

BMS COMMS & NAV MANUAL (ex CHART TUTORIAL)



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ex Chart tutorial V2

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FOREWORD

PURPOSE AND SCOPE

This manual is actually revision 3.00 of the old chart tutorial. The initial purpose of this publication was to document the approach charts created for BMS. With the release of 4.34, two major changes have been implemented: A completely revised and more realistic ATC system and the way radio frequencies are implemented. This publication will guide you through the new ATC and radio management in BMS 4.34, and as before, explain the use of approach charts in BMS.

The following manuals supplement this manual to establish the complete Falcon BMS 4.34 series:

- TO-BMS1F-16CM-1 (aircraft, avionics, normal procedures and abnormal procedures).
- BMS-Training (documentation to accompany Falcon BMS 4.33 & 4.34 training missions).
- TO-BMS1F-16CM-34-1-1 (weapon systems, support equipment and munitions).
- Checklists and Cockpit Diagrams (avionics, emergency, non-F-16 pit layouts).
- Airport Approach & Navigation Charts (including KTO AIP).
- Key Files & Input (Key File, Key File Editor, Keystrokes, Callbacks, etc.).

These are all located in the \Docs folder of your Falcon BMS 4.34 install, with other supporting documents.

LIST OF CHANGES:

V4.34: Document renamed and adapted for the new ATC and Comms plan in 4.34.

V3.0 update of the chart tutorial, published September 2018

V2.00: chart tutorial, published March 25th, 2010.

V1.00: chart tutorial, published November 6th, 2010.

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Introduction

When I first wrote the chart tutorial there were many different versions of Falcon active within the community. As I said back then BMS would supplant them all and nowadays we only have BMS left but we do have many other terrains, many not yet fully covered by approach charts.

Creating charts for BMS remains a work in progress, a job that was started some 15 years ago.

Back then there was also no way to have a realistic Air Traffic Control (ATC) system, so that pilots who flew IFR with the charts were on their own. Compromises with the radio implementation were also required as we only had one frequency per airbase. Now with BMS 4.34, flying IFR has become more interactive with a much better implementation of both ATC and radio communications. The ATC is now able to guide pilots in different kinds of weather for visual and instrument approaches.

Regarding radios, BMS 4.34 now features multiple radio frequencies for each airbase with a dedicated ATIS, ground, tower and approach & departure frequency. AI also are now on dedicated frequencies as per their human counterparts and follow the frequency changes. In earlier versions of BMS (and Falcon) AI were magically on the radio net inducing some weird artefacts (like hearing AWACS while talking to a tower). Radio range is now also limited to Line of Sight which might impact your radio plan when you fly low or when you want to talk to a guy far away from your position.

Radio changes are not limited to ATC and impact all entities communicating with the VHF and/or UHF radios (AWACS, AI flights, Tankers, etc). Each callsign now always has the same assigned frequency and if you don't know that frequency, you can't talk to them.

Previously BMS ATC was only able to guide aircraft back to base using a strange pattern very specific to Falcon and resembling none of the real-world procedures. BMS 4.34 introduces a completely revamped ATC system where ATC is able to deal with many aircraft on the ground and in the air and to process traffic according to weather conditions (visual approaches like the overhead recovery or IFR recovery following published charts in bad weather). ATC now also consider flights as a full entity and will talk only to the flight leads, thereby considerably decreasing the volume of traffic on the radios.

We will start by introducing the BMS 4.34 ATC changes, followed by a quick chat about the AI using the new radio code. After the new features of 4.34 have been discussed, the rest of this publication will be devoted to the update of the previous chart tutorial document with many new additions. As well, a completely new demonstration flight between Osan and Taegu complemented by 2 training missions is available from the Tactical Engagement training tab of BMS.

PART 1:

THE NEW BMS

AIR TRAFFIC

CONTROL

BMS 4.34 introduced a completely revamped ATC system thanks to the new radio code mechanisation.

Prior to 4.34, ATC was limited to a tower frequency where everything happened in a very limited way. Since 4.34, each airbase has been equipped with multiple control frequencies for ops, ground, tower & approach/departure (these last two are shared on the same frequency).

Procedures were also greatly enhanced and both AI ATC and AI pilots are able to cope with more realistic scenarios such as:

- Quick sequencing for departure (greatly decreasing the traffic jams we had before in 4.33 especially in campaign scenarios.)
- ATC now considers a flight of multiple aircraft (flight of 2, 3 and 4) as a single entity not subject to the regular separation laws. As a consequence, ATC will only communicate with the flight lead and it is the flight lead's responsibility to maintain his flight's cohesion. As such, wingmen should not communicate with ATC unless in specific cases which are going to be demonstrated further in this chapter.
- AI pilots are now able to fly more realistic departures (multiple ships) and approach types such as overhead recovery, visual recovery and instrument approaches.
- Realistic frequency use: In case pilots use the wrong frequency to contact ATC services, the ATC will redirect the pilot to the correct frequency.
- Correct sequencing of the returning aircraft back to the parking positions.

Although the new ATC system is a huge step forward – you must understand that managing both human pilots and artificial intelligence aircraft all along the same real-life procedures is a huge challenge and compromises had to be made. Therefore the ATC system may not be as flexible as if you were flying with human controllers. Nevertheless, it's probably never been as good in any flight simulator (including civilian ones).

1.1 AIRBASE COMM PLAN

Each airbase now has multiple frequencies for managing traffic according to their position.

The frequencies are mostly UHF as opposed to 4.33 where we had a unique frequency per airbase but it was available on both VHF and UHF.

VHF is mostly used for intra-flight communication (talking to your wingmen) while UHF is mostly used for inter-flight, tactical and ATC communications. Splitting all the ATC frequencies in both VHF and UHF was deemed overkill and we decided to exclusively use UHF frequencies. Granted Tower still has the old VHF placeholder but we advise you not to use it and stick to UHF.

The only exception is the ATIS which is a VHF frequency.

List of control agencies:

1.1.1 Ops. (Operations)

Not much to say about this except it is a kind of placeholder for the future. The initial idea was to create an Ops frequency that humans could revert to when voice traffic was too disrupting as was often the case with AI in campaigns. A few development facts solved this issue and made this frequency kind of useless:

1. The fact that ATC now talks only to flight leads and consider each flight an entity rather than talking separately to the 4 AI within the same flight reduced the voice traffic considerably.
2. An Ops frequency should be squadron dependent and not airbase dependent. Indeed different squadrons on the same airbase all using the same frequency would create the same issue of too much voice traffic. The only way to decrease traffic would be for the squadrons populating the same airbase to have a dedicated squadron ops frequency, just like in real life.

There are solutions to overcome this.

It would have been great to have this Ops frequency user configurable through the BMS config file so that each squad can have their own.

But in the meantime, you may simply assign yourself a discrete frequency and save it in your DTC as preset #1 for instance. This will then replace the default preset #1 specific to that airbase.

Unless you use the default Ops as the initial frequency to contact your flight on, you can ignore it. It's not very useful and it is not even published on the charts.

Ops does not have a dedicated ATC menu.

1.1.2 Ground

Ground is the control agency that manages all the ground movement on the airbase. From the parking spot to the runway hold lines at departure and from exiting the runway back to the parking spot (or the ramp) upon arrival.

Ground has its own page in the ATC menu, it is the default page displayed upon the first "t" press.

1.1.3 Tower

The Tower control agency manages traffic on the active runways. Its main job is to clear flights for take-off and landing. Upon departure you will be handed to Tower once the system detects you close to the runway hold lines and upon arrival, Approach will hand you over to Tower before final approach where Tower will take the responsibility to clear your flight to land. Tower is the second page of the ATC menu (press "t t").

1.1.4 Approach/Departure

Very often these two control agencies are merged together. This is the case in BMS where they share the same frequency. This control agency will manage flying traffic around the airport.

Departing traffic is managed by the Departure control agency but basically it's not much more than a simple "resume own navigation."

Departure is the 4th page of the ATC menu displayed after 4 consecutive "t" presses.

Recovering traffic is managed through the Approach control agency from the IAF (Initial Approach Fix) or whenever you make initial contact with ATC for recovery to the final approach point where the flight will be handed to Tower for landing clearance.

Approach is the 3rd page of the ATC menu.

1.1.5 Common

Not quite a dedicated control agency but we needed a common page in the ATC menu to get valuable information regardless of the frequency the radios are set to. It was done so as to avoid duplicating common menu items in all ATC menu pages. Please note your radio needs to be set to either one of the airbase frequencies to be able to use the options from the common page. It's the 5th page of the menu.

1.1.6 Carrier

BMS 4.34 implemented some part of carrier ops and thus we needed a dedicated carrier page to simulate the LSO (6th page). More information on this can be found in the Carrier OPS manual located in your \Docs\Other Aircraft folder and the associated Carrier Ops training missions.

1.1.7 Contingencies

As the common page, it is not quite a dedicated control agency but a special page in case any flight member needs to abort at ramp. See chapter 1.4.6 at the end of this chapter for further information.

To communicate with the ATC you need to be on the relevant frequency. If you try to talk to ground while your radios are set to Tower the same thing will happen as in reality. The controller will tell you it's the wrong frequency and will most probably give you the right frequency to dial in and you will have to remake your call.

As a pilot you therefore need to know a lot of different frequencies to be able to use the radios once you are in the cockpit. The airbase relevant frequencies are listed in the header of the BMS approach charts and on the briefing UI. Depending on the type of chart, you will find them all (Ground, Tower Approach & Departure) in the airbase ground chart, or only some of them (for instance ground frequency is not listed in ILS or SID charts because it is irrelevant to that procedure).

TCN:	ATIS:	GND:	TWR:	APP/DEP:	TA(ft) / TL:	GPS:	ELEV:
94X	132.125	253.7	308.8	306.3	14000/FL140	N37°04.141' E128°00.881'	97'

COMM LADDER:		FREQUENCY	PRESETS	
AGENCY:	CALLSIGN:	UHF [CHNL]:	VHF [CHNL]:	NOTES:
INTRA-FLIGHT:	Goblin2	--	138.750 MHz [15]	Flight Management Comms
GUARD:	None	243.000 MHz [13]	121.500 MHz [13]	Distress / Emergency
COMMON:	None	339.772 MHz [14]	123.500 MHz [14]	Advisory / UNICOM
BASE OPS:	None	304.800 MHz [1]	--	Homeplate Operations
TACTICAL:	None	250.600 MHz [5]	--	Package Comms
DEP GROUND:	Kunsan Ground	273.525 MHz [2]	--	Departure Airbase
DEP TOWER:	Kunsan Tower	292.300 MHz [3]	126.500 MHz [3]	Departure Airbase
ARR APPROACH:	Kunsan Approach	292.650 MHz [6]	--	Recovery Airbase
ARR TOWER:	Kunsan Tower	292.300 MHz [3]	126.500 MHz [3]	Recovery Airbase
ARR GROUND:	Kunsan Ground	273.525 MHz [2]	--	Recovery Airbase
ALT APPROACH:	Seosan Approach	253.950 MHz [9]	--	Alternate Airbase
ALT TOWER:	Seosan Tower	353.100 MHz [10]	126.750 MHz [10]	Alternate Airbase
ALT GROUND:	Seosan Ground	275.800 MHz [11]	--	Alternate Airbase

The new comm plan in BMS automatically assigns radio presets to relevant frequencies you may need in flight. Please, before proceeding, further understand that presets are shortcuts to a frequency. The best example I can illustrate is that for years Tower frequency has been assigned to preset #15. Well in BMS 4.34, Departure Airbase Tower will always be preset #3.

Kunsan tower frequency has always been 292.3. The shortcut changed, not the frequency. Here is a list of automatically generated presets in BMS 4.34. Please note ATC presets are always assigned the same from one flight to another:

- #1: Home Airbase OPS
- #2: Home Airbase Ground
- #3: Home Airbase Tower
- #4: Home Airbase Departure & Home Airbase Approach
- #5 Tactical (AWACS) check in (Which is not yet implemented in BMS 4.34)
- #6 Tactical (AWACS)
- #13 for air to air refueling

So basically, a flight from ramp will use the following preset sequence:

#2, #3, #4 for communicating with the home airbase as you fly out

#5, #6 for communicating in flight on the tactical net with AWACS for instance (with #13 if doing an AAR)

#4, #3, #2 for communicating with the home airbase ATC upon your return.

Talking with the BMS control agencies is done through the ATC menu which is opened with the "T" key. "T" because it was called the Tower menu back when we had only one Tower frequency at our disposal. The first "T" press opens the Ground menu, the second "T" press opens the Tower menu. Next one opens Approach then Departure then Common and Contingencies then finally Carrier.

<p>ATC COMMANDS Ground Page</p> <ol style="list-style-type: none"> 1 Install / Remove EPU Ground Safety Pin 2 Install / Remove Chocks 3 Request Taxi for Departure 4 Request Taxi Back to Ramp 5 Request Hotpit Refuel 6 Say Again 7 Recharge JFS 	<p>ATC COMMANDS Taxi Page</p> <ol style="list-style-type: none"> 1 Ready for Departure 2 Request Landing 3 Request Formation Landing 4 Report On Final 5 Report Overhead Break 6 Declare Emergency 7 Abort 8 Say Again 	<p>ATC COMMANDS Approach Page</p> <ol style="list-style-type: none"> 1 Request Vectors for Visual Approach 2 Request Vectors for Instrument Approach 3 Request Overhead Approach 4 Request Unrestricted Approach 5 Declare Emergency 6 Abort 7 Traffic in Sight 8 Say Again
<p>ATC COMMANDS Departure Page</p> <ol style="list-style-type: none"> 1 Report Airborne 	<p>ATC COMMANDS Common Page</p> <ol style="list-style-type: none"> 1 Request QNH 2 Request QFE 3 Takeoff Runway 4 Landing Runway 5 Request Wind Check 	<p>ATC COMMANDS Contingencies Page</p> <ol style="list-style-type: none"> 1 Request Ground Abort 1 2 Request Ground Abort 2 3 Request Ground Abort 3 4 Request Ground Abort 4
<p>ATC COMMANDS Sands Page</p> <ol style="list-style-type: none"> 1 Inbound "Mother" 2 Report "See You" 3 Report "Platform" 4 Call "the Ball" 5 Report Overhead Break 6 Abort 		

Greyed options are not available, white options are available. The available options do not depend on your radio frequency but on your position and status around the airfield.

You may close the menu with the escape key or the menu will close automatically once you have chosen the option with the relevant numerical key.

Depending on the UI options, subtitles for the AI ATC voice may be displayed, and these will appear on the top left of the main screen. This option may greatly help non-native English speakers. These subtitles are colour coded depending on their category, and therefore you may notice more colours than before.

1.2 Real radio discipline

Managing radios correctly can be challenging but is a required skill in aviation.

First, like any specific language, there are rules to follow and specific vocabulary to apply:

in this case the brevity (which is included in your \Docs\Other documentation folder) and specific ATC phraseology.

Secondly, the volume of radio communications can be staggering and junior pilots may have a hard time keeping a good situational awareness listening to the radio traffic and be able to pinpoint the important messages directed specifically to their flights at the same time.

Luckily a flight of multiple aircraft is considered by the ATC as a single entity and communication will happen only between ATC and the flight lead. Flight lead should be experienced enough to manage the radios. Flight members should just listen and not interact with the ATC save for switching frequencies when lead instructs them to do so. This rule is equally valid if the flight lead is AI with human wingmen. In case a wingman initiates contact with ATC he will be repeated the same instructions as his flight lead. It does nothing good but to increase the volume of radio communication (which in aviation is bad).

On top of all of this there is a dimension in BMS that real life does not have: mixing computer driven aircraft with human driven aircraft. This represented one of the greatest challenges of coding the new BMS 4.34 ATC while keeping a fluid situation at all costs.

As a consequence some compromises had to be made in the ATC code which will make BMS deviate from real life ATC. Some of these compromises are listed below:

- There is no clearance required to cross a runway at double runway airbases.
- The switch from one frequency to another is not done at the pilot's or ATC's discretion but rather it is dependent on the aircraft's location.
- The departing and arriving traffic at BMS airbases always follow the same specific routes from spawn points chosen according to the active runway and back to the parking spots.
- Although not a compromise but a real fact, ATC will sequence the traffic according to take off time and a human pilot taxiing before an AI flight that normally takes off before him will create issues in the taxi sequence.
- There is no mandatory readback.
- BMS ATC still uses "Position and hold" – which has been proven confusing when mixing European and US pilots. FAA ruled out the "position and hold" and replaced it with "line up and wait" since 2010 in accordance with ICAO standards to avoid the possible confusion with hold position. BMS ATC uses both hold position (mean stay where you are) as well as position and hold (which means line up and wait). So stay sharp!
- The AI take-off with 10 second intervals unless having been asked to expedite, in which case they perform rolling take-offs.



1.3 The departing flow

1.3.1 Getting ATIS:

Although not mandatory in BMS, pilots should start by getting the ATIS (Automatic Terminal Information Service). In BMS, ATIS is broadcast continuously on a specific VHF frequency documented on the BMS charts.

Information provided by the ATIS are:

The name of the airport, the ATIS letter identifier in ICAO alphabet, the active runway, the wind, visibility and clouds (as sky condition depending on config settings) temperature and altimeter setting.

Taegu. Information Romeo

Runway 3 2. Expect instrument approach

Wind: 3 0 0 degrees, 1 4 knots, gusts 3 0. Thunderstorm rain

Sky conditions: Blue

Temperature: 1 0 degrees celsius. Altimeter: 2 9 6 4 inches

The only information that's not intuitive is the sky condition given as a colour code (blue, white, green, yellow, amber, red and black).

See the table for the visibility and clouds corresponding to each colour code. Please note by default, the ATIS does not use the colour codes but gives more specific details for clouds and visibility. The colour codes must be activated by adding this setting in the BMS config file:

[`set g_bUseATISColorCode 1`](#)

Military METAR color code		lowest cloudbase (3/8 or more)					
		>=2500ft	1500-2499ft	700-1499ft	300-699ft	200-299ft	<200ft
visibility	>=8km	BLU	WHT	GRN	YLO	AMB	RED
	5000-7999m	WHT	WHT	GRN	YLO	AMB	RED
	3700-4999m	GRN	GRN	GRN	YLO	AMB	RED
	1600-3699m	YLO	YLO	YLO	YLO	AMB	RED
	800-1599m	AMB	AMB	AMB	AMB	AMB	RED
	<800m	RED	RED	RED	RED	RED	RED

Black means the airport is closed, because the weather is below minima, the crosswinds are too strong or the runway is closed for whatever reason.

ATIS is a recorded message. You will therefore hear it constantly in loops as long as your VHF frequency is tuned to the relevant frequency. A known issue for the moment: you cannot change the ATIS volume with the VHF control knob and you may still hear the end of the ATIS loop after having changed the VHF frequency.

While you listen to the ATIS on VHF, you may hear other communications on the other radios simultaneously.





1.3.2 Ground agency

When ready to taxi, the flight lead should initiate contact with Ground on the relevant frequency with a ‘Request Taxi for departure’ with “t3”.

ATC will answer with one of the following possibilities:

- **Hold position** means you have to stay where you are and ATC will recontact you when it’s your turn to taxi.

- **Give way to callsign** means you have to wait for a particular flight to taxi past your position before you will be cleared to taxi. Unfortunately the flight call sign is not written on the aircraft fuselage so in a dense traffic scenario it might be hard to know which aircraft type you have to give way to. Obviously the flight with an earlier take-off should taxi first, so by studying the take-off time in the mission planning UI you will be able to link a callsign to an aircraft type and how many aircraft there are in that flight. In any way the ATC will clear you to taxi in due time.

MISSIONS				
P	Takeoff	Role	PKG	Status
F	10:11:00	BARCAP	1031	Briefing
F	10:19:00	BARCAP	1417	Briefing
F	10:21:00	BARCAP	1524	Briefing
F	10:23:00	BARCAP	1576	Briefing
F	10:25:00	BARCAP	1613	Briefing
F	10:32:19	TRAINING	1627	Briefing

- **clear to taxi, Runway xx, hold short.** You are cleared to taxi to the active runway and once there you should hold short of the active runway. Please note: ATC doesn’t give the taxi route and as said above, there is no crossing runway clearance required. ATC might yell at you when you cross a runway if you stay more than 90 seconds on the runway or if there are landing traffic in final approach for that runway. Bottom line: consider the taxi clearance as a clearance to cross runways along your taxi route for the time being but always have a look before crossing.

The flight can move as a single entity according to ATC instructions to the hold short position. The flight cannot trespass the active runway hold lines unless cleared by tower frequency. To ensure fluidity it is advised to taxi staggered to minimise the traffic queue. Arriving at the active runway, the flight lead should park as close as possible to the runway hold lines because the ATC code detects the position of the flight lead from the runway hold lines and will automatically trigger a ground ATC message to switch to the tower frequency.



- **Contact tower, switch xxx.xx.** Most of EOR in Korea airbase will be close enough, just ensure that flight leads take the EOR position closest to the runway hold lines.

Please note AI do not use EOR spots. Failure to be close enough to the runway hold lines will prevent the switching message to be broadcast.



1.3.3 Tower agency

Where before the ATC guys sitting in the tower did all the work, now with 4.34 they have fun with the ground and approach controllers working more than them. Tower doesn't do much more than clearing flights to take-off and land. So expect to be on and off tower frequency very rapidly upon departure.

Considering the above remark about proximity of the runway hold lines, initial contact after being instructed to switch to the tower frequency will be made by the flight lead through the **Ready for departure** option in the ATC menu (tt1).

Tower may respond:

- **Hold short** because of departing or arriving traffic or because your take-off time is still too far ahead (>3 minutes). This might be problematic when you want to take off earlier for whatever reason. Fortunately, there is a way to request an earlier departure by duplicating the ready for departure message. If Tower can they will then clear you for departure regardless of your take-off time.
- **Position and hold** which means you may line up on the runway and wait for further clearance. This happens when there are still aircraft on the runway either taking off or having just landed, or you are ahead of time and no traffic is reported in the traffic queue and you may wait for the take-off time on the runway. Please note Position and hold is not a clearance to take-off and tower will recontact you to provide the specific clearance in due time. If you want to avoid waiting on the runway for the proper take off time, call again the tower with the message ready for departure. Tower will then expedite your release.
- **Clear to take-off, runway xx, contact departure when airborne.**

This is the actual take-off clearance which is usually preceded by wind information.

Do not switch to Departure too soon; the system expects you to wait till all your flight is airborne to actually contact Departure. Besides, you need to maintain situational awareness regarding traffic around the airbase to time your departure staying out of the way of the other flights.

Remaining on the tower frequency will tell you if there are landing traffic waiting for the runway to be cleared. Once all the flight is airborne then you may contact Departure.

- **Expedite departure.** If Tower asks your flight to expedite departure they need the runway for other traffic and as a flight lead you should ensure you clear the runway as fast as possible, even if that means switching to a rolling take off.

AI and humans alike are expected to line up in formation on the runway and take-off in sequence. AI within a flight will take off at 10 second intervals. If Tower requests expediting the departure, AI will start rolling ASAP and might even execute a rolling take-off as explained above.

1.3.4 Departure

Departure is the same frequency as Approach (although the ATC menu has specific pages for each) and manages both the departing and arrival traffic around the airport.

The initial contact with Departure should be done with the **report airborne** message from the departure page of the ATC menu (tttt1)

ATC will respond with a **fly heading xxx** or a **resume own navigation** which terminates Air Traffic Control services around that airbase.

From that moment you are clear to change to whatever frequency your mission requires.

1.4 The arrival flow

Returning traffic will sequence their radio communication with ATC through the Approach, Tower and finally Ground frequencies.

Approach will manage the sequencing of all returning flights until the final approach.

Tower will manage the final approach until the flight exits the active runway.

Ground will manage the taxi back.

If the flights are considered a single entity at departure, it is not always the case at recovery.

Flight members might have separated during the mission and may come back for landing at different times or the type of approach dictated by the weather may force ATC to deal with each aircraft separately.

If wingmen are within 20 NM from lead at the time of initial contact, they will be included in the flight landing queue.

If the wingmen are further than 20 NM from their lead at time of initial contact, they will be considered as a separate flight from BMS ATC and they will have to contact ATC on their own.

The number of aircraft in the flight taken into account by ATC is stated at initial contact with the approach frequency: "Falcon 1, **4 Ships F16**, 15 NM North West, 10 000 ft, request visual approach."

As a flight lead or element flight lead you will thus always know what ATC considers to be the number of aircraft in your flight.

There are 4 main approaches available with BMS ATC:

- Overhead recovery
- Unrestricted approach (free approach – the old "autonomous" approach)
- Formation landing
- Visual (vectored visual approach)
- Instrument (vectored instrument approach)

1.4.1 Overhead recovery

The overhead recovery is the type of approach that is mostly used by returning fighter aircraft. AI are now able to fly the overhead recovery which is already a huge step ahead of 4.33.

Human pilots flew the overhead recovery before but often we had to request the ill-named autonomous approach to be included in the landing queue (to have the lights at night for instance).

With 4.34 the overhead approach became a valid recovery on its own both for humans and AI alike.



The overhead approach is requested through the “request overhead approach” menu item on the approach page of the ATC menu: (ttt3) and will be granted according to the following conditions:

- VMC.
- All aircraft in the same flight are within 15 NM of flight lead at time of initial contact.
- No other traffic in the landing queue except those on base or final.

Please note, the overhead option is only valid for ground based runways and not available for carrier operations which have their own procedures.

If the option is denied by ATC, one of the conditions above is not met. You can't really manage the VMC (5km visibility, outside of the clouds and visual with the ground) but you can time your initial call according to the other 2 options. Ensure your flight is regrouped and wait for the right time according to the other traffic to make your initial request.

Once the flight lead has requested an overhead recovery, approach control will clear the flight in without any vectoring. The overhead procedure requires the flight to be fully setup for the approach at initials. For AI, initial is at 10 NM from the active runway threshold, on that side of the runway. Humans can use a lesser distance such as 5 NM which is more common.

The flight should be established in wingtip (echelon close) formation at that point. The side of the formation is opposite of the break direction (echelon right for a left break). The break unless otherwise specified is on the airfield side opposite to the control tower but basically the flight lead decides the side of the break by establishing his formation on his left or right side.

At initials or at least within 10 NM of the landing, Approach will switch the flight to Tower by giving out the relevant tower frequency.

Once the whole flight has checked in on the tower frequency, the flight lead has to establish initial contact with the tower from the Tower page of the ATC menu and request landing option (tt2). This call has to be made before the break. The tower will clear the flight inbound and ask the flight lead to report in final.

The AI will fly at 1000ft AGL but the more common 1500ft AGL works as well for human pilots. The speed should be around 300kts.

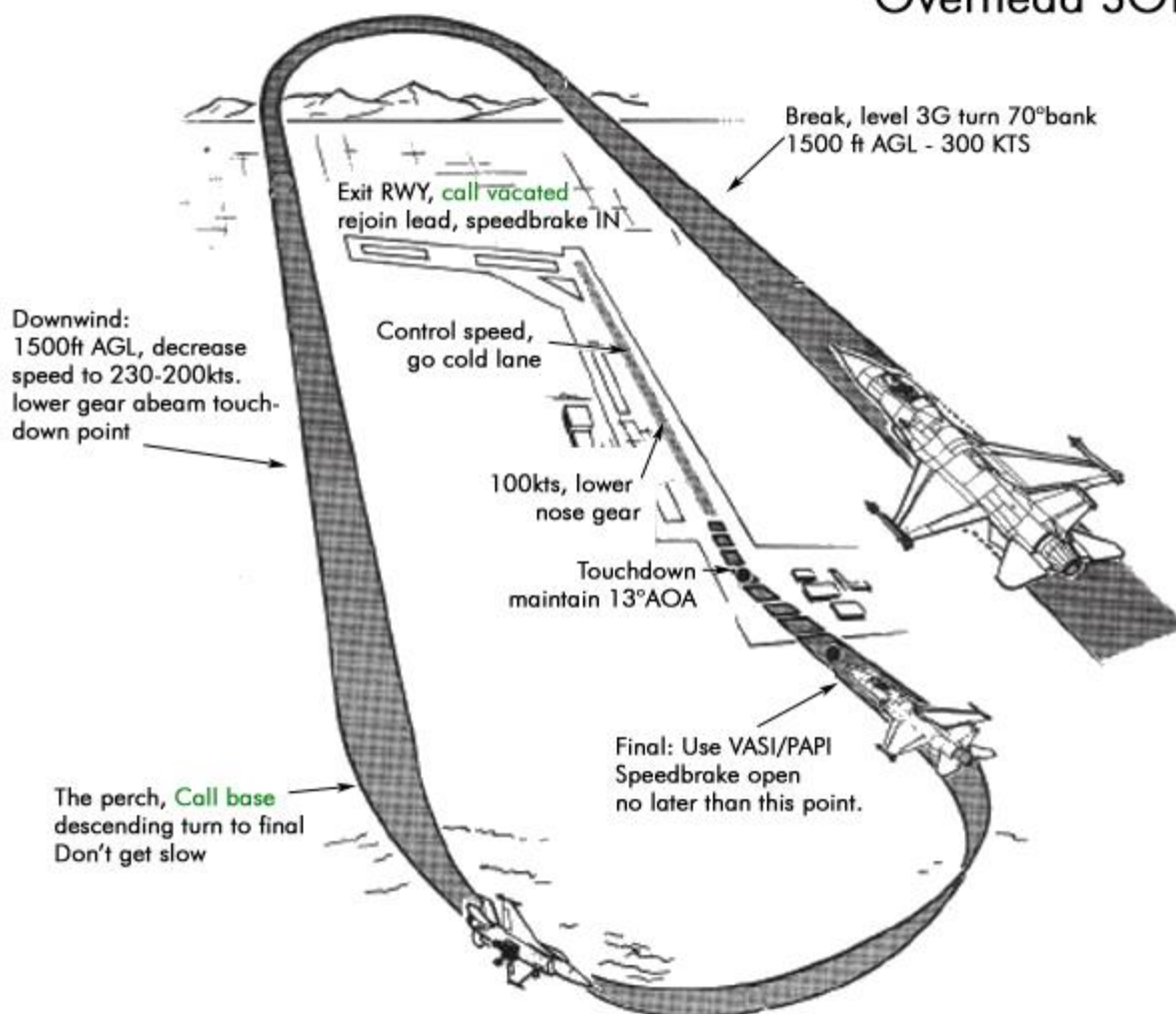
There is another option in the tower page that may be confusing: it is the “Report Overhead Break” (tt5). This call is only necessary when there are AI in your flight.

There is no way for an AI to know when a human pilot will execute his break. The AI expects a signal when you break. That could only be done with this radio call. All humans in the mixed flight should make that call when they are breaking.

When your flight is completely made of humans it is not necessary to make this call.



Overhead SOP



When the flight lead turns final he has to report final to the tower ("Report On Final" of the tower page of the ATC menu (tt4)). Tower will then clear the whole flight for landing.

Please note: the wingmen do not have to call final, the clearance is valid for the whole flight.

1.4.2 Unrestricted approach

This type of approach is exclusively for human pilot use. Formatting the approach with ATC may not be suitable for all situations where humans expect flexibility. With this type of procedure the human is free to perform an approach as he sees fit. He can fly the instrument chart, fly an overhead, fly a straight in or a test engine flight profile without being bothered by the ATC but still have a place in the landing queue.

Like the other approaches, the flight is considered as a single entity and wingmen must be within 20NM of their flight lead at the time of initial approach. If not they will be considered a separate flight.

The switch to the tower frequency will automatically be triggered when the flight is within 10NM of the airbase on the side of the landing runway. Initial contact with the tower should be done before final approach. Depending on the flight position the tower may provide instructions to get on final approach or may clear the flight for landing straight away.

With this approach, reporting final approach is optional and not mandatory.

Please note, there is no way the ATC can guess which approach profile will be executed under an unrestricted approach. Therefore deconfliction happens only at final approach. The flight lead should maintain his situational awareness and make his request at the right time considering other traffic around the airport.

1.4.3 Formation landing

Formation landings must be initiated with a request for unrestricted approach on the approach frequency. Once the flight is switched to Tower, the flight lead may request a formation landing on the tower frequency (tt3).

This option is not valid for AI as they are unable to fly a formation landing. Even for human players, the aircraft must be within the same flight. The tower will clear the whole flight (of max 2 ship) for landing without spacing restrictions. No further action is required and it is not necessary to report on final.

If you want to make a formation landing from a 4 ship F-16s in 2 pairs of two you should separate the flight at least by 20NM before initiating contact with approach. Each pair will then be considered separately and can execute formation landings on their own.

1.4.4 Vectored visual approach

In real aviation, a visual approach is not vectored by ATC. Normally the pilots report visual points identified on visual charts and are cleared to the next. ATC doesn't really give vectors to the next reporting point, pilots are able and expected to navigate on their own.

In BMS the visual approaches are vectorised and the reporting points are not necessarily visual.

Although a compromise, this ensures compatibility between AI, human pilots and ATC and has the added benefit to make it easier for the pilots albeit in a less realistic way.

This type of approach is the main AI recovery option in VMC.

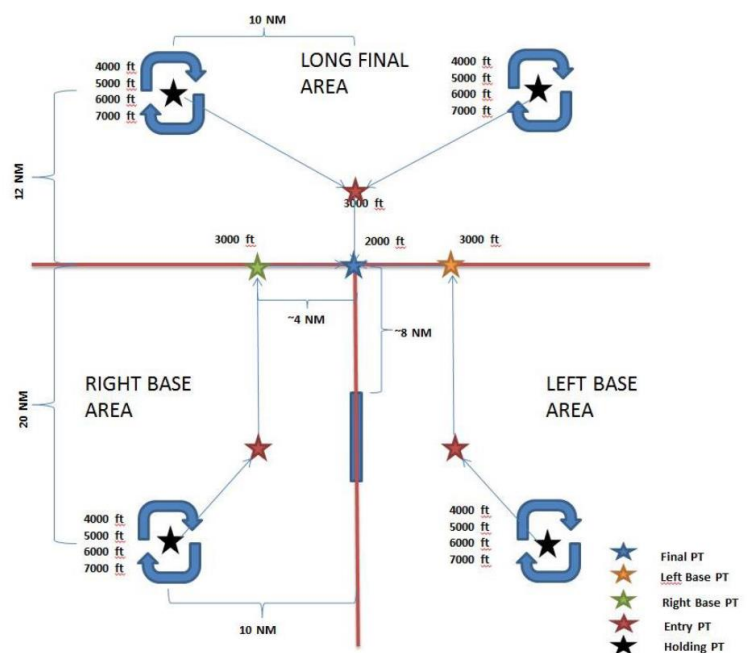
It may be denied with the following conditions:

- Orbit altitude is in the clouds (stratus layer) => not VMC.
- Initial request done on top (of the stratus layer) and the cloud layer (stratus) is under 8000 feet AGL => not VMC – (strictly speaking it's VFR on top).
- Horizontal visibility at ground level is smaller than the VFR minima => not VMC.
- Airbase is closed, because of weather or any other reason.

When the request is denied, ATC will instruct to switch to an instrument approach or instruct to divert to an alternate if the airbase is closed.

The visual approach uses 10 reference points each placed geometrically from the active runway threshold:

- 4 holding points (black stars)
- 3 entry points (red stars)
- 2 base points (green & yellow star)
- 1 final approach point (blue star)



For a 1 runway airbase (example 18/36) we therefore have a total of 20 points:

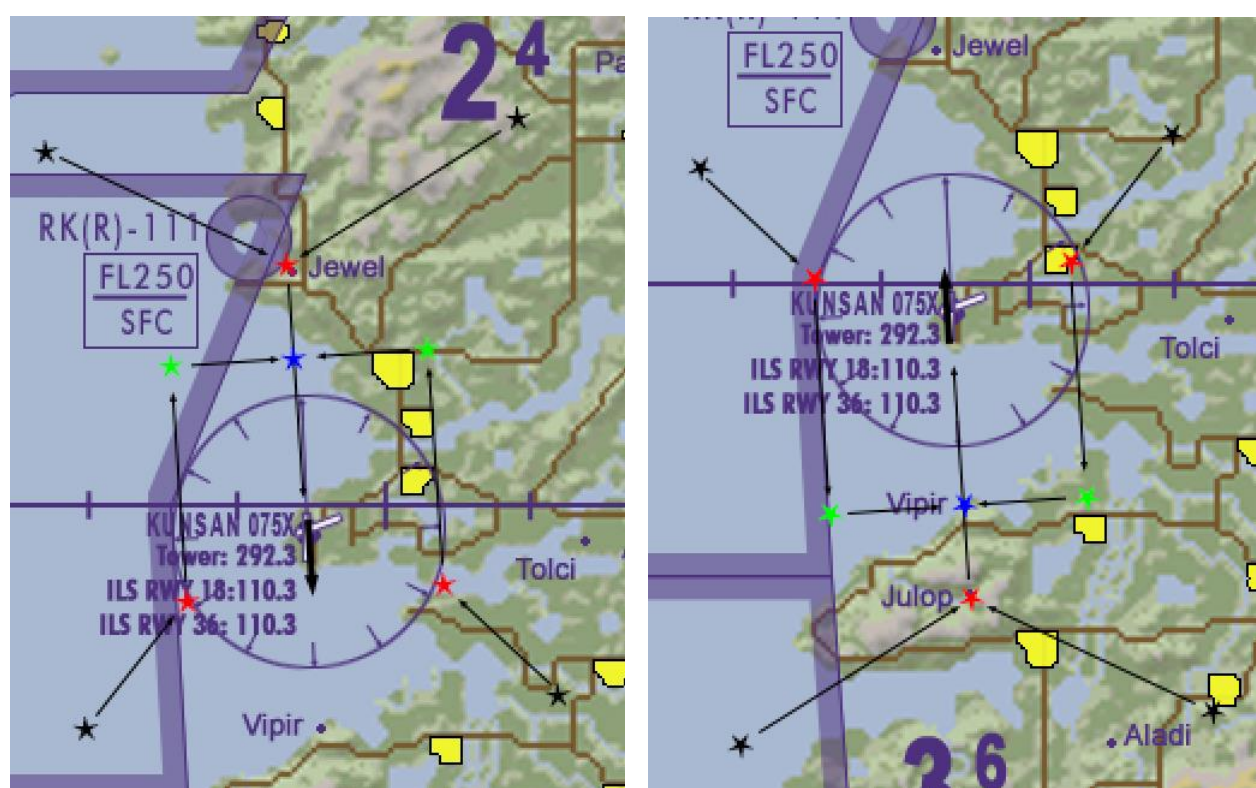
10 points for runway 18 and 10 points for runway 36.

ATC will guide aircraft to the relevant 10 reference points according to which runway is active for landing.

The holding points (black) are where ATC will stack returning aircraft 1000 feet apart. You should depart the holding point at 4000 feet AGL. If you receive instruction to hold higher, it means there is an aircraft below you.

The final approach point is to be reached at 2000 feet AGL and is 8 NM aligned with the active runway.

The points before the final approach point (either the 2 base points coming from the opposite side of the landing runway or the entry point coming from the side of the landing runway) are to be reached at an altitude of 3000 feet AGL



The left diagram above shows the 10 reference points over the Kunsan area for landing on runway 18. Note how the North entry point corresponds to the Jewel point.

The right picture shows the same diagram for runway 36 at Kunsan. Note that the South entry point corresponds to Julop and the final approach point corresponds to Vipir.

Flight leads wanting to request a visual vectorised approach should do so by calling Approach and selecting option #1 "Request vectors for visual approach" (ttt1).

Unlike the approaches illustrated previously this approach considers each flight member separately and does not consider the flight as a unique entity. From the moment the flight lead requests this recovery procedure, each flight member will be vectored separately.

Depending on your position in the diagram and on the traffic around the airbase, ATC will either vector you to the holding points or one of the 3 entry points. These points are chosen according to your arrival quadrant.

If ATC vectors you to the holding points, they will provide holding instructions (speed and altitude) once you get there. You are expected to make right turns (ie. a clockwise pattern) around the holding points until ATC clears you on your way (it may take a while depending on the traffic).

Flight members will be deconflicted in altitude in the holding stacks. Remember your flight has been separated in different entities that the ATC will manage separately. Each flight member will receive different vectors according to his position in the recovery.

When you depart the holding point, ATC will sequence each aircraft to the entry point, then the base and or the final points by giving altitude, heading and speed instructions. Be aware that there are probably other flights returning at the same time from different directions and ATC will manage these at the same time. As a pilot you must follow closely ATC instructions to ensure deconfliction with these other flights.

Upon reaching the final approach point, approach will ask you to switch to the tower frequency. Change frequency and report on final (tt4) no earlier than being on final approach, 6 NM from the airbase. Tower will provide instructions for the final approach and clearance for landing. Remember that your flight has been separated into different entities and each flight member will have to report on final to the tower controller in a timely manner.

If you are not on final approach when you report on final to the controller, the ATC will kick you out of the landing queue because you are not where you report you are. The tolerances are plus or minus 45° of the threshold which is already rather large.

As you would have noticed by now, this is nothing like a real visual approach where by definition, pilots fly according to visual landmarks. The difficulty in implementing this is managing the AI and humans alike with a system that has no way to know where the aircraft are from the airbase. The position of the reference points and the vectors from one to the next point were the only way to implement this in an efficient way providing deconfliction from one flight to another and ensuring at the same time quick processing of all flights around the airbase. (Don't forget that while you and other flights are landing, other flights may be departing the airbase!)

For some airbases surrounded by high terrain very close to the runway, the default approach layout might be a problem for the AI to follow as the altitude call given by ATC is neither QNH altitude or height (AGL) but rather given with the field elevation (QFE) as a reference. The given altitude might be too low and force them to crash into mountains.

To overcome that aspect some airbases like Sokcho and Taegu for instance have shorter patterns with a much closer BASE distance than the default layout. This ensures that the AI stays closer to the runway and don't venture over mountains avoiding the terrain.

1.4.5 Vectored instrument approach

This type of approach is meant to be used in Instrument Meteorological Conditions (IMC). They are based on the Falcon charts available in the “\Docs\03 KTO Charts” folder.

For the instrument approach to work correctly, each airbase must have an airbase.dat file in the “data\terrdata\atc” folder. If the airbase does not have its own dat file, then the visual reporting point explained in the chapter above will be used instead, unless deactivated for the reasons explained just earlier.

Instrument approaches may be denied by ATC under certain circumstances:

- Airport is closed.
- Crosswind on the active runway is above 25 kts.
- For airbases without a dat file, if stratus are lower than 500 feet AGL and visibility is less than 900m.
- For airbases with a dat file, if the weather conditions are below the minima stated in the lower right corner of the approach charts.

MINIMA:	
ILS: 390'(203' AGL)	Vis: 210ft-800m*
LOC: 540'(353' AGL)	Vis: 400ft-1600m**
Circling: 740'(553' AGL)	Vis: 1300ft-3000m
*When ALS inop, increase vis to 1200m	
**When ALS inop, increase vis to 2000m	

In case of runway closure the approach controller will try to provide information to the next best suitable open runway. Pilots should ensure that the alternate runway is differently oriented than the main closed runway to ensure the crosswind conditions are different.

Pilots willing to execute an instrument approach should contact the relevant approach frequency and select the option “Request Vectors for Instrument Approach” (ttt2) from the ATC menu.

Obviously the initial contact should be made prior to overflying the IAF published on the chart.

Like the visual approach, the flight will be separated into different entities upon flight lead’s initial request.

The approach profile tries to match the IFR approach chart with 4 reference points. Usually the first is the IAF (Initial Approach Fix) and the last one is the final approach point. That leaves 2 extra points placed accordingly on the approach track. The location of these 4 points are declared in the airbase.dat file (hence why the presence of these dat files are mandatory for the approach to work).

