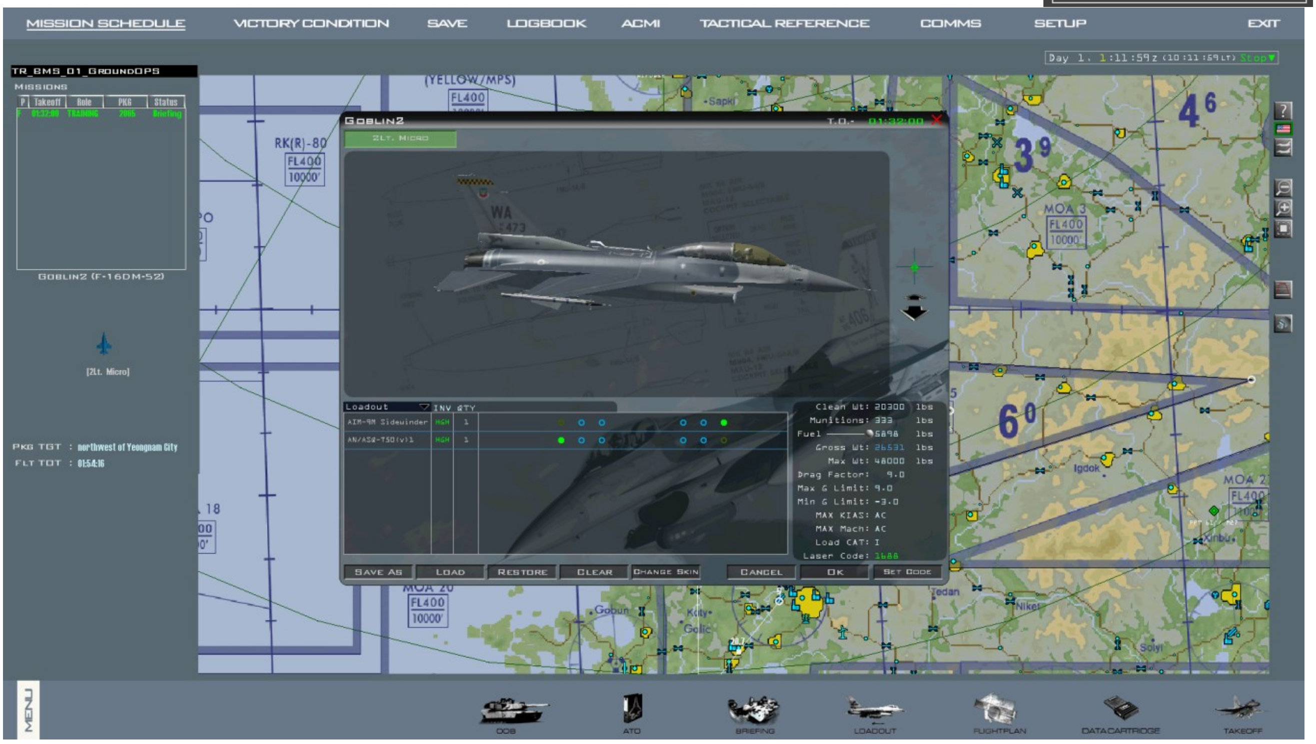
Taking off seems a relatively easy task. All you have to do basically is increase the throttle setting, keep on the centerline and pull gently on the stick once you reach rotation speed. There are a few tricks to it though.

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

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



WDP (Weapon Delivery Planner) is the only tool that will calculate your rotation speed for you. Its use is strongly advised. Refer to the WDP documentation as it is outside the scope of this manual to document WDP use. The desired rotation speed is 126kts (see on the right)



In this training scenario your jet is empty and you are only carrying 1 AIM-9M + T50 on the wingtips. It is a very light configuration.

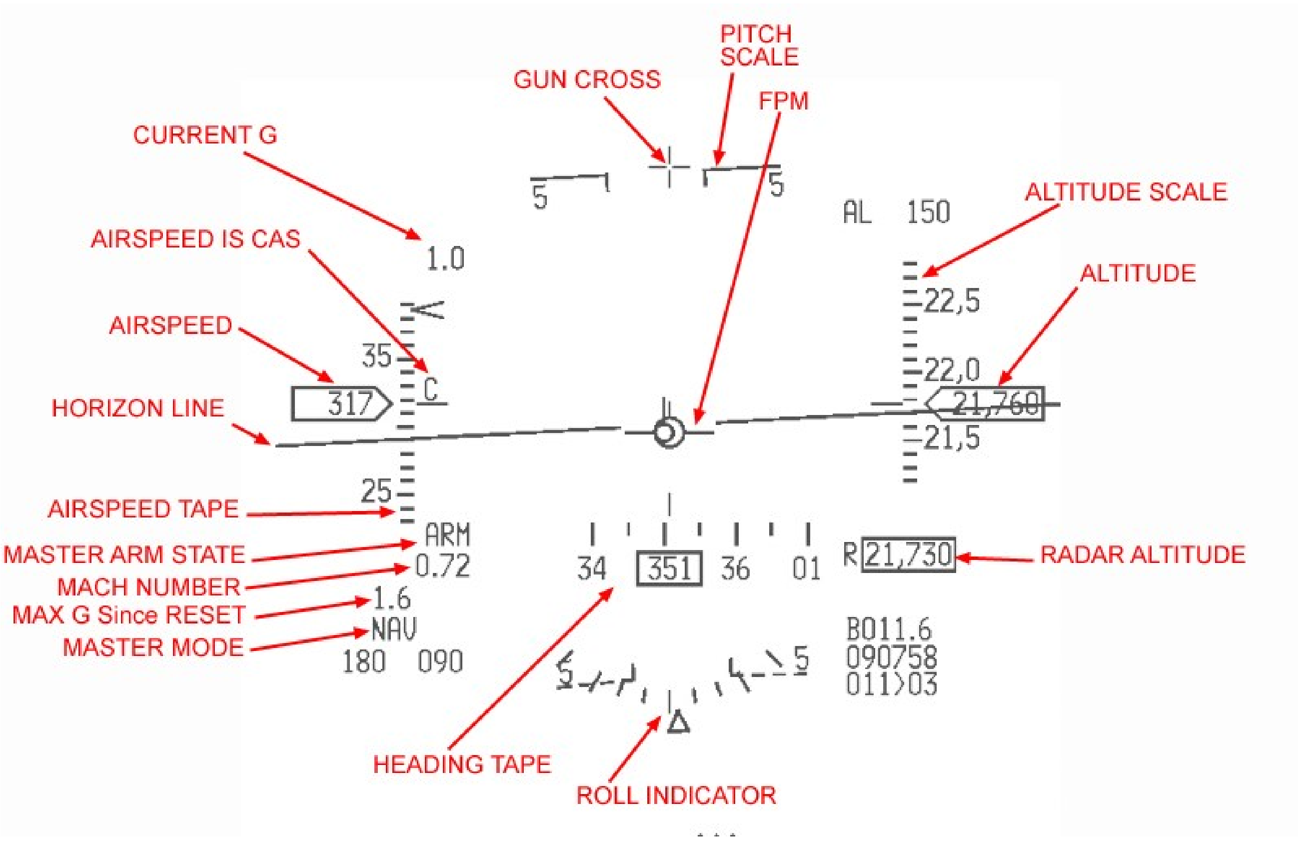
The bottom right box of the arming screen gives you more detail about your jet configuration:

- Clean Weight of 20300 lbs is the empty weight of the aircraft. It is consistent for each aircraft model.
- Munitions gives you the weight of the stores loaded; just 333 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; 5898 lbs this time.
- Gross Weight is the sum of all the first three lines and represents your actual weight at take-off.
- Maximum Weight is the weight limit of the aircraft and changes for a specific F-16 variant; 48000 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 the maximum and minimum G one can pull for the current store loading. If one exceeds these limits, the stores may become completely unusable. Bombs can still be dropped, but the fuses may not work. The system will not warn you if these limits are exceeded.
- Maximum KIAS and Maximum Mach are the maximum speed in knots and in Mach. Since that depends on altitude, the UI refers to AC. Or in other words you should use the VNE line on your Machmeter.
- Load Category will show either CAT I or III. That load category must be set appropriately with the STORES CONFIG switch on the GEAR panel.
- LGB Laser Code is used for LGB delivery and outside the scope of this mission. Basically laser guided weapons loaded on your jet are set with a fixed laser code and the aircraft system must match the weapon laser code for the bomb to guide accordingly. The arming screen is where different bomb codes are set. It's important to note that these are the fixed weapon codes and they can't be changed in the air (you change your laser code to match these). More on that in the LGB training mission.

The difference between your actual Gross Weight (26,531 lbs) and the Max Weight (48,000 lbs) informs how heavy or light your jet is configured. WDP for this configuration gives a rotation speed of 125 kts. Compared to the 165 kts rotation speed for a typical combat laden aircraft, 125 kts is a relatively slow rotation speed. If you perform an afterburner take-off you will reach that speed quickly.

The jet will continue accelerating once you are airborne. It will soon reach the 300 kts gear-down limit. Disengage the afterburner quickly to avoid damaging your landing gear. Gear damage modeling in 4.37 is superior to that of 4.36.

The second trick during take-off is avoiding excessive steering while rolling. When NWS is enabled the nose wheel turns with the rudder and should be avoided at high speed. NWS should be deactivated before you reach 80 kts and used with caution even below that. Remember though that your airspeed scale will not start to move until you reach 60 kts, so the window of action is very small. If your jet is positioned correctly with the nose wheel straight on the centerline you will not need NWS during take-off, so it may be safer to align carefully on the runway and disable NWS before advancing the throttle.
If NWS is disabled, one will not be able to steer the aircraft on the runway with the nose wheel; however, as speed increases so does the air flow on your rudder. Increasing rudder authority/effectiveness allows one to steer and compensate for crosswinds.



All relevant information for take-off is displayed on the HUD. For a deeper explanation of the HUD please refer to Dash-34 Manual, chapter 2.1.7.

The left scale is your airspeed. As the Dash-34 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-34, chapter 2.1.7.4). The reason is TAS is not relevant 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.

The airspeed scale remains at zero when 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 current 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 1500 feet. 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 Gunsan RWY36. Remember the better it is aligned, the less steering you will have to do initially.

The center part of the HUD displays the attitude lines, the Flight Path Marker (FPM), the Great Circle Steering Cue (aka tadpole) indicating the steer point 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 stabilized, 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 have not already) and steer lightly with the rudder to keep on the runway centerline. Be aware that the wind may push you sideways.

Once rotation speed is attained, 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 quickly accelerate.

Continue flying on the runway heading and raise the landing gear. The gear must be in the wells before the airspeed reaches 300 kts. It takes a few moments for the gear to retract so do not wait until 300 kts limit. Retract the gear as soon as a positive climb rate is established.

While the gear is in transit the gear handle red lollipop light will be ON. The gear is confirmed up & locked when the 3 gear green lights on the gear panel and the lollipop red light are OFF. If the lollipop remains lit, a gear malfunction is indicated and aircraft speed should stay under 300 kts while solutions are considered.

Congratulations, you are flying!

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

Climb and fuel efficiency, Optimum cruise altitude

Another important factor in aviation is fuel efficiency. Again, use WDP to calculate the MIL climb speed based on DRAG factor, GW (Gross Weight) and weather.

As seen on the right, the ideal climb speed at MIL to climb to 10200 ft is Mach 0.84 (445kt) with a drag factor is 9.

If you want to climb with 445kt/Mach 0.84 as mentioned on the right image, you will reach your target altitude 10200 ft in 40 seconds and 5.0nm distance.

If your drag factor is higher, you have to adjust your speed accordingly.

CLIMB SCHEDULE **MIL**

DRAG INDEX	KIAS / MACH
0	470 / 0.90
50	435 / 0.90
100	410 / 0.85
150	390 / 0.82
200	365 / 0.82
300	340 / 0.73
400	320 / 0.67

HMCS Re-Alignment

Due to a 5 to 10 mR alignment drift following takeoff, it is recommended that an airborne fine alignment (AZ/EL) be performed after takeoff and with regular intervals (15-20 min) or anytime HMCS alignment is critical.

Helmet Visor

BMS provides the option for a Helmet Visor in the case of to sun glare.

The helmet-mounted visor operates as a toggle, lacking a cockpit hotspot for initiation. To activate it, you'll need to utilize the corresponding callback linked to a keystroke (typically ALT V), which can be mapped to an available HOTAS button for convenient in-flight access.

In general, “Taxi” and “Take-off” options start by default with visor-down position in 3d, while only the “Ramp” option defaults to visor up.

You can modify the visor's default position during taxi/runway and in-flight start using the "set g_bVisorUpByDefault" configuration line in the falcon bms config file.

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

MISSION 2: BASIC NAVIGATION *(TR_BMS_02_Navigation)*

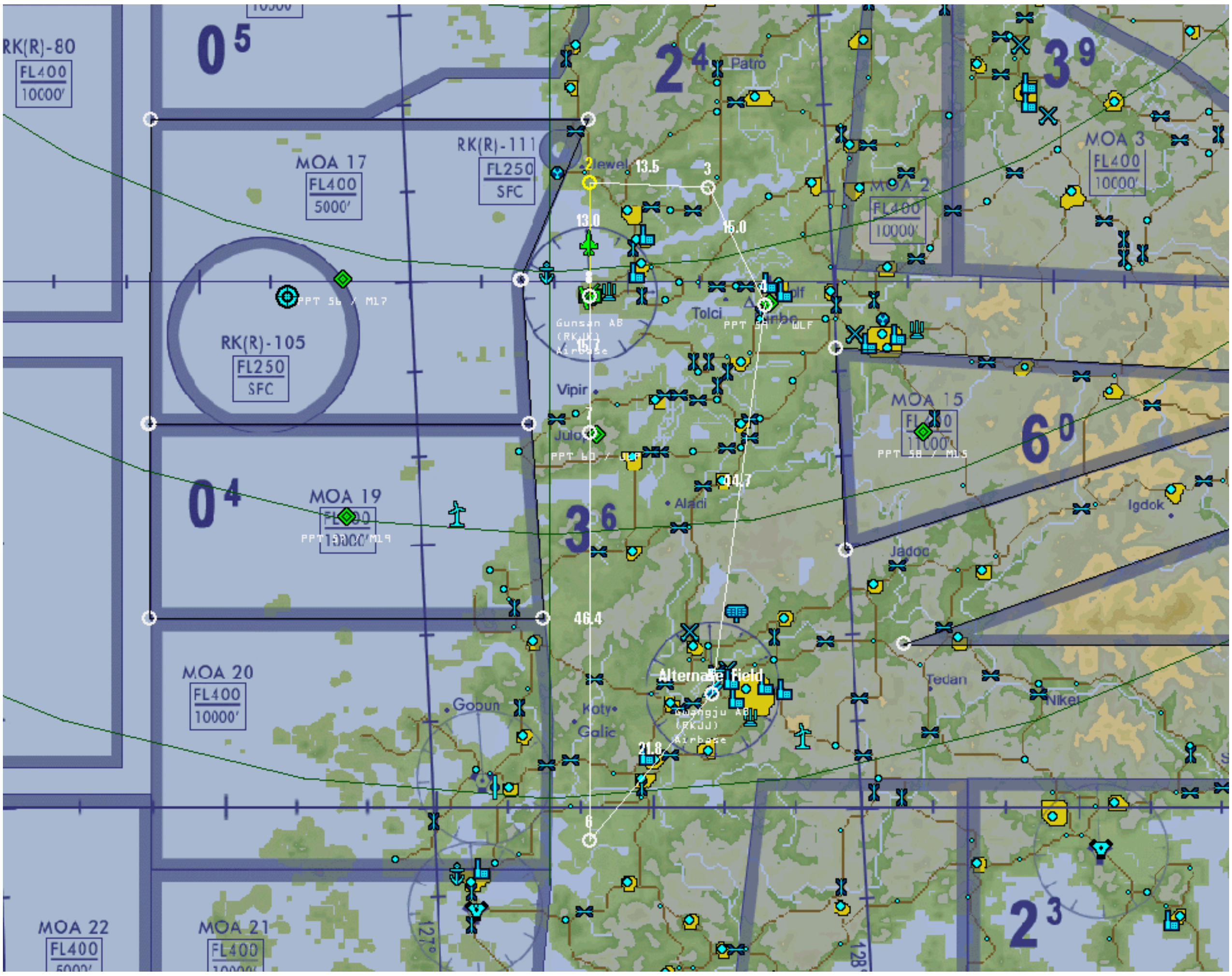
1. **TAKEOFF OPTION:** In Flight.

LOCATION: Approximately 5 Nm north of Gunsan.

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.

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

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



The flight will bring us south of Gunsan in the area of Gwangju airbase.

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

2.1 In-Flight Emergencies

Before flying the mission (see chapter 2.2), we need to consider certain failures included in BMS and suitable emergency procedures to avoid unsafe conditions. For further information, please refer to the F-16 checklists section “EP In-Flight”, In-flight Emergencies.

2.1.1 Canopy Warning Light On

If the canopy warning light illuminates, it indicates that your canopy is not locked. Gently push the canopy spider outboard, being attentive to a small hotspot that may be easily overlooked. Once the canopy light extinguishes, you can proceed with your flight.

However, if the canopy light does not go out, please refer to the section on CANOPY LOSS/PENETRATION during flight for further instructions.

2.1.2 Canopy Loss/Penetration in Flight

Although this scenario is unlikely in BMS, if, by any chance, the canopy spider fails to lock, and the canopy warning light remains illuminated, follow these steps:

1. Ensure the visor is down (typically, it should be down to protect your face in such improbable events).
2. Reduce speed to 180 knots.
3. Lower the seat to its lowest position.
4. Set ALT FLAPS to the EXTEND position.
5. Plan and execute a landing as soon as it is feasible.

2.1.3 Cockpit Pressure Malfunctions

The illumination of the CANOPY warning light signifies a loss of cockpit pressure, potentially attributed to issues with the canopy seal or a malfunction or shutdown of the Environmental Control System (ECS). If the cockpit pressure exceeds 27,000 feet, the CABIN PRESS caution light will activate. In response, descend below 25,000 feet altitude and maintain a speed below 500 knots. The flight can be safely continued below 25,000 feet.

In BMS 4.34, hypoxia has been modeled. Failure to descend quickly enough may result in a blackout. If a blackout occurs while descending, recovery will happen as you reach lower altitudes, unless, of course, the aircraft contacts the ground first.

2.1.4 Equip Hot Caution Light

In such instances, the initial step is to ensure that the AIR SOURCE knob is set to NORM. Reduce power to 80% RPM. Another potential cause for the illumination of the EQUIP HOT indicator is extended flying with the landing gear extended at low altitudes. Prolonged flying below 8000 feet with the gear down for more than 7 to 8 minutes could lead to the ECS shutting off. If the EQUIP HOT indicator persists, shut down all non-essential avionics (the FCR will be automatically shut down) and initiate a landing at the earliest practical opportunity.

2.1.5 Ejection

Given the absolute absence of any risk of fatality or injury in our hobby, there should be no hesitation about utilizing ejection when deemed necessary. Simply pull the handle, and you will safely ascend to meet the parachute.

2.1.6 Electrical System Failure

Indications of Electrical System failures are marked by the illumination of the ELEC SYS caution light. For troubleshooting, please consult chapter 6.10 of the Dash-1. It's important to note that the ELEC SYS caution light cannot be reset using the MASTER CAUTION light. To reset any ELEC SYS caution light, utilize the CAUTION RESET pushbutton located on the ELEC panel.

2.1.7 Engine Malfunctions

In BMS several possibilities for engine trouble during flight have been introduced. Nearby explosions from AAA or SAM may lead to engine flameout, while fuel starvation can occur when running on fumes, especially during negative G maneuvers. In most cases, attempting an engine restart can be done using an air-start procedure.

Air-Start Procedure

The air-start procedure varies based on the setting of the Idle Cut-off option in Falcon BMS.cfg. If the Idle Cut-off option is deactivated (default), the (unrealistic) idle detent keystroke is required. With the Idle Cut-off option enabled, reliance on the flight controller's mechanical detent for idle detent makes the keystroke unnecessary.

The initial signs of an engine shutdown include a decrease in RPM and FTIT, accompanied by changes in engine noise. If the Emergency Power Unit (EPU) is in NORM, it will immediately start running to power the emergency and hydraulic buses. However, the EPU's hydrazine may deplete based on RPM %. An EPU running on hydrazine lasts approximately 10 minutes before running out of fuel.

When the engine flames out, the RPM may still remain high enough, especially in a dive, to attempt an air-start without using the Jet Fuel Starter (JFS). JFS-assisted air-starts are only necessary when the engine RPM falls below the 20-25% limit.

To initiate an air-start with sufficient engine RPM, place the throttle in the CUTOFF position, move it past the idle detent (or use the idle detent keystroke), and place it mid-range (standing up). Monitor for signs of engine relight, such as increasing FTIT and RPM.

If RPM alone is insufficient for an air-start and there is altitude to spare, diving the aircraft can windmill the turbine, providing enough pressure to relight the engine.

If there is insufficient altitude to increase speed by diving, the JFS can be used to assist the air-start. Engage the JFS below 20,000 feet and at airspeeds below 400 knots. Once within the JFS envelope, with the throttle in CUTOFF, switch the JFS on to help get the RPM up to 25%. After a successful engine restart, manually switch off the JFS.

It's crucial to note that the JFS has limitations similar to those on the ground, allowing two attempts (50/50 chance in START1 and 1 attempt in START2) with recharge occurring only when the engine is running. After the engine relight and with sufficient thrust for level flight, set the throttle as desired. Confirm that both MAIN GEN and STBY GEN lights are OFF. Use the ELEC CAUTION RESET pushbutton to clear any ELEC SYS caution lights. Reset the EPU to OFF, then back to NORM.

Flameout Landing *(also see training mission TR_07)*

Landing the aircraft without an engine is a challenging task that requires careful consideration. Factors such as current weather conditions, visibility, wind, pilot training, and success in simulated flameout exercises must be taken into account. However, failure does not carry significant consequences, and the BMS ejection envelope is extensive.

To execute a flameout landing, promptly turn towards the nearest runway. Jettison stores to reduce drag and establish the best range airspeed. It's essential to have awareness of your location, identify the closest runway, and determine the best range airspeed. Best range speeds are influenced by gross weight, typically set to 210 knots, and can be determined by maintaining a 7° AOA attitude.

Long glides to the runway require consideration of EPU fuel for hydraulics and emergency power. Once the hydrazine is depleted, the EPU will shut down, making the F-16 uncontrollable. The EPU has approximately 10 minutes of autonomy running on hydrazine, so plan flameout landings not exceeding this timeframe.

Two basic types of flameout approaches are direct (straight-in) and overhead. The direct approach is simpler but provides no margin for error. The overhead pattern is safer, given sufficient altitude, as it provides good visual cues against known references if practiced and memorized.

2.1.8 Jettison

Both Selective Jettison and Emergency Jettison are Master Modes in BMS.

Selective Jettison

Selective Jettison serves to release chosen stores and racks, with the exception of A-A missiles and pods. This mode allows preprogramming through the SMS S-J page, enabling the pilot to select specific stores, such as fuel tanks, for potential jettison during flight.

To access Selective Jettison:

1. Navigate to the SMS MFD page.
2. Select the S-J subpage using OSB #11.
3. The first press on the OSB next to a station chooses the store(s), and a second press selects the rack (if available) for jettison.
4. The pilot can preselect a configuration in S-J Master Mode, and these settings will be remembered during master mode transitions.
5. Press the pickle button when the MASTER ARM switch is in ARM to jettison the selected stores.
6. Once released, the highlighted stations are removed from the S-J page, displaying a weapon quantity of zero. S-J mode overrides any other weapons settings.

Emergency Jettison

Emergency Jettison is a one-step operation to rapidly reduce Gross Weight in emergency situations. It releases all stores except A-A missiles and pods. Unlike Selective Jettison, Emergency Jettison does not necessitate activating the MASTER ARM.

To use Emergency Jettison:

1. While depressing the Emergency Jettison button, the SMS page displays the E-J subpage.
2. Release all expendable stores and racks from the aircraft.
3. Emergency Jettison can be executed without activating MASTER ARM.

Warning:

While infrequent in BMS, jettisoning stores with the gear down may lead to collisions and should be avoided. Ensure the gear is up before initiating jettisoning.

Jettisoning on the ground is possible only when the GND JETT ENABLE switch on the gear panel is set to ENABLE. However, this option should be considered a last resort.

2.1.9 EGI In-Flight Alignment (IFI)

While not fully implemented, in-flight EGI alignment is possible in BMS, with the system currently modeling AUTO IFA to some extent. This process relies on GPS for internal alignment and eliminates the need for pilot input in creating a fix. If MANUAL IFI is introduced in the future, pilot input for creating a fix may become necessary.

Procedure:

1. When in-flight alignment is required, maintain a straight, level, and non-accelerated attitude.
2. Set the EGI knob to OFF for 10 seconds (ensure both OFF and AUX flags are displayed on the ADI).
3. Move the EGI knob to the in-flight ALIGN position.
4. The DED will show the INS page, allowing monitoring of EGI status, while the HUD displays ALIGN.
5. Note that manual entry of magnetic heading in the UFC is not possible; the process is entirely automatic in BMS.
6. Similar to ground alignment, all navigation data is removed from the HUD and MFDs during in-flight alignment.
7. There is no explicit notification indicating the completion of alignment, and the process continues until the EGI knob is returned to NORM.
8. An EGI status of 8.1/10 is deemed sufficient (alignment in BMS becomes accurate with GPS as soon as the AUX flag disappears from the ADI).
9. Move the EGI knob back to NORM, and navigation data will be reinstated on the HUD and MFDs.

2.1.10 Controllability Check

Performing a controllability check is essential whenever structural damage or any failure affecting aircraft handling is suspected or identified. The following steps should be executed:

1. **Attain a Safe Altitude:** Ascend to a safe altitude to allow ample time for the controllability check.
2. **Reduce Gross Weight:** Decrease the aircraft's Gross Weight to enhance maneuverability and control.
3. **Lock LE FLAPS if LEF Damage is Observed:** In the event of observed Leading Edge Flap (LEF) damage, secure the LE FLAPS to mitigate potential handling issues.
4. **Determine Optimum Landing Configuration:** Evaluate the optimum configuration for landing by adjusting to the landing configuration, taking into account factors such as dirtying up and assessing the best Angle of Attack (AOA) and landing speed.
5. **Land Using Identified Settings:** Execute the landing procedure employing the settings determined through the assessment.

If, during the controllability check, the aircraft proves uncontrollable to achieve a reasonable landing speed, consider the option of a controlled ejection.

2.1.11 Out of Control Recovery

Typically, recovery from most departures in BMS occurs automatically within 10-20 seconds when controls are released, evident by the nose pitching down and airspeed increasing.

To avoid a recurrence of departure, the pilot should exercise patience and wait until the airspeed reaches 200 knots before making any control inputs.

2.1.12 Fuel leak

Battle damage may result in fuel leaks, which can be visually identified by a sudden drop in fuel quantity at the time of the damage, accompanied by an unusually rapid needle movement towards empty. When a fuel leak is suspected:

1. **Visual Confirmation:**
   - Observe a sudden drop in fuel quantity.
   - Note an abnormally fast needle movement towards empty.
2. **Avoid Afterburner Use:**
   - To prevent exacerbating the fuel leak, refrain from using afterburners.
3. **Maximize Range and Climb:**
   - Extend the range by maximizing fuel efficiency.
   - Climb to higher altitudes to optimize glide range.
4. **SFO Planning:**
   - Plan for a Simulated Flameout (SFO) landing, considering the potential fuel-related challenges.
5. **Minimize Fuel Leak:**
   - Identify the source of the leak.
   - Bypass automatic forward fuel transfer by adjusting the FUEL QTY SEL knob out of the NORM position.
6. **Manage Imbalance:**
   - Adjust ENG FEED based on the source of the leak to counterbalance fuel imbalance.
7. **Critical Emergency:**
   - Recognize that a fuel leak is a critical in-flight emergency.
   - Initiate landing preparations as soon as possible.

Prompt and effective actions in response to a fuel leak are crucial for ensuring the safety and successful landing of the aircraft.

2.1.13 Oil leak

External damage can result in oil loss, critical for engine functionality. Signs of an oil leak may manifest on the OIL pressure gauge. Maintaining adequate oil pressure is vital for engine operation, with specific thresholds for PW and GE engine F-16:

- PW Engine: Minimum 30 psi at flight idle
- GE Engine: Minimum 25 psi at flight idle

If oil pressure falls below these limits, it constitutes an in-flight emergency, and immediate landing considerations are necessary.

Important Points:

1. **Warning Light Delay:**
   - The HYD OIL PRESS warning light may not illuminate immediately, as oil pressure issues tend to develop slowly.
2. **Throttle Management:**
   - Suspecting oil pressure loss, minimize throttle movement (keep throttle around 80%, unless necessary).
   - Restrict maneuvering to minimize stress on the engine.
3. **SFO Approach Planning:**
   - Plan for a Simulated Flameout (SFO) approach at the earliest convenience.
4. **EPU Activation and Monitoring:**
   - Activate the Emergency Power Unit (EPU) to monitor hydrazine consumption.
   - If the EPU is initially off, be prepared to turn it on promptly in the event of engine seizure.

Addressing engine oil loss requires a cautious and proactive approach, emphasizing the need for immediate action and preparedness for potential emergency scenarios.

2.1.14 External Damage Checks

BMS heightens the potential for system failures resulting from battle damage and other damage. Engine stalls, fuel leaks, and oil leaks now pose a tangible threat, underscoring the critical importance of conducting thorough battle damage checks. It is strongly recommended to enlist the assistance of one of your human wingmen (if available) to perform a visual assessment and ascertain the extent of the damage.

Fuel leaks and oil leaks may be discernible from your wingman's perspective. Both instances generate white smoke; however, it's crucial to note that oil leaks specifically emanate from the engine, while fuel leaks may originate from various sources such as tanks in the wing, fuselage, etc.

2.1.15 Icing

With its introduction in 4.35, icing conditions are now a notable feature. It is strongly advised to steer clear of known icing areas. Icing tends to be more significant at medium altitudes in humid air, particularly in cloudy conditions. In BMS, this corresponds to flying in adverse weather conditions. The F-16 is equipped with two anti-icing protection systems.

The first system is designed to prevent the accumulation of ice in the engine inlet, which could pose a hazard to the engine. The second system involves probe heating to avert ice contamination of the data probes, preventing erratic instrument readings.

While the onboard systems can handle light to moderate icing, it is not recommended to intentionally fly into known icing conditions, as severe icing may compromise the effectiveness of the onboard systems. Failure to appropriately utilize the ANTI-ICE inlet protection or encountering ANTI-ICE failure may result in severe engine damage.

Similarly, improper use of PROBE HEAT or experiencing PROBE HEAT failure can impact flight instrument readings, making instrument meteorological conditions (IMC) piloting highly perilous.

2.1.16 FLCS Failures

Depending on the gravity of the FLCS failures, pilots will receive notifications in three distinct ways:

- **FLCS WARNING Light:** This light only resets when the failure itself resets. These are considered serious failures.
- **FLCS CAUTION Light:** The light resets upon fault acknowledgment or when the fault resets. These are significant failures.
- **PFL Messages:** Some less significant failures may only be notified through a PFL message.

The procedure to manage a FLCS emergency is as follows:

1. Note the PFL displayed.
2. Acknowledge the fault.
3. Refer to the Pilot Fault List (Chapter 3.4.3 in this document or in the BMS Emergency checklists).
4. Refer to the appropriate FLCS emergency procedure.
5. Perform FLCS RESET if instructed by the emergency checklists.
6. Perform fault recall.

BMS Consideration: Not all FLCS failures are implemented in BMS. The FLCS is a quad-redundant system, and the Digital Backup (DBU) is not implemented at all.

Air Data Malfunction

The likelihood of probes feeding wrong information to the FLCS in BMS is very low. A single failure triggers the FLCS CAUTION light and a FLCS ADC FAIL PFL. A dual failure triggers the FLCS WARNING light and switches the FLCS to STBY gains, indicated by a PFL warn level message. A FLCS Reset may clear the dual failure and exit STBY GAIN, but the first-level failure (single) remains latched.

AOA Malfunction

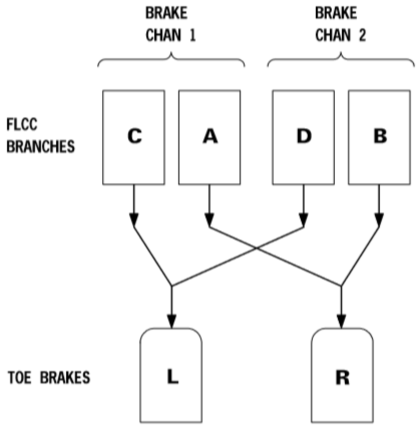
A single failure is indicated by the FLCS CAUTION light and FLCS AOA FAIL PFL. Dual failure is a warning level, identified by FLCS WARNING light and FLCS AOA WARN PFL. FLCS selects 11° AOA during dual failure, affecting cruise configuration but should be adequate for landing. Depending on the situation, a FLCS Reset may clear the dual failure and revert to a single failure state. In case the dual failure persists, land as soon as possible and do not exceed 11° AOA on approach.

CADC & Servo Malfunctions

Not implemented in the current BMS.

FLCS Electronic Malfunction

Two single electronic failures are reported in flight: BRK PWR DEGR & FLCS CCM FAIL PFLs. In BMS, only the first is relevant, impacting wheel brake management. The Coil Current Monitor (CCM) message might be displayed but has no consequence for BMS flyers. It's essential to test FLCS power if BRK PWR DEGR PFL is displayed to ensure proper brake operation.



Since BMS 4. 35, any of the four FLCC branches may fail separately, and in the unlikely event of two branches failing, a DUAL FLCS electronic malfunction may occur. This triggers the FLCS WARNING light and further PFL messages. The dual electronic failure may be reset with a FLCS RESET, but it will only reset to the single failure level. If the dual failure cannot be reset, land as soon as possible, mindful of degraded STBY GAINS flying characteristics. Set brake channel to channel 2, plan for cable arrestment if possible, and avoid increasing AOA past 11° during approach and aerodynamic braking.

For more information, please refer to chapter 7 of the Dash-34.

2.2 The mission

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 Intl. Airport (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 Gunsan (STPT 1) and ends at Gunsan (STPT 8) therefore the alternate runway (Gwangju 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.

Here is the required information for this flight:

- Gunsan: TACAN 075X - RWY 18/36 - ILS RWY 36: 110.3 – Elevation: 10 feet -
  ATIS: 120.225 - Ground: 273.525 – Tower: 292.3 – Departure & Approach: 292.65

- Gwangju (Alternate): TACAN 091X – RWY 04/22 (L&R) – ILS RWY04L & 22R: 111.1 – Elev: 110 feet - ATIS: 128.875 - Ground: 275.8 – Tower: 254.6 – Departure & Approach: 268.0

- MUAN TACAN: 065X

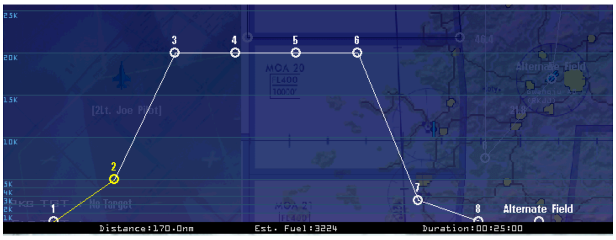
- MOA 15 active: 11000' to FL400
  MOA 17 active: 5000' to FL400
  MOA 19 active: 10000' to FL400
  (these are restricted to you as other aircraft train in these areas).

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

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

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

The map also displays MEF (Maximum Elevation Figures) in each box created by one degree of latitude and one degree of longitude. The MEF are the highest known point of elevation in each box. They are given in hundreds of feet, with the large number being thousands and the smaller number being hundredths of feet.



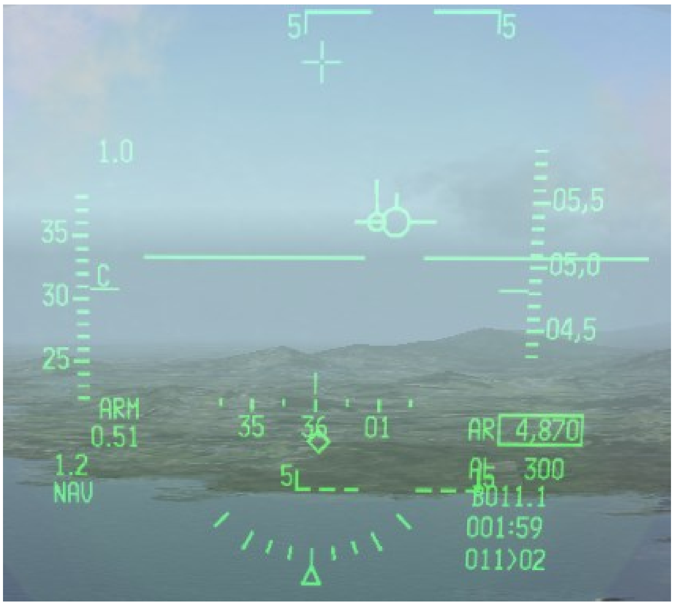
For instance, 5^2 indicates 5200 feet. To stay safe from hitting the ground (in bad visibility for instance) you should stay above that reference by at least 500 feet. MEF + 500feet = MSA (Minimum Safe Altitude), unless you are on a published SID or approach chart which will keep you safe from the terrain. The altitude of your flight plan can be checked as well: the first and 2 last steerpoints (departing airbase, arrival airbase and alternate) are at ground level. The altitude of the other steerpoints is displayed in two different graphics which you can enable or disable with the 2 graphic buttons on the right side of the UI screen. The total distance of the flight plan is 218 Nm and the ETE (Estimated Time Enroute) will be 25 minutes.

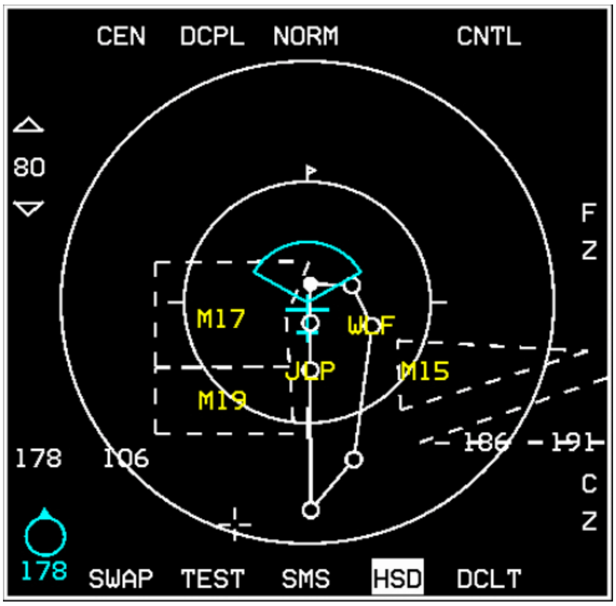
More information can be found for each steerpoint if you click on it. A new window will open up with steerpoint information:

- Flight callsign: Goblin 2-1.
- Steerpoint number.
- Time over Steerpoint (TOS)
- Altitude required for steerpoint passage.
- True Airspeed passing the steerpoint.
- Calibrated airspeed.
- Formation required.
- Type of action enroute and at steerpoint. If the latter type is defined, then the Option box below will be filled in with relevant information.
- Type of climb when a change of altitude is set. It can be immediate or delayed.

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-34 (chapters 2.1.7 and 2.16.18 respectively).





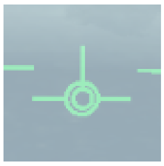
The pictures above are taken at the starting point of the Navigation training mission. You are between Gunsan airbase and steerpoint 2, level at 4800 feet QNH. Calibrated airspeed is 300 kts.

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

The HUD indicates the direction of the selected steerpoint with the Great Circle Steering Cue (aka tadpole), right of the FPM. Distance and ETE to the selected steerpoint are displayed in the bottom right block of the HUD. Steerpoint 2 is ~11.1 Nm away and at this speed you will need ~1 minute 59 seconds to reach the steerpoint.

Zoom out the HSD to 80 Nm to display the whole flight plan. And set HSD to CEN (OSB 1) option so own ship is centered 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. Gunsan airport in the background



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

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

While on the CNI page moving DCS right will display wind direction and speed, used to show how much you are drifting. In this case the wind is from 319° at 14 kts. We are flying 360° so the wind is pushing us to the right. This is also illustrated by the slight offset of the FPM, tadpoles and the pitch lines. If you look closely the FPM is not in the center 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 CP DRIFT switch in the DRIFT C/O position. The FPM will then remain centered in the HUD. Just ensure you replace the switch in NORM before landing.

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

Between STPT 2 and 3 we will perform our G-Warmup. 4.36 introduced the concept of Warm up and Fatigue. In order to get the best G response from the pilot, a G warm up procedure shall be done prior to each combat or training sortie. The G warm up consists of flying in the 3 -5 G region to train the body, the more you train in this area, the longer your body will remember the warmup. For example, a 45 seconds warmup in the 3-5 G region will provide a 20 minutes full G capability, after 20 minutes, a new warm up should be done again. Without Proper warm up, the resistance of the pilot will be limited. The more you fly above 7G, the quicker a fatigue effect of the warmup will be in effect. After a certain amount of time above 7G, the G Load resistance of the pilot is equivalent to the one with no warm up. Execute two g-warmup sessions before reaching STPT 3 with one 90° left and 90° right turn at 5000ft and 400-425kts. For the first 90° turn hold 3-5G. For the second turn hold 5-7G. Go gate or buster to achieve/hold these forces. ***Note: For other trainings and mission sorties, execute your G-warm up inside the aircraft limits (Loadout) and energy limits (Altitude, Drag, Speed).***

The flight plan calls for a climb to FL200 [20000 feet on QNE (29.92 or 1013Mb)]. Climbing to altitude can be achieved by pulling gently on the stick. The aircraft will climb, and airspeed will decrease.

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

Passing 14000 feet, set your altimeter to QNE: 1013 Mb or 29.92 inHg (use the barometric setting knob, located at the lower left corner of the instrument. Refer to section 29.1 of the Dash-1 flight manual for detailed information about the altimeter). 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 hundreds of feet. e.g.: FL150 is 15000 feet. Before reaching FL200 decrease your climb to level out at your assigned altitude. Depending on your gross weight you may also need to retard the throttle a bit to maintain 350 kts.

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

Passing steerpoint 3, the avionics will switch to STPT 4 and your HUD should show information related to STPT 4. Steerpoint information can also be displayed on the Horizontal Situation Indicator (HSI) located on the center console. This instrument is explained at length in the BMS COMMS and NAV Book, Chapter 3.1.3.

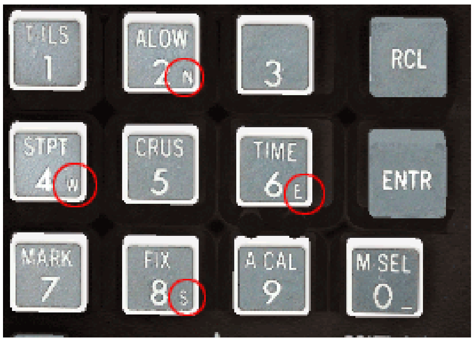
Depending on the position of the INSTR MODE knob the HSI will indicate navigation information related to the active TACAN station (TCN & TCN/ILS positions) or the active steerpoint (NAV & NAV/ILS positions). Move the knob to TCN and notice the bearing indicator pointing to KUN TACAN moving to the three 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 centered with the CRS knob the CDI indicates the bearing to Gunsan is 248°.

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

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

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

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



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

Move DCS down until the scratchpad is around the latitude line. Since 4.33 we first have to start the coordinate input with one of the cardinal direction symbols (N E S W) that are indicated on the 2, 4, 6 and 8 ICP buttons. Failure to do so will prevent any numbers from being entered in the scratchpad.

Hit 2 for North then 3, 5, 5, 7, 9, 9, 0 and ENTR. The latitude lines will change to the new coordinates and the scratchpad will move down to the longitude line.

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

It is not 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.

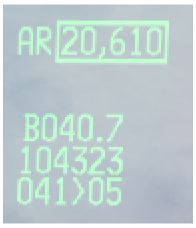
The mode that is interesting to us for this training mission is the STRG SEL mode that will follow the INS route. It must be used in conjunction with the AUTO steerpoint toggle we discussed before, so the AP is able to steer to the next steerpoint when the current one is reached. Failure to use the AUTO 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 chapter 17.13:

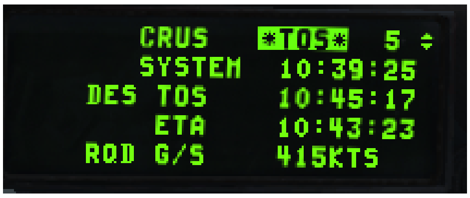
- Gear is not down.
- AR door is not open.
- ALT Flaps switch is not in EXTEND position.
- AOA is not greater than 15°.
- DBU is not engaged.
- MPO switch is not held in OVRD.
- There is no A/P failure or FLCS failure PFL message (STANDBY gains would be active).
- TRIM A/P DISC switch is not placed in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

Move the LEFT AP switch to STRG SEL and move the right AP switch to ALT hold. The autopilot will engage (if the above conditions are met) and fly the aircraft. At any moment you can take control over the AP simply by moving the stick but be aware that if you exceed any of the above limitations the autopilot will disengage and WARN will be displayed in the HUD. *Note: there is no auto throttle on the F-16 so the throttle always has to be controlled by the pilot.*

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

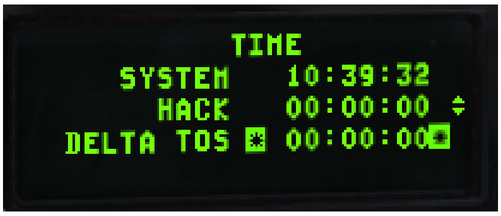


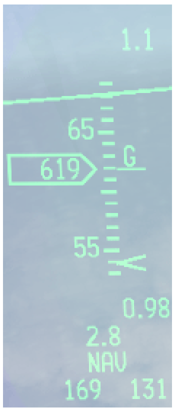
Let's look at the lower right block of information on the HUD. STPT 5 is selected and is 40.7 Nm away. The ETA is 1043 and 23 seconds Falcon time. This line can display ETE or ETA according to the status of the TOS subpage. Let's select the CRUS page with button 5 of the ICP. DCS right to review all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



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

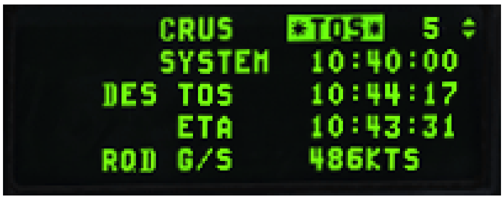
Current speed is 465 CAS. Let's switch the HUD speed scale to GS with the relevant switch on the HUD panel (right console). Our actual groundspeed is 619 GS: 204 kts too fast. Notice the TOS airspeed caret at the bottom of the HUD airspeed scale. To fly TOS the caret must be aligned with your current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





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

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



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

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

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

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

Passing steerpoint 5 the aircraft, still on Autopilot, steers towards steerpoint 6. It is now time to switch from INS navigation to TACAN navigation.

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

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

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

Remember that the MOAs West of Gunsan 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 is the cue to start descending.

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

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

MISSION 3: LANDING *(TR_BMS_03_Landing)*

TAKEOFF OPTION: In flight.

LOCATION: Approximately 15 Nm south of Gunsan.

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

LEARNING OBJECTIVES: Land on Gunsan RWY 36 Straight-in or Overhead.

This mission starts over JULOP fix 15 Nm south of Gunsan 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. For deeper information we refer to the Dash-1 manual chapter 32.6.

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

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

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

3.1 Landing Emergencies

Before landing the aircraft (see chapter 3.2-3.4), we need to consider certain failures included in BMS and suitable emergency procedures to avoid unsafe conditions. For further information, please refer to the F-16 checklists section “EP Landing”, Landing Emergencies.

3.1.1 Landing With A Blown Tire

The primary risk associated with landing with a blown tyre is the potential collapse of the landing gear and the difficulty in maintaining directional control during the landing roll. If a blown tyre condition is suspected, it is crucial to minimize the gross weight before attempting to land. Retain external fuel tanks if empty, and depressurize them to reduce the risk of explosion. In BMS, this involves opening the AR door, but it comes at the expense of the Nose Wheel Steering (NWS) system. While the risk of explosion is not explicitly modeled, the importance of NWS functionality should be considered.

During landing, favor the side opposite the blown tyre. Utilize roll control to alleviate pressure on the blown tyre and NWS to ensure directional control. If equipped with differential braking, apply brakes on the undamaged tyre.

Bring the aircraft to a stop in a straight-ahead direction and proceed to shut down the engine. Avoid attempting to taxi unless facing an emergency situation.

3.1.2 LG Extension Malfunctions

Typically, issues with extending the landing gear manifest as the landing gear handle failing to lower or the failure of one or more landing gear to extend, accompanied by the absence of corresponding green lights and continuous illumination of the red light in the landing gear lollipop. The lollipop's red light signals a problem, while the green lights indicate the specific gear affected.

As of BMS 4.35, the landing gear handle might not lower at all times due to the implemented gear handle solenoid, which may encounter failure. To address this, the DN LOCK REL button has been introduced to offer a mechanical bypass for the electrical solenoid.

Procedure for Unresponsive Landing Gear Handle:

1. If unable to move the landing gear handle to the down position, it's likely due to an electrical solenoid failure.

2. Utilize the DN LOCK REL button to mechanically bypass the solenoid. Depress the button and promptly attempt to lower the gear handle. (Note: In real life, these actions should be simultaneous, but in BMS, perform them in quick succession.)

In the improbable event of mechanical handle failure, switch the brake channel to Channel 2, as Channel 1 is inactive in the UP position. Manually extend the ALT FLAPS. With the PW229 engine, nozzle scheduling is tied to the landing gear position, resulting in a closed nozzle and higher than normal idle thrust.

Consider alternate gear extension as a final option to lower the gear. Keep in mind that after alternate gear extension, the lollipop's red warning light may remain illuminated, indicating a disparity between the gear status and handle position.

3.1.3 Alternate Gear Extension

The alternate gear extension serves as a pneumatic, one-time-use method for lowering the landing gear. When the alternate gear handle is pulled, the landing gear doors open, releasing the main legs, which lower and lock in place due to gravity and airflow. The nose wheel, however, must be pushed forward using the pneumatic system involved in the alternate gear extension.

To ensure a secure lock of the nose wheel gear, this procedure should be executed at the lowest feasible airspeed, ideally below 190 knots and certainly below 300 knots.

Steps for Alternate Gear Extension:

1. Pull the alternate gear handle, initiating the process.
2. Allow the landing gear doors to open and release the main legs.
3. Confirm the gear is down and locked by verifying the absence of the lollipop's red light and the illumination of all three green lights.

Once the gear is confirmed down and locked, proceed to land the aircraft normally. If any landing gear remains unsafe or up, refer to the "LANDING WITH GEAR UNSAFE/UP" procedure.

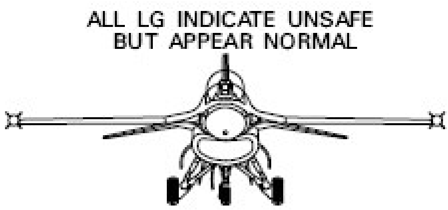
Important Note: Following an alternate gear extension, the Nose Wheel Steering (NWS) is unavailable, even if System B hydraulics are operational. Be mindful of this limitation during post-extension operations.

3.1.4 Landing With Gear Unsafe/Up

In the event of landing gear problems, it is advisable to retain empty fuel tanks and minimize gross weight to enhance the chances of a successful landing. Given the heightened risk of a potential crash, additional precautions may include shutting down the Fire Control Radar (FCR) and any non-essential avionics. These measures aim to optimize the aircraft's controllability and increase the likelihood of a safe landing under challenging circumstances.

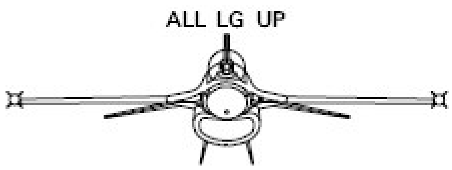
All landing gear indicate unsafe but appear normal:

In the event of a potential landing gear failure, take preventive measures by shutting down all non-critical avionics, including the Fire Control Radar (FCR) and Stores Management System (SMS), before initiating the landing procedure. Subsequently, execute a standard landing protocol. If the designated runway is equipped with arrestment cables, deploy the hook and strategize to engage the end cable during the landing process. This approach aims to enhance the safety of the landing and mitigate potential risks associated with landing gear issues.



All landing gear up:

1. EPU ON.
2. EXTEND ALT FLAPS.



Land from a low angle approach at 13° AOA.
Throttle OFF immediately prior touch down.
Cable arrestment not recommended.

Both main landing gear up or unsafe:

Alternate Gear Retraction Procedure

1. Activate the Alternate Gear handle and wait for 5 seconds.
2. Raise the Landing Gear handle.
3. Press the Alternate Gear reset button.

In the event that the nose landing gear fails to retract, contemplate executing a low-angle approach at 13° Angle of Attack (AOA) with empty fuel tanks if applicable, or opt for a fly-in engagement with the arrestor cable.

For a cable engagement:

- Deploy the hook.
- Cut throttle immediately after engaging the cable.

Nose landing gear up or unsafe:

1. Activate the EPU.
2. Discourage cable arrestment usage.
3. Contemplate executing a low-angle approach at 13° Angle of Attack (AOA).
4. Cut throttle after touchdown.
5. Lower the nose to the runway before control effectiveness diminishes.
6. Deactivate the EPU once the aircraft comes to a stop.

One main landing gear and nose landing gear unsafe or up:

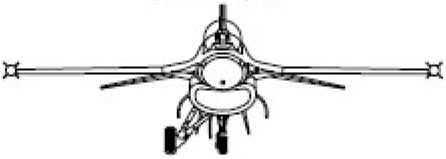
1. Avoid cable arrestment.
2. Engage the Alternate Gear handle and wait for 5 seconds.
3. Raise the Landing Gear handle.
4. Press the Alternate Gear reset button.

If landing gear retraction fails:

- Contemplate executing a low-angle approach at 13° AOA with empty external tanks.
- If external tanks are absent, consider ejection.

Land on the side of the runway opposite the malfunctioning gear.

One main landing gear unsafe or up:



1. Avoid cable arrestment.
2. Engage the Alternate Gear handle and wait for 5 seconds.
3. Raise the Landing Gear handle.
4. Press the Alternate Gear reset button.

If landing gear retraction fails:

- Consider landing with a low angle approach at 11° AOA, using empty external tanks.
- After touchdown, use roll control to maintain wing orientation.
- If external tanks are not present, contemplate ejection.

Land on the side of the runway opposite the malfunctioning gear.

3.1.5 Brake Malfunctions

For detailed information on managing the "HOT BRAKES" condition, please consult the "HOT BRAKES, GROUND EMERGENCIES" chapter 1.5.9.

Important note: When landing with the gear handle in the UP position, brake Channel 1 will not be powered. Operational wheel brakes will rely solely on Channel 2. If you encounter issues with wheel brakes, promptly switch to BRAKE CHANNEL 2 for proper braking functionality.

3.1.6 Nose Wheel Steering Malfunctions

For comprehensive guidance on addressing "NWS FAILURE" scenarios, kindly refer to the "NWS FAILURE, GROUND EMERGENCIES" chapter 1.5.8.

Important note: After executing an alternate gear extension or if the AR door is open (for depressurizing fuel tanks before landing), please be aware that Nose Wheel Steering (NWS) functionality will not be available. Exercise caution and adapt your ground operations accordingly.

3.1.7 Anti-Skid Malfunction

If the ANTI-SKID caution light illuminates while the groundspeed exceeds 5 knots and the landing gear handle is lowered, it indicates an ANTI-SKID system failure. Typically, this signals the loss of a wheel speed sensor signal, triggering the system to adopt an alternate braking method.

In cases where differential braking is applied (more than 15% pressure difference on the pedals), braking efficiency is reduced by 50%. Alternatively, if no differential braking is used (pressure difference on the pedals less than 15%), the reduction is 25%.

The alternate method persists until the ANTI-SKID system is manually turned OFF, and the brake channel is set to Channel 2. It's essential to note that a portion of the ANTI-SKID system remains active on Channel 1 regardless of the ANTI-SKID switch position.

Attempt to clear the fault by cycling the ANTI-SKID (switching it off and selecting Channel 2). If the issue persists, anticipate decreased brake efficiency or the absence of ANTI-SKID protection upon landing.

3.1.8 Cable Arrestment

As of version 4.35, arrestor cables are operational on non-generic airbases. Engaging a cable requires no special ATC procedures; the cables are consistently present on applicable runways and are always ready for use (unlike real-life scenarios).

The number of cables varies across runways. Some may lack cables, while others have two cables at each runway end section, and certain runways feature a total of four cables. Cable positions are indicated by vertical panels displaying a plain yellow circle on both sides of the runway.

When uncertain about stopping within the available runway length, lower the hook and aim to engage the arrestor cable as close to the runway centerline as possible. Avoid riding the brakes over the cables, as this could compress the nose gear and potentially lift the hook above the cable, preventing proper engagement.

Plan your touchdown at least 500 feet from the cable to allow ample time for lowering the nosewheel to the ground before engaging the cable. Once the aircraft comes to a halt, raise the hook and, if possible, exit the runway promptly.

3.1.9 Takeoff/Landing In Crosswinds

To effectively manage wind conditions during take-off and landing, the initial step involves determining the wind direction and speed.

On the ground, obtain wind information through pre-flight briefings, contacting ATC for up-to-date wind speed and direction before departure, or tuning in to the VHF ATIS frequency for the latest conditions.

In-flight wind data can be acquired from the F-16 probes by navigating to the UFC CNI page and selecting DCS right.

The subsequent step is calculating the crucial crosswind component—the aspect of the wind perpendicular to the runway. While headwind or tailwind is favorable for take-off and landing, any crosswind component can potentially push the aircraft sideways.

Wind force is delineated into two components: the head or tail component and the full cross component. This can be determined using a graphic, considering the wind direction relative to the runway orientation and the wind speed. Refer to the example on the following page.

In BMS, a crosswind limit of 25 knots is established based on the graphical representation. Crosswind situations up to 24 knots can be managed in BMS, but any condition exceeding 25 knots necessitates diverting to an alternate runway with more favorable wind conditions.

Consider the following example:

Runway heading: 360°
Wind direction: 330° at 20 knots

1. Enter the graph on the line representing the wind direction relative to the runway: 360° - 330° = 30°.
2. Find the wind speed on the left side of the graph.
3. Follow the curve until it intersects the first line.

By plotting these coordinates, you determine the full headwind and full crosswind components. In this case, it results in 17.5 knots headwind and 10 knots crosswind.

Take-Off in Crosswind:
Position the aircraft on the upwind side of the runway centerline for take-off. Maintain directional control using the rudder until the ARI (Aileron Rudder Interconnect) engages. In BMS, crosswind effects are typically felt after the main wheels leave the runway.

Landing in Crosswind:
For the F-16, use the wing-level crab technique for crosswind landings. Avoid using the rudder during landing due to the ARI connection. Release the rudder pedals, pointing the aircraft nose into the wind. In high crosswinds, use the DRIFT C/O switch to center the FPM if it drifts outside the HUD field. Plan the touchdown point on the upwind side of the runway.

Upon touchdown, ARI disengages, and there may be yaw transients. Allow the aircraft to stabilize without applying additional controls. During aerobraking, use rudder and aileron for directional control. As airspeed decreases, more rudder input is required. Once the nose gear is down, initiate braking while maintaining control with rudder, differential braking, and NWS below control speed. Avoid excessive differential braking to prevent hot brakes conditions.

3.2 Landing Straight-in

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

The TE starts 15 Nm out at 2500 feet and 400 kts, allowing a few miles to adjust parameters for the straight-in approach. Gunsan Runway 36 should be visible ahead. Adjust your line up, descend to 2000 feet and reduce speed to 300 kts. Due to the low drag nature of the F-16, speed brakes may need be opened to reduce speed.

Initiate contact with ATC by requesting unrestricted approach. ATC will insert your flight into the landing queue, light up the approach lights and afford your flight some flexibility for this scenario. Open the ATC menu Approach page and select 'Request unrestricted approach' by pressing ‘t t t 4’. Approach will instruct us to continue inbound and give us QNH.

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

First lower your landing gear (double-check your airspeed: it must be below 300 kts). Doing so will automatically deploy leading and trailing edge flaps and the FLCS will switch to take-off and landing gains. The drag caused by dirtying up your aircraft configuration will further decrease your airspeed and pitch the nose down a bit.

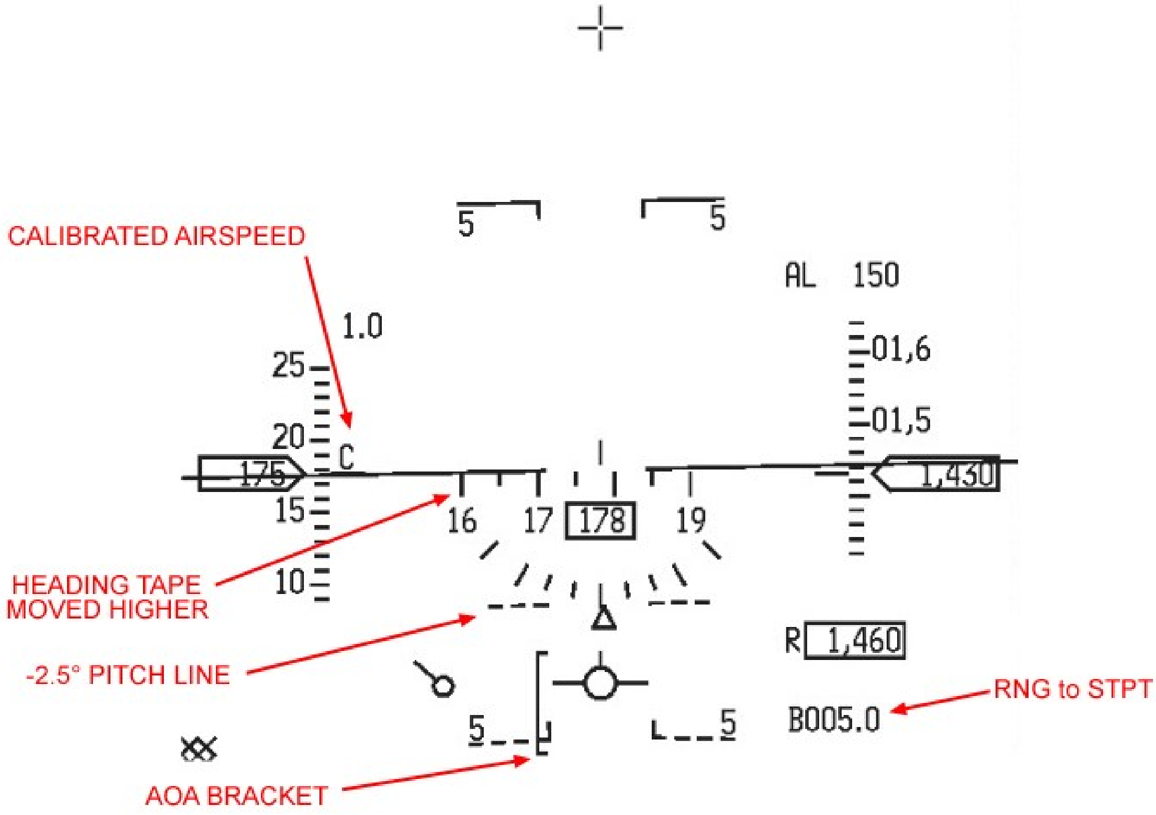
The HUD symbology will change: notably an AOA bracket will be displayed upon nose wheel lock in the down position. This symbol is used in conjunction with the flight path marker and the Indexer lights as your main cues for controlling the approach.

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

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

Most runways in BMS are equipped with a visual landing aid system called Precision Approach Path Indicator or PAPI. It consists of four equally spaced lights situated to one side or both sides 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 are visible from the landing aircraft, the lower you are on the glideslope. The more white lights seen from the aircraft the higher you are above the glideslope. The optimal glide slope is thus flown when 2 red and 2 white lights are seen. A rule of thumb to remember: Red is dead!

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



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

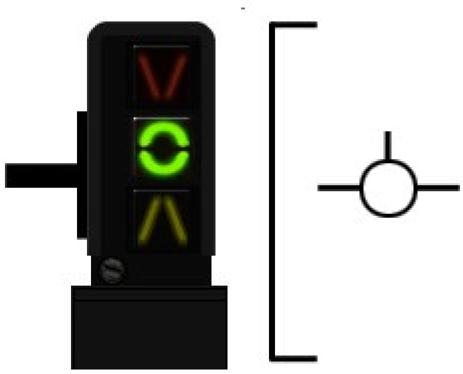
You also know that to maintain two red and two white lights on the PAPI you have to fly a 3° glideslope to the runway; the FPM has to be around the -2.5° dashed pitch line. This is done with the sidestick controller.

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

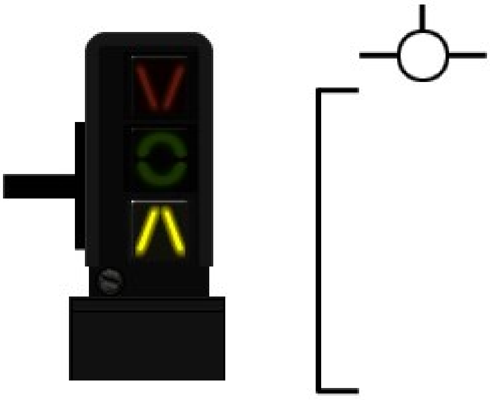
AOA is the angle between the aircraft wing chord line (equivalent here to the airframe longitudinal axis) and the relative vector of motion of the aircraft. Basically, it's the angular difference between where the aircraft is pointing and where it is going.

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

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

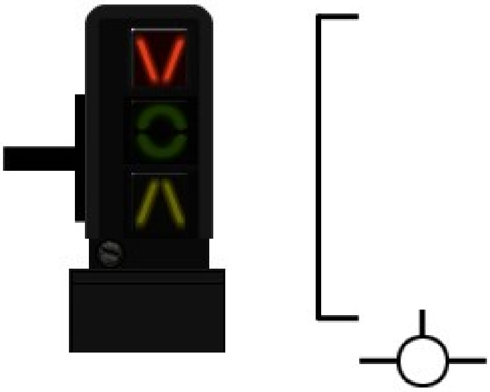


AOA is controlled by the power setting. Increasing power decreases AOA. (The FPM moves up while the nose remains steady) Reducing power increases the AOA (The FPM moves down in the HUD while the nose remain steady)



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

You are too fast.



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

You are too slow.

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

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

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

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

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

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

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

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

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

3.3 Overhead landing

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

- Flight conditions must be VFR.
- The ATC must be able to manage all the flights recovering at the same
- All aircraft in the flight must be within 15 Nm of flight lead at time of initial request.

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

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

The last 5 miles are used to fine tune the formation, so the landing looks good. Aircraft fly a constant airspeed level altitude until overhead the runway. To make overhead less restrictive and granted more often, the ATC code now requires the lead to call it's break turn at all times. This is done with the 'Report Overhead Break' option on the Tower ATC menu: 't t 5'. This is the only indication for the AI ATC to know you're breaking so it can deconflict other flights faster.

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

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

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

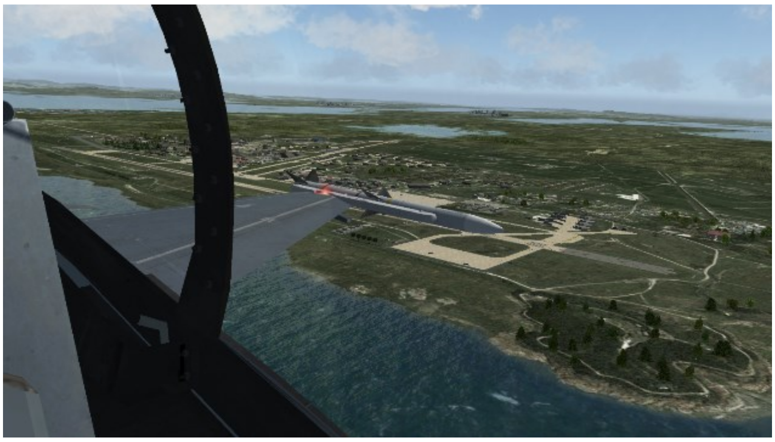
Your jet should be within parameters at least 5 Nm from the runway threshold. Continue straight & level until you overfly the runway. Timing the break turn depends on how many aircraft there are in your flight and on how long you want your downwind leg to be. The sooner you break, the shorter your downwind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

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

The break turn is a maneuver that will turn 180° level. Don't forget to report the break to ATC with "t t 5". While turning you will be bleeding airspeed and once established on the downwind leg (356-180=176°) you can lower your landing gear immediately.

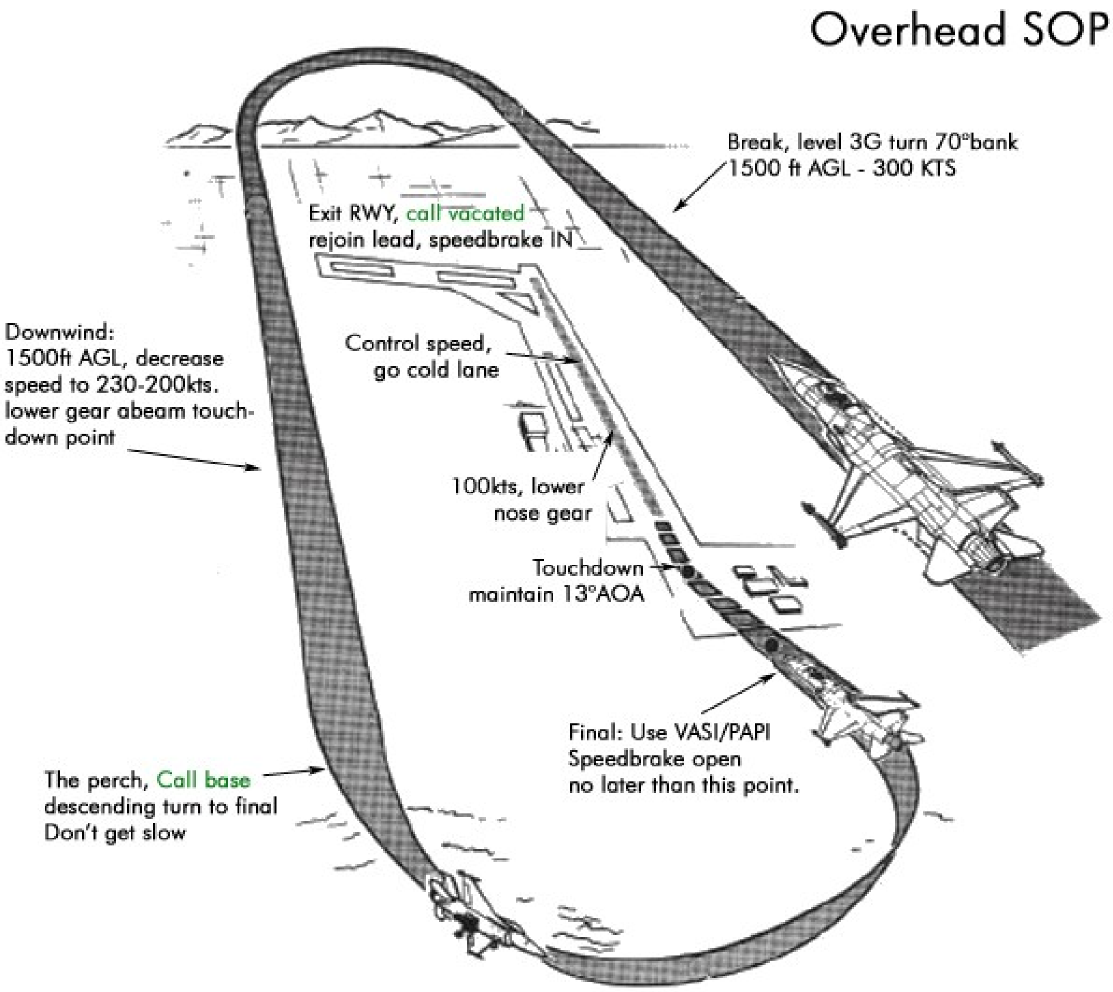
The turn will define how wide your lateral separation with the runway will be.

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



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

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



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

If you reported the break to ATC correctly, tower will clear you to land automatically as you reach a final position. If you forgot to call the break, the landing clearance will never come. The clearance is given for the whole flight entity, so wingmen do not need to report break or final. They are cleared automatically when the flight lead is cleared to land. Basically, the only thing wingmen need to do is call out their 'break' if they have AI in the flight.

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

In case of a go-around the speed brakes are retracted and the engine spool time will be faster since the setting was higher than without use of the speedbrakes. Touch down on centerline and maintain aerobraking as explained in the section above.

3.4 Taxi back and shutdown the jet

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

ATC will automatically ask you to switch to the Ground frequency as you exit the active runway. Set Ground (preset #2). Taxi to the EOR north RWY 18 and hold at the yellow half-moon de-arming area like shown below:

Please note that arming and de-arming procedures at EOR areas are airbase and/or SOP driven and will vary in amount/position of areas and taxi patterns. Refer to the EOR-procedure chart if available.

Once arrived at the EOR, set your nose gear light to: OFF. External lighting settings at EOR are as follows:

PROCEDURE	SCENARIO	MASTER COVERT	ANTI-COLL	POSI-TION	WING/TAIL	FUSE-LAGE	FORM(%)	AR (%)
EOR	DAY – Good weather	NORM	OFF	STEADY	BRT	OFF	100	0

'Request Taxi Back to Ramp' on the Tower ATC page: 't 4' if you finished your post landing checks (lights, speedbrakes, etc.). ATC will give you clearance to taxi back and will assign you a taxi route to your assigned parking spot (example below: "05"). Check again the APC charts for airport orientation.

Goblin 2-1 Taxi back to the ramp Echo Papa Charlie 0 5

Set your nose gear light to TAXI if you are leaving the EOR. External lighting settings are as follows:

PROCEDURE	SCENARIO	MASTER COVERT	ANTI-COLL	POSI-TION	WING/TAIL	FUSE-LAGE	FORM(%)	AR (%)
TAXI	DAY – Good weather	NORM	1	FLASH	BRT	OFF	100	0

Taxi back to where the mission started in Wolfpack flows, south of the tower. Taxi on Taxiway Papa all to way to the transient ramp and turn left behind Wolfpack flows. Select one emplacement and roll into it. Once parked, 'Install / Remove chocks' on the Ground ATC menu: 't 2' and then safe the EPU: 't 1'.

Shutting down the jet, you start with shutting 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, we will push now for the Advanced Handling Course made of 9 independent training flights in the F-16CM/DM Blk 52, the F-16CM Blk 50 and the F-16C ROKAF Blk52.

Other aircraft types will be available as options in certain missions (for example: Mission 4c -> F/A-18C).

Mission 4A: Formations.

Mission 4B: Tactical Turns.

Mission 4C: HARTS.

Mission 4D: Air to Air Refueling.

Mission 5: Night ILS Landing Clear Weather.

Mission 6: Bad Weather ILS Landing.

Mission 7: Simulated Flameout Landing.

Mission 8: Terrain Following Radar and FLIR.

Mission 9: In-flight Failures.

MISSION 4A: FORMATIONS *(TR_BMS_04A_Formations)*

TAKEOFF OPTION: In flight.

LOCATION: Approximately 6 Nm southeast of Cheonan City.

CONDITION: F-16 CM Block 52 - 4-ship - Callsign Hawkeye 1.
Day time - Aircraft level at about 20000 feet - heading 090° - speed 350 kts.
Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.
You may have to set your MFDs according to your personal preferences.

WEATHER: RKJK INFO: B 010625Z ILS RWY36 TRL140 360/10KTS 7SM FEW050 15/5 A2980 NOSIG
Visibility >5000m, Altimeter 2980.

LEARNING OBJECTIVES: Learn to establish and maintain different formations in a 4-ship flight

In this training sortie you will learn about different types of formations, how to establish different formations and how to maintain them. Accurate formation flying is one of the most important (but often less trained) skills a fighter pilot must have.

In this training it is recommended to take seat #2 or #4 of the flight
Aircraft slots in BMS are always sorted like in the picture to the right. If you join the seat of your choice, the text will be highlighted green. If other human players join other seats, the text will change to green as well. Only non-human used seats have white text.

The flight you will be part of is a 4-ship. Your wingman duty as #2 and/or #4 is to maintain formation to your element leader.
At certain STPTs the AI flight lead will give you order to establish certain formations. How they look like and what is important to know about certain formation types will be covered in the following chapter.

Fluid Four Formation

4A.1 Formation types – A bit of theory

For each phase of the flight (Takeoff Rejoin, Ingress, Tactical, Refueling, Egress, Landing, etc) certain formations can be used depending on the size of the flight, the task and the overall tactical conditions. In BMS, most of the following formations are available to direct the AI as a flight lead or to be directed from the AI flightlead.

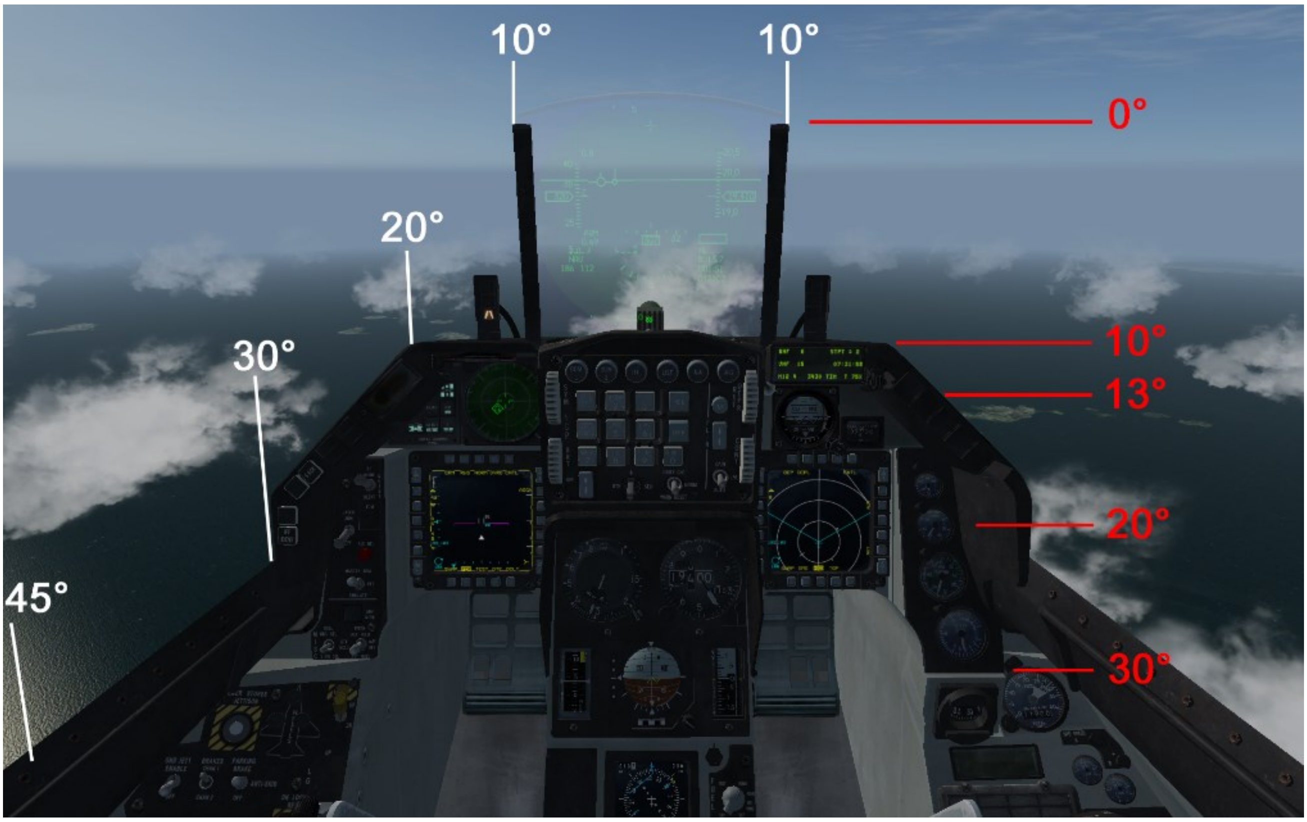
In addition, some clarification about the basic terminology of aircrafts in a formation is needed. The usual size of a flight (if more then one aircraft) is called a 2-ship (= two aircraft) or a 4-ship (= four aircraft). In the case of a 4-ship the following nomenclature is used:

First Element	**Second Element**
#1 - Flight Lead	#3 - Element Lead
#2 - Wingman	#4 - Element Wingman

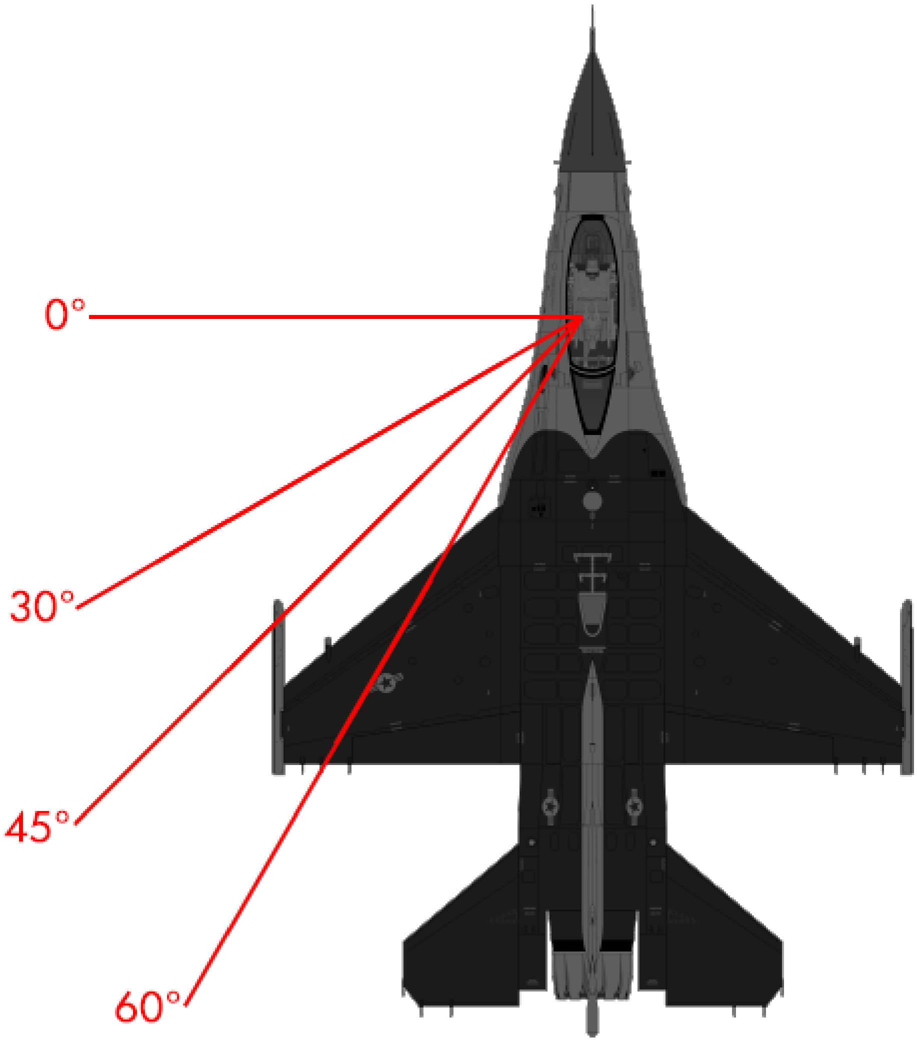
To verify that the pilot is at the right spot, certain tools can be used:

a) Canopy Cues in BMS (UI/Graphics)
b) Canopy Angles Cues

4A.1.1 Canopy Angles Cues

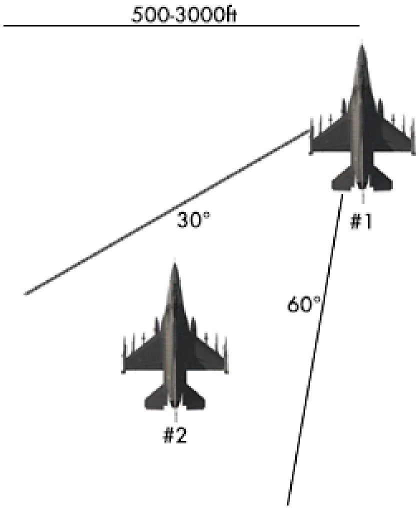


Canopy cues help the pilot to measure the angle between aircraft. Those angles will be described more in detail for the following formations.


0°
30°
45°
60°

4A.1.2 2-ship Formations

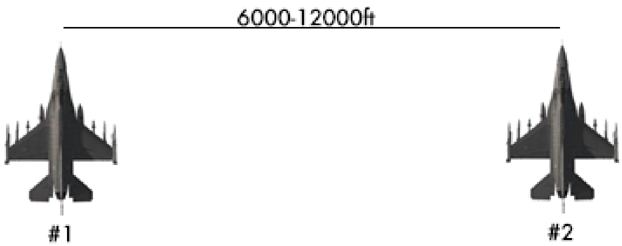
Fighting Wing



This formation is a two-ship formation. The wingman's maneuvering cone is from 30-60° aft of the line abreast line with a spacing between 500-3000ft.
The "Fighting Wing" is flown when maximum maneuverability is required and can also be flown as a 2-ship formation. Examples for this are:
a) On Route (flying into the operational area)
b) Holdings in a tactical environment
c) Rejoins
d) Flying around obstacles or clouds.

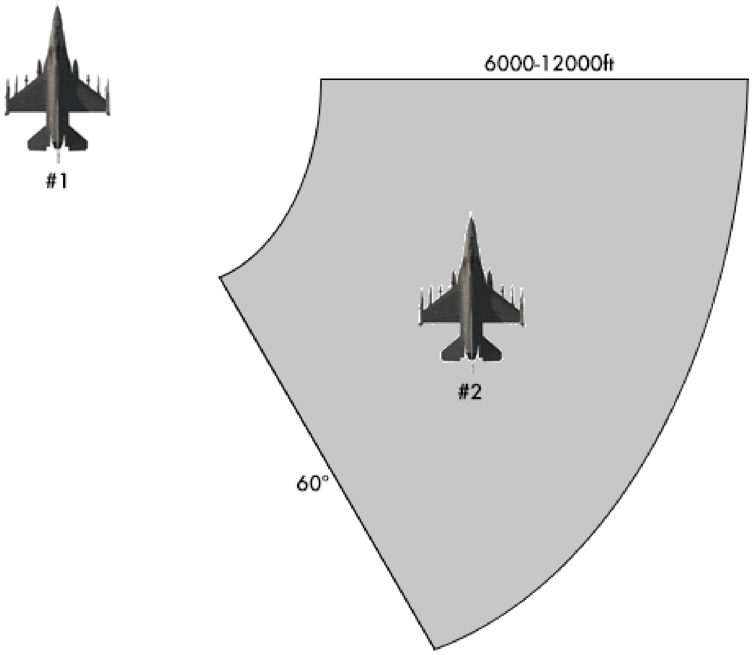
The wingman can switch sides and move above or below his lead within the 30-60° cone. In addition, it is also practical to use an „Extended Line Abreast" (EFW) with a spacing between 3000-6000ft if needed. Please note that this formation is not part of the BMS AI Comms menu but is important to know.

Line Abreast LAB (2-ship)



The LAB formation is flown as a 2-ship next to each other with a separation of 1-2NM between flight lead and wingman. The wingman can be 2000ft higher or lower than lead if conditions allow it (Threats, etc.). Ideally the wingman is on the 0° line. The cone to maneuver can be extended to 20°.
This formation is quite challenging for the wingman and requires staying constantly visual to the flight lead. A good flight lead always maintains speed and heading, if possible, so that the wingman can maintain the formation easier. The wingman can also be on the left side of the flight lead depending on the briefing or tactical situation.

Spread (2-ship)



The "Spread" formation is similar to the LAB formation but gives the wingman more room to maneuver.

The cone is between the LAB 0° line and 60° with a spacing between 1-2NM. The wingman can be 2000ft higher or lower than lead if conditions allow it (Threats, etc.).

The wingman can also be on the left side of the flight lead depending on the briefing or tactical situation.

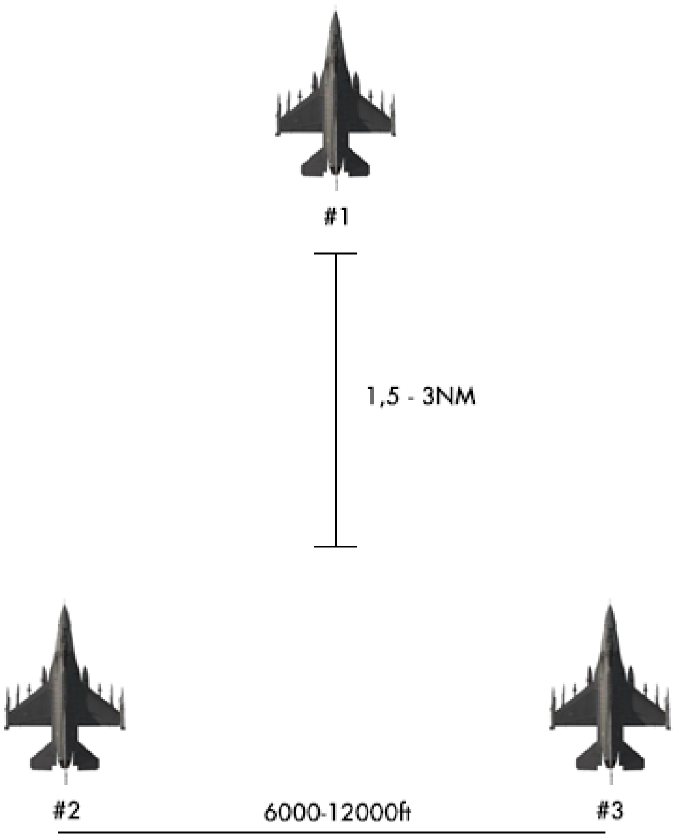
4A.1.3 3-ship Formations

Vic

The flight lead operates as a single ship element. Number #2 and #3 are the second element. They are in line abreast formation with a spacing between 6000-12000ft.

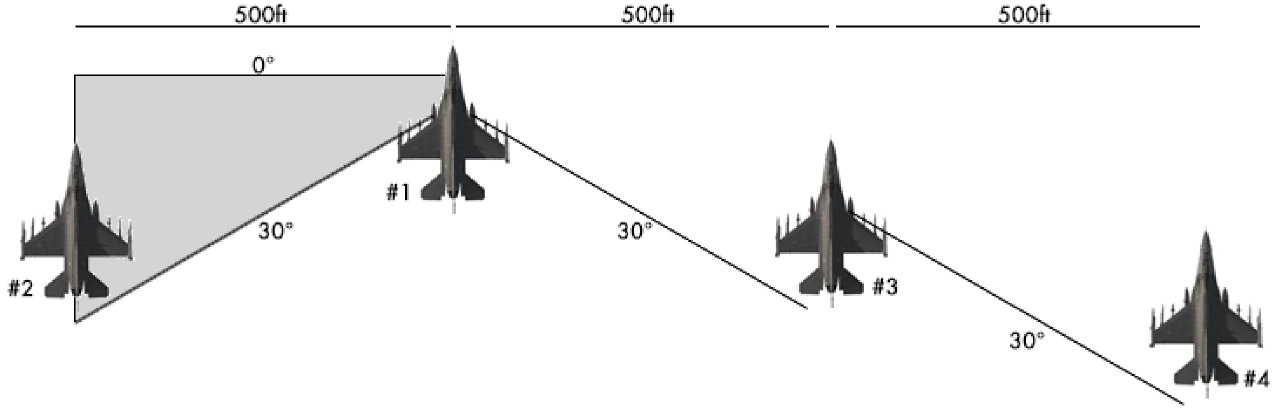
The second element normally flies in 1,5-3Nm trail of #1.

Please note that Vic is typical 3-ship formation. In BMS there is an even tighter "Fluid Four" (see 4-ship formations) formation with all aircraft separated by less than 2000 feet.



4A.1.4 4-ship Formations

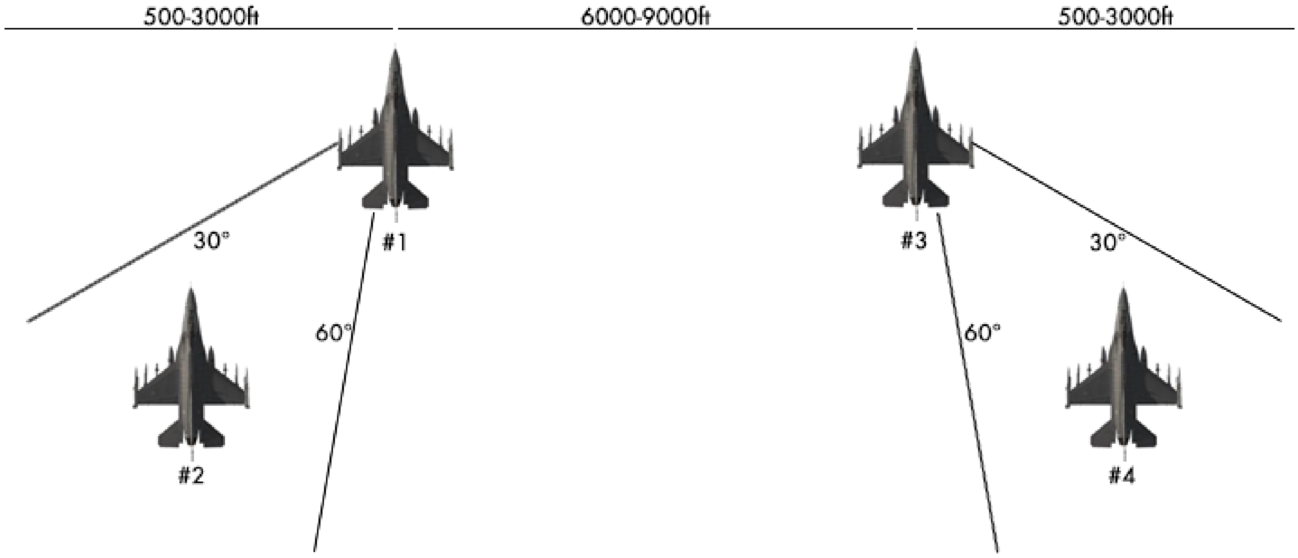
Route



The "Route" formation is a loose formation which corresponds to an enlarged "Fingertip" formation (see chapter 4A.1.5). It allows to increase flight maneuverability as well as to let the flight control instruments, airspace and do other tasks in the cockpit in more safe conditions.

The distance between each aircraft is about 500ft. The flight can operate at the same altitude or element can be 200ft higher/lower. The cone to maneuver (grey area in the picture above) is the 30° and the 0° line.

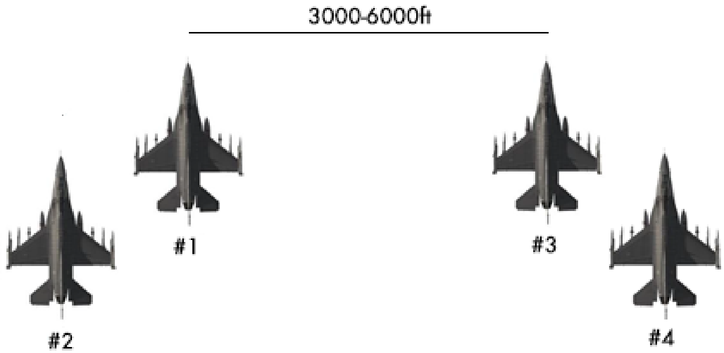
Fluid Four



The "Fluid Four" consists of two "Fighting Wing" formations with an element spacing between 6000-9000ft. Both element leaders fly "Line Abreast" between 6000-9000ft. The wingman are flying in fighting wing.

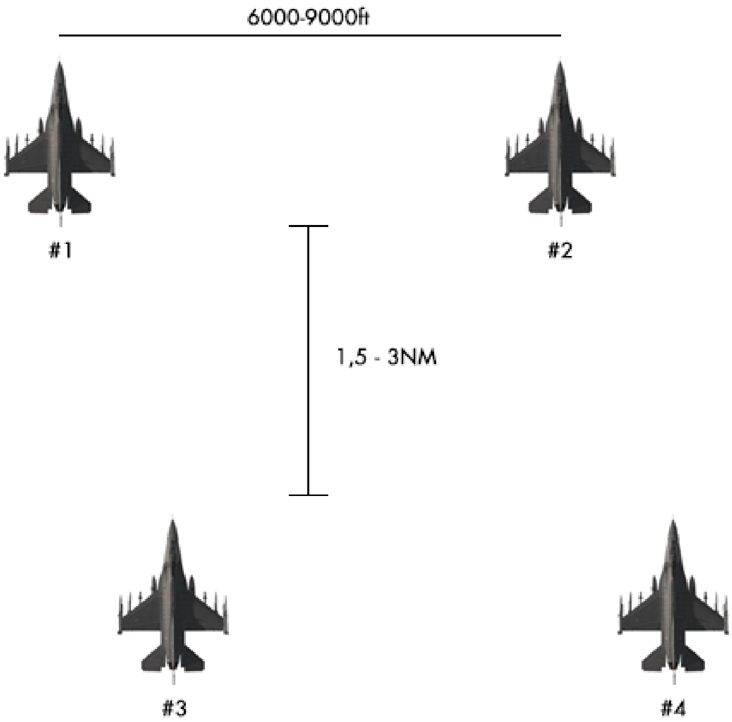
Res Cell

The “Res Cell” formation is similar to the “Fluid Four” formation but tighter. Both wingmen are flying in “Fingertip” formation.
Both element leaders are in LAB formation with a spacing between 3000-6000ft.

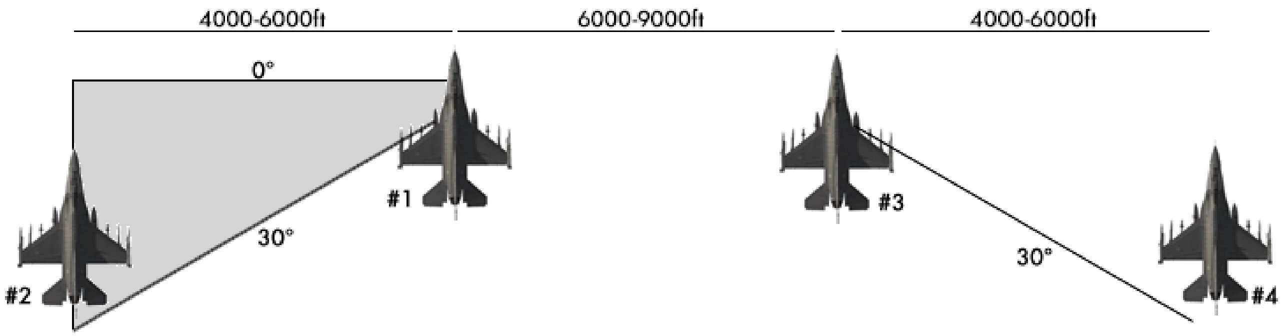


Box

For the “Box” formation each element establishes a LAB formation with a spacing between 6000-9000ft. The element spacing is between 1,5-3NM. The elements can slightly offset (right picture) or fly directly behind each other.



Spread (4-ship)



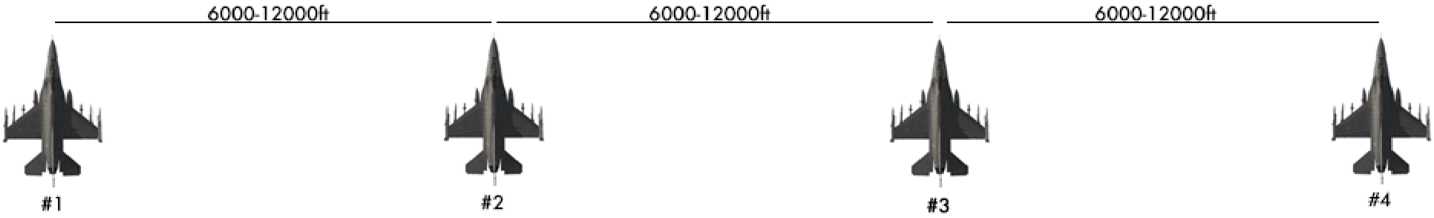
The “Spread 4-ship” consists of two “Spread” formations with an element spacing between 6000-9000ft. Both element leaders fly “Line Abreast”. The wingmen are flying in spread (0-30° cone).

Line Abreast LAB (4-ship)

The LAB formation is flown as a 4-ship next to each other with a separation of 1-2NM between each aircraft. Ideally the flight is on the 0° line. The cone to maneuver can be extended to 20°.

This formation is quite challenging for the whole flight and requires staying constantly visual to the aircraft next to you. A good flight lead always maintain speed and heading if possible to so the wingman can maintain the formation easier.

The flight can also be on the left side of the flight lead depending on the briefing or tactical situation.



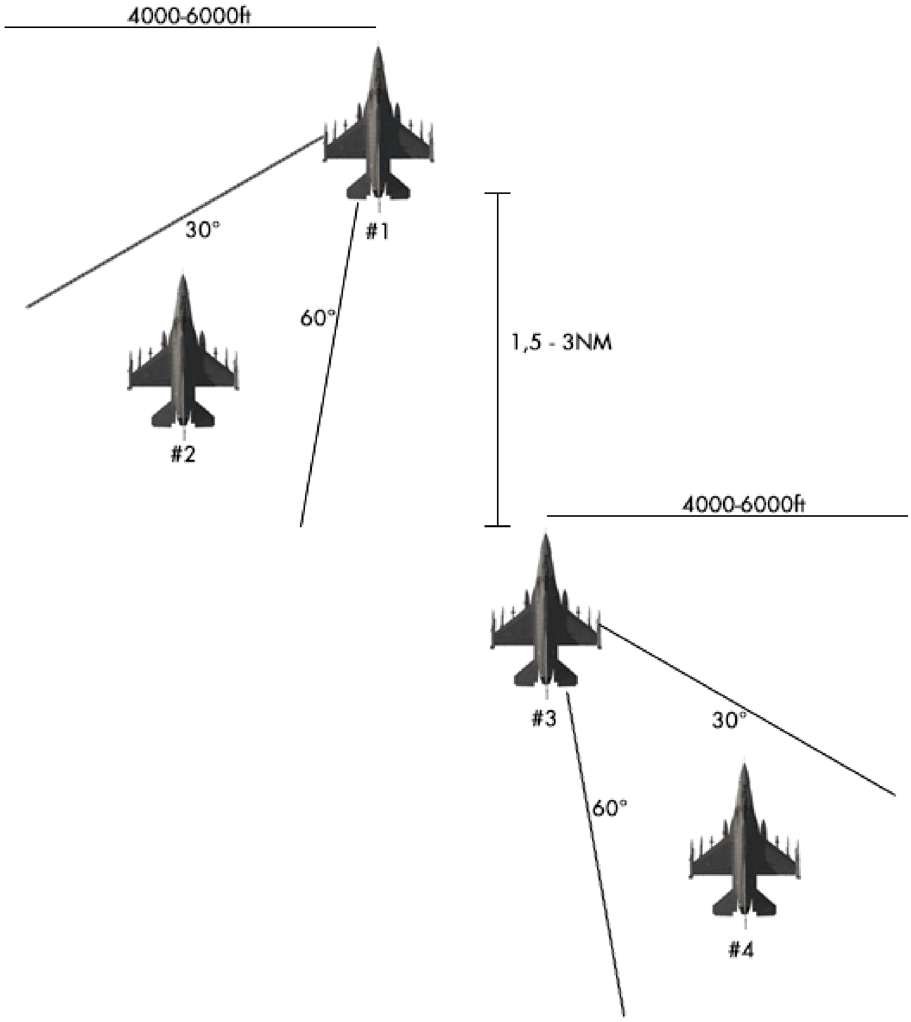
Wedge

Wedge is defined as the wingman positioned from 30° to 60° aft of the leader's 3/9 line with a spacing of 4000 to 6000ft and at the same altitude level.

The advantages of the "Wedge" formation for each element are that the leader is well protected in the 6 o'clock area and is free to maneuver aggressively.
The wingman can switch sides for turns or to avoid any obstacle.

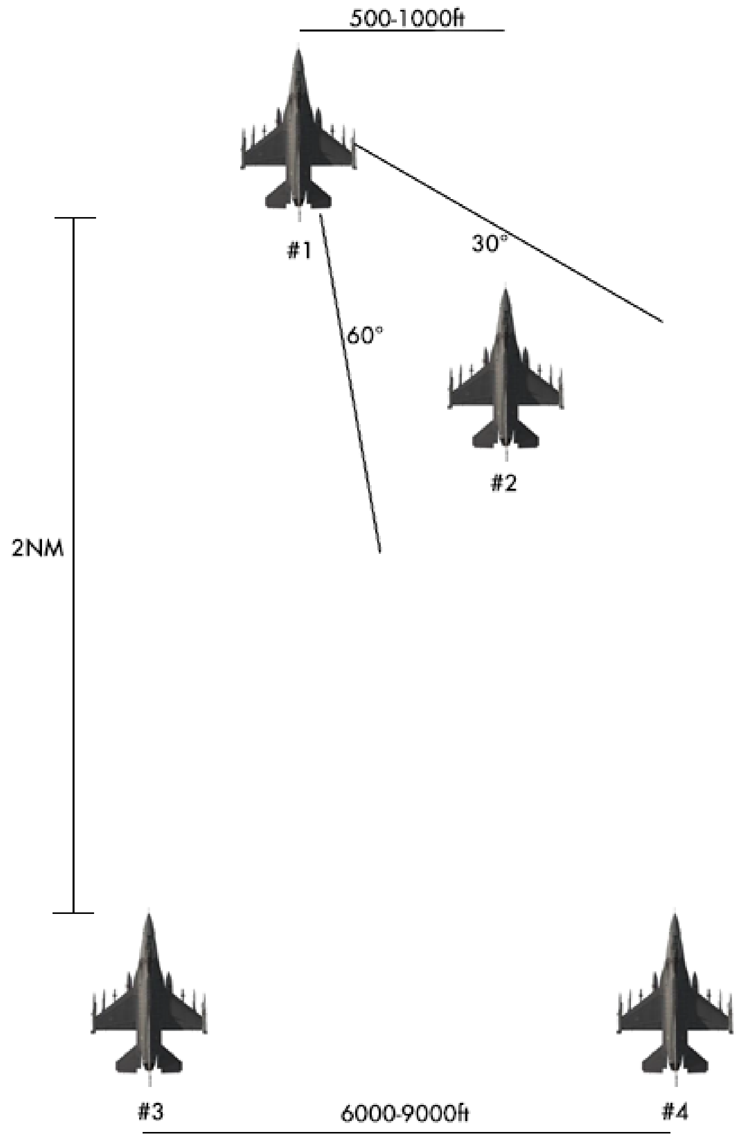
The tactical advantage is that flights, especially with an Air-to-Air task (Sweep, etc.), can establish much quicker 4-ship tactics like a grinder, a CAP or a bracket because there is already distance between elements.

The wingman may switch sides as required during turns.



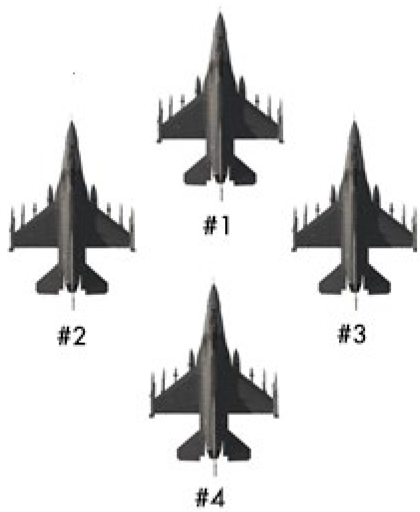
Arrowhead

The “Arrowhead” formation is a mixture of a “Wedge” formation (first element) and LAB formation (second element). The second element is in 2NM trail.



Diamond

This formation can be flown tight or loose and is mostly used for airshows (no tactical advantage).



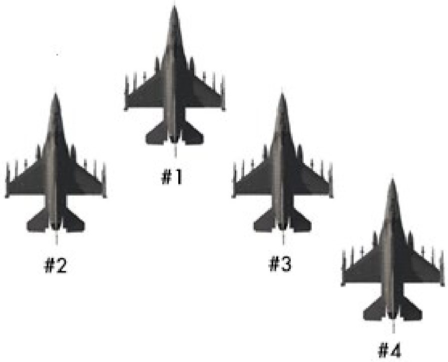
4A.1.5 2-/3-/4-ship Formations

Fingertip (Close)

The "Fingertip" (close) formation is a closely flown standard formation. It requires that the wingman is constantly visually fixated on his lead.

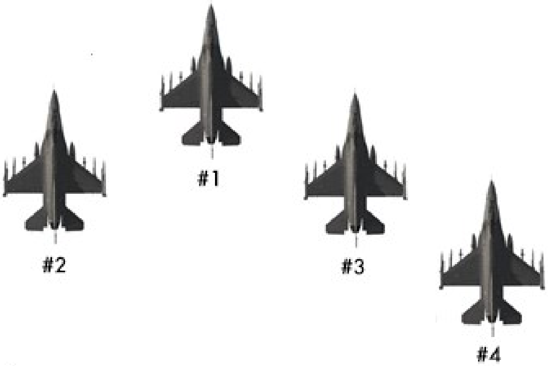
The wingtip rail / wingtip missile aligned with the canopy frame (= 45° canopy cue) serves as a reference for close formations. A decent stacking from high (#1) to low (#4) is practical.

The shown formation can also be flown with #2 on right side, #3 on left side and #4 left of #3, depending on the SOP.



Finger Four

The „Finger Four" formation is similar to the „Fingertip" formation, but more loose with a spacing up to 1500-2000ft.



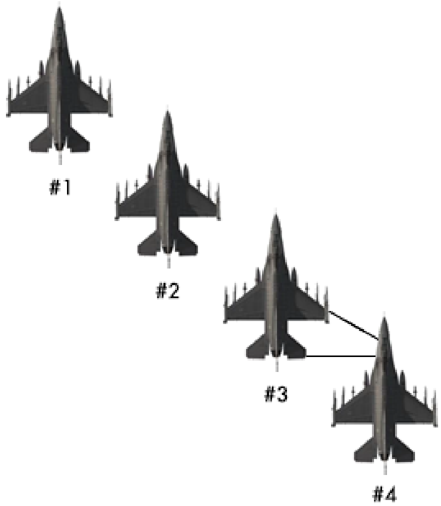
Echelon left/right

The "Echelon" formation (left / right) is the standard formation for:

a) Overhead Approaches *(see Chapter 3.2)*
b) Tanker operations *(see Chapter 4D)*

"Echelon" formations are normally flown very tight (similar to fingertip). The wing tip rail / wingtip missile aligned with the canopy frame (= 45° canopy cue) serves as a reference for close formations. A decent stacking from high (#1) to low (#4) is practical.

On the right you see a "Echelon right" formation. "Echelon left" is the same but #2-4 are on the left side of #1.



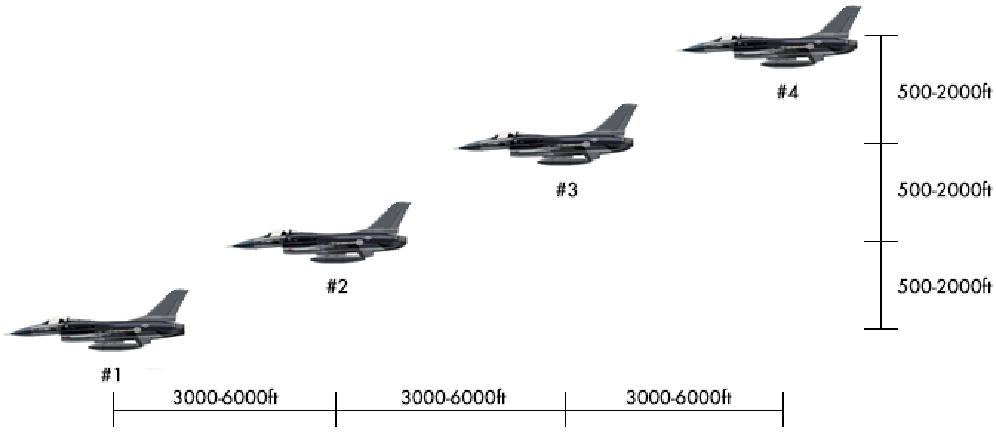
Trail

Especially in IFR (Instrument Flight Rules = Bad weather conditions) departure conditions, a "Trail"/radar assisted "Trail" formation is used.

The spacing between each aircraft is defined by flight lead or by outside conditions (IFR, etc.). A decent stacking from high (#1) to low (#4) is practical to increase visibility to all aircraft in front but can be also flown at level altitude. The briefed/given spacing between each aircraft can be monitored via A-A TACAN or FCR lock (radar assisted trail).

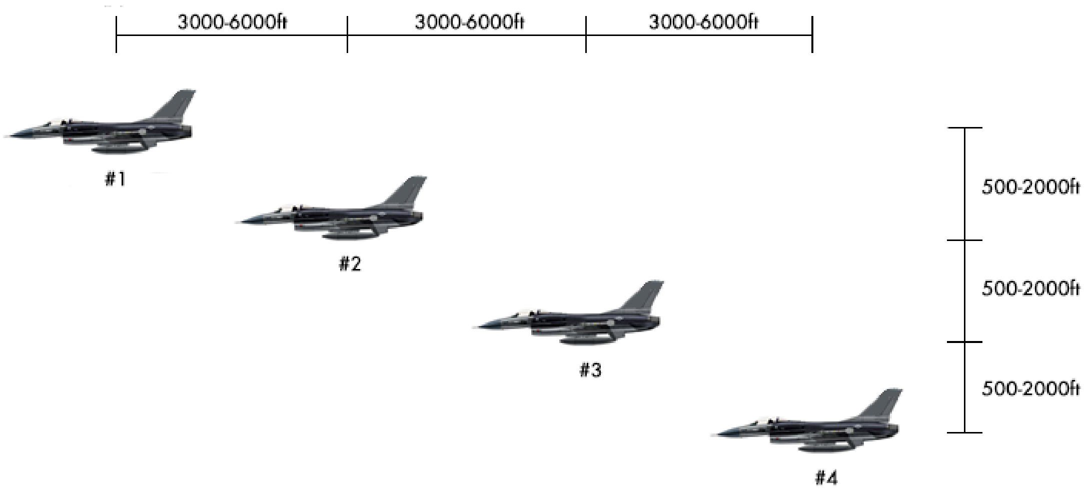
Ladder

The "Ladder" formation is similar to the "Trail" formation and often used for A-G operations to enable vertical separation between aircraft.