ATC will detect your position around any of the 4 reference points and provide vectors, speed and altitude calls for the next reporting point. Obviously having a total of 4 points may not be enough to guide aircraft perfectly along a smooth DMEARC (discussed later). The vectors provided by ATC will often cut short the curves but ultimately will guide aircraft to the right location. It is not perfect but it will certainly keep the AI from crashing into the terrain as with some cases using the visual system.

A new type of BMS chart has been created specifically to work along this ATC procedure: the RADAR vector chart. Whenever an airbase has RADAR charts, these should be used primarily with the “Request Vectors for Instrument Approach.”

This should minimise the possible problems trying to make a DMEARC procedure with only 4 reference points. Unfortunately, not all airport charts have been updated to include their own radar vectors procedures.

The biggest caveat of this procedure is that the ATC expects you to overfly the reference points before giving the next heading and altitude call.

A chart on the other hand gives you a track that you must stay on. To do that pilots lead their turn before reaching the reference point to avoid overshooting the chart track. It is particularly important when flying lower than the minimum safe altitude or minimum elevation figure close to an airport.

Obviously humans can lead their turn, but AI cannot. Mixing both is again the source of the needed compromise.

Although outside the scope of this manual, the above caveat can be managed through smart placement of the reference points in the airbase ATC files. Rather than placing them exactly on the turning points, the ATC file points should be placed where the pilots initiate their turn to ensure there is no track overshoot on the way to the new point.

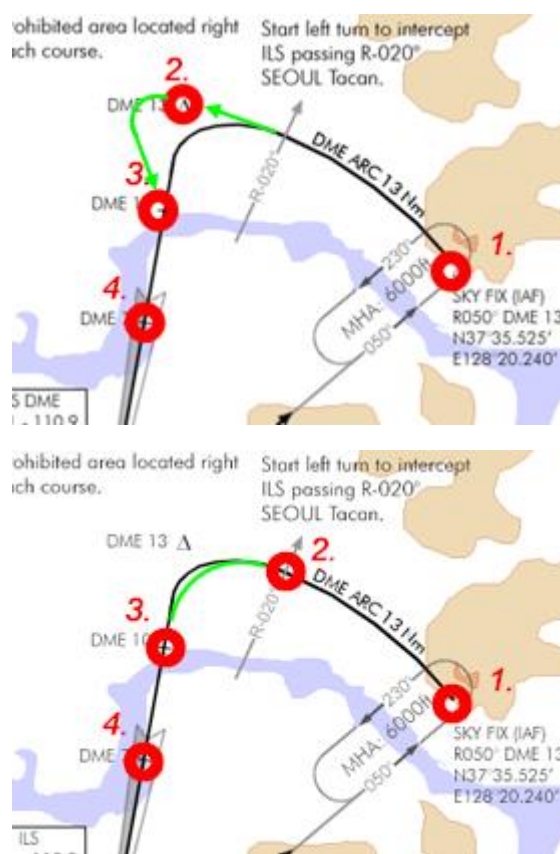
Here is an example:

The reference point 2 at DME 13 is exactly what should NOT be done! The ATC will first guide the aircraft to point 2 before issuing the vectors to point 3 resulting in a green overshoot track (and a turn that may not be possible at all considering the small distance between point 2 and 3).

A much better implementation would be to move point 2 to the reference radial (crossing R-020°) where the pilot should leave the arc to intercept the final radial.

This position ensures that the green course matches the approach track given on the chart.

Yet the heading ATC will issue is a straight line to the next reference point, so it will still not perfectly match the heading a pilot following the chart may have planned.

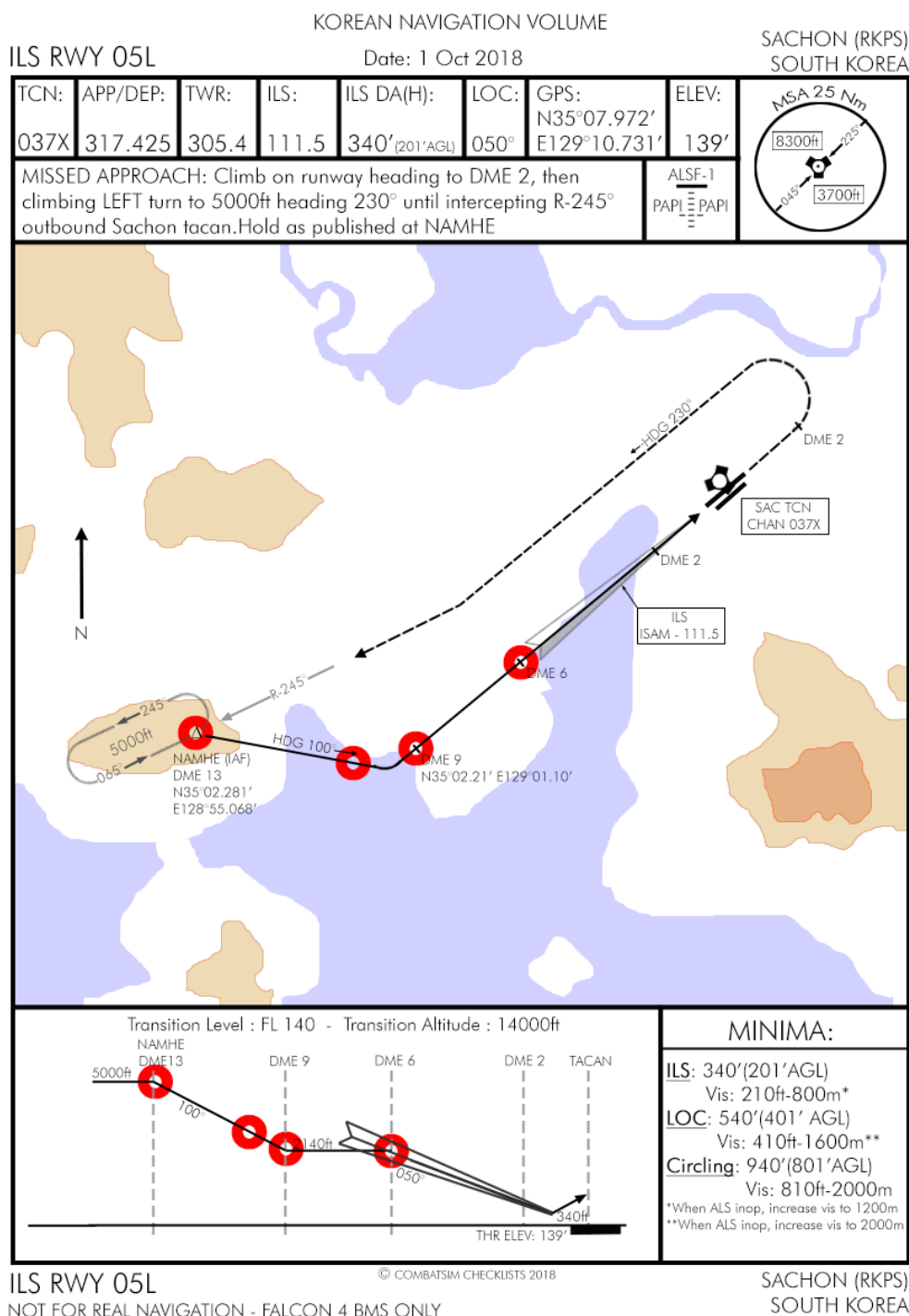


If the ATC fails to detect you close enough to a reporting point and you continue the procedure the vectors you receive next may direct you back to the previous reporting point. Don't follow them. Chances are that the ATC will detect you closer to the next point and will correct its heading quickly according to your position.

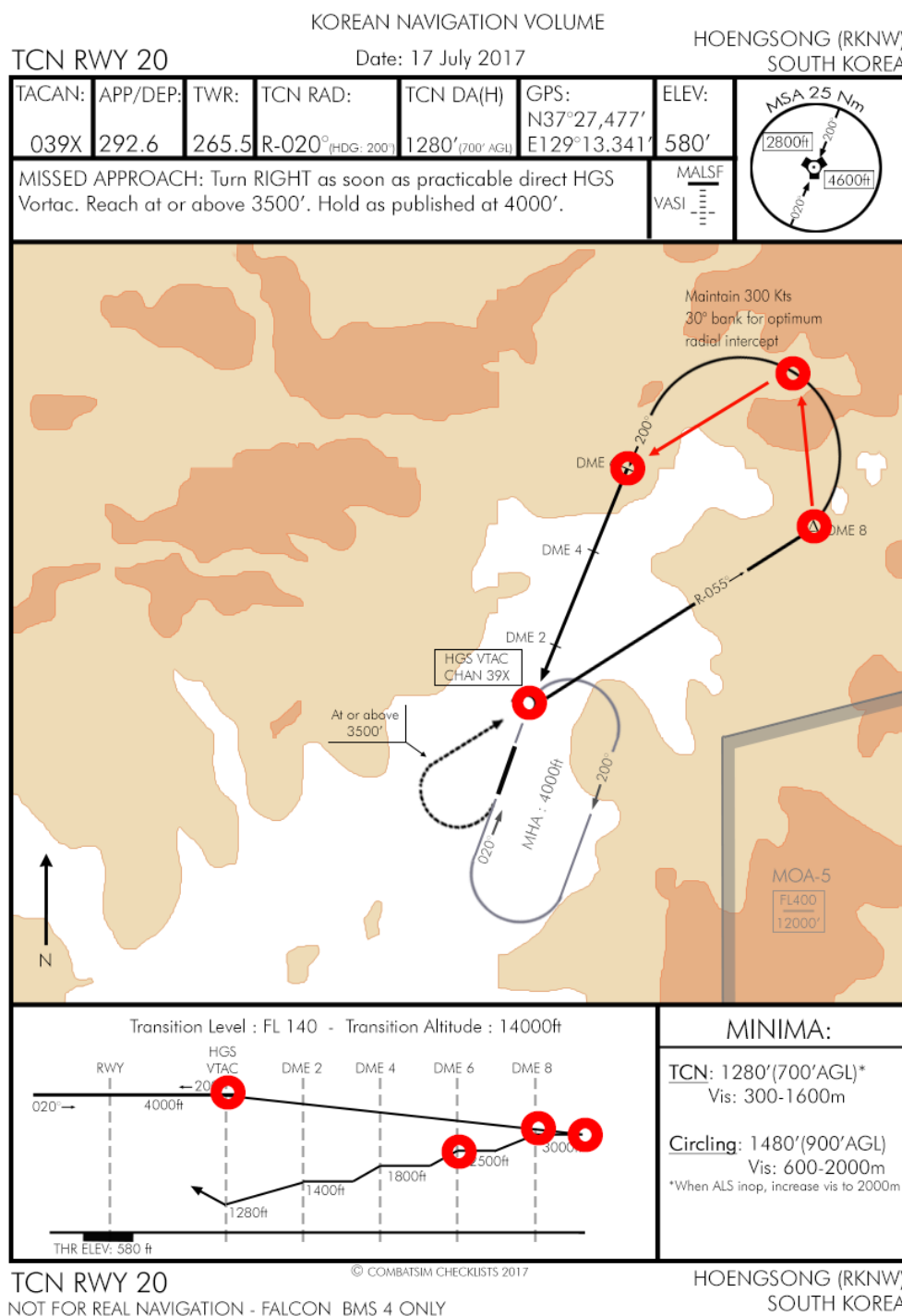
To avoid the issue in the first place you should aim to fly as close as possible to the reference points. If things don't go as planned, you can always abort the approach (ttt6) and request an unrestricted approach to finish the procedure on your own.

Upon reaching the final approach point the approach controller will switch you to the tower frequency. Change your radio settings and contact Tower when you are on final (report on final from the ATC menu). Tower will then clear you to land accordingly.

The following picture of Sachon ILS 05L illustrates in red the coded reporting points for the approach. In this specific case, the 4 points work quite fine and should not create any issue.

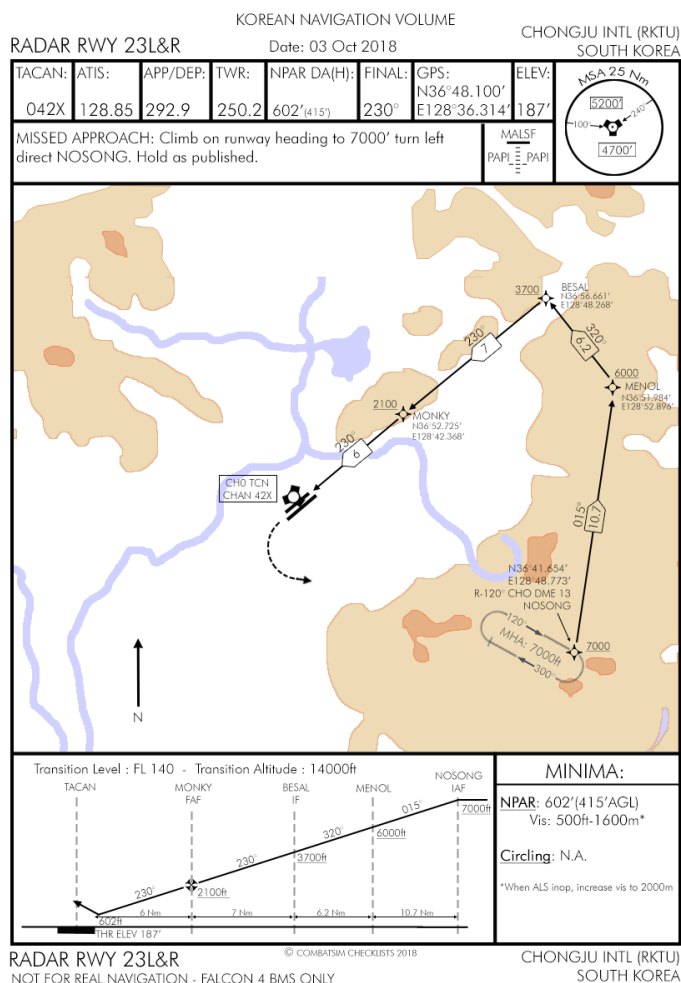


Unfortunately some procedures with longer ARCDMEs or procedure turns might be much more problematic as illustrated below:



The 180° turn required with the above approach is difficult to do with only 4 reporting points. There will be quite a difference between the actual heading in the turn and the vectors given by ATC. It is not impossible but unfortunately the headings given by the ATC as you fly the chart are more annoying than anything else, as they don't match what the pilots are doing.

To overcome these issues, we had to create a new type of approach plate for BMS: the radar vectors approach plates. These are made specifically to better match the procedure when requesting “Vectors for Instrument Approach” from ATC in BMS.



On the new radar charts, the 4 points used by the ATC are clearly identified as a fix symbol, negating the need to identify them with a red circle.

Each fix has a name, coordinates and an altitude. Fixes are linked together with a heading and a distance.

Whenever necessary, the actual points in the ATC file are not exactly the same as the fix coordinates, but cleverly positioned near to them to avoid the overshoot issue that was explained earlier.

Unfortunately, not all airports have radar approach plates (yet), due to time constraints. We will implement first the approach where the ATC vectors procedures create too many discrepancies with the regular ILS or Tacan approaches.

If an airbase features radar approach plates, that is the one that should be used alongside the ATC vectors for instrument approach procedures.

If the airbase does not feature any radar approach chart, then the regular approaches are to be used alongside the ATC vector procedures.

More information about these new radar approaches type can be found in the relevant chapters of this document. (Falcon charts review – approach charts.)

1.4.6 Additional notes

When under approach control ATC may announce traffic around you. Traffic calls should be acknowledged using the ATC menu, approach page, “Traffic in Sight” option (ttt7). This should not happen after the IAF in an instrument approach.

A “Say Again” option is also available from the Ground, Tower and Approach pages of the ATC menu. Obviously this option will make the ATC repeat its last transmission but it is also useful for the wingmen when they are unsure they have been inserted in the landing queue. By asking a say again, ATC will either repeat the transmission (you’re in the queue) or state that you need to contact approach first (you were not).

With the new FTIT and OIL code, pilots may seize the engine if they mismanage the abnormal procedures (oil pressure problem or Hot start). A stuck jet on the ground will disrupt the whole ATC sequence and it is critical that the player abort through the Contingency page of the ATC menu. Failure to do so will prevent any aircraft behind in the ATC queue to be cleared to move. A “contingencies” page has been created in the ATC menu for this very case. Pilot aborting should use the corresponding option from the contingencies page. In other words, if he is number two, he should use option 2 “Request Ground Abort 2” which is the ground abort for number 2 in the flight. Any AI behind the human aborting (say 1&2 are human and 3&4 are AI) will abort as well but will stay on the ground for a bit longer before de-spawning to allow the aborting pilot to jump into a spare aircraft. Please note, initial contact with ATC will need to be redone as the AI aborting were discarded from the ATC queue.

ATC COMMANDS Contingencies Page

- 1 Request Ground Abort 1
- 2 Request Ground Abort 2
- 3 Request Ground Abort 3
- 4 Request Ground Abort 4

As a wingman within a flight considered as a single entity for ATC, you can always detach from the flight and be treated by ATC on your own. You must first abort the approach (ttt6) and then request the type of approach you desire. You will then be a separate entity from your initial flight for the ATC.

If you forgot to abort first the ATC will not be able to remove you from the landing queue and will tell you that you are already in the landing queue.

Remember if you’re early at EOR and Tower isn’t ready to clear you for departure although there’s no traffic around the airbase, requesting ready for departure again is the same as requesting an earlier departure. If nobody is around, Tower will then clear you on your way.

Finally, for all approaches once your aircraft has landed and you have taxied off the active runway, Tower will instruct you to switch to the ground frequency. Set your radio accordingly and contact ground with (t4): request taxi back to the ramp.

Ground will clear you all the way in. They’re not really interested in the route you’ll take or where you will park your jet to exit the mission. That being said AI have an imposed route back to their spawn point.



PART 2:

AI & RADIOS

MANAGEMENT



Up to 4.34, the AI always followed their own way when using the radios. They were always listening to what the humans were ordering them no matter what.

The new 4.34 radio code changes all that.

Now if you want to talk to any entity you need to ensure that you contact them on the right frequency. If you get no answer from AI, you are probably not on the right frequency!

This manual made that fact obvious for the ATC but it is a fact quite valid for all the entities in the BMS world: AI in your flight, AI in your package, AWACS, Refueller.

From now on the radio frequency for each flight is assigned to the callsign. The same callsign will always have the same VHF & UHF radio frequencies assigned to them.

Every mission (campaigns and TE alike) have their own briefing page, accessible from the briefing button. Within the brief is a section devoted to the comm plan. This should be studied before every flight and relevant frequencies or presets recorded.

1.5 VHF

VHF is mainly used for intra-flight communication, so dealing with VHF will mainly be focused on managing the AI in your flight.

1.5.1 VHF frequencies in the comm plan

Let's summarise the allocation of VHF frequencies to presets:

- 3: Departure tower
- 4: Arrival tower (if arrival is different than departure)
- 11: Alternate tower
- 14: Common (always 123.5)
- 15: First flight in the package default intra-flight frequency
- 16: Second flight in the package default intra-flight frequency
- 17: Third flight in the package default intra-flight frequency
- 18: Fourth flight in the package default intra-flight frequency
- 19: Fifth flight in the package default intra-flight frequency

The above are only populated if the agency in question exists. For example a package with 5 flights will have all of flights 1 through 5 assigned to presets but smaller packages may have only flight 1 or flight 1 and 2.

There is no preset for VHF guard, that is quite logic as all you have to do to transmit on guard is to switch the COM2 knob to GD.

VHF common (preset #14) is a kind of unicom frequency which might be useful for human players willing to communicate on a commonly shared frequency with a preset assigned to it.



Please note, although Tower is still assigned a VHF preset, BMS 4.34 does not have VHF frequencies (hence no preset either) for ground, approach and departure.
It is advised to communicate with ATC using UHF radios.

1.5.2 Your AI Wingmen

The important thing to know about your wingman VHF radio plan is that beside the VHF frequency assignment now being dependant and relevant to the callsign, corresponding presets are setup in the DTC.

The first flight in the package (ID10) will be assigned VHF Preset #15,
The second flight in the package (ID20) will be assigned VHF Preset #16,
the third flight in the package (ID30) will be assigned VHF Preset #17,
the fourth, VHF Preset #18 and the fifth (last) will be assigned VHF Preset #19.

The above is an important rule to follow because if you want to be able to communicate with the AI you will need to either know the frequency they use or know the preset associated in your DTC.

Therefore you must check the package composition and the briefing comms plan:

PACKAGE ELEMENTS:				
x = Primary Flight				
CALLSIGN:	FLT #:	ROLE:	AIRCRAFT:	TASK:
Viper2	3236 x	OCA STRIKE	4 F-16CM-40	Destroy Radar EW & SSR or other facilities at target site
Jaguar2	3237	SEAD	2 KF-16C ROKAF	Protect package from enemy air defenses
Mako2	3238	ESCORT	2 F-16CM-40	Protect package elements from enemy aircraft
	T/O: 05:55:55	Push: 06:08:40	Tgt: 06:15:00	IFF: M124/4/121/20230-3/36554-7
	T/O: 05:48:00	Push: 06:04:40	Tgt: 06:11:00	IFF: M124/4/121/20234-5/36560-1
	T/O: 05:52:43	Push: 06:06:40	Tgt: 06:13:00	IFF: M124/4/121/20240-1/36564-5

If we are Mako 2 flight, we are number #3 in the package, our IDM is 3x (31 & 32 as we are a two ship).

COMM LADDER:					
AGENCY:	CALLSIGN:	UHF [CHNL]:	VHF [CHNL]:	NOTES:	
INTRA-FLIGHT:	Mako2	--	142.125 MHz [17]	Flight Management Comms	
GUARD:	None	243.000 MHz [14]	121.500 MHz [13]	Distress / Emergency	
COMMON:	None	339.772 MHz [15]	123.500 MHz [14]	Advisory / UNICOM	
BASE OPS:	None	272.700 MHz [1]	--	Homeplate Operations	
CHECK-IN:	Magic1	392.800 MHz [5]	--	AWACS: Global Check-In	
TACTICAL:	Magic1	249.600 MHz [6]	--	AWACS: Package Comms	
TANKER / AAR:	Copper1	--	--	Boom Operator	
DEP ATIS:	Osan ATIS	--	132.125 MHz	Departure Airbase	
DEP GROUND:	Osan Ground	253.700 MHz [2]	--	Departure Airbase	
DEP TOWER:	Osan Tower	308.800 MHz [3]	122.100 MHz [3]	Departure Airbase	
ARR ATIS:	Osan ATIS	--	132.125 MHz	Recovery Airbase	
ARR APPROACH:	Osan Approach	306.300 MHz [4]	--	Recovery Airbase	
ARR TOWER:	Osan Tower	308.800 MHz [3]	122.100 MHz [3]	Recovery Airbase	
ARR GROUND:	Osan Ground	253.700 MHz [2]	--	Recovery Airbase	
ALT ATIS:	Pyongtaeg ATIS	--	128.250 MHz	Alternate Airbase	
ALT APPROACH:	Pyongtaeg Approach	363.100 MHz [10]	--	Alternate Airbase	
ALT TOWER:	Pyongtaeg Tower	257.800 MHz [11]	122.500 MHz [11]	Alternate Airbase	
ALT GROUND:	Pyongtaeg Ground	229.700 MHz [12]	--	Alternate Airbase	

And as seen on the comm section of the briefing, our assigned VHF frequency is 141.125 and the corresponding preset is displayed within brackets [17].

Therefore at ramp start, you must initiate radio contact on VHF preset #17 or 141.125.



Your wingmen will always stay on their assigned VHF radio. As VHF is intended to be exclusively used for intra flight they should not change VHF frequency.

UHF frequency is different and will be changed often along the flight. AI will follow your frequency hopping from one frequency to the next. (ATC, TACTICAL, AAR, TACTICAL, ATC). See the next section of this chapter.

The Wingman/Element & Flight radio menu

As a flight lead you can communicate with your AI flight members through 3 different menus:

- The wingman menu ("z" or "w" depending on your keyboard layout)
- The element menu ("e")
- The flight menu ("r")

Each menu has multiple pages accessible with a repeat of the initial key and is specific to whom you want to talk to.

- The wingman menu is only when you want to talk to your direct wingman. That is #2 if you are flight lead (#1) and #4 if you are element lead (#3). It has 8 pages.
- The element menu is only when you as flight lead want to talk to your element (#3 and #4) regardless of instructions given to your direct wingman (#2). Obviously, this menu will be greyed out in a 2-ship scenario. It has 8 pages.
- The flight menu is suitable when you as flight lead want to issue commands to your whole flight (#2, #3 and #4). Obviously this menu will be greyed out in a 2-ship scenario. It has 7 pages.
Please note, in an engagement you cannot direct your flight as a whole. You must direct your element and your direct wingman will fly tactically with its lead. Unlike previous versions of BMS, in an air to air engagement, tactics are applicable by element => use the element menu.

Previously in BMS, the management of the AI through the wingman, element and flight menus was very confusing because it was the result of multiple groups modding Falcon 4.0 over a 20 year timeframe period and the big picture was a little bit overlooked.

Luckily a lot was done on this very aspect in BMS 4.34 and now we should have much better control with intuitive commands.

I decided not to explain each menu (wingman, element & flight) separately because there are way too many redundancies. I will rather keep them together but separate the explanation in the same way each menu is separated with:

- Combat management commands.
- Mission management commands.
- Formation management commands.
- Miscellaneous commands.
- Line-Up commands.

Please note, in all cases needing a specific target, that target does not have to be locked.

The target under the sensor will be considered.

<p>WINGMAN COMMANDS Combat Management 1</p> <ol style="list-style-type: none"> 1 Attack My Target 2 Buddy Spike 3 Raygun 4 Weapons Free 5 Weapons Hold 6 Check Your Six 7 Clear My Six 8 Attack Targets 9 Go Shooter 0 Go Cover 	<p>WINGMAN COMMANDS Combat Management 2</p> <ol style="list-style-type: none"> 1 Rejoin 2 Split Wing 3 Glue Wing 4 Drop Stores 5 Datalink Ground Target 	<p>WINGMAN COMMANDS Combat Management 3</p> <ol style="list-style-type: none"> 1 Offensive pursuit 2 Offensive Split 3 Beam Deploy 4 Grinder 5 Wide Azimuth 6 Short Azimuth 7 Sweep 8 Defensive 	<p>WINGMAN COMMANDS Mission Management</p> <ol style="list-style-type: none"> 1 Resume Mission 2 Return to Base 3 Snooze Radar 4 Activate Radar 5 Say Position 6 Say Damage Report 7 Say Status 8 Say Fuel State 9 Say Weapons State
<p>WINGMAN COMMANDS Formation Management 1</p> <ol style="list-style-type: none"> 1 Close up 2 Switch Side 3 Break Right 4 Break Left 5 Go Higher 6 Go Lower 7 Flex 8 Take the Lead 9 Kickout 	<p>WINGMAN COMMANDS Formation Management 2</p> <ol style="list-style-type: none"> 1 Go Wedge 2 Go Trail 3 Go Ladder 4 Go Stack 5 Go Fluid 6 Go Spread 	<p>WINGMAN COMMANDS Miscellaneous</p> <ol style="list-style-type: none"> 1 Fence In 2 Fence Out 3 Music On 4 Music Off 5 Turn Smoke On 6 Turn Smoke Off 	<p>WINGMAN COMMANDS Runway Lineup</p> <ol style="list-style-type: none"> 1 Single-Ship 2 Element

The above are pictures of the wingman commands.

Combat Management Pages

- Attack My Target:** Directive call for the wingmen to attack the specific target that is either under the sensor but not necessarily locked. It can be either an air to air or an air to ground target. (Will be greyed out if no target is available.) In AG mode the AI will acquire target, fire one weapon and then rejoin.
- Buddy Spike:** An informative call you announce on the radio when a friendly locks you up on FCR. By stating Buddy Lock you tell him that the contact he bugged is a friendly.
- Raygun:** After locking up a target you call Raygun to request a buddy lock. Helps you determine if the contact you just bugged is a friendly. Be aware he will answer on his radio frequency, you won't hear the answer if you are not on the same frequency. (Will be greyed out if no target is available.)
- Weapons Free:** Self-explanatory – Clearance for the wingmen to use its weapon in a self-directing targeting manner. The initial state of AI wingmen is Weapon hold. When wingmen receive the weapon free command they will start looking for the target on their own.
- Weapons Hold:** Self-explanatory – Directive call to the wingmen to hold fire. Wingman will then request clearance before targeting. This is the default state of the AI wingmen. In this state, AI will request permission to engage when they spot a target of interest. Failure to answer their call within 30 seconds will be considered a clearance for them to attack.
- Check Your Six:** Self-explanatory – Wingmen will automatically engage any threat found and will rejoin after threat is eliminated or if clear.
- Clear My Six:** Self-explanatory – Wingmen will automatically engage any threat found and will rejoin after threat is eliminated or if clear.



Attack Targets:	<p>Directive call to attack targets with default sort doctrine. It is assumed that lead will target the enemy lead and wingmen will target enemy wingmen counterparts. Rather than the “Attack My Target” where everyone attacks the same target here it’s more a 2 vs 2 or 4 vs 4 scenario.</p> <p>In air to ground mode, the AI will attack briefed targets and prioritise them as assigned in the briefing. They may execute multiple passes until you call them to rejoin. (Will be greyed out if no target is available.)</p>
Go Shooter:	<p><i>Only available in the wingman menu</i> - Directive call assigning the wingman as primary shooter. The wingman will engage when within weapon parameters. It is assumed that lead will cover the engaged fighter.</p> <p>(Will be greyed out if no target is available.)</p>
Go Cover:	<p><i>Only available in the wingman menu</i> - Directive call assigning the wingman to cover lead who will assume the role of primary shooter. It is unknown how the wingman will assign this role.</p> <p>(Will be greyed out if no target is available.)</p>
Rejoin:	<p>Self-explanatory – Wingman will stop whatever he’s doing (unless defensive) and rejoin previously briefed formation.</p>
Split Wing:	<p><i>Only available in the wingman menu - Issued to #4 from #3</i> - Used only when element lead (#3) wants to order his wingman (#4) to stay with him while breaking formation from the leading element.</p>
Glue Wing:	<p><i>Only available in the wingman menu - Issued to #4 from #3</i> - Used only when element lead (#3) wants to order his wingman to stick with the flight lead while he breaks formation from the flight.</p>
Drop Stores:	<p>Directive call to the wingman to perform an emergency jettison.</p>
Datalink Ground Tgt:	<p>Request for the wingman to send a datalink of its AG FCR cursor if possible.</p>

The next page (Combat Management #3) are specific to wingmen and the element section and not available from the Flight menu. Indeed, you can either assign these orders to the wingman (in a 2-ship scenario) and the element in a four-ship scenario = in this case, the wingman #2 will tactically fly with his leader).

Offensive Pursuit:	<p>The AI ordered with this command (either #2 in a 2-ship or #3 and #4 as an element in a four ship) will fly a pure pursuit intercept, fire when in range and pump after Husky and recommit if necessary.</p> <p>(Will be greyed out if no target is available.)</p>
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Offensive Split:

This command will send the second element (either #2 in a 2-ship or #3 and #4 as an element in a four ship) notching LEFT and engage the target applying complex offensive and defensive behaviours based on RWR nails and MAR.

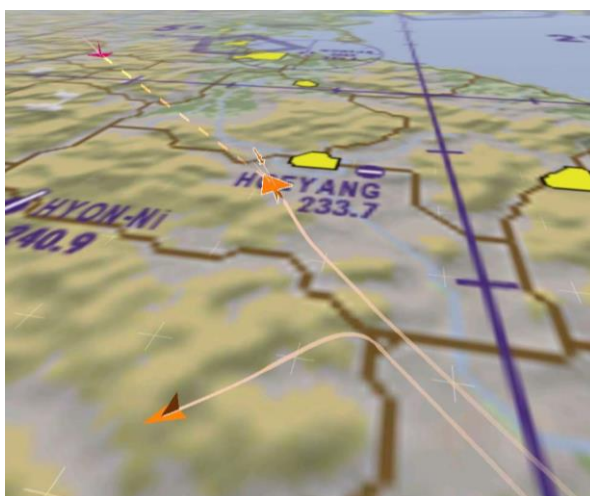
The expected behaviour from the leading element is to do the same but notching RIGHT. In a 4-ship scenario, wingman #2 will stay with its lead and fight as an element. This order should be issued before 30 NM range. (Will be greyed out if no target is available.)



Beam Deploy:

Same as Offensive Split (lead element goes right and trailing element goes left).

Except in the behaviour of the lead element: the notch RIGHT will only happen if element is Spiked. If not intended behaviour is to fly a pure pursuit intercept on the contact. The beaming element will engage the target. This order should be issued before 30 NM range. (Will be greyed out if no target is available.)



Grinder:

Instruction for the element to initiate a Grinder which is a BVR tactic to constantly have one element on the offensive while the other element is either retreating or supporting their missile. When told Grinder the element will go in 6 NM trail.

Intended behaviour from the leading element is to fly a pure pursuit and engage when in range then crank while supporting their missiles then out once pitbull.

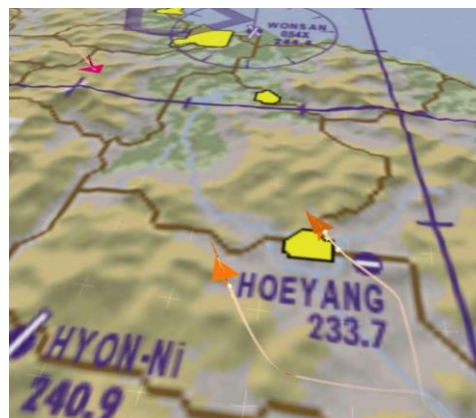


The trailing element will execute the same tactics while the lead element will either support their missile or disengage to reposition. This order should be issued before 30 NM range. (Will be greyed out if no target is available.)



Wide Azimuth: Lead element (#1 & #2 in a four-ship scenario) crank LEFT while trailing element (#3 and #4 in a four-ship scenario - #2 in a 2-ship scenario) crank RIGHT. All elements will engage the target when in range applying complex offensive and defensive behaviours based on RWR nails and MAR. This command should be issued before 30 NM range ensuring the WIDE Azimuth aspect.

(Will be greyed out if no target is available.)



Short Azimuth: Same as the Wide Azimuth command but should be issued within 15 NM of the target to ensure the SHORT Azimuth aspect.

(Will be greyed out if no target is available.)

Sweep: The Sweep commands order the element (#3 and #4 in a 4-ship and #2 in a two-ship) to sweep for contacts by flying pure pursuit on them and engaging while in range. Expected behaviour from the leading element (lead in a 2-ship scenario and lead and #2 in a 4-ship scenario) is to continue flying their INS route.

Depending on how many bandits are still hot after the first pass, all aircraft will engage and apply complex offensive / defensive behaviours, based on RWR nails and MAR. This order should be issued before 35 NM range.

(Will be greyed out if no target is available.)

Defensive: When issued this command all aircraft will avoid combat at all costs by pumping away from the threat. Should be issued when threats are outside 30 NM.

(Will be greyed out if no target is available.)



The Mission Management Page

Resume Mission:	Directive call to your wingmen to proceed with the mission objectives.
Return to Base:	Self-explanatory – wingmen will follow flight plan back to home base and land.
Snooze Radar:	Directive call to put FCR in standby.
Activate Radar:	Directive call to resume FCR operations.
Say Position:	Self-explanatory – Request position update from wingmen who will answer with clock reference, BRAA or bullseye depending on distance from lead.
Say Damage report:	Self-explanatory – the wingmen will provide a list of bent systems.
Say Status:	Request current engagement status (offensive, defensive, clear.)
Say Fuel State:	Self-explanatory – gives total fuel in hundreds of pounds remaining (for example 83 means 8300 Lbs).
Say Weapon State:	More complete report than above listing AG weapons, AA weapons remaining and total fuel in hundreds of pounds remaining.

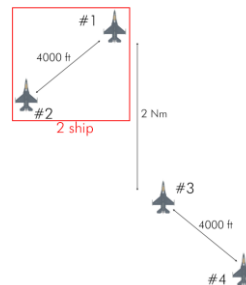
The Formation Management Pages

Close up:	Self-explanatory – distance is reduced by a factor of 2.
Switch Side:	Self-explanatory.
Break Right:	Self-explanatory – wingman will rejoin formation after the break.
Break Left:	Self-explanatory – wingman will rejoin formation after the break.
Go Higher:	Self-explanatory – incremental by 1000 feet.
Go Lower:	Self-explanatory – incremental by 1000 feet.
Flex:	When the wingmen are told to flex they start one holding pattern and then rejoin. The tactical aspect of such command escapes me. The only possible advantage of this command is to put them in trail of 10 - 15NM. But they will speed up for rejoin after and it will make them burn lots of fuel, unless you made it easy for them
Take the Lead:	Directive call for the wingman to take the lead. Doing so he will resume mission objectives. It is not said how one should re-take lead.
Kickout:	Self-explanatory – (opposite of close up) distance is increased by a factor of 2.



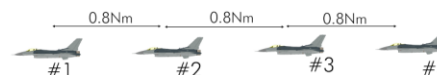
Go Wedge:

Directive call to change formation to Wedge. In a two-ship scenario the wingman will go on the 4-5 o'clock position in wedge. In a 4-ship scenario the trailing element is about 2 NM in trail and the wingman flies wedge on his lead.



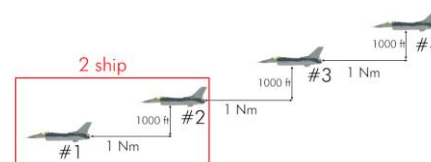
Go Trail:

Directive call to change formation to trail. In a two-ship scenario the wingman will go trail 2 NM. In a 4-ship scenario each aircraft will trail the previous one by 0.8 NM (about 5000ft).



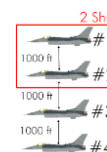
Go Ladder:

Directive call to change formation to ladder. Each aircraft in the formation will fly 1 NM and 1000 feet high than the aircraft it is following.



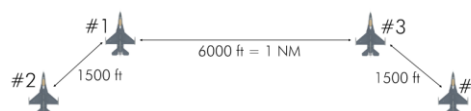
Go Stack:

Directive call to change formation to a stack. Stack is the same as line abreast but in the vertical plane. Each aircraft in the formation will fly 1000 feet lower than the previous aircraft.



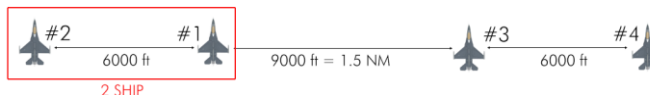
Go Fluid:

Directive call to change formation to Fluid. It was initially named RES CEL in Falcon 4.0. In a 2-ship scenario, the wingman simply goes spread 1NM left. In a four-ship, wingmen go wedge on their lead and element lead is spread with flight lead.



Go Spread:

Directive call to change formation to line abreast. In a two-ship scenario the wingman will go either 1NM spread left. In a four-ship scenario the Wingmen will go half a mile from their lead on the outside of the formation. Lead and element lead will be spaced 1 NM apart with element lead on the right of flight lead.

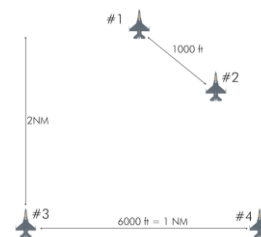


Go Arrowhead:

Only valid for a 4 ship but does not work - Directive call to change formation to arrowhead. Lead element in wedge and trailing element in spread 2 NM behind.

(Will be greyed out if you are not in a 4-ship flight).

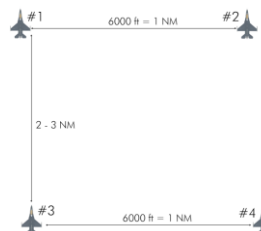
When instructing this formation, the trailing element will wave continuously around the leading element never finding the right spot. This formation is currently not to be used. Instead Use 4 ship wedge which is an arrowhead anyway.



Go Box:

Only valid for a 4 ship but does not work - Directive call to change formation to Box. Lead element in Spread and trailing element in spread 2 NM behind.

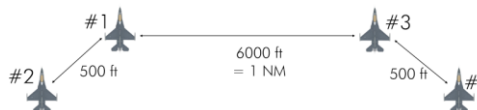
When calling into this formation, the trailing element will wave continuously around the leading element never finding the right spot. This formation is currently not to be used.



The next ones are only available from the Formation Management 3 page, accessible only from the Flight menu:

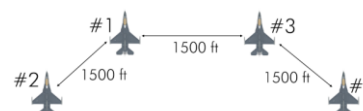
Go Res Cell:

Same as tight fluid four - Res cell is probably a left over from the original Falcon 4. Since the RP5 days Res Cell has been updated to Fluid four in the element menu. Chances are that the option Res Cell in the flight menu was forgotten. Res Cell provides the same result as Fluid four but with the wingman closer to their respective lead. Lead and element lead are 1 NM just like in Fluid four.



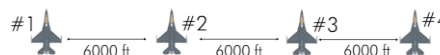
Go Vic:

Vic is an even tighter fluid four formation with all aircraft separated by less than 2000 feet.



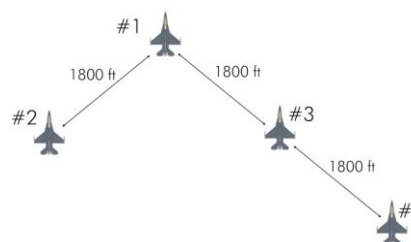
Go Line Abreast:

Same as spread - Line abreast is the other name of spread formation. In this case the difference between the two is that in spread all the wingmen are on the outside of the formation. In line abreast, wingman #2 is inside the formation. Distance between aircraft is constant at 1 NM.

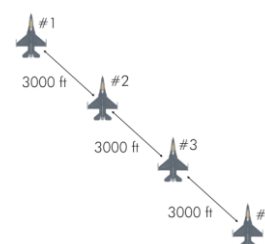


Go Finger Four:

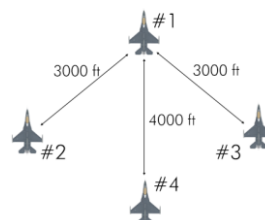
Finger four is a tight V formation which is resembling what the original Falcon 4.0 manual described as a wedge formation. Each aircraft is separated by 1500-2000 feet apart in a V formation.



Go Echelon Left: Standard echelon formation. Each aircraft is separated by 3000 feet or half a mile.
Go Echelon Right: Same as above but on the right (pictured)



Go Diamond: Airshow formation in the shape of a diamond with #4 trailing #1 at 4000 feet. #2 and #3 are wedge on lead.



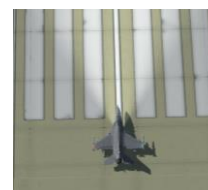
The Miscellaneous page

Fence In: Self-explanatory. Note that wingmen will keep their lights on whereas it's standard procedure for humans to turn their lights off at Fence In. As well, wingmen will still fight even if the fence in command was not issued.
Fence Out: Self-explanatory.
Music On: Directive call to activate electronic counter measures (if possible).
Music Off: Directive call to terminate electronic counter measures.
Turn Smoke On: *Unrealistic* - Instruct wingman to turn smoke ON for easy ID.
Turn Smoke Off: *Unrealistic* - Instruct wingman to turn smoke OFF.

The Runway Line-Up page

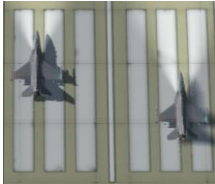
Only the WINGMAN and the FLIGHT have the Line-up page. The element does not have the Line-up page. Please note, default line up is always in element. ATC will expect 2 ship flights to line up in echelon with the lead on the downwind side of the runway. 4 ship will line up in 2 ship echelon as well unless called otherwise.

Single Ship: Directive call to make a single ship line up. The wingmen will stay behind the hold lines and will line up after the previous take-off is complete. In this scenario the aircraft will line up on centreline.




Element:

This call is completely useless as AI line up in echelon as default anyway. So using this command does nothing more than if you used no comments at all. Behaviour is the same from the wingman and flight menu. Just ignore this option. In an echelon 2 ship line up, each aircraft lines up in the centre of its lane. Flight lead always takes the downwind part of the runway to avoid being pushed into the wingman’s side.