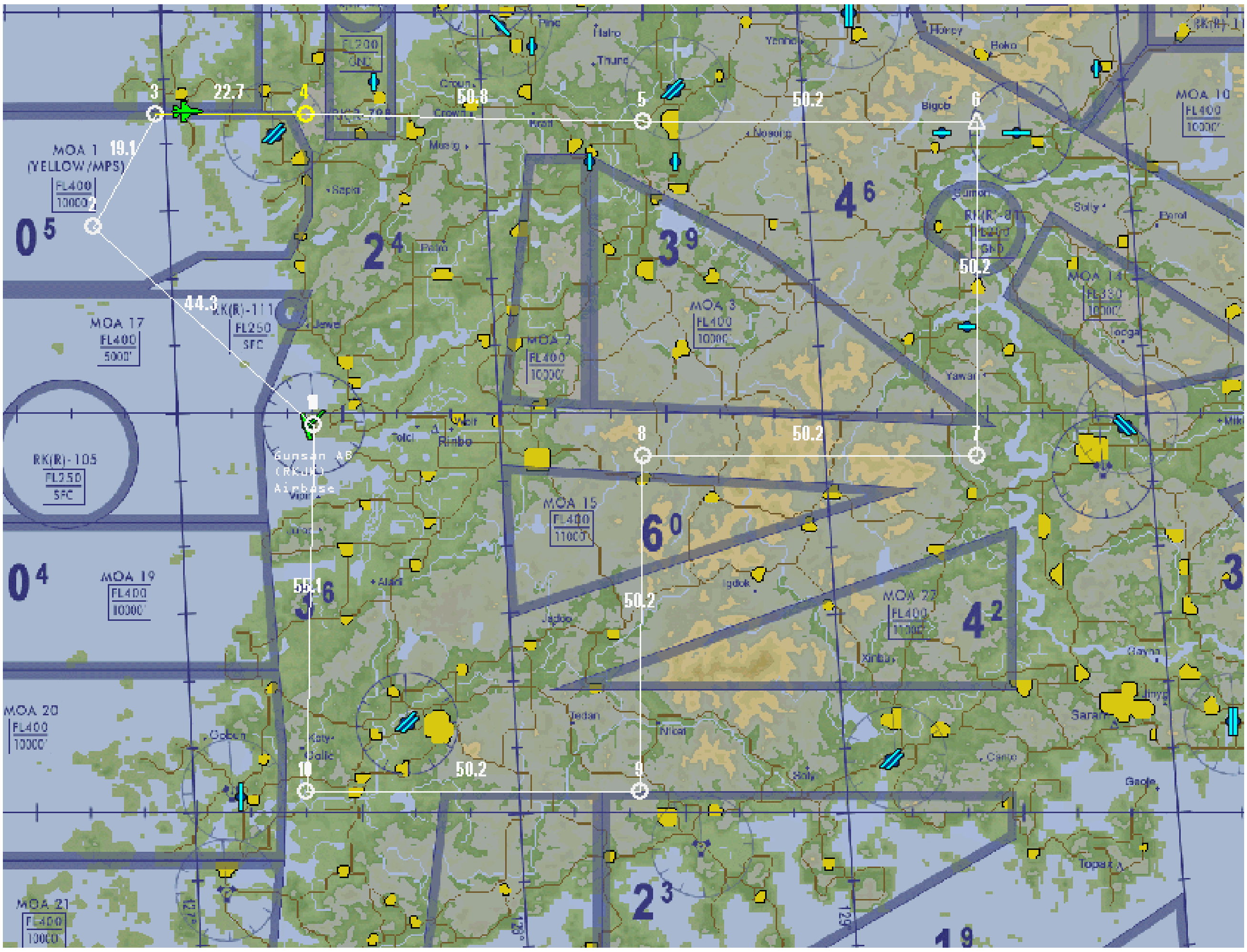


Stack

The "Stack" formation is similar to a "Trail" formation but with tighter distance limitations and a must for vertical stacking.



4A.2 The mission



As mentioned before, this training will require certain knowledge about different formations. You will execute six different 4-ship formations in this sortie. Each formation leg is about 50NM. The contract speed is about 330 KCAS at 20000ft. The goal is to establish the formation as fast and safe as possible and to maintain it the whole leg. In terms of spacing the AI flight lead will not call out any spacing. Adapt the used distance of the other flight members as good as you can.

Your flight starts between STPT 3 and 4. Once you are in the pit, all settings for radios, A-A TACAN and IDM will be set automatically. Activate your ACMI to analyze your performance and formation quality after the training.

A formation is not called out yet. Just try to stick with your element lead on his wing. Shortly before STPT 4 the AI flight lead will call out a new formation. The first formation will be a “Wedge” formation. Just remember what you’ve learned in the previous chapter and establish a distance to your element lead between 4000-6000ft at his 30-60° cone level with him.

At STPT 5 the next formation will be a “Trail” formation. Because normally AI formations are flown pretty tight, establish a 0,2-0,5NM trail. Use your A-A TACAN to measure the distance to your element lead and use your eyeball.

Each formation transition requires an extra portion of situational awareness. Look around and make sure that no other AI aircraft crosses your flight path when you execute the transition.

At STPT 6 the flight lead will call for a "Fluid Four" formation.

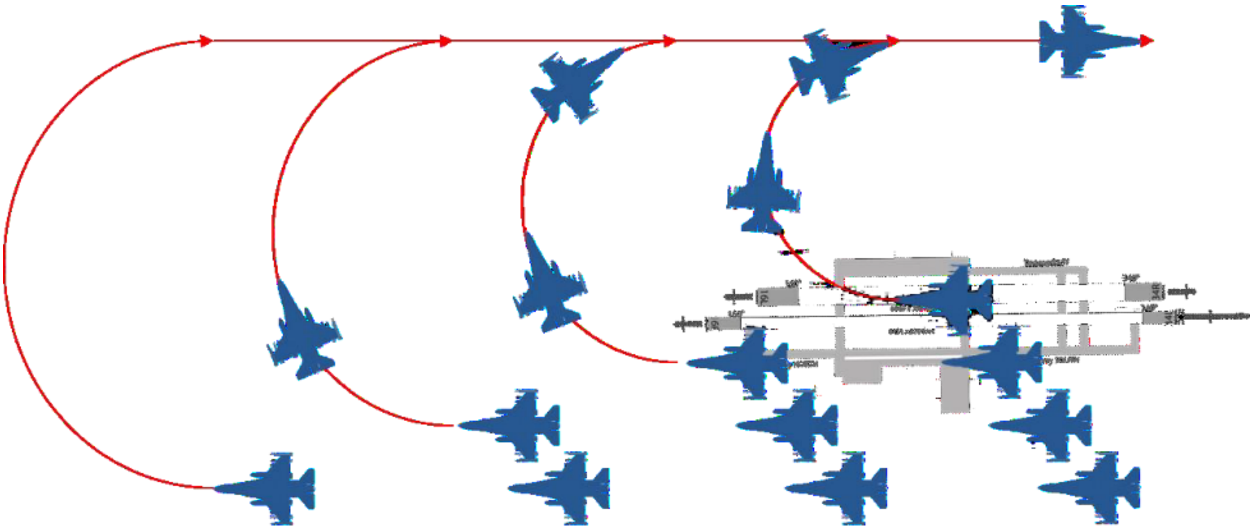
STPT 7 will be a "Spread" formation. Please note that the "Spread" formation will bring the #2 to the left side of #1 and #4 to the right side of #3. The cone is between the LAB line and 60° with a spacing between 1-2NM.

At STPT 8 the flight will transform in a "Box" formation.

STPT 9-10 will again a "Fluid Four" formation as a preparation for the approach in Gunsan.

The last formation will be "Echelon" left or right (depending on the active runway) to execute a 4-ship overhead break. Make sure you understood the principles of the overhead break. We refer you to chapter 3.2 to get a refresher.

A 4-ship overhead break works in theory like in the picture below:



The flight will be inbound to runway heading in "Echelon" at about 300 KCAS and 1500ft AGL. Follow your element lead and fly as tight and precise as possible. The AI uses 4-5 seconds delay in between breaks, so wait 4-5 seconds before you break.

Congratulations! Your formation training was hopefully a success. You may check now your ACMI to analyze your training.

Keep in mind that a solid formation performance will support your element lead so he can concentrate on his job. Any flight lead is happier when he looks out of the window and sees you at the position where he expects you to be.

MISSION 4B: TACTICAL TURNS *(TR_BMS_04B_Tac_Turns)*

TAKEOFF OPTION: In flight.

LOCATION: Approximately 20 Nm northwest of Gunsan Airbase.

CONDITION: F-16 CM Block 50 - 2-ship - Callsign Cyborg 6.
Day time - Aircraft level at about 12000 feet - heading 307° - speed 320 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: RKJK INFO: B 010730Z ILS RWY36 TRL140 360/10KTS 7SM FEW050 15/5 A2989 NOSIG
Visibility >5000m, Altimeter 2989.

LEARNING OBJECTIVES: Learn to execute tactical turns and enhance formation flying skills.

To achieve a quick, safe and coordinated direction change, fighter pilots train and execute 2-ship or even 4-ship tac-turns (Tactical Turns) heavily in their career. Tac-turns are used to gain tactical advantage and/or establish a new heading without much communication. They are often used for any kind of mission profile (Air-to-Air as well as Air-to-Ground).

This mission is designed to train tac-turns with the AI at a contract speed of 350kts and 20000ft. Even when AI tac-turn orders are not implemented yet in BMS, there are interesting ways to train some of them. We also recommend doing this training with other humans to gain experience and to enhance your skillset. **In this sortie it is recommended to take seat #2 of the flight.**

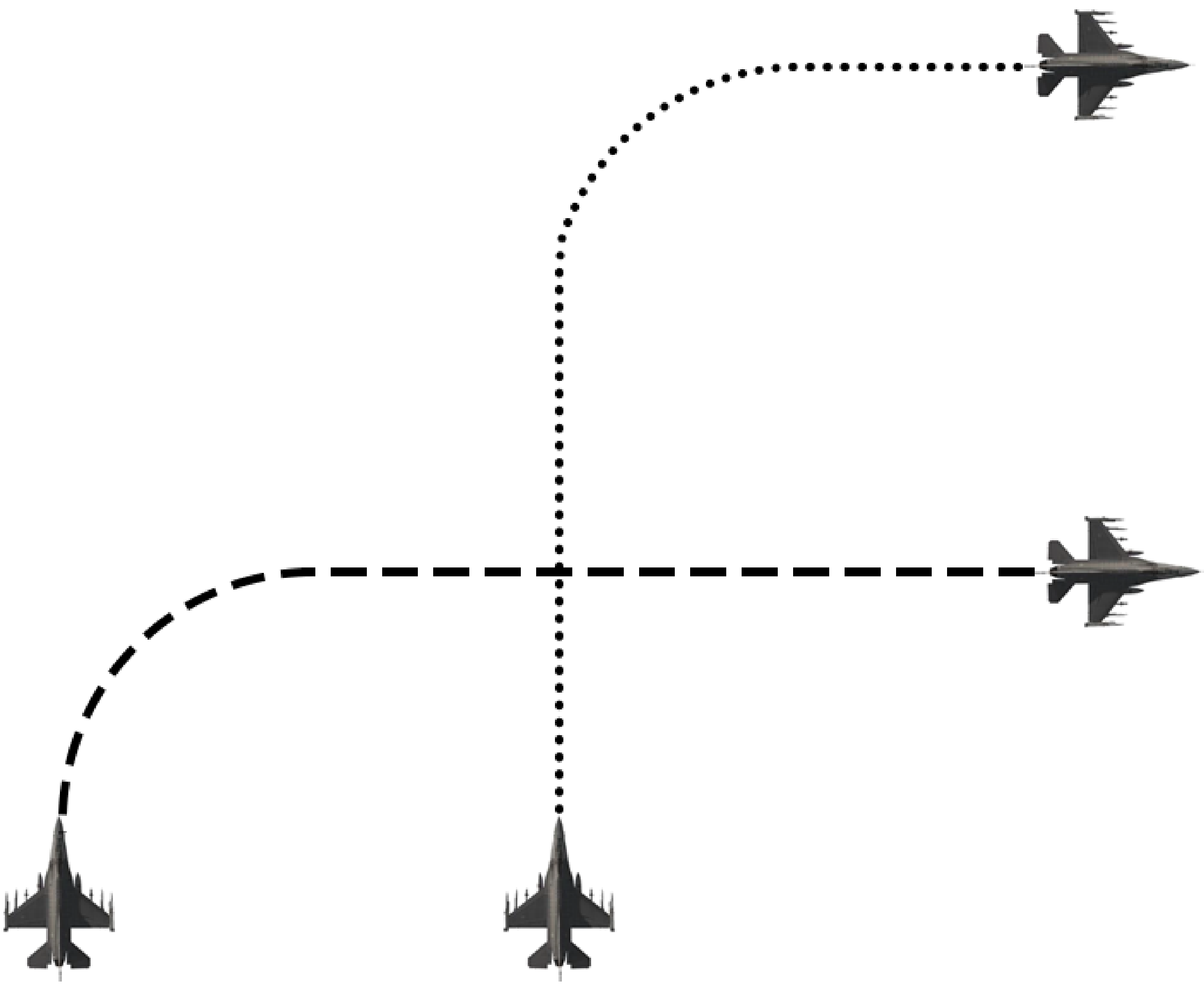
Cross Turn with Shackle

4B.1 2-ship Tactical Turns

Delayed 90° Turn

Delayed turns are calculated and executed in a fashion that allows a flight currently in "Spread" or "LAB" formation (normally 0,5-1nm distance between aircraft) to maintain the formation and distance after executing a 90° turn. The turn is executed 90° level within a briefed or standardized contract speed.
In a delayed turn, the pilot on the outside of the turn always turns first. This may not be the flight- or element lead. As delayed turns require turning in towards aircraft, it is the job of the wingman to deconflict with the element lead to avoid any unsafe conditions.

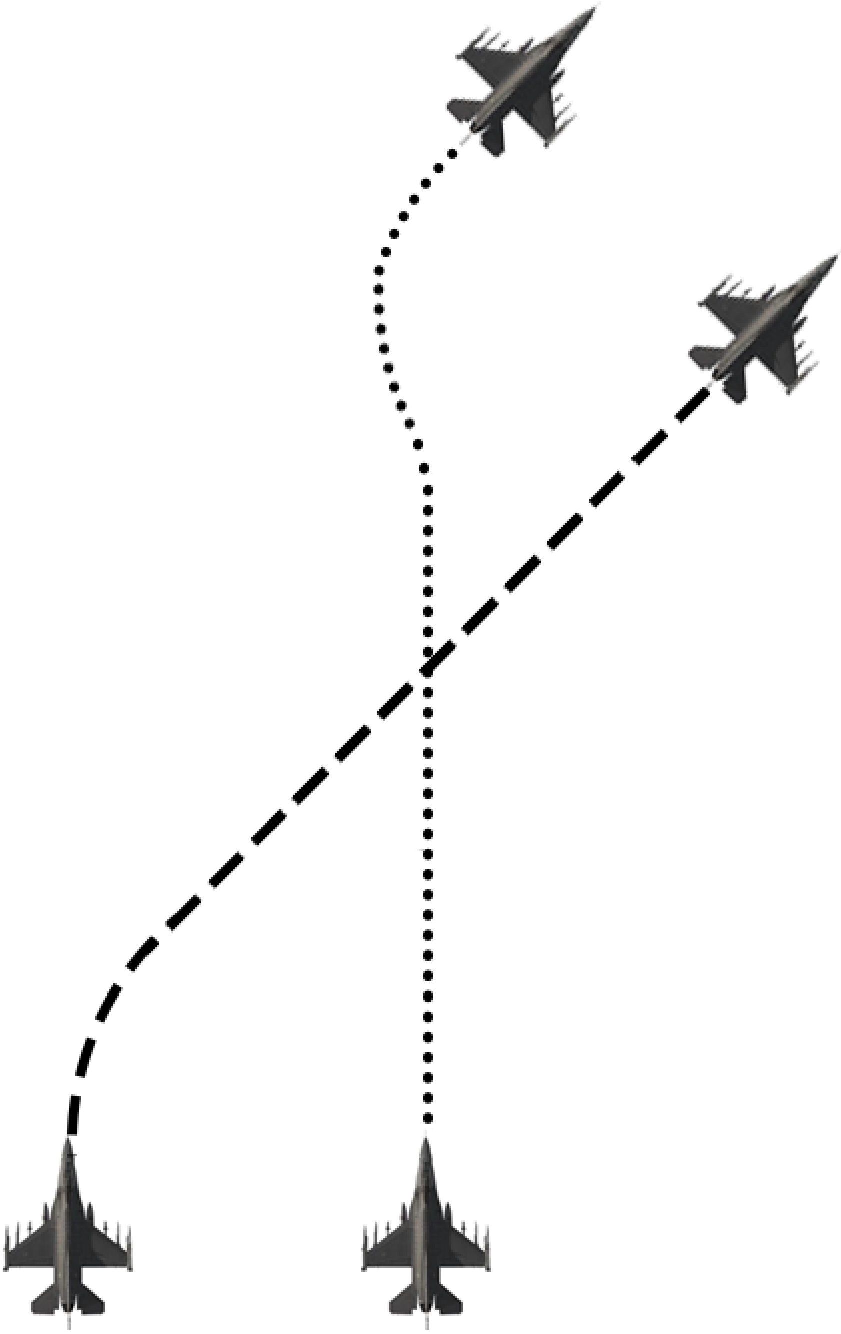
If doing training with two human pilots, it is best practice that the wingman must confirm the turn order from the flight-lead before executing the maneuver to make sure that both flight crews are aware of the following turn.



Delayed 90 right

Delayed 45° Turn

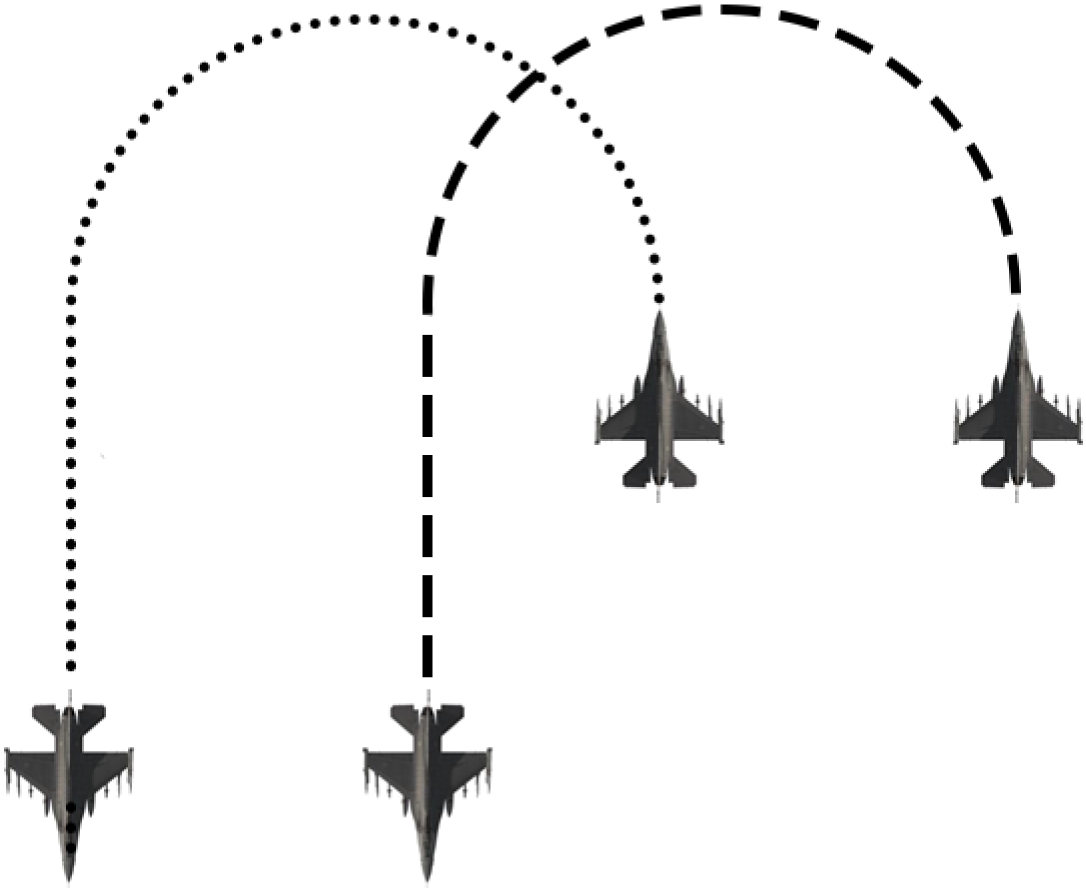
The delayed 45° turn is very similar to the delayed 90° turn. The flight start is in spread/LAB. The pilot on the outside of the turn initiates the turn. The wingman is always responsible for deconfliction.



Delayed 45 right

Hook Turn

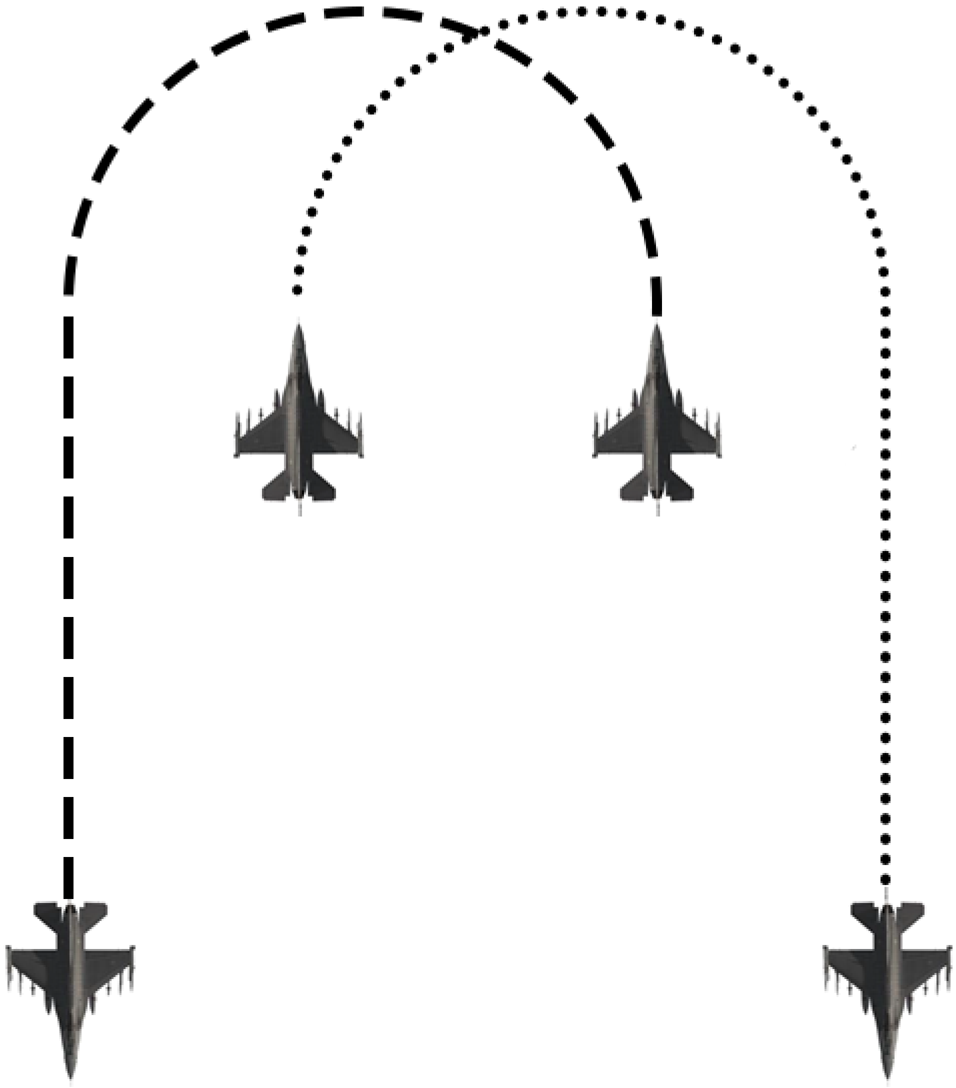
For the Hook turn the flight will again start in spread/LAB formation. This turn is a synchronized maneuver at level on contract speed. That means, both airplane initiating the turn at the same time. The wingman is always responsible for deconfliction.
This turn is ideal for CAPs.



Hook left

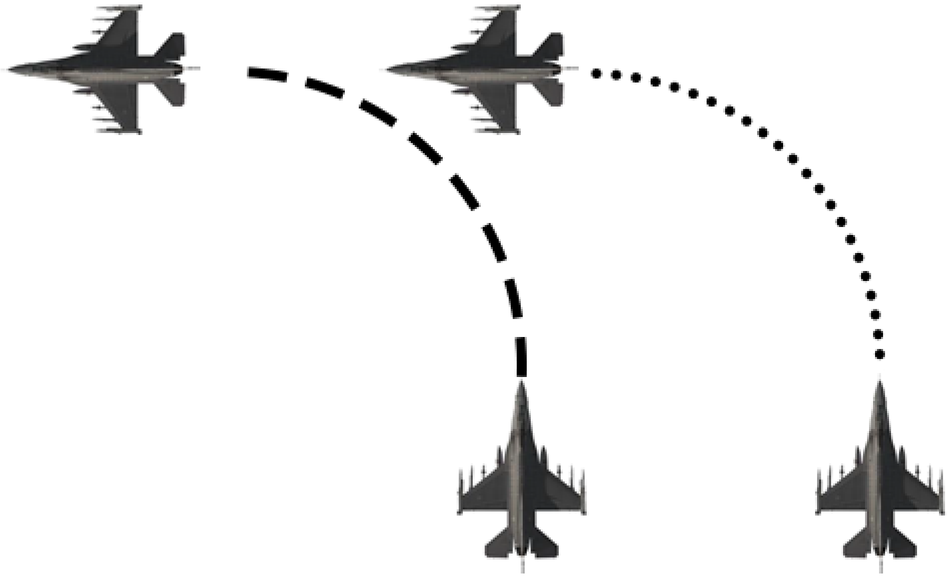
Cross Turn

The Cross turn start in spread/LAB formation. This turn is a synchronized maneuver at level on contract speed. That means, both airplane initiating the turn at the same time. The wingman is always responsible for deconfliction. Be aware: this turn needs an extra portion of visual deconfliction because the aircraft will come very close to each other. This turn is ideal for checking the 6 o'clock of an aircraft.



In Place 90

This turn is a synchronized maneuver at level on contract speed starting in Spread/LAB formation. The wingman is again responsible for deconfliction.
This turn is often used for a tactical recovery to homeplate.

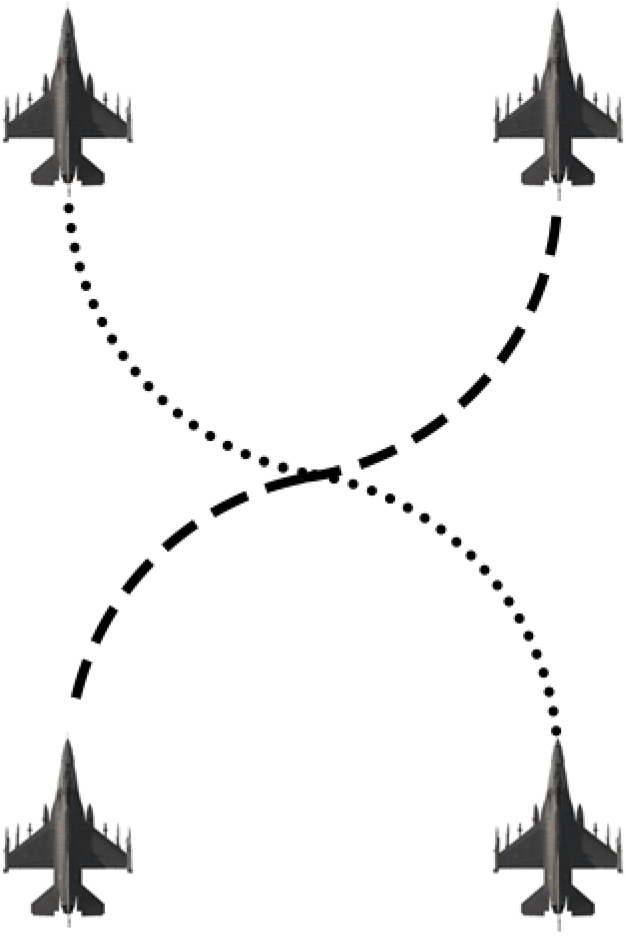


In Place 90 left

Shackle

A shackle is often used to switch the position of both aircraft quickly in a synchronized manner. If altitude and threat situation allow, the wingman turn below the flight-lead. Again, the wingman is responsible for deconfliction.

Especially when executing a cross turn, a shackle is often used after to bring the flight back in a tighter spread/LAB formation.

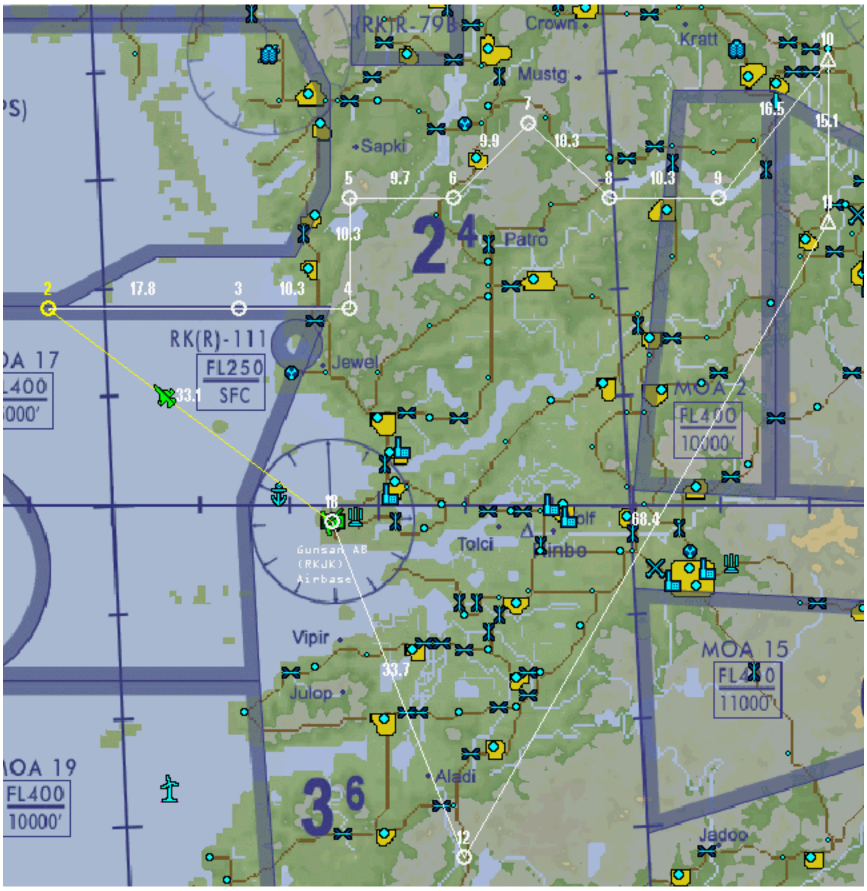


4B.2 The mission

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

In this training you take the wingman seat. The mission will start between STPT 1 and 2 at FL200 with a speed of 310-340kts. Go in Fighting Wing formation till STPT 2. No tac-turns will be executed yet. At STPT 2 the flight-lead will call for a “Spread” formation. Go spread **left** 1NM, heading 093°.

Use your A-A TACAN to measure the distance to your flight-lead. Another tool you can use to increase your SA is the HSD and the HMCS. The HSD is good reference to see where your lead is in relation to your position. The HMCS is good to check if you are in correct formation in relation to your flight-lead. For example, between STPT 2-4 the heading of the flight is 093°: if you see your lead in your HMCS at 183° (so called “3-9 line”) and the A-A TACAN shows 1NM at 350kts, you are spot on. You have time till STPT 4 to establish and maintain your formation. At STPT 4 the tac-turn series start.



The contract speed for all upcoming turns are 320kts-ish. This contract speed has to be maintained as well as the current altitude of 20000ft. Use your throttle, bank and the resulting g-forces (mostly about 2G) to execute your turn in the mentioned parameters.

At the beginning, it will be quiet hard because you have to fly very precisely and learn how to use your throttle and stick effectively. Again, the goal is to end this turn in a reversed “Spread” formation at nearly the same distance, altitude and speed. To get an idea when to turn we will talk about turning cues next.

As you may know, the BMS AI has no direct order or the option to give a call when the turn starts. It means basically you have to be visual on your flight lead all the time. This is not far from real life because in some scenarios tac-turns will be executed silently (= Ziplip), without any communication.

As you can see in the picture to the right, the flight executes a delayed 90 left turn. Your turning cue is when your flight lead is on your 4 o'clock (left turn) or 8 o'clock (right turn).

At STPT 4, the flight will do a "Delayed 90" left turn. STPT 4, the flight will do a "Delayed 90 left turn". Stay concentrated, deconflict the turn of your flight-lead and execute your turn as explained before. The new heading is 003°. After rolling out, check your distance and position to your lead. It is always the job of the wingman to come back in formation. You should be now in "Spread right" 1NM. At STPT 5, the flight-lead will initiate a "Delayed 90" right resulting in a 093° heading. Again, check position, check where your lead is during his turn and wait for your cue. You are now again in "Spread left" 1NM. 10NM later, at STPT 6, your flight will execute a "Delayed 45" left (heading 040°) and at STPT 7 another "Delayed 90" right (heading 128°). The last delayed turn is at STPT 8 ("Spread left" 1NM) ending in a 093° heading. Those pretty quick sequences are quite usual because in certain scenarios a flight has to change direction quite often.

Let's be fair here: in a tactical mission environment no one will do accurate 2G 350kts "jumbo" tac-turns. They will be executed less precisely and more aggressively, especially if there's a threat. The goal is that after this training you will know by heart how a tac-turn is executed if your flight-lead orders you to do a "Hook turn" right to avoid a 4-ship SU-35 hot on you. If you don't have to think about it anymore how to do it, you are set.

Okay, we are not done for this training yet. Speaking about "Hook turns", they will be next.

Your flight will now CAP the area between STPT 10 and 11 for 12 minutes. Establish a "Spread right" 1NM formation when your flight is reaching STPT 10. All turns will be now executed right hand. The same parameters (speed, altitude) are valid like before. It can be that the AI will increase speed when finishing the turn. Adapt if needed. You can also try out a cross-turns if your position and SA allows to do so.

After the CAP time is over, you can decide to land in Gunsan or restart this mission to train this important skill to become a better wingman and tactical partner.

MISSION 4C: HARTS (TR_BMS_04C_HARTS)

TAKEOFF OPTION: In flight.

LOCATION: Approximately 13 Nm west of Chik-Do range.

CONDITION: F-16 CM Block 52 - single-ship - Callsign Mako 2.
Day time - Aircraft level at about 15000 feet - heading 180° - speed 350 kts.
Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.
You may have to set your MFDs according to your personal preferences.

WEATHER: RKJK INFO: B 010730Z ILS RWY36 TRL140 360/10KTS 7SM FEW050 15/5 A2980 NOSIG
Visibility >5000m, Altimeter 2980.

LEARNING OBJECTIVES: Learn how to execute HARTS 1-5 maneuvers.

In the Horn Awareness and Recovery Training Series (HARTS 1-5) maneuvers, recovery procedures are trained from high-pitch altitude, slow airspeed conditions that are normally indicated by the horn. Initially, it will be flown in a series. In certain situations (ACM, etc.), you will perform low speed and high AOA maneuvers. To recover your jet safely in these extreme conditions, the HARTS training is therefore.

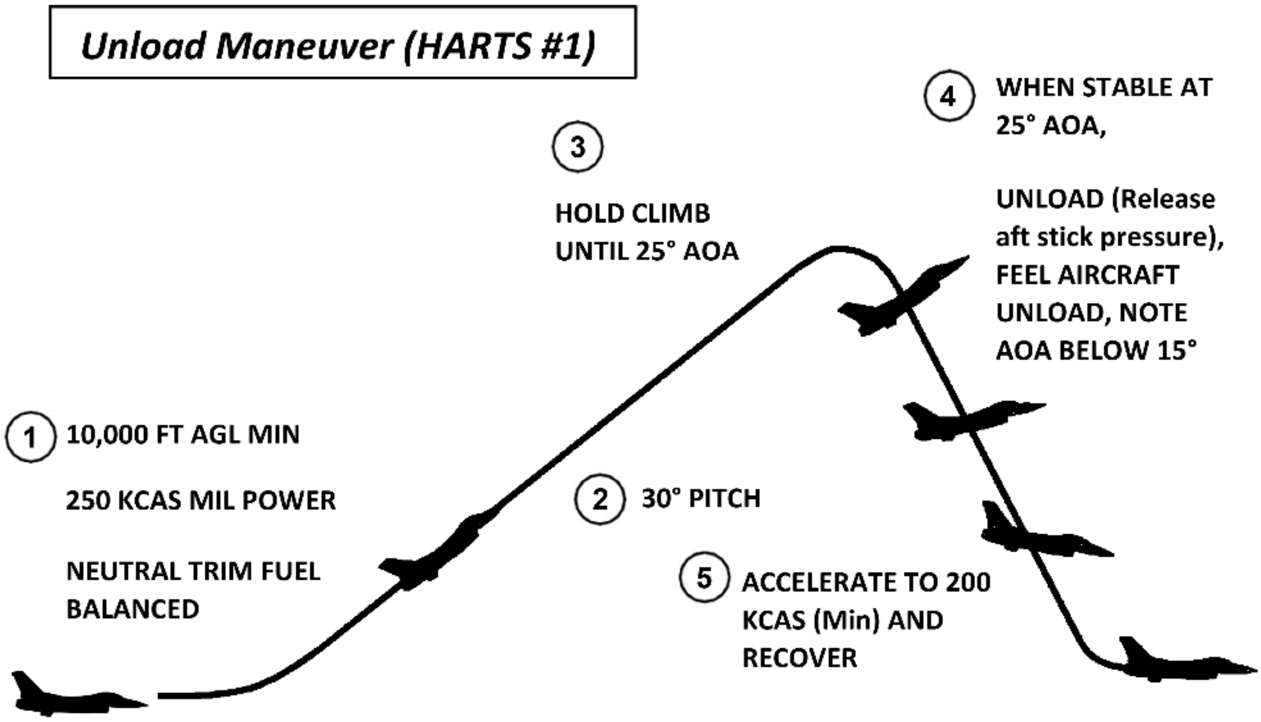
On the next pages all five HARTS maneuvers are illustrated. Follow those instructions step by step and monitor the given parameters when executing those maneuvers. Monitor the attitude direction indicator (ADI) not the flight path marker (FPM). Reference to the HUD flight path results in an increasing attitude as the angle of attack (AOA) increases.

Using finesse is key to fly these maneuvers thoroughly. Unsafe conditions may occur if the pilot fails to react quickly, the warning horn fails, or abrupt inputs are made.

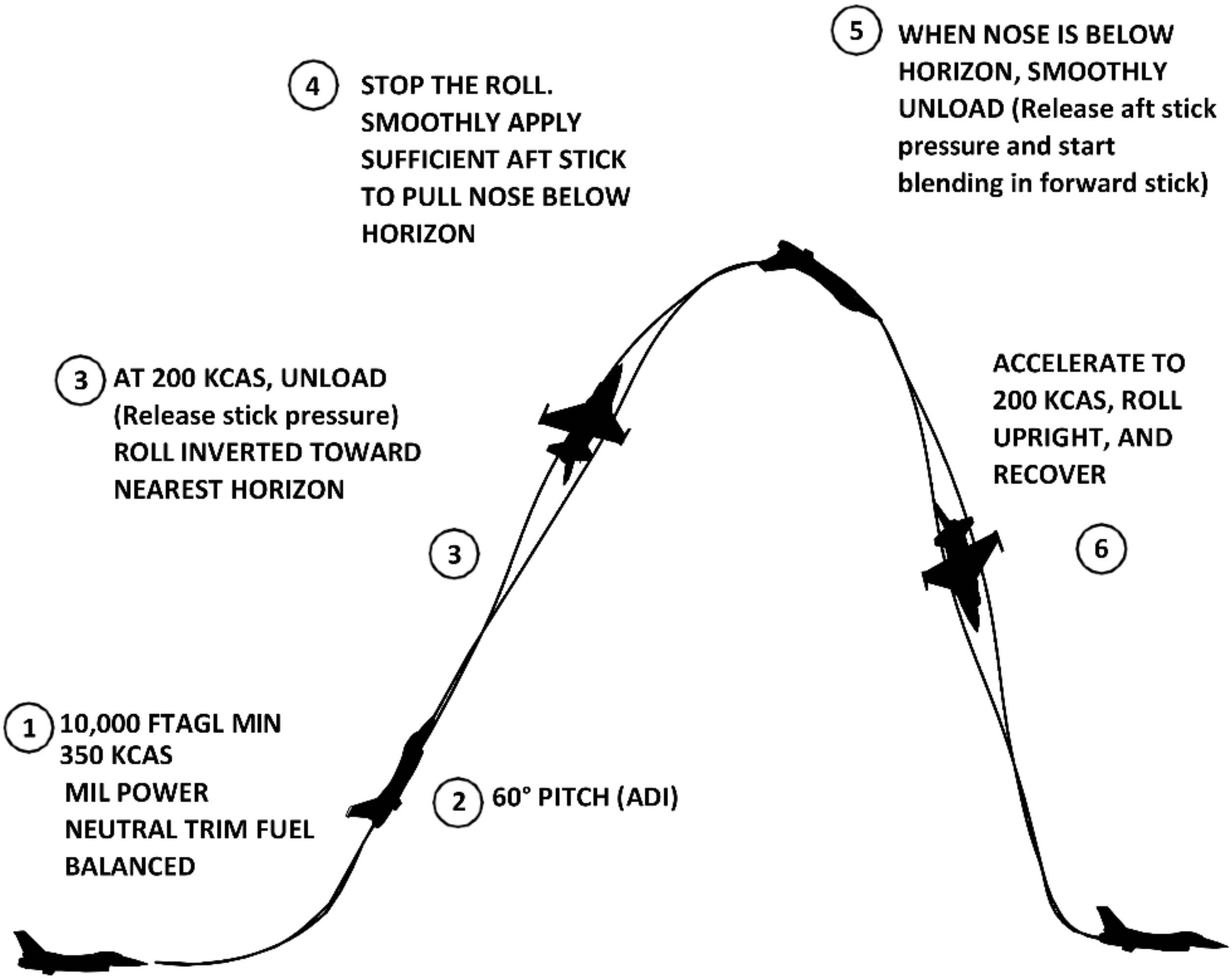
During the roll to the horizon, it is essential to avoid buffeting and to smoothly stop before applying the aft stick. It is important to smoothly apply the aft stick to move the nose toward the horizon. If the nose is very high and the airspeed is very low, rapid pitch rate downward may develop.

To protect against overshooting the AOA limiter in this case, a good technique is to apply slight forward stick pressure when the nose approaches vertical downward.

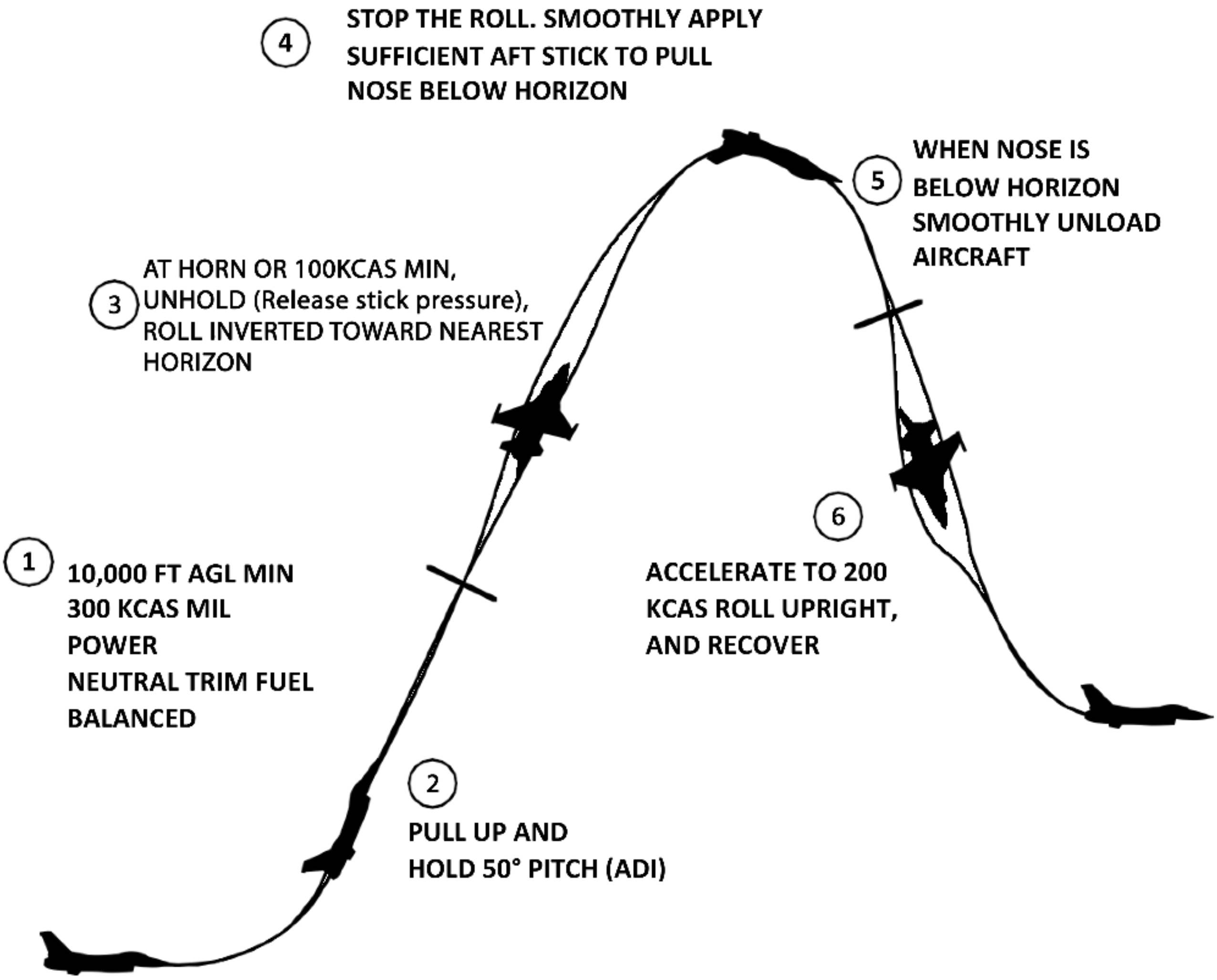
HARTS #1 conditions


Unload Maneuver (HARTS #1)
1 10,000 FT AGL MIN
250 KCAS MIL POWER
NEUTRAL TRIM FUEL BALANCED
2 30° PITCH
3 HOLD CLIMB UNTIL 25° AOA
4 WHEN STABLE AT 25° AOA,
UNLOAD (Release aft stick pressure), FEEL AIRCRAFT UNLOAD, NOTE AOA BELOW 15°
5 ACCELERATE TO 200 KCAS (Min) AND RECOVER

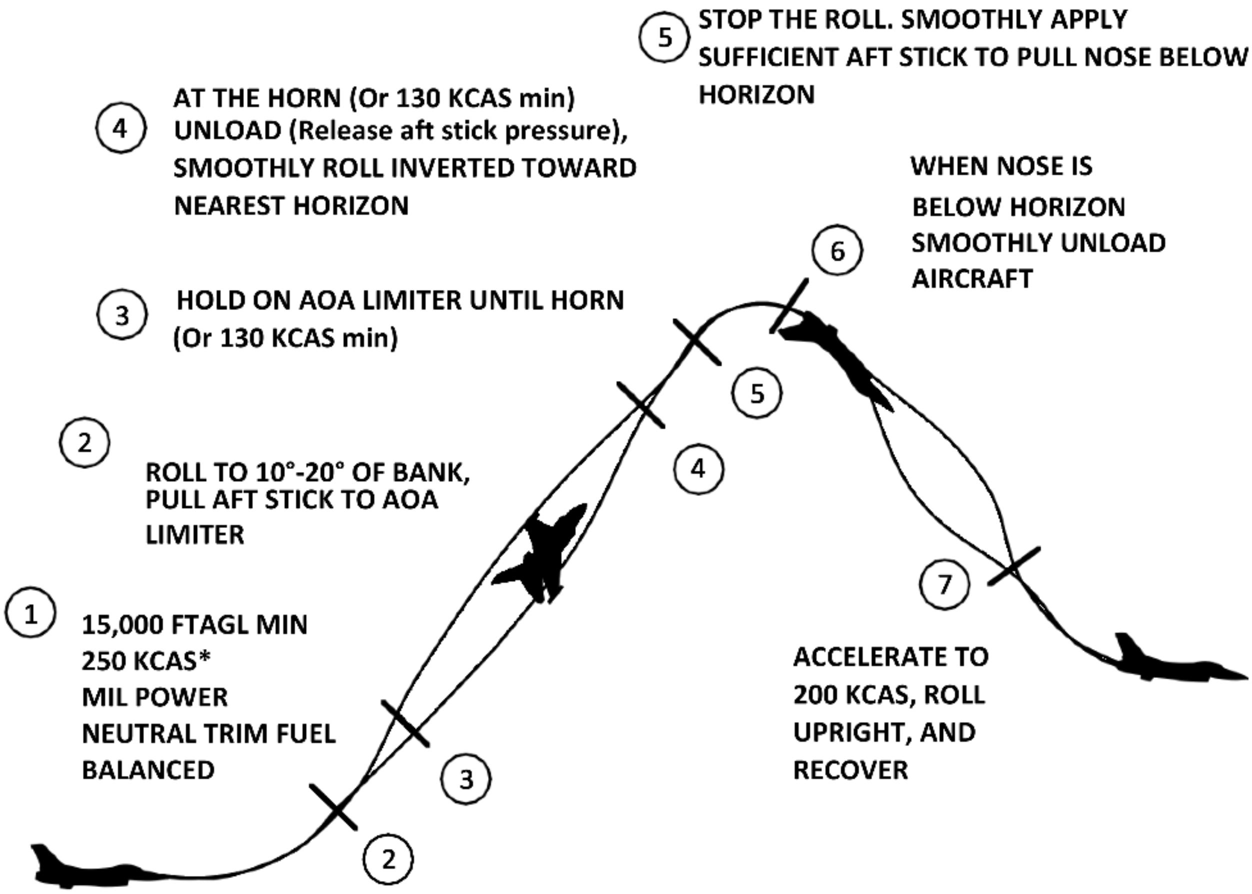
Nose High Recovery Maneuver (HARTS #2)



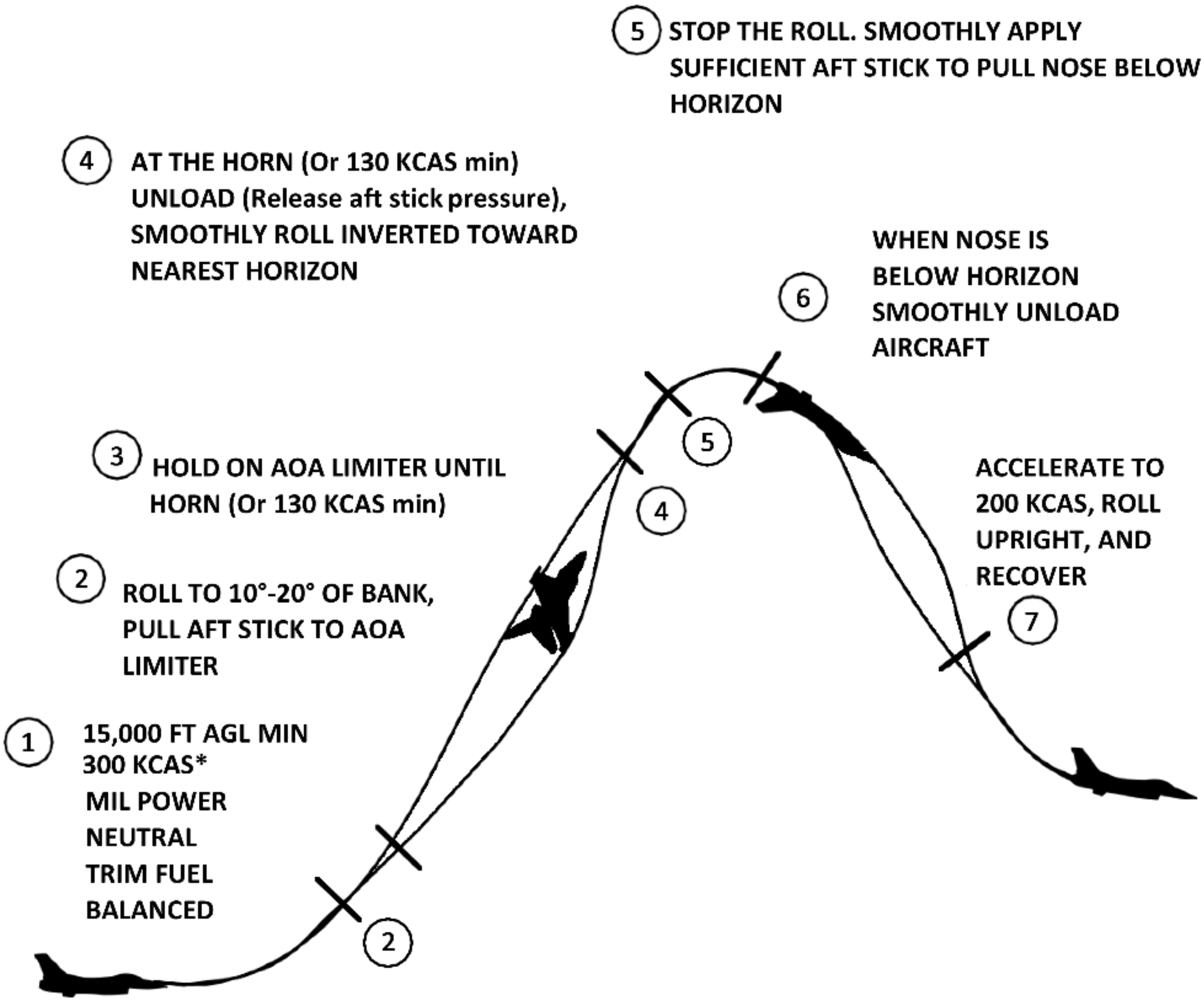
Horn Demonstration Maneuver (HARTS #3)



Horn Recovery Maneuver 50° - 70° (HARTS #4)



Horn Recovery Maneuver 70° - 110° (HARTS #5)



MISSION 4D: AIR TO AIR REFUELING *(TR_BMS_04D_AAR)*

In this training mission you have three possible scenarios to master. The first one is a typical post-attack refueling with a relatively light F-16DM-52. The second one is a pre-target refueling with a fully loaded F-16CM-50. In the third scenario you can fly the F/A-18C and test the new drogue basket refueling option introduced since 4.36. The fourth scenario will add the option to refuel with the F-15C.

All happen in daylight at the usual refuel altitude (20000-24000ft) and speed (280-300kts). The light scenario takes place on the east coast of South Korea with a KC-10, the heavy scenario is situated on the west coast of South Korea with a KC-135 and the drogue basket scenario takes place on the south coast with the KC-130. Most techniques for AAR with the F-16, F-15C and F/A-18 are the same and will be explained once for all scenarios. In chapter 4D.4 we will explain the peculiarities for probe/drogue basket refueling. Chapter 4D.1 – 4D.3 can be mostly adapted for F/A-18 and F-15C as well, but we will focus on the F-16.

TAKEOFF OPTION: All scenarios: In flight.

CONDITIONS:

(1) Low Gross Weight AAR (Boom)
KC-10: Camel1 - A-A TCN: 63Y – UHF 294.725
50nm tanker orbit legs
Package 4977
Callsign: Goblin 2-1 (F-16DM block 52) - Pkg 4977
GW: 25294 lbs
Fuel load: 3900 lbs
6 Nm trail on tanker, entering AAR box

(2) High Gross Weight AAR (Boom)
KC-135: Canteen1 - A-A TCN: 28Y – UHF 348.625
50nm tanker orbit legs
Package 4980
Callsign: Goblin 3-1 (F-16CM block 50) – Pkg 4980
GW: 32153 lbs
Fuel load: 3900 lbs
3 Nm trail on tanker, entering AAR box

(3) Basket AAR
KC-130: Cajun 4 - A-A TCN: 62Y - UHF 340.45
50nm tanker orbit legs
Package 2028
Callsign: Wildcat 2-1 (F/A-18C) - Pkg 2028
GW: 37686 lbs
Fuel load: 3700 lbs
6 Nm trail on tanker, entering AAR box

(4) High Gross Weight AAR (Boom)
KC-10: Copper2 - A-A TCN: 29Y – UHF 356.850
50nm tanker orbit legs
Package 2077
Callsign: Eagle 5-1 (F-15C) - Pkg 2080
GW: 54447 lbs
Fuel load: 3700 lbs
6 Nm trail on tanker, entering AAR box

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

4D.1 Setting up and finding/intercepting the tanker

Air to air refueling is not an easy task and requires formation skills, concentration, control and good preparation, just like the real thing. As a matter of fact, some pilots say a simulator is harder than in reality.

All scenarios start far enough away from the tanker to allow a bit of time to setup. Rest comfortably in your seat and ensure your throttle is loose enough to allow precision settings. Select the BNGO page on the DED (LIST 2) so you can monitor fuel transfer and disconnect from the tanker at the prebriefed top off (in this case you can top off but in some TEs you might be instructed to fill up to a certain level). 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 external tanks fuel from 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. Don't open your AAR door too soon (start at 5nm distance to the tanker if you go straight to the boom or when arriving at the observation area).

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

You can also contact the tanker on UHF on his assigned frequency via the Tanker menu using the 'y' key and 'Request Air Flight Refueling'. Outside 10 Nm the tanker will give you a heading and a distance for rejoin. Note: the refueling options for flights were enhanced since 4.36. Refer to the BMS Comms and Nav Book, Ch. 2.2.2.

You can find the tanker frequency in the briefing (if there's a refuel point assigned to your flight it will be Preset 13), in the ATO or just hover the mouse over the tanker icon on the map. Note that the same callsign *always* has the same frequency.
Snap to the heading provided and set your radar antenna elevation to cover airspace around FL200/FL240. Look for the tanker contact on your FCR.

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

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

Depending on which scenario you choose, you may (not) have bearing information to the tanker. The KC-135 A-A TCN only provides distance information, the bearing pointer will spin around the HSI at a set frequency. The KC-10 A-A TACAN provides distance and bearing information, therefore the bearing pointer of the HSI will point to the direction of the A-A TACAN emission. The KC-130H only provides distance information like the KC-135.

In addition to setting up your systems, the following pre-tanker checks should be done before entering the 10nm tanker bubble and having the tanker visual:

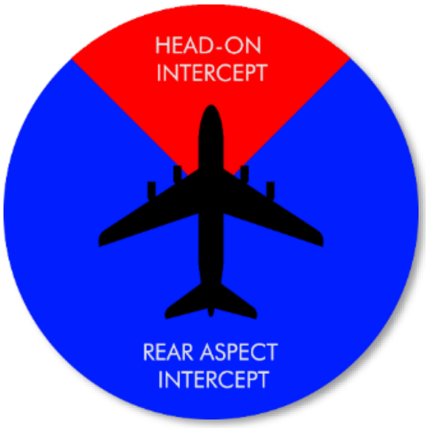
1. All electrical emitting components (Radar, TACAN, IFF, ECM, Radar altimeter): safe or off.
2. Master ARM: safe.
3. External lights: per briefing/SOP
(Refer to the attachments 1A/1B in this document to learn more about optional external lighting settings).

Once you as the receiver are close to the refueller (less than 10 DME) open the Tanker menu: 'y 1' to 'Request Air Flight Refueling'.
The tanker will clear you to pre-contact position and lower the boom. Before concentrating on rejoin open your air refueling door with the AIR REFUEL switch on the FUEL panel located on the left console. Confirm it is open with the right indexer blue RDY light. This will allow time for the fuel system to depressurize the external tanks so fuel can flow into them. The speed limit for opening the AR port is CAS 400 kts / Mach 0.85 (whichever is lower) and flying with the AR receptacle open is CAS 420 kts / Mach 0.95 (whichever is lower).

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

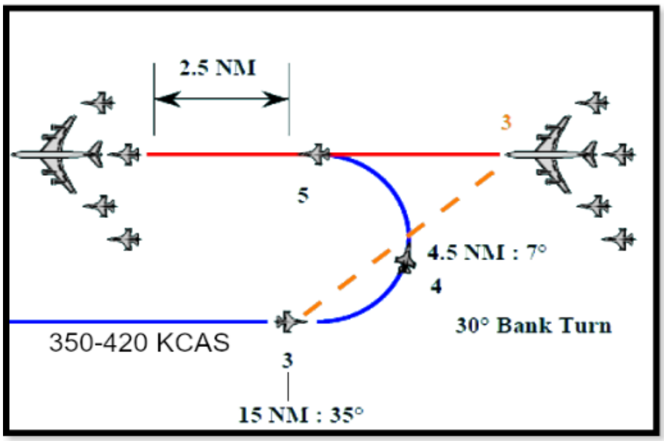
Closure rate limit = 10 kts /1,000'

In detail:
- Over 2 Nm = 100 kts overtake
- 6000 ft = 60 kts,
- 3000 ft = 30 kts
- 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 either go straight to pre-contact (if single-ship or flight lead), or to the observation position on the left wing of the tanker.
In terms of tanker rendezvous procedures, this training is designed to execute a "Rear Aspect Intercept". It is also known as "Point Parallel Intercept". That means, you are pursuing the tanker behind the tanker's 2-10 line within the closure rate limits.

Another procedure is known as the "Head-On", or "Fighter Turn-On" intercept and is initiated head on between the tanker's 11-1 line. Even when this latter procedure is not part of this training, you find the general concept in the below:



For the "Head On" intercept to work correctly, you must offset your flight from the tanker track so that you will pass approximately 8-9nm apart. Upon reaching the tanker's 2 or 10 o'clock position, you should be 15nm away and heading in the opposite direction (#3 in the pic not to scale).

At this point, begin a 30-degree bank turn into the tanker at 350-420 kts. Half way through this turn the tanker should be at your 12-1 o'clock and approximate 5nm away (#4 in the pic). As you complete your turn, roll out behind the tanker on the tanker heading; you should be roughly 2.5nm in trail. Accelerate to expedite the rejoin following the closure rate limitations.

If you took your seat as number two of the flight, your AI flight lead will go straight to the boom while you have to move to the observation area. The correct formation in the observation area is echelon left to the tanker (as shown below):

If you took the flight lead seat, you as the first receiver can go straight to the boom in pre-contact position.

4D.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 achieve this position correctly is to reference the gun cross and the boom. The position of the boom tip gives you the location of the pre-contact position. Follow the lower part of the boom and align the gun cross with it. The HUD side mounts are also a good cue. Align them with the inboard engines of the tanker.

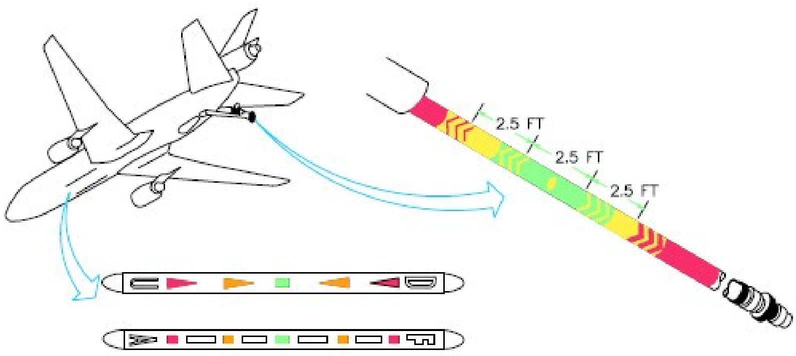
Mind the tanker speed and try to minimize your stick and throttle inputs.

Very often pilots tend to get stiff on the controls. Being tense does not help so try to relax your death-grip on the stick and throttle and you will find it easier to fine-tune your stick and throttle control. You should fly the refueling as you fly a fingertip formation. **Don’t look at your HUD cues, look at the aircraft you are flying formation with** and match its attitude and position.

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 stabilized 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.

4D.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 refueling 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 stabilize in the contact position. When the lights go off, you're in the correct position and the boom operator is flying the boom into your F-16's AAR receptacle. Maintain your position, wiggle your fingers and toes and breathe.



"CONTACT"

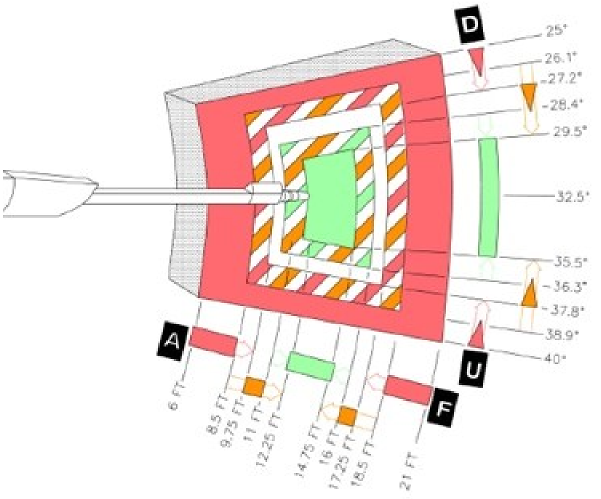
Once contact has been made, the yellow and green lights will become active as well; these will help you to adjust your position to stay connected with the boom. When the boom connects, the blue RDY light on the right indexer shuts off and the green AR/NWS light comes on signaling fuel transfer, which can be checked on the UFC BNGO page. Usually the connected pilot will make a call on UHF if successfully connected to the boom, for example: "Goblin 31, Contact".

The next challenge is to maintain your position while the fuel is being transferred. The tanker will maintain a straight leg for your initial refueling training but be prepared for a turn while refueling. Whether straight or in a turn, maintain the same sight picture on the tanker as when you first made contact. Reference the director lights for guidance on maintaining position.

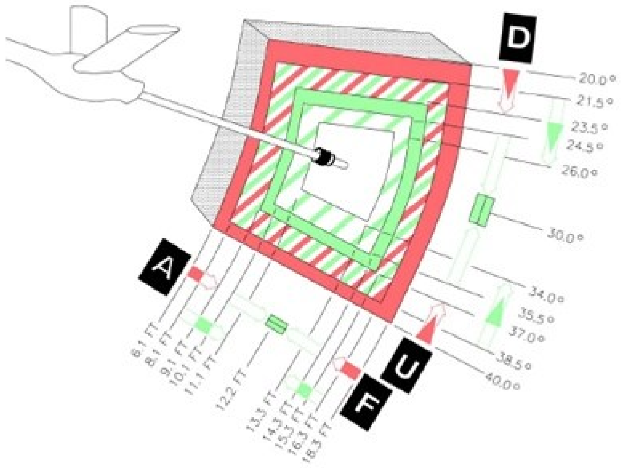
The director lights are slightly different from the KC-10 to the KC-135 but work along the same principles. They are made up of 2 lines with different symbols.

The left line is relevant to your height from to the contact position and features letters U for Up, D for Down and different colored 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 colored position symbols. The color 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 color 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 color 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 Refueling. 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 it. It will bank exactly 30° for a 180° turn for the opposite leg of his racetrack pattern. Stay in position and match its 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. The best advice is simply to focus on the tanker as you fly in formation. Remember what the sight picture looks like when you are in position and try to remain relaxed. It’s easy to become tense trying to get into and maintaining position. Making a conscious effort to relax may help. Practice, practice, and more PRACTICE!

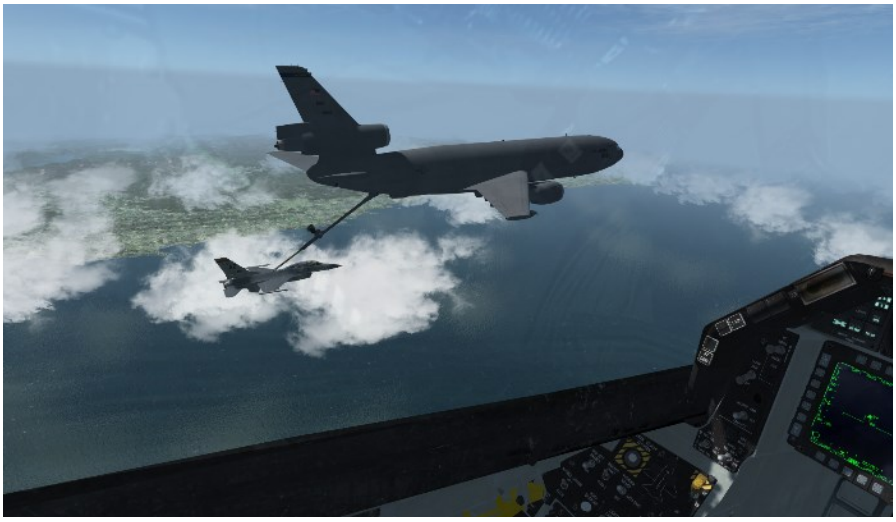
Pilots can make a “1000 lbs to go” call on UHF to inform the next pilot in the queue it's time to get ready for their turn. Once you have the desired amount of fuel offloaded you can disconnect manually from the boom by pressing the A/R DISC button on your stick. The right indexer amber DISC light will come on momentarily and the green AR/NWS light will turn off and be replaced by the blue RDY light, signaling that the AR door is open.

”DISCONNECT”

Retard the throttle a notch to separate from the tanker and initiate a gentle slide to the right wing of the tanker. You must tell the tanker that you are done refueling. Use the Tanker menu: ‘y 3’ ‘Done Refueling’. This removes your aircraft from the queue. Only after having done so, the tanker will clear your wingmen to pre-contact.

In multiplayer ownership of the tanker is transferred from one player to the next at this point accordingly.

The fueled aircraft fly formation with the tanker on its right wing called “Reform Area” while the rest of the flight refuels. The picture below shows the correct position in the reform area which is echelon right with the tanker.



“REFORM AREA” POSITION (Echelon right with the tanker)

Once you are in position in the reform area, close your AR door and check that the right indexer has no lights illuminated. You can reset your UFC to the CNI page and place the FCR out of OVRD.

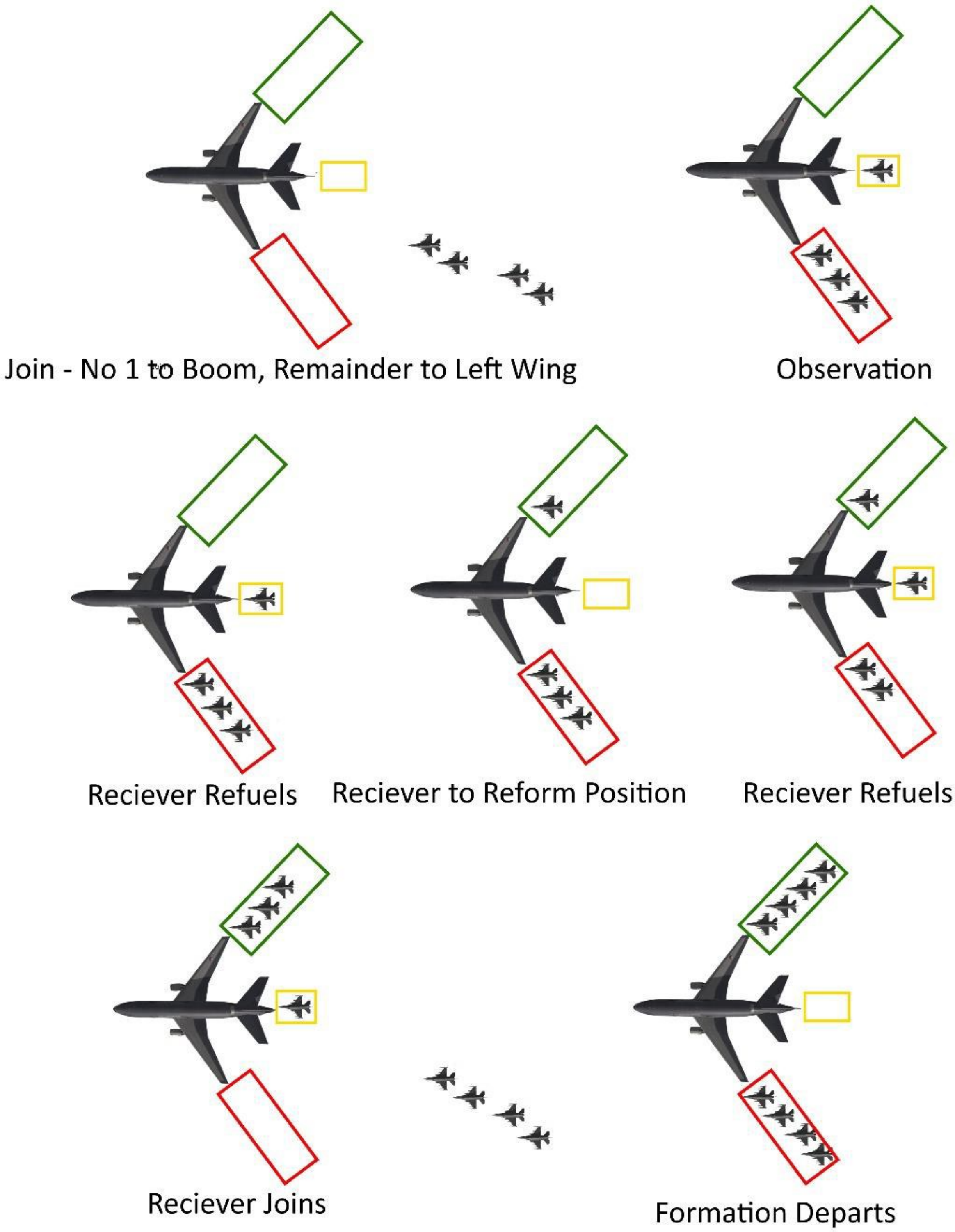
Before going on with your mission check the fuel gauge on the right auxiliary console to ensure that your fuel load is balanced.

You may have noticed that during your refueling sequence your AI wingman was in close echelon left formation to you. This procedure is called “Quick flow” like shown in the picture below:

”QUICK FLOW POSITION”

Quick flow is used by BMS AI aircraft by default in air refueling operations. The advantage is that the time going to the boom can be shortened in a very efficient way. When flying with humans only, this procedure should only be initiated if conditions and pilot skills permit it to be done safely.

Let's wrap up the whole refueling sequence in the overview below. The example shows the refueling flow of a 4-ship flight:



4D.4 F-15C - Air-to-air refueling

To be successful in refueling the F-15C in the air, please read chapter 4D.1-4D.3 to get a general understanding of the air-to-air refueling procedure which is the same as for the F-16.

The major difference between the F-16 and F-15C in terms of AAR (Air-to-air refueling) is the position of the refueling door. It's on the left side behind the canopy.

Offset yourself a little bit to the right side of the boom to achieve optimal refueling conditions.

4D.5 Basket Air-to-air refueling

4.36 introduced a new era for air to air refueling in BMS.
Receiver aircraft equipped with a probe/drogue such as F/A-18, Mirage 2000, Harrier, Mig-29 and more are now able to refuel in the air. Compatible tankers are available as well such as KC-135, KC/DC-10, KC-130H, C-160R NG and IL-78M.

In this chapter we will take a look to the main differences when performing air to air refueling with the F/A-18C. All other previous chapters 4D.1 – 4D.3 should be read entirely to understand the basic concept and flow of air to air refueling.

In this training exercise we have the KC-130H on station which will be our tanker. We are a 2-ship F/A-18C. Please note that we do not delve into the F-18's avionics in this document. Please refer to */Docs/02 Aircraft Manuals & Checklists/03 Other Aircraft/F-18* to learn the functionalities of the Hornet.

Once the tanker frequency is dialed in (UHF 13) and the tanker is found (you start from roughly 4-5nm trail formation to the tanker), open your tanker comms menu and “request refuel”.

When the initial contact call is made on UHF, the tanker will give us clearance to move to the pre-contact position. If the tanker has multiple hose refueling areas available, he will add this information. In the example below we will be sent to the right basket.

Wildcat 2-1 Cajun 4-1 cleared to pre-contact position right

Once we have entered the pre-contact area, the tanker will allow us to move to the contact position. Remember to wait some seconds till he makes this call.

Once you catch the basket, you need to push forward to get the fuel flowing. The fuel flows when you push forward the hose. Once your hose is in between the two red marks, the POD light turns green and fuel is flowing.

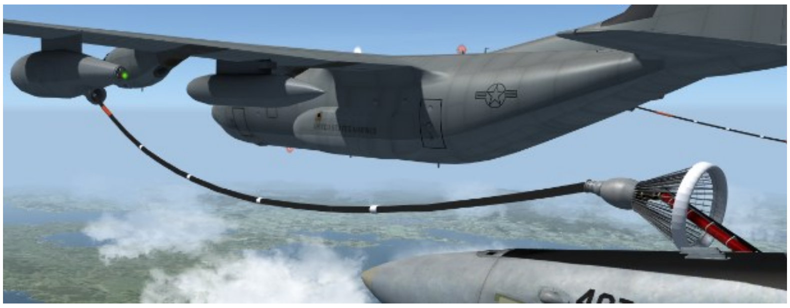
Each hose is tanker dependent. Please refer to the tanker specification.

Pod Lights:

- RED : not available
- AMBER : ready to connect
- GREEN : fuel flowing

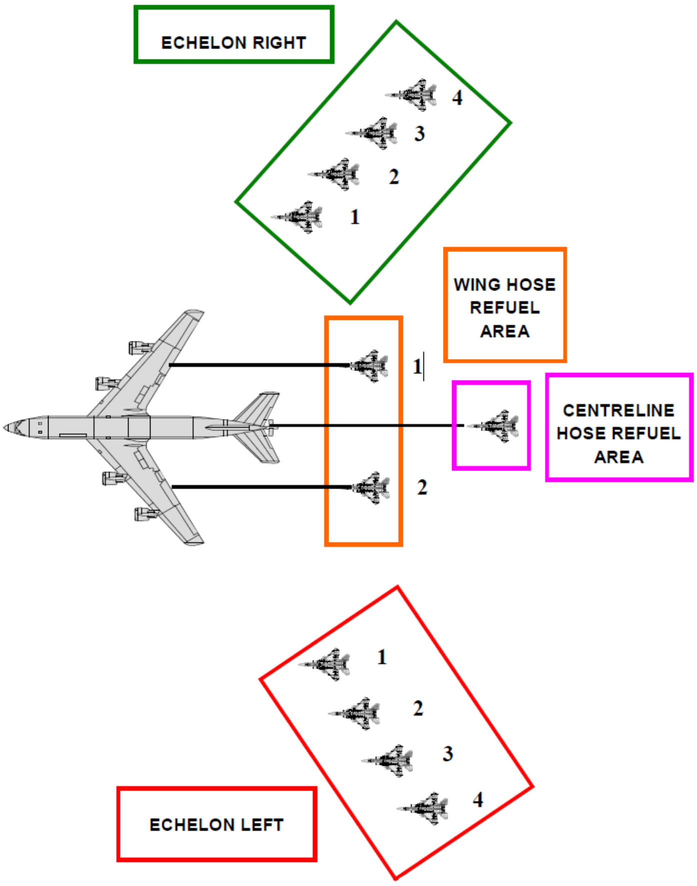
In case you push too much forward, the basket will disconnect, the hose will stay retracted and the POD light will turn red. You need to come back in pre contact position and call "back in position". The operator will then deploy the basket again for another attempt.

It's all about concentration (and patience). Basket refueling is very different from boom refueling. In BMS, weather and wind conditions are modelled. So expect that the basket will move under certain conditions.



You need to keep a constant approach speed. Don't chase the basket, never stop going forward. Taking the POD as reference is a good starting point. Don't look at the basket, except at the last moment. Again, don't chase the basket!

The overall flow for air to air refueling was explained in the previous chapters. The scheme below explains again some terminology for basket refuel operations.



Congratulations, you just succeeded at one of the most difficult tasks in BMS: Air to Air Refueling! Practicing this training mission often will help you fly formation better as well as refuel more easily. This is an aspect of flight simulation that is both demanding and rewarding.

MISSION 5: ILS LANDING AT NIGHT *(TR_BMS_05_ILS_Landing)*

TAKEOFF OPTION: In flight.

WEATHER: RKJK INFO: B 011855Z 320/10 KT 9999 FEW050 15/ 5 Q1009 NOSIG.

LOCATION: Approximately 15 Nm south of Gunsan.

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

LEARNING OBJECTIVES: Land on Gunsan 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 Gunsan. The next ILS scenario will be in bad weather.

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

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

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

Both emitters create a radio 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 center of both cones and stay there until minimum. The ILS symbology in the instruments then displays a centered cross created by both the glideslope and the localizer.

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

In BMS the DME is always to the tacan, and the tacan is never at the runway threshold. So, the distance indicated when overflying a marker may vary according to the tacan position. But these are referenced on the airport charts.

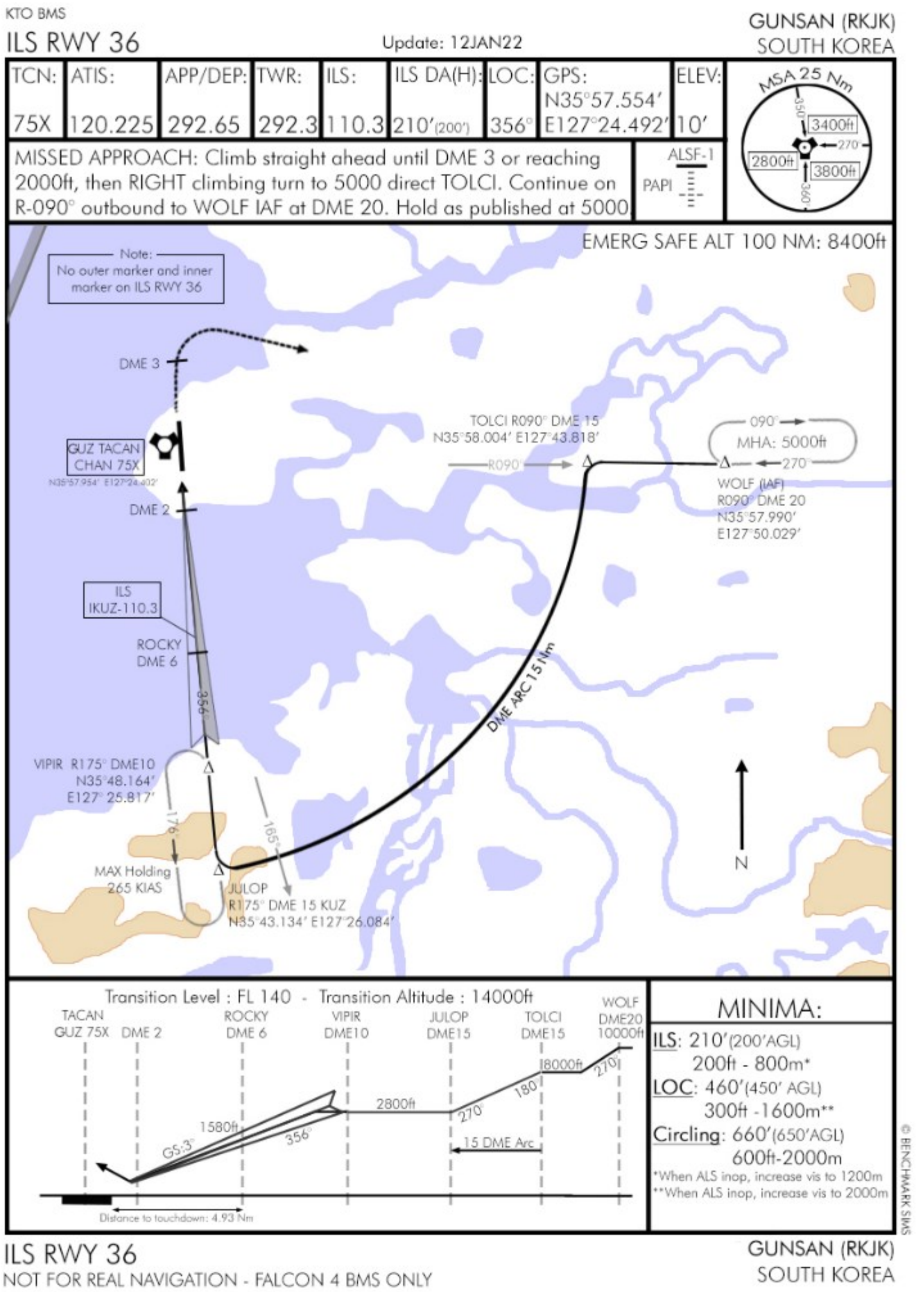
Unfortunately, Gunsan does not have these beacons because the approach is over water. We will demonstrate their use though in the next ILS training mission.

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

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

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

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



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

Contact Gunsan Approach immediately to request an approach. Unfortunately, we can't request an instrument approach from this point because the ATC would send us back to the IAF, even though we are already in the ILS cone. Open the

ATC menu at the Approach page and select "Unrestricted Approach" 't t t 4'. Approach will clear you to continue inbound, give you the latest QNH and at a certain point will ask you to switch to Tower.

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

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

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

Once the ILS frequency is set the scratchpad moves to the CRS setting. This course is independent of the HSI CRS and should allow the HUD Command Steering Cue to work correctly in relation to the ILS radial. The course for Runway 36 is 356° so input 3 5 6 ENTR. (BMS will guide you to optimal intercept even if you do not enter the CRS in the DED).

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

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

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

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

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

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

The ADI gives us the same localizer and information. In addition 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 the glideslope in the HUD is dashed.

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

The EHSI CRS is set to 000 so 4° offset from the ILS course. It is good practice to set the ILS course in the EHSI as well. Although it will not impact the localizer deviation it will make your situational awareness better as it points straight along the ILS approach track.

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

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

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

A good idea is to check the winds. You can ask ATC or listen to ATIS 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. Your crosswind drift can also indicated by the offset of the FPM from the center of the HUD in NORM.

All the approach will be made flying the needles and the CMD STRG cue. The CMD STRG cue will guide you horizontally and vertically once you are within 5° of the ILS cone. If you place the cue into your FPM you will fly a perfect approach. As we approach the airbase maintaining our localizer centered the glideslope will start to move down towards the center 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 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 of the ILS bars. Each bar has 5 marks; each represents 2.5°. The optimum position is both bars centered at their middle mark.

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

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

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

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

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

Also note the **v** on the heading tape. This cue gives you the wind corrected heading you need to steer to maintain the desired approach course. So, if you have the CMD STRG cue under the FPM and the V centered on the heading tape, your nose should be crabbed into the wind just the right amount to maintain ground track along the approach course centerline to the runway.

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 see the runway lights is unique and very rewarding.

The following parameters are needed to do a safe and proper ILS landing

- FPM on top of the AOA bracket, aimed at the touch down point.
- 2 white & 2 red on the PAPI.
- Localizer & glideslope centered.
- Heading on runway QFU (356°).

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

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

We mostly used the HUD for the ILS, but you can also perform ILS approaches without the HUD by staying in the head down view. You then scan the main flight instruments (ADI, HSI, Machmeter, Altimeter, AOA and VVI) without looking up until minima, where you transition to visual and look for the runway to land.

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

NVG - Night Vision Goggles

To enhance your situational awareness (SA), BMS provides the option for Night Vision Goggles (NVG). To activate the NVGs, you must use the designated callback linked to a keystroke (usually "n" by default). The activation is a toggle function, allowing for convenient on/off operation. In BMS, NVGs limit the pilot's field of view, aiming to simulate a tunnel vision experience.

MISSION 6: ILS LANDING IN BAD WEATHER *(TR_BMS_06_ILS_Weather)*

TAKEOFF OPTION: In flight.

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

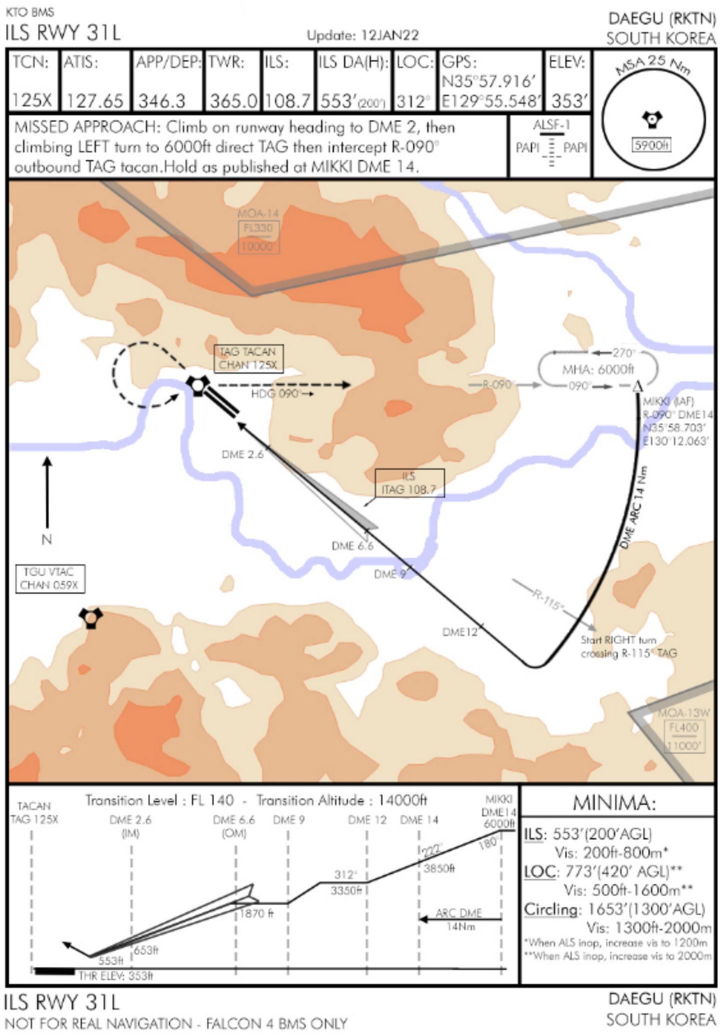
CONDITION: Day time - Aircraft level at about 15000 feet - heading 180° - speed 350 kts. Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly. You may have to set your MFDs according to your personal preferences.

WEATHER: RKTN INFO: B 010025Z ILS RWY31 TRL140 325/22G30 TSRA 1200 OVC010Wind 325° at 22 kts gusting 30, Visibility <1200m, Thunderstorms & Rain Overcast 1000 feet. Altimeter 2950.

LEARNING OBJECTIVES: Land on Daegu RWY31L ILS.

Daegu Elevation: 353 feet	Daegu Approach: 346.3 - Tower: 365.0 – Ground: 275.8
Daegu TACAN: 125X	ILS RWY 31L: 108.7 (Minimum 553 feet – Localizer 312°)

This training mission is technically the same as Mission 5 but this is the real thing. Visibility is very low and cloud coverage is total up to the minima. You will see the runway only during the final stages of the approach. **This training mission is intentionally difficult.** Mission 4 afforded you the chance to train ILS in good weather, now it's time to try it in true ILS conditions.



The approach starts before you reach the IAF just on top of the cloud layer. It is getting dark and you may have to raise your visor (ALT + v) before going into the clouds.

You will need the DAEGU ILS RWY 31L chart to fly the published approach. The airport is surrounded by mountains and you will need to stay on the published route to avoid crashing. The chart is in you *\Docs\03 KTO Charts\01 South Korea\Daegu* folder.

The approach will be made in two steps. The first will be to fly the ARCDME until you cross Radial 115° and then we will turn to intercept the ILS on RWY31L.

Your TACAN is already set to 125X and the HSI mode is set to TCN. The HSI therefore points to TAG (Daegu TACAN). If not, it will come in range in a bit. The ILS is ON, Daegu Approach is set to COMM1 and the QNH is set for approach.

ATC will try to vector you in bad weather using the published RADAR approach chart when available, which is the case for Daegu.

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

The first action you should take is to contact Daegu Approach and 'Request Unrestricted Approach' through the ATC Approach menu: 't t t 4'.

Upon contacting Approach, ATC will give you the altimeter setting (QNH) and clear you for the 'Request Unrestricted Approach' option. You need to maintain 6,000 ft and fly to the MIKKI fix.

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

You will have to set your ILS frequency to 108.7 using the T-ILS page of the UFC. Input 10870 into the scratchpad and press ENTR. The scratchpad moves to the ILS CRS. Input 312 and ENTR which is the localizer course for Daegu 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 240° at 12 kts and the initial heading is 180°. The wind is stronger at 6000 ft. The UFC reports the wind at this altitude at 17 kts. Don't be surprised that the FPM, pitch lines and tadpole are offset to the left as the wind is pushing the aircraft to the left. Blame the weatherman!

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

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

As the bearing pointer drifts down the CDI (Course Deviation Indicator) will move towards the center of the instrument. When both the CDI is centered and the bearing pointer is 90° from our heading, we will overfly MIKKI and the approach will start. There is no need to turn as we are already set on the right heading to enter the ARCDME. Should a turn be needed, you have to lead that turn (3NM for a 90° turn at 300 kts)

Flying the ARC DME is explained in the BMS COMMS & Nav Book in your Docs folder. The principle can be summarized as simply keeping the TACAN bearing pointer on the HSI (set to TCN) 90° offset from your heading. In this case to the right as the airbase is on our right and the ARC turns right. Place the bearing pointer a bit before 90°.

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

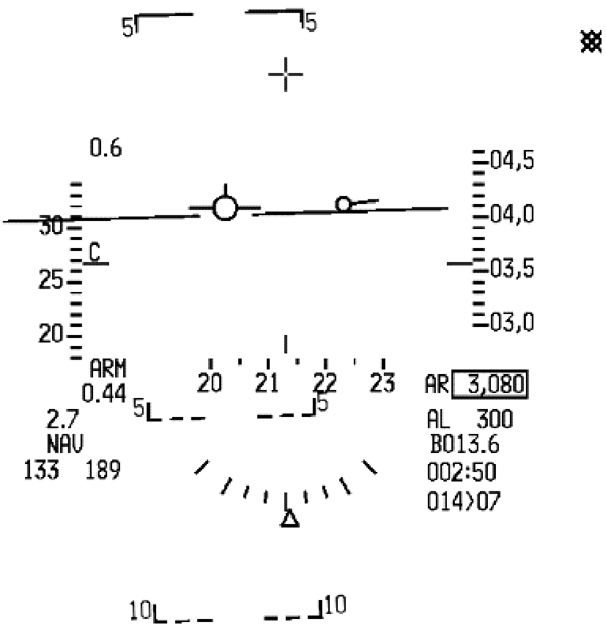
Doing so you will fly a series of straight legs and small right turns. If you have the home plate selected as your steerpoint of interest (STPT 7) your tadpole in the HUD should mimic the bearing pointer behavior and point 90° to the right.

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

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

The next reference point is passing R-115° from TAG. Set the HSI CRS to 115° so you are ready for the next step when the CDI will center on R-115° but continue to fly the descending ARCDME. Level your altitude when reaching 3350 feet.

When the CDI centers on R-115 your heading should be around 210 - 220° with the bearing pointer still pointing 90° right and a DME of 14 Nm. As you can see on the picture taken just after crossing R-115° we didn't correct enough for wind and we drifted our ARC out to 14.8 DME! Better avoid that as there might be mountains outside the published approach track. We are also a bit too high at 3500' rather than the 3350'. The lower you go the higher the chances you might lose tacan signal due to mountain. The charts have been tested so the published altitude should ensure proper tacan signal but if you go lower, you might lose it.



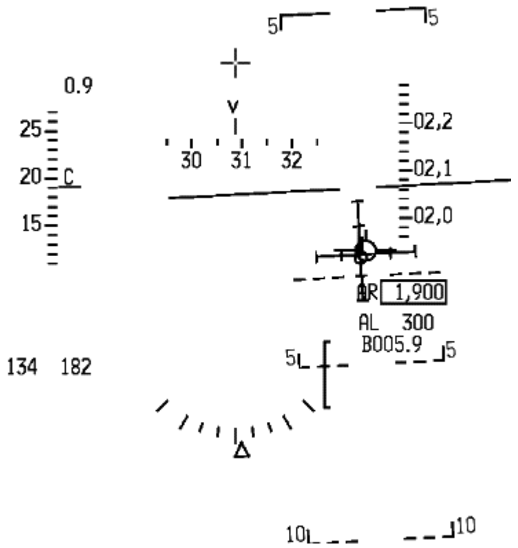
Once the CDI centers immediately switch the HSI to TCN/ILS mode and start a right turn towards 312°.

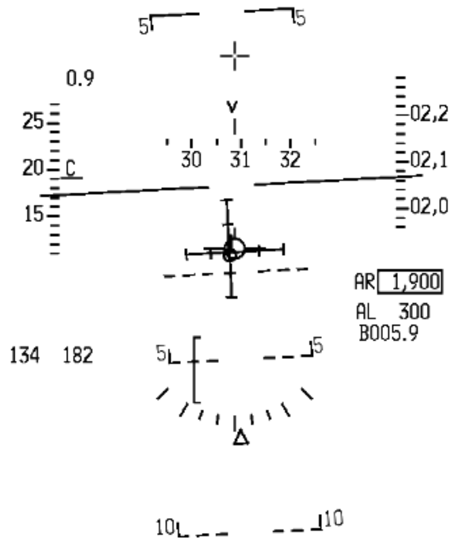
While turning, the localizer visible on the ADI and the HUD are offset to the left and will move towards the center, indicating that the 312° localizer course is approaching. Alternatively, just follow the command steering caret in the HUD to smoothly intercept the localizer. The CMD STRG cue is offset 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 312°, level at 3350ft with an airspeed of 300 kts. At that point the localizer is centered, and the glide slope is above your FPM. The next step is glide slope intercept around 6 Nm from the runway around 2000 feet. Descend to 1870 feet while maintaining localizer course and still with the glide slope above. Mind your speed which should remain below 300 kts. At this point slow to 250 kts to give yourself a bit more time.

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

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





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

You are on localizer, on glide slope so it's time to lower the landing gear and check for 3 greens and check that your brake switch on the gear panel is set to ANTI-SKID. The runway is wet and RCR 12(WET) will make good use of the ANTI-SKID system. 'Report on Final' on the Tower frequency using the ATC Tower menu: 't t 4'.

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

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

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

Open speed brakes to decrease engine spooling time in case you need to go around. Without speed brakes the engine will need a longer time to go from 70 to 100% RPM and you may sink for too long. Using the speed brakes decreases that risk. Somewhere during that descent Tower will clear you to land on Runway 31L and give you surface winds.

Maintain your instrument scan and include the ILS bars. You will overfly the inner marker 2.6 Nm from the TACAN which is on the opposite side of the runway. The MRK BCN in the cockpit will flash and sound again, this time at a higher frequency.

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

Now that you have the runway in sight you can land visually. Be ready for turbulence close to the ground. Welcome back. You can be proud of your success as it is not an easy exercise. Mind your braking due to the runway conditions and the ANTI-SKID system. The braking will seem to take longer.

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

Now you have practiced flying the ARCDME you can re-fly this mission using ATC radar vectors instead. You will find the DAEGU RADAR RWY 31 chart in your *\Docs\03 KTO Charts\01 South Korea\Daegu* folder. Select 'Request Vectors for Instrument Approach' when you initially contact ATC on the Approach menu page and follow ATC instructions to arrive on the runway heading safely and then continue your ILS approach as before.

6.1 Calculating the crosswind component

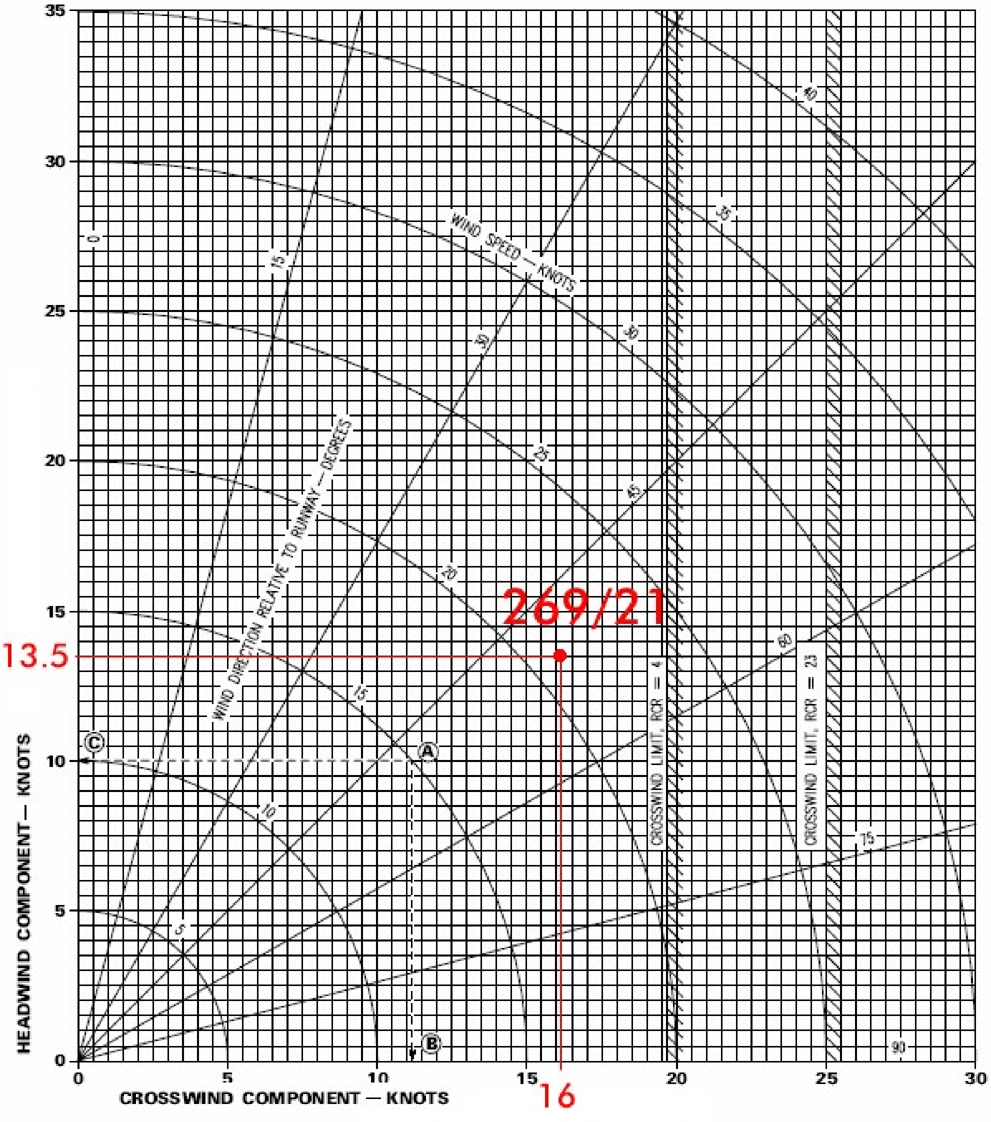
The maximum crosswind component on take-off and landing depends on the runway conditions (RCR).
4 RCR are implemented:

- RCR 23: DRY runway
- RCR 18: LIGHTLY WET runway
- RCR 12: WET runway
- RCR 04: ICE runway

As you see from the graph below, there are two limits for the F-16: one at RCR 4 (worse): 20 kts and the other at RCR 23 (optimal): 25 kts.

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

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



MISSION 7: FLAMEOUT LANDING *(TR_BMS_07_Flameout)*

LOCATION: Approximately 13 Nm south of Osan airbase.

CONDITION: Barrel 1, In flight - Engine out - Aircraft level at 21000 feet - heading 270° - speed 300 kts.
GW: 20633 lbs with stores – 20300 lbs without stores (Fuel at 0 lbs).

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

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

WEATHER: RKSO INFO B 002225Z RWY09 TRL140 100/4kt 9999 12/2 Q1034
Sunny, clear skies, wind 100° at 4 kts, temperature 12°C, dewpoint 2°C Altimeter 1034 hPa

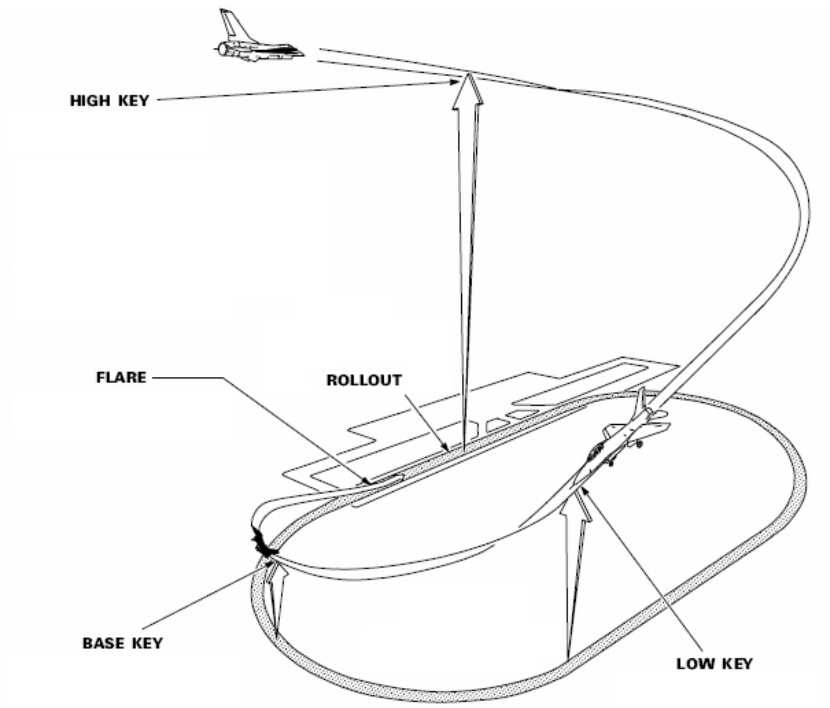
LEARNING OBJECTIVES: Land the aircraft with no engine on RWY 09 Osan airbase.

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

7.1 The overhead approach

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

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



Some Numbers

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

Best glide speed is thus typically set to ~200 knots; with landing gear down just subtract 10 knots (~190 kts). **A useful tip to find out your best glide speed in any configuration is to just fly a 7° AOA attitude**. The F-16 will go 7 Nm over the ground for every 5000 feet of altitude loss. That's a glide ratio (or "finesse") of 8.4. You will cover 8400 feet for every 1000 feet of altitude you lose.

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

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

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

Let's review the numbers for this training scenario:

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

The above numbers should be committed to memory.

Please have your BMS checklists handy (C-33 "Flameout landing") in addition to the following chapter.

7.2 The training mission

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

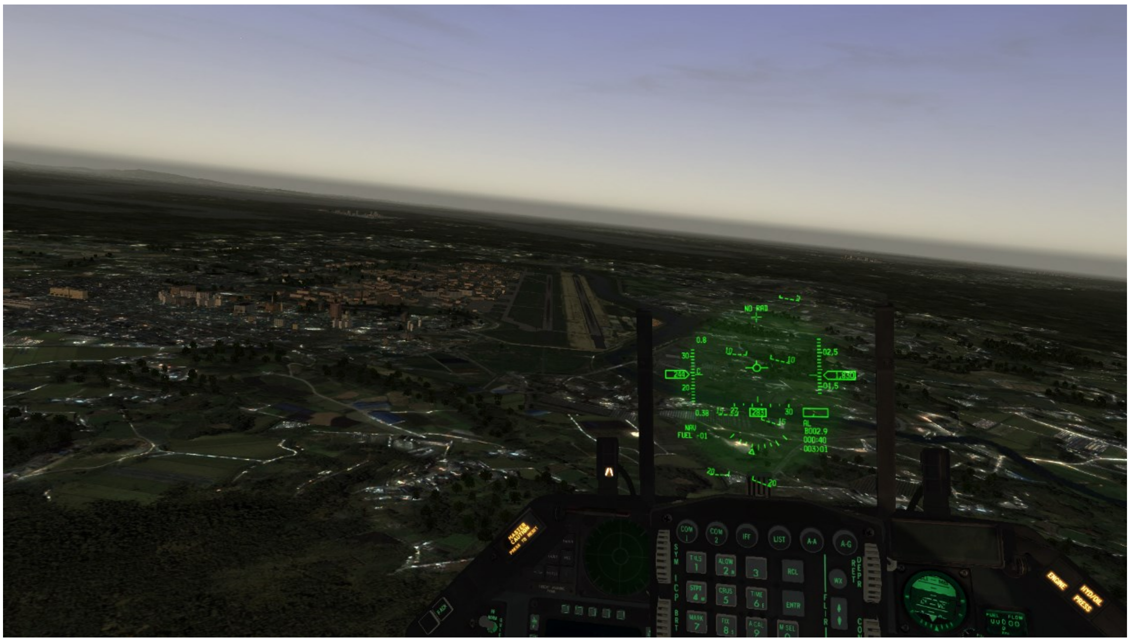
Base key is the mid-point of the turn and should be reached no lower than 2000 feet AGL. At that point the gear should be down. The gear handle alone will not work. You must execute an alternate gear extension. Start by lowering the regular gear handle and then use the ALT GEAR handle further left on the auxiliary console to 'blow' the gear down. The nose wheel may not lock in place until speed is below 190 Kts. You may not have three greens till then.

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

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

The Osan Tower Controller will clear you to land once you are in position. Osan features parallel runways. Plan on landing on 09L, as instructed by ATC.

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



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

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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. If you have any doubt you might not be able to stop the aircraft before the end of the runway, drop the hook and take the cable at the end of RWY 09L.

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

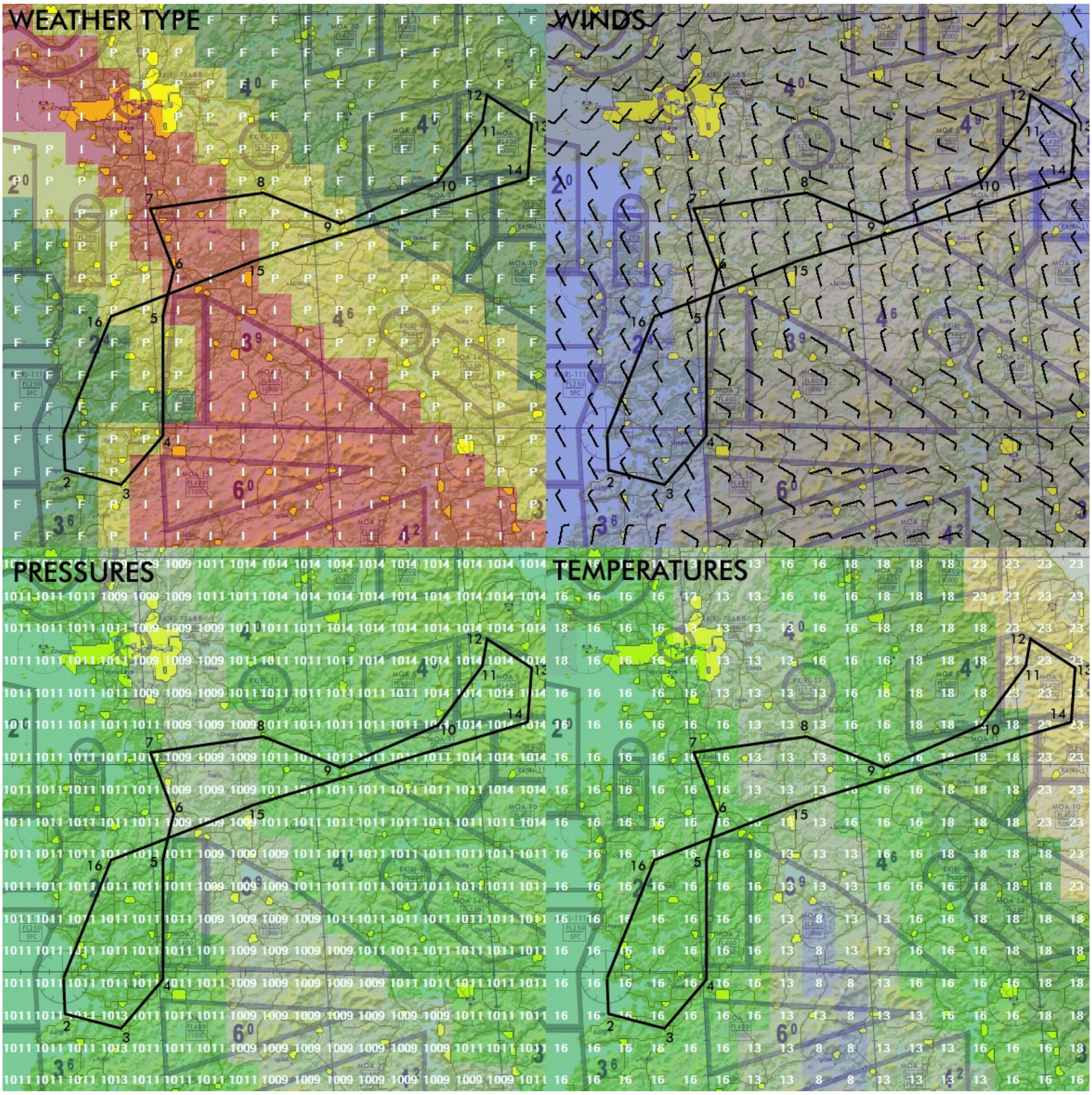
MISSION 8: LOW LEVEL NAVIGATION - TFR – FLIR *(TR_BMS_08_TFR)*

LOCATION: Gunsan Airbase Ramp.

CONDITION: ROKAF F-16 block 52 – Flight of 2 - Callsign Sherpa 2.
GW: 39424 lbs. 4 GBU-12 & both LANTIRN pods. Max G: 5.5/-2.0 Max speed: 550 kts / 0.95 Mach.

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

The following images will give you an overview of the weather situation for this flight. The top left image shows the kind of weather expected at specific locations: green = FAIR; yellow = POOR; red = INCLEMENT. The top right image shows wind speed and direction. The bottom left image shows QNH and the bottom right image gives temperatures.



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

LEARNING OBJECTIVES: Low level (500 feet) navigation to the target area (KOTAR, STPT 14) at night and in bad weather using FLIR/TFR capabilities.

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

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

Operational use of the LANTIRN suite is documented in the BMS1-F16CM-34-1-1 manual, which should be read before attempting this mission.

The training mission starts at the ramp as the TFR and FLIR need to be checked on the ground and in-flight soon after take-off before operational use. We will demonstrate the required checks and fly low level in weather to the target area. The training will then stop at IP and the bombing part of this TE is not relevant to this training mission. Nevertheless, you can choose to pursue your flight and practice LGB runs on targets at KOTAR. If you do, don't forget to make a note of the bomb code in the LOADOUT screen before entering the aircraft. (1688)

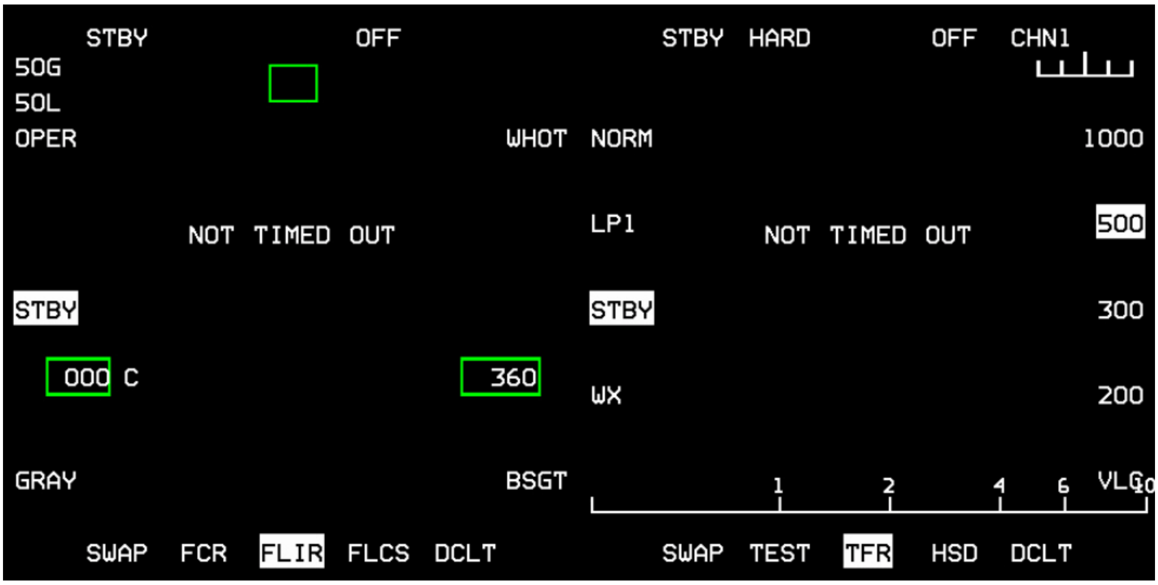
It's getting dark and it might be difficult to see the switches in the cockpit. To overcome this problem, cockpit spot lights (utility lights) are available from the moment the aircraft in on battery. Make use of these when you need to ramp start in the dark. Place the MAIN PWR switch to BATT and activate the spotlights (default keystroke SHIFT + S) Please note, spotlights are not NVG compliant green lights but quite bright, don't forget to turn these OFF once the normal cockpit lights become available.

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

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

Next select the TFR page on the MFD and place the TFR in STBY as well; the same NOT TIMED OUT message appears.

The TFR will need about 3 minutes to warm up. the NOT TIMED OUT message will disappear when it is ready.



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

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

If the switch is in disable, the FLCS caution light will illuminate, FLCS FLUP OFF displayed on PFL, and FLCS 054 displayed on TEST page. A FLCS reset will clear the PFL and caution light even if the switch is not moved to ENABLE.

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 maneuver.

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

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

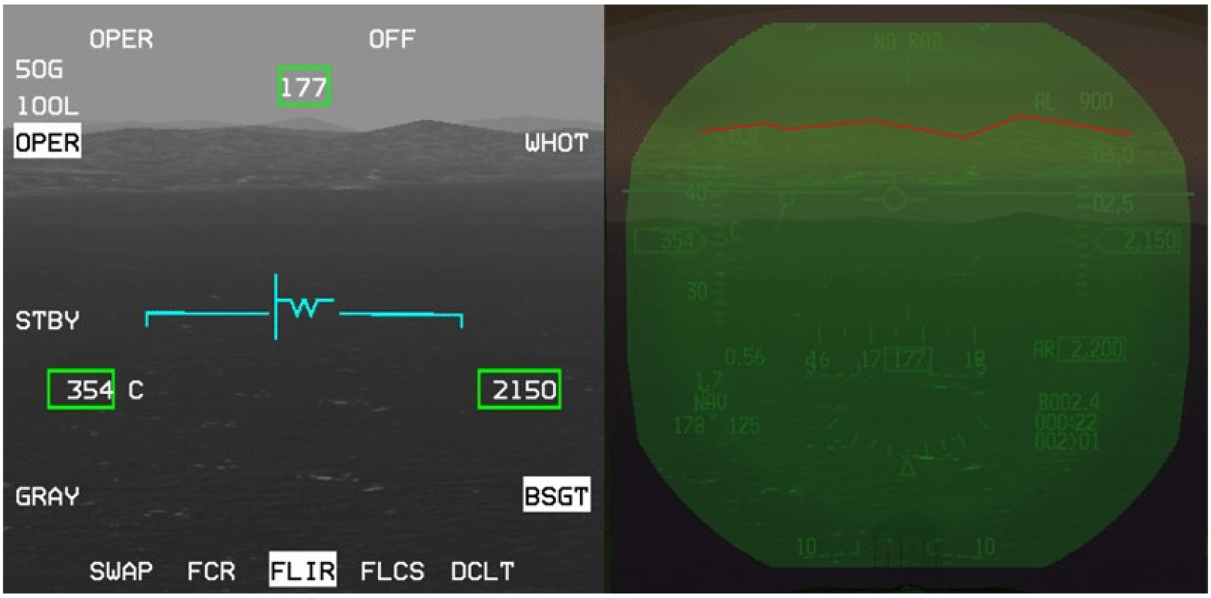
Except for the RALT switch still in STBY, the TFR has been ground checked and is ready for in-flight use. The FLIR is still cooling down and may still need another 10 minutes, so we will resume checks at EOR. Concentrate on finishing your ramp start and taxi to the assigned holding point of the active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

When the FLIR is ready press OPER (OSB 20) and display the FLIR image on the HUD with the ICP BRT wheel (bottom left wheel). You can set the required GAIN level on the displays using the up and down arrows in the FLIR section on the ICP. The FLIR image on the HUD should be correctly aligned with the HUD image. But in case of misalignment, it is possible to boresight the FLIR image on the HUD. We will do so immediately after we get airborne. You don't need the FLIR displayed in the HUD for ground operations so place the FLIR in STBY. The pods have been ground checked; let's see how they behave in flight.

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

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

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



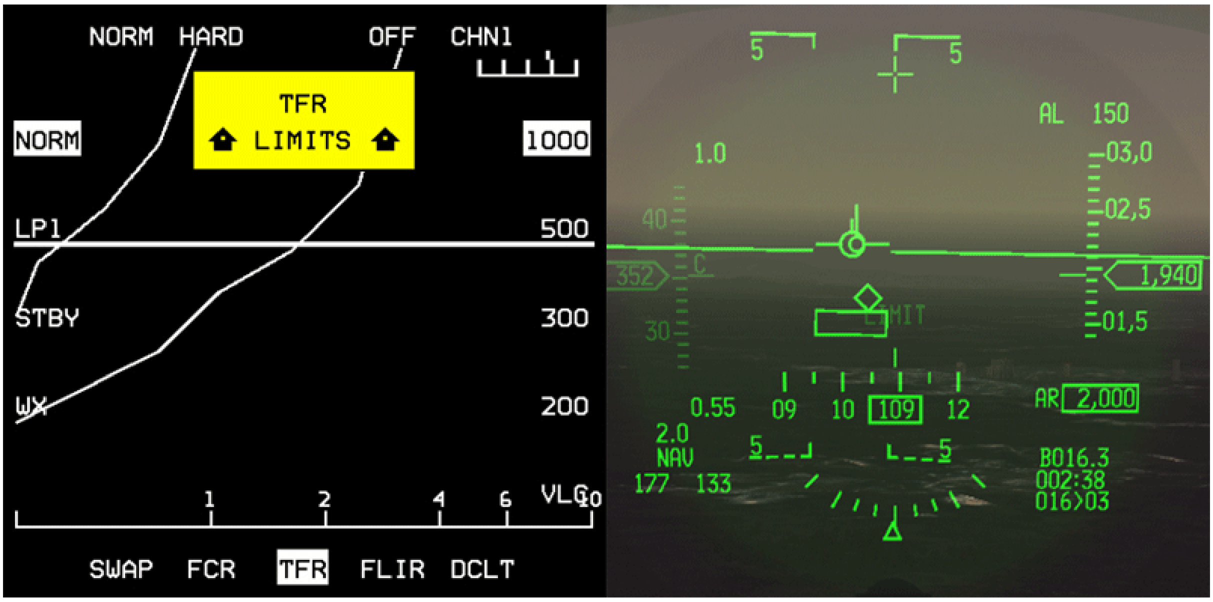
Before using the TFR in flight we need to ensure that the systems are reliable. This is done with a series of checks that take less than 2 minutes. The leg between steerpoint 2 and 3 is designed for LAN (Low Altitude Navigation) checks. We'll test Manual TFR (MAN TF), Auto TFR (AUTO TF), FLYUPS and the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

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

8.1 Speed Limit check

- Accelerate to 350 kts and climb above 1000 feet AGL. We will test that the TFR LIMITS warning works properly.

- Select the TFR MFD page and place the TFR in NORM. Since we are flying below the airspeed limit of 360 kts the TFR will display multiple warnings:
  HUD: LIMIT displayed and speed scale flashing – verify also the MAN TF box is displayed.
  MFDs: a yellow TFR LIMITS square is flashing.



- Accelerate to 400 kts and check that the LIMITS disappear past 360 kts.

- Bank past 60° *(also called "Limit Turn check")* and verify:
  MFDs: yellow TFR LIMITS square flashing.
  HUD: LIMIT flashes and the MAN TF box disappears if the bank is held for more than 2 seconds.
  The airspeed scale does not flash because the limiting factor this time is not airspeed but bank angle.

- Roll wings level and verify that all LIMITS have disappeared and that the MAN TF box reappears.

8.2 Fly-Up check

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

- From SCP 1000 feet in MAN TF push the stick until approximately 500 feet AGL.

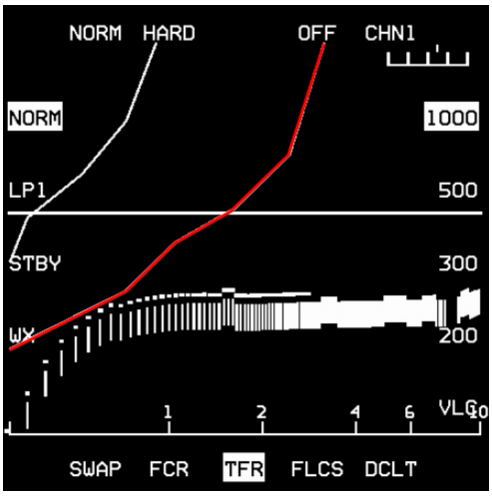
- Verify G-LIMIT and OBSTACLE warning fly-up occurs.
  PULLUP is displayed on the HUD.
  Flashing break X is displayed on both MFDs .
  VMS is issuing an aural "PULL UP – PULL UP".

- Set ALOW to -10% of SCP.

8.3 TFR Letdown check

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

- Activate AUTO TF with the ADV MODE switch (AMS) on the MISC panel. Once activated the green indicator ACTIVE will be illuminated signifying that the TFR is now in AUTO TF mode. The aircraft will gradually descend to the programmed SCP (1000 feet).
- Verify that the AUTO TF LINE is displayed in the HUD (it replaced the MAN TF command box).
- Verify that NO TER is displayed in the HUD (No Terrain) and verify ground return on the TFR MFD.
- Monitor automatic level off at SCP (1000 feet).
- Push stick -2.5 deg forwards to commence a shallow dive.
    - Verify aural “ALTITUDE – ALTITUDE” at A-LOW (900 feet AGL).
    - Verify LO TF is displayed in the HUD, LIMITS in both MFDs and aural “PULLUP – PULLUP”.
- Allow the fly-up to level altitude at 1000 feet and once there depress and hold the paddle switch to cancel the fly-up. Verify STBY light on AMS indicator.
- Press the AMS switch until both lights are off to cancel AUTO TF and release the paddle switch.
- You are now back in MAN TF, check the MAN TF command box is displayed in the HUD.



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

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

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

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

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

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

8.4 TFR SWIM check

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

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

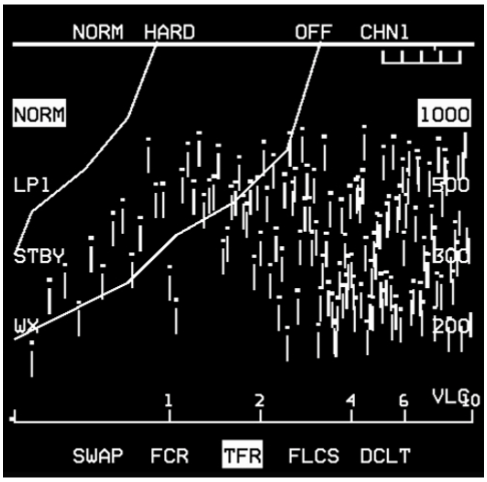
All TFR systems have been checked and our level of confidence in the TFR is high so we can continue with the mission.

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

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

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

As you may have noticed during your TFR checks the weather has worsened. Gunsan 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 WX mode the TFR will constantly try to fly-up to avoid the raindrops. 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 wants to be alone flying in these conditions, but you are and the enemy manning the air defenses at target will certainly not expect you.

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

The TFR will also indicate the direction of any 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 if you slow down to 300 kts). The TF will FAIL and pitch authority will be given back. If you don't take proper action, you may depart controlled flight.

If the idea was to stay low avoiding detection letting the fly-up climb the aircraft at 45° pitch up is a bad idea. Stay low and fast and override fly-ups as soon as you are in a safe position to do so. You can proceed low level to STPT 14 or further

The Dash-34 (chapter 2.6.3) contains a section on the TFR and FLIR. As you will not use TFR and FLIR on most of your flights, you will need to practice them from time to time to remain competent with these systems.

MISSION 9: IN-FLIGHT FAILURES *(TR_BMS_09_Failures)*

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

CONDITION: F-16 DM block 52 – Single ship - Callsign Magnet 4-1.
GW: 34198 lbs. 2 370 Gal Fuel tanks, standard A-A loadout. Max G: 7/-2.0 Max speed: 600 kts / 1.6 Mach.

WEATHER: RJFF INFO Echo 010355Z ILS RWY02 TRL140 339/04G06KT NOSIG 9999 27/20 Q3068
Fair weather turning Poor, Winds 340/5 kts. Visibility over 10 km. Temperature 27°C, dewpoint 20°C,
Altimeter 3068 inHg

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

Please do not use Freeze mode in this Mission – if you need to interrupt the training use pause!

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

The in-flight failures are a glimpse of the malfunction system in BMS. The whole PFL and other warning and caution systems were re-written to emulate many realistic failures. In-flight BMS malfunctions can happen as a result of battle damage or pilot negligence or randomly if you have random failures enabled.

The purpose of this training mission is to teach you to deal with specific emergencies. Most of the emergencies in BMS result from battle damage and unfortunately quite often the amount of damage is so important that you will not quite have time to deal with each reported emergency in sequence before needing to pull the eject handle. This training mission should ensure your safe return, but it may also leave you struggling to fix a few of the failures.

The Dash-1, Dash-34 and BMS Checklists go into more depth about the mechanization of Caution, Warning and Fault analysis. These documents should be read and understood before attempting 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 Blk40-52 checklist, section EP (T.O. BMS1F-16CM-1CL-1) 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 the new Iwakuni Marine Corps Air Station (126X) in Japan.

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.

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

Then…

9.1 The Mission

1st fault *(BMS checklist pages A-14.2 and A-15):*

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

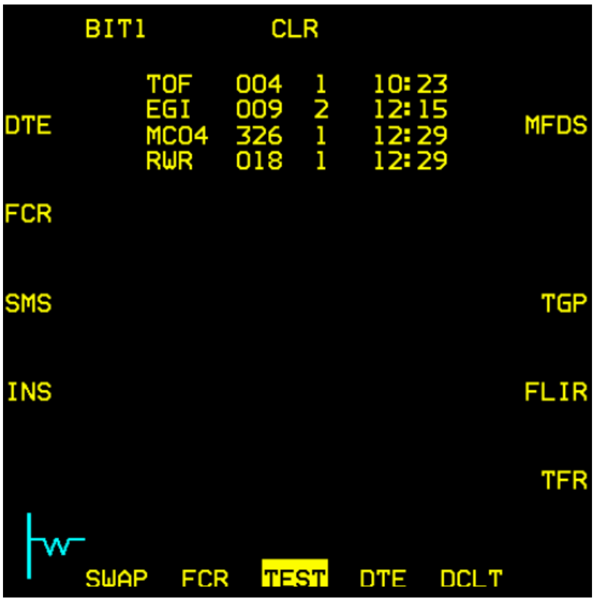
The aircraft electrical system is managed through the ELEC panel on the left console so naturally you must check the panel and look at the light status. The MAIN GEN light is ON, indicating a problem with the main generator.

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

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

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

The above recycle is actually not necessary and the checklist (pages A-14.2 and A-15) recommends you press the ELEC CAUTION RESET push button to reset both generators. Fortunately, 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. Thankfully this is not the case in this training exercise



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 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 to the alternate now and abort the mission. It's time to say goodbye to the Tomcats.

2nd fault:

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

3rd fault *(BMS checklist pages B-17, D-13)*

The first indication of the next malfunction is an FLCS FAULT caution light and Betty calling CAUTION, CAUTION. PFLD reports ISA ALL FAIL. This is typical of hydraulic malfunctions and should trigger a glance at the Hydraulic gauges on the right aux console. The hydraulic system is made of two independent hydraulic systems: A and B, each providing hydraulic power to different aircraft systems. In normal operation both needles should point to the 12 o'clock position. In this scenario the HYD A system needle started moving slowly backward to zero. You are suffering from a single hydraulic (A) failure.

The Warning light did not illuminate yet because the hydraulic slowly depletes and the warning light will come ON only once system A or B will drop under 1000. Do not worry (actually you may worry) it will get there and the warning light will come ON and Bitchin Betty will call WARNING - WARNING. Until then you are able to reset the FLCS to clear the FLCS fault on the PFLD but it will come back as it will be triggered again due to the loss of hydraulic pressure in system A. Once the Warning light comes ON, you will not be able to reset the FLCS PFL message with the FLCS reset switch.

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

There is not much you can do to fix hydraulic system A in flight. EPU will provide sufficient SYS A pressure if it is enabled, but it is not recommended. 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.

Your jet is definitely compromised, and you must prepare yourself for the worst. Losing all systems above the ocean will place you in a predicament. Try to stay ahead of the aircraft by anticipating further system losses over the next few minutes. The more you can do to make your life easier in case the situation really goes down the drain, the better. What more could go wrong?

If the remaining MFD or UFC fail, you won't be able to find the airbase. The aircraft you are flying today does not have the backup TACAN controls on the left side console because this one has been replaced by the IFF panel. TACAN backup is managed in the MFD TCN page. Time to plan ahead and set this already to 126X TR
On the remaining MFD, select TCN page from the menu and double check that channel 126, band X and mode TR are set. At least your backup tacan is ready should the worse happen.

You may also set the backup UHF radio to the landing airbase tower (299.75). That will ensure that we are not losing radio communications at a critical time. A good idea is to squawk emergency by moving the IFF switch to EMERG.

4th fault:

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

5th fault:

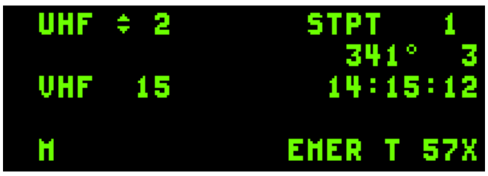
The HUD failed and you don't need any fault indication or VMS message to tell you that. Acknowledge the fault with the F-ACK button anyway. As usual with these specific bus failures there is nothing you can do to fix them in flight. The challenge in this case will not be to manage the fault but to manage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

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

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

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

6th fault:



You contact Iwakuni Tower on 299.75 and 'Declare Emergency'. Tower clears you for an emergency landing on RWY 02 (Since it's an emergency you can bypass Approach).

With a wounded bird you planned for a Simulated flameout pattern and you aim for 15000 feet above Iwakuni airbase (High key) allowing you to land the airplane dead-stick if the engine dies at any point during the approach. Once vertical of the runway, you turn right on downwind and start your descent. The speedbrakes do not work since Hydraulic System A is out. Manage your descent profile accordingly. You want to maintain an airspeed allowing safe gear operation throughout the descent.

Having plenty of altitude, you lower the gear in downwind on a heading of 200° but nothing happens.
The gear handle does not move and seems stuck in the up position.
Quick check of the HYD B gauge: all good. But no gear. From here you have two solutions:

- You go straight for an alternate gear extension, but with the gear handle stuck in the UP position, you will have a lot of remaining problems to solve:
  - The gear will be down and locked once below 190kts, but the FLCS will not switch to landing gains, the low speed warning tone will sound which is unusual with the gear down. To overcome this situation, you must manually extend the ALT FLAPS as your flaps will not deploy automatically with the gear lever remaining in the UP position.
  - Brake channel one is not powered with the gear handle up so you must switch to brake channel 2 to ensure you can stop the aircraft.
  - Nose wheel steering will not be available upon alternate gear extension
  - The PW nozzle scheduling is inoperative which is going to give you an idle power higher than normal, hence a higher speed.

  You may still at any time (even past alternate gear extension) realize your mistake and attempt to lower the gear handle, this time with the DN LOCK REL button and resolve many of the above issues at once.

- Or you do as the checklists says and you first try the DN LOCK REL button. The push button is a mechanical bypass of the electric solenoid which failed in this case. Pushing the DN LOCK REL button allows the handle to move down and the gear will lower. For practical reasons, BMS differs a bit from reality where the DN LOCK REL button must be pressed first and kept depressed while the gear handle is lowered. In BMS, you do it in quick succession: first depress the DN LOCK REL button then immediately after attempt to lower the gear handle.

Now that the gear is down, you noticed that the NWS caution light is illuminated, it happened at gear extension for some reason. Not taking chance with this broken aircraft, you decide to take the end of the runway arrestment cable on this landing just to make sure you can stop before the overrun in case the wheel brake doesn't work as well.
With the gear handle down and hydraulic SYS B operating, there is no clue the wheel brake might not work as expected but this aircraft has a mind of its own.
Lower the hook and check the caution panel for an extra caution light coming up.
There is no communication needed with ATC to take the cable.
Iwakuni 02/20 runway features 4 cables and you intend to take the third just past taxiway F. You must land long and touch down past the first two cables placed at the 02 threshold and between taxiway C and D. So aim for touchdown just past taxiway Delta.

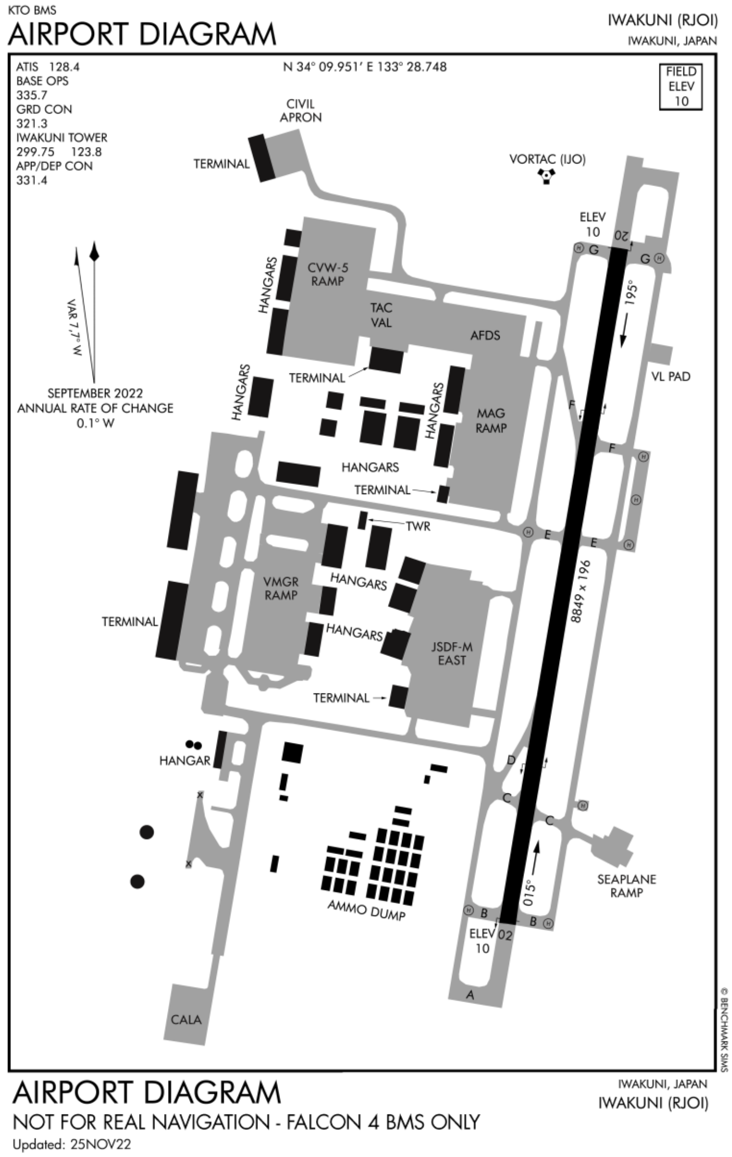
Do not delay setting the nosewheel on the ground to ensure correct hook contact with the cable and aim for centerline. Once past the cable reference panels, the aircraft should engage the cable and be brought to a stop. Welcome back on the ground safely!

Raise the hook and try to vacate the runway. Nose wheel steering will not be available so if your brakes are working you may steer the aircraft with the toe brakes. If not, well you made the right decision to take the barrier.

Next faults:

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

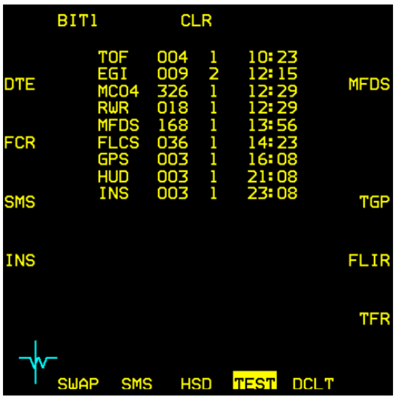


Conclusions:

The mechanics for system failure analysis are always the same:

- First the aircraft will let you know that there is a caution or a warning present. If it is a warning, WARN in the HUD will be displayed and Betty will call: “WARNING – WARNING”. If it is a caution, the relevant caution light will illuminate on the caution panel and a few seconds after that the MASTER CAUTION light will come on. Betty will call: “CAUTION – CAUTION”.

- You should then check the relevant warning lights or caution lights. The pilot fault display should be checked as well as it may give more information about the failed system, especially the first line mnemonic that will lead you to specific aircraft systems, i.e. engine, FLCS, avionics.



- From the information above look at the specific panel or gauge and take action to clear the failure condition, if it is possible. A quick look at the MFD MFL (Maintenance Fault list) on the MFD helps tracking the faults as well.

- If the fault has been fixed acknowledge the fault with the F-ACK, the MASTER CAUTION or the HUD WARN RESET. If the fault wasn’t cleared the process will start again.

  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.

9.2 Controlled failures

In BMS, it is possible to enable certain failures in flight.
Modify the “falcon bms.cfg” file and enable “set g_bActivateDebugStuff 1”.

Then while in 3D, bring up the chat window and type **.sefault X** (where X is the fault ID ->see table below).
Here is an example of a single and dual FLCS electronic failure.

ID	Fault name	Note
0	FID_UNDEFINED	can't be set via debug
1	FID_LANDING	
2	FID_TAKEOFF	
3	FID_FLIGHTDATARECORDER	
4	FID_FLCS_BIT_PASS	marks passed FLCS BIT TEST, is set automaticaly when start warm
5	FID_GEAR_FAULT	
6	FID_OBOGS_FAULT	can't be set via debug
7	FID_OXY_LOW_FAULT	can't be set via debug
8	FID_FUEL_LOW_FAULT	can't be set via debug
9	FID_FUEL_TRAPPED_FAULT	can't be set via debug
10	FID_FUEL_HOME_FAULT	can't be set via debug
11	FID_EQUIP_HOT_FAULT	can't be set via debug
12	FID_ELEC_FAULT	can't be set via debug
13	FID_MAINGENERATOR_SOFT_FAULT	can't be cleared via debug, use ELEC CAUTION RE-SET button
14	FID_MAINGENERATOR_HARD_FAULT	can't be cleared via debug
15	FID_STANDBYGENERATOR_SOFT_FAULT	can't be cleared via debug, use ELEC CAUTION RE-SET button
16	FID_STANDBYGENERATOR_HARD_FAULT	can't be cleared via debug
17	FID_ENGINE_FAULT	can't be set via debug
18	FID_ENGINE2_FAULT	can't be set via debug
19	FID_ENGINE_FLAMEOUT_FAULT	
20	FID_ENGINE2_FLAMEOUT_FAULT	
21	FID_ENGINE_HYD_FAULT	can't be set via debug
22	FID_ENGINE_FIRE_FAULT	
23	FID_ENGINE2_FIRE_FAULT	
24	FID_SEC_FAULT	can't be set via debug
25	FID_HTS_FAULT	
26	FID_HOOK_FAULT	
27	FID_FLCS_FAULT	can't be set via debug
28	FID_DBU_FAULT	can't be set via debug
29	FID_ENGINE_OIL_PRESS_FAULT	can't be set via debug
30	FID_ENGINE2_OIL_PRESS_FAULT	can't be set via debug
31	FID_HYD_A_COMPRESSOR_FAULT	
32	FID_HYD_B_COMPRESSOR_FAULT	
33	FID_HYD_A_FAULT	can't be set via debug
34	FID_HYD_B_FAULT	can't be set via debug
35	FID_CABIN_PRESS_FAULT	can't be set via debug

36	FID_CANOPY_FAULT	can't be set via debug
37	FID_DUAL_FC_FAULT	can't be set via debug
38	FID_ECM_FAULT	can't be set via debug
39	FID_OVERHEAT_FAULT	can't be set via debug
40	FID_SEAT_NOTARMED_FAULT	can't be set via debug
41	FID_TF_FAIL_FAULT	can't be set via debug
42	FID_STORES_CONFIG_FAULT	can't be set via debug
43	FID_PROBEHEAT_FAULT	can't be set via debug
44	FID_TO_LDG_CONFIG_FAULT	can't be set via debug
45	FID_FRONT_GEAR_FAULT_LAUNCHBAR	can't be set via debug
46	FID_RADAR_ALT_FAULT	can't be set via debug
47	FID_NWSFAIL_FAULT	
48	FID_BUC_FAULT	not used in modern jets
49	FID_FUELOIL_HOT_FAULT	can't be set via debug
50	FID_ANTI_SKID_FAULT	no real effect
51	FID_PULLUP_FAULT	can't be set via debug
52	FID_ALT_LOW_FAULT	can't be set via debug
53	FID_FWD_FUEL_LOW_FAULT	can't be set via debug
54	FID_AFT_FUEL_LOW_FAULT	can't be set via debug
55	FID_CADC_FAULT	no real effect
56	FID_IFF_FAULT	no real effect
57	FID_ECS_FAULT	
58	FID_IFF_INM4_FAIL_30	
59	FID_INT_NO_KEYS_46	
60	FID_XP_NO_KEYS_131	
61	FID_WARNING_ENGINE	can't be set via debug
62	FID_WARNING_ENGINE_FIRE	can't be set via debug
63	FID_WARNING_HYD_OIL_PRESS	can't be set via debug
64	FID_WARNING_FLCS	can't be set via debug
65	FID_WARNING_DBUON	can't be set via debug
66	FID_WARNING_TOLDG_CONFIG	can't be set via debug
67	FID_WARNING_CANOPY	can't be set via debug
68	FID_WARNING_OXY_LOW	can't be set via debug
69	FID_WARNING_TF_FAIL	can't be set via debug
70	FID_WARNING_OBS_WRN	can't be set via debug
71	FID_WARNING_ALT_LOW	can't be set via debug
72	FID_WARNING_DUAL_FC	can't be set via debug
73	FID_WARNING_ECM	can't be set via debug
74	FID_WARNING_OVRD	can't be set via debug
75	FID_CAUTION_FLCS_FAULT	can't be set via debug
76	FID_CAUTION_ELEC_SYS	can't be set via debug
77	FID_CAUTION_PROBE_HEAT	can't be set via debug
78	FID_CAUTION_CADC	can't be set via debug
79	FID_CAUTION_STORES_CONFIG	can't be set via debug
80	FID_CAUTION_FWD_FUEL_LOW	can't be set via debug
81	FID_CAUTION_AFT_FUEL_LOW	can't be set via debug
82	FID_CAUTION_ENGINE_FAULT	can't be set via debug

83	FID_CAUTION_SEC	can't be set via debug
84	FID_CAUTION_FUEL_OIL_HOT	can't be set via debug
85	FID_CAUTION_OVERHEAT	can't be set via debug
86	FID_CAUTION_BUC	can't be set via debug
87	FID_CAUTION_AVIONICS_FAULT	can't be set via debug
88	FID_CAUTION_RADAR_ALT	can't be set via debug
89	FID_CAUTION_IFF	can't be set via debug, does not illuminate Master Caution light
90	FID_CAUTION_SEAT_NOT_ARMED	can't be set via debug
91	FID_CAUTION_NWS_FAIL	can't be set via debug
92	FID_CAUTION_ANTI_SKID	can't be set via debug
93	FID_CAUTION_HOOK	can't be set via debug
94	FID_CAUTION_OXY_LOW	can't be set via debug
95	FID_CAUTION_CABIN_PRESS	can't be set via debug
96	FID_CAUTION_EQUIP_HOT	can't be set via debug
97	FID_FLCS_BIT_FAIL_55	
98	FID_FLCS_LEF_LOCK_43	can't be set via debug
99	FID_FLCS_AP_FAIL_50	
100	FID_FLCS_BUS_FAIL_3	illuminates AVIONICS FAULT light instead FLCS FAULT light, all subseqent FLCS faults are not on PFD and causes FLCS FAULT light to comes on and non resetable, FLCS page shows OFF.
101	FID_FLCS_DUAL_FAIL_21	
102	FID_FLCS_SNGL_FAIL_49	
103	FID_STBY_GAIN_14	
104	FID_FLCS_ADC_FAIL_13	second ADC fail fires STBY GAIN and latch ADC fail against FLCS RESET atempt
105	FID_FLCS_MUX_DEGR_71	can happen only on ground when FCC is not powered up prior starting FLCS BIT, non resetable, next successful BIT clears it
106	FID_FLCS_FLUP_OFF_54	not used yet
107	FID_ISA_ALL_FAIL_36	
108	FID_ISA_RUD_FAIL_34	
109	FID_ENG_AI_FAIL_15	
110	FID_ENG2_AI_FAIL_215	
111	FID_ENG_AB_FAIL_18	
112	FID_ENG2_AB_FAIL_218	
113	FID_RALT_BUS_FAIL_3	
114	FID_HUD_BUS_FAIL_3	
115	FID_FMS_FAIL_4	
116	FID_DLNK_FAIL_5	
117	FID_BLKR_BUS_FAIL_3	
118	FID_FCC_FAIL_4	
119	FID_MC04_DEGR_300	
120	FID_MC04_326	just for faked ramp start faults
121	FID_MC13_DEGR_300	
122	FID_MC13_326	just for faked ramp start faults
123	FID_AMUX_BUS_FAIL_3	

124	FID_BMUX_BUS_FAIL_3	
125	FID_DMUX_BUS_FAIL_3	
126	FID_EPOD_SLNT_DEGR_60	
127	FID_CADC_BUS_FAIL_3	
128	FID_UFC_BUS_FAIL_3	
129	FID_CMDS_BUS_FAIL_3	
130	FID_CMDS_INV_DEGR_6	
131	FID_CMDS_DSPN_DEGR_4	
132	FID_CMDS_DEGR_18	just for faked ramp start faults
133	FID_TCN_FAIL_4	
134	FID_FCR_BUS_FAIL_3	
135	FID_FCR_XMTR_FAIL_94	
136	FID_IFF_BUS_FAIL_3	
137	FID_MSL_SLAV_FAIL_4	
138	FID_RWR_BUS_FAIL_3	
139	FID_RWR_DEGR_21	just for faked ramp start faults
140	FID_GPS_BUS_FAIL_3	
141	FID_INS_BUS_FAIL_3	
142	FID_EGI_AE_FAIL_9	just for faked ramp start faults
143	FID_EGI_NAV_FAIL_13	
144	FID_IDM_1	just for faked ramp start faults
145	FID_IDM_BUS_FAIL_3	no real effect
146	FID_MFDS_LFWD_FAIL_168	
147	FID_MFDS_RFWD_FAIL_177	
148	FID_SMS_BUS_FAIL_3	
149	FID_SMS_STA1_DEGR_103	
150	FID_SMS_STA2_DEGR_104	
151	FID_SMS_STA3_DEGR_105	
152	FID_SMS_STA4_DEGR_106	
153	FID_SMS_STA5_DEGR_107	
154	FID_SMS_STA6_DEGR_108	
155	FID_SMS_STA7_DEGR_109	
156	FID_SMS_STA8_DEGR_110	
157	FID_SMS_STA9_DEGR_111	
158	FID_SMS_STA1_FAIL_87	
159	FID_SMS_STA2_FAIL_88	
160	FID_SMS_STA3_FAIL_89	
161	FID_SMS_STA4_FAIL_90	
162	FID_SMS_STA5_FAIL_91	
163	FID_SMS_STA6_FAIL_92	
164	FID_SMS_STA7_FAIL_93	
165	FID_SMS_STA8_FAIL_94	
166	FID_SMS_STA9_FAIL_95	
167	FID_HMCS_LBUS_FAIL_3	
168	FID_HMCS_RBUS_FAIL_6	
169	FID_HMCS_TEMP_FAIL_20	can't be set via debug
170	FID_FCC_TEMP_132	can't be set via debug

171	FID_MMC_TEMP_5	can't be set via debug
172	FID_FLCS_HOT_TEMP_48	can't be set via debug
173	FID_SMS_TEMP_19	can't be set via debug
174	FID_UFC_TEMP_42	can't be set via debug
175	FID_ENG_AI_TEMP_84	can't be set via debug
176	FID_ENG2_AI_TEMP_284	can't be set via debug
177	FID_ENG_AI_FAIL_85	unused
178	FID_ENG2_AI_FAIL_285	unused
179	FID_ENG_AB_FAIL_87	unused
180	FID_ENG2_AB_FAIL_287	unused
181	FID_TGP_HADF_FAIL_9	
182	FID_TGP_HADF_FAIL_10	
183	FID_TGP_HADF_FAIL_18	
184	FID_TGP_HADF_FAIL_19	
185	FID_LF_RWRRECIEVER_FAULT	internal fault proxy
186	FID_RF_RWRRECIEVER_FAULT	internal fault proxy
187	FID_LA_RWRRECIEVER_FAULT	internal fault proxy
188	FID_RA_RWRRECIEVER_FAULT	internal fault proxy
189	FID_RWR_DEGR_6	
190	FID_RWR_DEGR_7	
191	FID_RWR_DEGR_8	
192	FID_RWR_DEGR_9	
193	FID_SWIM_ATTD_FAIL_75	
194	FID_SWIM_NVP_FAIL_76	can't be set via debug
195	FID_SWIM_RALT_FAIL_80	
196	FID_SWIM_SCP_FAIL_79	unused
197	FID_NVP_FAIL_10	can't be set via debug
198	FID_NVP_TFR_FAIL_24	can't be set via debug
199	FID_NVP_FLIR_FAIL_9	can't be set via debug
200	FID_NVP_FLIR_ALIGN_12	unused
201	FID_NVP_COMM_FAIL_13	unused
202	FID_NVP_COMM_FAIL_14	can't be set via debug
203	FID_NVP_COMM_FAIL_15	can't be set via debug
204	FID_TGP_BUS_FAIL_3	
205	FID_NVP_FAULT	
206	FID_TFR_FAULT	
207	FID_FLIR_FAULT	
208	FID_CAUTION_ATF_NOT_ENGAGED	can't be set via debug
209	FID_CMDS_MAN_DEGR_39	unused
210	FID_CMDS_SEMI_DEGR_40	unused
211	FID_CMDS_AUTO_DEGR_41	unused
212	FID_ENGINEHOTSTART	
213	FID_ENGINE2HOTSTART	
214	FID_FLCS_FLCC_A	
215	FID_FLCS_FLCC_B	
216	FID_FLCS_FLCC_C	
217	FID_FLCS_FLCC_D	

218	FID_GEAR_STUCKED	
219	FID_BRK_PWR_DEGR	
220	FID_FLCS_AOA_FAIL	
221	FID_FLCS_CCM_FAIL	
222	FID_ANTI_SKID_OFF_FAULT	
223	FID_CAUTION_INLET_ICING	
224	FID_INLET_ICING_HEATING_FAIL	
225	FID_FLCS_AOA_WARN	
226	FID_FLCS_AOA_1_FAIL	
227	FID_FLCS_AOA_2_FAIL	
228	FID_INLET_ICING_FAULT	
229	FID_FLCS_HYD_FAULT	
230	FID_ISA_HYD_FAULT	
231	FID_ISA_ALL_FAULT	
232	FID_DN_LOCK_FAULT	

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 13 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 (Basic) – D model and good weather.

Mission 14: AGM-65 Mavericks (Advanced) - L + G models and fair weather

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

Mission 16: SPICE bomb.

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

Mission 17B: A-A IR missiles (& IFF Procedures).

Mission 17C: IDM / LINK 16 Procedures.

Mission 18: A-A Radar missiles (BARCAP).

Mission 19: Guns & HMCS.

Mission 20: Harpoons & TASMO.

MISSION 10: AIR TO GROUND GENERAL PURPOSE BOMBS *(TR_BMS_10_GPbombs)*

LOCATION: North of KOTAR.

CONDITION: F-16CM block 50 – Single ship - Callsign Stud 1.
GW: 37189 lbs. 12 BDU-33. Max G: 5.5/-2.0 Max speed: 550 kts / 0.95 Mach.
Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.

WEATHER: RKTY INFO: B 012255Z ILS RWY28 TRL140 200/15KT 9999 FEW050 28/18 Q1013 NOSIG

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

10.1 The weapons

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

In BMS these weapons are:

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

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

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

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

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

10.2 Delivery methods

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

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

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

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

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

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

10.3 The Mission

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

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

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

First pass: CCIP

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

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

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

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

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

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

You cannot place the piper directly on your intended target unless you are very close. Forward stick pressure is needed to avoid a "banana pass". Hold the FPM steady on its current ground reference. This will slow the piper track rate and improve accuracy. Below are the unload G factors:

Dive angle	Unloaded G
10	1.0
20	0.9
30	0.8
45	0.7.

Once the pipper is on the target pickle the bombs. It is a good habit to keep the pickle button depressed for a longer time, especially if you ripple multiple weapons, to ensure they all are released. While the pickle is kept depressed the FPM will flash.

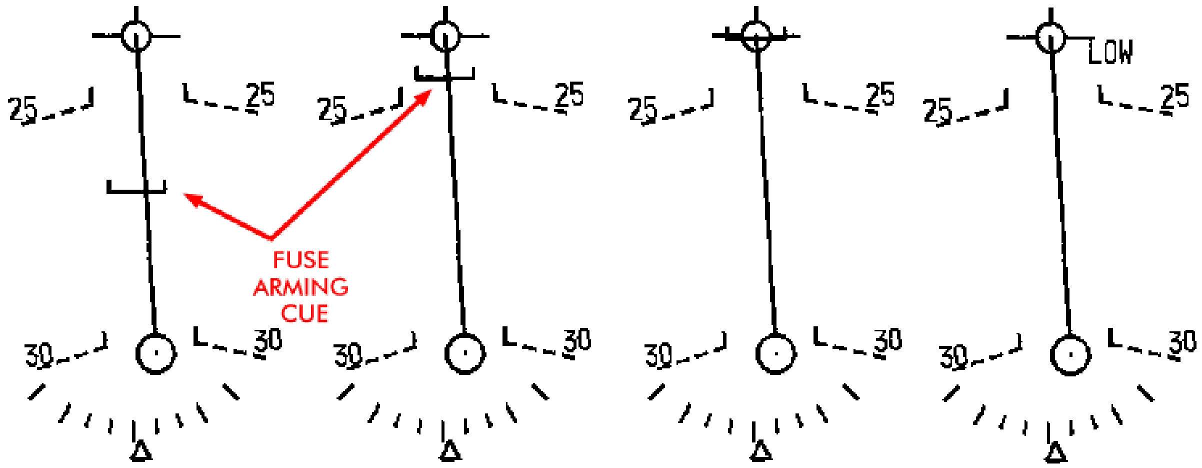
A quick note about ripple in CCIP: when you ripple bombs in CCIP, they are released individually in sequence and not simultaneously. The pipper shows the center of the bomb stick so you need to aim at what you want to bracket. Ripple has many release parameters that are explained in the Dash-34 (chapter 4.2.2.1.2.1).

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

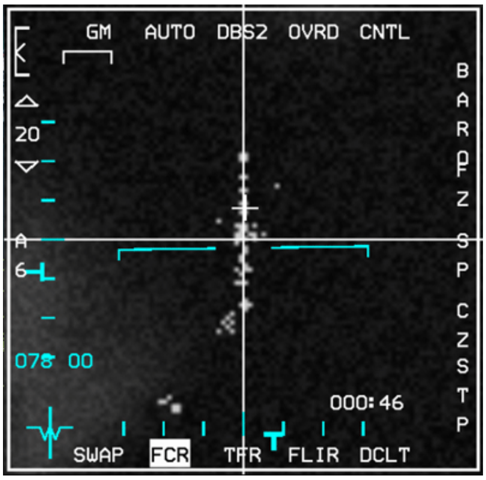
While we are flying outbound setting up for the next pass let's discuss fuses and arming delays. As you noticed there is a fuse arming cue on the bomb fall line (see screenshot below).

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

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



Second pass: CCRP

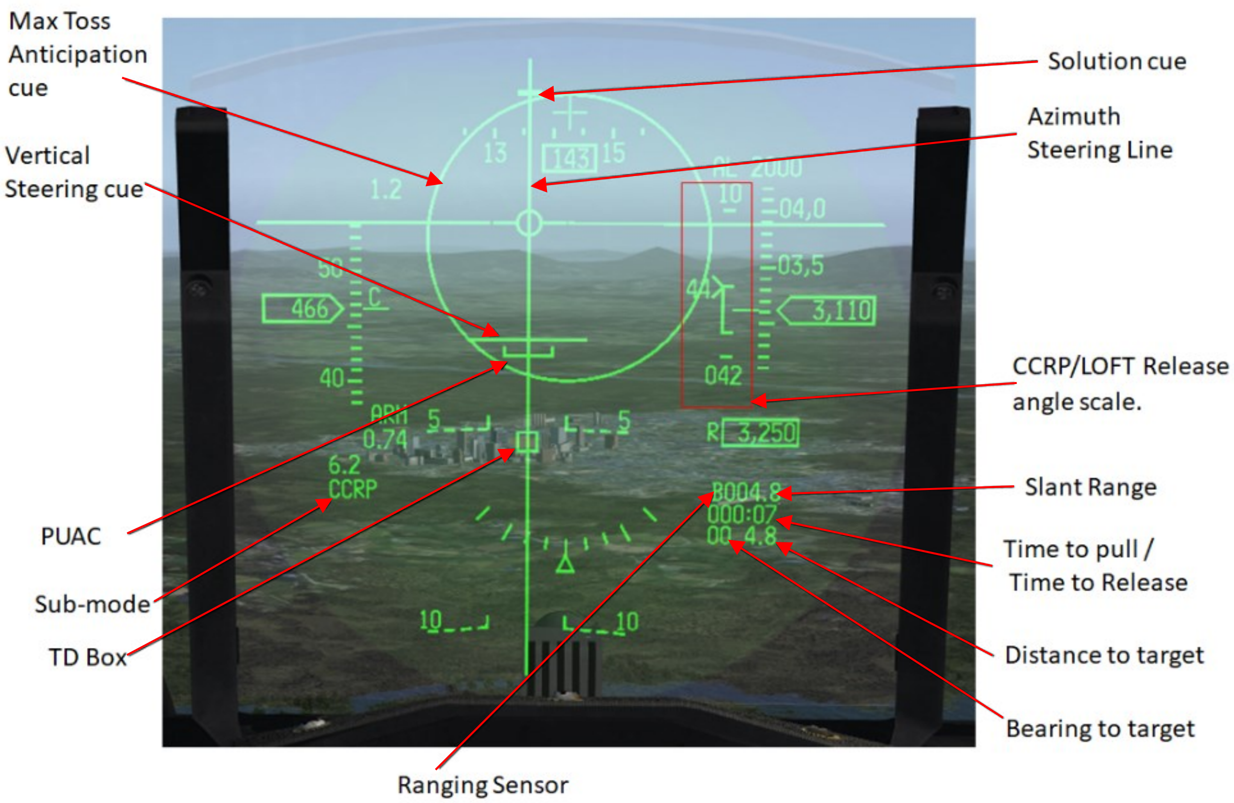


Approaching IP1 turn back towards the range and concentrate on using the FCR to acquire the target. Select the target steerpoint (STPT 6) and zoom the FCR into DBS2 mode with OSB 3. The structures should be clearly recognizable. Designate a target with TMS up.

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

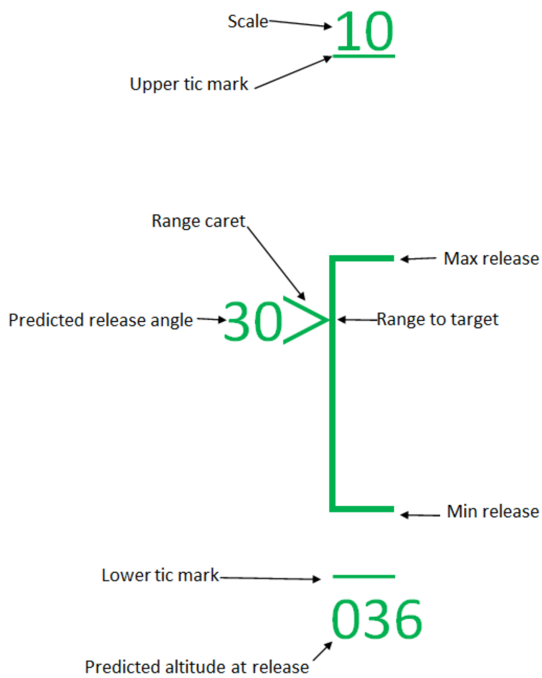
CCRP provides azimuth steering and distance information to the target. Place the FPM on the azimuth steering line to fly directly towards the target. As you approach the target the HUD symbology will change. CCRP has two solution cues. The first one is the loft solution cue; the second one is the level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

Although we are set to release bombs in pairs, CCRP ripple is different in behavior than CCIP ripple. When you ripple bombs in CCRP, the pipper shows where the first bomb will impact. By contrast, CCIP ripple shows the computed center of the rippled pair.



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

As you approach the target a horizontal line will appear at the top of the azimuth steering line and start descending towards the FPM. That's the first solution cue (loft). The counter, the PUAC and vertical steering cue VSC (new since 4.36) 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 follow the vertical steering cue (normally a 4G pull) to the intended release angle and give release consent by depressing and holding the weapon release button. When the next solution cue hits the FPM the bombs should be released automatically. If they are not, the parameters weren't met, and the system inhibited release.

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

After the first solution cue passed through the FPM the timer resets to Time to Release for the second solution cue. The flashing PUAC disappears and a second solution cue appear on the azimuth steering line, again descending towards the FPM. This is the level solution cue. As the solution cue approaches the FPM depress and hold the weapon release button to give release consent. When the counter reaches zero and the solution cue is on the FPM the bombs will drop.

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

If the weapon didn't drop the solution cue will climb away from the FPM and you will have to reset for another try. Let's fly back to IP1 and reset for the next pass. For more information about CCRP, please refer to the Dash-34 manual, chapter 4.2.14.2.1.

Third pass: DTOS

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

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

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

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

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

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

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

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

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

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

For more information about DTOS, refer to the Dash-34, chapter 4.2.2.1.3.

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

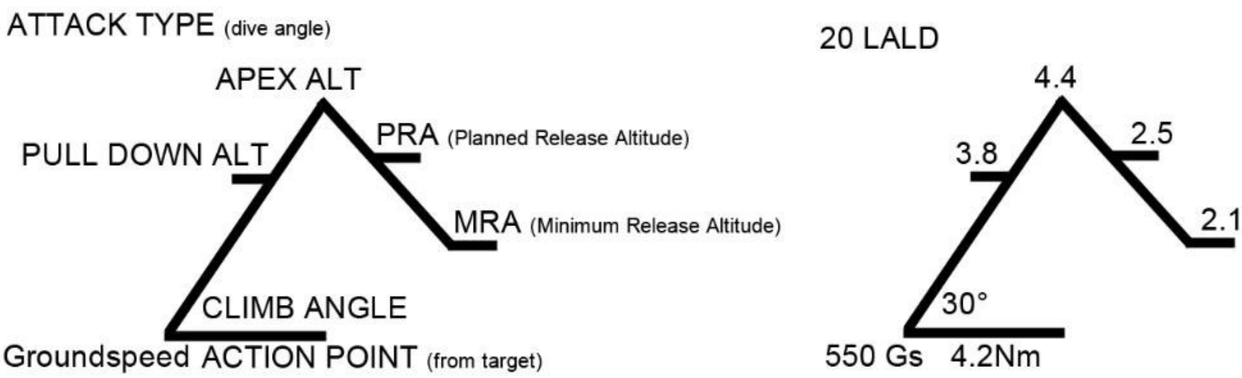
Fourth pass: Pop-up

This is where things get interesting. Let's descend to a 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 maneuver 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 to a low level again to minimize exposure to air defenses.

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 maneuver by the number, without relying on HUD symbology. To execute a pop-up you need to know some parameters:

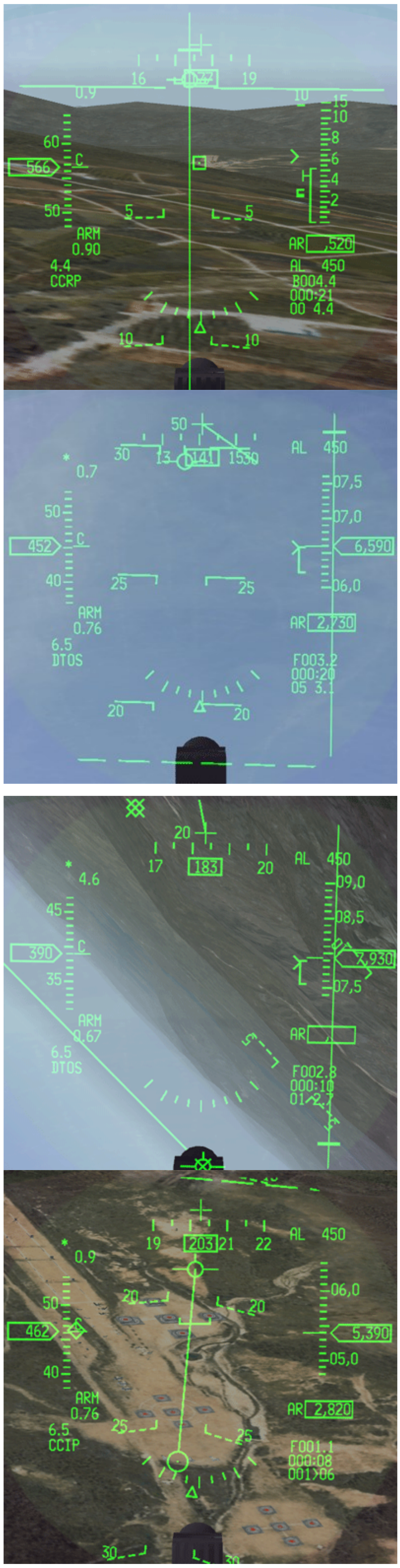
- The first one is the type of attack defining the dive angle. In this example we will do a 20LALD (20° Low Altitude Low Drag).
- The Dive Angle is used to calculate the climb angle. It is Dive Angle + 5° for less than a 20° dive and Dive Angle + 10° for a dive of 20° or more; so in this case 30°.
-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



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

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

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



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

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

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

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

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

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

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

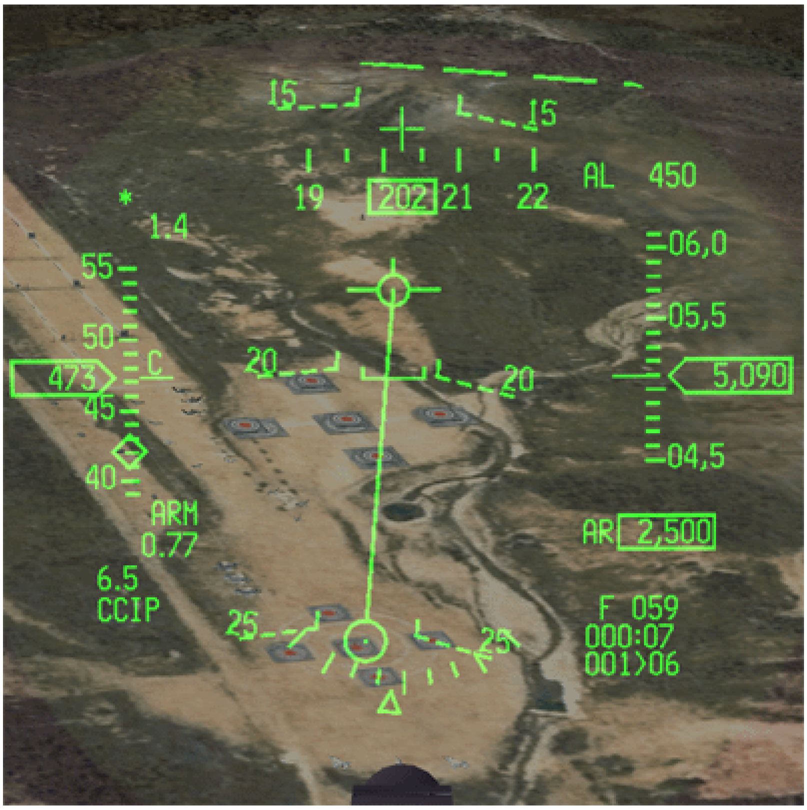
Pop-up planning is the key to success. Studying the terrain around the target will help you decide the attack direction, the required offset and the exit heading. When the target is well defended you want to stay hidden as long as possible behind terrain and you want to get back into hiding as soon as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

The most common errors during pop-ups are failure to commit the numbers to memory (bad planning) and flying approximate numbers, resulting in a failed mission.

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

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

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



Bombs on the way

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

MISSION 11: LASER GUIDED BOMBS *(TR_BMS_11_LGB)*

LOCATION: In flight somewhere inside DPRK West District airspace.

CONDITION: KF-16 block 52 – Flight of 2 - Callsign Vandal 3.
GW: 39424. 4 GBU-12. Laser code: 1511/1512. Max G: 5.5/-2.0 Max speed: 550 kts / 0.95 Mach.
Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.

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

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

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

To perform successful LGB drops, knowledge of the TGP is mandatory. The TGP is extensively documented in the Dash-34 (chapter 2.6.1) located in your Docs folder. We will only cover the aspects of the TGP we need in this training scenario to successfully release laser guided munitions.

11.1 Laser guided bombs – what is there to know?

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

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

- The weapons have a code which is set in the UI LOADOUT screen prior to flying. That code is inalterable in flight (it is set in the bomb itself) and **must** be set correctly for each flight member **before** hitting the FLY button.
- The TGP code is set with the ICP on the LASER page (LIST 0 5). You can set the code to guide your bombs or your human wingman's bombs if you're flying multiplayer. If the TGP code doesn't match the weapon code the bomb will not guide.

- A bomb will only guide on a Combat laser. Change from TRNG to CMBT by pressing any ICP key with the scratchpad on the A-G line.

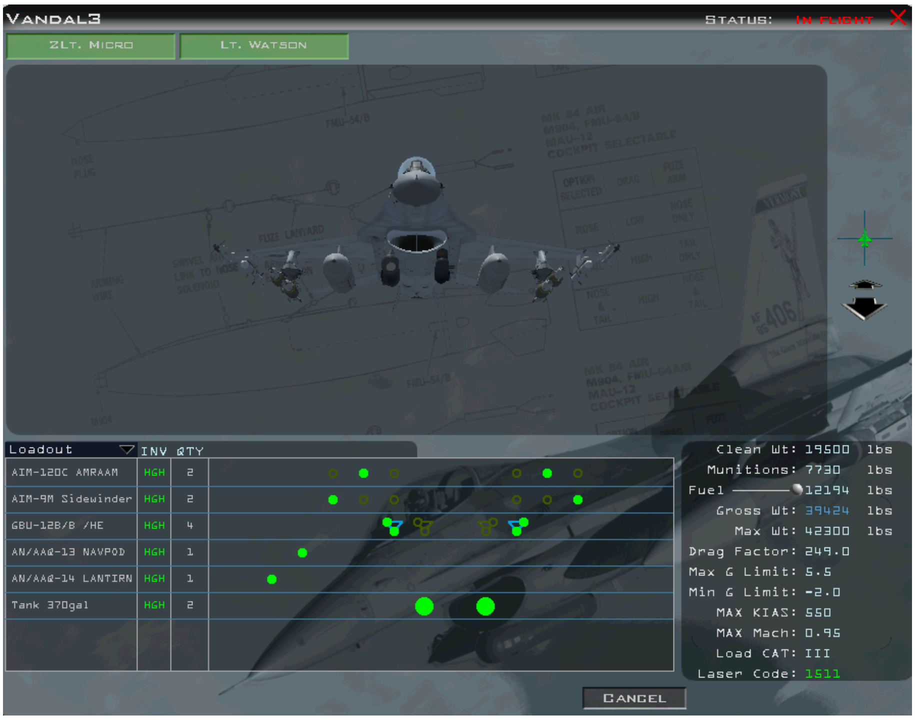
The LOADOUT screen can be tricky when you have to set different configurations for different flight members. By default, when you enter the LOADOUT screen all flight members' names/tabs are green. That means they are all selected. If you want to unselect one you need to click on the pilot's name. That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

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

You can set specific weapon codes in the TE for all aircraft of the flight. It is nevertheless good practice to check them before going into 3D as it is too late to change them once you have hit TAKEOFF.

By default, laser codes are set to 1688 in TE. For this training we have already set the laser codes to 1511 and 1512. Although it is no longer possible to change codes in BMS training missions, this is how you would change them and assign specific codes to specific aircraft when editing a none BMS Training mission.

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



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

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

The second way is automatic; the TGP will fire the laser at a specified time before predicted weapon impact. That time can be changed in the LASER page by selecting the LASER STart TIME. By default, it's 16 seconds, but you can set it to a realistic setting of 12 seconds for Paveway II bombs now. Paveway III bombs need a longer lasing time. Set 20 seconds but it is advised to manually lase earlier, sometimes as early as weapon release to ensure good guidance, especially for moving targets.

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

11.2 Single ship LGB release

As with any strike mission, recon the target carefully before flying. The target today is a large North Korean Naval base 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 Port in the target list and click on the first dock crane (yellow). It will turn green in the list and the Recon window will show the selected crane in the center.

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

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

You can also note down the coordinates of the target which are displayed at the top left of the recon windows. This is more useful when you have to strike 2 targets but have only one target steerpoint in the flight plan – just as in this scenario. Write down the coordinates for the second transport crane in the list (red): N37°48.440’ E126°14.747’ 24 feet elevation and find a suitable attack heading, e.g.: 360°.

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

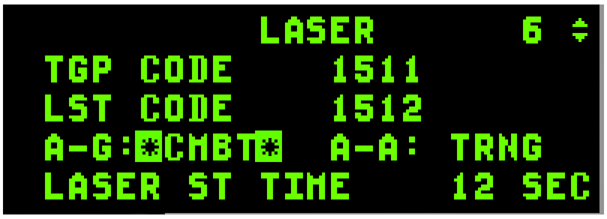
The in-flight scenario training flight starts about 10 Nm from the IP (STPT 6), which is 15 Nm from your target. Weapon loadout is 4 GBU-12 Paveway II 500 lbs bombs loaded on TERs on stations 3 and 7.

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

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

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

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



A-G laser can be set to TRNG (Training) or to CMBT (Combat) mode. A weapon will only guide on a combat laser, so ensure that the A-G LASER in the UFC page is set to CMBT. Select that line with the DCS; once highlighted press any ICP key to toggle it to CMBT. It will flash for a few seconds before displaying CMBT. The A-A laser cannot be toggled to CMBT and the A-G laser can remain in TRNG for simulated drops.

Finally, we can change the default auto-lase time. Dobber (DCS) down to that line and enter 12 seconds. That will ensure that the laser will fire for final guidance of the bomb 12 seconds before predicted impact.

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

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

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

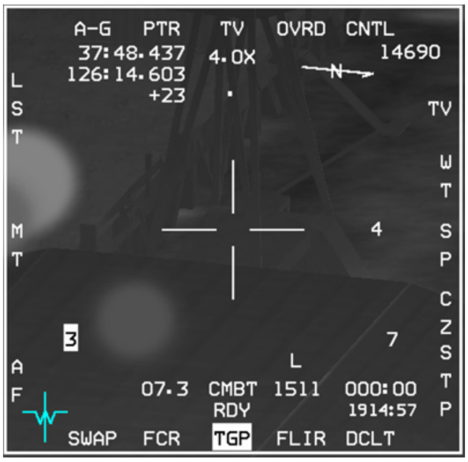
It is important to realize that the slew creates an offset from the default position and that offset is applied to all sensors and all steerpoints.

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

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

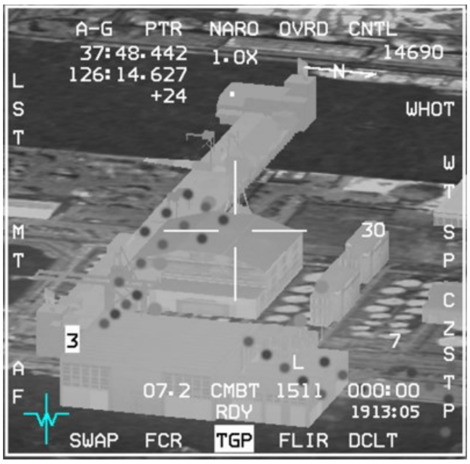
It is *very* important therefore to cancel any cursor slews with Cursor Zero (OSB 10 – highlighted when a slew exists on newer blocks) whenever the slew is no longer required.

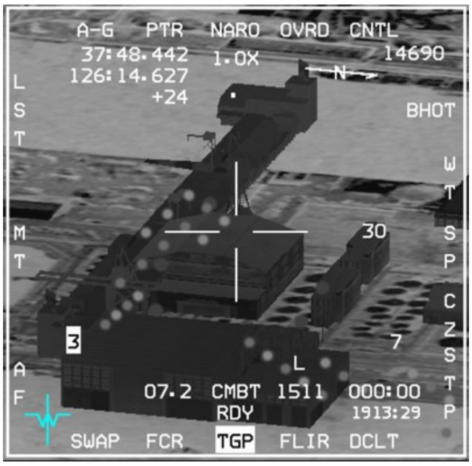
Add it in your fence check or IP routine to avoid any problems. We will come back to this egressing from our first target. More information can be found in the Dash-34, chapter 4.2.1.

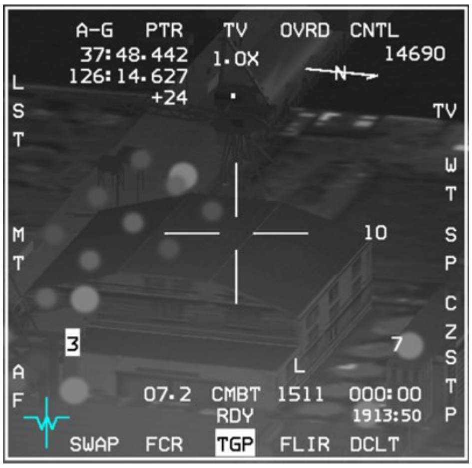


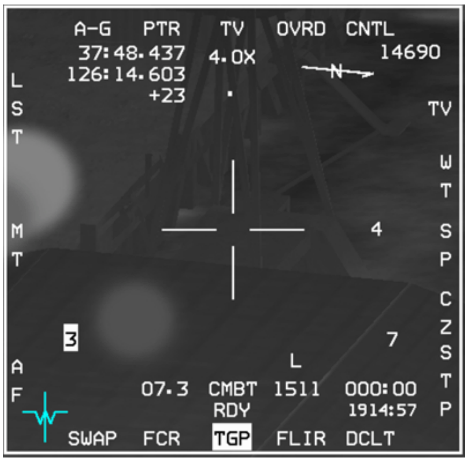
Switch the left MFD to the TGP page with DMS left, or by depressing the relevant OSB on the base page of the MFD. If TGP is not Sensor of Interest (SOI), DMS down to make it SOI and ground-stabilize the TGP with TMS up. The laser will only fire if the TGP is SOI.

By default, the TGP is in WIDE field of view and WHOT (White = HOT targets). We are still 15 Nm away, so depress OSB 3 to switch to NARO (narrow) field of view, to have a better view of the target area. The TGP has three display options: WHOT, BHOT (Black = HOT) and TV. Toggle with OSB 6.

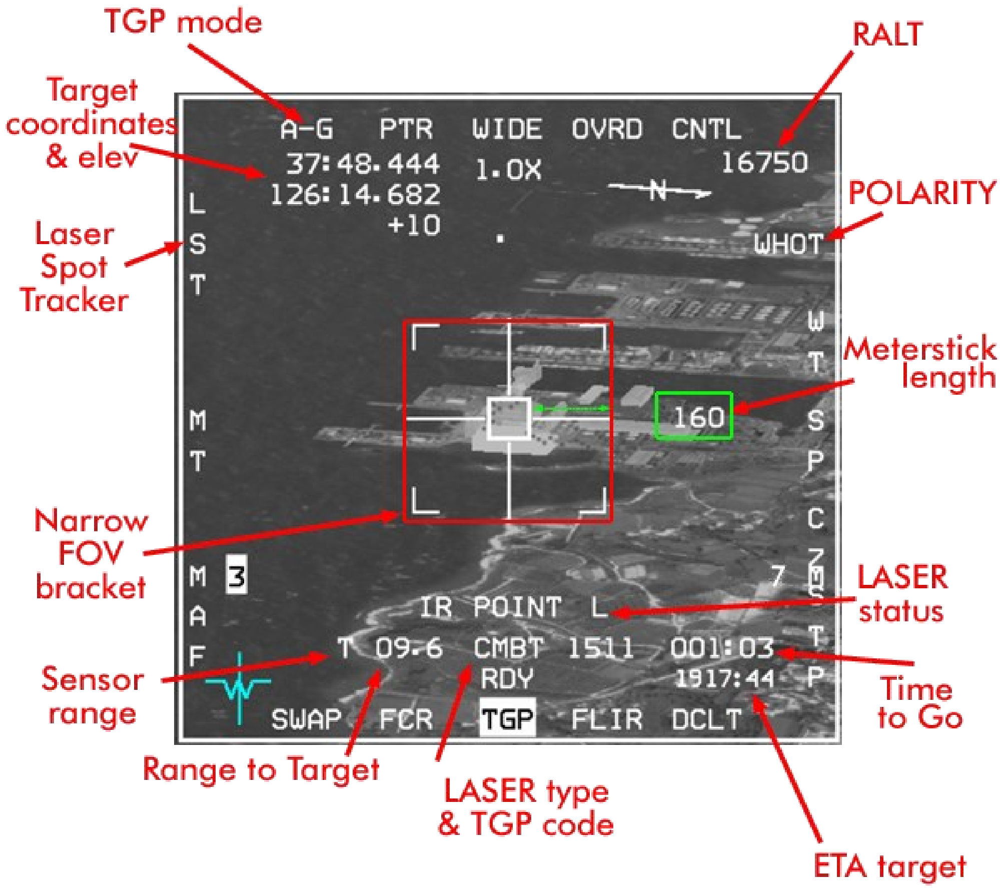






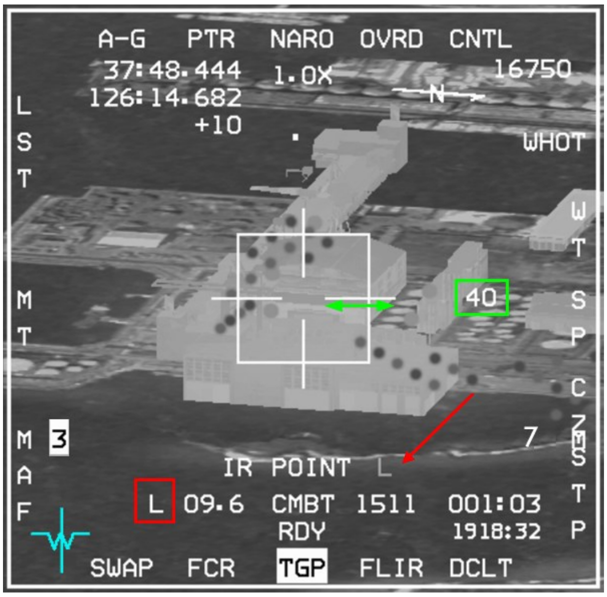


As you can see from the above 4 images, BHOT and WHOT are FLIR modes, picking up targets according to their temperature and usable day and night. TV is a daylight mode that offers greater zoom capability using the MAN RNG knob on your throttle (if set up correctly).



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

- The Narrow FOV brackets show the area you will see magnified when you switch to NARO FOV.
- The LASER status is the same as the one in the bottom left corner of the HUD. L means laser is set to Combat and T means laser is set to Training. Flashing means the laser is firing. CMBT is also repeated on the bottom of the TGP next to the laser code. When the laser is set to Training the laser code is not displayed.
- The range to the ground stabilized 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. If you see clouds over the target, expect to lose laser track due to humidity. You may need to descend under the cloud base (FL150 in this training mission).



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

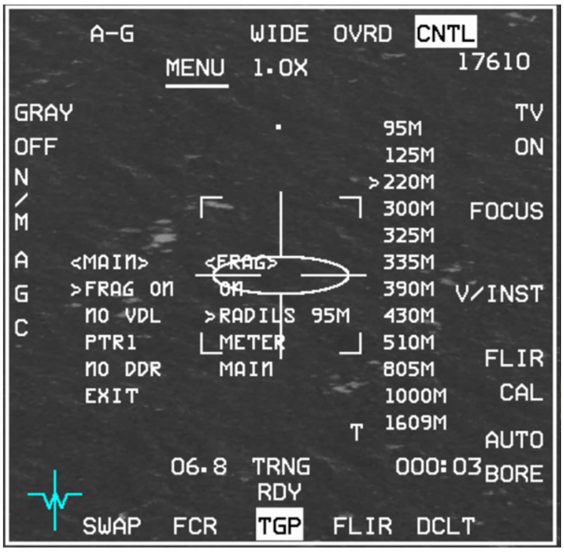
  When you pickle (bombs) the laser fires automatically to more accurately range the target. Laser ranging happens as long as the pickle button is depressed.

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

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

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

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



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

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

Both options are extremely useful when doing CAS if you know the Risk Estimate (Danger Close) Distances for your weapon(s). You can then display distance from SPI and the relevant frag pattern on the TGP and ensure that friendly troops or off-limit targets stay outside the weapon envelope. Anyway, we are not doing CAS for now (check out Mission 27 for that), so let’s go back to the task at hand… As we expected our target is obstructed by a large building. We will drop the bomb and as we near the target fine-tune the TGP cursors to the crane location past the warehouse. The target is now captured, so we can switch our attention to the HUD and CCRP release cues.

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

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

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

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

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

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

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

The bomb is now falling ballistically towards the target. As we approach the target the TGP cursors can be moved to the base of the crane as the warehouse is not obstructing our target anymore. When the Time To Go indicates 12 seconds the L will start to flash, indicating the laser is firing. The bomb acquires the laser spot and guides on it to the target.

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

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

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

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

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

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

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

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

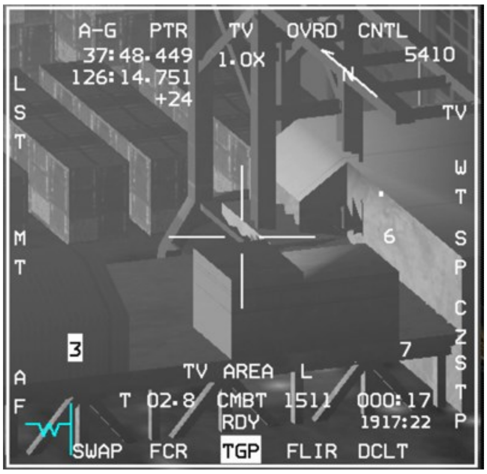
The Time to Go in the TGP display counts down time to the next event. In this case the first TTG is the loft release cue. Once past the loft release cue the TTG will count down to the level release cue and after that it will count down to the time of impact.

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

We could decrease the release angle in the SMS CNTL page to 30°, but in this scenario we will just wait until we are 4.5 - 5 Nm from the target to pull up. That will maximize our P_k (probability of kill) and simplify bomb release.

To ensure bomb release using the default 45° loft cue all parameters have to be spot on, because it is the maximum distance possible from the target, which makes the loft very susceptible to any fluctuations in speed, G and angle. It is not uncommon to miss release parameters when following the default 45° loft cue. After the first release cue, wait until the PUAC stops flashing and don't pull up until the distance to target is 4.5 - 5 Nm. This is the action point.

At the action point go afterburner and 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. This maneuver needs to be aggressive otherwise you will miss the release point, so ensure you keep your speed up in the climb (hence the need for AB) and pull these G's. Start then your gentle egress turn 90° left and start a gentle descent back to low altitude. You have plenty of time to stabilize 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 defense 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 12 seconds from impact the laser will fire. The range will be preceded by an 'L' and the laser status will be a flashing 'L'. The bomb is now guiding on the laser spot from your targeting pod. There is nothing more you can do but to enjoy the feeling of a job well done as you watch the bomb hit the target.

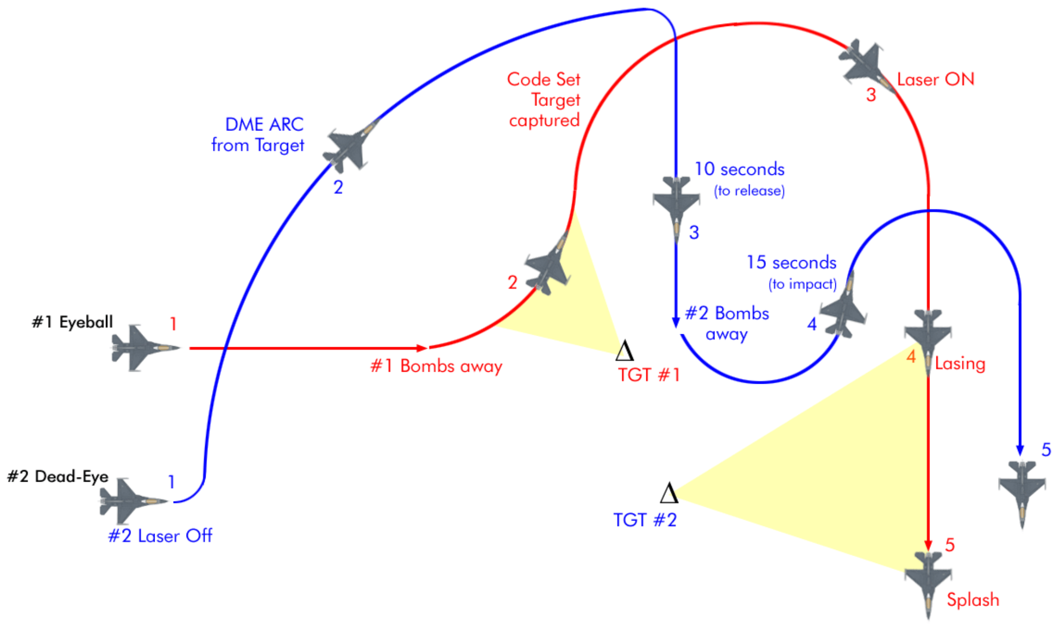
Once the target is destroyed cancel any cursor slew with: TMS down, Wide Field of View, Cursor Zero. This procedure needs to be practiced until it becomes second nature.

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

11.3 Buddy Lasing

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

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



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

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

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

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

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

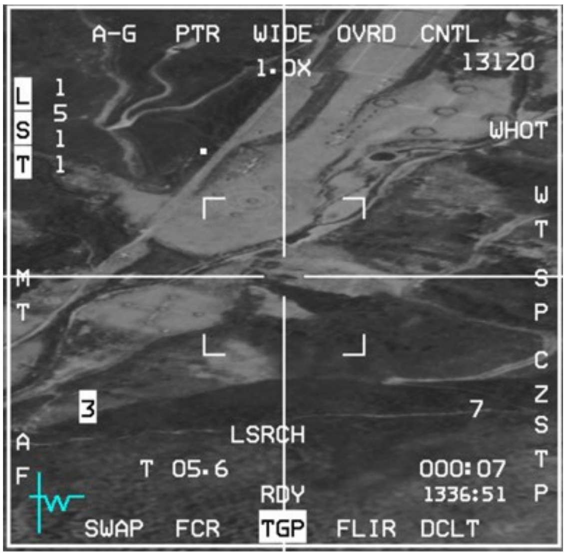
The wingman calls "bombs away" and monitors his time to impact. When it reaches a pre-briefed time before impact, in this case 15 seconds but it could be longer, he calls it on the radio: "Vandal 3-2, 15 seconds". Lead manually lases the target with the first trigger detent and refines his aimpoint if necessary until impact.

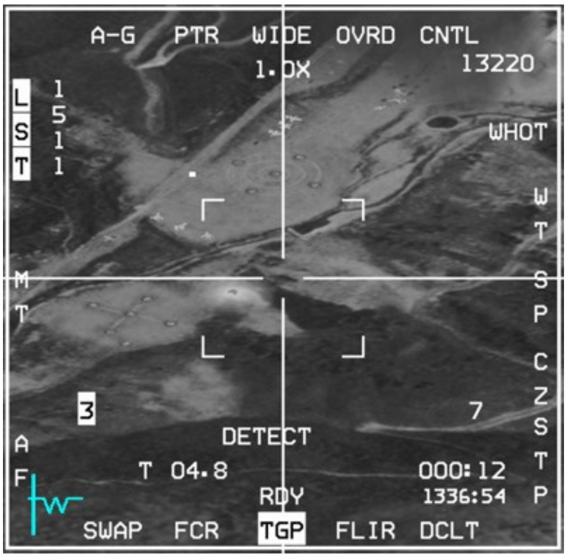
11.4 Laser Spot Tracker (LST)

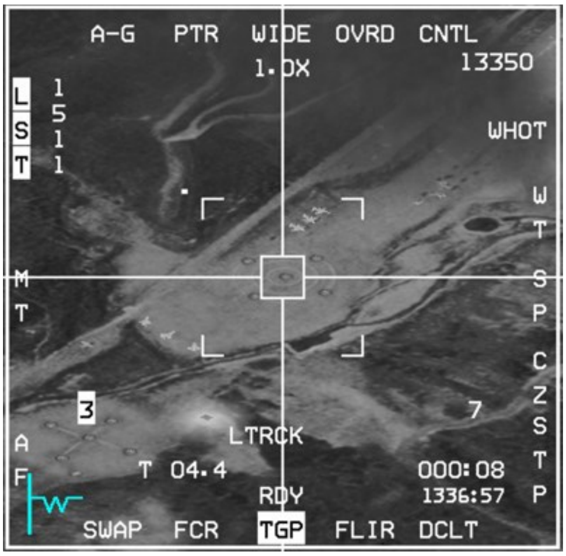
The Laser Spot Tracker can detect and track laser spots being designated by other aircraft in BMS. It is very convenient when you want to know which target your wingman, or a FAC(A) is lasing. To enter LST on your TGP first ensure that your LASER UFC page has the correct laser code entered on the LST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

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

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







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

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

MISSION 12: AGM-88 HARMS *(TR_BMS_12_Harm)*

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

CONDITION: F-16 block 50 – Single ship - Callsign Weasel 3.
GW: 38758. 2 AGM-88 HARM missiles, HTS pod, Sniper pod. Max G: 6/-2.0 Max speed: 600 kts / 1.2 Mach.
Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.

LEARNING OBJECTIVES: Destroy SAM Radars.
This mission is meant to be done twice. The first time focusing on POS EOM targeting PPT 57 (SA-2) and HAS targeting PPT 56 (SA-2). Since only two HARMs can be carried, a second TE run focusing on the SA-4 battery using the HTS pod and HAD page needs to be executed.

WEATHER: Cloud base 35000 feet, visibility 10 km or more, Winds from the south at 4Kts+ QNH 1030.

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 Defenses).
DEAD (Destruction of Enemy Air Defenses).

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

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

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

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

- With HTS, the pod is the main sensor. The HAD page is able to display which mode the air defense radar is using through colored or flashing symbols. You can then be more confident the radar is emitting before firing your missile (though it may still switch off after). The pod sensor is also still usable after all your missiles have gone. HTS detects all threats and is not limited to threat tables.

- Without the HTS pod, the sensor is the missile itself and therefore will not be available once all missiles have been fired. Targeting is done through the WPN page. The two modes available in BMS: HAS and POS are limited to specific threats, which need to be pre-selected to be visible on the WPN page.

This training mission will document all three modes, but we only have two missiles onboard. The instructions will have you execute the same mission twice to fully learn this complex weapon system.

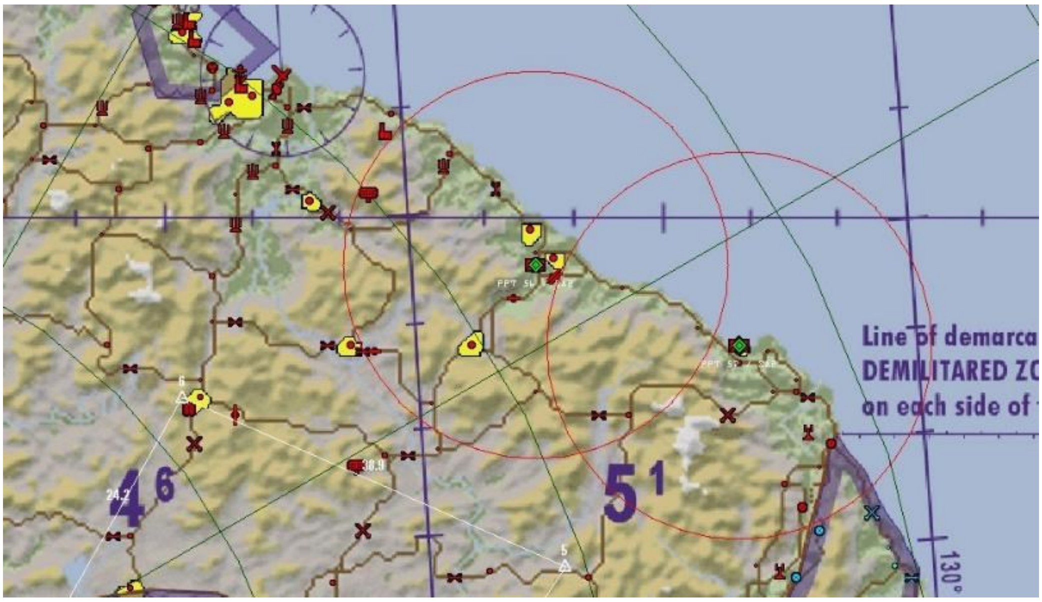
As a SEAD or DEAD flight lead your responsibility will be to protect the strike package or to destroy enemy air defenses, but to be able to do that you need to have a good idea of where the threat will be located. Let’s start with a recon of the target area for this flight.

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

- PPT 56: SA-2 (fixed) Fan Song missile guidance (‘2T’)
- PPT 57: SA-2 (fixed) Fan Song missile guidance (‘2T’)

There is also an SA-4 present, but these are mobile units so their position can never be accurately known. For this reason, the BMS "fog of war" prevents it from showing on the 2D planning map. We will find and destroy it in the second mission execution. The SA-4 can be avoided for the first occurrence of the mission.

The last versions of BMS introduced significant changes to the way SAM systems work. The most obvious change though is the fact that all SAM battalions now have both a Search and Acquisition Radar and a Fire Control Radar. To render a SAM site ineffective, the FCR must be destroyed. In latest BMS versions, the lethality of the SAM tactics has increased, so we must adapt our methods.



We need to differentiate fixed from mobile SAM systems. If we intend to fire a HARM in POS EOM mode, we need to be certain that the radar will be close to the steerpoint we'll use during the firing procedure (most of the time a PPT). If the SAM moves away from that location the missile will certainly miss. As a rule of thumb: we will use POS mode only for known, fixed targets (the SA-2 in this scenario). POS can also be used against mobile battalions that have stopped to engage us. A markpoint from the TGP can be used once we are certain they are stationary. Note that since 4.36 it is now possible to create A-G markpoint with the HMCS as well.

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

AGM-88 HARM

12.1 First mission run: POS EOM & HAS mode

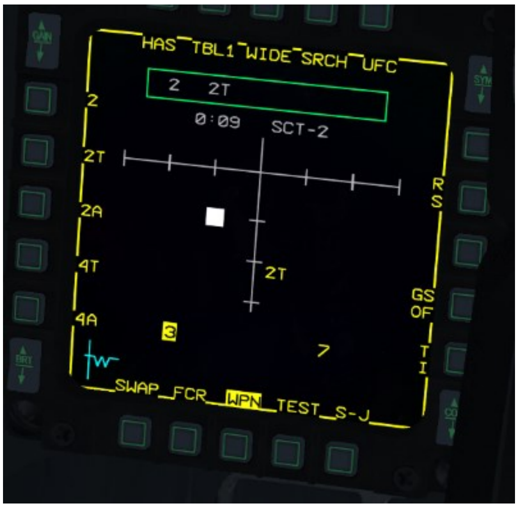
Because the HARM has complex functionalities in BMS, we refer you to the Dash-34, chapter 4.2.5.1. Learning and understanding the different HARM modes/functions and sensors (HTS) are crucial for success in this training.

Before entering 3D, we will have a look at the DTC in 2D. A new “HARM” DTC tab has been introduced since 4.36. This table give you the possibility to create three individual TBL tables. In previous BMS versions, these tables were hardcoded and not changeable in the UFC DED and in the POS/HAS page. Now you can define them before your mission starts. It is also now possible to set different codes for a) a specific SAM system, b) the FCR (Fire Control Radar) and/or c) the EWR (Early Warning radar). This way, you have a clear indication in the HAS and HAD page which radar type is emitting.

As mentioned before, the main threat in this first run will be two SA-2s. An SA-2 has multiple radar units which can track you. The FCR is the “Fan Song” and the EWR is the “Spoon Rest”. The following table provides an overview about all codes which are implemented in BMS:

SAM SYSTEM	ALIC CODE	SYMBOL	FCR	ALIC CODE	SYMBOL	EWR	ALIC CODE	SYMBOL
SA2	102	"2"	FAN SONG	202	"2T"	SPOON REST	402	"2A"
SA3	103	"3"	LOW BLOW	203	"3T"	FLATFACE	403	"F"
SA4	104	"4"	PAT HAND	204	"4T"	LONG TRACK	404	"4A"
SA5	105	"5"	SQUARE PAIR	205	"5T"	BARLOCK	405	"5A"
SA6	106	"6"	STRAIGHT FLUSH	206	"6T"			
SA8				608	"8"			
SA9						DOGEAR	609	"D"
SA10	110	"10"	FLAPLID	210	"10T"	BIGBIRD	410	"10A"
SA11	111	"11"	FIREDOME	211	"11T"	SNOWDRIFT	411	"11A"
SA13						DOGEAR	609	"D"
SA15			SCRUMHALF	615	"15"			
SA17	117	"17"	CHAIRBACK	217	"17T"	SNOWDRIFT	417	"17A"
SA19			HOTSHOT	619	"19"			
PATRIOT			AN/MPQ-53	693	"P"			
HAWK	130	"H"	AN/MPQ-46	230	"HT"	AN/MPQ-50	430	"HA"
NIKE				696	"N"			
SKYGUARD				695	"SKY"			
AAA	692	"AAA"						
SEARCH	801	"S"						
UNKNOWN	99	"U"						

Set the code for the SA-2 (102), the “Fan Song “ (202) and the “Spoon Rest” (402) as well as “Pat Hand” (204) and “Long Track “(404) on the first TBL page (as shown above) and click save. Note that codes must be unique. Two identical codes cannot be set up in the same page or across pages.



Fan Song emitting in HAS (2T)

Fan Song + Spoon Rest emitting in HAD (2T+2A)

Both pictures above show the benefit of these new features which increase the efficiency for SEAD/DEAD missions, like ours.

Steerpoint 5 will be used as our attack point for the fixed SA-2 radar at PPT-57. We will attack in POS EOM mode. We will then turn towards North to engage the second SA-2 at PPT 56 using HAS mode.

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

All HARM's will be handed off with the current steer point. Increase or decrease the STP number, and all missiles will be updated.

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.

POS mode

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

In POS mode the missile is not fired at a radar, but at a **steerpoint**. It is programmed to start looking for a *specific radar type* at a certain distance from the steerpoint and if the radar is emitting the missile will target it. 4.35 introduced changes if the radar is not emitting: If the radar is not emitting the missile will either FLEX (pick a new target within the missile's field of view), or GLIDE (flatten its flight trajectory to maximize loiter time) or hit near the coordinates of the steerpoint it was fired at.
Also available are the Target Isolate (T/I) modes. Please refer to the chapter dedicated to AGM-88 HARM in the Dash-34 (Chapter 4.2.5 and 4.2.5.1.4.3 to 4.2.5.1.4.4) to read more about FLEX, GLIDE and Target Isolate.

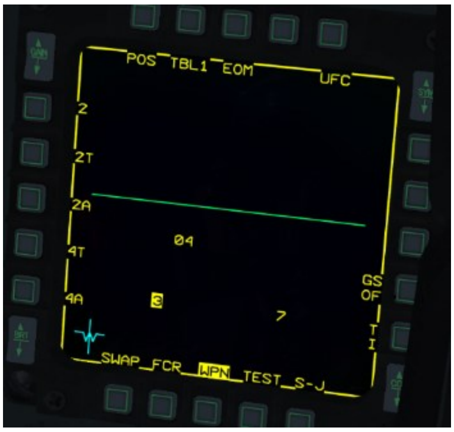
When using POS mode, the pilot has no way of knowing from the WPN page if the radar is actually emitting or not. Using the RWR and HAS page may provide clues about the state of the SAM radar and is essential to ensure a high Probability of Kill (PK).

POS is also 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 fulfill mission objectives.

POS mode is accessed from the WPN page as the sensor is in the missile. It has three sub modes: EOM, PB and RUK. OSB 3 provides hands-off sub mode selection; the HOTAS pinky switch on the stick will provide hands-on sub mode selection when the WPN page is SOI.

Each mode controls at which point the missile will activate its seeker and what the FOV of the seeker will be. They all use the same WPN page symbology:

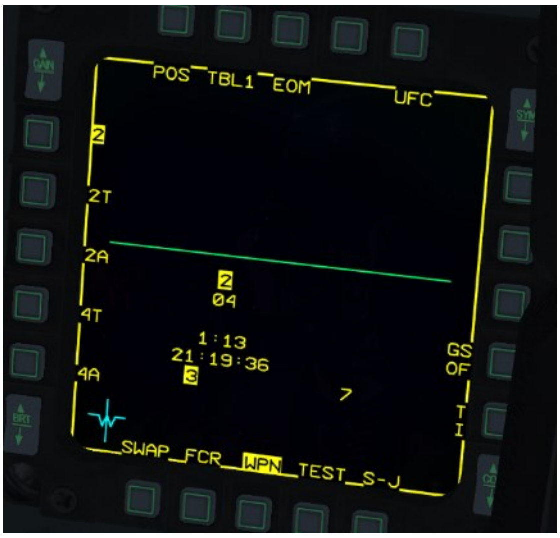
- **EOM** (Equations of Motion) is the most accurate POS sub-mode. The seeker is activated with a narrow field of view quite close from the known threat position. This mode should only be used when the location of the emitter is well known (i.e., collocated to a steerpoint).
- **PB** (Pre-Briefed) mode is used for long range delivery with high confidence of the target location. The seeker will activate at a longer range than in EOM from the steerpoint with a wider FOV.
- **RUK** (Range Unknown) is a degraded EOM mode where confidence in range of the target is very low. The seeker will activate at maximum range from the steerpoint with an equally wider FOV. Be careful using RUK with T/I set to FLEX, you may hit an emitter well short of the target.



The WPN page in POS mode is divided into two parts by the green Launch Status Divider Line (LSDL). Pre-launch information will be displayed below the LSDL and post- launch information will be displayed above the line.

As stated 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 mission as described earlier. OSB 2 toggles between 4 different tables of threat types. OSB 16-20 will allow selection of a radar type according to the selected threat table. TBL1 is selected in the picture at left and contains (as set in the DTC): SA-2 (2), Fan Song (2T), Spoon Rest (2A), Pat Hand (4T) and Long Track (4A). Use TMS left when the WPN page is SOI to toggle between threat tables.

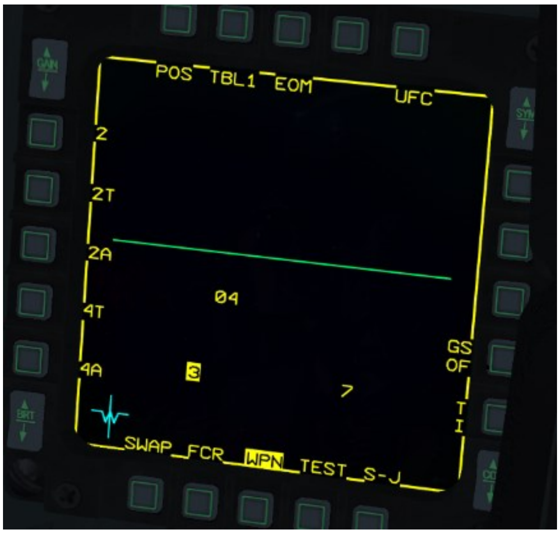


Depress OSB 20 to handoff SA-2 threat type to the missile, or toggle through the threat types with TMS right. The threat type will be added below the LSDL, above the steerpoint. Missile time of flight and the time of impact are also displayed. Should the missile be fired now it would go toward steerpoint 4, activate its seeker at a defined range and look for radar emissions from a "Fan Song" or "Spoon Rest" radar. This should take about 1 minute and 13 seconds.
Note: Of course, one can directly select the Fan Song (2T) to kill the SA-2 if the Fan Song is emitting; however, it is best practice for most situations to choose the SAM type and not a specific radar. This is especially true for SEAD missions.

We can step the missile and select the other AGM-88 on station 7 with the MSL STEP button and preset this station to HAS mode. This self-defense preparation will be useful if a pop-up threat comes active while approaching our target. For this training mission ensure you have both HARMs in POS mode.
If your mission requires two POS engagements, you can set the second missile to a different threat type or even a different mode. Missiles will retain their handed off threat types, but the steerpoint is always the currently selected steerpoint.

It is important to note this because it is rare to fire two missiles at two different 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.

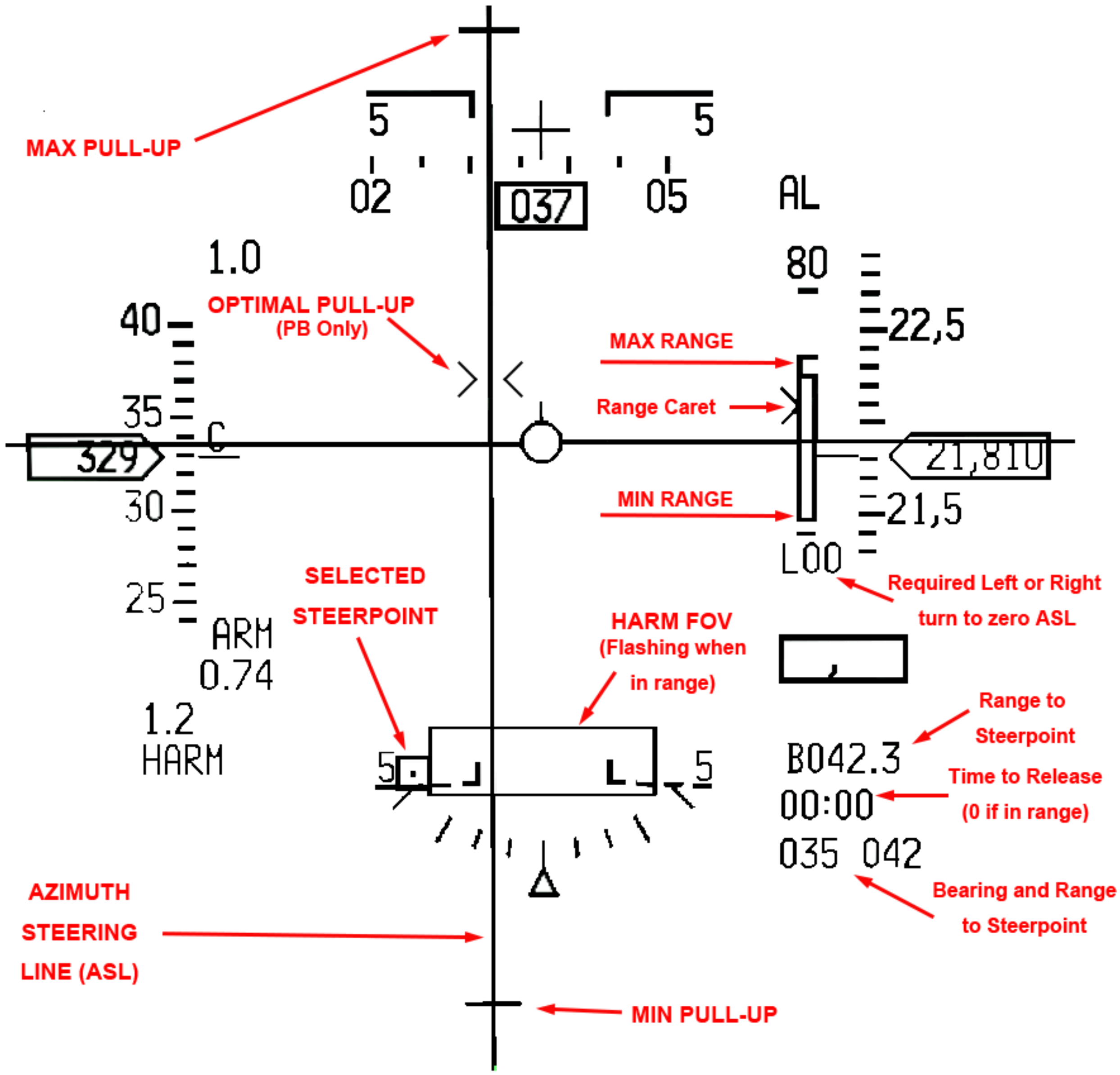
There are multiple ways to change the active steerpoint:



If you remember the PPT number of your target, use the STPT page of the UFC and enter the PPT number. Otherwise select the HSD page, make it SOI and move the cursor to the intended target at the center of the threat ring. With the cursor just above the threat symbol press TMS up. That will make it the active steerpoint of interest. The relevant PPT number will also be displayed on the DED.

Remember that all your other sensors are pointing to that steerpoint now, including your INS. If you are flying with the autopilot in steering mode, the aircraft will immediately turn to the new steerpoint. In the WPN page the steerpoint, TOF (Time of Flight) and TOI (Time of Impact) are updated accordingly.

The HARM missile is capable of Mach 3+ speeds, has a missile motor burn time of about 45 seconds and a range of up to 60 Nm in BMS. This is longer than any SAM engagement zone in Korea (the SA-10 is 50 Nm and the 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 defenses in the area (these are Pre-Emptive Targeting (PET) shots).



The HUD provides cues according to missile mode. The Missile FOV box will be different in POS/EOM than in PB and RUK sub-modes and reflect the narrower FOV in EOM and the wider FOV in PB and RUK. The HUD HARM FOV will be larger in PB/RUK. The above picture shows the POS/EOM shot we are about to take on the SA-2 at PPT57.

The range of the missile depends on the launch aircraft's altitude, speed and loft angle. The more energy the missile has, the longer its range. Judging efficient AGM-88 range is tricky in BMS as the missile is shown in the HUD with its nominal range (displayed on the top of the range bar right of the HUD).

Although 60 Nm is sufficient to beat any BMS SAM engagement zones (PPT threat rings) you can still have valid shots at longer ranges than 60 Nm. Be warned though if you fire too soon the missile will self-destruct in the air when its battery runs out. So if you want to ensure best hit probability wait for the HUD in-range cues. Just be aware you might have a bit more margin if needed.

A valid shot happens when the range caret is within the max and min range. The HARM FOV will flash indicating the missile is in range. If the azimuth to the target is not 0° then the HARM missile will need to maneuver, which will decrease its range. The ASL is similar to the CCRP steering line and the HUD also provides indication of any left or right turns needed (in tens of degrees) to zero the azimuth.

The SA-2 is still 42 Nm away and we are way outside its threat circle. We will close a little bit more, tempting the SAM operator to turn on his Fire Control Radar. Having the SAM radiating greatly increases the chance of our missile killing the radar. If you see a '2' on the RWR, fire your missile. If the Fan Song does not turn on, fire before entering the SA-2 threat ring and fly towards it; hopefully the SAM site will engage you.

AGM-88 missiles are heavy and as soon as one missile is away the aircraft will enter an asymmetrical store condition with one heavy wing. Be ready to add roll trim to counteract this.

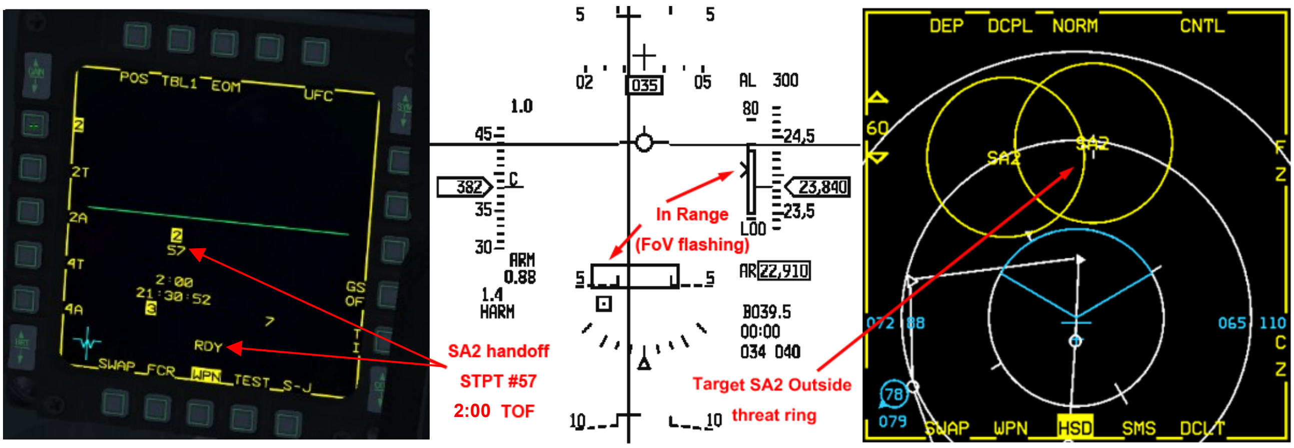
While we close with the target let's have a quick look at the other two POS sub-modes:

RUK (Range Unknown) can be selected with OSB 3 on the WPN page, or the pinky switch on your HOTAS if the WPN page is SOI. 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. The range and loft cues are not displayed. The seeker of the AGM-88 will activate at the furthest possible distance from the steerpoint and look for the pre-set handoff threat (in this case a Fan-Song) with a wide FOV. RUK is considered to be a self-defense mode.

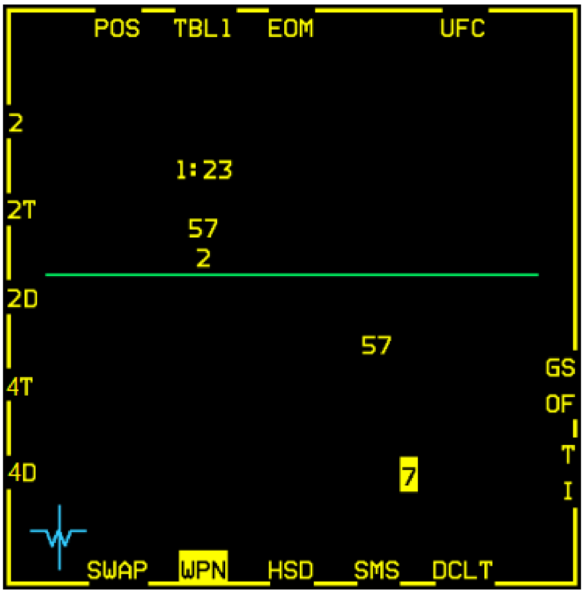
A further press on OSB 3 or the pinky switch selects PB (Prebriefed) mode. The seeker will then activate at an intermediate range (between EOM and RUK values) from the active steerpoint with a wide FOV°. The WPN page is identical to the EOM sub mode. The HUD cues display the larger HARM FOV and an optimal loft cue is displayed within **> <** carets. POS PB may be used at long range when you have good confidence in the target location.

Let's switch back to POS EOM. The SA-2 is now 40 Nm away and we are well within range. If our mission is suppression (SEAD), we can fire when the time matches the package trespass time.



Press the pickle button and keep it depressed until the missile is away. A radio call on UHF is required, to alert any aircraft in the vicinity: "Weasel 3-1, Magnum PET Alpha 2 minutes ". This is their cue to enter the SAM WEZ.

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".



This is where the difference between SEAD and DEAD is noticeable. In SEAD you do not necessarily need to destroy the radar. Keeping it shut because anti-radiation missiles are flying and the operator knows that if he switches the radar ON for too long it will get destroyed is enough to fulfil your objectives. So, with a SEAD mission objective you don't really care if you miss your target (if you hit, it is better) but you would ensure a constant umbrella of AGM-88s over the target area for the duration of the package's trespass into the SA-2 engagement zone.

If your mission objective is DEAD, you want that radar to radiate so that your AGM-88 can hit it.
To maximize your chances, you should:

- Wait until you are just outside the threat ring to fire, (21-20Nm) and then …
- Continue inbound to trespass the SAM WEZ until the Fan Song appears in the RWR ...
- Put the emitter at your 3 or 9 position (beam) and watch for any launches (known as “wild weasel”), evade as necessary.

If, regardless of your efforts into baiting him, the Fan Song never emits, BMS offers you Target Isolate possibilities to maximize the chances of hitting the radar:With the Target Isolate options, you can prescribe this missile to:

1) FLEX to a new threat if detected (useful if several SAMs are collocated on the target), or

2) GLIDE (flatten the trajectory to lengthen the “loiter time” near the target. (Be aware, if the Fan Song comes active while the AGM-88 is overhead or past the steerpoint, it will be outside of the missile’s FOV and will keep flying until the self-destruct timer fires), or

3) neither GLIDE nor FLEX (self-destruct on impact).

When the counter reaches zero the missile will impact the Fan Song radar (we’ll assume it was radiating).

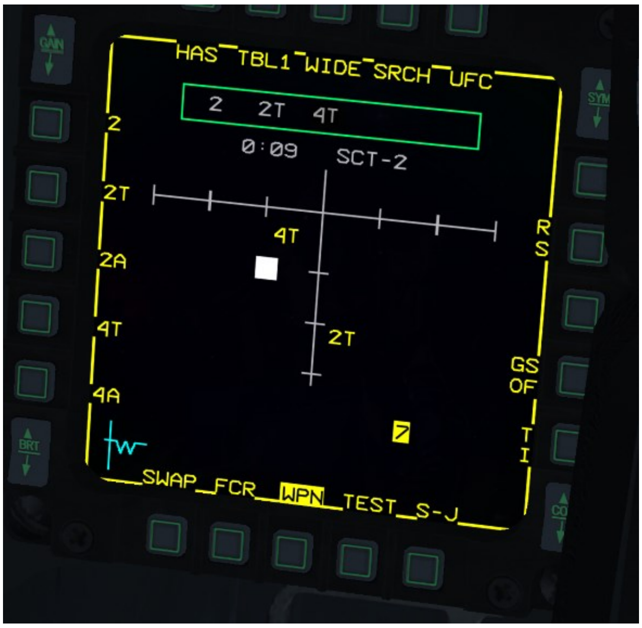
The SA-2 site is now harmless and its threat ring can be removed from the HSD with a TMS down on its PPT.

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

HAS mode

HAS mode is the second mode that is available to F-16s which have no HTS pod loaded. Like in POS the HARM missile is the sensor and provides data for the WPN page.

HAS mode is selected from the WPN page by pressing OSB 1 and selecting HAS (OSB 19) on the menu, or as mentioned above with the CURSOR ENABLE button from the POS WPN page when it is SOI.

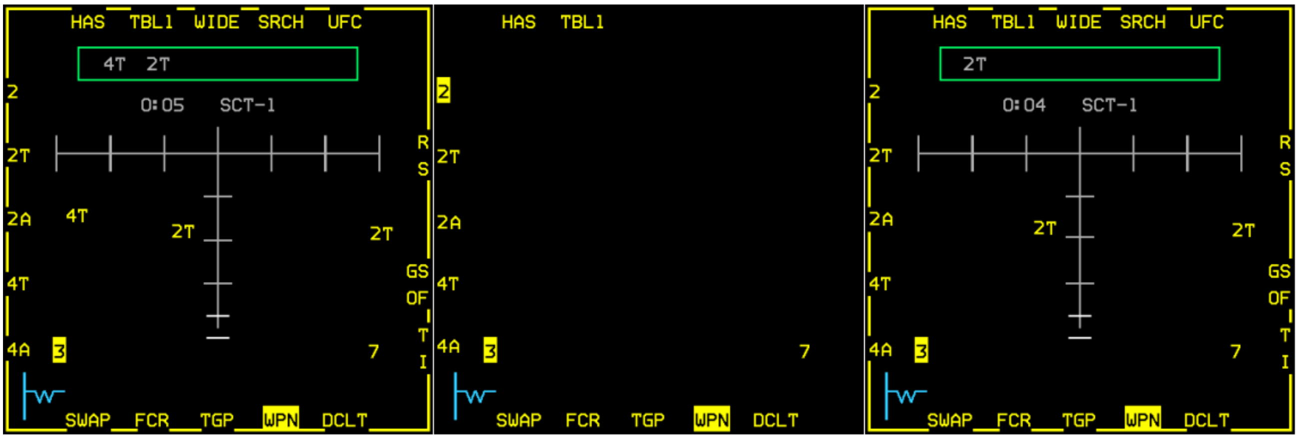


The WPN page displays the Aircraft Launcher Interface Computer (ALIC) which is the HARM WIDE field of view (ahead and down by default). Up to 10 emitting radars from the selected threat table will be visible as symbols within the ALIC area.

Like POS mode threat types must be preselected (DTC or DED) through one of the 4 available tables, which can be toggled with OSB 2 or TMS left. 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 Detected Threat Status Box (DTSB - green rectangle on the top of the WPN page) lists detected threats.

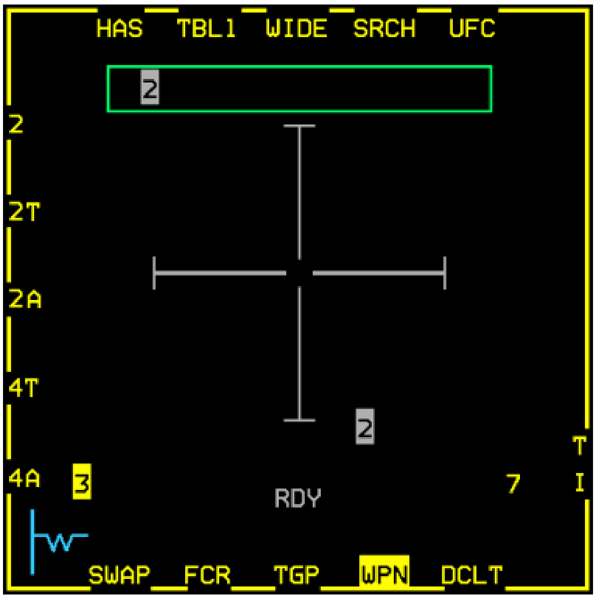
OSB 3 allows you to narrow the missile field of view. When OSB 3 is depressed CENTER will replace the WIDE mnemonic and the missile's FOV is halved. A further OSB 3 press switches the missile 's FOV to the left (LT) and another OSB 3 press shifts the missile's FOV to the right (RT). When changing FOV, the HAS display resets. Any previously displayed threats disappear until they are detected again. A further OSB 3 press resumes WIDE FOV. Hands on FOV switching can be made with the pinky switch when the HAS is SOI.