Echelon:

Only available in-flight menu - Directive call to make a 4-ship echelon line up. Using this command the 4-ship flight will align in echelon with flight lead on the downwind side of the runway, close to the runway edge so the other aircraft have enough room. Normally this line up formation is restricted to wide runways.



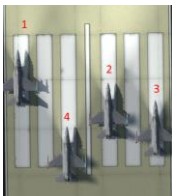
Four Ship Three In:

Only available in-flight menu - Directive call to make a 4-ship line up with number 3 in the slot. This is the most common 4 ship formation line up used. Flight lead when aligning should take care to leave enough room for the slot position and place his aircraft a bit closer to the runway edge than in regular 2 ship line up.



Four Ship Four In:

Only available in-flight menu - Directive call to make a 4-ship line up with number 4 in the slot which is the least used formation for line up. The lead element positions as in the 3-ship line up.



The Element Menu

<div> <div>ELEMENT COMMANDS</div> <div>Combat Management 1</div> <div> 1. Attack My Target 2. Buddy Spike 3. Clear my 4. Weapons Free 5. Weapons Hold 6. Check Your Six 7. Clear My Six 8. Attack Targets </div> </div>	<div> <div>ELEMENT COMMANDS</div> <div>Combat Management 2</div> <div> 1. Rejoin 2. Single-Side Offset 3. Pinch 4. Posthole 5. Chameleon 6. Drop Stores 7. Datalink Ground Target </div> </div>	<div> <div>ELEMENT COMMANDS</div> <div>Combat Management 3</div> <div> 1. Offensive Engagement 2. Conservative Engagement 3. Defensive Engagement </div> </div>	<div> <div>ELEMENT COMMANDS</div> <div>Combat Management 4</div> <div> 1. Beam Deploy 2. Beam Beam 3. Wall 4. Grinder 5. Wide Azimuth 6. Short Azimuth 7. Wide LT 8. Short LT 9. Defensive </div> </div>
<div> <div>ELEMENT COMMANDS</div> <div>Mission Management</div> <div> 1. Resume Mission 2. Return to Base 3. Snooze Radar 4. Activate Radar 5. Say Position 6. Say Damage Report 7. Say Status 8. Say Fuel State 9. Say Weapons State </div> </div>	<div> <div>ELEMENT COMMANDS</div> <div>Formation Management 1</div> <div> 1. Close up 2. Switch Side 3. Break Right 4. Break Left 5. Go Higher 6. Go Lower 7. Flex 8. Kickout </div> </div>	<div> <div>ELEMENT COMMANDS</div> <div>Formation Management 2</div> <div> 1. Go Wedge 2. Go Trail 3. Go Ladder 4. Go Stack 5. Go Fluid 6. Go Spread 7. Go Arrowhead </div> </div>	<div> <div>ELEMENT COMMANDS</div> <div>Miscellaneous</div> <div> 1. Fence In 2. Fence Out 3. Music On 4. Music Off 5. Turn Smoke On 6. Turn Smoke Off </div> </div>

The Flight Menu

<p>FLIGHT COMMANDS Combat Management 1</p> <ol style="list-style-type: none"> 1. Attack My Target 2. Buddy Spike 3. Raygun 4. Weapons Free 5. Weapons Hold 6. Check Your Six 7. Clear My Six 8. Attack Targets 	<p>FLIGHT COMMANDS Combat Management 2</p> <ol style="list-style-type: none"> 1. Rejoin 2. Drop Stores 3. Datalink Ground Target 	<p>FLIGHT COMMANDS Mission Management</p> <ol style="list-style-type: none"> 1. Resume Mission 2. Return to Base 3. Snooze Radar 4. Activate Radar 5. Say Position 6. Say Damage Report 7. Say Status 8. Say Fuel State 9. Say Weapons State 	<p>FLIGHT COMMANDS Formation Management 1</p> <ol style="list-style-type: none"> 1. Close up 2. Switch Side 3. Break Right 4. Break Left 5. Go Higher 6. Go Lower 7. Flex 8. Kickout
<p>FLIGHT COMMANDS Formation Management 2</p> <ol style="list-style-type: none"> 1. Go Wedge 2. Go Trail 3. Go Ladder 4. Go Stack 5. Go Fluid 6. Go Spread 7. Go Arrowhead 8. Go Box 9. Go Res Cell 	<p>FLIGHT COMMANDS Formation Management 3</p> <ol style="list-style-type: none"> 1. Go Vic 2. Go Line Abreast 3. Go Finger Four 4. Go Echelon Left 5. Go Echelon Right 6. Go Diamond 	<p>FLIGHT COMMANDS Miscellaneous</p> <ol style="list-style-type: none"> 1. Fence In 2. Fence Out 3. Music On 4. Music Off 5. Turn Smoke On 6. Turn Smoke Off 	<p>FLIGHT COMMANDS Runway Lineup</p> <ol style="list-style-type: none"> 1. Single-Ship 2. Element 3. Echelon 4. Four-Ship Three In 5. Four-Ship Four In

1.6 UHF

UHF is usually used for inter-flight communications or two-way communications between flight and control agencies.

As you have realised by now, every flight in the sim has a comms plan associated with it.

In a package, the first flight callsign determines the UHF frequency for the whole package. This is a small detail that may have important consequences, especially in the way missions are created. Think that if an AWACS or a refueller are part of multi flight packages and are the primary flight, you will hear all the flights on the AWACS or refueller frequency. Sometimes it's necessary, sometimes it just crowds the frequency for nothing.

In the UHF range, the specific frequencies associated with the DTC presets are as follows:

- Preset #1: Departure airbase Ops frequency.
- Preset #2: Departure airbase Ground frequency.
- Preset #3: Departure airbase Tower frequency.
- Preset #4: Departure airbase Departure/Approach frequency.
- Preset #5: Tactical check-in (place holder for the future AWACS operations, not mandatory in 4.34).
- Preset #6: Tactical frequency (AWACS controller assigned to your package).
- Preset #7: Arrival airbase Departure/Approach frequency.
(If both bases are the same, preset will be the same as departure airbase and #7 will not be used.)
- Preset #8: Arrival airbase Tower frequency.
(If both bases are the same, preset will be the same as departure airbase and #8 will not be used.)
- Preset #9: Arrival airbase Ground frequency.
(If both bases are the same, preset will be the same as departure airbase and #9 will not be used),
- Preset #10: Alternate airbase Departure/Approach frequency.
- Preset #11: Alternate airbase Tower frequency.
- Preset #12: Alternate airbase Ground frequency.
- Preset #13: Air to Air refueling.
- Preset #14: UHF common also called Advisory (always 339.750). This preset allows communication with the UI and corresponds to the F1 IVC push to talk.

Preset #13 (AAR) will only appear if the flight is fragged to refuel and has a refuel steerpoint within its flight plan. Preset #20 (LSO) will only appear if the arrival airbase is a carrier.

1.6.1 The Tactical Net

Normally when you're not under the control of ATC, you should be tuned to the mission's tactical net.

The DTC by default assigns UHF preset #6 for the Tactical Frequency. Most of the time it's an AWACS controller assigned to your mission frequency. AWACS have multiple controllers and each of them manage specific packages within the same area.

It's important to notice that different packages may be assigned different tactical frequencies, as having everyone on the same frequency would not be efficient. On the other hand, having limited numbers of aircraft on a single tactical frequency might not be enough to build a valid situational awareness.

Flights within the same package will be on the same tactical net. Another package flying at the same time in the same area might be on a different tactical net.

The immediate consequence of this is that when you are flying solo in a single flight, the radio will sound quite dead when compared to before 4.34 when we had the radio working magically according to the proximity of other flights.

On the other hand when part of a package mission you will now hear only communication within your package and that will allow you to build a much better SA than before where we heard completely useless calls from aircraft 100 NM away, often not in any way related to our mission.

AWACS has been completely overhauled with 4.34 and now is a good time to introduce these changes.

As before, to be able to benefit from the AWACS help, an AWACS must be in flight. Obviously if no AWACS is in the area, nobody will answer your call on the tactical net which will then be a kind of Unicom frequency.

The tactical net radio option menu can be accessed with the A or Q key (depending on your keyboard setting). Like the ATC menu it has multiple pages accessible by repeatedly pressing the same key (A or Q) The first page is the AWACS menu and the second page is the Vector page where you can ask radar vectors for specific situations. As you can see the tactical net is not only about managing combat operations but is also your go to frequency to get help whenever needed (can help to find your alternate airbase, can help you find and establish contact with a tanker, ...)

AWACS COMMANDS AWACS Page	AWACS COMMANDS Vector Page
1 Request Picture	1 Vector to Nearest Air Threat
2 Declare	2 Vector to Target
3 Request Help	3 Vector to Package
4 Wilco	4 Vector to Tanker
5 Unable	5 Vector to Divert Field
6 Check-In	6 Vector to Home Plate
7 Check-Out	7 Vector to Carrier Group
8 Request Relief	
9 Request Rescue Chopper	

The most used options will no doubt be either the "Request Picture" or the "Declare" menu items.



Picture call

The way AWACS responds to a “Request Picture” call is now much more realistic than before.

Cobra 2-1 magic 1 picture is multiple groups range and azimuth split

West group bullseye 3 6 0 / 1 4 24000 hot hostile

Northwest group bullseye 3 4 5 / 1 6 19000 hot hostile

East group bullseye 0 6 0 / 4 6 17000 track Southeast hostile

AWACS is now able to report up to 3 groups with the initial message being the overall picture aspect:

Range split: all contacts within 10° of azimuth.

Azimuth split: all contacts within 10 NM of range, with wider than 10° azimuth difference.

Range & Azimuth split: neither.

Cobra 2-1, Magic1, Picture is multiple groups range and azimuth split

Each group (which can be a single aircraft, a pair or 12 as long as they are very close to each other) will then have its own line with the relevant information:

LABEL group or Cardinal Direction, bullseye/BRAA XXX/XX, XX thousands, ASPECT, ID

- Label group is relevant only to Range split calls and will be either **Lead**, **Centre** and **Trail**
Cardinal direction is for all the 2 options (Azimuth split and Range & Azimuth split) with one exception: If one group is placed exactly in the middle of the 2 others, its label will be **Centre**.
West group; ...
- BULLs/BRAA XXX/YY is either the bullseye position of the group or the Bearing and Range of this group in relation to the station calling.*
By default, above 25NM you will get a Bullseye position (if the option radio calls use bullseye is active in your setup) and under 25 NM the AWACS controller will automatically switch to BRAA.
... bullseye 360 / 14 ...
- XX thousands is obviously the altitude of that group in feet.
... 24000 ...
- ASPECT is the group aspect:
HOT: 180-120° aspect,
BEAMING: 120-80° aspect,
DRAGGING: 80-40° aspect,
COLD: 40-0° aspect.
At longer ranges, the AWACS will use TRACK [cardinal direction] which is more useful than aspect.
... HOT ...
- ID is based on Declare call: Friendly, Bogey, Bandit, Hostile and Furball (if friendlies are mixed)
... Hostile.

* That BRAA call before 4.34 was always relevant to the player hearing the message regardless of who asked. In 4.34 that BRAA call is now ALWAYS relevant to who requested it. If you are not the originator of the call, the BRAA might not be accurate from your origin.





Some examples:

- If picture has only a single group :
Falcon 1, Sentry 1, picture is one group, bullseye XXX/YY NM, hot, hostile.
- If picture has several groups :
**Falcon 1 Sentry 1, picture is three groups, range split
Lead group bullseye XXX/YY NM, hot, hostile
Centre group bullseye AAA/BB NM, beaming, bandit
Trail group bullseye CCC/DD NM, beaming, bogey**
- Or:
**Falcon 1 Sentry 1, picture is two groups, azimuth split
West group bullseye XXX/YY NM, beaming, hostile
East group bullseye CCC/DD NM, cold, bogey**

Note: if more than 3 groups are detected by AWACS, he will report "picture is multiple groups" to let you know, but only the first three will be reported fully

Declare call

The Declare option is used when a pilot bugs a target on his FCR and asks AWACS for the ID of the contact. It works the same way as before with only one exception. If there are friendlies and hostiles close together (4NM horizontal range, 10000 ft altitude difference from the contact locked up), AWACS will now call "Furball" and give the number of friendlies and hostiles bunched up together.

Example :

**Sentry 1, Falcon 1, Declare
Falcon 1, Sentry 1, Furball, 2 friendly, 3 bandit.**

Bogey Dope

Bogey dope is a call made to AWACS to ask specifically for a vector to the nearest threat. It's made with opening the second page of the Tactical net menu and selecting option 1: "Vector to Nearest Air Threat".

AWACS will then answer with either a Bullseye or BRAA call depending on whether the contact is outside 25NM (BULL) or inside 25 NM (BRAA)

Cobra 2, Magic 1, nearest threat BRAA 345/19 miles 25 thousand, beaming, Hostile, Print Mig-21, 2 ship.

The rest of the options on the AWACS page are either self-explanatory or not working correctly in BMS. Just ignore them for the time being.



1.6.2 The Tanker

Like all other aircraft frequencies with the new radio plan, tanker frequencies are dependent on the tanker callsign. And luckily tankers always have specific callsigns.

Camel 1 will always be UHF 301.850 & Canteen 1 will always be UHF 292.875, ...

But since you can have multiple Camels, Texaco or Canteen flights, it is not suitable to remember their frequency by heart, so you need a way to get the tanker frequency.

Whenever a flight has a refueling point in its flight plan, there is a tanker associated to it. When this is the case, the tanker frequency will appear in the COMM LADDER of the briefing and usually a DTC preset will be associated with it (by default UHF PRESET #13):

CHECK-IN:	Eyeball1	331.875 MHz [5]	--	AWACS: Global Check-In
TACTICAL:	Eyeball1	250.600 MHz [6]	--	AWACS: Package Comms
TANKER / AAR:	Camel1	301.850 MHz [13]	--	Boom Operator

A problem arises when there is a tanker in the air but your flight has no refueling point planned. The tanker frequency will then NOT be listed in your own briefing and without knowing the tanker frequency you won't be able to contact them to request fuel.

As said earlier the ATO lists the frequencies for each flight. So if you look up the tanker flight prior to flying you may record its tactical frequency (UHF) and by setting up that frequency you may be able to talk to them.

If you went flying without checking that beforehand, you may use the AWACS to give you the tanker information. On your tactical UHF frequency, open the tactical net second page radio menu and select option #4: "Vector to Tanker":

Cobra 2 magic 1 tanker Texaco 1 bullseye 1 5 0 / 1 2 4 TACAN channel 2-9 Yankee

Cobra 2 magic 1 tanker Texaco 1 Uniform 2 9 3 4 5

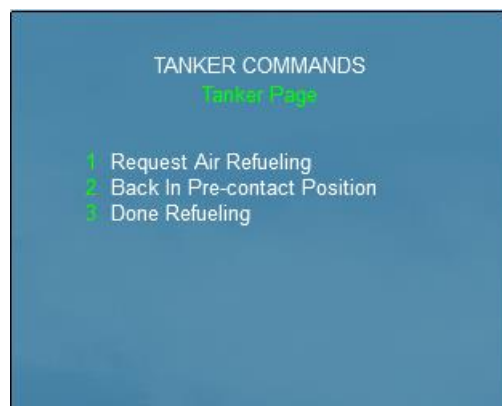
The AWACS will respond with the position of the tanker, its Tacan channel and its UHF frequency. The tacan channel is the one you should input (you don't have to calculate the matching 63 channel apart.)

If you have no AWACS in flight in that mission, well ... go alternate because you won't be able to request AAR.

Luckily most campaign flights will have an AWACS. As for TE's it's better if the TE is designed in such a way that if a tanker is present, the flights have a refuel point. That should simplify matters.

Another thing to avoid when designing a TE is to have the tanker the primary flight of the package. When that is the case, the tanker UHF frequency is the primary frequency for its package and you may hear all the AI flying in that package while you refuel. To avoid that always task the escort flight first which I agree is quite contrary to the TE edition workflow.

Once on the tanker frequency you will be able to communicate with the tanker with the Tanker radio menu accessible with the “y” key. It’s a single page menu with 3 options:



It is still the same as before except for the middle option that was rephrased from previous version.

- The Request Air Refueling is used on initial contact with the tanker (usually from flight lead) to request an air to air refuel for the flight. Once AAR is requested, the receiver flight is considered as a single entity and the whole flight should refuel in sequence.
- The second is used in case of a voluntary disconnect and a sudden change of mind where the pilot wants to get right back on the boom, before the next guy in sequence. This option is hardly required and will probably never be used unless on purpose. You should not use this option to tell the boomer you’re stabilised and ready in pre-contact.
- The third is still to be used after refueling to let everyone know you’re done and the next guy can get cleared to pre-contact.

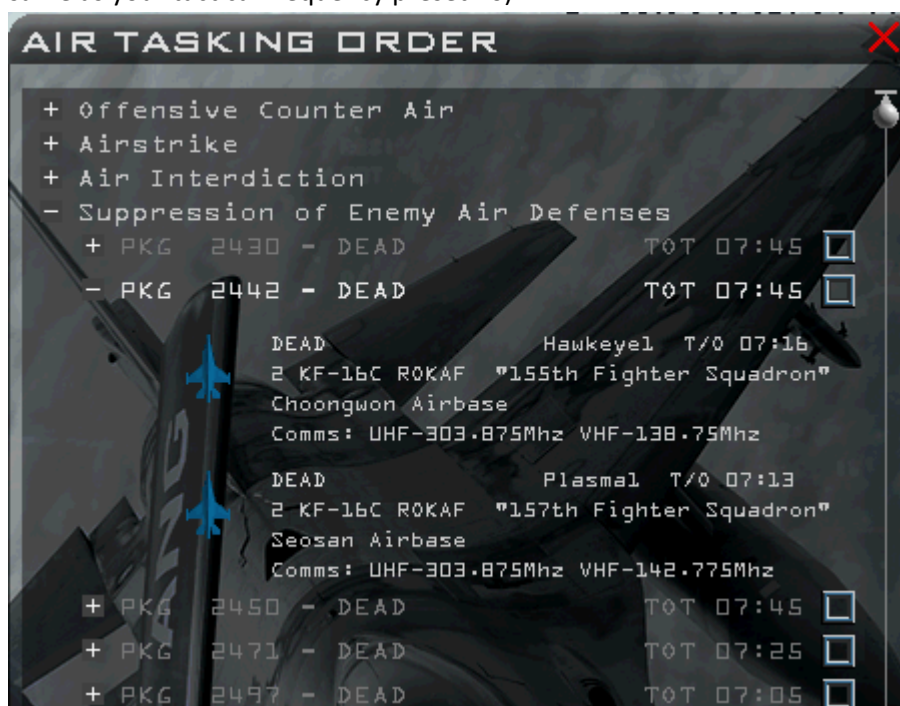
For further information about refueling, please refer to the BMS -1 AAR section.

1.7 Other ways to find frequencies for a specific flight

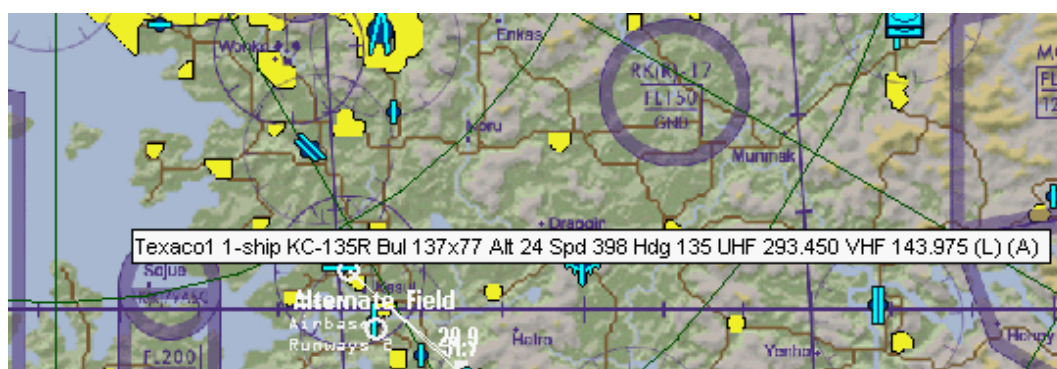
If you need to contact a specific flight on the radio, you need to know the frequency set they use.

Beside the briefing page, there are two ways to get that information from the UI:

- The ATO will list both the VHF and UHF frequency of a flight.
The VHF is the intra flight frequency.
The UHF is the assigned tactical frequency for that package (their preset #6 – which might not be the same as your tactical frequency preset #6)



- Placing your mouse cursor over a flight icon on the UI map will display the info relevant to that flight and the frequencies are listed as well.



1.8 IDM

IDM sends and receives data through the radios. It can be set to either VHF or UHF.

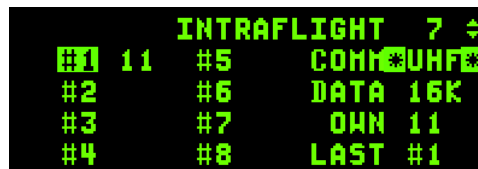
By default in 4.34 Air to Ground IDM is set to VHF and Air to Air IDM is set on UHF. The default settings can be changed through the UFC LIST, ENTR page:

The DED defaults to Air to Ground datalink and the scratchpad is set around the radio set for AG datalink. To toggle it to the other radio, simply press any ICP key (1-9) .



A-G DL 7 ÷
XMT 10 COMM UHF*
OWN 11 DATA 16K
FILL ALL PRTL AFAPD

To select the Air to Air page of the Datalink, you must dobber right to display the INTRA FLIGHT page. It's not called Air to Air, but this is the AA part of the datalink. As you see it defaults to UHF and you may change it in the same way as explained above.



INTRAFLIGHT 7 ÷
11 #5 COMM UHF*
#2 #6 DATA 16K
#3 #7 OWN 11
#4 #8 LAST #1

In an air to air situation, you may need to add IDM addresses of other flights from your package. As an example, if you're a strike flight with an escort flight in your package, getting the air to air information of your escort flight on IDM will be critical. Since you are not on the same VHF frequency as your escort flight, you cannot set VHF as AA datalink and expect to receive their data. That's the reason why UHF is set as default for AA: so you can get AA datalink from other flights in your package if you set your IDM page with relevant addresses.

Air to ground will most likely remain linked to your direct wingmen, hence why AG datalink is VHF by default as you will be on their VHF frequency obviously.

Now there's a catch with the AI. Positional updates you get from your package members are part of the Air to Air datalink and AA datalink will work with the AI only on the tactical net. That is: only on preset #6 (AWACS frequency).

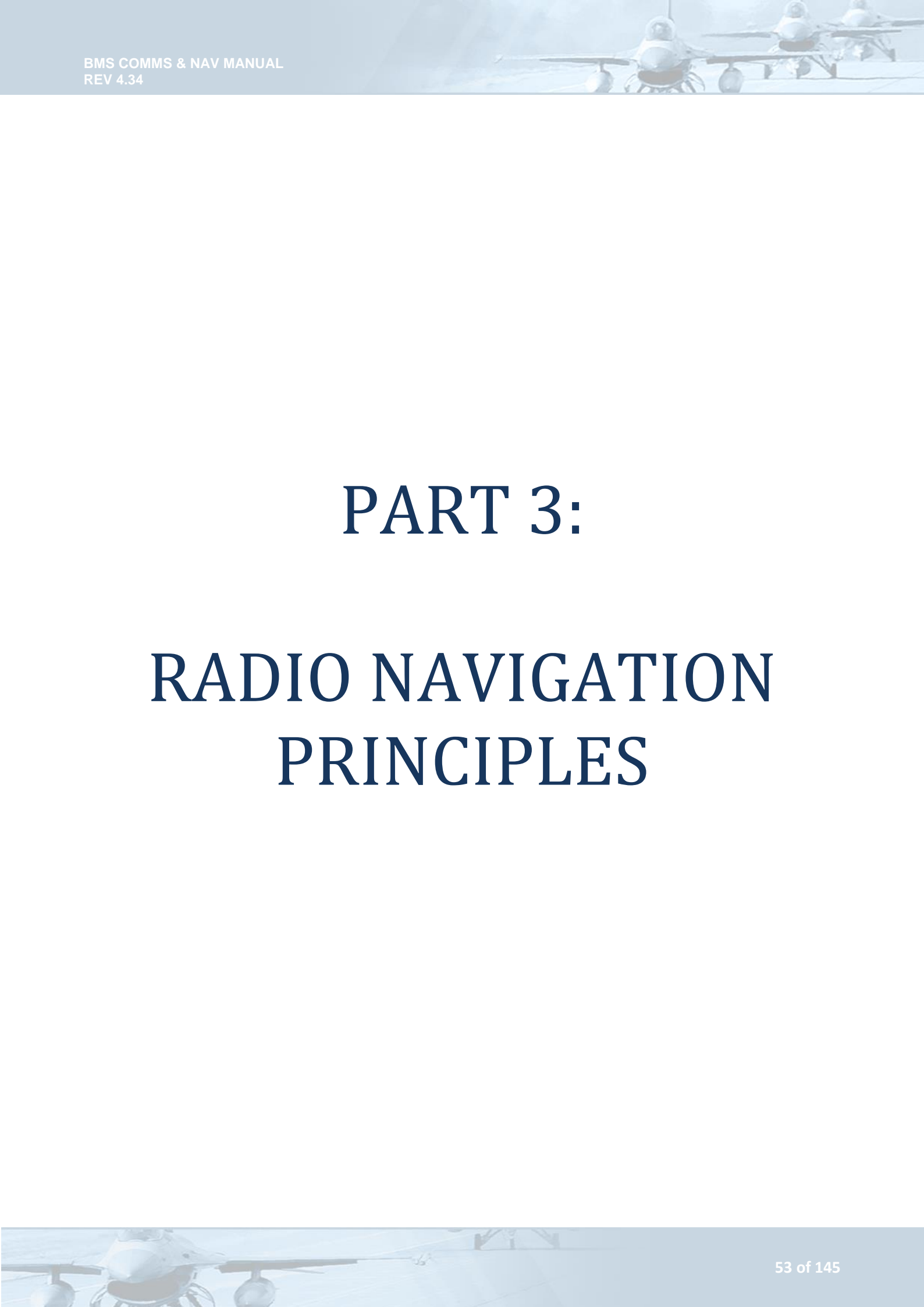
The consequence of that is that you will not get any AA datalink (positional updates, cursor positions, ...) when you are not set to the tactical net on UHF => read ATC for instance.

Back in 4.33, positional updates from the AI was very useful around airbases because their ATC procedure was a bit wild to say the least. Fortunately ATC is way better in 4.34 and you will be able to build your SA from the radio traffic between the AI and the ATC. So the loss of the IDM during approach and departure will not be as critical as one would imagine.

Still it is important to realise that AA IDM with AI will now only happen on the tactical net.

1.9 Technical notes

- If you select briefing for a flight in which you have not taken a seat, you may not see all the frequencies assigned to presets for that flight. To see them all, make sure you take a seat in that flight.
- The briefing also includes (in the header section) the type of flight it is related to and the package ID. These values give you a way to look into the ATO dialog box to find the flight more quickly if you need to do that since the ATO is indexed by type of flight and then in package number order.
- The assignment of frequencies to flights is based on callsigns. There is a list of callsigns used in all TE and campaign settings. Based on this list there is a new data file "radiomap.dat" that is located in the data\campaign directory. This operates similarly to the stations+ils.dat file in that it is loaded when you commit to a mission so it can be theatre specific if needed. For more information about the format of the radiomap.dat file, please refer to the BMS technical manual.



PART 3:

RADIO NAVIGATION PRINCIPLES

3.1 Basic Radio Navigation in Falcon

We can't really hope to explain how to use the charts in BMS without talking a little bit about radio navigation, can we? Radio navigation is a vast subject and there are publications and tutorials available on the web to learn how to master IFR flights. One of the best resources for us are the civilian flight sims such as Prepar3D or X-plane. There are also a lot of Jeppesen publications - very useful. (See sources ...)

As opposed to VFR (Visual Flight Rules), IFR (Instrument Flight Rules) uses radio beacons aids and allows the pilots to fly without any visual reference. In real life, there are quite a few different beacons:

- NDB: Non Directional Beacon
- VOR: VHF Omni Directional Range
- DME: Distance measuring equipment
- VORDME: Beacon combining the VOR and the DME.
- TACAN: TACTical Air Navigation system.
- ILS: Instrument Landing System

BMS supports only Tacans for navigation and ILS for landing. Tacans are typical of military radio beacons but restricting the navigation stations in BMS to tacan only would not allow complete navigation coverage of the theatre. Therefore it was decided long ago to consider the real world civilian VOR-DMEs as Tacans in BMS. From now on, we will name them tacan to avoid further confusion.

A tacan is a beacon emitting radio waves in all directions (360°) with a fixed range and a distance measuring capability. In BMS we have two type of tacans:

- The terminal area tacan used for airbase approach and located near airbases – often on the runway axis. Usually these beacons have a maximum range of 25 to 50 NM.
- The navigation tacan which has a longer nominal range of 100 or even 200 NM. They are placed strategically in high grounds to maximise their range (LOS) and usually located at airway intersection points.

In the cockpit, we read the tacan information through the HSI Instrument.



3.1.1 Tacan mechanisation

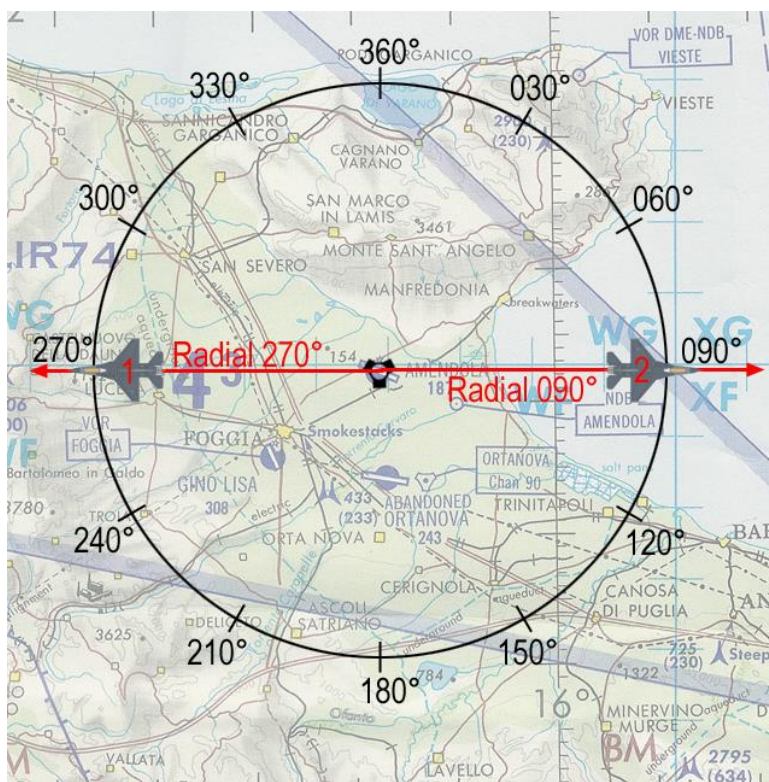
But first, let's come back for a while to discuss the Tacan.

A tacan station emits 360 radials, one for each degree of the circle. Please note that the further you are from the station, the further apart the radials are and as a consequence, navigating far away from a station is less precise than navigating near the station.

Radials are half-lines with a fixed origin (the station) but reach infinity on the other side.

Well in this case infinity stops at the station maximum emitting range ☺ which is set in the stations+ils.dat file but this range will be reduced if you fly low (curvature of the earth limiting your horizon) or if there are natural obstructions between the emitter and the receiver. Basically the receiver must be line of sight with the emitter to allow signal reception.

We accept the fact that as for the headings 360° is North, 090° is East, 180° is South and 270° is West.



As a consequence we need two radials to cover one direction:

Radial 090° for the right quadrant and radial 270° for the left quadrant for instance. Those two radials draw a full line in the middle of the circle.

An aircraft cannot be on the 270 radial if it is east of the station. It is on the 090 radial.

But established on the same radial (090° for instance), you can fly a heading of 090° (outbound the station – your distance to the tacan is increasing) or 270° (inbound the station – your distance to the tacan is decreasing).

This is mainly semantics because you will realise that using R-270° or R-090° whatever your quadrant is has no real importance in BMS. The important thing to note here is that when you talk to somebody, being a wingman or ATC, you need to stay coherent and use the correct terminology. So even if you are flying a

heading of 270° to the station but you're still east of the station, you need to state that you are on the 090 radial inbound the station. I know this is probably confusing at this time, but read on.

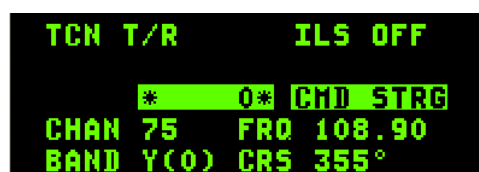
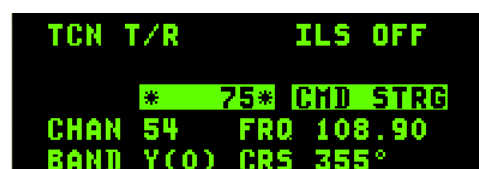
Tacans also have a distance measuring equipment (DME) that gives the distance in Nautical Miles (NM) between your aircraft and the selected station. That indication is given in the top left window labelled "miles" in the HSI. If you fly beyond the tacan range or if for any reason you do not have line of sight to the station, the instrument will be flagged with large red indicators to notify the pilot that the data received are not usable. See the HSI description further down for more information.

3.1.2 Setting up the cockpit

Obviously, the first thing you'd need to do is to set the correct information in the cockpit: Tacan channel, tacan band, radio frequency, ILS frequency etc.

The correct method to input the tacan channel and band into the cockpit is through the Up Front Controller (UFC) by using the ICP and the DED. For that to work, obviously the CNI switch of the AUX COMM panel needs to be placed in the UFC position, but that's an item required to be done at the ramp start (see checklists).

Depress the T-ILS button #1 of the ICP to enter the Tacan/ILS page of the DED:



In the example above the first picture initially shows the T-ILS page with a 54Y TR tacan selected and we will change it to 75X TR. First check that the asterisks are correctly placed around the scratchpad (DCS up or down if necessary) and press the ICP numerical keys 7 and 5 (middle picture) then the ENTER key. As you see on the bottom picture, the 54 on the 3rd line has been replaced by your input: 75.

Next is to set the correct band. In BMS, we mostly use the X band for ground and Y band for air. Strictly speaking we are not restricted to enforce that rule, Y band tacan may work for ground stations but most of the time we stick to Y band for air to air. To change the band simply input "0" (zero) in the scratchpad (bottom picture) and press ENTER. That will toggle the band from Y to X to Y ... (see figure above right).

The last thing you need to set as far as the tacan is concerned is the T/R or A/A TR. That is done by depressing the DCS switch to the right (SEQ position). The value will toggle from T/R to A/A TR and back. T/R means Transmit/Receive and is the ground to air mode and A/A TR is the air to air mode. Therefore you must set the correct T/R mode according to which type of station you want to receive: A/A TR for tacan from other aircraft and T/R for ground stations. In this example we do not need to change it as the initial setup was already set to T/R and we want to track Kunsan ground station.



T-ILS is also the page where you input the ILS frequency. The UFC is capable of detecting the difference between a tacan channel and an ILS frequency so if you enter 11090 in the scratchpad the UFC will understand it's an ILS frequency and will input it in the FRQ line after you hit ENTER.

CMD STRG is the military equivalent of the flight director. When mode selected it will enable a steering cue on the HUD for optimal ILS intercept and tracking. CMD STRG can be toggled off and on by moving the asterisks around it with DCS up or down and hit zero to mode select it. It is enabled when it is highlighted.

CRS can also be changed by moving the asterisks around it and inputting the desired course which is the runway heading. This feature should actually be used for the CMD STRG to work correctly but in BMS it is not implemented correctly. Normally if you don't tell the CMD STRG mode the ILS magnetic heading it cannot compute the optimal intercept angles. Unfortunately that is not implemented in BMS.

Please note the DED CRS is not the same as the HSI CRS. The DED CRS is only relevant to CMD STRG. In this example, the DED CRS was set to 355° which is the magnetic heading for ILS RWY 36 Kunsan.

In case of UFC failure there is a backup mode to select tacans (but no ILS). As soon as there is a UFC failure the CNI switch on the AUX COMM or C&I switch on the IFF panel must be placed to BACKUP. This disables the UFC as the primary system and enables all the backup panels. Depending which F-16 block you fly you may have an AUX COMM (left) or IFF panel (right) on the left console.



As you can see, the backup control heads are different. On the AUX COMM panel, the control heads are relevant to the tacan and on the IFF panel there are no tacan backup controls but backup IFF settings.

Where there is an AUX COMMS panel, the tacan channel and tacan band can be set with the control heads and the tacan can be placed in T/R or A/A TR with the relevant switches depending on whether you want to track ground or airborne stations (in the exact same way as you would do it with the UFC).

Where you have the IFF panel, the backup controls for the tacan have been moved to a specific MFD page accessible from the MFD menu page via the TCN OSB (OSB 12 in the left picture below).



OSB #6 toggles AA T/R and T/R, OSB #7 increases the current channel by 1, OSB #9 decreases the current channel by 1 and OSB #10 toggles band between X and Y. If you press OSB #8, a new page opens where you can input the channel with OSB rather than by increment or decrement. Just input the channel with the labelled OSB and confirm your entry with OSB#3 RTN which will then revert the MFD back to the previous page.

Obviously this new system raises a few questions. How do you for instance set your backup tacan settings when you lost your MFDs alongside your UFC?

Proper planning may save your day in this scenario. Make sure you set your backup tacan settings before you lose your system, that way they are preset and ready after a potential failure. Granted you won't choose your airbase to land at, but again planning will help you decide which contingency you may need in case of a problem.

Okay; the basic steps are done. Now is a great time to introduce the main navigation instrument of the F-16 cockpit: the Horizontal Situation Indicator. When you're simply following your pre-planned route, your main navigation instrument will of course be the HSD page of your MFD. But when you will be doing radio-navigation you will need to use the HSI.

BMS 4.34 has 2 HSI modelled dependent of the F-16 block you're flying. The analog HSI equips older blocks (non CCIP) and the newer blocks (or those updated to CCIP standards) have the EHSI (Electronic HSI).

The principles of use are the same, the only difference is that the older instrument has a small panel on its left to set its mode of operation (next page left picture) and the newer electronic instrument does not have that panel, it is replaced by a blank panel left of the HSI and the mode of operation is toggled with a button labelled "M" for Modes centrally located on the bottom of the instrument (next page right picture). The EHSI has the active mode of operation labelled inside the instrument (PLS NAV in the picture). EHSI does not label ILS but uses PLS instead for Precision Landing System.



The HSI has 4 different working modes.

TCN MODE: The instrument uses the set tacan station as a reference and gives bearing and distance relative to that station.

TCN/ILS (PLS) MODE: Same as above but gives steering cues for the ILS. Please note, BMS does not feature ILS DME so in TCN / ILS (PLS) mode the DME is from the tacan.

NAV MODE: The HSI in this case will not use a radio-navigation station as a reference but the currently selected INS steerpoint. That is very handy when you want to navigate to a waypoint and arrive with a set heading. In this mode, the steerpoint is considered a virtual tacan.

NAV/ILS (PLS) MODE: same as above but providing ILS steering cues at the same time. That position will be used for instance when returning at the pre-planned airbase and shooting an ILS approach. Please note, BMS does not feature ILS DME so in NAV / ILS (PLS) mode the DME is from the selected steerpoint.

3.1.3 The main navigation instrument: The HSI

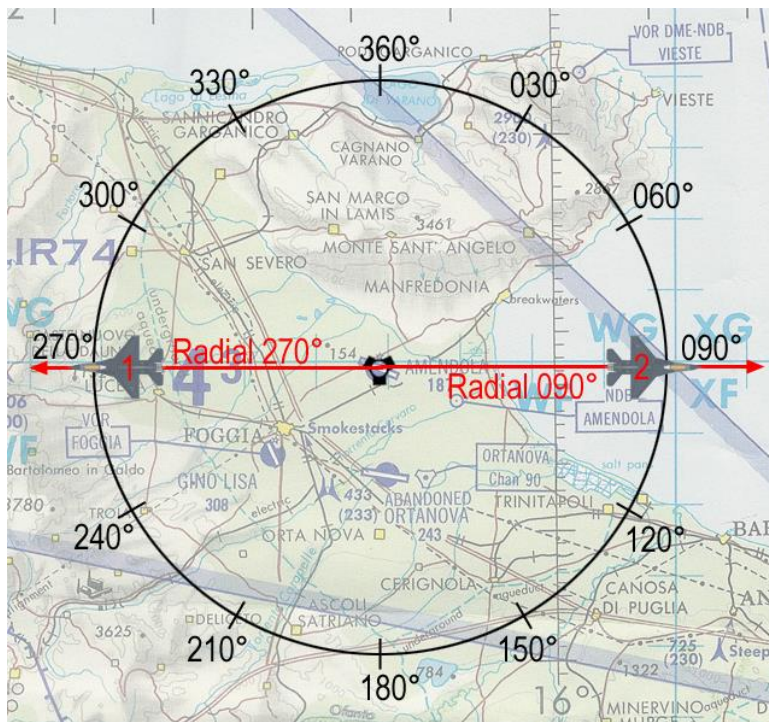
Still there? Perfect. Let's move on to the main course, the Horizontal Situation Indicator.



The instrument gives you a God's eye view of your aircraft (in the centre of the instrument) and its position relative to the selected reference (radio-navigation station in TCN mode or Steerpoint in NAV mode).

- The Heading tape: Gives your heading at the 12 o'clock position.
- The DME window: Gives the slant range (discussed later) between you and the selected station (or steerpoint).
- The Course window: Gives the currently selected radial.
- The Course knob: Sets the desired radial.
- The Heading knob: Sets the heading bug to the selected heading.
- The Course arrow: points to the selected course on the heading tape.
- The CDI (Course Deviation Indicator): Gives the position of the selected radial relative to the position of your aircraft.
- Station bearing pointer: Points directly to the selected station. This arrow is really interesting both for the beginner and the advanced user. Firstly it clearly gives the bearing to the station and for the most advanced user it can be used as an ADF (Automatic Direction Finder) able to track a virtual NDB. More on this later.
- Station bearing pointer tail: That's the tail of the red pointer, giving the reciprocal heading of the station bearing.
- To/From indicator (discussed soon).
- Heading Bug: Moves with the rotation of the HDG knob. It's a reference heading that is used by the autopilot system in ROLL HDG SEL mode. It can also be used as a reminder of headings (wind corrections, ...) when you don't use the autopilot.

Let's start with a simple ☺ example::



AC#2 – Option 1 : Set R-090°



AC#2 – Option 2 : Set R-270°

The airplane #2 is on the 090 radial. But the HSI can display two readings, depending on which radial is selected:

First, notice that the actual heading is 095°, since you see the position of AC#2 on the image above; you know the aircraft is EAST of the station and is going away. We say it's OUTBOUND.

The station bearing pointer points at 6 o'clock, meaning the station is behind AC#2.

The set course is 090 and the course arrow is aligned with the 090° on the heading tape.

The CDI is centred; meaning AC#2 is spot on the radial. If the pilot were to continue flying on the 095° heading (considering a 5° wind correction angle) the aircraft would continue flying away from the station established on the 090° radial.

The TO/FROM indicator points below meaning we are navigating FROM the station.

The bottom left picture is taken at exactly the same moment but this time the course 270° has been selected. The aircraft is still on a 095° heading OUTBOUND the station. The Course arrow points close to the 270° mark on the heading tape and the CDI is centred, meaning we are still on the 090° radial. The TO/FROM indicator points below indicating we are still navigating FROM the station. This is where which radial you are on gets tricky!