OSB 4 labelled SRCH brings up the search filter page. It allows removal of certain threat types from the table. It is useful when there are more than 10 threats emitting within the same table. As the ALIC is only able to display a maximum of 10 threats we need to delete some threat types to ensure we see all threats from the relevant types. Depressing OSB 4 displays a menu page with the threat types corresponding to the selected table. They are all highlighted meaning they are all active. To deactivate a threat type simply depress the relevant OSBs. In this case we will deactivate Pat Hand (4T) and the Long Track (4A) from the detection pattern. It can be done to other tables as well by first selecting them with the OSB 2 TBL button. Once selection is complete depress OSB 1 (HAS) to return to the HAS page. The SA-4 is now absent from the detection pattern of the ALIC. The SA-4 is still a threat to us in this case, but it is no longer visible in the HAS WPN page.



You should be south of the 2nd SA-2 and outside of its threat ring. Since HAS requires an emitter to be active before handoff, we will need to wild weasel this threat to reveal its location. Ready your jet and take a course inbound to PPT 56. You will not have much time between the detection and a SAM launch, so read the following instructions before getting too close. You can pause the mission as needed.

Threats must be handed off to the missile before firing. The WPN page must be SOI, so the cursors can be moved to the selected threat. Handoff is initiated with TMS up. When a threat is handed off the display will change to the missile boresight view. Only the handoff threat is now visible in the display, but the DTSB still shows all the emitting threats. Handoff can take up to 5 seconds. When the threat is correctly handed off RDY appears above OSB 13. If a missile is fired before handoff is complete it will miss.



In this case we handed off the SA-2 to the missile. The handoff is complete as RDY is displayed. Although not visible on the MFD, the SA-4 is still emitting, but we will address that later.

HAS mode does not provide HUD in-range cues as the missile is unable to compute range to the radar. We know that the HARM missile has a range of 60-65Nm in BMS so range must be deduced from the HSD and PPT threat rings.

As we have only one missile left we will lose POS/HAS symbology once we fire but we still want to play bait so that the Fan Song keeps radiating.

Both SA-2s should now be terminated and you're out of missiles. The SA-4 is still there and you as a student still need to learn firing AGM-88 in HAD mode using the HTS pod. You may RTB and restart this training mission from scratch to learn the more complex HAD system.

12.2 Second mission run: HTS & HAD mode

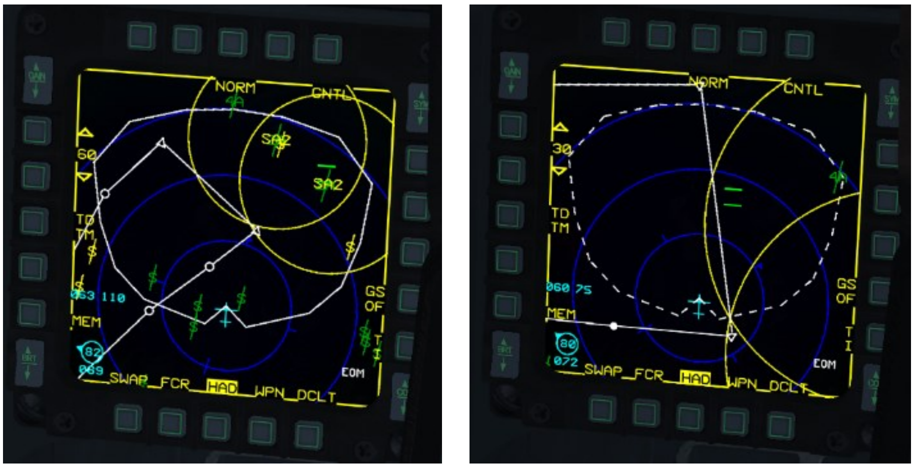
HAD mode is only accessible when the aircraft carries a HTS pod on the left chin pylon. The pod needs to be powered with the LEFT HDPT power switch on the SNSR panel. If the hard point has no power the HAD page will display HTS OFF.

The HAD page is accessible from the MFD menu via OSB 2. It can then be displayed in any master mode, but A-G master mode must be selected to be able to fire the AGM-88.

HAD page mechanization is very similar to the HSD but can also display radars in different colors according to their status.

HAD is forward looking only (about 120-180° forward sector).

HAD range can be changed with OSB 19 & 20 or with cursor bumping, as you would do with the HSD. FOV can be changed from NORM to EXP1 and EXP2 with OSB 3.



The HARM WEZ footprint (in white), which depends on the launch aircraft's speed and altitude is also displayed on the HAD page. As you can see from the left side of the picture it is just short of 60 Nm in the forward quarter at our current attitude.

If HARM WEZ is greater than the HAD range being displayed, the footprint will be dashed, indicating that all visible threats are in range. This can be seen on the right part of the picture set to 30 Nm. The white lines representing the footprint is dashed indicating it is greater than the current MFD range.

The WEZ is dynamic and will react to speed and altitude changes. Any emitter within the missile footprint is nominally in range.

The INS flight plan is displayed in white. Fortunately, the HSD PPT and their threat rings are now displayed on the HAD page. Toggling between the HAD and the HSD pages is no longer necessary to maintain SA.

The displayed symbols change color according to their emitting state:

- GREEN:
    1. Radar (previously detected by sensors or intel) in HTS pod FOV but currently not radiating, or
    2. Radar outside HTS pod field of view and status cannot be determined.
- YELLOW: Radar is emitting.

On this second run of the training mission, the SA-2 will be ignored, try to remain outside their WEZ and upon entering the mission, steer to steerpoint #6. Setup your jet 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. Select the HAD page. We will concentrate on the mobile (this is not visible on the UI map) SA-4 last seen Northwest of PPT56. We will have to find it, disable the Long Track search radar, and then engage the Pat Hand fire control radar.

The Pat Hand is the critical asset to destroy to render the SAM ineffective. A search radar like the Long Track cannot guide missiles on its own. The advantage of first destroying the search radar is that the Fire Control Radar will then have to fulfill both the search and the fire control role. The overall range of the SAM system will be decreased but the Fire Control Radar will come online sooner and stay online longer, allowing better targeting and a higher probability of kill.

If missile number is not a factor, target both the Search and the Fire Control Radars. If on the other hand you're short of missiles, you may try to target only the FCR but be aware it is much harder and yields lower chance of success. In this training scenario the SA-4 battalion poses a threat to follow-on missions and must be eliminated completely. We will thus target both the search and fire control radars.

The first indication of the SA-4 threat will be an "L" in the RWR. Early warning radars will announce the battalion’s bearing as it scans for aircraft. Please note, you can use this to build SA on pop-up threats that present a danger to your mission. After a while, the HAD will show a “4A” as well.

When we put the cursor over it, we get a line of information in the top of the HAD display indicating from left to right:

- The bearing of the contact
- The major axis tolerances distance
- The minor axis tolerances distance
  (both major and minor axis referring to both axis of an ellipse (see Dash-34, chapter 4.2.5.1.8))
- The confidence level starting from PGM5 (low confidence) and progressing to PGM1 (high confidence) as the system is able to triangulate the accurate position of the emitter. You will note the tolerances in the major and minor axis becoming smaller as the PGM status increases to PGM1.

To help the system getting higher level of confidence, the emission must be detected and computed from multiple bearing lines to allow good triangulation of the origin of the radar emission.
To do that you as pilot should beam the radar which not only allows good triangulation but also should keep you out of its engagement range albeit you do not have threat circles for mobile SAMs.

Thundering on straight to the radar will not help the system to triangulate the actual position of the radar source and will definitely pose a threat to your safety, so you need to employ wild weasel tactics and beam the radars.

PGM5

PGM3

PGM2

In the PGM5 picture only search radars (Longtrack) were emitting. After some time and beaming the area, the FCR (Pat Hand) came up with the “4T” symbology. Because the fire control radar is always the main priority in SEAD/DEAD missions, we will attack it and try to get a lock/handoff on the Pat Hand.

PGM1

PGM1 (Lock)

PGM1 (Handoff)

Note that we have switched to "EXP1" FOV to get a better picture of the area and be able to the select the correct TGT. Once we have the PGM1 resolution, it is time to engage in ideal conditions.
Press TMS up to lock and start the handoff of the target to the AGM-88. We will get TOF and impact time displayed on the bottom right corner of the HAD page, just like in POS EOM.
When you designate with TMS up, a white box surrounds the target. Once handoff is complete that box is filled with a pale magenta color (please note it does not anymore identify the radar as tracking).

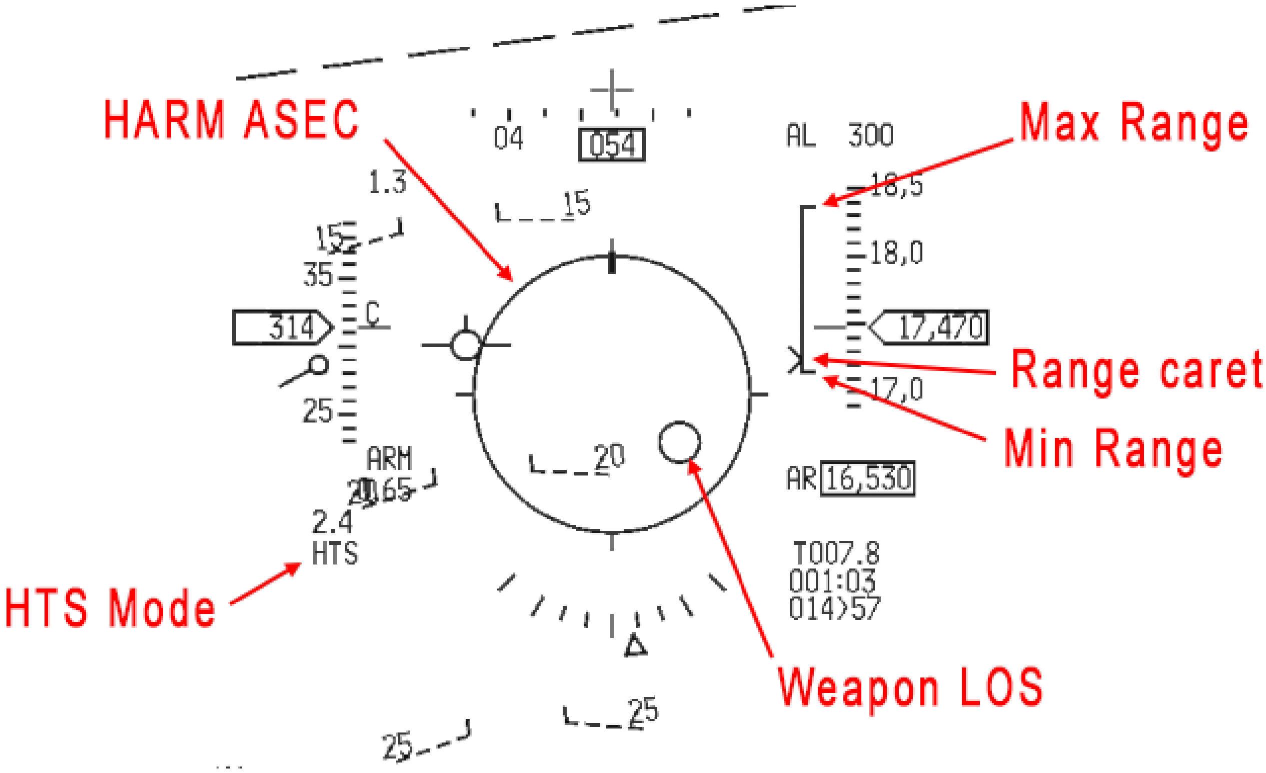
A long TMS up will change modes for this missile. If we wanted to fire in PB, the display will show the missile's FOV to use as a guide for a pre-launch turn (left side of image below).

As expected, in RUK there is no TOF information (right side of image below).

Please note that HAD SPI capabilities had been improved since 4.36. It is possible now to lock target a SPI in the HAD. This way you can indicate the target in the A-G radar and/or TGP to verify and identify targets more precise.

The search radar of the SA-4 (Long Track) has a large rotating antenna on top of a tracked vehicle (center picture).
The Pat Hand FCR has a solid antenna mounted on a tracked vehicle as well (left picture).
The SAM site has 3 launchers with 2 missiles each (right picture).

We designate the Pat Hand on the HAD page and we will confirm its destruction using the TGP. Once designated, the HUD provides in-range and targeting cues: the SA-4 was well within the missile footprint displayed in the HAD, so the HUD flashes the ASEC to confirm the target is in range. Fire the missile by depressing the pickle button.
As always with missiles you must keep the pickle depressed for a few seconds for the missile to release.



If the HARM hits the right target, the Pat Hand ('4T') hopefully will disappear in the HAD (getting green or disappear completely). You can monitor the time to impact in the HAD.

The Pat Hand is quickly destroyed. Good job!

12.3 SEAD / DEAD in BMS

In real life there is a clear distinction between SEAD (Suppression of Enemy Air Defenses) and DEAD (Destruction of Enemy Air Defenses).

This distinction has not always been so easy to make in BMS.

In 4.32 mission types were either SEAD Escort or SEAD Strike.

In 4.33 these mission types were replaced with SEAD and DEAD, though essentially remained the same.
In real life, good SAM operators are smart and cautious if they value their life and their mission. Until BMS 4.33 SAMs were not particularly (artificially) intelligent and didn't have the same priorities. They hardly ever switched their radars off, providing easy targets for anyone carrying anti-radiation missiles. As a result, most HARM shots were kills and SEAD was almost impossible to carry out, as it usually turned into DEAD after the first AGM-88 was fired.

SAM operators became much smarter since 4.35, playing a much better game of cat-and-mouse. They had dedicated EWRs (Early Warning or Search radars) and FCRs (Fire Control Radars). Both were completely separate entities, so destroying a Search radar would not prevent a SAM system from engaging you, but it might force the Fire Control Radar to radiate longer, allowing you to target it next. Destroying the FCR would prevent the SAM site from firing a missile, but its Search radar would remain active and could still radiate, cluttering up your RWR.
The missile INS drift was also very large inducing a lot of HARM misses whereas the location of the steerpoint was very accurate.
SEAD finally started to make sense in certain scenarios and users had to upgrade their tactics to suppress or destroy SAM sites especially at higher skill levels, but it was still incomplete.

Since 4.35 more HARM shots will miss when the target radar they were homing on suddenly goes silent.
Proper triangulation is now required to build the confidence level before being able to engage successfully a SAM radar. More study is necessary for options to "fine-tune" your approach to SAM killing.
Remember to refer to the AGM-88 chapter in the Dash-34, chapter 4.2.4.1.
Also, BMS allows some SAMs to defend themselves, adding the capability to shoot down an incoming missile.

Since 4.36, HARM and HTS avionics have again improved tremendously to increase the efficacy for SEAD/DEAD missions.

SEAD becomes very unpredictable, and you will need to once again upgrade your tactics to suppress or destroy SAM sites.
Get ready to play bait by tempting the radar to stay on your aircraft while your wingman attempts to kill the SAM radar. Do not be surprised when that tactic is not always successful. SEAD / DEAD work continues to get more interesting and rewarding in 4.37.

You will not always win and the SAM operators have the advantage.

If you want to execute a more advanced SEAD / DEAD training, refer to chapter 28.

MISSION 13: AGM-65 MAVERICKS - Basic *(TR_BMS_13_Maverick_Basic)*

LOCATION: On the ground at Osan Airbase.

CONDITION: F-16 block 50 – Single ship - Callsign Rocket 2.
GW: 40706. 6 AGM-65D – 2 wing bags – 1 ECM pod and Targeting pod + standard Air to air load
Max G: 6.5/-2.0 Max speed: 600 kts / 0.95 Mach.

LEARNING OBJECTIVES: Train maverick procedure in a light-threat scenario, clear weather and optimal conditions.
Your target is an artillery battalion (BM-30) at the Nojeon HART site close to the DMZ.
Target is STPT #4, STPT #3 is Seoul airbase where you can boresight your mavericks.

WEATHER: RKSO INFO: B 0725Z ILS RWY27 TL140 300/15KT 9999 FEW050 28/18 Q1013 NOSIG

13.1 Maverick mechanics

There are five types of Mavericks in the BMS database. The older A and B models (white) and the more advanced D (green), G (grey) and L (Laser) models. We will concentrate on D and G models. The earlier models are only carried on older blocks and the D/G models are standard on all modern F-16 blocks in BMS.

The lighter AGM-65D, with a range of 15 Nm is optimized for use against armored vehicles and small hard targets. The heavier AGM-65G and L models are optimized for use against larger target structures and have a range of 20 Nm. 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. The G and L models are only carried on the single missile LAU-117 pylons. The triple missile launcher was never used operationally on the F-16 and has only been seen in flight on weapon test airframes.

Mavericks are fire and forget missiles. They will guide themselves to correctly tracked targets. Mavericks require a significant workload from the pilot to attain a successful track prior to launch.

Both missile type (D+G) have many operational limitations. You must keep these limitations in mind when you carry the missiles, as the potential problems may really happen now in BMS.

1. **Time limitation**
   Missiles need a 3-minute gyro spin up time before use.
   The maximum power on time is 60 minutes in power-on mode with video off. The maximum full power mode (when video is visible) is 30 minutes. These times are cumulative over the mission timeframe.

   Therefore, it is strongly advised to power off the missiles whenever you don't need them and ensure that you use the video only when you need it. Don't fly around with the WPN page showing missile video (or you'll not be able to use them when you need to, and it will hurt your FPS too).

   Automatic POWER ON is accessible by pressing CTNL on the WPN page. This allows automatic powering of the missiles when you pass North/East/South/West of a selected steerpoint.

2. **Ground use**
   Maverick video is inhibited when the MASTER ARM switch is OFF. On the ground, video is inhibited unless the GROUND JETTISON switch is placed in the ENABLE position. Ground boresight is not possible in BMS due to the inability to move the cursor a bit above the horizon.

3. **Launch restrictions**
   The AGM-65 missile is always hot. Even if out of range or outside parameters pressing the pickle button will fire the missile. A Maverick launched outside these limits will miss:
   - Maximum launch speed: Mach 1.2
   - Maximum gimbal offset angle: max 10° azimuth and 15° elevation (keyhole)
   - Maximum dive angle: 60°
   - Maximum bank angle: 30°
   - Maximum roll rate: 30°/s
   - Maximum load factor: 3G
   - Minimum load factor: 0.5G
4. **Structural restrictions**
   Stores restrictions are listed as usual in the arming screen. Mavericks are cleared for 7G / -2G and a max speed of 600 kts or Mach 0.95. Over-speeding/stressing the jet may damage the missiles or the pylon and cause a hung missile upon firing. It's important to realize that you may not detect the problem until you try to fire the weapon. To avoid problems, fly within the store restriction envelope. The condition may be visible on the station number when a missile is selected, or you try to fire it.
   If you see F, D or H replacing the station number the missile may have Failed, be Damaged or Hung.

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

- **PRE** for pre-planned delivery (CCRP type). Initial target selection is made with other onboard sensors, such as the FCR or TGP. The LOS of the missiles needs to be boresighted to the LOS of the sensors.
- **VIS** for visual mode (DTOS type). Target selection is made with the TD box with the HUD as SOI.
  VIS mode can be boresighted as well.
- **BORE** for boresight. Allows firing on targets of opportunity. Target selection is made by placing the target within the HUD boresight cross and using the WPN page to refine cursor position.

The selected mode can be changed with OSB 2 on the WPN page or with the CURSOR ENABLE button on the throttle when the WPN page is SOI. The mode is also displayed in the HUD.

13.2 Boresight or not boresight

Boresight is often misunderstood. Boresighting the maverick is the action to align the missile rail LOS with the sensor LOS. Note I said rail and not weapon. When rails are mounted on the aircraft there is always a small degree of angular offset and that tiny angular issue may create LOS differences when you look at targets 10 Nm in front of you with the TGP or the missile head seeker (WPN)

The boresight is the process to align the LOS (Line of Sight) of the missile rail with the TGP.

First thing to note, since we are boresighting the rail, it has to be done for each missile rail. So, if you have 2 mavericks on LAU-117 on station 3 and 7, you must boresight the 2 stations, hence the 2 missiles in sequence.
On the other hand, if you have 6 mavericks on 2 LAU-88 rails, you do not have to boresight all 6 missiles but you nevertheless have to boresight one missile on station 3 and another on station 7 therefore doing the process for both LAU-88 rails.

The second thing to notice is that boresighting is not mandatory.
If you plan on using the mavericks only from the WPN page with no other onboard sensor, you might simply overlook the boresighting process and select the target from the WPN page and fire your missile.
Boresighting will help when you search for targets with the TGP because it will ensure that once you handoff the target to the weapon page, the target matches from one sensor to another therefore saving you the need to reacquire the target in the WPN page. That is counterproductive since you already acquired the target on TGP.

So boresighting the maverick is only necessary when you want to be quick and efficient attacking targets using the TGP.

13.3 The Mission

The weather is clear and you pre-flight your F-16 block 50 at Osan airbase. Your jet is loaded with 6x AGM-65D on stations 3 and 7 and your target is an artillery battalion at the DMZ. You have the TGP pod and boresight practice will be performed at steerpoint #3 on the Seoul airbase building structure.

Ramp start is performed as usual, care must be taken to setup the TGP early enough and to power the mavericks early enough so they are ready in time when we need to boresight them.
Remember the mavericks have a 60-minute battery life with no video and only 30 minutes with video. It is cumulative and you can power the missile off whenever you do not need them to extend their battery life.
This training mission is relatively short so you could get away by leaving the maverick powered with no videos ON but remember that for longer mission, you must manage their battery life.
The next training mission will show you how to automatically turn mavericks power ON at specific point in your flight plan.

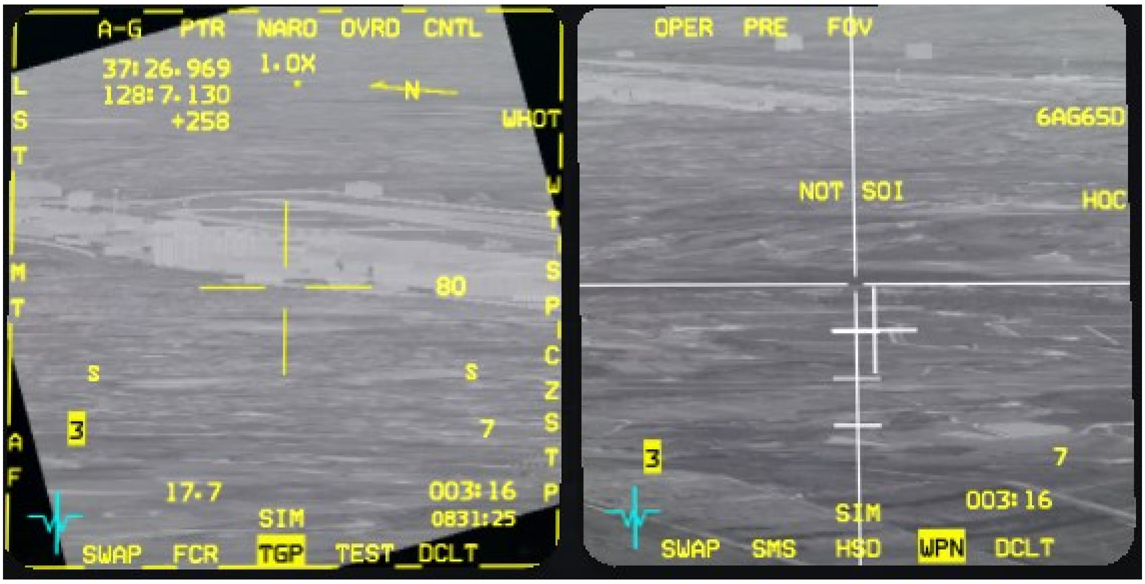
Once in flight climb to a medium altitude of about 6000 feet on your way to steerpoint #3 which is Seoul airbase. Set up your jet for the boresight process:

- Air to Ground master mode & master arm SIM
- FCR/TGP on the left MFD and WPN/HSD on the right
- Mavericks have been powered before and are ready.
- You may engage the Autopilot in steerpoint mode to drive the plane as you are heads down with the avionics. Bear in mind that the faster you fly, the less time you have to boresight.

Initially, mavericks will not display video on the WPN page unless the master arm is in SIM or ARM and the missile has been uncaged. Uncage is done with the throttle UNCAGE button.
If your WPN page remains blank, check master arm and/or uncage your missile seeker head.

You should be at altitude and ready 20 Nm from Seoul airbase with plenty of time to perform the boresighting procedure.
Steerpoint #3 is situated on the airbase so if you have cancelled any possible cursor drift, you should start to see the outlines of Seoul airbase on your TGP.
Because of the LOS difference between the TGP and the current pylon, it is best to find an isolated building to ensure you will select the same target with both sensors. Some buildings can be point-tracked by the TGP but cannot be locked by the AGM-65, select a different building if you have difficulties.
The chosen building for boresight is identified by a red arrow on the TGP on the second picture

You will notice the difference of LOS from station #3 to station #7.
Station #3 is looking below the airbase (first picture) and station #7 is looking above the airbase, whereas the TGP on the left side is always looking at the airbase with either station selected.



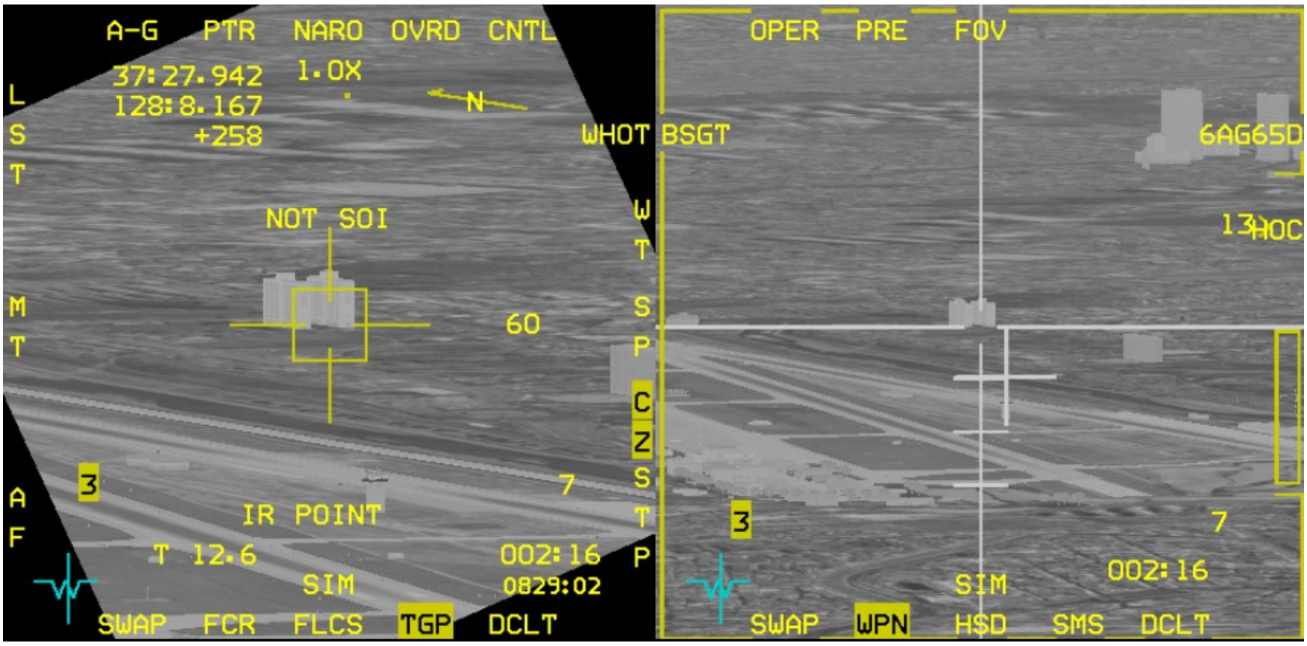
The chosen building is a bit brighter than the others so it should be easy to find on the WPN page.

Let's boresight station #3 first. Step the weapon till station #3 is highlighted on the TGP.

With the TGP Sensor of interest, move the crosshair to the chosen building and attempt to point track with TMS up. The WPN page should move a bit and state that handoff is in progress.

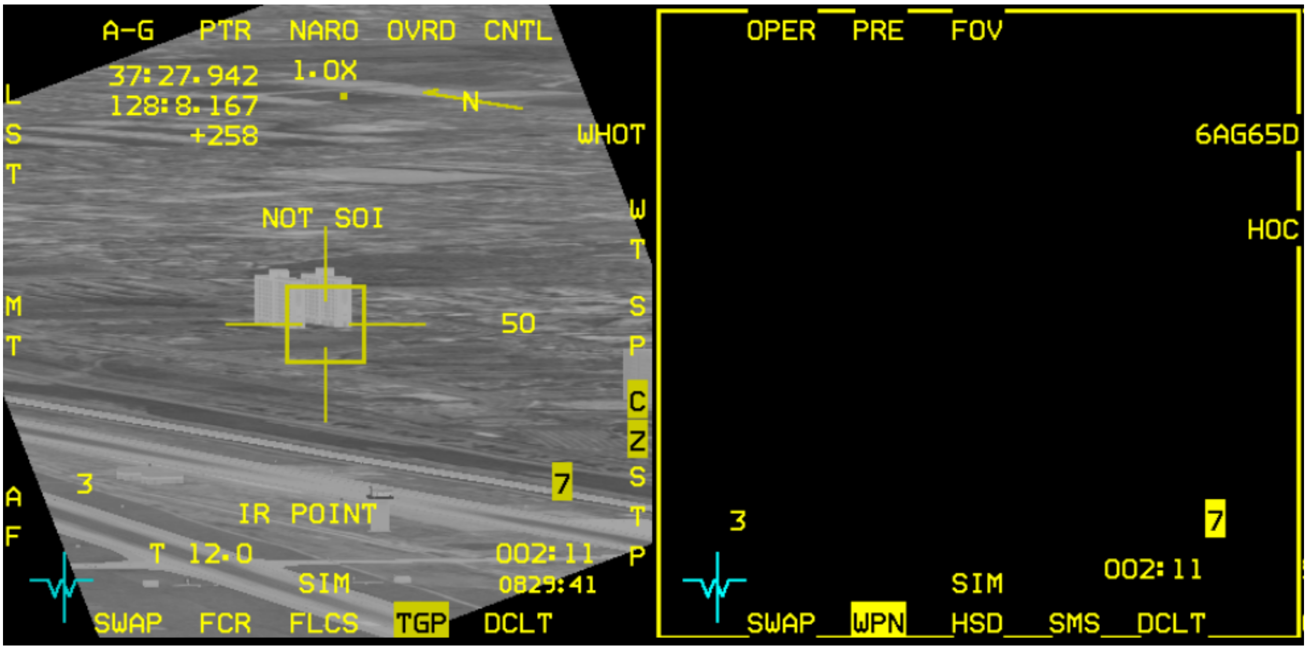
The WPN page is not able to terminate the handoff process because of the LOS angular error. It has to be done manually and that is the boresighting procedure.
Transfer SOI to the WPN page and move the WPN crosshair to the same building acquired with the TGP. As you can see the zoom levels and the overall pictures are different from the TGP to the WPN page. That is why it is so important to select your boresight target smartly to ensure you can find your way back to it with the WPN page.

Once the crosshairs are placed correctly, TMS up to designate and the BSGT mnemonic will appear at OSB#20. You must depress it and it will momentarily highlight.

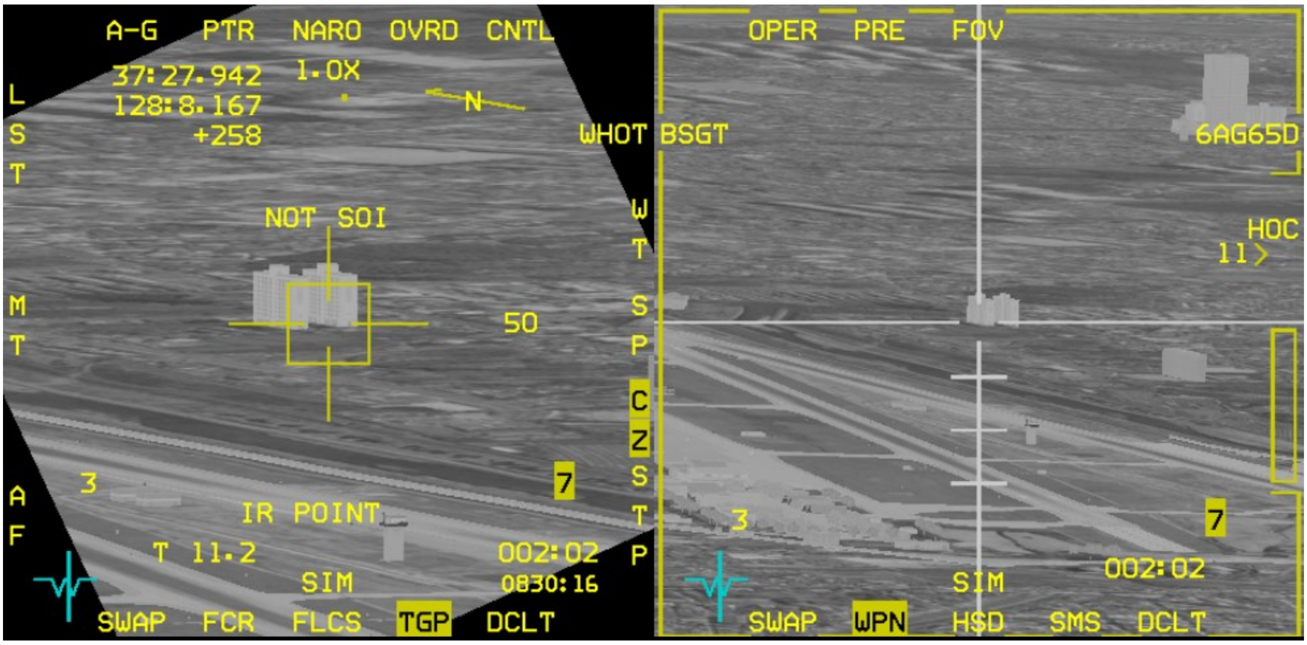


All missiles on the LAU-88 Station #3 are now perfectly aligned with the TGP LOS, we need to do the same for station #7. Step the weapon and station #7 should highlight instead of station #3.

Note that doing so the WPN page will blank because that missile has not been uncaged yet. So, in order to display video, uncage the missile seeker head first.



Note also you do not need to change the TGP target, you are still on the initial building in point track and the LOS remains valid. We will just zero the angular LOS for that station.
With the missile uncaged, video is displayed and SOI in transferred again from the TGP to the WPN page, the target is placed under the crosshairs and designated, the BSGT mnemonic appears and OSB #20 is depressed to boresight. It highlights momentarily and boresight is now complete for station #7



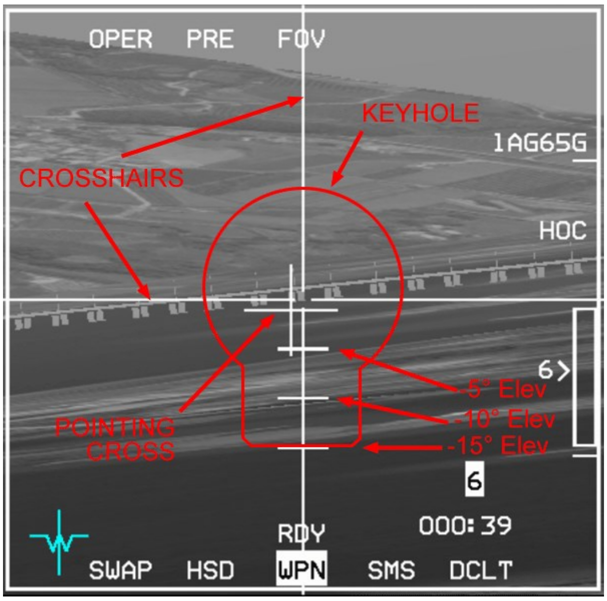
From this point, both your station #3 and #7 are boresighted but you want to confirm it before entering in real battle. The quickest way to check is to switch to AA master mode by selecting dogfight or MRM overwrite and re-enter AG master mode.

Select another target with the TGP and point track it. Do not transfer SOI to the weapon page, from now on it is not necessary anymore. Cross check the WPN page and confirm that the crosshairs is exactly on the same target and that there is a "C" above the active station (in this case station #3).
That “C” means the station is boresight **C**omplete. An “I” would mean boresight **I**ncomplete; a “S” means the station is **S**laved (not locked)

In the above scenario, the missile is just in range (look on the right side of the WPN page where the range scale is displayed and the 8 indicates a range of 8 NM. The maverick cross is steady and in the keyhole. The shot is valid and if the missile were fired, the auxiliary control tower would be hit.

The keyhole is a concept to ensure that the missile has the target within its gimbal limits to ensure a valid shot. As pilot you do not see the missile gimbal limits but you do see the maverick pointing cross positioned around the center of the WPN page.

The keyhole is an imaginary shape around the center of the WPN page displayed in red in the picture below. The target is within the missile gimbal limit when the maverick pointing cross is within the keyhole:



You are now ready to ingress your target at steerpoint #4.
Before doing anything else, you must cancel all cursor slew. Boresighting induced cursor movement and you should perform a Cursor zero (CZ) by depressing the OSB #9.

Press TMS down to cancel all lock, go Wide field of view on your sensor and press OSB#9 labelled CZ which is highlighted. Once the mnemonic is not highlighted anymore, the cursor slew is zeroed.

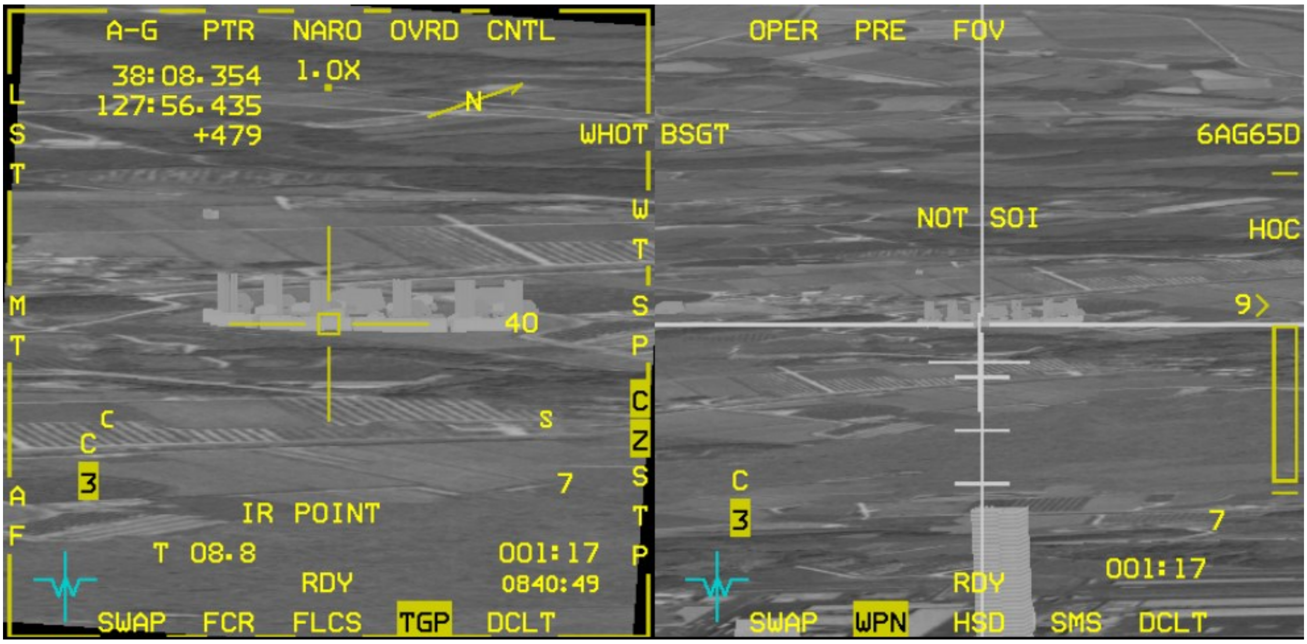
Go back to NAV master mode and select steerpoint #4 and fence in. Make sure you switch the master mode to ARM as it is currently in SIM. It might also be safer to power mavericks down from the SMS page to conserve their battery life. Do remember to turn them back ON just before getting close to your target.

Your target is an artillery battalion located at a HART site just south of the DMZ. the battalion is composed 6 BM-30 Smerch and their support vehicles. BM-30 are MAZ chassis with 12 vertical 300mm rocket launchers. They have a devastating effect on friendly troops.

Artillery battalions are usually positioned at the HART site which are reinforced positions protecting the artillery units from counter battery fire.

Enemy air defenses are very limited and you should be able to practice your mavericks firing sequence with no serious hassle from AAA unless you become very complacent.
You have 6 mavericks and we will use the first two in PRE mode using the TGP to acquire the BM-30 rocket launchers.

Stay under the clouds between 4000 and 6000 feet and as you ingress to the target, try to find the launchers with the TGP which shouldn't be very complicated since these are all packed inside a single HART site. It looks like their commander was never briefed about dispersing assets to optimize survivability as a unit.
You probably will not need 6 missiles to destroy this battalion.



Locking the target with the TGP will immediately handoff the target to the weapon. Target is matching and the C confirms a completed handoff on the selected station #3. The missile is not yet in range but will be shortly.

Once in range you can fire the missile. There is no need to transfer SOI to the WPN page or lock the WPN page. With the first missile flying, cancel the TGP lock, reacquire another target, TMS up to lock, cross check the WPN page for in range cue and steady cross and pickle again.

The Maverick is not a very fast missile. If you continue flying towards the target you may reach it before your weapon, so turn away from your target to stay out of range of the SHORADs and recycle to a safe distance for the next pass.

The next two missiles will be used in BORE mode.
Select the SMS page and change the AGM-65 mode from PRE to BORE with OSB#2 or with the cursor enable button on your throttle.

Boresight mode is particularly interesting for targets of opportunity as it will not change the FCR or TGP SPI.
The missile looks straight ahead and a boresight cross is displayed on the HUD.
The targeting procedure is quite simple: Overlay the missile boresight cross in the HUD with the target and TMS up to lock it. Eventually you can finetune the targeting on the WPN page.
As usual, ensure you have a valid range and a non-flashing pointing cross before firing to ensure a valid hit.

Train the boresight procedure with the next 2 mavericks.

The final two mavericks can be used in VIS mode.
Again, switch to VIS mode either through the SMS page or using the HOTAS cursor enable button.
VIS mode defaults to HUD being SOI. The TD box can be moved within the HUD FOV with the cursors and once ground stabilized, SOI will be transferred first to the TGP if active or WPN, if the TGP is not active.
The procedure is from this point basically the same as with PRE mode. If the TGP was active, going point track will handoff the target to the WPN page and the behavior will depend on whether the pylons were boresighted or not.

If the TGP was not active, SOI will be transferred straight to the WPN and it's basically the same method as the BORE mode.

Upon these two final missiles launches, egress back to Osan. If you were too complacent and got hit by SHORAD, remember you have Seoul airbase not too far away for an emergency landing. Battle damage and failure troubleshooting is becoming better with every new version of BMS and light AAA can ruin your mission and force you to RTB managing all sorts of emergencies.

Let’s discuss again 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.

All the launch restrictions documented earlier in the previous 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 centered 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.

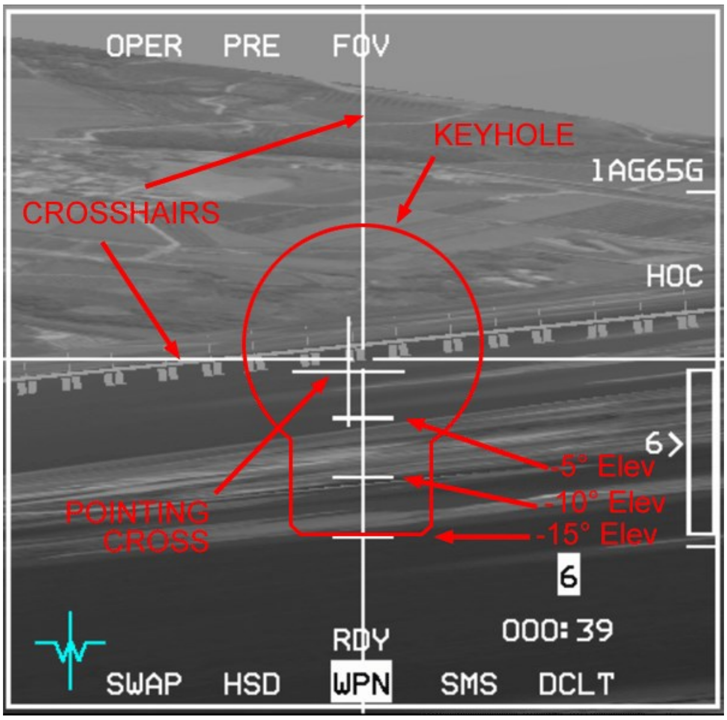
If the pointing cross is outside the keyhole you must turn your aircraft more towards the target and designate your target only when the pointing cross is within the keyhole. On the same note if you are outside the launch limits explained above at the time of lock up then the pointing cross will also 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" and "Crosshairs" 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 color. 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.



MISSION 14: AGM-65 MAVERICKS – Advanced *(TR_BMS_14_Maverick_Advanced)*

NOTE: You may want to disable trees by moving the tree density slider full left on the SETUP > GRAPHICS page.
This training mission is very challenging on purpose. Do not expect to achieve a 100% success rate from the first try.
It is assumed that the content of training mission 13 is mastered.

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

CONDITION: KF-16 block 52 – Flight of 2 - Callsign Boxer 2.
GW: 38371. 1 AGM-65G – 1 AGM-65L – 2 370GL tanks, Navigation and Targeting pods.
Max G: 6.5/-2.0 Max speed: 600 kts / 0.95 Mach.
Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.

LEARNING OBJECTIVES: Destroy 1 ZSU-23 at STPT 7 and Tangch'on bridge at STPT 11.

WEATHER: RKND INFO: F 012225Z ILS RWY26 TL140 360/17KT 9999 RA OVC 010 22/17 Q994 NOSIG

This training mission's goal is to locate and destroy the air defense vehicle at steerpoint 6. The target is a HQ battalion that will be attacked by A-10s later in the day. We need to locate one ZSU-23 and destroy it with the AGM-65L. The battalion is at the extreme range of an SA-10 SAM site, 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 one span with your AGM-65G.

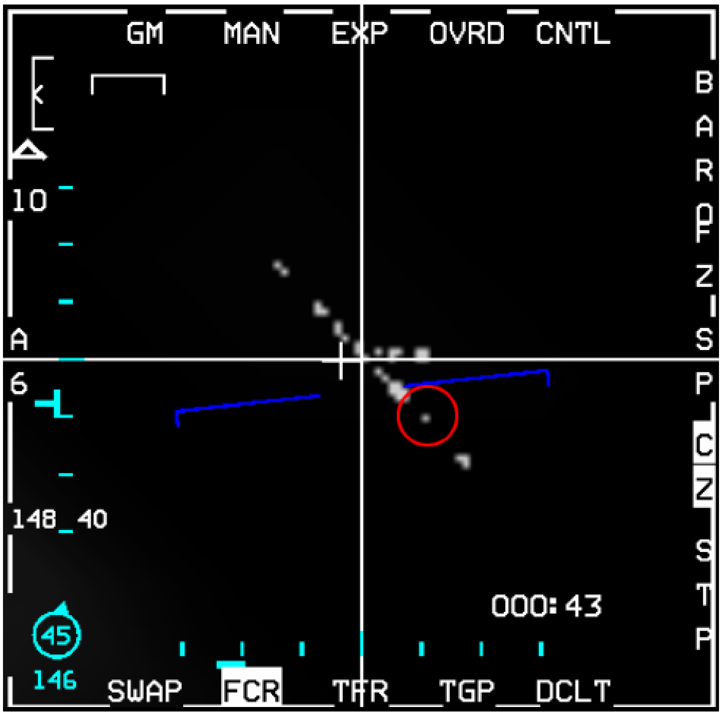
The weather is not going to make this mission easy. Visibility is reduced and there is extensive cloud cover. The ingress will be made at low level through the valleys, where visibility should be acceptable. Both target areas are in mountainous terrain and we will ingress using the terrain following radar in autopilot blended mode. Trust your TFR and you will be able to let the system fly the airplane while you concentrate on firing the Mavericks.

The real challenge of this training mission will be to quickly locate, target and destroy the ZSU-23 located near steerpoint 7. The target is in high mountainous terrain (around 5700 feet elevation) and the low ceiling and visibility will greatly reduce your search capability and ability to pace your attack.

Intel reports suggest that the AAA is located very close to the village on the eastern side. It is valuable information, as it should decrease your search time.

He may be moving, but at least you know you will have to search right and close to the buildings for the air defense vehicle.

The picture below shows the A-G FCR scan of the target area. The ZSU is circled in red.



Ceiling and clouds will present some difficulties. 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 ZSU.

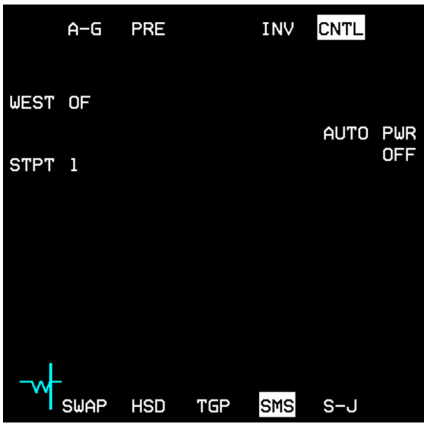
Staying at 500 feet SCP on the TFR may not provide enough time for targeting. 1000 ft SCP might be preferable, but if you fly above mountain peaks rather than staying in the valleys the TFR might fly into clouds, spoiling the attack run. You will have to override the autopilot to stay in valleys under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

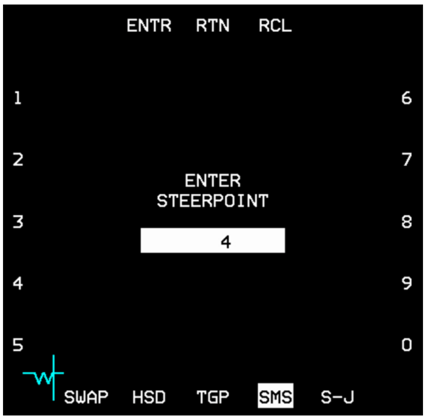
To maximize chances of success you must ensure quick targeting and firing. Weapon LOS will have to be boresighted to the TGP beforehand.

The slightest delay will force a miss. Nobody ever said the training missions had to be easy. Remember the fighter pilot saying: “Train how you fight”.

Entering the cockpit in flight over the Eastern Sea we need to power on the Mavericks immediately so their gyros can spin up. Do your fence checks, select A-G master mode and access the SMS page. Press OSB 7 to power on the AGM-65G. After boresighting the AGM-65G we will turn them off to save their battery. To avoid having to turn them back on manually we will activate AUTO POWER ON West of steerpoint 5.

Enter the CTNL page and press OSB 20 until WEST OF is displayed. Press OSB 19 to select the steerpoint. A new page opens; select STPT 5 with OSB 16, then ENTR (OSB 2) which takes you back to the CNTL page. Press AUTO PWR ON with OSB 7. Exit the CNTL page with OSB 5 and note the A mnemonic next to OSB 7, confirming that AUTO POWER ON is activated. Note: the L-model doesn’t have the AUTO POWER function and must be powered on separately.





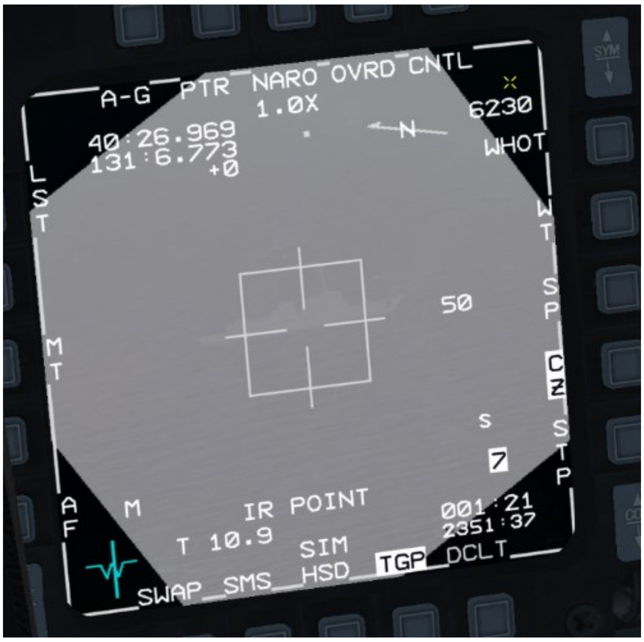
In this training scenario we plan on using the L model on the moving vehicle and the larger G model on the bridge using VIS mode.

At the very least therefore the G (not the L) model must be boresighted. There is a US destroyer near steerpoint 4 which we can use to boresight the missiles. Select AGM-65G on the SMS page (station 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-65G the WPN page will remain blank for each missile until you uncage the Maverick with the MAN RNG/UNCAGE button on your throttle.

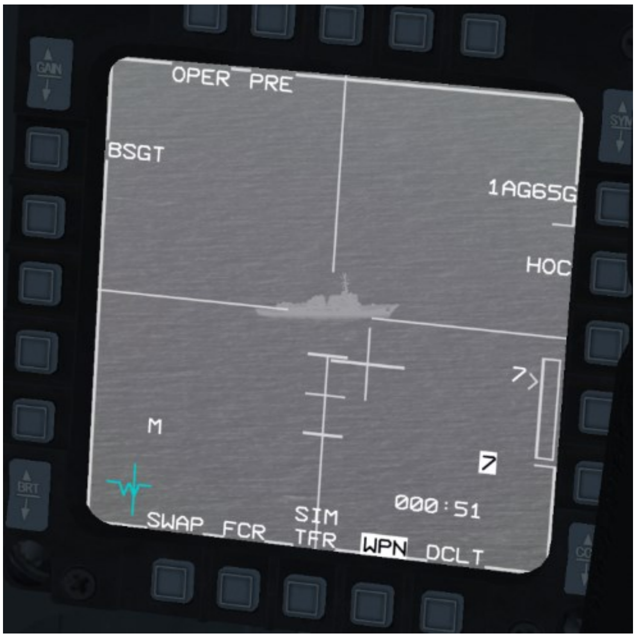
Around 10-12 Nm from the STPT you should be able to find the destroyer with the FCR in SEA mode. If you designate it, SOI will be transferred to the WPN page on the right MFD. Transfer SOI to the TGP and look for the destroyer, which should be moving on a north-easterly heading. Minimize the time between finding it on the FCR and switching to the TGP or you may lose it. If that happens, switch back to the FCR and acquire it again. There is no need to designate with the FCR; simply move your SPI with the radar cursors just in front of the destroyer's path and then switch to the TGP (SPI position is automatically shared between sensors) to pick it up visually on the TGP. Go NARO field of view to zoom in and obtain point track with TMS up.
You can also practice boresighting on one of the buildings on the coast; though if you do this remember to pick one that is separate from the others, so you can be confident you are boresighting on the correct building.

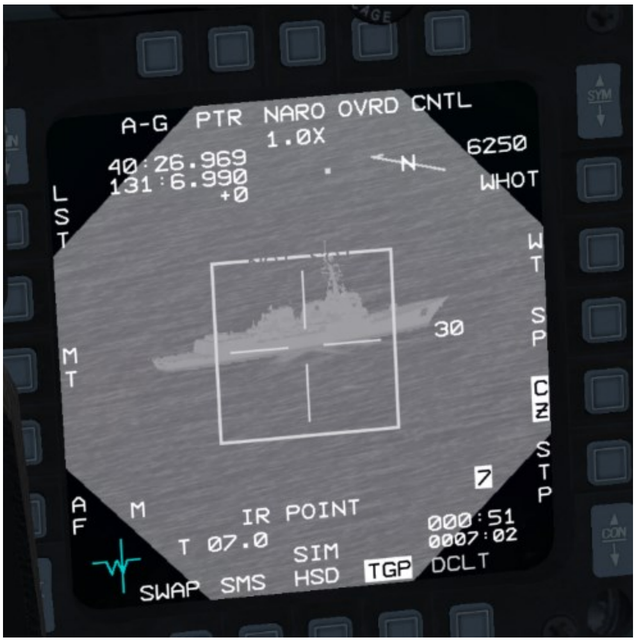
The WPN page then shows HANDOFF IN PROGRESS STATION. During handoff the TGP is trying to download the target position to the selected missile.



Ignoring the handoff in progress message for now move SOI to the WPN page, zoom in to EXP FOV with OSB 3 / pinky, then slew the cursors to the same target as the TGP. Press TMS up to track the target. The handoff in progress message does not mean the WPN page can't be used.

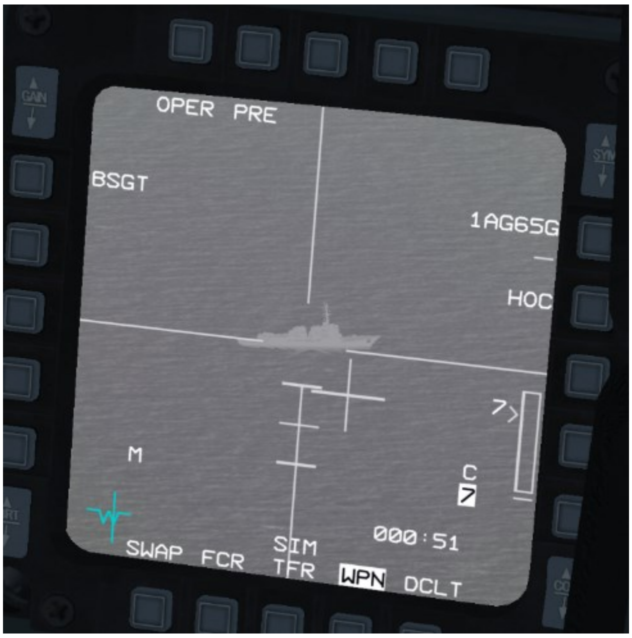
When the missile is successfully tracking the target BSGT will appear next to OSB 20. Press it to boresight the station. BSGT will momentarily highlight. Missile LOS on that stores station is now looking at the same spot as the aircraft sensors.

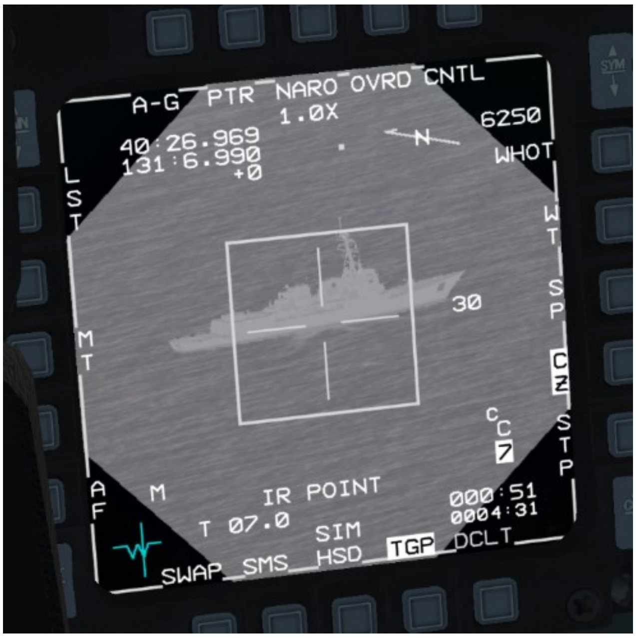




It is a good idea to handoff the TGP target to the missile again to ensure the boresight was done correctly.
The quickest way to start afresh is to cancel all locks by switching master mode. Select MRM override, then cancel it to go back to A-G mode. The TGP is SOI on the left MFD and the WPN page is on the right MFD.

Obtain POINT TRACK on the destroyer in NARO FOV. Handoff this time will be successful. The WPN page will be looking at the same spot on the destroyer as the TGP page. To confirm handoff is complete the TGP page will display a “C” above the stores station number.





You may have noticed that there are different symbols appearing over the station number on the TGP and WPN pages. These symbols give the handoff status:

- I for Incomplete handoff.
- C for Complete handoff.
- S for Slave (the missile is not tracking).
- T for Track (track mode has been commanded).

We don't *need* to boresight the AGM-65G because we will use them in VIS mode to attack the bridges, though boresighting them is a good idea if you have time, as it ensures they are looking exactly where you expect, minimizing the time you have to spend fine-tuning your aim on the WPN page after designating the target on the HUD (or FCR).

Bridges are not point-trackable in BMS, so they can't be handed off to the WPN page from the TGP anyway.

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-65G is boresighted we can power them down to conserve battery life. They will power on west of steerpoint 5. The weather isn't getting any better and we are approaching feet dry. We'll ingress in AUTO TFR set at 500 feet SCP.

Select the TFR page, set the SCP and don't forget to engage weather mode (WX) as soon as you see rain which will clutter the TFR display. Engage AUTO TFR and let the aircraft descend to its SCP. A/P STRG SEL can be blended with TFR but exit A-G master mode if you want to enable auto steerpoint as it does not work (on purpose) in A-G mode. If you choose to stay in A-G mode, you will have to change steerpoints manually.

But first let's reset SPI with the usual routine of TMS down, Wide FOV, Cursor Zero. Remember, if you don't do that the SPI offset/delta (from boresighting the Maverick) will remain active for all steerpoints, including the target, which will make finding and targeting the ZSU-23 even harder. Also change the FCR from SEA back to GM (Ground Map) mode. Once all that is done set A-LOW to 10% less than SCP.

The TFR is a huge help in these situations. It will fly the aircraft for you at low level while you concentrate on the upcoming attack. All you have to do is monitor the TFR and keep your attitude and airspeed within the TFR limits.
Do not hesitate to override the AUTO TFR with the paddle whenever you want to steer around mountain peaks.
While doing so the MAN TFR box will be displayed in the HUD, as will LIMITS if your bank angle is excessive.
Don't push the LIMITS too far and resume AUTO TFR when steering is no longer required.

After passing steerpoint 5 check on the SMS page that the G Maverick is powered back on as planned. The L-Model has to be powered on separately.
Setup your cockpit: A-G master mode, MASTER ARM to ARM, Laser ARM, TGP in A-G mode, fuel & switches checked.

Our first target is the ZSU-23. As mentioned, we will engage it with the AGM-65L.
The L model was newly introduced since BMS 4.36. In comparison to boresight/using the G model, the handling of the AGM-65L is fairly simple and similar to using LGBs.
First, we have to open the Laser page in the ICP (LIST -> 0 -> 5) and make sure the laser-code is set to 1688.
Change the A-G mode to "CMBT" and "Laser ST Time" to 40 seconds (this procedure was already described in the LGB training mission 11). Second, we have to activate the laser master mode to "Laser Arm". Third, activate the WPN page.

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 target. Increase SCP to 1000 feet and A-LOW to 900 feet. As you do, your RWR may start chirping with AAA noises.

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 target 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. This one should be easily identifiable from the rest of the trucks and BMPs in the column. Remember they are on the right (east) of the village.

Because the usage of the AGM-65L is similar to LGBs, we only need the TGP and the laser to bring the weapon to bear on its target. The AGM-65L WPN page indicates the laser status (assigned laser code, active /non-active laser) and the already discovered Maverick modes (PRE, VIS, BORE) and sub modes (AREA, BOW, WOB). BORE in this case is to change the laser code of the seeker head.
A more detailed explanation of how to do this is available in the Dash-34, chapter 4.2.3.1.10. Please note the new procedure since 4.36.1:
after the L-Maverick is aligned you have to uncage it like all other -65 models
(S symbol appears on the WPN page).

Once all systems are set, the target is found and the Maverick is in range, you can either point track (POINT) or area track (AREA). Quickly designate the ZSU on the TGP with TMS up to command point track. If not possible, keep it in area track. The missile is ready to fire if range and keyhole conditions are valid. Release the weapon (Pickle) and press the gun trigger to activate the laser immediately ("L" besides IR AREA/IR POINT flashes) till the Maverick hits the target. The big advantage of the L model is that you can use the TGP which has a greater zoom and FOV then the Maverick sensor. Another advantage is that you can concentrate only on one MFD (TGP) on the final attack phase and you don't have to take care about the WPN page (if you have a good laser solution).
The disadvantage is that if you are alone, you have to beam the target after releasing your weapon and may stay much

longer in the target area because you have to keep the laser active on the TGT till your weapon hits, especially if a target is moving.
For multi-ship flights, this can be solved through buddy lasing or using a JTAC if available. Make sure that your beaming maneuver doesn't create too much offset and risk that the TGP loses its laser track/FOV.
If you couldn't fire at the ZSU in time, break off the attack and try again if you wish, but remember the element of surprise is gone now and the AAA (and possibly MANPADS) will be waiting when you return.
Expect to be greeted with a deadly stream of tracers and shoulder launched missiles if you get too close. After analyzing what went wrong, you may prefer to restart the mission from scratch. The challenge is hard, but it is doable.

If you managed to locate and destroy the AAA though, congratulations. The convoy is now all but defenseless 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 one pillar with the G Maverick in VIS mode.
Select the remaining AGM-65G with the SMS page and select VIS mode with OSB 2.
You may shut down the TGP as we don't need it for this procedure since the bridges are not point trackable anyway.
Also note that the FCR will go into AG ranging once VIS is selected.

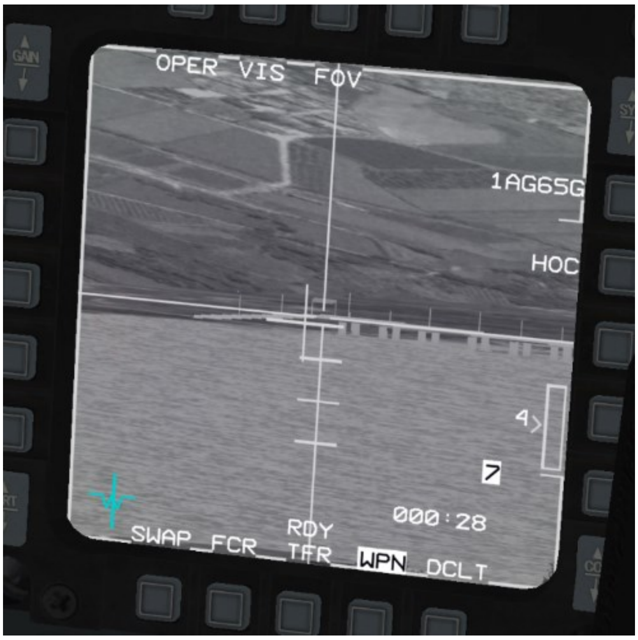
The HUD is made SOI by default, indicated by the asterisk in the top left corner and the TD box is placed on the FPM.
You can move the TD box in the HUD with the cursors. Once you are visual on the bridge, place the TD box on the outer left pillar of the bridge. TMS up to ground-stabilize the TD box and SOI automatically transfers to the WPN page.

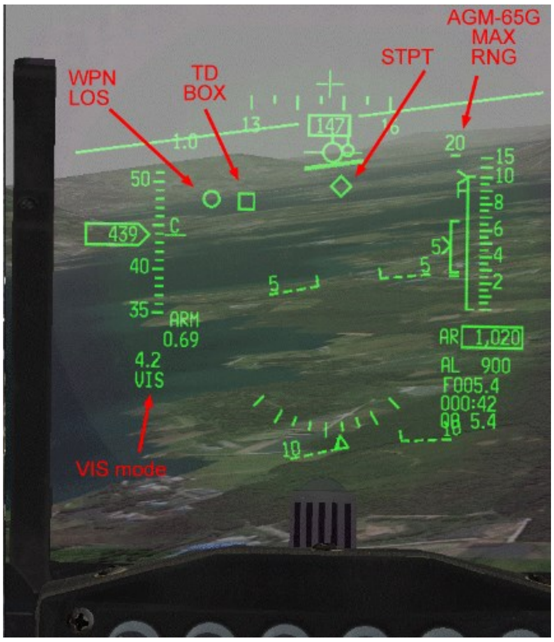
Refine the cursors if necessary and once you are happy, designate with TMS up to command track.
The missile LOS will then be displayed in the HUD as a 10 mr (miliradians) circle as before.

Check the pointing cross; if it's steady fire the missile.

The picture on the next page illustrates the HUD with the TD box, the steerpoint diamond and the AGM LOS as the aircraft flown by AUTO TFR is approaching the target. Notice the lack of the small square under the HUD missile LOS as the Maverick wasn't handed off from the TGP.

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

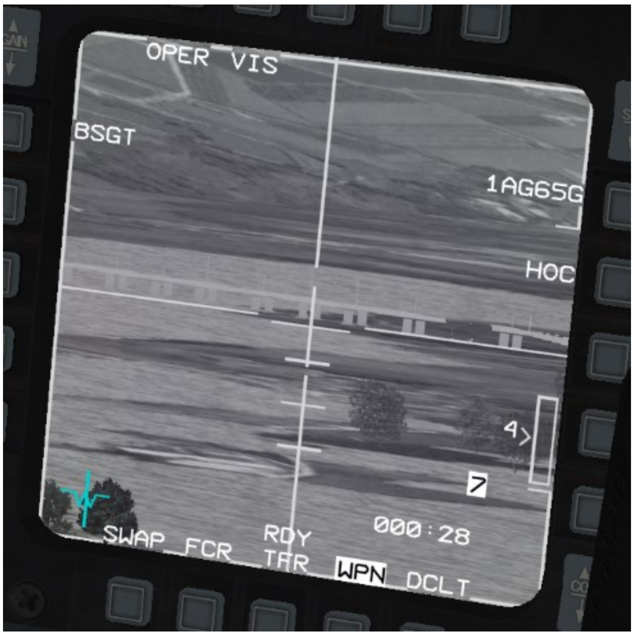


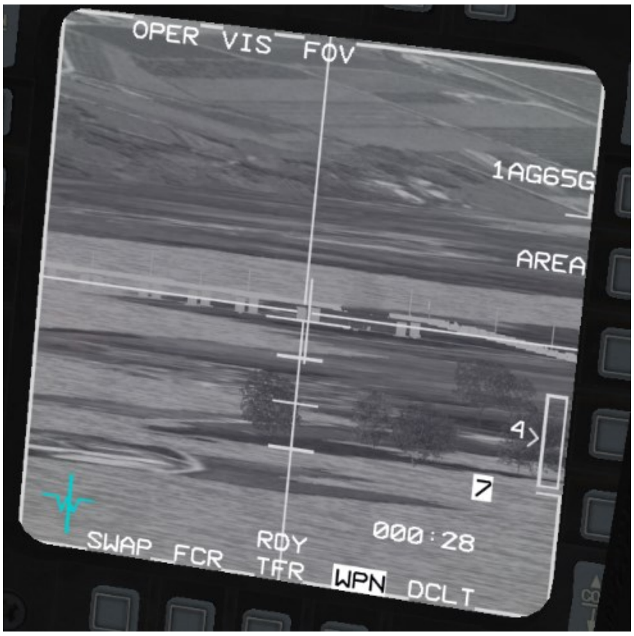


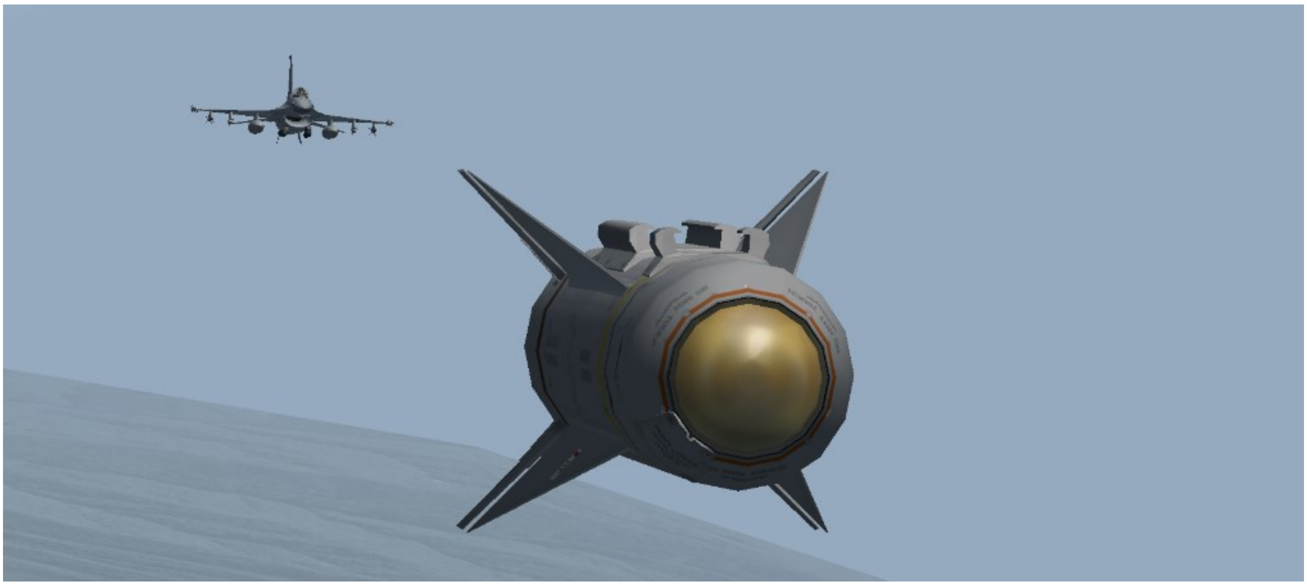
When you command a missile track from the WPN page the missile doesn't always lock at the exact same spot you commanded the lock. It may move LOS slightly because of the centroid track mode of the missile.

To force the missile to track the exact spot you designated you must use the force correlation track mode, only available with the AGM-65G. This mode is useful when you want to target specific parts of a larger target such a building door, a bunker entry or even an aircraft parked inside a hardened aircraft shelter. To illustrate this feature we will target the third bridge pillar from the right.

Move the cursors to the right of the bridge and select the third pillar. Designate when ready and notice how the centroid mode tracks the 5th pillar (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 pillar. 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.







Rifle

If your last missile missed maybe due to the fact that you didn’t target the lowest point of the pillar. If you aimed too high, there are high chances that the missile looked further beyond the bridge at the ground spot your cursor was aimed at. That is the reason you don’t target the bridge spans in this scenario, but rather the pillars. Remember, aim for a ground spot.

Your mission is accomplished; you may return to base.

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.

The weather makes this mission particularly difficult (but incredibly immersive). The weather is more realistic in BMS now that it brings an element of randomness and a completely new perspective to regular TE's.

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. ☺
If weather prevented pinpointing that Shilka on your initial attack heading, then a quick look around should have told you where the visibility would have been better.
You should have changed your run-in heading to exploit that hole in the weather. That is how immersive this weather model can be.

Maverick HOTAS summary:

Throttle:	UNCAGE:	Blow dome cover (AGM-65A, B and D, G).
	CURSOR/ENABLE:	Change E-O delivery mode when WPN is SOI (PRE – VIS – BORE).
	Cursors:	Move cursor on SOI (HUD, FCR, TGP, WPN).
Sidestick:	TMS up:	Command track on SOI.
	TMS down:	Reject track on SOI.
	TMS left:	Change polarity (AGM-65G only).
	TMS right:	Reject handoff target (TGP SOI). Toggle AREA/Polarity (AGM-65G WPN SOI).

MISSION 15: INERTIALLY AIDED MUNITIONS *(TR_BMS_15_IAM)*

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: 42252 lb. 4 AGM-154A JSOW - 2 wing tanks – TGP and A-A missiles.
Max G: 5.5/-2.0 Max speed: 550 kts / 0.95 Mach.
Wingman: GW: 40884 lb. 2 GBU-31(v)1/B - 2 wing tanks – TGP and A-A missiles.
Max G: 5.5/-2.0 Max speed: 550 kts / 0.95 Mach.
Once in the cockpit the training scripts will freeze BMS and setup your systems as usual.

LEARNING OBJECTIVES: Attack & Destroy HQ battalion and Mech battalion just North of the DMZ.
Air defenses: AAA & SHORAD and SA-3 at target, SA-4 north of target.

WEATHER: RKTY INFO: B 011755Z RWY08 TRL140 360/20KT 9999 OVC 040 25/15 Q995.

Inertially Aided Munitions (IAMs) are INS or GPS guided bombs providing standoff capabilities for Air to Ground attack. Since BMS 4.33 they have been correctly implemented as JDAM (Joint Direct Attack Munition), LJDAM (Laser Joint Direct Attack Munition), JSOW (Joint Stand Off Weapon), WCMD (Wind Corrected Munition Dispenser) and SDB (Small Diameter Bomb).

For a full explanation about IAMs, please refer to the Dash-34, chapter 4.2.8. in your Docs folder.

This training scenario will document JSOW and JDAM procedures. Sparky 3-1 will be the JSOW shooter on both HQ and Mechanised battalions and Sparky 3-2 is loaded with JDAMs to destroy the Dalsan bridges. The training mission can be flown single ship in either of the positions, or multiplayer by alternating roles.

15.1 JSOW

For this section, select the flight lead position of the training flight.

JSOWs are gliding cluster weapons that guide to their target using INS/GPS coordinates. Their range varies according to release altitude. The ideal range is usually around 20 Nm from 25000 feet. Since they use INS/GPS to guide they can be used in zero visibility and unlike laser guided munitions they are not affected by moisture and clouds. Two AGM-154 versions are available in BMS: the AGM-154A is most effective against soft targets; the AGM-154C is best used against hard targets. In this training mission we will drop the AGM-154A version against vehicles. The interesting fact about A model JSOWs is that the pilot can program their final heading and altitude to best match the target geometry to cause maximum damage.

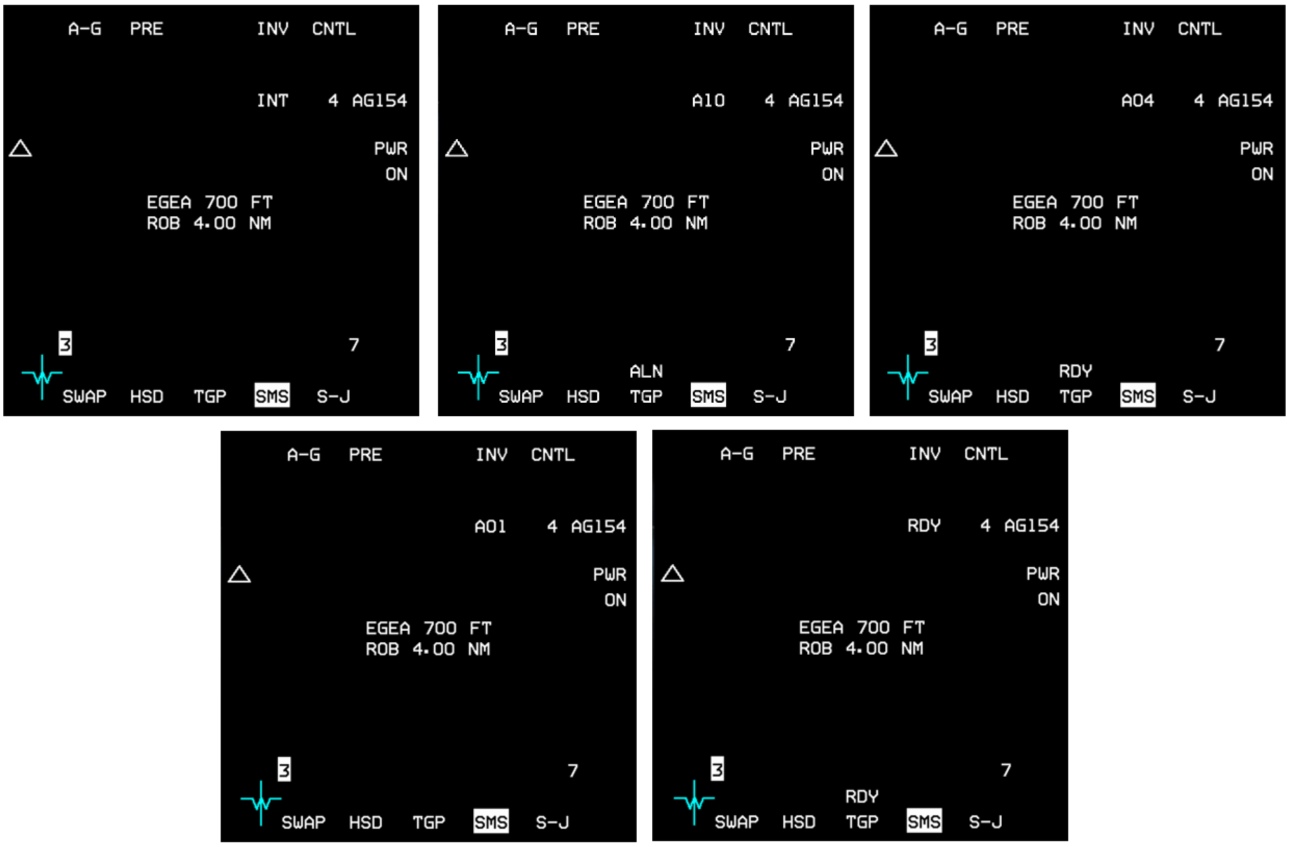
This training scenario reflects the early days of a BMS campaign where HART site targeting is executed to soften up enemy artillery as allied armor progresses against enemy lines. We will target Dalsan HART site, where reconnaissance flights spotted enemy HQ and Mechanized battalions earlier in the day.

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

The training mission starts enroute to Yangyang VORTAC 043X. Altitude should be ~ 24000 feet. You can select AP Steering and Pitch altitude mode. JSOWs need a bit of time to align their INS, so the first thing you should do is to select the SMS page and power on the JSOWs. You don't need to power all 4 weapons individually.

The initialization sequence (Mass Data Transfer) of the weapon will show various mnemonics in the SMS page. After initial power up the weapons will first initialize (left picture), then start their alignment process (center 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 minute alignment time requirement.

In this training scenario the weapons should be aligned and ready no later than overflying the VORTAC at steerpoint 4.

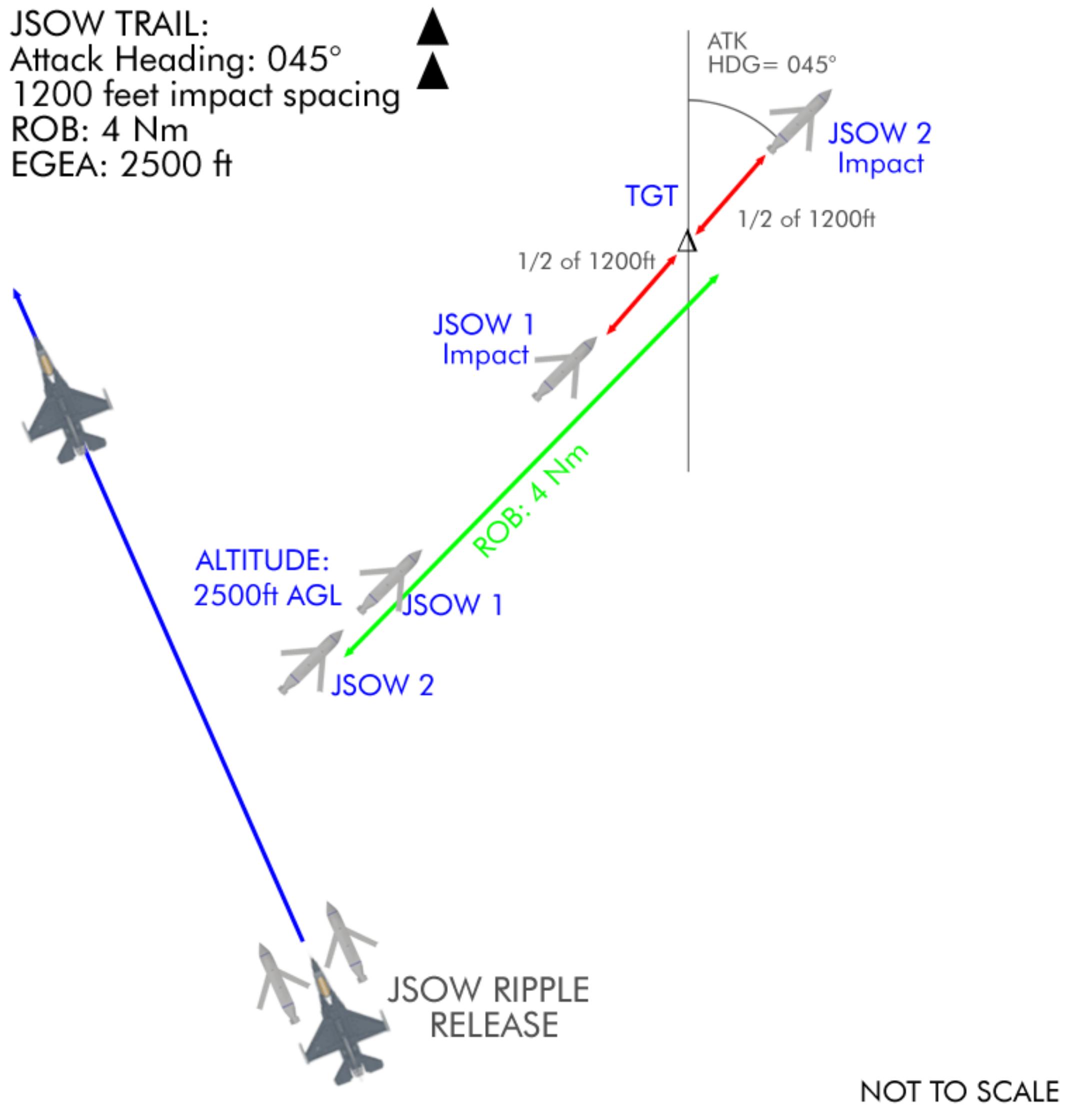
While the INS/GPS of the JSOWs align you can setup your attack parameters. OSB 19 displays a triangle which represents a JSOW. In this configuration a single JSOW is programmed for release. If you press OSB19 the triangle will be replaced by two triangles indicating 2 JSOWs side by side release and a further press of OSB 19 sets a trail/tandem formation of 2 JSOWs. The symbols are then stacked on top of each other. OSB 19 therefore sets the ripple mode of the weapon. When either side by side or trail/tandem is set a further spacing option appears next to OSB 18 on the SMS page.

Press OSB 18 to set spacing between the two glide bombs. A new page will be displayed where the spacing can be input and entered in the system with OSB 2 ENTR.

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

When side by side is selected, the JSOW will fly in a spread formation spaced by the distance entered in the SMS page. The left bomb will hit a point left of the target at half the distance spacing; the right bomb will hit right of the target at the same half spacing distance. The target therefore lies at mid-point between the two impact points.

When trail/tandem is selected the JSOW will follow each other separated by the distance entered in the SMS page. The lead bomb will hit the short point (before the target) at half spacing distance and the trailing bomb (second released) will hit the long point (past target) at the same half spacing distance. The target therefore lies at mid-point between the two impact points.



The choice between options will depend on the target geometry, as we will see later on. If we are able to align the JSOW final heading with the axis of the target, trail formation will provide a better result. If on the other hand the JSOW attack the target at a 90° angle, side by side will be more effective.

Determining the best spacing is also dependent on target geometry and the ripple option. If the target is long, like the vehicle column in this training scenario, spacing will be important. If the target is condensed in a small area, spacing can be tighter. You may use the TGP meterstick or frag pattern to evaluate distances.

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

Set course to steerpoint 6 (approx. 295°) and let the AP fly the aircraft while you manage the systems.

The CNTL page of the SMS allows you to set ATK AZ (Attack Azimuth), EGEA (End Game Entry Altitude) and ROB (Range on Bearing). These parameters allow you to set the final heading and altitude the JSOW should fly at from a certain distance from the target. 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.

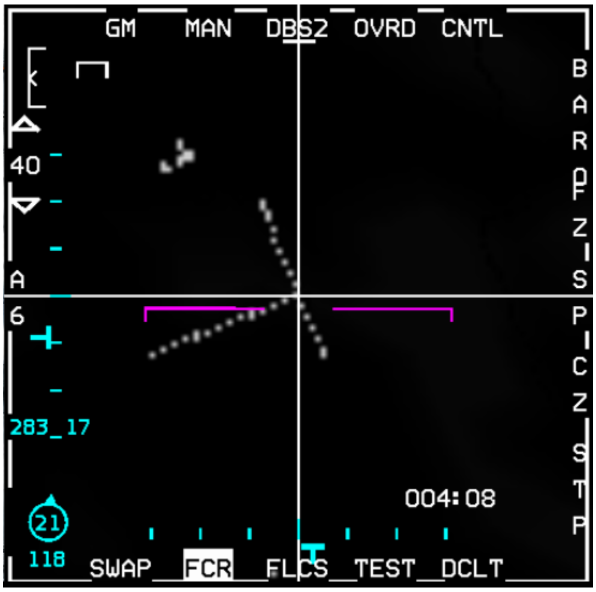
To be able to choose the best options we first need to have a good picture of the target geometry. So we need to get closer to the targets and paint them on radar before deciding how to attack. In some cases, it could be done during the flight planning phase when the target is spotted and visible on the UI map. Recon the target to determine the best weapon heading and attack settings.

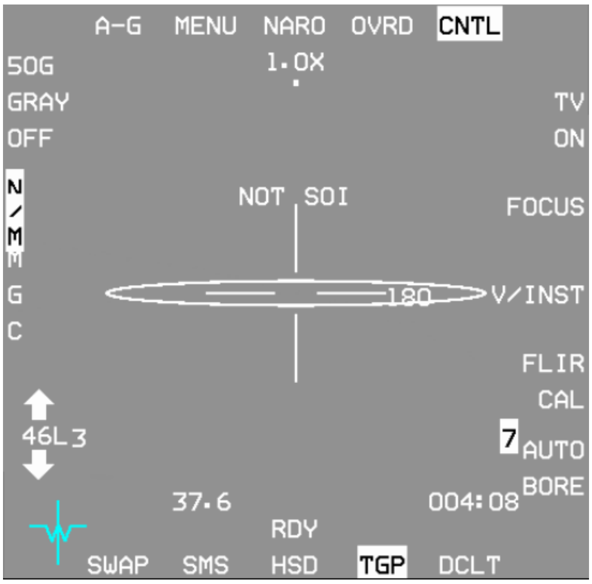
The target is about 35 Nm away and you know the optimal launch envelope for the JSOWs at this altitude is around 20 Nm. We have 10-15 Nm to define target geometry and plan our attack.

Set A-G FCR to a 40 Nm scope and ensure the TGP is set to A-G and the N/M (North/meterstick) option is active on the TGP CNTL page. The target should be visible on the FCR, but we need to get a clearer view by going into Expanded DBS2 mode. We now clearly see two different vehicle columns in the target area.

The FCR vertical line is representative of our current heading: 295°. As you can see the first column is angled about 10-15° to the left and the second column is angled about 60° to the right. We can now estimate the axis of the first column to 270° and the axis of the second column to 360°. We will set an attack azimuth of 270° and attack the right column (270°) with two JSOWs in trail, then attack the left column (360°) with a 270° attack azimuth, but this time with two JSOWs side by side.

The TGP is useless because of the weather conditions at this distance. The frag pattern has been selected to 1280 feet and displayed through the menu (OSB 2) of the Control page (define the options with TMS).This draws an ellipse on the TGP 600 feet around the target. Once the target comes into view, the side of the ellipse should give us an estimation of the JSOW separation at impact.





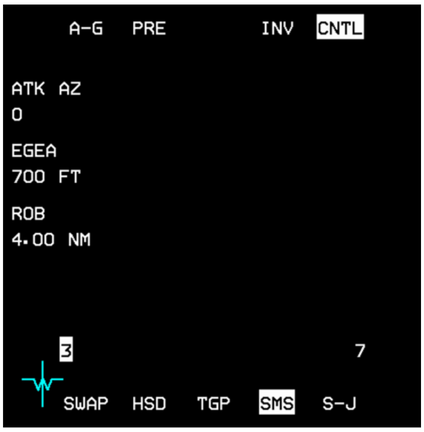
It’s best to fire JSOWs at INS steerpoints rather than cursor positions, so we need to mark both centers of the columns and use them as our attack INS steerpoints. As both attack axes are different, we’ll also have to set the first two bombs for the 270° column, (right one, almost vertical) ripple the first two JSOWs, then program the SMS for the next column axis (360° - left one – almost horizontal) before releasing the last 2 bombs.

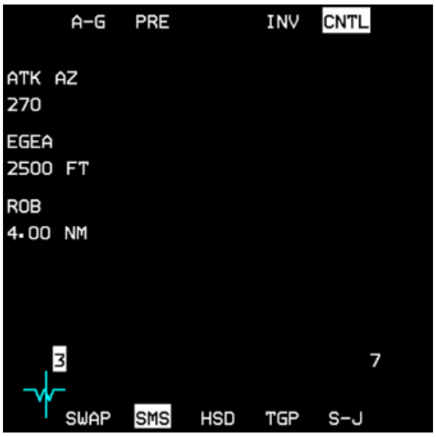
As you ingress, keep an eye on that SA-3 right of your route. Don’t trespass its WEZ.
First designate the center of the right column on the FCR.
Select the ICP MARK page and hit TMS up to create Markpoint 26.
As the FCR was tracking, the MARK page defaulted to FCR MARK. When the Markpoint is created, press M-SEL to make it the active steerpoint.

Un-designate the A-G FCR, cancel slew by hitting Cursor Zero (CZ) and move the cursors to the center of the left column. Ensure the MARK page is still active and press TMS up to create Markpoint 27 for the second column axis. Note this doesn’t designate on the FCR as the MARK page has ownership of the TMS.

Cancel all slews by hitting CZ (OSB 9) on the FCR. This is critical to avoid any unwanted cursor slews. Both your attack INS steerpoints have been created.

Markpoint 26 is selected as the current steerpoint; that’s our first target: the right column with an axis of 270°. Let’s select the SMS CNTL page and enter 270° as ATK AZ, 2500 feet for EGEA and 4 Nm ROB.
2500 ft AGL seems a good altitude for cluster munitions and ROB is left at the default of 4.0 Nm.

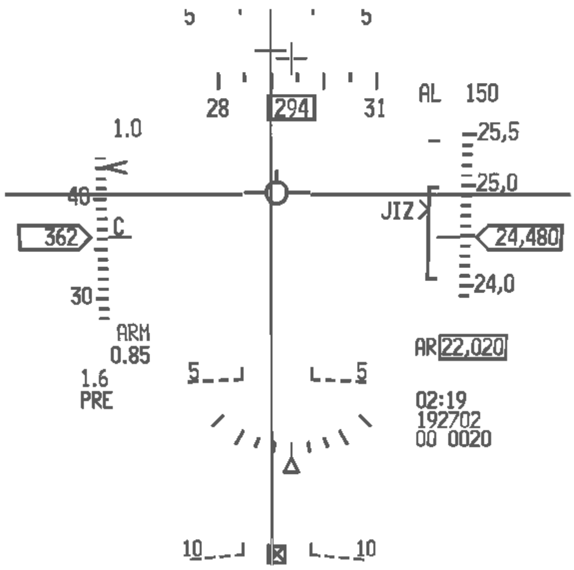




Exit the SMS CNTL page and check the JSOW settings and RDY status:

- JSOW set to ripple trail.
- 1200 feet spacing.
- Attack Azimuth of 270°.
- End Game Entry Altitude: 2500 ft AGL.
- Range On Bearing: 4 Nm.
- JSOW status: RDY.

The JSOWs are ready to be released. We just need to wait until the HUD reports JSOW in Zone (JIZ), around 20-22 Nm from the target steerpoint. The JIZ indication will be blanked for altitudes above 40000 ft, airspeeds below M0.6 or above M0.95, pitch or bank angles greater than 30° and when target bearing exceeds 60°.



When JIZ is displayed, press and hold the pickle button;
IAMs need about 1.6 seconds weapon release consent.
As you are rippling two, make sure you keep the pickle depressed for at least 3.2 seconds. Failure to keep the pickle depressed long enough may result in hung weapons.

As the bombs release the FPM will flash and the RDY status will be replaced briefly by REL for release.

When both of the first pair of JSOWs have been released select STPT 27 for the second column. Don't forget or you will send the second pair to the same location as the first!

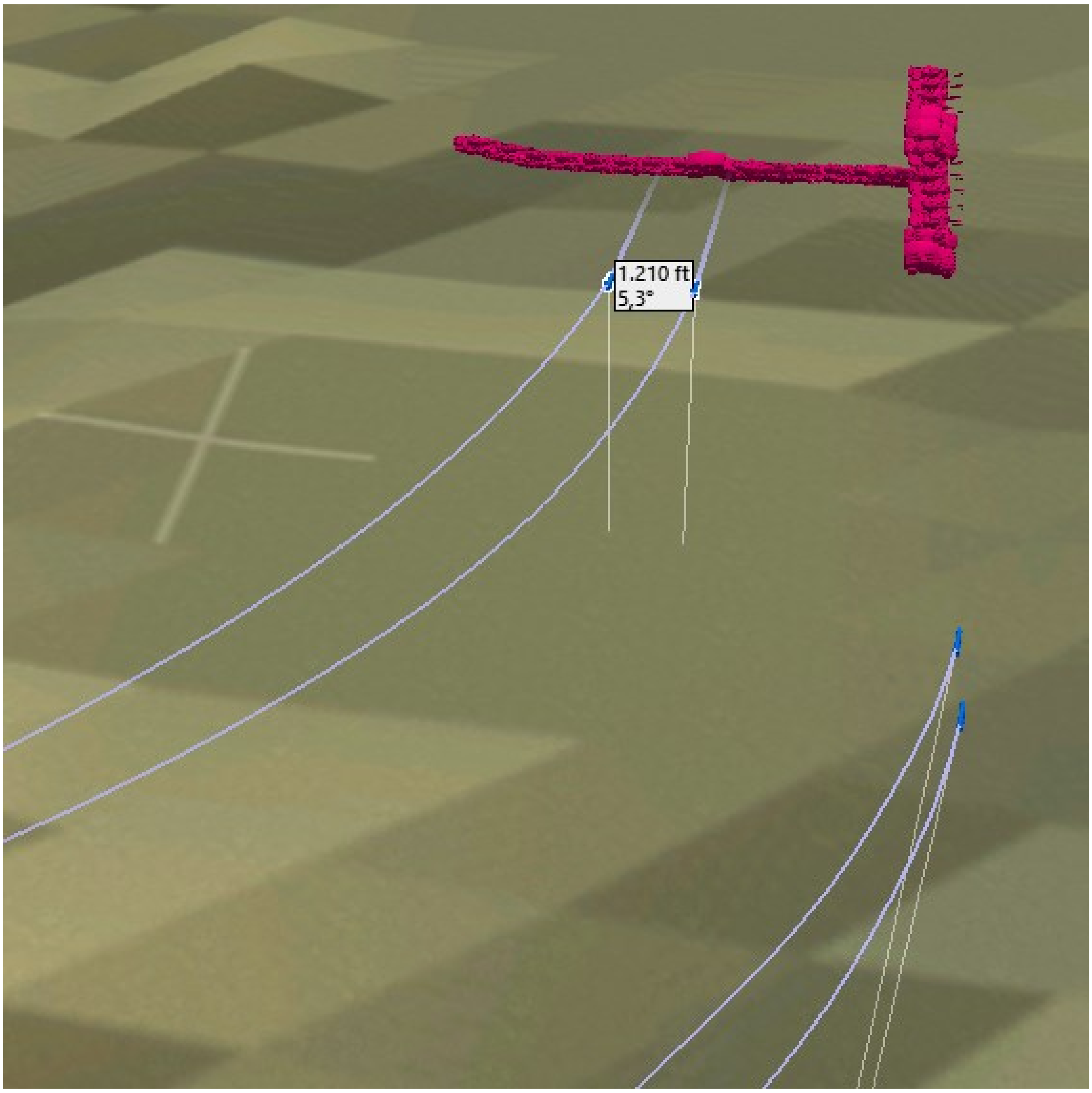
We will keep the same attack azimuth of 270° but set the ripple to side by side. As the column is oriented 360°, 90° off side by side will provide the best attack geometry. Leave spacing at 1200 ft.

Once you are confident that settings are correct and JIZ is displayed in the HUD DLZ depress and hold the pickle again for just over 3 seconds and monitor the JSOWs release.

After weapon release your CAUTION light will come on indicating a CATI/III mismatch. Switch to CAT I with the relevant switch on the left auxiliary console.

Don't fly too close to the columns as there is another SA-3 protecting them!

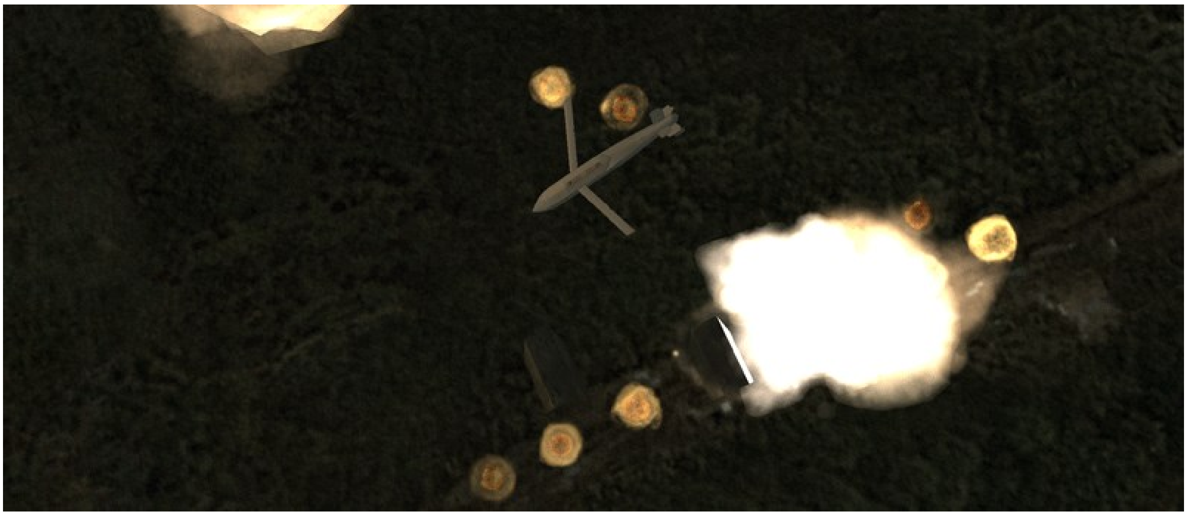
If any weapon fails, the station number will be replaced by either H for Hung, D for Degraded or F for Failed. That weapon will be unusable for the remainder of the mission.



The second side by side pair (released last) will hit the 360° column first, perpendicular to the column axis.
The first pair released (right on the picture above) is flying in trail and aligned with the 270° column. JSOWs are unpowered, very slow as a consequence and will take quite a bit of time to get to their target.

The first rippled weapon in a trail formation hits the short point. The second weapon hits the long point.
The cluster munitions will cause a huge amount of damage in both enemy vehicle columns, but looking at the result with the ACMI, 1200 feet spacing could have been increased to 2000 ft. There is your excuse to restart this training mission with a better spacing.

As soon as all 4 JSOWs are gliding towards their target turn your aircraft away from the enemy air defenses. Select steerpoint 6 to exit the target area, staying out of the SAMs pre-planned circles.



Follow your INS flight plan back to Yechon. Congratulations. Well done!

15.2 JDAM

For this section, select the wingman position of the training mission. As you fly wingman you may hear your AI lead giving instructions to attack his target. Ignore him or change your VHF frequency away from preset #15, so you can concentrate without his constant calls.

JDAMs are conventional bombs fitted with a GPS/INS kit. They fall ballistically and don't have the standoff range of gliding bombs like JSOWs or SDBs. In BMS the F-16 can carry the GBU-31(v)1/B based on the Mk-84 2000 lb bomb, the GBU-31(v)3/B based on the 2000 lb BLU-109 penetration bomb and the smaller GBU-38B based on the 500 lb Mk-82 bomb.

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

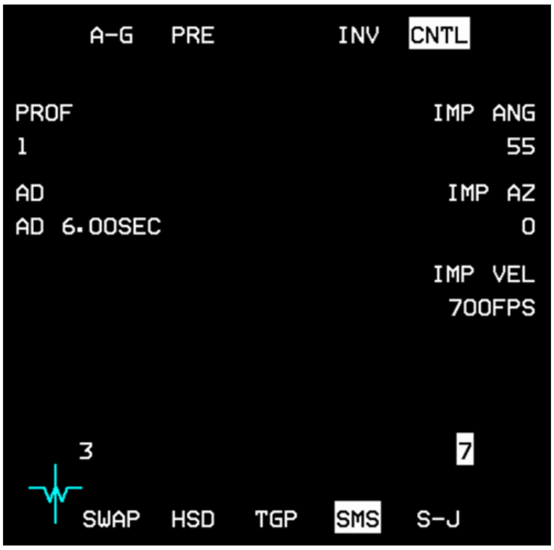
JDAMs are primarily meant to be used on INS target steerpoint coordinates. The TGP might be useful to designate and drop JDAMs, but it is not mandatory. As you have checked the weather briefing you know you can expect a cloudy situation in the target area and TGP target identification might be limited. Luckily the target coordinates were 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°34.298" Elevation 1895 feet (265°/085°).

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

JDAMs allow the pilot to set 4 different profiles, accessible with OSB 20 on the A-G SMS page. Each press will toggle between 4 profiles, containing settings for:
- Arming Delay (AD)
- Impact Azimuth (IMP AZ)
- Impact Angle (IMP ANG)
- Impact Velocity (IMP VEL).

The last two are not implemented in BMS at this stage.



Since we have two different targets to destroy, we will create two distinct profiles, so we can quickly swap settings between the two bomb drops. Profile 1 will be used on the Dalsan South Bridge (first target STPT 5) and Profile 2 will be used on the Dalsan North Bridge (STPT 6). This will be quicker than going to the CNTL page and changing the impact azimuth between the two bomb releases.

Choosing the right impact azimuth is not easy and requires careful planning. 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 desired impact azimuth.

In this case our flight approaches the target from the South East on a 300° heading. The targets are located slightly to the right of the route and oriented east/west. In that configuration, if you request an impact azimuth of 090° for instance, the bomb would have to turn 150° to the right to comply. That will seriously decrease your range and will almost certainly force the bomb to override the settings and fly direct to the target. To ensure a good envelope you must try to plan for an offset of no more than 60° from the target bearing. In this scenario we will set an impact azimuth of 350° for the 1st target (Dalsan 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.

Next, select PROF 2 with OSB 20 and enter the following settings:
- Delivery mode: PRE
- Arming delay: 7.00 seconds
- Impact Azimuth: 340°
- Impact Angle and Impact velocity left at default.

Once done, exit the control page and check the different options are displayed for Profiles 1 and 2 in the center of the SMS page by toggling OSB 20.

You will notice that impact azimuth is not available when the release mode is set to VIS (PROF 4 for instance). In such cases the weapon will fly direct to its INS target. JDAMs set in PRE mode with an impact azimuth of 0 will also fly direct to their target.

Your IAMs are all set and you are probably close to steerpoint 4. If you haven't done so already you may engage steering autopilot so you can concentrate on the avionics.

As we have two targets and no attack steerpoints defined, we must input the target coordinates into the INS system. We will assign the closer target (Dalsan South Bridge) to STPT 5 and Dalsan North Bridge to STPT 6.

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

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

Ensure the scratchpad is on the Latitude line and enter the Latitude of Dalsan South Bridge by starting with ICP 2 for North, then 3821463 and press ICP ENTR.

The scratchpad moves down to Longitude. Start your input with ICP 6 for East and type 12934837 ENTR. Remember, you must start coordinate inputs with the cardinal symbol N and E.

Bomb accuracy is highly dependent on target elevation. In BMS 4.34, target elevation is not yet part of the bomb accuracy code, so although the steerpoint elevation in the DED has been updated to ground elevation in 4.34, changing the 1377 ft elevation to the target elevation of 1573 ft is not required, but advisable to do anyway (good practice for the future). You will notice Steerpoint 5 moved to the new coordinates in your HSD.

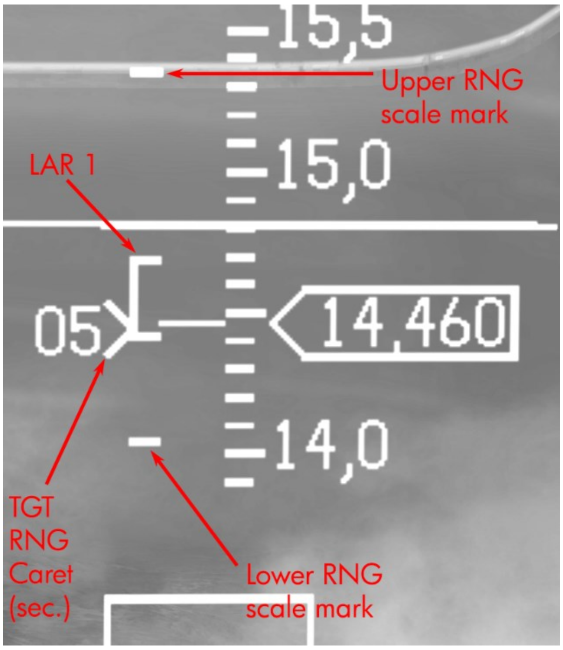
Toggle the DEST page to STPT 6 and place the scratchpad on the Latitude line. Start entering the full coordinates for the other bridge: N3823466 E12934298, elevation 1895 feet and check that STPT 6 moved position on the HSD.

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

Exit the DEST page back to the CNI page, select STPT 5 and monitor the autopilot turning the jet towards the first target. Time for FENCE checks:

- MASTER ARM to ARM
- STPT 5 (first target) selected in UFC
- Master lights switch OFF
- Cursor Zero,
- SMS set to PROF 1,
- IAMs status RDY.

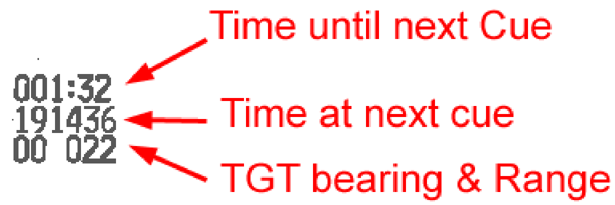
Airspeed is within M0.5 and M1.5, Target bearing within 60°, pitch and bank are less than 60°: all these conditions ensure that the HUD displays DLZ and LAR1.



The target is defended by an SA-3 but we should be able to remain outside its WEZ. If needed, switch the autopilot to heading mode and turn left a notch to stay just outside the SA-3 WEZ. You may turn towards the target later by flying round the SA-3 WEZ. Let's close up while monitoring the LARS.

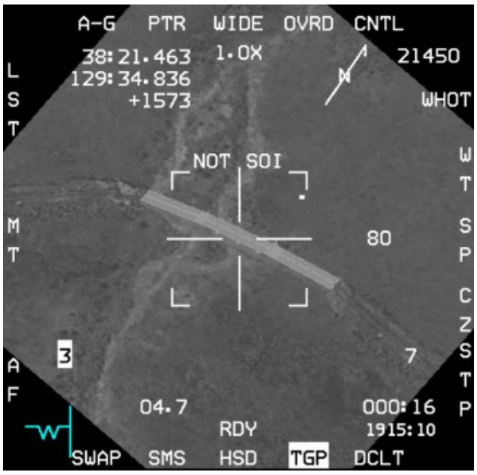
LAR1 is displayed as [and has RMAX1 and RMIN1 marks extending to the right. RMAX 1 is at 70% of the IAM kinematic range (which depends on the aircraft flight conditions). The Upper range scale mark is the maximum range of the IAM. JDAM release is inhibited until the target range caret is within RMAX1 and RMIN1 but releasing within RMAX1 & RMIN1 may not ensure the weapon has enough energy to meet the current end game (impact azimuth) settings.

LARs are the equivalent of the JIZ indication for the JSOWs and allow the pilot to ensure the JDAM is in its optimal launch envelope. If LAR1 is not displayed it is because your aircraft attitude is not within limits, MASTER ARM is SAFE, or target bearing is more than 60° offset. In that case, a turn indication will be displayed in the HUD as Rxx or Lxx for right or left turn and xx representing the required turn in degrees to place the target within 60°.



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 (number of seconds past RMAX1 as you wait for the weapon caret to meet RMAX2). After bomb release the timer displays the 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 shows the target bearing (00°) and Range (22 Nm).



As the weapon caret descends from the upper range to RMAX1 have a glimpse at the TGP to confirm we have the right target designated. You may have to turn slightly back towards the target. When the weapon caret hits RMAX2 give release consent by holding the pickle button for about 2 seconds. The first JDAM will release and you will have to compensate for the wing drop.

Quickly select STPT 6, switch SMS to PROF 2 and adjust course to keep the weapon release cue displayed.

Wait for the weapon caret to hit RMAX2 before releasing the second JDAM on the North Bridge. The sequence should be very quick and since JDAMS can't be rippled this 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 CAT I and MRM to defend yourself against possible air threats.

Both JDAMs will destroy the bridges as your flight lead attacks the movers with his/her 4 JSOWs. You can now return to base and compliment yourself once again on a job well done.

15.3 Other IAMs

There are other types of IAMs in the inventory:

- SDB are GBU-39 Small Diameter Bombs, most effective against soft 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).

- LJDAMs are GBU-54 500-pound JDAMs fitted with both a GPS/INS and laser guidance kit. They provide increased flexibility, as the laser kit can track the coordinates of the laser spot, making them suitable for either stationary or moving 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 Dash-34, chapters 4.2.8.4/4.2.11.2/4.2.10.1 for further information about these IAMs.

MISSION 16: SPICE *(TR_BMS_16_Spice)*

LOCATION: Inbound Ongjin DPRK Airbase on the South West coast of North Korea.

CONDITION: KF-16 block 52 – single ship - Callsign Falcon 1.
GW: 41003 lb (Fuel state 6.4, dry). 2 SPICE 2000 - 2 wing tanks – TGP and A-A missiles.
Max G: 5.5/-2.0 Max speed: 550 kts / 0.95 Mach.

LEARNING OBJECTIVES: Attack & Destroy installation at Ongjin airbase defended by SA-11 and SA-17 while remaining outside the SAM weapon engagement zones.

WEATHER: RKJK INFO: B 010755Z ILS RWY36 TRL140 360/15KT 9999 FEW050 28/18 Q1013 NOSIG

Recently ROKAF acquired modern Israeli weapons, such as the SPICE (Smart Precise Impact Cost Effective) designed by Rafael industries. BMS reflected that change and the ROKAF block 52 can use the Israeli glide bomb.

SPICE in BMS comes in 4 versions: 2000 lb (Mk-84) or 1000 lb (Mk-83), both with either a high-explosive or penetration (BLU-109) warhead. SPICE1000 is the 1000 lb bomb and SPICE1000P is the 1000 lb bomb with the penetration warhead (BLU-109). SPICE 1000 has less punch, but a longer range and features deployable wings to increase its range further. ROKAF F-16s in BMS can only carry the SPICE 2000 & 2000P; they can't load the SPICE1000 & 1000P, although the Israeli blocks can.