Obviously, it is easier to radio-navigate with option 1 when the course arrow is pointing to the actual heading. So you will want to align as much as possible the Course arrow with the actual heading to avoid thinking about reciprocal radials. In case of option 1 above, it is clear we want to fly outbound using the 090° radial. Because first we are flying outbound and secondly we are indeed on the radial 090°.

Let's go back to BMS by considering the following example:



AC#3 is WEST of the station and is flying toward the station with an actual heading of 090°. It's actually on the 270° radial. But it will be easier to use the 090° course in the HSI because the reading will be clearer.

Indeed if we select course 090° in the HSI, the course arrow points at the 12 o'clock position and is the same as the heading – as pictured below on the left picture you see all the arrows pointing up. On the contrary if course 270° is set, the course arrow points at the 6 o'clock position and although it is more correct, it's not easy to work with as illustrated in the bottom right picture.



As a conclusion, even though the radials are half-lines with a fixed origin, it's always better to navigate in TO when you are flying towards the station and in FROM when you are going away from the station.

So far, we have been considering very easy cases where the aircraft is already tracking a radial – with the CDI centred – it is called 'tracking' a radial and it's the easy part.



The hard part happens before that stage when the pilot tries to intercept the desired radial.

Initially, when the pilot sets the required radial in the HSI, he gets something like the picture on the left:
what does the instrument tell us?

1. The tacan is somewhere behind him on the right hand side on the 250° bearing. So we are going away from the station
2. The selected course is 090°
3. The 090° radial is on the right (CDI is offset to the right)
So we are LEFT of course.
4. Heading is 112°
5. The station is at a distance of 14.4 NM

With a little experience, you will have a rather good idea of your position in space relative to the station. It is important because the first thing you should know when you want to navigate somewhere is where you are first.

A good trick to visualise in space your position before starting a radial interception is to centre the CDI by turning the CRS knob. Once the CDI is centred you know for sure on which radial you currently are... Bear in mind that the CDI will be centred on two reciprocal radials (310° and 130° for instance) and as you are usually moving at high speed in your F-16 the CDI may not remain centred for long.



The 2 pictures above have been taken around Kunsan. By centring the CDI we see where we are:

We are on R-074° (reciprocal is R-254°) Kunsan tacan.

Therefore we know our position is somewhere on a line originating at the station and extending on the 074° direction. The DME indication gives you the distance to the station fixing the point on that imaginary line where you are at exactly 14.4 NM.

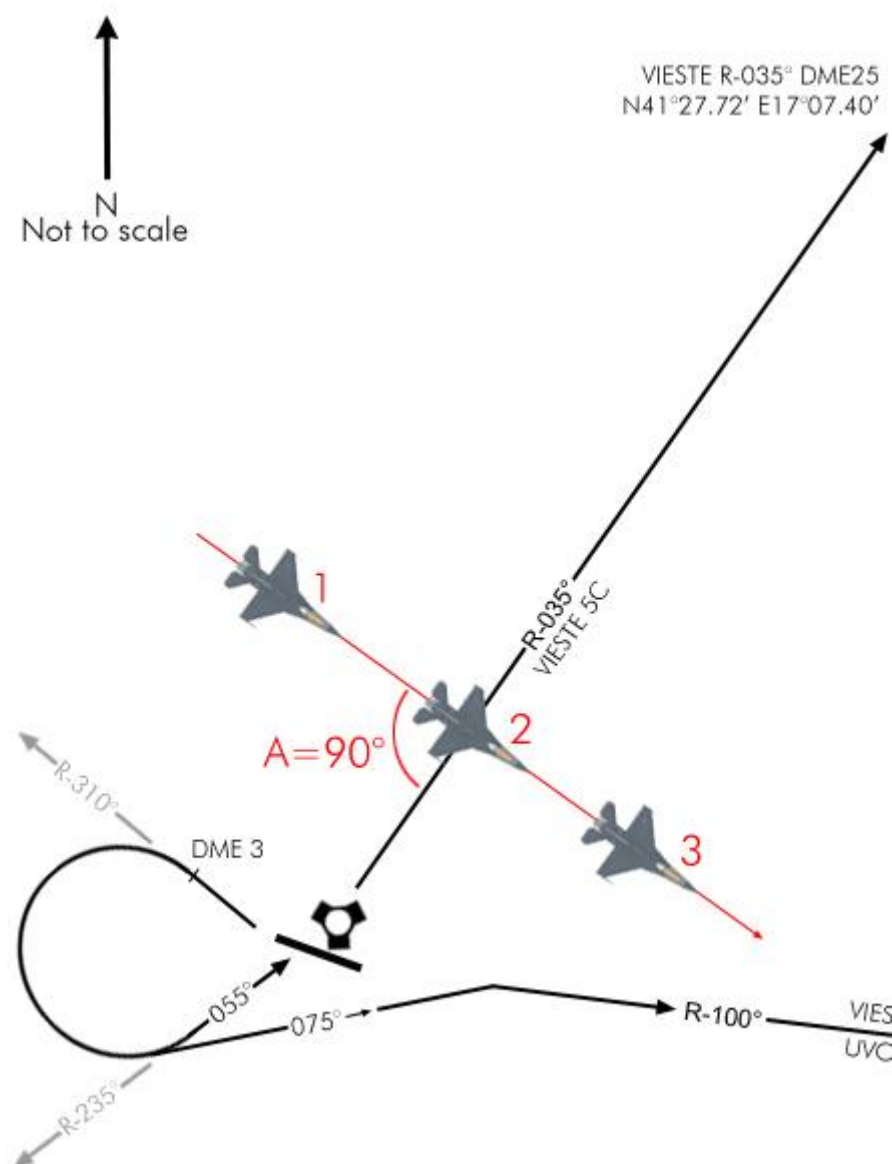
You may wonder why you couldn't be on the 254° radial? Well if you were, the station bearing pointer would point on your left side, while it's clearly on the right side. The only way to have the station right of your heading is if you are on the 074° radial.

By now you should have realised that to succeed in correctly intercepting a radial you first need to know exactly where you are relative to the emitting station, hence the relevant radial.

3.1.4 How to intercept a radial

Once you know where you are and you know which radial you need to intercept, you need to fly towards the imaginative line drawn in space by the radial. The shortest route to that interception point is to fly a heading at 90° from that line. With such a perpendicular heading, you will reach the radial very fast but you will have lots of difficulties to make a smooth interception because the CDI will pass from one side to the other very rapidly.

Let's consider the following example:



We have to intercept R-035° outbound Amendola tacan. We are on the ground, ready to take-off on RWY 29 and once airborne, we will make a right turn to heading 310° as the procedure implies. Once we fly away a little from the airbase, we will make a large 180° turn to the right and attack the radial with a 90° angle and see what happens on point 1, 2 and 3. The HSI is in tacan mode, radial set to 035° and we are rolling on the runway.



At point 1, we show a 90° attack angle (A) on the 035° radial. The “A” angle is clearly pictured on the HSI by the angle created by the actual heading (125°) and the set course (035°). Note the position of the station bearing pointer. As you are nearing the radial, it will descend to the 215° mark that will be reached when the radial is intercepted.



Nearing the radial, the CDI will start to move towards the centre of the dial. The greater the interception angle, the faster the CDI will move. When the CDI is centred with the arrow, it means you are spot on the radial. That is point 2. Note that the course arrow points to the left, meaning that the 035° radial extends to the left side. So if you were to intercept it OUTBOUND, you should turn LEFT. If you were to intercept it INBOUND, you should turn RIGHT towards the tail of the arrow, or toward the station bearing pointer.

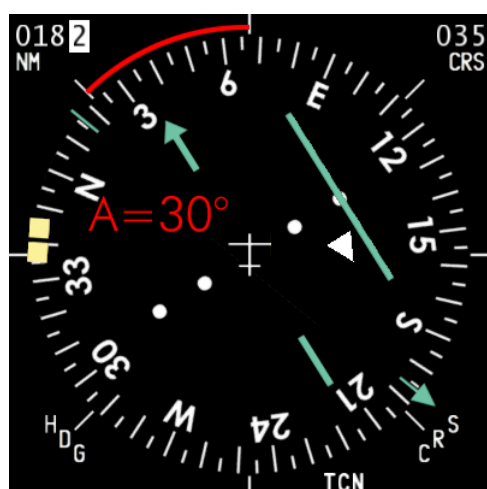
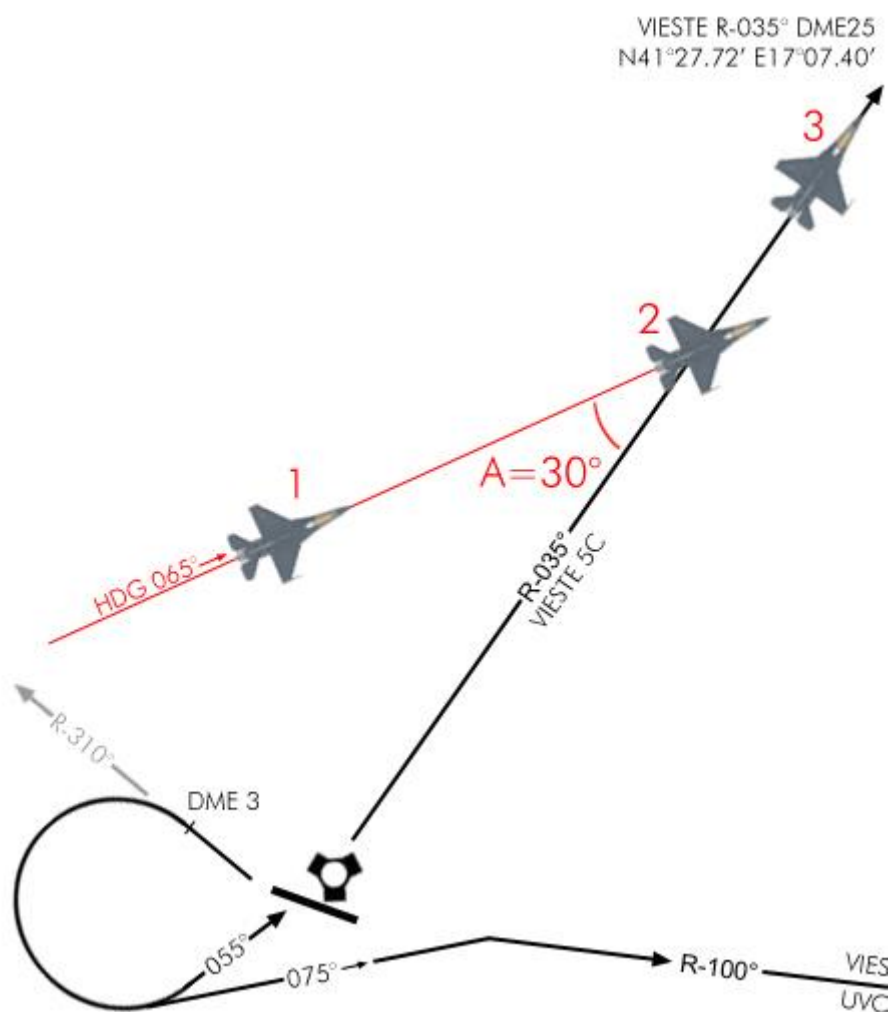


Now of course you are flying a 125° heading, so you’re just a fraction of a second on the radial. After that time, the CDI will start to move on the other side of the course arrow. You have just passed the radial and are now on the other side. That is position #3. Notice the station bearing pointer continues its progression past 215° now that you overshot the radial.

Notice that according to your distance to the station, the amount of time it takes the needle to swing from one side to the other will be different. Really fast at close range, slower but still faster than desired due to the 90 intercept at longer ranges.

Fine, you probably have it figured out by now; intercepting a radial with a 90° attack angle won’t provide a smooth ride. But who cares? You don’t have passengers – do you? The guy in the back you say – don’t worry about him, he likes being bounced on the canopy.

In general aviation they teach you to intercept a radial with a 30° attack angle. That indeed will provide plenty of time for the pilot to see the CDI start moving towards the centre and the final turn will be smooth: Here's how it's done still using the same example:



After taking off from runway 29, we turn right to a heading of 065° to have a 30° interception angle on the 035° radial. As before, that interception angle is perfectly visible on the HSI as pictured on the left.

At position 1, the CDI is offset to the right (meaning the set radial is on your right side) and will start to move slowly towards the centre of the dial as we near the imaginary line.



At point 2, the CDI is centred and we turn left to follow the radial on a heading of 035°. Notice, I already started a gentle turn to the left to intercept. If you delay your turn too long you run the risk of overshooting the interception and end up flying parallel to the radial right next to it.

You would then have to restart a smooth interception to get back on the correct route.

At 26 DME and with such a small interception angle, the CDI moves very slowly giving you plenty of time to intercept smoothly.



Here's the instrument view at point 3. We are going away from the tacan, tracking the 035° radial outbound.

The station bearing pointer and the TO/FROM indicator show the tacan right behind us, confirming the fact that we are outbound.

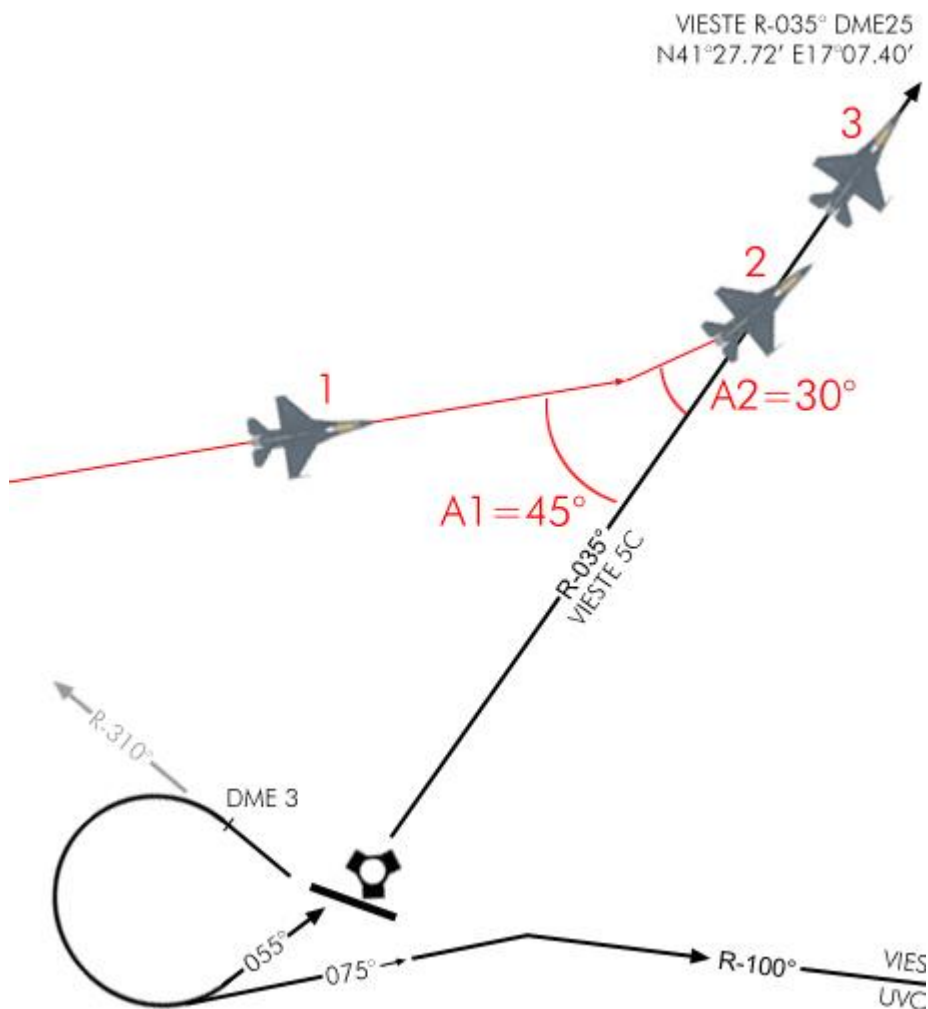
In a no wind situation, we would remain on the radial and the CDI would remain aligned with the course arrow.

In a windy situation, you might drift off the radial and might need to start compensating for wind drift with a small correction angle into the wind.

Of course, the situation is a little bit more dynamic than explained on paper. Once the CDI starts to move toward the course arrow you will need to be ready to turn. You might also turn a little; say by 10° increment, to slow the CDI progression toward the centre. That will give you more time and will flatten the final interception turn and decrease the risk of overshooting the radial.

With a little experience, you will increase your interception angle; according to the distance you are from the station (the closer you are, the faster the interception will occur) and smooth it on the run to fly a curved interception on the radial, finishing your turn correctly aligned.

Personally in BMS, I tend to use a 45° interception angle and decrease the angle a little once the CDI is one dot from the centre.



As I mentioned above when you are very far from the radio navigation station, you might want to start your interception with a rather large angle to ensure that you do not go too far away especially when intercepting outbound. (Tacans in BMS have a limited LOS range, remember?) So start with a 90° intercept angle and decrease your angle once you near the radial. Bear in mind the distance to the station also when deciding an intercept angle!

A very good tip here is to use the station bearing pointer. Indeed you know it points directly to the station, so when the bearing pointer starts to move towards the course arrow (or the end of the course arrow when intercepting outbound) you know the radial is nearing even before the CDI starts to move. That indication is good information to help you decide what interception angle to use.

Consider again the following images and concentrate on the cyan bearing pointer:



The example is the same as the 90° interception above. The important thing here to visualise take note of is the progression of the bearing pointer starting at the 2 o'clock position and descending to the 4 o'clock position.

As you know the cyan arrow points to the selected station and as you are nearing radial 090°, the pointer will move toward the course arrow (point or tail depending if the radial you set is outbound or inbound).

When you are on the radial the pointer will be aligned with the cyan line (middle picture).

As we are just passing the radial in this example the pointer continues drifting downwards as the tacan goes to our right rear quadrant.

The bearing pointer is a very helpful instrument to help you visualise your position in space relative to an emitter, which is after all the goal of radio navigation. Don't hesitate to use it!

Then there is a trick to intercept the radial very precisely. You know the small aircraft icon in the centre of the HSI represents your aircraft. If you extend a line in front of your aircraft longitudinal axis, you picture your flight path (the cyan arrow). If that line were to always remain between the CDI and the course arrow you would constantly turn your aircraft until the three lines were perfectly aligned and you would have flown a perfect intercept.





Once established on the radial, all the reference lines are aligned. The CDI is centred on the course arrow, the 2 green lines are common and the white line is also aligned with the green one. As pictured on the left image, we made a textbook perfect intercept.

Of course in the cockpit, you don't have the green lines or white arrow. Still there is the 12 o'clock mark on the HSI that could be used as the white arrow to help you, as illustrated in red on the right image.

For the green lines, you will have to find your way, but it becomes second nature very quickly with a little experience.

3.1.5 Tracking a radial once established:

Now that you know how to intercept a radial, let's see if we can track it.



Maintaining the aircraft on the selected radial is very easy in a no wind and no turbulence situation. Luckily the BMS F-16 is a very stable platform making things easy for you to learn basic radio-navigation. Be aware though that a no wind situation barely happens in real world conditions. Wind and turbulences will be a factor in BMS as well, but let's start by covering the basics in a no wind situation:

Established on R-280° inbound the station, you need to fly a heading of 280° in a no wind situation. Let's say you concentrate on your mission and drift slowly to the 285° heading. It's visible on your HUD heading tape but you are head down in the cockpit checking the SMS system (next time turn the autopilot on).

Slowly the CDI will start to drift to the left side of the course arrow. After a while you notice the drifting of the CDI and decide to centre back on the selected radial. Now don't go take a 30-45° interception angle to get back on course, there is a great chance that you will overshoot the line and zigzag around it.

The best course of action here is to first fly a heading of 280° to stop the drifting from the radial then turn left 2 to 5, max 10 degrees (depending how far you have drifted) to gently intercept again the radial.

Try to visualise the position in space by looking at the God's eye view the HSI gives you.

The cyan line is the set radial, you are in the small aircraft in the centre and the CDI illustrates the radial position. The intercept angle will become obvious at a glance: place the longitudinal axis of the small plane always between the CDI and the course arrow. Turn your airplane accordingly and you will make a perfect interception. Once the CDI centres; turn right to fly a heading of 280° to remain on the radial.

The closer you get to the station the more precise the CDI will become so it's normal to have to adjust your course when you fly inbound an emitter. The contrary is true as well. The further you fly from a station the less accurate the CDI becomes.



3.1.6 What about the wind ?

You know the wind will naturally push you to one side or the other of the radial, so depending on its force you will need to fly a wind corrected angle to remain perfectly aligned.

Of course that means you need to be aware of the wind direction and speed but that's easy. Just dobber right on the DCS switch (SEQ position) on the ICP while the DED in on the main page and a new line will appear with wind direction and speed.

In this example the wind is 326° at 14 Kts.

Draw the wind direction on your HSI and you will immediately realise that the wind will push you to the left of your course and therefore the radial will drift to your right if you do not apply a wind correction angle (WCA).

The easy part is to determine the side to apply the WCA: since the wind will push you left you must counter it to the right, into the wind. The hard part is to evaluate how large that WCA should be. The stronger the winds the higher the WCA but there is no real rule here: apply a small correction, judge the result and correct if need be.

UHF 292.65 STPT ÷ 2
326° 14
UHF 15 10:45:05
M1234C 7630 TIM T 75X



3.1.7 Station passage.

Imagine that you're tracking R-130° inbound of a known tacan. Your flight plan will take you right over the emitter and then you will continue on your heading and fly on R-310° outbound the same tacan. You will overfly the station and your 130° heading will remain unchanged (in a no wind situation).

Nearing the station the CDI which is centred will start to drift one side or the other. And the bearing pointer will rotate 180°. Once the CDI starts to move don't try to follow it. You're too close to the station and the instrument readings are inaccurate. Just fly along your heading until you are on the other side of the emitter where the CDI will centre again. It might not centre perfectly and you may need to adjust a bit.

In real life we talk about a cone of uncertainty when we are that close to the station. It starts sooner the higher you fly.

Also remember that the DME is a slant range, if you overfly a tacan at 24000 feet the DME will indicate 4 NM as you're 4 NM away from the emitting station (height).

3.1.8 IFR instrument scanning.

Radio-navigation will bring you from point A to point B on a pre-planned route but try to remember that your first goal is to fly the plane safely. So don't get fixated on the HSI because obviously it does not give you information about the altitude and speed of your aircraft.

To be able to fly correctly a let-down chart you will need to master heads down flying by completely forgetting the HUD (and that is the real challenge)!

Down below on the instrument panel you have some analogue instruments you will need to use all at the same time – I know, the HUD is much easier, but you can't see the HSI in HUD view, no escape here.



You have 3 main instruments you need to scan one after the other at all times. The artificial horizon, altimeter and machmetre. What you need to do is this:

1. Look at the artificial horizon, check it's correct according to what you want to do;
2. Look at the altimeter check your altitude is correct;
3. Look back at the artificial horizon, check it's still correct;
4. Look at the Machmetre to check your speed;
5. Look back at the artificial horizon, still correct?
6. Look at the HSI for radial alignment or intercept;
7. Back at the artificial horizon...

And start all over again. That technique is called scanning and it helps the pilot check that his airplane is doing what he wants it to do. By acting like this, there's a very small chance that you'd miss a parameter going out of limit (speed too high, wrong altitude,...). You also noticed you

always have to go back on the artificial horizon, because it really is the instrument giving your attitude. For instance, if the artificial horizon is flat and shows no turn or a climb, then you're almost sure your speed will remain the same (if the throttle hasn't been touched) and the altitude will be fine as well. So centre your scanning technique on that primary instrument.

You can also include other instruments in your scanning like the AOA and VVI indicator. And according to the situation, you might want to concentrate on the HSI for a little while, but always do get back often to the artificial horizon and to a lesser extent the other instruments.

Needless to say, that scanning technique is mandatory once you switch to heads down view and transition to IFR flying. It is also the only method that will let you fly an IFR approach, STAR or SID procedure because you will need to be at specific altitudes, headings and speeds all along the route.

I also discovered while training that talking to myself greatly enhanced my scanning and gave me an audible cue of what needed to be done next. That is especially useful when climbing or descending. I state warning that I have a thousand feet to go before level off. Or I always remind myself by speaking what would be the next step to be completed.

3.1.9 Transition Altitude / Level / Layer.

Here comes one aspect that probably most if not all the Falcon flyers are confident with. And I reckon it's not easy to grasp. One feature dearly missing from Falcon is a correct atmospheric model with pressure changing with altitude (amongst other things).

In BMS, it is now implemented and that makes the whole experience much more realistic and introduces a real need for altitude calibration and a common reference above a certain altitude. What does it all mean?

Pressure varies with many different variables. One of them obviously being weather and the second obvious variable is altitude. A lesser variable is temperature. In BMS, all those variables are taken into account and may change your data in your altimeter since that instrument uses pressure to give altitude.

As a consequence, your altimeter may give you an altitude one day in fair weather and give different data at the exact same spot another day in bad weather.

Why? Because if the altitude remains the same, pressure (hi pressure system in good weather and low pressure system in bad weather) is different and temperature is different to a lesser extent as well.

Your instrument needs calibrating with the local pressure. That information is given by ATIS that you may get by listening to the new 4.34 ATIS VHF frequency or by the old method consisting of using the relevant option in the ATC menu:

Request QNH.

QNH is the code word for local pressure (also referred to local altimeter setting) it is given in Hecto Pascal (millibars) or inches of Mercury for you Americans, depending on how your BMS config file is set (see BMS-34) for further information.



Once you have that pressure, you need to set your altimeter to that exact same value.

The current calibrated pressure is displayed in the altimeter instrument, below right of the altitude block. If you rotate the bottom left knob on the altitude bezel, the value changes. Set it to the value the tower gave you. Once done, you should check that the altitude displayed now by your analogue instrument matches the airport elevation given by the chart. You have just calibrated your altimeter for the first time in Falcon.

On the left picture, the local pressure setting (QNH) given by the tower is 1038 and sitting at Kunsan we crosscheck the altitude given by the altimeter with the airport elevation: 10 feet.

Obviously, when you travel in an aircraft you travel through air mass with different characteristics and the local area pressure changes often. It is impossible to always fly with the local altimeter setting on cross country flights, especially for long distance flights. That is where the transition altitude/level comes into play. It is an imaginary altitude where pilots are required to switch their altimeter to the standard pressure (QNE) of 29.92 inches of Mercury or 1013.25 Hecto pascals (millibars).

In Korea the transition altitude/level is set at 14000 feet/FL140. So anytime a pilot climbs through 14000ft he must change his altimeter setting to 29.92InHg or 1013hPa.

From that moment, altitude is not called in feet anymore, but in flight levels. 15000feet= FL150, 23000feet= FL230. Basically, it's the hundredth of the altitude expressed in feet.

If all pilots do so, they will all be on the same standard pressure setting and that will make it easy to coordinate altitude calls. One single pilot forgetting to do so may create a safety hazard because of wrong indicated altitude and a potential of mid-air collision when deconflicting with altitudes when flying IFR. It is therefore important not to forget to make the switch of altimeter calibration. A very convenient way NOT to forget is to use the MSL floor in the UFC. By depressing button A-LOW #2 of the ICP, you can easily set an audible ALTITUDE warning at a specific altitude.



The first line is the cara ALOW and often used for specific altitude floors. The best setting to change is the MSL Floor which you access by dobbering down. It is by default set to 10.000ft but I suggest you set it at the transition altitude (14000ft for Korea – 7000ft for Balkans, etc etc). You can change its value once the asterisks are around the value and

then enter the new value. You can even set this in the DTC (through your callsign.ini file in the config folder) so you don't have to change this for every flight. Once done, Betty will call altitude as soon as you climb through or descend below 14000ft, warning you to switch your altimeter setting.

When you descend back through the transition level, you will of course reset your altimeter to the local altimeter setting QNH. But since the weather model in Falcon is now dynamic, it might be different than the one you had at take-off. So you must contact a tower in the vicinity and request QNH. You can request that information outside of the 30NM Range of your destination. Although I recommend that in fast changing weather you keep it updated as you come closer to the Initial approach fix.



In a tactical situation, you may need to descend lower than the transition altitude and have no facility to contact to get the local altimeter setting. Well you can always contact the nearest tower, even if outside of the 30NM radius. That compromise was implemented to get round the fact that AWACS or Jstars can't get you the local altimeter settings. And you always have the radar altimeter when you are in North Korea and when you don't know the local altimeter setting. Just use extra caution when that happens. Falcon still isn't perfect, but we are way more advanced than before now that an atmospheric model has been implemented.

3.1.10 Things to remember.

Although what has been covered is only the very basic stuff, it's enough for basic radio-navigation in Falcon. You should now stop reading and launch the sim to make some very basic exercises. Start by making sure you know how to fix your position with a tacan (by centring the CDI) and try some radial busting (90°) and finally some intercepts, both outbound and inbound. Experience will do the trick here – we aim for precision flight, so you will need to learn to intercept a radial with a nice curve and finish the turn perfectly aligned and directly correcting for wind drift. So get some practice, read back some pages from this document and/or call for help if anything is still unclear.

Some points to remember:

- The interception angle will vary according to the distance of the emitter due to radial spread.
- The interception angle has to be determined accordingly to outbound or inbound intercepts.
- To intercept a radial by flying a nice curve, keep the longitudinal axis of the small HSI airplane between the CDI and the course arrow.
- Within 2 DME of a tacan, the reading of the HSI becomes erratic – just fly the constant heading.
- Don't forget to check the wind.
- Reduce speed; it gives you more time to think things over.
- When you're heads down in the cockpit, SCAN the instruments or you'll buy the farm. Mind your altimeter setting, it became quite important.

3.2 Advanced Radio Navigation in BMS

Before reading further, you should be able to intercept and track precisely any inbound or outbound radial while maintaining a set speed and set altitude.

To follow the charts, you will need to understand the principles of some more advanced manoeuvres such as performing DME ARC, follow an ILS, study the different holding pattern entries and performing circle to land procedures. Offset tacan approaches will also be documented.

3.2.1 Following the ILS to the minima.

The ILS works the same way as a fixed tacan radial along a runway centreline but with some important differences. It's a double radio emitter. One emits in VHF for the localiser also referred to as LOC, and is usually located at the end of the runway. The other emitter is paired to the localiser but emits in UHF for the glideslope, also called glide for short. It's usually placed offset to the runway centreline at a distance from the approach end of the runway.

The localiser provides guidance to the centreline of the runway and is pictured in the cockpit by the vertical line in the HSI, the ADI and the HUD. The width of the localiser emission cone varies between 3 and 6°. Such a small cone provides higher sensitivity of the CDI than when tracking a tacan radial. As a consequence, pilots tracking the ILS should make smaller corrections and should make them more promptly than tracking a simple radial.

As mentioned above, the localiser emits only in the runway centreline direction. That's why you don't need to set the course for the HUD and ADI vertical bars to work as advertised. The HSI course arrow doesn't really need to be set to the runway approach course, the reading of the CDI will remain correct to the ILS but it may lead to some confusion if the course arrow points backward. The deviation of the CDI will then be opposite to the side of the ILS. This is a normal behaviour when the course arrow points to a reciprocal heading of the approach runway heading.

So to avoid any confusion, it's better to set the HSI course arrow on the runway approach heading. That way the CDI deviation will point to the Localiser as it would to tracking a radial inbound.

The glideslope provides the vertical guidance to the optimum descent profile which is usually 3°. In the cockpit it is pictured by the horizontal needle in the HSI, ADI and HUD. Since the emitter is offset of the runway centreline, the glideslope can't be followed right through to touchdown. Usually pilots need to transition from an instrument approach to a visual approach at the minima. There are visual aids helping the pilot's transition at this critical point, we will cover these later on.

ILS procedures also use two (or more) beacons along the approach track: the outer/middle marker and the inner marker. Markers are displayed in the cockpit both visually by flashing lights and audibly by different frequency Morse code activated when you fly over them. The F-16 cockpit features a green lighted indicator labelled MRK BCN on the right of the HSI, above the FUEL QTY panel. That indicator will flash accordingly.



The markers provide range information to the runway. The outer/middle marker is usually placed between 4 and 7 NM (usually 6) from the runway threshold and is actually the point where the glideslope is intercepted. Inner markers are placed closer to the runway, usually 3500 feet and should be heard and seen in the cockpit around 200ft above the ground, usually near the minima.

Both markers light up the MRK BCN indicator making it flash at different frequencies: (low frequency for OM and higher frequency for MM). Although in general aviation the colours for each marker are different, in the F-16 cockpit the indicator is monochrome and remains green.

Backing up the visual cues a different Morse code is played in the pilot's headset according to which marker is overflown.

Please note, not all runways have all markers. Kunsan approach being over water there is no way to precisely place these markers on the approach path.



Finally visual aids are placed on the runway to help the pilot's transition from instrument to visual flying at the minima. In BMS, we have different kind of lighting aids such as the bright runway approach lights (ALSF1&2 (precision) and MASLF (non-precision)) which should help the pilot to get the runway in sight at minima.

Runways also feature glideslope visual aids such as PAPI. In previous versions of BMS we mostly had VASI (Visual Approach Slope Indicator) which consisted of a double bar row each side of the runway reflecting coloured lights according to your position on the 3° glidepath. In the latest releases of BMS, most runways were updated with PAPI (Precision Approach Path Indicator). PAPI is a row of four lights placed right or left of each runway. They give your position relative to the optimal glideslope by varying each of the 4 the lights from white to red:

Four whites mean too high, Four reds mean too low, 2 reds & 2 whites mean on glideslope. 1 white, 3 reds mean a bit too low, and 3 whites and 1 red mean a bit too high.

Please note, both the runway lighting and the PAPI are off by default. ATC will turn them on when aircraft need them. Therefore you must first contact ATC to ensure the lights are turned on.

Intercepting the ILS is done in two steps. The first step is to intercept the localiser (runway axis) and the second step is to intercept the glideslope from below.

Intercepting the localiser usually happens at the longest distance from the runway. With the Falcon charts it's usually done between 14 and 9 DME. At this point, you concentrate on getting the localiser (vertical bar) centred while having stabilised the aircraft at a certain altitude with a certain speed.

Between 9 and 7 DME, you usually should be at 2000ft with the localiser centred and the glideslope above you and coming down to meet your flight path. At DME 6 or 7 according to the approach, you should meet the glideslope (and the outer marker when implemented). Pop the airbrakes if they are not out already and lower the landing gear. In Falcon, extending the gear also lowers the flaps so your aircraft may pitch up for a moment but speed will greatly decrease because of the increased drag. Usually, the drag created by the gear is enough to create a pitch down motion so your aircraft starts descending along the glidepath. If not, reduce speed a little and place the flight path marker on the minus three degrees on the HUD scale. Concentrate on the instruments; keeping the Localiser and glide centred, the on speed AOA (13° green doughnut) and you should make a perfect approach.

The HUD is a real great help here because you can keep the ILS indicators, speed tape, altitude and heading tape as well as the AOA indicators all in view at the same time. And on top of that the runway will be seen as well helping greatly the transition to visual approach at the minima.



In the above picture, the aircraft is aligned with the localiser, the glideslope is just a bit higher (horizontal bar above the FPM) and 1 white, 3 reds on the PAPI. Airspeed is just above the on speed AOA (FPM on top of the bracket) although not visible in the picture, the yellow top triangle is lit on the left indexer, soon to be replaced by the green doughnut as the airspeed is decreased a bit.

Quite often, in F4 and in real life, you may get a visual on the runway well before reaching the minima just to lose the visual a few moments later because a low cloud drifted in the way or because of low fog. So care should be taken to keep scanning the instruments as long as you are unsure that the approach can be finished visually.

Since you committed the minimum decision height to memory, you wait for this moment at the final stage of the approach (see the chart section for a discussion about the decision height). A good clue for minima is also the inner marker. Pilots should then announce runway in sight and finish the approach using the VASI

lights and maintaining the green AOA doughnut lit. Should the runway not be in sight, the pilot is best advised to initiate a missed approach and call it on the radio.

3.2.2 DME ARC.

Many instrument approaches start with a DME ARC because they are an easy way to transition from the enroute phase of the flight to the final approach course. It seems quite complicated but actually it is very simple to fly.

A DME ARC is simply part of a circle around an emitting station (here a tacan) at a given distance. The arc is 1 NM wide and the pilot tries to remain within that arc by constantly turning toward the station. The trick is to keep a constant mental image of your position throughout the ARC and to the tacan.

Larger arcs are easier to maintain than smaller ones. The speed at which you fly the arc will also define its difficulty level. Obviously higher speeds make it more difficult. And if you try to fly a small arc at high speed, you are in for a lot of fun!

Flying a DME ARC is done in three steps: Intercepting the ARC, flying the ARC and intercepting the final approach course.

The first and last parts are usually the most difficult ones because they usually induce a 90° turn which takes time to perform.

3.2.2.1: Intercepting the arc:

A 90° turn takes time. And that time is dependent on your speed. Obviously, if you wait to hit the DME mark to start your 90° turn, you will not be able to fly the correct DME ARC and you will be inside it. So the basic problem of correct DME ARC interception is actually to be able to lead the initial turn. Luckily we know how to do that with the following formula:

$$\frac{Kias}{60} - 2 = \text{Distance of lead required.}$$

Example: You need to intercept a 14 DME ARC with a speed of 300 kts indicated:

$$\frac{300}{60} - 2 = 3. \text{ You need to start your turn 3NM before DME14: that is at DME17.}$$

You can also apply this formula with a Mach number: $(M \times 10) - 2$ ex: $(0.5 \times 10) - 2 = 3$

3.2.2.2: Intercepting the final approach course:

This one is a little bit trickier. You are at the end of your DME ARC and you need to intercept a specific exit radial and thus will be required to perform a 90° turn again. Since you are often close to the ILS, it is best to make a correct interception that will give you a smooth transition to the ILS track. So obviously you will first need to calculate your distance required to lead the turn with the above formula. Very often, your speed will be the same or close and your lead distance might be the same. I'd estimate: 3NM

So the big question here is how many radial will I cross while doing that 90° turn over a 3 NM turn radius? Well, there's a rule saying that at 60NM, the distance between two radials is 1NM. That's the famous 1 to 60 rule. Knowing that, you realise that at 30NM the distance between two radial is ½ NM, at 20NM = 1/3 NM at 10NM = 1/6 NM.

So if you come out of a 20 DME ARC, you know that the distance between two radials is 1/3NM, that's 3



radials in 1NM. And since you need a 3NM radius, you know that over the turn, you will cross 3×3 radials = 9 radials.

So you start your turn let's say 10 radials before the intercept radial. If that one is Radial 360 from Kunsan for instance, you start your turn at R-010° from Kunsan. What do you do with that information? Simple: In the DME ARC, set your CDI to that specific radial (10°) and check it while in the arc DME. Once that radial centres, that's your cue to start your turn. Don't forget to reset your CDI to the final intercept radial (360 in this example) so you can fly a smooth final interception.

So to summarise:

1. Calculate the lead distance (NMlead): $\frac{300}{60} - 2 = 3$
2. Calculate Radials per Lead turn = $\frac{60 \times Nmlead}{ArcDme} \Rightarrow \frac{60 \times 3}{20} = 9$ radials (round up to 10)

For a 14 Dme ARC, the formula would give: $\frac{60 \times 3}{14} = 13$ radials (round up to 15)

The above is correct for an indicated speed of 300 kts. If you slow down in the ARC to 250 kts:

1. $\frac{250}{60} - 2 = 2.16$ = lead distance
2. $\frac{60 \times 2.16}{14} = 9.25$ radials

Obviously, you don't have a calculator with you when flying Falcon and all calculations will be done mentally, so keep it simple: round your numbers and the decimal part won't be of great importance anyway. You will soon realise that your speed below 10,000 feet is usually between 250-300kias and since all the DME ARCs are often the same (14NM, 20NM) very few different formulas are needed. It's always the very same one that comes back.

As a rule of thumb, for 250-300 kts, Lead turn distance is 3NM and number of radials to lead is often 5 for ARC DME30, 10 for ARC DME20 and 15 for ARC DME10. The most common one (ARC DME20) is often referenced on the charts.

3.2.2.3 Maintaining the arc:

Maintaining the arc is done by using once again the red station bearing pointer (it's not red anymore in BMS but it is in the pictures below). Since you want to turn around the station, all you actually need to do is to maintain the bearing pointer on your wingtip and turn accordingly so it remains there for the duration of the arc. It is as simple as that! As you see on the following image, once the DME ARC has been intercepted (by leading the initial 90° turn), the bearing pointer is on the nine o'clock position on the HSI (left wingtip). That's position #2. The aircraft flies a heading of 90° or already a little less. In a no wind situation, it would be possible to make a constant turn toward the station to maintain the bearing pointer exactly on the nine o'clock position and the required DME distance. In real conditions, it's best to let the bearing pointer drift some 5 to 10° past the wingtip and then turn to replace it some 5 to 10° forward of the wingtip. And start the process as often as necessary to maintain the ARC.

At position #2, if the pilot were to continue on this heading, he would reach position #3 and the bearing pointer would start drifting aft of the left wingtip position. The pilot should then turn left a bit so the bearing



pointer points ahead of the left wingtip position. Then he can fly in a straight line, letting the bearing pointer point to the nine o'clock position and slightly past it, where the process starts all over again.

At position #3, If the pilot over-corrects (by placing the bearing pointer too far forward of the left wingtip position), he would find himself in position #4 with the DME indicator reading 11NM. On the other hand, if he corrected not enough (by placing the bearing pointer not forward enough of the nine o'clock position) he would find himself in position #5.

It's simpler to fly the DME ARC on the inside of the curve, letting the ARC come to you and then turning a little to replace the bearing pointer forward of the wingtip.

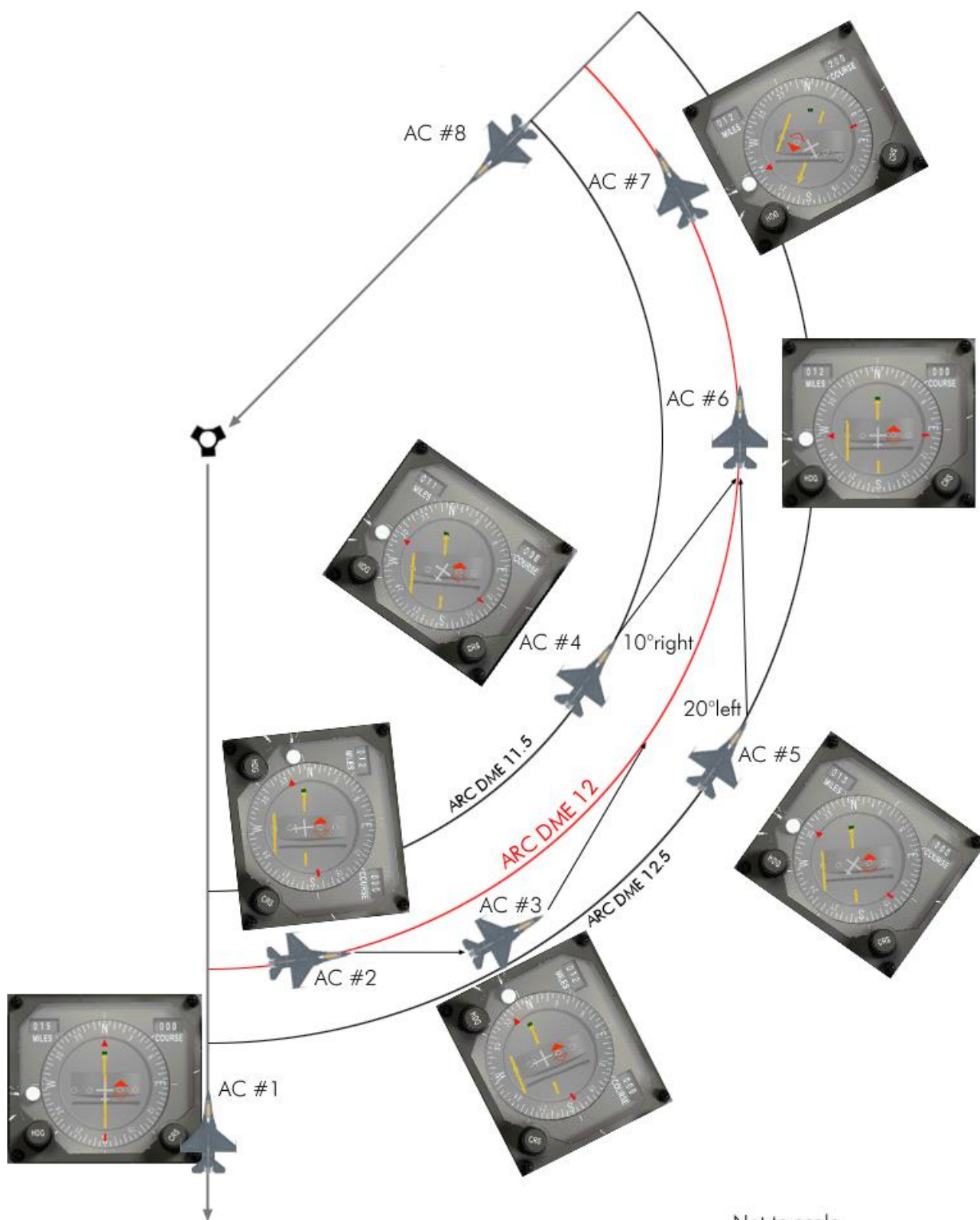
To come back on track when inside the curve – like at position #4, a 10° turn (for each half mile deviation) outside the ARC is enough. If the pilot is outside the arc at position #5, a 20° turn (for each half mile deviation) inside the arc will be required to get back on the required DME ARC. That is of course when the bearing pointer is correctly placed on the wingtip position.

AC #6 is spot on the DME ARC, flying a heading of 360° and having completed 90° of the turn. AC #7 is also perfectly on the DME ARC and the pilot is now getting ready to intercept the final approach course as pictured by AC #8. A lead turn will be required to intercept correctly the radial – notice the 200° radial has been set on the Course arrow to give the reference point for the lead turn. Bear in mind that you might also want to intercept an ILS instead of a tacan radial. Refer to the approach chart section for an explanation of the final turn.

Correcting for the wind may seem complicated since your heading is not constant and the wind correction angle will constantly change. If the wind is pushing you away from the station, place the bearing pointer ahead of the wingtip position and use this as the new reference for your turns. If the wind is pushing you towards the station use a new reference point past the wingtip position. The wind correction angle is then easily viewed: it's the angle between the wingtip position and the new reference point on the HSI.

Beside speed, keeping the altitude at the correct level is critical. Quite often you are flying below the MSA (Minimum Safe Altitude) and there are mountains around you. So scan your instruments properly to not only remain on the DME ARC but also to keep the correct speed (300-250 kts) and the correct altitude mentioned on the charts.

Usually you start the DME ARC at a relatively high altitude and higher speed (350-300kts) and you want to leave the DME ARC at a lower altitude and with a lower speed near the gear down speed. Be mindful of the required need to descend and decrease your airspeed throughout the procedure, you have a limited amount of time to execute these changes.



3.2.3 TACAN APPROACH.

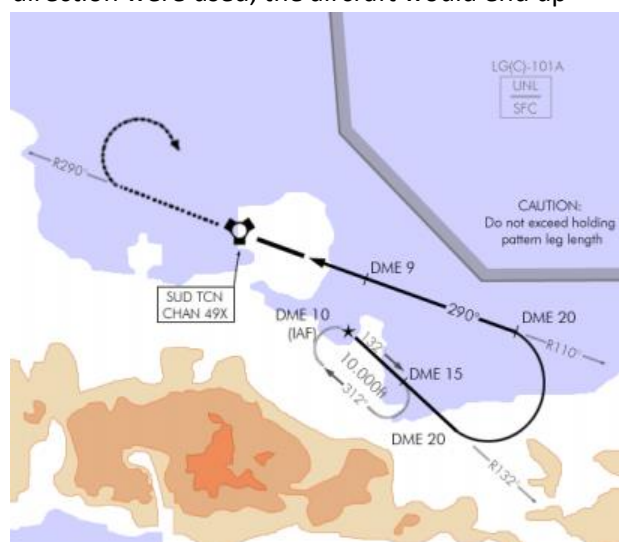
Following a tacan radial to the minima is the same kind of approach as the ILS but with less precision. Rather than being guided by two emitters perfectly aligned with the runway you use a tacan station which is only able to provide alignment radials. Furthermore in BMS stock Korea the origin of the tacan emissions is often located by default at the centre of the airbase layout (objective) unless a specific tacan feature is placed at the airbase that emulates the tacan station (like at Kunsan for instance). In that case the emissions originate from that feature location.

Needless to say, it is rarely aligned with the runway and prevents the approach track to be perfectly aligned with the airbase runway. Some other third-party theatres (Ikaros, EMF, ...) use this feature much more smartly than stock BMS Korea and align the approach tacan stations 3NM from the runway centreline as part of the airbase objective providing much more natural approach tracks (same as runway headings) than the ones you will find in Korea at this time (right picture below).

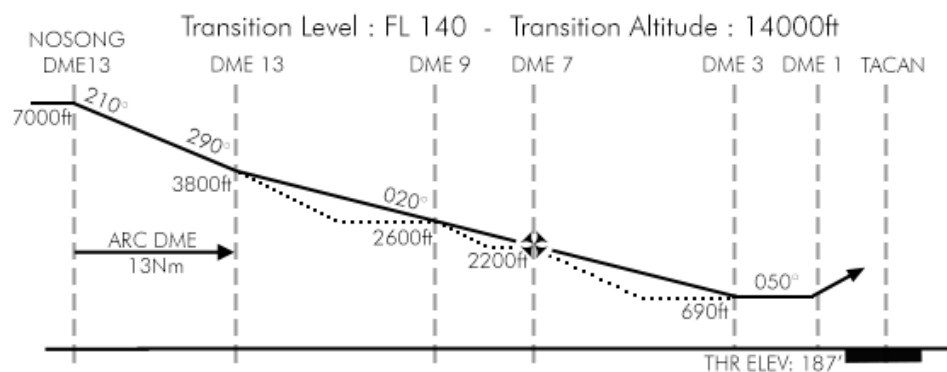
In Korea most tacan approaches are offset from the runway axis and generated to provide the smallest possible turn for final alignment (left picture below). In these cases, if the same radial as the runway direction were used, the aircraft would end up



laterally displaced and parallel to the runway.

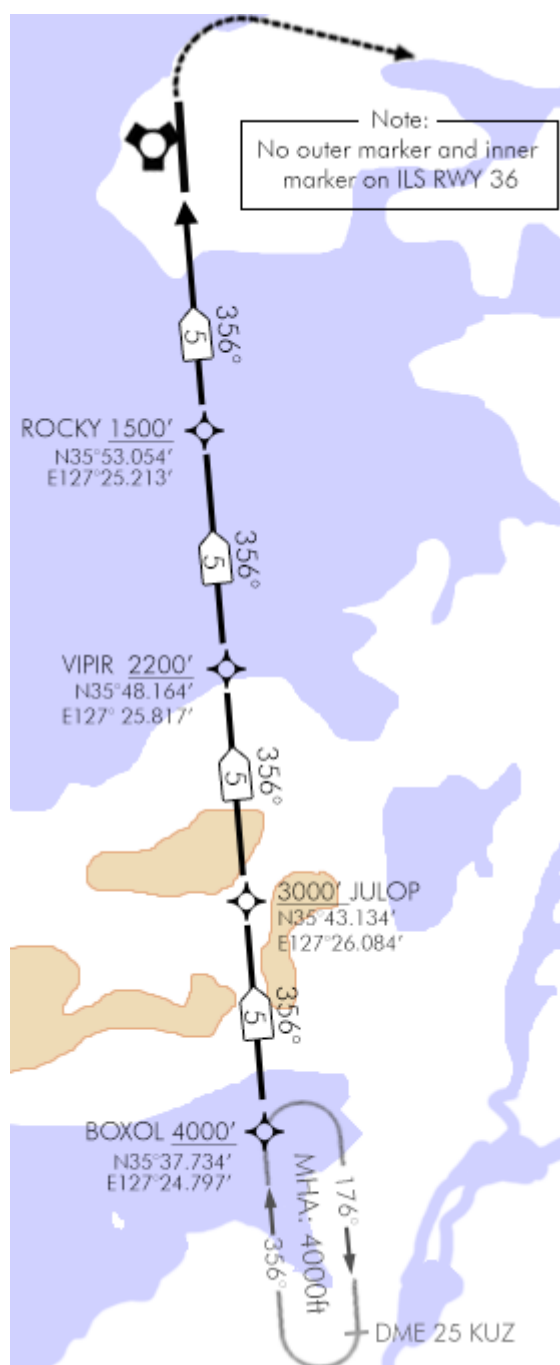


Beside the alignment issues the tacan is unable to provide glideslope indication. The descent profile is therefore given gradually on the chart. Pilots can descend to the next altitude once they reach a specific distance from the station. The descent profile is depicted by a dotted line but experienced pilots can time their descent in a more constant way by following the solid line. You just can't go lower than the published altitudes.



For all these reasons the tacan approach minima are usually much higher than the ILS minima. Where a usual ILS approach minimum is 200 feet AGL, a tacan approach minimum would be 300-400 feet higher. In very bad weather these non-precision approaches may not be an option.

3.2.4 RADAR APPROACH.



The radar approaches are new in 4.34 and have been designed specifically to match the ATC radar vectors given by the AI approach controllers. Therefore they should primarily be used when requesting a “Vector for Instrument Approach” from the BMS ATC.

These are made of 4 radar fixes displayed on the charts corresponding to the 4 points approach system the AI ATC uses. (These are configurable in the `airbase.atc` files located in your `Data\Terrdata\ATC` folder. See the annexes at the end of this manual for further information about the ATC files.)

The first radar fix is always the Initial Approach Fix (IAF) and the last radar fix is usually the Final Approach Fix (FAF) where the aircraft should be aligned with the runway and the approach controller will hand you off to the tower controller.

In between are two remaining points that are placed along the approach track to avoid mountains and align the aircraft (AI and humans alike) with the runway. Most of the radar approaches though are in a straight line like the one illustrated on the left for Kunsan RWY 36.

The radar fixes have their own symbol and the distances are not related to the tacan and it's DME but to the runway threshold.

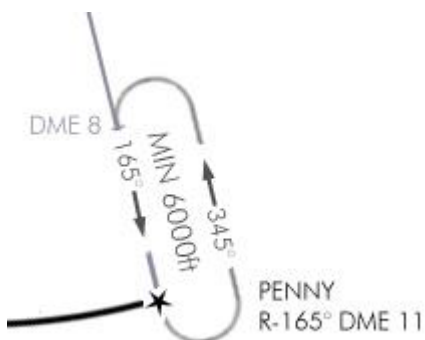
They each have an altitude which also corresponds to the altitude reference the ATC will give you.

Radar fixes always display their GPS coordinates making it possible to place steerpoints over each fix and in so doing, getting navigation symbology relevant to each of them.

Flying a radar vector procedure consists simply in following the ATC heading, altitude and speed calls from one fix to the next until you reach the Final Approach Fix. At this point, you will continue inbound, contact the tower to get clearance to land and continue your descent to the minima. You should now be in a position to see the runway and terminate the procedure by landing visually. Being a non-precision approach, the minima should be higher than the precision approaches like the ILS.

3.2.5 HOLDING PROCEDURES.

Holdings are racetrack patterns where the aircraft fly at a specific altitude & airspeed while waiting for trailing elements to rejoin, or waiting during a refueling, or waiting clearance from ATC... you get the picture; it is all about waiting.



The holding entry point (usually the IAF or the exit point or a steerpoint) is marked on the approach charts along a known radial and at a given DME. Holds are usually flown at 300 kts or less and the turns are made at a standard rate: 45° bank angle, 1.5G.

This is a great time to introduce a way to calculate your standard rate of turn:

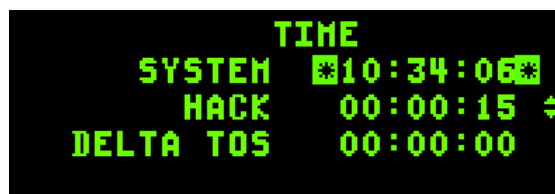
A standard rate of turn is a 180° turn in one minute. Obviously, it depends on your airspeed. The formula to calculate it is:

$$\frac{\text{Speed}}{10} + 50\% \Leftrightarrow \frac{300}{10} + 15 = 45$$

That means that at 300Kts, a one minute 180° turn will require a 45° bank angle.

Using your standard rate of turn each 180° turn takes about one minute to complete which is also the requirement in real aviation. The straight legs are also flown for one minute, unless a DME is mentioned on the chart. In that case the turn should be started passing the mentioned DME. At 300 kts, one minute leg covers a distance of 5 NM. Note that usually one leg is timed and the other leg is adjusted according to the wind. To time your legs you need a stopwatch. The easiest to use is the UFC Time page (#6).

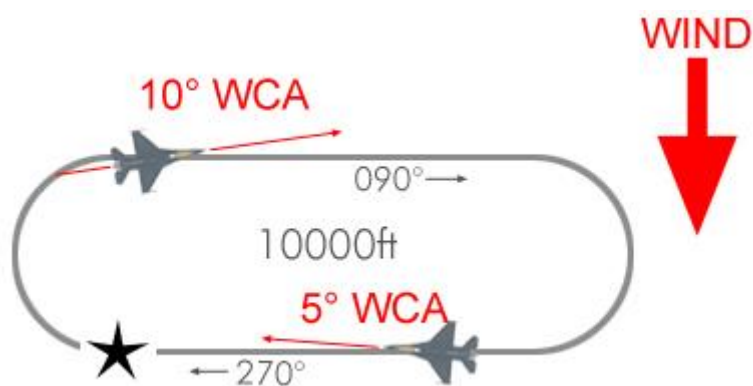
The ICP next button (up arrow) starts and stops the stopwatch and the previous button (down arrow) resets it. Start timing the leg once the turn is finished. Then fly the required heading until the stopwatch reads 60 seconds and start the next 45° bank angle turn. At 300 kts, such a bank angle will make the nose of the aircraft pitch down so constant back pressure at 1.5G will keep the flight path marker on the horizon line. Keeping your altitude is critical since other aircraft may be in the pattern above or below you and you want to maintain vertical separation.



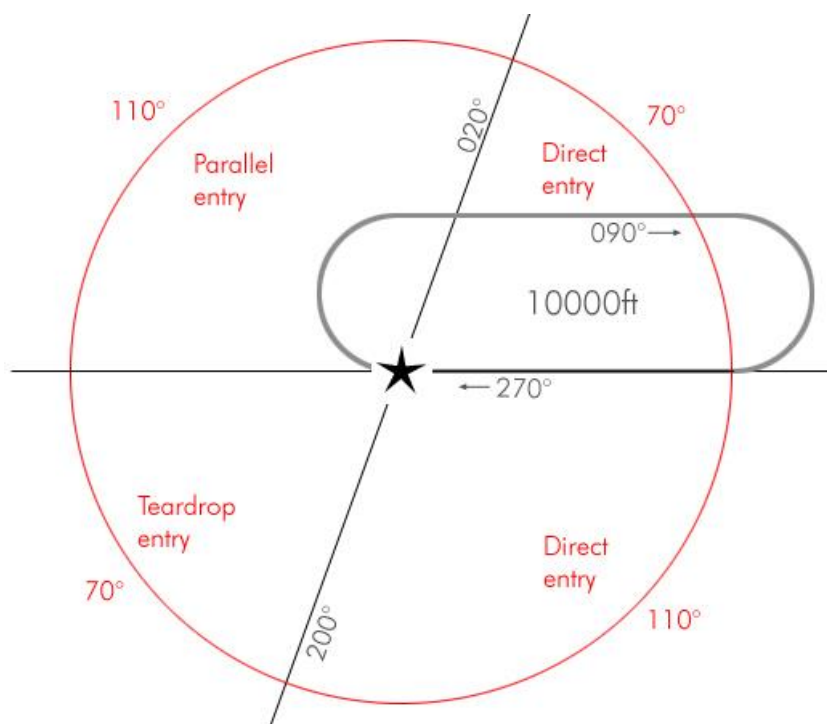
Both heading legs are mentioned on the chart so you don't even have to calculate the reciprocal headings. (This might not be the case holding at a push point so always make a note of your reciprocal heading before starting your first turn.) You will need to account for the wind though. Heavy winds can push you out of the holding area. You calculate the wind drift when tracking the inbound leg of the holding – the one you are tracking a radial along (165° in the image above). If you encounter a tailwind during that leg resulting in shortening the leg to 45 seconds, you might want to lengthen the outbound leg by 15 seconds to compensate. So fly the 345° leg for one minute and fifteen seconds. The same method applies when you encounter a head wind on the inbound leg that will lengthen the time. Just shorten the outbound leg by the same time difference.

Crosswinds can be trickier and you will probably notice it when doing the final turn to intercept the holding radial. If that turn is very steep there is a great chance that the wind is pushing you. Once again calculate the

wind correction angle while flying the inbound leg. If you have to apply a 5° correction to compensate for wind drift, double that correction on the outbound leg to keep the holding in the safe area.



The biggest challenge with holding patterns is to know how to enter them. When you are coming from the holding radial it's very easy since you naturally enter the racetrack. Unfortunately it's hardly the case. Depending on your arrival heading there are three different entries: Direct entry, parallel entry and teardrop entry.

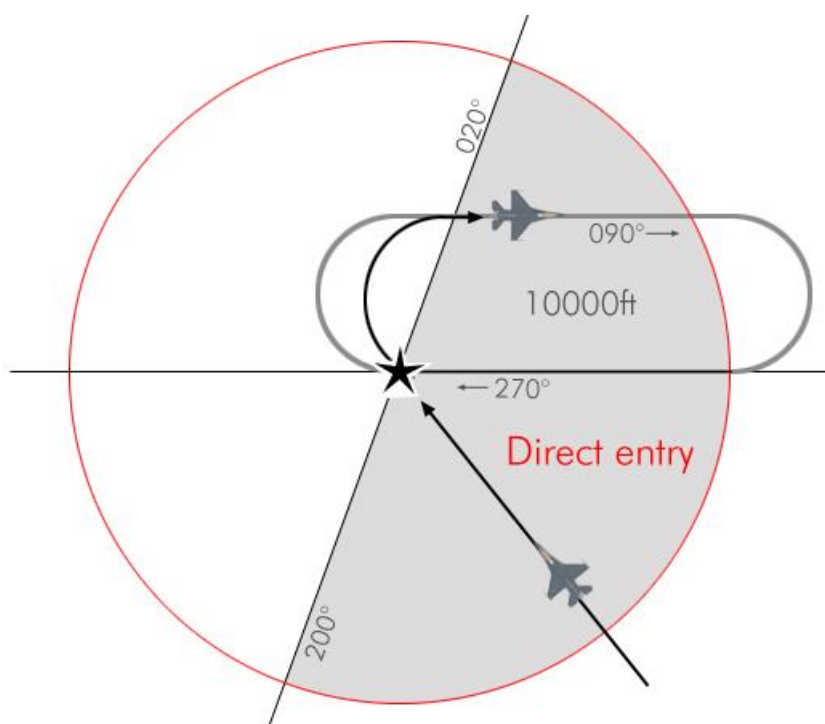


The first thing to do is to visualise the 20° angled line from the entry point. Here it is particularly easy since the holding axis is 090°/270° - so the angled line is 020°/200°. But it's not always the case and determining the entry you have to fly is often the hardest part of the holding procedure.

3.2.5.1 Direct Entry

The direct entry is the easiest one and luckily covers 180° of arrival route so with a little planning you can easily manage to always enter the racetrack with this procedure.

Flying this entry you just have to overfly the entry point, and then turn towards the outbound leg. It may take several turns for you to fly the correct racetrack but use the inbound leg to position your aircraft easily on the holding radial.



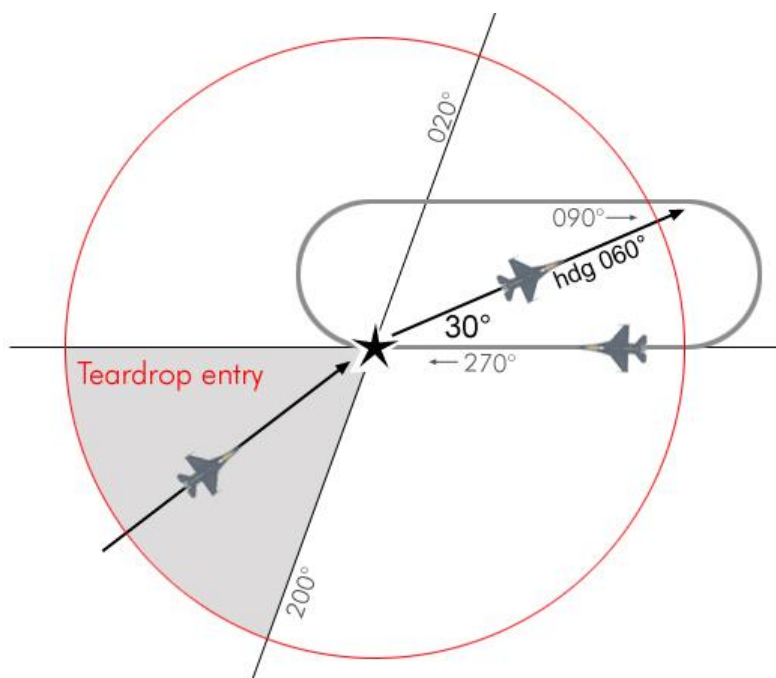
In the above example the aircraft reaches the holding area with a 315° heading which is within the direct entry quadrant. The pilot simply overflies the entry point, turns right to the outbound leg of 090° and starts the clock when abeam the entry point. The racetrack should be easy to fly since the aircraft is almost directly established.

If the aircraft was coming from the North East on a 220° arrival route, the pilot would do the same but since the initial turn will remain south of the holding area for a certain time, it might fly the outbound leg a little south of the published route. By intercepting the holding radial on the inbound leg, the pilot will be able to correct his racetrack.

3.2.5.2 Teardrop Entry

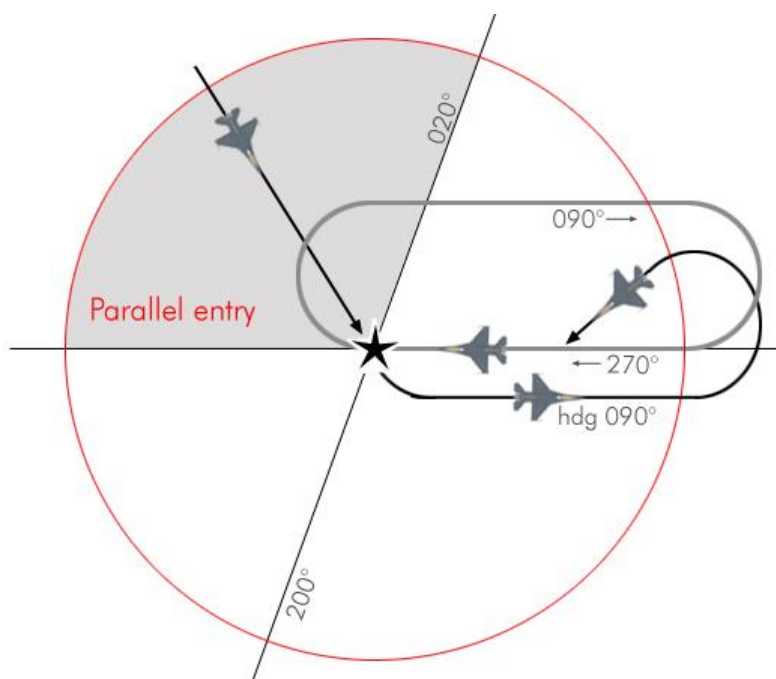
Entering the holding from the South West quadrant the pilot should aim his aircraft some 30° off the inbound track so he cuts the racetrack diagonally in two equal parts. Once established on this heading he flies for one minute and then starts a right turn to intercept the holding radial.

Arriving with a heading of 040° the pilot overflies the entry point and then turns to a heading of 060° which is 30° from the holding radial. That will give him enough room to execute the intercept turn on the holding radial. He flies that teardrop leg for about 60 seconds before starting the turn.



3.2.5.3 Parallel Entry

As its name implies the pilot will need to fly a parallel course outside the holding area before making a turn to intercept back the holding radial. After overflying the entry fix the pilot will turn his aircraft to the reciprocal heading of the inbound leg while taking care to remain outside the holding area where other aircraft might be flying the racetrack. That parallel course needs to be timed to one minute as well. Then turn left and cross the inbound holding radial and intercept it from the holding area. Once the radial is intercepted, proceed to the entry fix and fly the racetrack.

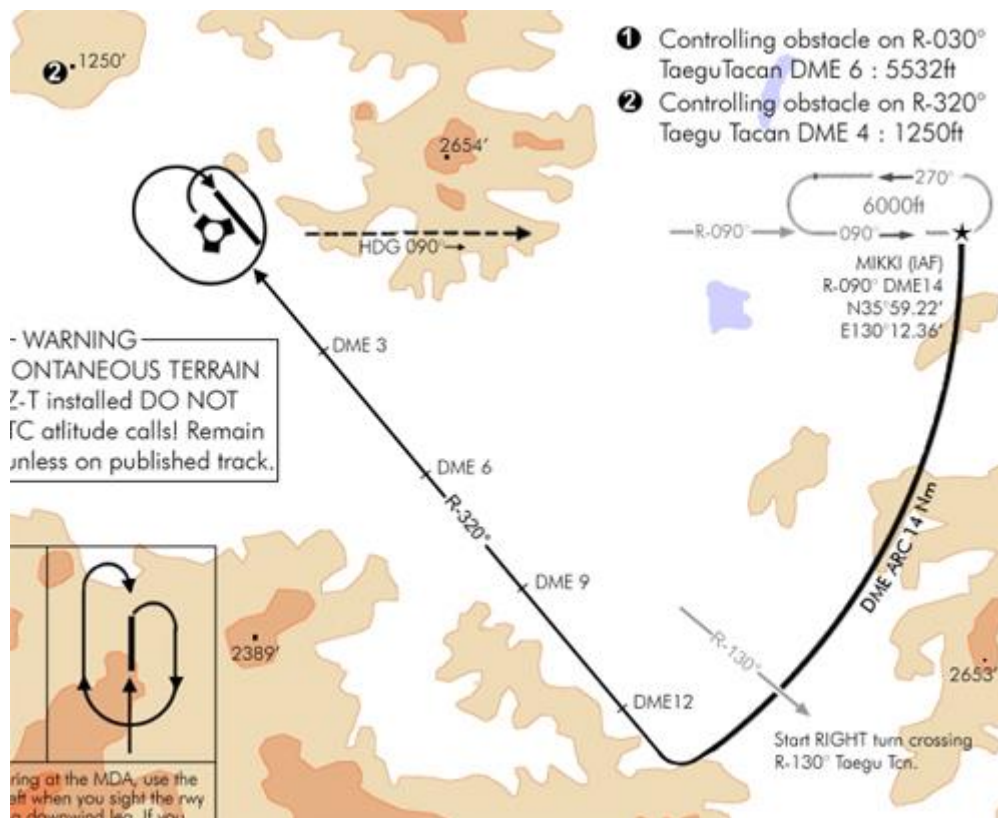


Holding patterns may not be published and it's the responsibility of the pilot to visualise the racetrack mentally so he can decide which entry to use.

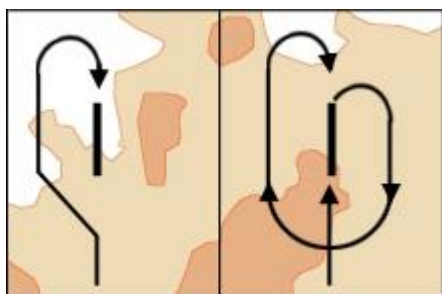
For approaches in stock BMS Korea most holdings are published so you can have a quick reference and decide easily which entry to fly.

3.2.6 CIRCLE TO LAND.

On some airbases the approach track of one runway can't be flown because of higher terrain or other restricted airspace. This is the case with Taegu for instance which is surrounded by high mountains and the glideslope to runway 14 would be too steep to ensure flight safety.



The difficult part of the approach is the non-precision final approach that is done visually. Basically, you need to fly the ILS 32 approach, get the airport in sight above the minima and circle the airport at slow speed remaining at or above the decision height to get on the opposite runway heading (140 in this example). You cannot descend lower than the decision height as long as the visual approach on the active runway is



possible. In the Taegu example above there are mountains all around the airport, so it is critical that you stay very close to the airport while performing the circle to land.

You don't necessarily have to wait for the minima to fly the circle. You can do it as soon as you can see the runway and maintain visual on it. The sooner you have it in sight the easier the circle will be because you can then enter the downwind leg earlier (the pattern on the left in this picture). If you get a late visual you will need to fly the pattern on

the right, which is longer and more difficult.

It does look simple enough for most of you average Falcon flyers. (AI pilots are unable to cope with this procedure.) However the circle to land is not an easy manoeuvre because you're low and slow and need to fly precisely while keeping the runway in sight – which unless you have a Track IR will require a new dimension real pilots don't have to cope with: the view panning. Besides, when low and slow your AOA will probably be close to 13° and forward visibility may be decreased. If at any time you lose sight of the runway declare missed approach and climb as fast as you can on the missed approach track.

PART 4:

FALCON BMS

CHART REVIEW



The purpose of this chapter is to review and explain each section of the Falcon BMS charts.

The Falcon BMS charts are heavily inspired from real navigation charts. Unfortunately many real life aspects are not transposable in Falcon. As a consequence real navigation charts cannot be used accurately in our simulation. I decided to make a chart set for each South Korean airbase using the relevant real navigation charts where appropriate and a lot of guessing when I was lacking real world information. At this time the whole of Korea is covered and the charts are part of the default BMS installation.

Each set is made of an airport diagram, at least one departure chart and one approach chart per runway wherever possible. Some sets have more “special” charts as we will see later in this document.

The tacans implemented in BMS are accurate and correspond both in range and channels to the real world data. This work was started in the SP days and real life radio navigation stations may have been updated since then.

There are two types of stations usually in real life, short range for terminal nav aids and longer ranges for enroute navigation stations. Both are implemented in BMS.

Tacans in BMS correspond to both tacan and vordme in real life.

Unlike in real life, the ILS are never ILS DME. Be aware that when you reference a distance in TCN/ILS mode, the distance you see is always related to the tacan, NOT to the ILS. In some cases, the tacan station may be 1 or 2 miles or more away from the runway threshold.

When using charts, always plan to make time, before being in the thick of the procedure, to set your cockpit accordingly. Setting the comms and nav frequencies and the instruments may take some time which is very precious when you are already devoting all your attention to flying in the weather, concentrating on your instruments.

Everything you can set on the ground before departure is a bonus. Equally, everything you can prepare while flying on top before going through the weather for landing is a bonus as well.



4.1 Airport Diagram Charts

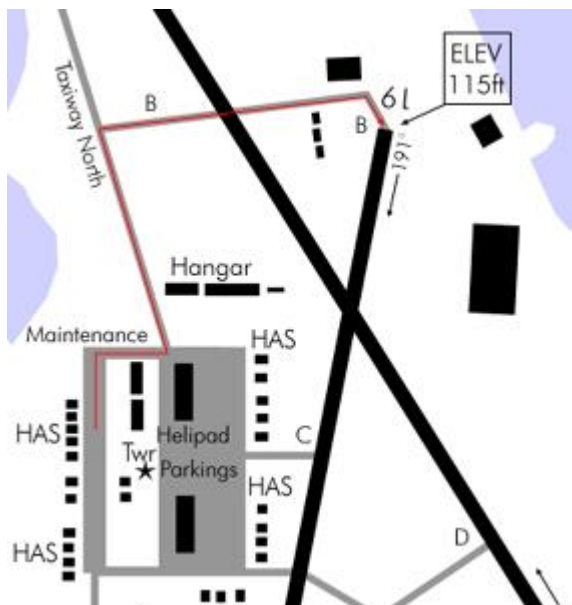
This chart is a top view of the airbase in BMS. It has been redrawn from a satellite view in the 3D world, so it corresponds perfectly to Falcon.

The purpose of this chart is pretty obvious; it allows the pilot to taxi to any place on the airbase according to ATC instructions or multiplayer procedures of each squadron. The runways are marked with their orientation: 15/33 and 01/19 in the Fukuoka example on the right. 15/33 means that the general orientation of the runway is running along the 150° heading and the reciprocal to 150° which is $150+180=330^\circ$. Only two large figures are painted on the runway pavement - there is no room for three. So it was decided to give the orientation with the two first numbers of the runway heading. Of course the precise orientation might be slightly different, as is the case in our example. Runway 19 of Fukuoka is actually 191°: 1 degree more than 190. So the reciprocal would be 1 degree more than 010: 011°. Indeed, $191-180=011^\circ$. The actual heading of the runway is always given along the runway edge with a black arrow. (See picture on the right)

Except for the non-generic airbases the runway lengths in BMS are standardised. The length of usable runway is given alongside the runway on the charts. The taxiways are labelled from A to F or more whenever necessary. That will allow a multiplayer pilot to state his position very easily for other members of his flight. Lead can also state his taxi route from the parking position to the runway for all his flight members: "Sting flight, lead – taxi to runway 19 via taxiway North, Bravo". The new BMS ATC doesn't provide taxi routing

when issuing their taxi clearance and the route is hardcoded and always the same (for AI at least).

As illustrated on the left picture by the red line, a flight cleared to runway 19 would follow the assigned taxi route to the runway – provided they were initially parked at the HAS (Hardened Aircraft Shelter). Care should also be taken before crossing Rwy 15/33 that there is no aircraft taking off or landing on that runway. The new BMS ATC does not require runway crossing clearance but will yell at you under certain circumstances (see part 3 of this manual).



You may also have noticed that the charts always share the same colour codes. The runway and objects such as buildings and installations are always black. Tower is always a star symbol (★). Taxiways are always grey, ground is white and water is blue. The magnetic North is always pictured by a black arrow – for obvious reasons I choose not to illustrate the magnetic variation. Most of the airport charts are oriented with the North pointing on top of the page, but in some cases, like the 08/26 airport diagrams I preferred to rotate the whole airport layout so it may be printed larger. Thus on those charts, you may find a North arrow pointing towards the side.

Most indications on the airport templates are self-explanatory. (I will explain the charts header later on.) Taxiways are labelled alphabetically by capital letters starting with A. On the ground, you see those labels on yellow signs – so use them to taxi correctly.



In Falcon, only the taxiways connected to a runway are labelled. The ones parallel to the runways are not labelled (at least on the generic airbase models). I decided to call these according to their main direction from the centre of the airbase. So you may find taxiway North, South, East and West. With this information, any taxi route should be clearly stated. In some case they have also a letter (F) as identification.

Here's a list of some terms used which may not be understood directly:

HAS: Hardened Aircraft Shelter.

POL: Petroleum Oil Lubricant – basically some large tank.

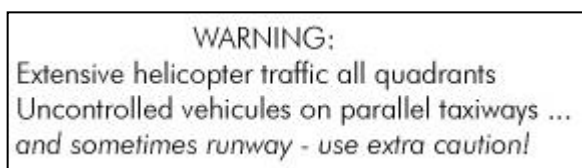
Twr: Control Tower.

Apron: parking area for planes - mainly used on the airstrips charts.

Base Ops: Stand for base operations; it's just some buildings I designed as such.

Mil Ramp: was initially designating the spot where the player would enter the 3D world but was abandoned in the process.

Each runway end has its elevation in feet given in a square box. These are MSL altitudes (Mean Sea Level – an altitude given with the level of the sea as zero.) In Falcon, it will not change because the entire airbase stands on the same tile with a fixed altitude. But in real life, you may have variations from one end to the other, telling the pilot if the runway has a slope.



Sometime, a warning or a caution or a notice box will also be displayed on the airport charts warning the pilots of any event that may be a concern to flight safety. I admit; some of those boxes might just be eye candy and not

really appropriate for the Falcon world. Still do read them, some might be important.

Most of the airbases in BMS are generic. In other words, they share the same template according to their runway orientation. There are actually **27** different layouts, some of which are not used at all. Only Seoul, Sunan, Osan, Kunsan and Kimpo have unique layouts in Korea and are modelled closely on the real airbases. All the others are generic airbases categorised according to their runway headings. A 03/21 airbase will always be the same – the taxiway may switch sides but the layout will remain identical. So it is not uncommon to see two airports almost identical and not matching the ground features or even having runway orientations different than their real life counterparts.

4.2 Approach charts

Let's get to the heart of the matter. The approach charts are clearly what makes these charts worthy. The purpose of the approach charts is to ensure that the pilot can land on the assigned runway whatever the meteorological conditions are. As a fighter pilot with modern systems needs to be able to hit his assigned target in bad weather, he also needs to be able to find his way back and land safely in the same kind of weather.

When the weather deteriorates, the pilot transitions to IFR which stands for Instrument Flight Rules as opposed to VFR (Visual Flight Rules). As the names imply VFR is flown with the head outside of the cockpit looking for visual landmarks and IFR is flown with the head inside the cockpit looking at the flight instruments and navigation charts.

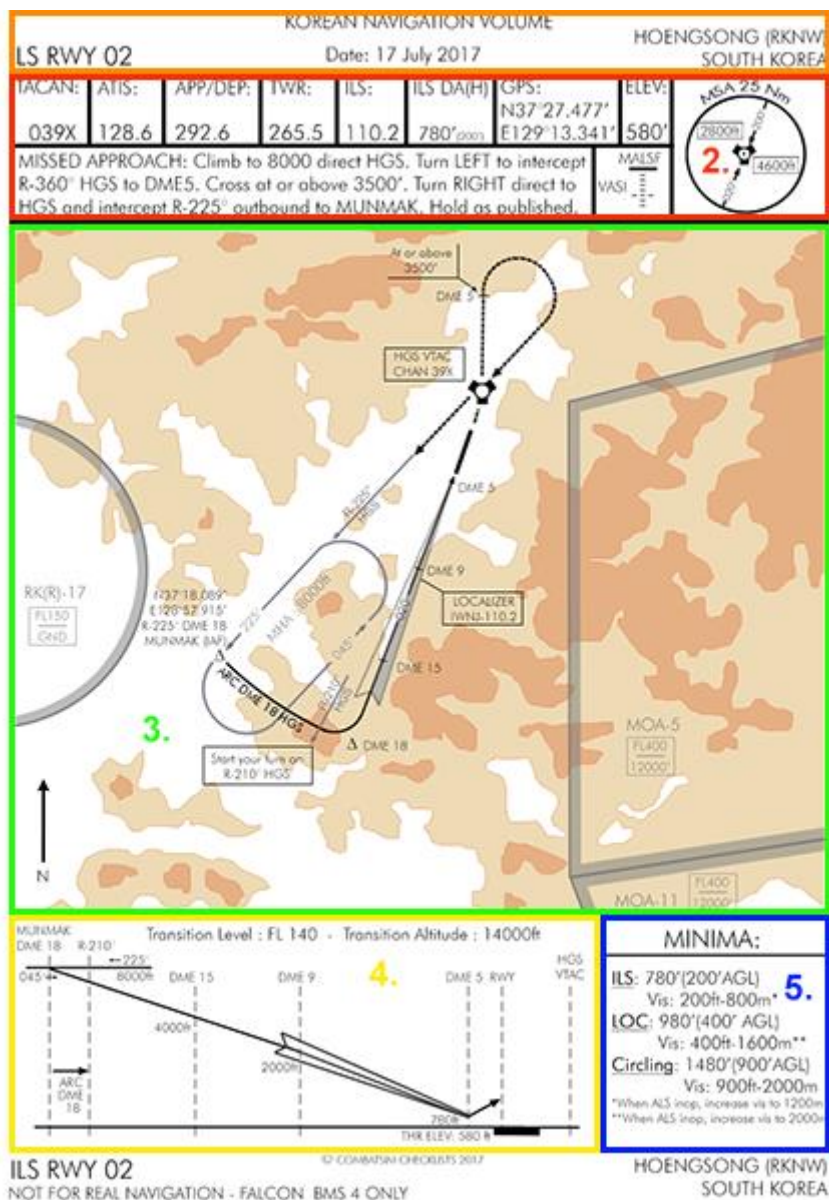
Each approach plate is subdivided into five different zones – as pictured on the following page:

1. Titles (orange)
2. Header (red)
3. Main View (or better named Plan view) which provides a God's eye view around the airport (green).
4. Side view (or profile view) of the approach to see the altitude throughout the approach track (yellow).
5. Minima: A window giving information about the minimum altitude according to the type of approach (blue).

In Falcon, we have five different types of approaches:

- Visual where no chart is required. This is the standard overhead recovery.
- ILS (instrument Landing System) where the pilot follows the ILS steering cues.
- Radar vectors: A new type of approach chart where the ATC guides the aircraft to the landing runway with heading, speed and altitude calls.
- Tacan approaches when there's no ILS available and the approach is flown along a set tacan radial.
- Circle to land approaches when for any reason the approach cannot be made on a certain runway – we use the other runway approach and then circle the airport to land on the correct runway.

There are many more approach types in real life such as NDB, VOR approaches, GPS approaches, ... But the charts mainly cover the five types mentioned above.



The above picture illustrates the five different zones of the approach chart for the RWY 02 ILS approach on Hoengsong – South Korea.

Let's see each section in detail but bear in mind that as the pilot you will need to read all of them at the same time according to the position of your aircraft on the approach.



4.2.1 Titles

KOREAN NAVIGATION VOLUME		HOENGSONG (RKNW)
Date: 17 July 2017		SOUTH KOREA
ILS RWY 02	© COMBATSIM CHECKLISTS 2017	HOENGSONG (RKNW)
NOT FOR REAL NAVIGATION - FALCON BMS 4 ONLY		SOUTH KOREA

The titles are made of the top and bottom section.

The first indication is for which navigation volume the chart is made for, in this case Korea.

Then it clearly states the type of approach (here an ILS). The runway the approach refers to (rwy 02) and the name of the airbase: Hoengsong AB and the country: South Korea.

The date is simply the date at which the chart was created or last updated.

4.2.2 Header

TACAN:	ATIS:	APP/DEP:	TWR:	ILS:	ILS DA(H)	GPS:	ELEV:	
039X	128.6	292.6	265.5	110.2	780' (200)	N37°27.477' E129°13.341'	580'	
MISSED APPROACH: Climb to 8000 direct HGS. Turn LEFT to intercept R-360° HGS to DME5. Cross at or above 3500'. Turn RIGHT direct to HGS and intercept R-225° outbound to MUNMAK. Hold as published.								MALSF VASI

The header section gives the pilot plenty of information relevant to the airbase and approach. The headers are always similar even for different approach types. Only information relevant to this type of approach will be displayed. For instance, tacan approaches will state the tacan radial and tacan decision height rather than ILS information.

The top left section gives the airbase tacan channel and band. Although this information is not really useful when shooting an ILS approach it is nevertheless required because most of the navigating before intercepting the ILS will be made using the tacan as the main radio-navigation station.

The second section states the airbase radio frequency in the order the pilot will need them. For an approach chart it will start with ATIS, Approach then Tower. For a departure chart it will be Tower first and then Departure. Please note, since BMS 4.34 the ATC frequencies are exclusively UHF, except ATIS which is VHF.

The next section gives the ILS frequency. For the ILS cues to be displayed the aircraft instruments need to receive the radio emissions of the ILS. As explained earlier, that frequency is inputted in the UFC via the T-ILS page. Bear in mind that not all runways have an ILS approach. Some terrains only have non-precision tacan approach. BMS tries to reflect the real-world navigation data so you will find the same kind of approaches that the real airports have.