16.1 SPICE bomb

SPICE in BMS is considered as an IAM. Actually, it's an electro-optical GPS glide bomb but the electro-optical part is not implemented in BMS; only the GPS is.

Using SPICE is very easy as it's a true fire and forget weapon. As it is a glide bomb its range will depend on the altitude and speed of the launching platform and it may take a while to reach the target.

As a rule of thumb, you may assume that the SPICE can glide 1 Nm for every 1000 feet of altitude at launch. A launch at 20.000 feet will give an approximate range of 20 Nm.

Being GPS guided it is only suitable for fixed targets. SPICE cannot attack targets of opportunity as it cannot be reprogrammed in flight. Targeting needs to be assigned on the Recon screen.

The real challenge of deploying SPICE weapons is setting up the avionics during pre-flight planning. So don't go straight to 3D as you need to set up a few things first in the UI. Make sure you stop the clock if it's running.

In this training scenario you are tasked to destroy the Control Tower and the SSR radar at Ongjin airbase. This shouldn't be a problem even for dumb Mk-84 bombs. Unfortunately, the airbase is very well protected by SA-11 and SA-17 batteries, forcing you to use standoff weapons, unless of course you're feeling suicidal as the SA-11 and SA-17 are lethal air defense systems in BMS.

16.2 Strike Planning

Ever wondered what the WPN TGT box purpose is in the Recon window of the UI? Well it is specifically for SPICE targeting. SPICE bombs are pre-programmed on the ground with a database for 99 possible target coordinates. It is important to note that these target waypoints are totally independent from the DTC.
They are a little bit confusing to set up, so we'll go through how to program the weapon in the UI.
Let's recon a target; in this case Ongjin airbase. Open up the list of targets under Ongjin airbase and select the Control Tower.

Usually when you want to assign a specific target to a steerpoint, you need to know your steerpoint number for the target and use the first box labelled as "DESIGNATE AS TGT STPT #X" with X being your target INS steerpoint. You increment/decrement the steerpoint number with the 2 small arrows placed on the right and hit the "ACCEPT" button once the correct steerpoint is selected. This actually changes your DTC, by assigning the precise coordinates of the target to your target INS steerpoint. But have a look at the second drop down box further to the right. It is set to STPT for steerpoint. That is the reason that when you select a waypoint with the first box, it is an INS steerpoint.

What we want to do here is totally different than setting up your DTC steerpoints.
We need to assign weapon targets, not steerpoints. See the difference? A steerpoint is an INS waypoint, to which you as the pilot steer to. A weapon target is specific to a weapon, in this case, only the SPICE.
To assign weapon targets you need to change the second dropdown menu to WPN TGT, rather than STPT.
Open the drop-down menu and click on WPN TGTs.

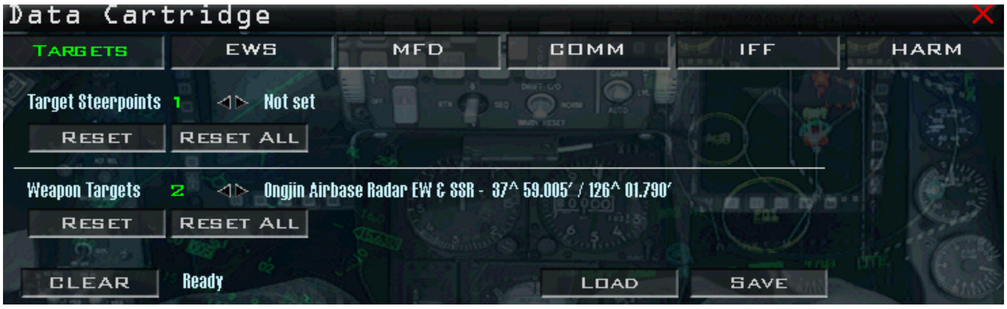
But you still have to assign them; that is still done with the first box and the 2 small arrows left of it.
The label of that box does not change and it is still named: “DESIGNATE as TGT STPT”.

Ensure that the "Targets" box to the right displays "WPN TGTS" and that the Control Tower is selected in the Recon view. We have two SPICE bombs loaded, so we need to set up at least 2 weapon targets. We could set up more targets in case they were needed; up to a total of 99. Check that STPT 1 is selected and that WPN TGT is active and hit ACCEPT. The Control Tower has been assigned as the first weapon target.
Please note that since 4.36 it is now possible to assign a target individually for any aircraft at any steerpoint as well.

Select the radar EW & SSR radar in the target list of the recon window, increment STPT to 2, cross check that WPN TGT is active and hit ACCEPT to assign the SSR radar coordinates to the second weapon target.

It is important to understand what you are doing as you can mistakenly change your INS steerpoints rather than assigning weapon targets for the SPICE. In that case, you will not see the changes on the UI map, but it will nonetheless create a mess on your HSD after having loaded your DTC. As you will be in 3D by then, it will be impossible to fix without restarting the mission.
Just remember the difference between steerpoints and weapon targets; how to switch from one to another and learn to cross check before hitting the ACCEPT button.
Fortunately, there is a way to check before stepping to the aircraft. If you open the DTC, you can check your steerpoints and you can also check any weapon targets you have assigned.

As you can see TARGET STEERPOINT 1 is not set (meaning steerpoint 1 is the regular flight plan steerpoint) and WEAPON TARGET 1 is assigned to Ongjin airbase.



Depressing the right arrow next to the weapon target will select the second weapon target, which is correctly assigned to the SSR radar.

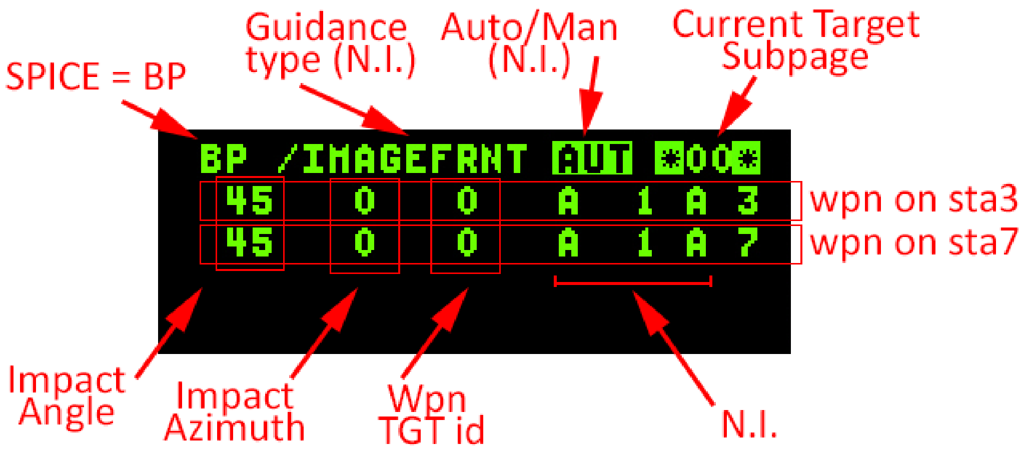
So whenever you assign SPICE targets, cross check your DTC before flying. Needless to say, if no targets are assigned to the SPICE the weapon will be useless, as you cannot assign coordinates to them in flight.
You are now ready to go flying.

16.3 In flight

Like all GPS weapons, the SPICE needs time to align. Alignment starts automatically upon weapon power up and will last approximately 3 minutes. As soon as you enter the training mission select A-G master mode and display the A-G SMS page on the MFD. Power up the weapon with OSB 7. The SMS page will go through different statuses during alignment until displaying RDY when the weapon is ready to be launched.

Set Master ARM to ARM on the MISC panel. If you want to make your life easier, engage autopilot in steering mode while you set up your avionics.

Assigning targets and flight parameters for each bomb is done through a dedicated DED page.
Select LIST on the UFC and then zero for the MISC page.
Select the specific SPICE page with ENTR.



- BP is the mnemonic for IAM in BMS and you can't change it.

- IMAGEFRNT is specific to each bomb and is one of three options for guidance type: IMAGEFRONT, IMAGETOP and GPS. As mentioned earlier, the BMS SPICE is GPS only. Although you can toggle the options, with the M-SEL button when the asterisks are around the guidance type box, it is not implemented in BMS and regardless of the chosen option the guidance type will always be GPS.

- AUTO/MANUAL is not implemented and cannot be toggled. SPICEs are always in AUTO in BMS

- The current target subpage displays which DED subpage you are looking at. As more than 4 weapons cannot be loaded on an F-16 (max. 2 on KF-16 and max. 4 on Israeli models) you will never use another subpage, since the primary page can display settings for 4 bombs.

- The SPICE DED page will display one line for each weapon loaded. You can select each bomb line by moving DCS up and down to the relevant bomb line you want to set. By default the WPN TGT box will be selected. To select further options for the same bomb, use DCS SEQ to toggle through all remaining options.

- Impact Angle is not implemented in BMS and by default is set at 45°. Although you can change the option to any value, the impact angle will always remain at 45°. The impact angle setting is displayed in the SMS MFD page.

- Impact azimuth can be changed to the heading you want the bomb to strike its target. It is implemented but will decrease the bomb's glide range. Entering zero in this box means that the weapon will fly directly to its target.

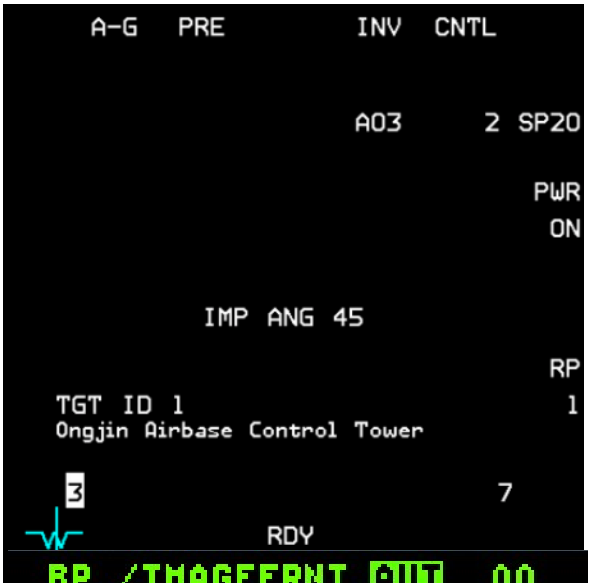
- Weapon Target ID is the weapon target number assigned to this bomb. This is the weapon target that you assigned in the UI at flight planning. You need to assign a target to each weapon before firing.

- A 1 A never changes in BMS. The last A is the position of the bomb in case you are carrying multiple bombs on the same station, but this is never the case with SPICE bombs in BMS.

- The last number is the station number where the bomb is loaded.

In this case we have 2 bombs loaded on station 3 and station 7, we therefore have two lines in the DED page, one relevant to the bomb loaded on station 3 and the other relevant to the bomb on station 7. You can switch from one bomb to the other with DCS down or up. When selecting a weapon line, the scratchpad defaults to the WPN TGT ID entry. Enter the weapon target ID that you set at prestrike planning. In this case, we will input 1 then ENTR to set weapon target 1 for Ongjin Control Tower.

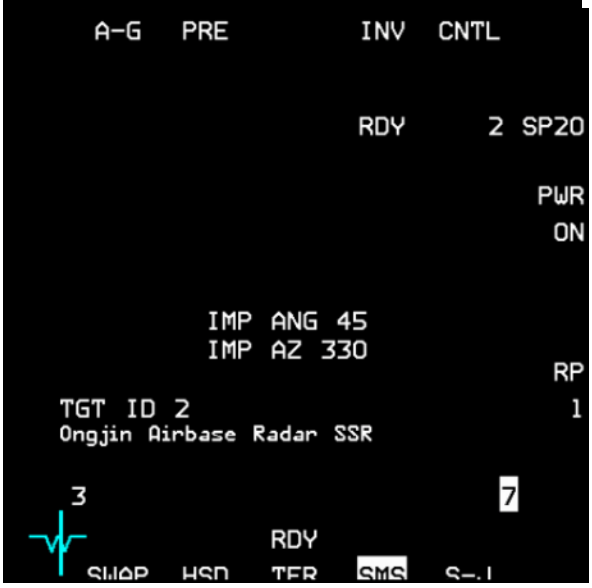
Once done, cross check the SMS page. The target ID we just assigned is relevant to the bomb loaded on station 3. So make sure that the SMS is set to the station 3 SPICE. This is done by depressing the MSL STEP button on the HOTAS; the relevant station number in the SMS page will highlight. The target ID set in the DED will be displayed on the bottom left of the SMS page. As you can see the SMS reports that the weapon loaded on station 3 is targeted at the Ongjin airbase control tower.



Note that although the SMS system is RDY (above OSB 13), the weapon on station 3 is still aligning, as reported by the weapon status (A03) left of the SP20 mnemonic (OSB 6).

DCS down on the ICP will select the bomb on station 7, assign WPN TGT 2 for the SSR radar and cross check the station 7 SMS. We will also assign an impact azimuth of 330° for this bomb. Press DCS SEQ until the scratchpad is on the impact azimuth box and input “3 3 0 ENTR”.P

The SMS page when set to display station 7 will then report the correct target ID (Ongjin SSR radar), the default impact angle (45°) and the set impact azimuth (330°).



Be aware that assigning an impact azimuth will decrease the bomb glide range, since you force it to maneuver. In our training mission it is critical since you may have to wait longer for the second bomb to be in range and trespass the SAM threat rings. To avoid the problem, carefully chose your impact azimuth to minimize the effect on weapon range. Our heading at bomb release will be close to North so setting an impact azimuth of 330° creates an angular difference of 30°, which should have a minimal effect on range, allowing us to release before trespassing the SAM rings.

Please note that unlike the bomb on station 3, this one is now fully aligned. Both RDY statuses are displayed.

A quick note about the Ripple function (OSB 9): SPICEs can be rippled from the same weapon pickle, but in that case the DLZ will use an average between different target assignment ranges. In this case, because we have one bomb set with an impact azimuth, it is better not to ripple them. If both configured to track directly to the target, they could be rippled together as both targets are very close and the average DLZ should remain accurate.

That is all you have to do to set up the SPICE weapons. You may set other options in the DED pages, but those are not implemented yet and will not change bomb behavior in BMS. Remember to select the active weapon with DCS up/down and then toggle through options for this weapon by moving the scratchpad with DCS SEQ.

By now you should be close to steerpoint 4. Your avionics are set up correctly and you may start hearing chirps on your RWR from the SA-11 and SA-17. These missile systems are not to be underestimated. Treat them with respect and be fully aware that trespassing their threat rings is very dangerous, even at low level;
a luxury you do not have when deploying glide bombs that need high release altitudes. Speaking of which, check that you are flying around 18000 - 22000 feet for release. The higher you are the longer the range of your weapons. Remember the glide ratio of the SPICE2000: about 1 Nm for every 1000 feet.

Your IP is steerpoint 5 and before you get there you need to think about what you're going to do after weapon release. The BMS SPICE is a true fire and forget weapon, so you could turn tail and egress right after bomb release. If you do that you may seriously increase the distance between you and the target and create bubble issues, which can be a problem with long range standoff weapons. If you drop 20 Nm from your target, by the time the bomb has glided the distance, you may be very well 35-40 Nm away from your drop point, thus around 60 Nm from your target. In the case of structures, it is not a real problem, but it might become an issue in some cases. Although it is of no particular relevance in this training mission, it is important to remain aware of this limitation when using standoff weapons. To avoid the issue one possible scenario is to offset 90° from the target and wait until impact, just like you would do with weapons that you need to guide to impact. Doing this you may also monitor your target with your TGP.

Before reaching the IP, it might be a good idea to switch back to MRM mode to assess the air picture in front of you and towards the target area. We have been in A-G mode, setting up the systems for quite a while. Normally you fly in an air to air mode, ready to react to any threat. Always keep that in mind when you're flying an air to ground mission. The Dogfight/MRM switch on the throttle is the easiest way to easily switch from A-A to A-G in such scenarios. When you are confident there is no immediate A-A threat to you, center the switch on your throttle to cancel MRM and the system will revert to A-G, if it was the last master mode you were in.

At IP, turn towards the target. Check your switches before bomb release; everything is going to happen fast now. Another good habit to develop if you have the chance is to check the target.
We have a targeting pod and although we don't need it for releasing the SPICEs, nothing prevents you from using it.

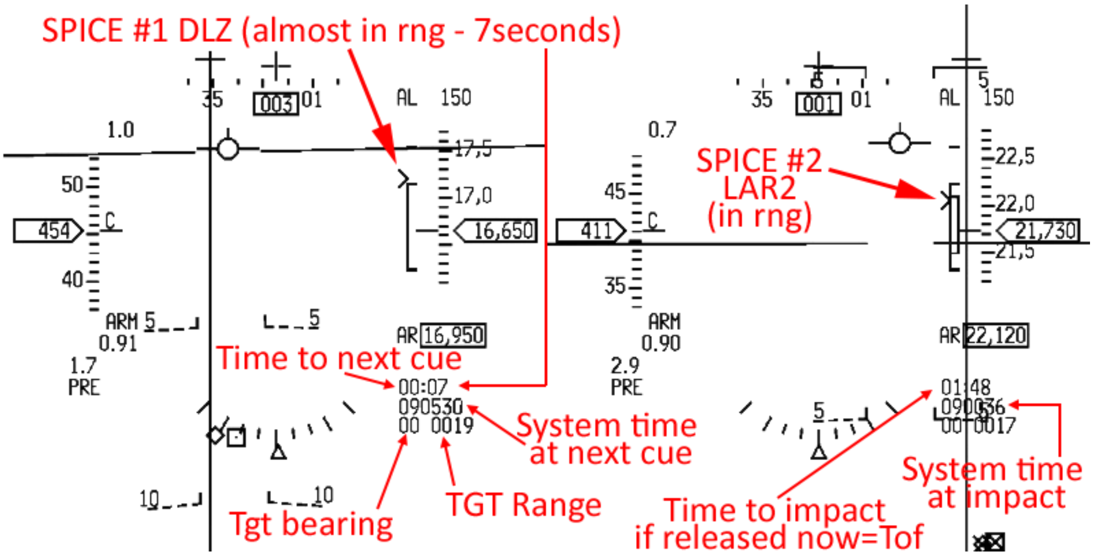
As you can see on the TGP image, it's too bad the SPICE can't be reprogrammed in flight. That said, you could have planned up to 99 weapon targets at prefight, so nothing prevented you from assigning much more than what you need and then reassigning the weapon from the DED page before release. These Su-7s will not stay on the active runway for very long.

SPICE HUD symbology is the same as other IAMs in BMS and therefore you have a DLZ (LAR1) on the right side of the HUD. If your bomb is set to glide direct to the target you will have a simple DLZ (LAR1). This is the case for the SPICE on station 3.

3 lines are also displayed in the HUD below the radar altimeter, they are respectively:

- The time to go before next cue. With Spice selected and RDY it is the timer to in-range cue for the selected Spice bomb - when the counter hits zero, the caret will be on top of the DLZ. The next cue will then switch to weapon hit (so the timer will display weapon time of flight if released now).
- The system time at next cue.
- Bearing and range to the target.

For the first bomb, assigned to the Control Tower (left picture below), you must wait until the range cue hits the top of the DLZ, as the counter tells you the Spice will be in range in 7 seconds.
From that moment you can pickle. For the second bomb (right picture), you need to wait for the range cue to hit the top of the LAR inner scale before releasing. Monitor the threat rings as you wait for the second bomb to be in range and pickle as soon as possible. You certainly don't want to venture into these nasty SAM threat rings. Should you need to pickle before reaching the top of the LAR, the bomb will fly straight to the target and ignore the impact azimuth. By the way, it's never a good idea to release a glide bomb in a dive!



Once both SPICE bombs are released, turn 90° to beam the target and switch back to MRM mode.

Remember, you saw a flight of 4 aircraft taking off just before you attacked the airbase. Be ready in case they want to play with you (and if you get shot by the SAMs trying to engage, well, you had been warned!

MISSION 17A: IR MISSILES - Intercept *(TR_BMS_17A_IR_Intercept)*

LOCATION: MOA 18.
Please note, make sure you select the F-16 flight from the mission window. If you select the first flight without checking, you will end up piloting a C-160 Transall, a military transport aircraft.

CONDITION: F-16 block 50 – Single ship - Callsign Falcon 1.
GW: 35950 (fuel 6.6 dry). 2 AIM-9M, 1 AIM-9P, 2 wing tanks, 1 ECM pod and 1 LANTIRN.
Max G: 7.0/-2.0, Max speed: 600 kts / 1.6 Mach.
Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.

WEATHER: RKJK INFO B 010755Z ILS RWY18 TRL140 140/13KT 9999 FEW080 25/15 Q1013 BCMG 0109/0110 1500 BR OVC040 (Basically FAIR turning POOR)

LEARNING OBJECTIVES: Destroy the aircraft in MOA18 with infrared missiles. RoE (Rules of Engagement) require VID (Visual Identification) before firing.

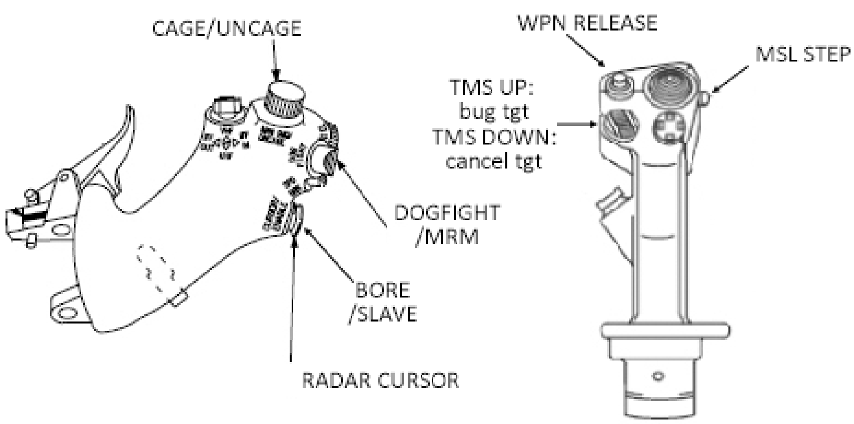
17A.1 The infrared Sidewinder missiles

The F-16 in BMS is able to carry 3 types of infrared missiles:
- AIM-9P an older rear-aspect only short-range missile.
- AIM-9M an all-aspect short-range missile.
- AIM-9X a modern high-angle off-boresight (HOBS) short range missile.

All infrared missiles are relatively short-range missiles because they guide on heat emissions and heat dissipates quickly in the atmosphere, especially in clouds, so if you are tracking an aircraft which flies into clouds you will notice your missile seeker will often lose track; if you've already fired, you may have wasted a missile. An aircraft engine generates a lot of heat, but the surfaces of the aircraft travelling through the air generate heat by friction as well. Newer missiles are unsurprisingly better at detecting this:

- The AIM-9P seeker can only detect heat from the engine and so must be fired from behind an aircraft to have a view of the engine exhaust. It has a max range of about 3-4 Nm and a FOV of 3 degrees.
- The AIM-9M seeker is more sensitive and is able to guide on the heat generated by the friction of the aircraft moving towards you, so it can be fired regardless of the aspect of an aircraft if it has a good track. It has a range of about 6-10 Nm depending on aspect and a field of view of 3 degrees.
- The AIM-9X seeker is significantly more advanced and the missile more maneuverable with less drag. It is often used with the HMCS. This model will be covered in the HMCS Training Mission.

HOTAS controls for IR missiles



The MAN/RNG rotary has a push down function to UNCAGE or CAGE AIM-9 missile seekers. Uncage the missile to allow its seeker to move and track a target; press the button again to re-cage the seeker head.

The DOGFIGHT/MRM override switch is a three position slider that overrides the master mode. Left position (outboard) is for Dogfight, right position (inboard) is for MRM (Medium Range Missile) override mode. The center position cancels the override mode and reverts to the previous master mode. Dogfight gives quick access to the gun and short-range missiles (if you're carrying them). It also sets the FCR to ACM (Air Combat Mode) and stops it radiating. MRM provides access to missile mode (long range or short range).

The RADAR CURSOR moves/slews the ACQ (acquisition) cursor (aka captain's bars) on the FCR. It also has a push down function ENABLE that allows you to toggle momentarily from SLAVE to BORE (see SMS display below) while the button is pressed/held in.

The WPN RELEASE (aka pickle) button must be held down to fire a missile and is always hot for IR missiles.

MSL STEP selects the next available missile of the same type.

TMS up is used to bug (track) a target on FCR, once the captain bars have been placed over it. TMS down cancels the track.

SMS display for IR missile

OSB 6 displays which weapon is active. In this case the AIM-9M. The AIM-9P has its own SMS page but there are no options on it.

OSB 8 is a two-position rotary that commands cooling the AIM-9M seeker head with argon gas. Options are WARM and COOL.

In WARM the seeker head is not cooled and RDY status is not achieved. IRL missile wouldn't fire but in BMS you only have a degraded track and a lower efficiency of the missile.

In COOL the seeker head is being cooled with argon gas and you will notice the missile audio tone will change to indicate this. RDY status is achieved. Cooling in BMS will last for 90 minutes until the virtual argon gas bottle is empty.

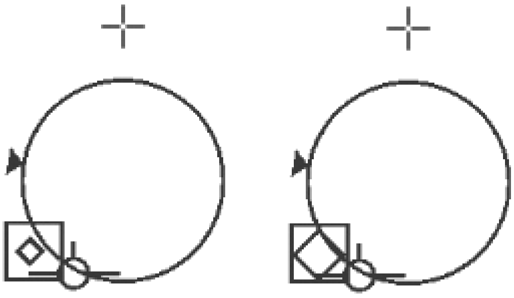
OSB 18 is a two-position rotary labelled TD (Threshold Detection) or BP (Bypass). When set to TD the missile automatically uncages when it finds a valid heat source. When set to BP the missile needs to be uncaged manually by the pilot.

OSB 19 toggles SLAVE or BORE. In SLAVE the seeker head is slaved to the radar line of sight. In BORE the missile seeker head is fixed 3° below the gun cross. In that case, the pilot must maneuver to place the target aircraft within the field of view of the seeker head in order for the missile to see the target. The missile can then be uncaged to command it to track.

OSB 3 is a two-position rotary labelled SPOT/SCAN. If SCAN is selected the seeker head scans on its own and increases its field of view slightly until a heat source is detected or the seeker head is uncaged; at which point the seeker head reverts to its nominal size. In SPOT the seeker head does not scan, and the field of view stays at its usual size.

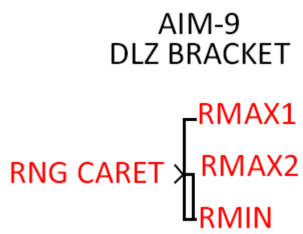
HUD symbology for Infrared missiles

There are a few HUD symbols specific to Sidewinders that you should know. First, the missile diamond will be displayed in the HUD to tell you where the missile seeker is looking. The missile diamond changes in size, according to its caged or uncaged status. When caged, the missile diamond is half the size as it is uncaged.
In the following example the missile diamond is within the TD box, as we have a radar lock, but it is the same behavior (without the TD box) when the radar does not have a valid lock.



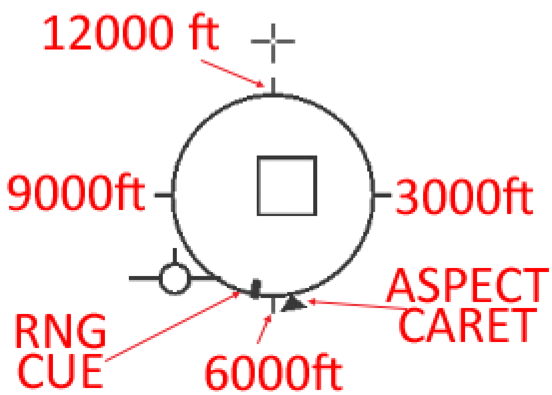
The left image shows the missile diamond with radar contact when caged. The right image shows the increased sized missile diamond after uncaging.

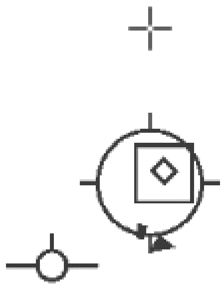
When a contact is radar designated a Dynamic Launch Zone (DLZ) is displayed on the right side of the HUD. This bracket tells you if you are in range for a missile shot. A range cue caret slides along the DLZ to signify the range. When the cue is at RMAX1, the missile is at maximum range. If the target maneuvers, it will probably miss. When the cue is at RMAX2, you are within maneuvering range; the missile circle and diamond will start to flash. RMAX2 is a more reliable max range, because even if the target starts maneuvering, the missile will still have a good chance of hitting it anyway.



When the cue hits RMIN (there are actually RMIN1 & RMIN2) you are too close for a missile shot and a large break X will appear on the HUD.

Once within 2 Nm or 12000 feet of the target the seeker head field of view will change and display 4 range marks; respectively for 12000, 9000, 6000 & 3000 feet. A range cue moves along the inner missile field of view circle to give an indication of range. The aspect caret is a triangle moving around the circumference of the circle and indicates the aspect angle of the bugged target.

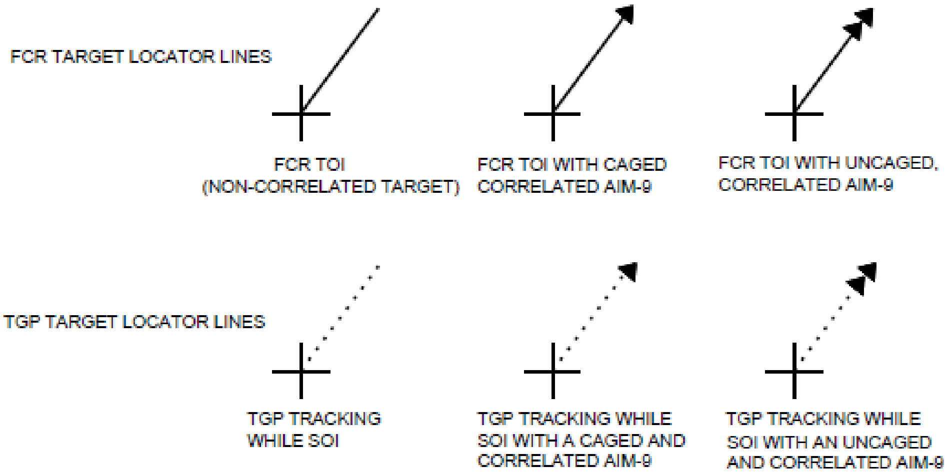


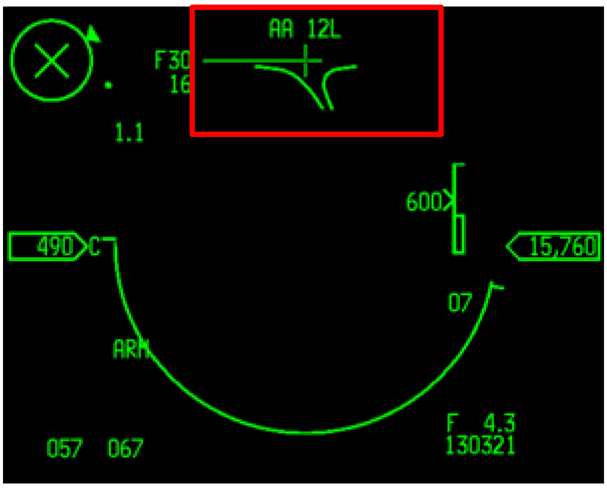


Left shows the display for the AIM-9M, above is the display for the AIM-9P.

In addition to the HUD symbology, sidewinders will emit an audio tone providing feedback on the quality of the missile track. If the tone is faint, the track is faint. If the tone is loud, the track is solid. Trust the heat tone as range is one thing but never forget an infrared missile needs a heat source to guide on. Tone will also change according to CAGED / UNCAGED status.

Since 4.36 there’s an enhanced symbology (TTL = Target Locater Lines) for IR missile correlation implemented:





TLL Symbology (Dogfight mode)

TLL Symbology (A-A mode)

F Active sensor: F = FCR | T = TGP

30 Offset from the own heading in degress (Range 0-120° will be displayed, greater 120° will initiate a loss of the lock).

16 Altitude of the looked target

AA 12L Aspect Angle (in this example: 120 to the left)

The same symbology is shown in all AA modes (DGFT, AA, MSL, OVRD). The HMCS shows the same symbology as well . Refer to the Dash-34, chapters 2.5.5 and 2.1.7.5.2 for more information.

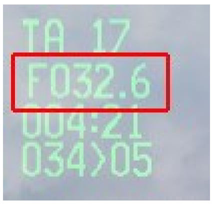
17A.2 Positional geometry

Before getting into combat there are a few academic subjects that need to be covered. Aerial combat is by far the most difficult aspect of flight to understand and master. We can only begin to scratch the surface of this complicated subject in this manual, so you are strongly advised to also read the AIR-TO-AIR chapter of the BASIC EMPLOYMENT MANUAL Vol 5, located in your *Docs**05 Other Documentation**Real Manuals* folder.

One such topic is how to describe the spatial relationship between two or more aircraft maneuvering against each other. You need to be familiar with terms like: aspect angle (AA), range, angle-off (HCA), antenna train angle (ATA) and different pursuit curves.

Range

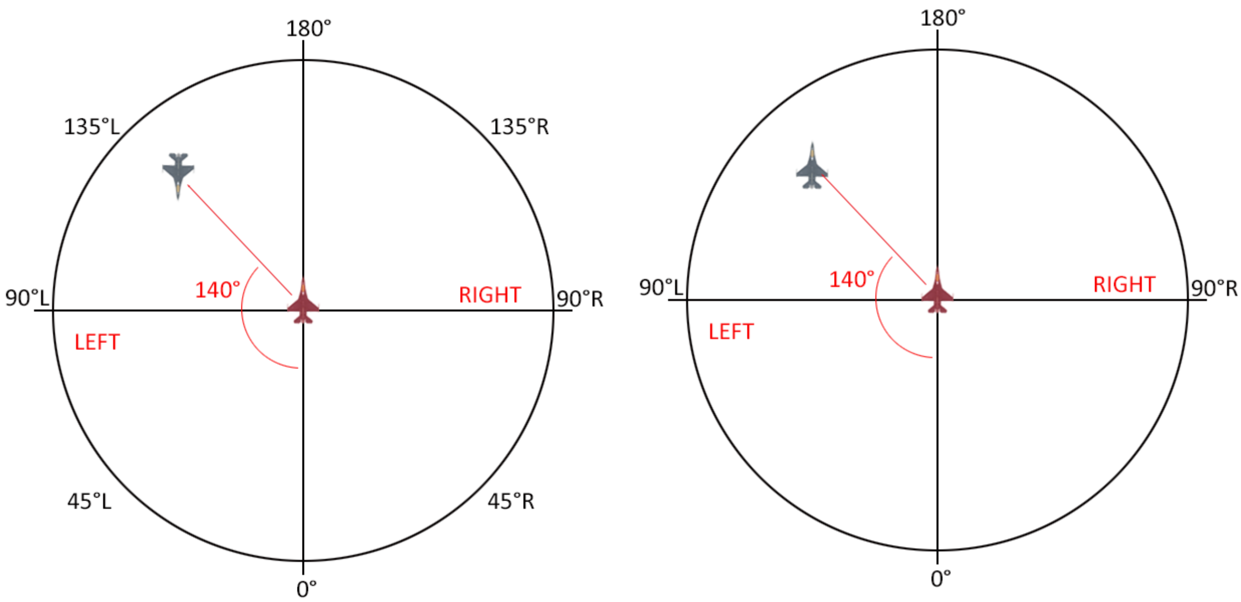
Range is easy. It is the distance between you and the target. It's measured in nautical miles or feet, depending on how close you are from one another. 1 Nm is 6000 feet. Distance is given at multiple places in your avionics depending on your configuration. With a bugged target, the range is given in your HUD below the altitude scale.
Range can also be determined from the A-A FCR MFD page.



Aspect angle

Aspect angle is the number in degrees measured from the tail of the target to your aircraft. It usually has a suffix for left (L) or right (R).

Please note: aspect angle has nothing to do with your heading, as you will see below. It is simply a description of your position *in relation to the bandit's tail*.



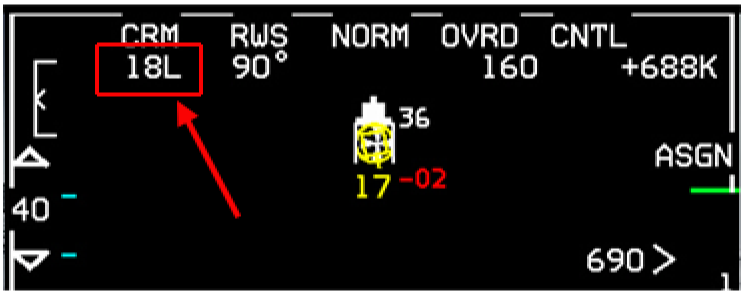
The aspect angle concept must be burned into your brain before proceeding further. Some typical scenarios should be easy enough to memorize:

When you are face to face with your enemy, your aspect is 180° if none of you gets turning room (the aspect will then decrease) you will pass canopy to canopy on a head on pass.

When you are perfectly at your enemy's six o' clock, waiting to fire, your aspect is 0°.

It is your position on the *bandit's* left or right side that determines left or right aspect. It is not which side of your nose the bandit is. Both circles above display 140L aspect, but in the left diagram the bandit is on your left side, in the right diagram the bandit is on your right side. In both cases, however, you are *left of the bandit*, hence 140 *left*.

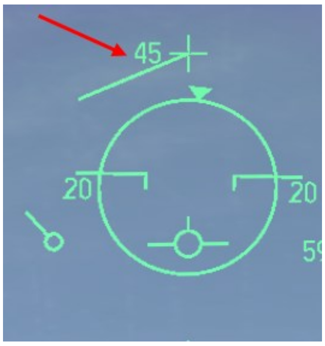
Aspect angle is visible in the FCR and your HUD in any A-A mode once you have bugged a contact.



On the FCR, the aspect angle is displayed in the top left corner in 2 digits plus the L or R suffix. 18L means 180° Left aspect. It's rounded to the nearest 10 degrees. On the HUD, there is a caret on the SRM reticle (representing the missile seeker field of view) identified with the red arrow above. The caret moves around the circle to indicate aspect. When the caret is at 12 o'clock, aspect is 180° (like in this scenario). When the caret is at 3 o'clock, aspect is 90°L. When the caret is at 6 o'clock, aspect is 0°.

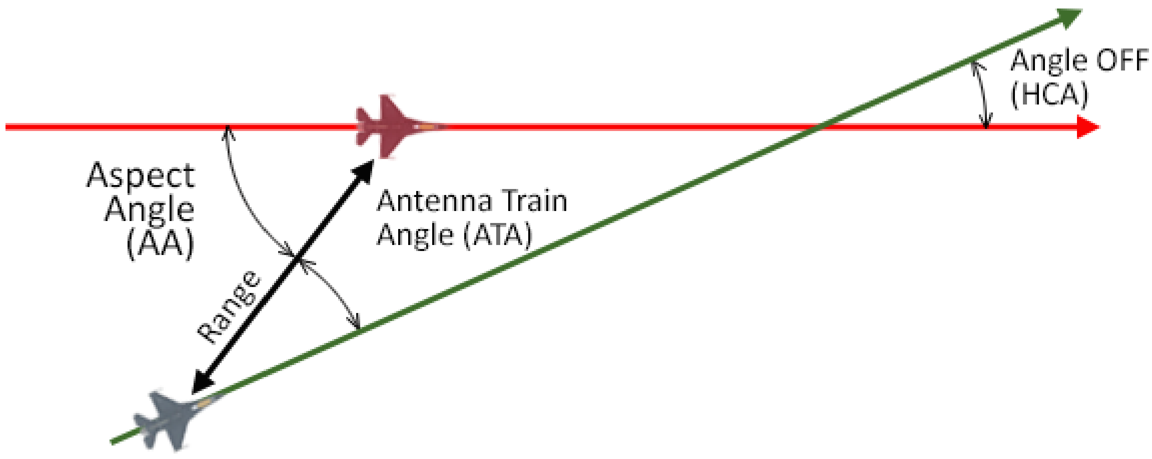
Angle-off or Heading Crossing Angle (HCA)
This angle tells you relative fuselage alignment. It's the angle between your heading and the bandit's heading.
A HCA of 0° tells you that you are flying a parallel course with the bandit. A HCA of 90° tells you that you are flying perpendicular to the bandit.

Antenna Train angle (ATA)
The ATA is the number of degrees the defender is off-boresight of the attacker. This angle is very important because it will tell you when your FCR is about to lose track because the contact exits your FCR scan limits (around 55°).



ATA is displayed next to the TLL (Target Locator Line) on the HUD, which becomes visible as soon as the TD box exits the HUD field of view. It is a concept used often in both BVR and WVR when you want to keep a contact
as close as possible to the radar gimbals.

How does it all work together?
The following image should give you an idea of how these aspects all work together:

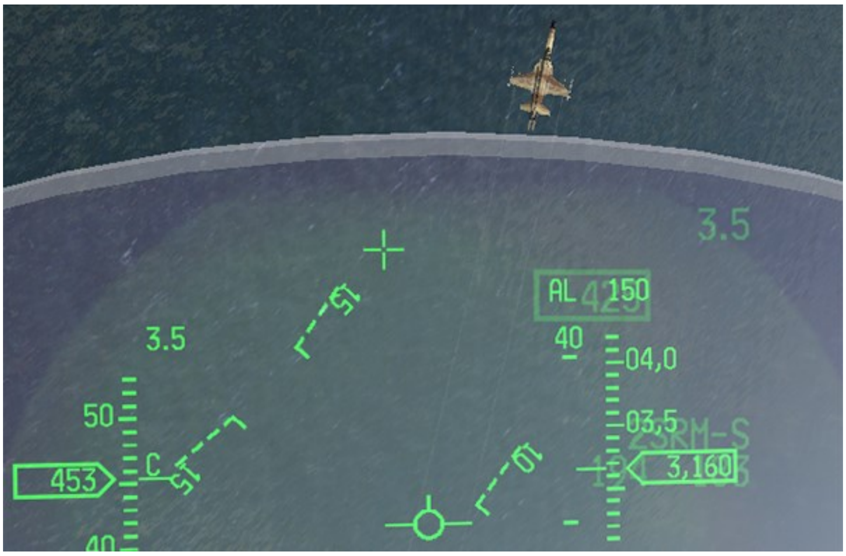


Pursuit Courses
When you maneuver in the same plane of motion as the bandit, your velocity vector determines your pursuit course. This is displayed by the flight path marker (FPM) in the HUD.

With the FPM on the bandit, you're flying a pure pursuit course and will collide with the bandit.

FPM in front of the bandit; you are flying a lead pursuit course and will pass in front of the bandit.

FPM behind the bandit; you are flying a lag pursuit course and will fall behind the bandit.



17A.3 The baseline intercept

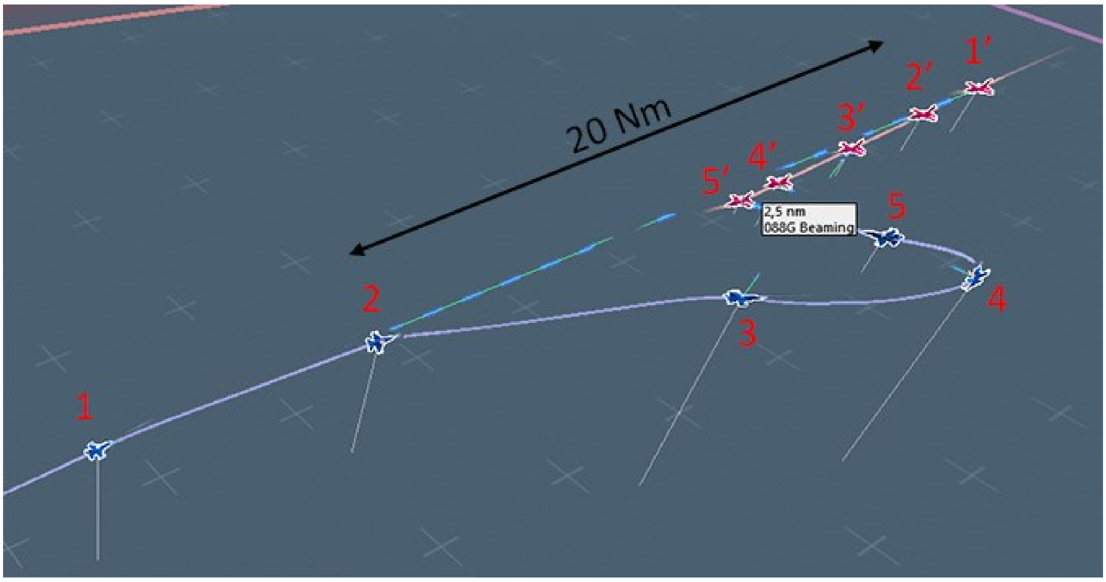
This training mission starts with a contact off the nose at 40 Nm with a requirement that you visually identify (VID) the bogey before shooting. If you keep the contact on your nose you will end up in a head on pass.
You probably will have time to identify the type of aircraft as you flash past, but by the time you have done that you will not be in a good position to shoot it out of the sky anymore.

If the bandit continues straight on course, you now need to turn back towards him and then chase him down before you can actually engage the bandit with your weapons. This wastes time and fuel.

To avoid this situation, we fly intercept profiles. There are many types of intercept profiles. The most common are the baseline intercept and the single side offset. They are basically the same profiles. The SSO is made from further away to minimize the enemy’s capability to target you with its radar, if so equipped. The baseline intercept is usually made on non-maneuvering non-fighter aircraft.

The baseline intercept profile is made up of 5 steps:

1. Detect and close on the target, gain speed and altitude advantage.
2. Offset for maneuvering room.
3. Monitor aspect and range.
4. Go pure pursuit.
5. VID & shoot.



Gain radar contact with your target and assess its speed, altitude, range and initial aspect angle. Increase speed to close the gap quicker and gain altitude separation to make it harder for your opponent to track you.

Around 20 Nm from your target offset to one side to gain lateral turning room. But which way do you turn? First determine which side of the target's flight path you are on by looking at its aspect angle. This is the side you will want to stay on, and will want to turn toward later, since it's the shortest path to the bogey's six o'clock and avoids you flying across its nose. So if the MFD shows *right* aspect, turn (opposite what it shows, i.e. to the left) to keep the contact on the *right* side of the MFD. If it gives you a *left* aspect, turn (right) to place the contact on the *left* side of the MFD. If the contact has an aspect of 180° it doesn't matter which way you turn.

Once you have decided which way to turn, you need to determine how much to turn. The higher the aspect, the more turning room you will need to create; if aspect is lower, you will need to create less turning room.
For higher offsets try to keep the radar contact near the side of the MFD, but be careful not to lose it by exceeding (gimballing) the FCR antenna limits.

Continue to monitor aspect angle, antenna train angle and range. If your target continues flying straight, seemingly unaware of your presence, aspect angle will decrease, ATA will increase, and you may have to turn into the contact to avoid losing FCR track. Use the TLL in the HUD and don't let it go above 50°. Range to the target will decrease. If you notice aspect angle starting to increase, the bogey has probably detected you and is turning toward you to deny you turning room.

When the aspect angle reaches 120° it is time to go pure pursuit on the bogey. Usually that happens around 6-8 Nm. No matter the aspect, go pure no later than 5 Nm. Use the TLL to help bring the bogey into the HUD field of view and try to VID the aircraft. Upon positive hostile identification you can release an infrared missile. To fire a Mike, you don't have to be behind the bandit and pure pursuit will probably bring you within valid shot parameters. To fire a Papa, you may need to maneuver behind the target during your conversion turn.

17A.4 The Mission

This mission starts in MOA 18 at around FL150. You have 2 AIM-9M and 1 AIM-9P Sidewinders and a full load of 20 mm cannon shells for your gun.

A contact will appear on your FCR at around 40 Nm in front of you. You will make a baseline intercept on that contact, identify it as a military transport plane and shoot it with one of your infrared missiles.

Note: You have no AWACS on station and the first contact will lack of any IFF mode 4 response when interrogated (IFF will be the main topic in mission 17B). The ROE (Rules of Engagement) authorizes you to shoot as you meet the declared hostile conditions.

First, set up yourself. Fence in as usual. Make sure you don't forget anything: A-A or MRM master mode, FCR set to 40 Nm on the left MFD, ACQ cursor and ANTenna ELEVation wheel centered, TGP in A-A mode and HSD and SMS on the right MFD. Weapon selected: AIM-9P and MASTER ARM set to ARM.

And don't forget to record your flight instead of analyzing your ACMI will prove invaluable in air to air situations.

Let's make a quick remark about MRM or Dogfight override modes here. The advantage of MRM or Dogfight override modes is that you can quickly access them with just a flip of the switch on the throttle. In an air to ground mission, you are not in A-G master mode all the time. You fly in and out of the target area in A-A and switch to A-G just before striking the target. If you switch to A-G too early, or stay in A-G master mode too long, you may get intercepted by enemy aircraft you were not aware of.

A good habit is to select A-G master mode at fence in, then after you have checked your A-G setup is correct, immediately switch to MRM override mode. That way you stay on top of the air to air picture. Should you need to assess the A-G situation, a swift re-centering of the DOGFIGHT switch on the throttle cancels MRM and puts you back in the previous master mode you were in, in this case A-G.

Another advantage of Dogfight and MRM modes is that your AIM-9M (and newer IR missile seekers) are automatically cooled when in these modes. Since 4.35, the missiles cool in both Dogfight and MRM modes.

We don't use Dogfight mode in this training scenario initially as the intercept starts at 40+ Nm. We use the FCR in CRM or TWS at first to assess the target. Switching to Dogfight mode at the end is optional if you want to gain access to the gun.

Back to the mission…

A radar contact should start to appear around steerpoint 5. If not, check that your antenna is set to scan a volume around 17000 feet at 30 Nm. By pressing TMS left you start the IFF interrogation for mode 1+2+4. Once you received a negative response for mode 4 (no green "4" symbol in the FCR), immediately bug (track) that contact by placing the ACQ cursor (captain's bars) over the blip and depressing TMS up once. You do not want to hard lock the contact by depressing TMS up a second time, because you would go STT on him and if he is equipped with an RWR it will scream at him notifying of your impending attack. So a single TMS up is enough to track the contact in RWS-SAM (Situational Awareness Mode).

After bugging the target, the top of the FCR will provide more information, such as: target aspect angle (18R), target heading (090°), target velocity (160 knots KCAS) and target closure rate (724 kts TAS). From the airspeed you can deduce that the contact is *probably* not a fighter. The contact is at 17000 feet, as are we and it's always better to avoid remaining co-altitude. So start climbing to 20-21000 feet to make you more difficult to detect on radar now, or visually later. You could accelerate, but you already have quite a speed advantage.
You now need to close up on the contact. The FCR displays a 'steering cross' (visible in the screenshot below right - to the right of the bugged target) called the CATA (Collision Antenna Train Angle). When you want to fly the most direct route to a bugged target, center the CATA symbol in the middle of the MFD. In this case, we are already flying a collision course and the CATA is centered already.

At 20 Nm it is time to offset for maneuvering room (below left). I decided to turn left and placed the contact on the right side of our MFD. The aspect reports 17R as I am clearly on the *right* side of the bandit, you may decrease FCR range to 20 Nm to keep the contact in the top half of the FCR page.

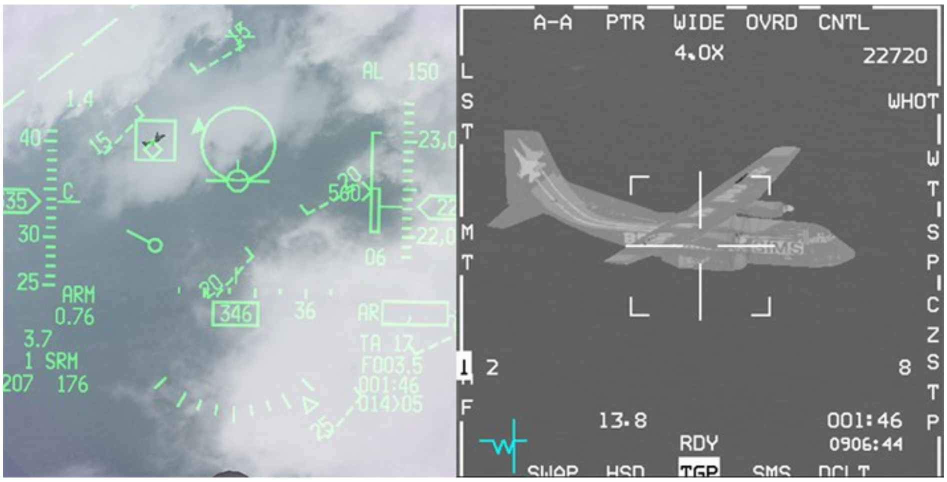
Once the contact is on the side of the MFD, it is easy to lose track and let it drift outside FCR scan limits. To avoid that use the HUD TLL. It displays a line pointing towards the contact outside your HUD field of view and the ATA in degrees. Don't let it go above 50° (55° max). Anytime you come close to 50°, make a check-turn towards the contact to bring ATA back to 45-50°. That will ensure the contact stays within your FCR scan volume. Continue to monitor target aspect angle.

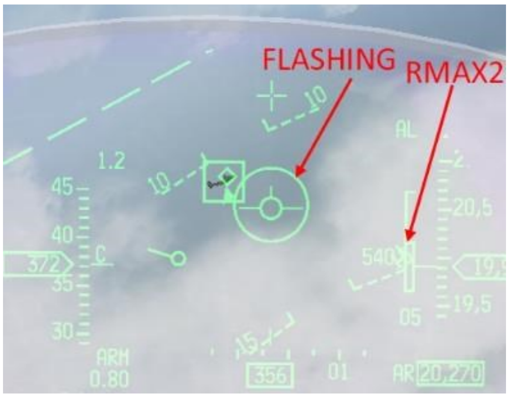
If the adversary pilot is unaware of your intercept, his aspect angle will steadily decrease as you get closer to his six o'clock. If you see the aspect suddenly increase back towards 180°, then he's probably detected/seen you and turned into you, negating your turning room offset. If the aspect angle suddenly decreases rapidly to zero, then the aircraft has turned away from you and is trying to escape.

It is easy to ignore these scenarios at this time, because the target in this mission is totally unaware and continues to fly straight and level. Bear in mind though that a fighter, or a human opponent, will not play the game according to your rules; he will fight back. Paying attention to any aspect angle changes will help keep you in charge of the intercept, provided you know what to do to react to any sudden change.

Range is also decreasing fast and once aspect angle hits 120° (12R) turn towards the contact by flying pure-pursuit. As you can see on the following picture, the contact is now 5.3 Nm at 51° off-boresight to the right.

An aggressive turn to the right brings the TD box into the center of your HUD and you can try to identify the bogey visually. It's definitely a twin engine transport but if you need a better tool at VID, the TGP is your friend. It's a Transall C-160. The TGP will track the same A-A contact as the FCR provided it was setup in A-A mode.





Now that your target has been positively identified, all you have left to do is shoot it out of the sky. But we're not done yet, so spare your weapons. This one doesn't shoot back!

You are almost in a perfect position to shoot one AIM-9P; although not perfectly astern yet. Once you are at RMAX2, the missile circle in the HUD will start to flash.

Wait for the tone to maximize your missile's P_k. AIM-9P seekers are not that sensitive so be patient. Uncage the missile and confirm that the diamond increased in size and you have a good tone; then shoot. **Always uncage before firing**, as you command self-track and can confirm visually that the missile is tracking the correct target before you let it go! If the diamond does not go to the target when you uncage the missile you might not be at a low enough aspect angle, so keep sliding into its tail and attempt to uncage the missile again.

Since 4.34 infrared missiles are impacted by clouds. If the C-160 enters a cloud, chances are that the Papa will miss. Beware of that for now and most importantly for your future use of sidewinders.

Left picture shows the AIM-9P missile just off the rail and the right image shows the missile hit the Transall.

One AIM-9P probably won't be enough to destroy the Transall, so ease up your stern conversion turn to end up straight behind the bandit and select Dogfight mode on your throttle. That will give you immediate access to the gun; line up the bandit in your gunsight and send a few cannon shells on the way to finish him off.

Don't waste your AIM-9M missiles; you may need them for the next aircraft heading in from the North.

Now that's certainly a nice view, but don't celebrate just yet as more aircraft are coming to you and these might fight back. Reset your systems and turn to the North, scanning the skies ahead of you. Check your fuel and weapons remaining. Fuel should be ok and you should have 2 AIM-9M all-aspect sidewinders and some cannon rounds left.

Reset MRM mode, the Mikes are selected automatically. Reset your FCR to 40 Nm range and center the antenna for good measure. HSD and SMS reset on the right MFD.
Scan the airspace in front of you for bogeys.

As said earlier the AIM-9M needs to be cooled. A warm missile seeker will not be as efficient and may fail to track correctly.
Remember Dogfight and MRM mode cool the missile seeker automatically but if you do not use the MRM or Dogfight mode, you need to do this manually.
To cool the missile seeker press OSB 8, labelled WARM.
The mnemonic will change to COOL and the tone will become higher pitched after a short while. Missile status will also change to RDY. Continue to scan north and after a while you will paint a two-ship MiG-19 flight. They are line abreast and fly around 20000 feet on a 200° heading. They are armed with AA-2 (R-13D) ATOLL, which is a reverse-engineered early model sidewinder.

After verifying the contacts are hostile (negative IFF mode 4), perform an intercept on these two contacts, trying to sneak behind them without them noticing you. Follow the same procedure as before, but pay attention to your speed and altitude advantage, and monitor aspect closely to detect immediately if they maneuver. Remember that you perform intercepts from further away on fighters.

A good starting point is offsetting at least 35-40 Nm from them. They don't have a radar as powerful as yours (if any), so although they are a bigger threat than the Transall, they should still be an easy target for you.

You have three missiles left and two targets. The first one you will bug on the FCR for the intercept; your last missile should be fired without radar lock, or in DOGFIGHT override mode. After successful dispatching the MiGs, you can recover at Gunsan airbase to analyze that ACMI tape of yours. Good luck and good hunting.

MISSION 17B: IFF - Intercept *(TR_BMS_17B_IFF_Intercept)*

LOCATION: 13Nm west of Incheon Airbase.

CONDITION: F-16 block 50 – Single ship - Callsign Falcon 1.
GW: 32042 (fuel 8.5). 1 AIM-9M, 2 wing tanks, 1 ECM pod and LANTIRN.
Max G: 7.0/-2.0, Max speed: 600 kts / 1.6 Mach.
Once in the cockpit, the training scripts will freeze BMS and setup your systems accordingly.

WEATHER: RKJK INFO C 020-155Z ILS RWY18 TRL140 140/10KT BLU9/-1 A2974 NOSIG

LEARNING OBJECTIVES: Base intercept an aircraft identified by Seoul GCI which is crossing the Korean DMZ. It is reported that possible defector flights from North Korea may enter the DMZ into South Korea. Identify the aircraft via Mode 3 IFF interrogation. Use the IFF table provided in the following documentation. If the aircraft IFF response matches with the given code at the matching daytime, escort the aircraft to Seoul airbase and defend it on the way to all costs.

NOTE: Please do not use Freeze mode in this Mission – if you need to interrupt the training, use pause.

NOTE: In this training, you will hear scripted sound files which simulate the voice of a Seoul GCI. Volumes can only be adjusted when changing master volume on your playback device. Adjusting UHF and VHF volumes doesn't affect any change.

17B.1 IFF Principles

In modern air warfare, the ability to accurately identify friendly and hostile aircraft is of utmost importance to ensure effective command and control, prevent friendly fire incidents, and maintain situational awareness. The F-16 in BMS is equipped with an IFF (Identification Friend or Foe) transponder and IFF interrogation system, which play a crucial role in enhancing airborne identification capabilities.

The IFF transponder, fitted onboard the F-16, is a sophisticated electronic device that enables the aircraft to respond to IFF interrogations from ground-based or airborne interrogators. It serves as an active transceiver, emitting a coded signal in response to specific queries. The transponder operates on a specific set of frequencies and employs encryption techniques to securely transmit and receive identification information.

The IFF interrogation system, on the other hand, is responsible for sending out identification queries to nearby aircraft. It can be operated by ground-based radar systems or other aircraft equipped with IFF interrogators. These interrogators transmit coded signals, referred to as IFF modes, which prompt the transponders on aircraft to reply with their unique identification codes.

The primary purpose of the IFF system is to distinguish between friendly and hostile aircraft. When an F-16 receives an IFF interrogation signal, the transponder decodes the message and generates a response. This response includes information such as the aircraft's identification code, altitude, and other relevant data. The F-16's onboard systems utilize this data to determine if the interrogating aircraft is friendly or hostile.

The integration of IFF transponder and interrogation capabilities into the F-16 provides numerous advantages. Firstly, it enables rapid identification of friendly forces, reducing the likelihood of mistaken engagements. Additionally, it aids in the identification of non-compliant or hostile aircraft, allowing pilots to take appropriate defensive measures. The IFF system also enhances overall situational awareness by providing real-time information on nearby aircraft, facilitating effective tactical decision-making.

For further information, we recommend reading through the IFF chapter of the Dash-34, chapter 2.2.4 and the Dash-1, chapter 26 to get a complete picture of the IFF functionality in BMS. In this document we only refer to the very basics to avoid doubled reading and doubled content.

17B.2 IFF Modes

One of the critical features of the IFF system is its ability to operate in multiple modes. Mode 1 includes additional information such as the aircraft's mission or role, while Mode 2 includes a unique identification code for the aircraft. Mode 3/A is used to transmit the aircraft's altitude, enabling controllers to monitor and separate aircraft vertically. The F-16's IFF system can also operate in Mode 4, which incorporates encrypted codes for enhanced security.

Mode 1 – Military, 00-77
Mode 2 – Military, 0000-7777
Mode 3 – Military/Civil, 0000-7777
Mode 4 – Military, Encrypted code

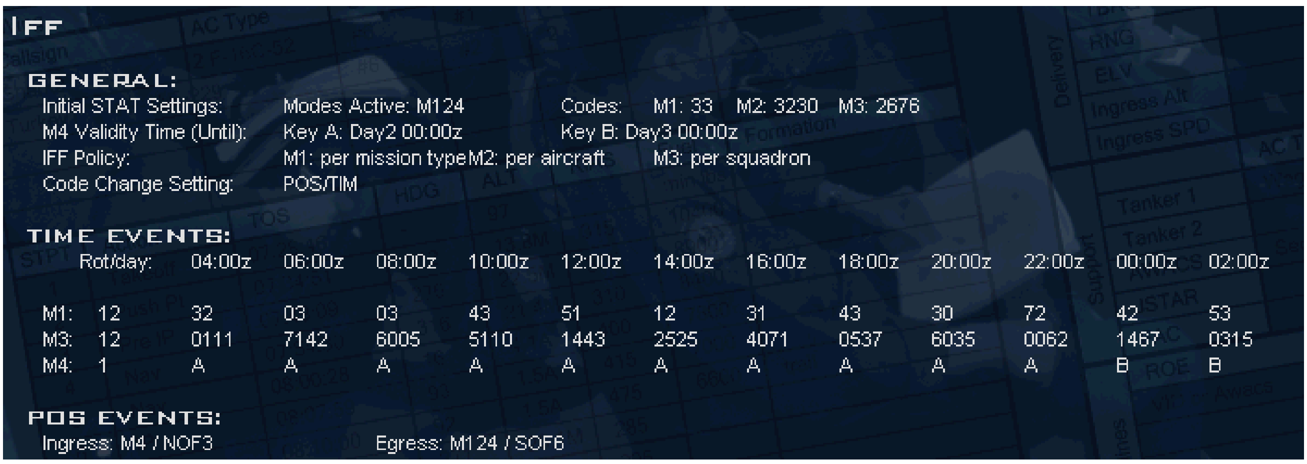
17B.2 IFF Management in BMS

BMS will allocate modes and codes to each aircraft in a flight. AI-controlled aircraft will adhere to the assigned modes and codes, ensuring consistency. As for the player, the DTC (Data Transfer Cartridge) will automatically update with the mission's specific modes and codes.

DTC in BMS

The allocation of codes will be based on the IFF "policy" established by each team for the given mission type. This policy, which defines the rules and guidelines for identification, is documented in a dedicated file named "[MissionName].iff". The structure and content of this file are explained in detail in the BMS Technical Manual.

On the briefing page, you will find all the pertinent information regarding your assigned codes. This includes details on the modes and codes to be used. Additionally, the briefing page will provide policy options for your team, allowing you to make informed decisions in accordance with the established IFF policy.



17B.3 IFF Transponder DED Page

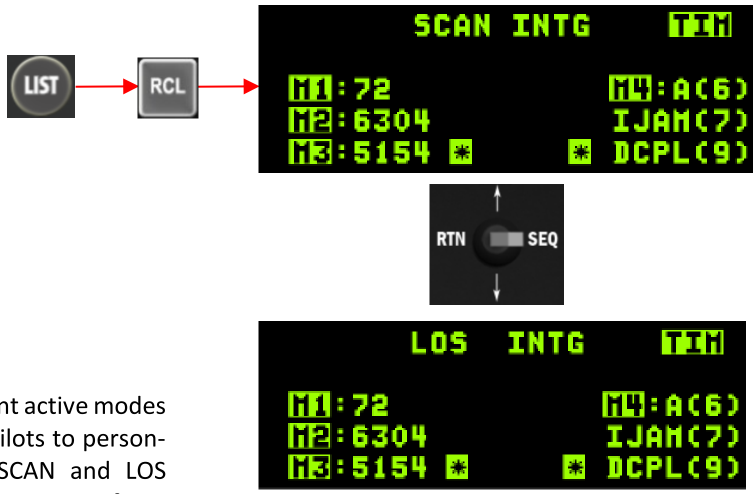
The transponder page can be accessed by pressing the IFF ICP button. This page is used to manage the responses to IFF queries.

The main page is the STATUS page, which displays the currently active modes (highlighted) and their corresponding codes. It is important for these codes to align with the briefed IFF policy.

By pressing DCS right (SEQ), the page will change to the TIME and POSITION pages. These pages are preconfigured based on the DTC setting and will modify the IFF transponder according to the specified time (TIM) and/or position (POS) events outlined in the BMS UI briefing page and BMS UI DTC page. For more information about IFF Transponder DED page and functionality, refer to the Dash-34, chapter 2.2.4.4.

17B.4 IFF Interrogator – Modes and DED Pages

Aircraft equipped with an interrogator have two interrogation modes available:



SCAN and LOS (Line of Sight). Each mode has its dedicated DED (Data Entry Display) page, which can be accessed by pressing the LIST RCL button.

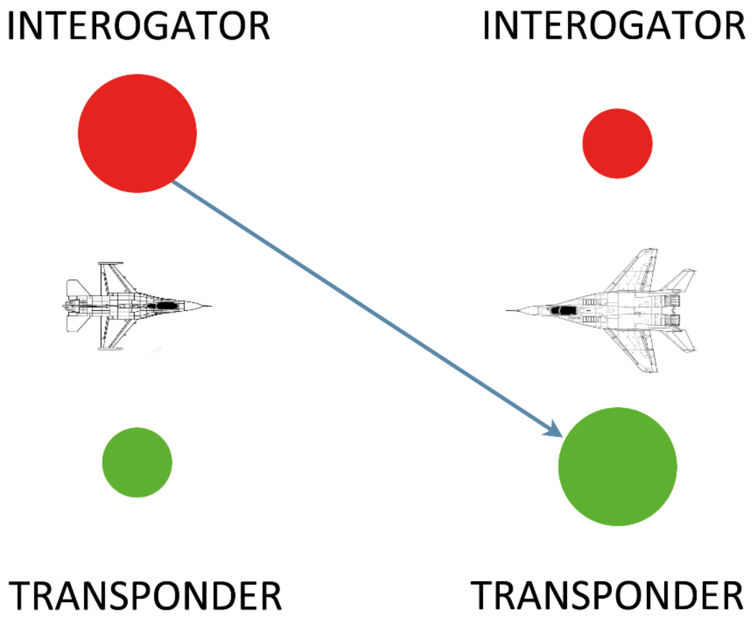
By default, the SCAN INTG (Interrogator) page is displayed, while the LOS page can be accessed by pressing DCS right (SEQ). Both pages follow the same format and operate independently.

For each page, pilots have the option to select different active modes and codes. These selections are retained, allowing pilots to personalize their interrogation configurations for both SCAN and LOS modes. It's worth noting that the transponder and interrogator functions operate independently. While the active modes on the transponder page may align with the IFF policy, pilots retain the flexibility to tailor their interrogation sequence according to their preferences.

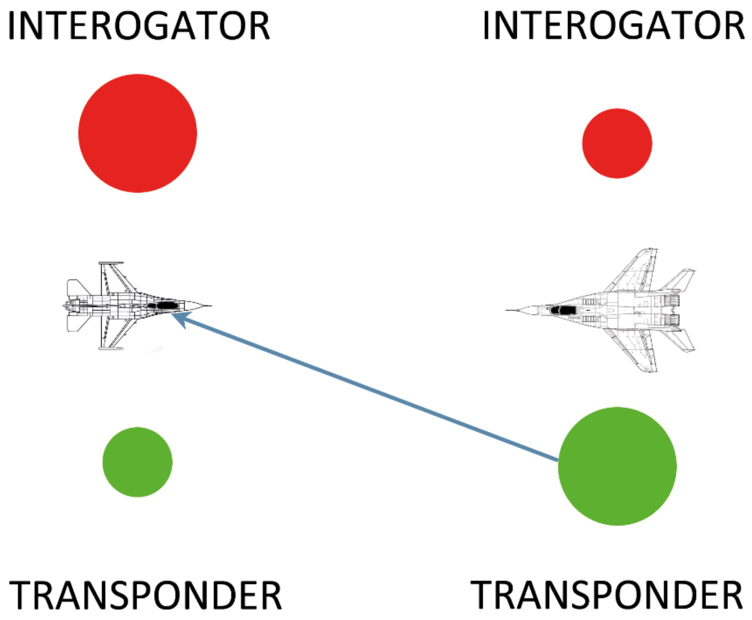
For more information about IFF Interrogator modes and DED pages, refer to the Dash-34, chapter 2.2.4.4.2.

17B.5 IFF Interrogation - Principle

1) Interrogator Aircraft sends query (Mode 1-4 possible, Single mode interrogation or multi-mode interrogation).



2) Receiver Aircraft respond or not respond.



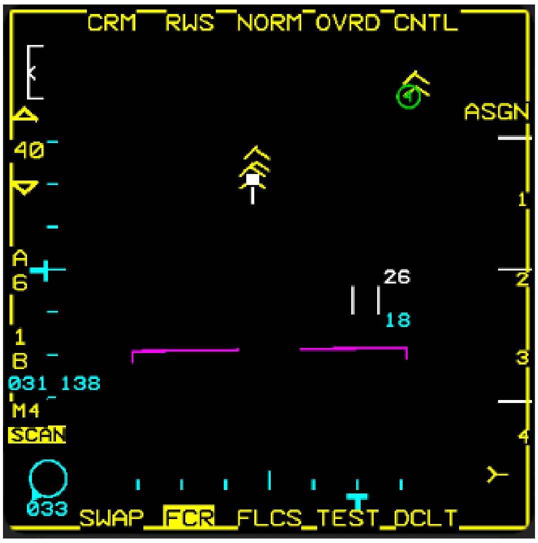
Possible Interrogation responses (MFD)

- A green circle displaying the mode indicates a correct answer and categorizes the target as friendly.

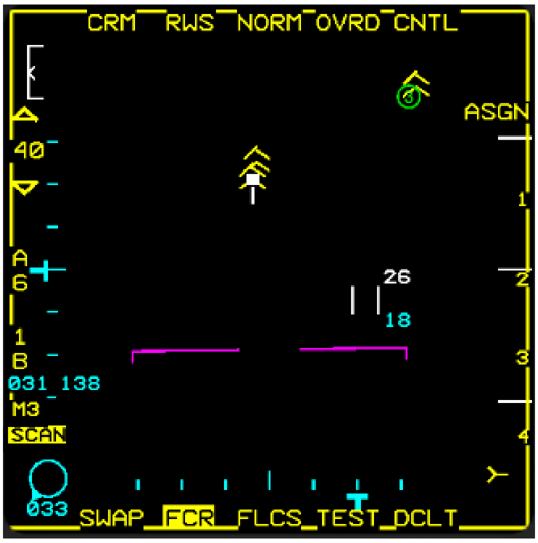
- A yellow square displaying the mode indicates an incomplete answer and categorizes the target as unknown or a bogey.

- During the interrogation process, the current interrogation mode is shown to the left of the acquisition cursor (captain's bars). The display of "M+" (OSB #16) is replaced by the actual mode being interrogated by the IFF system. Additionally, the type of interrogation (in this case, SCAN) is highlighted and displayed below the mode mnemonic.

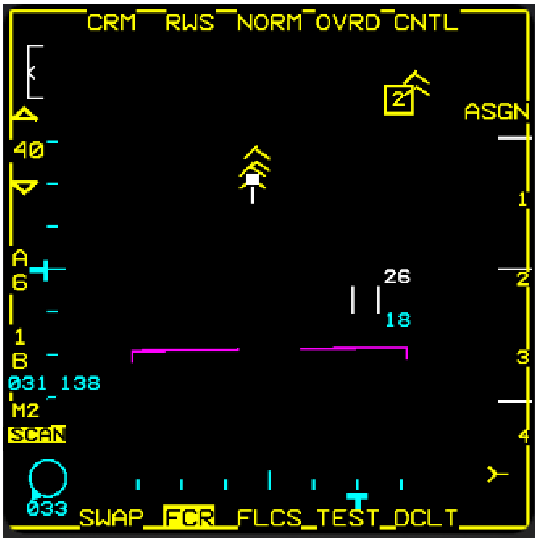
- No responds = No sensor indication



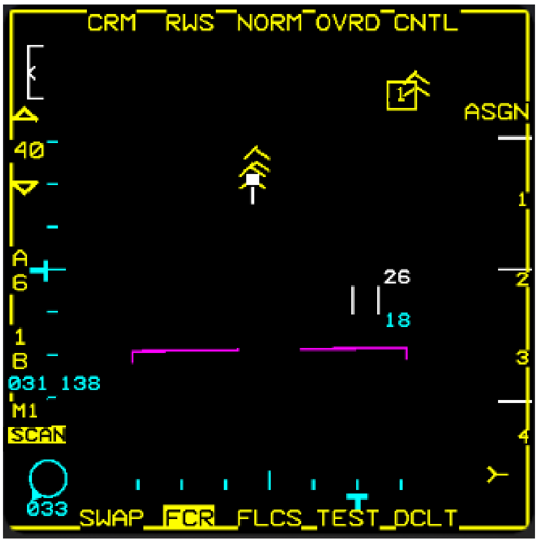
POSITIVE M4 INTERROGATION RESPONSE



POSITIVE M3 INTERROGATION RESPONSE



INCOMPLETE M2 INTERROGATION RESPONSE



INCOMPLETE M1 INTERROGATION RESPONSE

Possible reasons for none responding receivers

- Enemy/hostile aircraft
- IFF receiver is damaged
- Wrong IFF code (also called “Squawk”) is set
- Emergency codes (deviation from IFF policy)

17B.6 IFF Emergency Codes and IFF Control Panel

In case of an emergency, pilots should transmit the following codes appropriate to their status:

EMERGENCY - Mode 3A Code 7700

COMMS FAILURE - Mode 3A Code 7600

UNLAWFUL INTERFERENCE - Mode 3A Code 7500

On IFF control panel of the F-16 you have the option in case of an emergency to select EMER.

In EMER, the IFF can interrogate but responds to interrogations with a fixed emergency code:

Mode 1: 70; Mode 2: 7777 and Mode 3: 7700; Mode C and Mode 4 response is normal.

17B.6 The Mission

This mission is meant to be a continuation of the previous Training "Mission 17A_IR_Intercept".

After your engagements against the Mig-19s, you only have one AIM-9M left. On your way home to Gunsan, you had received order to extend your station time and go to the tanker. After you finished your refueling from Copper 7, a GCI (Ground Controlled Interception) operator contacts you on UHF radio.

Falcon 1

The GCI orders you to intercept a contact near the Korean DMZ (Demilitarized Zone). He gives you a vector of 060° and an altitude of Angels 23 (= 23000ft MSL).

➔ A "Vector" means the instruction to change your aircraft heading to the vectored heading.

He also mentions that the contact is a "Bandit". The brevity code "Bandit" is used in military aviation to refer to a suspected hostile aircraft.
In addition, he uses the brevity "Possible Renegade". "Renegade" means it could be a civilian aircraft hijacked by terrorists to be used as a weapon.

Proceed with heading 060° and descent to 23000ft AGL. Go "Buster" (full MIL power), not "Gate" (full Afterburner).

INTEL officers reported that there is the possibility that enemy military personnel and/or civilian may desert to South Korea soon via aircraft. Therefore, there's a daily IFF policy communicated to undercover agents which are operating in North Korea to identify possible defectors:

TIME EVENTS:

	Rot/day:	00:00z	01:00z	02:00z	03:00z	04:00z	05:00z	06:00z	07:00z	08:00z	09:00z	10:00z	11:00z	12:00z
M1:	24	71	51	63	32	22	20	72	33	50	21	10	40	42
M3:	24	6554	7017	2512	0122	3654	5165	3703	2220	7656	5310	0330	3141	2006
M4:	1	A	A	A	A	A	A	A	A	A	A	A	A	A

The current zulu (Z) time at mission start is 0:53:00z. This indicates that the current Mode 3 (M3) code is 6554 (see above).

Your next task is to insert the correct Mode 3 code in the IFF Interrogator page.

As you can see, the current code in the SCAN interrogator page is 3530. In addition, the M3 is query is not activated.

To activate Mode 3, press “3” on the ICP and “ENT”.

Next, type in the valid code from 0000z-0100z which is 6554. Insert “6”, “5”, “5”, “4” and “ENT” on the ICP.

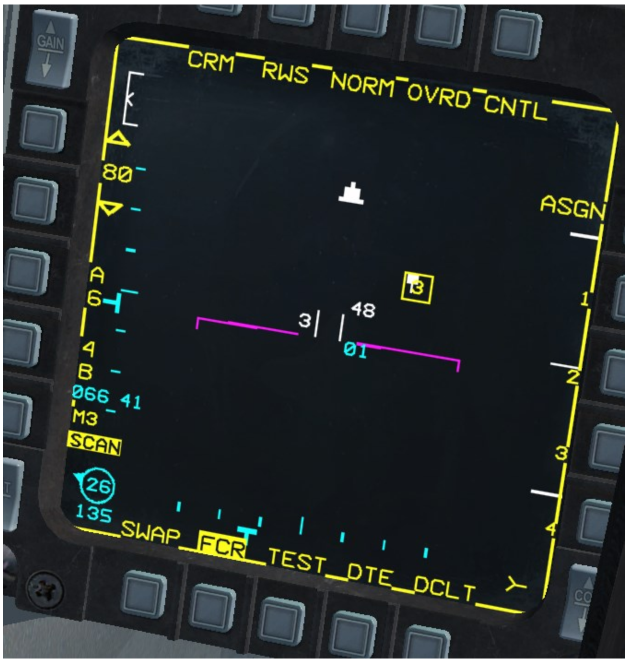
Please note that we only prioritize Mode 3 for this mission because we expect military or civil aircraft. Mode 1 and 2 are for military use only.

Another important step is to check your FCR settings. As you can see, there is already a contact shown in your FCR.

First, adjust Range and Azimuth/Bar Scan parameters as desired. We recommend a range of “80” and a “A6/4B” scan area.

Since we only want to interrogate Mode 3, change your IFF mode to interrogate with OSB 16 to “M3”.

Finally, send your IFF Interrogation by pressing TMS left short.



Depending on the current zulu time it can be that the valid Mode 3 code changed already. The IFF response above shows a yellow square response which indicates an incomplete answer and categorizes the target as unknown or a bogey.

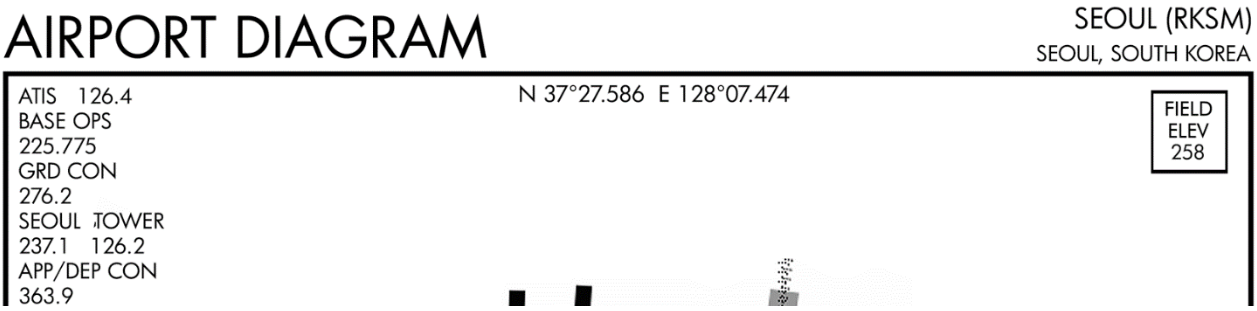
Double check the current zulu time and switch to mode 3 code valid between 01:00 – 02:00z if needed. If there's no discrepancy with the code, chances are great that this aircraft is a bogey or didn't switches to the correct IFF code yet.

Verify again and send another query.

As you can see, the IFF response now shows a green circle which indicates "friendly". Chances are good that our contact will desert to South Korea and has no hostile intentions.

Intercept the aircraft, go in a spread formation to his left side and listen to the instructions of the GCI. Now it is your job to bring this contact home safely!

Seoul airbase is the briefed airport to land on for all cases of defectors. Make sure you have the airport charts ready for Seoul. Punch in the coordinates of the ARP (Airport Reference Point) to give yourself an idea about the location of the airport. Use STPT 99 for LAT/LONG and elevation data.



Since North Korea is aware of the threat of possible deserters, certain SWEEP flights may operate in the DMZ to prevent any transgression of the border to South Korea. Again, protect the aircraft with everything you have at all costs.

In addition to the GCI, you can use AWACS on UHF 6 to give you additional pictures to identify threats to you and the AN-24 flight.

If everything goes as planned, guide the flight to Seoul airbase, land in Seoul as well or fly back to Gunsan if fuel is not critical.

Boxer 7 flight is landed. Well done!

MISSION 17C: IDM – LINK 16 *(TR_BMS_17C_IDM_LINK16)*

LOCATION: 15Nm southwest of Namyang City.

CONDITION: F-16 block 50 – 2-ship - Callsign Mako 6 – Role: SEAD
GW: 39058 (fuel 11.4). 4 AIM-120C, 2 AGM-88, 2 wing tanks, 1 HTS pod, 1 ECM pod and SNIPER.
Max G: 6.0/-2.0, Max speed: 600 kts / 1.2 Mach.
Once in the cockpit, the training scripts will freeze BMS and setup your systems accordingly.

WEATHER: RKSO 010625z 360/10 KT 9999 FEW050 5/-6 Q1009 NOSIG

LEARNING OBJECTIVES: This training is all about basic IDM and Link 16 features. First, you start with IDM but you are free to switch to the Link16 part if IDM knowledge is already existing. When you have finished all IDM related tasks, we will switch to Link 16 related exercises. You will learn how initiate MIDS/Link 16 information, how to use Link 16 information to enhance your SA (situational awareness) and to modify certain Link 16 data.

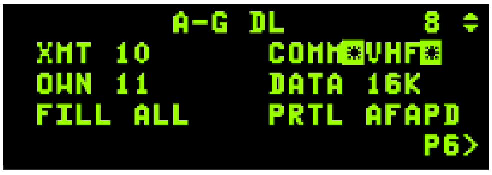
NOTE: The mission will start with autopilot on (ALT hold, STPT select) which should help you to concentrate on avionics changes. You can either use seat #1 or #2 for this training mission.

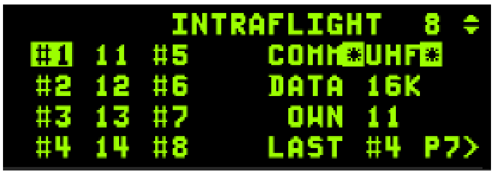
NOTE: If you are already familiar with IDM and you want to learn about the L16 only, please skip the rest of this chapter and move straight to chapter 17C.3.

17C.1 IDM Principles

The F-16's improved data modem is a crucial component of its avionics system, enhancing communication capabilities for both command and control purposes and data transfer. The IDM facilitates seamless and secure transmission of various types of data, including mission-critical information, sensor data, and tactical updates between aircrafts. IDM was designed in the late 70’s before LINK 16 was on the horizon of the aircraft manufactures. Even if limited in features compared to MIDS/JTIDS systems, it follows the same principle of exchanging data.

Since 4.32, IDM is implemented in BMS. This manual will not repeat the principles and knowledge which is already written down in the Dash-34 chapter 2.4.4. If you want to learn everything about IDM, please refer to this chapter.



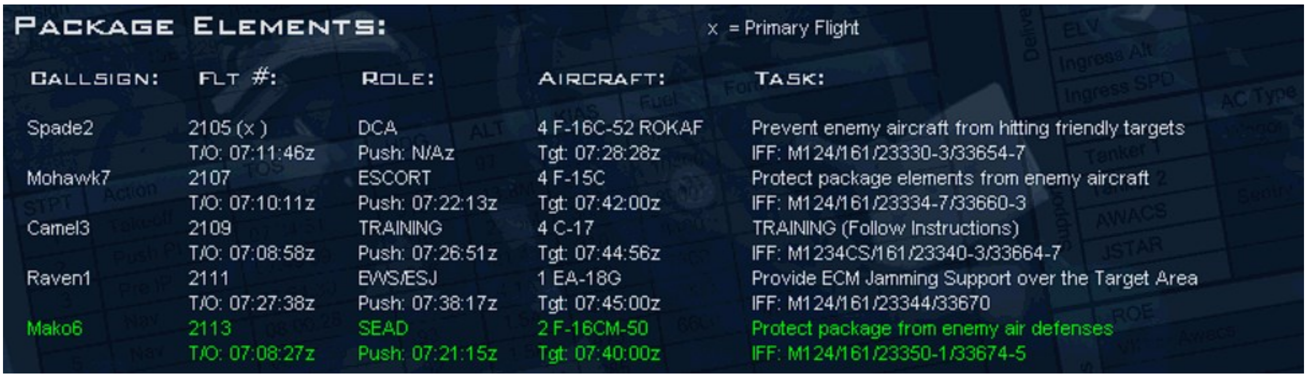


Exchanging IDM data in BMS between aircraft is based on the following factors:

- AVIONICS POWER Panel must be in the DL position for the system to be functional.
- Aircrafts which want to exchange data are on the same UHF or on the same VHF radio frequency.
- Aircrafts have set IDM numbers from aircrafts which they want to exchange data with (set in the DED page 7).
- CONT, DMD or ASGN mode of operation is activated to exchange location data.
- HSD is SOI when exchanging A/G data (Markpoints).
- FCR is SOI when exchanging A/A data (Data link assignment target positions).

17C.2 The Mission - Part 1 (IDM)

In this training mission, our flight Mako 6 consists of a package of five flights as seen below:



PACKAGE ELEMENTS: x = Primary Flight

CALLSIGN:	FLT #:	ROLE:	AIRCRAFT:	TASK:
Spade2	2105 (x)	DCA	4 F-16C-52 ROKAF	Prevent enemy aircraft from hitting friendly targets
	T/O: 07:11:46z	Push: N/Az	Tgt: 07:28:28z	IFF: M124/161/23330-3/33654-7
Mohawk7	2107	ESCORT	4 F-15C	Protect package elements from enemy aircraft
	T/O: 07:10:11z	Push: 07:22:13z	Tgt: 07:42:00z	IFF: M124/161/23334-7/33660-3
Camel3	2109	TRAINING	4 C-17	TRAINING (Follow Instructions)
	T/O: 07:08:58z	Push: 07:26:51z	Tgt: 07:44:56z	IFF: M1234CS/161/23340-3/33664-7
Raven1	2111	EWS/ESJ	1 EA-18G	Provide ECM Jamming Support over the Target Area
	T/O: 07:27:38z	Push: 07:38:17z	Tgt: 07:45:00z	IFF: M124/161/23344/33670
Mako6	2113	SEAD	2 F-16CM-50	Protect package from enemy air defenses
	T/O: 07:08:27z	Push: 07:21:15z	Tgt: 07:40:00z	IFF: M124/161/23350-1/33674-5

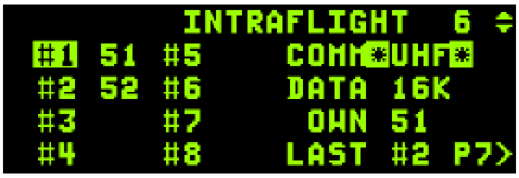
The package task is to simulate a halo jump from a SEAL team in one of the C-17 above international waters. The task of all other flights of the package is to protect the C-17 flight and secure the area. All other nations in this environment are neutral. Only CIS is hostile. Avoid crossing the border line which is marked in the 2d map and your HSD.

Be aware that your autopilot is activated automatically and STPT 6 is selected once entering 3d. That gives you more freedom to be heads down and learn more about today's topic.

Since you decided now to learn more about IDM, the first step to execute is to switch OFF MIDS LVT knob on the right panel so we can fully concentrate on IDM.

The first thing we want to achieve is that we are aware about the position of all C-17 aircraft in our package. Since the C-17 is not L16 capable, we must use IDM to enhance our SA (Situational Awareness) on the HSD and FCR.

Let's look on the IDM DED page 7. Select LIST and then ENTER on the ICP. This brings you to the IDM subpage 5. Select two times SEQ on the DCS switch to select IDM subpage 7 (P7 bottom right).

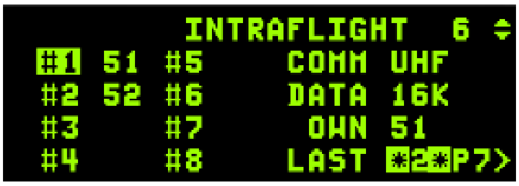


As you can see, the IDM position #1 and #2 is set by default to 51 and 52. Since we are the fifth flight in the package (see package picture above), our IDM group is 50. The flight lead has the number 51, the wingman 52, etc.

The Camel 3 flight (C-17) is the third flight of the package. So, it has IDM group 30. Since this flight consist of four airplanes, we need to insert IDM number 31-34 in our IDM list for slot #5-8. You can also use slot #3-6 or whatever you prefer.

Since U4 the process of adding new IDM numbers has changed a little bit. The entry process goes as follows:

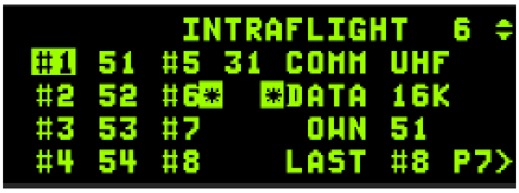
Select UP or DOWN on the DCS switch till the entry for LAST is selected.



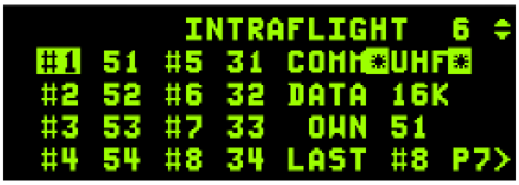
Since we plan to fill IDM slot #5-8, we must set #8 for the LAST entry on the IDM list (till U4, this was done automatically). Press 8 and ENTER.

Please note that if you didn't increase the LAST number to the IDM entry you want to fill, the IDM page will blink with no entry saved.

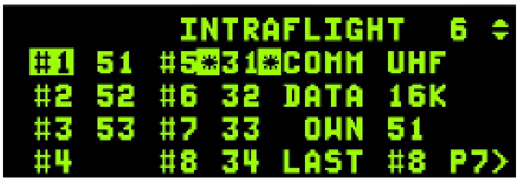
Next, move the ICP switch UP or DOWN till we have #5 selected. Press 3 and 1 on the ICP and ENTER. Congratulations, you created your first IDM entry.



Repeat the process till you have all IDM entries 31-34 inserted.



Note: as you can see, entry 53+54 for #3 and #4 has been created automatically. If you need more entries, you can easily delete any entry by selecting the desired number with DCS UP or DOWN, press 0 and ENTER on the ICP.

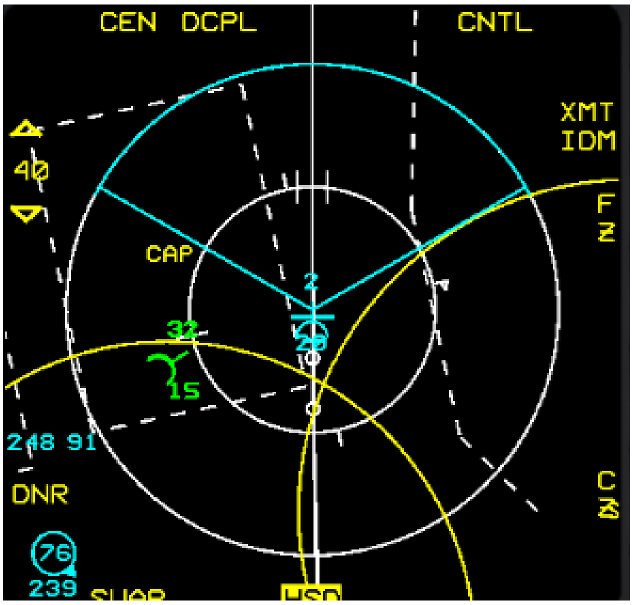


Next, let's focus on the HSD.

So far, you should see no datalink indication on your FCR or your HSD page. To start the data exchange, you must initiate the IDM query. You can do that either in DMD, ASGN or CONT mode (mode select OSB 6 on the FCR). Please refer to chapter 2.4.4.4.1 of the Dash-34 for in depth info of all modes of operation. Select ASGN mode.

Depress COMM switch left for >0.5 sec. Verify ASGN mnemonic is highlighted for 2 seconds. The IDM query begins and will take about 8 seconds. Now monitor the HSD and FCR.

As you can see we have now different data link tracks after one full query. The cyan "2" is your wingman. The green contacts to the south are the C-17's.



You can now decide to switch to CONT mode. This initiates an IDM query round every 10 seconds automatically.

Since the goal is to have complete SA about all assets of your package, we will now focus on Link 16.

17C.3 LINK 16 Principles

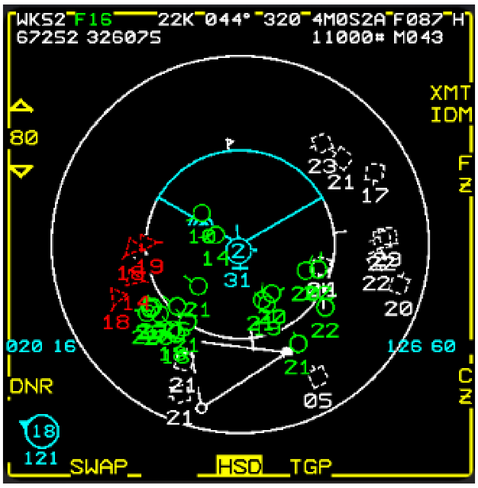
Link 16 is a secure, jam-resistant, digital data link used by military aircraft, including the F-16, for real-time exchange of tactical information. It enables seamless communication and coordination between friendly forces operating in the air, on land, and at sea.

Link 16 operates in the UHF frequency band, providing line-of-sight and beyond-line-of-sight connectivity over considerable distances. It employs a TDMA (Time Division Multiple Access) architecture, allowing multiple users to transmit and receive data on the same frequency without interference.

Key features of Link 16 in BMS include:

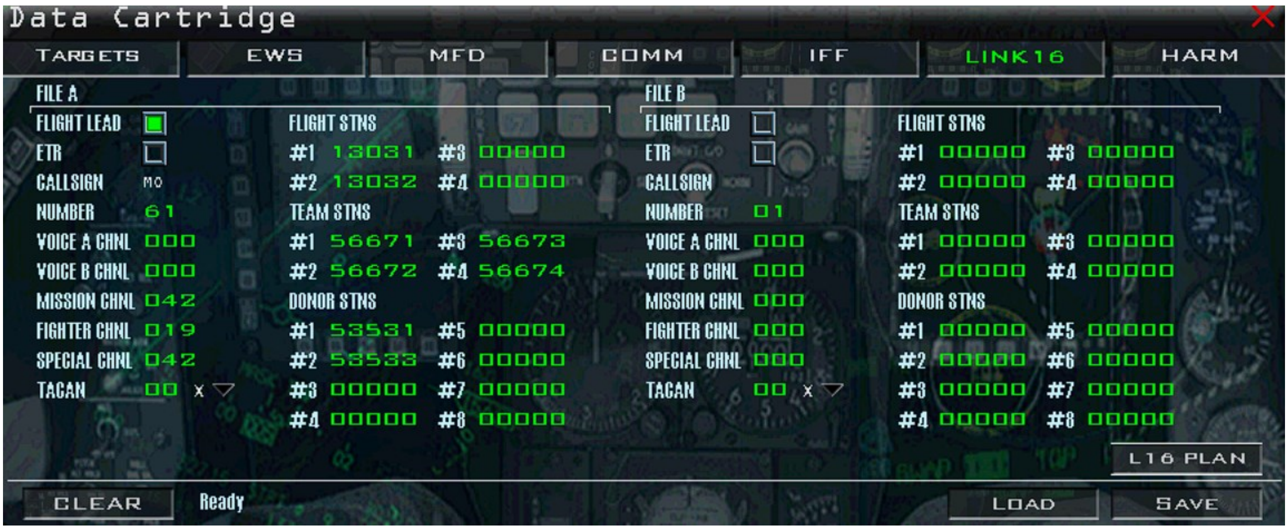
- Network-centric operations: Link 16 facilitates network-centric warfare by enabling sharing of critical battlefield information such as aircraft position, velocity, identification, mission status, and target data in near real-time. This enhances situational awareness and enables more effective decision-making.

- Interoperability: Link 16 is designed to be interoperable with allied forces and coalition partners, allowing seamless integration and coordination between diverse military assets, including aircraft, ships, ground vehicles, and command centers receiving PPLI and SURV air track data (refer to the -34 for more information).



For the F-16, Link 16 integration enhances the aircraft's ability to operate as part of a networked force, enabling effective collaboration with other platforms and improving overall mission effectiveness. It supports various mission types, including air superiority, close air support, interdiction, and reconnaissance, by providing pilots with timely and accurate battlefield information.

Since 4.37 U4 Link 16 is implemented in BMS, and its features will be further enhanced in future updates. This manual will not repeat the principles and knowledge which is already written down in the Dash-34 chapter 2.4.3. If you want to learn everything about Link 16, please refer to this chapter.



In terms of handling the L16 tab in BMS: once you have taken your desired seat in 2d, a new part of your already know DTC "Click Dance" will be pressing the L16 PLAN button. All data is set by BMS automatically but can be changed if necessary. For more information about the BMS DTC Link 16 tab, please refer to the BMS User Manual chapter 5.1.8.

17C.4 LINK 16 General Terms

FC Fighter Channel (automatically set by BMS), can be manually set between 0 and 126-> is responsible for exchanging information between fighter aircraft *(tracking and lock information -> not implemented yet).*

MC Mission Channel (automatically set by BMS), can be manually set between 0 and 127-> is responsible for exchanging information with AWACS or other C2 platforms (SURV air track data).

STN Source Track Number. Contains all members of your own flight by default, can be manually changed between 00000 and 77776 (excluding 00077, 00176, 00177, 07777).

PPLI Air Precise Participant Location Identification is a transmission from Link 16 air participants, furnishing network participation status, identification details, positional data, and relative navigation information. It encompasses the voice call sign, position coordinates (latitude/longitude), altitude, course, IFF codes, air platform type (e.g., fighter, bomber, attack), and air platform activity (such as engaging, investigating, etc.).

SURV This message serves to share air track data, predominantly disseminated by a command and control (C^2) agency. It comprises details regarding exercise/non-exercise tracks, including track number, strength, position, speed, course, identity (such as pending, unknown, assumed friend, friend, neutral, suspect, hostile), IFF codes, air platform type (generic categories like fighter, bomber, attack, etc.), and specific air platform type (e.g., F-15, F-16, Mig-29, etc.).

JDN Joint Data Net is an interconnected network of JTIDS/MIDS–based systems, which links air and missile defense command and control and weapons systems across armed forces.

NPG FC and MC channels are part of dedicated NPG’s (Network Participation Group). Each channel and its number define what data can be exchanged on the channel. If you create a package for example, all Link 16 capable aircraft of this package will have the same FC and MC (because one AWACS controller will be responsible for this package).

17C.5 LINK 16 Context and examples

Ownship position (i.e., you)

AWACS ownship position

AWACS L16 SURV air track transmission range (~400nm) *NOT TO SCALE*

SURV ownship receiving range (~100nm from ownship)

Flight STNS PPLI air track (1-4)

Friendly PPLI air track

Contact detected by AWACS, not shown on ownship HSD/FCR/HUD/HMCS

Unknown/Suspected Hostile SURV Air Track

PPLI air track transmitting/receiving range (~150nm from ownship)

Hostile SURV Air Track

Team STNS PPLI air track (5-8)

Friendly SURV Air Track

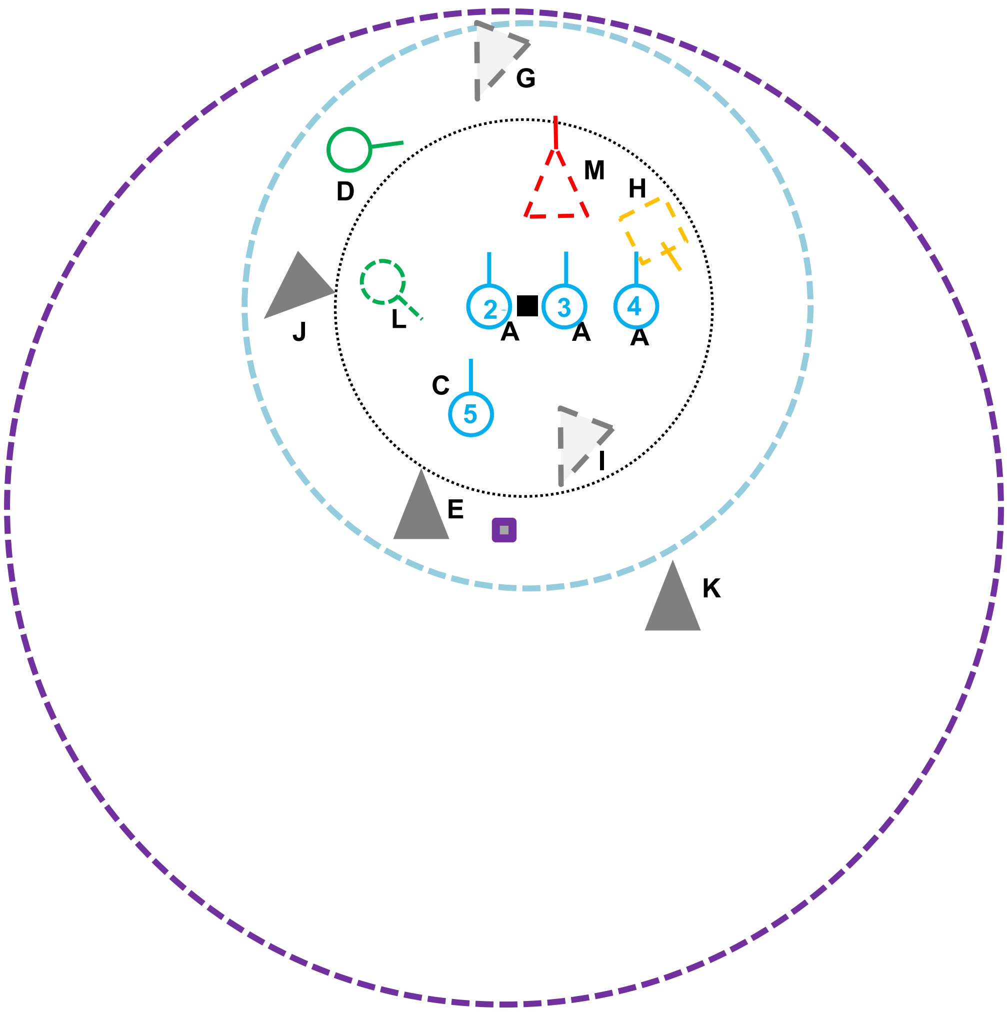
Aircraft not detected by AWACS

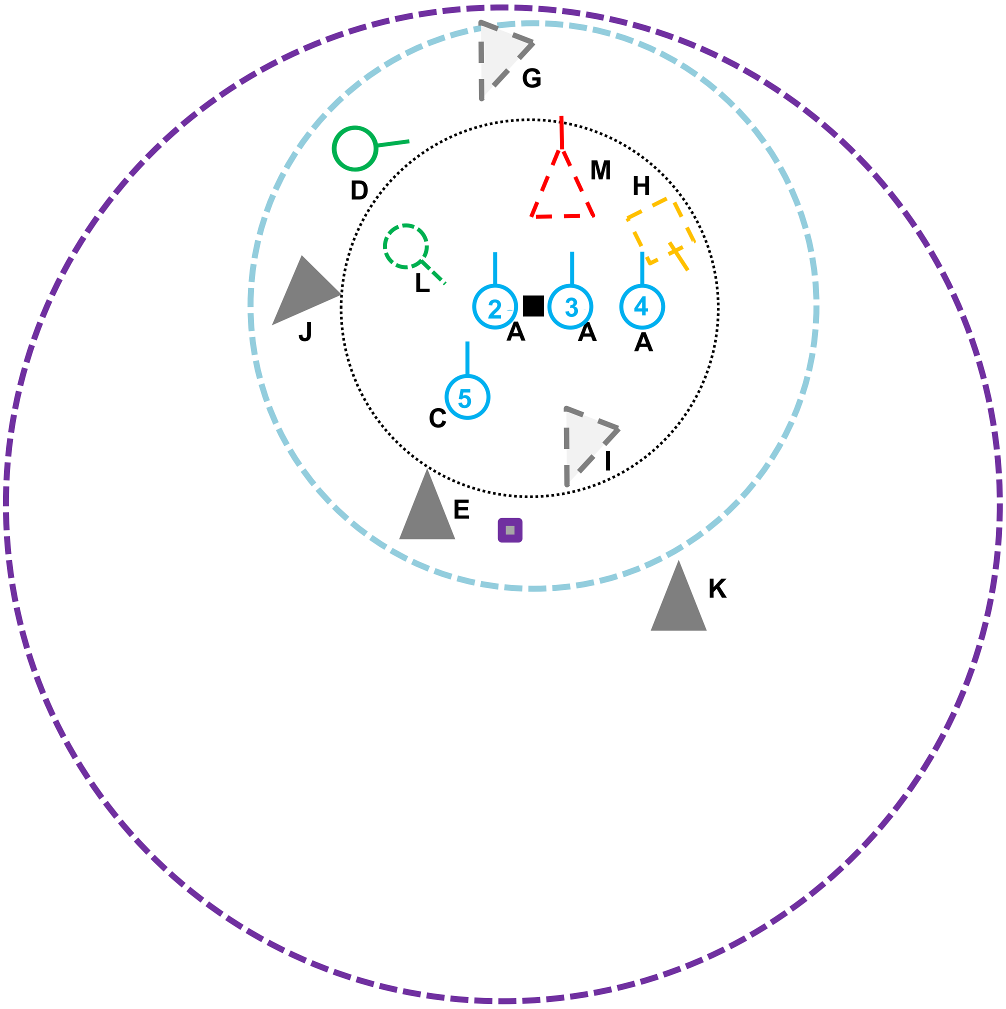
Practical examples

A) Flight members, set as ‘Flight STNS’ in DTC, within 150nm PPLI receiving range: Shown on HSD/FCR/HUD/HMCS (PPLI air track).

B) Placeholder (no icons shown).

C) Package Member, set as ‘Team STNS’ in DTC, within 150nm PPLI receiving range: Shown on HSD/FCR/HUD/HMCS (PPLI air track).





D) Friendly, on the same Joint Data Network, within 150nm PPLI receiving range: Shown on HSD/FCR/HUD/HMCS (PPLI air track).

E) Friendly, detected by AWACS, within AWACS 400nm SURV air track transmission range but outside 100nm SURV receiving range: Not shown on HSD/FCR/HUD/HMCS (SURV air track).

F) Placeholder (no icons shown).

G) Hostile not yet detected by AWACS (outside of the ~135nm AWACS radar range), hence no SURV track.
Note (once within 100nm SURV receiving range): Once detected by AWACS, track will become 'Unknown' (white dashed square). Once ID'ed as unknown/suspected hostile, it changes to a yellow square (e.g. H). It will change to a red triangle (e.g. M) once classified as hostile.

H) Unknown/suspected hostile, detected by AWACS, within AWACS 400nm SURV air track transmission range, within 100nm SURV air track receiving range: Shown on HSD/FCR/HUD/HMCS (SURV air track).

I) Hostile, not detected by AWACS (despite being within AWACS detection range, e.g. bandit terrain masked or stealth). No SURV air track, despite being within 100nm SURV receiving range and 400nm SURV air track transmission range.

J) Hostile, detected by AWACS, within AWACS 400nm SURV air track transmission range, not within 100nm SURV air track receiving range: Not shown on HSD/FCR/HUD/HMCS (SURV air track).

K) Friendly, on the same NPG, not within 150nm PPLI receiving range: Not shown on HSD/FCR/HUD/HMCS.

L) Friendly, detected by AWACS, within AWACS 400nm SURV air track transmission range, within 100nm SURV receiving range but on different NPG or not L16 capable: Shown on HSD/FCR/HUD/HMCS (SURV air track).

17C.6 LINK 16 Q&A

Since Link 16 is a milestone to the BMS community, we summed up the most frequently asked questions in this Q&A section:

1) Why the circles of Link16 on the HMCS are not overlapping with the aircraft?

BMS simulates drift of the HMS in a very accurate way. As in real life, the HMS needs to be re-aligned a couple of times during a mission.

We suggest aligning at ramp start, end-of-runway (EOR) checks and fence-check in. This will mitigate the offset but will not eliminate completely, as in the real aircraft.

2) Why the circles on HMS and HUD keep jumping around and sometimes do not overlap with the aircraft?

Link16 is a network based on updates at given times. Update times can be fast within few seconds for FLIGHT PPLIs to very long values (3 minutes) like fuel updates for PPLIs.

So, depending on the track type (PPLI or SURVEILLANCE) and track quality, these updates times may change significantly and lead to these jumps.

Remember, Link16 is not an continuous signal. MIDS/JTIDS receive signals and do extrapolations.

If the aircraft makes abrupt changes in flight path between updates, circles etc. will not overlap at all with aircraft anymore.

Moreover, BMS implementation in U4 simulates delays, precision, and different types of updates.

3) Everything seems correct on UI, but I cant see any L16 symbology on my displays.

Check if MIDS is on, DTC loaded, Net sync.

4) I am trying to run an old TE/Campaign but I cant see any L16 symbology in cockpit.

Link16 in BMS requires a configuration file for the network (extension xxx. l16.txtpb). This file is already set for all campaigns and new TEs created in 4.37.4.

For old TEs and campaigns you need to follow these steps:

- Simply make a copy of the Te_New.l16. txtpb
- Rename it with the name of your TE/Campaign. For example, if the file is Operation Puma.tac , then rename the copy of the Te_New.l16.txtpb to Operation_Puma.l16.txtpb

And you are good to go.

5) I can see the PPLI circles in green and blue, but I don't see any other white, yellow, or red circles.

These other circles are Surveillance (SURV) circles. To see them, there are a couple of things which are required:

- The Link16 Network design must have a Surveillance NPG.
- You need an AWACS on your team.
- AWACS must be able to detect these tracks. It considers terrain/altitude, if in range and if jammed by SOJ platforms.
- You need to be in range of the JTIDS of the AWACS to get the signal. The JTIDS of a E-3 is more powerful than MIDS of the F-16 (about 400nm 'ish range)

6) Why some Link16 symbology keeps disappearing and reappearing in the MFDs?

BMS simulates the MIDS/JTIDS by implementing the so called System Track File (STF). This file is a container for a up to 40 tracks.

BMS simulates a priority system to display the most important tracks. So, the simulated logic may drop less important tracks in situations with many tracks.

For example, friendly surveillance tracks far away from own aircraft are less important than tracks identified as hostile at closer range.

Logic in the MIDS/JTIDS to store tracks on the STF follows this priority system as per real life:

- PPLI of FLIGHT and TEAM are always stored.
- Mission objectives track (N/I in U4)
- FLIGHT and TEAM members TOI (N/I in U4)
- FLIGHT and TEAM members shot lines (N/I in U4)
- DONOR tracks (TOI and shots) (N/I in U4)
- Surveillance Tracks (range, ID, closure rate)
- DONOR PPLIs (range)
- Other PPLIs (range)
- additionally, the PDLT is ALWAYS stored.

7) I can't distinguish surveillance friendlies from PPLI tracks.

The surveillance friendlies are green circles with dashed lines. Due to the low resolution of the MFDs in U4, it is indeed hard in some cases distinguish them from PPLI tracks, especially when circles are overlapping.

8) If I shot down an enemy AWACS E-3, will the enemy loose its Link16 capability?

No, only the SURVEILLANCE NPG will be out. PPLI NPG will still be active as far the aircraft are in range of each other.

MIDS/JTIDS in fighters has a typical range of 150nm.

9) I don't understand this NPG thing.

This first round of development of Link16 in U4 enables two types of NPG (Network Participation Groups): Precise Participant Location and Identification (PPLI) and SURVEILLANCE INFORMATION (SURVINFO).

The PPLI is a type of NPG where aircraft (and later ground units, ships, patriots, etc.) with a Link16 terminal (like the MIDS) share tons of data like ammo, position, speed, altitude, etc.

The SURV is a type of NPG where a C2 unit (in BMS = AWACS) shares tracks it has detected. As you can imagine much less information is available and in U4 it (try to) aligns with our AWACS Request Picture/Declare the best we can.

The way NPGs were implemented allows to implement Link16 in different ways. In U4, one can have three different types of Link16 networks:

1. One with PPLI and SURVINFO

2. One with only PPLI

3. One with only SURVINFO

10) Why are tons of F16s flying in Korea without any PPLI?

Not all F-16s have Link16. The F-16s block 32 of ROKAF are one example.

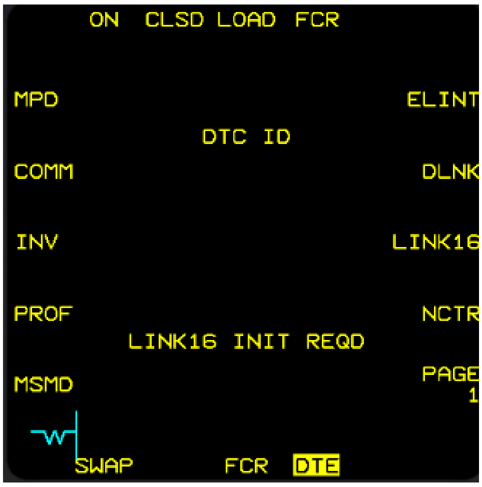
11) Where are the shot-lines in the HSD?

N/I in U4. Check 4.38.

12) When I am deep into enemy territory, I only see the blue circles of my FLIGHT PPLI. Why is that?

You are too far away from the AWACS to receive SURV tracks (>400nm ish) and too far away from other PPLI (> 150nm ish).