The following box gives the ILS DA(H) where ILS DA is the ILS Decision Altitude in MSL, and (H) is the Decision Height in AGL.

An altitude is always given from a known reference. Most of the time this is sea level or QNH. When we talk about an altitude above ground level (AGL), we should use the term “height” as the ground level is not a valid reference for altitude.

The value is given in feet MSL (here 296’ where ‘ means feet) which is the altitude above sea level where the pilot should have the runway in sight to be allowed to continue the approach. If the runway is not visible the pilot needs to go around. We then say the runway is below minimum. The smaller numbers (200’AGL) is the real Decision Height because it’s given above ground level.

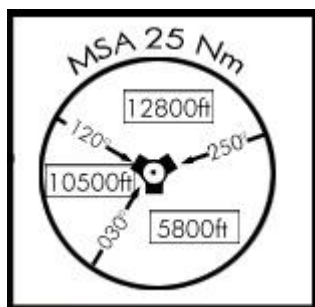
Notice that the indicated altitude given by your altimeter in the F-16 cockpit gives you the altitude MSL. But you always have the Radar altitude box in your HUD giving you your height above the ground. We will return to talking about the minima when covering this section later on.

The next box is the GPS coordinates of the airbase reference point (usually the tower or the middle section of the main runway). Due to some projection problem in the way Falcon was originally coded, these GPS coordinates don’t correspond to the real world. No big deal since the one given on the charts are the ones used to navigate to the airbase by punching them into the STPT or DEST page of the UFC.

The ELEV box gives the elevation in feet of the airport above mean sea level. Hoengsong stands at 580 feet above sea level. It means that sitting on the ground the altimeter should read 580 feet when set on the QNH given by Hoengsong ATC.

The bottom window is the Missed approach procedure. In case of a go around the pilot needs to follow this route back to the IAF (Initial Approach Fix. A pilot may decide to go around at any moment along the approach but he has to go around if he doesn’t have the runway in sight at the minimum altitude. When going around the pilot declares missed approach (abort “ttt6”) on the approach frequency and flies back to IAF or follows instructions given by ATC.

The next box gives information about the ALS (Approach Lighting System) for this runway. In BMS we have three types of approach lights: MALSF, ALSF1 & ALSF2 and 2 types of glide slope lights (PAPI & VASI). Normally MALSF is a non-precision approach lighting system whereas ALSF1&2 are precision approach lighting systems and only the runways with ILS should have those kinds of lights. Unfortunately as illustrated here, the generic airbases don’t always feature the matching ALS according to the approach type (that’s because generic models are used for multiple airbases with different approaches implemented). Hoengsong, although having an ILS on RWY 02 has MALSF and VASI whereas it should be ALSF and PAPI.



The final section is the large square on the right with the big circle in it. It’s the MSA information: Minimum Safe Altitude. It gives a topside view of a circle of fixed radius centred on the relevant tacan with safe altitudes (MSL) according to quadrants limited by arrival headings. On this example pilots should note that the minimal safe altitude between arrival headings of 250° and 030° is 5800 feet MSL. The minimum safe altitude between arrival headings of 030° and 120° is 10500ft MSL and the last sector between arrival headings of 120° and 250° is 12800ft MSL.



Basically, it means that we have high terrain of at least 11000 ft on the northern sector and high terrain at least 9000ft on the western sector.

Pilots should stay at or above MSA when arriving at an airbase unless they are on an approach track which remains safe because it's clear of known obstructions.

In the Falcon charts, the radius of the circle will always be 25 Nautical miles. Those figures are checked in the 3D world and once again are relevant to BMS. An empty circle with only the tacan in the centre and only one altitude means that the MSA is valid all around the airbase for the fixed radius.

As said earlier, tacan approaches charts have a different header since some information such as ILS are not required. Rather than the ILS frequency and the ILS DA(H) you get the final approach course and the radial to track and the tacan DA(H) which is obviously higher than the ILS minima.

TCN:	ATIS:	APP/DEP:	TWR:	TCN DA(H)	APP CRS:	GPS:	ELEV:	
72X	108.7	232.4	236.6	640' (603' AGL)	075° R-225°	N36°02.779' E130°48.826'	37'	
MISSED APPROACH: Climb straight ahead to DME 1 POHANG tacan Then turn LEFT heading 360° to intercept R-030° outbound POHANG tacan. Climb to 6000 feet and hold as published at DEABO DME 11.								MALSR PAPI

Radar approaches also have a different header with specific information for the radar approaches, but the structure always remains the same with the relevant frequencies, the decision altitude/height and the final approach course.

TCN:	ATIS:	APP/DEP:	TWR:	NPAR DA(H):	FINAL:	GPS:	ELEV:	
75X	120.225	292.65	292.3	310' (300')	176°	N35°57.554' E127°24.492'	10'	
MISSED APPROACH: Climb runway heading. Reaching 2000ft turn LEFT climbing to 5000 direct TOLCI. Contact Approach for resequencing to JINRO.								ALSF-1 PAPI

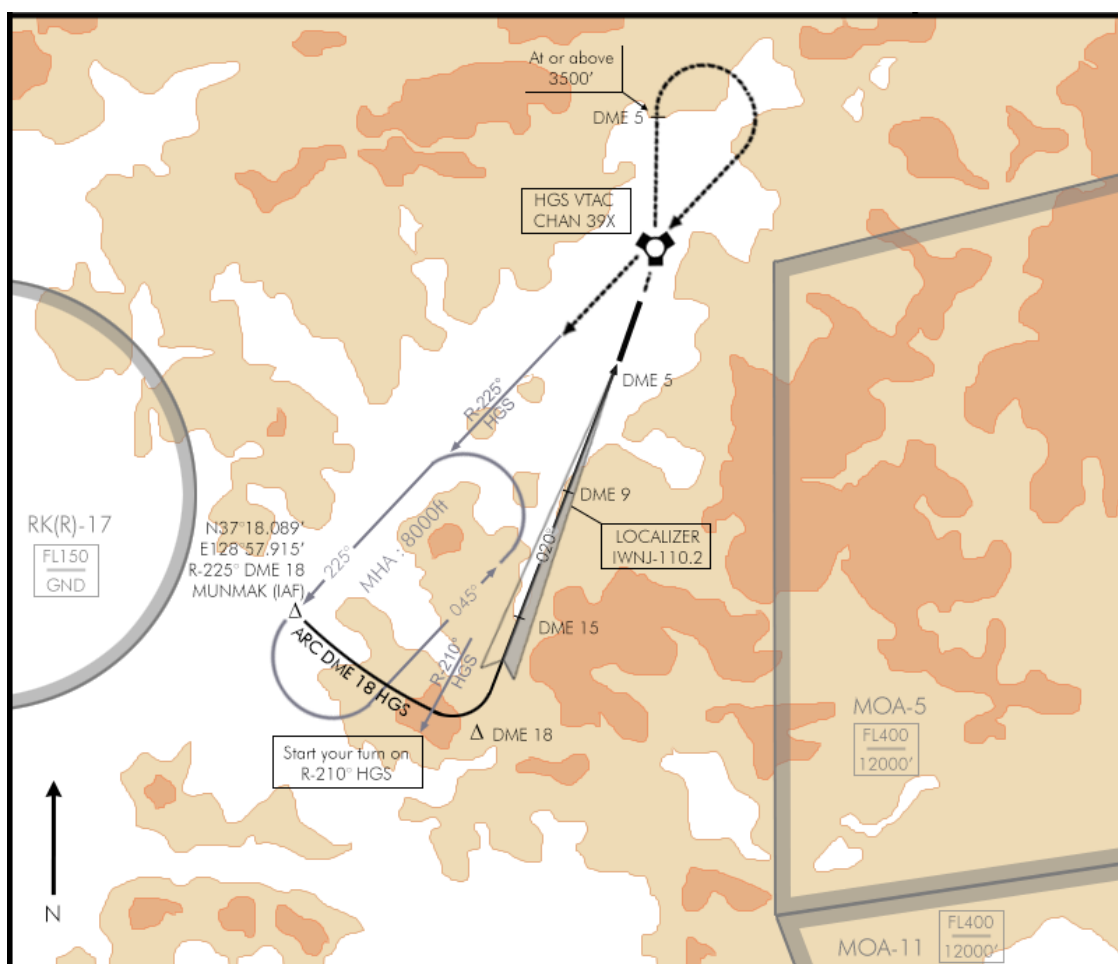
Note that the radar approaches have a NPAR DA which stands for Non Precision Approach Radar. It's a term that was invented specifically for these BMS approaches for lack of a better one.



4.2.3 Plan view

The main view is also called the airport plan view and illustrates the airport and its surroundings with the approach track when viewed from above. A lot of information is given in this view.

The most obvious one is the approach track pictured in black and finishing with an arrow pointing at the runway. That track always starts at the IAF (Initial Approach Fix). You also see the runway(s), correctly oriented and the tacan – properly placed from the runway with its frequency and ID. The missed approach track is always pictured as a dashed black line finishing with an arrow usually pointing back at the IAF.



When ILS is featured the ILS symbol arrow is present pointing to the runway and stating the ILS frequency and ID. A tacan approach track is only made of a black arrow.

Relevant radials and holding tracks are dark grey.

Airspace boundaries (restricted, danger, prohibited or training areas) are light grey with their ID and usually their altitude limits. Those airspace limitations are pretty useless in BMS as we lack a NOTAM system to activate them properly and we don't really mix civilian aviation and military flights.

Just be aware that Prohibited airspace is identified with P (RK(P)-73B for instance) and shouldn't be entered unless you have a very good reason. RK stands for Republic of Korea. (P) means Prohibited and 73B is the number assigned to that prohibited area.

Restricted airspace is identified with an R (RK(R)-17 for instance) and training areas are usually identified as MOA (Military Operating Area) and a number.



All of these airspaces might be limited in altitude. That information is stated on the charts. The box illustrated on the left has an airspace from ground to FL200. You can overfly the area above that altitude but you cannot go under.

The AI doesn't care about these airspace limitations. These airspaces are meant for TE scenarios and can be marked accordingly at flight planning with the DTC lines. They will then be visible on both the planning map and in the HSD MFD once DTC has been loaded.

For the rest, airspace restrictions in BMS are purely eye candy.

The terrain is illustrated on the charts in colours: Water is light blue, ground level is white and various shades of brown are used for elevation (usually in 1000 feet steps), the darker the brown the higher the terrain is from the field elevation.

This is an area that still needs some love with the charts. Normally the colours used versus altitude should always be the same but in high elevation terrain, having a chart on a brown background didn't feel natural. So white was decided as the colour of the elevation of the airport (a layer of 1000 feet) and the light brown would start from 1000 feet above this. One day I will have to revisit this and hopefully new tools will help getting some organisation in there.

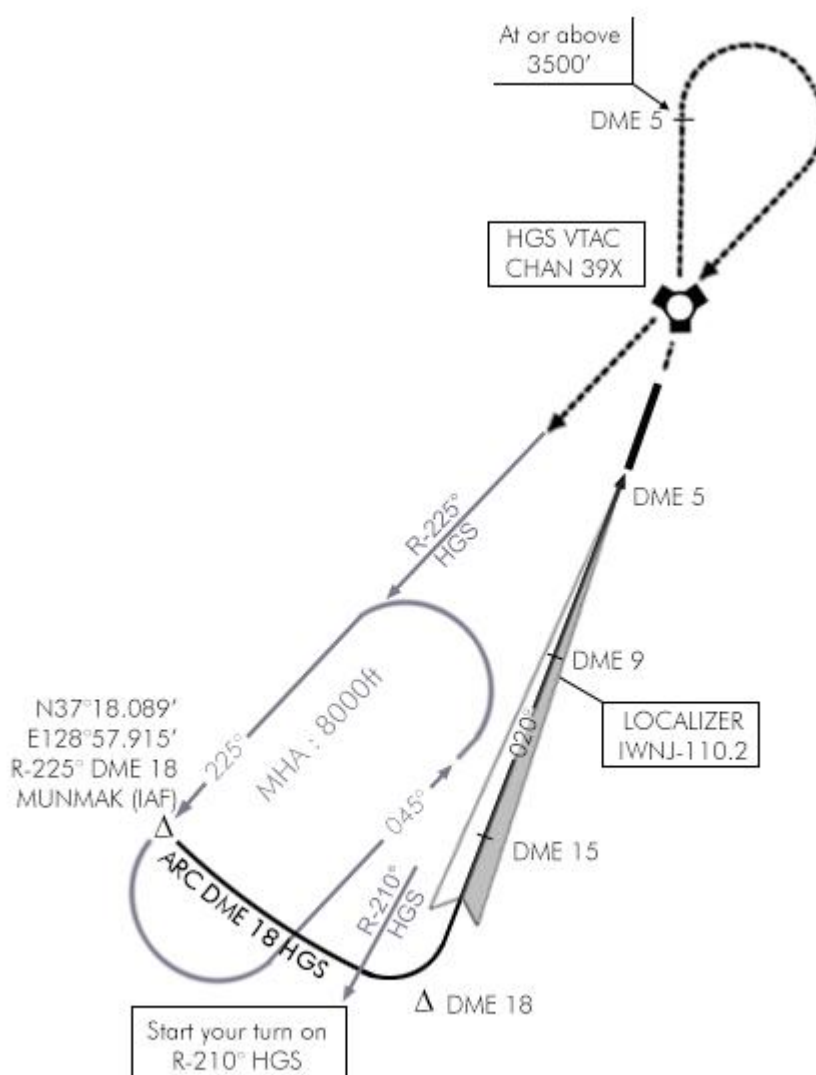
You may also find different caution and notice boxes warning the pilot of relevant items to this specific approach.

Let's go back on the approach track:

Here's an example for the ILS approach on RWY 02 at Hoengsong, South Korea.

The approach track always starts at the IAF which stands for Initial Approach Fix. It is named as a fix usually with a 5 or 6 letters name (here MUNMAK). Its position is given both in GPS coordinates and with a radial from a known tacan and the distance from the station (DME).

R-225° DME 18 means that MUNMAK is on the 225° radial at a distance of 18 Nautical Miles. To get there the pilot has two choices: the first would be to intercept R-225° and get to DME 18 by flying INBOUND the station if the intercept is done further than



18 DME (and make a parallel entry in the hold) or by flying OUTBOUND if the intercept is done before 18 DME (and making an easier direct entry in the hold).

The second possibility and by far the most used when returning from a mission would be to take the last waypoint of the flight plan before landing and change its coordinates so it is set at the IAF (if the TE creator didn't think of that). That is quite easily done with the INS system of the aircraft computers.

Changing a steerpoint coordinates is done either straight from the STPT page or the indirect DEST page (LIST – 1). Set the asterisks over the latitude of the steerpoint to change and enter the new latitude starting with the North key (2). Confirm with enter then do the same for the longitude starting with the East key (6). More information about entering coordinates in the INS system can be found in the Dash 1 or training manual.

Once inputted all the pilot has to do is to fly to the IAF as he would do with a simple steerpoint by making this the active steerpoint and follow the system cues.

The altitude at the IAF is the minimum altitude of the holding pattern. You may deconflict altitudes by holding higher but try to leave the IAF at the correct altitude.

Usually, there will be a fixed holding pattern at the IAF. That racetrack pattern in grey in the chart allows a pilot to hold while the airport is busy launching or recovering other aircraft. The relevant approach frequency should be contacted some time prior to reaching that point as the IAF is the first point the ATC will vector you to.

When holding, each aircraft should be stacked 1000 feet apart in the same holding track. It is quite possible (and fun) to hold in wingtip as a two-ship tight formation in bad weather as long as you can stay visual with each other. Anything more than a 2 ship or if you cannot maintain visual with your wingman, deconflict with altitude separation.

See the advanced radio-navigation section to see how to enter and fly a holding pattern. It's not easy and a lot of practice will be required before you can fly it precisely. Bear in mind that holding areas may be quite filled with airplane at different altitudes so fly it safe by remaining on track and at the assigned altitude.

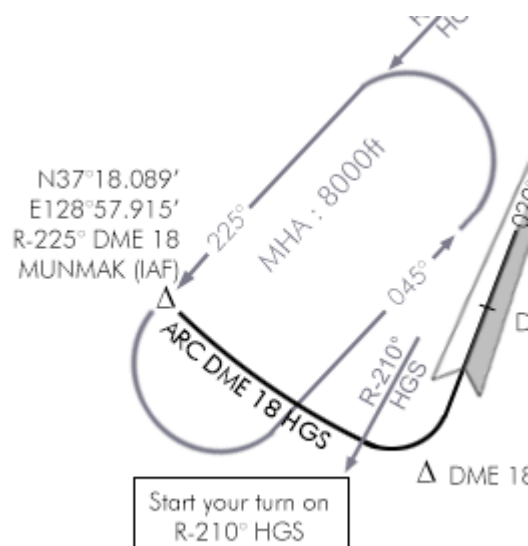
Speed control is also an important aspect of holding. Obviously you will want to conserve fuel and since you may already be low on fuel, it is even more important.

Besides, flying fast will give you less time to make a perfect holding pattern and the turn will also be wider. Pilots should try to fly at a comfortable speed. Unless otherwise noted, the airspeed is at the pilot discretion. Personally, I try to fly at maximum 300 KIAS throughout the approach until established on the glide where I adjust my speed to fly the correct AOA.

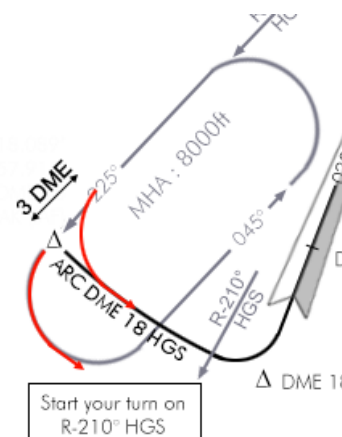
You don't have to necessarily fly the holding when flying the approach. If there's no need to regroup or if the airport is not so busy you can simply proceed with the approach without holding.

As a matter of fact that's usually what the approach ATC will instruct you to do upon initial contact.

Most often, the transition between the IAF and the line-up is made by an ARC DME. Performing these might seem pretty complicated but using the HSI it's actually pretty easy. The idea is to remain at the same



Bear in mind that leaving the holding pattern, you will need to turn usually 90° which takes time and might push you out of the required distance. The formulas to calculate your lead are given in the advanced radio-navigation section. Just take into account the lead distance from IAF you will need, to start your turn into the DME ARC. At 300 kts, it's usually 3 NM. If you wait until you're overflying the IAF before turning, you will end up on a DME ARC 21 NM. So you should start your turn around 15 DME to end up on the published DME ARC 18 NM.



The same lead will be required when leaving the DME ARC to line up on the approach track. You usually have plenty of time to line up properly before intercepting the glidepath but the sooner you are on the correct track the better.

Remember that one, because it's really the key to a correct approach. The sooner you have the proper attitude and speed, the easier the approach will be.

Usually, I would start the line-up turn passing the approach radial minus (or plus) 10-15°. From there, the line-up turn doesn't have to be a perfect curve. It can be a hard turn to get a 30° interception on the line-up radial and then intercept it smoothly.

The difficulty with the Hoengsong example is the very short DME ARC. The distance between the moment the DME ARC 18 NM is established and the turn to the ILS is very short, nevertheless let's stick to our active example:



You will land on ILS RWY 02 and you are inbound to the IAF on radial 225° outbound the station at 8000 feet.

You contacted Hoengsong approach on 292.6 and requested an instrument approach. ATC will vector you to the MUNMAK IAF. Your EHSI is set to TCN with the “M” button (the old analogue HSI has been replaced by the EHSI in the modern blocks of BMS) and your tacan has been obviously set to HGS channel 039X. You know you should not overfly the IAF (if ATC calls a vector back to it, ignore them). As explained above you need to lead the turn by 3 NM to establish a DME ARC 18 NM. When the DME indicates 15 NM on R-225, you turn left and place the station pointer at the 9 o’clock position. That will induce a 90° turn approximately to 135°. You should also start your descent to 6000 feet.

At the same time the EHSI course is changed from 225 to 210 as it is your next reference point where you will need to turn towards the ILS. As you see on the left picture, the CDI (Course Deviation Indicator) already started moving and we are already very close to the turning point. Note as well that a .7 DME overshoot is reported by the DME, probably due to being faster than 300 kts in the turn.



The station pointer is perfectly at the 9 o'clock position, the CDI is centred on R-210, we're just 18.9 NM from the station and we should be 18NM, so we're just outside the DME ARC.

The left turn towards the ILS must now be started and altitude can be lowered to 4000 feet.



The ILS course and radial 200° may not be aligned as they have different radio sources which are not collocated. So during that final turn, the EHSI is switched to PLS/TACAN with the M button. From that moment, the deviation will not be from the tacan radial but from the ILS signal. DME remains to the tacan though as we do not have ILS DME implemented in BMS. Having switched to ILS (PLS) the ILS needles become visible in both the ADI and the HUD. I find it easier to switch focus to the ADI as it gives a lot of information on a single instrument. The aircraft is in a left descending turn, the localiser is on the right and the glideslope is up. That's exactly how it should be during that turn. The pilot is mostly focusing on the localiser needle to avoid overshooting the ILS. The glide will be properly intercepted from below a little bit later once aligned, and around DME15 (from the tacan which is 3 NM north of the runway in this case). At DME 15, ATC will instruct you to descend to 2000 feet. You should have the glideslope intercepted then. The HUD displays the ILS bars as well and to align perfectly the ILS cues, the pilot should place the FPM on top of the flight director (the circle with the vertical line extending at 12 o'clock). Obviously bad weather means turbulence and the FPM will not stay perfectly on top but that symbol will guide you to the optimal ILS path. Alignment correction should be minimal from



initial interception since the aircraft heading should be close to the runway heading. Only turbulences will deviate the aircraft from the ILS course.

Reaching DME 9 (actually 6 NM from the threshold) the outer marker will flash and its audible sound will be heard in the cockpit. As the instrument picture on the left shows, airspeed should be close to 250 kts, altitude around 2000 feet, ILS needles centred, heading close to 020°.

You should lower the gear (check speed) if it's not done yet.

The approach controller will tell you to switch to Tower on 265.5. Change your UHF radio (preset #3) and report on final (tt4). The tower controller will clear you to continue inbound and will clear you to land in a few moments. Continue flying the ILS to the inner marker which will happen at 2 NM from the threshold (5 NM from the tacan). Besides following the flight director, using the HUD dashed line between 0 and -5° is usually a very good cue for a proper ILS descent (usually 2.5-3°).





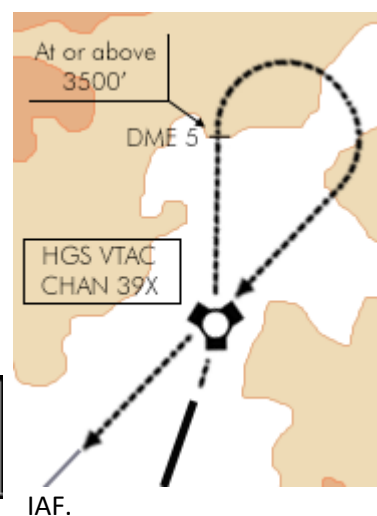
Passing the inner marker the runway lights should be in sight. If not, you are below minimum and need to find another place to land. Normally if that was the case the new BMS ATC would have closed the airbase. The ILS cues form a perfect cross in the HUD and ADI, the FPM is just on top of the AOA bracket, the altitude should be approximately 200 feet above runway elevation ($580+200=780\text{MSL}$) and the wind should be displayed in your DED and tower has cleared you for landing. From this point you just land the jet using the available visual cues.

Remember there is no fixed speed for landing. You land on speed AOA which is whatever speed to fly a 13° AOA touchdown. Concentrate on the AOA indicator as you know AOA is maintained with throttle inputs, no pitch inputs. Increase power if the red triangle is visible, decrease power if the yellow triangle is visible. On speed AOA is attained when the green circle is visible. Normally before touchdown the FPM is just above the AOA bracket and the yellow triangle is visible. Just before landing, decreasing the throttle is usually enough to lower speed a touch for the green doughnut to become visible.

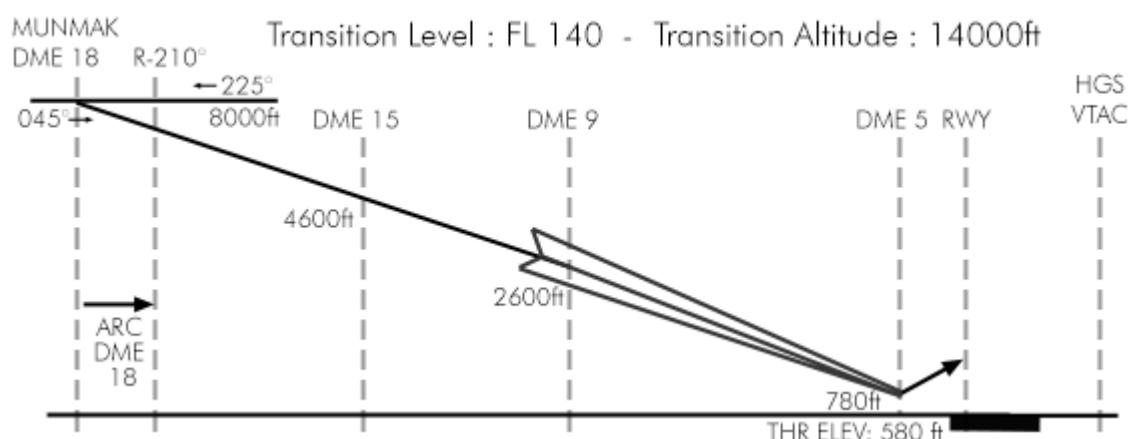
When landing in bad weather in 4.34, looking up at the minimum and finding your aircraft perfectly aligned with the runway with the correct speed is quite an accomplishment and something you can be proud of!

In case you need to go around, the missed approach track is displayed as a dashed line in the main view. The routing is given in the Missed approach part of the header: in this case you need to climb direct to the tacan then intercept a northbound radial until a distance of 5 NM not below 3500 feet, before turning back towards the HGS tacan and re-intercept the IAF radial $R225^\circ$ outbound. Don't forget to tell Tower that you're aborting the approach. They will acknowledge your call and instruct you to switch to the approach frequency which you should contact again prior to reaching the

MISSED APPROACH: Climb to 8000 direct HGS. Turn LEFT to intercept $R-360^\circ$ HGS to DME5. Cross at or above 3500'. Turn RIGHT direct to HGS and intercept $R-225^\circ$ outbound to MUNMAK. Hold as published.



4.2.4 Side view



This view is the same as the plan view but viewed from the side which gives the pilot the required altitude at specific points of the approach.

At MUNMAK (IAF) the altitude reads 8000ft which is the minimum holding altitude. Between the two vertical grey lines at DME 18, the black arrow displays the DME ARC and its distance: 18NM, which is very short in this example. Also of interest near the MUNMAK line are the two reciprocal headings for the holding: 225 & 045°.

Leaving IAF, a descent should be immediately initiated to reach DME 15 at 4600 feet. At DME 9, altitude should be 2600 ft and heading 020° already lined up on the ILS localiser. Usually 2000 feet AGL is where the glide is intercepted from below but in this example it's done from further out and might happen very quickly after localiser intercept.

We always intercept a glideslope from below to avoid diving to the ground to chase it. In most approaches the goal is to fly level at 2000 feet AGL and let the glide slowly come to you from above, which usually happens 6-7 NM from the runway at the outer marker.

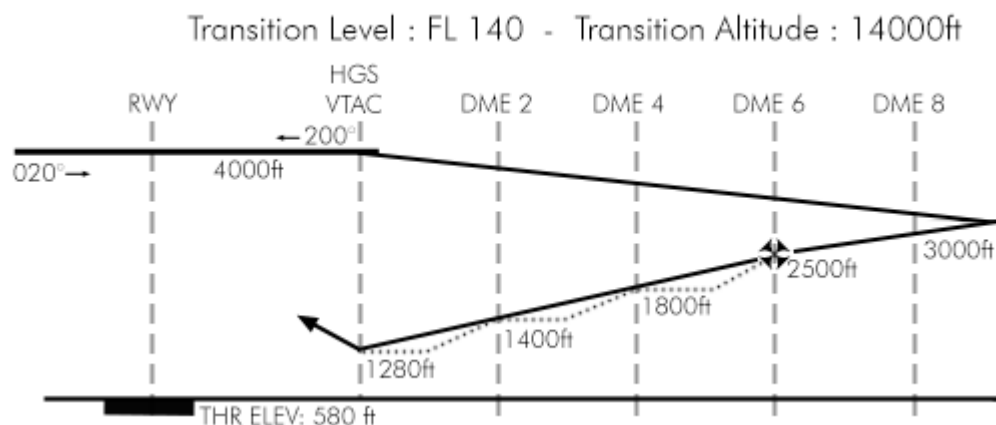
Once established, pop the airbrakes, lower the landing gear, add a notch of power and pitch 3° down to follow the glideslope.

From the outer marker the 3° glideslope will bring you the minima usually identified by the inner marker. On the chart the arrow points upwards at the minima. That is the start of your missed approach track in case you can't land because you do not have the runway lights in sight.

The text line on the top of the window gives the transition altitude and transition level.

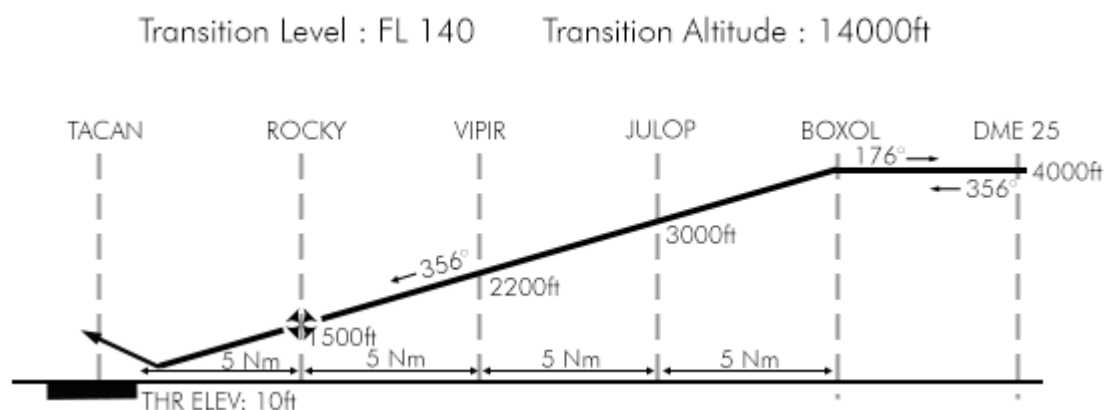
The transition altitude in Korea is 14000 feet. The transition level is FL 140. It might be different in other BMS theatres. See chapter "1.1.9 Transition Altitude" of this document.

On non-precision approaches like tacans, the altitudes displayed on the chart are not mandatory (except stated otherwise) – if you can plan your descent to be at the required altitude at each point by flying a constant descent profile, that's fine. The constant descents are displayed as straight lines but as you can see the level descents are displayed as dotted lines as well.



The maltese cross is the symbol for the Final Approach Fix (FAF) which is the point where final approach starts. (Usually that's where the BMS approach controller switches you to the Tower frequency.)

Radar approaches have specific information on the side view:



The distances are from the runway threshold and not from the tacan DME (except for the outer holding point). Each point is represented by its name, the altitude at which it should be overflown and its distance from the runway threshold.



4.2.5 Minimum

The minima window just gives the minimum altitude height of the approach. When you reach that altitude/height you should look up outside and have a visual on the runway to be allowed to continue the approach. There are usually 3 minima for an ILS approach:

The first one is the minimum when the ILS is fully working: 780 feet MSL which is 200 ft AGL for this approach.

The second one is when you perform an approach based on the localiser only (no glideslope information) which may happen in BMS on some airports where the glideslope does not provide enough obstacle clearance.

The third minimum is applicable to the circle to land.

MINIMA:
<u>ILS</u> : 780'(200'AGL) Vis: 200ft-800m*
<u>LOC</u> : 980'(400' AGL) Vis: 400ft-1600m**
<u>Circling</u> : 1480'(900'AGL) Vis: 900ft-2000m
*When ALS inop, increase vis to 1200m **When ALS inop, increase vis to 2000m

Each minimum also has a notion of ceiling (in feet) and visibility (in metres) that need to be met for the approach to be completed.

Plus some extra information about the ALS (which basically are the runway lights) that require an extra visibility distance in case they are inoperative.

Tacan approaches and non-precision Radar approaches have their own minima, usually higher than the ILS approaches.

MINIMA:
<u>TCN</u> : 1280'(700'AGL) Vis: 800ft-1600m*
<u>Circling</u> : 1480'(900'AGL) Vis: 1000ft-2000m
*When ALS inop, increase vis to 2000m

MINIMA:
<u>NPAR</u> : 400'(303'AGL) Vis: 400ft-800m*
<u>Circling</u> : N.A.
*When ALS inop, increase vis to 1200m



4.3 Standard Instrument Departure

SID stands for Standard Instrument Departure. It's a published departure procedure from an airport. It decreases the load of communication between ATC and pilots since each knows what to do to get to the exit point. In real life, its purpose is also to deconflict traffic and provide noise abatement by avoiding populated areas whenever possible.

Although BMS 4.34 features a dedicated departure frequency (shared with approach) no instructions are given according to the type of departure. BMS ATC might just give a heading departure and send you on your way.

It remains the flight leader's responsibility to decide which SID to use, according to the take-off direction and meteorological conditions. Flight lead may elect not to follow any procedure at all and dash towards the FLOT or simply follow his flight plan, which may be perfectly valid.

Normally a SID is flown in IMC as a single ship or in a long radar assisted trail departure up to the exit point (usually on top of the clouds) where the flight can be regrouped during hold procedures.

If all follow the same route at the same speed, then the rejoin will be natural at the exit point. Just think about a radar departure where each aircraft uses its radar to lock onto the next aircraft in front of it, to provide correct spacing and thus deconfliction. Please note this may sound simple but care should be taken NOT to all lock onto the leader, as this increases the risk of collision for wingmen. #2 is tied on lead; #3 is tied on #2 and #4 is tied on #3. When going through the top of the clouds, if spacing is correct, all flight members should easily gain visual on the aircraft in front of them.

As you may have noticed – and quite logically – the SID doesn't necessarily point to the North in Korea and you may fly southbound to the exit point before starting your northbound flight plan.

Another consideration is the TOT (Time Over Target). Flying the SID will certainly push your flight out of your assigned TOT, so care should be taken to adapt the TOS (Time over Steerpoint) at waypoint 2 or 3 to have plenty of time to fly the SID.

Usually, a good idea would be to place waypoint 2 on top of the SID exit point. That can be done during flight planning in a general way and refine its placement once in the cockpit with the GPS coordinates of the exit point or directly from the planning UI map (which features the exit and IAF points).

Flying such a departure procedure involves a lot of preparation in flight planning. First you need to be aware which runway is likely to be active. For that you need to check the wind in the briefing. Then you should review the procedure before entering the aircraft and know what radio-navigation as well as radials to set in the cockpit. If you stay behind the airplane once in the air and need to constantly check the chart you will probably find you're not following the published route. Some SIDs are very easy to follow, others are much more complicated and involve a lot of tacan switching.

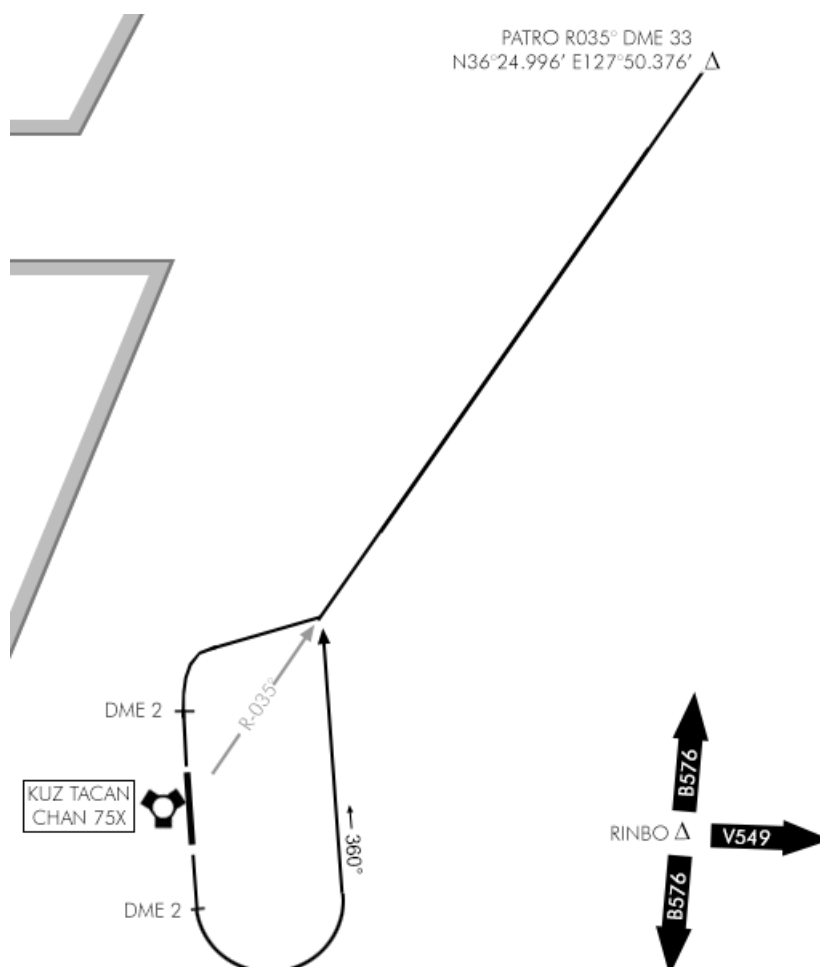
4.3.1 SID review

As with the other charts, the SID chart starts with a title section and a header section. These two sections are quite similar to the ones we explained in the approach chart chapter, so I won't cover them again here. The main difference is that the missed approach has been deleted and there's no mention of ILS or tacan for the approach. These are replaced by the Transition altitude and transition level, more important here since we are likely to use them while climbing out. Please note the UHF radio frequencies are displayed in the order pilots will most likely need them for a departure: first tower then departure (which is shared with approach). There is no ATIS frequency displayed either as usually, when departing, you don't really need it.

TACAN:	TWR:	APP/DEP:	TRANS LEVEL:	TRANS ALT:	GPS:	ELEV:
075X	292.3	292.65	FL140	14000ft	N35°57.554' E127°24.492'	10'

The remainder of the chart is a plan view of the departure route and a written description of the route. There is no side view for altitude. The required altitudes are mentioned on the plan view at key points along the departure.

Let's consider Kunsan PATRO departure



Some airports have a single SID chart with multiple routes displayed. Larger airports may have one chart for each SID. This is the case with Kunsan airbase which has a total of 3 standard departures and therefore 3 different charts. The South departure is the ALADI departure, the East departure is named COYOTE and transits to the WOLF fix and the North departure transits to the PATRO intersection and the one used in this example. A SID is always valid for all airbase runways.

The procedure is explained in plain text in the Departure route description. The first thing to do is to read the section relevant to the departure you will be flying.

DEPARTURE ROUTE DESCRIPTION

TAKE-OFF RWY 18:

Climb on runway heading direct DME 2 KUNSAN tacan. Cross at or above 500ft. Left climbing turn to 360° to intercept R- 035° outbound direct PATRO. Cross DME30 at or above 7000ft. Thence, ...

TAKE-OFF RWY 36:

Climb on runway heading direct DME 2 KUNSAN tacan. Cross at or above 500ft. RIGHT climbing turn to Intercept R- 035° outbound to PATRO. Cross DME30 at or above 7000ft. Thence...

Let's say RWY 36 is active at Kunsan today. Prior to lining up the tacan is set to 075X and the course arrow is set on the 035° radial. The instrument mode is obviously in TCN position. Check waypoint 2 coordinates and adjust them to the GPS coordinates of Patro if necessary.

Once airborne climb runway heading to DME 2. Initiate contact with Kunsan departure frequency on 292.65 and report airborne. Then initiate your right turn to intercept the departing radial. As the F-16 is accelerating and climbing fast you should take care to get out of AB as soon as possible and don't climb like a rocket. 8° pitch up is usually more than enough showing a speed of 300 kts indicated.

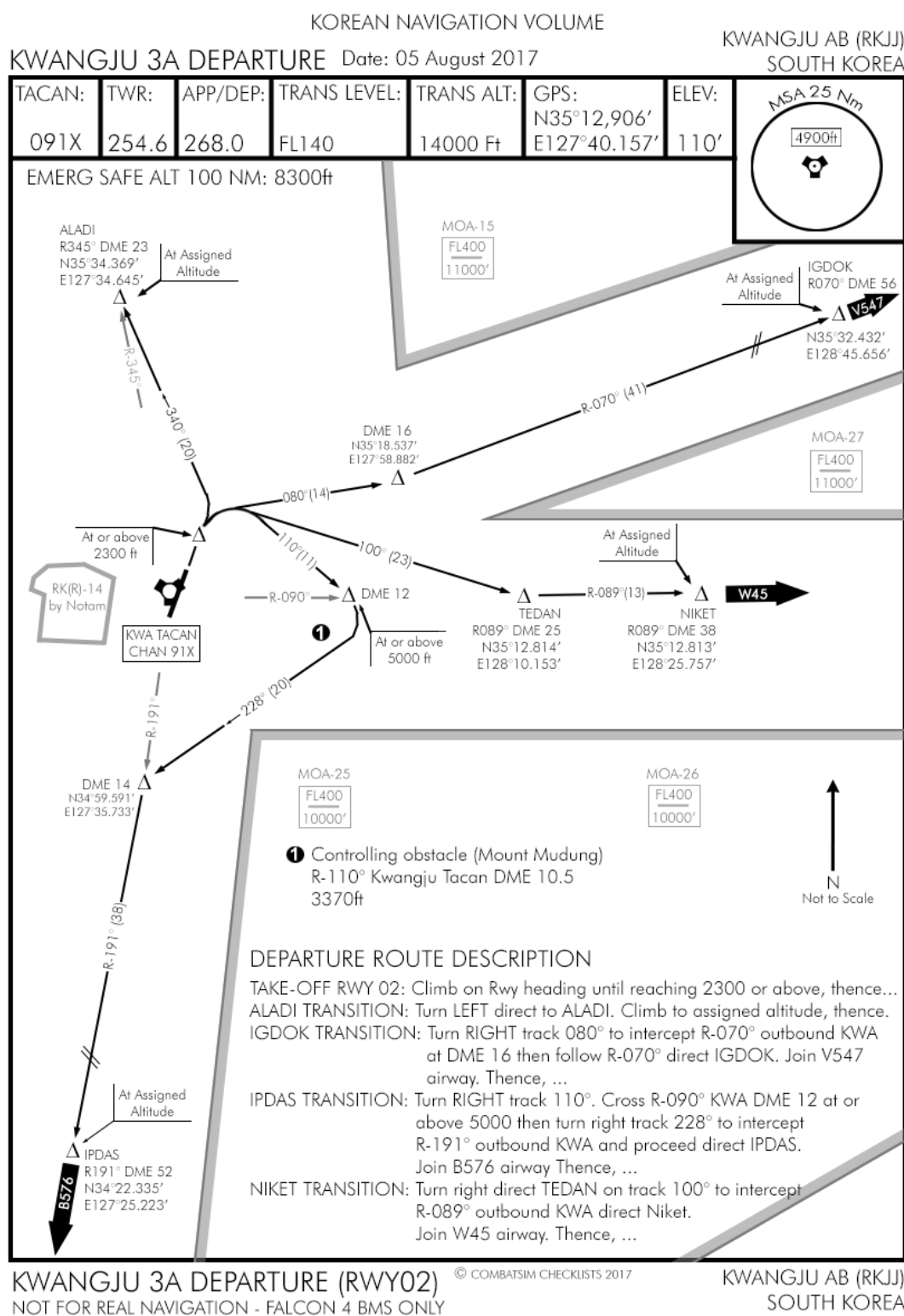
Although not stated on the departure, intercept angle should be $30-45^\circ$ from the radial. Fly an initial heading of 075° and look at the EHSI to execute a perfect intercept on radial 035° outbound KUZ tacan.