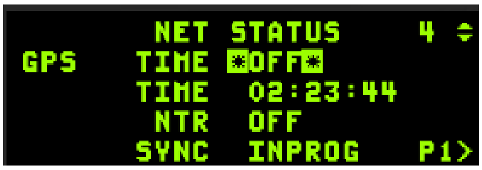
17C.7 The Mission - Part 2 (LINK 16)



If you haven't switched OFF your MIDS LVT selector yet (as mentioned in chapter 17C.2), do it now. Link 16/MIDS is now deactivated. To reactivate it, switch the MIDS LVT selector back to ON position and open the DTE page on the MFD.

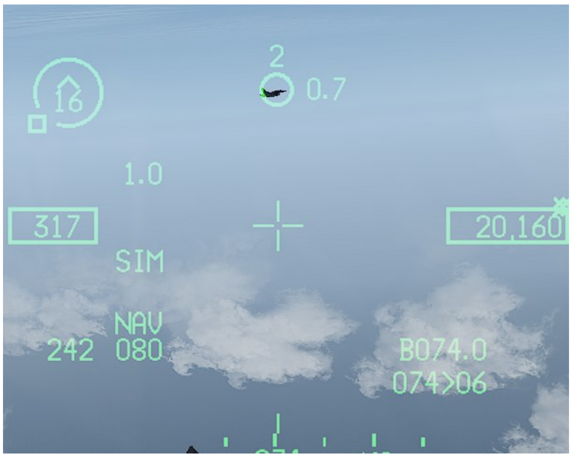
The L16 data base needs to be loaded again from the DTC. Press OSB 8. The LINK16 mnemonic will illuminate. After 10-15 seconds, you get the information LINK16 INIT REQD (Link 16 Initialization Required). Press again OSB 8. After another 15-20 seconds the status will read LINK 16 INIT CHECK.

That means that the DTC is now fully loaded, and the net entry process begins. The status of the net entry can be monitored on the IDM/L16 subpage 1. SYNC status goes from BLANK to INPROG to COARSE to FINE. When the status shows FINE, Link 16 initialization is complete.



Link 16 in BMS doesn't just bring DED and HSD/FCR features, but dedicated HUD/HMCS symbology as well.

The first feature is the Flight Member 1-4 symbology which indicates the flight member number and the distance to the ownship. This tool is very useful to keep a detailed overview about your own flight or other assets.



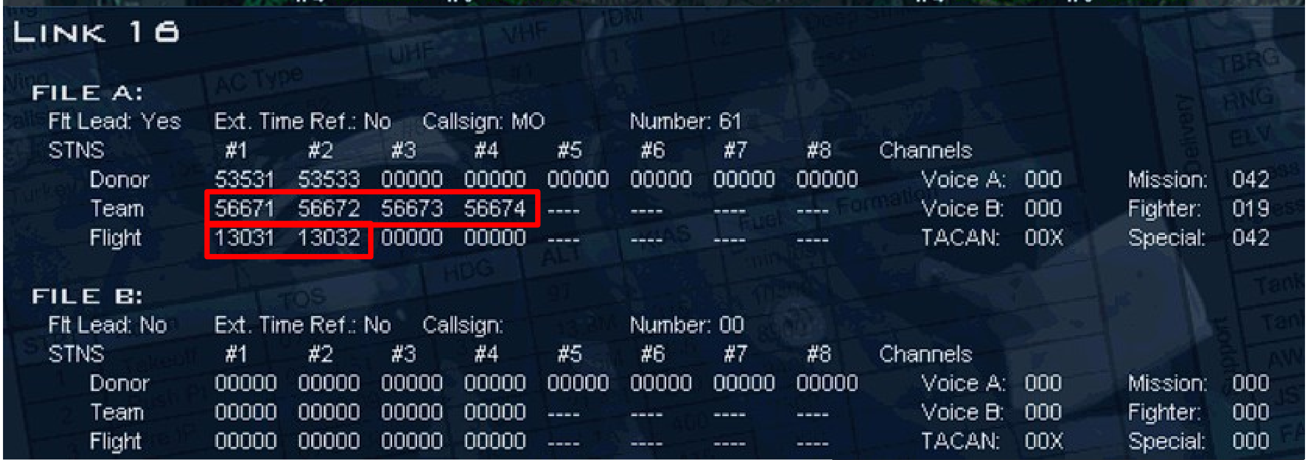
HUD Flight Member symbology (#2)

The second feature is the team member symbology which indicates the position of a team members 5-8. Please note that team member information includes a circle only, but no distance or number data.

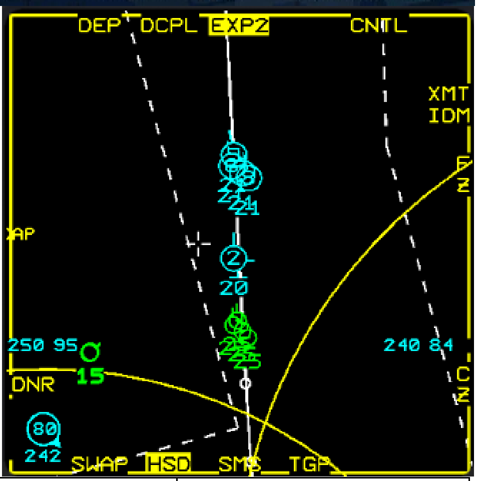
Team Member symbology

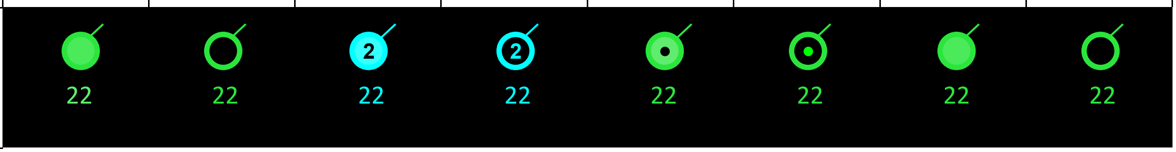
Flight and team members are organized in the Link 16 STN (Source Track Number) page. As you can see on the right picture, there are six slots filled with six independent STN's. #1 till #4 is set by BMS automatically with all members of your flight. In this mission, we are a 2-ship with STN 13031 and 13032. Team #5-#8 is set by BMS with the first/next flight in your package. In our case, it's the DCA flight Spade 2 with STN numbers 56671-56674.

In the DTC and briefing page of the BMS user interface, you can verify/modify those numbers before the mission begins. By default, BMS sets the number based on your package information if the "L16 PLAN" tab is pushed after you took your desired seat.



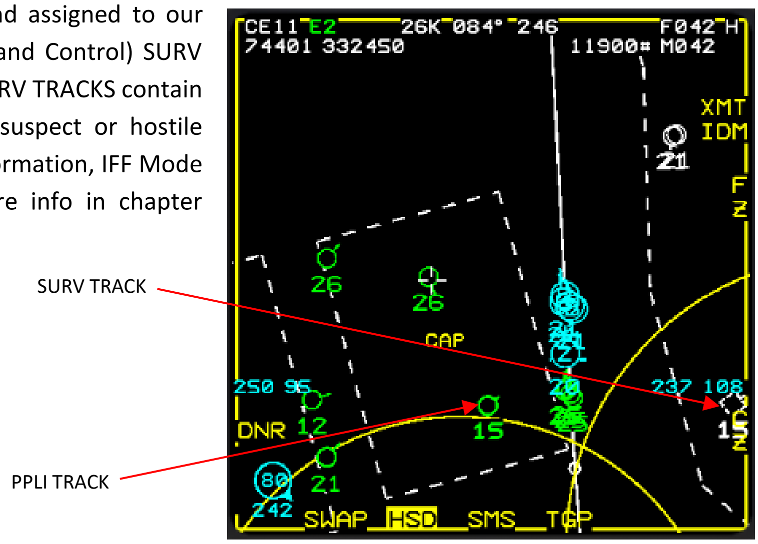
Let's have a look on the HSD. As you can see, we have different friendly Link 16 PPLI (Precise Participant Location and Identification) Air tracks presented in the picture to the right. All air tracks are shown with individual symbology, altitude and course information. FLT/TEAM members are cyan with the team member number inside. All DONOR members *(DONOR will be explained later)* are shown as a green circle with a dot inside. All other friendlies have a green circle. PPLI tracks are created by each member of the NPG (Net Participation Group) and contain information only for friendly aircraft.

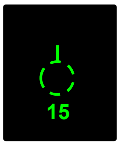
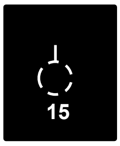
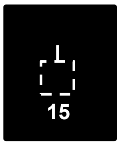
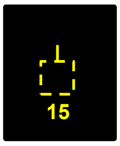
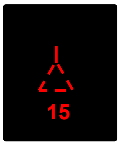


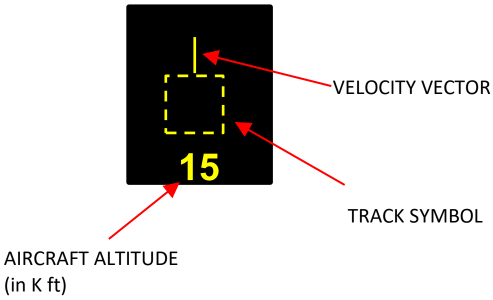
DISPLAY FORMAT	J2.0 Indirect Air PPLI		J2.2 Interface Unit PPLI (FLT/TEAM)		J2.2 Interface Unit PPLI (DONOR)		J2.2 Interface Unit PPLI (FRIENDLY)	
	Correlated to Onboard	Correlated to Offboard	Correlated to Onboard	Correlated to Offboard	Correlated to Onboard	Correlated to Offboard	Correlated to Onboard	Correlated to Offboard
HSD/FCR	 22	22	2 22	2 22	22	22	22	22

PPLI Air Track information

Since we have AWACS Chalice 11 on station and assigned to our package, we are able to receive C² (Command and Control) SURV (Surveillance) Track information from AWACS. SURV TRACKS contain information if a contact is friendly, unknown, suspect or hostile based on NPG (Network Participation Group) information, IFF Mode 4 information and BMS team restrictions (more info in chapter 2.4.3.5.1.2 in the Dash-34).



DISPLAY FORMAT	FRIEND	NEUTRAL	UNKNOWN/ ASSUMED FRIEND/ PENDING	SUSPECT/ ASSUMED HOSTILE/ PENDING	HOSTILE
HSD/FCR					



Surveillance (SURV) Air Track information

Your next task is to modify Flight member STN data in the DED based on the given expanded data in the HSD.

Activate EXP mode 1 in the HSD (verify HSD is SOI) and search with your HSD cursor for the E-2 Hawkeye, callsign Chalice 11 in the CAP box with STN 74401 (see picture above).

Once found, open the LINK 16 STN DED page and move DCS UP or DOWN till you have #3 selected. Type in STN number 74401 and press ENTER on the ICP.

As you can see on the right, the symbology of Chalice 1 has changed to flight STN #3. Now you can track the AWACS distance and position.

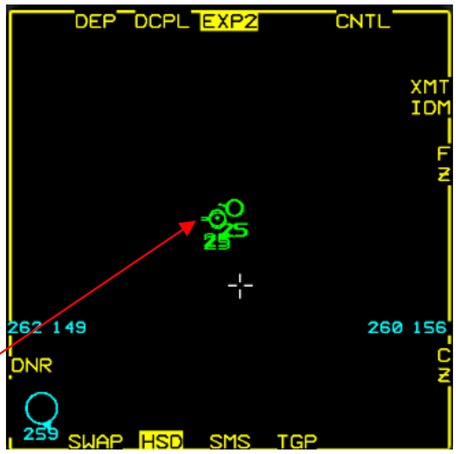
Now you have constant HUD/HMCS information of AWACS. This can be helpful to know since SURV Track data quality is based on the distance to C² units. The closer you are, the more precise information you receive about non-friendly units.

Okay, we talked about Flight & Team members and SURV + PPLI tracks. Still there? Good, let's move on.

In the most modern F-16 variants, you have also up to eight DONOR entries in the Donor DED page available. For situational awareness during a mission, pilots may want to monitor targets reported by aircraft that aren't part of their flight or team. These aircraft, known as donors, can be designated during mission planning, and their selection or deselection can be managed in the cockpit through the Link 16 DNR page on the DED.

Aircraft using Link 16 periodically transmit their positions via a PPLI message. When a PPLI message is received from a designated donor aircraft, the donor symbol is displayed. Donor symbols appear on both the HSD and A-A FCR formats, featuring a friend symbol (green PPLI circle) and a two-digit altitude below (also green). Donor symbols on the Multifunction Displays (MFD) are displayed at a reduced size (75%) and have a green dot in the middle.

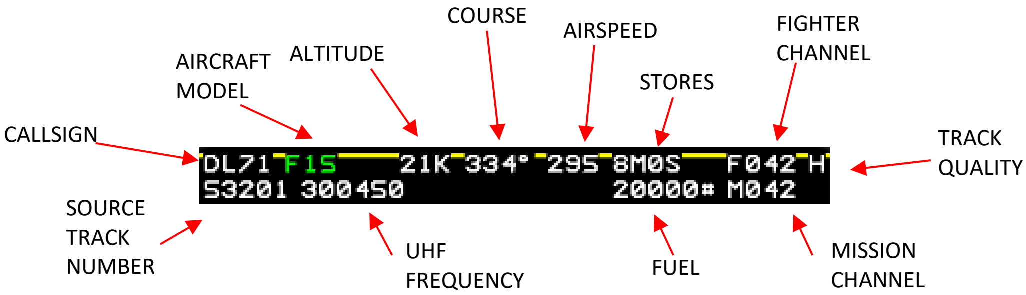
DONOR Member



The process of adding/changing a donor entry based on a given STN in the HSD is the same as for flight/team members which is already explained. The only difference is that you are modifying data in the Donor DED page.

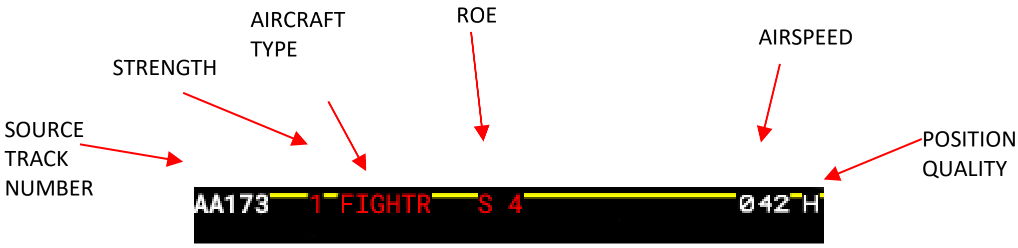
Please note that OSB 16 in the HSD provides direct access to the DED Donor page which might can be handy to save time when adding another donor entry.

Speaking about data and information in the HSD, the F-16 can receive expanded data from A-A tracks who are Link 16 capable and part of the NPG (Network Participation Group). Below you find an overview about the given data from friendly aircraft. Please note that the HSD must be SOI to see the data entries.



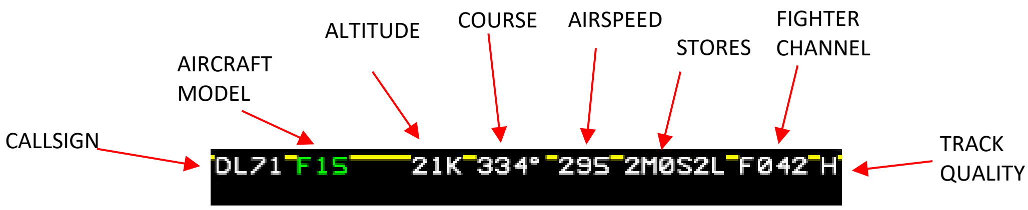
More information about friendly expanded data is available in the Dash- 34 chapter 2.4.3.5.1.4 and 2.4.3.5.2.1.

As AWACS provides SURV Track data, part of it is also expanded data for non-friendly air tracks each for the FCR and HSD as listed below:



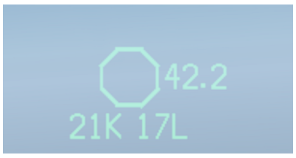
More information about non-friendly expanded data is available in the Dash- 34 chapter 2.4.3.5.1.5 and 2.4.3.5.2.2.

The FCR also provides expanded data, but limited compared to the HSD. Please note that the FCR must be SOI to see the data entries.



Till you arrive at STPT 6, you can try adding new STN entries in the DED for Flight, Team or Donor members, check out the different HUD symbology and go in depth of the given expanded data from all assets shown in the DED.

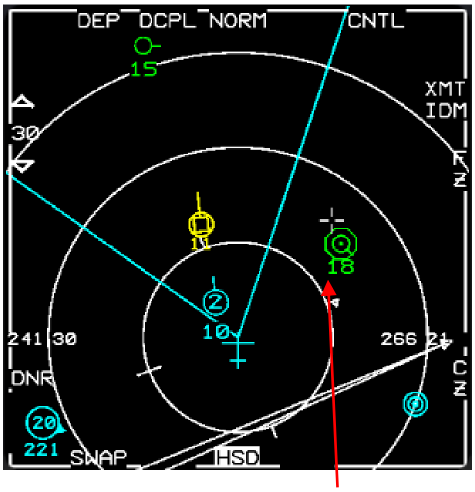
Before we move on, there’s one last HUD feature in which we didn’t talked about it yet, which is PDLT. PDLT (Primary Data Link Track) refers to a Link 16 air track, such as an air target track or PPLI, singled out by the pilot for special attention. The PDLT gives Altitude, Distance, and aspect angle information.



To create a PDLT, you shift the SOI to the HSD, place the HSD cursor onto a Link 16 air data link track or a Link 16 radar track that is not TOI correlated, and then designate it by pressing the TMS forward button.

To mark a Link 16 air track as the PDLT, an octagon is positioned around its symbol. By using TMS forward while the HSD cursor is over a different DL target on the HSD, the octagon shifts to the newly designated PDLT.

When the HSD is the SOI and a PDLT is present on the HSD, you can cycle through DL and radar correlated tracks on the HSD using TMS right depressions. The PDLT moves to the next DL target in the stepping sequence, bypassing radar TOI and proceeding to the subsequent DL track. This sequence follows a pattern from bottom to top and from right to left.



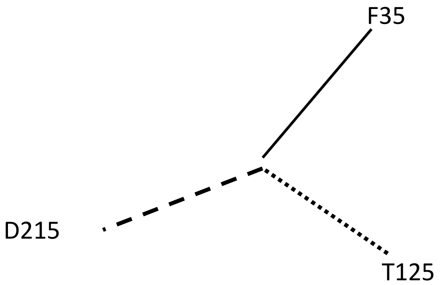
CREATED PDLT

If a PDLT is present and falls beyond the HUD's field of view, a DL Target Locator Line (TLL) appears on the HUD. This TLL is represented by a dashed line spanning 40 milliradians in length, projecting outward from the boresight cross towards the PDLT's direction.

Radar - SOLID LINE

Targeting Pod - DOTTED LINE

Data Link - DASHED LINE



Since we are operating close the DMZ to north korea and over international waters where flight activities from China, Russia and North Korea are expected, it is important to monitor all contacts which are possible factors. During your ingress, you will notice that multiple J-20 from China are operating close to the border. Set a PDLT above the closest operating J-20 to monitor his movement. The big advantage of PDLT is that you can track a contact without any usage of radar emissions.

It is known that a CIS carrier battlegroup is operating north of the yellow sea 60nm west of Pyongyang. Since our operating area is close to STPT 6 and the border, turn your attention now more to the north and monitor your HSD for new SURV tracks.

After some time, AWACS relays multiple unknown SURV air tracks. The ID is confirmed unknown. The aircraft type is SU-27 and A-50. Since CIS has a confirmed C² asset on station as well, it is obvious that the other side is aware of our existence as well.

The ROE (Rules of Engagement) include that you are not allowed to attack offensively in any case. You are only allowed to protect yourself and other friendly assets once engaged.

Monitor those contacts intensively and listen to AWACS for picture updates and act/react if needed.

In terms of Link 16, we talked about most of the new features which are coming the 4.37 U4. Further details are explained in the Dash-34 and BMS User manual.

Feel free to find creative and efficient ways to use Link 16 in connection with IDM to achieve greater SA, better mission results and greater options for good decision making.

MISSION 18: RADAR MISSILES – BARCAP *(TR_BMS_18_Barcap)*

LOCATION: North of the demilitarized zone (DMZ)
Please note, make sure you select the F-16 flight (BARCAP) from the mission window; if you select the first flight without checking you will end up piloting an AWACS.

CONDITION: F-16 block 52 – Two ship - Callsign Falcon 1.
GW: 36788. 1 AIM-9X, 5 AIM-120C, 2 wing tanks, 1 ECM pod and 1 Sniper targeting pod.
Max G: 7.0/-2.0, Max speed: 600 kts / 1.2 Mach.
Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.

WEATHER: RKSM INFO: B 011225Z RWY01 TRL140 360/15KT 9999 FEW050 28/18 Q1013 NOSIG

LEARNING OBJECTIVES: Prevent red air from trespassing your AOR during your CAP patrol time of 30 minutes.

18.1 BVR – Beyond Visual Range Tactics

Beyond visual range (BVR) tactics refer to strategies used by military pilots to engage enemy aircraft beyond the range of visual identification. With advancements in technology, BVR combat has become increasingly prevalent in modern warfare, and has led to the development of highly sophisticated aircraft and weapons systems designed for long-range engagement.

BVR combat takes place at ranges beyond what the human eye can discern. This means that pilots must rely on a variety of sensors and systems to detect, track, and engage enemy aircraft. These sensors include radar, infrared imaging, and other electronic systems that provide situational awareness, as well as weapons systems that are designed to engage targets at extended ranges. The objective of BVR combat is to eliminate the enemy threat before they can get close enough to engage in a dogfight or launch their own weapons.

To achieve this objective, BVR tactics typically involve a series of steps. The first step is to detect the enemy threat. This can be accomplished through the use of radar, which can detect aircraft at long ranges. Once the enemy has been detected, pilots will attempt to identify the threat and determine whether it is hostile or friendly. This can be accomplished through a combination of visual identification, radio communication, and other means.

Once the threat has been identified as hostile, the next step is to track the target. This involves using radar, infrared imaging, and other sensors to continuously monitor the enemy aircraft and predict its movements. By tracking the target, pilots can predict where it will be in the future and plan their attack accordingly.

Finally, once the target has been tracked and its movements have been predicted, pilots will launch their weapons.

18.2 Leader's role

BVR will be a continuous cycle of commit (heading to the adversary to shoot) and abort (turn away from adversary). The leader has to decide the tactic prior to each commit. Commonly either Wall or Grind will be applied.

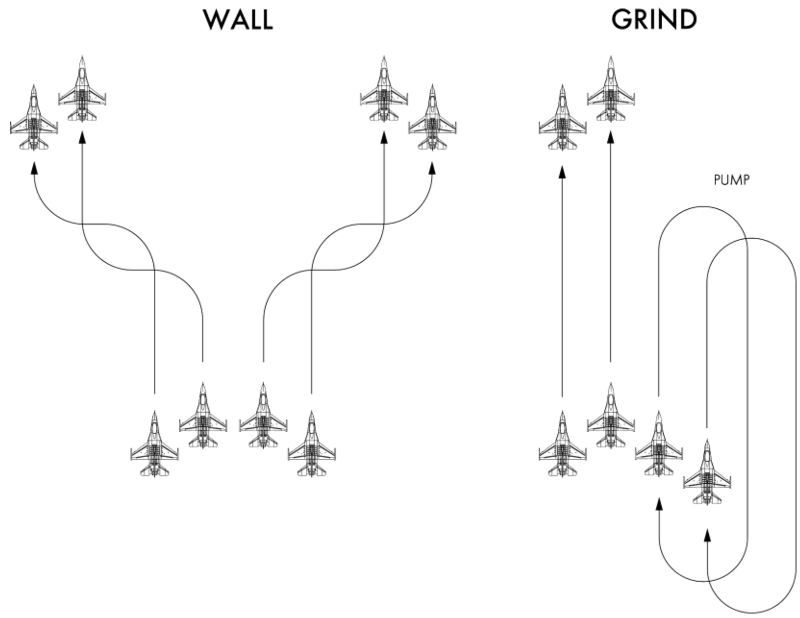
Wall

Deploys two elements line abreast.

Grind

Deploys two elements in trail formation.

When you decide the Grind tactic, **Pump** either one of the elements before pre-briefed Pump Range.



18.3 Wingman roles

Wingman's task priority is as follows:

1. Stay Visual on Lead (If lost visual on lead call "Blind")
2. Keep Formation to the Lead (Commonly line abreast is applied)
3. Check Radar

Wingmen usually don't have to watch radar that much unless AOR search is directed. This is because in a Visual Mutual Support they should stay in visible formation so that leader and wingmen should see the same contact in their FCR page.

Inexperienced wingmen often try to check radar more than keep visual on his lead and end in "Blind". They also often move to Trail (wingman goes behind the lead) or Fighting Wing but BVR Timeline changes if range to the adversary differs between lead and wingman. Line Abreast is the ideal formation inside the element.

18.4 Common formations and tac turns

The most common formation in a BVR environment is the "Line abreast" formation (see chapter 4A.1).

"Hook turn's" and "Delayed turns" are the most often used tac turns for BVR (see chapter 4B.1).

18.5 BVR Flow

The flight/element lead has to decide “Skate”, “Short Skate” or “Banzai” prior to each commit.

Skate
Skate is a “launch and leave” tactic. FOX3 before TR (Transition Range) will allow HUSKY before you reach DOR (Desired Out Range). You should abort before DOR and it would defeat the adversary's FLO (First Launch Opportunity) shot and preserve enough distance to recommit with “launch and decide” tactics.

DOR = DR + Adversary Closing Range while Aborting and Recommitment.

Short Skate
Short Skate is another “launch and leave” tactic. You should abort before MAR (Minimum Abort Range) or DR (Decision Range). Aborting before MAR would defeat the adversary's FLO (First Launch Opportunity).

MAR = Max F-POLE of FLO Shot + Turn Radius.

Banzai
Banzai is a “launch and decide” tactic. FOX3 before DR (Decision Range) and separate element for opposite direction to notch against adversary (for ex: if adversary is at 360 then notch to 270 and 90). Keep notching for pre-briefed time (commonly 15 seconds) and check if you and your wingman has been spiked or not. If spiked, then abort and you will be outside of a STERN WEZ. STERN WEZ is a range where an adversary's shot will hit you even if you are turning away from them. If you are naked and got no spike while notching, then turn in to pursue the adversary and push away them.

DR = STERN WEZ + Adversary Closing Range While Notching for 15 seconds than aborting.

18.6 BVR Timeline

MTR (Minimum Targeting Range)
The range flight member share into a group to ensure group elimination or support planned intercept flow. MTR is also a decision tool for flight leads to directively target wingman (greater than MTR) or flight leads inside of MTR

eg:"Wall, Skate, #1,2 Target East Group #3,4 Target West Group, #2,4 Sort Leader."

TR (Transition Range)
The minimum range at which the AIM-120 must be launched in order to achieve an active state and be out no later than DOR.

DOR (Desired Out Range)
Range from the closest group where a fighter's "out" maneuver will defeat any weapons in the air or still on the jet and preserve enough distance to recommit with sufficient time to re-engage with L-D tactics

DR (Decision Range)
The minimum range at which an aircraft can execute the briefed notch maneuver, remain there for a pre-briefed period of time in an attempt to defeat spikes, and then execute an abort or exit maneuver. This will kinematically defeat any missiles shot at the fighter and momentarily keep the fighter outside the threat's max stern WEZ

DR = STERN WEZ + Adversary closing range during 15sec notch + Margin t

MSR (Minimum Shot Range)
The minimum range at which the MRM must be launched in order to achieve an active state and be out no later than MAR.

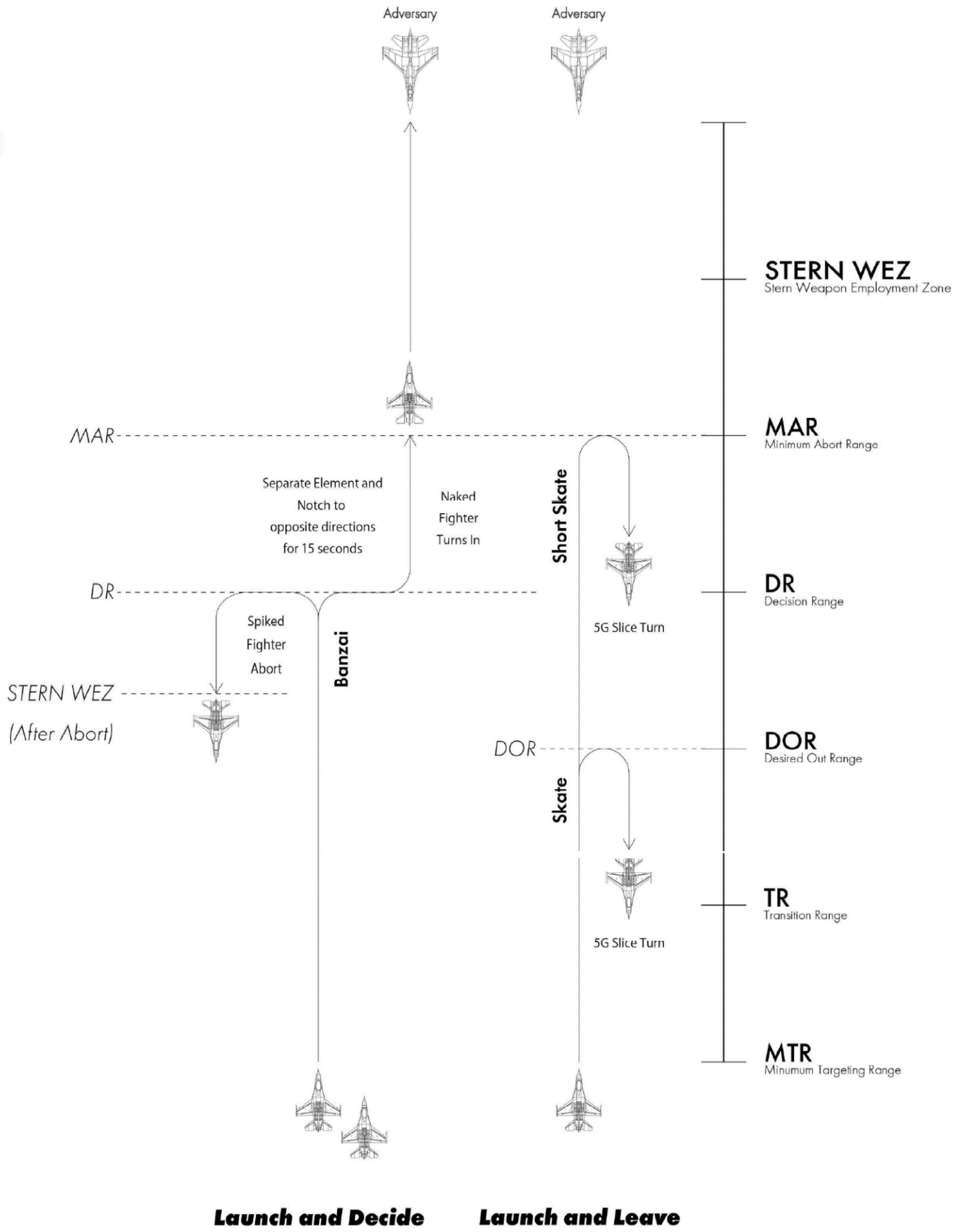
MAR (Minimum Abort Range)
The range at which an aircraft can execute an MDS-specific standard abort maneuver and initially kinematically defeat any missiles and momentarily remain outside the adversary WEZ

MAR = Max F-POLE of adversary's shot + Your Turn Radius + Margin

MRR (Minimum Recommit Range)
The minimum range at which the Fighter recommit, target and employ MRM while turning and remain outside of STERN WEZ. Assuming threat is HOT.
STERN WEZ
The maximum range at which an adversary's weapons can be effectively shot at fighters.

STERN WEZ = Range where adversary's shot hits you from your behind.

On the next page you will find on overview to help you to understand the BVR timeline.


Adversary
Adversary
STERN WEZ
Stern Weapon Employment Zone
MAR
MAR
Minimum Abort Range
Separate Element and
Notch to
opposite directions
for 15 seconds
Naked
Fighter
Turns In
Short Skate
DR
DR
Decision Range
5G Slice Turn
Spiked
Fighter
Abort
Banzai
STERN WEZ
(After Abort)
DOR
DOR
Desired Out Range
Skate
TR
Transition Range
5G Slice Turn
MTR
Minumum Targeting Range
Launch and Decide
Launch and Leave

18.7 Targeting / Sorting

Targeting

The leader has to decide targeting before committing adversaries. If you are going to Short Skate you should decide it before MTR (Minimum Targeting Range).

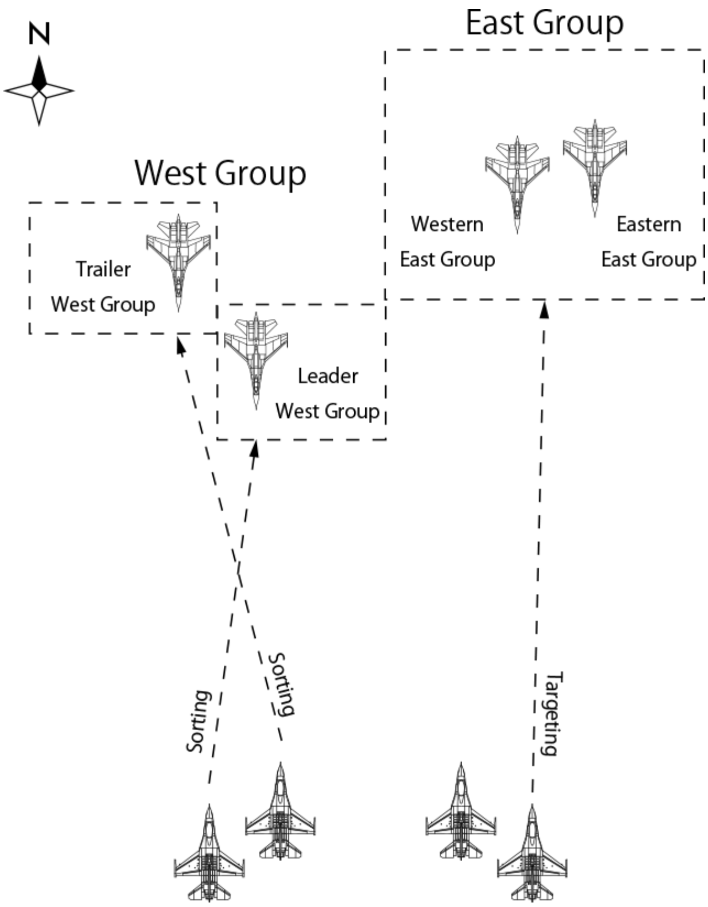
Fighter targeted a group (contact within 3 nm) has a responsibility to engage the targeted group with a directed flow. Once targeted a group you can FOX3 at pre-briefed timing. If you completed targeting, then call “<Callsign> Targeted <Targeted Goup Labeling>”.

ex: “#4 Targeted East Group”

Sorting

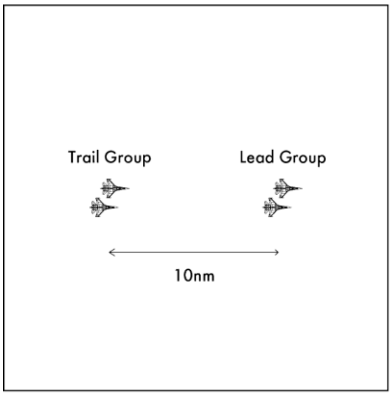
Fighter Sorted an inner group has a responsibility to engage a sorted inner group with a directed flow. Once sorted an inner group you can FOX3 at pre-briefed timing. If you completed sorting, then call “<Callsign> Sorted <Sorted Group Labeling>”.

ex: “#2 Sorted Leader West Group”

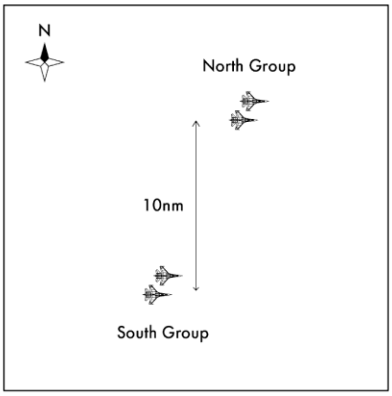


18.8 Picture Labeling (AWACS)

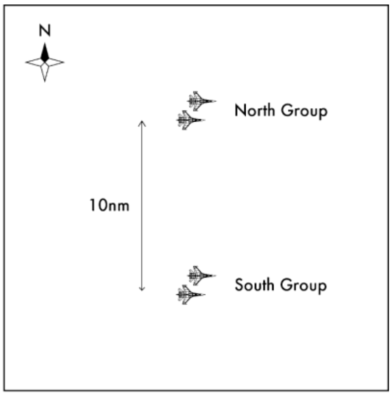
Group Picture



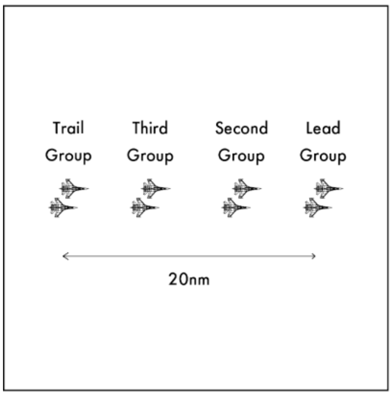
2 GROUP RANGE 10



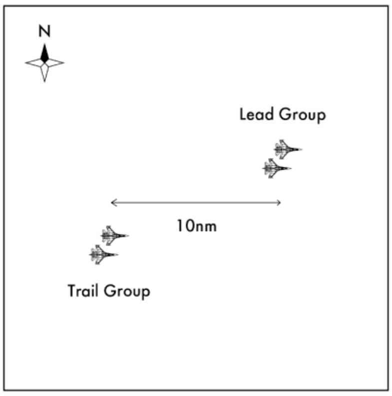
2 GROUP AZIMUTH 10
ECHELON SOUTH WEST



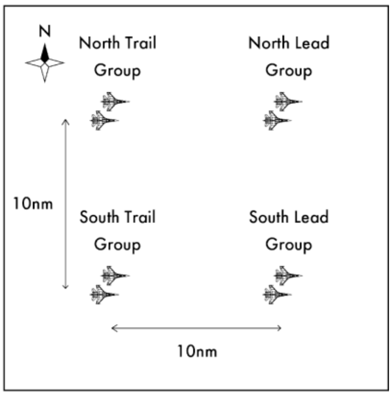
2 GROUP AZIMUTH10



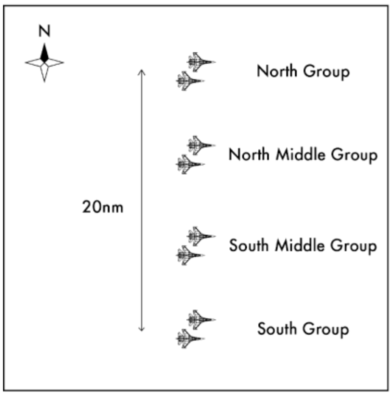
4 GROUP LADDER
20 DEEP



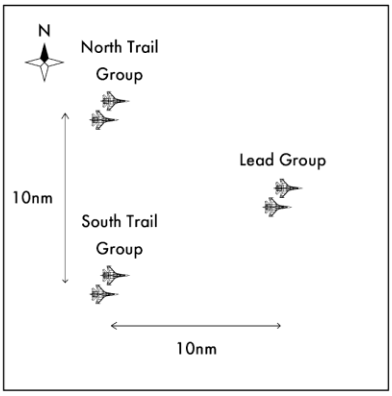
2 GROUP RANGE 10
ECHELON SOUTH WEST



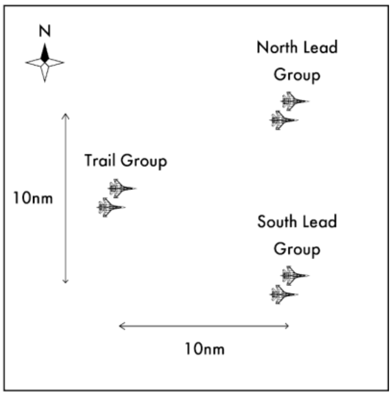
4 GROUP BOX
10 WIDE 10 DEEP



4 GROUP WALL
20 WIDE

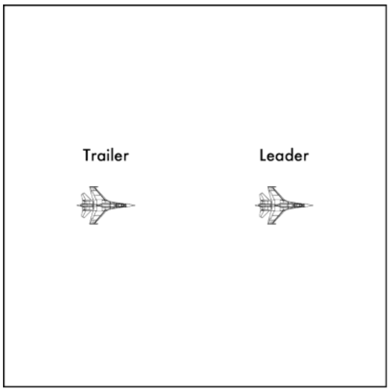


3 GROUP VIC
10 DEEP 10 WIDE

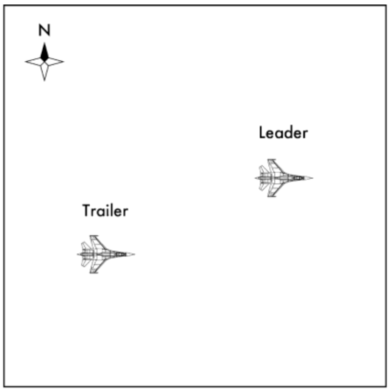


3 GROUP CHAMPAGNE
10 WIDE 10 DEEP

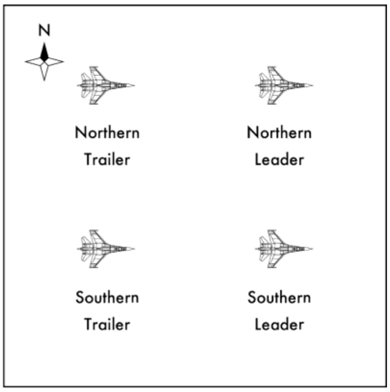
Inner Group Picture



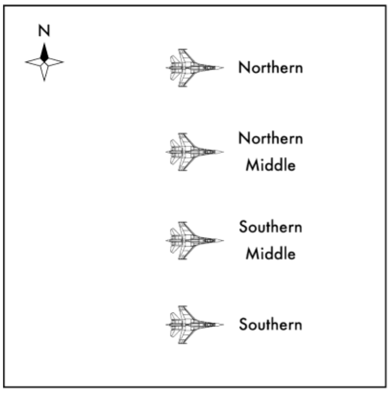
LEAD TRAIL



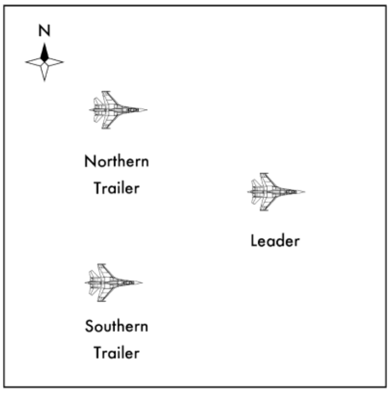
SWEPT



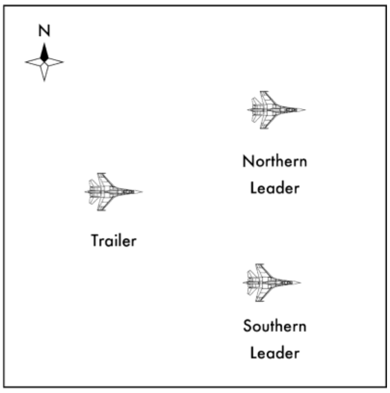
CONTAINER



LINE ABREAST



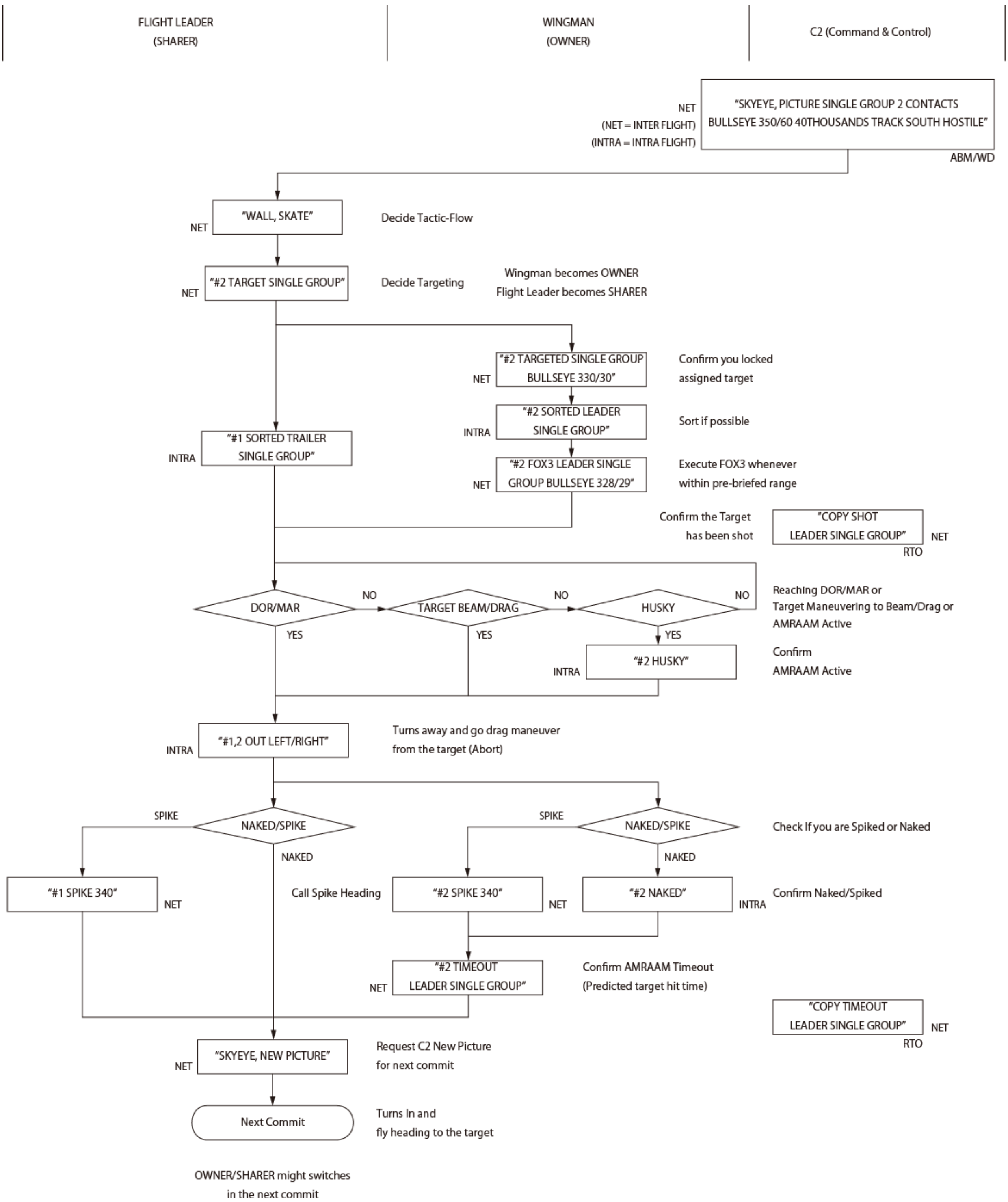
WEDGE



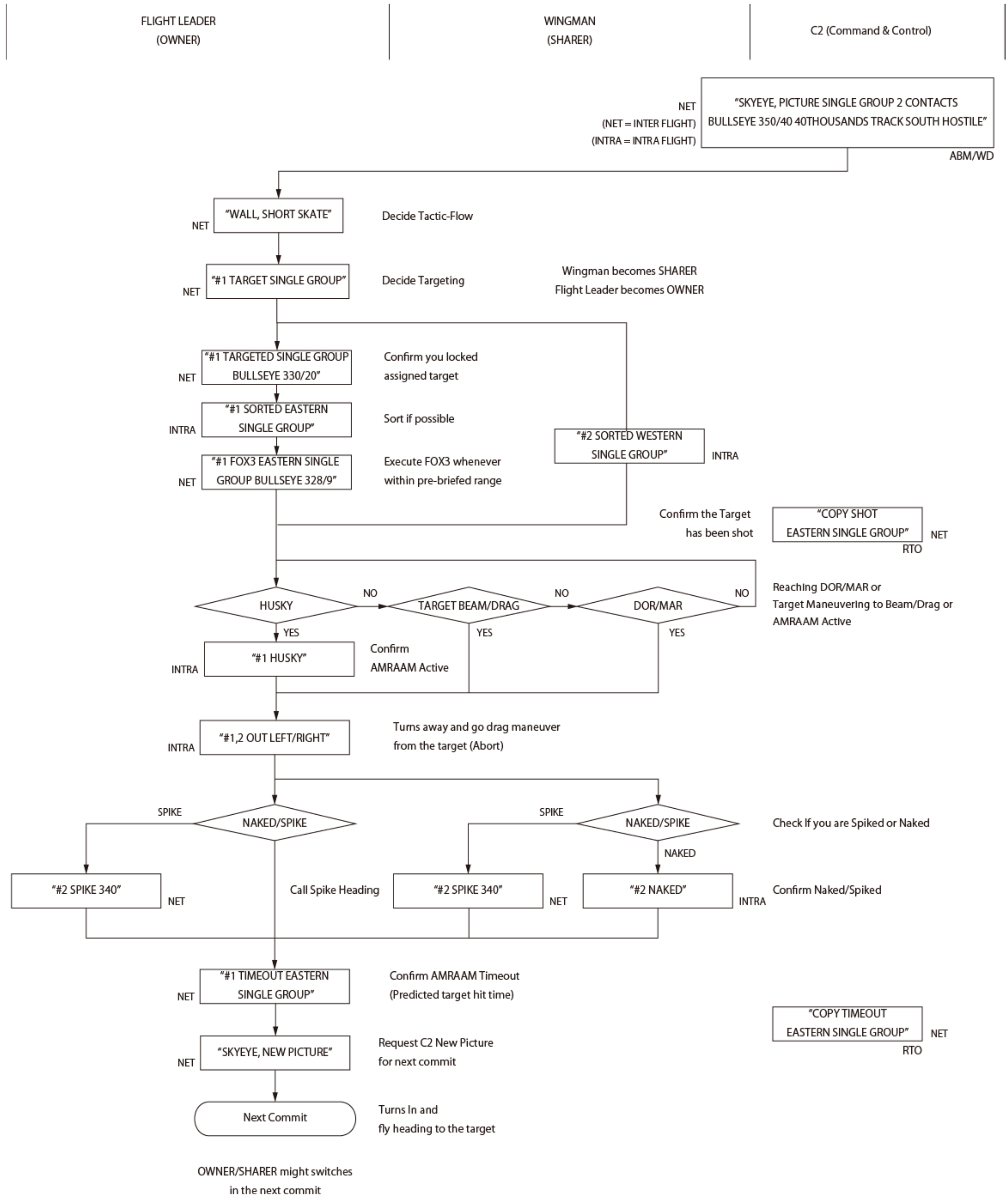
STINGER

18.9 BVR Flow Chart

Traditional Launch & Leave Example (FL Sharer)



Traditional Launch & Leave Example (FL Owner)



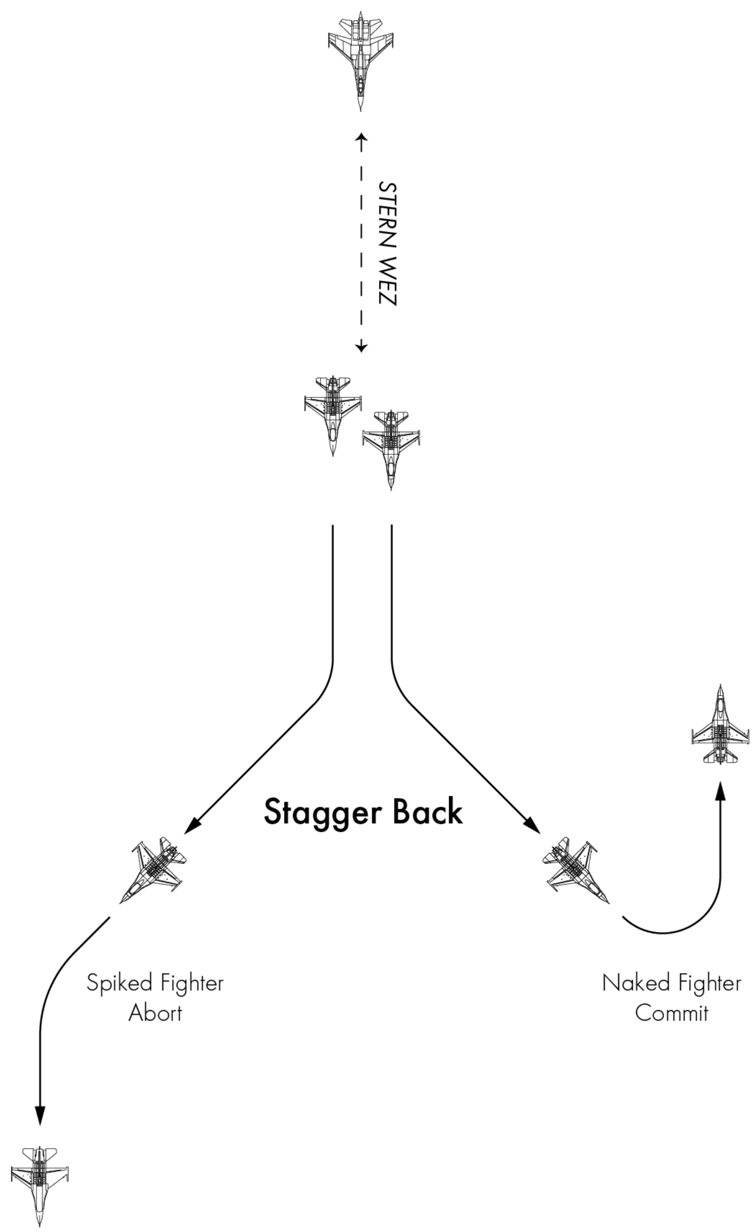
18.10 Cold OPS Game Plan

2 ship options - Stagger back, Notch back

4 ship option - Delouse

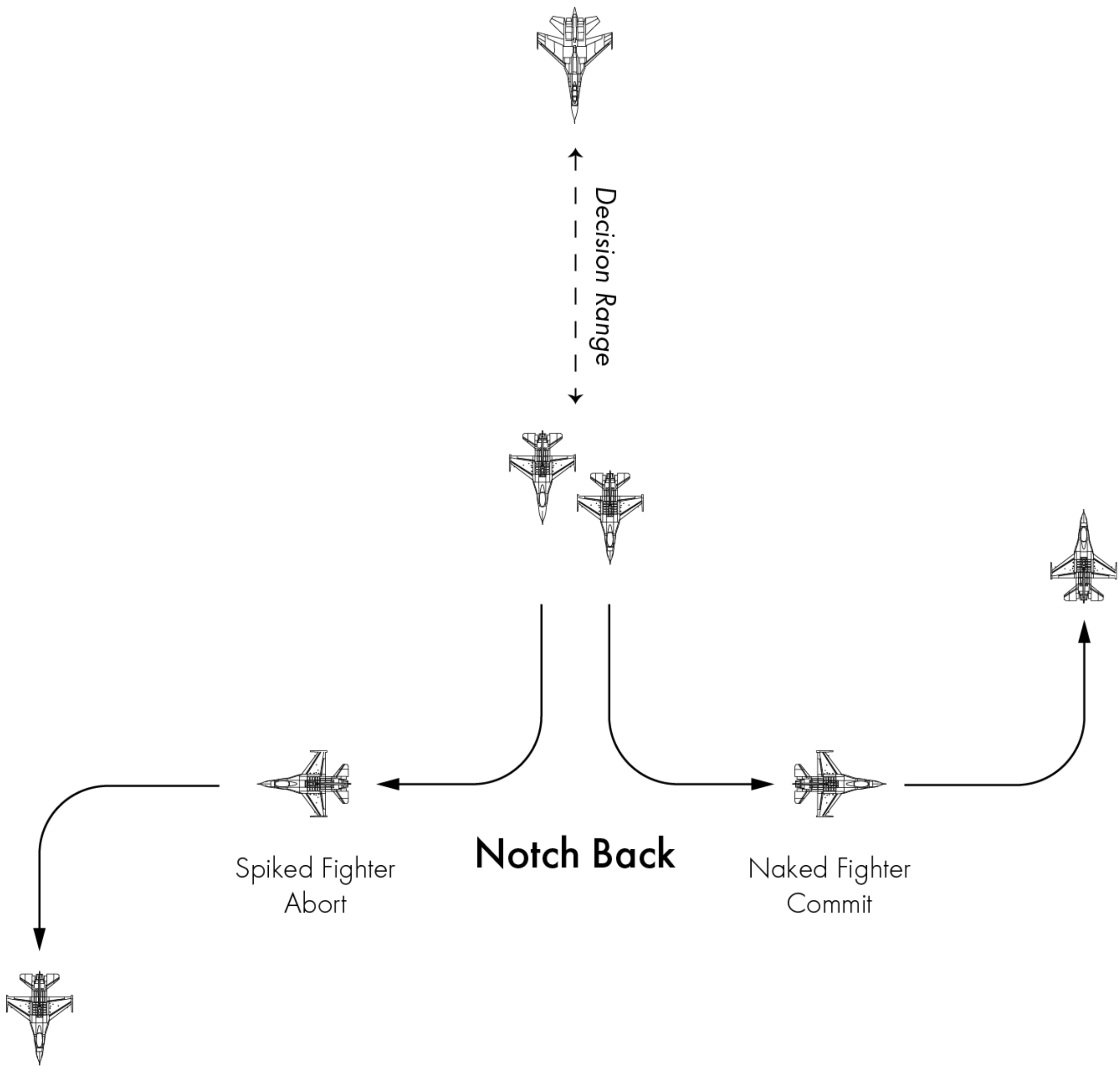
Stagger Back

A spiked fighter will run until pitchback criteria are met and untargeted fighter will pitchback.



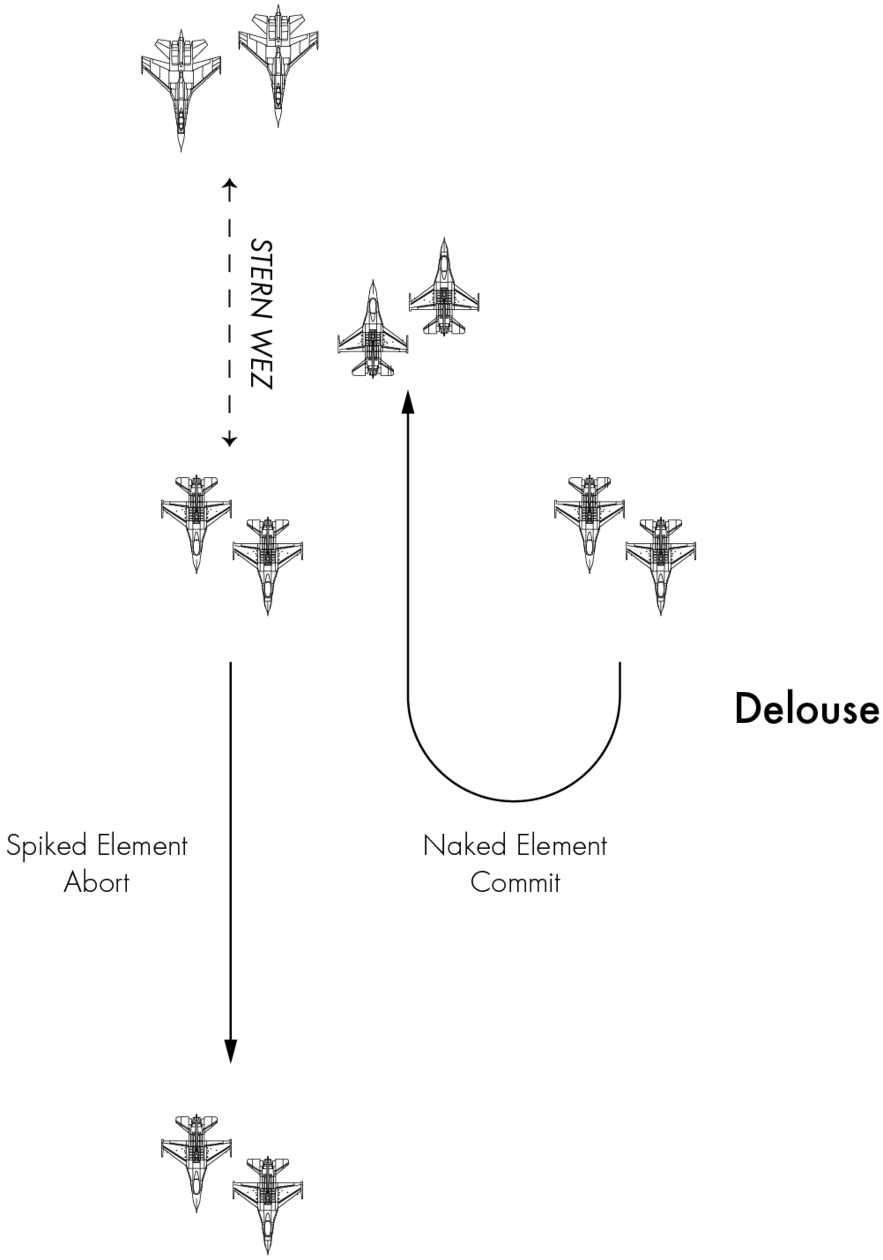
Notch Back

One fighter being spiked but continuing cold is not an option (boundary or stranger etc). at the expiration of the notch, the spiked fighter will access pitchback criteria.



Delouse

Element being leaned on runs while other element recommits and targets.



18.11 The AIM-120 AMRAAM missile

The primary BVR missile of the F-16 is the AIM-120 AMRAAM (Advanced Medium Range Air-to-Air Missile). It is an Active Radar Homing (ARH) missile with launch-and-leave capability. This means the missile's own radar can find and track a target at a specific point during the missile's TOF (time of flight).

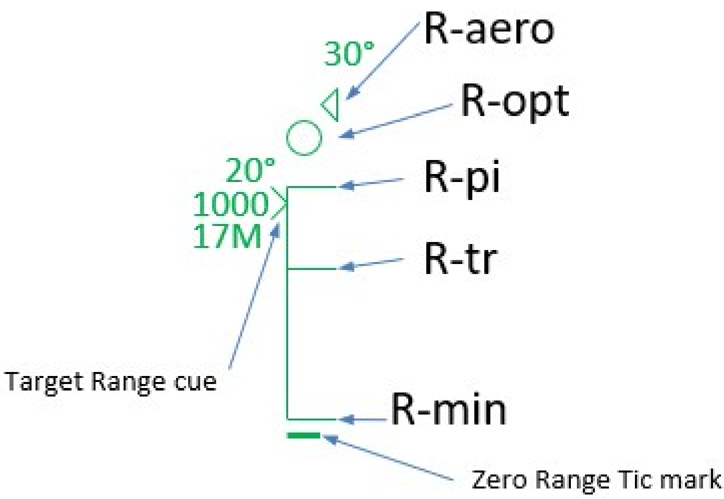
Because of the relatively small missile cross-section its on-board sensors are rather small and its radar range is limited. Therefore, the missile is supported via datalink from the launching aircraft, which continues to track the target using its own, more powerful radar, until the missile is close enough for its own radar to take over. Once the missile becomes active, you can decide to continue supporting it (for better accuracy), or snip it by dropping the track on your aircraft's radar to let the missile continue its intercept autonomously.

In BMS both the AIM-120B and AIM-120C are modelled. The differences are slight, with the newer block lighter with slightly longer range. The general HUD symbology is explained in the Dash-34 (chapter 2.1.7) and AMRAAM usage in more depth in the Dash-34 (chapter 4.3.2.5) as well , so we will not cover all the tiny details, but rather stick to what is really important in this training scenario. Note that the AMRAAM chapter in the Dash-34 is now enhanced with an additional ARH chapter. So a re-read is recommended.

18.11.1 DLZ

What is the range of the AIM-120? Well if you look at the right side of the HUD, or on the right side of the FCR when the AIM-120 is the selected weapon, you can find what we call a Dynamic Launch Zone (DLZ). The reason why it is called Dynamic should answer your question. There is not a fixed range for missiles; it depends on many factors that a human cannot compute. So the avionics system does it for us and presents it as the DLZ and its range cue.

To be able to measure range the system must have a reference: the bugged contact on the FCR. Once a contact is bugged and MASTER ARM is in ARM or SIM, the missile symbology will be displayed. The Target Range Cue on the DLZ gives you information about missile range.



The AMRAAM DLZ consists of five ranges:

- **R-aero**: (Range aerodynamic) represents the maximum kinematic range of the missile. When the target range cue is next to the R-aero symbol, you could fire the missile and it *may* hit if the target is not maneuvering at all *and* if you make a perfect shot by following the attack steering cue and lofting the missile. A missile fired at R-aero range will always terminate in nominal termination.
- **R-opt:** (Range optimal) is the same as R-aero but the missile will terminate in high termination criteria.

  Termination criteria *are used to describe the kinetic energy and maneuverability potential the missile has to successfully intercept the target and destroy/damage it. It can have* ***High Termination Criteria*** *or* ***Nominal Termination Criteria****. The latter means the missile will have less energy/ maneuverability thus less probability to hit the target.*
- **R-pi**: (Range probability of intercept) represents the maximum range shot with high probability of intercept given *current* steering; that is to say without following attack steering or optimal loft cues.
  We still assume a non-maneuvering target though. The missile diamond flashes at R-pi.
- **R-tr** (Range turn & run) represents the maximum range assuming that the target turns away from you to a tail aspect at launch. The ASEC flashes at R-tr.
- **Rmin** - represents minimum launch range based on missile kinematics and current steering.

If there is only one thing you can remember from this page: the highest probability of kill (P_K) is at R-tr when the ASEC flashes. You're also closer to the target though and it may be firing back at you!

18.11.2 The ASEC (Allowable Steering Error Circle) and ASC (Attack Steering Cue)

The ASEC is a variable diameter dynamic circle centered on the FCR and HUD. The ASEC can be used as an aid for positioning the ASC, which helps you to steer your aircraft into the best position to launch your missile to maximize missile energy and therefore range.

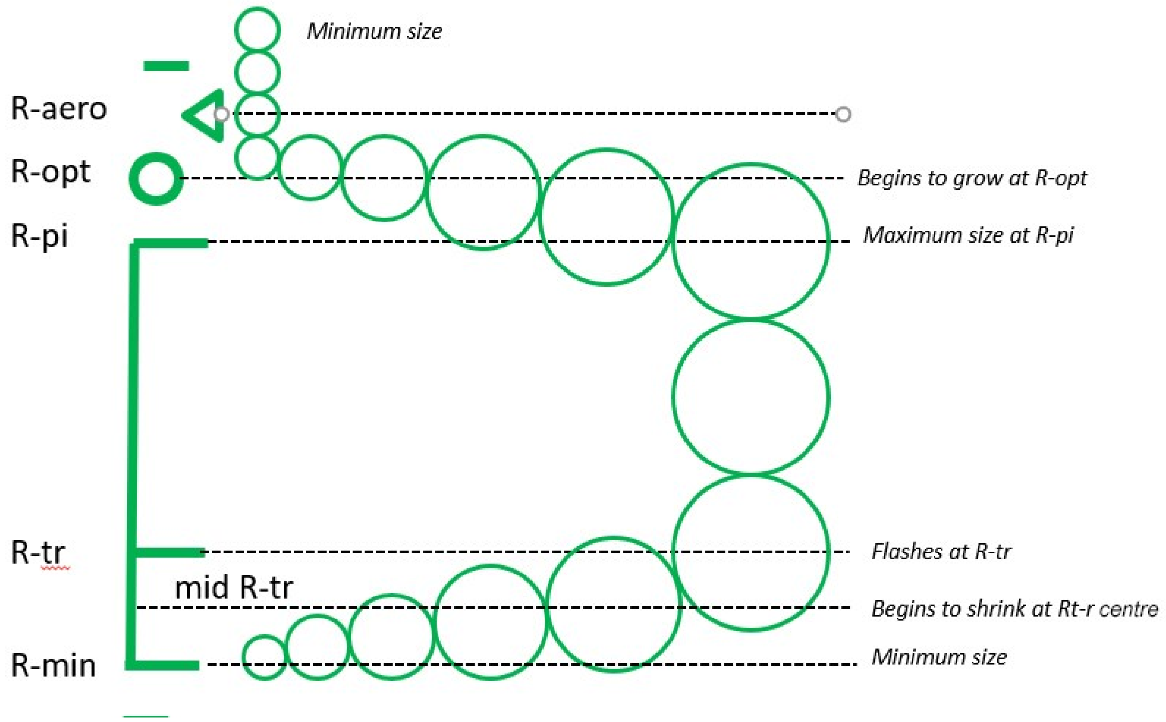
For the ASEC to be displayed a target must be bugged, the AIM-120 selected as the active weapon and MASTER ARM needs to be set to ARM or SIM.

At target ranges from outside R-aero to R-opt, the ASEC is set to a minimum size of 11 milliradians.

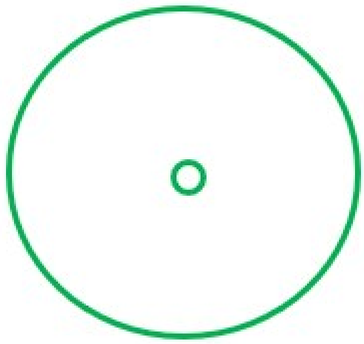
At R-opt the ASEC begins to grow until the target range reaches R-pi, where it reaches its maximum size of 56 mr. At R-pi the ASEC represents 45° of allowable steering error. The ASEC remains at maximum size until the target range reaches the center of the Maneuver zone, at which point it begins to shrink until it reaches its minimum size again.

The ASEC will flash when target range is between R-tr and R-min and within missile LOS limits.

The larger the ASEC, the higher the P_K. The smaller the ASEC, the lower the P_K.



The ASC (Attack Steering Cue) is a 8 mr diameter circle in the HUD and a 10 pixel radius circle on the FCR. It provides a reference for guiding the aircraft to the target. If the target is outside the range of the DLZ, the ASC represents the required course for the aircraft to maximize closure rate on the target. Once within range of the DLZ, the cue indicates the optimum course for the AIM-120 to intercept the target.



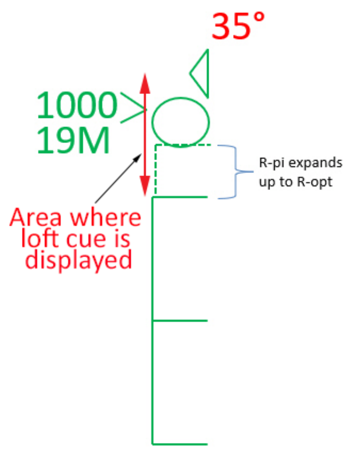
Optimal Missile Steering

Flying the cue to the center of the ASEC before firing will provide the missile with the best kinematic advantage, making the ASEC grow as large as possible.

For the best shot possible, place the ASC at the center of the ASEC.

18.11.3 Loft Solution Cue

The loft solution cue is displayed when the target range cue is between R-aero and R-pi. At that range the ASC provides horizontal steering only. The Loft solution cue provides vertical steering optimization. The loft angle is shown in 5° increments and illustrated in red in the picture on the right.



Once the AMRAAM leaves the rail, it will loft on its own, but by pulling your aircraft up into a climb you reduce the energy the missile will need to use in loft itself, thereby increasing its range.

Lofting at R-opt will expand R-pi up to R-opt, thus increasing missile range.

To follow the loft cue in the example on the right, simply accelerate and nose up to the 35° pitch line before depressing the pickle button.

18.12 The mission

In this training scenario you fly in a 2-ship element, but we will focus on what happens in your own cockpit.
The mission has the engagement timed in a manner to avoid the need for mutual support. Your AOR is clearly marked on your HSD and your simplified single commit criterion is any enemy aircraft that enters your CAP box.
Fly your hot leg, investigate any contacts. Commit only if you can conclude the engagement without being dragged away. Turn cold to maintain your CAP geometry. It's harder to do in single-player but hopefully you will learn things in the process.

The training mission is a 2 ship CAP flight north of Seoul. Expected opposition are MiG-23 and MiG-29.
The MiG-23 carry R-23R (AA-7) semi-active radar homing missiles and the MiG-29 carry the more advanced R-27R (AA-10A) semi-active radar homing missiles.

Both these missiles are inferior to the AIM-120 AMRAAM (the equivalent in the red team is the R-77 (AA-12), so you should always have first shot opportunity (when co-speed and co-altitude), if you apply the techniques explained earlier to prevent the bandit from trespassing your FAOR (Fighter Area of Responsibility).

The flight will start just before entering the CAP box; AWACS is available on UHF preset 6 and your wingman is on VHF preset 15. Bullseye is at steerpoint 5, which is the northernmost point of your CAP.

The IFF plan for this engagement is Mode C active at departure and Mode 4 only active once in the CAP; your DTC has been loaded accordingly. More information about IFF in BMS can be found in the Dash-34, chapter 2.2.4.

You can fly this mission in multiplayer with a human partner, or with an AI wingman. The latter will require you to issue commands to the AI wingman, which work much better now as AI BVR tactics have been completely rewritten in the last versions. This chapter will consider that your wingman is AI and will cover how to manage him in this scenario.

18.12.1 Getting Ready

Upon entering the jet, the sim will freeze, and some systems will be set for you. Once you get control back, make sure you can communicate with the AI wingman and instruct him to go SPREAD via the Wingman menu ('w' or 'z' depending on your keyboard). If the wingman does not respond, check that your VHF is set to VHF preset 15. To increase your SA further, you can also set your A-A TACAN to 85Y to display your wingman's separation from your own plane in the DED.

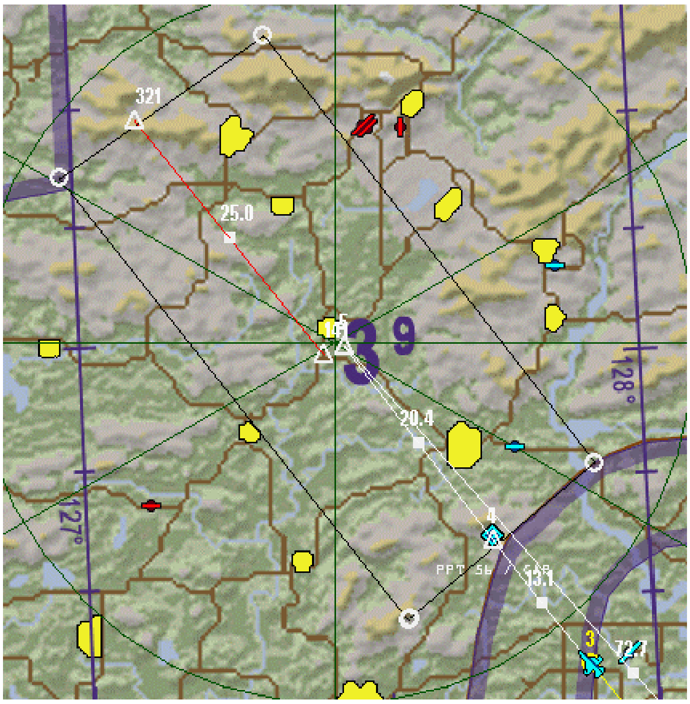
A Communication check with the AWACS might be a good idea as well. Check that the UHF radio is set to preset 6 and 'Request Picture' with the AWACS menu ('q' or 'a' depending on your keyboard). The AWACS should respond with a bullseye call for the first bogey.

Bullseye has been placed at steerpoint 5, which is the end of your CAP hot leg. There are many ways to place bullseye for CAP flights, this is one of them. Such placement simplifies your commit criteria.

Since you do not want to leave your CAP box unattended, you want to set commit criteria. These will include a distance from a reference point that will trigger you engaging any trespassing aircraft. That reference point is bullseye. The distance in this case is the end of the AOR (Area of Responsibility).

Since bullseye is 25 Nm from the forward edge of your AOR, as illustrated in the following image, your commit criteria should be bullseye + 25 Nm. Any contact reported within 25 Nm of bullseye should be engaged.

Knowing the position of bullseye is vital to understand contact position reports. The CAP box is orientated along a 320° (Hot lane), 140° (Cold lane) axis. Bullseye calls below 320° will be left; over 320° will be right when you are hot. 320° will be dead ahead.

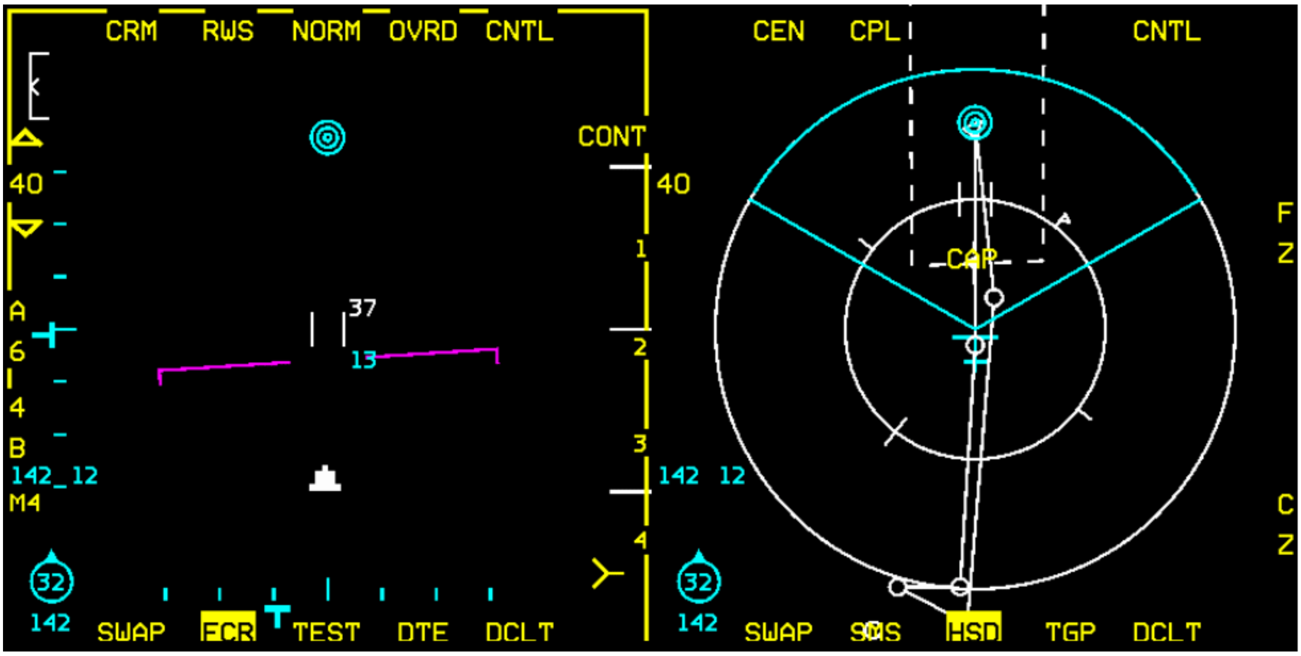


Normally AWACS will switch to BRAA (Bearing, Range, Altitude and Aspect) calls when contacts are within 25 Nm.

You are about 12 Nm from your CAP box; climb to FL260 or even 300 and accelerate to Mach 0.85 before entering the CAP.

The CAP is a 30-minute patrol. In campaigns, leaving the CAP before your station time is over will result in failed mission rating. It is best to time your patrol with the HACK timer on the ICP to avoid leaving early.
When you reach steerpoint 4, your first CAP point, start the HACK timer on the ICP TIME page with the up arrow. You may return to the CNI page and the Hack time will still be displayed.

Fence in before entering your CAP. Instruct wingman to turn off lights / fence in, set MASTER ARM to ARM, select MRM mode, ensure the TGP is set to A-A mode, start your ACMI recorder, ensure that your IFF is just Mode 4 and set FCR on the left MFD and HSD on the right MFD with option CEN (Centered) and CPL (Coupled).



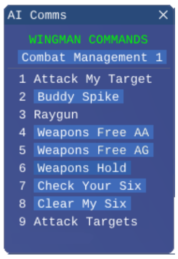
The advantage CEN/CPL will bring is that HSD range will automatically change to match the FCR range.
It is not mandatory; it’s just a bit easier.

The last thing you may want to do is to set FCR OSB 16 to Mode 4 only. That way when you interrogate you will do so in Mode 4 only. If a contact doesn’t answer a Mode 4 interrogation on this side of the demilitarized zone, it’s *probably* not going to be friendly…

18.12.2 Managing the AI wingman

Before entering the CAP, a small word about managing your AI wingman. In a 4-ship multiplayer flight, a CAP is usually done with counter-rotating elements; while one element is hot, the other is cold. Elements coordinate their turns so that there is always one set of radars scanning the AOR in the primary threat direction. Elements cover each other; when one element turns cold, the hot element takes over responsibility for the engagement, aka a 'Grinder', and engages the enemy while the cold element resets.

With AI, it is a bit more difficult to do this. In a 2-ship scenario with AI, it's best to keep your wingman in spread and on the same leg as you. For more information about managing AI, please refer to Chapter 2.1.2 in the BMS COMMS and Nav Book in your Docs folder.



The default state of your wingmen is 'Weapons Hold'. He will, however, want to engage much sooner than you and without regard to commit criteria. You must therefore ensure you monitor him closely.

When the wingman asks you for "permission to engage air targets", you will have to respond to that call. Lack of response on your part will be taken as implied permission after a while. So, if you do not respond, your AI wingman will engage.

If the contact is too far away, select 'Weapons Hold' from the Wingman menu to tell your wingman to wait.
Get ready to use that one often.

Default sorting upon issuing an 'Attack Targets' command is: lead sorts lead, wingman sorts wingman.

Using the 'Weapons Free AA' command instructs the wingman to look around for targets on his own, so no sorting will occur and missile spillage will be very likely as a result. Alternatively, you may place your cursor over the desired contact and instruct your wingman to 'Attack my target'; then acquire you own target and engage it. You do all the work this way and lose precious time.

In our opinion, the best course of action is to use the 'Attack Targets' command and sort accordingly.
But bear in mind AI are not as smart as you; always double-check (with IDM) which target your wingman is tracking before sorting yours, to ensure you don't waste precious missiles.

After terminating an engagement, always instruct your wingman to 'Rejoin Formation', otherwise he will go off chasing MIGs. At lower skill levels, the AI may fire up to 4 slammers at a single MiG-23 when they get excited, so pay attention to what they are doing at all times and don't let them off the leash.

If you want to monitor the distance from your AI wingman you need to set up your A/A TACAN according to AI default use of A/A TACAN. AI flights always use the same structure:

- 1st flight in a package: Lead: **12Y** - Wingman #2: **22Y** - Element Lead: **75Y** - Wingman #4: **85Y**
- 2nd flight in a package: Lead: **13Y** - Wingman #2: **23Y** - Element Lead: **76Y** - Wingman #4: **86Y**

Up to 5 flights can be supported using the same format.
This training mission is in the first flight of the package, so your wingman's A/A TACAN is **22Y**. To pair with him set **85Y** (22 + 63).

Initiating IDM CONT ensures that you can track your wingman's position and who he is targeting.
As a reminder, that is done by pressing OSB 6 on the FCR until it reads CONT and then initiating an IDM round with a long COMM switch left.

18.12.3 The CAP

You have just entered the CAP in SPREAD formation. Ordinarily you would check in with AWACS, but that code hasn't been implemented yet. Start your HACK timer and 'Request Picture' from the eyes in the sky.

Falcon 1-1 Chalice 1 picture is 1 group bullseye 3 2 5 / 3 7 26000 track Southeast hostile

You already have one group dead ahead (325°), outside your commit criteria at 37 Nm but they are flying south-east (135°), so they are approaching. Select steerpoint 5 (end point of the CAP) and monitor them.

The BMS AWACS picture calls are a real game changer. They really help to build a mental picture of what's going on around you. As a rule of thumb 'Request Picture' when you turn, especially when turning cold. The reply from AWACS will help you time your turns to keep the bandits at bay, for example you don't want to turn cold with a contact only 15 Nm behind you and then have a missile in your face when you turn hot again.

Approaching steerpoint 5, make another picture request:

Falcon 1-1 Chalice 1 picture is 2 groups range and azimuth split

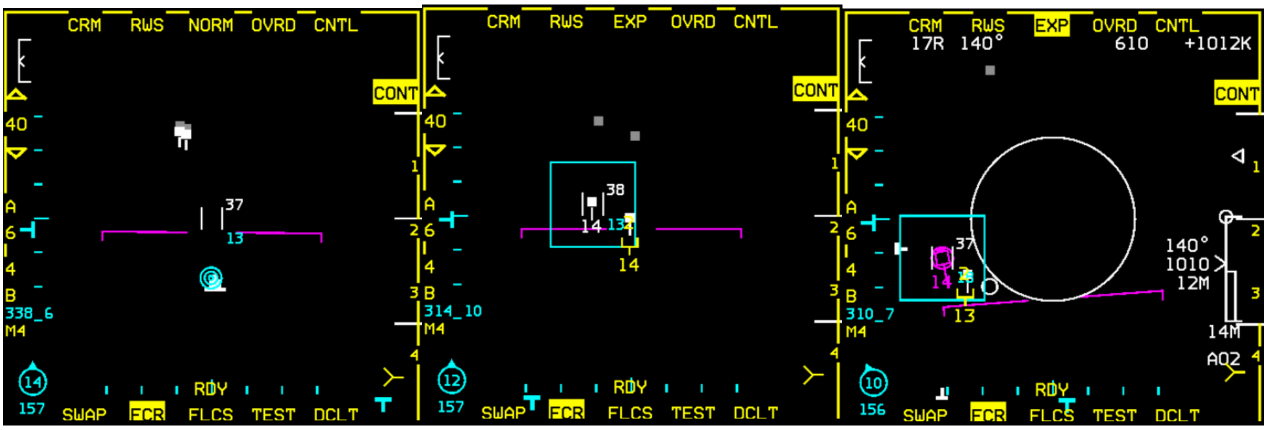
Southwest group bullseye 3 2 5 / 3 1 19000 hot hostile

Northeast group bullseye 0 3 3 / 6 6 5000 track Southwest hostile

The first group is closer (31 Nm) but still outside your commit criteria (25 Nm). There is a second group coming from the right but they are still 66 Nm away. You've reached the decision point to turn cold or commit on the first group. Since it is outside briefed commit criteria turn cold, but be aware that they are a bit too close for comfort. Your AI wingman will want to engage; issue a 'Weapons Hold' command.

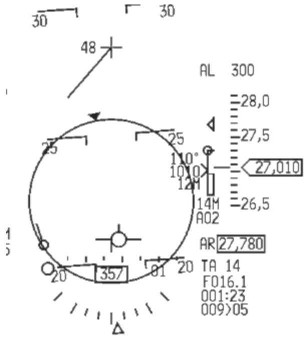
While you are on the cold leg get ready for an immediate engagement when you turn hot. In such a situation, with no friendly element pointing at the enemy the cold leg is your weak point. With the distance reported in this example it is best to turn hot before reaching your usual turning point. The longer you wait the closer they will probably be when you turn hot again.

You will find it unnecessary to contact AWACS when turning hot again as the first group quickly appears on your FCR and your RWR shows you have MiG-23s at your 11 o'clock.



30 Nm is perfect timing for engaging these guys. You have first shot opportunity and they are within your commit criteria. From here everything goes fast, as illustrated by the three FCR pictures above.

- Left FCR: detection. Initiate a quick IFF interrogation in SCAN mode. No Mode 4 indication shown on the FCR.
- Center FCR: you issue the 'Attack Targets' command to your AI wingman and wait to see his IDM radar cursor appear on your FCR. You expand your FCR to get a better view of who he is targeting. He was supposed to sort the wingman, but he didn't – hence the reason why you should always check.
- Right FCR: you bug the trailer, go AB, loft and fire your first slammer at the bandit. Crank right and monitor the situation, waiting for your slammer to go active. Keep an eye on your wingman DME (A/A TACAN) and position in IDM. Be ready with that leash.



When your wingman calls "PITBULL", issue the 'Rejoin' command. When your missile goes active, drag back to the start/anchor point of your CAP to increase your F-pole even further. Depending on your attack, both MiGs might be destroyed. If not, regroup and finish them off.

Drawing conclusions from the first engagement, you realize that a commit criteria of 25 Nm is too close. The MiG-23 engagement was concluded within 15 Nm and the MiGs might have fired missiles back. Had they been more advanced fighters, you and your AI wingman would have had to defend against incoming missiles. Learn from your mistakes and extend that commit criteria to bullseye + 40 Nm.

While you let your blood pressure drop, check that your wingman is in spread and fly the CAP as usual, waiting for more trade. It's always a good idea to keep a close eye on your wingman's fuel state and weapons remaining. Ask him for a 'Weapons Check' via the Wingman menu second page. He will give you his fuel state as well.

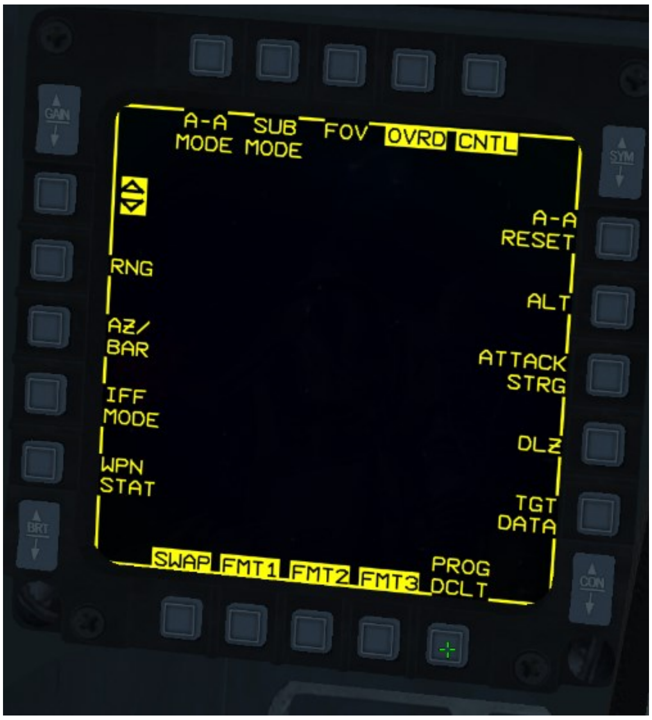
'Request Picture' whenever you turn in the CAP. There was a second group loitering on the East and you can expect them to try to penetrate your AOR at some point. Monitor your Hack time; your patrol time was set to 30 minutes from 0410z to 0440z (1310 to 1340 Local Time).

There is no need for guidance in the next engagement; the mechanics will remain the same as the first one. Just bear in mind the distance at which you engage. The more advanced your opponent, the smaller the margins between who has the first opportunity to launch. Therefore, know your opposition, as they may become more advanced as this training mission evolves.

The most dangerous opponent (short of a human player with slammers) will be MiG-29 or Su-27 type aircraft carrying the R-77 (AA-12) Adder. The young, bold pilots amongst you (there are no old bold pilots) might stay after their CAP patrol time for some real fun.

And here's a last bit of advice: BMS features IFF functionality. So use it, especially in these types of scenarios. You never know when a friendly AI aircraft might enter the fray…

We also want to mention the new declutter page on the FCR for A-A and A-G mode.
Press OSB 11 long on the FCR to open the declutter “DCLT” programming page.
Decluttering is especially useful to “Clean up” the FCR and blend out certain symbology.
It can be used to blend out certain target information such as altitude, attack steering, DLZ, TGT data, etc. as well as your own weapon state and sensors.
Set your values to your taste and task.
If you want do declutter your FCR page, press OSB 11 short.
More info is are available in the Dash-34 document, chapter 2.1.6.20.



MISSION 19: GUN & HMCS/AIM-9X *(TR_BMS_19_Guns)*

LOCATION: Over the demilitarized zone. No AWACS, no tanker in the area.

CONDITION: F-16C block 50 – Single ship – Package 1606 - Callsign Falcon 1.
GW: 31159 lb, 4 AIM-9X, 1 Sniper pod, 1 Centerline tank.
Max G: 7.0/-2.0, Max speed: 600 kts / 1.6 Mach.
Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.

WEATHER: RKSM INFO B 011625LT RWY01 TRL140 360/15KT 9999 FEW050 28/18 Q1013 NOSIG
(Fair weather)

LEARNING OBJECTIVES: Shoot enemy aircraft with the gun and the HMCS & AIM-9X combination.

At mission start your aircraft will be placed in an offensive situation against a Q-5 Fantan. The initial goal is to use the cannon to shoot it down, before other enemy flights enter the area and put you in a defensive situation, where you can use the high off-boresight capabilities of the AIM-9X to defend yourself.

Basic Fighter Maneuver (BFM)

19.1.1 Definition

„There is only one thing in the mind of a fighter pilot - To kill the enemy, to destroy the enemy and survive.“

To be successful in BFM (also called: Dogfighting), certain basic principles are important to understand before you are able to be a successful and efficient BFM fighter pilot.
Remember that the following information is very quick and dirty guide to give you the basic foundation.

What is BFM?

„Basic Fighter Maneuvering (BFM) is one vs one aircraft air-to-air combat utilizing canned maneuvering for solving range, angle and closure problems in order to achieve or deny a positional advantage and either employ a weapon or deny an opponent a shot opportunity. “(*Source: Naval Training Command CNATRA P-826 (06-18)).*

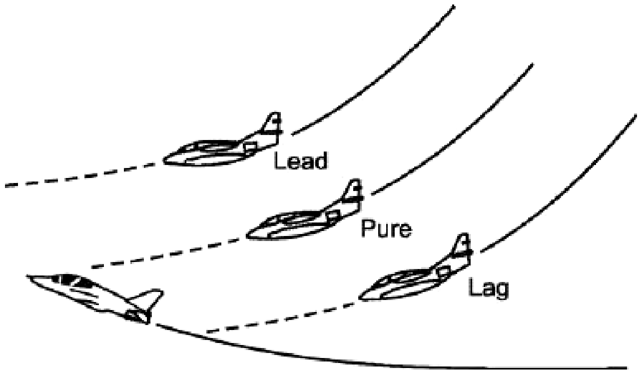
Each BFM engagement follows the same basic rules:

- **Observe** the enemy
- **Predict** the enemy’s trajectory
- **Maneuver** accordingly to your prediction
- **React** if a change appears

The golden rule of BFM is: **“Loose sight, loose fight”.**
It is always your highest priority to always know opponent position (visual) on your opponent. If you lose sight, your chances to survive will decrease tremendously.

19.1.2 Pursuit Curves

To bring yourself in an offensive position (Offensive BFM), you can use Lead, Pure and Lag pursuits. Each pursuit curve has different advantages/disadvantages:



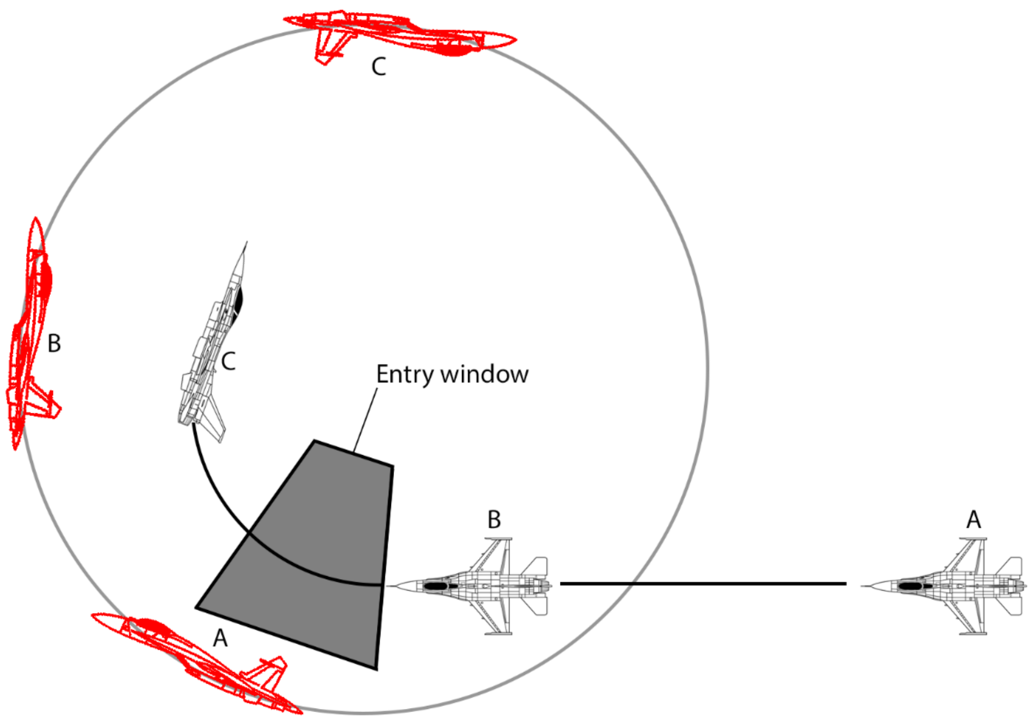
Curve	LEAD	PURE	LAG
Range	Decrease separation	Decrease separation	Increase/maintain separation
Angle	Increase AOT	Increase AOT	Decrease/maintain AOT
Speed	Increase closure	Increase closure	Decrease/maintain closure
Energy	Decrease energy	Decrease energy	Increase/maintain energy

19.1.3 Offensive BFM

„The goal of offensive BFM is to kill the adversary as quickly as possible “.

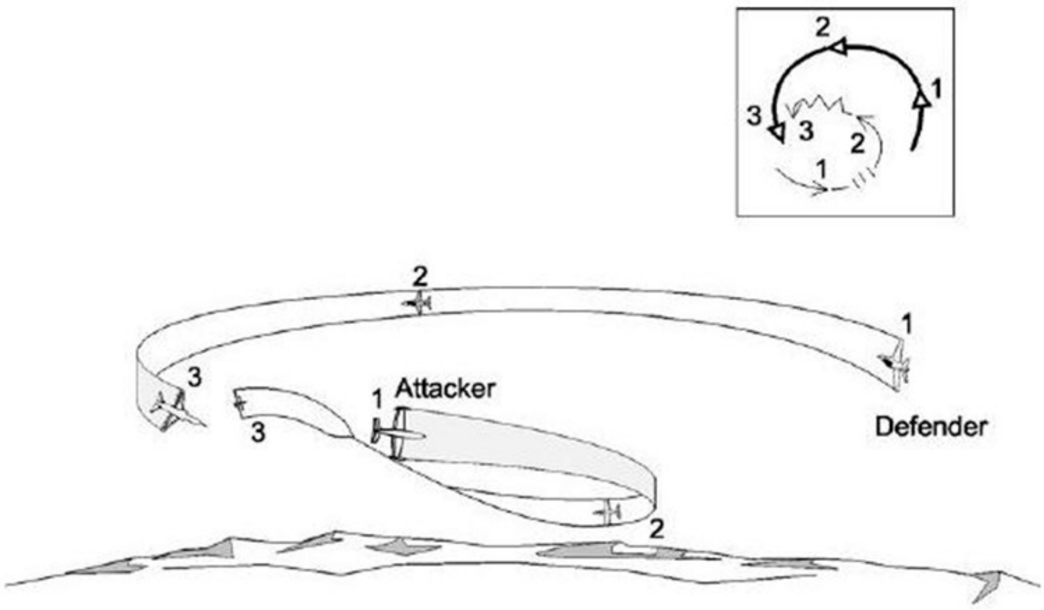
When being in an offensive position, the goal is to enter the turn circle of the enemy (=Entry window) at the right time with the right choice of the pursuit curve and with the appropriate speed as a well as needed amount of G-force. Before entering this circle, VID (visual identify) your enemy and make sure you know what you are fighting against. Fighting against a Q-5 will always make you more relaxed then fighting against a SU-27 where you have to perform higher energy maneuvers to stay offensive.

The following picture explains the entry window:

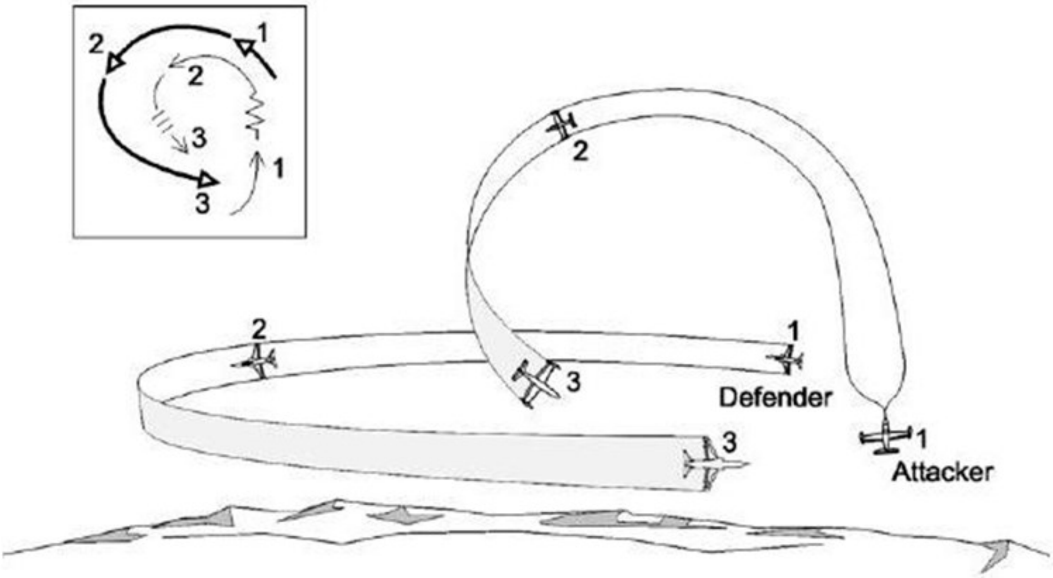


The goal is to achieve a quick kill with you gun or heaters so the optimal position after entering the turn circle is the 6-o'clock (behind the enemy).

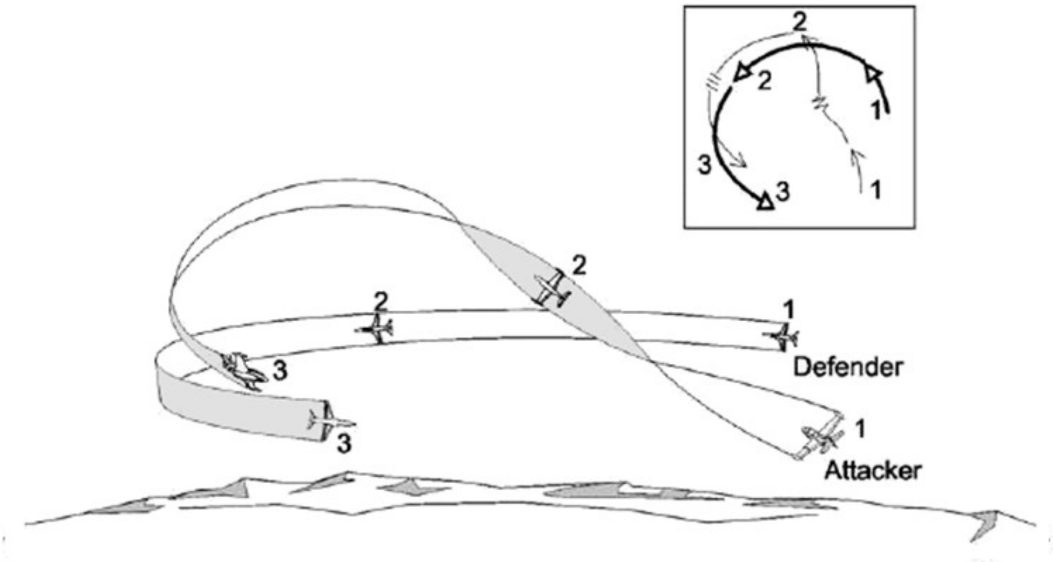
As in real life, your enemy will never fly a perfect circle all the time. So you have to use geometry maneuvers to enter the WEZ (Weapon engagement zone). "Low Yo-Yo", "High Yo-Yo" or "Displacement Roll" are some classic maneuvers:



Low Yo-Yo



High Yo-Yo



Displacement Roll

When you we're able to maneuver yourself on the "6" of your enemy, it's time to engage and kill him.

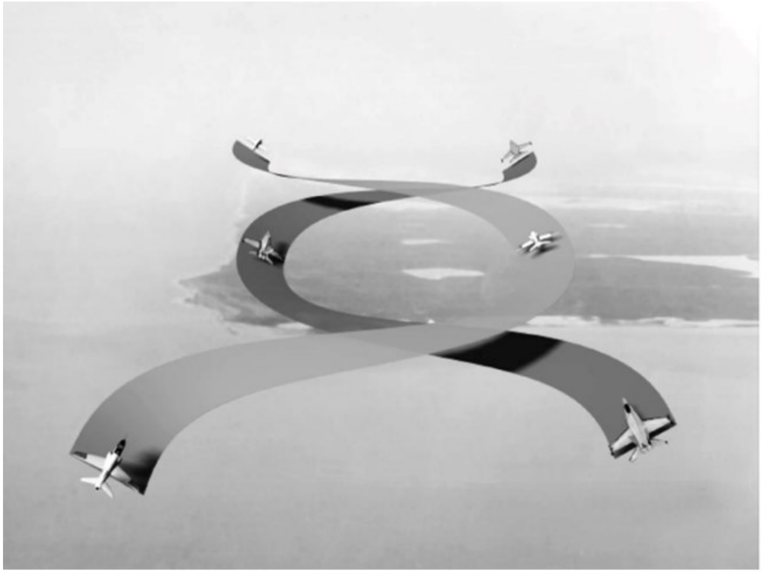
- Check that you are in range of your selected weapon (inside the WEZ)
- Both aircrafts movement is equal
- Go Lead pursuit
- Check your closure rate (don't overshoot!) -> throttle alignment
- Pull the trigger.

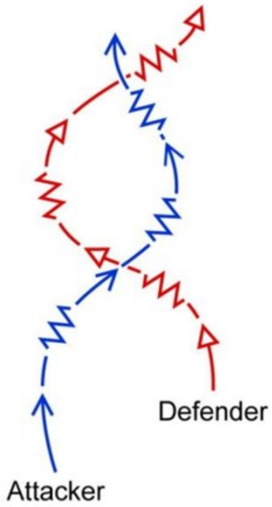
If you weren't able to maneuver in a proper way and may lost your offensive advantage, we recommend you to read the next chapter.

19.1.4 Defensive BFM

Being the hunted rabbit in a fight is always unpleasant. Mostly you cannot do much against it except four things:

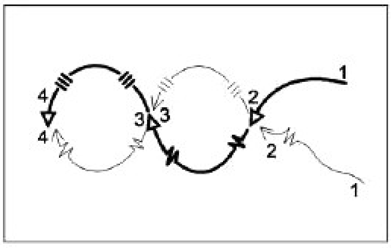
1- Never fly straight
2- Deflect shots on you -> Jink
3- Enhance turning room -> Lift vector for the enemy
4- Create BFM problems for your opponent -> Max performance turns, etc.

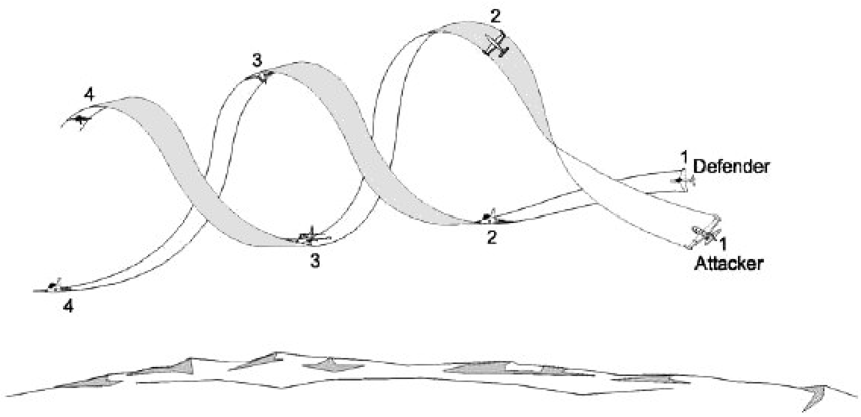




The best outcome of your maneuvers will create an overshoot of your hunter. The next possibility to gain upper hand and bring you back to a hunter role is the so called “Scissors” maneuver (see picture on the right and below).

The “Rolling Scissors” results from an in close vertical overshot and is usually a product of a successful counter to a BRA (Reversal). The main objective is to execute the scissors perfectly and capitalize on any mistake the bandit makes. Position assessment before committing into the Rolling Scissors is crucial.
If you feel you will end up defensively its better to bug out.
The only appropriate time to disegnage is from the top of the roller.
The main goal is to stay behind bandit Wing Line.
A key determinant in winning the roller is to strive to get your nose up when you are at the bottom before the bandit can get his nose down when he is on the top and vice versa.
Offensively if you find yourself in a roller you have made a mistake.





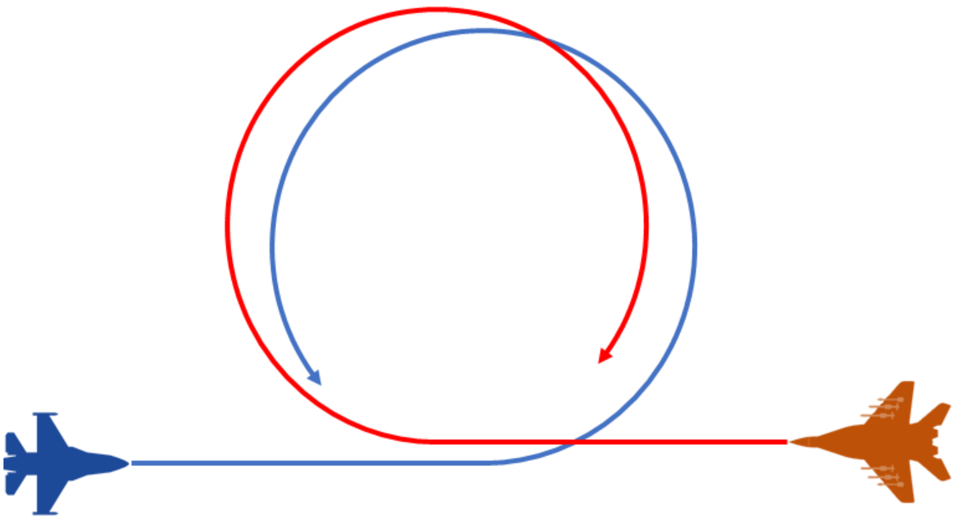
19.1.5 High Aspect BFM

In some BFM engagements you will find yourself head-on to the enemy aircraft. This is the most advanced and dangerous starting point of an engagement. Pilot skills, aircraft capabilities and maneuvers will define the outcome of the engagement.

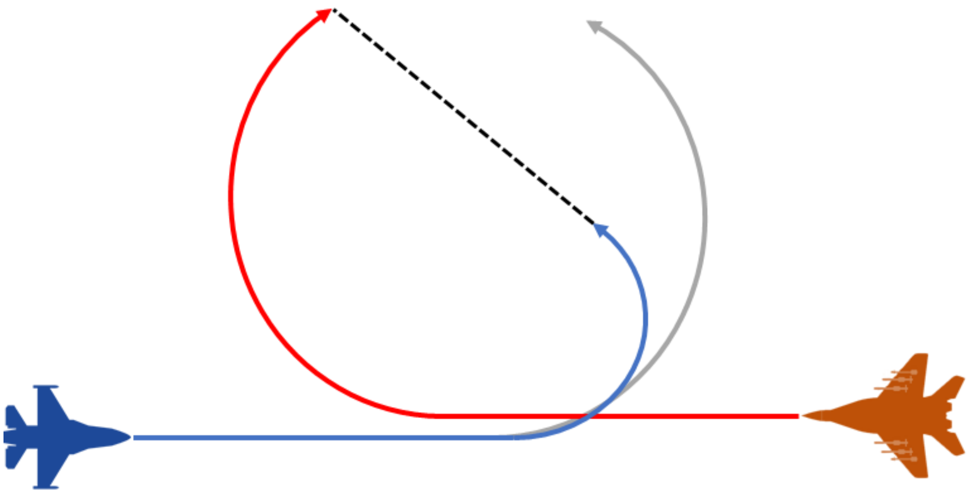
We distinguish between two types of initial engagement phases:

- One circle fight
- Two circle fight

One circle fight

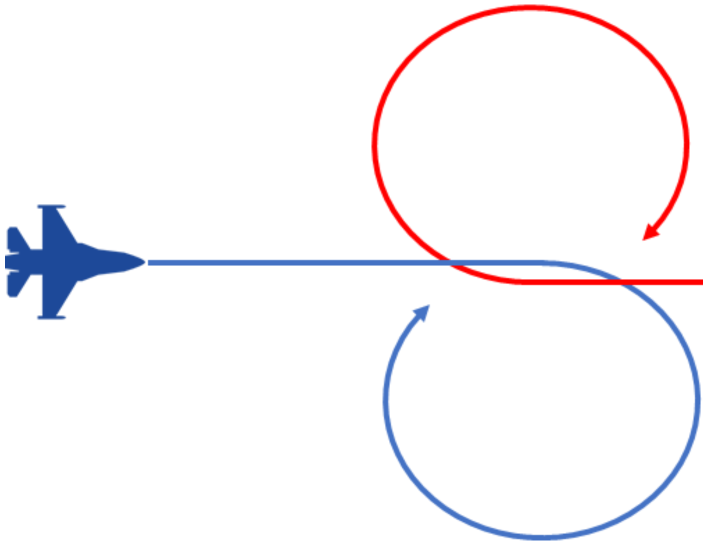


The “One Circle Fight” is a “Head-to-head” fight we’re both opponents have no possibility to use heaters (even all-aspect heaters will have their problems to be successful). The only chance in this case is to use gun snapshots.



The trick to win a one circle fight to reduce your turn radius. The only way to reduce your radius is to reduce your speed. Whoever will minimize his turn radius first and pull enough G’s, will increase his chance to win this engagement.

Two circle fight



The “Two Circle Fight” is a “Head-to-tail” fight we’re both opponents have good possibilities to use all-aspect heaters. Whoever has the greater turn rate will win. To increase your turn rate, you have to increase your speed.

19.1.6 Energy management

The F-16 is a tremendous dogfighter with great BFM capabilities. As you see below, the F-16 has a sweet spot for low and high energy turns.

Tightest turn (constant): ~ 160kts / 2.1G

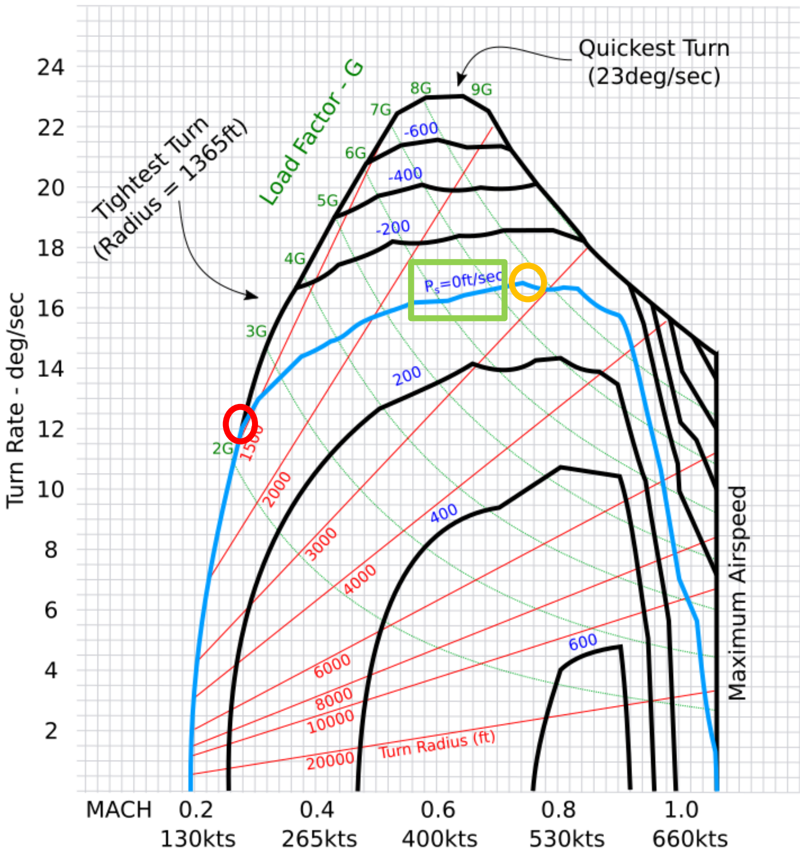
Tightest turn (max): ~ 200kts / 3.5G

Fastest turn (constant): ~ 500kts / 7.8G

Fastest turn (max): ~ 400kts / 8.5G

Plateau: 340-440kts / 4.5 - 6.5G

➔ Best speed for a sustainable fastest turn



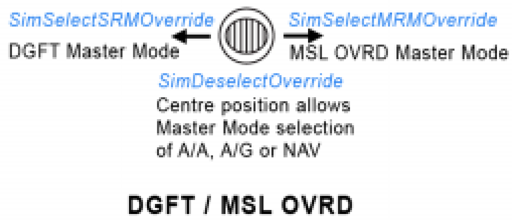
The Gun

The quickest way to select the gun is to select DOGFIGHT master mode with your HOTAS.

As its name implies, Dogfight mode sets your aircraft systems for WVR (Within Visual Range) air-to-air combat; unlike MRM mode which sets your aircraft systems for BVR.

Settings may be customized in your DTC file but default settings for DOGFIGHT are: FCR/ACM (radar off) on the left MFD,
SMS on the right MFD with SRM (short range missile) or HOB (high off-boresight) active (if carried) and the gun ready for use.

The gun can also be selected from the A-A SMS page by selecting OSB 1 to toggle between missiles and the gun.



The gun in the F-16 has different gunsights according to blocks. There are 4 modes available, depending on your Avionics profiles (for information on the Avionic Configurator, please refer to the BMS Technical Manual).

EEGS is the newest gunsight and will be found on most F-16s, though older models might include older gunsights. All gunsights have been improved since BMS 4.36; consult the -34 for more details.

- **EEGS**

EEGS represents a funnel and an aiming point.
The main advantage of EEGS over older sights is that it doesn't just work for one fixed distance - it works for all distances between min and max range.
The size of the funnel depends on the wing span setting entered in the LIST 5 page (MAN). Default is 35 feet which corresponds to a MiG-23 wing span. The perfect solution cue is attained when the funnel touches both wingtips of your target and the core of the aircraft is placed on the dot of the funnel.

The following EEGS symbology was improved since 4.36:

- Upon acquiring a radar lock, EEGS progresses realistically from level 3 (only target range is known) through level 5 (target range, velocity, and acceleration are known)
- Improved BATR symbology: with a radar lock, the Bullets At Target Range symbol now appears one bullet time of flight after squeezing the trigger (when bullets start passing the target!) and disappears one BTOF after releasing (when the bullets stop passing the target)
- More accurate max-G cue (the minus at the bottom of the tee showing target position if they pulled max G into you) and maneuver potential cue (the bars of the T showing the target's max out-of-plane maneuver)
- Smoother sight motion at high aspects and short ranges

- **SNAP**

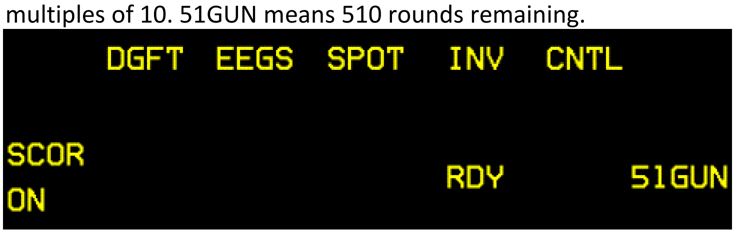
This mode draws only a gun snake, showing where bullets shot in the last 1.5 seconds would go. With a radar lock, the circular pipper moves along the snake according to target range. Very difficult to use by itself.

- **LCOS**
  Lead Correcting Optical Gunsight. With no lock, it works like a traditional gyro gunsight (think WW2, Korea). With a lock, the pipper shows a "range L" that works just like the range cue in the EEGS TD Circle - it unwinds counterclockwise, starting at 12000 feet. A tic near the 4 o'clock position indicates one second bullet time of flight. Once the radar has velocity information, an "overtake velocity caret" appears, which shows closure. If the caret is at 12 o'clock, you have zero knots closure. Positive closure makes the caret wind clockwise, and negative closure makes it wind counterclockwise, where each o'clock is 100 knots.
  LCOS also draws a line from the gun cross to the pipper to help you line up your shot, and a lag line, which shows the direction the pipper is moving. LCOS is designed for stable tracking shots! For the pipper to be accurate, get in the target's plane of motion and let the sight settle out. When the lag line disappears, shoot!

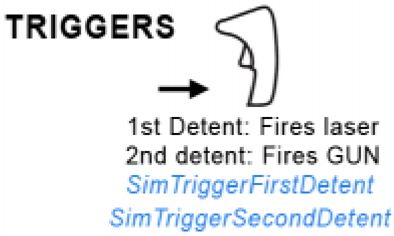
- **SSLC**
  A combined Snapshot & LCOS sight, with the LCOS pipper and the snapshot gun snake. Use LCOS to take your shots, and the snake to evaluate them (since it will show where your bullets flew!).

For further information about the gunsights we refer you to the Dash-34, chapter 4.3.2.3.

When flying a block that features any of the 4 gun modes implemented, they can be toggled with OSB 2 of the A-A SMS page: Pressing the button will toggle the different modes displayed in the HUD. The amount of gun rounds remaining is displayed next to OSB 6 in multiples of 10. 51GUN means 510 rounds remaining.



Once the gun is selected, it's hot if MASTER ARM is in ARM. It may sound obvious, but there is a difference between firing the gun and firing missiles or dropping bombs. Missiles are fired and bombs released using the pickle button; the gun is fired with the trigger.



The F-16 HOTAS has a double trigger detent, so has BMS.
The first trigger usually starts the gun camera (or recording),
or fires the laser; the second trigger fires the gun.

Therefore, you must ensure that you have programmed your HOTAS with the *SimTriggerSecondDetent* callback to ensure your HOTAS trigger will activate the gun.

Helmet Mounted Cueing System (HMCS)

The HMCS is fully explained in the Dash-34 manual, chapter 2.5. This chapter will cover its operational use with the AIM-9X loaded in this training mission. HMCS use will be explored after the first gun kill on the Q-5.
In the meantime, here is some basic information on how to setup the HMCS in the cockpit.

The HMCS is mounted on top of the pilot's helmet. It must be turned on with the knob on the HMCS panel located on the left auxiliary console.
The knob has an ON/OFF button at the beginning of its course of travel and controls HMCS brightness and intensity as well. Once activated, it is an extension of the HUD and both are considered as one SOI (Sensor of Interest).

The HMCS features two DED control pages (LIST – MISC - RCL) to manage different options, such as HUD and COCKPIT blanking (HMCS display will blank automatically when the pilot looks at the HUD and inside the cockpit), different levels of de-cluttering and new alignment options were implemented since 4.36. These options are set by default and described in the Dash-34.

The use of the HMCS can be passive or active:

- You can use the HMCS to keep basic flight information in your view at all times as you look around.
  Aircraft airspeed and altitude are displayed on the HMCS and are valuable information when you are looking away from the HUD, keeping a tally on a bandit for instance. The heading is not the aircraft heading, but the bearing you are looking towards, helpful for calling out bandits to your wingmen.
- Uncaged AIM-9 seekers can also be switched from the FCR to the HMCS by depressing CURSOR ENABLE on your throttle. By default, the button has to be kept depressed for the seeker to slave to the HMCS. As soon as you release the button, the seeker will return to the FCR LOS. This behavior can be changed to a toggle in Avionic Configurator. This allows you to boresight the infrared missiles to the HMCS without using the FCR, for when you want maximum surprise.

- You can also use the HMCS more actively by slaving FCR LOS to the HMCS.

  In DOGFIGHT override mode, switch the FCR to ACM BORE (Boresight) sub-mode by pressing and holding TMS up; an ellipse is displayed on the HMCS. Move that ellipse over the target and when you release TMS up, the radar will start to radiate and attempt to acquire/track a target within the ellipse.

  For this to work, the HMCS LOS must be within FCR gimbal limits. When you move the ellipse out of the FCR gimbal limits, the ellipse will stop being displayed on the HMCS center but will remain on the side of the gimbal with a X superimposed on it.

These two methods are documented in detail in the training mission.

The Mission

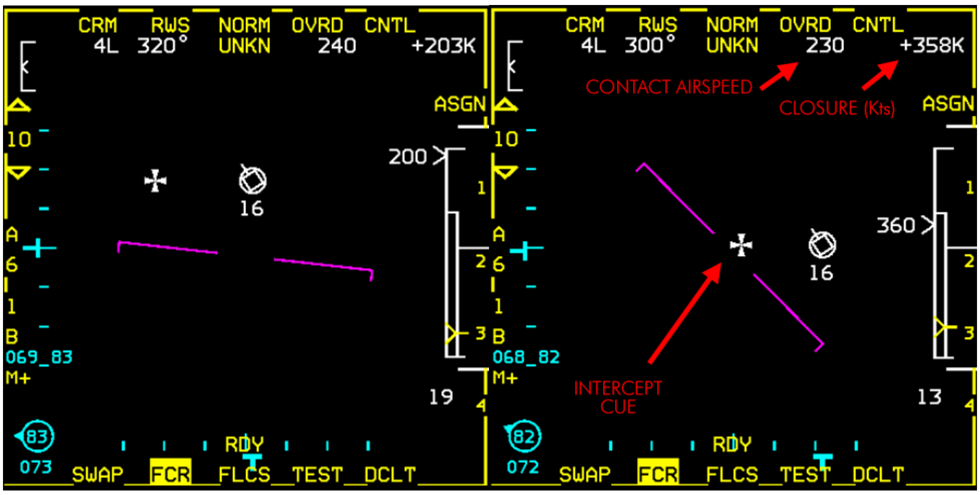
Timing air to air engagements with AI is not an exact science. The idea in this training mission is to place you in an offensive situation for an easy gun kill against a Q-5 fantan, while a MiG-21 attempts to intercept you.
As the mission evolves, more single-ship red aircraft will pop up and each will be a more advanced fighter than the previous one.

The situation will be very dynamic, and we will consider the engagements one by one:

- Q-5 with guns.
- MiG-21 with HMCS passive AIM-9X (no radar lock) off-boresight.
- MiG-23 with HMCS FCR/HMCS BORE.
- The 4th fighter will be up to you as a bonus.

19.4.1 The Q-5: 30mm Guns

Entering 3D, you seem all alone cruising lazily above the clouds. Select Air to Air master mode and make an FCR sweep in front of you. You will notice a contact inside 10 Nm in front of you, he's cold meaning flying away from you. Don't wake up the guy by going STT (double TMS UP) on him right away but lock him up with one TMS UP so you can get his speed at least. Quick round of IFF LOS gives no response. You have no AWACS and must close to visually ID the bogey before engaging.
Closing on him, monitor your closure rate with the FCR. Check your switches for Master arm ON and that the HMCS is ON. If contrast against the clouds is a problem, use your visor.

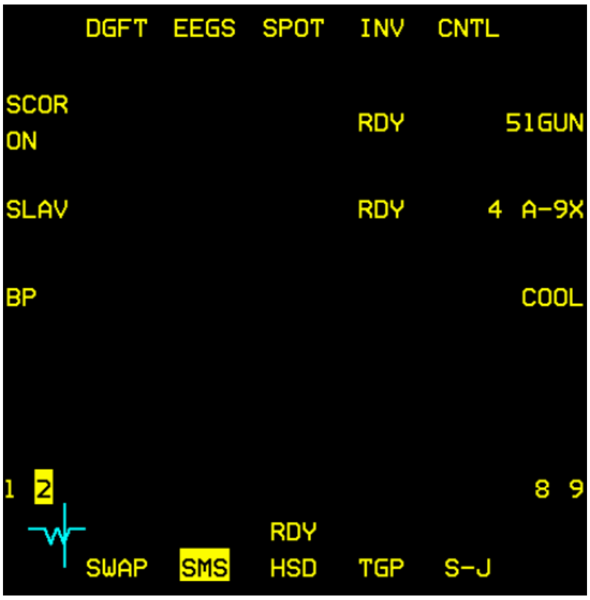


The left FCR picture on the previous page should be close to your initial lock on the FCR. The bogey is dead ahead, 7 Nm, 16000 ft, aspect 4° left, flying on course 320° at an airspeed of 240 kts.
To intercept a radar contact from this position you need to closely monitor your closure, which is located at the top right corner of the FCR (second picture above). It is currently 360 kts. As you may have noticed, the closure rate is also displayed on the scale on the right of the FCR.

Flying lead pursuit is the quickest way to intercept the contact and that is done by simply placing the CATA in the center of the FCR, as illustrated in the right FCR picture.

As you close in on the bogey you must adjust your speed. An overshoot would place you in a very awkward situation wouldn't it?

Once you have a tally on the bandit (you classify it as a bandit when you see it is a DPRK Q-5 Fantan) and you've got your closure rate under control, switch to Dogfight mode. This will provide many advantages:

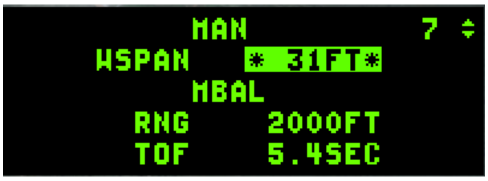


- The radar will switch to ACM mode and will snooze (stop radiating) until you select a sub-mode.
- Infrared missiles will be selected and can be fired with the pickle button (note RDY next to AIM-9X on the right SMS picture).
- IR missiles are automatically cooled (in Dogfight and MRM mode). In regular A-A master mode, IR missiles need to be manually switched to COOL (OSB 8). If they are not cooled, RDY status may not be displayed; the missile will fire but with degraded seeker efficiency.
- The gun will be selected and can be fired with the second trigger detent (note RDY state next to the GUN on the right SMS picture).

As explained above the F-16 block 50 you are flying today only has the EEGS gunsight. You therefore cannot change it with OSB 2, but you wouldn't want to anyway as it's the best F-16 gunsight.

EEGS displays a funnel and a reference aiming point in the HUD as a solution cue. The funnel should be adapted to the wingspan of your target for better accuracy. This is done through the LIST – 5 page of the ICP.

It defaults to 35 ft for a MiG-23 and the Q-5 has a 31 ft wing-span.
It won't prevent you from shooting the aircraft down, but if you want to change the wingspan setting to 31, simply enter '3 – 1 – ENTR' with the ICP with the scratchpad on the WSPAN line.



Now you must maneuver your aircraft into a control position behind your target, trying to position the Q-5 on the EEGS dot which is 2000 feet in front of you with the EEGS funnel on its wingtips. Once you get that sight picture (or actually a fraction of a second before) fire a short burst of cannon fire.

If you close too much, an X will superimpose on your HUD. If you fire and hit the aircraft in front of you, you might get damaged by the blast, or debris as you fly through the explosion. Still, that allows you to admire the marvelous new 3D model of this not very well-known aircraft.

The pilot of the Q-5 must be junior, as he’s flying slowly and remains unaware of your attack for a long time. Once he detects you he will start to jink, and he will use the sun a lot, hoping to decoy your infrared missiles.

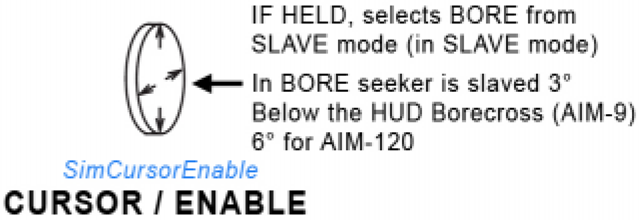
It shouldn’t take long for you to saddle up behind the Q-5 and shoot him. But be aware that while you’re having fun with the Q-5, a MiG-21 may be maneuvering behind you; check your six often, or you may see a few tracers flying past your canopy if you become fixated on that weird aircraft.

19.4.2 The MiG-21 : AIM-9X

We can't tell you where the MiG-21 will be after the Q-5 engagement. He might be in firing position on your six, he might have flown back to base; he could be anywhere in a block of airspace 40 Nm around you. All we can tell you is that when you spawned he was supposed to come in from your 4-5 o'clock quarter. You'll have to find the MiG with your Mark1 eyeballs or your on-board sensors. First have a careful look around you.
If you can't see him and your FCR doesn't auto-lock him in ACM mode, start a wider FCR search by moving the dogfight switch to MRM override mode, which will place the FCR back in RWS mode. Pay attention to your RWR. If he finds you first you may hear the spike and be able to get an idea of his direction from the RWR display. Continue scanning the skies until you spot him.

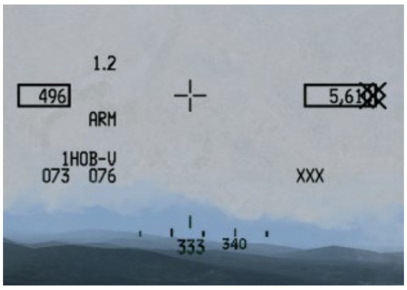
Once you have radar contact, let's try to sneak up on him and send an AIM-9 up his tailpipe. Once you have tally, go back to dogfight mode, which will snooze the radar, and keep him padlocked. Let's try to get him with a radar-off infrared shot. First uncage the first AIM-9X. The missile diamond seeker in the HUD doubles in size (left picture below).

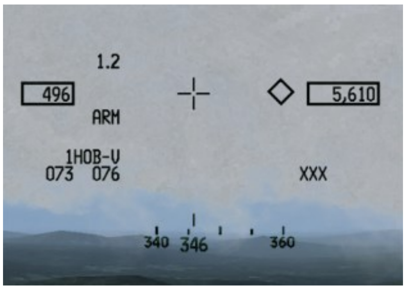
By default, the missile seeker is pointed 3° under your HUD boresight cross. As we are in
off-boresight geometry we need to slave the missile seeker to the HMCS. This is done with the CURSOR ENABLE button on your throttle
(press in and hold). The missile seeker will go to the HMCS LOS as long as you keep the button in.

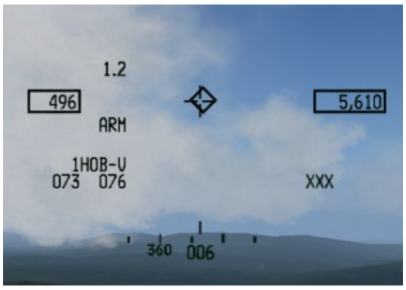


As you see on the second picture, the missile diamond moved from the HUD to the center of the HMCS display but it didn't acquire the MiG-21, as it's still outside the seeker field of view. The cursor enable switch is not released. If you release it, the missile seeker will return to the HUD. Instead, keep it depressed and place the HMCS missile seeker head on top of the aircraft, then release cursor enable. If the seeker sees the aircraft it will lock up, the growl will change in pitch and you're ready to fire. Last check of the firing parameters and you let fly the sidewinder, which will find its prey as it's climbing, trying to outmaneuver you.

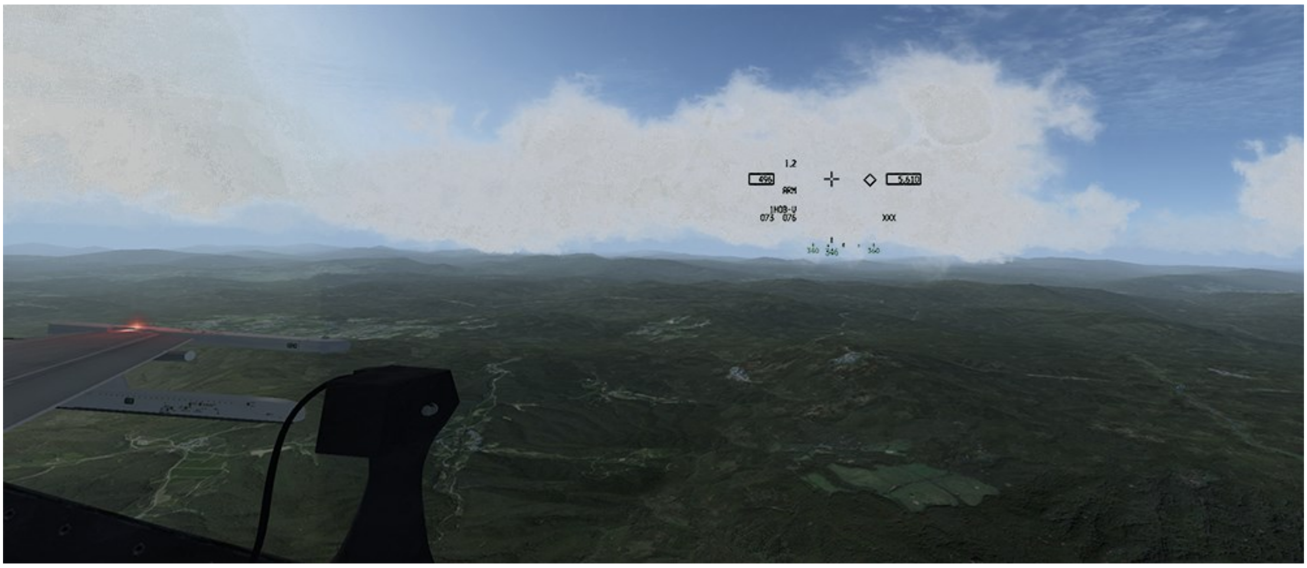
For the off-boresight sidewinder to score, the aircraft you are targeting must be located within the missile seeker gimbal limits. These limits are greater (for the AIM-9X at least) than the FCR gimbal limits that often become the limiting factor when you try to make an off-boresight shot with a radar lock. The next three pictures are taken looking left of the airplane at about the 3/9 line. The right picture shows the seeker still centered on the HMCS LOS when looking at 006°. When looking further left (346°) the diamond is offset as if becoming stuck on the side of the HMCS. You have reached the missile seeker gimbal limits.



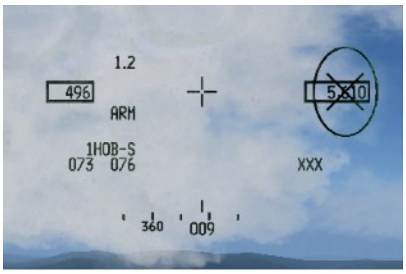


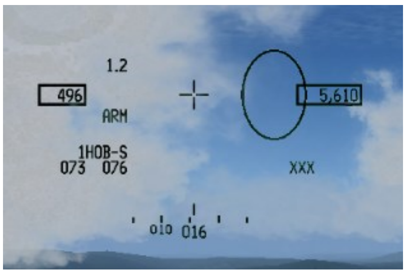


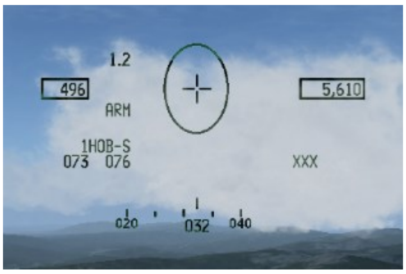
If you look further left at 333° (left picture) the missile seeker head is crossed and stuck at the side of the display, indicating that the boresight limits are outside the HMCS display. It's hard to judge from the pictures above how far off-boresight you can get. With the AIM-9X it's just under 90°; the following picture shows the missile diamond tied on the HMCS just above its gimbal limit, and we're barely looking at our left 9 o'clock.



The FCR has less off-boresight capability, as the following images will show you. The same test was performed looking left, with TMS up to slave the radar in BORE to the HMCS. The right picture shows the FCR BORE ellipse still centered when looking at 032°. Looking further left (016°) the ellipse offsets to the right, it remains stuck at the FCR gimbal limits. If you look further left (009°) on the left picture the ellipse is crossed and stuck on the side of the HMCS display.







As you see the infrared seeker reaches gimbals around 360° whereas the FCR gimbals around 030°, equating to 60° either side of your heading, which corresponds to the 120° scan volume of the FCR. The next picture might give you a better idea of the off-boresight limits using the FCR:

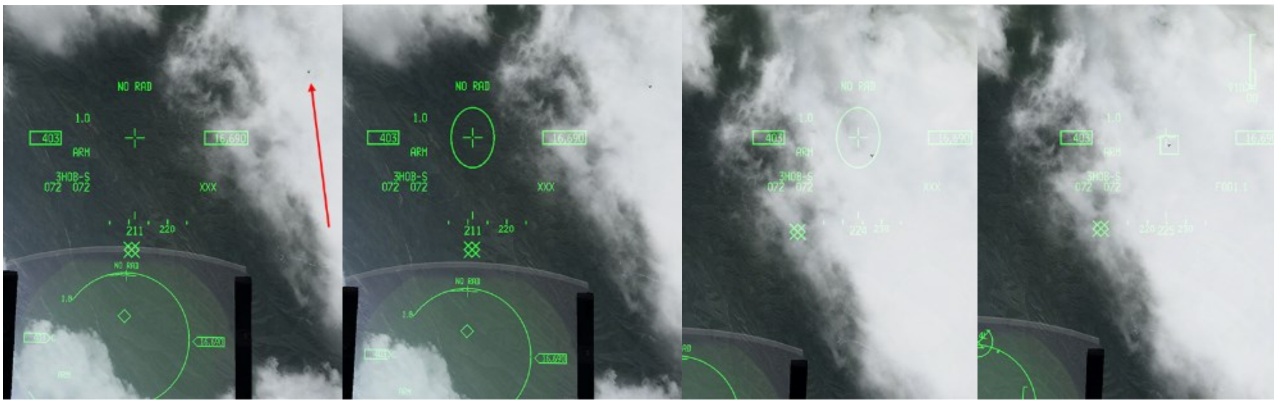
19.4.3 The MiG-23 : HMCS

While engaging the MiG-21 you may have had a glimpse on your RWR of 'nails' from a MIG-23. He is set to come in from the West. Hopefully you were able to deal with the MiG-21 before the MiG-23 finds you.

If you have no indication of his position, start a search to the West and you should find him quickly. As always, don't go STT on the radar contact. You want the bandit to stay unaware as long as possible. Climb to get an altitude advantage, the MIG-23 is a very fast aircraft and you will need all the energy you can get.

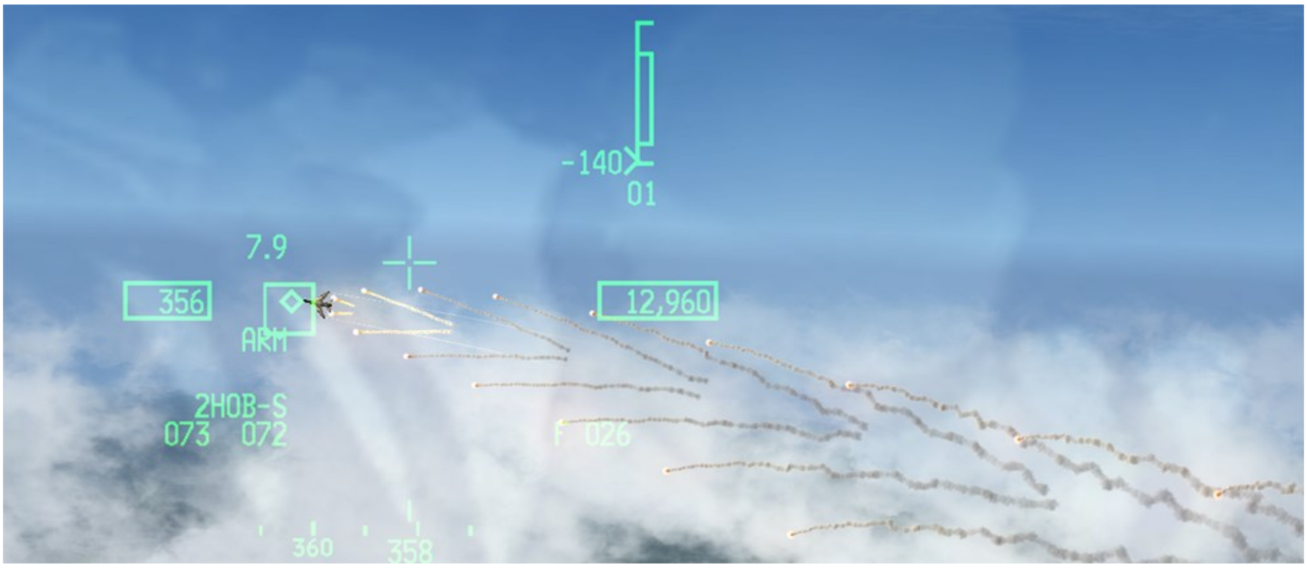
We will attack the MiG-23 with an AIM-9X using an FCR lock. As always, use the FCR in CRM mode to start your intercept and get as much information on your opponent as possible: airspeed, altitude, closure, aspect angle etc. Once you have tally, switch to dogfight mode and start using your HMCS.

Slaving FCR LOS to the HMCS is done, within FCR gimbal limits, with TMS up. TMS up actually switches the FCR, when it is in ACM (Air Combat Mode) to ACM BORE. Just like the Cursor Enable button for the missile seeker, it's a dead man press and the FCR will start radiating when TMS up is released. So press and hold TMS up and an FCR Field of View ellipse will be displayed in the HMCS. Place that display over the position of the contact you want to lock and release TMS up. Upon release the FCR will start radiating and any contact within the HMCS ellipse will be locked up.



In the 4 pictures on the previous page, the left most picture is the initial attack on the MiG-23 in the top right corner. Dogfight mode is on; the radar is snoozed. In the second picture, TMS up is pressed and held. The FCR doesn't radiate yet but the FCR LOS ellipse is displayed in the HMCS. In the third picture, the HMCS ellipse is moved over the visual contact and TMS up is released. The FCR starts to radiate, finds the contact and locks it (right most picture).

Upon FCR lock, the MiG-23 reacts, breaks left and tries to run away, popping chaffs and flares.
He can run, but he cannot hide. Well, not with a trail of flares like that anyway…

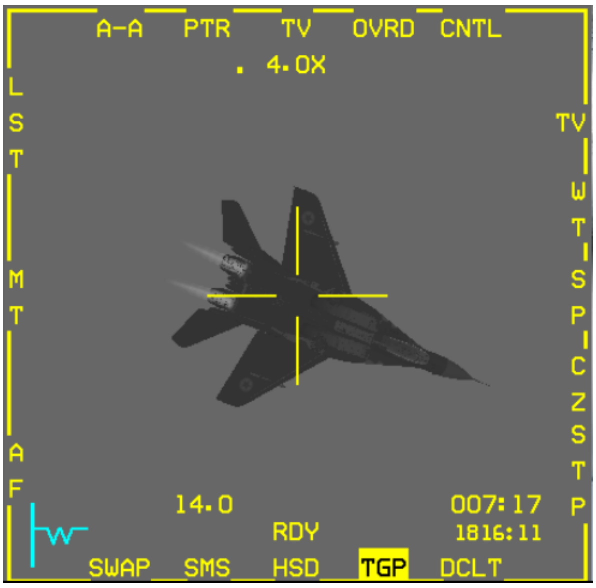


Wait until the sight picture looks better, then uncage and fire your infrared missile.

Well done, that's three you're almost ace!!

19.4.4 The MiG-29

The MiG-29 engagement is the icing on the cake.
It's where you will apply all the skills you have learned in the previous training sessions. He's not supposed to be anywhere nearby as you dispose of the MiG-23, but he is taking off from Wonsan for a Sweep in your area. Knowing that, you may therefore maneuver into an offensive position on him. Turn towards Wonsan and start a radar search.



You've learnt how to use the gun, short range AIM-9X and the HMCS, so you're on your own now.

Avail yourself of the pause, freeze, invulnerability and unlimited guns and missiles as necessary to train as much as you need, until using these systems becomes second nature. Practice is what you need.

Try this mission as often as required and it will play out differently depending on how you manage the first engagements. The situation is very dynamic and may not play out exactly as it was documented here. That's not the really important part. Learn these systems regardless of the way the training mission develops. And above all: have fun doing it.

MISSION 20: AGM-84A HARPOON *(TR_BMS_20_Harpoon)*

LOCATION: Over Sokcho airbase close to the DMZ.
Please note, make sure you select the TASMO F-16 flight from the mission window.

CONDITION: RSAF F-16D block 52+ – Flight of 2 – Package 4964 - TASMO - Callsign Falcon 2.
GW: 42575 lb, 3 AIM-120B 1 AIM-9X, 4 AGM-84A Harpoon, 1 TGP, 1 Navigation pod.
Max G: 5.5/-2.0, Max speed: 550 kts / 0.95 Mach.
Once in the cockpit the training scripts will freeze BMS and setup your systems accordingly.

WEATHER: RKJK INFO: B 010455Z ILS RWY26 TRL140 360/10KT 9999 FEW050 18/8 Q1009 NOSIG

LEARNING OBJECTIVES: Identify and attack the Russian Carrier Kusnezow, cruising within its battle group alongside the North Korean West coast. Intel reports its destination is Wonsan harbor.

20.1 TASMO

TASMO stands for Tactical Air Support Maritime Operations; you will be attacking naval targets for a change. BMS 4.34 introduced a lot of new features supporting naval operations. Amongst them is the Russian carrier battle group of the Admiral Kusnezow, which is currently cruising off the north-east shore towards Wonsan.
The Kusnezow is a formidable weapon and can deploy its air wing of Su-33 fighters. Considering the opposition, your package will be supported by an F-16 escort, AWACS, HAVCAPs and a tanker.
Your mission is to identify the carrier from the rest of the naval group and sink it.

The best weapon for the mission is the AGM-84A Harpoon; a sea-skimming anti-ship missile. It is designed to be simple to use and its operational range of 60-70 Nm allows standoff attacks, usually keeping the launching platform out of range of all but aerial retaliation. It can be carried by Korean and Singaporean F-16s in BMS.

The Carrier group around the aircraft carrier Kusnezow consists of 6 ships; the largest being the carrier itself. It contains the highest threat to attacking forces: its aircraft. Regarding close air defense SAM systems the Kusnezow is equipped with the medium range SA-N-9 missiles, the equivalent of the SA-15 (Tor). The second largest ship is the Kirov class missile cruiser Peter the Great (Pyotr Velikiy). This nuclear-powered cruiser is equipped with the longest range SAM in the carrier group with the SA-N-6 the naval equivalent of the SA-10.

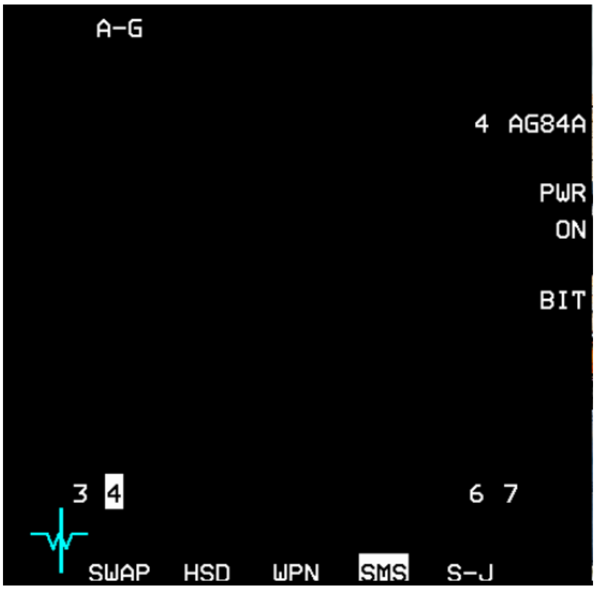
The last 4 ships in the group (unless there are a few submarines underwater) are Sovremenny-class destroyers equipped with SA-N-7 medium air defenses, the naval equivalent of the SA-11.

Note that the Harpoon can be engaged by ships with missiles and AAA. So, TASMO is not a milk run anymore.

20.2 The AGM-84A missile

Let’s review AGM-84A Harpoon employment. Before use each missile needs to be powered up separately. You carry 4 of them for this mission, so you will have to power all 4 on the SMS page. Missiles will power off automatically if A-G mode is exited, or another weapon type is selected (including another A-G weapon).

Power-on time for the harpoon missile is around 20 minutes. Keeping the missile powered up for longer may degrade missile functionality, or at worst render the missile unusable.



Powering the missile is not required for managing the weapon before launch, it is only required for launching it. Therefore, you may elect to power the missile just before launch; in fact, it is advised to do it exactly like this. Powering up is immediate, but the missile needs approximately 10 seconds to display a RDY state.

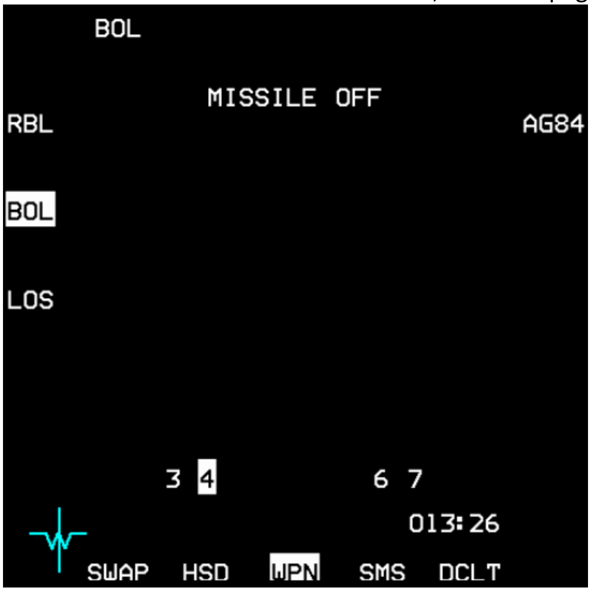
With 4 missiles loaded, stepping the missile with OSB 10 or OSB 16 will alternate missile position. For instance, if the missile on station 4 is selected (left wing) and you want to select the missile on station 7, you will need to press OSB 10 for selecting the next right wing station (station 6), then press OSB 16 to select the next left wing station (station 3) then once more press OSB 10 to finally select the next right wing station which is station 7.

You can’t step within the same wing with either OSB 10 or OSB 16; you have to toggle through all 4 stations. This might be confusing when you power on all the missiles together. Do remember to always check the station number to have a clear view of which missile is powered and which is not. Again, it is easier to power them up in sequence just before firing them.

The harpoon can be launched in one of three modes, set through the WPN page:

- **RBL** (Range Bearing Launch)
  RBL is the primary launch mode of the missile and is used when the target position is well known – meaning known to the aircraft sensors, which can provide accurate target position to the missile interface before launching. The harpoon will be fired on SPI coordinates and will fly and acquire the target according to the WPN page options.
- **BOL** (Bearing Only Launch)
  BOL mode is used when the exact position of the target is not known. It is a slightly degraded mode when target range is not computed (read no sensor on the target) but approximate target bearing is known. There are no search area or priority options available. The pilot can set a defined range for missile seeker activation and missile destruction.
- **LOS** (Line Of Sight)
  LOS is a backup mode used only in case of malfunction in the avionics. The missile attitude reference will be established in a self-level mode and the bearing to target will be established by pointing the launching aircraft in the direction of the target. In LOS it is mandatory to maintain straight and level flight for at least 40 seconds prior to weapon release, fire the missile and continue flying the same straight and level attitude for another 40 seconds after missile launch. The missile seeker will activate automatically shortly after its boresight launch. The search pattern is pre-programmed and cannot be altered by the pilot.

The relevant mode can be selected with OSB 1. Another selection menu will then be displayed where RBL (OSB 20), BOL (OSB 19) or LOS (OSB 18) mode can be selected. Once a mode is selected, the WPN page will revert to its initial state.

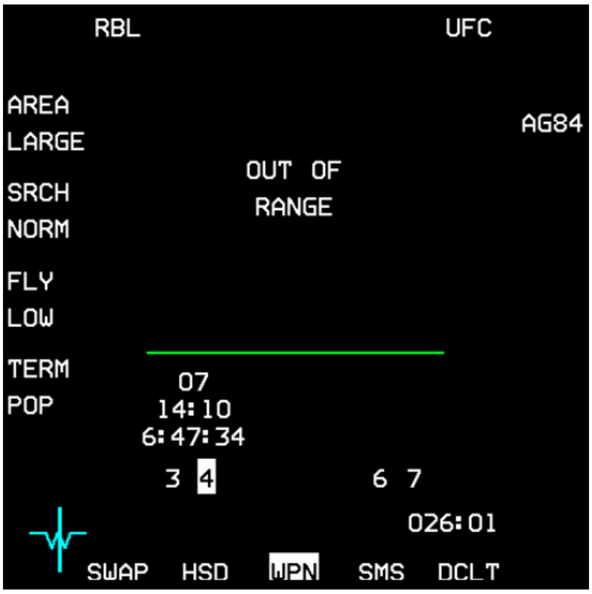


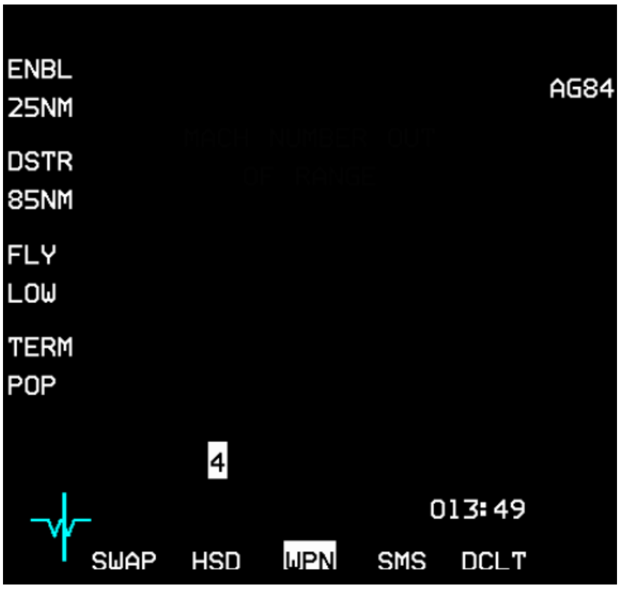
OSB 20 is mode-dependent.

With RBL mode selected (left picture below) OSB 20 sets the Harpoon Search Area Size. Depressing OSB 20 will toggle between Large, Medium and Small. Large area is default and expands with longer ranges. Small and Medium are fixed area modes (i.e. they don't depend on range) and are mostly used when multiple ships are in the area, or in narrow waterways to avoid the harpoon targeting ground targets. It is not advised to use Small or Medium search area when launching at long range because the target may exit the search area by the time the missile gets to the area.

With BOL mode selected (right picture) OSB 20 sets the Enable Range (ENBL), which is a distance in nautical miles after the launch point where the missile seeker goes active looking for targets. It is also the set distance from launch point where the missile will descend to a lower altitude (see OSB 18). Depressing OSB 20 enters a sub-menu, allowing you to set the range in nautical miles.

With LOS mode selected, there are no options available for OSB 20.





OSB 19 is also mode-dependent.

With RBL mode selected OSB 19 sets the Harpoon Search Priority (left picture above). This option is only available with RBL launch mode when the search area is set to LARGE. Depressing OSB 19 will toggle between available options:

- **NORM**: default - the search pattern will start at the center of the area and extend outward in all directions.
- **NEAR**: will start the search at the bottom of the search area and expand first on the sides (left and right) and move back towards the rear of the search area.
- **FAR**: will start the search at the rear of the search area and expand first on the sides and move towards the front of the search area.
- **LEFT**: will start the search at the left side of the search area, expand front and back and then move to the right of the search area.
- **RIGHT**: will start the search at the right side of the search area, expand front and back and then move to the left of the search area.

The search priority may become handy according to the position of the target you want to attack in a group of different ships.

With BOL mode selected (right picture above) OSB 19 sets the Harpoon Destruct Range (DSTR). It is a distance in nautical miles from launch point at which the missile will self-destruct. Depressing OSB 19 enters a submenu allowing you to set the range in nautical miles.

With LOS mode selected, there are no options available for OSB 19.

Fly-Out mode

OSB 18 sets the Harpoon Fly-Out Mode. It is available in all modes except LOS mode. If the last part of the missile flight will be at low level to avoid detection the first part of its flight can be set to high or low altitude. Depressing OSB 18 will toggle between these two options.

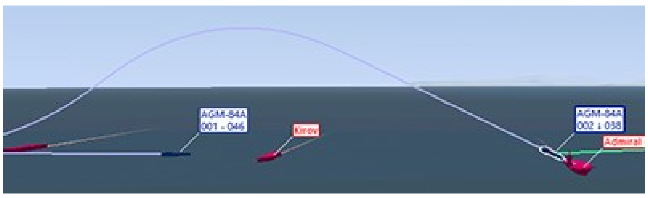
With LOW selected, the missile will immediately descend to low altitude, which may provide better protection against earlier detection, but may increase the risk of obstacles such as civilian or allied ships cruising close to the launch point. Selecting HIGH will ensure that the missile will remain at higher altitudes during the first part of its flight. The missile will descend to lower altitude at a specific range from the launch point:

- When launched in RBL, the missile will descend 10 Nm from the launch point.
- When launched in BOL, the missile will descend at the set enable range (see BOL paragraph).

Terminal maneuver

OSB 17 sets the terminal maneuver of the missile. It is available in all modes except the LOS mode. Depressing OSB 17 will toggle between POP (default) and SKIM.

Selecting POP commands, the missile to execute a pop-up maneuver before impact, to allow the missile to strike the target from above.
It is also the option that works best against short-range defenses the target may deploy to shoot the missile (which are not implemented in BMS).



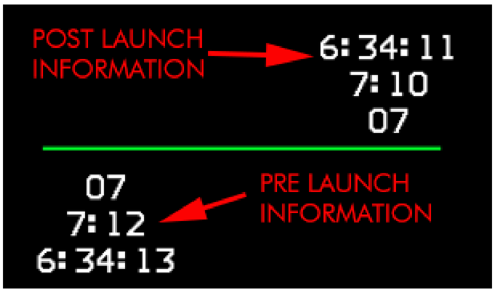
Selecting SKIM will command the missile to remain at very low altitude and therefore hit the target closer to the waterline. Smaller ships may be too small, so missiles set to SKIM may fly over their target in such cases.

Launch status divider line (RBL)

As with all AGM-8x series, the WPN page features the green launch status divider line displayed in the center of the MFD in RBL mode (BOL and LOS do not have the LSDL). Anything below the green line is pre-launch information and the information displayed above the LSDL is post-launch information.

Post launch information can only display information for 2 missiles. If you fire more than 2 missiles, post launch information of the first missile fired will be overwritten by the second missile fired from the same wing.

Pre & Post launch information (RBL)



Pre-launch information is displayed only in RBL mode and consists of three lines: Target steerpoint – Missile time of flight if fired now – System time of impact if fired now.

Once the missile has been fired the information move above the launch status divider line and changes to: System time of impact – Missile time of flight remaining – Target steerpoint.

Alert (& Priority Alert) messages

The harpoon WPN page is also able to display 2 types of alert messages. The top line is reserved for priority alert messages and the second line may display regular alert messages according to missile mode or status.

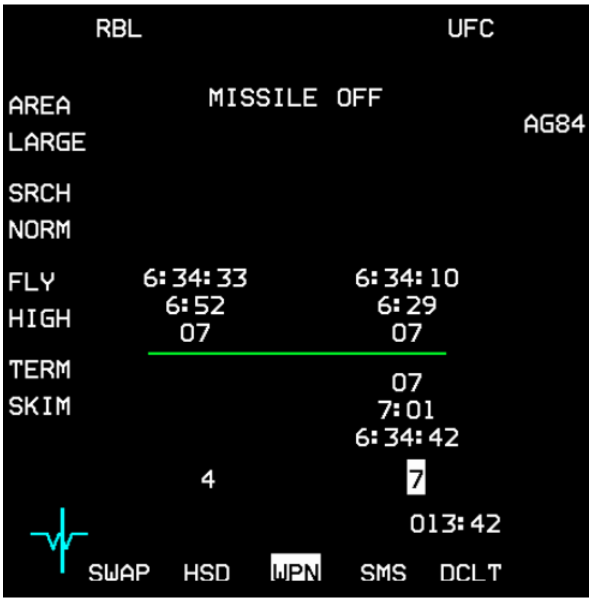
The priority alert messages are common to all modes (RBL, BOL & LOS). They are limited to two priority alert messages:

- MISSILE OFF reminds the pilot that the currently selected missile has not been powered up yet. The pilot should go to the SMS page and power on the missile before launching.
- BATTERY ACTIVE is displayed after an interrupted launch sequence (pickle button not held long enough) and reminds the pilot that the missile has an activated battery and launch should be executed as soon as possible to avoid the missile running out of power before reaching its target.

The priority messages apply to all modes and are displayed under the priority alert messages. They are mode-dependent and display information about missile status and aircraft parameters that may degrade (or prevent) a missile launch.

Once such a message is displayed the pilot should take corrective action. As soon as the issue is corrected, the alert message will disappear. If the issue cannot be corrected, the pilot needs to either select LOS mode or abort the attack. Examples of alert message include:

- MISSILE NOT READY (missile needs power).
- OUT OF RANGE (fly closer to attack steerpoint (67 Nm)).
- ACTIVE RANGE TOO SMALL or DSTR RANGE TOO SMALL in BOL mode.
- FLY WINGS LEVEL (counter) SECONDS in LOS.
- MACH NUMBER OUT OF RANGE (launching platform is too slow or too fast).



The above pictures illustrate a launch sequence.

The missile on station 6 has been fired at target steerpoint 7 and will impact at 063410 system time.

The missile on station 3 was fired as well and will impact target steerpoint 7 at system time 063433.

Both have the post launch information above the LSDL.

The weapon on station 7 is the next one set to fire. In the left picture the missile is not yet powered up as illustrated by the priority alert message “MISSILE OFF”, reminding the pilot to power up the missile before firing, which is done with a quick toggle to the SMS page.

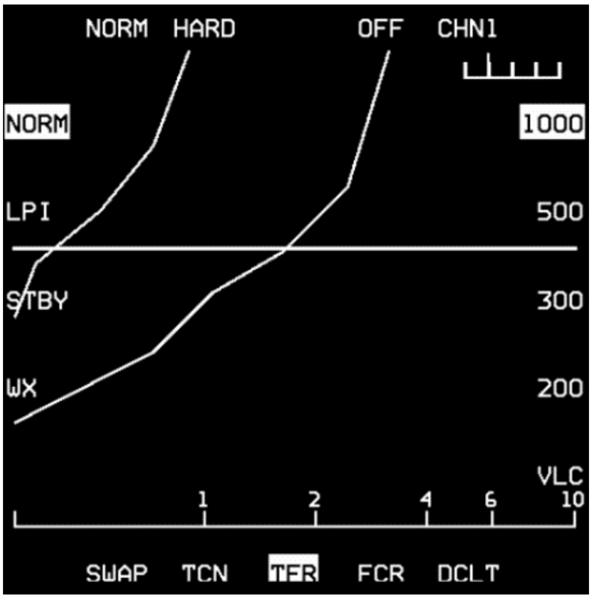
The right picture is taken seconds later while the missile spins up for 10 seconds. Immediate launch is prevented as notified by the alert message “MISSILE NOT READY”. As soon as the missiles gyros have spun long enough, the missile sends a RDY state, the alert message is removed and the missile can be fired.

Once fired, the missile information currently displayed under the LSDL will move above the green line, overwriting the information relevant to the missile fired from station 6.

Station 4 remains loaded and will be selected automatically upon firing the weapon on station 7.

20.3 The Mission

Your flight starts just as you go feet wet north of Sokcho. The North Korea shores are defended with SA-10 so most of your flight will be over water, close but outside the SA-10 envelope. Keep that in mind when you're maneuvering and activate the SEARCH feature of the TWA so you can detect search radars earlier. If the
SA-10 sites become too interested in your package, don't hesitate to extend away from their WEZ.



You can also decide to go lower on your threat horizon and have less chance of detection. You are still far away from your target area (more than 120 Nm) and the maximum SEA radar range is 80 Nm. You may need to fly high to acquire the target on your onboard sensors, but it's pointless remaining in harm's way so far away from your target – unless fuel is an issue?

Start a descent to stay safe from enemy threats for now.
A good way to relieve a bit of pressure is to enable the TFR in blended mode (AP steering). Select the TFR on the left MFD, set SCP at 1000 feet and enable TFR AUTO mode. Once done, set the AP switch to Steering Select and make STPT 7 the active steerpoint (DCS right on the STPT page allows auto-switching of the next steerpoint when you get close to your active steerpoint).

As always when you get in the cockpit, the first thing to do is to setup your jet according to your mission. Select A-G mode and set the left MFD to FCR SEA mode. To do so press OSB 1 which opens a menu of possible sub-modes available (GM – GMT – SEA) and press OSB 8 corresponding to Sea mode. SEA mode is the same as GMT optimized to find ships. It may track movers on the ground as well and may have a hard time finding ships at anchor, or sitting dead in the water. For that purpose, GM radar will sometimes be a better choice.

Set the right MFD slots to SMS, WPN and HSD. Since you may be under threat of the carrier air wing, you will need to configure an A-A mode as well. While in A-G mode, select MRM override on the HOTAS. Set your left MFD to FCR, 40 Nm range and center the antenna. Set the right MFD to HSD & TGP.

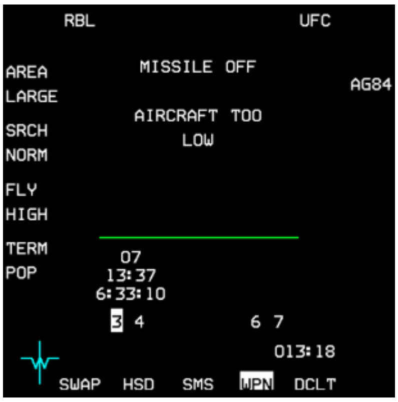
When you center the dogfight switch on the throttle, you will immediately revert back to the last mode you were in before selecting MRM, in this case A-G set for TASMO. As always, remember that anytime you do not need the A-G mode you should be ready for an air-to-air engagement in MRM mode.

Fence in, switch off your external lights with the master light switch on the left console, set MASTER ARM to ARM and set your master mode to A-G as we now will setup the missiles. You have 4 missiles and we will try to make different shooting profiles targeting the biggest ship in the enemy battle group. The first 3 missiles will be fired in RBL with an accurate SPI on the Kuznetsov and the last missile will be fired in BOL mode, to simulate not having an accurate fix on the carrier. Once set, the SMS will remember each station settings.
As we don't get debrief with training missions, make sure you tape your flight by switching on ACMI.

Select WPN page and select station 4 (left wing). By default, RBL mode is active and the search area is set to LARGE. Search priority is set to NORM by default as well; no reason to change that. Set the fly-out mode to HIGH and the terminal attack to POP.

Step weapon to select the missile loaded on station 6 (right wing) and apply the same settings except for the fly-out and the terminal maneuver. Set them to LOW and SKIM respectively.

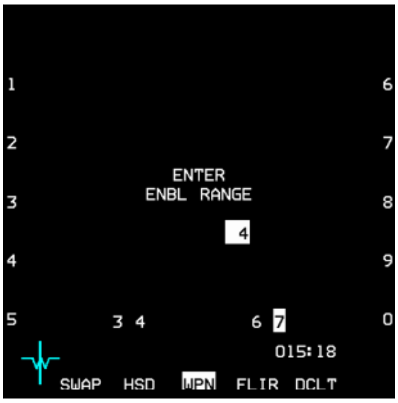
Step weapons once more to select station 3. Keep the search area and search priority default and set fly-out to HIGH and terminal attack to POP.

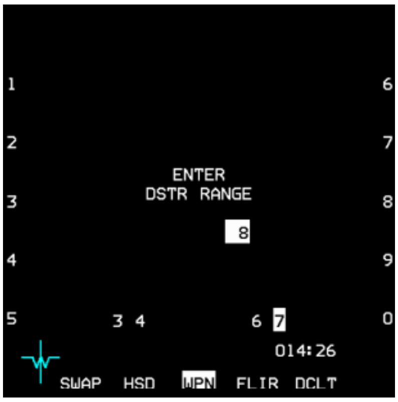


Step to the last weapon on station 7 and depress OSB 1 (RBL) to access the mode menu and select BOL mode with OSB 19. The default values of BOL mode are seeker activation after 1 Nm and self-destruct range at 95 Nm. We will change that to 40 and 86 Nm respectively.

Depress OSB 20 in BOL mode and a new MFD page allowing you to input a distance is displayed. Hit the relevant OSBs for '4' and '0'. Upon entering a valid range, the MFD reverts to the WPN page with the corrected seeker activation range of 40 Nm.

Do the same for the self-destruct range, entering the menu with OSB 19. Input '8' then '6'.



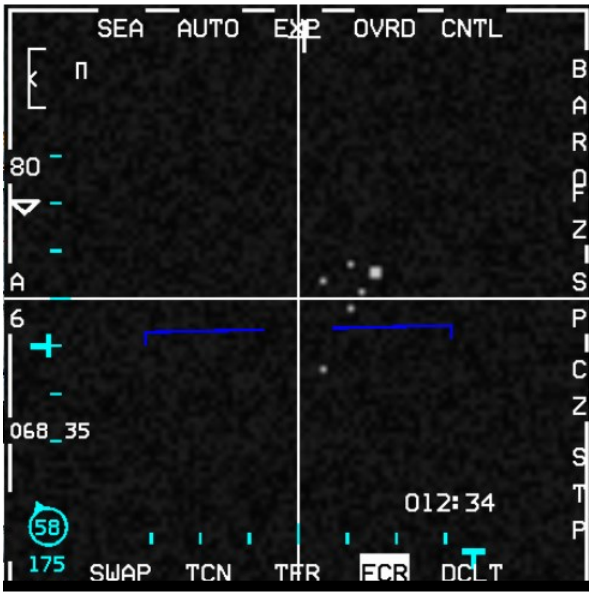


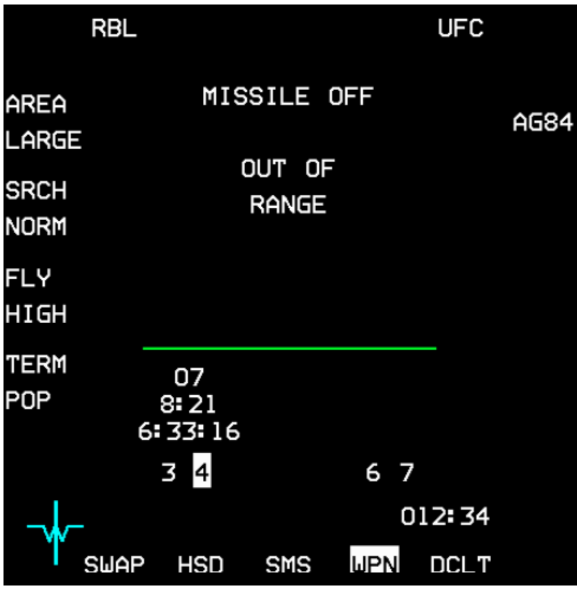
On the WPN page set fly-out to HIGH (OSB 18) and terminal attack to SKIM (OSB 17).

The 4 weapons are set and are ready to fire, except we still need to power them up as we can see by the priority alert message "MISSILE OFF" for each of them. The alert message displayed underneath is normal as we are ingressing low level using TFR. Once your systems are configured for the strike, check your distance to target steerpoint 7 and switch back to MRM mode, in case you have to fight your way in.

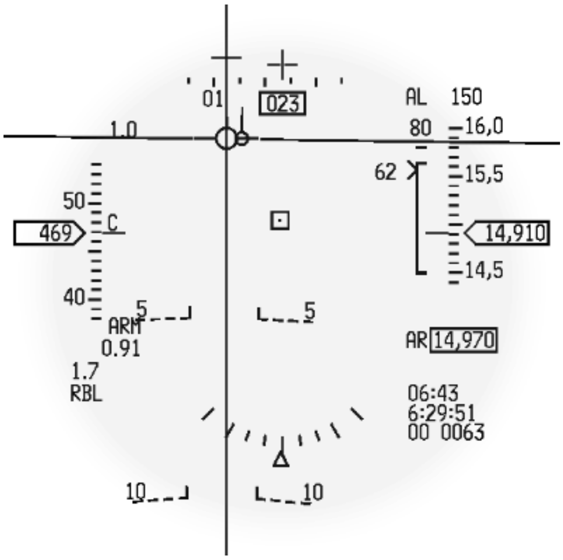
At 85 Nm from the target you need to gain some altitude to be able to spot the carrier group on radar. If you stay too long at low altitude your targets will be below your horizon and you will spot them too late on your sensors, losing the advantage of the standoff capability of your Harpoons. On the other hand it is not necessary to go high further than 80Nm away from your target as your SEA radar has a maximum range of 80 Nm. Normally, once the battle group is spotted on the on-board sensors the strikers would freeze their FCR and go low again, but in this case the distance between acquiring and firing is very small as the harpoon has a range of 67 Nm. The situation might be different if we were inside the battle group's SAM WEZ.

Climbing to FL150, monitor your FCR and start looking for ships. As soon as you see blips on your FCR, go to expand mode. The idea is to try to differentiate the smaller ships from the larger carrier and target the Kuznetsov. As you can see from the SEA radar picture below the carrier has a much bigger return than the





other ships in the formation. It's harder to differentiate the Kirov class missile cruiser from the Sovremenny-class destroyers though. At this distance trying to use the TGP for identification is pointless. So bear in mind that you do not have a precise way to target specific ships within the same group unless there is a carrier.



Place your cursors over the larger contact and designate with TMS up. We are now ready for the RBL mode as bearing and range is provided to the missile brain.

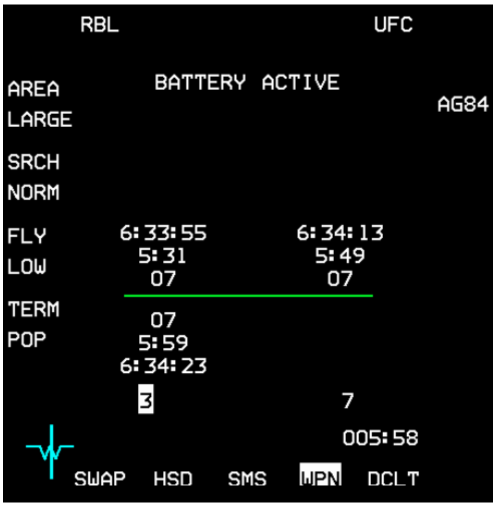
The HUD in RBL mode has a range scale displayed on the right. A tick mark is displayed at 80 Nm and the dynamic range starts at 67 NM. A caret with the actual range from SPI descends
down the scale. When the caret is within the dynamic launch range, the missile is in range and the alert message OUT OF RANGE will disappear.

We can't really ripple the 4 missiles together as we need to power them up in sequence and wait about 10 seconds for the missiles to be ready. So we will use that to our advantage to fire the first three in a common sequence:

- Right MFD to SMS.
- OSB 7 to power that missile.
- Right MFD back to WPN page.
- Wait for the alert message "MISSILE NOT READY" to disappear.
- While waiting for the missile gyros to spin up, open the Wingman comms menu and select option 1 'Attack my target'. This will ensure the enemy carrier group gets 4 more missiles inbound.

- When the alert message has disappeared, press and hold the pickle button until weapon release. Please note Harpoons require a very long pickle. It might take anything between 1 and 6 seconds. Make sure you hold it long enough. The FPM will flash when the missile is away.

- Rinse and Repeat: once the missile is flying the missile information will move up the LSDL and the priority alert message MISSILE OFF will be displayed again as the system selects the next missile, which has not yet been powered up.

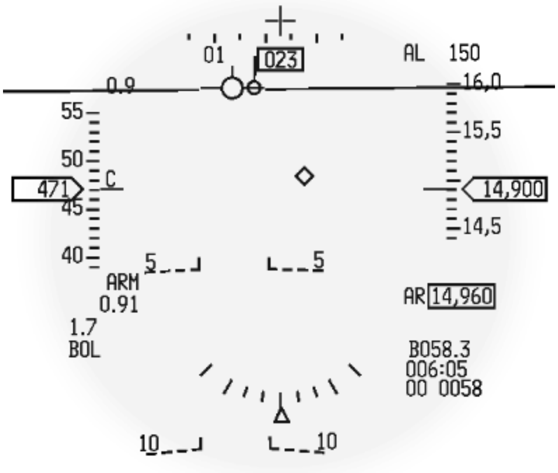


Repeat the whole sequence to fire the second and third missile.

As noted above, the Harpoon may need a very long held pickle.
It is not uncommon to misfire by releasing the pickle too soon.
In that case a priority alert message will be displayed on the WPN page alerting the pilot that the misfired missile has an activated battery. Batteries have a very short lifespan and a battery activated missile may run out of power quickly.

To avoid this, the pilot should reattempt to fire this missile as quickly as possible. In this scenario, the third RBL launch was misfired and a second attempt was made immediately after to send the missile on its way to the target.

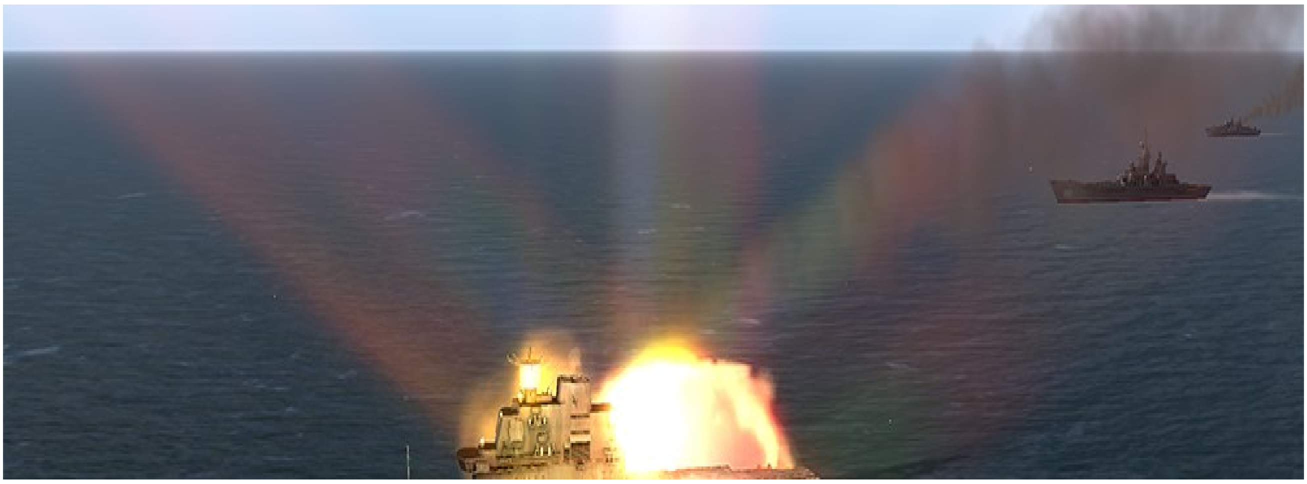
The final missile will be fired in BOL mode. It is kind of wasted, but done specifically for training purposes, to see the differences between RBL and BOL modes. The last missile needs to be powered up first through the SMS page and as always we need the missile to be ready before firing.



Since the missile is fired without range information, the HUD symbology will be different. Mainly there is no dynamic range scale (It is the same in LOS mode). The Harpoon mode is displayed in the lower left corner of the HUD and there is no azimuth steering line displayed and no target box.

In this scenario the missile will go on its way and probably target another ship than the carrier. You have no control on the ship priority the missile will target.

Fire the missile anyway and don't forget to instruct your wingman to attack your target one last time.



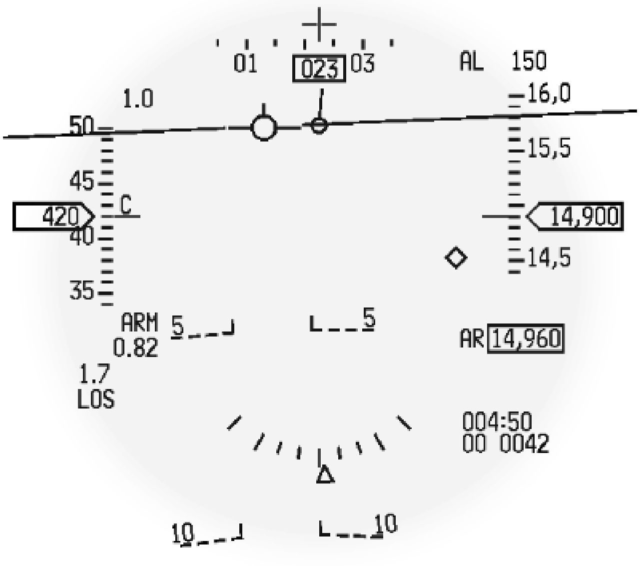
Your job is done, switch back to MRM and CAT1 in case you need to defend your flights against naval interceptors scrambled against you and dive back for the deck if your fuel state allows it.

Before succumbing to the temptation to look at your missiles, make sure you select a steerpoint taking you back to friendly lines and reengage the autopilot. You may elect to fly all the way back to Gunsan or divert to Sokcho which is just south of steerpoint 5.

The missile launched in BOL mode didn't target the carrier but one of the 4 destroyers.

It takes multiple missiles to sink such ships, destroyers need at least 2 Harpoons, the Kirov was sunk with 3 AGM-84A and carriers like the Kuznetsov need about 6 Harpoons.

We didn't use it but there is a third harpoon mode. It does provide targeting possibilities, but it's mostly a backup mode used when neither the aircraft avionics nor the missile are working correctly.



LOS needs a very stable launching platform because flight attitude and launch bearing are provided to the missiles according to the launching platform references. This process needs a straight and level flight for 40 seconds each pre and post launch.

In LOS the pilot follows the information provided by the alert messages displayed on the WPN page and waits for the countdown from 40 to zero to launch the missile.

After launch the FLY WINGS LEVEL alert message will continue to display.

The HUD LOS mode is similar to the BOL mode with no range scale indication, no azimuth steering line and no target box.

PART 4 + 5 : ADVANCED NAVIGATION + NAVAL OPERATIONS

The following training missions are not documented in this manual. They are relevant to other very specific manuals and have their own dedicated chapters. They are built and documented in the very same way as the previous 20 training missions.

MISSION 21: NAVIGATION FLIGHT OSAN-DAEGU: Part 1 *(TR_BMS_21_Osan_Daegu)*

This training flight is a ferry flight from ramp to ramp illustrating the new communication protocols and the navigation aspects in BMS. You are tasked to ferry an F-16 from Osan to Daegu in poor weather.
This first part starts at Osan Ramp and can be continued through to shut down at Daegu.

The training flight is completely documented in part 5 of the BMS COMMS and Nav Book, located in your *\Docs\00 BMS Manuals* folder.

MISSION 22: NAVIGATION FLIGHT OSAN-DAEGU: Part 2 *(TR_BMS_22_Osan_Daegu)*

This training flight is the second part of Mission 21; it starts just before reaching the top of the descent before the IAF at Daegu and is meant to concentrate on the approach part of the training mission.

As above the training flight is completely documented in part 5 of the BMS COMMS and Nav Book as well.

MISSION 23: CARRIER OPS - Launch (F/A-18D) *(TR_BMS_23_CarrierTakeoff)*

This training flight is the first of the three carrier operations missions flown with the F/A-18C from the deck of the USS Enterprise CVN-65 cruising west of the Korean peninsula. It will cover the launch sequence from the catapult of the Enterprise.

The training flight is completely documented in section 5 of the BMS NAVAL OPS volume located in your *\Docs\00 BMS Manuals* folder.

MISSION 24: CARRIER OPS - CASE 1 RECOVERY (F/A-18C) *(TR_BMS_24_Case1Recovery)*

After the launch from your catapult you eventually need to land back on the carrier. This training mission documents Case 1 recovery procedures (VFR) for landing on the carrier.

The training flight is completely documented in section 5 of the BMS NAVAL OPS volume located in your *\Docs\00 BMS Manuals* folder.

MISSION 25: CARRIER OPS - CASE 3 RECOVERY (F/A-18C) *(TR_BMS_25_Case3Recovery)*

Still flying the Hornet, this training mission will document the Case 3 recovery procedures (IFR) on the carrier.

The training flight is completely documented in section 5 of the BMS NAVAL OPS volume located in your *\Docs\00 BMS Manuals* folder.

MISSION 26: CARRIER OPS – VERTICAL OPS (AV-8B) *(TR_BMS_26_Wasp)*

This training mission will document the vertical operations around the LHD-1 USS WASP with the AV-8B+ harrier.
The training flight is completely documented in section 5 of the BMS NAVAL OPS volume located in your *\Docs\00 BMS Manuals* folder.

PART 6: AIR TO GROUND OPERATIONS

In this part we will learn about combined A-G operations. The main focus in those mission(s) is on procedures and combines different “A-G Skillsets”. Each pilot starting those trainings should have succeeded at all air-to-ground related training missions in many practice flights before he attempts to complete one of those missions.

Mission 27: JTAC

Mission 28: SEAD-EW

MISSION 27: JTAC *(TR_BMS_27_JTAC)*

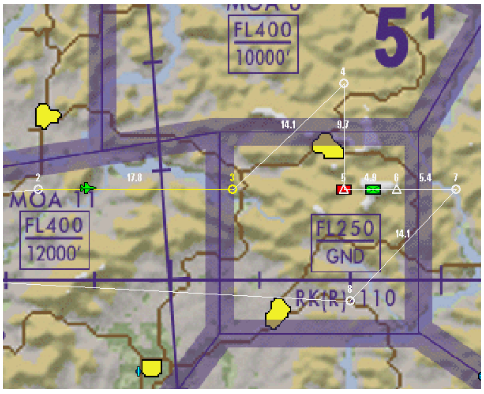
LOCATION: South of Hwangji.

CONDITION: F-16C block 40 – 2-ship – Package 2024 - Callsign Cyborg 7.
GW: 39552 lb, 2 AIM-120C, 2 AIM-9X, 4 GBU-54, 1 AN/AAQ-33, 1 AN/ALQ-184, 2 370GL bags.
Laser code: 1688.
Max G: 5.5/-2.0, Max speed: 550 kts / 0.95 Mach.
Support unit: Tanker 60 miles east of STPT 6.

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

WEATHER: RKSO INFO: B 010625Z RWY36 TRL140 1/10KT 600 FG FEW300 27/27 Q1020 NOSIG

LEARNING OBJECTIVES:
1. Learn how CAS (Close Air Support) procedures work.
2. First mission option:
Work together with the included BMS JTAC to perform CAS procedures. Destroy the 2030th supply battalion to support friendly units.
3. Second mission option:
Work together as a 2-ship (both human) to perform CAS procedures as a FAC(A) and CAS aircraft. Destroy the 2030th supply battalion to support friendly units.



27.1 CLOSE AIR SUPPORT - Introduction

The main task of a CAS (Close Air Support) flight is to protect and support friendly units on the ground, either in an offensive, neutral or defensive battlefield situation. In BMS, we now have two options to perform CAS operations :

a) Working with the BMS AI JTAC (Joint Terminal Attack Controller).
b) Working with a human FAC(A) (Forward Air Controller Airborne).

CAS procedures are one of the most complex and challenging scenarios in military aviation and are highly dynamic. The procedures follow a standardized, repeatable format that has been implemented by most of the world's armed forces, known as the « 12 Steps of CAS » :

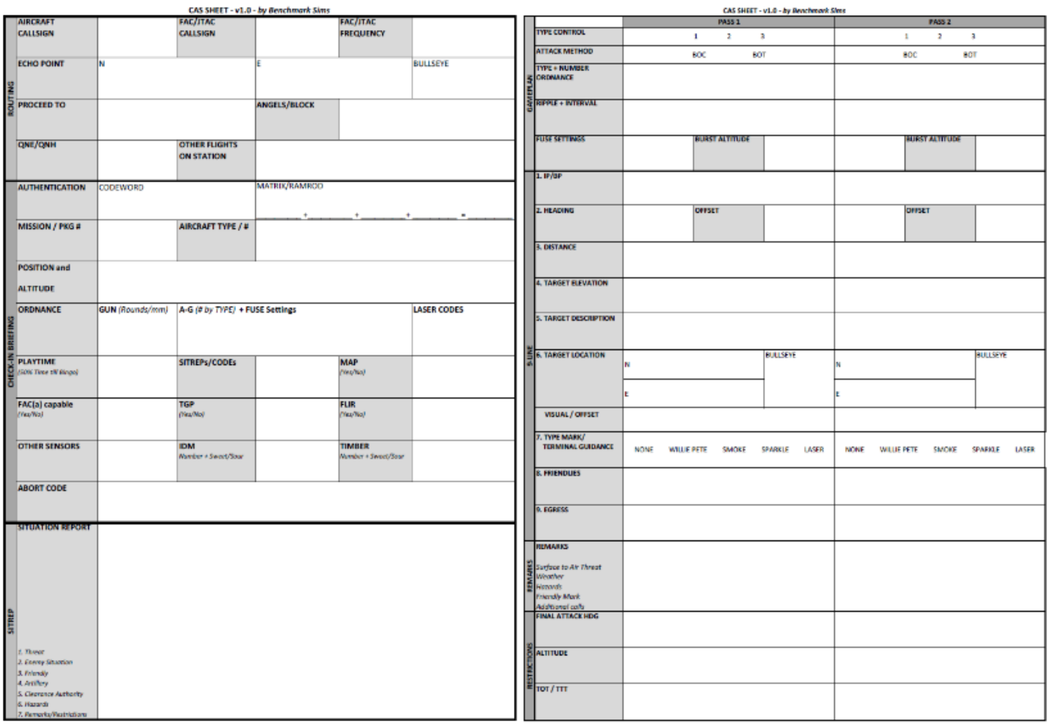
(1) Routing/Safety of Flight	(7) Readbacks
(2) CAS Aircraft Check-in	(8) Correlation
(3) Situation Update	(9) Attack
(4) Game Plan	(10) Assess Effectiveness of the Attack (repeat steps 4-9 as necessary)
(5) CAS Brief / 9-line	(11) Battle Damage Assessment (BDA)
(6) Remarks/Restrictions	(12) Routing/Safety of Flight.

Before we jump into the procedures and explain these 12 steps and practical tips in more detail, we need some tools that can process all the necessary information in this training. The most powerful CAS tools still in use today are: Paper and Pencil.
If you own any mobile device with the option to make notes on PDF files, that also works.

To make your training more efficient, we created a CAS sheet template that is similar to RL documents.
In the BMS folder « *Docs\07 Kneeboard Templates\Close Air Support* » you find several files which are important for this training:

1. CAS_NATO_Alphabet.pdf	A list of the NATO phonetic alphabet.
2. CAS_Codewords.pdf	A list of ramrod code words.
3 + 4. CAS_Routing-Checkin-Sitrep.pdf	First part of the CAS sheet template (can either be printed out in double or single execution per page).
5 + 6. CAS_Gameplan-9line-Remark-Restrict.pdf	Second part of the CAS sheet template (can either be printed out in double or single execution per page).
BMS_CAS_Template.xlsx	Source file of all documents above for individual modifications.

Please print out both CAS sheet files and clip them on your kneeboards. Make sure you have a backup pencil ready.
If you use a mobile device, please import those files.


CAS SHEET - v1.0 - by Benchmark Sims

ROUTING: AIRCRAFT CALLSIGN | FAC/JTAC CALLSIGN | FAC/JTAC FREQUENCY
ECHO POINT: N | E | BULLSEYE
PROCEED TO | ANGELS/BLOCK
QNE/QNH | OTHER FLIGHTS ON STATION

CHECK-IN BRIEFING: AUTHENTICATION: CODEWORD | MATRIX/RAMROD ___ + ___ + ___ + ___ = ___
MISSION / PKG # | AIRCRAFT TYPE / #
POSITION and ALTITUDE
ORDNANCE: GUN (Rounds/mm) | A-G (# by TYPE) + FUSE Settings | LASER CODES
PLAYTIME (50% Time till Bingo) | SITREPs/CODEs | MAP (Yes/No)
FAC(a) capable (Yes/No) | TGP (Yes/No) | FLIR (Yes/No)
OTHER SENSORS | IDM Number + Swsct/Soar | TIMBER Number + Swsct/Soar
ABORT CODE

SITREP: SITUATION REPORT
1. Threat
2. Enemy Situation
3. Friendly
4. Artillery
5. Clearance Authority
6. Hazards
7. Remarks/Restrictions

CAS SHEET - v1.0 - by Benchmark Sims

	PASS 1	PASS 2
GAMEPLAN: TYPE CONTROL	1 2 3	1 2 3
ATTACK METHOD	BOC BOT	BOC BOT
TYPE + NUMBER ORDNANCE		
RIPPLE + INTERVAL		
FUSE SETTINGS	BURST ALTITUDE	BURST ALTITUDE
9-LINE: 1. IP/BP		
2. HEADING	OFFSET	OFFSET
3. DISTANCE		
4. TARGET ELEVATION		
5. TARGET DESCRIPTION		
6. TARGET LOCATION	N E BULLSEYE	N E BULLSEYE
VISUAL / OFFSET		
7. TYPE MARK/ TERMINAL GUIDANCE	NONE WILLIE PETE SMOKE SPARKLE LASER	NONE WILLIE PETE SMOKE SPARKLE LASER
8. FRIENDLIES		
9. EGRESS		
REMARKS: REMARKS Surface to Air Threat Weather Hazards Friendly Mark Additional calls		
RESTRICTIONS: FINAL ATTACK HDG		
ALTITUDE		
TOT / TTT		

We have to do some ground school prior to the flight(s) to make sure you will not get task saturated too quickly.
At first it's very important to understand the flow of the procedures and to learn dealing with the information given.

Note that the following chapter 27.2 is a guide about how CAS is done in real life and how you can do it in BMS when flying with humans. The BMS AI JTAC functionality will vary compared to the next pages but will be described in more detail in chapter 27.3. The JTAC is a perfect tool to start practicing CAS procedures if you fly alone.

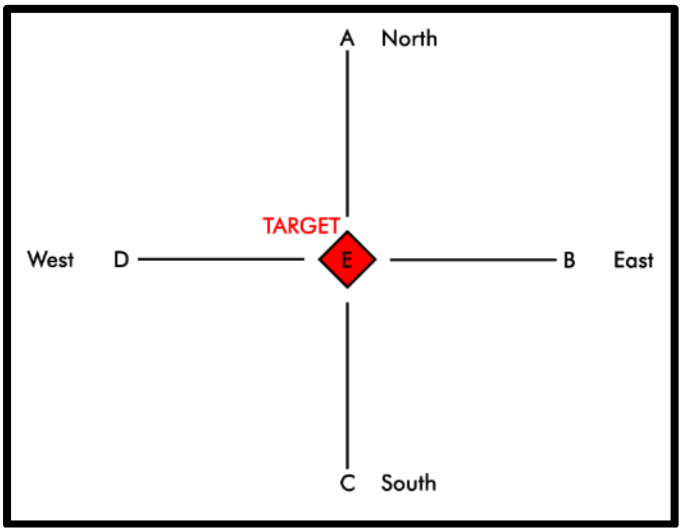
Let's come back to the « 12 Steps of CAS ».

27.2 12 Steps of CAS

(1) Routing/Safety of Flight

Routing is the initial phase of each CAS mission. The CAS flight gets in touch with the JTAC/FAC(A) on the briefed/given frequency. The JTAC/FAC(A)s first job is to clarify intentions and deconflict assets. CAS Aircrafts need to be deconflicted properly from: 1. other Aircraft | 2. surface threats | 3. other known hazards.

Depending on the number of CAS flights on station and the overall tactical situation, the JTAC/FAC(A) may assign you to a specific holding point before you check-in.
To achieve that, JTACs/FAC(A)s use a method which is called the "Keyhole Template".
In most cases, the centerpoint E of the keyhole is a specific target, a target area or a landmark, depending on the situation. The CAS flight will be assigned to establish a holding at a certain radial and distance from E or directly above E in a specified altitude block. Let's take the example B 25 *(Bravo 25) Block 20-22.* Bravo equals EAST in the keyhole template (see on the right).
25 means 25NM distance from the center. Block 20-22 means 20000-22000ft MSL (standard QNH).
Conclusion: B25 Block 20-22 means 25NM east of the center between 20000-22000ft.
The center (E) of the keyhole is also called "Echo Point", "Wheel" or "Overhead".
Okay, let's summarize the routing with the following example.
Monitor the CAS sheet section on the right in parallel. There you can find all information already filled in:



Keyhole Template

CAS SHEET - v1.0 - *by Benchmark Sims*

ROUTING	AIRCRAFT CALLSIGN	CYBORG 7	FAC/JTAC CALLSIGN	EYEBALL 9	FAC/JTAC FREQUENCY	301.75
	ECHO POINT	N 37 08 060		E 130 20 021	BULLSEYE	-
	PROCEED TO	B 25- 35, left hand		ANGELS/BLOCK	20-22	
	QNE/QNH	1013	OTHER FLIGHTS ON STATION	Bone 1, F-15E 2ship, C25, Block 22-24		

CAS Flight: Eyeball 9, Cyborg 7 on Uniform.
JTAC/FAC(A): Cyborg 7, Eyeball 9 , read you 5/5, say intention.
CAS Flight: Eyeball 9, Cyborg 7, CAS capable, ready for check-in.
JTAC/FAC(A): Cyborg 7, Eyeball 9, say current position and altitude.
CAS Flight: Eyeball 9, Cyborg 7 is 20 miles north, 15000.
JTAC/FAC(A): Cyborg 7, hold position, climb 20000, keyhole template in effect, advice when ready to copy coordinates.
CAS Flight: Eyeball 9, Cyborg 7, ready to copy.
JTAC/FAC(A): Cyborg 7, Echo Point North 37 08 060 , East 130 20 021, Proceed B 25 and hold between B25-35, left hand pattern, Angels 20-22, Report established, hold your check-in, Attack in progress.
Bone 1 on station, 2 ship F-15E, C25, Block 22-24, System Readback.
CAS Flight: Eyeball 9, Cyborg 7, System Readback. North 37 08 060, East 130 20 021, Proceed B 25 angels 20-22, Will report when established.
JTAC/FAC(A): Cyborg 7, Readback correct.

This first example already provides a good portion of data. What happened? The JTAC/FAC(A) first asked for the flight's intention, for the current position and then deconflicted the arriving CAS flight by providing keyhole and holding information. The CAS flight had to readback this information from their system (DED in our case), not from kneeboard notes or tablet.

So why a “system readback”?

Mistakes can happen on several steps when receiving and processing information. With a “system readback” the JTAC/FAC(A) ensures that the pilot has the right information in his system and prevents any typo mistakes on the paper on his kneeboard or in the system interface.

In this mission [both with BMS AI JTAC or FAC(A)] we will modify a PPT (Pre-planned threat point) which will become our echo point (center of the keyhole).
We included PPT 56 into this mission for this purpose.
The advantage having a PPT is that you have a visual indication in the HSD where the echo point is.

The best way to modify a STPT/PPT is on the DEST page (LIST->DEST) in the ICP. Select STPT 56.
This page can already be selected before contacting the JTAC/FAC(A).
In addition, you should be already in a solid left hand holding with the autopilot selected on ALT HOLD, so you can go “heads down”.
To deconflict with your wingman (if you are a 2-ship), send him 1000ft below you in a fighting wing formation.

If the JTAC/FAC(A) starts to provide any LAT/LONG/holding information, 100% of your attention is required.
There are three ways to save those coordinates:

1. Note it down on CAS Sheet, then type the information into the ICP/DED -> long process.
2. Type it straight into the ICP/DED -> faster, but only recommended if you have a physical ICP or extracted on a monitor. Or you are a very fast mouse user.
3. Use the VIP function (described on the next page) -> very flexible when having no echo point available.

Let’s analyze option 2.
To implement LAT/LONG information, you must press (2) on the ICP first to be able to enter the north coordinates.

After you successfully processed those coordinates with pressing (ENTR), press (6) on the ICP immediately to enable east coordinates. Type in those as well and add the altitude given to you, in our case 20000ft. Note that each offset point altitude is in MSL.

After you have read back the data, the next step is to establish your holding point which is B25. You can use the HSD to orientate yourself and find the position.
If you don’t have SA where you are and where you must fly to, you can use this technique: As your DEST page is still open, create an offset point based on PPT 56.
Go to the first offset page (OA1) with pressing (SEQ) on the DCS.

The next step is to change the range unit from “FT” to “NM”. Press (UP) twice on the DCS. Only “FT” should be highlighted. Press any number (1-9) on the ICP to change the range unit to “NM”.
Next, type in the offset data. First, type in 25.0NM for the range. Bravo means east so the radial is 90° for the bearing. Elevation again is 20000FT.

If you successfully processed that information, please check your HUD data. A new symbol appeared which is the latest created offset point. Since 4.36, it is now also possible to see those offset points in the HMCS which is a big advantage to gain situational awareness. Note that you must have the NAV or AG mode enabled to see the offset point. In AA mode there are no offset points visible.

Close the DEST page, select STPT 56 and check the HSD. The PPT has moved and is now around the area of STPT 5. Fly to the assigned holding point and report to the JTAC/FAC(A) when you arrive.

CAS Flight:	Eyeball 9, Cyborg 7, Established Bravo 25, left hand pattern 10mile leg B 25-35, Blk20-22, ready for check-in.
JTAC/FAC(A):	Cyborg 7, Eyeball 9 copies, standby.

Let's take a look on option 3, the **VIP**.
If the JTAC/FAC(A) is not able to provide LAT/LONG coordinates for the echo point, he may give you a reference landmark (bridge, mountain top, own or enemy position marked by smoke, IR pointer, Laser).
In our example, the JTAC marks his contemplated echo point with smoke. Activate the TGP and slew the TD box to the smoke position.
The next step is to create a markpoint. Press (7) on the ICP and activate the MARK TGP mode. Press TMS up once to create the markpoint. The first markpoint created is STPT 26.
Press LIST and (3) to bring up the VIP subpage. Type in 26 for the VIP, 90° for the TBRG, range 25,0NM (change of range unit similar to offset points) and elev 20000ft.
Highlight the upper line and press ENT. The VIP is now active only for STPT 26.
Go to your STPT page, select 26 and bring up the A-G mode. The TD box in the HUD/HMCS symbology will now move according to the input and marks your holding position B25.
We will come back to the VIP later in the 9-line chapter.

This marks the end of the first routing/safety of flight procedure.

(2) CAS Aircraft Check-in

The purpose of the check-in procedure is to give the JTAC/FAC(A) an overview about the flight which could be a possible CAS asset.
Whenever unsecure communications are used (BMS UHF/VHF is unsecure), it is a standard to use pre-briefed authorization codes, for example a ramrod codeword or authentication tables (AKAC 1553, etc.).
The ramrod is the easiest procedure which we will use for this training. We use the 2-letter Ramrod. The code word in this example is "SOUNDTRACK", marked as 1 on the sheet to the right side. Note: you find a table with possible code words in the CAS docs folder.
Most times a ramrod code word consists of 11 letters. Each letter only can appear once in the word.
Let's have a look on the authentication example which can be found under 2 on the CAS sheet as well.

CHECK-IN BRIEFING

AUTHENTICATION	CODEWORD: SOUNDTRACK 1	MATRIX/RAMROD: T A R 2			
MISSION / PKG #	2024 3	AIRCRAFT TYPE / #	2x F-16C 4		
POSITION and ALTITUDE	B25 , 20000 5				
ORDNANCE	GUN (Rounds/mm): 510, 20 6	A-G (# by TYPE) + FUZE Settings: 4x GBU-54 - NOSE/TAIL 7		LASER CODES: 1688 8	
PLAYTIME (50% Time till Bingo)	40 9	SITREPs/CODEs	- 10	MAP (Yes/No)	NO 11
FAC(a) capable (Yes/No)	Yes 12	TGP (Yes/No)	SNIPER 13	FLIR (Yes/No)	NO 14
OTHER SENSORS	- 15	IDM Number + Sweet/Sour	11,12 16	TIMBER Number + Sweet/Sour	- 17
ABORT CODE	18 OSCAR + NOVEMBER -> UNIFORM				

JTAC/FAC(A): Cyborg 7, Eyeball 9, Code word "Bravo 1" in effect, Authenticate Tango Alpha.
CAS Flight: Eyeball 9, Cyborg 7, Authenticate Romeo.
JTAC/FAC(A): Cyborg 7, Eyeball 9, send your check-in.
The authentication procedure in this example shows the following:
the JTAC challenges the CAS flight with a code word which both parties have in their documentation, in our example "Bravo 1" = SOUNDTRACK. This way, both sides make sure that they are authorized to work with each other and to verify that they are friendly.

The next step is the check-in from the CAS asset. Only the flight lead checks in for his flight. The flow is as follows (3-18 in the sheet above):

CAS Flight: Eyeball 9, Cyborg 7, Mission number 2024, two by F-16C, Currently Bravo 25, block 20-22, 510 rounds of 20 mike mike, four by GBU-54 each aircraft, Nose/Tail fusing, Laser code 1688 each aircraft, Playtime four zero minutes, FAC(A) capable, Sniper, IDM 11 and 12 sweet, Abort Code: Oscar November.
JTAC/FAC(A): Cyborg 7, Eyeball 9, abort code Oscar November, advice when ready for sit-rep.

A lot of information was passed to the JTAC/FAC(A). In the best case, he has written down all info on his sheet and is now aware of the capabilities of the CAS flight. He has received information about the type/number of aircraft, the ordnance/laser codes of each aircraft, all sensors/IDM capabilities and the abort code.
The abort code is the most important information which the JTAC/FAC(A) must repeat to the CAS flight. He must only repeat the abort code, no other information. In this example, the abort code is generated again from our check-in code word. The letter between "Oscar" "November" is "Uniform". Having multiple flights on station mostly require a clearly assignable abort code for each flight. If the attack of the CAS flight must be aborted, the call would be:
JTAC/FAC(A): Cyborg 7, Eyeball 9, ABORT UNIFORM, ABORT UNIFORM, ABORT UNIFORM.
CAS Flight: Cyborg 7 aborts the pass.

It is also possible that no abort code is passed to the JTAC/FAC(A), especially when only one CAS is on station like in this training mission. Then the abort is in the clear. **JTAC/FAC(A):** Cyborg 7, Eyeball 9, ABORT, ABORT, ABORT.

CHECK-IN BRIEFING

AUTHENTICATION	CODEWORD: SOUNDTRACK (1)		MATRIX/RAMROD: T A R (2)		
MISSION / PKG #	2024 (3)	AIRCRAFT TYPE / #	2x F-16C (4)		
POSITION and ALTITUDE	B25 , 20000 (5)				
ORDNANCE	GUN (Rounds/mm): 510, 20 (6)	A-G (# by TYPE) + FUZE Settings: 4x GBU-54 - NOSE/TAIL (7)		LASER CODES: 1688 (8)	
PLAYTIME (50% Time til Bingo)	40 (9)	SITREPs/CODEs	- (10)	MAP (Yes/No)	NO (11)
FAC(a) capable (Yes/No)	Yes (12)	TGP (Yes/No)	SNIPER (13)	FLIR (Yes/No)	NO (14)
OTHER SENSORS	- (15)	IDM Number + Sweet/Sour	11,12 (16)	TIMBER Number + Sweet/Sour	- (17)
ABORT CODE	OSCAR + NOVEMBER -> UNIFORM (18)				

Let's analyze again each section of the check-in:

Mission/PKG #: Your package number (via ATO).

Aircraft Type/#: Your aircraft type + amount of aircraft.

Position and Altitude: Your current position.

Ordnance Gun: Amount + caliber of gun ammunition for each aircraft.

Ordnance A-G: Amount + type of A-G ordnance for each aircraft.

Ordnance Fuse Settings: Possible fuse settings *[in BMS: Nose, Tail, Nose/Tail (N/T)].*

Laser codes: Laser code for each aircraft.

Playtime: Your possible time on station
calculate 50% time until bingo -> ICP (CRUS 5) -> EDR subpage-> TO BNGO.

SITREP/Codes: Your existing knowledge of the tactical situation
For example: "Cyborg 7 has Sit-rep alpha passed by Magic 7".

Map: Map of the area available or not.

FAC(A) capable: You are FAC(A) certified or not.

TGP: TGP type on board or no TGP.

FLIR: FLIR on board or no FLIR.

OTHER SENSORS: You have other sensors on board (RECON equipment, etc.) or none.

IDM/TIMBER: IDM/Link-16 capabilities. Your link is online (Sweet) or offline (Sour).

ABORT CODE: "None" or a clearly assignable abort code for your flight.

After the check-in is completed, the JTAC/FAC(A) will proceed with the situation report (SITREP).

(3) Situation Update

The “SITREP” gives each CAS flight an overview or an update about the tactical situation on the ground to increase the situational awareness. The following elements can be included:

Enemy activity | Surface-to-air threat activity | Friendly situation | Artillery | Clearance Authority | Ordnance | Hazards Remarks | Restrictions

For example:

CAS Flight:	Eyeball 9, Cyborg 7 ready for sitrep.
JTAC/FAC(A):	Eyeball 9 to all flights on station, new Sitrep. Sitrep Bravo is now in effect:
	Current surface-to-air threat is an SA-8 at Delta 15, just west of Hwangji; target is an light armored
	resupply battalion to flank us to the left, break.
	Friendlies are one infantry battalion 3 miles east of the target, break.
	Eyeball 9 has control and is part of the friendly battalion.
	Plan on using your GBU-54 bombs to disrupt the trucks. Winds on the deck are 15 knots out of
	the east. Eyeball 9 is laser and sparkle capable, advise when ready for game plan.

To reduce workload for the JTAC/FAC(A), a situation update code can be generated for the current tactical situation and handed over to the CAS flight and/or C2/AWACS. In our example, Sitrep “Bravo” is valid.

The order of the transferred information in the SITREP vary depending on the needs of the JTAC/FAC(A) and the situation he is in. The key elements should always follow a clear structure:

Threat -> Enemy Situation -> Friendlies -> Clearance Authority -> Controllers intend -> Hazards -> Remarks/Restrictions.

SITREP	SITUATION REPORT *1. Threat* *2. Enemy Situation* *3. Friendly* *4. Artillery* *5. Clearance Authority* *6. Hazards* *7. Remarks/Restrictions*	- SA-8 D15 - Target: Light armored Resupply battalion - Friendlies 3nm east of target - Control: Eyeball 9 (Laser, Sparkle) - Winds 15knt east - GBU-54

The CAS flight should write down all key information on the CAS sheet (see above) to update his SA.

The sitrep doesn’t need any readback from the CAS flight. If he has any questions, he can ask the JTAC in plain language.

This marks the end of the first page of the CAS sheet. All information has been passed from the JTAC/FAC(A) to the CAS flight and vice versa.

CAS SHEET - v1.0 - *by Benchmark Sims*

ROUTING	AIRCRAFT CALLSIGN	CYBORG 7	FAC/JTAC CALLSIGN	EYEBALL 9	FAC/JTAC FREQUENCY	301.75
	ECHO POINT	N 37 08 060		E 130 20 021		BULLSEYE -
	PROCEED TO	B 25		ANGELS/BLOCK	20-22	
	QNE/QNH	1013	OTHER FLIGHTS ON STATION	Bone 1, F-15E 2ship, C25, Block 22-24		
CHECK-IN BRIEFING	AUTHENTICATION	CODEWORD SOUNDTRACK		MATRIX/RAMROD ___ + ___ + T + A = R		
	MISSION / PKG #	2024	AIRCRAFT TYPE / #	2x F-16C		
	POSITION and ALTITUDE	B25, 20000				
	ORDNANCE	GUN *(Rounds/mm)* 510, 20	A-G *(# by TYPE)* 4x GBU-54 - NOSE/TAIL			LASER CODES 1688
	PLAYTIME *(50% Time till Bingo)*	40	SITREPs/CODEs	-	MAP *(Yes/No)*	NO
	FAC(a) capable *(Yes/No)*	YES	TGP *(Yes/No)*	SNIPER	FLIR *(Yes/No)*	NO
	OTHER SENSORS	-	IDM *Number + Sweet/Sour*	11,12	TIMBER *Number + Sweet/Sour*	-
	ABORT CODE	OSCAR + NOVEMBER -> UNIFORM				
SITREP	SITUATION REPORT *1. Threat* *2. Enemy Situation* *3. Friendly* *4. Artillery* *5. Clearance Authority* *6. Hazards* *7. Remarks/Restrictions*	- SA-8 D5 - Target: Light armored Resupply battalion - Friendlies 3nm east of target - Control: Eyeball 9 (Laser, Sparkle) - Winds 15knt east - GBU-54				

Still there? Good! The game plan will be next.

(4) Game Plan

The game plan describes in detail how to achieve the ground commander's intent and the desired effects on the target. The JTAC/FAC(A) developed this game plan through his knowledge about the enemy and friendly situation, the available CAS flights on station, their capabilities/resources and all other conditions which could influence the actual situation. Each game plan could start with:

a) More detailed intent of the ground commander (general intent is part of the SITREP) or

b) Straight with the game plan.

CAS Flight: Eyeball 9, Cyborg 71 ready for game plan.
JTAC/FAC(A): Cyborg 71, Eyeball 9. Type 2, Bomb on coordinate. One by GBU-54, Laser mode, N/T fusing, Advice when ready for 9-line.

GAMEPLAN	PASS 1		
TYPE CONTROL	1 [2] 3		
ATTACK METHOD	[BOC] BOT		
TYPE + NUMBER ORDNANCE	1x GBU-54, LASER		
RIPPLE + INTERVAL	-		
FUSE SETTINGS	N/T	BURST ALTITUDE	-

Note that for the game plan no readback is needed. Let's analyze the information in this example:

Type of Control
The ground controller has three types of control available. The type of control is determined by the position / distance of the enemy from friendly units as well as the general conditions (collateral damage, friendly fire, etc.).

Type 1: The JTAC/FAC(A) must have acquired visually a) the target **and** b) the attacking aircraft at the same time for each attack.

Type 2: The JTAC/FAC(A) must have acquired visually a) the target **or** b) the attacking aircraft for each attack.

Type 3: The JTAC/FAC(A) does not have acquire visually both the target nor the attacking aircraft for each attack.

Attack Method
We have two attack methods which are most common in CAS operations, depending on whether the aircraft has to visually acquire the target or not. The first method is BOC (Bombs On Coordinate) and second BOT (Bombs On Target).

BOC: The aircraft does not need to be tally (= visually acquired) on the target during the attack (via eyeball or sensor).
This method is mostly used in bad weather conditions in combination with GPS guided or LGB munition.

BOT: The aircraft must be tally on the target during the attack (via eyeball or sensor).
This method is mostly used in good weather conditions in combination with guided/unguided munition or gun strafes.

TYPE + NUMBER ORDNANCE/FUSE Settings, etc.
The ground controller will ask for a specific type and amount of ordnance as well as weapon settings. Because we have a GPS/Laser capable GBU-54 onboard, he decided to use it in laser mode. There could be several reasons for this:

a) Visibility is a factor (he could use his laser to guide our weapon).
b) Due to the dynamic situation the ground the target could move…etc.

The available fuse settings in BMS are Nose, Tail or N/T (Nose Tail) which are three different “Instantaneous” fuse settings. Fuse settings like “Delayed” or “Airburst” are not available yet.

Other possible weapon settings could be burst altitude (for cluster munition) as well as ripple and interval settings when releasing multiple weapons in a single attack. In this example, we keep it simple with a single GBU-54 release.

How to setup your weapons and sensors is not part of this section. You should already know everything about it, as you successfully mastered all A-G related training missions already.

(5) CAS Brief / 9-line

The CAS Brief/9-line describes the attack plan.
It contains precise information about where the attack begins, what the target is, where the target is, where friendlies are relative to the target, which support can be contributed from the JTAC/FAC(A) and finally the egress plan.

The 9-line contains the biggest portion of data and is executed in a quick communication sequence. Like for the routing and the check-in procedure, it is best practice to capture those data on your CAS sheet first or transfer it straight to your systems. We will start again with an example:

CAS Flight: Eyeball 9, Cyborg 71, ready for 9-line.
JTAC/FAC(A): Cyborg 71, Eyeball 9. Bravo 25. Heading 270. Right. 25 miles. 2854 feet. Single truck in the open.
North 37 07 059. East 130 20 011. Laser, Sparkle, Smoke, 3 miles east, Left B25.
Advice when ready for remarks and restrictions.

When you are well trained, the process from receiving and processing the information will take less than 30 seconds. At the beginning, this process could be overwhelming and will take some time because first you must fly the aircraft, second write down the information and then type it in your system. But let's proceed step by step here.

Similar to in the check-in, you can type in the elevation + LAT/LONG information straight into the system via the ICP. This saves time and in a worst-case scenario, lives.
It is well described in the check-in procedure how to modify STPT information. Just use any STPT you want (except route or bullseye STPTs).

Let’s have a closer look on the filled out 9-line sheet on the right side.

1. IP/BP Initial point for the attack, in our case our holding point which is the same.

2. HEADING+ OFFSET “Heading” means the magnetic heading from the IP to the target.
“Offset” means the side from IP-to-target line where the aircraft can maneuver to arrive at the final attack heading (via Remarks/Restrictions).

3. DISTANCE The distance from the IP to the target.

4. TGT Elevation Target elevation in feet

9-LINE

1. IP/BP	B25		
2. HEADING	270	OFFSET	Right
3. DISTANCE	25 miles		
4. TARGET ELEVATION	2854		
5. TARGET DESCRIPTION	Single truck in the open		
6. TARGET LOCATION	N 37 07 059 E 130 20 011	BULLSEYE -	
VISUAL / OFFSET	-		
7. TYPE MARK/ TERMINAL GUIDANCE	NONE WILLIE PETE SMOKE SPARKLE LASER		
8. FRIENDLIES	3 miles east		
9. EGRESS	Left back to B25		

5. TGT DESCRIPTION Target type and number of units.

6. TGT Location LAT/LONG coordinates or Bullseye.

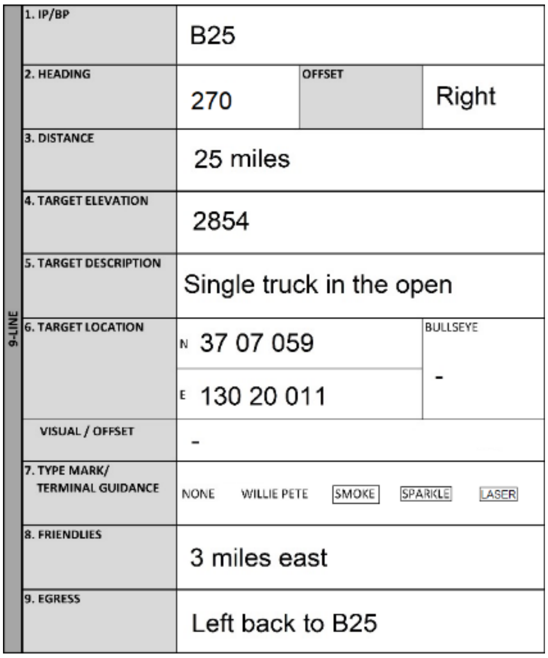
Visual / Offset = for Talk-on's (see page 227) or if no LAT/LONG available

7. TYPE MARK Marking equipment provided by the JTAC/FAC(A).

None =	No marking
Willie Pete =	Phosphorus munition
Smoke =	Smoke
Sparkle =	Infrared Pointer
Laser =	Laser equipment

8. FRIENDLIES Position of nearest friendly forces in relation to the target.

9. EGRESS Post-attack direction and position.



9-LINE

1. IP/BP	B25		
2. HEADING	270	OFFSET	Right
3. DISTANCE	25 miles		
4. TARGET ELEVATION	2854		
5. TARGET DESCRIPTION	Single truck in the open		
6. TARGET LOCATION	N 37 07 059	BULLSEYE	-
	E 130 20 011		
VISUAL / OFFSET	-		
7. TYPE MARK/ TERMINAL GUIDANCE	NONE WILLIE PETE SMOKE SPARKLE LASER		
8. FRIENDLIES	3 miles east		
9. EGRESS	Left back to B25		

In the routing/safety flight section we already talked about the **VIP** function. There are some more applications especially when using the VIP in the 9-line process.
Let's assume the following situation: we must use a landmark, marked or known location as our IP because we don't have a valid echo point to use the keyhole template. We already created a mark point from the position of the JTAC. The JTAC/FAC(A) can now provide us a VIP-to-TGT information in the 9-line. For example:

JTAC/FAC(A): Cyborg 71, Eyeball 9. IP is my latest location. Heading 270. Right. 3 miles. 2854 ft. Single truck in the open. North 37 07 059. East 130 20 011. Laser, Sparkle, Smoke, 3 miles east, Right 15 miles east of IP. Advice when ready for remarks and restrictions.

Another scenario for the **VIP** could be that you have no echo point, no pre-briefed game plan, no 9-line LAT/LONG/Elev information and only the location of the friendlies which are under heavy fire. So, you must act quickly.
The JTAC/FAC(A) can provide you the TGT position relative to his position. For example:

JTAC: Cyborg 71, Eyeball 9. Type 1. BOT. Request immediate gun pass on target. IP is our location marked with smoke. Heading 090. Right. Elevation 2854. Target is a single truck in the open, 4000ft south of our position. Right back 5 miles west of IP. Remarks: good visibility, gunfire. Restrictions: final attack heading 090-110. Call tally and IN 15 seconds before attack with heading.

1. Set the STPT closest to the friendly position as VIP.
2. Punch in 4000ft for the RNG (Range) and 180,0° for the TBRG (Target Bearing), ELEV (Elevation) 2854ft *(example on the right).*
3. Enable the VIP for the modified STPT.
4. Select the modified STPT as current STPT. As soon as you select the correct STPT, the VIP becomes visible.
5. Activate your TGP. You should see "IP" at OSB 10.
6. Slew the VIP (Visual Initial Point) on top of the smoke.
The TGT is now 5000ft south of the IP [indicated as the TD (Target Designator) box].
7. Toggle the SPI *(NWS A/R DISC MSL STEP SWITCH)* to the TGT ("TGT" in the TGP at OSB 10)> TGP moves automatically.
8. Verify the target with the TGP and pickle/riffle/strafe.

Especially slewing the IP on top of the smoke is helpful reducing the heads down time instead of typing LAT/LONG/Elev coordinates. This is certainly another great improvement since BMS 4.36.

To reverse all STPT changes, press CZ (Cursor Zero) in the HSD or FCR.

Note: to make the VIP/VRP working correctly, the elevation of the STPT and the VIP elevation must be the same.

Conclusion of VIP: in highly dynamic CAS environments without any keyhole information and/or LAT/LONG target coordinates as well as enemy / friendly movement, the VIP comes in very handy.

Okay, lets come back to our main example of the BOC attack together with the full 9-line information.

After all information of the 9-line is processed in your systems, you will challenge the JTAC/FAC(A) to give you remarks and restriction information.

Again, you set the speed of the communication, no matter how long the JTAC/FAC(A) must wait until he can provide the next information. Make sure to process the data correctly and precisely!

Refrain from providing your 9-line read back just yet! **After** you received the remarks and restrictions, you have to read back line 4 and 6 of the 9-line. Note that in some air forces, the read back of line 8 is also mandatory to initiate the attack.
In this training you can do both.

Cyborg 71 with four GBU-54

(6) Remarks/Restrictions

Remarks and restrictions are the final information handed over to the CAS aircrew.

CAS Flight:	Eyeball 9, Cyborg 71. Ready for remarks and restrictions
JTAC/FAC(A):	Cyborg 71, Eyeball 9, Remarks. Manpad near TGT. Wind 15kts from the west, few clouds. Eyeball 9 will be lasing with laser code 1688 at IP inbound call, confirm SPOT. Restrictions. Final attack heading 220 clockwise 250. Stay above 15000. TOT 15:25 System readback line 4 + 6, All remarks/restrictions. How copy?

REMARKS	REMARKS *Surface to Air Threat* *Weather* *Hazards* *Friendly Mark* *Additional calls*	MANPADS Winds 15kts west, less clouds. Laser on Target from JTAC. LC 1688. IP inbound
RESTRICTIONS	FINAL ATTACK HDG	220 -> 250
	ALTITUDE	15000
	TOT / TTT	15:25z

Almost there. Again, another big portion of data. Let's have detailed look.

Remarks Everything important to secure the aircrew and ground forces must be mentioned (again). Surface to Air Threats, updated weather information, updated hazards, Friendly markings, additional calls, etc.

Final Attack Heading The first attack restriction is the final attack heading given in a clockwise manner. Normally it is heading "cone" to give the CAS aircraft enough room to maneuver. Depending on friendly, civil and geographical conditions as well as threats, this cone can be bigger or smaller.

Altitude Minimum altitude restriction to avoid portable SAM systems (MANPADS, etc.) or gunfire as well as geographical conditions.

TOT/TTT TOT = Time Over Target. The impact time on which the weapon hits the target.
TTT = Time to Target. A precise time delta in minutes or seconds between a time hack and ordnance effect.

To enable a time hack in BMS for a TTT, press (6) on the ICP which activates the time page. The JTAC/FAC(A) will give the CAS flight a countdown for a hack:

JTAC/FAC(A): Cyborg 71, Eyeball 9, TIME TO TARGET 5 minutes. READY, READY, HACK.

Press (NEXT) on the ICP to start the hack. To reset the hack time, press (PREVIOUS).