Once the radial 035° is intercepted you can continue your climb out to your assigned altitude and you should have no problem reaching 7000 feet at DME 30 with your F-16. Once on top, flight lead may elect to cancel IFR and regroup their flight with a few weaving 90° turns for the lagging wingmen to rejoin in tactical formation. Another possibility is to fly to the exit point PATRO and hold there waiting for the wingmen to regroup before resuming your mission.

As mentioned earlier, BMS ATC doesn't care much for your departure from the airbase. I would advise staying on the departure frequency until the exit point or when you cancel IFR and then switch to the prebriefed tactical net.

Usually SID routes are self-explanatory. Some may be a bit more complicated than this overly simple one.

Flying a SID is not overly complicated as long as only one tacan is concerned. The trick is to plan the procedure properly before departure. It gets trickier when more than one tacan station is necessary to follow the route and when you have multiple transitions like on Kimpo and Kwangju. Transitions are different routes leading to different exit point of the same departure.



The SID itself says to climb on runway heading until reaching 2300 feet. Then the pilot has 4 transition routes at his disposal, depending on which direction his flight plan takes him: ALADI to the North, IGDOK to the North East, NIKET due East and IPDAS due South.

Also of interest is the black circle with a 1 inside. It gives the position of an obstacle near the route. In this case, a mountain with a highest point at 3370ft. Since you're supposed to pass DME12 at or above 5000ft continuing your climb you should be safe. But it does highlight the importance of altitude control throughout the route. Since you're heads down in the cockpit flying IFR you won't see the mountain that will spoil your mission ... and reputation.

4.4 Special charts

BMS 4.33 had some special charts for airstrips that were being converted to airbases. In 4.34 this conversion is fully done and both Sokcho and Hoengsong are fully developed airbases with their own tacans and approach procedures. So their special charts are not necessary anymore in BMS 4.34. Suffice to say they might be needed again in the future and we will reuse them accordingly.

4.4.1 ADIZ charts

There is only one ADIZ crossing chart between Japan and South Korea, included in the Fukuoka package.

It's a chart created for documenting safe routes to cross the Korean straits. During the crossing, aircraft will need to enter the respective country's ADIZ and the aircraft needs to be properly identified at the ID points INVOK and SAPRA. Obviously these procedures are mostly aimed at Multiplayer when humans can manage the situation. AI are not able to deal with such procedures.

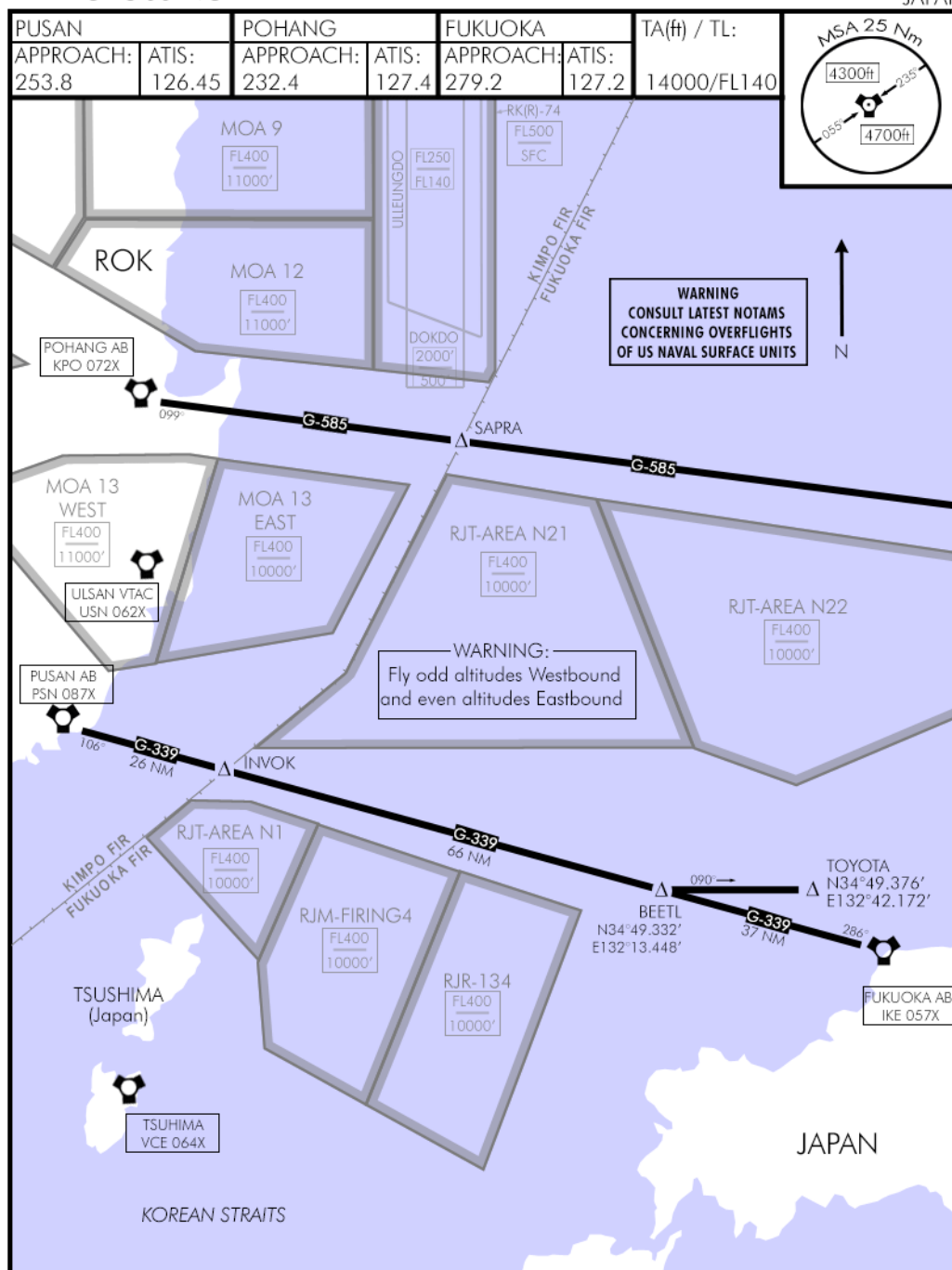
Since all aircraft are likely to be on those corridors, Westbound aircraft need to fly at odd altitudes while Eastbound traffic need to be at even altitude in thousands of feet. That will provide at least a thousand feet separation between crossing flights. But don't worry too much.

KOREAN NAVIGATION VOLUME

FUKUOKA (KADENA)(RJFF)
JAPAN

ADIZ CROSSING

Date: 23 Dec 2018



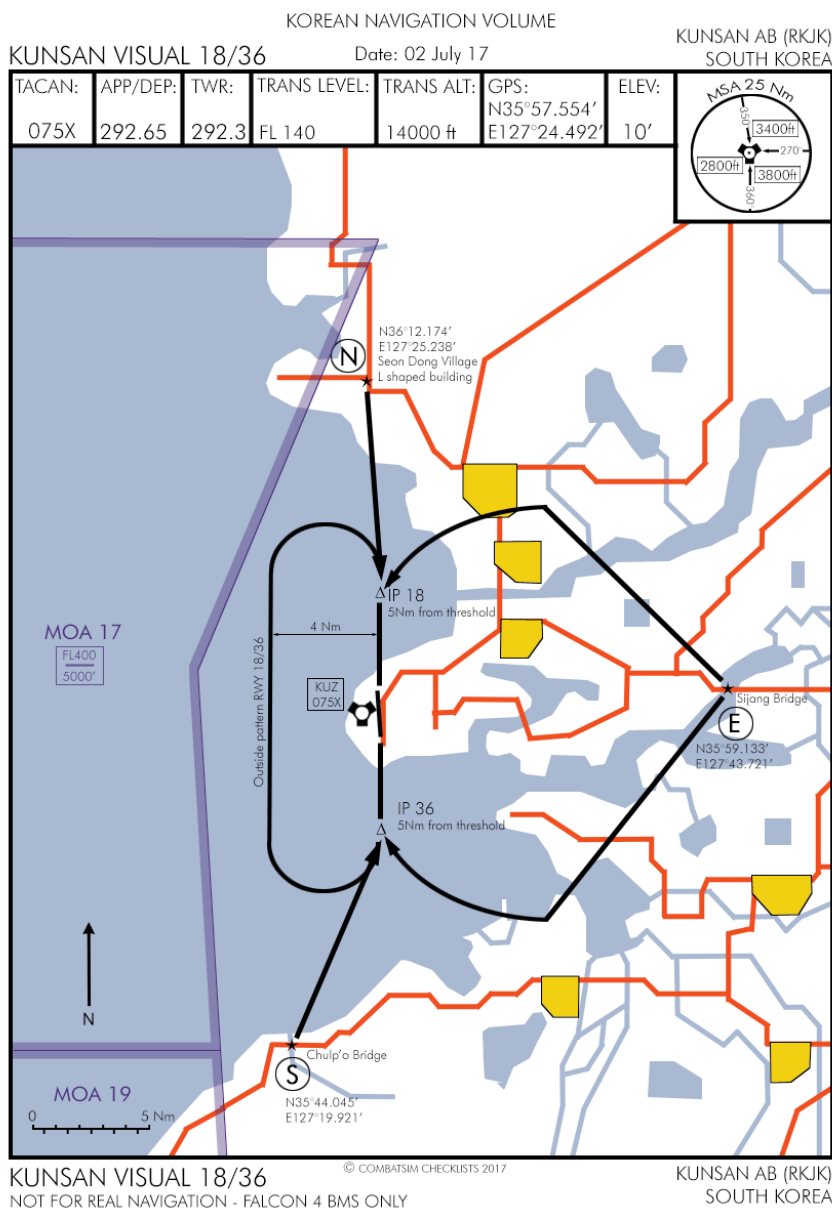
ADIZ CROSSING

NOT FOR REAL NAVIGATION - FALCON 4 BMS ONLY

FUKUOKA (KADENA)(RJFF)
JAPAN

4.4.2 Visual charts

Real charts are Visual Approach Charts (VAC) and mainly focused on VFR procedures to specific airports. Usually a VAC chart has multiple visual reporting points: usually one for each cardinal direction: November for the North point, Echo for the East point, Sierra for the South point and Whiskey for the West point. The idea with these charts was for pilots to report the entry point and fly to the runway to land visual, either overhead or straight in.



These charts are not to be confused with the new BMS 4.34 ATC procedure for vectored “visual” approach which to me, remains a contradiction. A visual approach is made using visual reporting points. It certainly shouldn’t use geometrically placed points from the same diagram used for all airports, as the reporting points won’t correspond to any visual landmark. Furthermore a pilot landing visual should use his eye to land and should not be radar vectored by ATC.



The visual charts are meant to be used separately from the ATC system. You may try to time a request for an overhead (around initials) while performing a visual recovery with the chart, or simply declare an unrestricted approach and contact Tower on final to at least get proper clearance to land.

From the visual reporting points, flight lead brings his flight to the relevant initial point – usually 5 NM within the parameters for the overhead break (for instance we use 300Kias, 1500feet AGL) lined up on the runway centreline. From there the wingman have a short distance to close up the formation to execute an overhead break.

The direction of the break is illustrated by the outside pattern – which as the name implies is a safe pattern wider than the overhead that is used if one aircraft has to re-enter the downwind because of an abort at some point.

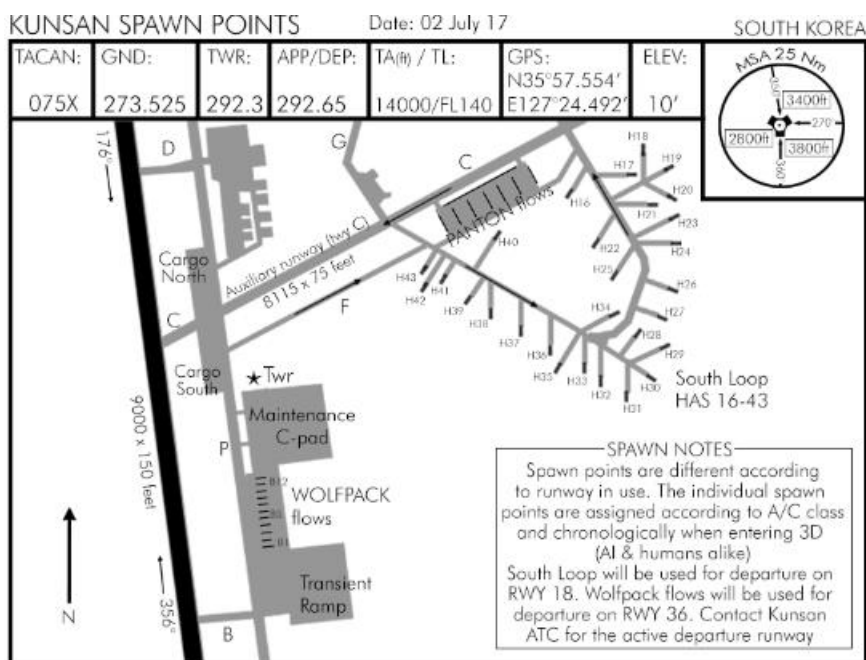
In this case, patterns at Kunsan are always over the sea to avoid overflying the city.

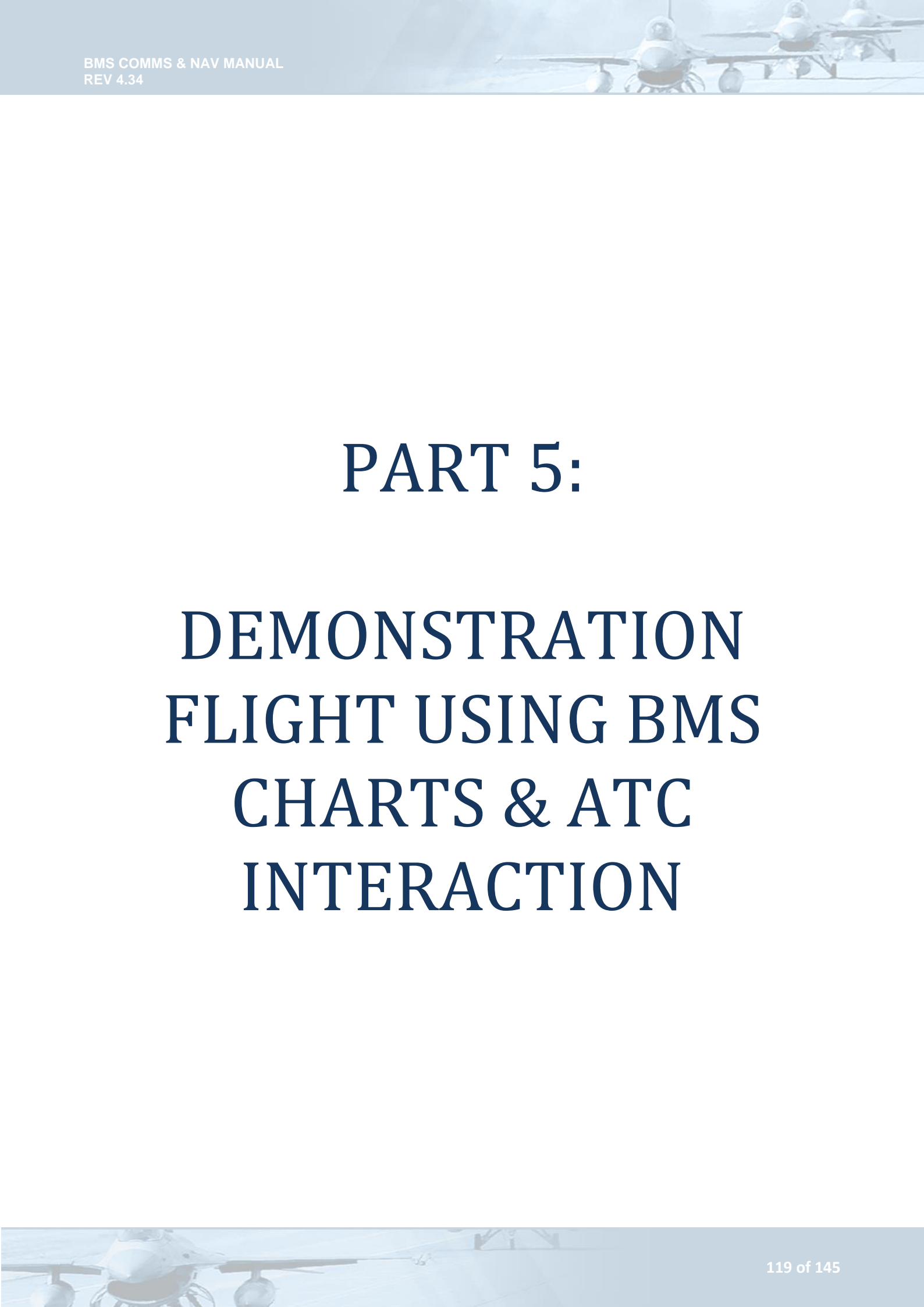
Since we actually use landmarks for those VFR charts, they have to be BMS compliant. This means that the road and rivers and cities are exactly displayed the way you see them in the Falcon 3D world. The entry points specifically are visual Falcon landmarks such as a bridge, a building, a city, etc.

The roads are in red. Cities are yellow and rivers are blue. The entry points are named according to the 4 cardinal points N, E, S and W. Each entry point has its own GPS coordinates.

4.4.3 Spawn point charts

Some airbases in Korea have a specific ground chart to locate spawn points. Spawn points are decided according to type of aircraft (large or small) and active runway. Each airbase has a specific taxi route depending on the active runway (to and from the runway). When you spawn on an airbase, you might have trouble finding where you're parked. This information is missing from the brief and ATC will not state your taxi route upon giving you clearance to taxi. The spawn chart may help you locate your position so you can plot your taxi route. GPS coordinates are usually provided for each parking position.





PART 5:

DEMONSTRATION FLIGHT USING BMS CHARTS & ATC INTERACTION

To illustrate the use of charts and the new ATC in BMS 4.34 we will fly from the new airbase Osan (RKSO) to Taegu (RKTN).

Osan was updated with 4.34 to a double 09/27 runway airbase with a new taxiway layout to avoid traffic jams during intense operations. Taegu is not new but presents some interesting challenges because of the surrounding terrain.

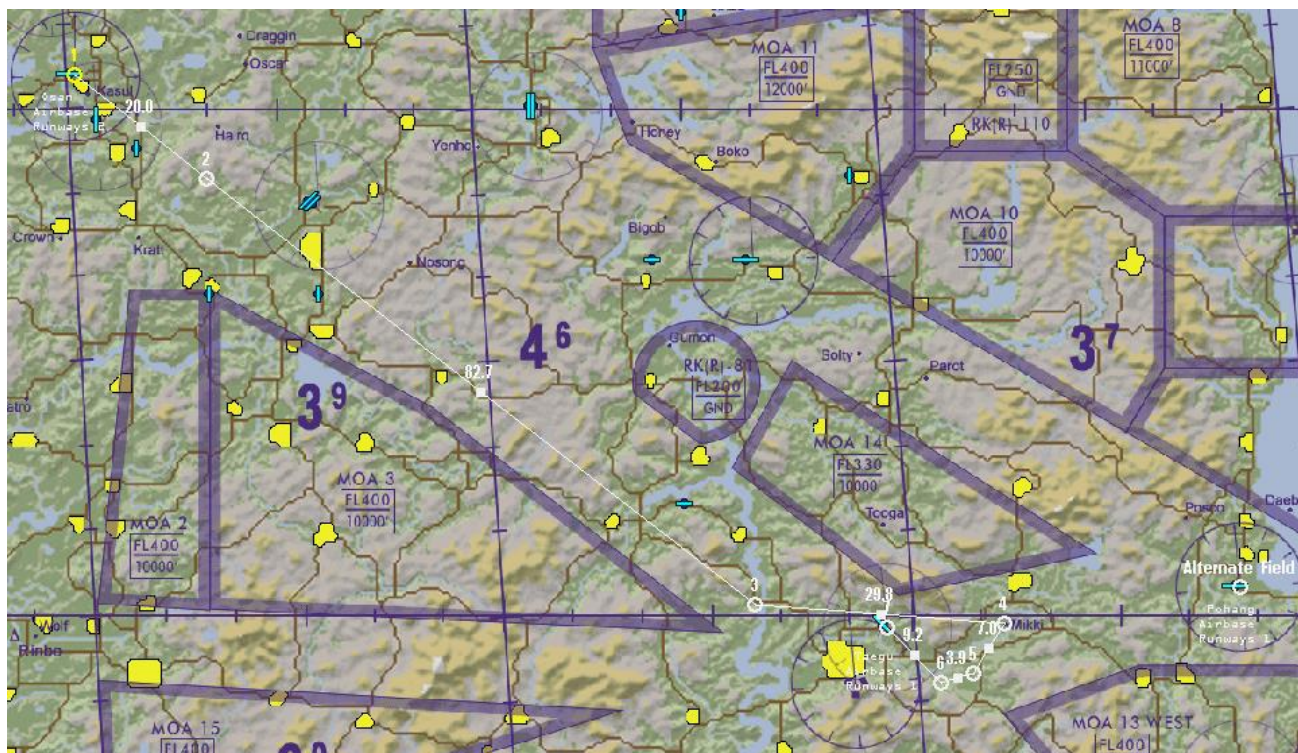
This chapter is accompanied by two training missions (TR_BMS_21_Osan_Taegu and TR_BMS_22_Osan_Taegu) that you can use to actually fly as you read this chapter. You can access these training missions from the tactical engagement – training tab – of the BMS UI.

The first training mission is the full flight from one airbase to the other. The second training mission is a shortened version for the approach at Taegu only. If you fly the second mission, start at chapter 4.5.

Once the mission is selected, select the single F-16 flight from the ATO Take-off 18:22FT, Training, Package 1939.

5.1 Flight planning

There is a lot of activity at your home airbase today. Multiple flights are trying to benefit from a hole in the storms currently washing down Korea to fulfil their assigned missions. Incidentally, it's the same for you. You must ferry an F-16 to Taegu and now is your chance. The weather won't be perfect but just good enough to make the flight and more especially the approach at Taegu which lies in mountainous central South Korea.

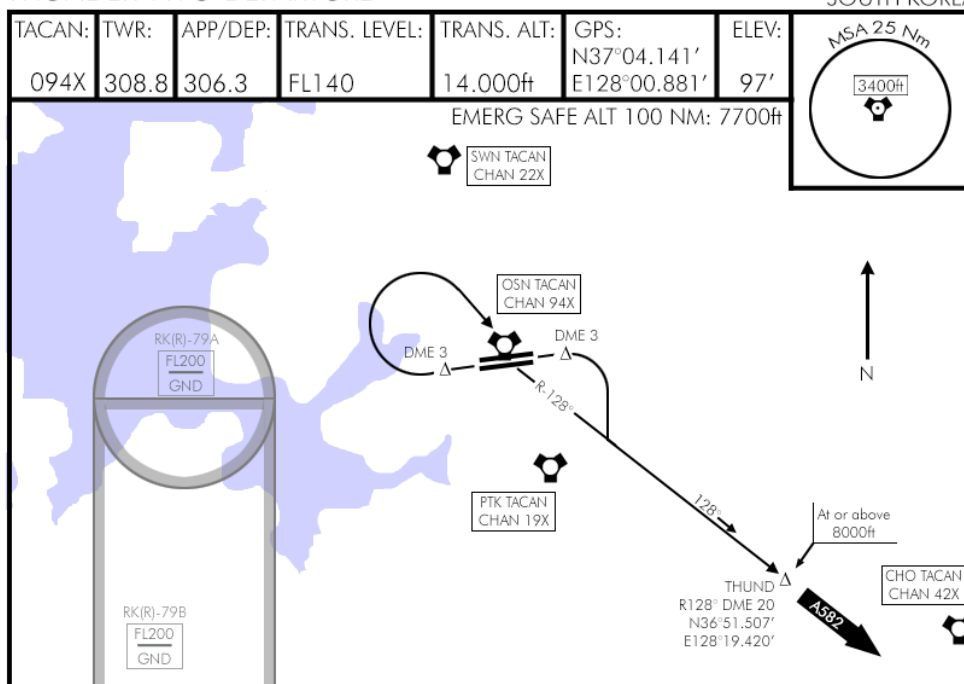


Most of the flight will be IMC though, so prepare your charts for Osan, Taegu and your possible alternate along your route. It will be mostly a straight line from Osan to Taegu with the new THUNDER 2 Standard Instrument Departure (SID) chart. You will join the A582, tracking radials from OSN tacan and to Talsung tacan for the high altitude enroute part of the flight until reaching the top of the descent point where we will contact Taegu approach for landing procedures.

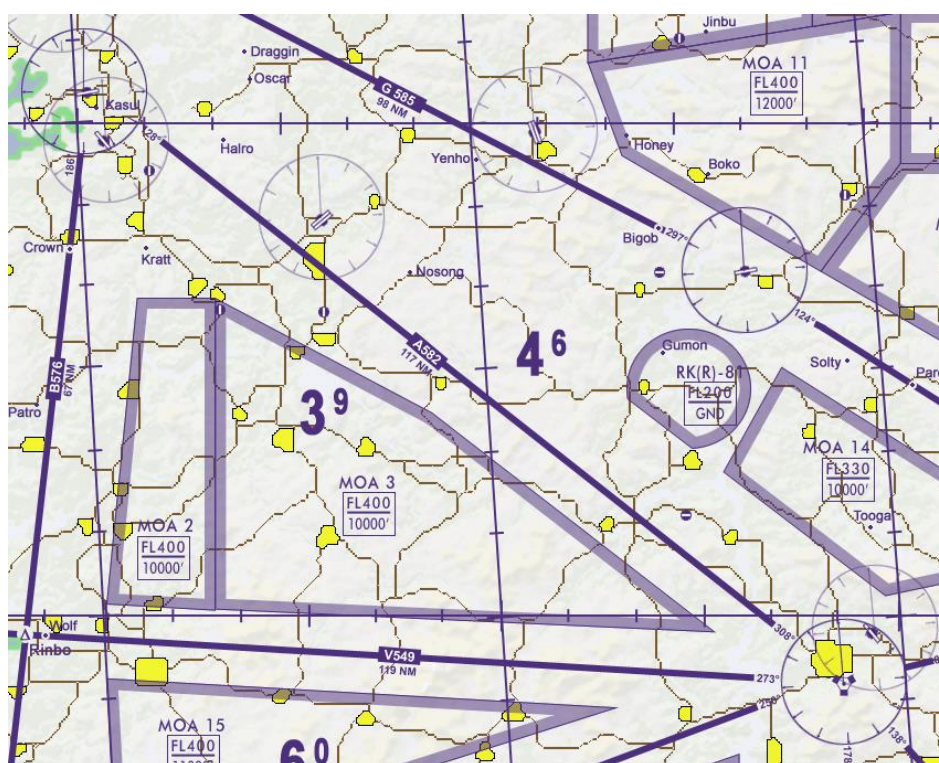


THUNDER TWO DEPARTURE Date: 14 Dec 2017

OSAN AB (K50)
SOUTH KOREA



Both Osan 94X and Talsung 59X tacans are enroute station and have power output allowing long range navigation. Taegu tacan 125X on the other hand is limited for approach procedures.



The User interface briefing is separated into different sections:

The first section relevant to our flight today will be the comm ladder listing all the frequencies (and their eventual presets) we will need for this flight. (Osan, Taegu & Pohang).

COMM LADDER:				
AGENCY:	CALLSIGN:	UHF [CHNL]:	VHF [CHNL]:	NOTES:
INTRA-FLIGHT:	Falcon1	--	143.550 MHz [15]	Flight Management Comms
GUARD:	None	243.000 MHz [14]	121.500 MHz [13]	Distress / Emergency
COMMON:	None	339.772 MHz [15]	123.500 MHz [14]	Advisory / UNICOM
BASE OPS:	None	272.700 MHz [1]	--	Homeplate Operations
TACTICAL:	None	290.600 MHz [6]	--	Package Comms
DEP GROUND:	Osan Ground	253.700 MHz [2]	--	Departure Airbase
DEP TOWER:	Osan Tower	308.800 MHz [3]	122.100 MHz [3]	Departure Airbase
ARR APPROACH:	Taegu Approach	346.300 MHz [7]	--	Recovery Airbase
ARR TOWER:	Taegu Tower	365.000 MHz [8]	126.200 MHz [4]	Recovery Airbase
ARR GROUND:	Taegu Ground	275.800 MHz [9]	--	Recovery Airbase
ALT APPROACH:	Pohang Approach	232.400 MHz [10]	--	Alternate Airbase
ALT TOWER:	Pohang Tower	236.600 MHz [11]	118.050 MHz [11]	Alternate Airbase
ALT GROUND:	Pohang Ground	275.400 MHz [12]	--	Alternate Airbase

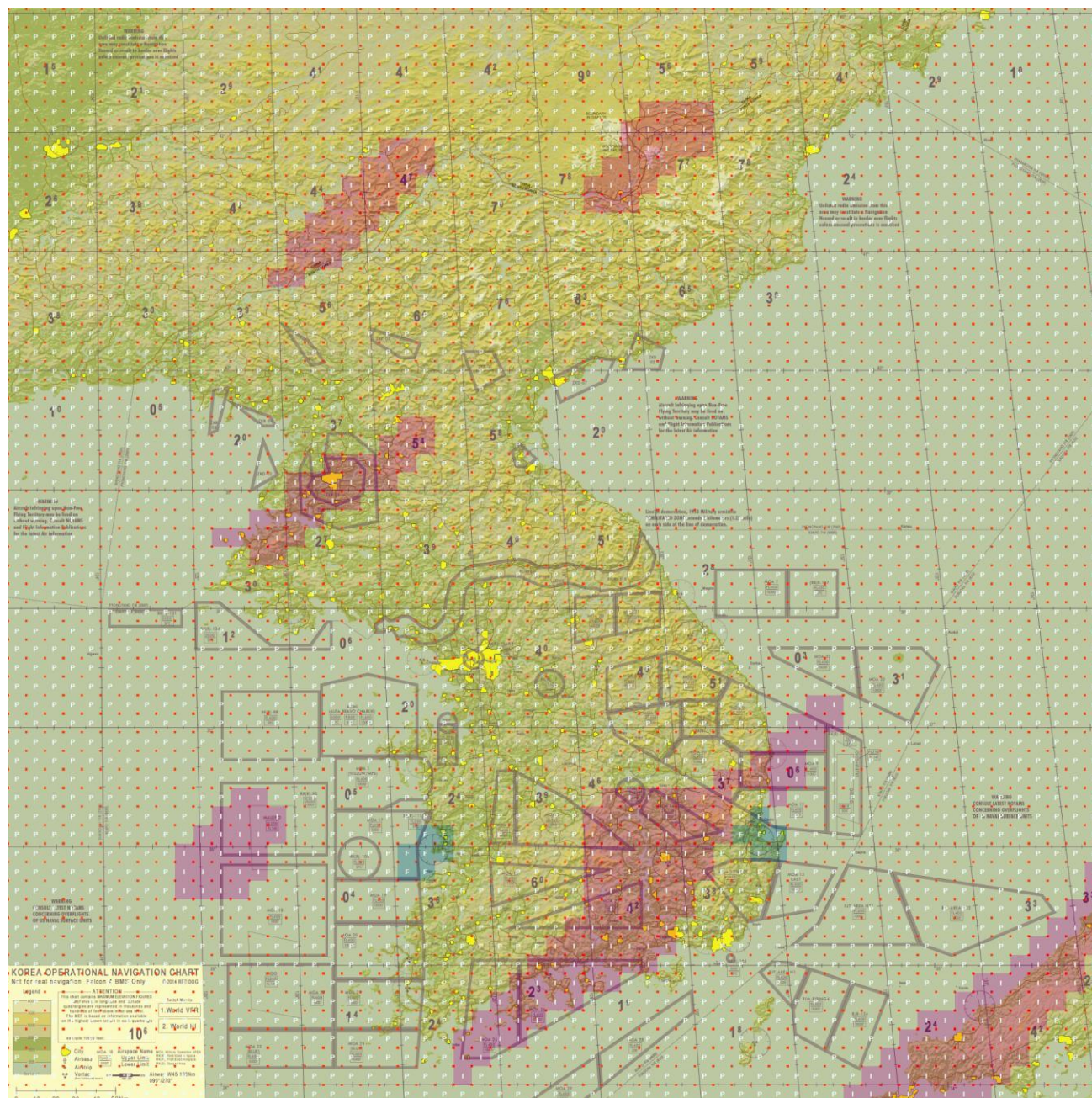
The second important part of our flight today will be the weather report:

WEATHER:		
CONDITIONS @	TAKE OFF:	TARGET AREA:
SITUATION:	Poor	Poor
WIND:	19 deg @ 8 kts.	5 deg @ 8 kts.
TEMP:	10 deg C.	10 deg C.
CLOUD BASE:	3,000 ft MSL base	3,000 ft MSL base
CON LAYER:	25,000 ft MSL base	25,000 ft MSL base

The briefing reports weather at departure and at target area but not at landing. This is a limitation induced by the fact that in BMS missions most of the flights are departing and arriving at the same airport. Unfortunately that does not take into account the missions where departure airbases are different from landing airbases, or the use of Fmaps which may make weather vary according to time at the same location (when departure and arrival happens at the same airbase but spaced 90 minutes apart for instance).

So in this scenario you do not have the weather at the landing airbase, and the only way for the flight lead to get the information is to get a more accurate weather report with a satellite image, the availability of which greatly depends on whether the TE designer chooses to supply an Fmap image or not. In this case you have access to such briefing aids but you may not always.

Another tool to provide the weather information at the landing or alternate airbase will be provided by these airbases' ATIS.



As you can see from the Fmap image, the situation is overall Poor (yellow) with a few squall lines (Inclement red) and very small pockets of fair weather (Green).
Osan airbase lies in poor weather which confirms what the brief said, Taegu lies in inclement weather and your alternate was wisely chosen as it lies in a small Fair weather pocket.

GENERAL:													
Initial STAT Settings:	Modes Active:	M124	Codes:	M1: 73	M2: 3030	M3: 3404							
M4 Validity Time (Until):	Key A:	Day2 00:00	Key B:	Day3 00:00									
IFF Policy:	M1:	per team	M2:	per aircraft	M3:	per aircraft							
Code Change Setting:	TIM												
TIME EVENTS:													
Rot/day:	19:00	20:00	21:00	22:00	23:00	00:00	01:00	02:00	03:00	04:00	05:00	06:00	
M1:	24	33	30	03	21	71	31	31	62	71	23	52	32
M3:	24	5530	7654	3754	7030	7204	3504	4254	0304	1054	3030	3254	3254
M4:	1	A	A	A	A	A	B	B	B	B	B	B	B
POS EVENTS:													
Ingress:	M124 / ----	Egress:	M124 / ----										

Codes for M1 is 73, Code for M2 is 3030 and Code for M3, although not active today is 3404

In case Taegu gets closed because of weather, our alternate will be Pohang which is a 08/26 runway. Weather forecast at that location is pretty good with light winds from the West and fair weather. So we should expect a RWY 26 ILS approach or even visual should be possible.





The list of charts you will need for this flight (all located in the Docs\03 KTO Charts\01 South Korea folder – or on the [interactive map for KTO](#)) are:

- Osan (Airport diagram, Thunder 2 departure)
- Taegu (Radar Rwy 32, Airport diagram)
- Eventually alternate Pohang (ILS 26, airport diagram)

5.2 Starting engine

The start-up sequence should be no different to what you have been taught in the early training missions. The only thing I would do differently here is to input the ground frequency as soon as possible into the Backup UHF radio – you can do that even before engine start. That will give you an early start on situational awareness of the traffic at Osan airbase.

As soon as you're on battery power, power up the radios and place the backup UHF panel left knob to both and the right knob to MNL for manual frequency. Then input 253.7 into the frequency dials. You are now listening to ground frequency radio traffic.

Continue your ramp start sequence as usual. Once you have loaded your DTC and switched the system to UFC, the Backup radio will be overridden by the main UFC radios. Depending on your DTC settings, the UHF radio (COM1) may default to specific presets, so make sure you check that preset #2 for Osan ground is active. If not either set your COM1 radio to 253.7 or preset #2.



While your systems come online, contact ATIS to get the latest information about the weather. Set the VHF radio to the ATIS frequency for Osan: 132.125. When you enter .125 decimals in the F-16 radios only .22 is displayed. Don't worry about it. Even though the frequency doesn't look complete it works as expected.

Osan. Information Romeo

Runway 0 9. Expect instrument approach

Wind: 0 1 9 degrees, 1 4 knots, gusts 2 7

Sky conditions: Blue

Temperature: 1 0 degrees celsius. Altimeter: 2 9 6 4 inches

After the ATIS identifier letter (Romeo) the automated message will provide the expected type of approach, active runway (09), wind direction and speed 019° 14Kts gusting to 27, sky conditions, temperature in Celsius (10°) and altimeter setting (2964). The blue sky condition corresponds to less than 8 kilometres visibility and ceiling 2500 feet AGL. Wind is a concern as it's quite a crosswind from the left with high gusts. The local pressure is inputted into the altimeter and the airfield elevation should be our indicated altitude (97 feet).

Finding our way to runway 09 should not be an issue as you see the outgoing traffic getting there and all you would have to do is to follow them to the EOR, but you are parked so close from the runway that even that is not necessary. In other situations you might have a hard time knowing where you are on the airbase and should then use the airport chart with visual landmarks to pinpoint your precise location and get the taxi route to the active runway.



The INS is almost ready and we will use the time to setup our jet for the upcoming SID: Thunder2.

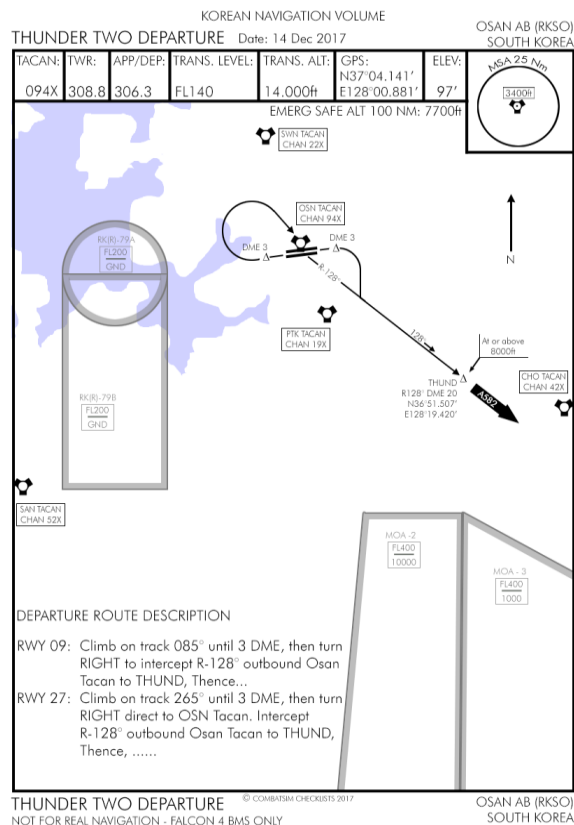
The procedure calls for a runway heading (085°) climb to DME 3 from OSN tacan (094X) and then a right turn heading south to intercept Radial 128° outbound Osan tacan until reaching THUND exit point at or above 8000 feet.

Once flying in the weather, you will be very busy just flying so set as much as possible while on the ground:

Set the tacan to 94X in the T-ILS page.

Set your EHSI to TCN mode by pressing the M button until TCN is displayed and set the CDI to 128°.

I usually also set my heading bug to 180° to give me a visual cue of my first turn (in case I need to use the Autopilot in heading mode, I won't have to play around with the knob).

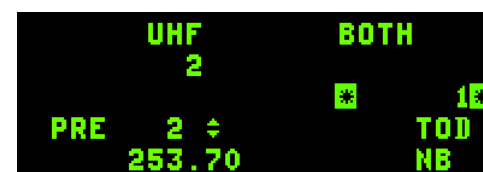


Steerpoint #2 of the INS flight plan is THUND exit point, so once the INS is aligned, we can cross check the coordinates of steerpoint #2 with the THUND coordinates displayed on the SID chart. Charts state THUND is at N36°51.507' E128°19.420'. As seen on the right DED picture the latitude and longitude of STPT #2 are in the ballpark (no need to have the exact same decimals). If not, the coordinates of the steerpoint may need to be changed to those given on the chart.



Another thing we can prepare while sitting on the ground waiting for our taxi time is our ability to change frequency quickly. Obviously you may not know all airbase frequencies by heart. To overcome that your DTC has been preprogrammed with sequencing presets for ATC communications. Preset #2 is ground, #3 is tower, #4 is departure. So basically, even without knowing the frequency you can quickly sequence the presets in the COM1 radio. Besides, there is always a way to know what the frequency assigned to a specific preset is: let's see how:

Hit COM1 on the ICP and the UHF radio will be displayed in the DED, it's currently set to preset #1 with preset #2 ready to be activated (within scratchpad). In the bottom left corner, you see that preset #1's actual frequency is 272.7.



If you press the up arrow on the ICP, the PRE line will switch to the preset #2 value which is assigned to Osan ground 253.7

A further press of the up arrow will display the assigned value for preset #3: Osan tower 308.8 and a last press on up arrow will show you the frequency assigned to preset 4: Osan departure.

You can obviously change presets or frequencies from this specific DED page but there is an even quicker way:

Dobber left to go back to the UFC main page.

By default the selection arrows are placed on the steerpoint. But you can move them to other lines as well. In this case, we want them on the UHF preset to be able to sequence them rapidly. Dobber down and notice the double up/down arrow moves to the UHF section between UHF and the active preset (another dobber down will move it to the VHF part).

UHF	÷ 2	STPT	1
VHF	15	18:19:42	
M12	4	3404 TIM	T 94X

If you now press the up or down arrow on the ICP you will sequence the presets accordingly. Basically, once the up/down symbols are placed on UHF, you can increment presets with the ICP up arrow and decrement the UHF preset with the ICP down arrow.

That's by far the quickest way to change your radios according to ATC instructions.

Once ready to taxi, initiate contact with the ground agency to request taxi clearance.

Open the ground ATC menu and select Request Taxi for Departure. The airport is busy and ground answers we're number 5 for departure. We should give way to Texaco and hold position until then.

Texaco is easy because it's a refueller callsign and very well identifiable on the apron. But it would be completely different if the callsign was more common. In any case, Ground will clear us to taxi in due time. So stay put until ATC calls you again and in the meantime, observe what's going on, so that you can be ready when that KC-135 heavy starts moving. You know you will be next.



Ground will then call Texaco for clearance to taxi and the KC-135 will start rolling towards the active runway. Right after that, Ground will call you and clear you to taxi and hold short runway 09 right.

Remove the chocks, test your brakes and cautiously get in line behind the KC-135. Don't get too close though as you don't want to encounter the jet wash from Texaco's 4 engines.

The KC-135 will then be switched to the tower frequency and will take the active. Advance to the hold short position and as the refueller starts its take-off roll, Ground will instruct you to switch to tower frequency as well.

With your arrows on the UHF line on the ICP, hit up arrow and check that the preset on the CNI page moved to #3 for tower. Then initiate contact with tower reporting that you're ready for departure.



Tower will report wind and clear you for take-off and instruct you to contact departure. Shoot a quick glance at the approach end of the runway because a few aircraft are in the pattern. At double runway airbases ATC usually assigns one runway for departure and the other for landing. But even if aircraft are landing on 09L while you're taking off on 09R, making sure is always a good thing.

Your jet is setup, the SID procedure is committed to your memory, last checks of the engines and you're ready to take-off.