Your goal now is to maneuver the aircraft, so that your ordnance hits the target in 5 minutes.
A good way to time yourself is to use your HUD TOT to match the TTT like in the example to the right:

1:05 (Hack) + 3:55 (HUD) = 5:00min

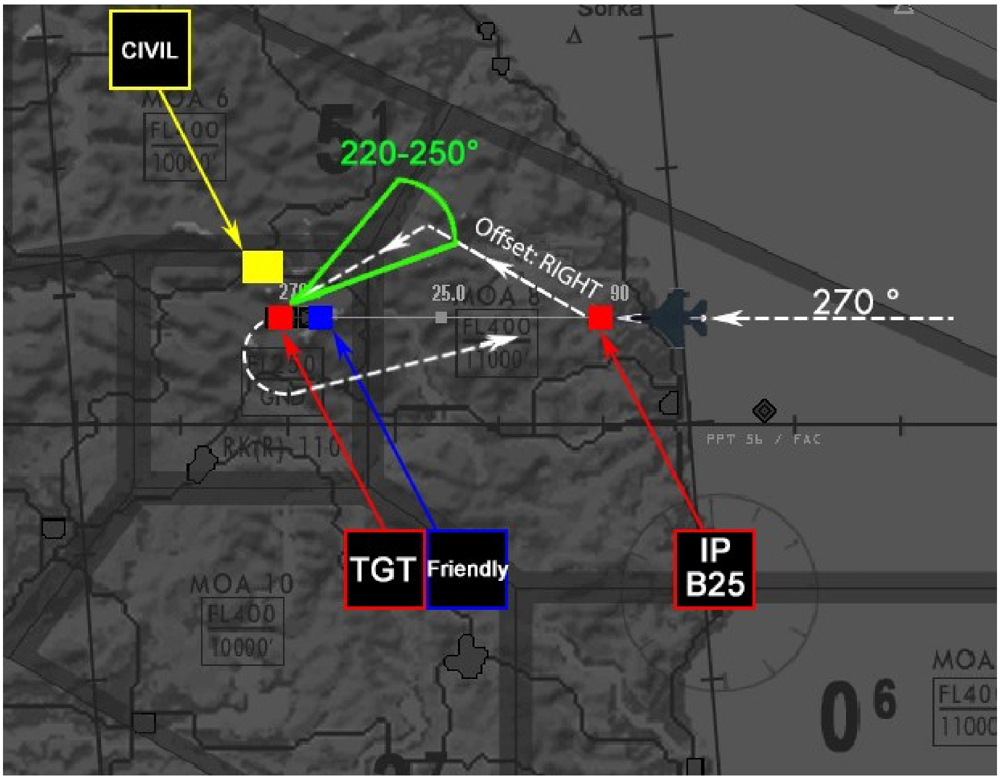
(7) Readbacks

The JTAC already challenged us in the "Remarks/Restrictions" section to read back the given data:

CAS Flight:	Eyeball 9, Cyborg 71. System readback. 2854 feet. North 37 07 059. East 130 20 011. Remarks. MANPAD near target. Wind 15kts from the west, less clouds, Eyeball 9 will be lasing with laser code 1688 at IP inbound call, will confirm SPOT. Cyborg 7 laser is off. Restrictions. Final attack heading 220 clockwise 250. Staying above 15000. TOT 15:25z.
JTAC/FAC(A):	Cyborg 71, Eyeball 9, readback correct, Call IP inbound and IN 30 seconds prior release with heading.
CAS Flight:	Eyeball 9, Cyborg 71, Wilco.

We now have received and transmitted all required parameters to the JTAC/FAC(A) and vice versa.
We are now ready for the attack.
One note again about the system read back for the 9-line: because this is a BOC (Bombs On Coordinate) attack, a system read back is indispensable. The pilot and JTAC/FAC(A) don't have any other "backup verification" (for example: Eyeball, Sensors) to ensure the pilot will attack the correct target. Both sides must make sure that the target data is 100% correct, especially in bad weather conditions.
For a BOT (Bombs On Target) attack, a system read back is no requirement because the "backup verification" is given via a tally on the target through the pilot.

Okay, it's quite possible you've lost track and may be a bit data saturated. To get you back on to the same page, please have a look at the scheme below. Hopefully the procedure is easier to understand by looking at the situation from the the gods eye view:



As you can see, the main purpose of the chosen game plan is to avoid overflying friendly units / civil territory as well as respecting the blast direction of the ordnance to minimize collateral damage. It shows that every JTAC/FAC(A) must respect all of these parameters when creating a game plan. His focus is not only to destroy the target but also to elaborate and maximize safe conditions for all friendly forces and the civil population.

(8) Correlation

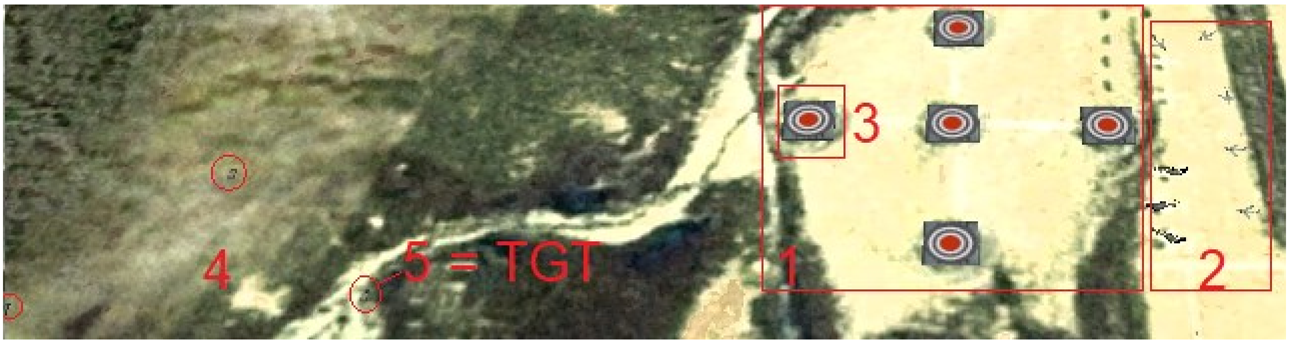
Because we perform a BOC (Bombs On Coordinate) attack, the correlation is already done after sending the read back for line 4 and 6 as well as the restrictions to the JTAC/FAC(A). He correlated the read back data with his data and authorized the attack.

Let's quickly drift away from our BOC attack.

Another scenario would be a BOT (Bombs On Target) attack.
In some situations, the JTAC/FAC(A) will provide a "Talk-On" to the CAS aircrew for example if a target is on the move.
The "Talk-On" objective is to correlate target or target area information between the JTAC/FAC(A) and the CAS flight visually (via Eyeball or Sensors). The goal of this procedure is to enable the CAS aircrew to find and identify the target assigned by the JTAC.
A sensor or eyeball "Talk-On" will be provided after the game plan, 9-line, remarks/restrictions and read back have been finished.
It can start from the line 4 and 6 coordinates or any other visual reference point. The basic requirement is that both JTAC/FAC(A) and CAS aircrew have clear visibility on the point where the "Talk-On" starts, to the target and to the target area.
The "Talk-On" requires a specific brevity and language. The following example shows how a "Talk-On" procedure works:

JTAC/FAC(A):	Cyborg 71, Eyeball 9, read back correct, Advice when ready for sensor talk-on.
CAS Flight:	Eyeball 9, Cyborg 71. Ready.
JTAC/FAC(A):	Cyborg 71, SLEW to line 4 and 6. Describe what you see.
CAS Flight:	I see five circular training targets (1)
JTAC/FAC(A):	Which type of aircraft targets are east of the circular training targets?
CAS Flight:	I see three choppers and five jets. Type unknown. (2)
JTAC/FAC(A):	Roger, you are looking at the correct circular training targets.
	Call contact on the most western training target of those five training targets. (3)
CAS Flight:	Cyborg 71, CONTACT.
JTAC/FAC(A):	Do you see any trucks 100 meters west of the western training target?
CAS Flight:	I see three trucks there in a triangle shape. (4)
JTAC/FAC(A):	Roger, the most eastern truck is your target. (5)
CAS Flight:	Cyborg 71, CAPTURED.

This is what both JTAC/FAC(A) and CAS aircrew saw and correlated to each other (see red numbers above):



This example shows a very advanced technique which can be used to provide efficient and quick target information. Especially when starting with CAS, it is better to start slow and easy with BOC procedures. If you are experienced enough in those, "Talk On's" will be the next logical step to train.

Let's come back to our BOC attack plan. We are inbound to the IP and the next step of our procedures is close.

(9) Attack

The attack phase is the critical point where all of our previous efforts come together. The CAS aircrew has to make sure that their systems are set up, the right weapon and settings are set, the right IP is chosen and the position of the airplane fits to the overall attack plan. The communication example would be as follows:

CAS Flight:	Eyeball 9, Cyborg 71. IP inbound, heading 270. Laser on
JTAC/FAC(A):	LASING 1688. CONTINUE.
CAS Flight:	Eyeball 9, Cyborg 71. Laser SPOT.
CAS Flight:	Eyeball 9, Cyborg 71. IN, 30 seconds, heading 230.
JTAC/FAC(A):	Cyborg 71, CLEARED HOT.
CAS Flight:	Eyeball 9, Cyborg 71. CLEARED HOT. Paveway one time, 30 seconds to impact, proceeding B25.

Let’s analyse the communication in more depth.

As planned, the CAS flight called “IP inbound” with the current heading. In addition, they gave the call “Laser On”. This is the cue for the JTAC/FAC(A) to activate the laser. He responded “Lasing” which is the brevity for “Laser is active”. Also, he verified again the set laser code. The CAS flight confirmed that their TGP acquired the laser with “SPOT”. Note: If you forgot how to activate the Laser Spot Tracker in the TGP, refer to chapter 11.3 (Buddy lasing).

With the next call, the CAS aircrew called “IN” with the correct TTR (Time to Release) and the final attack heading which is inside the final attack heading “cone” mentioned in the restrictions (220-250°).

The MOST important call of all procedures is the **“CLEARED HOT”** from the JTAC/FAC(A).
If that call is not clearly heard, CAS aircrews are not allowed to release any ordnance and must abort the attack.
In terms of radio malfunction, jamming or terrain covering it is possible that this call is blocked and not transmitted. In that case, the CAS flight goes back to their IP and tries to get in touch with the JTAC/FAC(A) to clarify the situation.

In our example, the call was made by the JTAC/FAC(A) and confirmed by the CAS flight, authorizing the CAS aircrew to drop the weapon as planned. The release was called with the brevity “Paveway” (= release of a Laser Guided Bomb). The time to impact and the proceeding of the CAS flight to the egress point was included as well.

The weapon is on the way and hopefully will hit its target. To confirm a hit/miss, the tenth and eleventh step are next.

(10) Assess Effectiveness of the Attack

In terms of a miss (the weapon has no effect on the assigned target), the JTAC/FAC(A) can ask for a re-attack.
If the target conditions don’t have changed, the JTAC/FAC(A) could act as follows:

JTAC/FAC(A):	Cyborg 71, No effect on target. Eyeball 9 has to relocate to enable LASING. Same game plan, 9-line and restrictions. New TOT: 15:37. How copy?
CAS Flight:	Eyeball 9, Cyborg 71. Copies all, new TOT 15:37.
JTAC/FAC(A):	Cyborg 71, Eyeball 9, readback correct, Call IP inbound and IN 30 seconds prior release with heading.
CAS Flight:	Eyeball 9, Cyborg 71. Wilco.

Steps 4-9 must be repeated if the target has significantly moved, or the threat conditions have changed. If the JTAC cannot properly lase the target or any technical malfunction on the bomb or laser created the miss, further communication is needed.

(11) Battle Damage Assessment (BDA)

The last important step is the BDA. The BDA is given from the JTAC/FAC(A) to the CAS aircrew to verify that the target is destroyed the way it was intended by the ground commander.
The safe routing out of the target area will mark the end of the entire CAS procedure in this example:

JTAC/FAC(A):	Cyborg 71, Good impacts, standby BDA
JTAC/FAC(A):	Cyborg 71, Target neutralized, Ground commander's intent met.
	Fly back B25 Block 20-22 and hold between B25-35 left hand.
	Report established.
CAS Flight:	Eyeball 9, Cyborg 71. Wilco.
JTAC/FAC(A):	Cyborg 72, Advice when ready for game plan.

Cyborg 71's first run is now completed. The JTAC will now start repeating steps 4-12 with Cyborg 72.
Whether an individual gameplan and updated sitrep is necessary is to be determined by the JTAC/FAC(A), depending on the situation.
If you are a wingman in a CAS flight, it is always a good idea to write down all information your flight lead receives even when you are not the one who is about to attack. Chances are that the JTAC/FAC(A) has the same game plan, remarks and restrictions for you and only the 9-line is slightly different to the recent one. This way he and you could save important time.
You as a wingman are not responsible for the communication in terms of Routing (1), Check-in (2) and Sitrep (3).
If the JTAC calls for a game plan which effects the whole flight at the same time (attack on the same or different targets), he will make individual read backs with each CAS aircrew.

(12) Routing/Safety of Flight.

Once all CAS aircrews from the flight have achieved their goal/playtime is over/mission is aborted, the JTAC/FAC(A) will send them to a point and altitude block to maintain safe conditions for all flights on station. He also safeguards the egressing flight from any threats. For example:

CAS Flight:	Eyeball 9, Cyborg 7 is checking out. We are Dakota and have no playtime left.
JTAC/FAC(A):	Cyborg 7, Eyeball 9 roger. Fly B40 Block 26-28. Keep minimum 40 miles distance to echo point.
	Avoid all blocks below 26. Report established.
CAS Flight:	Eyeball 9, Cyborg 7. Wilco.
CAS Flight:	Eyeball 9, Cyborg 7. B40 established at block 26-28. We are switching to Magic 2. Bye bye.
JTAC/FAC(A):	Cyborg 7, Eyeball 9 copies. Thank you.

Congratulations! If you have come that far and understood the basic concept of CAS, then you have achieved a lot already. Now it's time to get in the air and train alone with the BMS AI JTAC or with other human pilots.

27.3 BMS JTAC

Since 4.36, we now have a JTAC (Joint Terminal Attack Controller) available.
This brings great opportunities to anyone who wants to perform CAS (Close Air Support) operations in BMS using the AI.
There are five prerequisites for using the JTAC:

a) UHF 6 is set
   - UHF frequency from DTC
   - No need for an AWACS/JSTAR flight to be fragged/on station to use the JTAC function.

b) Enemy force is in theater.

c) Friendly unit is in theater within **10NM** from a target waypoint or within **6NM** distance to enemy forces
   The following units can provide the JTAC function:
   i. HQ
   ii. Infantry
   iii. Mechanized
   iv. Airmobile
   v. Marine

d) CAS flight is tasked in the ATO as « CAS » | « On-Call CAS » | « Pre-Plan CAS ».

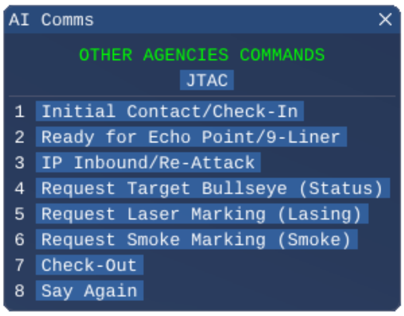
e) CAS flight position is inside a 30nm radius of the JTAC position.

If you start using the BMS JTAC without having a clue about CAS, we strongly advise you to read through the previous chapters 27.1 and 27.2. Even if you are more advanced in CAS, it is a good idea to read the chapters above. We will not talk about the 12 steps of CAS and the general concepts described in this chapter again.
We will only show the JTAC functionality, possibilities and the main differences to real life procedures described before.

The BMS JTAC can provide most of the features which a human JTAC/FAC(A) would provide in a CAS environment. Consequently, it's great a training tool especially for nuggets when exploring the world of CAS.

Please keep the previously provided CAS sheet ready (refer to page 214).

Let's start the mission. BMS will setup frequencies settings automatically, sensors and master arm settings when entering 3D.
Because you are already close the JTAC, you can start to communicate with him immediately after entering 3D.
The JTAC radio menu is accessible with the "**y**" or "**z**" key (second page) as well as the tanker. It's a single page menu with 7 options.



(1) Routing/Safety of Flight

The routing to a holding point and deconfliction with other aircrafts/threats/etc. is not part of the BMS JTAC yet.
For this part of the training, we advise you to fly to your holding between B25-35 at Block 20-22.
The echo point information will be passed to the CAS flight after the check-in. This varies a little bit from the explained procedures explained in chapter 27.2. The initial contact will start straight with the check-in without any authentication.

(2) CAS Aircraft Check-in

The JTAC follows the same order as RL JTAC/FAC(A) would. To start the check-in, activate the JTAC radio menu and press (1). After the initial contact press (1) **again** to start your check-in procedure.

The flight check-in includes the package number, the type and number of aircraft, the current position and altitude relative to the JTAC, the load out (no specific ordnance type is mentioned yet) and the playtime.
When the check-in is completed, the JTAC will give you an advisory call for the LAT/LONG coordinates of the echo point.

To receive the coordinates, press (2) "Ready for Echo point/9-line" on the radio menu. Write them down on your CAS sheet and enter those in your system via the ICP for PPT 56 in the DEST page (refer to page 216 for details).

Your CAS sheet and DED now should display the following information like in the examples below after sending your check-in and receiving the echo point.

Troll 7 Cyborg 7-1 checking in
Cyborg 7-1 Troll 7 ready to copy

Troll 7 Cyborg 7-1 package 2 0 2 4
2 ship F-16s 25 miles West 14000
8 Bombs
sniper
0 plus 3 5 on station

Cyborg 7-1 Troll 7 advise ready for echo

Cyborg 7-1 ready to copy Echo
Cyborg 7-1 Troll 7 Echo
North 3 7 / 0 8 / 0 0 3
East 1 3 0 / 2 0 / 0 2 4

	AIRCRAFT CALLSIGN	CYBORG 7	FAC/JTAC CALLSIGN	TROLL 7	FAC/JTAC FREQUENCY	301.75	
ROUTING	ECHO POINT	N 37 08 003		E 130 20 024		BULLSEYE -	
	PROCEED TO	-		ANGELS/BLOCK	-		
	QNE/QNH	1013	OTHER FLIGHTS ON STATION	-			
CHECK-IN BRIEFING	AUTHENTICATION	CODEWORD -		MATRIX/RAMROD + + + = -			
	MISSION / PKG #	2024	AIRCRAFT TYPE / #	2x F-16C			
	POSITION and ALTITUDE	25Nm miles west 14000					
	ORDNANCE	GUN (Rounds/mm) 510, 20	A-G (# by TYPE) 4 GBU-54 each		LASER CODES		
	PLAYTIME (SOK Time till Bingo)	35	SITREPs/CODEs	-	MAP (Yes/No)	-	
	FAC(a) capable (Yes/No)	-	TGP (Yes/No)	SNIPER	FLIR (Yes/No)	-	
	OTHER SENSORS	-	IDM Number + Sweet/Sour	11, 12	TIMBER Number + Sweet/Sour	-	
	ABORT CODE	-					

(3) Situation Update

The Sitrep is not implemented in the BMS JTAC yet.

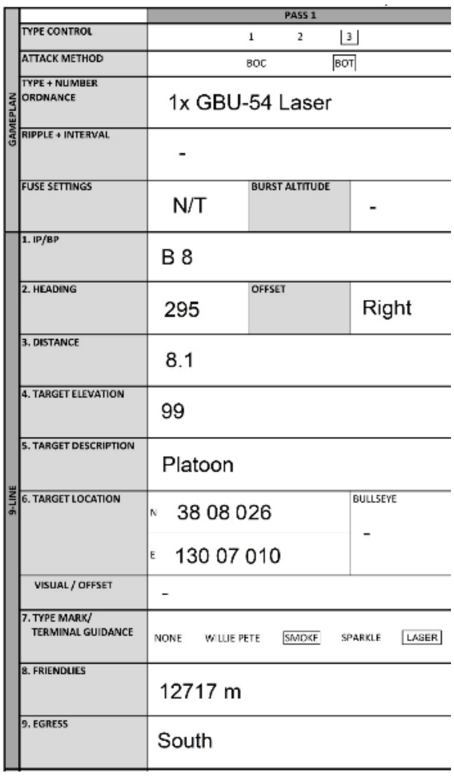
(4) Game Plan

When the echo point coordinates are given, the JTAC will provide the game plan to you. He mentions which type of control is in effect and provides an advisory call for the 9-line.

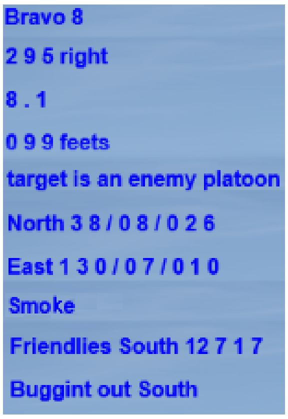
The attack method (BOC or BOT) as well as precise ordnance information and settings are not implemented yet.
For the first run we recommend doing a BOT (Bomb On Target) attack using a single GBU-54 release either in GPS or laser mode (the JTAC is laser capable) with the N/T fuse setting. The Sniper pod should be active as well to acquire the target visually (tally).

(5) CAS Brief / 9-Line

After you have processed all the previous information press (2) **again** to start the 9-line procedure. The JTAC will pass you the whole 9-line in a short sequence.
Write down all information on the CAS sheet and then transfer it to your system via the ICP.
Your CAS sheet should now read the following information like in this example:



		PASS 1		
GAMEPLAN	TYPE CONTROL	1 2 [3]		
	ATTACK METHOD	BOC [BOT]		
	TYPE + NUMBER ORDNANCE	1x GBU-54 Laser		
	RIPPLE + INTERVAL	-		
	FUSE SETTINGS	N/T	BURST ALTITUDE	-
9-LINE	1. IP/BP	B 8		
	2. HEADING	295	OFFSET	Right
	3. DISTANCE	8.1		
	4. TARGET ELEVATION	99		
	5. TARGET DESCRIPTION	Platoon		
	6. TARGET LOCATION	N 38 08 026	BULLSEYE	-
		E 130 07 010		
	VISUAL / OFFSET	-		
	7. TYPE MARK/ TERMINAL GUIDANCE	NONE WILLIE PETE [SMOKE] SPARKLE [LASER]		
	8. FRIENDLIES	12717 m		
	9. EGRESS	South		



Note that the 9-line information provided by the JTAC in this training will vary from the 9-line in the example above.

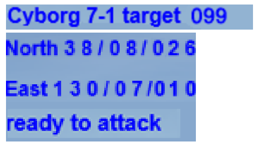
As you can see, the BMS JTAC will provide you a complete 9-line the same way as you receive it from a human.
Line 1 and 3 are nautical miles (nm). Line 4 in feet (ft).
Note that in line 7 the JTAC only mentions that he is smoke capable, but he is laser capable as well.
Line 8 (distance to the nearest friendly) is given in meters (m).

(6) Remarks/Restrictions

Remarks/Restrictions are not implemented in the BMS JTAC yet.
Because of this it is recommended to use line 2 of the 9-line for the final attack heading when using the BMS JTAC.

(7) Read backs + (8) Correlation + (9) Attack

If the in-game player voice *(UI Setup/Sound)* and info bar is activated, your AI pilot will readback line 4 and 6 of the 9-line after pressing (3) in the JTAC radio menu.



If you de-activated these functions, readback line 4 + 6 + (8) on UHF for the training purpose and then press (3).

Straight after the readback of the 2/3 lines the JTAC will give you a "Cleared Hot" call which indicates you are authorized to attack. Note that the JTAC will call you "cleared hot" even when you are not at the correct IP position because of technical limitations at the moment. We recommend pressing (3) if you are 3 miles out till your IP is reached.

The JTAC in BMS is smoke and laser capable. To support your attack, you can ask for these JTAC tools by pressing (5) for lasing or (6) for smoke.

When requesting lasing, the JTAC will use the assigned laser code from the weapons screen in the UI. After requesting lasing, the JTAC calls "Laser On" which is your cue to activate the Laser Spot Mode in the TGP
(explained in the buddy lasing chapter 11.3). The lasing is now active until the ordnance has had any effect on the target.

Smoke can also be requested from the CAS aircrew. After some seconds, the JTAC will confirm that the target is marked with smoke. The smoke will appear for 1:00 minute and can be requested again on the same target if necessary.

Target is marked with smoke.

(10) Assess Effectiveness of the Attack

If we were successful with our attack and there are targets left, the JTAC will ask for a re-attack.

Cyborg 7-1 Eyeball 6 can you re-attack, I still have targets

Press (3) again. The JTAC will give you the next LAT/LONG coordinates.

If you hear nothing from the JTAC after your attack, you properly hit the wrong target or your attack had no effect. The JTAC will not respond till you hit the correct target or till you check out.

As a side note: the JTAC is also capable of providing Bullseye information of the target. Press (4) in the radio menu.

(11) Battle Damage Assessment (BDA)

If you have no ordnance left (Dakota/Winchester) or you must go RTB, press (7) to check-out with the JTAC. He will give you a BDA of all your attacks.

Eyeball 6 Cyborg 7-1 Checking out

Cyborg 7-1 Roger BDA is 1 vehicles

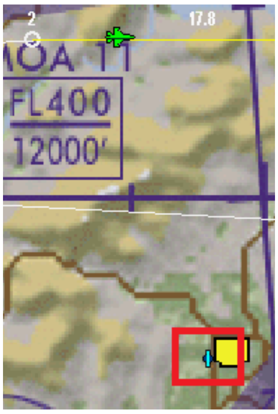
(12) Routing/Safety of Flight

See step (1).

This marks the end of using the AI JTAC as implemented by BMS. In the future, we hopefully will see more improvements to provide you an even more realistic non-human training partner.

BUT WAIT, THERE IS A LITTLE MORE…A HUMAN JTAC?

Even though the AI JTAC is not designed for that approach, there's another possible, interesting way of doing trainings with two human pilots. One acts as human JTAC, the other one as the CAS asset:



1. When you start the mission, the human JTAC should fly to "Yongju Highway Strip" straight south and land there (as marked on the right picture). Before you land, please drop your stores because the runway is very short. Use your toebrakes as early as possible. Note that only "Yongju Highway Strip" can be used in this training because it's inside of the 30nm distance limit.

2. The CAS pilot should fly to STPT 3 as planned and establish an orbit. No communication yet with the AI JTAC from both assets.

3. Once the human JTAC has landed in Yongju, he must taxi to a safe parking position. Let the ground crew install his chocks. Don't shut down the jet and stay on UHF 6 / VHF 15.

4. Only the CAS pilot now switches to a different UHF channel, for example UHF 7. Which one is not important. The main goal is that he leaves UHF 6. The human JTAC stays on UHF 6.

5. The human JTAC now checks in with the AI JTAC and makes note of all Echo point/Game plan/9-line/Target information.

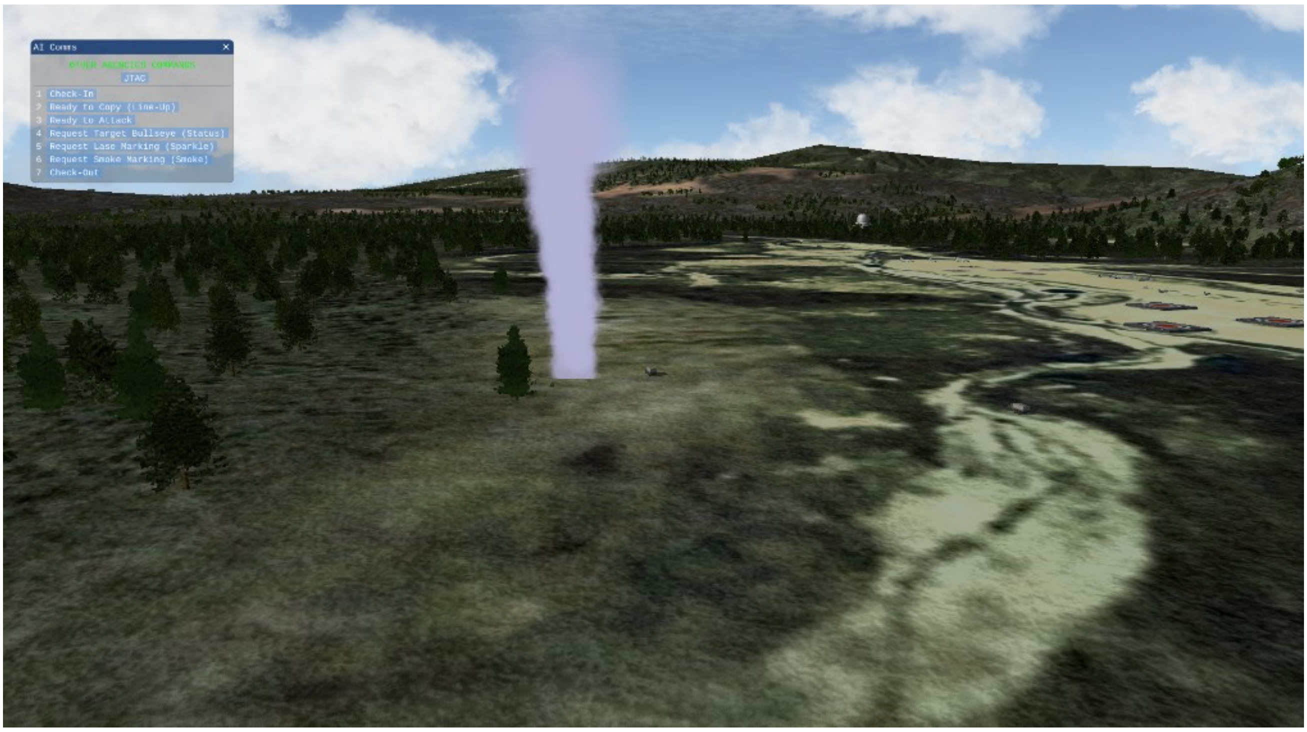
6. After he has received and processed all data and pressed "Ready for attack", he can start the whole CAS procedure with the CAS pilot including all steps 1-11. They can communicate on their VHF or on the GUARD frequency.

7. It is now up to the human JTAC to decide how he wants to use and setup the CAS pilot. The only information which is mandatory to use from the AI JTAC is the LAT/LONG/ELEV target information from the 9-line of the first target.

8. If the CAS pilot needs to request laser or smoke, the human JTAC can request this from the AI JTAC and simulate a real JTAC this way. Remember, all communication between the human JTAC and AI JTAC will be not be heard by the CAS pilot.

9. The human JTAC can decide to change his view to the enemy territory with the keystroke "VIEWEXT: Enemy Ground Unit Camera" or even use the “Eye fly” camera to observe the area.

10. In terms of communication between the human JTAC and the CAS pilot, your IVC will work in the external view as well as how you use it in the cockpit.



As you can see, there are plenty of options possible. Enjoy your trainings!

No matter how deep you want to dive into the world of CAS, it is one of most challenging and stressful tasks that you can do in BMS. Hopefully this training mission and documentation provides you with the necessary toolbox for becoming a serious and useful CAS/JTAC/FAC(A) asset.

MISSION 28: SEAD-EW *(TR_BMS_28_SEAD-EW)*

LOCATION: Northeast of Seoul.

CONDITION: F-16C block 50 – 2-ship – Package 2071 - Callsign Panther 4.
GW: 38976 lb, 2 AIM-120C, 2 AIM-9X, 1 AGM-88, 1 CBU-105, 1 AN/AAQ-33, 1 AN/ALQ-184, 2 370GL bags.
Laser code: 1688.
Max G: 6.0/-2.0, Max speed: 600 kts / 1.2 Mach.

Support units:
- Tanker - 40 miles east of STPT 5 (Copper 3: UHF 289.65).
- J-STARS - 50 miles southeast of STPT 5 (Chalice 7: UHF 281.10).

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

WEATHER: RKSM INFO: B 010725Z RWY 36 TRL 140 360/15KT 7SM FEW 050 25/15 A1012 NOSIG

LEARNING OBJECTIVES: Understand/increase knowledge of different SAM threats. Learn about basic SEAD/DEAD/EW tactics. Learn how to use the new ECM functions effectively for jamming a threat offensively (EW) or to protect yourself if engaged.

Note: This training can be flown as a single-ship (take #1 seat and send #2 RTB when in 3D) or as a human two-ship to train hunter-killer tactics and other EW (Electronic Warfare) scenarios.

Panther 4 with SEAD/DEAD/EW loadout (HARM + HTS, CBU-105, ECM Pod)

28.1 SEAD, EW, DEAD: Basic principles

Suppression of enemy air defense (SEAD) is a military strategy that involves neutralizing or destroying an enemy's air defense systems in order to establish air superiority. The F-16 Fighting Falcon is a multirole fighter aircraft that is often used for SEAD missions due to its versatility and advanced capabilities.
The F-16 is equipped with a variety of weapons and sensors that allow it to detect and target enemy air defense systems from a distance. It can carry a variety of missiles and bombs specifically designed to destroy radar and other air defense systems, as well as electronic warfare systems that can disrupt enemy communications and radar signals.

The F-16's advanced avionics and cockpit design allow it to operate in a wide range of environments and weather conditions, making it well-suited for SEAD missions that may require it to fly low and close to the ground in order to evade enemy detection and engage targets.
In addition to its offensive capabilities, the F-16 also has a robust self-defense system that includes radar warning receivers, chaff and flare dispensers, and missile approach warning systems. These systems help to protect the aircraft from enemy air defenses and allow it to operate in high-threat environments.

Overall, the F-16 is an effective platform for SEAD missions due to its versatility, advanced capabilities, and robust self-defense systems. It has been used by many countries around the world for this purpose, and has proven to be a valuable asset in establishing air superiority and achieving military objectives.

This training is designed to allow pilots to expand their knowledge of SAM threats and to develop the required skills and tactics to safely and effectively neutralize or destroy the threat. Emphasis is placed on SAM's as most AAA threats can be mitigated simply by flying at altitude.
This training is not intended to be 'How to guide' to SEAD/DEAD/EW. It is intended to foster a greater knowledge and understanding of SEAD/DEAD/EW considerations and to encourage pilots to think about and tailor their weapons and tactics accordingly depending on the unique circumstances/problems they are faced with.

SEAD
Also known as "Wild Weasel" and (initially) "Iron Hand" operations, are military actions to suppress enemy surface-based air defenses, including not only surface-to-air missiles (SAMs) and anti-aircraft artillery (AAA) but also interrelated systems such as early-warning radar and command, control and communication (C3) functions, while also marking other targets to be destroyed by an air strike. Suppression can be accomplished both by physically destroying the systems or by disrupting and deceiving them through electronic warfare.

DEAD
The intention of DEAD is not only to suppress the threat but to destroy it.

EW
Electronic warfare (EW) is any action involving the use of the electromagnetic spectrum (EM spectrum) or directed energy to control the spectrum, attack an enemy, or impede enemy assaults. The purpose of electronic warfare is to deny the opponent the advantage of—and ensure friendly unimpeded access to—the EM spectrum.

28.2 ECM/EWS - Know your system capabilities

Since 4.37 we have an enhanced EWS (Electronic Warfare Suite) with the implementation of the new ECM capabilities for the F-16.
Refer to chapter 2.7.3 in the Dash-34 to learn everything about the new ECM functionalities which will not be explained here in detail to reduce double content.

In addition, we suggest to give yourself a refresher for all AGM-88 HARM, HAD and CBU-105 aspects mentioned in this document as well as in the Dash-34 (Chapters: 4.2.4, 4.2.4.1.8, 4.2.11.2).

28.3 SAM Systems – Know your enemy

In BMS we have Command, Semi-Active Radar Homing and Infrared guidance systems.
Most Command/SARH SAM types have a tracking radar (TR) connected to other search radars (SR) and/or early warning radars (EWS). The tracking radar is always the main priority to destroy when it comes to SEAD/DEAD missions.
More modern SAM systems have their own tracking radar mounted on each launcher vehicle which increases the workload and risk for SEAD/DEAD flights.

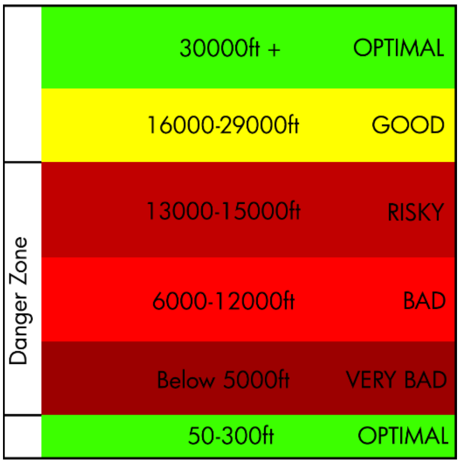
It is important to know all information about the capabilities of each SAM system you face with before entering any SEAD/DEAD mission. For example: Weapon range, Guidance type, ECM effectiveness, Radar frequency band, Home on Jamming (HOJ) capabilities, etc. In this training you deal with: SA-2, 3, 4, 6, 11 and AAA (KS-19).

28.4 SEAD/DEAD Tactics

One of the most effective ways to attack/defend SAM and AAA threats is to use altitude and speed to your advantage. Operating at the optimal altitudes for SEAD and DEAD (as shown in the picture on the right) can significantly reduce the chances of getting hit by these threats.
However, it's important to keep in mind that this is just one aspect of self-defense. There are many other factors to consider, such as the type of aircraft you are flying and the specific tactics you are using.
Before attempting to engage a SAM site, make sure you have a thorough understanding of these and other defensive measures to keep yourself and your aircraft safe.

SAM	Tactic		Weapon			Attack profile		
	Hunter killer	Search & destroy	HARM	Maverick			CBU	
				Hi/med alt	Low alt	Fly up	Pop up	Low alt loft
SA2	X	X	X		X	X	X	X
SA3	X	X	X	X				
SA4	X	X	X		X		X	
SA5	X		X		X	X	X	X
SA6	X	X	X	X	X		X	X
SA8		X	X	X	X	X		X
SA9	X	X	X	X	X	X		X
SA10		X	X		X		X	X
SA13	X	X	X	X		X	X	X
SA11		X	X	X			X	X
SA15		X	X	X		X		X
SA17		X	X	X			X	X
SA19		X	X	X		X		X

In general, try to operate in the two optimal altitude blocks for SEAD/DEAD (see on the picture on the right side):
- Above 30000ft AGL
- Between 50-300ft AGL



Maintaining a high speed is crucial for self-defense against SAM and AAA threats. In general, you should aim for speeds of 350 knots or higher. However, there may be situations where it is not possible to achieve these speeds due to factors such as aircraft weight or weather conditions. In these cases, it's important to adjust your plan accordingly and think about what altitudes you need to be at throughout different phases of the flight. Studying the BMS Threat Guide and understanding the range of SAM threats you may encounter can also be helpful in developing a successful self-defense strategy. Don't forget to consider all of these factors and plan carefully to ensure your safety and the success of your mission.
The table is designed to serve as a quick reference for pilots when determining the most appropriate tactics, weapons, and attack profiles to use in the face of a SAM threat. However, it is important to note that this is just a starting point, and pilots must also consider various other factors such as terrain, weather, enemy fighters, and fighter cover, as well as ingress and egress routes. This is not meant to be a comprehensive guide, but rather a tool to help pilots begin their decision-making process.

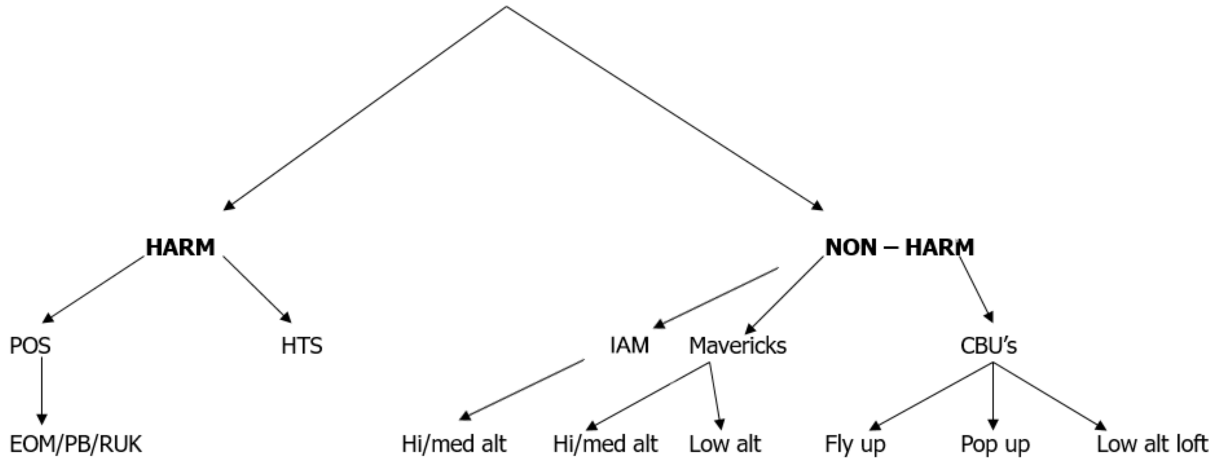
28.5 Location known vs. Location unknown

When planning our response to a SAM threat, it is crucial to first determine whether or not the location of the SAM site is known. This information will shape the selection of weapons and tactics that can be effectively employed against the threat. In addition to the location of the threat, we must also consider the capabilities and characteristics of the SAM system itself.

The next few slides provide a simplified overview of the weapons and tactics that may be used in response to a known or unknown location threat, depending on the specific characteristics of the threat.

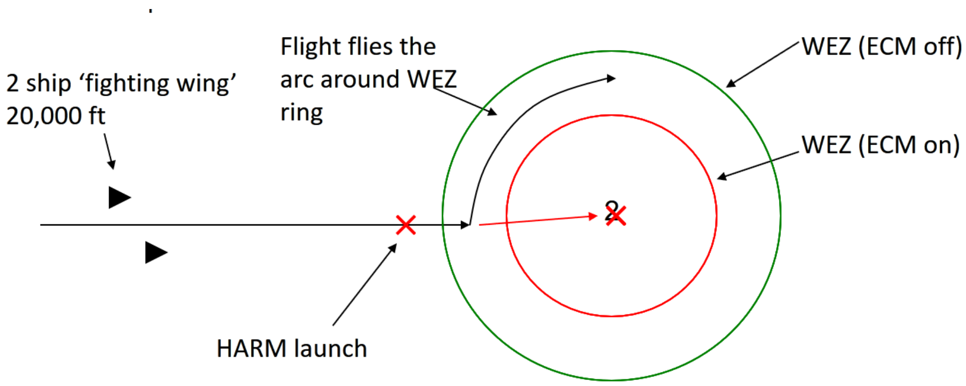
Location known

Since the location of the SAM site is already known to us, we can focus on devising a plan to attack the site rather than worrying about finding it or being ambushed. The options for attacking the site include using High Speed Anti-Radiation Missiles (HARM) or other non-HARM options such as Mavericks or CBUs. Once the appropriate weapon has been chosen, we must consider the attack tactic to be used in the strike.



Location known Tactics – HARM with HTS/POS/HAS

Once we have determined the location and characteristics of the SAM threat, we can begin to formulate tactics for attacking it. The goal is to choose a tactic that minimizes danger to the attacking aircraft while maximizing the chances of successfully neutralizing the threat. One option that can be effective against many types of SAM threats is the use of High Speed Anti-Radiation Missiles (HARM) in a standoff attack. However, it is important to keep in mind that these missiles can miss if the target radar is not emitting. To increase the chances of a successful strike, we can launch the missile outside the Weapon Engagement Zone of the SAM and then fly our aircraft into the radar search envelope of the SAM to prompt it to activate its radar and track us. The following example demonstrates this approach in a two-ship setup against an SA-2 threat.

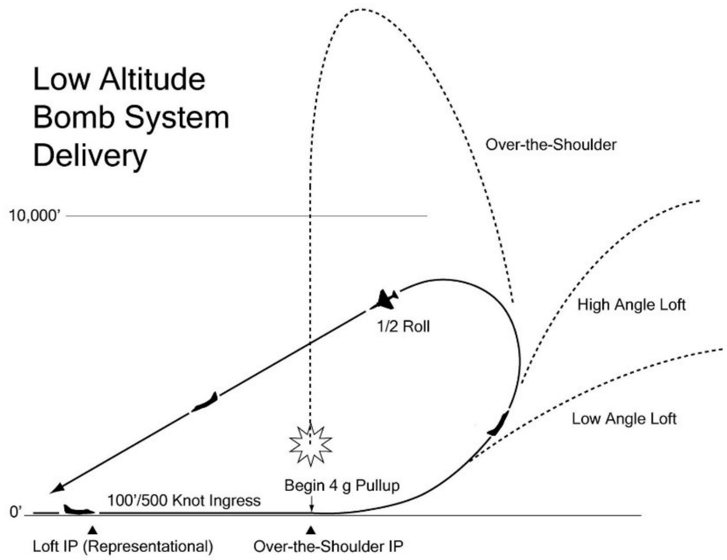


Location known Tactics – Mavericks/CBU's/IAM

If HARMs are not available, other options such as CBUs, Mavericks, or IAM can be used for Suppression of Enemy Air Defenses (SEAD) or Destruction of Enemy Air Defenses (DEAD). The choice of tactic will depend on the Weapon Engagement Zone of the threat, as well as its mobility and self-protection capabilities.
There are a wide range of tactics to choose from in these situations."

Mid-High Altitude
Releasing from an mid-high altitude is the easiest way and need no further explanation.

Low altitude – Loft
This is a method of employing bombs on target from a very low altitude using speed and a pitch up release maneuver to give additional bomb time of flight and range . This profile comes with a cost of decreased accuracy, but allows for standoff distances outside of small AAA and MANPAD threats when low level attacks are necessary.



Low altitude – Popup

To fly an approach to the target that is relatively easy to fly and keeps you save from AAA, you will have to fly some effective turns. This will generate some difficulty for the AAA.

To do this, you have to fly "past" the target at the right distance and then turn towards it to drop your bombs.

IP = Initial Point

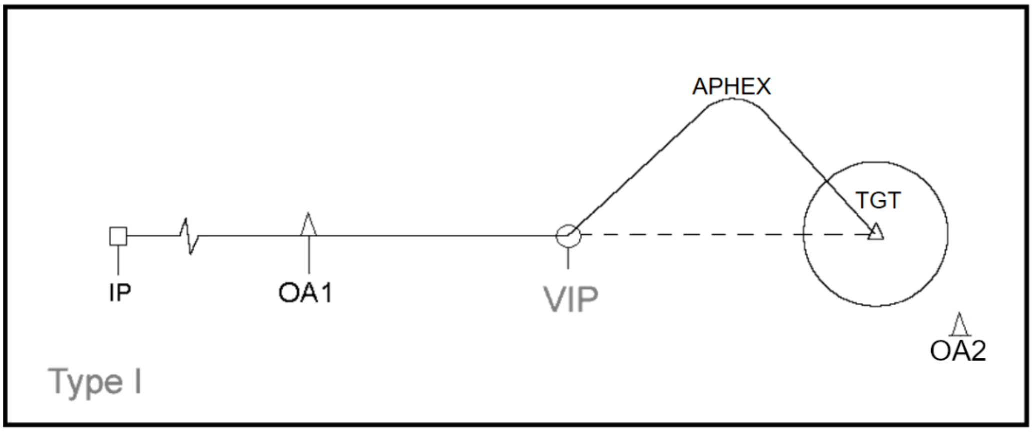
OA1 = Offset Aimpoint 1

VIP = is the point where you start turning and climbing

APHEX = is the point where you start turning to the target

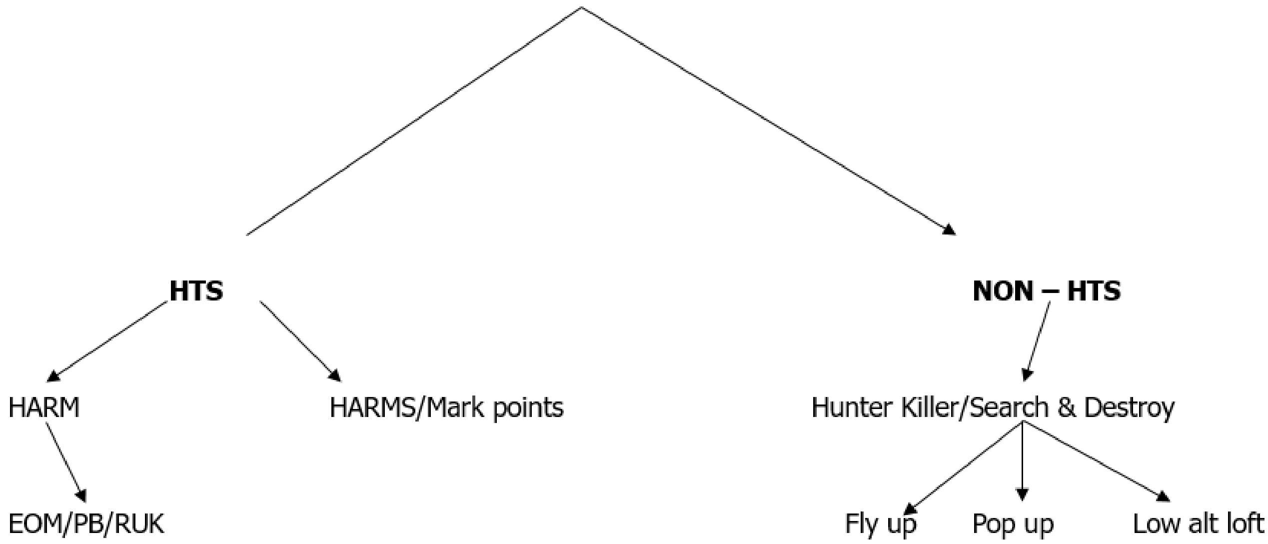
TGT = Target

OA2 = Offset Aimpoint 2



Location unknown

If the location of the SAM site is unknown, it is important to consider ways to locate the threat before it has a chance to locate and ambush us. One option is to use the HARM Targeting Sensor to locate the SAM. Alternatively, we can rely on other sensors such as GM radar, GMT radar, TGP, or the Mk I eyeball to find the threat. While using these other sensors carries a higher risk to the attacking aircraft, the risks can be reduced through proper employment of these sensors.



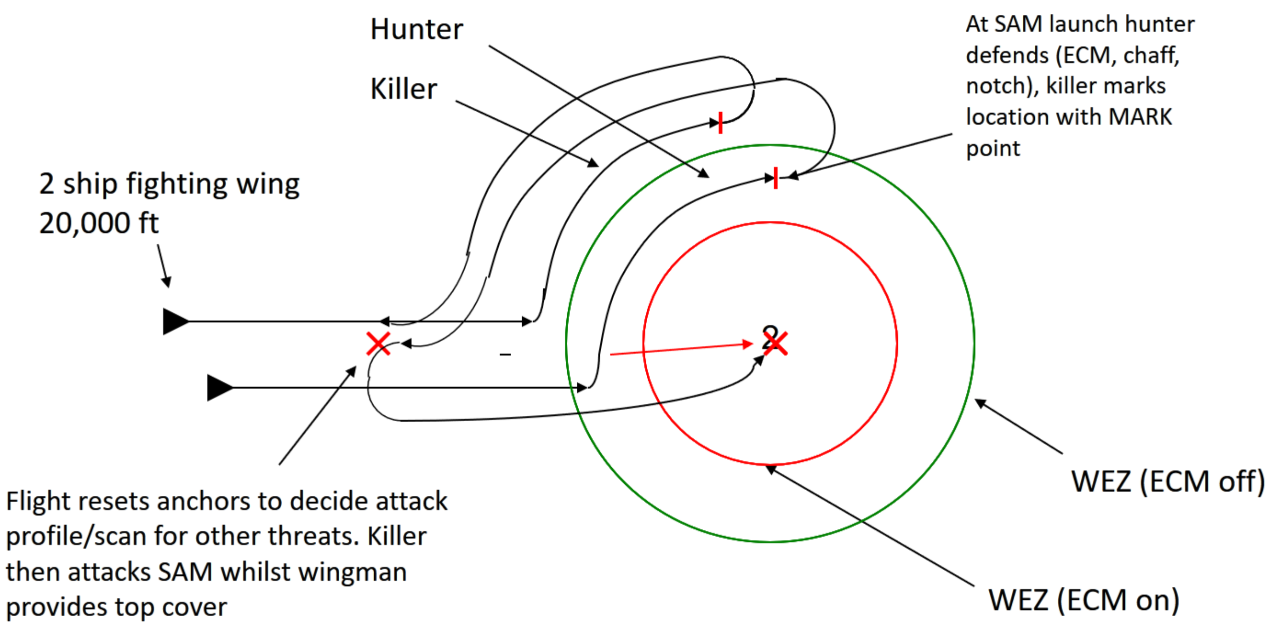
Location unknown Tactics – HARM with HTS

Having considered weapons and tactics where the SAM threat location is known, we need to consider how to find the SAM if we don't have the luxury of seeing it on the mission planning screen or the SAM's are mobile.
The location of ANY emitting radar can most easily be located by using the HTS HARM Attack Display (HAD) to locate the SAM then placing the Flight Path Marker (FPM) on the TD box, a MARK point can then be created using the HUD mark point mode on the location of the TD box. The TGP can then be used (if weather and visibility permits) to visually locate and ID the target and create a precise MARK point. It should be noted however that at least one HARM must be loaded on the aircraft. With no HARM's no TD box will be present.

Once the target has been located we can start to formulate a plan of attack using any of the methods mentioned previously after considering what weapons we have and the type of threat faced if this hasn't been decided before the flight.

Location unknown Tactics – Hunter Killer

The diagrams below show how hunter killer tactics can be employed (when flying as a 2-ship with humans only).
Note it is recommended to try and maintain mutual support by keeping both aircraft in formation thus maintaining element integrity. When considering a low level ingress to kill the SAM, beare of low level ground threats such as MANPADs and AAA. It is recommended that one flight member sets their radar to GM and the other to GMT to scan the approach path for columns of ground vehicles before run in.



28.6 Missile evasion

SA-2 and SA-3 are (mostly) easily to defend. A mixture of certain methods can be used:

1. Electronic Countermeasures (Music on -> choose the correct XMIT mode).
2. Maneuvering (vertical, horizontal).
3. Terrain masking.

One tactic that can be effective against low threat SAM systems like the SA-2 and SA-3 is the "Turn and run" tactic. If a missile is launched at your aircraft, use your eyeball or the RWR to determine the direction from which the missile is coming. Then, go to full throttle and bring the missile onto your six. Descend and make aggressive turns to increase speed, but be careful not to overstress your jet or risk a hung store. It is important to note that the "beaming" tactic is not very effective against missiles, especially short range systems like the SA-6 and SA-11. This is because you are still within the Weapon Engagement Zone and may be targeted with additional missiles.

The “beaming” tactic is not a reliable method for defeating missiles, particularly when facing short range systems like the SA-6 and SA-11. This is because you remain within the Weapon Engagement Zone when using this tactic, which increases the chances of being targeted with additional missiles."

28.7 EWS/ESJ support

In BMS it is possible to add jamming assets to support packages and flights. Assets are the EA-6B Prowler, the EA-18G Growler and the EA-111A Raven. Some general info:

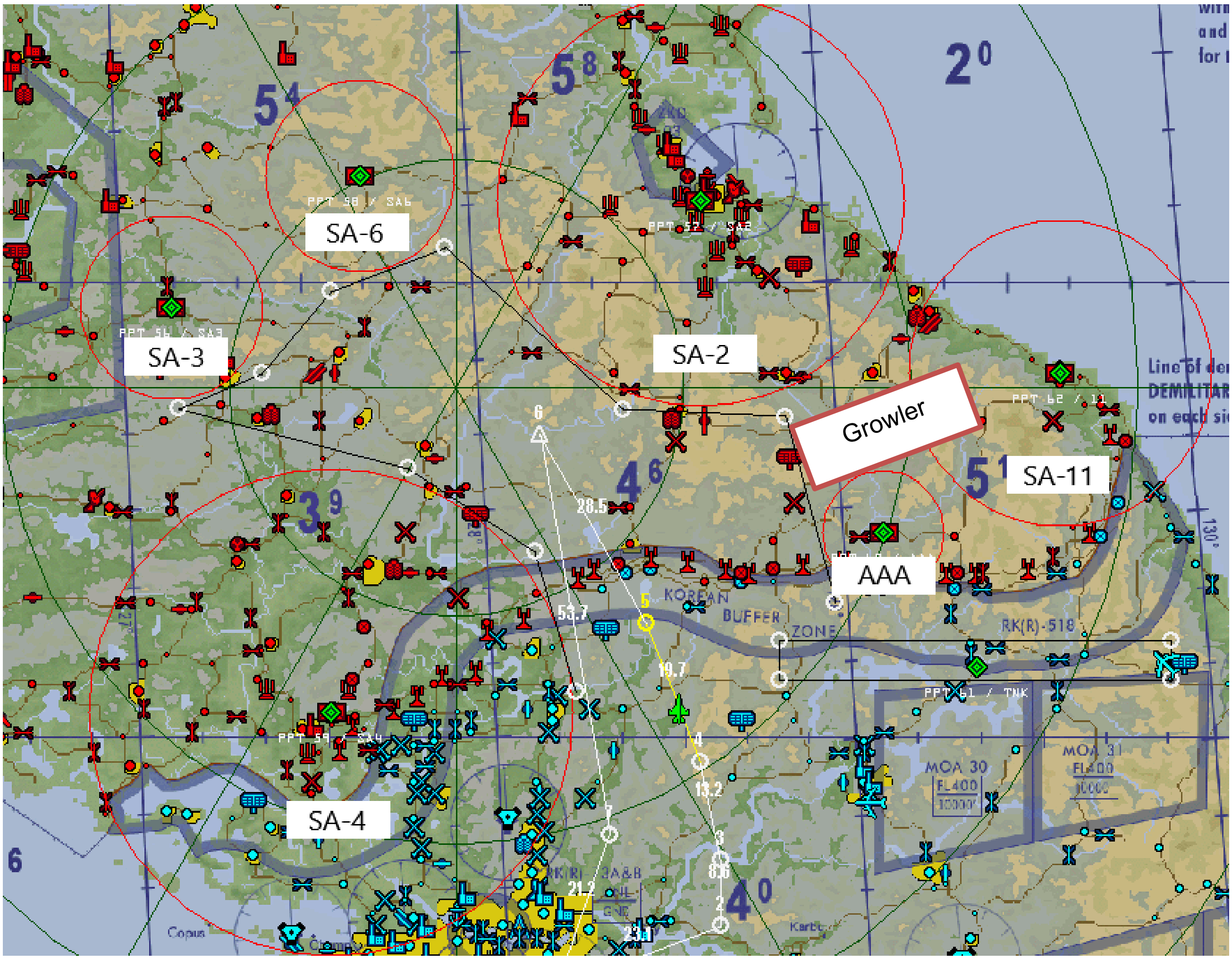
- Jamming assets needs to be tasked as EWS/ESJ.
- Provide ECM only to flights within the same package.
- The two patrol steerpoints need both "Enroute" and "Action" set to "Jamming".
- ECM will only be active if both the Music is on AND either of the "Jamming" steerpoint are selected (in the aircraft if seated with human).
- For AI flights, the ECM will go active at the TOS time of its first "Jamming" steerpoint and will cease when the "Patrol time" runs out.
- If the asset is lost, ECM ceases immediately.
- As is the case in real life, the asset cannot protect other aircraft for Air-to-Air radar from other aircraft.
- 100% effective jam radius is 40nm, relative to the jamming asset (and not its flight path).
- If other aircraft leave the 40nm radius the growler still protects itself (He thinks this can be increased to 75nm and is looking into it).
- If you delete an EWS/ESJ from a package and replace it with another, IT WILL NOT BE EFFECTIVE, you have to delete the package and start over.
- Altitude of the jamming asset is irrelevant, only the spherical radius.
- ECM are effective for all radar-based SAM sites and the radar ranging function of AAA.
- ECM is ineffective for all small-arms, tracer-based, IR-missiles and optical AAA systems.
- Does not prevent ground radars from indicating radar-locks or acquisitions to friendly RWRs.
- Momentarily dropping ECM (Music off or wrong steerpoint) will not jam missiles already in the air.

In this training, a singleton Growler is tasked near the SA-11 in the east and belongs to your package.

28.8 The mission

You will train to suppress, attack and/or defend different SAM systems. In this training mission you have several SAM systems available which are:

PPT 56: SA-3
PPT 57: SA-2
PPT 58: SA-6
PPT 59: SA-4
PPT 60: AAA (KS-19)
PPT 62: SA-11



Again, we recommend to read and process all data about the SAM system you want to attack/suppress/defend BEFORE entering 3D.
If you are flying this mission alone, send your number 2 home to make sure he doesn't interfere with your actions.
You start 10 miles before STPT 5. Once entered 3D, power on your HARM and CBU, activate TGP, set ECM parameters, CBU parameters and execute your fence in checks.
As you will notice, for certain threats are multiple options for SEAD/EW or DEAD available.
Re-fly this mission of as you like and find the best way for SEAD/EW or DEAD to achieve the mission goal.

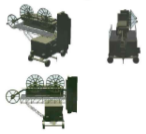
Since 4.37U4, we added an extra EA-18G Growler near the SA-11 location as part of the SEAD package to train working together with an EWS/ESJ asset (see chapter 28.7.)

SA-2

SA-2 Guideline 2 / 72

Tracking/ Name:	OC Fan Song Radar/ S-75 Dvina	Type:	Towed SAM
Min Rng Missiles:	4 nm / 300 ft launch / 80 ft track	ECM BT Range:	E:12 nm F:9 nm
Typical Engagement:	15 nm / 230,000 ft	Chaff Vulnerability:	Medium
Max Rng Missiles:	38 nm / 230,000 ft V-750	Init / Term/ Pursuit:	Cmd/ Cmd / Lead
Notes:	1957. Break turn 4g. Beam/ split-s/ turn away. SA Spoon Rest. 13nm pump bad. Pump/ nose up/ ECM.	Max Vel.(mach):	4.5 (2,997 kts) .83 nm/s
		Rdr Lock Range:	SA: 108nm / FC: E82-F62nm

Fan Song E 2 / 72



Tracking/ Name:	SA-2 SAM Radar/ SNR-75	Type:	Towed SAM Radar
Rdr Lock Range:	FC: 82 nm	ECM BT Range:	12 nm
Min Altitude:	Launch: 330 ft / Track: 80 ft	Chaff Vulnerability:	Medium
Notes:	1960. Destroy to neutralize SA-2 site. 1 target, 3 missiles. SA radar Spoon Rest.	Band (System):	G (PD/ CW)
		Initial/ Terminal:	Command/ Command
		Targets: 1	AZ: 120 (10) EL: 90 (10)

Fan Song F 2 / 72

Tracking/ Name:	SA-2 SAM Radar/ SNR-75	Type:	Towed SAM Radar
Rdr Lock Range:	FC: 62 nm	ECM BT Range:	9 nm
Min Altitude:	Launch: 330 ft / Track: 80 ft	Chaff Vulnerability:	Medium
Notes:	1960. Destroy to neutralize SA-2 site. 1 target, 3 missiles. SA radar Spoon Rest.	Band (System):	G (PD/ CW)
		Initial/ Terminal:	Command/ Command
		Targets: 1	AZ: 120 (10) EL: 90 (10)

Location:
PPT57

SEAD/EW options:

1. ECM (Jamming outside or inside of the WEZ)
– XMIT 3, Program 3 *(Fan Song: G-Band)*

2. HARM high altitude (Preemptive shoot outside the WEZ if “Fan Song” active)
– HTS (PGM 1-2) / POS / HAS
– XMIT 1, Program 3 *(Fan Song: G-Band)*

DEAD options:

1. HARM high altitude (Preemptive shoot outside the WEZ if “Fan Song” active)
– HTS (PGM 1-2) / POS / HAS
– XMIT 1, Program 3 *(Fan Song: G-Band)*

2. HARM high altitude (Targeted shoot outside/inside the WEZ if “Fan Song” active)
– HTS (PGM 1-2) / POS / HAS
– XMIT 1, Program 3 *(Fan Song: G-Band)*

3. CBU-105 low altitude
– Create lat/long coordinates via TGP, HUD, HTS, etc.
– Low level Loft- or Popup attack on coordinate

4. (if operating as a 2-ship)
– Hunter Killer tactics

SA-3

SA-3 Goa F | 3 / F | 3

Tracking/ Name: OC Low Blow Radar/ S-125 Neva	Type:	Towed SAM
Min Rng Missiles: 2.7 nm / 150 ft launch / 60 ft track	ECM BT Range:	6 nm
Typical Engagement: 9 nm / 120,000 ft	Chaff Vulnerability:	Medium
Max Rng Missiles: 11 nm / 120,000 ft 5V27/ D (V601/P)	Init/ Term/ Pursuit:	Cmd/ Cmd/ Lead
Notes: 1961. Break turn 6-7g (13g). Beam+ chaff. Beam/ split-s/ turn away. SA Flat Face, Squat Eye.	Max Vel.(mach):	2.4 (1,587 kts) .44 nm/s
	Rdr Lock Range:	SA: 108 nm / FC: 30 nm

Low Blow 3 / 3

Tracking/ Name: SA-3 SAM Radar/ SNR-125 Neva/ Pechora	Type:	Towed SAM Radar
Rdr Lock Range: FC: 30 nm	ECM BT Range:	6 nm
Minimum Altitude: Launch: 150 ft / Track: 60 ft	Chaff Vulnerability:	Medium
Notes: 1961. Destroy to neutralize SA-3. Beam + 6 chaff tends to break lock. Guide to one target at a time. SA radars Flat Face, Side Net, Squat Eye N/I.	Band (System):	I/ D (PD)
	Initial/ Terminal:	Command/ Command
	Targets: 1	AZ: 120 (10) EL: 90 (10)

Location:
PPT56

SEAD/EW options:

1. ECM (Jamming outside or inside of the WEZ)
– XMIT 3, Program 4 *(Fan Song: I-Band)*

2. HARM high altitude (Preemptive shoot outside the WEZ if “Low Blow” active)
– HTS (PGM 1-2) / POS / HAS
– XMIT 1, Program 4 *(Low Blow: I-Band)*

DEAD options:

1. HARM high altitude (Preemptive shoot outside the WEZ if “Low Blow” active)
– HTS (PGM 1-2) / POS / HAS
– XMIT 1, Program 3 *(Low Blow: I-Band)*

2. HARM high altitude (Targeted shoot outside/inside the WEZ if “Low Blow” active)
– HTS (PGM 1-2) / POS / HAS
– XMIT 1, Program 3 *(Low Blow: I-Band)*

3. CBU-105 low altitude
– Create lat/long coordinates via TGP, HUD, HTS, etc.
– Low level Loft- or Popup attack on coordinate

4. (if operating as a 2-ship)
– Hunter Killer tactics

SA-4

SA-4 Ganef

L | 4
4L | 74

Tracking/ Name:	OC Pat Hand, EOTS/ 2K11 Krug	Type:	Mobile SAM TEL
Min Rng Missiles:	4 nm / 500 ft launch / 50 ft track	ECM BT Range:	14 nm
Typical Engagement:	18 nm / 80,000 ft	Chaff Vulnerability:	Medium
Max Rng Missiles:	22 nm / 80,000 ft 9M8, 9M8M1/ M2	Init/ Term/ Pursuit:	Cmd / SARH/ Lead
Notes:	1967. Break turn 4g. Beam/ split-s/ turn away. SA Long Track. Missile can only pull 6g, weak turn.	Max Vel.(mach)	2.4 (1,587 kts) .44 nm/s
		Rdr Lock Range:	SA: 86 nm / FC: 48 nm

Pat Hand

4
74

Tracking/ Name:	SA-4 SAM Radar/ 1S32	Type:	Mobile SAM Radar
Rdr Lock Range:	FC: 50 nm	ECM BT Range:	14 nm
Min Altitude:	Launch: 500 ft / Track: 500 ft	Chaff Vulnerability:	Medium
Notes:	1965. Destroy to neutralize SA-4 site. SA radar Long Track, Thin Skin N/I.	Band (System):	H (PD/ CW)
		Initial/ Terminal:	Command/ SARH
		Targets: 1	AZ: 120 (10) EL: 90 (10)

Location:
PPT59

SEAD/EW options:

1. ECM (Jamming outside or inside of the WEZ)
– XMIT 3, Program 4 *(Pat Hand: H-Band)*

2. HARM high altitude (Preemptive shoot outside the WEZ if “Pat Hand” active)
– HTS (PGM 1-2) / POS / HAS
– XMIT 1, Program 4 *(Pat Hand: H-Band)*

DEAD options:

1. HARM high altitude (Preemptive shoot outside the WEZ if “Pat Hand” active)
– HTS (PGM 1-2) / POS / HAS
– XMIT 1, Program 4 *(Pat Hand: H-Band)*

2. HARM high altitude (Targeted shoot outside/inside the WEZ if “Pat Hand” active)
– HTS (PGM 1-3) / POS / HAS
– XMIT 1, Program 4 *(Pat Hand: H-Band)*

3. CBU-105 low altitude
– Create lat/long coordinates via TGP, HUD, HTS, etc.
– Low level Loft- or Popup attack on coordinate

4. (if operating as a 2-ship)
– Hunter Killer tactics

SA-6

SA-6 Gainful F | 6 / 4F | 76

Tracking/ Name: OC Straight Flush Radar/ 2K12 Kub
Min Rng Missiles: 2 nm / 550 ft launch / 80 ft track
Typical Engagement: 10 nm / 101,500 ft
Max Rng Missiles: 20 nm / 101,500 ft 3M9
Notes: 1970. Beam/ chaff. Beam/ split-s/ turn away. Break turn 7-8g/ chaff. SA Flat Face.

Type: Mobile SAM TEL
ECM BT Range: 4 nm HOJ
Chaff Vulnerability: Medium
Init/ Term/ Pursuit: Cmd / SARH/ Lead
Max Vel.(mach) 3.2 (2,116 kts) .59 nm/s
Rdr Lock Range: SA: 108 nm / FC: 30 nm

Straight Flush 6 / 76

Tracking/ Name: SA-6 SAM Radar/ 1S91 SURN
Rdr Lock Range: FC: 30 nm
Min Altitude: Launch: 550 ft / Track: 80 ft
Notes: 1970. Destroy to neutralize SA-6 sites. SA radar Spoon Rest, Long Track, Flat Face, Thin Skin, Side Net, Score Board N/I.

Type: Mobile SAM Radar
ECM BT Range: 4 nm HOJ
Chaff Vulnerability: Medium
Band (System): G/ H/ I (PD/ CW)
Initial/ Terminal: Command/ SARH
Targets: 1 AZ: 120 (10) EL: 90 (10)

Location:
PPT58

SEAD/EW options:

NOTE:
SA-6 is HOJ (Home on Jamming) capable -> stay outside the WEZ (if known)
Remember that the SA-6 is highly mobile.

1. ECM (Jamming outside of the WEZ)
– XMIT 3, Program 3+4 *(Straight Flush: G/H/I-Band)*

2. HARM high altitude (Preemptive shoot outside the WEZ if “Straight Flush” active)
– HTS (PGM 2-3) / POS / HAS
– XMIT 1, Program 3+4 *(Straight Flush: G/H/I-Band)*

DEAD options:

1. HARM high altitude (Preemptive shoot outside the WEZ if “Straight Flush” active)
– HTS (PGM 1-2) / POS / HAS
– XMIT 1, Program 3+4 *(Straight Flush: G/H/I-Band)*

2. HARM high altitude (Targeted shoot outside the WEZ if “Straight Flush” active)
– HTS (PGM 1-3) / POS / HAS
– XMIT 1, Program 3+4 *(Straight Flush: G/H/I-Band)*

3. CBU-105 low altitude
– Create lat/long coordinates via TGP, HUD, HTS, etc.
– Low level Loft- or Popup attack on coordinate

4. (if operating as a 2-ship)
– Hunter Killer tactics

SA-11

SA-11 Gadfly

D	11	Tracking/ Name:	OB Fire Dome (H/ I), EOTS/ Buk-M1	Type:	Mobile SAM TELAR
4D	42	Min Rng Missiles:	1.5 nm / 180 ft launch / 100 ft track	ECM BT Range:	19 nm HOJ
		Typical Engagement:	12 nm / 90,000 ft	Chaff Vulnerability:	Very Low
		Max Rng Missiles:	20 nm / 90,000 ft 9M38, 9M38M1, ...	Init/ Term/ Pursuit:	SARH / Lead
		Notes:	1979. 2msl/tgt. No smoke. Pump/ weave x3/ pull up at 15nm. Some launch warning. SA rdr Snow Drift.	Max Vel.(mach)	2.6 (1,720 kts) .48 nm/s
				Rdr Lock Range:	SA: 85 nm / FC: 30 nm
				Targets: 6	AZ: 120 (60) EL: 90 (60)

Location:
PPT62

SEAD/EW options:

NOTE:
SA-11 is HOJ (Home on Jamming) capable -> stay outside the WEZ (if known)
Every SA-11 launcher has its own tracking radar. So destroying one launcher doesn't do the job.
Remember that the SA-11 is highly mobile.

1. ECM (Jamming outside of the WEZ)
– XMIT 3, Program 3+4 *(Fire Dome: H/I-Band)*

2. HARM high altitude (Preemptive shoot outside the WEZ if "Straight Flush" active)
– HTS (PGM 2-3) / POS / HAS
– XMIT 1, Program 3+4 *(Fire Dome: H/I-Band)*

DEAD options:

1. HARM high altitude (Preemptive shoot outside the WEZ if "Fire Dome" active)
– HTS (PGM 1-2) / POS / HAS
– XMIT 1, Program 3+4 *(Fire Dome: H/I-Band)*

2. HARM high altitude (Targeted shoot outside the WEZ if "Fire Dome" active)
– HTS (PGM 1-3) / POS / HAS
– XMIT 1, Program 3+4 *(Fire Dome: H/I-Band)*

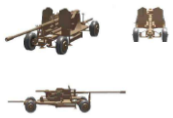
3. CBU-105 low altitude
– Create lat/long coordinates via TGP, HUD, HTS, etc.
– Low level Loft- or Popup attack on coordinate

4. (if operating as a 2-ship)
– Hunter Killer tactics

Since 4.37U4, we added an extra EA-18G Growler as part of the SEAD package to train working together with an EWS/ESJ asset (see chapter 28.7.). If you prefer to attack the SA-11 without the Growler, use your Air-to-Air skills 😉 .

AAA (KS-19)

KS-19 (KC-19)



Tracking:	OC Fire Can Radar/ Optical	Type:	Towed SHORAD
Min Rng Guns:	0 nm / 2,000 ft	ECM BT Range:	No Effect
Typical Engagement:	5 nm / 33,500 ft	Shoot and Move:	No
Max Rng Guns:	5 nm / 33,500 ft	Gun Caliber:	100 mm Flak
Notes: 1949. Jink vertically.		Max Vel.(mach):	N/A (N/A kts)
		Rdr Lock Range:	SA: 13nm / FC: 7nm

Location:

PPT60

SEAD/EW options:

1. ECM (Jamming outside or inside of the WEZ)

– XMIT 3, Program 2 *(Fire Can: E-Band)*

2. HARM high altitude (Preemptive shoot outside the WEZ if “Fire Can” active)

– HTS (PGM 2-3) / POS / HAS

– XMIT 1, Program 2 *(Fire Can: E-Band)*

DEAD options:

1. HARM high altitude (Preemptive shoot outside the WEZ if “Fire Can” active)

– HTS (PGM 1-2) / POS / HAS

– XMIT 1, Program 2 *(Fire Can: E-Band)*

2. HARM high altitude (Targeted shoot outside the WEZ if “Fire Can” active)

– HTS (PGM 1-3) / POS / HAS

– XMIT 1, Program 2 *(Fire Can: E-Band)*

3. CBU-105 low altitude

– Create lat/long coordinates via TGP, HUD, HTS, etc.

– Low level Loft- or Popup attack on coordinate

4. (if operating as a 2-ship)

– Hunter Killer tactics

The new ECM implementation is really something that will change how BMS will be flown in combat. Defensive avionics are no longer just something that is there to fill space in the cockpit.

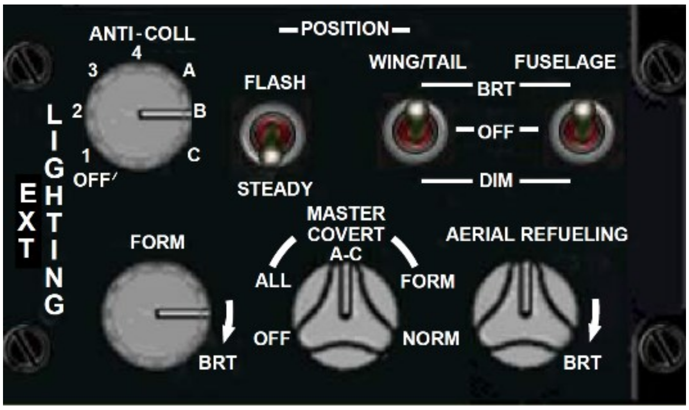
The SA-6 and greater are still a hard nut, but with the new ECM capabilities, “Weaseling” has become a lot more fun and challenging.

SEAD and DEAD missions are still one of the most dangerous and complex mission types in real life and BMS. This training mission and documentation can give you only the very basics. More information about this task is available in the world wide web. But in the end, everybody is thinking the same when dealing with SEAD/DEAD tasks. First in, last out. This doesn’t have changed since 50+ years: “YGBSM”!

ATTACHMENTS

I. External Lightning Settings

1A POSSIBLE EXTERNAL LIGHTING SETTINGS – NVIS compatible



RAMP

PROCEDURE	SCENARIO	MASTER COVERT	ANTI-COLL	POSI-TION	WING/TAIL	FUSE-LAGE	FORM(%)	AR (%)
RAMP	DAY – Good weather	NORM	1-C	STEADY	BRT	OFF	100	0
RAMP	DAY – Bad weather	NORM	1-C	STEADY	BRT	OFF	100	0
RAMP	NIGHT – Good weather	NORM	1-C	STEADY	BRT	BRT	100	0
RAMP	NIGHT – Bad weather	NORM	1-C	STEADY	BRT	BRT	100	0

TAXI

PROCEDURE	SCENARIO	MASTER COVERT	ANTI-COLL	POSI-TION	WING/TAIL	FUSE-LAGE	FORM(%)	AR (%)
TAXI	DAY – Good weather	NORM	1-C	FLASH	BRT	OFF	100	0
TAXI	DAY – Bad weather	NORM	1-C	FLASH	BRT	OFF	100	0
TAXI	NIGHT – Good weather	NORM	1-C	STEADY	BRT	BRT	100	0
TAXI	NIGHT – Bad weather	NORM	1-C	FLASH	BRT	BRT	100	0

EOR/HOLD SHORT

PROCEDURE	SCENARIO	MASTER COVERT	ANTI-COLL	POSI-TION	WING/TAIL	FUSE-LAGE	FORM(%)	AR (%)
EOR	DAY – Good weather	NORM	OFF	STEADY	BRT	OFF	100	0
EOR	DAY – Bad weather	NORM	OFF	STEADY	BRT	OFF	100	0
EOR	NIGHT – Good weather	NORM	OFF	STEADY	BRT	BRT	100	0
EOR	NIGHT – Bad weather	NORM	OFF	STEADY	BRT	BRT	100	0

RUNWAY LINEUP

PROCEDURE	SCENARIO	MASTER COVERT	ANTI-COLL	POSI-TION	WING/TAIL	FUSE-LAGE	FORM(%)	AR (%)
RWY LINEUP	DAY – Good weather	NORM	1-C	FLASH	BRT	OFF	100	0
RWY LINEUP	DAY – Bad weather	NORM	1-C	FLASH	BRT	OFF	100	0
RWY LINEUP	NIGHT – Good weather	NORM	1-C	FLASH	BRT	BRT	100	0
RWY LINEUP	NIGHT – Bad weather	NORM	1-C	FLASH	BRT	BRT	100	0

VFR DEPARTURE

PROCEDURE	SCENARIO	MASTER COVERT	ANTI-COLL	POSI-TION	WING/TAIL	FUSE-LAGE	FORM(%)	AR (%)
VFR-DEP	DAY – Good weather	NORM	1-C	FLASH	BRT	OFF	100	0
VFR-DEP	NIGHT – Good weather	NORM	1-C	FLASH	BRT	BRT	100	0

IFR DEPARTURE

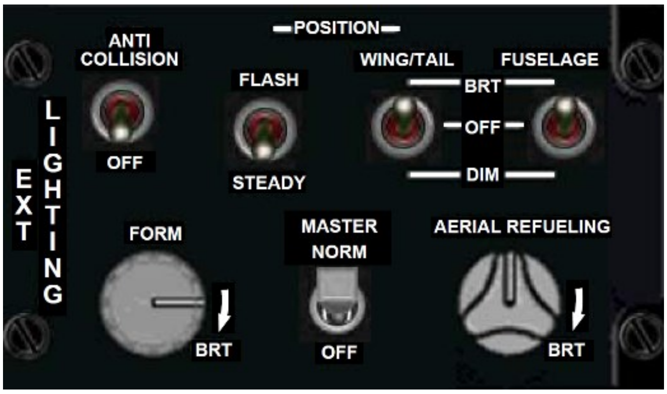
PROCEDURE	SCENARIO	MASTER COVERT	ANTI-COLL	POSI-TION	WING/TAIL	FUSE-LAGE	FORM(%)	AR (%)
IFR-DEP	DAY – Bad weather	NORM	1-C	FLASH	BRT	BRT	100	0
IFR-DEP	NIGHT – Bad weather	NORM	1-C	FLASH	BRT	BRT	100	0

AIR TO AIR REFUELING

PROCEDURE	SCENARIO	SITUATION	MASTER COVERT	ANTI-COLL	POSI-TION	WING /TAIL	FUSE-LAGE	FORM (%)	AR (%)
REFUEL	DAY – Good weather	PEACETIME	OFF	OFF	STEADY	BRT	OFF	0	0
REFUEL	DAY – Good weather	WAR	ALL	OFF	STEADY	OFF	OFF	0	0
REFUEL	DAY – Bad weather	PEACETIME	OFF	OFF	STEADY	BRT	OFF	0	0
REFUEL	DAY – Bad weather	WAR	ALL	OFF	STEADY	DIM	OFF	0	0
REFUEL	NIGHT – Good weather	PEACETIME	OFF	OFF	STEADY	DIM	DIM	50	25
REFUEL	NIGHT – Good weather	WAR	ALL	OFF	STEADY	OFF	OFF	0	25
REFUEL	NIGHT – Bad weather	PEACETIME	OFF	OFF	STEADY	BRT	BRT	50	50
REFUEL	NIGHT – Bad weather	WAR	ALL	OFF	STEADY	OFF	OFF	0	50

Please note that all these settings are just possible options. Depending on the conditions and the SOP you use, create your own settings as desired.

1B POSSIBLE EXTERNAL LIGHTING SETTINGS – NVIS Non-compatible



RAMP

PROCEDURE	SCENARIO	MASTER	ANTI-COLL	POSI-TION	WING/TAIL	FUSE-LAGE	FORM(%)	AR (%)
RAMP	DAY – Good weather	NORM	1-C	STEADY	BRT	OFF	100	0
RAMP	DAY – Bad weather	NORM	1-C	STEADY	BRT	OFF	100	0
RAMP	NIGHT – Good weather	NORM	1-C	STEADY	BRT	BRT	100	0
RAMP	NIGHT – Bad weather	NORM	1-C	STEADY	BRT	BRT	100	0

TAXI

PROCEDURE	SCENARIO	MASTER	ANTI-COLL	POSI-TION	WING/TAIL	FUSE-LAGE	FORM(%)	AR (%)
TAXI	DAY – Good weather	NORM	1-C	FLASH	BRT	OFF	100	0
TAXI	DAY – Bad weather	NORM	1-C	FLASH	BRT	OFF	100	0
TAXI	NIGHT – Good weather	NORM	1-C	STEADY	BRT	BRT	100	0
TAXI	NIGHT – Bad weather	NORM	1-C	FLASH	BRT	BRT	100	0

EOR/HOLD SHORT

PROCEDURE	SCENARIO	MASTER	ANTI-COLL	POSI-TION	WING/TAIL	FUSE-LAGE	FORM(%)	AR (%)
EOR	DAY – Good weather	NORM	OFF	STEADY	BRT	OFF	100	0
EOR	DAY – Bad weather	NORM	OFF	STEADY	BRT	OFF	100	0
EOR	NIGHT – Good weather	NORM	OFF	STEADY	BRT	BRT	100	0
EOR	NIGHT – Bad weather	NORM	OFF	STEADY	BRT	BRT	100	0

RUNWAY LINEUP

PROCEDURE	SCENARIO	MASTER	ANTI-COLL	POSI-TION	WING/TAIL	FUSE-LAGE	FORM(%)	AR (%)
RWY LINEUP	DAY – Good weather	NORM	1-C	FLASH	BRT	OFF	100	0
RWY LINEUP	DAY – Bad weather	NORM	1-C	FLASH	BRT	OFF	100	0
RWY LINEUP	NIGHT – Good weather	NORM	1-C	FLASH	BRT	BRT	100	0
RWY LINEUP	NIGHT – Bad weather	NORM	1-C	FLASH	BRT	BRT	100	0

VFR DEPARTURE

PROCEDURE	SCENARIO	MASTER	ANTI-COLL	POSI-TION	WING/TAIL	FUSE-LAGE	FORM(%)	AR (%)
VFR-DEP	DAY – Good weather	NORM	1-C	FLASH	BRT	OFF	100	0
VFR-DEP	NIGHT – Good weather	NORM	1-C	FLASH	BRT	BRT	100	0

IFR DEPARTURE

PROCEDURE	SCENARIO	MASTER	ANTI-COLL	POSI-TION	WING/TAIL	FUSE-LAGE	FORM(%)	AR (%)
IFR-DEP	DAY – Bad weather	NORM	1-C	FLASH	BRT	BRT	100	0
IFR-DEP	NIGHT – Bad weather	NORM	1-C	FLASH	BRT	BRT	100	0

AIR TO AIR REFUELING

PROCEDURE	SCENARIO	SITUATION	MASTER	ANTI-COLL	POSITION	WING/TAIL	FUSE-LAGE	FORM (%)	AR (%)
REFUEL	DAY – Good weather	PEACETIM	NORM	OFF	STEADY	BRT	OFF	0	0
REFUEL	DAY – Good weather	WAR	OFF	OFF	STEADY	OFF	OFF	0	0
REFUEL	DAY – Bad weather	PEACETIM	NORM	ON	STEADY	BRT	OFF	0	0
REFUEL	DAY – Bad weather	WAR	NORM	OFF	STEADY	DIM	OFF	0	0
REFUEL	NIGHT – Good weather	PEACETIM	NORM	ON	STEADY	DIM	DIM	50-	50
REFUEL	NIGHT – Good weather	WAR	NORM	OFF	STEADY	OFF	OFF	0	25
REFUEL	NIGHT – Bad weather	PEACETIM	NORM	ON	STEADY	BRT	BRT	50-	50
REFUEL	NIGHT – Bad weather	WAR	NORM	OFF	STEADY	OFF	OFF	0	50

Please note that all these settings are just possible options. Depending on the conditions and the SOP you use, create your own settings as desired.

II. Brevity Codes

Refer to /BMS 4.37\05 Other Documentation\Real Manuals\ATP_1-02.1.pdf for all relevant brevity codes.

BIBLIOGRAPHY

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- TO 1F-16CM/AM-34-1-1 BMS
- BMS Naval Ops
- BMS Technical Manual
- BMS Comms & Nav Book
- BMS Airport Charts
- BMS Checklists
- BMS Threat Guide
- Falcon 4.0 Original manual
- Falcon 4.0 Strategy guide
- BMS forums & articles
- Training scripts article
- Documentation from the 1st VFW (see TR_28_SEAD-EW)

GLOSSARY

A			
A-A	Air-to-Air	AOA	Angle Of Attack (Arrival)
AA	Aspect Angle	AOR	Areas of Responsibility
AAA	Attitude Awareness Arc	APC	Aircraft Parking Chart
AAF	Attitude Advisory Function	ARH	Anti-Radiation Homing
AAM	Air-to-Air Missile	ARMT	Armament
AATLL	Air-to-Air Target Locator Line	ARWR	Advanced Radar Warning Receiver
ABC	Automatic Brightness Control	ASE	Allowable Steering Error
AC	Aircraft Configuration	ASEC	Allowable Steering Error Circle
ACAL	Altitude Calibration	ASC	Attack Steering Cue
ACCTVS	Advanced Color Cockpit Television Sensor	ASCII	American Standard Code for Information Interchange
ACM	Air Combat Mode	ASGN	Assign
ACMDS	Advanced Countermeasures Dispenser System	ASL	Azimuth Steering Line
ACMI	Air Combat Maneuvering Instrumentation	A TGTS	Air-to-Air Targets
ACQ	Acquisition	ATC	Attack Target Complex (a type of Mission Assignment) , Air Traffic Controller
ACRIU	Advanced Conventional Remote Interface Unit	ATD	Advanced Threat Display
A-D	Analog-to-Digital	ATF	Automatic Terrain Following
AD	Arming Delay	ATK AZ	Attack Azimuth
ADDL	Additional	ATO	Air Tasking Order
ADI	Attitude Direction Indicator	ATP	Advanced Targeting Pod
ADL	Armament Datum Line	ATT, ATTD	Attitude
A DLNK	Air Data link	ATT/FPM	Attitude Bars and Horizon Line/Flight Path Marker
ADS	Avionics Display Set	Attack Profile	Weapon deliver options stored in SMS that are anticipated to be used in specific instances
ADTC	Advanced Data Transfer Cartridge	ATT	EGI Attitude Mode
ADTE	Advanced Data Transfer Equipment	AUTO	Automatic
ADTU	Advanced Data Transfer Unit	AUTO BRT	Automatic Brightness control to maintain, contrast ration between the symbols and background
A-G	Air-to-Ground	AWACS	Airborne Early Warning and Control System
AGC	Automatic Gain Control	AV	Avoid
AGL	Altitude Above Ground Level	AVTR	Airborne Video Tape Recorder
AGM	Air-to-Ground Missile	AZ/AZI	Azimuth
AGR	Air-to-Ground Ranging		
AGTD	Air-to-Ground Target Designator		
AGTLL	Air-to-Ground Target Locator Line		
AI	Airborne Intercept/Azimuth Indicator/ Artificial Intelligence		
A IDM	IDM Air Tracks		
AIFF	Advanced Identification Friend or Foe		
AIM	Air Intercept Missile		
Aimpoint	The preplanned point on or near target that is used to align pipper		
ALBIT	All Station Built-In-Test		
ALIC	Aircraft Launcher Interface Computer		
ALIGN	Alignment (INS)		
ALN	Transfer Alignment (IAM)		
ALOW	Altitude Low		
ALT	Altitude		
ALT CAL	Altitude Calibration (switch position)		
ALT REL	Alternate Release		
ALT TRK	Altitude Line Tracker/Blanker		
AM	Amplitude Modulation, Altitude Match (ATP)		
AMRAAM	Advanced Medium Range Air-to-Air Missile		
AMRIU	Advanced Missile Remote Interface Unit		
AMUX	Avionics Multiplex		
AMZ	Aircraft Maneuver Zone		
A/N	Alphanumeric		
ANT	Antenna		
ANT ELEV	Antenna Elevation		

B	
BA	Burst Altitude
BAL	Ballistics
BAI	Bank Angle Indicator
BAR	Elevation Bar
BARO	Barometric
BATR	Bullets at Target Range
BATT	Battery
BBS	Backup Bombing Sensor
BCN	Beacon
BCN DLY	Beacon Delay
BDA	Battle Damage Assessment
BDU	Bomb Dummy Unit
BGO	Bingo
BHOT	Black Hot
Bingo Fuel	A threshold fuel value that the pilot enters in MMC memory
BIT	Built-In Test
BKUP	Backup
Blind Bombing	Air-to-Ground weapon delivery modes that utilize radar ground map features rather than indicators to locate the target
BLOS	Beyond Line of Sight
BLU	Bomb Live Unit
BNGO	Bingo
BOC	Bomb On Coordinate
BORE	Boresight
BOT	Bomb On Target
BP	Bypass
BR	Bearing
BRG	Bearing and Range
BRT	Bright, Brightness
BRU	Bomb Rack Unit
BSGT	Boresight
BSU	Bomb Stabilization Unit
BTH	Both (Laser-Pointer)
BUP	Backup
BUS	Electrical connection and distribution point
B/R	Bearing/Range
B-W	Black-on-White
C	
CA	Cartridge
CADC	Central Air Data Computer
CAL, Cal	Calibration
Canned Value	Data stored in permanent memory
CARA	Combined Altitude Radar Altimeter
CAS	Calibrated Airspeed, Close Air Support
CAT	Category
CATA	Collision Antenna Train Angle
CATM	Captive Air Training Missile
CBU	Cluster Bomb Unit
CCIP	Continuously Computed Impact Point
CCMFD	Common Color Multifunction Display
CCRP	Continuously Computed Release Point
CCTVS	Color Cockpit Television Sensor
CDE	Circular Distance Estimates

CDEEU	Common Data Entry Electronics Unit
CDI	Course Deviation Indicator
CEM	Combined Effects Munitions
CEN	Centered
CENT	Map center
CFIT	Controlled Flight Into Terrain
CFOV	Center Field Of View
CG	Center of Gravity
CH	Chaff
CH/CHAN	Channel
CHNG	Change
CHNL	Channel
CIT	Combined Interrogator and Transponder
CIV/MIL	Civilian/Military
CJ/R	Center Jettison/Release
CKPT BLNK	Cockpit Blanking (HMCS)
CLM	Climbing
CLR	Clear
CM	Countermeasures
CMBT	Combat (LASER)
CMDS	Countermeasures Dispenser System
CMFD	Color Multifunction Display
CMS	Countermeasures Management Switch
CMSC	Countermeasures Set Control
CNI	Communication/Navigation/IFF
CNTL	Control
C/A	Coarse Acquisition
C/O	Cutout (HUD function)
COH	Cold on Hot (Maverick Sensor Mode)
COLR	Color
COM1	Communications Radio 1
COM2	Communications Radio 2
COMM	Communication
CONT	Contrast, Continuous
CONV	Conventional
CORR	Canopy/Camera Corrections
CPL	Couple
CRIU	Conventional Remote Interface Unit
CRM	Combined radar mode
CRM	Combined Radar Mode
CRS	Course
CRSE	Course
CRUS	Cruise
CRU/EM	Cruise Energy Management
CS	Carriage System, Control Section
CSFDR	Crash-Survivable Flight Data Recorder
CTFOV	Center Total Field Of View
CTVS	Cockpit Television Video System
CU	Cockpit Unit
CW	Continuous Wave Illumination
C/Z, CZ	Cursor Zero

D		**E**	
D	Degraded, Data Link	E	East
D&R	Depress And Release	ECM	Electronic Countermeasures
DAY	Day position allows control of brightness from off to full intensity	ECS	Environmental Control System
		DER	Endurance
DBS	Doppler Beam Sharpening	EEGS	Enhanced Envelope Gunsight
DBU	Digital Backup Unit	EGEA	End Game Entry Altitude
DCLT	The removal of display data from the HUD/ MFD/HMCS (Declutter)	EGI	Embedded GPS/INS
		EGR	Embedded GPS Receiver
DCPL	Decouple	EHL	Extended Horizon Line
DCS	Data Control Switch	EHSI	Electronic Horizontal Situation Indicator
DDR	Digital Data Recorder	EHSIM	Electronic Horizontal Situation Indicator Master
DE	Default		
DEAD	Destruction of Enemy Air Defense	EHSIS	Electronic Horizontal Situation Indicator Slave
DED	Data Entry Display, Dedicated Channel Mode		
DEG	Degree(s)	E-J, EJ	Emergency Jettison
DEGR	Degraded	EL	Elevation
Delta	An increment of a variable	ELEC	Electrical
DEP	Depressed	ELEV	Elevation
DEPR	Depression	ELINT	Electronic Intelligence
DEPR RET	Depressible Reticle	EM	Energy Management (HUD display)
DES	Desired	EMER	Emergency
DESIG	Designate	EMTY	Empty
DEST	Destination	ENABL	Enable
DF	Direction Finder	ENG	Engine
DFLCS	Digital Flight Control System	ENT, ENTR	Enter
DGFT	Dogfight	E-O/EO	Electro-Optical
DGPS	Differential Global Positioning System	EOM, E	Equations of Motion
DIR	Direct, Direct-In Range	EOMG	Equations of Motion Glide
DISP	Dispense Command (switch position)	EON	Engagement Order Number
DL	Data Link	EPU	Emergency Power Unit
DL/DLNK	Data Link	ERR	Error
DLAY/DLY	Delay	ESD	Enhanced Search Display
DLZ	Dynamic Launch Zone	ETA	Estimated Time of Arrival
DMC	Digital Maneuvering Cue	ETR	External Time Reference
DMD	Demand	EU	Electronics Unit
DME	Distance Measuring Equipment	EXP	Expanded
DMS	Display Management Switch		
DMUX	Display Multiplex Data Bus		
DNR	Donor		
DPL	Deploy		
DRIFT C/O	Flight path marker with drift cutout		
DRNG	Delta Range		
DS	Dispenser Station		
D/S	Wind Direction and Speed		
DTC	Data Transfer Cartridge		
DTE	Data Transfer Equipment		
DTED	Digital Terrain Elevation Data		
DTOS	Dive-Toss		
DTS	Digital Terrain System		
DTT	Dual Target Track		
DTU	Data Transfer Unit		
DU	Display Unit		
DVR	Digital Video Recorder		
Dynamic Launch Zone	The zone in which a missile would strike a maneuvering target		
DWAT	Descent Warning After Takeoff		

F			
F, FAIL	Failed	GM	Ground Map
F-ACK	Fault Acknowledge	GMT	Ground Moving Target, Greenwich Mean Time
FC	Flight Channel	GMTT	Ground Moving Target Track
FCC	Fire Control Computer	GND	Ground
FCR	Fire Control Radar	GND SPD	Ground speed
FD	Function delay	GP Bomb	General Purpose Bomb
FDR	Standard Flight Data Recorder	GPS	Global Positioning System
FEBA	Forward Edge of the Battle Area	G/S	Ground Speed
FEDS	Firing Evaluation Display Set	GS	Ground Stabilized, Glide slope, Geographic Specificity
FI	Free Inertial		
FINS	Forward Imaging Navigation Sensor	GT	Gyro Test
FIX	Fixtaking	G TGTS	Ground targets
FL	Flare	G/T	Ground Track
FL ON	Flight On	GW	General Weight
FLCS	Flight Control System		
FLIR	Forward Looking Infrared		
FLT	Flight	**H**	
FM	Frequency-Modulated		
FMCW	Frequency-Modulated Continuous Wave	HAD	HARM Attack Display
FOG	Fiber Optic Gyro	HARM	High-Speed Anti-Radiation Missile
FOV	Field of View	HARTS	Horn Awareness and Recovery Training Series
FPM	Flight Path Marker	HAS	HARM-As-a-Sensor Mode
FPS	Frames Per Second/Feet Per Second	HAT	Height Above Target
FR ON/OFF	Friendly Declutter	HD	Head
FRAG	Fragmentation	HDG	Heading
FRQ	Frequency	HDGP	High Drag General Purpose
FRZ	Freeze	HDPT	Hardpoint
FS	Front Section, or Fuselage Station	HE	High Explosive
FT	Feet	HEX	Hexadecimal
FTIT	Fan Turbine Inlet Temperature Gauge	HI, HOT	Hot Integration (LITENING)
Fps	Feet per second	HLS	HARM Launch Scale
FTT	Fixed Target Track	HOBO	Hands-On Black-Out
Fuze	A device used to initiate weapon detonation	HOC	Hands On Controls
FWD	Forward	HOM	Home
FZ	Freeze	HMCS	Helmet Mounted Cueing System
		HMPT	Home Point
G		HOS	Hostile
		HOTAS	Hands-On Throttle And Stick
g	Gravitational (acceleration)	HOT	Jettison mode ready indication (Weapons selected released unarmed)
G	Gravity		
g available	The maximum number of g's allowed by the flight controls	Hr	Hour
		HSD	Horizontal Situation Display
g sustainable	The maximum number of g's that can be pulled without losing current specific gravity	I	Horizontal Situation Indicator
		HTFOV	HUD Total Field-Of-View
GAAF	Ground Avoidance Advisory Function	HTS	HARM Targeting System
GBU	Guided Bomb Unit, conventional bomb with self-contained guidance system	HUD	Head Up Display
		HYD	Hydraulic
G/C	Great Circle Steering	Hz	Hertz
GC	Gyrocompass		
GCAS	Ground Collision Avoidance System		
GCS	Guidance and Control Section		
GD	Guard		
G DLNK	Ground data link		
GE	General Electrics		
GEM	GPS Embedded Module		
GEO	Geo-Location		
G FRND	Ground Friendlies		
GHL	Ghost Horizon Line		
G LIM	G Limit		

I		**L**	
I/O	Input/Output	L	Left
IAM	Inertially Aided Munition	LADD	Low Altitude Drogue Delivery
IAS	Indicated Airspeed	LANTIRN	Low Altitude Navigation Targeting Infrared
IBIT	Initiated Built-in Test		For Night
ICP	Integrated Control Panel	LAR	Launch Acceptability Region
ID	Identification	LASR	Laser
IDL	Intraflight Data Link, Initialization Data Load	LAT, Lat	Latitude
IDM	Improved Data Modem	LAU	Launcher Armament Unit
IFA	Inflight Alignment	Lb, Lbs	Pound
IFF	Identification Friend or Foe	LCD	Liquid Crystal Display
IFOV	Instantaneous Field Of View	LCODE	Laser Code
IKP	Integrated Keyboard Panel	LD	Low Drag, Lead
ILS	Instrument Landing System	LDETECT	LST Detect
IMP ANG	Impact Angle	LDG	Landing
IMP AZ	Impact Azimuth	LDGP	Low Drag General Purpose
INC	Increase	LDR	Laser Designator
IND LTS	Indicator Lights	LED	Light Emitting Diode
INIT	Initialization	LEV	Level
INR	Inertial Rates	LFT	Left
INS	Inertial Navigation System	LG	Large, Landing Gear
INSM	Inertial Navigation System Memory	LGB	Laser-Guided Bomb
INT	Intensity, Transfer of Initialization Data , Internal	LIS	Line-In-the-Sky
INTRG	Interrogator	LIT	LITENING Targeting Pod
INU	Inertial Navigation Unit	LJDAM	Laser Joint Direct Attack Munition
INV	Inventory	LJ/R	Left Jettison/Release
IP	Initial Point	L/L/E	Latitude/Longitude/Elevation
IP-TO-TGT	Initial Point to Target	LLLGB	Low Level, Laser-Guided Bomb
IP-TO-PUP	Initial Point to Pull-up Point	LM	Laser Marker (IR Pointer)
IR	Infrared, In Range	LMODECMD	Laser Mode Command
IRC	In-Line Release Connector	LMS	Linear Missile Scale
		LMZ	Laser Mask Zone
		LNCH	Launch, Launcher
		LNCHW	Missile Launcher With Track Adapter
J		LNG	Longitude
		LOB	Line of Bearing
JASSM	Joint Air-to-Surface Standoff Weapon	LONG/LNG	Longitude, Long Calibration (LIT)
J/R	Jettison and Release	LOS	Line-of-Sight
JDAM/JDM/	Joint Direct Attack Munition	LOTG	Loss Of Track Glide
JD		LPI	Low Probability of Intercept
JDN	Joint Data Network	LPRF	Low Power Radio Frequency
JETT/JTSN	Jettison	L/R	Loader Reader
JFS	Jet Fuel Starter	LRCVRCNTL	Laser Receiver Control
JHMCS	Joint Helmet Mounted Cueing System	LRG	Large
JIR	JSOW In Range	LRM	Line Replaceable Module
JIZ	JSOW/JASSM In Zone	LRR	Laser Range Receiver
JMR	Jammer	LRU	Line-Replaceable Unit
JSOW/JSW	Joint Standoff Weapon	LSCD	Laser Spot Search Code
JTAC	Joint Terminal Attack Controller	LSDL	Launch Status Divider Line
JTSN	Jettison	LSL	Laser Spot Locator
		LSR	Laser Designator
		LSRCH	LST Search
K		LSS	Laser Spot Search
		LST	Laser Spot Tracker, Land Specific Type
KF	Kalman filter	LT	Left
KL	Wind correction constant due to altitude gain	LTE	Launch To Eject
KCAS	Knots Calibrated Airspeed	LTF	Left
KIAS	Knots Indicated Airspeed	LTIP	Laser Target Imaging Sensor
kpbs	Kilobits Per Second	LT HPT	Left Hardpoint
KT	Knot	LUU	Illumination Unit, Flare
Kts or KTS	Knots	LVL	Level
KYBD	Keyboard		

M	
m	Meter
m/s	Meters per second
M	Mode, Multiple, Mask, Master, Mass Model, Meters, Mission Store
MA	MASTER ARM switch, Matrix Assembly, Medium Altitude, Mission Assignment
MAG	Magazine
MAG VAR/ MAGVR	Magnetic Variation Maintenance
MAL	Malfunction
MAN	Manual
MAU	Miscellaneous Armament Unit
MAX, Max	Maximum
MBAL	Manual Ballistics
MBC	Missile Boresight Correlator
MC	Mission Channel, Mission Commander
MDDE	Menu Driven Data Entry
MDS	Minimum Detectable Signal, Mission Data Set
MDT	Mass Data Transfer, Mission Data Table
MER	Multiple Ejector Rack
MFD	Multifunction Display (Unit)
MFDS	Multifunction Display Set
MFL	Maintenance Fault List
MGC	Manual Gain Control
MHz	Megahertz
MIDS	Multifunctional Information Distribution System
MIF	Missile-Inflight
MIL-STD	Military Standard
MISC	Miscellaneous
MIZ	Missile Impact Zone
MK	Mark, a designation preceding model num- bers
MK INT	Marker Intensity
MKPT	Markpoint
ML	Missile Launch
MLE	Missile Launch Envelope
MLG	Main Landing Gear
MLNCH	Missile Launcher
MM/mm	Millimeter
MMC	Modular Mission Computer
MNEMONIC	Code/display relating to memory
MMZ	Missile Maneuver Zone
MNL	Manual
MOD	Modification
MON	Monitor
MP	Monitor Program/Mission Planned
MPCTR	HSD Map Center
MPD	Mission Planning Data
MPL	Maneuver Potential Line
MPPRE	Mission Planned Preplanned
MPO	Manual Pitch Overwrite
MPS	Mission Planning Station
mR	Milliradians (see MILS)
MRA	Minimum Release Altitude
MRGS	Multiple Reference Gun Sight
MRIU	Missile Remote Interface Unit
MRM	Medium Range Missile
MRU	Magnetic Receiver Unit
ms, msec	Millisecond, 1 ms = 0.001 second
MSEC	Millisecond, 1 msec = 0.001 second
M-SEL	Mode Select
MSL	Mean Sea Level
MSL	Missile, Missile Override
MSMD	Master Mode
MSN DUR	Mission Duration
MSN RT	Mission Route
MT	Multi Track
MTR	Moving Target Reject
MTT	Moving Target Track/Multi Target Track
MULT	Multiple or Multi Mode
MUX	Multiplex
N	
N	North
N/A	Not Applicable
N/M	North Pointer/Meterstick
NARF	Navigation Alignment Refining Feature
NARO	Narrow
NAV	Navigation
NAV DB	Navigation Database
NC	Non-Cooperative
NCTR	Non-cooperative Target Recognition
NFOV	Narrow Field-of-View
NM	Nautical Miles
NOGO	Cannot Comply
NO RAD	No Radiation
NOM	Nominal
NORM	Normal
NOZ	Nozzle
NPG	Network Participation Group
NSTL	Nose-Tail
NRM	Normal
ns, nsec	nanosecond
NT	Neutral Track
NTR	Network Time Reference
NTO	Not Timed Out
NVIS	Night Vision Imaging System
NVM	Nonvolatile Memory
NVP	Navigation Pod
NWS	Nose Wheel Steering
NXT	Next
O	
O2	Oxygen
OA1	Offset Aimpoint 1
OA2	Offset Aimpoint 2
OAP	Offset Aimpoint
OBST	Obstacle
OCT	Octal
OFLY	Overfly
OFTRK	Offset Track
OOB	Out Of Bounds
OPER	Operate, Operational
OPS	Operation
OPT	Option
OSB	Option Select Button
OVL	Overlay
OVRD	Override
OVRFLY	Overfly

P			
PDLT	Primary Data Link Track	RDR ALT	Radar Altimeter
PDU	Pre-Briefed Submode, Playback	RDRCP	Radar Coupled
PFL	Pilot Display Unit	RDRDE	Radar Decoupled
PFLD	Pilot Fault List	RDY	Ready
PGM	Pilot Fault List Display	REC	Receive
Pickle	Program, Precision Guided Munition	REL	Release
	The act of depressing weapon release button	REL ANG	Release Angle
Pipper	Optical sight aim dot	REP	Release Pulse
PM	Power Management	RET	Reticle
PNL	Panel	RET DEPR	Reticle Depression
POI	Point-of-Interest	RF	Radio Frequency
POS	Position Known Mode, Position	RIU	Remote Interface Unit
PPLI	Precise Participant Location and Identification	RKT	Rocket
PPS	Precise Positioning Service	RM	Receiver Module
PR	Pull-up Range	RMAX	Maximum Range
PRA	Planned Release Angle	RMIN	Minimum Range
Pressure	Altitude measured from standard sea level	RMLG	Right Main Landing Gear
Altitude	pressure. Altitude 29.92 inches of mercury (1013Mbar)	RNAV	Area Navigation
PRE	Preplanned	RNG	Range
PRF	Pulse Repetition Frequency	ROB	Range On Bearing
PRGM	Program	Ropt	Optimum Steering
PRI	Primary	RP	Reference Point, Release Point,
PROF	Profile		Release Pulse
PSI	Pounds Per Square Inch	RPM	Revolutions Per Minute
PT	Precision Targeting (HTS)	RST	Reset
PTR	Pointer (Laser Marker)	R/T	Receiver/Transmitter
PUAC	Pull Up Anticipation Cue	RTAM	Reset Transfer Alignment Message
Pull-up	An air-to-ground indication/cue, displayed on HUD that	RT HPT	Right Hardpoint
	requires immediate action to avoid ground clobber	RTN	Return
PUP	Pop-Up Point	RTS	Return-to-Search
PW	Paveway , Pratt & Witney	RTT	Round Trip Timing
PWR	Power	RUK	Range Unknown Submode
	Power	RWR	Radar Warning Receiver
Q		RWS	Range While Search
		RWY	Runway
QFE	Atmospheric pressure at airfield elevation	RX	Receiver
QNH	Air pressure (Sea Level)		
QTY	Quantity	**S**	
R		S	South
		S#	Set number
R	Right	SA	Situation Awareness, Selective Availability
RA	Release Altitude	SAASM	Selective Availability Anti-Spoofing Module
RACK	Mnemonic for loading rack store number and	SAD	Search Altitude Display
	quantities	SAI	Situation Awareness Indicator
RAD	Radius	SALT	System Altitude
Radar Mile	A radar mile is the time required for one pulse of	SAM	Surface-to-Air Missile
	energy to be transmitted 6000 feet and reflected	SBC	Symbology Brightness Control
	back to the receiver (12.4 microseconds)	SBIT	Startup BIT
Raero	Maximum Kinematic Flight Range	SC	Scan Cycle, Special Channel
RALT	Radar Altimeter	SCP	Signal Control Processor
RAM	Random Access Memory	SD	Shutdown
Raster	Horizontal scan of the electron beam in a fixed TV	SDB	Small Diameter Bomb
	format	SDC	Signal Data Converter
R/B	Range/Bearing	SDP	Signal Data Processor
RCCE,	Reconnaissance	SEA	Sea State Clutter Reduction Mode
RECCE		SEC	Secondary Mode
RCL	Recall	SEAD	Suppression of Enemy Air Defenses targets
RCVR	Receiver	SEL	Selective Emergency Jettison
RDR	Fire Control Radar	SEL JETT	Selective Jettison

S		T	
SEQ	Sequence	T	Training, track, TGP
SFW	Sensor Fuzed Weapon	T/R	Transmit/Receive
SGL	Single	TA	Threat Area, Transfer Alignment
SH	Stored Heading	TAA	Target Aspect Angle, Threat Area
SIM	Simulate		Avoidance
SJ or S-J	Selective Jettison	TAC	Tactical
SLAV, SLV	Slave	Target	Height of target above mean sea level
SLNT	Silent	Elevation	True Airspeed, Tail Actuator Subsystem
SMS	Stores Management System	TCN/TACAN	Tactical Air Navigation
SMTH	Smooth ride option (TFR)	TD	Target Designator, Time Delay
SNAP	Snapshoot gunnery (display)	TD	Threshold Detect (AIM-9L/M), Target
SNGL	Single		Detector
SNSR	Sensor	TDMA	Time Division Multiple Access Detector
SOI	Sensor of Interest	TE	Tactical Engagement
Solution	In air-to-ground modes, a symbol that indicates	TEF	Trailing Edge Flaps
Cue	when bombs should be released to hit the target	TER	Triple Ejector Rack
SOP	Standard Operational Procedure	TF	Terrain Following
SP	Snowplow	TF or Tf	Time of Flight or Time of Fall
SPD	Speed	TFOV	Total Field-of-View
SPI	System Point of Interest	TFR	Terrain Following Radar
SQL	Squelch	TGM	Training Guided Missile
SR	Smart Rack	TGP	Targeting Pod
SRCH	Search	TGT	Target
SRM	Short Range Missile	THDG	True Heading
SS	Snapshoot	THLD	Threshold
STA	Station	Threat	A passive system which detects and
STAT	Status	Warning	identifies
STBY	Standby	System	threat radar signals
STOR	Stored	TI	
STOR HDG	Stored Heading	TISL	Target Isolate
Store	Identifier for weapons/racks (SMS)	TL	Target Identification Set, Laser
Number		TLA	Tail
STP/STPT	Steerpoint	TLL	Target Locator Angle
STRF	Strafe	TM	Target Locator Line
STRG	Steering	TMD	Track Mode, Telemetry
ST SAM	Single Target SAM	TMP	Tactical Munitions Dispenser
STN	Source Track Number, Station	TMS	Temperature
STT	Single Target Track	T/O	Target Management Switch
SW	Software	TOF	Takeoff
SY	System Computed, System Measured (WCMD)	TOI	Time of Flight
SYM	Symbology	TOS	Target Of Interest
SYNC	Synchronization status	TOT	Time Over Steerpoint, Time On Station
		TPNDR	Time on Target
		TQ	Transponder
		T/R	Track Quality, Time Quality
		T-R	Transmit/Receive
		TR	Threat Rings Training
		Track	To lock on a target with the radar and
			continue following its position.
		TRK	Track
		TRNG	Training (LASER)
		TUI	Time Until Impact, Time Until Intercept
		TV	Television
		TWA	Threat Warning Aux
		TWP	Threat Warning Prime
		TWS	Track While Scan
		TX	Transmitter
		TXA	Transfer Alignment

U		**X**	
UAI	Universal Armament Interface	XMIT/XMT	Transmit
UFC	Upfront Controls	XMTR	Transmitter
UHF	Ultra High Frequency	XR	Extended range
UI	User Interface		
ULFT	Unified Loft	**Y**	
ULS	Up-look Search		
UNK	Unknown	**Z**	
UNLK	Unlock		
UTC	Universal Time Coordinated		
UTM	Universal Transverse Mercator		
UV	Ultraviolet		
V			
V	Velocity, Volts		
VAH	Velocity, Altitude, Heading (HUD)		
VEL	Velocity		
VG	Aircraft Groundspeed		
VHF	Very High Frequency		
VID	Visual Identification		
VIP	Visual Initial Point		
VIPCRP	VIP/CCRP Combination		
VIS	Visual		
VMS	Voice Messaging System		
VMU	Voice Message Unit		
VOL	Volume		
VOR	VHF Omnidirectional Range		
VRP	Visual Reference Point		
VRPCRP	VIP/CCRP Combination		
VS	Velocity Search		
VSR	Velocity Search with Ranging		
VV	Vertical Velocity		
VVI	Vertical Velocity Indicator		
VX	X-Axis Velocity		
VY	Y-Axis Velocity		
VZ	Z-Axis Velocity		
W			
W	West		
WAC	Wide Angle Conventional		
WAR	Wide Angle Raster		
WAT	Along track winds at run-in altitude		
WCMD	Wind Corrected Munitions Dispenser		
WD	Wide, Wind		
WEZ	Weapon Engagement Zone		
WHOT	White Hot		
WL	Waterline, a plane of horizontal reference on an aircraft		
WLCO	Will Comply		
WOB	White on Black		
WOW	Weight-On-Wheels		
WP/WPT	Waypoint		
WPN	Weapon		
W/SPAN	Wingspan		
WUP	Warm-up		
WVR	Within Visual Range		
WX	Weather		