5.3 Flying the SID

A lightly loaded jet accelerates fast and speed should be kept under 300 Kts, so a military power take-off on this 10,500 feet runway is adequate. Crosswind is from the left so correct a bit left as soon as you are airborne and maintain runway heading while climbing out.

You may contact departure once airborne, but I tend to do that a bit later to still hear what's going on in the pattern. Depending on when you contact departure and report airborne, ATC will either give you a heading to fly or a resume own navigation call. The heading ATC may give you is a straight line towards your departure point (stpt #2) and will not take into account the SID procedure. That's another argument in favour of delaying that call and getting the resume navigation call straight away.

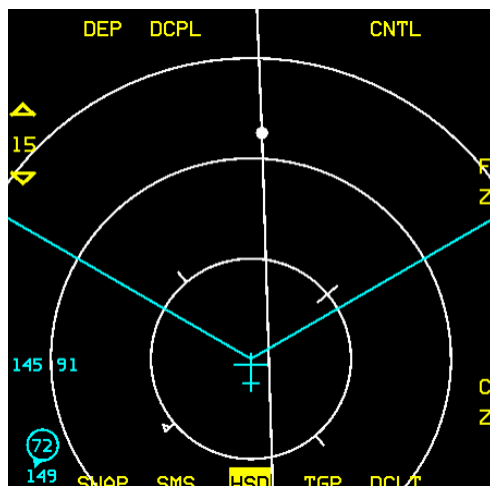
Besides managing your speed (under 300 kts) and attitude (FPM on 10° line for a normal climb) your next point will be reaching 3DME from OSN tacan (left picture below) which will correspond to around 2000 feet altitude.

At that point you must turn right towards the heading bug which has been set to 180° and keep a close look at that CDI set on 128° to avoid overshooting your reference radial. With a 180° heading you have a 62° angle of interception on the radial which, given that you're still so close to the tacan, is quite aggressive (centre picture below).

Once the CDI starts to move (right picture below), turn left to start your intercept and if you timed it right then you will roll out on heading 128° centred on the radial. Due to the 60° intercept angle, it's important to start your turn quickly to soften up the intercept.



Once established around 9NM out, track the radial outbound while continuing your climb. You should be above 8000 feet when overflying THUND exit point which is still 11 NM ahead. If you haven't done it yet contact departure and report airborne with the ATC menu.



Once ATC clears you to resume your own navigation, you usually contact a tactical frequency manned by an AWACS controller. It's preset #5. It's not really mandatory in this scenario but you may enjoy some quiet on the frequency. Climbing past 14,000 feet set your altimeter setting to 29.92 and continue your climb to FL210.

5.4 Enroute

The enroute section is between the exit point and the top of the descent point. Usually that is where you carry on your assigned mission as a combat aircraft. In this scenario though we're just ferrying a F-16, so the enroute part is one long straight line between two navigation stations: Osan which is behind us and Talsung in front of us.

You may use the autopilot to relieve you from flying while reading the next few lines. The autopilot features different modes and will be perfectly able to fly the aircraft to the next steerpoint.



There are two switches located on the MISC panel controlling the autopilot mode.

The left most one (ROLL) sets either the steering mode (STRG SEL) where the AP will fly to the active steerpoint and hold there until the steerpoint is incremented to the next one either manually or automatically depending on the UFC setting, or Roll heading mode (HDG SEL) where the autopilot will

steer the aircraft to the heading set with the heading bug in the EHSI.

The right most switch (PITCH) sets either altitude mode or attitude mode. Altitude mode is used to maintain a level non-turning flight whereas attitude mode can be engaged to maintain a constant rate of turn or a constant climb or descent. The right switch is also the autopilot master switch. The autopilot is engaged in its respective mode when the switch is moved either up or down and disengaged if placed in its centre position.

You may choose to use either STRG SEL if you want to track the next steerpoint or HDG SEL if your heading bug is set to 128° on your EHSI (130° will do). The PITCH switch should be put to ALT HOLD mode as soon as you reached your cruise altitude of FL 210.

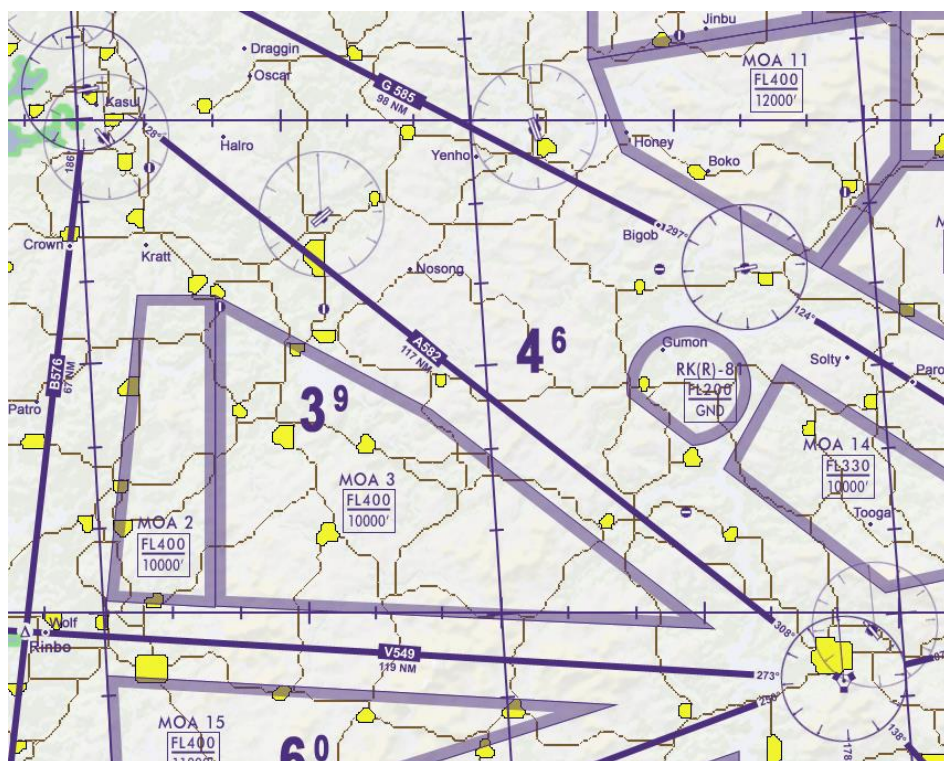
From this moment the aircraft will fly on its own.



Tacans in BMS, just like in real life, are limited in range according to their power output. Some tacans are used exclusively for approach to an airport and others are used for long range navigation within the FIR (Flight Information Region).

That is the reason why we don't fly straight to TAG tacan (125X) which is located on Taegu airbase. TAG is an approach station and has a limited range both because of its power output and its location. As you know radio waves are line of sight and Taegu airbase lies in mountainous terrain. Therefore TAG could not be used as a long range navigation station even if it had a powerful output because the signal would be blocked by mountains.

That is why we use Talsung tacan (59X) which is the relevant long-range station in the area.



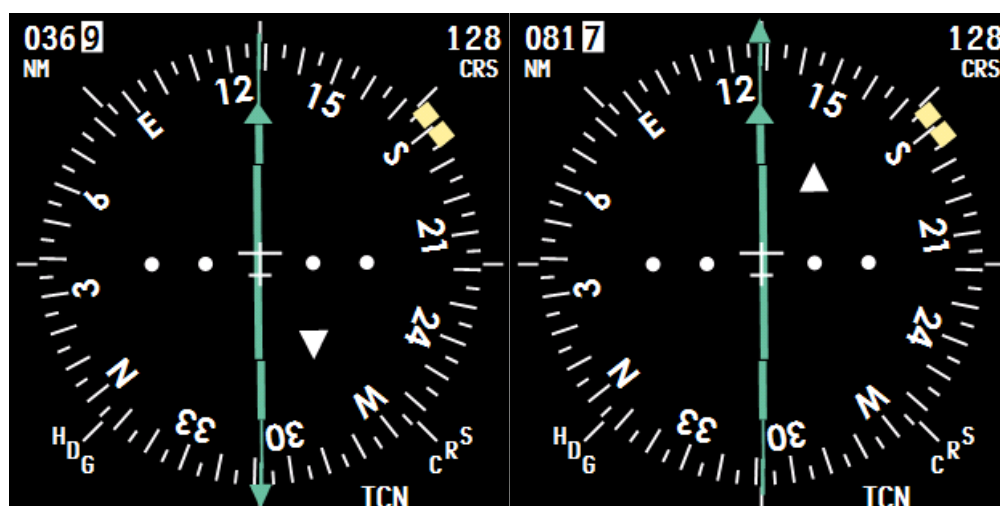
The published route between the two long range stations is called an airway and although we usually don't bother with these in a combat flight sim, look out for civilian like traffic sharing the airway with you. Should you encounter them, you will be able to spot their contrails.

The route we are flying today is along airway A582 and this keeps us clear from the usual Military Operating areas.

Our flight plan is along the airway and we have a steerpoint close to Talsung where we will deviate from

the airways and contact Taegu approach to start our descent towards our destination. At this time we track radial 128° outbound Osan tacan. The bearing pointer is at the 6 o'clock position and the TO/FROM triangle points down indicating FROM mode: the station is behind us at a distance of 36.9 NM as stated by the DME on the top left corner of the instrument.

The CDI is centred (with a slight left offset) on course 128° (left image below)



If we switch the UFC to Talsung tacan by inputting 59X in the T-ILS page, the EHSI will get its signal from the Talsung tacan and the bearing pointer will shift to the 12 o'clock position and the TO/FROM triangle will also point up (TO mode) telling us the tacan is in front of us. The distance reads now 81.7 NM and the CDI is still centred (right image above). We will not fly all the way to Talsung as our top of descent point has been calculated a bit earlier than the tacan. At steerpoint #3, we will switch to Taegu approach and start our descent into the weather. In the meantime sit back, relax and enjoy the flight!



5.5 The approach

This chapter is where Training mission 22 starts.

Getting close to our steerpoint #3, we will start to setup the system for the approach.

Our STPT #4 is Mikki which is the published initial approach fix for Taegu.

Although not mandatory we can check the coordinates of our steerpoint to see if they closely match the Mikki chart's coordinates.



STPT 4 HAN
LAT N 35° 58.598'
LNG E 130° 13.136'
ELEV 252FT
TOS 18:43:04

Switch the tacan to 125X for TAG and CRS to 090° (in case we have to hold) and set the ILS frequency to 108.7 from the T-ILS page. Check that your ILS is turned ON with the ILS knob located on the AUDIO 2 panel (left side console).

Set your radios: we'll use Taegu approach 346.3 for UHF initially and Taegu tower 365.0 on final approach.

A trick to gain time in case of a failure is to prepare your Backup UHF radio on the landing tower frequency.

That way even if you lose some systems prior to landing you have an easy way to ask for help or declare an emergency. Set already your UHF BUP to 365.0 and put it in MNL mode.



In a few moments we will descend into the weather and it will be darker outside, so turn on your cockpit lights as required. You'll be very busy flying instruments and you don't want to lose it because you need to search for that backlight switch.

If it is not done already, set your CNI page to display the winds (dobber right) and put the ICP in DRIFT mode so you can easier counter a crosswind.

As you can see, every step you can plan ahead for is welcome when you know the next few minutes of your flight are going to be intensive work. That is valid not only for instrument flying but also when you prepare yourself for a combat scenario.

The usual distance before contacting an approach frequency for landing is 20 NM. Once you are within that distance and ready for approach you can contact ATC. But before doing so, let's check Taegu ATIS to get the weather at the destination. Switch your VHF radio to 127.65 and listen to the automated message being broadcast in loops.

Taegu. Information Romeo

Runway 3 2. Expect instrument approach

Wind: 3 0 0 degrees, 1 4 knots, gusts 3 0. Thunderstorm rain

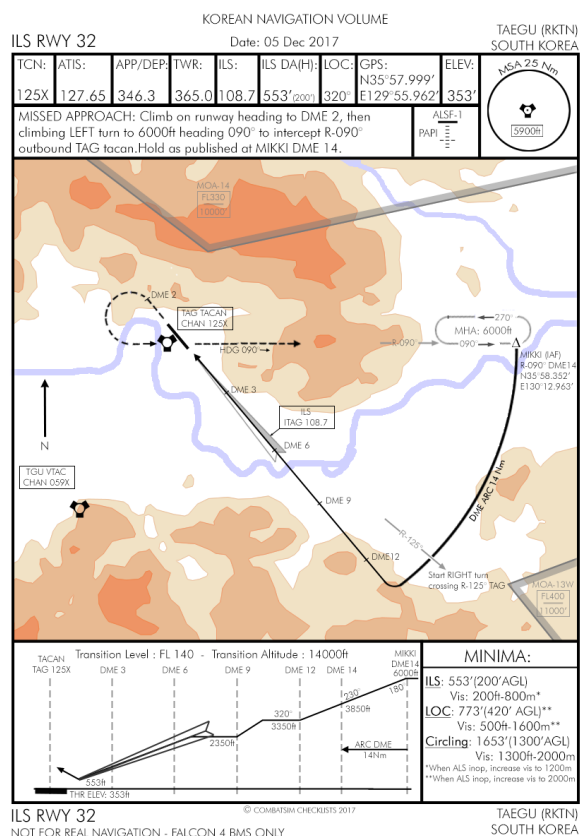
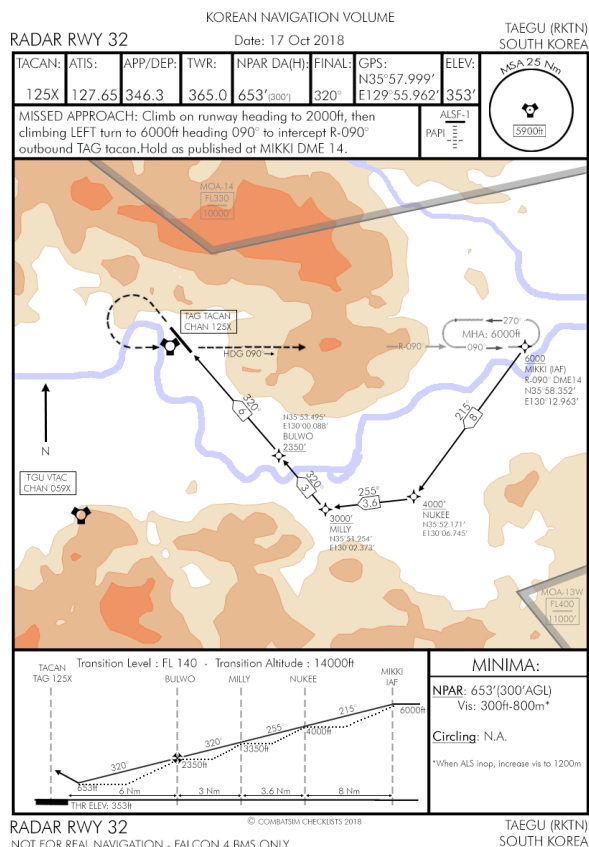
Sky conditions: Blue

Temperature: 1 0 degrees celsius. Altimeter: 2 9 6 4 inches

ATIS confirms the weather forecast and we can expect runway 32 for landing. We will fly the radar approach procedure but we'll tune the ILS in anyway for proper line up.

The radar charts are new to BMS 4.34 and attempt to match the vectors you will receive from ATC upon requesting a vectored instrument approach. Yet the ATC expects you to overfly the radar fix before giving you the new heading while the experienced pilot flying an approach procedure will lead his turn to stay on the published track. This slight difference may create differences in the vectors given by ATC and the actual heading the experienced pilots will fly. Either way should work fine and result in you being in the right position for a safe landing. If the heading offsets are too much of an annoyance you may always cancel the approach and request an unrestricted approach. But be aware that doing so you will not be separated from other traffic until you are on final approach.





The radar and the ILS chart are displayed above. They share the same IAF and although ILS wouldn't really be used on a radar approach procedure it does provide a nice alignment help. We will tune the frequency in to check alignment during the final approach phase.

The radar chart lists the coordinates of all radar fixes. You may use these coordinates to set steerpoints for the approach in your INS system using existing steerpoints (including lines or PPT steerpoints) from the UFC STPT page (#4).

Coming from A582, we will fly close to Taegu on our way to the IAF Mikki which we need to reach at 6000 feet.

Being at FL210, we have about 30 NM to descend which is more than enough.

Now that your jet and your mind are ready for the approach, initiate contact with Taegu approach requesting a "Vector for Instrument Approach" (ttt2).

The AI controller will acknowledge your request by confirming a Radar approach for RWY 32 and giving the QNH again.

Soon after confirming you are now in the landing queue, Approach will issue its first vector and will instruct you to turn to fly a heading of approximately 100° and descend and maintain 6000 feet.

You must lose 21000-6000=15000 feet of altitude and you have approximately 30 NM to do that. There is no need to dive for 6000 feet and fly level in the weather for anytime longer than necessary. Beside that would also use more fuel.

Plan a low throttle setting descent to reach the IAF at 6000 feet.

There is an easy formula to calculate your descent gradient according to the altitude you must lose in a certain distance:

$$\frac{\text{Altitude to lose (feet)}}{\text{Distance to travel (Nm)}} = \text{Descent gradient (fpm)} \Leftrightarrow \frac{15000}{30} = 500 \text{ fpm}$$

By simply placing the VVI to a 500 feet per minute descent you will time your descent to the IAF correctly.



Descending through FL140, don't forget to switch your altimeter to the QNH given by Taegu approach. Maintain a maximum speed of 300 Kts in the descent. You may be slower but as a general rule, don't speed up too much in IFR as it will give you less time to react, screw up your rule of thumb estimations and may increase your chance of spatial disorientation (don't laugh it may happen in BMS flying IFR as well!!)

During your descent you will hear other flights checking in for recovery with approach. Try to establish a mental picture of what's going on around you. You know that these guys will be vectored to the same approach as you and although ATC should provide separation it's good airmanship to know where they are.

In an instrument approach, the ATC will sequence aircraft from the same flight separately so a two ship flight returning to Taegu and contacting approach will be vectored to the IAF in sequence with a 1000 feet separation (flight lead at 6000 and his wingman at 7000 feet for instance). You have been cleared to descend to 6000 feet in this case, but stay sharp; once in the soup you won't have a lot of visibility to spot them visually.

Upon reaching the IAF, ATC may ask you to hold for traffic. The holding is illustrated on the charts. In this case, ATC will expect us to hold at our ATC assigned altitude with left turns on R-090° from Taegu tacan. With our current heading reaching the IAF we can make a direct entry into the holding if required.

Remember that IAF are choke points and you may encounter a lot of traffic, fortunately separated 1000ft apart by the ATC. As you will likely be in the clouds, you can't spot other aircraft. Your next best sense to create a spatial picture around you are your ears while listening to the approach frequency radio traffic.

Once ATC has worked the separation from returning flights, they will clear you to the next radar point. NUKKE is 8NM away on a 215 heading from MIKKI. ATC will also instruct you to descend to 4000 feet. 2000ft/8NM is 250 feet per minute. But in this case a regular 500 fpm descent followed by a level leg maintaining 4000 feet works better.

As you fly towards the Radar fix, ATC may provide a new heading according to your deviation from the Fix. That is one of the reasons it is suggested to input the radar fixes as INS steerpoints. When you have a steerpoint diamond to follow it is much easier to counter the wind drift. Following a radar vector, the wind is not really taken into account and the ATC may actually guide you in a dog's leg rather than in a straight line. Just follow ATC instruction and you will get there.

Reaching NUKKE ATC provides heading and altitude to the next radar fix: MILLY. Heading should be close to 255°, the distance is 3.6 NM and in the meantime you need to lose 1000 Feet.

The last radar fix before the runway line-up is always the trickiest one.

Depending on the approach procedure the turn between the last radar fix and the final approach course will be decisive for the rest of the procedure.

In this case there are two Radar fixes on the runway axis: MILLY at 9NM and the IF (Initial Fix) BULWO at 6 NM from the runway threshold. Even if the initial alignment is wrong at Milly, it will be easily corrected when arriving at Bulwo.



Of course having the ILS needles displayed helps even more and that is the reason I advised you to enable them if available. The ILS needles will provide visual cues to time that last turn and line up with the runway avoiding the overshoot and to guide your descent to the minima.

Having two radar fixes on the final approach course greatly decreases the potential problem because the last turn at the IF will be smaller with almost no lead required. So in the worst case, the aircraft will be lined up at the IF. Unfortunately it is a luxury we do not always have.

The problem is potentially more important when there is only one radar fix on the approach track and even more important if that radar fix is close to the runway threshold. The overshoot may very well make the approach impossible. It all comes down to how the ATC file was created (see the BMS technical manual for explanation about creating ATC files)

The IF (BULWO for this approach) is usually a point some 6 NM from the threshold at 2000 feet AGL. It is the usual Outer marker point on an ILS approach where the gear is lowered and the glideslope is intercepted.

The IF is where the final approach starts. So lower your gear, slow down to on speed AOA and descend on a 3° slope (the -2.5° degree dashed line on your HUD is a good reference cue).

ATC approach will instruct you to switch to the tower frequency.

It's always tricky to start pushing buttons when you need to fly precisely, hence why it is so important to pre-plan as much as possible. Toggle the UHF radio to preset #8 (remember the briefing) and initiate contact with Tower by reporting final with the tower page of the ATC menu.

Tower will detect your position in a final approach cone and may either tell you to continue inbound if you're too far away or clear you for landing if you are close enough. If tower can't detect you in that cone the ATC will kick you out of the landing queue and re-sequence you with approach.

ATC tower does not provide guidance to the runway so if you still don't have the runway in sight keep flying the final approach course or keep following the ILS needles if you have them.

The radar approaches have higher minima than ILS approaches but are close enough to the ground to scare you if you're not properly aligned. Reaching 653 feet (300' AGL) you should have the runway lights in sight. If not you must declare a missed approach and go around for another try or decide to go to your alternate Pohang where conditions are more favourable but that shouldn't be the case in this training scenario.

Once you have the runway in sight you may fly visually. Place the flight path marker just above the AOA bracket, maintain runway alignment and your slope using the PAPI lights.



After landing, exit the active runway at the last exit. Tower will provide the ground frequency and instruct you to contact them. Set your radio to Taegu ground and initiate contact by requesting taxi back to the ramp from the ground page of the ATC menu. Ground will clear you to taxi back without any specific instructions, so pick up a parking spot and shut down the jet.

Welcome to Taegu.

5.6 Alternate

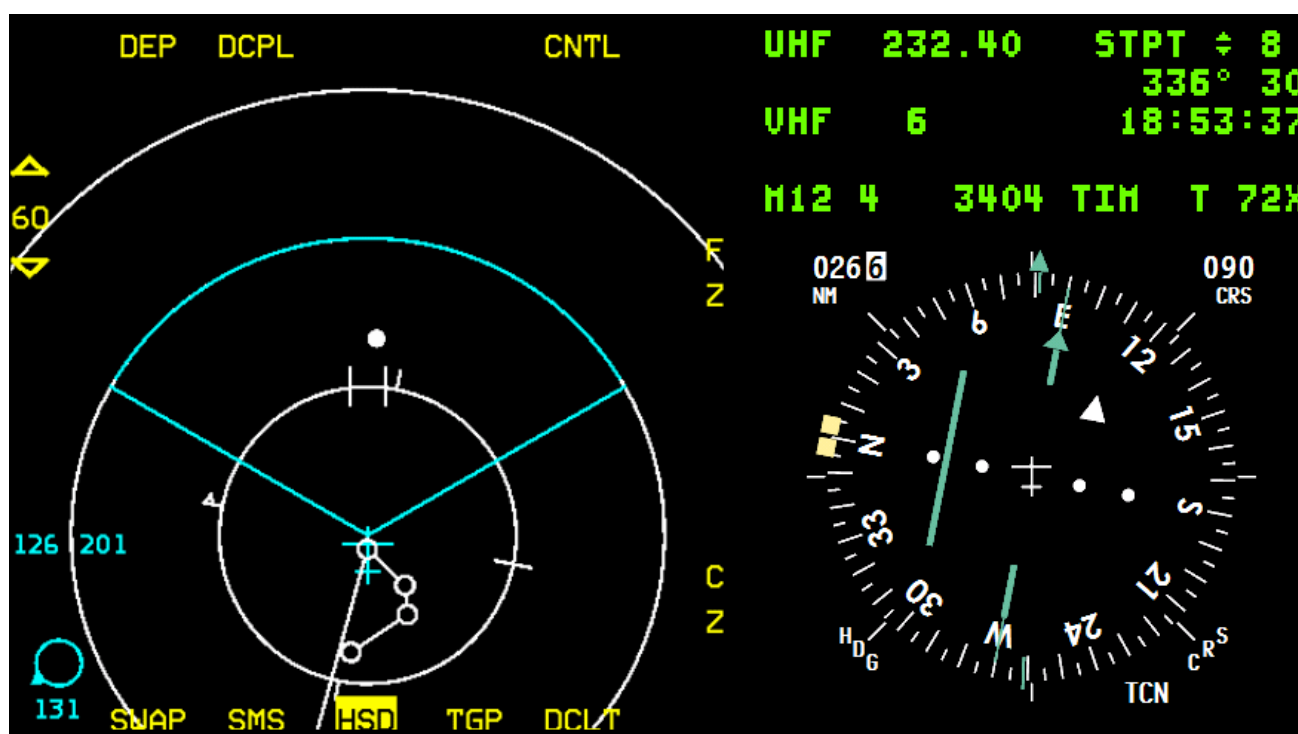
Let's imagine that the landing conditions at Taegu are below minima and we need to go to the alternate. You just declared going around on the tower frequency by selecting the "abort" option on the tower page of the ATC menu. Tower acknowledged your call and told you to recontact approach when able. Do that immediately to listen to what's happening around you but you don't need to specifically establish two way radio communication with them at this time as you will not land again at Taegu.

The radar chart has the missed approach procedure illustrated and you will follow it back to the IAF before proceeding to Pohang.

Climbing on the runway heading you accelerate and raise your landing gear. Reaching an altitude of 2000 feet you start a left turn direct to TAG tacan while continuing to climb to 6000 feet.

Passing the station you intercept radial 090° outbound TAG on your way back to Mikki.

Continue your climb past 6000 feet to get on top as soon as possible. Once past Mikki you may leave the Taegu approach frequency in favour of the tactical net or straight to Pohang approach which is 232.4 but don't contact them yet.



Pohang is due East at around 30 NM and you can fly there either by following your INS steerpoint set to your alternate (STPT #8) or by tuning Pohang tacan (72X) and following your EHSI set in TCN mode.

At the time of writing this chapter Pohang airbase does not have an ATC file in the DATA\Terrdata\ATC folder. The absence of a relevant file prevents the ATC from being able to provide vectors for an instrument approach. In these situations, ATC will always respond with a clearance for a VISUAL approach.

The other option you have is to request the ever-working unrestricted approach and fly the ILS 26 procedure until established on final for Runway 26. That is what we are going to demonstrate here.

To smartly prepare an IFR approach in flight I use the mnemonic WRIMTM (pronounced Rimtim), which stands for Weather – Radios – Instruments – Minima – Time and Missed approach. Normally with every item covered in the preparation you should decrease your chances to actually lag behind the airplane as you fly the approach.

Weather:

Punch the ATIS frequency (127.4) into the VHF radio and listen to the automated terminal information service.

Weather has cleared and Pohang is VFR. Active runway is 26 with minimal crosswind. You could plan for a visual approach but it's not really the purpose of this chapter so we will make an ILS 26 approach.

Radios:

Set COM1 to Pohang approach: 232.4 if you haven't done it yet. Get the preset or frequency for Tower (236.6) ready and input it into the UHF Backup radio.

Your COM2 is already set to Pohang ATIS 127.4, you may lower its volume as you're single ship and won't need the VHF to talk to your wingmen or simply select another frequency if you don't want to be bothered by the constant messages.

Tacan is set to 72X already. Input the ILS frequency for runway 26: 110.9.

Instruments:

Check that the EHSI is in TCN mode, set CRS to 030° considering we may overfly the tacan and then track R-030° outbound to the IAF. Quickly after that you will need to switch it to 065° as it's your leading radial to leave the DME ARC to intercept the localiser. Eventually you may input the coordinates of DAEBO (IAF) into the INS and fly direct without following the 030° radial from Pohang tacan.

Check that your ILS is ON.

Bug your Machmetre at 300 kts and set your heading bug as required.

Set cockpit lights as required.

A quick look at your engine gauges doesn't hurt either.

Minima:

ILS 26 has minima at 240 feet. Airport elevation is 37 feet.

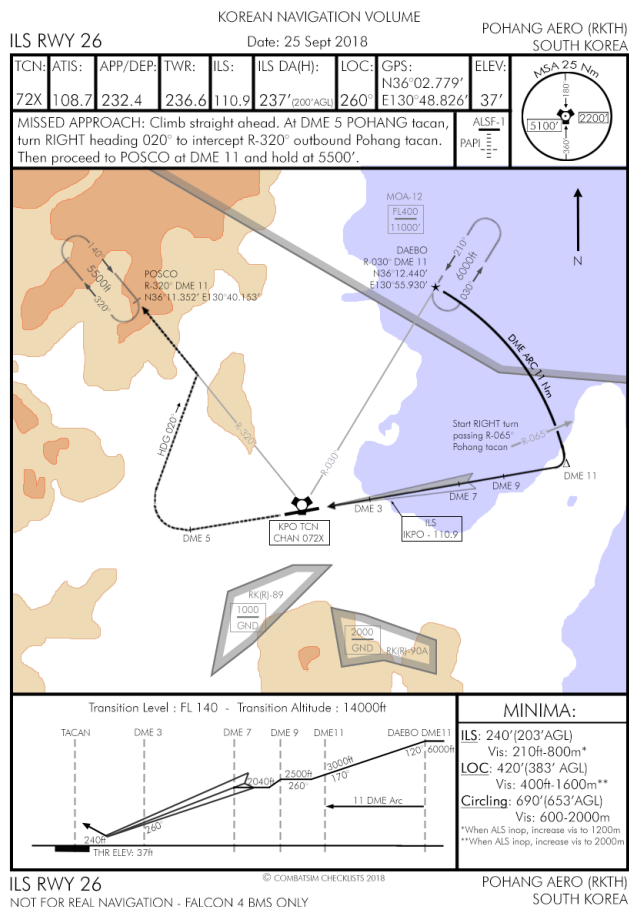
Time:

Timing the approach is not quite mandatory in BMS but if you like you can start your stopwatch at the IAF.

Missed approach:

It always starts with a climb! That's the bit you should know by heart.

The rest is on the chart but knowing how to start it without referencing the chart is a recipe for more success. In this case, a climb on runway heading to DME 5 then a right turn heading 020° (setting your heading bug as required – I hope you remember?)



For the sake of the exercise, let's input the coordinates of the IAF into the INS. The chart locates DAEBU at N36°12.440' E130°55.930'.

You know you can do it either with the STPT page (#4) or the DEST page (LIST #1). The difference is that with the steerpoint page, the steerpoint is active and with the destination page you can input the steerpoint coordinates and you will have to make it active afterwards. This is particularly important if for instance you are on command steering autopilot. If you use the STPT page and select a steerpoint (even not included in your INS flight plan), the autopilot will steer to its coordinates which by default are set to the North pole: 90°North, 0° East. In that case, it is always better to do it on the DEST page.

We're not on autopilot so let's make it with the steerpoint page:

Open your UFC STPT page (#4 STPT) and select Steerpoint #9 with either the ICP arrows or by punching 9 while the scratchpad is around the active steerpoint. Your INS flight plan has 8 steerpoints but you may assign new steerpoints in

your flight plan up to steerpoint #25 which by default is assigned to the active bullseye. Steerpoint 9 is the next available steerpoint and thus a perfect candidate.

Besides, if you select one of the actual flight plan steerpoints, the INS will draw lines between them and that may create a confusing image on your MFD. Selecting a non-used steerpoint avoids that because lines are not drawn in these cases.

Once steerpoint 9 is selected in the UFC, dobber down to place the scratchpad on the latitude line.

You must start by inputting N for North by pressing the ICP #2 key. (There is a small cardinal N on the bottom right of the key). The line changes then to a series of zeros.

Then input the latitude coordinates of DAEBU as they are given by the chart: 3612440. Before hitting the ICP ENTR key, check that the input line is correct.

Upon hitting the ENTR key the scratchpad will move automatically to the longitude line.

Start by pressing ICP key #6 for EAST and the line will again default to zero. Punch the longitude coordinates of the IAF: 13055930, check accuracy and then hit ENTR again.

If you notice a slight change in the coordinates at the end of the line (like 130 becoming 129) after input don't bother with it. The error is so minimal it is not a factor for navigation.

```
STPT 9 ÷ MAN
LAT*N 00°00.000'
LNG E 0° 00.000'
ELEV -0FT
TOS 00:00:00
```

```
STPT 9 ÷ MAN
LAT*N 36°12.440'
LNG E 0° 00.000'
ELEV -0FT
TOS 00:00:00
```

```
STPT 9 ÷ MAN
LAT N 36° 12.440'
LNG*E 130°55.930'
ELEV -0FT
TOS 00:00:00
```

The IAF is now steerpoint #9 and since this was done with the ICP steerpoint page the steerpoint is directly active. You may directly engage the autopilot in Command Steering mode to fly there.

As you see on your MFD set to the HSD page, a new steerpoint with no lines connected to it appeared close to the alternate steerpoint #8. The steerpoint is filled indicating it is the current steerpoint of interest. The location of steerpoint #9 related from the Pohang airbase seems correct.



The approach calls for a DME ARC at 11 NM from the IAF to intercept the runway axis. The DME ARC should start at 6000 feet with a right turn to a heading 120°.

Normally we reach the IAF on a heading of 030°, which creates a 90° turn to enter the DME ARC and we know that in such cases, we should lead our turns by about 3 NM when flying at speed of 300 kts.

In this case we are approaching DAEBO with a 60° heading, we will have to turn only 60° to enter the DME ARC with a heading of 120°. 60° being 2/3 of 90° we will lead the turn by 2/3 of 3NM, hence 2NM.

Before reaching the IAF, check the EHSI for TCN mode and set course to the leading radial (LR) of 065°. It is now time to initiate contact with Pohang approach and request an unrestricted approach. ATC will acknowledge your request and ask you to contact Tower on final. Bear in mind that during these approaches, ATC doesn't really monitor you and will not provide separation with other flights in the landing queue. You're on your own until you switch frequency to Tower.



Focus on the STPT info lines on your HUD and once you are at 2 NM from the steerpoint, initiate your right 60° turn and start flying the ARC DME. Once established on the ARC, the DME should read 11 NM in the EHSI, the bearing pointer is at the 3 o'clock position indicating that the tacan is abeam on your right and as you can see the leading radial of 065 has been set in the CRS window to provide a visual cue as to when to initiate our turn to intercept the localiser.



Switch the active steerpoint back to #8 which is your alternate landing point and check the HUD data for that steerpoint: The distance to the active steerpoint confirms the EHSI DME reading.

Another really interesting cue is the tadpole pointing to the steerpoint. As you can see, it's also pointing at the 3 o'clock position.

The trick to flying the ARCDME is to maintain both these visual cues at the 3 o'clock position; either the bearing pointer on the EHSI or the tadpole in the HUD.

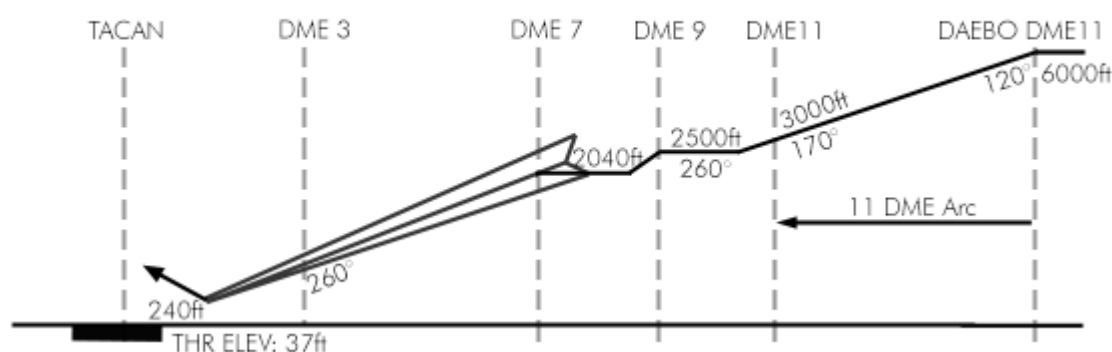
As you fly the ARC, you also decrease your altitude from 6000 to 2500 feet.

As you keep your 90° offset from the tacan, the leading radial 065° will start to move towards the centre of the EHSI. Once the CDI is centred, you are passing the specific point where you should start your right turn to intercept the localiser.





Transition Level : FL 140 - Transition Altitude : 14000ft



Once the glide centres and forms a nice cross with the localiser, lower your gear. Doing so will create a lot of drag and slow down the aircraft even more. Follow the glide using the -2.5° dashed line in the HUD and get to on speed AOA by placing the FPM just above the AOA bracket.

Switch your UHF radio to the tower frequency 236.6 and initiate contact with them with a report final call. There are no flights around so clearance should not be a problem to get. If you are outside the final approach cone, Tower will send you back to the approach controller. If you're too far away from final approach, the tower will ask you to report final. Once within 6NM Tower will clear you to land on Rwy 26.

Continue your controlled approach following the needles although the weather cleared and you have a good visual on the runway already. When approaching minima you should hear the inner marker which is the usual spot where you transition from flying instruments to landing visually.

Once you cleared the runway Pohang tower will switch you to Pohang ground frequency. Ask the controller clearance to taxi back to the ramp.

6. Credits and Sources

6.1 Credits:


- I want to thank first and foremost all the individuals having devoted their time to the flight sim we love most. It has sometimes been rough but you guys made a terrific sim.
- Thanks also to all the guys taking some time to send feedback on the BMS charts. You are too many to list you all but my heartfelt thanks go out to all of you. I still have to mention one guy in particular who spent a lot of time helping me improve the charts. Peter, many thanks.
- My squad mates who greatly helped test procedures and even create new charts: Many thanks Tom, Malc, Phil, Christos and Johannes.
- Thanks to JP, the guy behind all the new ATC stuff in 4.34. It's great to get feedback from the guy who wrote the code and it helped tremendously.
- And finally Many thanks to James "Nutty" Hallows who took the much needed time to proofread this document and tried to teach me proper English doing so. Many thanks James!!

6.2 Sources:


- Falcon 4 handbook
- RPx/SPx handbook
- F4-BMS_2.0-Manual
- CombatSim Checklists Navigation charts for Falcon: <http://www.combatsimchecklist.net/>
- Jeppesen Airway Manual Initiation.
- Jeppesen Instrument and Commercial Manual.
- Multi-Command-Handbook 11-F16.pdf
- ONC charts for Korea and Balkan
- Jeppesen charts for Korea and Balkan
- Korean AIP
- afman11-217


7. Glossary

AA T/R:	To track air emitters such as refuellers, the tacan needs to be set to Air-Air track and receive.
ADIZ:	Air Defence Identification Zone. A forward limit of national airspace.
AGL:	Above Ground Level: Altitude given above the ground.
AP:	Auto Pilot.
APRON:	Airbase parking.
ATC:	Air Traffic Control.
ATIS:	Automated Terminal Information Service.
CDI:	Course Deviation Indicator.
CRS:	Course.
DA:	Decision Altitude.
DCS:	The 4 way switch on the ICP.
DED:	Data Entry Display.
DH:	Decision Height. The height (height is always referring to vertical distance above ground) at which the pilot needs to transition from instrument flight to visual flight. At that point, the pilot needs to have visually acquired the runway to be allowed to continue the approach.
DME:	Distance measuring equipment. Gives the distance between your aircraft and the selected radio-navigation station.
ELEV:	Elevation – The height of the terrain above sea level (airports, structure).
FAF:	Final Approach Fix.
FIR:	Flight Information Region – airspace category around an ATC centre.
GS:	Glideslope: The horizontal beam of the ILS allowing the pilot to fly the correct slope (usually 3°) to the runway threshold.
GPS:	Global Position System: A system allowing precise navigation using 3 navigation satellites.
HAS:	Hardened Aircraft Shelter.
HDG:	Heading.
HSI:	Horizontal Situation Instrument. The main navigation instrument to track radials.



IAF :	Initial Approach Fix.
ICP:	Integrated Control Panel.
IFR:	Instrument Flight Rules.
IM:	Inner Marker.
IMC:	Instrument Meteorological Conditions – the IFR regime.
ILS:	Instrument Landing System. A radio beam to help pilots land on a specific runway in poor visibility. The beam is made of a horizontal radio wave to guide pilots onto the glideslope and a vertical wave to guide pilots onto the runway centreline (localiser).
LOC:	Localiser: the vertical beam of the ILS allowing the pilot to align his aircraft with the runway centreline.
LOS:	Line of sight.
LSO:	Landing Signal Officer.
MEF:	Minimum Elevation Figure.
MM:	Middle marker.
MOA:	Military Operation Area: a limited zone where military training exercise occurs (live firing, dogfights, artillery ...).
MRK BCN:	Marker beacon. Along the ILS track, we often find 3 markers (outer, middle and inner) that are limited radio emissions emitting vertically at set distances from the runway threshold. They are seen in the cockpit through the MRK BCN green light, next to the HSI that blinks at a specific frequency according to the overflown marker. (In civil aircraft, each marker has its own coloured light but in the F-16, the light is always green). An audible code is also emitted when overflying the marker.
MSA:	Minimum Safe Altitude.
MSL:	Mean Sea Level: Generally referring to altitude above sea level.
NDB:	Non Directional Beacon.
NOTAM:	Notice to Airman. Procedures are published for a certain period of time. Punctual hazards to navigation (and other) are mentioned in the NOTAM. Each pilot needs to give NOTAM proper consideration.
NM:	Nautical Mile.
OM:	Outer Marker.
PAPI:	Precision Approach Path Indicator. A row of 4 lights placed on the side of the runway to visually indicate the optimal glide slope. Lights can be either white or red depending on the position of the aircraft landing. Red means too low, white means too high. The correct glide slope is indicated when 2 lights are white and 2 lights are red.





PLS:	Precision Landing System.
RAD:	Radial.
RWY:	Runway.
SID:	Standard Instrument Departure. Heavy traffic airports need to despatch outgoing traffic in an orderly way. As such different routes are published and pilots are instructed by ATC to follow one or the other. That decreases the volume of communication between pilots and ATC during departure.
STPT:	Steerpoint. An INS waypoint entered in the flight computer.
TACAN:	TACTical Air Navigation system.
TRANS ALT:	Transition Altitude: The altitude where the local altimeter setting is changed to the universal altimeter setting (29.92 inch of mercury). From ground to Transition altitude, we refer to altitude in feet.
TRANS LEVEL:	Transition level. Above the Trans Level, we refer to altitudes in flight levels (20000ft = FL200). Descending from FL150 to 3500ft with a trans level of FL70, we will switch universal altimeter setting from 29.92 to local altimeter setting at FL70 (7000ft).
T/R:	Transmit/receive. In Falcon, the tacan needs to be set in T/R to track ground emitters.
TWR:	Control tower.
UFC:	Up Front Controller (ICP+DED).
UHF:	Ultra High Frequency.
VASI:	Visual Approach Slope Indicator: A Visual aid to gauge glideslope when landing visually. In Falcon, it's made of two rows of lights each side of the runway. The lights turn white to red depending on the aircraft position on the glideslope. Mnemonic: Red over white is alright - red is dead. I guess you get the picture.
VFR:	Visual Flight Rules.
VHF:	Very High Frequency.
VMC:	Visual Meteorological Conditions (as opposed to IMC = Instrument Meteorological Conditions).
VOR:	VHF Omni Directional Range.
VORDME:	Beacon combining the VOR and the DME.
VMC:	Visual Meteorological Conditions – the VFR regime.
WCA:	Wind Correction Angle.